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Professor Dr. Md. Abu Hadi Noor Ali Khan
Director
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Address of correspondence:
Director
BAU Research System (BAURES)
Bangladesh Agricultural University
Mymensingh-2202, Bangladesh

Cable:
Agrivarsity
Mymensingh
Bangladesh

Phone : (091) 67417
(091) 67401-7 Ext. 2036
Fax : 88-091-67417
Email : director.baures@bau.edu.bd

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FOREWORD

Bangladesh Agricultural University Research System (BAURES) is coordinating, organizing and monitoring all non-degree oriented research programmes undertaken by the teachers of this university. At present 380 projects are being carried out by the teachers and researchers in different disciplines of agricultural sciences. The annual review workshop is a regular process to present, discuss and evaluate the progress of researches carried out in the preceding year. I am very happy to know that the publication of the 30 volume of the Bangladesh Agricultural University Research Progress in the form of proceedings of the workshop held on 01 & 02 February 2020. This volume contains 441 abstracts of on-going/completed research projects conducted in the fiscal year 2018–2019. I am confident that the research findings documented in this report would be much helpful to the researchers working in the field of agricultural sciences.

I am taking the opportunity to congratulate the Principal Investigators/Project Directors and all other investigators/researchers of different research projects for presenting their research findings to make the workshop a success. My heartfelt thanks are due to the former Director of BAURES, Associate Director, BAURES, Dr. Paresh Kumar Sharma and Mr. Abul Hashem, Deputy Director, BAURES.

Special appreciation and thanks are expressed to the national and international donor agencies for funding and implementing the research projects under BAURES. Finally, the encouragement and supports extended by the honorable Vice-Chancellor of BAU are gratefully acknowledged.

Professor Dr. Md. Abu Hadi Noor Ali Khan
Chief Editor
&
Director
Bangladesh Agricultural University Research System (BAURES)
Bangladesh Agricultural University, Mymensingh, Bangladesh

EDITORIAL NOTE

Bangladesh Agricultural University Research System (BAURES) is responsible for the overall administration, supervision and implementation of the project-based research conducted by the teachers and researchers of different Faculties and Institutions of Bangladesh Agricultural University (BAU), Mymensingh. To a considerable extent, BAU funds research projects which has been increasing over the years by volume of grants and numbers. In the recent years, different domestic and international donor agencies are increasing funding opportunities for the research projects at BAU. The progress of the projects is evaluated as part of the monitoring and evaluation process of BAURES regularly, and the findings of the research projects are presented in the annual workshop held every year. The present volume of the proceedings includes abstracts of 441 research projects presented in the workshop held on 01 and 02 February 2020, where 181 projects were funded by BAURES and the remainder were funded the national and international donor agencies.

BAURES's activities are steadily growing due to the gradual increase of the research activities of eminent researchers of BAU. This is good news for Bangladesh that in Mujib Year and the 50th Year independent Bangladesh, various technologies are invented through agricultural research which are playing vital role in building Bangabandhu's Dream of Sonar Bangla. The aim of publishing this proceedings is to consolidate the information generated through hundreds of research projects conducted by the teachers, researchers and extension workers engaged in agricultural development of Bangladesh. This will be very useful for the researchers to generate further research ideas in an interdisciplinary fashion to tackle various challenges. This volume of the proceedings is edited by an editorial board consisted of intellectual expert members of six Faculties of BAU. We have tried our best to maintain the quality of the proceedings. However, suggestions are always highly appreciated regarding improvement and standard of the publication and our best effort will be continued for improving the standard of the proceedings.

I would like to extend my sincere thanks and appreciations to the contributors and the learned members of the editorial board for their kind cooperation and help in preparing, improving and proof reading of the manuscripts. I would also like to acknowledge and appreciate the help and efforts of Dr. Paresh Kumar Sarma, Senior Scientific Officer (SG), Mr. Md. Abul Hashem, Deputy Director and Mr. Md. Nazrul Islam, Computer Operator, BAURES for their sincere cooperation in publishing this proceedings.

Professor Dr. Mohammad Mahfujul Haque
Executive Editor
&
Associate Director
Bangladesh Agricultural University Research System (BAURES)
Bangladesh Agricultural University, Mymensingh, Bangladesh

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Faculty of Veterinary Science

CHAPTER II
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CHAPTER III
Faculty of Animal Husbandry

CHAPTER IV
Faculty of Agricultural Economics and Rural Sociology

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CHAPTER VI
Faculty of Fisheries

BAU Res. Prog. 30, 2019

Identification of a safe alternative fixative to formalin for study and research in Bangladesh

Ziaul Haque*, Md. Asabur Rahman[1], Mohammad Rabiul Karim, Md. Alamgir Kobir and Imam Hasan

Department of Anatomy and Histology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and [1]Faculty of Animal Science and Veterinary Medicine, Patuakhali Science and Technology University, Babugonj, Barisal 8210, Bangladesh, E-mail: zhaqueah80@bau.edu.bd

Abstract

Formalin has been used as the "gold standard" fixative for study and researches. But the students, academicians, researchers and employees in these settings may be at risk for high levels of exposure to formalin. To date, no ideal fixative has been found, i.e., a safe fixative that perfectly preserves cellular morphology and yet does not modify the specimen composition so as not to change the reactivity of the chemical moieties therein for subsequent detection. Fast fixation, optimal preservation of specimens and a safer workplace environment, are some of the advantages of alcoholic fixation over formalin fixation. Therefore, our present study was designed to examine the efficacy of presumably less toxic alcoholic fixative (modified EthMeth) as an alternative to formalin. Our gross study showed that it was faster in penetration of tissues than formalin, fixed tissues ideally as early as 8 hours of fixation whereas improper fixation was evident for formalin at that time. In hematoxylin and eosin (H & E) staining, cellular disintegration and weak affinity for staining were evident for formalin. But alcoholic fixatives preserved tissue architectures better than formalin. Our nucleic acid (DNA and RNA) analysis revealed that total genomic DNA and RNA yield and quality of the modified EthMeth fixed tissues were significantly higher ($p < 0.05$) than formalin fixed tissues (poor preserver). These results suggest that alcoholic fixative could be a safe alternative to formalin for faster fixation and preservation of tissues at cellular and sub-cellular level.

Efficacy of alcohol-based fixative as a potential substitute to formalin for preservation of tissues in Bangladesh

Ziaul Haque[1]*, Md. Asabur Rahman[1,2], Md. Zahirul Islam Khan[1], Md. Alamgir Kobir[1] and Ummay Ayman[1]

*[1] Department of Anatomy and Histology and Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and [2] Faculty of Animal Science and Veterinary Medicine, Patuakhali Science and Technology University, Babugonj, Barisal-8210, Bangladesh, *E-mail: zhaqueah80@bau.edu.bd*

Abstract

The search for formalin substitute has been evolved by two fundamental developments- it is hazardous and the fact that formalin does not assure a complete RNA recovery, essential to molecular biology now. Under these circumstances, the alternative may be alcohol-based fixatives. In our study, we used alcohol-based fixative (modified methacarn) as a 10% formalin substitute for fixation and preservation of tissues. Our gross study showed that alcohol-based fixative was faster in penetration of tissues than formalin. It fixed tissues (liver, spleen and brain) ideally as early as 8 hours of fixation whereas 24 hours for formalin. These results indicate better diffusion power of alcohol-based fixative in the tissues within shorter time. Microscopic examination of tissues stained with hematoxylin and eosin (H & E) revealed that alcohol-based fixative preserved better histo-architectures than formalin. Our molecular analysis (total RNA yield and quality) showed that alcohol-based fixative fixed tissues produced significantly ($p<0.05$) higher quantity of genomic RNA than formalin with superior quality. These results are suggestive that alcohol-based fixative could be a potential alternative to formalin for morphologic and molecular analysis of tissues in Bangladesh.

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Evaluation of non-formalin fixation for preservation of tissues in Bangladesh

Ziaul Haque[1]*, Md. Asabur Rahman[1,2], Md. Zahirul Islam Khan[1], Imam Hasan[1] and Tanjina Amin[1]

[1] Department of Anatomy and Histology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and [2]Faculty of Animal Science and Veterinary Medicine, Patuakhali Science and Technology University, Babugonj, Barisal-8210, Bangladesh

**E-mail: zhaqueah80@bau.edu.bd*

Abstract

Fixation is a crucial step in processing of tissue specimen for preservation of cellular architecture and composition of cells. We evaluated the performance of non-formalin fixatives (EthMeth and methacarn) and formalin as a comparator fixative in the research laboratory. Following 24 hours of fixation, tissue morphology and cellular details of the liver, spleen and brain were evaluated. Morphological characteristics were evaluated by gross observations and analyzing cellular details, tissue architecture and overall staining characteristics (hematoxylin and eosin). EthMeth and methacarn fixation gave generally comparable and satisfactory results on the tissue morphology and subsequent identification of tissue characteristics. Particularly, tissues were well preserved and all nuclear as well as cytoplasmic details were clearly visible. On the contrary, formalin fixed tissues showed some peculiarity such as improper fixation, mild shrinkage, and alterations of tissue components. Overall, the best performance among the fixatives was observed in case of methacarn. These results confirm that methacarn fixation is the superior alternative to formalin for preservation of tissue morphology. However, it is required to standardize the formalin-free methods and harmonize diagnosis in the laboratory worldwide.

Impact of growth rate on the characteristics of breast and thigh myo fibers in broiler chicken

Nasrin Sultana[1*], Ferdoushi Akter[2] and Marzia Afrose[3]

[1]Department of Anatomy and Histology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. [2]Dept. of Pharmacology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. and [3] Faculty of Life Science, Bangabandhu Sheikh Mujibur Rahman Science and Technology University, Gopalganj

E-mail : nsultana.bau@gmail.com

Abstract

Fifty day old "Cobb 500" broilers were randomly divided into two groups i.e. control and experimental groups. The control and experimental broiler were grown on homemade and commercial broiler type ration respectively to evaluate the morphology of muscle fibers at day 7, 14 and 28. The breast muscle weight is higher than the thigh muscle at day 28. The size of muscle fibers (length and width) is increased with age and largest size was found at day 28. The number of muscle fibers is decreased in both thigh and breast muscle fibers. The length and width of breast muscle fibers and cholesterol level data was recorded among the groups are statistically insignificant. Number of breast and thigh muscle fibers were positively correlated (r = 0.98 and 0.28) with body weight at day 28 of age. At day 28, the positive correlation was observed between the body weight and breast muscle fibers whereas the negative correlation was observed between body weight and thigh muscle fibers. A negative correlation (r = -0.81) was observed between the length of thigh muscle fibers and body weight of the birds at day 28 of sampling. A very weak correlation (r = 0.1) was found between body weight and cholesterol level at day 28. Breast muscle dimension is affected by the growth rate. The growth rate of

the broiler was positively correlated with the characteristics of breast muscle fibers whereas negatively correlated with the morphometric characteristics of thigh muscle. Morphometric dimensions of thigh muscle were negatively correlated with body weight. The blood cholesterol is independent with the growth rate of commercial broiler. The close association of breast muscle fibers with the body weight yield indicates the importance of taking into account of the breast depth estimates in genetic selection programs that pursue breast yield improvements.

Identifying deleterious effects of growth promoters in terms of blood profile and toxicity in liver of Broiler chicken

Nasrin Sultana*, Marzia Afrose[1] and Tanjina Amin
[1]Department of Anatomy and Histology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and
[1]Faculty of Life Science, Bangabandhu Sheikh Mujibur Rahman Science and Technology University, Gopalganj
**E-mail : nsultana.bau@gmail.com*

Abstract
The study was conducted to observe the effects of dexamethasone (DEX) on alterations of biochemical parameters (ALT, ALP and AST) and histomorphometry of liver in broiler. 90 day old chicks were collected and assigned to control, experimental group A and B. The control, group A and B were maintained with homemade ration, commercial broiler type ration and homemade ration with DEX (7mg/kg feed) respectively for 28 days. To measure the biochemical parameters, blood samples were collected at day 7, 14, 21 and 28 days of experiment and then serum samples were prepared by centrifugation method. Liver sample was collected from the individual bird after sacrificing at day 7, 14, 21 and 28 days. Morphometric (length, weight, color, texture) diversifications of the liver samples of broiler were examined carefully. Liver function test was performed by analyzing serum biochemical markers i.e. ALT, AST and ALP through spectrophotometer. Thin Layer Chromatography (TLC) was performed for the detection of steroid in liver. Histomorphological alterations were recorded with routine Hematoxylin & Eosin stain. The weight, length and width of the liver were increased numerically. The histo-architecture of liver was found normal in control group. Whereas, accumulation of fat, congested sinusoids and central veins were observed in liver of DEX treated groups. In biochemical analyses, the ALT level is significantly decreased in group B as compared to group A at day 14 ($p<0.05$). TLC evaluation revealed positive result i.e. presence of DEX in group A and B at day 28 of the experimental period.

Effects of Steroid Growth Promoter: Glucocorticoid on the Immune Organs of Broiler

Nasrin Sultana*, Alamgir Kabir and Tanjina Amin
Department of Anatomy and Histology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : nsultana.bau@gmail.com*

Abstract
Dexamethasone (DEX) is a steroid hormone. It is used as a growth promoter to enhance the growth of meat producing animals and birds. In broiler chicken, the body weight and weight of immune organs of birds is decreased. However, the alterations in the morphology and biometry of lymphoid organs due to the effects of DEX are limited in broiler chicken. Therefore, the aim of the current study was to examine the histological changes i.e. morphology and biometry of immune organs (Thymus, Spleen and Bursa of Fabricious) of broiler chicken in response to dietary DEX. The day old chicks were obtained from the commercial hatchery and randomly divided into two groups i.e. control and experimental or treated group. The control group was reared on commercial broiler ration and the

experimental group (n=25) was maintained on commercial broiler type ration with corticosteroid (Dexamethasone- Decason, BP 0.5mg, Opsonin @ 7mg/kg feed). Tissue samples were collected from the ten control and ten experimental broilers at each of the sampling days at day14 and 28. After processing (Standard procedure), the tissue sections were stained with routine Hematoxylin and Eosin. The biometric measurements of different histological structures of the lymphoid tissues were performed in micrometer by the calibrated stage micrometer. Finally, the data were analyzed using GraphPad Prism 8 software. The morphology of thymus, spleen and bursa of Fabricious did not show any abnormal alterations in DEX treated group of broiler chicken. The length and width of bursal follicle of bursa of Fabricious, thymic lobule of thymus and white pulp of spleen are statistically consisted but numerically decreased in DEX treated group as compared to the control group at day 14 and day 28 of experiment. A numerical decreased in the biometry of immune organs may indicate the apoptosis of immune cells in broiler chicken.

Effects of chronic exposure of 4G cell phone radiation in mice

Imam Hasan, Tanjina Amin and Mohammad Rafiqul Islam*

Department of Anatomy and Histology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : rafiqah77@yahoo.com*

Abstract

The aim of this study was to investigate the effects of 4G mobile phone radiation in mice. A twenty one 4-week aged male mice were divided into three groups; group A (control), group B (exposed 40 minutes daily for 60 days), group C (exposed 60 minutes daily for 60 days). Exposure of radiation was given from 4G connected mobile phones in an interactive call with the 2100 MHz frequency. The control group did not receive any radiation. After exposure, the behavioural study was performed in every week by using elevated plus maze tool. The hematological, biochemical and histological studies were performed after radiation exposure. The behavioural study showed that the frequency of time spent and entries into the open arms of plus maze was decreased while time spent in closed arms was increased significantly in exposed groups. The mean body weight of the exposed group was decreased significantly. The TLC and Hb% were increased significantly in 40 and 60 minutes exposed groups while the values of TEC was decreased significantly in 60 minutes exposed group. The ALT, AST, and Serum creatinine values were increased significantly in 40 and 60 minutes of exposed groups. Marked lymphocytic infiltration was found surrounding the bile duct and hepatic artery in the liver and lymphocytic infiltration with severe vascular congestion was found in the kidney of 60 minutes exposed group of mice. Irregular shapes seminiferous tubules, and fewer spermatogenic cells with larger lumen were found in some of the seminiferous tubules of exposed mice. The pyramidal neurons in the CA1 and CA3 area of hippocampus showed variable degrees of degeneration in 60 minutes exposed groups. The findings of this study indicated that excessive use of mobile phone radiation leads to damage the structural integrity of the hippocampal neurons which may lead to anxiety like behaviors as well as the deleterious effects on hematobiology, impairment of liver, kidney, and testis in mice.

Effects of Dietary Supplementation of Soybean and Canola Oil on Liver, Heart and Serum Lipids in Swiss Albino Mice

MA Sharif, Z Haque, Marya Afrin and MR Islam*

Department of Anatomy and Histology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : rafiqah77@yahoo.com*

Abstract

The experiment was conducted to study the effects of dietary supplementation of Soybean and Canola oil on liver, heart and serum lipidsin Swiss albino mice. Thirty male mice were randomly divided into

5 groups (n=6) as A, B_1, B_2, C_1 and C_2. Group A was considered as control by feeding rat pellet, group B_1 (25 ml/kg rat pallet) and B_2 (35 ml/kg rat pallet) were supplemented with Soybean oil and group C_1 (25 ml/kg rat pallet) and C_2 (35 ml/kg rat pallet) supplemented with Canola oil, respectivelyfor 63 days. The haematological parameters (TEC and Hb) and biochemical parameters (TSC, Tg, HDL and Uric acid) of Soybean oil and Canola oil-treated groups were increased significantly compared to the control group. The hematobiochemical parameters were significantly higher in soybean oil groups than control and canola oil groups. No gross changes were found in the heart and liver after treatment of mice. The mean weight of the heart and liver were found significantly higher in Soybean oil supplemented groups of mice. Histomorphological study revealed that lymphocytic infiltration was found in the cardiac muscle of the heart; congestion and enlargement of portal vein was found in both the Soybean (B_2) and Canola oil (C_2) supplemented groups of mice; increased Bowman's space was found in the kidney of Soybean oil group (B_2) of mice and epithelial cast was found in the kidney of Canola oil supplemented group (C_2) of mice. The dose of Soybean and Canola oil in mice may be harmful because different histopathological lesions were found in mice. Therefore, further studies with more duration and some other organs histomorphology may be conducted.

Effect of toxic contaminants and adulterants of food on liver and kidney of birds and risk on the human and animal health

M. Rabiul Karim[1]*, Munmun Pervin[2], Alamgir Kobir[1] and Imam Hasan[1]

*[1]Department of Anatomy and Histology, [2]Department of Pathology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail : mrabiulkarim@bau.edu.bd (MRK)*

Abstract

Now-a-day, toxic chemical contaminantsand adulterants of foods are a major concern for food safety of Bangladesh. Toxic chemical can find into the diet by several routes, notably toxic food contaminantslike formalin, calcium carbide and urea. Here, to investigate the histo-physiological alteration of liver and kidney following formalin(37-40% aqueous solution of formaldehyde) and urea contaminated feed exposurein pigeons.**<Methods>**Adult pigeons (n=18)were categorized as control group (supply normal feed), formalin exposed and urea exposed groupsfor oral exposure of feed containing formaldehyde(25 mg per kg feed)& urea(50mg per kg feed) thrice daily for 15 days through supplementary diet.**<Results>**The level of serum hepatic enzymes (AST, ALP) were significantly increased in formaldehyde and urea exposedpigeonsin compared with control pigeons. The liver and kidney weight and color were normal as like as control pigeons.Histological arrangements of parenchymal hepatocytes as hepatic cords and non-parenchymal cellsin liver of control pigeons was normal. However, liver of formaldehydeand urea exposedpigeons, coagulation necrosis with infiltration of large number of inflammatory cells around the portal vein was seen. In case of kidney, histo-architecture was normal in kidney of control pigeon, but narcosis with inflammatory cellswere found in the cortical labyrinths around the glomerulus of kidney of formaldehyde and urea exposed pigeons. The necrotic areas are larger with huge infiltration of inflammatory cells both in liver and kidney of formaldehyde exposed pigeons in compared to the urea exposed pigeons. **<Conclusions>** Low exposure of formaldehydeand urea in feed induced liver and kidney lesions in pigeons. It is suggested that special precautions might be taken to limit the occupational and environmental formaldehyde and urea exposure; and to prevent or minimize its contamination with food.

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Effect of lambda-cyhalothrin into the testes of rabbits (*Oryctolagus cuniculus*)

Mohammad Rabiul Karim*, Ziaul Haque, Alamgir Kobir, Asabur Rahaman and Imam Hasan

Department of Anatomy and Histology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : mrabiulkarim@bau.edu.bd*

Abstract

Cyhalothrin is a broad-spectrum insecticide for controlling major agricultural pests on crops as well as public health pests. Pesticides or toxic chemicals have become a part of our food chain, but it is very hard to escape its exposure especially in occupational exposure. The present study was to elucidate the toxic effects of lambda-cyhalothrin on the testicular tissues of rabbits. <Methods> Adult male rabbits were fed fresh green grass (as control) and lambda-cyhalothrin (Karate 2.5 EC® 100 ml bottle containing 2.8 gm) contaminated (1ml per liter water) green grass and vegetables with wash or without wash for one times every alternative day upto 7 days. <Results> Gross features of testis were found normal both in control and pesticides exposed rabbits. Histo-architecture and distribution of the different phases of spermatogenic cells in seminiferous tubules of testis were normal in control rabbits. Interestingly, separation of primary spermatocyte from spermatogonia and the number of spermatogenic cells reduced in seminiferous tubules of pesticides exposed rabbits. The lumen of the seminiferous tubules becomes large in pesticides exposed rabbits. <Conclusion> Morphological changes of seminiferous tubules and alteration of spermatogenic cell populations, may affect the reproduction of rabbits. Therefore, it is very alarming for public health if being exposed to these toxic food contaminants (pesticide) may suffer from the reproductive problem.

Histopathology of gonads in toxic food contaminants exposed pigeons

M. Rabiul Karim[1]*, Munmun Pervin[2], Imam Hasan[1] and Alamgir Kabir[1]

*[1]Department of Anatomy and Histology and [2]Department of Pathology, Faculty of Veterinary science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail : mrabiulkarim@bau.edu.bd (MRK)*

Abstract

Food contaminants have become a part of our food chain, but it is very hard to escape its exposure especially in life occupational exposure. Contamination of foods with toxic chemicals like formalin (37-40% aqueous solution of formaldehyde), carbide and urea pose a serious threat to public health in Bangladesh. Here, to investigate the histopathological alteration of male and female gonads following exposure of formaldehyde (25 mg @ kg feed) and urea (50 mg @ kg feed) contaminated feed in pigeons. <Results>The mean body weights of pigeons were not changed significantly in formalin and urea exposed pigeon in compared with control pigeons. The color and appearance of testis (male) and ovarian follicles (female) were found normal in all groups of pigeons. Histological examinations of the testis from control pigeon showed normal appearance of seminiferous tubules with normal arrangement of spermatogenic cells. In formalin-exposed pigeons, the irregular arrangement of spermatogenic cells were observed in seminiferous tubules. The lumen of the seminiferous tubules becomes large and numbers of spermatogenic cells reduced in the testis of formalin treated pigeons. In urea-exposed pigeons, abnormal arrangement of spermatogenic cells were observed in seminiferous tubules. The histopathological changes were severe in testis of formalin treated pigeon in compared with the urea treated pigeon. In case of ovary, the numbers of ovarian follicles are normal with regular distribution in ovary of control pigeons. The numbers of ovarian follicles become reduced with irregular shape in both formalin and urea-exposed pigeons. <Conclusions> Low exposure of

formaldehyde and urea via feed affect the spermatogenic cells populations in testes and ovarian follicles in female of birds, which suggesting that toxic chemicals may affect reproduction in birds as well as mammals.

Probiotic strain of Lactobacilli and its effect in Japanese quail

Marya Afrin[*], Nusrat Jahan[1], Sabbya Sachi[2]

*Department of Anatomy and Histology, [1]Department of Physiology and [2] Department of Pharmacology, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh-2202, *E-mail: dr.marya.afrin@gmail.com*

Abstract

Probiotic supplementation would be a one key strategy to replace the use of antibiotics in poultry diet. Therefore, evaluating the efficacy of probiotic is essential especially on Japanese quails. Thus the objectives of this study were to investigate the histomorphological alterations of liver and intestine, the concentration of intestinal micro flora and organic acids, the hematological (TEC, Hb, DLC, PCV and ESR) and serum biochemical parameters (AST, ALT, ALP, Bilirubin and Creatinine) and the level of oxidative stress (glutathione peroxidase) in blood of Japanese quails fed with probiotic. A total of 60, day old chicks were randomly divided into four equal groups (n=15). They were grouped as: I (control) fed with placebo-saline solution and homemade ration; II, III and IV were additionally supplemented with probiotic (10^8 cfu Lactobacilli/ml) at the rate of 0.1ml Lactobacilli/bird; 0.5ml Lactobacilli/bird and 1ml Lactobacilli/bird in saline solution for 56 days. The results indicated that the body weight gain of all treated groups (II, III and IV) were significantly ($P < 0.05$; $P < 0.01$) higher compared to control group. There were no morphometric and histological alterations present in control as well as all treated groups. The application of probiotic significantly ($P < 0.05$) increased the population of lactobacilli and enterococci in feces and cecum of quail ($P < 0.05$) and significantly ($P < 0.05$) decreased the counts of *E. coli* in feces in treated group IV. Lactic acid increased significantly ($P < 0.05$) in the group IV of quails where other acids were not significantly affected. TEC, DLC, Hb, PCV and ESR value didn't differ significantly among the control and all experimental groups. The AST level of group IV was significantly ($P < 0.01$) lower than group I, II and III. The ALT level of group IV was significantly ($P < 0.01$) higher than group I. ALP, creatinine, bilirubin and glutathione peroxidase values didn't differ significantly upon probiotic supplementation. The results obtained in this study notion that dietary inclusion of probiotic concerning the optimum dose (1ml Lactobacilli/bird) supported a superior performance of quails and can be applied as antibiotic growth promoter substitution in quails' diet.

Isolation and characterization of bacteria causing enterltis in Turkey (*Meleagris gallopavo*) and their antibiotic resistance profile

Md. Amirul Islam, Md. Tawyabur Rahaman Soukhin and Md.Tanvir Rahman*

*Department of Microbiology and Hygiene, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. *E.mail: tanvirahman@bau.edu.bd*

Abstract

Enteritis caused by *Salmonella* is a major problem for the poultry industries including Turkey. The present study was undertaken with the aim to isolate and identify *Salmonella* spp. from diarrhoeicTurkey (*Meleagris gallopavo*) birds. For this purpose a total of 40 fecal samples were collected from diarrhoeic Turkey birds of Bogra and Mymensingh district, Bangladesh. Isolation and identification of *Salmonella* spp. were done based on culture on *Salmonella* selective media namely

Xylose Lysine De-oxy-cholate (XLD) agar. Among these 40 samples 14 (35%) were found positive for *Salmonella*spp. All the seven isolates fermented dextrose, maltose andmannitiol produced both acid and gas and did not ferment lactose and sucrose and were also found motile in nature. Moreover, isolation was confirmed by molecular detection e.g., by PCR using *Salmonella* genus specific primers *inv*A amplifying 796 bp amplification size. Phenotypically all the isolates tested were found sensitive to ciprofloxacin and imipenem. Maximum sensitivity was also noticed against nalidixic acid, while all the isolates were resistant to erythromycin, chloramphenicle, tetracycline, knamycin, azithromycine and colistinesulphate. Detail further studies are required to reveal the molecular basis of resistance in the isolated *Salmonella.*

Prevalence and characterization of antibiotic resistant *E. coli* and *Salmonella* spp. in dairy cattle and farm environment having potential public health significance

Md. Abdus Sobur, Mohammad Ferdousur Rahman Khan and Md.Tanvir Rahman

Department of Microbiology and Hygiene, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh.
**E-mail: tanvirahman@bau.edu.bd*

Abstract

Antibiotic resistance is one of the most significant public health challenge of this century globally. Infections with multiple antibiotic-resistant bacteria have been increasing at an alarming rate owing to the widespread dissemination of antibiotic resistance determinants. The present study was carried out to identify the occurrence and distribution of antibiotic resistant *E. coli* and *Salmonella* in various samples (Cow dung, milk, milker's hand wash, soil, water and vegetables) of dairy farms in Mymensingh area that could be potential threat to human and animal health. A total 90 samples were collected from four dairy farms of Mymensingh, Bangladesh. Identification and characterization of the isolated *E. coli* and *Salmonella* were carried out based on morphology, staining, cultural and biochemical properties followed by molecular detection (PCR). All the samples were *E. coli* positive. Among the three water samples two were found positive for *Salmonella* originated from Research Animal Farm and BAU Dairy Farm. On the other hand all the water samples of Dairy Farm in Boira and Sutiakhali were *Salmonella* negative. All other samples were *Salmonella* positive. The positive isolates were subjected to antibiogram profile against 12 commonly used antibiotics by disc diffusion method. *E. coli* and *Salmonella* of all farms were 100% resistant to erythromycin except *E. coli* of Research Animal Farm which showed 93.3% resistant to erythromycin. In Research Animal Farm 10% *E. coli* were resistant to gentamicin. However, more than 75% *E. coli* and *Salmonella* isolated from various farms were sensitive to gentamicin. On the other hand all (100%) *E. coli* and *Salmonella* of all farms were resistant to azithromycin, ertapenem and oxacillin. From this study it could be concluded that dairy farm and farm environments harbors antibiotic resistant *E. coli* and *Salmonella* that could transmit to human and possess a threat for human health.

Seroprevalence of *Mycoplasma gallisepticum* in layer chicken in selected areas in Bangladesh

Md. Muket Mahmud, Md. Shafiqul Islam, and Md. Tanvir Rahman*

Department of Microbiology and Hygiene, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh.
**E-mail: tanvirahman@bau.edu.bd*

Abstract

Mycoplasma gallisepticum is an important poultry respiratory pathogen and the etiology of chronic respiratory disease. The aim of this study was to determine the seroprevalence of *M. gallisepticum* in

layer and indigenous chicken in selected areas in Bangladesh as well as its isolation. A total of 216 samples were collected from layer chicken and 23 from indigenous chicken and analyzed by rapid slide agglutination test for the determination of seroprevalence of *M. gallisepticum* using commercially available antigen. Among these 216 layer samples 76 were found positive ***i.e.,*** 35.18% seroprevalence. On area basis the seroprevalence was 36.95% in Mymensingh and 33.87% in Gazipur in layer chicken. On season basis the seroprevalence in layer chicken was 24.17% in summer and 43.20% in winter. In addition, a total of 23 indigenous chicken samples were also tested of which seven were found positive for *M. gallisepticum* (seroprevalence 30.43%). Several attempts were also taken for the isolation of the *M. gallisepticum*, but none were successful. Present study found wide spread occurrence of *M. gallisepticum* in layer and indigenous chicken in study areas. Further work is going on for further seroprevalence of *M. gallisepticum* and its isolation.

Isolation, identification and characterization of bacterial pathogens in bioslurry from different biogas plants of Gazipur and Mymensingh districts of Bangladesh

Sukumar Saha*, Md. Ashraful Islam and Md. Tanvir Rahman
*Department of Microbiology and Hygiene, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. *E.mail: sukumar.saha@bau.edu.bd*

Abstract
The study was aimed to isolate, identify, and characterize common indicator bacteria, including *Escherichia coli*, *Salmonella* spp., and *Staphylococcus* spp. in manure and bio-slurry samples of different livestock farms and biogas plants of Bangladesh. A total of 114 samples of manure and bio-slurry were collected from different livestock farms and biogas plants in Bangladesh. The total viable count (TVC), *E. coli*, *Salmonella* spp., and *Staphylococcus* spp. counts were determined by the spread plate technique method. Isolation and identification were performed by colony characteristics, staining, biochemical tests, and, finally, by using PCR. Antibiotic susceptibility test of the isolated bacteria was tested against commonly used antibiotics by using the disk diffusion method. The mean TVC, *E. coli*, *Salmonella* spp., and *Staphylococcus* spp. counts were ranged from 8.19-10.75, 5.2-6.96, 5.81-6.87, 5.68-7.68 in manure samples and 7.26-8.65, 3.82-5.2, 4-5.54, 3.14-5.9 log cfu/gm in bio-slurry, respectively. In anaerobic digester after 30 days digestion, the presence of *E. coli*, *Salmonella* spp., and *Staphylococcus* spp. varied from 0-5.11, 0-4.84, and 0-5.59 log cfu/gm at 25°C, 27°C, 29°C, and 45°C temperature. Above-mentioned bacteria were absent in bio-slurry collected from anaerobic digester after 60 days digestion at environmental temperature. Bacterial counts were reduced significantly in both household slurry pits and experimental anaerobic digester. Antibiotic susceptibility results revealed that multidrug-resistant indicator bacteria were present in the bio-slurry samples. Our findings conclude that the microbial load after treatment of animal manure via anaerobic digestion (Biogas plant) was grossly reduced and the reduction of bacterial pathogen depends on the duration and temperature of digestion.

Detection of avian pathogenic *E. coli* (APEC) in the layer farms and their antibiogram profile

Samina Ievy, Mohammad Ferdousur Rahman Khan and Md. Tanvir Rahman*
*Department of Microbiology and Hygiene, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh, *E- mail: tanvirahman@bau.edu.bd*

Abstract
Antibiotic resistance is a global health crisis. Here we investigated the role of layer farms in harboring and dissemination of antibiotic resistance bacteria in the environment having public health impact. So

far a total of 99 samples comprising feces, air, tracher, intestine, liver, lung and yalk samples were collected from five layer farm. *E. coli*, *Salmonella* and *Staphylococcus* were the most common isolates. Out of 99 samples 82(82.82%) were found positive for *E. coli.* Among the 82 *E. coli* tested 36 (43.90%) were avian pathogenic *E. coli* (APEC) of which 7 were positive for *fimC, iucD* and *papC* genes specific for APEC. In addition, 18 of the isolated *E. coli* were found positive for any of the two APEC genes and 11 for any of the 1 APEC specific gene. The overall prevalence of APEC was 36.66%. From the antibiogram study it was evident that all the APEC isolates were resistant to ampicillin, 38.88% to norfloxacin, 36.11% to tetracycline and chloramphenicol, 33.33% to enrofloxacilin, 13.88% to streptomycin, 11.11% to ciprofloxacillin and 2.77% gentamicin. About 5.55% isolates were resistant to colistin. Further analysis is going on for detail molecular characterization of the isolates.

An epidemiological investigation of bovine genital campylobacteriosis of bulls in Mymensingh

S. M. Lutful Kabir

Department of Microbiology and Hygiene, Bangladesh Agricultural University,Mymensingh-2202, Bangladesh
E-mail: lkabir79@gmail.com

Abstract

This study was aimed for the isolation, identification and characterization of *Campylobacter fetus* and *Campylobacter jejuni* from different age groups of post-pubertal bulls in Mymensingh during the period of January to December, 2018. A total of 100 preputial samples were collected from different age groups of post-pubertal bulls in Mymensingh for the isolation and identification of *Campylobacter fetus* and *Campylobacter jejuni* by using cultural, biochemical and molecular methods. Moreover, the isolated *Campylobacter* species were subjected for antimicrobial susceptibility test. *Campylobacter* like organisms were presumptively identified in 18 samples. Isolates were biochemically positive to catalase and oxidase tests and in hippurate hydrolysis test all isolates (n=18) shown positive that indicated the isolates were *C. jejuni*. *Campylobacter* specific 16S rRNA genes were amplified from the isolates. *C. jejuni* were resistant to amoxicillin, erythromycin, azithromycin and susceptible to gentamicin, ciprofloxacin, norfloxacin and streptomycin. To the best of our knowledge, this study has brought the first report on the occurrence of *Campylobacter jejuni* with their antibiogram profiles in bulls of Bangladesh.

Analysis of mycotoxins in food grain samples

S. M. Lutful Kabir

Department of Microbiology and Hygiene, Bangladesh Agricultural University,Mymensingh-2202, Bangladesh
E-mail : lkabir79@gmail.com

Abstract

The present study was conducted to detect total aflatoxins in different food grains by applying direct competitive enzyme-linked immunosorbent assay (ELISA). A total of 252 different food grain samples (including Masoor Dal, Sola, Solar Dal, Motor, Motor Dal, Motor/Kabuli, Buter Dal, Khesari, Mas Kalai, Mug Dal, Bhutta, Wheat, Badam, Falone Dal, Anchor Dal and Danpich) were collected from local shops of different district in Bangladesh. To analyze those samples, "The AgraQuant® Total Aflatoxin Assay 1/20 kit" were used and samples preparation and analysis were done by following standard procedure provided with kit. A total 94 (37.30%) of 252 food grain samples were positive for total aflatoxin in this study where level of the content of total aflatoxin were 1.0 ppb to 18.0 ppb. All samples were found safe for human and animal food but content of total aflatoxin in some samples of

Badam and Mug Dal and wheat showed slightly higher than others samples and this is because the presence of aflatoxins near the limits has a serious bearing on the safety and ultimately can reduce the quality and Marketability of food products. So it is necessary to monitor and control contamination of these staple food and commodities from aflatoxins in both domestic and international trade.

Analysis of antibiotics in raw red meat from Dhaka retail markets

S. M. Lutful Kabir
Department of Microbiology and Hygiene, Bangladesh Agricultural University,Mymensingh-2202, Bangladesh
E-mail : lkabir79@gmail.com

Abstract

The major objective of this study was to determine the residue level of ciprofloxacin, oxytetracycline and sulphonamide antibiotics in targeted meat samples such as beef, chevon, beef kidney and liver. In this study, a total 90 different red meat samples including beef, chevon, beef liver, beef kidney were collected from different local markets in Dhaka city and then samples were transported to the Food Hygiene and Public Health Laboratory at Department of Microbiology & Hygiene, Bangladesh Agricultural University, and finally samples were processed and analyzed for detection of antibiotics residues using AgraQuant® Ciprofloxacin Assay Competitive ELISA kit and AgraQuant® Sulfonamides Assay Competitive ELISA kit for ciprofloxacin and sulfonamide respectively. In addition, presence of oxytetracycline in red meat was analyzed using TLC, then content of oxytetracycline in TLC positive samples were measured using HPLC. Out of 90 red meat samples, 45 (50%) samples were found to contain antibiotics residue (positive) in antibiotics residue test. The findings of this study may be indicative of the inappropriate use and management of veterinary drugs by livestock keepers. This is very concerning matter for human health because consumption of antibiotics residue meat may develop multidrug resistance in human body. We therefore recommend strict regulation of the use of veterinary drugs in the livestock industry as well as the inspection of livestock products prior to marketing.

Epidemiological investigation on zoonotic tuberculosis and campylobacteriosis associated with dairy farming practices in the selected districts of Bangladesh

S. M. Lutful Kabir
Department of Microbiology and Hygiene, Bangladesh Agricultural University,Mymensingh-2202, Bangladesh
E-mail : lkabir79@gmail.com

Abstract

The purpose of this study was to isolate, identify and characterize *Campylobacter* species from different samples of dairy farms and from human diarrhoeal samples. The present study was also aimed to investigate Guillain-Barre´ Syndrome-Related *Campylobacter jejuni* in Bangladesh. This study has also design to estimate the prevalence, isolation, identification and characterization of *Mycobacterium orygis* in Bangladesh as a potential cause of cattle TB that contributing to zoonosis in Bangladesh. A total 591 different types of samples were tested where 68 samples of dairy farms, 43 bull samples and 58 human diarrheal samples were positive for *Campylobacter* spp. A total of 40 blood samples were collected from patients with neurological disorders for the investigation of Guillain-Barre´ Syndrome-Related *Campylobacter jejuni* in Bangladesh. Farmer's training module was developed. The progress in this reporting period mostly the activities relating to routine surveillance sample collection from nodulated vital organs (lung and liver) of slaughtered carcasses and also post-

mortem samples of dairy farms to find out the causative agent. In combination with screening in cattle handlers and butchers were conducted for collection of sputum to find out the causative agent having zoonotic importance. Other planned activities viz. epidemiology of TB in dairy farms in terms of prevalence, transmission, and risk factor analysis along with molecular characterization, whole genome sequencing of the isolated new species of *Mycobacterium* (such as *M. orygis*) were not accomplished in this reporting quarter due to delay supply of chemicals and reagents. However, preparatory activities had been finished towards fulfillment of undone objectives by the 2nd half year. This project may ensure to reduce the burden of heavy economic losses due to the occurrence of zoonotic bacterial diseases particularly bovine tuberculosis and campylobacteriosis in Bangladesh all over the year.

Isolation, Identification and Antimicrobial Susceptibility of *Listeria monocytogenes* Isolated from Milk, Poultry meat and Meat products

Md. Omor Faruk, Md. Ariful Islam, Mst. Minara Khatun*

Department of Microbiology and Hygiene, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: mmkhatun@bau.edu.bd*

Abstract

L. monocytogenes has been considered an emerging public health problem because of its pathogenicity and ability to grow on both raw and cooked meat at refrigerating temperature. The purpose of this study was to isolate, identify and antimicrobial susceptibility of *Listeria monocytogenes* in raw and frozen milk, raw and frozen poultry meat and meat products. A total of 60 samples such as raw milk (n=15), frozen milk (n=15), raw poultry meat (n=10), frozen poultry meat (n=10), frozen chicken meat ball (n=5) and chicken burger (n=5) were collected from four different places such as K-R market, BAU dairy farm, Seshmore bazar and Iqbal's dairy farm at Mymensingh town. Samples were cultured onto *Listeria* selective PALCAM agar to isolate of *L. monocytogenes*. In this agar, *Listeria* spp. produced black zone around the colonies. Different types of test like Gram's staining, motility test, CAMP test, hemolysis test, biochemical test (Catalase, Voges-Proskauer, Methyl red and Indole) and sugar fermentation test (Dextrose, Sucrose, Mannitol, Lactose, Maltose and D-xylose) were conducted to confirm *L. monocytogenes*. Antibiotic sensitivity test was performed against ten antibiotics such as ampicillin, vancomycin, gentamycin, streptomycin, cefixime, cefalexin, norfloxacin, colistin, erythromycin and amikacin by using the disc diffusion method. The prevalence of *L. monocytogenes* of different samples was 26.67% in raw milk, 0% in frozen milk, 30% in raw poultry meat, 0% in frozen poultry meat and not detected in meat products. The place wise prevalence was 13.33% in K-R market, 15% in Seshmore bazar, 0% in BAU dairy farm and 0% in Iqbal's dairy farm. All *L. monocytogenes* isolates were found to be sensitive to amikacin, gentamycin, vancomycin, streptomycin, norfloxacin and resistant to ampicillin, cefixime, cefalexin, colistin and erythromycin. Data of this study indicates the presence of multidrug resistant *L. monocytogenes* in milk, poultry meat and meat products which may cause public health hazard.

Prevalence and Molecular Characterization of Shiga toxin Producing *Escherichia coli* in Poultry and Their Products in Bangladesh

Mst. Minara Khatun[1*], Md. Faiyaz Ahmed[1], Md. Sirajul Islam Ashek[1], Md. Latiful Bari[2], Md. Ariful Islam[1]

*[1]Department of Microbiology and Hygiene, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and [2]Principle Scientist, Food Analysis and Research laboratory, Center for Advance Research in Sciences, University of Dhaka, Dhaka, Bangladesh, *E-mail: mmkhatun@bau.edu.bd*

Abstract

Shiga toxin-producing *Escherichia coli* (STEC) are an *important* cause of *food borne* illness worldwide. This study was designed to determine the prevalence of shiga toxin producing *E. coli*, their

serogroups and antimicrobial susceptibility profile in poultry and their products. Cloacal swabs (n=180), egg washing (n=60) and poultry meat samples (n=60) were collected from four major live bird markets. Samples were streaked onto Eosin Methylene Blue agar and incubated at 37°C for 24 hours for isolation of *E. coli*. Shiga toxin (*stx*) producing *E. coli* were identified by detecting *stx1* and *stx2* genes by PCR. Serogrouping of *E. coli* was performed targeting *rfb*, *O26*, *O45* and *O111* genes by PCR. Antibiotic susceptibility of *stx* producing *E. coli* was determined against eight antibiotics by disc diffusion method. A total of 159 culture positive isolates were confirmed as *E. coli* by API 20E system and 16sRNA specific PCR. The prevalence of *stx1* and stx2 genes was 21.38% and 5.66%, respectively. On the contrary, the prevalence of *rfb O157:H7, O26, O45* and *O111* were 5.66%, 8.81%, 6.92% and 3.14%, respectively. *E. coli* was found sensitive to amikacin (57.7%), azithromycin (61.54%), norfloxacin (73.38%) and resistant to colistin (100%), cephalexin (100%), ciprofloxacin (100%), neomycin sulphate (84.62%) and erythromycin (88.47%). Data of this study indicate that poultry and poultry products were contaminated with multidrug resistant *stx* producing *E. coli* which may cause public health hazard if enter into the human food chain. These results underscore the need of implementation of good biosecurity practices in poultry production chain.

Prevalence and Characteristics of Bacteria in Ready to Eat (RTE) Foods in Mymensingh Cities of Bangladesh

Fateha Akther Ema, Md. Ariful Islam and Mst. Minara Khatun*

Department of Microbiology and Hygiene, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: mmkhatun@bau.edu.bd*

Abstract

Ready to eat foods are widely used at home, restaurants and festivals. The present study was undertaken to determine the prevalence and antibiotic sensitivity of the bacteria obtained from ready to eat foods of Mymensingh cities. A total of 100 ready to eat foods were collected from different super markets. Microbial quality of ready to eat foods were assessed by total viable count (TVC), total coliform count (TCC), total staphylococcal count (TSC) and total listeria count (TLC). Samples were inoculated onto Eosin Methylene Blue (EMB) agar, Mannitol Salt (MS) agar, Salmonella-Shigella (SS) agar and PALCAM agar. Isolation of bacteria was performed by colony morphology and Gram's staining. Identification of bacteria was confirmed by biochemical and molecular methods. The TVC in Chicken roll, Chicken meat loaf, Chicken fry, Burger, Pizza, Sandwich, Salad Vegetables, Ice-cream, yogurt and milk shake samples were 5.30±0.50, 5.58±0.40, 4.20±0.25, 4.47±0.50, 5.78±0.40, 5.20±0.40, 5.10±0.20, 5.86±0.37, 5.10±0.30, 5.20±0.40 and 5.64±0.35 mean log CFU±SD/ml respectively. The TCC were 2.20±0.10, 2.37±0.45, 3.20±0.30, 2.36±0.50 mean log CFU±SD/ml in chicken roll, Chicken meat loaf, Burger and Salad Vegetables. The TSC in Chicken meat loaf, Sandwich and Salad vegetables were 2.43±0.40, 2.23±0.20, 2.40±0.35 mean log CFU±SD/ml respectively. The TStC in Chicken roll, Chicken meat loaf, Chicken fry, Burger, Pizza, Sandwich, Salad Vegetables, Ice-cream, yogurt and milk shake samples were 3.20±0.24, 4.50±0.40, 3.22±0.35, 4.20±0.34, 3.32±0.40, 3.85±0.40, 4.24±0.51, 2.84±0.40, 2.14±0.50 and 3.24±0.30 respectively. The TLC was 2.20±0.40, 3.10±0.20, 2.25±0.30 and 2.34±0.30 in Burger, Pizza, Salad vegetables and Milk shake samples respectively. Staphylococci were sensitive to Cefalexin, Vancomycin, Gentamicin, Ciprofloxacin and resistant to Ampicillin. *E. coli* were sensitive to Gentamicin and Ciprofloxacin and resistant to ampicillin, penicillin G and cephalexin. Listeria spp. was sensitive to Cefalexin, Vancomycin, Gentamicin, Ciprofloxacin and Doxycycline and resistant to Penicillin G, Ampicillin and Amoxycillin. Data of this study suggest that ready to eat foods carry multidrug resistant bacteria which may cause public health hazard.

Development and Validation of Vaccine Candidates for the Control of Bacterial Mastitis in Dairy Cattle of Bangladesh

Md. Abdus Sattar Bag, Sadia Afrin Punom, Md. Shafiqul Islam, Md. Shahidur Rahamn Khan and Jayedul Hassan*

Department of Microbiology and Hygiene, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: dr_jahid@bau.edu.bd*

Abstract

Dairying is considered a strong tool to develop a village micro-economy in Bangladesh in order to alleviate rural poverty and improve rural livelihoods. The almost total demand of milk for human consumption as well as dairy products industry of the whole country fully depends on dairy cattle raisers. Mastitis has been identified as one of the limiting factors in the development of a dairy industry in Bangladesh. The objectives of the present project were to develop and validate vaccine candidates for the control of bacterial mastitis in dairy cattle of Bangladesh. For this, milk samples from healthy dairy cattle at commercial/government and individual households' level were collected for the prevalence of subclinical mastitis using CMT kit. The clinical samples (milk) were also collected for the isolation and identification of the bacteria. Out of 360 samples collected from Mymensingh, Baghabarighat area and Savar dairy farm, 157 were tested positive by CMT kit. The overall prevalence of subclinical mastitis was 44%. The area wise overall prevalence of subclinical mastitis was 48%, 44% and 55% at Mymensingh, Baghabarighat area and Savar dairy far,m respectively. Positive samples were exposed to cultural examination in different bacteriological media for the isolation and identification of bacteria possibly associated with mastitis. *E. coli, Staphylococcus* and *Corynebacterium* were isolated and identified using cultural, staining and biochemical tests. Molecular characterization of the isolates is on progress.

Development of BHK-21 cell based chip for electrochemical detection of FMD virus infection

Kumar Jyotirmoy Roy, Aminur Rahman, Md. Ashikur Rahaman, Md. Shafiqul Islam amd Md. Abdul Kafi*

Department of Microbiology and Hygiene, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: makafi2003@bau.edu.bd*

Abstract

A cell chip based electrochemical detection has currently been attracted much attention because of its excellent suitability as rapid and label free diagnostic platform. The cell based chip employs establishment of living cell on a conductive platform for detecting electrochemical readout signal and thus design and fabrication of such cell chip depends on cellular attachment on a conductive platform where it monitors changes of cellular behaviors. In this research, a 3D chamber composed of PDMS with a dimension of $1\times1\times0.5cm^3$ was created and affixed with an ITO substrate ($2\times2cm^2$) for holding cell culture medium for maintaining living cell on it. Prior to cell seeding, the chamber was treated with 0.1M RGD solution for various period of time (2-10h). Then BHK-21 cells were installed from the frozen stock and seeded and maintained in the chip chamber using DMEM supplemented with 10% FBS, 1% Pen-strep antibiotic solution in a standard cell culture incubator providing 37^0C temperature with 5% CO_2 and 70% humidity for various experimental period ranging from 24 to 96h for attaining the maximum confluency of cell growth. The cellular morphology was investigated using phase contrast microscopy along with determination of cell viability using Trypan blue exclusion method.

The results revealed various period of RGD treatment showed influence on cellular attachment on the chip surface, where 10h RGD treated chamber showed highest cell adhesion and proliferation. Afterwards the 10h RGD treated chip was subjected to evaluate confluency of cell growth against post seeding periods. The result revealed confluency ≤50%, ≥90%, ≤70% and ≤50%, was achieved in 24, 48, 72 and 96h post seeding respectively. Hence the 10h RGD treated chamber at 48h post seeded BHK-21 cell was utilized as cell chip for investigating FMD virus infection electrochemically.

An Integrated approach to develop an anthrax-free model area in Bangladesh

Md Shahjahan Ali Sarker[1], Md. Muket Mahmud[1], Ajran Kabir[1], Md Ahosanul Haque Shahid[1], Md. Asaduzzaman Sarker[2] and KHM Nazmul Hussain Nazir[1*]

*[1]Dept. of Microbiology and Hygiene and [2]Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail : nazir@bau.edu.bd*

Abstract

In this study, an attempt was made to apply the extension works to improve the public knowledge, attitude and practice on the anthrax control program. An integrated approach was installed for educating the local community on anthrax transmission and prevention, control phases such as real-time surveillance, animal vaccination including mass awareness creation and motivation that was helped and thereby facilitate early detection, control, and prevention of anthrax outbreaks. Questionnaire survey results have indicated that the majority of the community members (97.5%) were aware of the nature, occurrence, public health importance and management of the disease. The attitude toward the slaughtering of the sick animals was reduced (<30%). The attention of local administration and law enforcing agencies markedly focused on that issue. One the other hand, Vaccination, and clinical record reveal that the vaccination coverage was increased from 40% to 85% and the explored of sick animals have been increased from 30% to 40%. However, the poor economic backgrounds together with the dispersed settlement nature of the farmers were the main identified gaps that have continued to force them to slaughter infected animals, sell their products and hide the information that demands a future focus. Based on findings, it can be concluded that this integrated approach continues to work for two years a model would develop and that model can be used in the other parts of Bangladesh as well as a similar geographic area like India, Nepal and other south Asian countries.

Epidemiology of diarrhea in goats caused by bacteria and its control measures

Farid Hossain, Rabeya Sultana, Fahima Akter, Sarbani Biswas, Tajkira Jahan and Md. Ariful Islam*

Department of Microbiology & Hygiene, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: islamma@bau.edu.bd*

Abstract

The present study investigated the epidemiological parameters of bacterial diarrhea in goats and selection of most appropriate antibiotic to treat bacterial diarrhea. A total of 250 fecal samples were collected from goats manifested clinical sign of diarrhea. Samples were streaked onto eosine methylene blue (EMB), salmonella-shigella (SS), mannitol salt (MS) and blood agar media and

incubated both aerobically and anaerobically at 37◦C for 24hrs. Identification of pure culture of bacteria grown on these media was confirmed by colony characteristics, Gram's staining, sugar fermentation and biochemical test. Molecular identification of E. coli, Salmonella spp., Staphylococcus spp. and Clostridium spp. was performed by genus and species specific PCR assays. Antibiotic susceptibility of these bacteria was performed against commonly used antibiotics by disc diffusion method. The overall prevalence of *E. coli*, *Salmonella* spp., *Staphylococcus* spp. and *Clostridium* spp. was 79.60%, 63.60%, 72% and 41.20%, respectively. In young goat (≤6months of age) the prevalence of *E. coli*, *Salmonella* spp., *Staphylococcus* spp. and *Clostridium* spp. was 86.79%, 69.81%, 80.18% and 44.33%, respectively. Goats aged between 6 months and above, the prevalence of *E. coli*, *Salmonella* spp., *Staphylococcus* spp. and *Clostridium* spp. was 74.30%, 59.02%, 65.97% and 38.88%, respectively. In male and female goats the prevalence of *E. coli*, Salmonella spp., *Staphylococcus* spp. and *Clostridium* spp. was (81.69% and 76.85%), (70.42% and 54.62%,), (76.06% and 66.66%) and (46.47% and 34.25%), respectively. The prevalence of *E. coli*, *Salmonella* spp., *Staphylococcus* spp. and *Clostridium* spp. in summer and winter season was (79.63% and 79.57%), (68.52% and 59.85%), (72.22% and 71.83%) and (45.37% and 38.02%), respectively. *E. coli*, *Salmonella* spp., *Staphylococcus* spp. were found sensitive to Co-trimoxazole, Gentamycin, Tetracycline and Ciprofloxacin. *Clostridium* spp. was found sensitive to Amoxycillin, Azithromycin, Oxacillin and Vancomycin. Data of this study will be helpful for formulating guideline for prevention and control of bacterial diarrhea in goats.

Perception of Public and Farmers Towards Dairy Cattle Welfare in Baghabarighat Milk Pocket Areas of Bangladesh

Md. Mahamudunnabi, Md. Shahin Alam, Rokiya Akter Lima, Solama Akter Shanta, Md. Amimum Ehsan, AKM Anisur Rahman and M. Ariful Islam*

Department of Medicine, Bangladesh Agricultural University, Mymensingh-2202,Bangladesh

E-mail: maislam77@bau.edu.bd

Abstract

Farm animal welfare has been gradually recognized as an important issue in the most parts of the world. Animal welfare is relatively new topic which is just beginning to attract attention in Bangladesh. The objective of the study is to find out socio-personal characteristics of the respondents and to assess public-farmers perceptions towards dairy cattle welfare in Baghabarighat milk pocket areas of Bangkladesh. The study was conducted from October 2018 to March 2019 in four Upazilas Shahjadpur, Ullapara and Sathia, Bera, respectively of Sirajgonj and Pabna districts. Survey data were collected from 740 public and 270 dairy farmers through the direct interviews by a structured questionnaire. The public participants were from different occupations such as student, driver, labour, mechanic, housewife, farmer, doctor, journalist, tailor, teacher etc. Among the participants, about 81.08% of the public participants have no knowledge about the animal welfare. About 73.35% public do not agreed to provide readily access to feed and 35.54% public participants were not willing to provide water at all times. Although, the dairy farmers do not know about the animal welfare but they want to provide the facilities of their dairy cow. But dairy farmers do not fulfill the animal welfare because of their financial limitation. About 86.63% (n=641) of public and 87.41% (n=236) of dairy farmers agreed that animal welfare is important for Bangladesh. But 75.54% (n=559) of public did agree to pay more for the animal welfare ensuring milk and milk product. In summary, farm animal welfare is still in its early stage of development and more efforts are needed to improve the public perception to animal welfare in the process of establishing farm animal welfare standards and legislations in Bangladesh.

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Socio-Demographic Characteristics of Dairy Farmers and Their Attitudes Towards Dairy Cattle Welfare in Baghabarighat Milk Shed Areas of Bangladesh

Md. Shahin Alam, Solama Akter Shanta, Md. Mahamudunnabi, Rokiya Akter Lima, A.K.M. Anisur Rahman, Md. Siddiqur Rahman and M. Ariful Islam*
Department of Medicine, Bangladesh Agricultural University, Mymensingh-2202,Bangladesh
***** *E-mail: maislam77@bau.edu.bd*

Abstract
Farmers' attitudes and behaviors have significant effect on cattle productivity and welfare. The objective of the study were to know farmers' attitudes and behavior towards production and dairy cattle welfare and to explore the socio-demographic status of dairy farmers in small family holder dairy units in Sirajgong and Pabna district. From October 2018 to March 2019 two hundred and seventy (n=270) farmers were selected for the study. On spot direct questioning was performed for assessment of farmers' attitude and behaviors towards dairy cattle welfare. About 50.37% dairy farmers have no formal education and 95.56% dairy farmers have no training on cattle rearing and only 4.44% have a little or short time training. 73.33% of dairy farmers are engaged with both dairy farming and agriculture. The majority (80.74%) of the farmers have high level of experience in dairying ranging from 10 to above years, followed by medium (13.33) and low (5.93%) level of experience in dairying in the study area. It was observed that 72.59% of the farmers were in the low income level because of high maintenance cost of dairy cattle rearing but less output, whereas 22.60% were in medium and only 4.81% were in high level of income. About 100% of the farmers believed that good attitudes and behaviors increase milk production. 92.97% of farmers' stated that negative handling (beat/slap/shouting) during milking decrease milk production and only 7.03% said that negative handling has no effect on milk production. 83.70% of farmers' believed that poor housing or management has no effect on milk production due to lack of their knowledge. Majority of the farmers (53.70%) stated that animal react better to shouting compared to calm voice and 46.30% stated that animal react better to calm voice compared to shouting. Almost all of the farmers (98.15%) stared that their economic pressure makes impossible to maintain the aimed level of animal welfare and only 1.85% stated that they no economic problem to maintain the aimed level of animal welfare. Our recommendation is to proper training on cattle rearing to dairy farmers so they will have proper knowledge about dairy cattle rearing and management. Bangladesh government may take necessary steps to maintain balance between feed cost and milk price in the study area. Animal welfare campaign may be held in the study area to make the farmers aware about desired animal welfare.

Survey of antibiotic use in selected layer farms of Mymensingh district with isolation of *Escherichia coli*, *Salmonella* spp. and *Staphylococcus aureus* from layer and backyard birds

Muhammad Tofazzal Hossain* and Mohammad Kamruj Jaman Bhuiyan[1]
Professor, Department of Microbiology and Hygiene and [1]Department of Agricultural Statistics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, E-mail : tofazzalmh@yahoo.com

Abstract
Poultry flocks are often raised under intensive conditions using large amounts of antimicrobials to prevent and to treat disease, as well as for growth promotion. Antimicrobial resistant poultry pathogens may result in treatment failure, leading to economic losses, but also be a source of resistant

bacteria/genes that may represent a risk to human health. The present study was undertaken to check the present situation about antibiotic use in the layer farms with the isolation of antibiotic resistant bacteria from layer birds of selected poultry farms located at Mymensingh district over a period of time. Initially a questionnaire was prepared and survey was done to check the status of antibiotic use by the owners of the selected layer farms. Fecal sample were collected from layer birds and surrounding backyard birds; and water sample was collected from the waterer for the isolation of *Escherichia coli*, *Salmonella* spp. and *Staphylococcus aureus*. Sampling will be done once a month from each farm up to one year. It was found that most of the farmers used antibiotics after taking suggestion from veterinary practitioner, representative of company, local drug seller, and other farmer or even by himself. Most of them also used more than five different antibiotics (Amoxycillin, colistin sulphate, ciprofloxacin, oxytetracycline, neomycin, chlortetracycline, levofloxacin, enrofloxacin etc) randomly in their farms. *E. coli*, *Salmonella* spp. and *S. aureus* was isolated from last three months sampling.

Motility analysis of *E. coli* isolated from birds and animals

H. M. Jamshed Azad, Sadia Afrin Punom, Md. Shafiqul Islam* and Muhammad Tofazzal Hossain

Dept. of Microbiology and Hygiene, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh.
**E-mail : shafiqdvm@yahoo.com*

Abstract

Motility and virulence of Shiga toxin-producing *Escherichia coli* (STEC) is regulated by various environmental and physiological factors. Among all of them, temperature and pH play an important regulatory function on motility and virulence. The objective of our study was to isolate and identify the Stx-1 (+) *E. coli* and to find the correlation between motility and virulence of isolated pathogenic *E. coli* at different pH and temperature. A total of 25 samples were collected from cattle, chicken, duck, pigeon and human. *E. coli* was identified from samples by culturing and staining followed by molecular detection through polymerase chain reaction (PCR). PCR analysis showed 12 isolates were positive (+) for Stx-1 gene. Positive and negative isolates then subjected to analyze motility using soft agar assay in different pH and temperature. Highest and lowest average diameter of diffusional motility of Stx-1 (+) *E. coli* was found(25.3±7.57 and 13±1) mm at pH-7 and pH-9 after 72 hrs incubation at 37^0C whereas at room temperature was 20±3.4 mm and 11.4±1.1 mm at pH-7 and pH-9 respectively after 72 hrs. In refrigeration temperature no visible zone of motility was observed. In virulence study, Stx-1 (+) *E. coli* did not show any sign of illness in mice. It might be concluded that pH and temperature regulate motility but Stx-1 gene had no significant effect upon virulence of *E. coli* in mice.

Prevalence and Characterization of Leptospira from hospitalized patients of Mymensingh City Corporation areas

Samia Affroze, Sadia Afrin Punom, Shyamal Kumar Paul[1], KHM Nazmul Hussain Nazir, Md. Shahidur Rahman Khan and Md. Shafiqul Islam*

*Department of Microbiology and Hygiene, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and [1]Department of Microbiology, Mymensingh Medical College, *E-mail: shafiq_micro@bau.edu.bd*

Abstract

Leptospirosis is an important re-emerging zoonotic disease in tropical and subtropical regions of the world with various animal species acting as carriers. It is considered as an emerging global public

health problem caused by different pathogenic species of Leptospira and is difficult to control in developing country like Bangladesh. The present project has designed to know the prevalence of Leptospirosis and also to characterize the etiological agents of Leptospirosis from suspected human patients of Mymensingh city corporation areas. For this, a total of 153 sera (102 from suspected patients and 51 from healthy cleaners) were collected from hospitalized patients of Mymensingh Medical College Hospital and healthy cleaners at Mymensingh City Corporation. All of the sera samples were exposed to Latex Agglutination test (LAT)/Rapid kit test for detection of Leptospira. Among 51 healthy cleaners, 8 (15.68%) were positive and 38 (37.25%) were positive for Leptospira from 102 hospitalized Leptospirosis suspected patients by Rapid kit test/LAT test. According to age group, commonest age group affected was >15-30 years (12/38), followed by >30-45 years (10/38). Out of 38 LAT positive cases 27 (71.05%) were male and 11 (28.95%) were female. Based on occupation, 12 (34.21%) were farmer followed by 09 (23.68%) were housewife and lowest number of cases were Businessmen 04 (10.53%). According to season, most of the positive cases were found in the month of August (23.68%) followed by 15.78% in the month of July, 10.52% in the month of June and it was lowest in the month of December with 2.63%. Results showed leptospiral infection was more common in rainy season. Leptospira were successfully isolated from blood samples of seropositive patients by culturing on EMJH media and detected by dark field microscopy. Isolates were also confirmed by PCR. Present finding of isolation of Leptospira is the first report in Bangladesh.

Sero-monitoring and detection of circulating Leptospira species in dairy cattle from milk producing selected areas of Bangladesh

Samia Affroze, Sadia Afrin Punom, Md. Shahidur Rahman Khan and Md. Shafiqul Islam

Department of Microbiology and Hygiene, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: shafiq_micro@bau.edu.bd*

Abstract

Leptospirosis is considered to be worldwide zoonotic, emerging infectious disease and having global public health problem with high morbidity and mortality. Bovine leptospirosis is a cause of mastitis, abortion, stillbirth, or birth of weak calves. The objective of the present project was to conduct serological surveillance, isolation and molecular detection of circulation Leptospira species in dairy cattle of selected areas of Bangladesh. For this, bulk tank milk and milk from individual animals was collected from different dairy farm at Baghabarighat, Milk Vita and Savar dairy farm, Dhaka and transported to the Laboratory of the Department of Microbiology and Hygiene, BAU, Mymensingh and screening test was performed using ELISA based Leptospira detection kit. Out of 94 milk samples tested, 6 samples (3 from bulk tank milk and 3 from individual cattle) were found to be moderately positive for Leptospira in cattle. The S/P ratio of positive and negative control milk was 0.255 and 0.004, respectively. The S/P ratio of positive milk samples from individual cattle was 0.191, 0.335, and 0.441, respectively and S/P ratio of positive bulk tank milk samples was 0.141, 0.141 and 0.175 respectively. Isolation and detection of Leptospira is on progress.

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Investigation and Characterization of Viral and Bacterial Diseases in Selected Fin fishes and Shrimp in Bangladesh and Development of Their Vaccines and Validation

Md. Alimul Islam* and Mahabubul Patrik Siddique
*Department of Microbiology and Hygiene, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh, *E- mail: alim_bau@yahoo.com*

Abstract
Five selected species of fin fishes namely Koi (*Anabas testudineus*), Tilapia (*Oreochromis niloticus*), Shing (*Heteropneustes fossilis*), Gulsha (*Mystus vittatus*) and Pangas (*Pangasius hypophthalmus*) those are considered as high valued fishes have been found affected with deadly bacterial and viral agents and causing high rate of their morbidity and mortality since 2014 to 2019. A new disease of V. Koi and Tilapia known as **popped eye disease** caused by *Streptococcus agalactiae* outbreak had been reported from cultured ponds of four different districts namely Mymensingh, Gazipur, Netrokona and Kishoreganj during April to June 2018. A total of 330 diseased fishes of which V. Koi (n=150) and Tilapia (n=180) were collected from four infected fish farms at Trishal and Bhaluka upazilla under Mymensingh and Kaliakair upazilla under Gazipur districts in the period of December to July 2018. The bacteria (*Streptococcus agalactiae*) have been isolated and characterized by using various cultural, morphological, biochemical and molecular tests. The bacteria *Aeromonus* spp. had been isolated and characterized successfully from the dead shing fishes having ulcer on their body form different upazilas like Tarakanda, Muktagacha and Gouripur under the districts of Mymensingh during January to April 2019. The microorganism *Vibrio* spp has been isolated successfully from dead shrimp collected from different ghers of Bagerhat and Khulna districts. The TiLV was isolated from dead Tilapia fishes of different outbreak areas of Gazipur district. Isolation and adaptation of the viruses were done using healthy Tilapia fishes and hen embryos. Distribution of the fish viruses in the liver, kidney and brain of the TiLV affected embryos was investigated by H & E staining.
Laboratory and field trials of a newly developed inactivated bacterial fish vaccine against popped eye disease of V. Koi has completed successfully.

Molecular characterization of multidrug resistance *salmonella spp.* and detection of class one integron *int1* isolated from broiler birds

Shanzida Binte Alam, Most. Rafiya Akter and Md. Marzia Rahman*
*Department of Microbiology and Hygiene, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh, *E- mail: Marzia_micro@yahoo.com*

Abstract
Salmonella is considered as a major pathogen of food borne diseases globally. Increasing antimicrobial resistance especially multidrug resistance in *Salmonella* is a threatening issue in current situation. The study was conducted to investigate the prevalence of *Salmonella* spp. in broiler birds, fecal samples and feed samples, molecular characterization of the isolates with antibiotic resistance pattern in Mymensingh region of Bangladesh. A total of 160 samples were collected and analyzed. The antibiotic resistance profile of the isolated *Salmonella* spp. was determined by disc diffusion test using Streptomycin, Tetracycline, Ampicillin, Cefixime, Ertapenem, Sulphamethoxazole, Chloramphenicol etc commonly used antibiotics followed by amplification of antibiotic resistant genes includes streptomycin resistant *aadA1*and *aadA2* tetracycline resistant *tetA, tetB* and *tetC,* beta-lactamase producing bla_{TEM} and bla_{CMY}, Sulphonamide resistant *sul1*, *sul2* and *sul3*, Chloramphenicol resistant *cat1* and florfernicol resistant *floR* genes. The antibiotic resistance gene cassette *int1* also amplified to

identify the multidrug resistance Salmonella. On the basis of conventional and PCR results the prevalence of isolated *Salmonella* spp was found 35% and motile *Salmonella* spp was 85.71%. Antimicrobial sensitivity results showed that the isolates were sensitive to Cefixime (94.28%) and Ertapenem (85.71%) and resistant to Sulphamethoxazole (100%), Tetracycline (97.14%), Ampicillin (82.85), Chlroramphenicol (94.28%) and Streptomycin (77.14%). Among 35 resistant strains, the most prevalent resistance genotypes were observed as *sul1, sul2* and *sul3* (100% sulphonamide resistant) *tetA, tetB and tetC* (97.14%, Tetracycline resistance) followed by *floR* and *cat1* (94.28%, Chloramphenicol resistance); bla_{CMY} and bla_{TEM} (82.85%, Beta-lactam resistant) and *aadA1*and *aadA2* (77.14%, Streptomycin resistance). Among the multidrug resistance *Salmonella* 17.5% (28/160) isolates were found positive for class I integron variable region (2000 bp). The increasing frequency of class 1 integron *intl* and multidrug resistance *Salmonella* spp. in broiler and their environmental samples are alarming and indicates increased risk of human infection via food chain.

Isolation and molecular detection of fish viruses responsible for cat fish (Heteropneustes fossilis) mortality in cultured fish farm of Trishal and Bhaluka of Mymensingh

Mohammed Alimul Islam* and Md. Ashikur Rahman[1]

Department of Microbiology and Hygiene, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and [1]Scientific Officer, Bangladesh Fisheries Research Institute, Mymensingh-2202, Bangladesh

**E-mail : alim_bau@yahoo.co.in*

Investigation and Characterization of Viral and Bacterial Diseases in Selected Fin fishes and Shrimp in Bangladesh and Development of Their Vaccines and Validation

M. Alimul Islam

Department of Microbiology and Hygiene, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

**E-mail : alim_bau@yahoo.co.in*

Abstract

Five selected species of fin fishes namely Koi (*Anabas testudineus*), Tilapia (*Oreochromis niloticus*), Shing (*Heteropneustes fossilis*), Gulsha (*Mystus vittatus*) and Pangas (*Pangasius hypophthalmus*) those are considered as high valued fishes have been found affected with deadly bacterial and viral agents and causing high rate of their morbidity and mortality since 2014 to 2019. A new disease of V. Koi and Tilapia known as **popped eye disease** caused by *Streptococcus agalactiae* outbreak had been reported from cultured ponds of four different districts namely Mymensingh, Gazipur, Netrokona and Kishoreganj during April to June 2018. A total of 330 diseased fishes of which V. Koi (n=150) and Tilapia (n=180) were collected from four infected fish farms at Trishal and Bhaluka upazilla under Mymensingh and Kaliakair upazilla under Gazipur districts in the period of December to July 2018. The bacteria (*Streptococcus agalactiae*) have been isolated and characterized by using various cultural, morphological, biochemical and molecular tests. The bacteria *Aeromonus* spp. had been isolated and characterized successfully from the dead shing fishes having ulcer on their body form different upazilas like Tarakanda, Muktagacha and Gouripur under the districts of Mymensingh during January to April 2019. The microorganism *Vibrio* spp has been isolated successfully from dead shrimp collected from different ghers of Bagerhat and Khulna districts. The TiLV was isolated from dead Tilapia fishes of different outbreak areas of Gazipur district. Isolation and adaptation of the viruses were done using healthy Tilapia fishes and hen embryos. Distribution of the fish viruses in the liver, kidney and brain of the TiLV affected embryos was investigated by H & E staining.

Laboratory and field trials of a newly developed inactivated bacterial fish vaccine against popped eye disease of V. Koi has completed successfully.

Detection and characterization of duck plague viruses from field outbreaks for development of live attenuated vaccine seed virus

Jahidul Islam[1], Md. Mohirul Islam[1], Mohammed Rafiqul Islam[2], Md. Ariful Islam[1,*]

*[1]Department of Microbiology & Hygiene, Bangladesh Agricultural University, Mymensingh-2202,Bangladesh and [2]Livestock division, Bangladesh Agricultural Research Council, BARC, Farm gate Dhaka, *E-mail: islamma@bau.edu.bd*

Abstract

Duck plague (DP) is one of the devastating diseases of duck. It is caused by a DNA virus belonged to the family herpesviridae. It causes huge economic losses in the duck farm. To protect the duck from DP an effective vaccine using field isolate need to be developed. The goals of this research project were isolation and characterization of duck plague virus from natural outbreaks and preparation of a live attenuated DP vaccine using the local strain. A total of 18 dead ducks and swans were collected from Mohongonj, Netrokona (n=4), Tarati,Mymensingh Sadar Upazilla (n=6), Nilphamari, (n=4) and Safari Park (n=4), Gazipur. Liver, spleen, kidney and lungs tissue were collected. A 10% tissue homogenate was prepared from the liver and spleen. A PCR assay targeting 446bp DNA fragment of DNA polymerase gene was carried out for identification of DPV in the liver and spleen tissues. Processed tissue homogenate (inoculum) was inoculated into 12 day old embryonated duck eggs through chorioallantoic membrane (CAM) route for isolation of DPV. Molecular characterization of duck plague virus was performed by sequence analysis of the 446bp fragment of DNA polymerase gene followed by construction of a phylogenetic tree. Enlarged and hemorrhagic spleen and liver and annular hemorrhagic ring in trachea were seen in the affected duck. The characteristics clinical signs and post mortem lesions indicated that the ducks were infected with duck plague virus (DPV). Degeneration of blood vessel in the CAMs and embryo death and dwarfism of the embryos were noticed following experimental inoculation of embryonated duck with DPV. The DVP were identified in the field sample as well as in the CAM of the experimentally infected embryos by PCR The phylogenetic analysis of the DPV isolates showed 100% sequence similarity with DPV isolates originated from Bangladesh, Vietnam and China. Total 10^{th} passages of attenuation of virulent DPV using embryonated chicken eggs were completed so far and need further 36 passages into embryonated chicken eggs for development of vaccine seed virus.

Isolation and Characterization of Multidrug Resistant Salmonella species from Cattle of Selected Farms at Mymensingh District

Shayka Tasnim Pritha, Sadia Afrin Punom, Saifur Rahman, Md. Shafiqul Islam*

*Department of Microbiology and Hygiene, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. *E-mail: shafiqdvm@yahoo.com; shafiq_micro@bau.edu.bd*

Abstract

Multidrug resistant Salmonella specially *Salmonella typhimurium* definite Type 104 (DT104) emerges as a cause of human illness and has received increasing attention because of its multidrug resistance. Since it has been isolated from humans and other sources including food-producing animals around the world; it has become a worldwide public health concern. *Salmonella typhimurium* DT104 first

demonstrated a typical pattern of penta- resistance to ampicillin, chloramphenicol, streptomycin, sulfonamide, and tetracycline (ACSSuT), but it has more recently displayed additional resistance to other antimicrobials. The present study was designed to isolate, identify and also study their antibiogram profile of multidrug resistant *Salmonella typhimurium* DT104 from different dairy farms at Mymensingh district. A total of 135 samples from dairy farms were collected aseptically among which 39(28.88%) showed positive results for *Salmonella* spp. in cultural, staining and biochemical tests, respectively. Isolated *Salmonella* were subjected to antibiotic sensitivity test by disc diffusion assay using 10 commercially available antibiotics. The antibiotic resistance patterns of the dairy farm isolates were 100% to Erythromycin followed by Tetracycline (73.68%), Colistin (89.47%), Ampicillin (47.36%), Gentamycin (21.05%), Ciprofloxacine (31.57%), Streptomycin (42.10%), Enrofloxacine (10.52%) and Chlormphenicol (31.57%). About 23.07% isolates were resistant to more than 5 antibiotics. All dairy farm isolates were 100% sensitive to Amikacin. Among the multidrug resistant *Salmonella* isolates only 6 were shown to be *Salmonella typhimurium* DT104 using species specific primer. It can be concluded that the presence of *Salmonella typhimurium* DT104 to animal is very alarming. It can impose great threat to public health. Public awareness about proper hygiene, sanitation and multidrug resistance should be improved at farm level as well as national level to combat such threat.
Keywords: Multidrug resistant Salmonella, Cattle, PCR, Antibiogram

Physiological performance, humoral and cellular immune responses in chromium and vitamin E fed broiler chickens under heat stress condition

Mohammad Alam Miah* Abu Foisal Md. Hridoy, Md. Symon Hossain. and Md. Iqramul Haque

Department of Physiology, Bangladesh Agricultural University, Mymensingh-2202,Bangladesh
**E-mail: alam.dina@gmail.com*

Abstract

Chromium (Cr) is a trace mineral, essential for humans and domestic animals. The use of Cr supplementation to overcome the detrimental effects of heat stress (HS) and to improve growth performance and immune responses in broiler chickens has been studied by a few researchers. The study was conducted to evaluate the effects of chromium picolinate (crPic) and vitamin E on growth performance, hemato-biochemical profile and immune responses in broiler chicken exposed to heat stress. A total of 48, thirteen days old Lohman broiler chicks were purchased and reared up to 32 days with timely vaccination. The chicks were randomly divided into four equal groups: A, B, C, and D. Each group contained twelve birds. Group A was considered as non-treated control, Group B was treated with organic CrPic through the commercial feed, group C was treated with vitamin E through drinking water and group D was treated with both organic CrPic and vitamin E in feed and drinking water respectively. Results showed that CrPic, vitamin E and combined treated group had significantly higher live body weight ($P<0.05$) and lower FCR ($p<0.05$) compared to the control group. Total erythrocyte count (TEC), PCV and Hb were found significantly ($P<0.05$) increased in CrPic, vitamin E, and combined supplemented group (B, C, and D) compared to the control group (A). Liver enzymes especially AST were increased significantly in the vitamin E treated group C than other groups. The mean ALT values were varied among the different groups but didn't differ significantly. Creatinine level was significantly ($p<0.05$) increased in CrPic and combined supplemented group (B and D) compared to the control group (A and C). Total protein, glucose, and albumin values were statistically non-significant at ($P>0.05$) between the treated and non-treated groups. Total cholesterol, triglyceride, HDL, and LDL were significantly ($p<0.05$) higher in treated groups compared to the control group.

The highest antibody titers against NDV were detected in birds of CrPic group B followed by combined (group D) and vitamin E (group C) supplemented group. Assessment of the cellular immune response by cutaneous basophilic hypersensitivity (CBH) test using PHA-P revealed that significant skin increases were observed in CrPic and vitamin E supplemented birds. Overall, this work explores the dietary organic chromium picolinate and vitamin E and both are effective in minimizing heat stress and enhance growth performance and quality of meat in broiler chicken.

Effect of Coupled Administration of Vit-E and black seed on Growth Performance and Blood Biochemistry in mice

Afrina Mustari*, Kamrul Islam,Muhammad Alam Miah and Khaled Mahmud Sujan

Department of Physiology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : afrina.mustari@bau.edu.bd*

Abstract

High intake of fats and dyslipidemia are risk factors for the development Coronary heart disease (CHD). Saturated fats and high plasma cholesterol in the diet play a major role in the causation of hypercholesterolemia and act as a risk factor of CHD.Elevation of plasma cholesterol is usually due to an increase in the level of low-density lipoprotein (LDL) cholesterol. The research was undertaken to observe the sequel of Vit-E and black seed on Growth Performance and Blood Biochemistry in mice. A total of 28 male Swiss Albino mice, aged 28-30 days with an average body weight of 27g were divided into 4 groups randomly with 7 mice in each group. Group A was the control group supplemented with normal mice ration, Group B were received black-seed oil (0.5 mL/kg), Groups C were administered vitamin E (200 mg/kg) and group D were received black-seed oil (0.5 mL/kg) + vitamin E (200 mg/kg) daily doses respectively, for 42 days. Body weight gain of all mice was gradually increased and maximum weight gain was recorded in mice of black seed fed group. Mice treated with black seed, Vit-E and black seed+ Vit-E had significantly ($p<0.01$) higher hemoglobin (Hb) concentration and total erythrocyte count (TEC). In case of lipid profile, mice fed with black seed shows increased HDL cholesterol than the other treated groups whereas the triglyceride level reduced in Mice treated with black seed, Vit-E and black seed+ Vit-E respectively. Our study revealed that mice treated with black seed, Vit-E and black seed+ Vit-E have beneficial effects on weight gain, lipid profile and hematological values but coupled administration of Vit-E and black seed did not have any synergistic effects on growth performance and blood biochemistry in mice.

Antidiabetic and reno-pancreas protective effects of spirulina platensis in streptozotocin induced diabetic mice

Kazi Rafiq*, Jannatul Ferdous, Md. Ruhul Amin, Al-Amin

Department of Pharmacology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
****E-mail: krafiq73@yahoo.com; kazirafiq@bau.edu.bd***

Abstract

Diabetes mellitus is one of the most common endocrine disorders characterized by hyperglycemia with hyperlipidemia, diabetic nephropathy, neuropathy and cardiovascular complications. A large variety of herbals are employed in the treatment of diabetes for their better efficacy and safety comparing to synthetic drugs. In this study *Spirulina platensis* is used to evaluate the antidiabetic potential on body weight, blood glucose, hemato-biochemical parameters, diabetic nephropathy and pancreatic injury

protective effects in streptozotocin (STZ) induced diabetic mice. Male white mice having 5 weeks age matching were used for the experiment and were collected from International Center of Diarrhea Disease Research (ICDDRB), Dhaka, Bangladesh. Diabetes was induced by intraperitoneal injection of STZ @ 65 mg/kg and experiment was carried out for a period of 6 weeks. The study was conducted by dividing the animal into five groups (n=7 mice for each group) indicated as with group-A, healthy normal mice supplied with pellet feed and water; group-B, diabetic mice supplied with pellet feed and water; group-C, D and E, Diabetic mice treated with *Spirulina platensis* @ 300, 400 and 500 mg/kg, respectively. *Spirulina platensis* reduced blood glucose significantly and increase body weight significantly in contrast to diabetic control group after 6 weeks of treatment. Pancreatic injury was produced by STZ induction characterized by destruction of the pancreatic β cells mostly in the central portion of the islets of langerhans and lymphocytic infiltrations, atrophy, and interstitial fibrosis, which were partially protected by *Spirulina platensis*. The up-to-date partial data obtained from this study suggests that *Spirulina platensis* may have antihyperglycemia and pancreatic injury protective effects. The collected samples were preserved for further analysis and hemato-biochemical parameters are ongoing and will be done in due course of time. Next year the remaining part of the project work will be done.

Residue and Potential Ecological Risk of Veterinary Antibiotics in Poultry Manure and Anabolic Steroids in Animal Products in Bangladesh: one Health Perspective

Azizul Haque, Md. Kawsar Ali, Izmal Hasan, Yusuf Ali Sarker, and Mahmudul Hasan Sikder*

Department of Pharmacology, Bangladesh Agricultural University, Mymensingh-2202,Bangladesh
**E-mail: drmsikder@bau.edu.bd*

Abstract

The residue of Veterinary antibiotics (VAs) and Anabolic Steroid (AS) is becoming an obstinate health hazard and environmental problem worldwide. Here, we systematically analyzed the usage pattern, occurrence, concentration and potential ecological risks of VAs residue in poultry manure and AS in fattened animal's blood and urine in Bangladesh. A questionnaire survey was conducted to understand farmer's and prescriber's perspective on VAs and AS. Residue was screened by TLC and only VAs was quantified by HPLC. In case of VAs, all farmers were multidrug users with a quarter had residual knowledge (35.49%). 86.08% farmers didn't respect the withdrawal period. Sixteen different patterns of antibiotics of seven classes mostly (86.84%) critically important for human medicine was used. These farms used poultry manure in the agricultural field and fish pond (91.96%) and rest in the biogas plant. Ciprofloxacin (CIP), enrofloxacin (ENR), oxytetracycline (OTC) and doxycycline (DOX) in 120 poultry manure sample were screened. Occurrence and concentration (mean±SD) of CIP, ENR, OTC and DOX are 40.83% and 28.81±20.85 mg/kg, 8.33% and 17.72±9.48 mg/kg, 23.33% and 16.50±11.48 mg/kg, 17.50% and 11.75±10.69 mg/kg respectively. The Hazard Quotient (HQ) of OTC found potential ecotoxic. In AS analysis, among 73 farms, 56.16% were non-commercial. 49.31% farms uses commercial feed whereas 47.94% use self-processed feed. Only two farmers used Urea-Molasses preparation. Most farms (70%) used different steroids through oral (93%) or parenteral (7%) route with three days interval (n=36). Few farmers (3%) had residual knowledge. All samples, blood (n=25) and urine (n=16) were shown negative in TLC screening probably due to below limit of detection. Overall, this work explores the perspective of VAs and AS that contributes to one health.

Investigation of *Eimeria* oocyst concentrations and species composition in litter from commercial broiler farms

Mohammad Zahangir Alam* and Anita Rani Dey
Department of Parasitology, Bangladesh Agricultural University, Mymensingh-2202,Bangladesh
**E-mail : mzalam@bau.edu.bd*

Abstract
Coccidiosis is one of the most important and costly diseases of poultry industry worldwide. Successful control of chicken coccidiosis in Bangladesh through application of anticoccidial drugs (ACD) depends a great deal on the level of *Eimeria* oocysts present in a poultry house during grow-out. While *Eimeria* oocysts are ubiquitous in litter, there have been no studies on tack changes in *Eimeria* oocysts levels and species composition in commercial broiler farms over time during ACD program. The purpose of this study was to determine if *Eimeria* oocyst concentrations and species composition in commercial broiler house litter changed during ACD control programs. Litter samples were collected from a total of 22 different broiler farms during at least one complete grow-out cycle. Samples were collected at 0, 1, 2, 3 and 4 wk of grow-out of the ACD cycle. *Eimeria* oocysts were isolated from 13 samples, counted by microscopy, and extracted for DNA to identify *Eimeria* species by ITS1 PCR. In general, *Eimeria* oocyst concentration in litter reached peak levels at 3–4 wk of grow-out cycle. However, sudden peak oocysts numbers in 7 farms, indicating some level of *Eimeria* spp. drug resistance. In microscopy, *E. tenella, E. acervulina, E. necatrix, E. mitis* and *E. praecox* were generally present in most of the samples. Molecular analysis is being carried out for the validation of microscopic findings.

Exploring anthelmintic resistance and molecular analysis of some economically important gastrointestinal nematode parasites of cattle in Bangladesh

Mohammad Zahangir Alam* and Anita Rani Dey
Department of Parasitology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : mzalam@bau.edu.bd*

Abstract
Anthelmintic resistance is considered to be a major concern in controlling GI nematodes of cattle throughout the world. The main aim of the proposed project is to: a) detect anthelmintic resistance and (b) molecular characterization of common GI nematode parasite (stomach worm.) of cattle. Meanwhile, the present study was designed to survey the status of anthelmintic resistance in different cattle farms in Mymensingh by *in vivo* and *in vitro* techniques. Thirty animals with faecal egg counts of at least 200 eggs per gram (EPG) were identified from the farms, numbering individually, weighing and were allotted to four treatment (I-III) groups of ten animals each. Group I animals were treated with albendazole (7.5mg/kg body weight), Group II with with ivermectin (0.2 mg/kg body weight) and Group III animals remained untreated and served as control. Fecal samples were collected per rectum of each animal just prior to treatment (pre-treatment) and on 14 days post-treatment. The study found that anthelmintic resistance was present against albendazole and ivermectin in BAU dairy farm. Suspected resistance to albendazole and ivermectin was detected in Bigban dairy farm. Asha Agro farm showed resistance to ivermectin, but suspected resistance to albendazole. GI nematodes were susceptible to albendazole in Chan Miah dairy farm, but suspected resistance was detected against ivermectin. In egg hatch assay, ABZ resistance was detected in all the examined farms except Chan Miah dairy farm. The farms that were tested positive in egg hatch assay were also tested positive in

Fecal Egg Count reduction Test. The EC_{50} value ranged from 0.087 to 0.176 µg ABZ/ml and the coefficient of determination (R^2) were all above 0.97. At the end of our investigation, we do hope to gain new insight into anthelmintic resistance of GI nematodes in cattle of Bangladesh.

Application of molecular technique for differentiation of *Haemonchus contortus*, *Haemonchus placei* and their hybrids

Mohammad Zahangir Alam* and Anita Rani Dey
Department of Parasitology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : mzalam@bau.edu.bd*

Abstract
Haemonchus spp. is the most prevalent parasitic nematode among the trichostrongylids causing severe health hazards leading to production losses in ruminants around the world. This study was conducted to explore the present status of *Haemonchus* species and genetic diversity of *H. contortus* populations from sheep and goats using second internal transcribed spacer (ITS-2) of nuclear ribosomal DNA. To do this, a total of 50 adult *Haemonchus* parasites were collected from abomasa of slaughtered sheep, goats and cattle from seven different geographic zones of Bangladesh. After the extraction of DNA, ITS-2 of nuclear ribosomal DNA gene was amplified with genus and species specific primers and followed by sequencing. After editing and alignment, sequences were employed for analysis to determine sequence variation and genetic diversity. Only *H. contortus* was detected by amplification with species specific primers. All the sequences have high identical ratio with *Haemonchus contortus* and sequence identities ranged from 96.9% to 100%. Genetic analysis defined 19 distinct ITS-2 genotypes among the *H. contortus* isolates. The nucleotide diversities were 0.0098 and 0.025 for ITS-2. Phylogenetic analysis (neighbour joining, maximum likelihood and maximum parsimony) of genotypes indicated the existence of two populations without marked specification of host and locations within *H. contortus* populations in the study areas. In conclusion, our study could confirm only *Haemonchus contortus* in the analyzed parasite isolates by amplifying and sequencing ITS2 gene in ruminant of Bangladesh and the present study could be the basis for further molecular epidemiological studies using more parasite isolates from different regions of Bangladesh

Prevalence and Associated Risk Factors of *Toxocara vitulorum* Infections in Buffalo and Cow Calves in selected districts of Bangladesh

Hiranmoy Biswas, Shirajul Islam, Nurjahan Begum and Md Hasanuzzaman Talukder*
Department of Parasitology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: talukdermhasan@bau.edu.bd*

Abstract
Bovine toxocariosis is among the most economically important parasitic diseases, affecting animals mainly at a young age due to maternal infection and cause frequent death. Our study aimed to determine the prevalence and associated risk factors of *Toxocara vitulorum* infection in buffalo and cattle calves in selected districts. Fecal samples were collected from 1751 buffalo and 160 cow calves between the ages of 1-12 months and processed for egg counts by floatation technique and McMaster egg counting method. Generalized Linear Mixed Model (GLMM) analyses revealed 13.71% (95% exact CI: 12.13-15.41) overall prevalence and 655.00 EPG (SE=143.91; range=66.66-30000) overall mean fecal egg count where as only 2.5% prevalence was in Mymensingh in cow calves. The region wise prevalence was 120 (20.00%; 16.87 %-23.43%), 47 (15.41%; 11.55%-19.96%), 42(10.55%; 7.71%-14.00%), 31(6.92%; 4.75%-9.68%) in buffalo calves were detected out to excrete *T.vitulorum*

eggs in feces from Bhola, Chattogram, Rajshahi and Sylhet regions respectively. Geographical origin had significant difference (P<0.05) for the prevalence of toxocariaisis in coastal regions compared to other regions. Statistical analysis showed that gender and BCS have no significant difference (P>0.05) in the prevalence of toxocariasis. The present study revealed that high infection by *T.vitulorum* is widely spread on coastal region than North-East and North West region by fecal examination. Geographical origin, ages and fecal consistencies are the risk factors associated with toxocariasis. Inaddition, we have collected larvae from colostrum and adult parasites for molecular studies. Upon completion of the project, the study will figure out the epidemiology and larval bionomics in the study areas.

Avian liver fluke infections in domestic ducks in some selected areas of Bangladesh; Prevalence and risk factors

Md. Abdul Alim*, Sharmin Aqter Rony
Department of Parasitology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : a.alim20471@gmail.com*

Abstract

Ducks rank second just after chickens in respect of population and producing poultry meat and eggs in Bangladesh. However, the avian liver flukes have been reported to greatly hamper health and production of ducks in many parts of the word. This project describes the prevalence and other epidemiological factors of avian liver flukes in ducks in haor area of Mohongonj Upazila of Netrokona and Tarakanda Upazila of Mymensingh for a period of one year, from July 2018 to June 2019. A total of 170 ducks were collected from Mohongonj (n = 80) and Tarakanda Upazila (n= 90). Post mortem examination revealed that 81 ducks were infected indicating an overall 47.65% infection with avian liver flukes. Four species of duck liver flukes viz. *Amphimerus anatis* (15.30%), *Amphimerus ovalis* (28.82%), *Amphimerus lancea* (5.39%) and *Metorchis orientalis* (6.47%) were detected. Mixed infection with *A. anatis* and *A. ovalis* was recorded in 8.24 % ducks. Quantification of the load of parasites revealed 1-22 parasites per infected liver. Spatial distribution showed higher prevalence of infections in ducks of Mohongonj (60%) than that in Tarakanda (36.67%). Significantly higher prevalence of infection was detected in female ducks (57.63%) than in males ducks (25%). Among the age groups, the highest prevalence of infection was detected in ducks of > 6 months (60%) followed by ducks of 3-6 months age (24%). No ducks below 5 months of age was found infected. Great variation in seasonal distribution of the liver fluke infection in ducks was detected with the highest prevalence in summer (60.86%) followed by winter (47.44 %) and the lowest in monsoon (34.78%). This study fairly suggests the status and the associated risk factors of avian liver fluke infections in ducks in the study areas. Molecular characterization and anthelmintic sensitivity screening of the duck liver flukes are under progress.

Assessment of the impact of climate change on arthropod vectors those transmitting vector borne diseases in Bangladesh

Thahsin Farjana* and Md. Abdul Alim
Department of Parasitology, Bangladesh Agricultural University, Mymensingh-2202,Bangladesh
**E-mail : thahsin.farjana@bau.edu.bd*

Abstract

Due to rising temperature and changing rainfall pattern, climate change is expected to have substantial effects on vector borne infectious diseases in developing countries like Bangladesh. This study was designed to recognize the trend of climate change, to identify the arthropod vectors with their seasonal

distribution in Bangladesh, and to relate the effect of climate change on arthropod vectors in Bangladesh. Arthropods were collected with appropriate collecting tools from seven topographic zones of Bangladesh. Arthropods were identified under stereo microscope up to genus and species level. Moreover molecular confirmation of arthropod species was done by polymerase chain reaction (PCR) using published primers. A total of 4789 ticks, 936 flies, 2096 lice, 17 fleas and 10997 mosquitoes were collected from seven topographical zones. Among them five tick species, four lice species, four fly species, one flea species and thirteen mosquito species were identified; and their distribution were calculated. Identified tick species were *Boophilus microplus, Haemaphysalis bispinosa., Rhipicephalus sp., Amblyomma sp,* and *Hyalomma sp*. From the flies, *Tabanus sp, Stomoxys calcitrans, phlebotomus sp* and *Pseudolynchia canariensis* were identified during July-2017 to June-2018. Five lice species viz. *Haematopinus sp, Linognathus stenopsis, Linognathus vituli,* and *Damalinia bovis* were identified. Single species of fleas e.g. *Ctenocephalides canis* was collected from Chokoria and Bandarban. Thirteen mosquito species belongs to three genera were identified, of them *Culex* (70.0%) were dominant over *Anopheles* (29.2%) and *Aedes* (0.8%). The identified mosquito species were *Cx. quinquefasciatus*, *Cx. Tritaeniorhynchus, Cx. fuscocephala, Cx. fuscanus, Cx. mimulus, Cx. sinensis, Cx. brevipalpis, An. quadrimaculatus*, *An. vagus, An. walkari, An. annularis* and *Ae. albopictus*. Among 5 types of arthropod vectors, ticks and mosquitoes showed their pick in summer followed by monsoon. On the other hand, lice and flies were most prevalent in monsoon followed by summer. All the arthropods were found the lowest prevalent in winter season. All the vectors had strong positive relation with temperature. Tick and mosquitoes had negative relation, whereas number of lice and flies showed positive relation with humidity. Almost all arthropods had a weak positive relation with the rainfall or precipitation.This information will help to predict the future pattern of vector borne disease occurrences due to climate change; and will help to develop early warning system and sustainable control measures against vectors and vector borne diseases in Bangladesh.

Species composition and seasonal dynamics of vector mosquitoes in Mymensingh in relation with meteorological factors

Thahsin Farjana

Department of Parasitology, Bangladesh Agricultural University, Mymensingh-2202,Bangladesh
E-mail : thahsin.farjana@bau.edu.bd

Abstract

Global climate change can potentially increase the transmission of mosquito borne diseases in many parts of the world. This study was designed to investigate the species composition and seasonal dynamics of mosquito vectors in relation with meteorological factors in Mymensingh. Adult mosquitoes were collected with light traps, spray catch and mosquito net from indoor and outdoors. Mosquito larvae were collected with dipper, pipette, and dropper. Outdoor rainfall, temperature and relative humidity data of the study areas, from January, 2017 to December, 2018 were collected meteorological department of Mymensingh. A total of 1842 adult mosquitoes were collected from different places of Mymensingh during the period of January to December-2017. All the collected mosquitoes were found to be family culicidae. Among the collected mosquitoes, two genera were identified. The identified two genera were *Anopheles* and *Culex*. Of the collected mosquitoes, density of *Culex* was 66.6% whereas *Anopheles* was 33.4%. Among *Culex,* five species, namely, *Cx. quinquefasciatus* (45.9%), *Cx. tritaeniorhynchus* (7.4%), *Cx. mimulus* (10%), *Cx. sinensis* (1.5%) and *Cx. vishnui* (1.6%); on the other hand, four species of *Anopheles,* namely *An, quadrimaculatus (24.6%), An. vagus* (7.8%), *An. walkeri* (0.1%) and *An. annularis* (2%) were identified during this study period. Out of 9 species of adult mosquitoes, *Cx. quinquefasciatus, Cx. tritaeniorhynchus, Cx. mimulus*, *An, quadrimaculatus, An. vagus* were of dominant classes, *Cx. sinensis, Cx. vishnui*, *An.*

annularis were the subdominant species, whereas *An. walkeri* was the satellite species. Both the genera, *Anopheles* and *Culex*, were most prevalent in monsoon (42.3% and 38%, respectively), followed by summer (37% and 32.6%, respectively) and were least in winter (20.7% and 27.8%, respectively). A total of 2056 larvae were collected from January to December 2018. All identified larvae belongs to genera *Culex, Anopheles* and *Aedes.* Among the collected larvae, density of *Culex* was 70.2% whereas *Anopheles* was 18.4% and *Aedes* was 11.4%. Five species of *Culex* larvae (*Cx. quinquefasciatus*, *Cx. tritaeniorhynchus, Cx. fuscocephala, Cx. pallidothorax* and *Cx. mimulus)* three species of *Anopheles* (*An, quadrimaculatus, An. vagus* and *An. annularis)* and two species of *Aedes* (*Ae. aegypti* and *Ae. albopictus*) were identified. All the genera, *Anopheles, Culex* and *Aedes* were most prevalent in monsoon, followed by summer and were least in winter. This information will add a concrete understanding on the species and seasonal dynamics of mosquito which will help to develop public health awareness and a sustainable control measures about mosquito and mosquito borne diseases.

Molecular epidemiological study of sand fly vectors from kala-azar endemic areas of Bangladesh

Shirin Akter*, Md. Shahadat Hossain and Shohel Rana

Department of Parasitology, Bangladesh Agricultural University, Mymensingh-2202,Bangladesh
**E-mail : shirin.akter@bau.edu.bd*

Abstract

Visceral leishmaniasis (VL), also known as kala-azar, is caused by the protozoan parasite, *Leishmania donovani* complex (*Leishmania infantum* and *L. donovani*). According to previous reports, the current prevalence in Bangladesh is estimated to be 40,000–45,000 cases per year. Female phlebotomine sand fly, *Phlebotomus argentipes*, is the only known vector for VL transmission on the Indian subcontinent. In Bangladesh, detailed molecular taxonomic knowledge of each species is poorly or not known. Correct sand fly species identification is very important to design strategies for surveillance and control of leishmaniasis in endemic areas. In this context, the present study was conducted to identify the field-captured sand fly species morphologically and for molecular detection and characterization of sand fly species in VL-endemic areas of Bangladesh. Field surveys were conducted to collect phlebotomine sand flies from VL-endemic areas of Mymensingh, Jamalpur, Tangail and Gazipur districts. Mainly sticky trap and Shannon trap methods were used to collect the sand flies. Unfortunately no sand flies were trapped still from the sampling areas. The reason behind, since 2011, the National Kala-azar Elimination Programme in Bangladesh conducted indoor residual spray (IRS) for vector control in the affected communities. In addition to IRS, two commercially manufactured long lasting impregnated bed-nets (LLIN) were given to each patient who was treated in the government hospitals. According to a previous study, the IRS and LLIN were associated to decrease the level of the *Phlebotomus argentipes* sand fly by 70±80% in Bangladesh. Due to these vigorous vector-control measures and programs conducted by government of Bangladesh, there is a tremendous low vector density in all the VL-endemic areas which may be the most crucial reason of not finding any sand fly samples in the already surveyed VL-endemic areas. In future, we should try different sand fly sampling methods in other VL-endemics areas of Bangladesh.

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PCR-based identification of schistosome species prevalent in Bangladesh directly from naturally infected vector snails

Anisuzzaman*, Sharmin Shahid Labony, Md. Shahadat Hossain
Department of Parasitology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail:zaman.a.bau@gmail.com*

Abstract
Schistosomiasis, a common neglected tropical disease (NTD) caused by blood flukes (nematoda: Schistosomatidae). Worldwide >250 million people are suffering from active infection and annually 3.31 million disability-adjusted life year (DALYs) is lost along with 530 million cattle affected. Here, schistosomes cercariae were isolated and identified from naturally infected snails for detecting their vector status along with the temporal and spatial distribution of vector snails. A total of 9589 snails belonging to different genera such as *Lymnaea auricularia, L. luteola, Indoplanorbis exustus, Vivipara vivipara,* and *Brotia* sp.were collected from different water bodies such as rice fields, rivers, drain and doba (small stagnant water bodies) located in Mymensingh from January to December 2018. Species of snails were determined following the shell characteristics. Snails were then placed into test tube containing tape water and exposed to direct sunlight to release cercariae reside them. Snails were then collected from tube and crushed through mortar and pestle. Then after, both suspension from test tube and crushed snails was placed under light microscope to identify schistosome cercariae and other developmental stages. Of the snails identified, *L auricularia* was more common in rice fields and rivers, and *L. luteola, I. exustsus* and *V. vivipara* were commonly found in doba and rice fields. Amid total snails, 180 (1.9%) were infected with schistosomes cercariae. *L. luteola*, *L. auricularia, I. exustus* and *V. vivipara* were found to act as the vector of schistosomes in Bangladesh, however, *L. auricularia* (3.2%) was more infected than *L. luteola* (2.4%). First and foremost, *V. vivipara*, collected from drains, harbored the developmental stages of the schistosomes. Schistosome infection was the highest in February and no infection was detected in April. Further studies, including the molecular characterization of schistosome cercariae will reveal the species of schistosomes prevalent in Bangladesh.

Detection of fish-borne zoonotic trematodes, the type 1 bio-carcinogen, from marketed fishes in Bangladesh

Anisuzzaman[1*], Sharmin Shahid Labony[1], Muhammad Mehedi Hasan[2]
*Department of Parasitology and [1]Department of Fisheries Technology, Bangladesh Agricultural University , Mymensingh-2202, Bangladesh., *E-mail:zaman.a.bau@gmail.com*

Abstract
Fish-borne Zoonotic Trematodes (FZT) are an emerging and devastating problems having impact on global health, in addition to wild and cultured fishes in aquaculture be faced with a major food safety risk, especially in Southeast Asia where aquaculture is economically important. A cross-sectional study was carried out to identify the metacercariae (MC) of FZT species diversity and to estimate the prevalence and infection status of FZT in two major groups of fish: wild and cultured species from Mymensingh, Kishoreganj and Chittagong. A total of 16 species of fishes were collected and digested with artificial digestion fluid to recover MC. A total of 65 wild and 93 cultured fishes from different local markets were examined for FZT infection. Out of 16 species of fishes, 14 species were infected with FZTs. Interestingly we found that grass carp and tilapia were free from infection. There was a significant difference ($p<0.05$) in FZT prevalence in wild (66.2%) and cultured (25.9%) fishes. The prevalence of FZT in Punti (*Puntius ticto*,87.5%) was significantly higher than that of other fish

species. The density of MC of FZT in wild fishes were significantly higher ($p<0.05$) than that in cultured fishes. The infection rate was significantly ($P<0.05$) higher in body (29.5%) than head (18.5%) of examined fishes. By morphological and morphometrical analysis, we identified MC of *Clonorchis , Opisthorchis, Metorchis* and *Metagonimus.* In molecular studies, *Clonorchis* sp. Was determined using ITS2 gene. Taken together, our results suggest that the frequent occurence of MC of FZTs in all fish types indicate that the wild and cultured fishes are equally at risk of infection and plays critical role in the transmission cycle of the pathogens in Bangladesh.

Investigation on the trematode infections in food animals associated with zoonoses and food-safety

Sayeda Anumika, Md Sherajul Islam, Hiranmoy Biswas, Mohammad Manjurul Hasan, Babul Chandra Roy and Md Hasanuzzaman Talukder*

Department of Parasitology, Bangladesh Agricultural University , Mymensingh-2202, Bangladesh
**E-mail: talukdermhasan@bau.edu.bd*

Abstract

To increase public health awareness for prevention of fish-borne trematode infections caused by eating raw freshwater fish, the distribution and abundance of metacercariae was investigated in freshwater fish obtained from local fish markets in Mymensingh. A cross-sectional survey was conducted. Fish were identified, counted, weighed, and digested using pepsin-HCl. Samples were examined for metacercariae by a sedimentation method, and metacercariae were identified under a stereomicroscope. Metacercariae are subglobular or disc-shaped, and 0.14-0.16 mm in diameter. They have yellow-brownish pigment granules, a ventral sucker located from median, and a V-shaped excretory bladder. Metacercariae were found in various fishes. Among the sites where metacercaria-infected fish were found, 70.0% were from ponds/lakes, and 7.7% were rivers. The mean intensity of metacercariae were ranged from 0.01 to 6.5 cysts per fish (or 1.3-287.5 cysts per kg of fish). DNA from metacercaria were used for testing with primers. In conclusion, metacercariae are prevalent in natural cyprinid fish, with the infection rate varying according to fish species and habitats in Mymensingh region. Therefore, detailed epidemiological studies on the food-borne trematode infections in intermediate host species, definitive hosts, genotypes of strains from different host species, zoonotic impact, food-safety and economic significance of food-borne trematode infections are urgently needed in different parts of Bangladesh.

Detection and identification of *Leishmania* species in field-captured sandflies from different kala-azar endemic areas of Bangladesh

Shirin Akter, Md. Shahadat Hossain and Shohel Rana

Department of Parasitology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh.
E-mail : shirin.akter@bau.edu.bd

Abstract

In human, VL, also known as kala-azar (KA), is caused by the protozoan parasite, *Leishmania donovani* complex. *VL* is a serious public health problem in Bangladesh where the current prevalence is estimated to be 40,000–45,000 cases/year. On the Indian subcontinent Female phlebotomine sand fly, *Phlebotomus argentipes*, is the only known vector for VL transmission. The detection and identification of *Leishmania* species within sand flies are important for predictions of the risk and expansion of the disease in endemic areas. The development of accurate methods for identifying the species of *Leishmania* in insect vector is crucial for epidemiological studies or control programs of

KA. Field surveys were conducted to collect phlebotomine sand flies from selected VL-endemic areas of Mymensingh districts in Bangladesh. Previously reported most endemic areas for KA like different Upazillas of Mymensingh districts (Fulbaria, Trishal, Muktagacha, Goforgao, Sadar Upazilla), Jamalpur, Tangail and Gazipur districts were visited for field sampling. Sticky trap and Shannon trap methods were used to collect the sand flies. Unfortunately no sand flies were trapped still from the sampling areas. Observed insects mostly include mosquitoes and biting midges in those traps. The National Kala-azar Elimination Programme in Bangladesh conducted indoor residual spray (IRS) for vector control in the affected communities since 2011. In addition to IRS, two commercially manufactured long lasting impregnated bed-nets were given to each patient who was treated in the government hospitals. These control programs were associated to decrease the level of the *P. argentipes* in Bangladesh. Due to these vigorous vector-control measures and programs conducted by government of Bangladesh, there is a tremendous low vector density in all the VL-endemic areas which may be the most crucial reason of not finding any sand fly samples in the already surveyed VL-endemic areas. Next, we will try different sand fly sampling methods in other VL-endemics areas of Bangladesh to collect.

Molecular detection of malaria parasite in vector mosquitoes in Mymensingh, a malaria endemic area of Bangladesh

Dr. Thahsin Farjana* and Dr. Md. Abdul Alim

Department of Parasitology, Bangladesh Agricultural University, Mymensingh-2202,Bangladesh
**E-mail : thahsin.farjana@bau.edu.bd*

Abstract

Bangladesh has made significant progress against malaria which is a Neglected Tropical Disease (NTD) and has a long way to go until elimination. This study focused on the molecular detection and differentiation of malaria parasite (*Plasmodium*) in vector mosquitoes in Mymensingh, one of 13 malaria endemic districts of Bangladesh. Adult mosquitoes were collected from indoors and outdoors from Mymensingh using light traps, mosquito spray and mosquito net. Mosquitoes were identified with compound microscope to the species following the published keys. Four species of *Anopheles,* namely *An, quadrimaculatus, An. vagus*, *An. walkeri* and *An. annularis* were identified during this study period. Out of four species, *An. quadrimaculatus* (53.3%), was the most predominant species followed by *An. walkari* (22.2%), *An. vagus* (19.4%), and *An. annularis* (5.1%). Mosquito pools were made to test the presence of malaria parasite. The procedure for pooling mosquitoes for malaria testing involves sorting samples by species and dividing the collection into pools of up to 40 to 50 mosquitoes. DNA was extracted from freshly collected mosquitoes or specimens stored in absolute alcohol using a commercial DNA Extraction Kit. Polymerase Chain Reaction (PCR) was done for detection and differentiation of *Plasmodium* species (*Plasmodium falciparum* and *Plasmodium vivax)*, causing malaria in Mymensingh using published primers. All the pool samples were found negative in this study. This result indicates reduction of malaria cases in Mymensingh. This study will contribute to malaria surveillance program and to develop a sustainable malaria control program in Mymensingh, as well as in Bangladesh.

A study to designing protocols for the detection and management of multi drug and extensively drug resistance Tuberculosis (TB) in human, dairy & slaughtered cattle and zoo animals of Bangladesh

S.M. Shariful Hoque Belal, Md. Golam Azam Choudhury, Umme Kulsum Rima, Abu Saleh Mahfuzul Bari and Md. Abu Hadi Noor Ali Khan*

*Department of Pathology, Bangladesh Agricultural University, Mymensingh, Bangladesh; Department of Medicine, Surgery & Obstetrics, Hajee Mohammad Danesh Science & Technology University, Dinajpur; Department of Livestock Services, Dhaka, Bangladesh, * E-mail: hadi.khan@bau.edu.bd*

Abstract

Tuberculosis (TB) is a chronic, debilitating infectious disease affecting wide range of mammals and are extremely zoonotic. Tuberculosis in man and animals are commonly caused by *Mycobacterium tuberculosis*, *M. bovis* and *M. avium spp. var paratuberculosis*. As a zoonotic nature, TB can be widespread in dairy cattle, wild animals and caretakers of animals and may disseminate infections, require monitoring. This study was carried out to identify tuberculosis in caretaker, cattle and wildlife of Bangladesh. A total of 284 samples were collected from dairy farms, slaughterhouses, and wildlife habitats. Dairy animals were screened with caudal fold tuberculin (CFT) test and comparative cervical tuberculin (CCT) test. The reactor animals were sacrificed for the collection of samples. Samples from zoo animal were collected from major enclosed areas of the country at necropsy. The collected samples were used in gross and microscopic pathology and PCR detection of specific causes of TB. Impression smears onto clean slides from the organs and cough were stained with Ziehl Neelsen (ZN) stain to detect acid fast bacilli. Gross pathological examination of visceral organs revealed hard and firm nodules bulging from serous or mucous surface. The samples were then processed, sectioned and stained with hematoxylin and eosin stain. The stained section was examined under microscope showed pink color acid fast bacilli characteristics of Mycobacterium spp. Out of 284 cattle samples tested, 58 were positive for tuberculosis. *M. bovis* was found in 19 cases, *M. tuberculosis* in 4 cases, and *M. avium* spp. in 34 cases. Seven zoo animals appeared to contain tuberculous infection, of which 4 were infected with *M. bovis* and 3 with *M. tuberculosis*. Infectivity due to *M. tuberculosis*, *M. bovis* and *M. avium spp. var paratuberculosis* appeared common in farm, zoo and slaughtered animals, they are all zoonotic; poses serious threat for public health In Bangladesh.

Identify carrier, transmission cycle, drug toxicity and drug resistance properties of Leishmaniasis (Kala-azar) in Bangladesh

Mahmuda Islam, Thahsin Farjana, Mohammad Abu Hadi Noor Ali Khan*

Department of Pathology, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, E-mail: hadi.khan@bau.edu.bd

Abstract

Leishmaniasis is a disease of man and animals and transmitted by the bites of infected flies. Common types of leishmaniasis is visceral leishmaniasis (VL). About 90% of global VL cases occur in India, Bangladesh, Sudan, South Sudan, Ethiopia and Brazil. Mymensingh, Netrokona, Kishorganj and Tangail districts are the endemic zone of VL in Bangladesh. Ruminants, dogs, and rats may carry the organism and may play role towards dissemination in human. A total of 100 cattle, 100 goats, 50 dogs and 10 wild rats from the VL endemic zone were tested for the presence of VL. Liver and spleen from the slaughtered cattle, goat and wild rats from Phulbaria and Haluaghat Upazila, Mymensingh district were investigated by using histopathology and PCR. Peripheral blood from the cattle (N=100) and goats (n=100) from the farms of previously suspected human shelter were examine for the detection of

leishmanial protozoa. DNA from the blood samples of cattle, goats, dogs and rats were used in PCR detection of specific cause of VL. A total of 10 human suspected blood samples were randomly collected from the patients attended at Suria Kanto Kala Azure Research centre, Mymensingh for the specific detection of amastigote stage of Leishmanial protozoa. Genomic DNA from human blood was used in PCR detection of VL. Two commonly used antileishmanial drugs Amphotericin B and Miltefosin tested in mice model to know their toxicity *in vivo*. None of the sand flies, cattle, goats, dogs and rats found to carry leishmania in their system. PCR showed that out of ten human samples tested eight were infected with *L. donovani*. Mice treated with Amphotericin B and Miltefosin and sacrificed 30 days of trials showed reduced weight gain, higher level of AST, ALT, AP and creatinine in serum. Histopathological examination revealed degenerative changes in the liver and kidney. Leishmanial infectivity in cattle, goats, dogs, and rats was not seen in this study. It needs to carry out routine surveillance of animals and sand flies vectors for the presence of VL to support VL elimination campaign in Bangladesh. The antileishmanial drugs Amphotericin B and Miltefosin may be toxic to mice model, require extensive investigation.

Identification of PPR virus specific caprine samples for the formulations of vaccine seed and PPR antigen

Sajeda Sultana, Munmun Parvin, Abu Saleh Mahfuzul Bari and Md. Abu Hadi Noor Ali Khan*

*Department of Pathology, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. *E-mail: hadi.khan@bau.edu.bd*

Abstract

Peste des Petits Ruminants (PPR) is an important OIE listed transboundary animal disease of small ruminants. PPR is much devastating in goats in rural areas due to high morbidity (10-100%), high mortality (up to 100%) and heavy production losses. To protect infectivity it needs routine immunization and monitoring of infectivity. Commercially available diagnostics are much expensive and the vaccine currently used in Bangladesh is derived from African isolate. This study was designed to develop diagnostics for PPR and isolation of native PPR virus for vaccine formulation. A total of 20 clinically infected goats were examined from Mymensingh and Chuadanga districts, Bangladesh. Goats were examined at necropsy, the gross changes observed were recorded. The prescapular, mesenteric and bronchial lymphnodes, liver, spleen, intestine, lungs, trachea, heart, kidney were collected and preserved in 10% neutral buffered formalin. Tiny parts of tissues were preserved at -20^0 C for virological study. Viral RNA from lymph nodes was extracted using SV Total RNA Isolation System and the RT-PCR was carried out using one step RT-PCR kit for the detection of PPR. PCR and RT-PCR was also carried out with the extracted DNA and RNA from lymphnodes for the detection of contaminating Pox, ORF and FMD viruses. Characteristics zebra stripes in ileum was seen in 70% cases. The lungs were severely congested and hepatizated. Fibrinous cast was observed in bronchus in typical cases. Congestion and hemorrhages were found in trachea, spleen, liver, and kidney. Histopathological examination revealed lymphocytic depletion, congestion and haemorrhages in lymphnodes. Fibrinous exudates were seen in in interlobular tissues. Out of 20 samples tested in PCR, PPR positive amplicon (402bp) was detected in 17 cases. None of the samples yielded amplicons suggestive for co-infectivity due to Pox, Orf or FMD viruses. Huge morbidity and high rate of mortality of goats due to PPR was seen in the study areas. Out of 20 samples tested 17 appeared positive for PPR, the samples are ready to isolate in culture, selection of vaccine seed and antigens for kit formulation.

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Mobile Veterinary Service: An innovative approach to improve health and productivity of livestock

Mustak Ahammad[1], Md. Taohidul Islam[2], Md. Rafiqul Alam[3] and Emdadul Haque Chowdhury[1*]

[1]*Department of Pathology,* [2]*Department of Medicine,* [3]*Department of Surgery and Obstetrics, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh, *E-mail: emdad001@yahoo.com*

Abstract

Veterinary services are mostly hospital based and not delivered to the farmer's doorstep in Bangladesh. Since Bangladesh does not have any ambulatory system for sick animal transportation, the hospital services are mostly accessible by the population who are within 1-2 km radius of the hospital campus. Thus the farmers at the periphery of Upazilla don't get timely proper health care of the animal. Therefore a doorstep veterinary service is required in Bangladesh at rural area to improve health care of livestock which will in turn improve the productivity. By the financial support from Krishi Gobeshona Foundation (KGF), we experimentally introduced "Mobile Veterinary Service" in few villages of two Upazillas of Bangladesh. The services included 3 packages: Service package-1 included mostly continuous surveillance of livestock diseases by a mobile veterinarian assisted with a filed veterinary assistant. Service package-2 included preventive veterinary services and service package-3 included doorstep clinical veterinary services e.g. diagnosis and treatment of diseases, artificial insemination, pregnancy and calf health management etc. The farmers were under the vigilance of a veterinary field assistant and also provided cell phone number of mobile veterinary team. Whenever the animals were sick, upon a phone call, the mobile veterinary team rushed to the farmer doorstep within shortest possible time. The study provided excellent results: calf mortality was reduced from 13.2% to 2%. In addition health status of cow and calves was improved. The average first conception age of calf was reduced from previous average 29 months to 19 months. To validate these data, the project is being implemented further in two more Upazillas. Our results showed similar trends as the mortality has already been reduced from 8.1% to 1.2%. Milk yield per cow has been increased from average 2.43 L/cow/day to 3.09 L/cow/day. Total livestock growth has been increased by 20.1% which is much above our national growth rate 3.1%. Number of repeat breeders has also reduced significantly.

Irradiation of transboundary animal disease (TAD) pathogens as vaccines and immune inducers

Mohammed Nooruzzaman, Azmary Hasnat, Rokshana Parvin and Emdadul Haque Chowdhury*

Department of Pathology, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

**E-mail: emdad001@yahoo.com*

Abstract

Mycoplasmosis is a major threat in achieving sustainable animal and poultry development in Bangladesh. Caprine mycoplasmosis is caused by a variety of pathogens under the *Mycoplasma mycoides* cluster. Isolation of Mycoplasma in the laboratory is a big challenge. Previous studies under this project have isolated and identified the etiology of caprine mycoplasmosis using culture, staining and PCR method from 18 goats. In culture, large colonies of cream yellowish color, a characteristic of M. mycoides subsp. capri (Mmc), were detected in 13 samples. Whereas, small colonies of cream

color, which is a characteristic of *M. mycoides* subsp. *mycoides* SC (MmmSC) were detected in 8 samples. Three samples showed both type of colonies. Recently we started working on avian mycoplasmosis. Isolation of *Mycoplasma gallisepticum* (MG) has been established using a positive isolate from a collaborating institute. MG produced orange color in Modified Ferry's broth within 24 hours after inoculation. On Modified Ferry's agar, MG produced round, transparent colonies with raised center within 5-7 days post-inoculation. PCR method using IGSR gene specific primers amplified 812 bp product of the MG isolate. Mass culture and irradiation of the MG isolate to produce vaccine are in progress.

Genetic evolution of *peste des petits ruminants virus* (PPRV) in Bangladesh between 2012 and 2018

Nazia Akter, Nahiatul Zannat, Mohammed Nooruzzaman, Jahan Ara Begum and Emdadul Haque Chowdhury*

Department of Pathology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: emdad001@yahoo.com*

Abstract

Peste des petits ruminants virus (PPRV) infection is one of the major constrains of sustainable goat farming in Bangladesh. Since 1993, outbreaks of PPR are being continuously reported across the country. Our recent molecular phylogenetic analysis using partial F and N gene sequences of a limited number of samples showed that Bangladeshi PPRV isolates belonged to lineage IV but formed a separate sub-lineage along with recent isolates from Nepal, Bhutan and China (Rahman et al., 2016). However, full length sequence analysis of Bangladeshi PPRV isolates is required to confirm the sub-lineage and to further assess the evolutionary dynamics of the virus. This study describes the genetic diversity of three PPRV isolates from Bangladesh collected in 2008, 2015 and 2017 based on their complete genome sequence analysis. Two PPRV isolates from 2015 (BD10/2015) and 2017 (BD11/2017) were obtained from local field outbreaks and RNA was extracted from lymph node homogenates of infected goats. The amplification of the full genome of PPRV was performed by 26 overlapping RT-PCR using custom designed primer sets. The amplified RT-PCR products were sequenced and sequence data were edited and assembled using Bioedit and MEGA 7 software and compared with other PPRV isolates from Bangladesh. The genome of all three field isolates of PPRV was 15948 nucleotide in length. Phylogenetic analysis using complete genomes and individual gene segments showed that all three PPRV isolates of Bangladesh belonged to lineage IV and were closely related to the viruses from Bangladesh, India, China, Tibet and Pakistan. The mean nucleotide divergence between the four lineages of PPRV varied from 9.7% to 14.8% based on their complete genome sequences. The highest divergence (14.8%) was found between lineage II and lineage IV. Bangladeshi PPRV isolates from 2015 (BD10/2015) and 2017 (BD11/2017) showed 1.7% and 2.3% divergence from isolate of 2008 (BD2/2008), respectively indicating that Bangladeshi PPRV are slowly evolving. Individual gene ‐ based comparative analysis of nucleotide identity among strains of the four lineages showed that the M gene was the most conserved (divergence: 7.1%-10.9%) whereas the H gene was the most divergent (divergence: 9.6%-13.6%) one. Further phylogenetic analysis of global lineage IV PPRV strains showed that Bangladeshi three PPRV sequences clustered under clade 4.3. Nucleotide divergence analysis between four clades showed a mean divergence of 3.2% to 4.1%. Comparative residues analysis of complete genome showed several conserved motifs in the studied field isolates. Further study is in progress.

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Detection of pathogenic *Escherichia coli* and *Salmonella* in the garden vegetable using untreated poultry waste and their antibiogram profile

Mohammed Nooruzzaman
Department of Pathology, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: khokondvm@yahoo.com

Abstract
Home gardens are integral part of rural households in Bangladesh. Farmers often use homemade organic fertilizers composed of cow and poultry manure directly to their vegetable garden and ponds. However, untreated wastes can contain potential pathogens which may affect man and animal health and environment. We investigated the microbial contaminants of garden vegetable originated from farms using untreated poultry waste as manure in their home garden. Poultry litter, soil, pond water and vegetable samples were collected from Sadar and Trishal upazilas of Mymensingh district and Sakhipur upazila of Tangail district. The samples were processed for the isolation and identification of *Salmonella* and *Escherichia coli* using standard procedure. We isolated Salmonella and E. coli in untreated litter material and pond water contaminated with poultry litter. Out of 45 vegetable samples tested, the presence of *Salmonella* and *E. coli* was detected in 19 and 1 samples, respectively. Moreover, both *Salmonella* and *E. coli* were detected in 13 vegetable samples including sponge gourd, spinach, taro, brinjal, bottle gourd, wax gourd, cucumber, bitter gourd and carrot. For the molecular detection of the isolated *Salmonella* and *E. coil*, polymerase chain reaction (PCR) methods have been established using published primers. The presence of shigatoxigenic *E. coli* (STEC) in the contaminated vegetable samples were tested by PCR methods using appropriate primer sets. We could not detected any STEC in the vegetable samples.

Intergenotypic cross-immunity of Newcastle disease viruses

Mohammed Nooruzzaman
Department of Pathology, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: khokondvm@yahoo.com

Abstract
Newcastle disease (ND) is endemic in poultry of Bangladesh. Our recent genotyping study of ND virus (NDV) from Bangladesh classified commonly used vaccines strains under genotype I and II and circulating field strains under genotype XIII. Published studies showed that genotype mismatch vaccines, i.e., where vaccine virus is genotypically heterologous to field virus, may still prevent clinical disease but do not fully prevent virus replication and shedding. Here we tested the intergenotypic cross-immunity of two different NDV genotypes by assessing their cross hemagglutination inhibition activity and clinical protection against velogenic NDV challenge. Commercial layer chicks were vaccinated with inactivated LaSota (genotype II) and Bangladeshi field strain BD-C161 (genotype XIII) vaccines at 5^{th} and 7^{th} weeks of age. At 8^{th} weeks of age, sera were collected and analyzed by hemagglutination inhibition (HI) assay to test the cross HI activity. During the same time birds were challenged with a Bangladeshi velogenic field strain (BD-C161) at 8 weeks of age and mortality was recorded. Unvaccinated infected birds were kept as control. To assess the virus shedding and contact transmission, 10-15 naïve chicks were introduced to vaccinated birds one day after challenge with BD-C161 and mortality was recorded. LaSota vaccinated sera tested with

homologous LaSota antigen showed a very high HI titer (16-1024 HI Unit, average: 168.4 HI Unit). However, when theses sera were tested against heterologous BD-C161 antigen, a remarkable reduction in the HI titer (4-1024 HI Unit, average: 102.67 HI Unit) was found. Similarly, when sera from BD-C161 vaccinated birds were tested against heterologous LaSota antigen, a reduced antibody response (4-256 HI Unit, average: 50.25 HI Unit) were induced compared to the homologous BD-C161 antigen (16-256 HI Unit, average: 96.94 HI Unit). Challenge experiment showed that vaccine prepared from both LaSota and BD-C161 strains conferred 82.3% protection against challenge with BD-C161. Where, all unvaccinated infected birds died by day 4 post infection. Contact transmission experiment showed that, both vaccines could not prevent virus shedding, as all naïve birds on contact died by 8 days post infection. In conclusion, genotype heterologous vaccines mounted reduced antibody response and NDV vaccines irrespective of genotype did not provide sterile immunity.

Pathogenicity of genotype XIII Newcastle disease virus in chickens

Mohammed Nooruzzaman
Department of Pathology,, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: khokondvm@yahoo.com

Abstract
The *in vivo* pathogenicity of a circulating strain of Newcastle disease virus (NDV) belonging to genotype XIII was studied in experimentally infected layer chickens. Commercial layer chicks of ISA Brown breed were raised in relative isolation with food and water ad libitum. At 35 days old, NDV-seronegative birds (n=10) were infected with 200 µl of $2^{5.68}$ HA unit of BD-C161/2010 strain of NDV via intranasal (100 µl) and intraocular (100 µl) route. The control birds (n=3) received uninfected allantoic fluid. Birds were observed twice daily until day 10 and the clinical signs, morbidity and mortality were recorded. The freshly dead birds were examined at necropsy and the gross pathological lesions were recorded. Tissues from selected organs were collected in 10% neutral buffered formalin for histopathology. Upon infection, most of birds showed clinical signs of depression and respiratory signs starting at day 2 post-infection. At day 4 and 5 post-infection, 40% and 80% of the infected birds died, respectively. Eventually, all infected birds died by day 8 post-infection. NDV affected chickens showed severe haemorrhage and congestion in lungs, haemorrhage at the tip of proventricular glands, mottling of spleen and multiple button-like ulcers in intestine and caecal tonsil. In addition, haemorrhages and congestions were also found in trachea, liver, kidney and bursa of Fabricius. Histopathologically, NDV-infected birds showed generalized haemorrhage and congestions in different visceral organs including lungs, trachea, liver and kidneys, and haemorrhages and lymphoid depletion in spleen, bursa of Fabricius, caecal tonsil and thymus. Taken together, based on clinical and pathological findings, the studied genotype XIII isolate of NDV could be classified as velogenic viscerotropic pathotype.

Optimization and validation of an enzyme-linked immunosorbent assay for detection of avian influenza virus subtypes H5 antibodies using a recombinant H5 (HA_1) antigen expressed in *E. coli*

Jahan Ara Begum*, Shukes Chandra Badhy, Mitu Rani Paul, Emdadul Haque Chowdhury and Md. Rafiqul Islam
Department of Pathology, Bangladesh Agricultural University,Mymensingh-2202, Bangladesh
**E-mail : happydvm23@gmail.com*

Abstract
On the incursion of HPAI in 2007, Bangladesh adopted the policy of stamping out and vaccination for HPAI control. Common sero-monitoring tools for AIV are ELISA and HI test. However, the ELISA

kits are solely imported from abroad, highly expensive and not readily available in Bangladesh. Thus it is necessary to develop ELISA reagents and kits locally to support seromonitoring. Therefore, the study was conducted to optimize an indirect ELISA for the detection of chicken antibodies against H5 AIV using *E. coli* expressed rHA1 as antigen and to validate the developed indirect ELISA with field sera. HA1 gene (960 bp) of a clade 2.3.2.1 HN1 HPAI virus was expressed in *E. coli* as a fusion protein with tetra Cystein Lumio tag and 6X Histidine tag. Expression of rH5_HA1 was induced with IPTG. The expressed protein was analyzed by SDS-PAGE with Lumio green detection method as well as Coomasie blue staining which revealed that rHA1 protein of ~40 kDa was successfully expressed in *E. coli* and best over expression time was found to be 4 hours after induction with IPTG. The *E. coli* expressed purified protein rH5_HA1 protein was used as the antigen for the optimization and validation of previously developed indirect ELISA by Badhy, 2019 in the department of Pathology. On chequer board titration optimum dilutions for antigen and sera were 1:100 and 1:500, respectively. The inter-assay co-efficient of variation was between 0.09% and 3.13%. The sensitivity and specificity of newly developed iELISA calculated from the test results of 96 filed sera 98.55% sensitive and 100% as compared to HI test and 100% and 69.23% as compared to a commercial cELISA. The results of iELISA correlated well with that of HI (R^2=0.885) and cELISA (R^2=0.882). The developed indirect ELISA using recombinant H5-HA1 protein might be used for seromonitoring of H5AIV in chickens. Further validation of the iELISA with more field sera samples is in progress.

Pathological investigation of diseases of sheep at Mymensingh municipality

M M Hosssain* and T. Ruba
Department of Pathology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: mmhossain04@yahoo.com.au*

Abstract

Pathological investigation of diseases of sheep at Mymensingh municipality was carried out in the Department of Pathology, Bangladesh Agricultural University, Mymensingh, Bangladesh. A total 22 sheep were thoroughly examined after slaughtering. Their age were >1 year and 11 sheep were male 11 were female. The number of samples were livers (n=13, male 7 and female 6), lungs (n=8, male 4 female 4), kidney 1(n=1, female=1) while large intestines (n=4, male 2 and female 2). Four sheep showed gross lesions in two organs. All 13 livers showed biliary cirrhosis, cholecystis and portal cirrhosis. Cross sections *Fasciola* were found in all 13 livers. Lungs (n=8) showed pneumonic lesions. Only 1 kidney showed renal infraction. The lumen of large intestines showed swollen with mild catarrhal enteritis with presence of *Moniezia* tapeworms. The isolated and identified bacteria were *E. coli* 1, *Streptococcus sp* 1, and *Staphylococcus sp* 3 out of 5 pneumonic apical lobes. This information will enrich the knowledge of Veterinarians for the management of sheep diseases.

Control of Brucellosis, a zoonotic disease in selected dairy farms

M M Hossain*and T Ruba
Department of Pathology, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: mmhossain04@yahoo.com.au*

Abstract

One health concept is progressing; as a result the control of zoonotic diseases is getting prime importance in Bangladesh. Brucellosis is a zoonotic disease caused by a group of *Brucella* organism and the infection is almost invariably transmitted to people by direct or indirect contact with infected

animals or their products. The disease mainly causes orchitis in bulls and abortion and retained placenta in cows. In the present investigation, the used methods were the application of bovine *Brucella* antibody rapid test strip, histopathology and direct immunohistochemistry (IHC) to determine *Brucella* organism in tissue/cell level. The used materials were sera from pregnant cows, aborted placenta and fetuses (include placental cotyledons and fetal organs such as the lungs, bronchial lymph nodes, spleen and liver) and mesenteric lymph node of cows from slaughtering places. A total of 20 sera samples were collected from pregnant cows (gestation ranges from 3 to 7 months) of Bangladesh Agricultural University Dairy Farm (BAUDF), Bangladesh Agricultural University (BAU), Mymensingh and screened with Bovine *Brucella* Antibody rapid test strip to detect *Brucella* antibody. A total of 10 sera samples were tested with Bovine *Brucella* Antibody rapid test strip following the standard technique of the manufacturer (Shenzhen Lvshiyuan Biotechnology Co., Ltd. China). All 10 samples did not show *Brucella* antibody in the sera. A total of 20 mesenteric lymph nodes were collected from 20 slaughtered cows. A total of 8/20 (40%) lymph nodes showed normal histological features, 5/20 (25%) showed lymphoid depletion, 3/20 (15%) lymph nodes showed hemosiderosis, 2/20 (10%) lymph nodes revealed edema. A suspected granulomatous disease 2/20 (10%) were reported in the present study. However, these 2 specimens will be confirmed by immunohistochemistry (IHC). Aborted fetal tissues and placenta (n=1) will be investigated for histopathology and immunohistochemistry. The study is on progress.

Biometrical, bacteriological and pathological investigation of diseases and disorders of female reproductive systems of goats

M M Hossain*, T Ruba and ABM Jalal Uddin

Department of Pathology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: mmhossain04@yahoo.com.au*

Abstract

The present investigation was designed for biometrical, morphometrical, pathological and bacteriological investigation of female reproductive system of Black Bengal goats. A total of 256 (200 for biometrical and 65 for pathological) samples of female reproductive tracts were collected and examined during the study period October 2016 to December 2018 from various slaughter places of Kishoreganj district of Bangladesh at 04 (four) age category (up to 6 month, >6 month to 1 year,> 1 year to 1.5 year and >1.5 year to 2 years). Various biometrical (measurements of length, width, weight of female genitalia grossly and microscopically), gross and histo-pathology, and isolation and identification of bacteria from uteri were followed. Maximum length, width and weight were found in right ovary as 2.14+0.13 cm, 1.47 ±0.03 cm and 1.4±0.05 gm at >1.5 year to 2 years. In case of uterine tube maximum length and width was 15.15±0.12 cm and 0.2±0.02 cm in right one at same age group. Maximum length of uterine horn, body of uterus, cervix and vagina were 12.9 ±0.11 cm, 2.45 ±0.09 cm, 3.45± 0.09 cm and 7.47±0.08cm respectively. Histomorphometrically, the length of all parameters as cortex length of ovary, mucosal, muscularis and serosal length of uterine tube, uterus, vagina and vulva were higher at age category of >1.5 year to 2 years than other categories. These were 163.172±5.057µm, 111.439±0.006 µm, 75.642±0.447 µm, 45.356±0.441057µm, 195.639±0.424 µm 453.057±.460 µm, and 32.739±0.435 µm, respectively. Gross pathological changes were detected in 65 cases (21.88%) which includes ovaro bursal adhesion (3.57%), par ovarian cyst (5.36%), persistent corpus luteum (14.28%), luteal cysts (19.64%), ovarian tumor (5.36%) ovarian hypoplasia (3.57%), oophoritis (3.57%) mesovarian cyst (1.78%), chronic salpingitis (5.36%), hydrosalphinx (1.78%), endometritis (28.57%), pyometra (32.14%), hydrometra (10.7%), mucometra (7.14%), cervicitis (3.57%), vaginal cyst (1.78%) and granular vulvo-vaginitis (1.78%). The investigation is on progress.

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Molecular diagnosis and epidemiology of Burkholderia pseudomallei in human and horses

M S Rahman*, A Nahar, AC Das, AA Maruf, MM Hasan
Department of Medicine, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: prithul02@yahoo.co.uk*

Abstract
Bangladesh is an agro-based country and horses are widely used for drought purposes such as pulling cart, transportation, land tillage and racing. It supports each family in densely populated pocket area since horse density area from ancient time. Glanders is one of the oldest known diseases of horses and it is a fatal infectious and notifiable zoonotic disease of equines caused by the Gram-negative non-motile bacterium Burkholderia (B.) mallei, which is responsible for chronic suppurative lesions of the skin and mucous membranes, pneumonia and septicemia in equines. Glanders in horses is worldwide distributed and reported from many countries. But no prevalence study was done in horses in Bangladesh so far. Therefore, this preliminary study was conducted to determine the seroprevalence of Glanders in horses and human using Complement Fixation Test (CFT) and Immunoblot (IB) assay. A total of 301serum samples from horses and 150 cases of human with the history of rearing horses were collected for the detection of Glanders antibodies from Mymensingh, Tangail and Jamalpur districts in Bangladesh. By CFT 105 samples were found positive and 23 samples were suspicious but there were no positives cases in human. The IB confirmed 26 of these samples but 3 remained suspicious. The overall seroprevalence of Glanders was 34.9% based on CFT and 24.8% based on IB. Higher prevalence was found in Jamalpur (11.81%) and the CFT is considered to be a suitable screening test for the diagnosis of Glanders in field conditions in Bangladesh.

Livestock and Human Brucellosis: Molecular diagnosis, treatment and control 2. Immune response of heat killed vaccine of Brucella abortus biovar 3 Asian strain in guineapig

MS Rahman, MM Hossain, BS Ahmed, AA Maruf, MF Karim, MM Hasan
Department of Medicine, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: prithul02@yahoo.co.uk*

Abstract
Brucellosis is a 'multiple burdens' disease with economic impacts attributable to human, livestock and wildlife disease. The importance of brucellosis is not known precisely, but it can have considerable impact on socio-economic development and continue to be a major public and animal health problem in many regions of the world especially in countries like Bangladesh where rural income relies largely on livestock breeding and dairy products. In animals, brucellosis mainly affects reproduction and fertility, with abortion and reduced milk yield. In man, the clinical picture resembles many other febrile diseases, but sacroiliitis and hepato-splenomegaly are the most prominent. Brucellosis is endemic both for human and animal in Bangladesh and it is a notifiable disease in many countries but it is not a notifiable disease in Bangladesh and there is also no vaccination program for this disease in Bangladesh. The objectives of this project were molecular characterization of strains and epidemiological risk factor analysis of brucellosis in livestock and human; comparison of immunogenicity between vaccinated and non vaccinated cattle with *Brucella abortus* strain RB51 (SRB51) and locally prepared heat killed *Brucella abortus* vaccine; histopathology of experimentally infected guineapig and naturally infected cattle with brucellosis and development of treatment strategy for human and animals infected with brucellosis. To do project activities one Research Fellow (RF),

one Research Assistants (RAs) and one Accountant cum Computer operator (Part time) have been appointed during reporting time. Inception workshop and a press conference were arranged to share the views and ideas with different expertise. PI, RF, RA visited the project site, Central Cattle Breeding and Dairy Farm (CCBDF) and Military Dairy Farm (MDF), Savar, Mymensingh Medical College Hospital (MMCH), Mymensingh. Suspected dairy cattle were screened for brucellosis by Rose Bengal Test (RBT), rapid test, Milk Ring Test (MRT), impression smear from aborted material and then modified Zeihl Neelsen staining, classical biotyping, guineapig inoculation, histopathology were performed. A questionnaire was developed by Project Team for collection of epidemiological data from different project areas. PI, RF, RA also have regular contact with the project areas to collect aborted fetus and milk and sera and relevant data of the suspected cases during this reporting period. A total 1003 cattle sera (503 from CCBDF and 500 from MDF) were screened with RBT, MRT and rapid kit test and 715 human sera were screened with RBT and rapid kit test in MDF and MMCH with the cooperation of a MBBS doctor who is studying in Department of Microbiology, Mymensingh Medical College (MMC), Mymensingh. Positive cases were re-tested with ELISA, conventional and real time PCR and MLVA (Multi Locus Variable Number of Tandem Repeat Analysis). Out of 1003 cattle sera 43 were positive with RBT, 14 in MRT and 14 in rapid kit test. And out of 715 human sera, 16 were positive with RBT. Positive human and cattle samples revealed 602 base pair band in conventional Polymerase Chain Reaction (PCR) and amplifications of *B. abortus* specific DNA were recorded through real time PCR. Histopathology of naturally infected aborted fetus characterized by lesion in different organs such as fibrinous pleuritic in lungs. Focal hepatitis in liver, capsulitis with thickening of capsule in kidney. Fibrinous pericarditis in heart, congestion and haemorrage in spleen. Experimentally *Brucella* infected guineapigs also revealed characteristics lesions in different organs such as granulomas, hemorrhages and necrosis in lungs parenchyma; hemorrhagic endocarditis, monocytes in heart; congestion, hemorrhage and multifocal accumulation of mononuclear cells in kidney. Hemorrhage, congestion and fatty change in liver and caseaus necrosis of splenic foci were recorded. The histopathological study for the first time in Bangladesh using guinea pig inoculation techniques, reports the successful detection of pathological changes in major organs after inoculation with aborted fetal contents. On the basis of the different characteristics (CO_2 requirement for growth, production of H_2S in culture, biochemical test like oxidase, catalase and urease, growth in safranin, thionin and fuchsin and agglutination against anti A and Anti M antibody) and motility test, *Brucella* species and biovar was determined as *Brucella abortus* biovar 3 and with the molecular technique (MLVA) the strain was similar to Asian strain. Guineapig inoculation technique could be used as a good alternative of culture and for the confirmatory diagnosis of brucellosis from contaminated clinical samples like placenta. Heat killed vaccine were prepared from isolated *Brucella* organism and inoculated into guineapig subcutaneously at dose (4×10^{10}cfu/2ml) and serum were collected upto 9^{th} week for observing immune response. The antibody level started to rise significantly ($p<0.01$) from the 2nd week (OD value 0.2287, reciprocal Ab titer 1:120) and reached a peak level at 4th week (OD value 0.2842, reciprocal Ab titer 1:800) and then started to decline significantly ($p<0.01$) at 9th week (OD value 0.1015, reciprocal Ab titer 0).

Molecular diagnosis and impact of brucellosis on human and domestic ruminant populations 3. Economic impact on small ruminants

MS Rahman*, AKMAA Rahman, BS Ahmed, AA Maruf, M Hasan
Department of Medicine, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail : prithul02@yahoo.co.uk

Abstract

According to the Food and Agriculture Organization (FAO), the World Health Organization (WHO) and the World Organization of Animal Health (OIE), brucellosis is considered to be the most

widespread zoonosis throughout the world. In animals, brucellosis mainly affects reproduction and fertility, with abortion and reduced milk yield. In man, the clinical picture resembles many other febrile diseases, but sacrolitis and hepato-splenomegaly are the most prominent. Brucellosis was first identified serologically in cattle in 1967 in Bangladesh and now it is endemic. However, the species designation of the prevalent *Brucella* is unknown and the impact of this disease in humans and animals has not been quantified in terms of economic and non-economic losses. In this study the sera from the blood of human and large (cattle and buffalo) and small (goat and sheep) ruminants have been tested by Rose Bengal Test (RBT) and rapid antibody test. A total of 250 sera from human and 2593 small ruminants sera (746 sheep and 1847 goat) and 799 large ruminants sera (700 cattle and 99 buffalo) were collected along with their clinical signs and reproductive history from the different districts of Mymensingh division. The economic model to quantify the financial losses due to brucellosis were estimated in all upzilas of Mymensingh district only for goats and sheep.The prevalence rate of caprine and ovine brucellosis was estimated to be 1.6% whereas it was found to be 1.56% and 1.65 % in goats and sheep, respectively. Out of 799 serum samples from large ruminant, 45 serum samples reacted positive in the RBT and there were no positive among human sera and the prevalence of cattle, buffalo and human brucellosis were 5.42%, 7.07% and 0%, respectively. The RBT positive sera were re-tested by monoclonal based blocking ELISA (Enzyme Linked Immunosorbent Assay). ELISA positive sera were considered for DNA extraction and further confirmed by real time PCR for cattle and buffalo. Fourteen (9 cattle, 5 buffalo) sera were found to contain *Brucella* DNA by genus specific IS711 screening using quantitative real time PCR (qRT-PCR); and all the 15 qRT-PCR positive samples were found to contain specifically *Brucella abortus* DNA. Out of 38 RBT positive sera of cattle, 23.68%, out of 7 RBT positive buffalo sera, 71.43% were *B. abortus* positives. RBT positive dairy cattle were also screened by milk ring test (MRT) and positive samples were further confirmed by conventional polymerase chain reaction (PCR). Detection of an amplicon of 136 bp confirmed the presence of *Brucella abortus* DNA in milk samples with conventional PCR. Clinical signs related with brucellosis were abortion, retention of placenta and orchitis in ruminants. The result presented here indicate that *IS711* real time PCR assay is a specific and sensitive tool for detection of *Brucella* spp infection in cattle and buffalo. The total losses attributed to the disease was 48436400 taka (605455 US$) annually in the district whereas 46462900 taka (580786.25 US$) and 1973500 taka (24668.75 US$) in goat and sheep, respectively. The study concluded that *IS711* real time PCR assay is a specific and sensitive tool for detection of *Brucella* spp infection in animals and brucellosis silently constitutes economic loss to the economy of the country and the producers due to insufficient knowledge and inadequate diagnostic facilities, lack of awareness and an effective prevention and control strategy.

Molecular epidemiology of *Mycobacterium bovis* infection in animals and man in Bangladesh

M.M. Alam[1*], M.K. Khan[1], M.N. Islam[1] and M.A. Islam[1]
[1]*Department of Medicine, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh*
**E-mail: asamahbub2003*yahoo.com*

Abstract

Tuberculosis (TB) is a progressive granulomatous infectious disease caused by the gram positive, acid fast bacilli classified under the genus *Mycobacterium*. Tuberculosis in human is mostly by *Mycobacterium tuberculosis* and primarily affects lungs causing pulmonary tuberculosis (PTB). It can also affect intestine, meninges, bones, joints, lymph nodes, skin and other tissues of the body causing extra-pulmonary tuberculosis (ETB). Tuberculosis also affects animal like cattle buffalo etc. known as bovine tuberculosis (BTB) caused by *Mycobacterium bovis*, a member of Mycobacterium tuberculosis complex (MTBC). The MTBC consists of closely related species that cause TB in both human and animal. From the total population of Bangladesh, about 85% of the people are engaged in agriculture

and are at risk of bovine TB. Bovine TB has great economic importance disease as well as public health significant. The study is designed to determine the prevalence of tuberculosis (*Mycobacterium species*) in human and animals by conventional and molecular techniques. The cross-sectional descriptive study is being conducted in Mymensingh, Sirajganj and Dhaka district during the period of January 2018 to December 2019. Data is being collected by history taking from the TB suspects (calculated minimum sample size is 369 in case of human and 1530 for animals especially dairy cows) and from the findings of laboratory investigations of relevant specimens especially sputum from human and milk, blood, lymph node aspirate and tissue from animals. A total of 444 TB suspects were interviewed. Sputum from 443 patients were examined under LED microscope after auramin staining and 46 was found positive for tubercle bacilli. A case of extra-pulmonary TB was detected by Fine Needle Aspiration Cytology (FNAC) of cervical lymph node. Culture in liquid media was done with 42 specimens of sputum. Thirty seven (37) of those showed growth while 5 did not. DNA was extracted from growth in liquid media by boiling method and was preserved accordingly in -20^0C. GeneXpert/RIF was done with 37 samples of sputum and 29 was found MTB positive and RIF sensitive while 4 were found MTB positive but RIF resistant. Conventional PCR showed 17 positive cases for *Mycobacterium species*. Multiplex PCR and gel electrophoresis were done and 10 were found positive for Mycobacterium tuberculosis. These Multiplex PCR products were used for DNA Sequencing. Results of DNA sequencing was submitted to GeneBank and the accession number has already been received. Isolated strains of *Mycobacterium Tuberculosis* showed similarity with the strains which are reported from other parts of the world. Overall incidence of TB in TB suspects was found 10.36%. A total of 470 BTB suspected animals were screened by CFT (Caudal Fold Tuberculin) using bPPD (Bovine purified protein derivatives) where 101 (21.49%) were shown sensitive. CFT sensitive animals were tested by CCT (Comparative Cervical Tuberculin) using bPPD and aPPD (Avium purified protein derivatives) where 36 (7.66%) were shown BTB sensitive. On the other hand, a total of 570 BTB suspected animals were tested with Bovine antibody rapid test kit where 0.88% found positives for *Mycobacterium bovis*. One thirty eight samples (Milk, blood and tissue) were tested by Zeihl Neelsen staining and light and inverted microscopy where 7 (7.97%) were positive. Conventional PCR was done for 214 samples (Milk, blood and tissue) and 06 (2.91%) found *Mycobacterium spp* positive from bovine tissue sample. Ending the TB epidemic by 2030 is one of the health targets of the newly adopted Sustainable Development Goals (SDGs). Understanding of molecular epidemiology of tuberculosis is essential for its effective control in human as well as in animal.

Epidemiological investigation of Ehrlichiosis, Bartonellosis and Q-fever of dogs and cats for better management

M.A. Reza, A. Kabir[1], F. Yeasmin, M. J. S. Bhuiyan, K. H. M. N. H. Nazir[1], M. Hasan[2] and M. A. Ehsan*

*Department of Medicine, [1]Department of Microbiology and Hygiene and [2]Department of Surgery and Obstetrics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: amimul.med@bau.edu.bd*

Abstract

Present research work is undertaken to estimate the prevalence and to identify the risk factors of 3 neglected zoonotic diseases of the domestic dogs and cats such as anaplasmosis caused by *Anaplasma phagozytophilum; bartonellosis caused by Bartonella henselae and* Q fever by *Coxiella burnetii*. A total of 50 pet (20 dogs and 30 cats; age between 1 week to 6 months) samples have been collected during July, 2018 to June, 2019 from Sagir's Pet Clinic, Dhanmondi, Dhaka(n=20); Veterinary Teaching Hospital, Bangladesh Agricultural University (BAU), Mymensingh (n=10) and the surrounding areas of BAU campus(n=20). Face-to-face interviews of the pet owners were taken with a questionnaire. Blood (n=35), Vaginal swab (n=25) and Oral Swab (n=50) were collected for the

detection of *Anaplasma phagozytophilum*, *Coxiella burnetii*, and *Bartonella henselae* respectively. Rapid test kit (Rapigen), culture in chocolate agar media and Grams and Wright Staining were performed for the screening test. As all these tests have low sensitivity, all samples were amplified with specific primers for the confirmatory diagnosis in PCR. In screening test, out of 20 samples 1 sample from dog of 6 month old was positive to Anaplasmosis. No samples were positive for Q fever and Bartonellosis in screening test. In PCR, 16 out of 30 cat samples were positive to Bartonellosis only. No significant association with age breed and sex were observed. This is the first report of *Anaplasma phagozytophilum* and *Bartonella henselae* in dogs and cats in Bangladesh.

Assessment of the welfare of dairy cattle using animal-based indicators in Baghabarighat milk shed areas of Bangladesh

M. Ariful Islam*, A.K.M. Anisur Rahman, Solama Akter Shanta and Rokiya Akter Lima

Department of Medicine, Bangladesh Agricultural University, Mymensingh-2202,Bangladesh
** E-mail: maislam77@bau.edu.bd*

Abstract

Animal welfare considerations are becoming increasingly important for farming of animals, both in developed and developing country including Bangladesh. Animal welfare is a multidimensional concept and welfare assessment system through animal-based measures is almost complex. In this context, a survey study was carried out in 89 dairy units to evaluate welfare quality in Sirajgonj district through some welfare indicators validated by the European Welfare Quality® protocol. The studied population size included 354 females (216 cows and 138 heifers). Data were collected through face-to-face interview with farmers followed by examination and observation of animals. Body condition score, body cleanliness, skin injury, lameness, health aspects and avoidance distance were assessed. Prevalence of sub-clinical mastitis and milk yield of cow was also estimated. Out of 130 milk samples, 54.38% cows were CMT positive and their av. milk yield was 8.35 l/d. 14.16 % of cows were sufferings from various levels of lameness where clinical lameness was 7.52%. Among examined cows, the median prevalence of BCS-2 was 61.32%. Mean milk yield, averaged across farms, was 11.3 l/d and BCS 1.92 on a 0-3 scale. Milk yield was reduced if a farm had a high proportion of cows with skin lesions. A significant number of hock injuries (58.54%) and knee injuries (39.27%) with hair missing were found, respectively. In addition, a significant number of animals were observed dirty condition in their hind limbs (65.23%), udder and teat (33.54%) and flanks (58.76%). The dirtiness of the cow's coat had a high prevalence (82.34%). Among health state, diarrhea, nasal and ocular discharge were present. Most farms did not display consistently good or poor animal-based indicators and there was a big variation in the animal welfare levels within and across farms. The study also showed that animals differ in their relationship with the stockholder and health state and subclinical mastitis is a major threat for dairy industry in the studied areas

Exploring antimicrobial resistance genes in bacterial isolates from red meat of cattle

Md. Yamin Ali[1, 2], Mst. Sonia Parvin[1], Sudipta Talukder[1], Md. Mehedi Hasan[1], Md. Tanvir Rahman[3] and Md. Taohidul Islam[1*]

*[1]Population Medicine and AMR Laboratory, Department of Medicine, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, [3]Department of Microbiology and Hygiene, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and [2]Department of Livestock Services, * E-mail: taohid@bau.edu.bd*

Abstract

The widespread overuse and misuse of drugs in food animal production has contributed resistant pathogens and the evolution of multiple drug resistant strains that emerged as a major public health

problem. Therefore, the purpose of the study to estimate the prevalence, antibiotic resistance pattern and resistance genes in red meat of cattle collected from butcher shop in selected ten districts of five divisions in Bangladesh. A total of 322 bacteria were isolated and identified from 240 red meat samples through standard cultural and biochemical protocol. Out of 322 isolates, the prevalence of *E. coli*, *Salmonella* spp. and *S. aureus* were 55%, 40.8% and 38.3%, respectively. Among the isolated bacteria, ESBL producing *E. coli* and *Salmonella* spp. were 84.1% and 58.2%, respectively. Antibiotic susceptibility results revealed that, 95.2% isolates of *S. aureus*, 77.6% *Salmonella* and 51.5% *E. coli* were multidrug resistant. Five isolates were identified as possible extensively drug-resistant (pXDR) as they showed resistant to 8-9 (out of 9) classes of antimicrobials**.** Resistance to colistin sulphate (*E. coli* 30.3%, *S. aureus* 43.9% and *Salmonella* 79.2%) indicate that the possibilities of cross-resistance. For *E. coli*, the *bla*TEM (100%) was common resistance gene, followed by *bla*CTX-1 (4.5%) and *bla*SHV (0.8%). None of isolates were positive for *bla*CTX-2 gene. Moreover, the prevalence of quinolone resistance genes in *E. coli* were *qnr*S (10.3%), *qnr*B(3.4%) and *qnr*A gene was not found to any isolates. For *Salmonella,* ESBL encoding gene *bla*TEM (100%) was most frequently observed but none of isolates were positive for *bla*SHV, *bla*CTX-1 and *bla*CTX-2 genes. The emergence of MDR and ESBL producing organism in beef of butcher shop may constitute a public health concern, adequate cooking and reinforce good hygiene practice of butcher shop to avoid cross-contamination.

Evaluation of different anionic surfactants for the development of cowside mastitis screening test

Tanni NS, Islam MS, Parvin MS, Ehsan MA and Islam MT*

*Population Medicine and AMR Laboratory, Department of Medicine, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: taohid@bau.edu.bd*

Abstract

Subclinical mastitis (SCM) is a highly economic disease for dairy cattle worldwide therefore regular screening is imperative to detect SCM in early stage as well as to control SCM. The research work was conducted to compare the test characteristics of Sodium lauryl sulphate (SLS) and Sodium dodecyl benzene sulfonate (SDBS) as test reagent to detect SCM in dairy cows. Firstly, 106 milk samples were subjected to compare the available indirect screening tests. Then 273 milk samples were subjected to react with SLS and SDBS with and without NaOH and indicators, Bromothymol blue (BTB) and Bromocresol purple (BCP). Of SLS and SDBS different concentrations of Sodium lauryl sulphate with and without NaOH and indicators gave high sensitivity (Se), specificity (Sp) with somatic cell count. The Se and Sp were higher than the White Side Test (WST), Surf Field Mastitis Test (SFMT) and Immucell. Among different concentrations of the SLS, SLS 3% + NaOH 1.5% (BTB) and SLS 2% (BCP) had high sensitivity, specificity and substantial agreement with somatic cell count. It may be concluded that SLS 3% + NaOH 1.5% (BTB) and SLS 2% (BCP) may be a potential reactor for the development of an effective cowside test to detect SCM, as SLS is considerably cheap and readily available in developing countries like Bangladesh.

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Patterns of antimicrobial resistance of *Escherichia coli* in broiler chickens, farm workers and farm sewage in Bangladesh

Amit Kumar Mandal, Sudipta Talukder, Md. Mehedi Hasan, Syeda Tanjina Tasmim, Mst. Sonia Parvin, Md. Taohidul Islam*

*Population Medicine and AMR Laboratory, Department of Medicine, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: taohid@bau.edu.bd*

Abstract

Antibiotic resistance has become a global public health concern as a wide number of resistant bacteria are continuously emerging. The present study was conducted to determine the prevalence of *E. coli* isolated from broiler chickens, farm workers and farm sewage in Mymensingh and Gazipur districts of Bangladesh. In addition, the study was also focused on determination of antibiotic resistance pattern of *E. coli* as well as the prevalence of carbapenem resistance gene (NDM-1). A total of 150 samples (cloacal swab = 50, farm worker = 50 and farm sewage=50) were collected from 50 different poultry farms and subjected to cultural and biochemical examination and were further confirmed by PCR. Carbapenem resistance gene (NDM-1) was also detected by PCR. The overall prevalence of *E. coli* was recorded as 76%. Highest prevalence (86%) was recorded in cloacal swab isolates and lowest prevalence (66%) in hand washed water of farm workers. The results of antibiotic sensitivity test showed that 82%, 78%, 78%, 70%, 66%, and 51% of the tested *E. coli* isolates from poultry sources were found resistance to levofloxacin, doxycycline, cefotaxime, ciprofloxacin, imipenem, and meropenem, respectively. About 76% of the total isolates were showed multidrug resistance. However, 69% isolates showed resistance to four to seven antibiotics while 27% isolates were resistant to one to three antibiotics and only 3.5% isolates were resistant to eight to nine antibiotics. None of the isolates of broiler chicken was found positive for NDM-1. The high level of antibiotic resistance in broiler chickens in Bangladesh is worrisome and indicates that widespread use of antibiotics could have negative implications for human and animal health and the environment.

Investigation on capture myopathy due to chemical immobilization in spotted deer *(Axis axis)*

Md. Badol Ashraf[1], Mohammad Raguib Munif[1], Pravin Mishra[1], Nazmul Hoda[2], Md. Mahmudul Alam[1*]

*[1]Department of Surgery and Obstetrics, Bangladesh Agricultural University , Mymensingh-2202, Bangladesh. and [2] Upazilla Livestock Officer (Leave/Reserve), Department of Livestock Services, attached to: Bangladesh National Zoo, Mirpur, Dhaka, *E-mail: mahmuddso2004@gmail.com*

Abstract

The present study has been conducted to investigate the stressful event after chemical immobilization of spotted deer *(Axis axis)* for translocation in different places of the country on personal demand. The animals were immobilized using intramuscular injection of ketamine HCl @ 6-8 mg/kg through dart gun. In some cases, Xylazine-Ketamine combination (1mg/kg and 2.2 mg/kg IM respectively) was used. Post-capture body temperature, respiration and heart rate were recorded. Peripheral blood was aspirated from jugular vein for serum biochemical analysis. Data from 2013 to 2019 revealed 189 animal captured through darting and among them 48 animals died due to post-capture myopathy reflecting death rate of 25.3%. We have closely studied on 16 animals captured on different occasions. Data revealed rapid elevation of body temperature indicating development of post-capture hyperthermia. Serum enzyme analysis exhibited increased levels of ALT, AST, Bilirubin, Creatinine, BUN, LDH, CK, Troponin, Cholesterol, Triglyceride, HDL and LDL and were highly indicative of

stress-linked muscle and organ damage. The macroscopic lesions consisted of muscular and cardiac degeneration, edema, hemorrhage and congestion in lung, adrenal gland and in kidney. Microscopically, there were loss of striation and fragmentation of skeletal muscle, formation of contraction band necrosis in myocardial fiber, degenerative changes in renal tubule and formation of central intraluminal eosinophilic casts. Immunohistochemical staining revealed the presence of myoglobin in the skeletal and cardiac muscle. All these pathological findings were indicative of capture myopathy in spotted deer. This report underlines that mortality from capture is a risk that must be considered during restocking programs.

Pregnancy rate in ewes through trans-cervical artificial insemination (TCAI) using produced chilled ram semen in the field condition

Farida Yeasmin Bari*, Amit Saha, Mohammad Asaduzzaman and Suravi Akter
Department of Surgery and Obstetrics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: fybari61@yahoo.com.au*

Abstract

Sheep the poor man'scow contributing a significant amount in meat production and income generation for the sheep farmers.However farmers dream is not fulfilling due to lack of using control breeding and Artificial Insemination (AI) in sheep rearing. The objectives of the present study were to assess the pregnancy rate in indigenous field sheep following Trans-cervical AI (TCAI) using chilled ram semen and to detect the most suitable technique of TCAI under field condition. The work was conducted in 30 field sheep (breeding season, n = 15 andnonbreeding season, n=15) around Mymensingh districts.The ewes were grouped into three viz. Traditional TCAI (n=10), Lab cradle TAI (n=10) and TCAI with GnRH treatment (n=10). Following proper management the ewes in each group underwent for induction of oestrus by double injection of 1ml Ovuprost® (Bayer,Newzealand Ltd.) at 9 days interval. The 24 fresh ejaculates from 3selected rams were evaluated (0h)immediately after collection and 2hrs.followingaddition of Tris-Fructose-Egg yolk media and stored in 4-5^{0}C. The mean volume(ml),color (1-5grade), mass activity (1-5grade), motility (%), viability (%), concentration (10^{6}/ml) and normal sperm percentage were 0.78±0.03, 3.64±0.06, 3.77±0.02, 79.38±0.24, 80.42±0.32, 3289.25±8.90 and 86.13±1.01, respectively.The motility for chilled semen before AI was74.5±0.19, 76.96±0.50 and 79.92±0.26%, respectively. The chilled semen which had the > 70% motility was used for TCAI having 300x10^{6}spermatozoawithin 2-4 hrs.of preservation. Pregnancy was diagnosed by ultrasonography at 45-50 days of post insemination. Fifty seven (15/26) and 75%(15/20)ewesresponded to estrous induction in non-breeding and breeding season,respectively.There was no significant difference between theseason on time of onset of oestrus and duration of oestrus. The ewes were inseminated around 13.66±0.14 hrs.of onset of oestrus.The pregnancy rate following traditional TCAI (50%) could be increased (60%) following injection of GnRH immediately after AI in field condition. However, use of lap. Cradle is also advantageous. The pregnancy rate was similar in both breeding and non-breeding season (60% and 53%).The overall pregnancy rate following TCAI using chilled semen in field level (57%) was highly acceptable level,could be used for speed up the production of quality sheep in Bangladesh.

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Optimizing first-calving target in heifers of commercial farms

Nasrin Sultana Juyena* and Farida Yeasmin Bari
Department of Surgery and Obstetrics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: nsjuyena@bau.edu.bd

Abstract
Fertility is the basis for milk production which convert heifers to valuable cows. Several factors have been suspected to be associated with fertilization failure in heifers. There is paucity of reports on risk factors associated with fertility traits for heifers in Bangladesh. Considering the above facts, the aim of the project is to investigate different factors that influence the reproductive characters of heifers and to optimize the strategies to be used to improve the pregnancy rate and to hasten first calving in heifers of commercial farms in Mymensingh. A questionnaire was developed for the collection of data from in ten upazillas, Mymensingh. Reproductive performances of 117 heifers were recorded. A total of 61 repeatedly inseminated heifers were grouped into five groups according to treatment purposes. Group T0 was considered as control group. In Group T1, heifers were supplemented with vitamin and minerals along with anthelmintic. Heifers of Group T2 were assigned for double timed AI and administration of GnRH at first AI. In Group T3, single time AI was performed after administration of anti-inflammatory drug at the time of AI. Heifers of Group T4 were synchronized with OVSYNCH (GnRH+$PGF_2\alpha$+GNRH) protocol and then inseminated. AI was performed with frozen-thawed semen after observing the natural heal in all heifers of Groups T0, T1, T2 and T3. Vaginal electrical resistance, ultrasonographic study of follicular dynamics and hormonal profile were also studied. Prevalence of RB cows were analyzed according to different parameters. Results showed no significant variation ($P>0.05$) in reproductive characters among heifers of different breeds. Number of services per conception ranged from 3.16±0.12 to 3.25 ±0.25 in heifers of different breeds. Pregnancy rate was 27%, 100%, 45%, 66.7% and 62.5% in Groups T0, T1, T2, T3 and T4 respectively. However, overall pregnancy rate of RB cows obtained during the study period was 54% (33/61) and seven calves are delivered from the pregnant heifers during this reporting period.

Bovine Blood Bank for Treatment of Critically Ill Animals

Md Rafiqul Alam* and Mirza Abul Hashim
Department of Surgery and Obstetrics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: alammr74@yahoo.com*

Abstract
This study was conducted to strengthen blood banking and institute transfusion therapy to the critically ill cattle brought and registered for treatment at the Veterinary Teaching Hospital (VTH), and also to some clinically sick animals at the farmer level. A total of 20 transfusions were performed to 18 anaemic animals. Single transfusion was performed in 16 animals and 2 animals received repeat transfusion of whole blood. Ten sick animals received transfusion from the donors of our blood bank and 8 animals in a farm were transfused fresh blood collected from the same farm. Before each transfusion, the donor and recipient blood profile was assessed. The blood parameters assessed included total erythrocyte count (TEC), total leucocyte count (TLC), haemoglobin(Hb), packed cell volume (PCV), and total serum protein (TP). A posttransfusion upgradation of the haematological parameters (TEC, Hb and PCV) and TP was noticed in the recipient animals. Blood banking can be of great importance to store and supply blood at the time of need to treat critically ill animals when life is threatened without such restoration.

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Application of Genomic Tools for Genetic Improvement of Crossbred Friesian Cattle in Bangladesh

M M U Bhuiyan*, M A Rahman, J Bhattacharjee and Nasrin Sultana Juyena
Department of Surgery and Obstetrics, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: mmubhuiyan@gmail.com*

Abstract
Productive and reproductive performances are crucial factors determining the profitability of dairy farming. The objective of the project is to identify the best crossbred Friesian dam and sire using genomic tools for future selection of sires to be used for AI in dairy sector of Bangladesh. A total of 1000 phenotypically looked crossbred Friesian cows from public and private commercial farms and 20 crossbred Friesian bulls routinely used for AI by Central Cattle Breeding and Dairy Farm (CCBDF), Savar, Dhaka have been selected. Ear tags were used in all selected cows of private farms. Phenotypic data on productive and reproductive performances were collected from all selected cows at 1-2 months interval using questionnaire. Single blood sample (5 ml) from 846 animals have been collected and stored at 4°C for DNA extraction. DNA has already been extracted from 150 blood samples by using commercial DNA extraction kit and stored at -80°C after measuring concentration by Nanodrop machine. The extracted DNA and the future extracted DNA will be analyzed by using low density single nucleotide polymorphism (SNP) array following standard protocol to detect the parentage and admixture of genome in crossbred Friesian cattle to relate with the performance data. The data and DNA have not yet been analyzed and the work is in progress.

Substantial Development of Genetic Potential for Improved Productivity in Cattle Through Manipulative Reproduction Technology

Nasrin Sultana Juyena
Department of Surgery and Obstetrics, Faculty of Veterinary Science, Bangladesh Agricultural University,Mymensingh-2202, Bangladesh,E-mail: nsjuyena@bau.edu.bd

Abstract
The aim of the project was to examine socio-economical impact of genetic improvement of cattle via conventional Artificial Insemination (AI) program in selective areas of Bangladesh, and to implement the manipulative reproduction techniques such as semen processing, estrus synchronization and timed artificial insemination (TAI) at the farm level for the production of sex selective offspring to speed up the genetic improvement of economic traits of cattle. Four experiments had been conducted. In, Experiment – 1, a survey was conducted on 970 farmers in 10 upazillas in Bangladesh to study the factors affecting farmer's adoption of AI and to evaluate the productivity and income after breed up-gradation by AI. It was observed that farmer's education and breed of bull played an important role for the adoption of AI. Income/cows slightly increased after breed up-gradation by AI in cattle. Experiment -2 was performed to study the factors affecting pregnancy rate and sex selective offspring production in cows inseminated after observing natural estrus. Results revealed that sex hormones oestrogen and testosterone present at the time of AI might play a major role for sex characterization. Experiment 3 was performed to study the sperm morphometry and to investigate the effect of swim up technique on quality of spermatozoa. A total of 229 AI was performed with fractioned semen in cows/heifers after observing natural estrus. There was marked breed variation in sperm morphometry in breeding bull. 72% male calves and 85% female calves obtained from Fraction -1 and Fraction-4 respectively. We found larger head wide in 4 Fractioned sperms produced more female calves. In

Experiment-4, efficiency of different synchronization protocols was evaluated and found that estrus synchronization protocols increased pregnancy and calving rates very markedly at commercial farms. It is very worthy to mention that vaginal speculum incorporated with video camera and AI gun equipped with mobile video monitoring system (BAU AI Vision) was developed for the Veterinarians and AI technicians under the financial support of this project. This study could help the animal scientists and farmers to draw attention on using different manipulative technologies for the increased production of sex selective offspring (male or female calves), specially by separation of X and Y spermatozoa based on motility characters of spermatozoa in bulls.

Epidemiological and Patho-biological Investigation of Repeat Breeding Syndrome and Development of Strategies for Improving the Fertility of Repeat Breeder Dairy Cattle

Nasrin Sultana Juyena[1*], Md. Siddiqur Rahman[2] and Mir Md. Iqbal Hasan[1]

[1]Deparment of Surgery and Obstetrics and [2]Deparment of Medicine, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, [*]E-mail: nsjuyena@bau.edu.bd

Abstract

The aim of the project was to investigate epidemiological factors that influence repeat breeder cows (RBCs) and to develop proper strategies for the improvement of fertility of RB. Data were collected from different project areas using a questionnaire during the three years project period. Hemato-biochemical parameter of RBCs and normal cyclic cows (NCCs) were analyzed. Microbiological tests were performed from the sample of deep vaginal swab and uterine fluid of RBCs and NCCs. Hormonal (estrogen, progesterone and prolactin) profile, Vaginal Electrical Resistance (VER) and follicular diameter with dynamics were determined in RBCs and NCCs. Selected RBCs were assigned for five experimental groups according to treatmental strategies. Results showed 20.48% (412/2012) occurrence of RB cows. Occurrence of RB cows were highest in Frisian (F x L) cross and in high milk yielding cows bred with AI. Among the hemato-biochemical parameters such as mean value of Red blood cells, Hemoglobin, Packed cell volume, Total cholesterol, Triglycerides, Total protein, Glucose, Calcium, Phosphorus, Zinc of RB cows were lower than that of normal cows. Results from the microbiological study revealed that bacterial isolates were higher in RBCs samples than NCCs. Hormonal profiles, VER and ovarian follicular dynamics indicates the disturbances in hormonal synchrony and also indicates the turbulence of synchrony between the ovarian structures and estrous cycle stages in RBCs. The pregnancy rates were 48.75% (39/80) in Experimental Group 1, 58.33% (70/120) in Experimental Group 2, 55.50% (111/200) in Experimental Group 3, 85.00% (102/120) in Experimental Group 4 and 45.45% (10/22) in Experimental Group 5. Overall pregnancy rate of RB cows obtained during the study period was 83.00% (332/400) and 325 calves (81.25%) were delivered from the pregnant cows, while 07 calves were aborted. Among the 325 post-partum NC cows 303 (93.23%) were pregnant normally through balanced feeding and double time AI (8-10 hours apart) after 40 days post-partum estrus. This study recommends good management practices during transition and post-partum periods for the prevention of repeat breeding syndrome in dairy cows.

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Application of Non-steroidal Aniti-inflammatory Drug of Wound Healing in Goats

Md. Mizanur Rahman
Department of Surgery and Obstetrics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: miznih@gmail.com

Abstract

Non-steroidal anti-inflammatory are the ketoprofen, diclofenac sodium and steroidal inflammatory drug Ketoprofen is non-steroidal aniti-inflammatory drug (NSAID) group. It is frequently used in pain management after injury. It is highly effective for pain and inflammation management. Ketoprofen acts as nonselective inhibitor of the enzyme cyclooxygenage (COX), which helps in inflammation,cell migration and collagen synthesis. The present study has been conductedon 16 goats to determine the effect of ketoprofen on wound healing. Goats were divided into 4 groups and long incised wounds were created on the back of four goats of each group. Healing process observed immediately after surgery to check the morphological changes like colonization, swelling, and elevation of suture line. Histopathological investigation was also carried out on Day 3, Day 7, and Day 21.Elevation of suture line (2.58±.08 mm), swelling of suture area (3.50±0.14 mm) were lower in wounds of group A than group D,(3.25±0.04 mm), (4.25±0.05). Healing time of group A (24.75±0.21 day) was higher than (19.5±0.20 day) in group D, whereas, contraction rate (1.33±0.04 mm) in group A was lower than group D (1.75±0.04mm). The level of total serum protein was within normal range in all experimental groups. Level of collagen fiber, blood vessels, hair follicles and keratin layer were reduced in ketoprofen treated group. The results indicated that ketoprofen has negative impact on wound healing process. These results suggested that ketoprofen could not be used randomly for clinical management of wounds.

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Weed Diversity in Field Crops of Agronomy Field Laboratory at Bangladesh Agricultural University

Mahfuza Begum*, Sad-A-Afreen and Fahmida Akhter
Department of Agronomy , Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
**E-mail: mahfuza.agron@bau.edu.bd*

Abstract
A weed survey was conducted at Agronomy Field Laboratory in Bangladesh Agricultural University, Mymensingh from November 2017 to November 2018 to study the weed diversity in wheat, *boro* and T. *aman* rice. Four sampling spots from each field (total four fields for each crop) were selected by zigzag method. Fields were surveyed at vegetative stage i.e. at 20 DAS (wheat), at 25 DAT (*boro* and T. *aman* rice) and at harvest of these three crops using quadrate (0.25 m^2). Weeds within quadrate were identified and counted species-wise. Relative abundance value (RA, %) was calculated from Frequency, Field uniformity, Mean field density, Relative frequency, Relative field uniformity, and Relative mean field density. Co-efficient of similarity (%) was calculated based on relative abundance value. A total of 64 weed species belonging to 28 different families were recorded in three crops of which 37 species (in wheat), 38 species (in *boro*), 36 species (in T. *aman*) belonged to 20, 18, 15 families, respectively. *Chenopodium album* (in wheat), *Eleocharis atropurpurea* (in *boro*) and *Monochoria vaginalis* & *Leersia hexandra* (in T. *aman*) were the common and most dominant weed species in both periods. In wheat four other dominant weed were *Polygonum hydropiper, Hedyotis corymbosa*, *Cynodon dactylon, Raphanus raphanistrum* at 20 DAS and *Phyllanthus niruri*, *Gnaphalium luteo-album, Cyperus rotundus, Echinochloa colonum* at harvest. In *boro* field *Eleocharis atropurpurea*, *Leersia hexandra*, *Cyperus difformis* were common and dominant with different rank in both periods. *Monochoria vaginalis and Polygonum hydropiper* were found at 25 DAT and *Echinochloa crus-galli,* and *Hydrocoty lesibthorpioides* were dominant at harvest. In *aman* field *Eleocharis atropurpurea, Echinochloa crusgalli, Eclipta alba* (at 25 DAT) and *Cyperus difformis, Pistia stratiotes* and *Sphenoclea zeylancia* (at harvest) were found. Poaceae was the most dominant family followed by Cyperaceae. Co-efficient of Similarity between two growing periods vegetative and reproductive were low to medium at 38.36% in wheat, 56.47% in *boro* and 21.96% in T. *aman* indicated divergence weed composition. From this study we may conclude that divergence and rank and order of most abundant weed species in different crops was different so, weed control measure should be adopted on crop basis considering the infestation of dominant weed species rather than any country wide recommended control measure.

Effect of Zinc and Boron on yield and quality of tropical sugarbeet

Swapan Kumar Paul*, Chandan Kumar Mahapatra, Md. Abdul Kader and Md. Abdur Rahman Sarkar
Department of Agronomy, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: skpaul@bau.edu.bd*

Abstract
Two experiments were conducted during July 2018 to June 2019 at the Agronomy Field Laboratory, BAU to assess the effect of Zn and B on the yield and quality of sugarbeet. Shubhra, Cauvery, HI-0044, HI-0473, KWS Danicia, KWS Serenada, KWS Allayana and KWS Gregoria varieties were used for both experiments. Zinc 0, 2, and 4 kg ha^{-1}, and Boron 0, 1.5 and 3 kg ha^{-1} were used to assess their response to variety. Irrespective of variety most of the cases Zinc increased beet yield up to 2 kg ha^{-1}. The highest beet yield (112 t ha^{-1}) was recorded in Cauvery fertilized with 2 kg Zn ha^{-1} which was at par with KWS Danicia and HI 0473 when fertilized with 2 kg Zn ha^{-1} while the lowest beet yield (58 t ha^{-1}) was recorded in Shubhra with 0 kg Zn ha^{-1}. The highest brix (18%) was recorded in KWS Danicia

with 2 and 4 kg Zn ha^{-1}. Boron also influenced beet yield and quality significantly. The highest beet length (34.67 cm) and beet yield (125 t ha^{-1}) were recorded in HI-0473 fertilized with 1.5 kg B ha^{-1} while the statistically identical beet yield was obtained in KWS Serenada and Shubhra with 3 kg B ha^{-1} while the lowest beet yield (62 t ha^{-1}) was recorded in Cauvery with 0 kg B ha^{-1}. The highest brix (18%) and pol (13.59%) were recorded in HI-0473 fertilized with 3 kg B ha^{-1}. Therefore, Zn and B appear as the promising micronutrients for tropical sugarbeet cultivation that influence beet yield and juice quality.

Influence of variety and weed free periods on the growth, yield and quality of soybean (G*lycine max* L.)

Swapan Kumar Paul*, Sadia Ferdausi Nimu, Shubroto Kumar Sarkar and Md. Abdus Salam

Department of Agronomy, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: skpaul@bau.edu.bd*

Abstract

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during December 2018 to June 2019 to study the influence of variety and weed free periods on the growth, yield and quality of soybean (*Glycine max* L.). The experiment was laid out in a randomized complete block design with three replications consisting of three varieties viz. Binasoybean-1, Binasoybean-3 and BARI Soybean-6 and five weed free periods viz. weedy check, weed free up to 20 days after sowing (DAS), weed free up to 40 DAS, weed free up to 60 DAS and weed free throughout the growth period. At 80 DAS, the highest plant height (44.75 cm), number of nodules $plant^{-1}$ (30.17) and dry matter production $plant^{-1}$ were obtained in BARI Soybean-6 along with weed free throughout the growth period. At harvest, BARI Soybean-6 gave the highest plant height, pods $plant^{-1}$, 1000-seed weight, seed yield, stover yield, protein content and oil content while Binasoybean-1 produced the lowest results of all parameters. Weed free throughout the growth period produced the highest plant height, branches $plant^{-1}$, pods $plant^{-1}$, 1000-seed weight, seed yield, stover yield, protein and oil content whereas the corresponding lowest values were recorded in weedy check. Seed yield increased by 91.58% in weed free throughout the growth period compared to weedy check. In case of interaction, the highest seed and stover yields, and protein content were observed in BARI Soybean-6 with weed free throughout the growth period which was at par with BARI Soybean-6 with weed free up to 60 DAS while the lowest values of all parameters were found in Binasoybean-1 with weedy check treatment. Therefore, it can be concluded that BARI Soybean-6 along with weed free up to 60 DAS appears as the promising practice for the maximization of seed yield and protein content of soybean.

Yield and Seed Protein Content of Faba bean (*Vicia faba* L.) in Response to Date of Sowing and Phosphorus Fertilization

Swapan Kumar Paul*, Wasima Yasmin and Md. Parvez Anwar

Department of Agronomy, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: skpaul@bau.edu.bd*

Abstract

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University (BAU), Mymensingh during November 2018 to March 2019 to assess the yield and seed protein content of faba bean (*Vicia faba* L.) in response to date of sowing and phosphorus fertilization. The experiments comprised three date of sowing *viz.* 25 November, 5 December, 15 December and five levels of phosphorus of *viz.* 0, 10, 20, 30, 40 kg P ha^{-1}. The experiment was laid out in a randomized

complete block design with three replications. Early sowing on 25 November produced the tallest plant (42.95 cm), highest number of branches plant^{-1} (8.31), number of pods plant^{-1} (49.87), 1000-seed weight (97.55 g), seed yield (1.21 t ha^{-1}), stover yield (1.98 t ha^{-1}) and seed protein content (31.54%) while the corresponding lowest values were recorded from late sowing on 15 December sowing. The crop fertilized with 40 kg P ha^{-1} produced the highest number of branches plant^{-1} (8.33), number of pods plant^{-1} (49.05), 1000-seed weight (97.40 g), seed yield (1.33 t ha^{-1}), stover yield (2.28 t ha^{-1}) and seed protein content (38.17%) while control treatment (0 kg P ha^{-1}) produced the lowest values of all parameters. In case of interaction, the highest number of pods plant^{-1} (58.42), seed yield (1.59 t ha^{-1}), stover yield (2.44 t ha^{-1}) and protein content in seeds (39.60) were recorded with 25 November sowing fertilized with 40 kg P ha^{-1} whereas the lowest seed yield (0.54 t ha^{-1}), stover yield (1.32 t ha^{-1}) and seed protein content (25.90%) were obtained from 15 December sowing along with control treatment. It can be concluded that early sowing (25 November) along with higher dose of phosphorus fertilization (40 kg P ha^{-1}) appears as the promising practice for obtaining higher seed yield and seed protein content of faba bean.

Evaluation of yield and nitrogen use efficiency in modern Wheat cultivars

Uttam Kumer Sarker* and Md. Romij Uddin
Department of Agronomy, Bangladesh Agricultural University Mymensingh-2202, Bangladesh
E-mail: uttam@bau.edu.bd

Abstract

The nitrogen (N) requirement of wheat cultivars may differ because of differences in growth duration and N dynamics in the soil. Variability in N utilization, content and uptake by grain affects physiological aspects and yield. Therefore, an experiment was conducted at the net house of Agronomy Department, BAU, Mymensingh, during the period from November 2018 to March 2019 to evaluate yield and nitrogen use efficiency in modern wheat cultivars. Ten wheat varieties viz. BARI GOM 24, BARI GOM 25, BARI GOM 26, BARI GOM 27, BARI GOM 28, BARI GOM 29, BARI GOM 30, BARI GOM 31, BARI GOM 32, BARI GOM 33 and four levels of nitrogen viz. i) 0 nitrogen, ii) 45 kg N ha^{-1}, iii) 90 kg N ha^{-1}, iv) 135 kg N ha^{-1} were included in the study. Nitrogen was applied as treatments in the study. The experiment was laid out in a completely randomized design (CRD) with three replications. Results revealed that the variety BARI GOM 32 produced the highest plant height (97 cm) and leaf area index (1.07). The yield and yield contributing characters of wheat increased with an increase in nitrogen levels up to 90 kg N ha^{-1}. The interaction between variety and nitrogen levels significantly influenced yield contributing characters, yield and nitrogen use efficiency. BARI GOM 32 produced grain yield (4.53 t ha^{-1}), straw yield (6.58 tha^{-1}) and nitrogen use efficiency (35.63) at 90 kg N ha^{-1} The result of the present study showed that the highest grain yield and nitrogen use efficiency was obtained from the variety BARI GOM 32 with an application of 90 kg N ha^{-1}.

Development of sustainable biological weed management techniques through allelochemicals from crop residues

Md. Romij Uddin* and Uttam Kumer Sarker
Department of Agronomy, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
**E-mail: romijagron@bau.edu.bd)*

Abstract

A two year study was conducted in the Agronomy Field Laboratory, BAU, Mymensingh, Bangladesh. Barley, sorghum, wheat, lentil, mustard, soybean, rice, maize and grasspea, acacia, pea and marsh

pepper crop residues were used. After collection, the crop residues were dried and crop residues were brought and chaffed with fodder cutter. Chaffed crop residues were soaked in water in the ratio of 1:10 (w/v) for 24 hours at ambient room temperature. The filtered extract was considered as 100% concentration and then they were diluted into 75% and 50%. The herbicidal activity of 12 different crop residues was tested on weed species of *Echinochloa crus-galli* (shama). Ten seeds of *Echinochloa crus-galli* were allowed to germinate in sterile Petri dishes at concentrations of 0, 100%, 75% and 50% concentrated crop residues extracts for 2 week. After that field experiment was conducted in *aman* seasons at Agronomy Field Laboratory, BAU, Mymensingh during the period from December 2017 to May 2018. The variety BRRI dhan29 was used as test material. The highest germination (85.00%) was obtained from pea leaf extract where as lowest (74.17%) was in sorghum leaf extract. The highest % inhibition for germination and shoot length (23.06%, 37.94%), shoot dry weight and root dry weight (40.48%, 39.60%) was obtained from sorghum leaf extract.The interaction on weed population, dry weight and growth inhibition of shama were significant. Combined effect of time of application and crop residues showed non-significant variation in grain yield. However highest grain yield (4.53 t ha^{-1}) was observed in sorghum residues application when applied before transplanting while the lowest grain yield (1.02 t ha^{-1}) was observed in T_2C_1 (applied crop residues at one week after transplanting and no crop residues application) treatment.

Designing and developing climate change resilient cropping systems for the *haor* area of Bangladesh

Md. Mafizul Islam, Md. Romij Uddin* and Uttam Kumer Sarker

Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : romijagron@bau.edu.bd*

Abstract

The *haor* region has long been lagging behind mainstream national development although the economic development of Bangladesh is moving steadily at a moderate pace. The future challenges in the context of climate change are also a major concern for the sustainable development of the region. Based on these issues, a number of studies were undertaken in the haor region of Bangladesh to create an inventory of existing cropping systems and to design, test and formulate the performance of climate resilient and nutrition sensitive cropping systems. First of all, the scenarios of existing cropping systems in the study area were evaluated through focus group discussion (FGDs) and in depth farmers' interview with questionnaire. The strengths points of the study area are fertile soil, surplus rice production, more per capita land, possibility of crop diversification with high value crop and struggling effort with adversity. Besides the weak points are water logging, mono-cropping, malnutrition, fallow land, poor communication system, absentee farmers, food insecurity and technologically poor. After that study the feasibility of crop diversification and intensification of Fallow-*Boro* rice was evaluated in the selected farmers' field with different vegetables and oilseeds but not neglecting *Boro* rice. The treatments were T_1-Fallow-Boro (Control), T_2-Potato-Boro, T_3-Red amaranth-*Boro*, T_4-Carrot-Boro, T_5-Spinach-*Boro*, T_6-Radish-*Boro*, T_7-Mustard-*Boro*, T_8-Chinashak-*Boro*, T_9-Sweetgourd-*Boro*, T_{10}-Tomato-*Boro*, T_{11}-Cabbage-*Boro* and T_{12}-Cauliflower-*Boro*. The comparatively higher yields were obtained from T_2-Potato-*Boro* (8.17 and 5.20 t ha^{-1}), T_{11}-Cabbage-*Boro* (39.52 and 4.80 t ha^{-1}), T_{10}-Tomato-*Boro* (21.74 and 5.01 t ha^{-1}), T_{12}-Cauliflower-*Boro* (30.87 and 4.85 t ha^{-1}), T_4-Carrot-*Boro* (14.82 and 4.90 t ha^{-1}) and T_5-Spinach-*Boro* (11.11 and 4.90 t ha^{-1}). Based on yield and economics the best responsive six cropping patterns were T_2-Potato-Boro, T_{11}-Cabbage-*Boro*, T_{10}-Tomato-*Boro*, T_{12}-Cauliflower-*Boro*, T_4-Carrot-*Boro* and T_5-Spinach-*Boro*.

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Assessment of cropping pattern Fallow-Fallow-T.aman rice with Wheat-Jute-T.aman rice in char areas of Netrakona region

Md Romij Uddin* and Uttam Kumer Sarker
Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : romijagron@bau.edu.bd*

Abstract
Fallow - Fallow - T. aman cropping pattern is the common and popular cropping pattern in char area of Netrakona region. Farmers mostly cultivate T.aman rice under rainfed condition and not interested to cultivate wheat or jute during rabi and kharif 1. Wheat and Jute may be introduced for improvement of cropping pattern. Considering mentioned points, the study was conducted to determine the yield and economic performance of two cropping patterns viz. IP: improved pattern (Wheat - Jute - T. aman) + improved management practice and FP: farmer's pattern (Fallow - Fallow - T. aman) + management practice. The experiment was laid out in a randomized complete block design with six dispersed replications at farmer's field in Netrakona region during 2017-18 and 2018-19. The data of improved management practice for the pattern produced significantly higher yield in T. Aman rice respectively and also gave additional jute yield .It was concluded that farmers of Netrakona region might follow Wheat (var. BARI Gom-26) - Jute (var. O-9897) - T. aman (var. BRRI dhan49) cropping system in char land for higher productivity and profitability.

Bioherbicidal activity of aqueous extracts of grass pea and lentil crop residues in upland crops

Md. Romij Uddin* and Uttam Kumer Sarker
Department of Agronomy, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail : romijagron@bau.edu.bd)*

Abstract
Two experiments were conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh to evaluate the effect of aqueous extract of grass pea and lentil crop residues on weed management and crop performance of wheat. These experiments consisted of three varieties of wheat viz., BARI GOM25, BARI GOM28, BARI GOM30 and six treatments such as no use of aqueous extract used as control (T_1), aqueous extract as pre-emergence application (T_2), aqueous extract as pre and post emergence at 15 DAS (T_3), aqueous extract as post emergence at 7 DAS (T_4), aqueous extract as post emergence at 7 and 15 DAS (T_5) and hand weeding (T_6)and in the second experiment the varieties and treatments were the same. These experiments were laid out in a randomized complete block design with three replications. In both experiments maximum weed growth was noticed with the variety BARI GOM25. The grain yield as well as the other yield contributing characters produced by BARI GOM30 was the highest among the studied varieties. The highest percent inhibition for all of the weeds was found in hand weeding treatment. The highest numbers of tillers $hill^{-1}$, numbers of grains $spike^{-1}$ and grain yield were observed where hand weeding is done followed by the application of aqueous extract of grass pea and lentil crop residues @as post emergence at 7 and 15 DAS. BARI GOM30 cultivar with all treatments produced the highest grain and straw yield among the treatment combination. Therefore, aqueous extract of grass pea and lentil crop residues might be used as an alternative way for weed management in effective and sustainable crop production.

Synergisms of allelopathic potential crop residues for weed management in rice

Md. Romij Uddin*, Nazia Tabassum[1] and Uttam Kumer Sarker
*Department of Agronomy and [1]Agribusiness and Marketing, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh, *E-mail : romijagron@bau.edu.bd*

Abstract
Department of Agronomy, Bangladesh Agricultural University, Mymensingh, Bangladesh For developing an alternative weed control strategy allelopathic activity of crop residues to common weeds and selectivity of crops were studied in upland organic farming. All crop residues applied in the experiments suppressed weed growth and inhibition at satisfactory level. Two experiments were conducted to evaluate the synergisms of allelopathic potential crop residues on weed suppression and crop performance of transplanted *aman* rice. Among the treatments used in both of the experiments, hand weeding was the most effective and among the crop residues used in this study, combined use of crop residues was the most effective compared to their single application. It was noticed that broadleaf weed species were more susceptible to crop residues than grass weed species. In this respect, the highest growth inhibition (91.66%) in experiment-1 and (88.33%) in experiment-2were observed in controlling Pani Shapla *(Nymphaea nouchali)*. In respect of yield and yield contributing characters, cultivar and crop residues responded significantly. The results indicated that the highest grain and straw yield (4.81 t/ha and 7.65 t/ha)in experiment-1and (5.26 t/ha and 7.65 t/ha)in experiment-2, both were observed in hand weeding along with variety BR11, whereas the second highest (4.19 t/ha and 7.36 t/ha)in experiment-1 and (4.89 t/ha and 7.29 t/ha)in experiment-2 were obtained from combined use of grass pea and mustard crop residues @ 1 tha^{-1} of each and combined use of sorghum and lentil crop residues @ 1 t $ha^{-1}$of each, respectively using the same variety.

Influence of water regimes and Nitrogen fertilizer on growth and yield of French bean

F M Jamil Uddin*, Abdur Razzak and Md Moshiur Rahman
Department of Agronomy, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: jamil.bau@gmail.com*

Abstract
The experiment was conducted at the Agronomy Field Laboratory of the Department of Agronomy, Bangladesh Agricultural University to study the effect of water regimes and nitrogen on the growth and yield of French bean during July 2018 - June 2019. The experiment consisted of two factors namely; (i) water regimes level (3); W_0= No irrigation, W_1=one irrigation during flowering and W_2=two-irrigation; (during flowering + pod development stage) and (ii) Nitrogen level (3): N_0 = No N fertilizer, N_1=100% basal application and N_2=50% basal application+ 50% pod development stage. BARI Jhar Sheem-3 has used as experimental crop. The experiment was laid out in randomized complete block design with three replications. Water regimes and nitrogen showed significant effect on most of the plant characters *viz* Plant height at harvest (cm), number of pods $plant^{-1}$, number of effective pods $plant^{-1}$, number of non-effective pods $plant^{-1}$, length of pod (cm), number of grains pod^{-1}, grain yield (t ha^{-1}), stover yield (t ha^{-1}), biological yield (t ha^{-1}), and harvest index (%).The maximum seed yield (2.07 t ha^{-1}) was found at one irrigation at flowering stage (40DAS) (W_1) and minimum seed yield (1.48 t ha^{-1}) was found at no irrigation (W_0). The maximum seed yield (2.23 tha^{-1}) was found at 195 kg N ha^{-1} at 50% (97.5kg) basal application and 50% pod development stage (60DAS) (N_2) and minimum seed yield at (1.10 tha^{-1}) was found at (N_0) treatment. The interaction between water regimes and

nitrogen had significant influence on the yield contributing characters and yield of French bean. Results showed that the yield contributing characters and yield of French bean was increased with the good combination of water level and nitrogen doses. The highest seed yield (2.52 tha^{-1}) was found at W_1N_2 treatment and the lowest seed yield (0.76tha^{-1}) was found W_0N_0 treatment (no irrigation and no nitrogen). Hence, the water regimes and nitrogen fertilizer management is very important agronomic management practices for higher and efficient production of French bean.

Effect of Phosphorus and Boron on the growth and yield of French bean

Mohammad Hadiuzzaman, F M Jamil Uddin*, Harun Or Rashid and Saedy Karim
Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**Email: jamil.bau@gmail.com*

Abstract
An experiment was conducted at the Agronomy Field Laboratory of the Department of Agronomy, Bangladesh Agricultural University, Mymensingh to study the effect of phosphorus and boron on the growth and yield of French bean during July 2018 to June 2019. BARI Jharsheem-3 was used as the experimental crop. The first experiment was comprised of two factors involving levels of phosphorus *viz.* P_1 = 15 kg P ha^{-1}, P_2 = 20 kg P ha^{-1}, P_3 = 25 kg P ha^{-1}, P_4 = 35 kg P ha^{-1} and levels of boron *viz.* B_1 = 0 kg B ha^{-1}, B_2 = 0.5 kg B ha^{-1}, B_3 = 1 kg B ha^{-1} and B_4 = 1.5 kg B ha^{-1}. TSP and Borax were used as source of phosphorus and boron, respectively. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The results exhibited that growth and yield contributing characteristics were significantly influenced by the phosphorus and boron applications. The experimental findings revealed that the tallest plant, maximum number of branches $plant^{-1}$, the highest leaf area, dry matter, number of pods $plant^{-1}$, pod length number of seeds pod^{-1}, and 1000 seed weight, seed yield (1.40 t ha^{-1}), stover yield (1.76 t ha^{-1}), biological yield (3.16 t ha^{-1}) and harvest index (46%) were recorded from P_2 = 20 kg P ha^{-1}. The experimental findings also revealed that the tallest plant, maximum number of branches $plant^{-1}$, the highest leaf area, dry matter, number of pods $plant^{-1}$, pod length, number of seeds pod^{-1}, and 1000 seed weight, seed yield (1.39 t ha^{-1}), stover yield (1.68 t ha^{-1}), biological yield (3.07 t ha^{-1}) and harvest index (45.27 %) were recorded from 0.5 kg B ha^{-1}. Again interaction of phosphorus and boron, the tallest plant, maximum number of branches $plant^{-1}$, the highest leaf area dry matter (24.75 g), number of pods $plant^{-1}$, pod length, number of seeds pod^{-1} and 1000 seed weight, seed yield, stover yield (1.88 t ha^{-1}), biological yield (3.31 t ha^{-1}) and harvest index were recorded from 20 kg P ha^{-1} and 0.5 kg B ha^{-1} (P_2B_2). So it may be concluded that 20 kg P ha^{-1} and 0.5 kg B ha^{-1} could be applied to obtain maximum yield of French bean.

Influence of the application of straw residue and poultry manure on soil carbon sequestration under different land uses

Sabina Yeasmin*, Asaduzzaman and Fahmida Akter
Department of Agronomy, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: sabinayeasmin@bau.edu.bd)*

Abstract
Soil organic carbon (OC) is the largest terrestrial C stock and soils' capacity to preserve OC varies with many factors including land use organic matter (OM) management. This study aimed to assess the effect of OM amendments on C sequestration of soils under diverse land uses. This was a pot

experiment under net house conditions and composed of two OM amendments: rice straw (RS) and poultry manure (PM); three application rates of OM: 0 g (control), 50 g, 150 g dry weight/pot and three land uses: cultivated: - (i) rice-rice and (ii) rice-wheat, and (iii) uncultivated: - grassland. After 4 months of incubation, soil samples were collected and fractionated into particulate (>53µm, labile) and mineral associated (<53µm, stable) OMs. Bulk soil samples (before and after incubation) and soil fractions were analyzed for OC and nitrogen (N), and C sequestration percentage was calculated. Among land uses, rice-rice system stored higher amounts of OC (27-53%) than rice-wheat (8-33%) and grassland (0.2-10%). This may be related to OC–mineral association (chemical stabilization) mechanism, since the mineral associated OM fraction was the highest in rice-rice system among the land uses. Application of PM led to a significant increase (9.59-92.78%) in OC content than RS (0.06-75.69%) which was attributed to the narrower C: N ratio of PM, that resulted higher decomposability of OM than RS. Application of manure showed higher C sequestration potential than RS application which was corresponding to the higher distribution of OC in the mineral associated fractions than labile portion. Use of higher organic amendments always did not enhance OC content and decreased C sequestration percentage in the soils. Because the microbial activity most likely did not match with the higher amount of OM, and resulted increased distribution of OC in the partially decomposed labile fractions compared to the mineral associated OM. Thus, C sequestration potential was higher in PM than RS, and in cropland soil than uncultivated soil. The findings revealed the necessity of paying more attention to the selection of the type and rate of organic amendments for enhancing C sequestration in soil and sustainable agriculture.

Suitability Assessment of Some Hilly Black Rice Cultivars in Plain Land Ecosystem

Md. Rashedur Rahman

Department of Agronomy, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
E-mail : rashedagron@bau.edu.bd

Abstract

To assess the suitability of hilly black rice cultivation in plain land ecosystem, an experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from April 2018 to March 2019. As the first phase, morphological, phenological and yield contributing and yield characters of the cultivars were identified. Three varieties named Knognang ene, Gelong ni and Gelong se with 12 date of transplanting (1st day of every months of the year) were used as experimental treatments. It was found that Gelong se produced tallest plant (115.25 cm), highest number of effective tillers (1071) per hill, number of grains per panicle (123.46), weight of 1000-grain (30.82) and grain yield (4.00 t/ha). Considering the date of transplanting it was found that highest number of effective tiller (13.72) was produced when the seedlings were transplanted on January 01. The same transplanting date also gave maxium number of grains (130.3) per panicle, highest grain yield (4.0 t/ha) and highest straw yield (7.66 t/ha). Days required to express different phenological characters were significantly differed among the rice cultivars and transplanting date. After transplanting, the cultivar Kongnang ene required minimum number of days (42.17) to panicle initiation (PI), 62.50 days to flowering and 95.67 days to harvesting. Considering transplanting date, minimum days (44.67) required to PI when transplanted on May 01, but 66.67 days required to flowering and 100 days required to harvesting when transplanted on April 01. However, longest period viz. 53 days to PI, 75 days to flowering and 112.0 days to harvesting was required when transplanted on December 01.

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Determination of economic efficiency by the performance of maize and french bean cultivated under intercropping system

Md. Rashedur Rahman
Department of Agronomy, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
E-mail : rashedagron@bau.edu.bd

Abstract
An experiment was set to find out economic efficiency of maize and french bean grown as intercrop. The experiment was conducted at the Agronomy Field Laboratory, BAU, Mymensingh during the period from October 2018 to April 2019. The experimental treatments were i) sole maize, ii) sole french bean, iii) single row of maize followed by double rows of french bean, iv) single row of maize followed by triple rows of french bean, v) single row of maize followed by quadruple rows of french bean, vi) double row of maize followed by double rows of french bean, vii) double row of maize followed by triple rows of french bean and viii) double row of maize followed by quadruple rows of french bean. The experiment were laid out in a randomized complete block design (RCBD) with three replications. Each plot size was 12 m^2 (4m × 3m). The unit plots were uniformly fertilized with, urea, triple super phosphate, muriate of potash and gypsum according to the recommended dose maize crop. All intercultural operations were done as and when necessary. Results revealed that seed yield of both maize (8.54 t/ha) and french bean (1.98 t/ha) were higher when they were grown separately as sole crops. But, when land equivalent ratio and benefit cost ratio is considered then it was found that intercropping of maize and french bean was far better than the sole cropping of either of the crops. More specifically, when one rows of maize is grown alternately with four rows of french bean then the land equivalent ratio become higher (1.13) than that of sole cropping (1.00). Again, when two rows of maize is grown alternately with four rows of french bean then benefit cost ratio become higher (1.8) than that of the sole cropping.

Evaluation of allelopathic potential of Marsilea crenata (shusni shak) extracts and residues

Md. Shafiqul Islam[1]*, Md. Rakibul Islam[1], Md. Abdur Razzak[2] and Md. Abdus Salam[1]
*[1]Department of Agronomy and [2]Department of Crop Botany, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail : shafiqagron@bau.edu.bd*

Abstract
The current agricultural system is seeking a biological solution to lessen hazardous impacts from the use of chemicals to control weeds in rice production. Plant allelopathy is one of the ways where allelopathic plant inhibits its surrounding plants by releasing allelochemicals. The present study was conducted to evaluate the allelopathic effects of the extracts and residues of *Marsilea crenata* on weed management and the yield performance of *boro* rice. The pot experiment consisted of five *M. crenata* extracts concentration such as 0% (control), 25%, 50%, 75% and 100%. The field experiment consisted of three rice varieties i.e. BRRI dhan28, BRRI dhan29 and BRRI dhan60 and five *M. crenata* residues such as 0, 1.0, 2.0, 3.0 t ha^{-1} and farmer's practices. Seven weed species belonging to four families infested the experimental pots, whereas four weed species belonging to three families infested the experimental field. Weed population and weed dry weight were significantly affected by the extracts, cultivars and residues. In pot experiment, with the increased of concentration, weed species and weed dry weight were gradually decreased. In field experiment, the maximum weed growth was found with the no residues and the minimum was at 3 t ha^{-1} residues treatments. The highest grain yield as well as the yield contributing characters were recorded in BRRI dhan29 and the lowest grain yield

was obtained in the cultivar BRRI dhan28. The highest reduction of grain yield was obtained in no crop residue treatment. Rice cultivar BRRI dhan29 with the incorporation of *M. crenata* residue at 3.0 t ha^{-1} produced the highest grain yield. The results of the study suggest that the *M. crenata* residues may possess allelopathic potential and might be used as an alternative way for effective weed management and sustainable crop production.

Assessment of allelopathic potential in Rumex maritimus extracts and residues

Md. Shafiqul Islam[1]*, Sumona Aktar[1], Debashis Roy[2], Farhana Zaman[1] and Ahmed Khairul Hasan[1]

*Department of Agronomy and [2]Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh-2202. Bangladesh, *E-mail : shafiqagron@bau.edu.bd*

Abstract

Recently, the use of chemical herbicide to control weed in rice field is being increased. But, due to the negative impact of chemical herbicides to the environment, human and animal, the researcher is now diverting biological ways to manage weed in rice cultivation. In this regard, the use of extracts and residues of crop could be a biological alternative to control weed. In the study, we conducted two independent experiment to evaluate the effect of aqueous extract and residues of *Rumex maritimus* on weed management and crop performance of *boro* rice. In first (pot) experiment, *R. maritimus* extract (0%, 25%, 50%, 75%, and 100%) was used and in second (field) experiment, three cultivars (BRRI dhan28, BRRI dhan29, BRRI dhan60, and four *R. maritimus* residues (0, 1.0, 2.0, 3.0 t ha^{-1}) were used as treatment. Six weed species belonging to four families were identified in pot at control. With the increased of the extract of *R. maritimus*, the weed species gradually inhibited. Weed population and weed dry weight were significantly affected by different concentrations of *R. maritimus* extracts. In field experiment, four weed species belonging to four families infested the rice cultivars. Weed density and dry weight were non-significantly affected by cultivar and crop residues. The highest reduction of grain yield was obtained in no crop residue treatment. The highest number of effective tillers $hill^{-1}$, number of grains $panicle^{-1}$, 1000-grain weight, grain and straw yields were observed at 3.0 t ha^{-1} residue treatment. BRRI dhan28 under residue of 3.0 t ha^{-1} treatment produced the highest grain (5.83 t ha^{-1}) and straw yields (7.53 t ha^{-1}). Results of this study indicate that, *R. maritimus* extracts and residues showed potentiality to inhibit weed growth and it has a significant effect on the yield of *boro* rice.

Selection of Agronomic Traits for Weed Competitiveness of Bangladeshi Popular Rice Varieties

A K M Mominul Islam[1*] and Md Anwarul Abedin[2]

*[1]Department of Agronomy and [2]Department of Soil Science, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh, *E-mail: akmmominulislam@bau.edu.bd*

Abstract

Current study aims to identify promising rice variety(s) with high yield potential and strong weed competitiveness from the popular rice varieties of Bangladesh. The study was conducted during *aman* and *boro* season (July 2018 to June 2019) at the Agronomy Field Laboratory of Bangladesh Agricultural University. *A total of 56 popular rice varieties (33 aman and 23 boro rice) were* grown under weedy and weed-free conditions. Plots with no rice were also maintained to observe the natural

growth of weed in absence of rice. The experiment was laid out in a randomized complete block design with three replications. Results showed that rice varieties varied widely in their yield performances and weed competitiveness. Among *aman* varieties, BRRI dhan31 allowed the minimum weed growth (32.5 g m^{-2}) while BRRI dhan51 allowed the maximum (155.3 g m^{-2}). Among *boro* varieties, BRRI dhan68 allowed the minimum weed growth (39.2 g m^{-2}) while BRRI dhan47 allowed the maximum (297 g m^{-2}). In *aman* season, grain yield ranged between 3.6 t ha^{-1} (BRRI dhan49) and 7.5 t ha^{-1} (BR 10) under weed-free condition and between 2.2 t ha^{-1} (BRRI dhan70) and 3.9 t ha^{-1} (BRRI dhan34) under weedy condition. In *boro* season, yield ranged from 4.3 t ha^{-1} (BRRI dhan61) to 8.3 t ha^{-1} (BRRI hybrid dhan3) under weed-free condition and between 1.3 t ha^{-1} (BRRI dhan61) and 5.3 t ha^{-1} (BRRI hybrid dhan3) under weedy condition. Weed inflicted relative yield loss (RYL) ranged from 10.2 to 66.9% among the *aman* varieties and 35.8 to 68.8% among the *boro* varieties. *Aman* varieties, BRRI dhan34 allowed the least yield penalty (10.2%) while BRRI dhan70 had the maximum (66.9%), whereas, *boro* rice BRRI hybrid dhan3 allowed the least yield penalty (35.8%) while BRRI dhan61 had the maximum (68.8%). BR 10 appear as the most productive *aman* variety (7.5 t ha^{-1}) but its weed inflicted RYT was higher (51.3%) than many other varieties with low yield potential. *Aman* rice, BRRI dhan34 appeared as the most weed competitive variety (only 10.2% RYT) with productivity of 3.9 t ha^{-1}. On the other hand, BRRI hybrid dhan3 appear as the most productive as well as weed competitive variety. Furthermore, plant height, tillering ability, above ground crop biomass, early visual vigor were identified as the major agronomic traits for higher weed competitiveness.

Competitiveness of Monsoon and Winter Rice Varieties against Weed under Puddled Transplanted System of Cultivation

A K M Mominul Islam* and Md Shafiqul Islam

Department of Agronomy, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: akmmominulislam@bau.edu.bd*

Abstract

Weed competitive rice cultivar may be considered as a viable tool for integrated weed management. In this circumstances, two experiments were designed to evaluate the weed competitiveness of selected monsoon and winter rice varieties of Bangladesh under puddled transplanted system of cultivation. The experiments were conducted during July 2018 to June 2019 at the Agronomy Field Laboratory of Bangladesh Agricultural University. *A total of 71 rice varieties (43 monsoon and 28 winter rice) were* grown under season-long weedy and weed-free conditions. Plots with no rice were also maintained to observe the natural growth of weed in absence of rice. Both experiments were laid out in a randomized complete block design with three replicates. Results showed that rice varieties varied widely in their yield performances and weed competitiveness. Among monsoon varieties, BU dhan 1 allowed the minimum weed growth (48.8 g m^{-2}), while BRRI dhan46 allowed the maximum (256.2 g m^{-2}). Among winter varieties, BRRI dhan28 allowed the minimum weed growth (53.0 g m^{-2}), while BRRI dhan50 allowed the maximum (326 g m^{-2}). Grain yield ranged between 3.0 t ha^{-1} (Binadhan-11) and 6.3 t ha^{-1} (Dhani Gold) under season-long weed-free condition and 1.9 t ha^{-1} (BRRI dhan38) and 3.8 t ha^{-1} (BRRI dhan31) under season-long weedy condition of monsoon rice. While, yield ranged from 4.3 t ha^{-1} (BRRI dhan84, BRRI hybrid5 and Lalteer) to 8.3 t ha^{-1} (Hira 6) under season-long weed-free condition and 2.3 t ha^{-1} (BRRI dhan84, BRRI hybrid5 and Lalteer) and 6.3 t ha^{-1} (Hira 6) under season-long weedy condition of winter rice. Weed inflicted relative yield loss (RYL) ranged from 4.0% (BU dhan1) to 59.4% (BRRI dhan71) and 23.7% (Hira 6) to 45.8% (BRRI hybrid 5) among monsoon and winter varieties, respectively. Hybrid Dhani Gold appear as the most productive monsoon variety (6.3 t ha^{-1}) but its weed inflicted RYT was higher (46.3%) than many other varieties with low yield potential. BU dhan1 appeared as the most weed competitive variety (only 4.0% RYT) with productivity of 3.6 t ha^{-1} among monsoon varieties. On the other hand, hybrid Hira 6 appear as the most productive as well as

weed competitive cultivar among winter varieties. Based on the results it is clear that rice varieties of Bangladesh differ among themselves for their weed suppressive ability. Hence, before designing integrated weed management system, weed competitive variety should be considered.

Effect of bio-slurry with chemical fertilizer on the performance of field crops

Uttam Kumer Sarker*, Md. Delwar Hossain and Md. Romij Uddin
Department of Agronomy, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: uttam@bau.edu.bd*

Abstract
Integrated use of organic manure and chemical fertilizer would be quite promising in providing better yield. To evaluate the effect of bio-slurry along with chemical fertilizer, two field experiments were conducted in the Agronomy Field Laboratory, BAU, Mymensingh. The experiment was comprised of four varieties of *boro* rice viz., (i) BRRI dhan28, (ii) BRRI dhan29 (iii) Binadhan-8 (iv) Binadhan-10 and three varieties of Wheat (i) BARI gom 25, (ii) BARI gom 28 and (iii) BARI gom 29. Regarding fertilizer management, four treatment *viz*., (i) control, (ii) recommended dose of inorganic fertilizer, (iii) bio-slurry@ 5 t ha^{-1} + inorganic fertilizer, (iv) farmers' practice (average 15 farmers) for *boro* rice and four *viz*., (i) control, (ii) recommended dose of inorganic fertilizer, (iii) bio-slurry@ 4 t ha^{-1} + inorganic fertilizer, (iv) farmers' practice. The experiments were laid out in a randomized complete block design with three replications. It is evident that variety and fertilizer management had significant effect on effective tillers $hill^{-1}$, number of grains $panicle^{-1}$ which ultimately influenced grain yield. The combined effect of variety and fertilizer application showed that highest grain yield (6.10 t ha^{-1}) was found from Binadhan-8 with bio-slurry @ 5 t ha^{-1} + inorganic fertilizer and the lowest grain yield (4.68 t ha^{-1}) was found from BRRI dhan28 with farmers' practice. The highest grain yield (4.80 t ha^{-1}) was produced by both interaction between BARI gom 28 with bio-slurry @ 5t/ha + inorganic fertilizer. The lowest grain yield (2.66 t ha^{1}) was produced by interaction of BARI gom 25 with control. Thus the variety Binadhan-8 with application of bio-slurry @ 5 t ha^{-1} + inorganic fertilizer and BARI gom 28 with application of bio-slurry @ 4 t ha^{-1} + inorganic fertilizer were superior for obtaining highest yield.

Morphological and physiological characterization of wild rice for their better utilization in improvement of cultivated rice

M.A. Kader
Department of Agronomy, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
E-mail : abdul.kader@bau.edu.bd

Abstract
Twenty two wild species of rice are available across the world having the untapped reservoir of genetic diversity, which could be of significant importance for improving the cultivated rice varieties. This project was designed to i) collect accessions of wild rice available in Bangladesh, ii) to characterize the morpho-physiological attributes of the accessions, iii) to screen them for salinity and drought tolerance and iv) to identify the traits conferring salinity and drought tolerance in the wild rice accessions. Forty one accessions of wild species of rice belonging to 10 species were collected from different places across the country. All of the accessions were grown and their morphological attributes were recorded including flowering time. Four accessions namely *O. alta, O. latifolia, O. rufipogon* and *O. coarctata* were found to have some unique morphological features, which could be of interest for

future breeding program. Among the species, *O. alta* showed very high biomass production (particularly with a very large leafblade) which could be of interest in relation to C4 anatomy in rice. *O. latifolia* was found to produce 4-5 panicles in a single tiller. *O. coarctata* is found as the most salinity tolerant and *O. rufipogon* as the most drought tolerant plant. Among the species, *O. coarctata* and *O. rufipogon* were found to flower in November-December irrespective of planting time and the other two several times in a year indicating that *O. coarctata* and *O. rufipogon* are photo-sensitive and short day plants. For future use, mRNAs from the leaf tissue of the four species were collected and cDNA libraries were prepared and preserved.

Developing salinity tolerant rice cultivar through transformation of plasma-membrane and tonoplast Na^+/H^+ antiporter genes

M.A. Kader

Department of Agronomy, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
E-mail : abdul.kader@bau.edu.bd

Abstract

Salinity stress is one of the most deleterious abiotic stresses causing significant crop loss in the southern coastal area of Bangladesh. Under the current climate change context with increasing incidence of salinity, rice production in the coastal area of the country is under a big threat. Therefore, it is imperative for the rice scientists of the country to develop salinity tolerant rice cultivars. The project aims to develop salinity tolerant high yielding rice cultivar through over-expression of rice vacuolar Na^+/H^+ antiporter gene (OsNHX1 and OsNHX2) and plasmamembrane Na^+/H^+ antiporter gene (OsSOS1). Previously developed entry clones (entry vector pDONOR221) of OsNHX1, OsNHX2 and OsSOS1 were transferred/ recombined in the expression vector pB2WG7 using LR clonase. The LR reaction products were then transformed into the *E. coli* strain TOP10 by heat shock method. Positives colonies from antibiotic selection were confirmed by colony PCR using *OsNHX1, OsNHX2* and *OsSOS1* gene specific primers. Positive colonies of the gene constructs (in plant expression vector pB2WG7) were isolated and used to transform in *Agrobacterium* strain GV3101 by heat shock method. Transformed products were further confirmed by colony PCR using gene specific primers. Then transformation of the genes was done in rice (cv. IR 64) through *Agrobacterium* mediated gene transformation. Embryogenic calli of IR 64 were developed and infected with *Agrobacterium* harboring *the* genes. Transformed calli were grown in selected media for plantlet regeneration and putative transgenic rice plants were developed. After sufficient root growth, the plantlets were transferred to earthen pot with soil in the greenhouse and kept for 10 days for hardening. These plants were then transferred to glass house and are being gown for collecting the seeds.

Enhancing the crop productivity through adoption of climate smart technologies in the salinity areas of Bangladesh

M. A. Kader

Department of Agronomy, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
E-mail: abdul.kader@bau.edu.bd

Abstract

Agricultural productivity in the coastal area of Bangladesh is very low due to unfavorable condition like water logging, salinity, drought etc. The situation is getting aggravated in the area day by day because of global warming and climate change. This research program was designed with a view to increasing crop productivity in the salinity affected two upazilas of Noakhali district by adopting

climate smart technologies. A benchmark survey was done with a semi-structured questionnaire in the area covering 141 farmers in both the Upazilas. The major cropping patterns identified in the area include transplant *aman* rice with fallow either in *rabi* or in *kharif*-I season. Salinity and drought are the major problems in the area causing lower crop yields. For improving the crop productivity in the study areas season-specific field trials have been conducted with transplant *Aman* rice was conducted with a view to increasing rice yield through varietal selection (Shawrna, BR11, BRRI dhan52 and Binadhan-7) and gypsum fertilizer application. In *Rabi* season experiments on *Boro* rice (BRRI dhan 28 and Binadhan-10), sunflower (Hysun-33 and BARI Surjamukhi-2) and maize (NK-40 and BARI Hybridbhutta-9) were done in the selected areas, which included stress tolerant varieties and improved management practices to ameliorate the stress effects. Irrespective of variety, application of gypsum fertilizer increased the yield of transplant *aman* rice nearly 10% in both the research locations. Effect of gypsum fertilizer was more pronounced in *rabi* crops like maize and sunflower. In combination with mulching, gypsum fertilizer increased maize and sunflower yields more than 50% as compared to no mulch and no gypsum fertilizer application. Furrow transplanting in *boro* rice along with gypsum fertilizer application appeared as very promising technology increasing the grain yield by more than 2 t ha^{-1} in Binadhan-10 and by more than 1.5 t ha^{-1} in BRRI dhan28.

Physiological Response of Wheat Plant under System of Wheat Intensification (SWI)

Ahmed Khairul Hasan

Department of Agronomy, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
E-mail : akhasan@bau.edu.bd

Abstract

System of Wheat Intensification (SWI) is an adoption technique analogous to the System of Rice Intensification (SRI) which is based on manipulation of soil environment by employing the minimum external inputs including very low seed rate. An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh to elucidate the physiological response of wheat plant under system of wheat intensification (SWI). This experiment compared the performance of different varieties of wheat under SWI with different spacing and conventional planting system. Three varieties viz. BARI Gom-26, BARI Gom-28, BARI Gom-30 and five spacing viz. continuous seeding with 20cm line spacing using conventional method, raised bed with 20 cm line spacing using conventional method, 15cm × 15cm using SWI, 20cm × 20cm using SWI, 25cm × 25cm using SWI were included as treatments in the experiment. The experiment was conducted in a randomized complete block design (RCBD) with three replications. The results revealed that the variety BARI Gom 30 with spacing of 20cm × 20cm under SWI produced the highest grain yield (4.57t ha^{-1}) which is 25.34% higher than that of the conventional planting system. Again, SWI method had significant influence on almost all plant characters. The highest number of tillers $hill^{-1}$ (8.22), spike length (13.38 cm), number of spikelets $spike^{-1}$ (17.56), number of grains $spike^{-1}$ (41.33) and thousand grain weight (60.56 g) was obtained from 25cm × 25cm spacing using SWI. But the total number of plant s unit $area^{-1}$ was less in 25cm × 25cm than 20cm × 20cm spacing. So the total grain yield was highest in 20cm × 20cm spacing under SWI. It was also observed that in all the three varieties, the 20cm × 20cm spacing having SWI performed better than conventional method. Overall, it may be concluded that SWI outperformed the conventional planting system. Among the different spacing under SWI, 20cm × 20cm spacing performed the best and this may be recommended for wheat cultivation in Bangladesh subject to validation at different AEZs of Bangladesh.

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Effects of methods of crop establishment on the growth and yield of rice

Md. Abdus Salam
Department of Agronomy, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
E-mail : salamma71@yahoo.com

Abstract
An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University during December 2018 through May 2019 to study the effects of methods of crop establishment on the growth and yield of *Boro* rice. The experiment comprised of two factors; factor A: Methods of crop establishment viz. Dry direct seeding, Unpuddle transplanting, AWD (Alternate Wetting and Drying) and Puddle transplanting; Factor B: Seven weed management practices. The experiment was laid out in a split plot design with three replications. Weed density and dry weight were not significantly influenced by the interaction methods of crop establishment and weeding except weed dry weight at 60 DAT. The highest weed dry weight was observed in DDSR with no weeding condition and the lowest one was recorded in puddle transplanting with application of early post emergence herbicide Acetachlor + Bensulfuron methyl followed by one HW at 35 DAT. The highest grain yield was produced in puddle transplanting which was statistically identical to unpuddle transplanting. Application of early post emergence herbicide Acetachlor + Bensulfuron methyl followed by one HW at 35 DAT produced the highest grain yield which was statistically similar with application of pre-emergence herbicide Pretilachlor followed by one HW at 35 DAT. Puddle transplanting with application of Acetachlor + Bensulfuron methyl followed by one HW at 35 DAT produced the highest grain yield which was statistically identical to puddle transplanting with application of Pretilachlor. The highest BCR was observed from pubbdle transplanting with application of Acetachlor + Bensulfuron methyl followed by one HW at 35 DAT. From the results of the study it may be concluded that puddle transplanting with application of early post emergence herbicide Acetachlor + Bensulfuron methyl followed by one HW at 35 DAT might be the best option for controlling weed effectively, obtaining maximum grain yield as well as highest BCR.

Field performance of drought tolerant rice varieties in drought prone area of Madhupur Tract

Md. Abdus Salam[1*] and Ashish Kumar Srivastava[2], M. Rafiqul Islam[3] and Md. Sultan Uddin Bhuiya[4]
*[1]Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, [2]IRRI, New Delhi, India, [3]Department of Soil Science Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and [4]Vice-Chancellor, Isha Khan International University, Sholakia, Kishoregonj, *E-mail : salamma71@yahoo.com*

Abstract
According to IPCC temperature would increase from 1.8 to 4.0°C by the next 100 years and the frequency of severe drought is expected to increase at an alarming rate. In severe cases, 100% yield loss can be experienced due to abiotic stresses, such as drought. Three field experiments were conducted at the Kathalia village of Muktagacha upazila under the Madhupur tract during 2016-2018 to see the performance of rice cultivar as rainfed condition in *Kharif* 2 (transplant *aman*) season. Form the first year experiment it was observed that, BRRI dhan66 produced the highest grain yield which was statistically similar with BRRI dhan49 and BRRI dhan71. In second year experiment it was observed that BRRI dhan66 with 30-day-old seedling produced the numerically the highest grain yield which was very close to BRRI dhan71 with 20-day-old seedling. But BRRI dhan71 was more resistant

to lodging due to strong wind in Kathalia village in *aman* season in 2018. From the third year experiment it was found that Drought Tolerant Variety + Improved Management Practices (BRRI dhan71 with 75% of recommended dose of chemical fertilizer +2.5 t ha^{-1} poultry manure) produced 52.32 to 64.56% higher grain yield than Farmers' variety + Farmers' management practices. This higher yield might be due to drought tolerant capacity of the variety BRRI dhan71 than BRRI dhan49. Moreover, the soil organic matter content was enriched with improved management practices. From the findings of the three years study it may be concluded that BRRI dhan71 with improved management practices might be used for obtaining higher yield of T. *aman* rice and for maintaining soil health in Kathalia, Muktagacha under Madhupur tract.

Increasing Seed Emergence Rate, Seedling Growth and Survivability of boro Ricethrough Seed Priming Under Cold Stress

Md. Parvez Anwar* and Dr. F. M. Jamil Uddin
Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : parvezanwar@bau.edu.bd*

Abstract
Priming is a seed enhancement method that results in increased germination, better seedling growth and establishment under stress conditions. Boro rice is very often exposed to cold wave in the nursery bed resulting poor seed emergence, poor seedling growth and low survival rate. The objectives of this study was to evaluate the efficacy of different seed priming techniques in increasing seed emergence, seedling growth, vigor and survivability of Boro rice seedlings under cold stress. A pot experiment was conducted at the Net House and Agro Innovation Laboratory, Department of Agronomy, BAU during December 2018 to January 2019. The experiment comprised two factors; twoBoro rice varieties namely, i) BRRI dhan29 and ii) BRRI dhan36 and15seed priming techniquessuch asi) Control (no priming), ii) 20000 ppm NaCl, iii) 30000 ppm NaCl, iv) 20000 ppm KCl, v) 30000 ppm KCl, vi) 20000 ppm $CaCl_2$, vii) 30000 ppm $CaCl_2$, viii) 50 ppm $CuSO_4$, ix) 75 ppm $CuSO_4$, x) 10000 ppm $ZnSO_4$, xi) 15000 ppm $ZnSO_4$, xii) 2 ppm Na_2MoO_4, xiii) 3 ppm Na_2MoO_4, xiv) 100 ppm PEG and xv) 150 ppm PEG . Seeds were sown on 1December and 1January so that seedlings are exposed to cold stress at different stages. The experiment was laid out in a completely randomized design (CRD) with three replications. Results clearly indicated that seed priming has a positive impact on seed emergence rate, seedling growth and survival rate. Priming withKCl and $CaCl_2$ performed best; while NaCl and PEG showed no advantages over control. In general, BRRI dhan36 performed better than BRRI dhan29 because of its higher tolerance to cold stress. In conclusion, seed priming technique can be considered as a tool for increased seed germination, better seedling growth and higher seedling survivability of Boro rice under cold stress.

Improvement of dry direct seeded boro rice based cropping pattern through climate smart technologies and its adoption in drought-prone areas

Md. Moshiur Rahman* and Md. Mazbahul Karim
Department of Agronomy, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
**E-mail : rahmanag63@bau.edu.bd*

Abstract
The project has been initiated with a view to enhance adoption of the newly developed T. Aman – Mustard–DDS boro rice cropping pattern through farmers' participation and also for the improvement

of the productivity of the pattern through incorporation of climate smart technologies. The study was conducted in two locations viz. Sundarban of Sadar Upazilla of Dinajpur and Khidra Kashipur of Durgapur Upazilla of Rajshahi districts of Bangladesh. A block demonstration of the new cropping pattern was established at two locations for awareness building of the farmers through training, field days, mass media and other extension tactics. After cultivation of Aman rice and mustard, boro rice var. BRRI dhan58 and BRRI dhan28 were sown in dry direct seeded method during 23-25 February and 6-7 March 2018 in Dinajpur and Rajshahi, respectively. The crop was harvested on 19 and 24 June 2018 respectively at Dinajpur and Rajshahi sites with the yield of 5.20 and 7.50 t/ha for BRRI dhan28 and BRRI dhan58 were, respectively. The DDS plots required 3-4 irrigations while the conventional plots required 15-17 irrigations to complete the crop production. Further, two field experiments were conducted at Rajshahi site. Experiment 1 included nine rabi crops: (1) Mustard, (2) Potato, (3) Lentil, (4) Field pea, (5) Radish, (6) Cabbage, (7) French bean, (8) Carrot and (9) Tomato to test the performance of nine cropping patterns. Experiment 2 was conducted to evaluate the effects of bio-amendment: (i) Trichocompost (TC) (T1), (ii) Vermi-compost (VC) (T2), (iii) Mustard oil cake (MOC) (T3), (iv) TC + MOC (T4), (v) VC + MOC (T5) and Control (no amendment) T6 on the performance dry direct seeded boro rice. Both the trials used BRRI dhan28 as test crop using RCB design with three replications. Results of Experiment 1 revealed that yield of dry direct seeded boro rice cv. BRRI dhan28 did not differ significantly due to the the crops grown in the previous rabi season. The highest system yield was obtained for T. Aman –Tomato–DDS boro rice cropping pattern tomato as rabi crop and the lowest for T. Aman –Mustard–DDS boro rice cropping pattern. Experiment 2 showed that application of tricho-compost and vermi-compost along with recommended fertilizers gave 16% higher yield of dry direct seeded boro rice cv. BRRI dhan28 than the recommended fertilizers alone. A baseline survey revealed that farmers were not aware of the new cropping pattern. Field demonstration, meeting, and training were conducted towards improve their awareness. The post-intervention survey and FGD revealed that the fixed rate irrigation system and lack of availability of good quality seeding machine are the major constraints for adoption of the new technology. The study concludes that irrigation as per farmers need, community based cropping practice and availability of good quality seeding machine should be ensured for rapid adoption of the technology to sustain productivity with less water in drought prone areas of Bangladesh.

Increasing water saving in dry direct seeded boro rice through agronomic manipulation

Md. Moshiur Rahman*, Biplob Hossain and Mahamudul Kabir Rajon
Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : rahmanag63@gmail.com*

Abstract

T. aman rice – Mustard – DDS boro rice cropping pattern is better than T. aman rice –Mustard – T. boro rice pattern as it gives higher economic return and uses minimal irrigation water. The present study was aimed at increasing cropping intensity under DDS boro rice based cropping pattern. Two experiments were conducted in 2018-2019 under T. aman rice – Rabi crop – DDS boro rice cropping pattern. Experiment 1 was done to select the best cropping pattern towards increasing cropping diversity and farm productivity while Experiment 2 was done to see the effect of mulch and organic amendments on the yield performance of dry direct seeded boro rice variety BRRI dhan28 under T. aman – Mustard – DDS boro cropping pattern. In experiment1 nine crops viz. mustard, potato, field pea, French bean, spinach, garden pea, tomato, broccoli and cabbage were cultivated in between aman and boro rice to form nine cropping patterns under RCBD with three replications. The results revealed that the *rab*i crop grown after *aman* rice had no significant influence on the yield and related attributes of the succeeding *boro* rice. The highest rice equivalent yield (19.69) and benefit cost ratio (1.71) was found with T.*aman* rice-Cabbage-DDS *boro* rice. The experiment2 included two levels of mulch viz.,

rice straw mulch @ 5 t ha^{-1} (M_1) and no mulch (M_2) and seven organic amendments viz., Control, Recommended Doses of Fertilizers (T_1), Farm Yard Manure (FYM) @ 5 t ha^{-1} (T_2), Mustard Oil Cake (MOC) @ 0.5 t ha^{-1} (T_3), Farm Yard Manure (FYM) @ 5 t ha^{-1} + Trico-compost (TC) @ 3 t ha^{-1} (T_4), Trico-compost (TC) @ 3 t ha^{-1} + Mustard Oil Cake (MOC) @ 0.5 t ha^{-1} (T_5), Farm Yard Manure (FYM) @ 5 t ha^{-1} + Mustard Oil Cake (MOC) @ 0.5 t ha^{-1} (T_6) and Trico-compost (TC) @ 3 t ha^{-1} (T_7) in a split-plot design with three replications. The result suggests that application of Mustard Oil Cake @ 0.5 t ha^{-1} with recommended doses of fertilizers (RDF) gave the highest yield which was similar to Farm Yard Manure @ 5 t ha^{-1} + Trico-compost @ 3 t ha^{-1} with RDF and Trico-compost (TC) @ 3 t ha^{-1} with RDF treatments. The study suggests that T. aman rice –Cabbage – DDS boro rice pattern is much profitable than T. aman rice –Mustard – DDS boro rice pattern and bio-amended with tricho-compost @ 5 t ha^{-1} or mustard oil cake 0.5 t ha^{-1} in addition to recommended chemical fertilizers could be practiced for increasing boro rice yield in the T. aman rice – Rabi crop – DDS boro rice cropping pattern.

Development of Integrated Weed Management System for Dry direct Seeded Boro Rice Based Cropping Pattern

Md. Moshiur Rahman*, Md. Abdus Salam, Mazahar Hossain Ahmed and Md. Shajahan Sarkar

Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : rahmanag63@gmail.com*

Abstract

Weed is the major constraint to the adoption of dry direct seeded rice system. Labour scarcity and higher wage rate is making manual weeding non-profitable. Herbicide is the cost effective solution but it may cause environmental hazards. Therefore, integrated weed management could be economic, effective, sustainable and eco-friendly approach towards weed management in dry direct seeded rice system. The present study was conducted during 2015-16 to 2017-18 with a view to develop an integrated weed management system for dry direct seeded boro rice based cropping pattern. Twelve different field experiments were conducted at the Agronomy Field Laboratory of Bangladesh Agricultural University, Mymensingh. Potential cultural and chemical weed control strategies were integrated where combined effect of mulching and planting spacing, mulching and sequential application of herbicides and sequential application of tank mixed herbicides were investigated. Results revealed that pretilachlor and butachlor are suitable for transplant aman rice while pendimethalin and oxadiazon are suitable for dry direct seeded boro rice. Bispyribac sodium + Bensulfuron methyl, Ethoxysulfuron , Pyrazosulfuran ethyl, Penoxulum and Bensulfuron methyl + Quinchlorac are suitable for T aman rice while Penoxulam, Fenoxaprop-p-ethyl, Quinclorac, Bispyribac sodium + Bensulfuronmehty, Acetachlor + Bensulfuron Methyl and Quizalofop-p-ethyl are suitable for dry direct seeded boro rice. For dry direct seeded boro rice, pendimethalin followed by one HW at 21 DAS followed by Pendimethalin, Ethoxy sulfuron/Pendimethalin as PRE fb Carfentrazon ethyl/Fenoxaprop-p-ethyl as EP, Ethoxy sulfuron/Pendimethalin as PRE, Carfentrazon ethyl/Fenoxaprop-p-ethyl as EP, Pendimethalin as PRE fb Bispyribac sodium+Bensulfuron methyl as EP fb 2, 4 D amine as POST are found as the suitable herbicide sequence. Rice straw mulch and mustard stover mulch provided better weed suppression than use of pre-emergence herbicides alone. Some rice varieties provided good weed suppression at closer spacings but they gave highest yield at their recommended spacings. The weed control in dry direct seeded boro rice greatly depends on the weed control of all the previous crops in the sequence. Therefore, integration of proper weed management in the previous crops in the pattern as well as use of mustard stover or rice straw mulches and the sequential application of any suitable pre- and early post emergence herbicides in tank mixture/alone in rotation could be practiced for effective, economic and sustainable weed control in dry direct seeded boro rice.

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Salt stress mitigation in wheat by arbuscular mycorrhizal fungi in the southwest coastal region of Bangladesh

Md. Harun Or Rashid
Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail : mhrashid@bau.edu.bd

Abstract
The use of arbuscular mycorrhizal fungi (AMF) symbiosis with plants have been shown very promising to reduce stress in plant and increase growth, particularly in problem soils including saline soils. Therefore, it is of utmost importance to evaluate the potential of AMF symbiosis to reduce salt stress and increase productivity of wheat in saline soil. A pot experiment was conducted at the net house of Department of Agronomy in Bangladesh Agricultural University to evaluate the effect of AMF inoculation on salt stress mitigation, growth, and yield two wheat varieties (BARI Gom-25 and BARI Gom-30). The experiment consisted of four levels of salinity (0, 4, 8 and 12 dS/m) and two levels of AMF inoculation (AMF-inoculated and non-inoculated). The experiment was laid out a randomized complete block design (RCBD) with 3 replications. 'Serakinkon', a commercially available AMF inoculum was collected from Japan and used in the experiment. The inoculum mainly consisted of *Gigaspora margarita* species of AMF. Data were collected on growth parameter (leaf number/plant, plant height, number of tillers/plant, are of flag leaf) and yield parameters (number of filled grain/panicle, grain and straw yields). Salinity significantly affected all the growth and yield parameters parameters (all $p<0.05$) and the lowest values were recorded in 12 dS/m salinity condition. AMF inoculation, though didn't significantly affect the growth parameters, it had significant effect on number of filled grains/panicle and grain yield. Wheat plants of both varieties produced higher number of filled grains and grain yield when they were inoculated with AMF. Effect of AMF was clearer in term of grain yield at 8 dS/m salinity. Further research should be conducted on the screening of naturally occurring AMF species found in saline condition which will work on wider range of soil salinity.

Effect of arbuscular mycorrhizal fungi on the yield and nutritional quality of wheat under salt stress condition

Md. Harun Or Rashid
Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail : mhrashid@bau.edu.bd

Abstract
Arbuscular mycorrhizal fungi (AMF) enables the plant with increased antioxidant capabilities to scavenge the reactive oxygen species (ROS) developed within the tissues of stressed plants. In addition, when AMF inoculated plant is grown in soil/media with high nutrient/metal contents (polluted, saline soil, etc), AMF reduces the uptake of the metal/nutrient by chelating in its root tissue, and therefore it can improve the national status of the plant in addition to reducing stress. A pot experiment was conducted at the net house of Department of Agronomy in Bangladesh Agricultural University to evaluate the effect of AMF inoculation on growth, yield and nutritional status of two wheat varieties (BARI Gom-25 and BARI Gom-30). The experiment consisted of four levels of salinity (0, 4, 8 and 12 dS/m) and two levels of AMF inoculation (AMF-inoculated and non-inoculated). The experiment was laid out a randomized complete block design (RCBD) with 3 replications. 'Serakinkon', a commercially available AMF inoculum was collected from Japan and used in the experiment. The inoculum mainly consisted of *Gigaspora margarita* species of AMF. It was found that though AMF

inoculation didn't significantly affect the growth parameters of wheat (leaf number, number of leaves/plant and leaf greenness), it had significant effect on number of filled grains/panicle and grain yield. The results of the proximate analysis of wheat grains showed that salinity drastically affected the percent protein content under higher salinity condition (8 and 12 dS/m) whereas AMF inoculation significantly increased protein protein of wheat grain in both varieties. The results of this research conclude that AMF inocula can be used to improve wheat yield and quality under saline condition. Further research should be conducted on the screening of naturally occurring AMF species found in saline condition and their effect on wheat yield and quality.

Management of acid soils for sustainable crop production in Madhupur Tract and Northern & Eastern Piedmont Plains

Md. Anamul Hoque* and Md. Rafiqul Islam
Department of Soil Science, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
**E-mail : anamul71@bau.edu.bd*

Abstract
Acid soil is an important issue because of its adverse effect on soil fertility and crop productivity. The goal of this research was to improve the crop productivity in the acid prone areas of Madhupur Tract and Northern & Eastern Piedmont Plains for sustaining food security. Two sites were selected for field experiments one in Nalitabari and the another one in Fulbaria Upazila covering acid soils of AEZ 22 (Northern and Eastern Piedmont Plains) and AEZ 28 (Madhupur Tract), respectively. Soil samples were collected at 0-15 cm depth from two AEZs covering two upazilas. Soil samples were analyzed for soil pH, texture, organic carbon and nutrients status (N, P, K & S). Considering the pH values of the soil samples collected, one site was selected for each upazila for conducting field experiment with different cropping patterns. Three cropping patterns *viz*. T. Aman rice - Wheat – Mungbean, T. Aman rice -Maize – Fallow and T. Aman rice -Mustard – Boro were followed for field experiments. All the crops were harvested at maturity and then data were recorded. Then plant samples were analyzed for N, P, K and S contents. All crops showed reductions in grain/seed and straw/stover yields in acid prone areas of Nalitabari and Fulbaria. On the other hand, application of lime showed an increase in grain/seed and straw/stover yields of crops in three cropping patterns. Additionally, organic manure alone or in combination with lime considerably increased yields of all crops. It was also observed that addition of lime or organic manure to acid soils increased nutrient uptake by crops. It might be concluded that addition of lime and organic manure to acid soils is beneficial for achieving sustainable crop productivity in the areas of Madhupur Tract and Northern & Eastern Piedmont Plains.

Nitrogen Use Efficiency in Rice under Continuous Flooding and Alternate Wetting and Drying Conditions

Md. Anamul Hoque* and Mahmud Hossain Sumon
Department of Soil Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: anamul71@yahoo.com*

Abstarct
Nitrogen is the major essential plant nutrient, leading to the contribution of the increment of rice production. The applied nitrogen is lost due to the leaching, NH_3 volatilization and other processes, consequently causing reduction of NUE. Deep placement of USG in rice field can increase the efficiency of applied nitrogen by improving absorption to a certain extent. Irrigated rice production is the largest consumer of water in the agriculture sector, and its sustainability is threatened by increasing

water shortages. AWD irrigation is useful strategy to reduce the excess use of water and increase crop yield. In addition, AWD is an effective practice to improve NUE when USG is incorporated into rice field. Therefore, this research project was undertaken to study the improvement of NUE in rice cultivation under continuous flooding and AWD conditions. A field experiment was conducted at Soil Science Field Laboratory, BAU with two water managements *viz.* continuous flooding and AWD, and seven nitrogenous treatments consisting of PU and USG *viz.* T_1: Control (no PU or USG); T_2: PU at 7 DAT+27 DAT+47 DAT (216) kg ha^{-1}; T_3: PU at 10 DAT+30 DAT+50 DAT (216) kg ha^{-1}; T_4: PU at 15 DAT+35 DAT+55DAT (216) kg ha^{-1}; T_5: USG at transplanting (216) kg ha^{-1}; T_6: USG at 7 DAT (216) kg ha^{-1}; and T_7: USG at 10 DAT (216) kg ha^{-1}. There was no considerable difference in growth and yield between continuous flooding and AWD. Application of PU and USG remarkably increased grain and straw yields of rice under both continuous flooding and AWD. Among PU treatments, T_3 treatment (10 DAT+30 DAT+50 DAT) produced the highest yield of rice. On the other hand, USG at 7 DAT produced the highest yield of rice and NUE among nitrogenous treatments. Continuous flooding and AWD increased N uptake and NUE but no considerable differences were observed between them. However, the performance of USG was superior in aspect of rice yield and NUE compared to PU under both continuous flooding and AWD conditions. It can be concluded that application of USG is profitable for rice cultivation under both continuous flooding and AWD conditions through increasing yield and NUE.

Mitigating Greenhouse Gas Emissions from Rice-based Cropping Systems through Efficient Fertilizer and Water Management

M.R. Islam[1*], H. Akhtar[1], M.R. Islam[1] and M. A. Ali[2]

*[1]Department of Soil Science and [2]Department of Environmental Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: mrislam58@bau.edu.bd*

Abstract

Two cropping pattern based experiments viz. Mustard – Boro -T. Aman(Continuous standing water condition, CSW) and Boro (Alternate wetting & drying condition, AWD)-T. Aus-T. Aman were set up at BAU Farm in 2016 to study the mitigation potential of GHG (CH_4 and N_2O) emissions from rice fields while maintaining the crop productivity. The fertilizer treatments included combination of both organic and inorganic fertilizers, laid out in a randomized complete block design with three replications. Three cycles of two cropping pattern -based field experiments have been completed. Nitrogen loss as ammonia volatilization and nitrous oxide were measured. Methane emissions were measured depending on time of AWD imposed to rice. Grain yield, straw yield, N uptake and recovery were recorded at harvest. In Boro rice, the highest grain yield was observed in T_2 (UDP 78 kg N ha^{-1}) which was statistically identical to those found in T_4 (Prilled urea deep placement) and T_6 (Prilled urea + Poultry manure).Addition of manure with broadcast PU significantly increased both grain and straw yields compared to without organic manure. The grain yield of Boro rice was slightly higher in AWD management plot compared to CSW plot. In *T.* Aus rice, the highest grain yield (4.25 tha^{-1}) was observed at T_2 (UDP 78 kg N ha^{-1}) which was identical to those found in the treatments with combined use of prilled urea and manure application (T_6, T_7 and T_8 treatments). Highest NUE was observed at deep placed treatment at 78 kg N ha^{-1} (Boro) & 52 kg N ha^{-1} (T. Aus) which was significantly higher than broadcast PU. UDP significantly reduced both methane & N_2O emissions compared to prilled urea. The practice of AWD for rice cultivation reduced the methane emission from rice field by 17% compared to that of rice cultivation under CSW condition. The integrated use of cowdung with PU increased the methane emission compared to PU application alone. The use of AWD water management in Boro season reduced CO_2eq emission by 0.28 t ha^{-1} and carbon credit by Tk. 861 ha^{-1} compared to that of CSW water management. According to global carbon market, this emission reduction produces carbon credit of BDT 3, 854 million. Similarly, adoption of UDP reduced CO_2 eq.

emissions by 1.67 and 1.14 t ha^{-1} for Boro and Aus seasons, respectively. These reductions produce carbon credit of Tk. 22,598 and TK 3,256 million in Boro and Aus seasons, respectively.

Effect of lime and organic matter amendment on wheat productivity in acidic Piedmont soil

Md. Rafiqul Islam* and Tahsina Sharmin Hoque
Department of Soil Science, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: rafiqss69@bau.edu.bd*

Abstract
Acid soil is a limiting factor for crop production in Bangladesh. An experiment was, therefore, conducted in Nalitabari Upazila covering acid soils of AEZ 22 (Northern and Eastern Piedmont Plains) to assess lime and organic manure requirement to attain suitable pH for better wheat production as well as to evaluate the effect of lime and organic manure amendment on yield and nutrient uptake in wheat crop. Twenty composite soil samples were collected at 0-15 cm depth from different sites of Nalitabari Upazila. The soil samples were analyzed for soil pH, texture, clay content and nutrients status in order to determine lime and organic manure requirement. Considering the pH values of the soil samples collected, one site was selected at Nayabil Union for conducting field experiment. To undertake the field trial nine treatment combinations were considered including T_1: Control, T_2: Lime1, T_3: Lime2, T_4: OM1, T_5: OM2, T_6: Lime1 + OM1, T_7: Lime1 + OM2, T_8: Lime2 + OM1 and T_9: Lime2 + OM2. Lime1 & Lime2 comprise dololime @ 1 t/ha & dololime @ 2 t/ha whereas OM1 & OM2 consist of cowdung @5 t/ha & poultry manure @3 t/ha. The N, P, K, S, Zn & B were applied at recommended and equal rates for all plots. The treatments were assigned to the plots following randomized block design with three replications. The test crop wheat cv. BARI Gom-30 was sown in the last week of November. Proper care was taken when required and the crop was harvested at maturity. The data revealed that grain and straw yields of wheat were reduced in acid prone area of Nalitabari. However, application of lime demonstrated an increase in grain and straw yield of wheat. Additionally, organic manure alone or in combination with lime remarkably increased the yield of wheat. The soil pH and P availability were improved due to lime and manure application. It might be concluded that addition of lime and organic manure to acid soils is beneficial for achieving crop productivity in the areas of Northern & Eastern Piedmont Plains.

Enriching beneficial indigenous soil microorganisms through integrated plant nutrient management and assessing their effects on soil fertility and sustainable rice production.

M. A. Hashem* and T.S.Hoque
Department of Soil Science, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: mahashem71@yahoo.com*

Abstract
Experiments were conducted both in the laboratory and field with a view to enriching beneficial indigenous microorganisms in soils through integrated plant nutrient management and assessing their effects on improvement of soil fertility and maximization of rice yield. In order to achieve the objectives of the study a research project was undertaken for a period of two years from July 2018 to June 2020 under the financial support of Bangladesh Agricultural Research System (BAURES). For the work of the project in addition to laboratory analyses a field experiment was conducted at the Soil Science Field Laboratory of Bangladesh Agricultural University, Mymensingh during boro season of

2019 with the combined application of organic and inorganic fertilizer through Integrated Plant Nutrient System (IPNS). Cotton seed oil cake and mustard oil cake were used as organic fertilizer. Cyanobacteria and *Azotobacter* were taken into account as beneficial indigenous soil microorganisms due to their ability to fix N from atmosphere. BRRI dhan29 was used as test crop. The experiment was laid out in Randomized Complete Block Design (RCBD) with seven treatments and four replications. The treatment combinations included T_1: Control (No organic and inorganic fertilizers); T_2: 100% of Recommended Fertilizer Dose (RFD); T_3: 50% of RFD; T_4: 50% N from RFD +50% N from Cotton seed oilcake, T_5: 50% N from RFD + 50% N from Mustard oilcake,T_6: 50% N from RFD + 25% N from Cotton seed oilcake + 25% N from Mustard oilcake,T_7: 50% N from Cotton seed oilcake + 50% N from Mustard oilcake. Cotton seed oilcake and mustard oilcake were applied before 7 days of transplantation. The results showed that the grain and straw yields as well as yield components, nutrient uptake and soil fertility were significantly influenced due to different treatments. The highest grain and straw yields of 6.25 and 8.17 t ha^{-1} respectively were recorded in treatment T_2 (100%RFD) which were statistically identical to that recorded in treatment T_4 having integration of 50% N from Fertilizer and 50%N from cotton seed oilcake. Among the treatments tested integration of 50%N from chemical fertilizer and 50%N from cotton seed oilcake showed the best performance in improving soil fertility and increasing rice yield.

Improving soil resilience to climate change for sustainable crop production through climate smart agricultural technologies

Mohammad Mofizur Rahman Jahangir

Professor, Department of Soil Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: mmrjahangir@bau.edu.bd

Abstract

Long-term impacts of integrated soil fertility management (ISFM) under conservation agriculture system are yet in debate and needs short-term evaluation before it continues for a longer period. The ISFM under reduced tillage with crop residue retention has been initiated from January 2017 for evaluation of soil resilience to climate induced degradation along with crop yield. The experiment had a split-split plot design with tillage (minimum, MT and conventional, CT) as the main plot; residue (with and without residue) as the sub plot and composts (Trichocompost-LC, bio-slurry-BS and recommended fertilizers-RD) as the sub-sub plot treatments. Postharvest soil samples were collected in November 2019 after harvesting the 6^{th} crop of mustard - rice – rice pattern to analyse for soil structural and elemental quality as an indicator of its resilience to degradation. Conversion to minimum soil disturbance (MT) had significantly lower ($p<0.05$) rice yield than conventional tillage (CT) with the mean value of 5.05 and 5.91 t ha^{-1} in Boro season (BRRI dhan28) and 4.82 and 5.73 t ha^{-1} in Aman season (BRRI dhan71), respectively. Likewise, mustard yield was also significantly higher in CT than in MT ($p<0.05$). The TN content in rice grain and straw was significantly higher with correspondingly higher uptake in CT than in MT. Conversely, soil structural quality, measured by aggregate size distribution, mean weight diameter and stability index, was better in MT than in CT. Equally, SOC, TN and available P increased in MT by 15, 3 and 30%, respectively over the CT which indicate higher nutrient sequestration in MT due to lower soil disturbance. Crop residue retention has significantly increased soil available P, available S and grain TN conetnt. With regard to ISFM, trichocompost based ISFM significantly improved soil structural and elemental quality and crop performance than bio-slurry. The results suggest that ISFM under MT system with crop residue retention improve soil structural and elemental quality for the sustenance of soil fertility under the changing climate. The reduction in crop yield in MT is likely to turn opposite within few years of adoption of ISFM as indicated by the improved soil resilience to degradation.

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Improvement of soil health and crop productivity in climate vulnerable and polluted areas through organic amendments

Mohammad Mofizur Rahman Jahangir
Department of Soil Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail : mmrjahangir@bau.edu.bd)

Abstract

Char land and acid soils occupy a substantial part of the arable land in Bangladesh. Maintenance or if possible, improvement of soil quality is a prerequisite to sustainable crop production in such climate vulnerable and polluted soils. Several organic fertilizers e.g., rice husk biochar, poultry manure biochar and vermicompost along with chemical (lime) amendments were used to improve soil structural quality, microbial biomass, enzyme and elemental content while increasing crop production in such nutrient poor soils. Soils, mixed with the organic amendments, were incubated at two moisture regimes viz. field capacity and continuous standing water for 120 days for understanding and quantifying rate of organic matter mineralization and nutrient release. During the reporting period mustard, boro and T. Aman were grown in acid soils whilst maize, jute and T. Aman were grown in charland soils. At this early stage of the experimentation an indication of higher crop yield was recorded from organic amended plots as a whole and poultry manure biochar, poultry manure and vermicompost in particular. The results indicate that poultry manure and either biochars (poultry manure and rice husk had liming effects on soil properties, thereby increased rice yield in acid soils. The causes of the liming effects and the mechanisms of increasing soil pH will be studied in the next few months to know if they produce bicarbonate or if the produce OH in soil. Likewise, organic amendments have significantly influenced maize and jute yield showing higher yield in poultry manure biochar and vermicompost. The effect of biochar on charland soil indicated that it can improve soil conditions like soil density, nutrient and water holding capacity and root growth that all together enhance crop growth and yield. These results suggest that biochar can be a good organic selection for soil conditioning and for improving soil health. However, the research will be continued to confirm the results obtained in the first year.

Adoption of drought tolerant rice varieties in northwestern Bangladesh: Constraints and measures at farmers' level

Md Anwarul Abedin
Department of Soil Science, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
E-mail : m.a.abedin@bau.edu.bd

Abstract

Rice is the dominant crop in Rajshahi region. During the last 15 years, the amount of rainfall and its distribution pattern, temperature and drought duration, has changed unfavorably to growing traditional rice varieties in this area. But due to drought condition, it caused damages in about 2.6 million ha of rice cropland. Of which, 2.2 million ha were in the 16 districts of northwestern Bangladesh. Considering the above, it is utmost important to disseminate and cultivate drought tolerant rice varieties namely BRRI dhan56 and BRRI dhan71 in the drought prone areas in Bangladesh to cope with. With this contrast, an field investigation for two consecutive years are done considering two varieties (BRRI dhan56 and BRRI dhan71), and four treatment combinations using split plot design having three replications at Nachole upazila under Chapai Nawabganj and Soil Science field laboratory, BAU, Mymensingh to not only identify the constraints of famers to adopt but also provide the action and policy links to accomplish the drought tolerant varieties in this area to ensure food security. The results revealed that there is no significant variation considering locations, but BRRI dhan71

performed better than BRRI dhan56 in Aman season compare to Boro season. Among the treatment combinations, the highest yield observed in soil test based fertilization with cow-dung in both the seasons. Furthermore, there is no significant variation among the interaction of Location X Treatment; Variety X Treatment; and Location X Variety X Treatment.

Determination of critical limit of Mg, S and B for wheat and mustard under AEZs 1, 3 and 9

Md. Anwarul Abedin*, Mahmud Hossain Sumon and Rubina Yesmin[1]

*Department of Soil Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and [1]UAO, DAE, Dhaka, Bangladesh, *E-mail : m.a.abedin@bau.edu.bd*

Abstract

Soil testing is a useful tool for measuring extractable quantity of a nutrient in soil, which would help predict the crop yield response to an application of that nutrient through fertilizers and manure. A good soil test should be able to predict the amount of plant available nutrient as well as the fertilizer responsiveness of crops growing on a wide range of soils. In this regard, determination of critical limit is important to determine optimum fertilizer requirement for a crop. Hence, the situation justifies a need to determine and update the critical limit of different plant nutrients in order to formulate an optimum fertilizer dose for deficient nutrients for different crops and soils for achieving satisfactory crop yield. Therefore, three AEZs have been selected as the study areas under the project. A bench mark survey have been conducted in the study areas to know the present nutrient and fertilizer use. For the purpose a total of 720 soil samples (3 AEZs/component x 2 Upazilas/AEZ x 3 villages/Upazila x 10 spots/ village) have been collected. Soil samples were analyzed for macro- (N, P, K, Ca, Mg & S) and micro- (Fe, Mn, Cu Zn & B) nutrients and basic soil characteristics like pH, organic matter and texture. Results of soil samples collected from Muktagacha varied available P 3.19-41.21 ppm, having SD 10.57-12.59 , Mymensingh Sadar varied available P 0.65-24.39 ppm, SD 2.61-6.7 and Muktagacha varied available K 0.07-0.19 ppm, SD 0.025-0.041 , Mymensingh Sadar varied available K 0.07 0.13 with SD 0.018-0.021. Mymensingh Sadar varied available Mg 1.49-4.01 ppm, SD 0.253-0.395. Muktagacha varied available S 0.89-25.07 ppm, SD 5.96-6.68, Mymensingh Sadar varied available S 4.42-73.44 ppm, SD 5.07-25.58. Muktagacha varied available B 0.183-0.252 ppm, SD 0.013-0.019. Similarly, other upzalas have different levels of P, K, S, Mg, values. In the next step, based on the above results pot experiments are conducted to determine the critical level of Mg, B and S of soils.

Screening of Selenium efficient rice varieties for biofortification in rice

Mahmud Hossain[1]*, Quazi Forhad Quadir[2], M. Lokman Hossain Mazumdar[1,3]

*[1]Department of Soil Science and [2]Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh, Bangladesh and [3]Department of Agricultural Extension, Government of the Peoples Republic of Bangladesh, *E-mail : mahmud.ss@bau.edu.bd*

Abstract

Selenium (Se) is essential for humans and animals because of its antioxidant properties and a key component of amino acids, selenoproteins, enzymes, and hormones. Worldwide over one billion people suffer from Se deficiency due to low dietary intake of Se. Cereals are an important source of Se intake in many countries. Two pot experiments were conducted to screen Se efficient rice varieties for the biofortification of Se in rice at the net house of the Department of Soil Science, BAU. Rice seeds of 41

BRRI/local T. aman varieties and 41 BRRI/local *boro* varieties were collected from BRRI and farmers of different areas of Bangladesh. The seedlings were raised in the field laboratory of the Department of Soil Science, BAU. A total of 246 plastic pots (15 L) were filled with 10 kg soil for each experiment. Two Se treatments were used in the experiments: 0 and 0.1 mg/kg Se. The experiments were laid out in completely randomized design (CRD) with 41 varieties and each variety was replicated three times for both Se treatments. Trace element grade sodium selenate (Na_2SeO_4) was used as a source of Se. Pots were fertilized with an equal amount of N, P, K, S and Zn. All the fertilizers were applied before transplanting except N. In T. aman season 25 days old seedlings were transplanted in the pots on July 27, 2017. Thirty-five days old seedlings were transplanted on January 25, 2018 in *boro* season. Five cm ponded water was always maintained in the pots. N fertilizer was applied in three equal splits, at 7 DAT (days after transplanting), 27 DAT and 45 DAT. Selenium was applied as per the treatment on 15 DAT. Weeds were hand cleaned whenever appeared. Rice was harvested, and yield attributes data were recorded for analysis followed by collection and drying of grains. Rice grains were oven dried, de-husked and grinded by Ball mill. Grain samples were digested using HNO_3 and H_2O_2. Grain Se increased significantly in few T aman rice cultivars. The highest Se uptake (4.06 mg/kg) was observed in BRRI dhan38. Balam, BRRI dhan30, BINAdhan16, BRRI dhan52 and Mala also had significantly higher Se content in rice. *Boro* rice varieties also showed much variabilities in terms of Se concentration in grain. The highest Se concentration (7.92 mg/kg) was observed in Jaisthoboro. Deshiboro, Guchiboro, Isamoti, Begunbitchi, Banajira, BRRI dhan36, BRRI dhan50 and BINAdhan10, also had significantly higher Se content in rice. The study revealed that rice varieties had much variabilities in Se uptake. So biofortification of Se could be a good means for the mitigation of Se deficiency in food chain.

Modifying the parboiling of rice to remove inorganic arsenic, while fortifying with calcium

M. Hossain[1*], M.H. Rahman[1], M.R. Islam[1] and A.A. Meharg[2]

[1]Department of Soil science, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh and [2]Institute for Global Food Security, Queen's University Belfast, Northern Ireland, UK

**E-mail : mahmud.ss@bau.edu.bd*

Abstract

This study considered ways in which the common post production technique of parboiling rice could be altered to reduce the carcinogen inorganic arsenic by village based processing plants in rural Bangladesh. Parboiling is normally conducted with rough rice, i.e. where the husk is intact, either steamed or boiled for ~10 mins after overnight soaking at ambient temperatures. It was found that a simple alteration to the procedure, parboiling wholegrain in boiling water (steaming had no impact), removed inorganic arsenic by a statistically significant median decrease of 25% in the final polished grain, across 13 geographically dispersed facilities, while having little impact on milling quality of final polished rice. The wholegrain parboiling approach caused statistically significant median enrichment of calcium by 213%, and a reduction in potassium by 40%, with all other nutrient elements being unaffected. Milled parboiled rough rice had enriched inorganic arsenic compared to non-parboiled milled rice, but parboiling of wholegrain rice did not enrich inorganic arsenic. Polished rice produced from the parboiling of both rough and wholegrain rice significantly reduced cadmium compared to non-parboiled polished rice, by 25%. This study also identified that trimethylarsine oxide and tretramethylarsonium are widely elevated in the husk and bran of rice, given new insights into the biogeochemical cycling of arsenic in paddy ecosystems.

Household biomass ash as a fertilizer to sustainability improve soil nutrition to enhance rice yields

M. Hossain[1*], M.R. Islam[1], Y Gupta[2], M.P. Carey[2], C. Meharg[2] and A.A. Meharg[2]

[1] Department of Soil science, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh. and [2] Institute for Global Food Security, Queen's University Belfast, Northern Ireland, UK
**E-mail : mahmud.ss@bau.edu.bd*

Abstract

Bangladesh has to feed an expanding population on a diminishing agricultural land resource. However, crop response to fertilizer addition has been steadily reducing, from 10:1 to 7:1 (kg grain/kg NPK) from the 1960s, when the Green Revolution introduced widespread adoption of artificial NPK fertilization, to the 1990s. Yield reduction is due to enhanced cropping intensity combined with the failure to recycle crop residues. New approaches are needed to sustainably enhance crop yields to feed Bangladesh's populace but any intervention must be of low cost & sustainably use local resources to be achievable. This application focuses on the Pleistocene Tracts of Bangladesh. This physiographical unit was selected as its soils are naturally more nutrient deficient & lower in pH compared to Holocene floodplain soils. The 2 most commonly used, high-yielding rice cultivars were used, BRRI dhan49 for the wet season & BRRI dhan28 for the dry-season. Experiments were conducted on 5m*5m subplots of 1 field, with 3 treatments * 3 replicates per treatment in 9 villages Valuka, Mymensingh and 9 villages at Tanor, Rajshahi. The treatments are: (a) conventional field application rates of NKP, (b) ash with standard rate of urea & any K & P supplementation needed to make up the difference between commercial rate, (c) conventional field application rates of NKP plus 1 t/ha. Straw & grain yields were recorded at harvest. The experiments worked as predicted & we see up to 15% increase (in Rajshahi) as compared to conventional. Yield increases at Valuka are slightly smaller, but yields are generally higher. It is interesting that the ash by itself was much more variable. Adding 1 t of ash to conventional fertilization looks like the most robust (i.e. works across all sites) approach. Quite remarkable that yields can be enhanced 10% using a waste-stream generated by every household.

Nutrient Management in Diversified Cropping in Bangladesh

M Jahiruddin* and M.M.R. Jahangir

Department of Soil Science, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh;
**E-mail: m_jahiruddin@yahoo.com*

Abstract

The challenge for the future agriculture is to develop nutrient management packages that will ensure sustainably improved crop production maintaining current nutrient levels where they are adequate, while avoiding nutrient deficiencies and imbalance or overuse of fertilizers. The Nutrient management project (funded by ACIAR and KGF) aims to develop nutrient management packages for emerging cropping systems based on reduced tillage and residue retention with suitable crop rotations. Conservation agriculture (CA) practices (Tillage: strip-ST vs. conventional-CT; residue retention: 15 and 40% crop residue) with low to high nutrient application rate (recommended dose-RD, 75 and 125% of RD) at five contrasting sites viz. BAU Farm, Ishwardi, Pabna, Godagari and Alipur are being carried out since January 2018 and will be continued through December 2021. The first year results on the effects of CA on crop production are not consistent. For example, rice yield at BAU Farm was significantly lower in CT than in ST, while higher at Alipur and Godagari sites. Conversely, wheat yield was higher in ST than in CT at all sites. Lentil yield significantly increased due to conversion of CT to ST at Alipur site but the result was opposite at Ishwardi site. However, the results would be clear through the next year results. Soil organic carbon (SOC), total N (TN), total- and available P, K and S

were higher in ST than in CT at all sites suggesting higher potential of ST for nutrient sequestration. On the contrary, mineral N content was found higher in CT than in ST indicating increased N mineralization rate in the CT. The ST appears to have removed plough pan in soil enhancing water percolation through the soil profile. With regards to crop residue retention, higher residue retention showed better soil quality, but its effects on crop productivity are not yet visible. Considering nutrient application rate, at most of the sites for all crops, 125% of the RD significantly increased the crop yield. Nevertheless, continuation of the research over the next few years would give comprehensive understanding about the impacts of soil, crop and nutrient management on profitable cropping systems as well as on the sustenance of soil fertility.

Mineralogy of Northern and Eastern Hills Soils (aez 29)

Abu Zofar Md. Moslehuddin
Department of Soil Science, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
E-mail: abunazia@yahoo.com

Abstract
Bangladesh has been divided into 30 Agro-ecological Regions (AEZs) based on which applied agricultural research has currently been conducted. Mineralogical composition of soils is a vital characteristic influencing its physical, chemical and biological properties. Due to the unavailability of sufficient mineralogical information of soils of those AEZs, there was an initiative to study mineralogical composition of major soils of different AEZs of the country. A research project has been undertaken in order to find out the mineralogical composition of the soils of the AEZ 29 Northern and Eastern Hills, to verify the proposed mineralogical suite for this AEZ. The project duration was from January 2018 to December 2018. In this project, the mineralogy of eight soils from five soil series (Pritimpasha, Varella, Pahartali, Mirsarai and Borkal) from AEZ 29, Northern and Eastern Hills, has been reported in this manuscript. The soils of the AEZ were medium textured, non-saline and slightly acidic to strongly acidic in nature. The average content of <2 μm clay fraction was 17.9% and it varied from 7.9 to 32.5%. The 2–20 μm silt fraction lied between 14.1 to 28.7% with an average of 21.5%. The clay fraction was dominated with mica, chlorite, kaolinite, quartz in all the soils studied. Presence of two interstratified minerals namely, vermiculite-chlorite intergrade and interstratified mica-chlorite minerals were evident in some samples. The findings of the present study do not support the proposed mineralogical suits of mica-kaolinite-vermiculite and kaolinite-mica for this AEZ.

Genetic variation of some entomopathogenic fungi isolated from Bangladesh

Khadija Akter* and Mohammad Tofazzal Hossain Howlader
*Insect Biotechnology and Biopesticide Laboratory, Department of Entomology, Bangladesh Agricultural University, Mymensingh-2202, *Email: khadijaaakter888@gmail.com*

Abstract
Entomopathogenic fungi (EPF) are those species of fungi that specifically infect and often kill insects and other arthropods and therefore, possessing have great potential as biological control agents against many insect pests of agricultural importance. The *Beauveria bassiana*, *Metarhizium anisopliae, Isaria fumosorosea, Lecanicillium muscarium* and *Nomuraea rileyi* are the most widely used EPFs in insect pest management around the world. In this study, attempt was taken to determine the genetic variations of the native EPFs of Bangladesh. About 200g of soils were collected from Mymensingh, Tangail, Bogra, Nilphamari districts of Bangladesh and fungal strains were isolated by using the selective medium (Oatmeal Agar,0.6g/L CTAB,0.5g/L Chloramphenicol, 0.1g/L Ampicillin) by incubating at 25°C in the dark for 7-14days before examination. Pure cultures were obtained by sub-culturing and

stored at-20°C. Isolated fungi were characterized on the basis of morphological characteristics. So far, we have isolated 15 fungi strains. The genomic DNA was isolated by mini preparation procedure for fungal DNA, quantified spectrophotometrically and confirmed by gel electrophoresis. Molecular identification of the isolated fungal strains is ongoing. The genetic variation among the isolated fungi shall be done by RAPD-PCR technique. We believe that our study will be helpful for fungal biopesticide development and eco-friendly pest management.

Isolation and molecular identification of local Entomopathogenic Fungi (EPF) from Bangladesh for fungal biopesticide development

Hasan Mohammad Tarique[1], Mohamamd Tofazzal Hossain Howlader[2*], Md. Azizul Haque[2] and Gopal Das[2]

*Insect Biotechnology and Biopesticide Laboratory, Department of Entomology, Bangladesh Agricultural University, Mymensingh, Bangladesh, *E-mail: tofazzalh@bau.edu.bd*

Abstract

The local isolates of entomopathogenic fungi (EPF) have great compatibility with the pest species in comparison to exotic isolates to develop fungal biopesticides. We here report the first investigation EPFs from Bangladesh. A total of seventy-five soil samples were collected from fifteen districts and the EPFs, especially *Purpureocillum*, *Beauveria,* and *Metarhizium* species were isolated using dodine based selective media (Potato Dextrose Agar with 1% Yeast containing 0.05 g/L dodine, 0.1 g/L chloramphenicol, 0.1 g/L ampicillin and 0.1 g/L tetracycline) by incubating at 25°C in the dark for ten days. A total of 65 EPFs out of 75 soil samples were isolated. Among them, the *Purpureocillum* sp. was isolated from 53 soil samples, while the *Beauveria* sp. was found in 10, the *Metarhizium* sp. and *Lecanicillum* sp. was found in 1 sample respectively. Thus, the *Purpureocillum* sp. was found as the most frequent EPFs from the soil in Bangladesh. For molecular characterization, ITS region was amplified by PCR using ITS1 and ITS4 primers. About 600bp of PCR band was amplified. DNA sequencing of the ITS region using forward primer has confirmed the identity of eight *Beauveria bassiana*, six *Purpureocillum lilacinum*, one *Lecanicillum saksenae* and two *Trichoderma* sp. fungal species. Our results confirmed the first isolation that entomopathogenic fungi in Bangladesh and evaluation of pathogenicity of these isolates can help to develop effective fungal biopesticides for insect pest management.

Effects of N-P-K based fertilizers and weather parameters on the incidence of sucking insect complex on okra

Tomalika Saha, Gopal Das* and Mst. Rokeya Khatun

Department of Entomology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: gopal_entom@yahoo.com*

Abstract

Sucking insect complex *viz*. jassid, white fly, aphid and thrips are the major threat for vegetable production in Bangladesh. In recent years, this infestation level became severe due to changes of climatic scenario especially sudden rainfall, changes of temperature and humidity. Moreover, injudicious application of N-P-K based fertilizers has triggered the infestation level. All the experiments were conducted in the Entomology Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from February to June, 2019. In the present study, effect of different weather parameters like rainfall, humidity and temperature on the incidence caused by sucking insects has been studied. It has been clearly found that there has a positive relationship between high incidence of sucking insects and rainfall, temperature and humidity. Sudden rainfall in the first week of April (about 23 mm) as well as high humidity and moderate temperature highly induced high incidence of

sucking insects. In case of fertilizer experiment, 10, 20 and 30% extra nitrogen, phosphorus and potassium was applied in addition with recommended doses. Data were collected at 10 days interval on number of insects/leaf, number of curled leaf/plant and yield of okra (t/ha). It was found that the highest jassid populations (35-38/leaf, on mid April), highest curled leaves (9.23/plant, on 1st week of May) and lowest yield (4.56t/ha) was recorded when 30% extra nitrogen was applied in addition with recommended doses but jassid populations and curled leaves were significantly reduced when 30% extra P or 30% extra K were applied in addition with recommended doses. Yield (t/ha) was also increased significantly following application extra 30% P or 30% K compared to recommended doses. Application of 20% extra N, P or K had moderate effect on the parameters studied while 10% extra N, P or K had no remarkable effect.

Relative efficacy of chitin synthesis inhibitor, juvenile hormone analogue and some new generation acaricides against red spider mite, *Tetranychus urticae* (Koch.) on marigold

Gopal Das* and Barun Kumar Roy
Department of Entomology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: gopal_entom@yahoo.com*

Abstract
In the present study, efficacy of chitin synthesis inhibitor (Heron 5 EC), juvenile hormone analogue (Pyrifen 10.8 EC) and some new generation acaricides (Oberon 240 SC, Mite Scavenger 10 EC and Omite 57 EC) were evaluated against red spider mite, *Tetranychus urticae* (Koch.) on marigold under laboratory condition. Experiments were conducted in the laboratory, Department of Entomology, Bangladesh Agricultural University, Mymensingh from the period of August 2018 to February 2019. All the selected molecules had two concentrations and sprayed directly on the marigold plants. Data were collected on abundances of mite populations per leaf, percent reductions of curled or infested leaf, formation of webs or silk ball (cm^2) and number of fresh or marketable flowers per plant. Mite populations were counted at 1, 3, 7 and 10 days after given each spray, curled leaves and webs were counted at 10 DAS after given 3rd spray. Marketable flowers were counted when flowers were attained the perfect size for selling. Among five molecules, Omite 57 EC @ 1.5 ml/L performed the best efficacy considering all parameters studied which was followed by 1.0 ml/L of water. This result was closely followed by Oberon 240 SC, Mite Scavenger 10 EC and Heron 5 EC respectively. Pyrifen 10.8 EC was found to be ineffective compared to untreated control.

Field evaluation of different non-chemical methods and biorational pesticides against major insect pests of cucurbitaceous vegetables on bitter gourd

S. M. Rakib Uddin Kawsher and Gopal Das*
Department of Entomology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: gopal_entom@yahoo.com*

Abstract
In the present study, effect of different non-chemical methods alone or in combined way as well as some biorational insecticides were evaluated against cucurbit fruit fly, red pumpkin beetle and epilachna beetle in field condition in kharif season, 2018-2019 at Entomology field laboratory, BAU to compare the infestation level as well as yield of bitter gourd. Different non-chemical methods *viz.* deep

ploughing, field sanitation, hand picking, fruit bagging, bait trap and sticky traps were evaluated. Moreover, five biorational insecticides like Pyrifen 10.8EC, Baicau 0.5%, Libsen 45 SC, Lumectin 10 WDG and *Bacillus thuringiensis* were evaluated. Data were collected on different parameters *viz.* percent fruit infestation, marketable or healthy fruit yield (t/ha), abundances of red pumpkin beetle and epilachna beetle etc. In case of non-chemical approach, the treatment field sanitation + hand picking + bait trap + fruit bagging + sticky trap (T_7) was found superior to minimize fly incidence and thereby reduction of fruit infestation (12.23%). This was closely followed by bait trap + fruit bagging + sticky trap (T_6) (14.45%) and deep floughing + field sanitation + hand picking + fruit bagging (T_4) (15.53%) respectively. On the other hand, the highest yield was recorded from T_7 (9.12 t/ha). This result was closely followed by T_6 (8.75 t/ha), T_4 (8.12 t/ha) and T_5 (7.75 t/ha) respectively. Other treatments also potentially reduced infestation level. Among the tested biorational insecticides, 8.73% infested fruits were found when plants were treated with Libsen 45 SC @ 0.5 ml/L that was closely followed by Lumectin or Pyrifen (12-17%). *Bacillus thuringiensis* had moderate effect on fruit infestation level. Baicau (Biotrin 0.5%) was found to be very ineffective against fruit fly infestation. Abundances of red pumpkin beetle and epilachna beetles/5 leaf were significantly reduced compared to control when plants were treated with Libsen 45 SC @ 0.5 ml/L that was followed by Lumectin and Pyrifen respectively. *Bacillus thuringiensis* was found moderately effective while Baicau was found very less effective against red pumpkin beetle or epilachna beetle.

Incidence, population dynamics and bio-efficacy of some new generation insecticides against major insect pests of soybean

Nabani Datta and Gopal Das*

Department of Entomology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: gopal_entom@yahoo.com*

Abstract

Soybean is an important oil crop that is severely infested by different sucking and leaf-eating insects. In the present study, incidence and population dynamics of different sucking and chewing insects were observed for the whole cropping season of soybean. Moreover, some new generation insecticides like Ravjum 14.5 SC, Lumectin 10 WDG, Intrepid 10 SC and Sniper 10 SC were evaluated against major insects of soybean. All the experiments were conducted in rabi season, 2018-2019 at Entomology field laboratory, BAU. A total of 12 insect pests were identified in soybean field from different orders and among them jassids, white fly, aphid, cutworm and soybean leaf rollers incidence were major. Among the sucking insects, the incidence of jassids, white fly and aphids were started from 2nd week of January, reached to the peak level in the month of February and then gradually declined. On the other hand, the incidence of leaf eating insects like soybean leaf roller, leaf beetle, grasshopper etc were started from mid of January, reached to the peak level by mid February to mid March and then declined gradually. Among the tested insecticides, Ravjum 14.5 SC @ 1.5 ml/L showed the best efficacy where 90% jassids populations were reduced over control that was followed by Lumectin 10 WDG @ 1.0 ml (85.01%). Similar trend of efficacy was found in controlling white fly and aphids. On the other hand, about 94% reductions of rolled leaves over control were found when plants were treated with Ravjum 14.5 SC @ 1.5 ml/L that was followed by Lumectin 10 WDG, Sniper 10 SC and Intrepid 10 SC respectively. Among the insecticides, Ravjum 14.5 SC @ 1.5 ml/L treated plots produced the highest yield (2.34 t/ha) that was followed by Lumectin 10 WDG, Sniper 10 SC and Intrepid 10 SC respectively. Minimum yield (1.41) was recorded from untreated control plot.

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Bio-rational Management of Tomato Leaf Miner, *Tuta absoluta* (Meyrick), a Threatening Pest of Tomato

Kazi Shahanara Ahmed* and Mahfuza Begum[1]
[1]Department of Entomology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh and [1]Department of Agronomy, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail : shahanara.bau@gmail.com*

Abstract
Tomato (*Solanum lycoperdicum* L.) is the most popular vegetable crop in Bangladesh as well as in the world. Huge amount of Tomato fruits become lost due to attack of insect pest. The yield of tomato decrease due to increase of insect infestation. Experiments were conducted at the Entomology field laboratory and Entomology laboratory, Department of Entomology, Bangladesh Agricultural University (BAU), Mymensingh during October, 2018 to 15 March, 2019 in order to evaluate the efficacy of some botanicals and to elucidate the efficacy of some bio-rational insecticides for controlling tomato leaf miner, *Tuta absoluta*. The experiment was laid out in complete randomized design (CRD) with five (05) replications and randomized complete block design (RCBD) with three (03) replications in laboratory and field condition, respectively. Lalima (BARI tomato-09) variety was used as experimental crop. Five (05) botanicals *viz.* Neem leaf extract @ 2.0 ml/L, Bishkathali leaf extract @ 2.0 ml/L, Lemon extract @ 2.0 ml/L, Garlic clove extract @ 2.0ml/L and Mahagany seed extract @ 2.0 ml/L, and five (05) bio-rational insecticides *viz.* Emamectin benzoate 5SG@ 1.0 ml/L, Lufenuron 5EC @ 1.0 ml/L, Spinosad 2.5 SC @ 0.4 ml/L, Buprofezin 40 SC @ 0.5 ml/L, Abamectin 1.8 EC @ 1.5 ml/L were used as treatments. From the result, it clearly revealed that, yield loss of tomato increased with the increase of infestation of tomato leaf miner. Among five (05) botanicals, neem leaf extract @ 2.0 ml/L was found the best followed by garlic clove extract, lemon extract, bishkathali leaf extract and mahagany seed extract for controlling tomato leaf miner in both laboratory and field conditions while yield and yield attributes were also higher. Furthermore, based upon the bio-rational insecticides, Emamectin benzoate 5SG was found best for controlling tomato leaf miner in both laboratory and field condition followed by Spinosad 2.5 SC, Abamectin 1.8 EC, Buprofezin 40 SC and Lufenuron 5EC.

Mitochondria COI-based molecular identification of leafhopper, Amrasca biguttula biguttula (Ishida) collected from Bangladesh

Most. Sirajum Munira*, Md. Azizul Haque and Mohammad Tofazzal Hossain Howlader
*Insect Biotechnology and Biopesticide Laboratory Department of Entomology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh, *E-mail: sirajummunira0756@gmail.com*

Abstract
The jassid, *Amrasca biguttula biguttula* (Ishida) (Homoptera: Cicadellidae) is a polyphagous sucking insect pest for various crops including Cotton, Brinjal, Okra, Sunflower, Cowpea, China Rose, and Pigeon pea. Populations of *Amrasca biguttula biguttula* (Ishida) from different geographical locations of Bangladesh possess considerable confusion over the systematics of this species and close relatives. Correct identification is necessary for best management strategies. Molecular techniques such as DNA barcoding of Mitochondrial Cytochrome Oxidase subunit I (COI) gene provide better understanding and identification of the insect pest than conventional morphology based identification. Jassids were collected from 11 districts of Bangladesh and the genomic DNA was extracted by Salt Extraction Method. The mtCOI gene fragment (700bp) was amplified by PCR using universal COI primers (LCO-

1490 and HCO- 2198) and analyzed on agarose gel electrophoresis. PCR products were sequenced and subjected to BLAST search at NCBI and phylogenetic tree was constructed. All the Jassids samples except CHBD & MYMBD were molecularly identified as *Amrasca biguttula* and considerable diversity was found among the Jassid populations in Bangladesh. We with this confirmed that DNA barcoding technique could be useful for proper identification of Jassid in Bangladesh.

Management of Jassid, *Amrasca biguttula biguttula* Ishida through biorational insecticides on brinjal

Mohammad Mahir Uddin* and Maria Begum
Department of Entomology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: mahir@bau.edu.bd*

Abstract
An experiment was conducted to determine the comparative efficacy of different biorational insecticides against brinjal jassid, at the field of Entomology of Bangladesh Agricultural University, Mymensingh, during December 2017 to April 2018. The treatments were Neem oil (2 ml/L), Bioneem Plus (1 ml/L), Karanja oil (2 ml/L), Mahogany oil (2 ml/L), Libsen 45 SC (0.5 ml/L), Buprofezin 40 SC (0.5 ml/L), Suspend 5 SG, and untreated control. All the treatments were laid out in the Randomized Complete Block Design with three replications. Three sprays of the treatments were made at 15 days interval. The effectiveness of each biorational insecticide was checked at 7 DAS (day after spraying), at each three spray. The results showed that at 7 DAS of 1st spray, the lowest mean number of jassid plant^{-1}(1.83) was recorded in Buprofezin 40 SC and Libsen 45 SC followed by Mahogany oil (3.77), Neem oil (3.99), and the highest mean number of jassid (8.11) was in Control. In case of jassid leaf^{-1}, at 7 DAS, the lowest mean number (1.55) was explored in Libsen 45 SC followed by Buprofezin 40 SC (2.99), Mahogany oil (3.22) and the highest mean number of jassid leaf^{-1} (6.66) was in Control. In case of infested leaf plant^{-1}, at 7 DAS of 1st spray, the lowest mean number was observed in Libsen 45 SC (1.11), followed by Mahogany oil (2.0), and Buprofezin 40 SC (2.33) but the highest was in control (4.89). A consistent trends were observed in case of cumulative mean number of jassid plant^{-1}, leaf^{-1} and infested leaf plant^{-1} at 7 DAS. After 2nd and 3rd sprays similar trends of mean number of jassid and infested leaf and percent reduction of jassid population over control were observed. In all cases Buprofezin and Libsen showed the best efficacy against jassid in brinjal ecosystem.

Development of IPM modules using microbials and their derivatives for managing bean aphid, *Aphis craccivora* Koch

Mohammad Mahir Uddin* and Farzana Akter
Department of Entomology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: mahir@bau.edu.bd*

Abstract
An experiment was conducted at the Entomology Field Laboratory of Bangladesh Agricultural University, Mymensingh, during October 2018 to March 2019 to develop IPM modules using microbials and their derivatives for managing bean aphid on IPSA Seem-2. Different parameters were evaluated through treatments viz. percentage of twig, flower and pod infestation at different time intervals, yield of marketable pod (t/ha). The experiment was laid out in RCBD model with 3 replications and 8 treatments viz. T_1: Bt + Spinosad (5g+0.5 ml/l), T_2: *B. bassiana* + Lufenuron (5g+0.5ml/l), T_3: Bt + Abamectin (5g+2.5ml/l), T_4: Bt + Neem oil (5g+1.5ml/l), T_5: Bt + Lufenuron (5g+0.5ml/l), T_6: *B. bassiana* +Abamectin(5g+2.5ml/l), T_7: Bt + Buprofezin (5g+0.5ml/l), T_8: Control was included in the present study. Three sprays of the treatments were made at 15 days interval. The

lowest percentage of infested twig, flower and pod was found 8.12%, 4.55% and 5.13%, respectively at *Beauvaria bassiana*+Abamectin sprayed plot after 1st spray. Other modules were more or less similar. After 2nd spray the lowest percentage of infested twig, flower and pod was observed 2.56%, 1.73% and 2.16% at *Beauvaria bassiana*+Abamectin sprayed plot, respectively. Similarly, after 3rd spray the lowest percentage of infested twig, flower and pod were 1.08%, 0.47%, and 0.78%, respectively at *Beauvaria bassiana*+Abamectin sprayed plot. The highest twig, flower and pod infestation was always recorded from control treatments in all three sprays. The highest percentage reduction of infested twig, flower, and pod over control was observed 98.33%, 98.9% and 98.99%, respectively from the plots treated with *B. bassiana* + Abamectin. The highest yield (12.46t/ha) was also found from *B. bassiana* +Abamectin sprayed plot but the lowest yield was in control plots. Therefore, it can be concluded that *B. bassiana* +Abamectin might be applied for the sustainable management of country bean aphid.

Bio-intensive IPM modules for managing pod borer, *Maruca vitrata* Geyer on country bean

Mohammad Mahir Uddin* and Most Shamima Yasmin
Department of Entomology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: mahir@bau.edu.bd*

Abstract
Efficacy of some bio-intensive IPM modules against the infestation of bean pod borer (BPB), *Maruca vitrata* Geyer was evaluated in the Entomology Field Laboratory, Bangladesh Agricultural University (BAU), Mymensingh during September 2018 to April 2019. The experiment consisted of 8 treatments viz. Untreated Control, Spinosad (Libsen 45SC) + Bt+ Hand picking, Abamectin (Benten 1.8EC)+ Bb+ Hand picking, Emamectin benzoate (Suspend 5SG)+Spinosad+Hand picking, Spinosad+ Hand picking, Emamectin benzoate (Suspend 5SG) + Hand picking, and Abamectin (Benten 1.8EC) + Hand picking, Ostad 10EC + removal of infested plant parts. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications of each treatment. The effectiveness of selected IPM modules was evaluated based on different parameters viz. no. of larva per flower and pod, no. of healthy pod per plant, no. of infested pod per plant, weight of healthy pod per plot and weight of infested pod per plot. All the treatments significantly reduced the no. of larva per flower and pod. Similarly all IPM modules could reduce significantly the number and weight of infested pod per plant and plot. Number of healthy pod per plant as well as weight of healthy pod per plot was also increased significantly with the effect of all the IPM modules used in the experiment. Among the IPM modules, T_4= Emamectin benzoate (Suspend 5SG) + Spinosad + Hand picking showed the best performance in all the parameters studied. Therefore, IPM module consisting of Emamectin benzoate (Suspend 5SG) + Spinosad + Hand picking might be used for the successful management of bean pod borer.

Biological control of Papaya mealybug using two potential entomopathogenic fungi, *Beauveria bassiana* and *Metarhizium anisopliae*

Mohammed Abul Monjur Khan
Department of Entomology Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: khan@bau.edu.bd

Abstract
The papaya mealybug has been identified recently in Bangladesh and within the last few years this insect pest spread throughout the country very rapidly and has become major concern to papaya

growers in Bangladesh. The infestation of papaya mealybug in papaya orchard is ranged from 26.67% to 60% in Bangladesh. Traditionally, farmers of Bangladesh use different broad spectrum chemical insecticides to control papaya mealybug, which cause environmental hazards and kill beneficial fauna. It is therefore necessary to find out other control options rather than chemical control. The goal of this project was to evaluate the efficacy of two potential entomopathogenic fungi, *Beauvaria bassiana* and *Metarhizium anisopliae* against papaya mealybug. Application of entomopathogenic fungi significantly increased the mortality of papaya mealybug. The mortality of papaya mealybug was 72%, 66% and 36% in *Beauvaria bassiana*, *Metarhizium anisopliae* and control treatments, respectively. Above findings revealed that *Beauvaria bassiana* and *Metarhizium anisopliae* provided moderate control of papaya mealybug. Therefore, these two entomopathogenic fungi can be used to control papaya mealybug along with other control tactics in the fields.

Sustainable Management of Maize Insect Pests with Special Emphasis on the Corn Borer, the Emerging Species through Innovative, Participatory and Collaborative Research

Khandakar Shariful Islam* and Mahbuba Jahan
Department of Entomology, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
**E-mail : ksharif_bau@yahoo.com*

Abstract

This project is aimed to conduct basic and applied research on modernizing the existing IPM modules of maize pest to increase the yield of maize. The project activities started with inception workshop with the presence of maize growers, stakeholders, Scientists, Extension workers of DAE to develop final framework of the project. Farmer's perception about maize insect pests was studied by structured questionnaire and interview of selected maize growers of the project areas viz. Mymensingh, Chuadanga and Gaibandha. Incidence of maize pest complex and prevalence of natural regulatory forces in the ecosystem have been studied in the University Campus of BAU and Farmers field of Chuadanga as well as Gaibandha to describe the relationship between the maize pests and their natural enemies. Cutworm, Corn borer, Aphid and Fall Armyworm were listed as major pest. Some experiments for developing new IPM packages have been completed and some are on progress. Investigation of cutworm Agrotis ipsilon on the effect of flood irrigation involving different treatments such as irrigation accompanied by hand picking showed that one flood irrigation after 7-8 days of sowing i.e., around three days after germination reduced 72 percent seedling damage . Thorough coverage of pesticide in the area five cm radius of the seedlings provided good protection. Susceptibility study of five maize varieties viz., Bari Hybrid Maize 7, Bari Hybrid Maize 9, Alfa Seed, Super Shine and C.P 333 showed that all the five varieties were susceptible to cutworm although it was noticed that the variety BARI Hybrids and Alfa seed were less damaged. As the Baseline toxicity of the insecticides would be expedient in understanding the level of susceptibility of corn borer to the particular insecticide, test with five new molecules including two Diamide products namely Chlorantraniliprole (Coragen), Flubendiamide (Belt 25WG), three biopesticide and two conventional insecticides including Cloropyriphos and carbusulfan in four geographically distinct field populations of Bangladesh is on progress and from preliminary result flubendamite was found to be superior against corn borer considering the toxicity ratio. Awareness development were made through training and field days at Upazila Agriculture Training Center, Alamdanga, Chuadanga , Dharmapur, Sundarganj, and Gaibandha.

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Surveillance of guava fruit fly, *Bactrocera correcta* (Bezzi) and its management through integrated approach for safe guava production

Khandakar Shariful Islam*, Mahbuba Jahan and Md. Mehadi Hasan
Department of Entomology, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
**E-mail : ksharif_bau@yahoo.com*

Abstract
This population demography studies focuses on surveillance for better management of guava fruit fly, *Bactrocera correcta* (Bezzi)Infestations of fruit fly was discovered at early stage through regular monitoring by using Bactro-D pheromone trap, Population reached in peak at September and sharp declined occur in November. Control approaches of guava fruit fly must be initiated from the month of May. The efficacy of *B. bassiana, M. anisopliae, M. anisopliae + T. harzianum* and poultry manure were investigated against guava fruit fly under laboratory condition in Entomology department of Bangladesh agricultural University. In mortality test, all the test entomo pathogens were significantly lethal compared to control as all the adult died resulting from microbial application during the experiment. From this present study, it was observed that the effect of entomopathogens is different in different life stage of fruit fly. The higher efficacy was found in the combined product of *M. anisopliae + T. harzianum* in larval condition . In pupal condition the higher efficacy found through the application of *B. bassiana and M. anisopliae*. But the efficacy of the combine entomo pathogen was lower against adult fruit fly.

Eco-friendly Management of Sugarcane Stem Borer with special emphasis on the use of the parasitoid *Trichogramma chilonis*

Khandakar Shariful Islam*, Mahbuba Jahan and MNA Siddiquee
Department of Entomology, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
**E-mail : ksharif_bau@yahoo.com*

Abstract
Present study was investigated the better performance of the parasitoid *Trichogramma chilonis* against sugarcane stem borer a major damaging pest of sugarcane, In order to develop ecofriendly management approach , a spatial distribution and extent damage of stem borer in synchronization with parasitoid *T. chilonis* field efficacy performance were evaluated Spatial distribution Pattern of sugarcane stem borer infestation was determined growing season. The population of *C. tumidicostalis* was gradually increased from second to twelfth internode and then started to decline to twenty-third internode. The mean top or highest stem borer bore was 43.67 in twelfth and lowest (0.0) in first and twenty-sixth internode respectively. The highest number internode infestation was evident in the month of August which gradually increased from month of April to July and decreased from month of September onwards. The performance of the parasitoid *T. chilonis* against sugarcane stem borer was significantly higher (62.00, 47.78, 40.01 and 45.20%) when the dose was @ 50,000 Adult/Week/ha as compared to those plots where release of *T. chilonis* were @ 75,000 Adult/fortnight/ha (64.00, 42.60, 32.54 and 28.78%) and @ 100,000 Adult/Month/ha (66.00, 29.29, 23.35 and15.35%) as found in June, July, August and September respectively. The both inoculative and inundative *Trichogramma chilonis* released at different doses significantly reduced the stem borer infestation compared to untreated control plot. The rate of effectiveness of July, August and September was ranged from 40.78 – 71.05%, 21.24 – 53.29% and 11.56 – 36.09 %, respectively. Maximum mean efficacy parasitization percentage by the parasitoids (53.48%) was recorded in release @ 4,00,000 Adult/ha *T. chilonis* treated plot.

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Banana Pseudostem weevil *Odoiporuslongicollis* Oliver (Coleoptera: Curculionidae, a major pest of banana and its ecofriendly management for food security

Mahbuba Jahan
Department of Entomology, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
E-mail : Jahan-bau@bau.edu.bd

Abstract
Banana cultivation is seriously affected by Pseudostem Weevil, Odoiporus longicollis in recent years in Bangladesh This proposed project was determined the severity of pest attack 'toppling of Banana plantation' in different hot spots. On farm and laboratory experiments were carried out at the farmers field to assess the bio-efficacy of Beauveria bassiana, Bioneem and volium flexi (spray and injection) insecticide against pseudostem weevil, Odoiporuslongicollis Oliver (Coleoptera : Curculionidae) in Amrotosagor banana. Injection of volium flexi @ 2ml/plant exhibited the highest per cent reduction (78.00%) followed by the injection of Bioneem 2ml/plant (72.0%), application of B. bassiana @ 25g on the pseudostem trap (58.70%) and volium flexi spray (39.50%). However, application of volium flexi (2ml/plant) and Bioneem (2ml/plant) by stem injection proved to be more effective than by spraying of volium flexi. Stem injection of volium flexi, bioneem and the application of B. bassiana recorded the highest per cent mortality of 95.0, 83.58 and 76.4%, respectively, after 7 days of application. All the treatments were found to increase the fruit yield with better cost benefit ratio.

Efficacy of the Naturally Derived Safe Insecticide, Spinosad Against Aphids

M. Ahmad and A. Akter[1]
*Department of Entomology and [1]Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: masum_bau2006@yahoo.com*

Abstract
Aphids are among the world's most destructive small soft bodied sap sucking insect pest of grain crops, vegetables, ornamentals, fruit trees.Aphids attached to other plant parts such as stems or twigs may cause stunted growth, early leaf fall, or twig mortality.They also transmit disease causing organisms. So, in this study, a laboratory experiment was conducted to check relative efficacy of spinosad insecticide against aphid infestation in bean and maize plants at the laboratory of Entomology, Bangladesh Agricultural University, Mymensingh by applying treatment T_1= Spinosad @ 0.5 ml/L with three replication using leaf dipping method. Spinosad, a systemic insecticide based on chemical compound found in the bacterial species *Saccharo polysporaspinos a*and it is a new generation safe insecticide & highly toxic to a broad array target pests and having low residual toxicity. Firstly, bean and maize plants were grown on pots in the laboratory with suitable temperature. When plants became 10 inches height, aphids were placed on the plants taken from the fields. It took some days for rearing them. Secondly, 15 bean leaves were taken on individual petri-dish by leaf dipping method. Thirdly, 10 aphids were inserted on each leaves. Then the movement of aphidswere observed and data were collected on mortality rate of aphid at 24 hours interval until all the aphids die. The same procedures were followed for maize aphid. Spinosad exerted insecticidal activity against maize aphid. The effect is concentration and time depended. Spinosad showed much effect for both 300 ppm and 400 ppm concentration. About 34% mortality was observed on 3rd day of application. The Spinosad was found effective against bean aphid. The effect is also concentration and time depended, i.e., Mortality increases with the increase of time and dose. About 30% mortality was

observed in 2nd day and 3rd day of application for 200 ppm and 500 ppm concentration, respectively. Spinosad insecticide showed its best performance after 2nd and 4th day of application for bean aphid where 3rd day of application in case of maize aphid. For bean aphid, Spinosad @ 500 ppm concentration proved as better effective compare to other concentration (100 ppm, 200 ppm, 300 ppm, 400 ppm). For maize aphid, Spinosad @ 400 ppm concentrations showed best performance. So, for the management of these two aphid species, Spinosad could be recommended as above mentioned concentrations for their control.

Effects of maturity stages and organic treatments to control postharvest fungal infection, shelf life extension and quality retention of papaya for nutritional food safety

Md. Harun Ar Rashid*, Md. Ahsan Habib and Ashrafun Nahar
Department of Horticulture, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: harun_hort@bau.edu.bd*

Abstract
An experiment was conducted to study the effects of maturity stages and organic treatments to control postharvest fungal infection, shelf life extension and quality retention of papaya at the Laboratories of the Departments of Horticulture and Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh during the period from August to November 2018. The two-factor experiment consisted of two maturity stages viz. M_1: mature green colour and M_2: 0-10% yellowing on the fruit; and six organic postharvest treatments viz. control (T_0), hot water @ 50°C for 10 minutes (T_1), aloe vera extract @ 1% (T_2), garlic extract @ 1:1 (T_3), hot water + aloe vera (T_4), and hot water + garlic (T_5). The experiment was laid out in a completely randomized design with 3 replications. Results showed that combined application of maturity stages and organic treatments were significant on almost all the parameters studied except titratable acidity. Peel colour was light greenish yellow in hot water+aloe vera extract, while yellow in rest of the treatment combinations. Maximum weight loss (18.82%), TSS (14.68%), disease incidence (100%) and severity (80.67%) were recorded from control, whereas minimum values (18.82, 10.30, 58.33 and 15.17%, respectively) were found from hot water+aloe vera under both maturity stages. Highest pulp to peel ratio (4.33), pulp pH (6.32), vitamin C (53.96 mg/100g) and shelf life (15.08 days) were obtained from the combined treatment of hot water+aloe vera extract followed by hot water+garlic extract, while the lowest values (3.10%, 5.02%, 39.77 mg/100g and 8.27 days, respectively) were observed in control under maturity stage 2 fruits. Therefore, it can be concluded that combined application of hot water+aloe vera extract, followed by hot water+garlic extract under both maturity stages found to be better in respect of reducing fungal infection, extension of shelf life and quality retention of papaya fruits without affecting the nutritive value.

Induction of flowering, fruit setting and seedless fruit in tomato

Tajmoon Nahar and Md. Rezaul Karim*
Department of Horticulture, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: mrkarim1996@yahoo.com*

Abstract
Two separate experiments were carried out at the Horticulture Farm, Bangladesh Agricultural University, Mymensingh during the period from November 2018 to February 2019. **Experiment 1** was a single factor experiment consisting of 17 treatments (100, 150 and 200 ppm of IAA and GA_3 singly and their combinations; control and open pollination) which was laid out in Completely Randomized

Design (CRD) with three replications. Plant growth regulators showed significant effect on % fruit set, individual fruit fresh weight, pericarp thickness of fruit and seedless tomato fruit. The highest value of all those parameters were obtained from treatment combination of 200 ppm of IAA and 200 ppm of GA_3. From this experiment we got 100% seedless fruit. **Experiment 2** consisted of two factors, (i) four different doses of IAA *viz.*, 0, 100, 150, 200 ppm and (ii) four different doses of GA_3 *viz.*, 0, 100, 150, 200 ppm. The was laid out in Randomized Complete Block Design (RCBD) with three replications. Plant growth regulators showed significant effect on all the parameters studied. The plant treated with 200 ppm IAA produced the highest plant height (97.89 cm), minimum days to first flowering (31.85), fruit yield/ha (37.68 t/ha), lowest number of seed (92.08). The plant treated with 200 ppm GA_3 produced the highest plant height (90.81 cm), minimum days to first flowering (32.07), fruit yield/ha (35.61 t/ha), lowest number of seed (95.42). The plant treated with 200 ppm IAA in combination with 200 ppm GA_3 produced the highest plant height (104.30 cm), minimum days to first flowering (28.96), fruit yield/ha (42.48 t/ha), lowest number of seed (43.33).

Morpho-molecular characterization of some mango germplasms of Chapainawabganj district

Md. Mohimenul Islam and Md. Rezaul Karim*

Department of Horticulture, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: mrkarim1996@yahoo.com*

Abstract

In this study, morphological and molecular characters of mango germplasm were assessed by using six simple sequence repeat (SSR) markers. Thirty mango germplasm were selected and their leaf, panicle, fruit and stone samples were collected to study their morphological and molecular traits respectively. In-situ characterization and evaluation of fruit samples revealed phenotypic variations among mango germplasm. In the present study wide variability was observed among these 30 mango germplasm. Two types of leaf shape, two types of leaf margin and one type of leaf tip were observed in 30 mango germplasm. Light green to dark green color of mature leaves were recorded among the 30 mango germplasm. The longest leaf was recorded in the germplasm Lokhonvog. Maximum leaf breadth was recorded in the germplasm Kachmithi. Gopalvog had the highest (92.33%) and Langra had the lowest (67.33%) of male flowers per panicle. Langra showed maximum (32.67%) of bisexual flowers per panicle. The color of the panicle was observed light green to light green with red patches. Kalua had the maximum initial fruit set per panicle (35.00). The germplasm, Fazli was the longest fruit having maximum fruit weight with highest pulp/peel ratio (9.83) among the germplasm. The highest breadth was observed in Nora. Two types of fruit shape and three types of color were observed among mango germplasm. The ripe mango contained highest TSS in the germplasm Bombai (20.00%). Maximum stone weight was recorded in Fazli whereas the minimum in Nora. Polymerase chain reaction (PCR) amplification of the DNA isolated from 30 mango germplasm with 6 SSR primers were used. The allele size detected ranged from 121 to 223 bp. SSRs gave moderate values of polymorphic information content (PIC) range of 0.6499 to 0.9311. We obtained moderate degree of genetic diversity, highest level of genetic diversity value (0.9343) in loci MIGA179 and the lowest level of genetic diversity value (0.6643) was observed in loci MIGA253 with a mean diversity of 0.8703. The dendrogram generated from the unweighted pair group arithmetic average (UPGMA) cluster analysis broadly placed 30 mango cultivars into eight major clusters. The cluster size varied from 2 to 6 and cluster VII was the largest cluster comprising of 6 cultivars. The tendency of clustering among mango cultivars revealed that they have strong affinity towards further breeding programme.

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Effects of boron and GA_3 on yield and quality seed production of summer onion

Nabila Tabassum and Md. Rezaul Karim*
Department of Horticulture, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: mrkarim1996@yahoo.com*

Abstract
An experiment was conducted at the Horticulture Farm, Bangladesh Agricultural University, Mymensingh during November 2018 to April 2019 to study the effect of boron and GA_3 on yield and quality seed production of summer onion. The two factor experiment was laid out in Randomized Complete Block Design with three replications. The first factor experiment was having four doses of boron, viz., 0, 1, 2 and 3 kg/ha and the second factor was GA_3 having four different concentrations, viz., 0, 100 and 150 ppm. The results of the experiment showed that the boron had significant effects on all the parameters studied. The highest number of umbels per plant (8.89), seeded fruits per umbel (89.56), percentage of fruit set (53.78), seed yield (237.96 kg/ha) and germination of seed (85.12%) were recorded from the application of boron at the rate of 3 kg/ha whereas the lowest values for these characters were obtained from control treatments. The GA_3 had also significant effects on all the parameters studied. The highest number of umbels per plant (8.27), seeded fruits per umbel (81.05), percentage of fruit set (41.98), seed yield (196.96 kg/ha) and seed germination (88.37%) were recorded from the application of GA_3 at the rate 150ppm whereas the lowest values for these characters were obtained from control treatments. Among the treatment combinations, highest number of umbels per plant (10.18), seeded fruit per umbels (97.19), percentage of fruit set (57.15), seed yield (283.66 kg/ha) and germination of onion seed (93.37%) were recorded from the application of boron at the rate of 3kg/ha with GA_3 at rate of 150 ppm whereas the lowest values for these characters were obtained from control treatments.

Induction of flowering, fruit setting and seedless fruit in watermelon

Meftahul Jannat and Md. Rezaul Karim*
Department of Horticulture, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: mrkarim1996@yahoo.com*

Abstract
Watermelon is one of the most common cucurbits grown in Bangladesh and used as dessert. The popularity and cultivation of watermelon is increasing day by day in Bangladesh due its high nutritive value. Seedlessness is appreciated by consumers both in fruits for fresh consumption as well as in food processing industries. Seedlessness can contribute to increase the quality of the fruits when seeds are hard or have a bad taste. Furthermore the shelf life of seedless fruits is longer than seeded fruits because seeds produce hormones that trigger senescence. With this point of view, experiments were carried out at the Horticulture Farm, Bangladesh Agricultural University, Mymensingh. The two-factor experiment consisted of two factors, (i) four different doses of IAA *viz.*, 0, 100, 150, 200 ppm and (ii) four different doses of GA_3 *viz.*, 0, 100, 150, 200 ppm. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Results of the experiment revealed that plant growth regulators induced seedless fruit in watermelon which will be presented in workshop.

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Improvement of yield and quality of turmeric genotypes through cultural management

Md. Mokter Hossain* and Tamanna Haque
Department of Horticulture, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: mokter.agr@bau.edu.bd*

Abstract
Turmeric (*Curcuma longa* L.) is one of the most important spice crop of Bangladesh. Yield and quality of turmeric can be improved by adopting proper cultural managements and using high yielding variety. Therefore, this study has been undertaken to improvement of yield and quality of turmeric genotypes through cultural management practices. The experiment was conducted at Horticulture Farm, Bangladesh Agricultural University, Mymensingh during 2018-2019. The two-factor experiment was carried out following randomized complete block design with three replications. Factor A comprised with five turmeric varieties *viz.,* V_1: Dimla Houlud (BARI houlud-2) (Check variety), V_2: Mala Houlud, V_3: Patnai Houlud, V_4: Makhalbari Houlud, V_5: Local variety and Factor B comprised with six treatments *viz*., T_1: Control (10 t/ha well decomposed cowdung (WDC) + non mulch), T_2: 10 t/ha WDC + mulch , T_3: 15 t/ha WDC + non mulch, T_4: 15 t/ha WDC + mulch, T_5: 20 t/ha WDC + non mulch, T_6: 20 t/ha WDC + mulch. Results showed that growth and yield contributing traits were varied significantly among the varieties. It was observed that BARI houlud-2 and Local variety exhibited statistically similar performance on most of the parameters as compared to other varieties. It was also found that weight of turmeric fingers per plot as well as yield per hectare was superior in case of V_1 which was similar to V_5. While different cultural management treatments significantly influenced on growth and yield contributing characters. It was noticed that application of 20 t/ha WDC + mulch condition gave the highest growth and yield of turmeric. In combination of T_6 with V_1 and/or V_5 gave better yield of turmeric. Therefore, it can be concluded that 20 t/ha WDC along with mulch condition may be used for improvement of yield and quality of turmeric in Mymensingh condition.

Effect of preharvest fruit bagging on postharvest quality and shelf life of dragon fruit

Md. Mokter Hossain
Department of Horticulture, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
E-mail: mokter.agr@bau.edu.bd

Abstract
This study was carried out at Bangladesh Agricultural University Germplasm Center (BAU-GPC) during July 2018 to June 2019 with a view to determine the effect of preharvest fruit bagging on postharvest qualities and shelf life of dragon fruit. Two-experiment were carried out where experiment-1 was comprised with two varieties *viz.,* V_1: BAU Dragon fruit-1; V_2: BAU Dragon fruit-2 and five bagging materials *viz.,* T_0: non-bag control T_{CB}: cloth bag, T_{BB}: brown paper bag, T_{BP}: black polythene bag and T_{WP}: white polythene bag. Experiment-2 was comprised with above two varieties of dragon fruit and three bagging time *viz*., T_1: fruit bagging at 7 days after fruit setting (DAFS), T_2: 12 DAFS and T_3: 17 DAFS. Both the experiments were laid out following randomized complete block design with three replications. In experiment 1, results showed that fruit bagging with black polythene bag significantly increased fresh weight (287.47 g), diameter (7.91 cm), peel-flesh ratio (5.97), total dry weight (61.33 g) and shortest days to maturity (22 days), peel weight (48.11 g) in BAU Dragon fruit-1 while black polythene bag extended shelf life (12.05 days), TSS (14.40°Brix) and reduced peel thickness (0.21 cm) in BAU Dragon fruit-2. In experiment 2, it was observed that fruit bagging at 7 DAFS significantly increased fruit length (11.74 cm), flesh weight (188.59 g), moisture content

(85.06%), TSS (14.79°Brix) and decreased days to maturity (21.66 days) in BAU Dragon fruit-1. Besides, fruit bagging at 7 DAFS increased significantly fruit diameter (7.60 cm), edible rate (74.29%), total dry weight (50.51 g), pH (4.72), dry matter content (20.59%), shelf life (11.65 days) and reduced peel weight (62.57 g), peel thickness (0.22) in BAU Dragon fruit-2. From the findings of this study, it can be concluded that black polythene bag would be a suitable option as bagging material and bagging at 7 DAFS would be a suitable time of fruit bagging to improve the quality and shelf life for dragon fruit.

Influence of Age of Vine Cuttings and Genotypes on Growth, Yield and Nutritional Value of Colored Sweet Potato Genotypes

Md. Mokter Hossain*, M. A. Rahim and Hasna Nasrin Moutosi
[1]*Department of Horticulture, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh*
**E-mail: mokter.agr@bau.edu.bd*

Abstract
This study was carried out at Horticulture Farm, Bangladesh Agricultural University, Mymensingh in order to identify the effects of age of vine cuttings and genotypes on growth, yield and nutritional qualities of colored sweet potato (CSP) genotypes. The two-factor experiment comprised with eight CSP genotypes *viz.,* SP1, SP2, SP3, SP4 (BARI released variety used as check), SP5, SP6, SP7, SP8 and two-age of vine cuttings *viz.,* terminal and older vine. The study was conducted following randomized complete block design with three replications. Results showed that the age of vine cuttings and genotypes significantly influenced on growth, yield and nutritional qualities of sweet potato. Leaf length, fresh weight and leaf area of majority CSP genotypes were higher as compared with SP4. In case of number of storage root tubers, it was observed that SP8 and SP4 produced maximum number (4.8) with terminal vine which was statistically similar with SP5 and SP7 (4.6) irrespective of vine age while SP2 produced minimum number (0.4) with older vine. Fresh weight of storage root tubers was higher in SP6 (0.75 kg/plant) with older vine which was similar with SP6 (0.67 kg/plant), SP7 (0.60 kg/plant), SP4 (0.56 kg/plant) with terminal vine. Highest yield (47.74 t/ha) was obtained from SP6 with terminal vine followed by similar genotype (38.19 t/ha), SP4 (33.3 t/ha) with older vine. The lowest yield obtained from SP2 (2.1 t/ha) with older vine. Leaf dry matter and flavonoid index were higher in SP2 (15.44%, 0.78) with terminal vine. Anthocyanins index in leaves were maximum in SP5, SP6 (0.24) followed by SP4 (0.23) and lowest in SP3 (0.16). Moreover, chlorophyll index was highest in SP4 (35.1) which was similar with SP1 (34.76). Considering the above findings it can be summarized that SP6 genotype performing superior based on growth, yield and some nutritional values in leaves.

Characterization and Documentation of Minor Fruits in Bangladesh with Special Emphasis on Coastal and Hilly Areas Fruits

Md. Mokter Hossain* and Md. Abdur Rahim
Department of Horticulture, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
** Email: mokter.agr@bau.edu.bd*

Abstract
A number of indigenous minor fruits namely monkey jack (*Artocarpus lakoocha* Roxb*.)*, velvet apple (*Diospyros discolor* Willd.), river ebony (*Diospyros peregrina*), cowa (*Garcinia cowa* Roxb.), governor's plum (*Flacourtia indica*) etc. are found in the coastal areas while the hilly areas are full of various indigenous minor fruits such as lukluki (*Flacourtia jangomas*), gutgutia (*Protium serratum*) etc. but detailed studies on these fruits are not available in Bangladesh. Therefore, this project has been

undertaken to collect, conserve and evaluate them morphologically, biochemically and nutritionally and documented them for future use. Five minor fruits from coastal (Barishal and Patuakhali districts) and two from hilly areas (Bandarban district) were selected for this study. *In situ* data on morphological traits of selected minor fruits were recorded following other crop descriptors. Saplings of those fruits were collected and conserved at Bangladesh Agricultural University Germplasm Center (BAU-GPC). Fruit samples were collected and biochemical and nutritional analysis were done in the laboratory following standard methods. Data were statistically analyzed following standard method. Results showed that each fruit species bears significantly different morphological features and nutritional qualities. In case of vitamin C content, it was evident that maximum vitamin C (21.74 mg/100g) contained in gutgutia followed by monkey jack (20.86 mg/100g) and the minimum (5.73 mg/10g) found in velvet apple. It was also observed that river ebony contained highest amount of potassium (258.68 mg/100 g) and phosphorus (293.47 mg/100g), while gutgutia contained maximum amount of calcium (112.59 mg/100g), magnesium (98.88 mg/100g), zinc (2.08 mg/100g), and cowa contained highest amount iron (4.56 mg/100g) as compared to other test fruits. It can be concluded that the selected minor fruits have tremendous potentiality in human nutrition and soci-economic development of Bangladesh. The information on the test minor fruits could be useful for further improvement of minor fruits in the country.

Exploration, Identification, Characterization, Multiplication and Ex-situ Conservation of Endangered Forest Genetic Resources including Medicinal plants of Bangladesh

Md. Habibur Rahman* and M A Rahim

Department of Horticultur, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : mhrahmand3@yahoo.com*

Abstract

The majority of human populations in developing countries rely on traditional medicines. The loss of habitats and overharvesting has threatened the availability of medicinal plants. This study was undertaken to explore, identify, and collection of fruits/seeds/plants species which contains medicinal value from the selected area of Natore, Tangail (Modhupur natural forests), Jamalpur, Sherpur and Mymensingh; and to develop propagation techniques for multiplication and ex-situ conservation at BAU-GPC, Bangladesh Agricultural University, Mymensingh. Base line survey on medicinal plants was carried out in five districts using FGD during July 2018 to June 2019. Several medicinal plants species were recorded in the surveyed areas. At Natore 38, Modhupur 40, Jamalpur 10, Sherpur 35 and Mymensingh 20 medicinal plants were listed which are grown in homestead, roadside and in the field. Among the listed medicinal plants in Natore, Aloevera, shimul alu and ashogandha are cultivating commercially in 150ha, 1000 and 20 ha of land respectively. The farmer also planted basak in their homesteads and in the road sides. In Modhupur, Creats (Kalomegh/Chirata) and Aloe vera are cultivating commercially in the field and basak is also growing in a large scale in road side. In Sherpur Aloe vera is cultivating in a small scale. In Mymensingh and Jamalpur most of the medicinal plants are found in homestead area. Among the medicinal plants the most prevalent species were Aloe vera, Bashok, Shimul alu, Tulshi, Neem, Nishinda, Aurjun, Bohera, Horitoki and Akonda etc. Most of the respondents reported that many of medicinal plant species are over exploited and will face extinction. At BAU-GPC 80 different medicinal plants species were planted and conserved in a separate area. The growth performances of these medicinal plants were observed excellent. Morphological characterization of some of these medicinal plants was done. Propagation of bashok, nishinda, arjune and harzora were performed well by stem cutting where as kalomegh, ashwagandha and tulshi by seed. Training on medicinal plants with 30 participants from Natore, Modhupur, Sherpur, Jamalpur and Mymensingh also were successfully conducted at BAU-GPC.

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Zinc fertilizer influence on plant growth, yield and uptake of zinc in twenty five varieties of potato

Md. Ashraful Islam[1*], Mahmud Hossain Sumon[2] and Sultan Ahammed[1]
*[1]Department of Horticulture and [2]Department of Soil Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: ashrafulmi@bau.edu.bd*

Abstract
Micronutrient malnutrition is very common in women, children and poor families as a whole. About one-third of the World's population are zinc (Zn)-deficient. Potato (*Solanum tuberosum* L.) is the staple food in more than 40 countries of the world and it is considered as one of the most popular and common vegetables in Bangladesh. In this experiment, 25 potato varieties were planted with spacing 60x25 cm^2 and planted on 26 November 2018. Each genotype had two treatments (with zinc and without zinc fertilizer). RCBD design was followed with three replications. Growth and yield parameters like plant height at 30, 45 and 60 days after planting and yield related parameters like number of tubers, length and diameter of tuber, weight of individual tuber, tuber yield were recorded. Powdered samples of dried potato were digested and determined the zinc concentration using AAS (atomic absorption spectrophotometer). Plant height, leaf length and other growth parameters had the significant different due to application of Zn fertilizer. The higher number of tubers per plant was found from the variety 25. The highest tuber weight of potato per plant was found in variety 25 (614 g) and the second highest was in variety 1 (612 g). In case of interaction effect, the highest tuber weight per plant was found in variety 1 with zinc fertilizer (702 g) and second highest was found in variety 25 with zinc fertilizer application (699 g). Variety and zinc application had significantly different on zinc uptake in tuber of potato. In case of combination, the highest uptake of zinc in potato tuber was found in variety 11 with zinc fertilizer application (40.95 ppm) which was significantly different from other varieties of potato and the lowest uptake of potato was 2.42 (ppm) without any application of zinc fertilizer.

Screening and selection of Zinc efficient potato cultivars for biofortification

Md. Ashraful Islam[1*], Mahmud Hossain[2] and Sultan Ahammed[1]
*[1]Department of Horticulture and [2]Department of Soil Science, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh, *E-mail: ashrafulmi@bau.edu.bd*

Abstract
Micronutrient malnutrition is very common in women, children and poor families as a whole. About one-third of the World's population are zinc (Zn)-deficient. Potato (*Solanum tuberosum* L.) is the staple food in more than 40 countries of the world and it is considered as one of the most popular and common vegetables in Bangladesh. In this experiment, 25 potato varietieswereplanted with spacing 60x25 $cm^2$and planted on 26 November 2018. Each genotypewas treated with two treatments (with and without zinc fertilizer). RCBD design was followed with three replications. Growth and yield parameters like plant height at 30, 45 and 60 days after planting and yield related parameters like number of tubers, length and diameter of tuber, weight of individual tuber, tuber yieldwere recorded. Powdered samples of dried potatowere digested and determined the zinc concentration using AAS (atomic absorption spectrophotometer). Plant height, leaf length and other growth parameters had significant difference due to application of Zn fertilizer. The higher number of tubers per plant was found from the variety ????25. The highest tuber weight of potato per plant was found in variety 25 (614 g) and the second highest was in variety 1 (612 g). In case of interaction effect, the highest tuber

weight per plant was found in variety 1 with zinc fertilizer (702 g) and second highest was found in variety 25 with zinc fertilizer application (699 g). The highest zinc concentration in potato tuber was found in variety 11 with zinc fertilizer application (40.95 ppm) which was significantly different from other varieties of potato and the lowest concentrationof potato was 2.42 (ppm) without any application of zinc fertilizer.

Evaluation of Carrot Germplasm and farmers training in stressful areas of Bangladesh

M.A. Rahim*, ATM Majharul Mannan, Ferdouse Islam, Shamsul Alam, Phillip W. Simon and Benjamin Kilian

Department of Horticulture, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
**E-mail : marahim1956@bau.edu.bd*

Abstract

The present research work was conducted USDA-Alliums' Field Laboratory, Horticulture Farm of Bangladesh Agricultural University, Mymensingh for study, field of Spices Research Sub Centre (SRSC) of Bangladesh Agricultural Research Institute (BARI), Lalmonirhat and Farmers field at Norar Chak, Debhata, Satkhira during the period of 2016 – 2018 to screen out suitable carrot accessions in respect of quality root and seed production under these three stressful condition of Bangladesh. Eight experiments were carried out in this study. A laboratory experiment conducted for germination test of 57 carrot wild relatives (CWR) accessions with 7 different salinity level viz. 0 dS/m, 2 dS/m, 4 dS/, 6 dS/m, 8 dS/m, 10 dS/m, 12 dS/m regarding pre assessment to grow at saline prone areas of Bangladesh, results revealed that accession PI 652359 gave highest germination (62.85%) in control salinity (0 dS/m) and it was given maximum germination (20%) even in 10 dS/m, accession no. Ames 27396 given longest (2.51cm) shoot and highest root length measured in PI 652238 under control and it was observed that increasing of salinity significantly decreasing in all parameters studied. In a field trial of 100 CWR accession under warm soil condition it was found that check variety Brasilia agroflora (BA) germinated maximum (66.67%) and gave maximum root yield (5.07 t/ha) but seed yield found maximum in PI 163235 (447.20 kg/ha), under dry soil condition that also BA germinated maximum (19%) but maximum root yield found (13.04 t/ha) from PI 218076 where as minimum root yield given (1.36 t/ha) by PI 181052 and under saline soil condition that check variety Prima agroflora (PA) germinated maximum (31.33%), maximum root yield (13.81 t/ha) found from Ames 29084, minimum root produced (0.17 t/ha) from PI 652370 and maximum seed yield found from PI 163235 (1000.64 kg/ha). Another field study was conducted in two factor randomized complete block design during 2016-17 to show the combine effect of CWR accession and location, resulted that dry areas of Lalmonirhat location gave maximum root yield (9.09 t/ha) and PI 502654 produced 35.6 (t/ha) and in combination of PI 502654 and location for warm area of BAU, Mymensingh gave the highest root yield (53.42 t/ha) on the other hand PI652370 with saline area of Satkhira location combination given minimum root yield (0.29 t/ha) in respect of seed yield BAU location gave maximum seed yield (108.58 kg/ha) and PI 163235 produced 505.5 (k/ha) and in combination of PI 163235 and location Satkhira produced the highest seed (604.0 kg/ha) on the other hand PI PI652364 with location Satkhira combination given minimum seed yield (16.0 kg/ha). In a secondary field trial conducted of 116 CWR accession under warm soil condition it was found that check variety PA germinated maximum (45%) and gave maximum root yield (13.61 t/ha) but seed yield found maximum in another check variety BA (416.0 kg/ha) and minimum seed produced by PI 478884 (13.6 kg/ha), under dry soil condition among 70 CWR accession PI 478882 germinated maximum (50%) but maximum root yield found (11.52 t/ha) from PI 652410 where as minimum root yield given (2.86 t/ha) by PI 652235 , seed yield found maximum in Ames 26376 (3056.0 kg/ha) where as minimum seed produced by Ames 26404 (23.6 kg/ha)and under saline soil condition also evaluated 70 CWR accession and found that PI 478881

germinated maximum (34.0%), maximum root yield (5.13 t/ha) found from PI 652410 and minimum root produced (1.69 t/ha) from check BA , maximum seed yield found from PI 652410 (1048.40 kg/ha) and minimum was also produced from Check BA 124.8 (kg/ha). An experiment also conducted for improvement of local varieties and crossing between selected 15 accessions with two local and after getting the F1 seed a field evaluation was carried out that resulted PI 269486 X PI 652410 F1 derivatives was produced maximum root yield 9.78 t/ha compare minimum 0.68 t/ha from PI 269486 X PA and seed yield was maximum in 196.24 kg/ha in PI 163235 X BA though the seed higher in check BA 356.8 kg/ha. In advanced field trial was established by 48 selected CWR accessions at same three location it was found that PI 652410 gave maximum root yield (28.18 t/ha) and minimum was 2.04 (t/ha) and seed yield also found maximum from same accession (64.24 kg/ha) and minimum seed produced by PI 478884 (9.04 kg/ha) at BAU, maximum root yield found (23.18 t/ha) from accession no. PI 163235 where as minimum root yield given (2.3 t/ha) but seed yield found maximum in check BA (419.09 kg/ha) where as minimum seed produced by PI 652295 (12.0 kg/ha) in Lalmonirhat and maximum root yield (13.09 t/ha) found from PI 652410 where as minimum root produced (1.98 t/ha) from PI 652398 and maximum seed yield found from PI 652410 (981.36 kg/ha) on the other hand minimum was also produced from Check BA (21.36 kg/ha).

Characterization of Indigenous Banana, Aroids and Yams of Bangladesh in Referance to Geographical Indication Cultivars

M. A. Rahim*, Setara E Bilkis, Sufia Begum and Fatema Nasrin Jahan

*Department of Horticulture, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh and Director of BAU Germplasm center-the largest fruit repository in Bangladesh, *E-mail : marahim1956@bau.edu.bd*

Abstract

An investigation was made to study "Characterization of plant genetic resources viz. Indigenous Banana, aroids and yams of Bangladesh in Reference to Geographical indication cultivars" at the Fruit Tree Improvement Programme, Germplasm Centre, Bangladesh Agricultural University, Mymensingh. For this purpose, seventy indigenous banana cultivars were collected from different parts of the country. Of them sixty cultivars were transplanted. Morphological and molecular characterization of these indigenous bananas (55 dessert and 5 plantain) were assessed during the period of 2014 to June, 2017. The genotypes were analyzed using 63 morphological descriptors; where descriptors, relating to plant and leaf, male bud and fruit were respectively 20, 11 and 32. Molecular characterization was done using RAPD and SSR markers. The IPGRI descriptors were efficient in the characterization and identifying specific characteristics. The experiment included both qualitative and quantitative characterizations. Genetic diversity of banana germplasm was estimated in two ways; univariate technique and multivariate technique, using the data obtained from morphological experiment. Results obtained using the descriptors showed wide variability of the characteristics that would facilitate its use in preparing the specification for geographical indication of the indigenous banana products. Among the dessert type accessions the highest yield was observed in MS044 (Aitta Kala, BAU; 32.68 kg); and the lowest yield was observed in MS040 (Shail Kala, Sylhet Sadar; 2.08 kg). In plantain type, the quantity ranged between MS056 (Anaji kala, BAU; 15.0 kg) to MS058 (Anaji kala, Sylhet Sadar; 10.79 kg). Among the top ten accessions out of forty three dessert accessions in respect of the highest yield per plant, only three were found in the group of seedless or less seeded type. In descending order of total yield per plant, they were MS020 (Joltaranga, Akra, Dumuria; 21.66 kg), MS006 (Bou Sundari/ Bodhu Sundari kala, Lalmonirhat; 21.61kg) and MS024 (Kanthali Kala, Pirojpur; 19.6 kg) and the observed 'pulp to peel ratio' in those accessions were 3.94, 2.92 and 5.68, respectively. Total days required from plantation to harvesting of these accessions were 510 days, 628 days and (690 days for MS020, MS006 and MS024 respectively. Differences between both the maximum and minimum genotypic and phenotypic variances (GVC and PVC respectable) for the collected genotypes were

quite large. In case of genotypic it was from 0.005 to 25876.20, and for phenotypic it was 0.007 to 25918.62. The highest PCV and GCV ((64.01% and 63.87%) were recorded in weight of peel, and lowest PCV and GCV noted were 15.55% and 13.01%) in breadth of leaf blade. The low difference between GCV and PCV indicated the less influence of environment in the expression of the character studied. Genetic diversity from the multivariate analysis of 14 morphological characters of the 55 dessert accessions was grouped into eight clusters. It was observed that accessions collected from the same location had been grouped into different clusters. Cluster II contained the largest number of accessions (12); the other clusters depending on the number of accessions are as following: cluster III (9); cluster VII (8); cluster IV, V and VI each one with 6 accessions and cluster I and VIII having four accessions. The highest inter cluster distance was found between cluster VIII and V (90.47) and the lowest was observed between cluster III and II (38.11).

Varietal Development of garlic and onion through selection and molecular techniques with special emphasis on higher yield and allicin contents

M. A. Rahim
Department of Horticulture, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
E-mail : marahim1956@bau.edu.bd

Abstract
To achieve against the specific objectives already different germplasm of short day onion and garlic have been collected from different places of Bangladesh and abroad. Twenty four Germplasm were planted in early November 2018 in the research field for trial. Twelve more germlasm has also been planted in late November 2018. Now it was harvested and post harvest operations also been completed. Sorting, grading, marking, data collection, drying and storage have been done in the laboratory and field store-house. Allicin content of 24 accessions has been assessed in the laboratory. Morphological and Molecular characterization is going on. In order to get a fruit full research findings a number of MS and PhD student are attached with this project work. Within these Germplasm observation is going on to select clones with higher yield potential, long shelf life and higher allicin content. Observation of storage behavior of the collected germplasm is also going on. After selecting the quality germplams among the collecting germplasm will be planted for 2nd year trial for finalization of the project work.

Effect of Tricho-suspension for Management of Viral Diseases of Vegetables

Mohammad Delwar Hossain
Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: delwarmhossain@gmail.com

Abstract
The experiment was carried out in the pot, in the field of horticulture farm of Bangladesh Agricultural University, in the farm of BINA (Bangladesh Institute of Nuclear in Agriculture) , Mymensingh to know the efficacy of tricho-suspension in controlling yellow mosaic virus of okra and leaf curl of chilli and tomato. Different treatments of Tricho-suspension (@ 10^8CFU/ml) such as: T_1 (IPM lab biopesticide: *Trichoderma harzianum* CP 32), T_2 (BAU-Biofungicide: *Trichoderma harzianum*), T_3 (*Trichoderma virens,* TR 06), T_4 (*Trichoderma asperellum,* TR 08), T_5 (*Trichoderma viride),* one chemical treatment T_6 (Malathion 57 EC @0.2%) and T_7 (non-treated treaments) were applied in three different growth stages (30, 45 and 60 days after sowing) of okra, chilli and tomato. Yellow

mosaic virus incidence was recorded severe in early stage of the plant growth that was gradually decreased at the later growth stage of okra plants. In both pot and field experiments, the highest percentage of yellow mosaic virus incidence (30% and 40%) was recorded at 30 days after sowing (DAS) and the lowest incidence was observed at 60 DAS (20% and 15%). Again, the lowest yellow mosaic disease incidence of okra was observed in plots where Tricho-suspensions were applied in compare to chemical treatment T_6 (Malathion, 50 EC). Among the treatments, treatment T_2 (BAU-bio-fungicide) showed better performance (8.0% incidence) at 60DAS in reducing the yellow mosaic virus incidence than all other treatments. Significanly the lowest leaf curl disease incidence (3%) was obserbed in chilli when Tricho-suspensions of *T. harzianum* (Bau-biofungicide) and *T. asperellum* were applied while non-treated treatment resulted 26% leaf curl incidence. On the otherhand, the lowest leaf curl incidence of tomato (9%) was found in treatment T_2 (Bau-biofungicide) treated plots and the highest leaf curl incidence (20%) was recorded in control plots. Among the four tomato varieties tested, BARITomato 14 was found highly susceptible to leaf curl incidence (30%) followed by BARI Tomato 16 (28%) and the lowest leaf curl incidence was recorded in var. BARI Tomato 5 (15%). Tricho-suspension of *T. harzianum* (Bau-biofungicide) reduced about 66% yellow mosaic in okra and 55-80% leaf curl incidence of tomato and chilli over control. From this research work, it was observed that all the tricho-suspensions used in this experiment also showed better performance in yield and yield contributing characters of okra, chilli and tomato than chemical treatment. Non-treated treaments always yielded the highest yellow mosaic and leaf curl incidence with lowest yield of those tested three vegetebles.

Management of Wheat Blast: A Holistic Approach with Emphasis on Early Stage Detection for Forecasting

Humayun Kabir, Yeasinul Haque, Ashraful Islam, Intiaz Uddin, M A Kashem and M Bahadur Meah*

Dept. of Plant Pathology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: bmeah@yahoo.com*

Abstract

Wheat blast continued to appear in the hot spots of the south-south western part of Bangladesh since its first epidemic attack in 2016. By 2019, the number of districts the wheat blast pathogen crawled is raised to 20. It's a big threat to cultivation of wheat in Bangladesh. Research strategies for developing effective GAP including developing resistant variety to face this threat is in progress. Seeds with 5, 10, and 20% MoT infection were planted in pots in BINA nethouse under natural condition to see seed-borne nature of MoT and its transmission through plant to seed. Anatomical study of different parts of an infected wheat plant matched with corresponding DNA band detection confirmed the presence of *Magnaporthe oryzae* Triticum (MoT) structures in all the way from root to rachis. The research finding indicates MoT is seed-borne and it is transmitted to plant through seed. Preventive sprays of fungicides given for two times starting from booting stage before symptoms appearance effectively reduced blast incidence while curative sprays given for two times starting on-sight blast symptoms could not stop or reduce blast infection after it started. No grass or cereal crops have so far been proved to serve as alternative host to *Magnaporthe oryzae* Triticum. Investigation of the over-summering of MoT in wheat stubbles in the field is continued. Soil amendments and foliar spray of Si, Se and B displayed a positive effect in reducing wheat spike infection by MoT. *Bacillus* spp., some wheat endophytes isolated from healthy wheat plants of age 30 days are under investigation for their antagonistic properties against MoT. M3 and M4 families grown out of M2 and M3 seeds displayed differential reaction to MoT upon inoculation.

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Assessing Field Performance of Virus-krimi Solution in Reducing Leaf Mosaic Disease of Some Winter Vegetables

Beauty Khatun, Mahbuba Siddiqua and M Bahadur Meah*
Dept. of Plant Pathology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: bmeah@yahoo.com*

Abstract
Mosaic/leaf curl virus diseases of winter vegetables are severe causing stunted growth and distorted or no fruiting. Almost all of these viruses are transmitted by insects. Growers are used to spray insecticides repeatedly to control vectors. Resultant is the fear of health hazard and secondary pest emergence. Virus –krimi solution is an alternative organic product developed by IPM Lab BAU to replace or reduce use of insecticide. Plumeiride is the active ingredient of virus-krimi solution, containing glycosides having germicidal action. Virus –krimi solution was sprayed onto foliage of four winter vegetables such as tomato, papaya, cow pea and sweet gourd with the aim of reducing severity of mosaic/leaf curl viruses following a schedule. An insecticide Admire was sprayed on mosaic/leaf curl symptoms showing plants, three days after one spray of virus-krimi solution, again three days after one spray of tricho-suspension followed by one more spray of tricho-suspension seven days after. Spray solution was applied to both infected and healthy plants available in the plot or kitchen garden. Experiments were conducted in plant pathology field lab farm and in BAU residential kitchen garden. Incidence and severity of mosaic and leaf curl was scored before and after spray schedule continued for 4-5 times @ seven days interval. Mosaic or leaf curl severity on the infected plants was not changed during the spray schedule nor even a week after. However, new leaves on the treated plants did not show mosaic/leaf curl and treated healthy plants were never attacked with viruses. Tomato plants got recovered of leaf curling giving normal fruiting, papaya plants carried green leaves and normal fruits, cow pea yielded green vines and pods while sweet gourd produced normal leaves and fruits. Virus-krimi solution proved thus effective in suppressing mosaic/leaf curl viruses of winter vegetables.

Environment-friendly management of Alternaria leaf spot disease of mustard-rapeseed

Muhammed Ali Hossain*, Fatema Tuz Zohura, Md. Atikur Rahman and Md. Zahidul Islam
Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail : alihossain.bau@gmail.com*

Abstract
Alternaria leaf spot or black leaf spot caused by *Alternaria brassicicola* is one of the destructive disease of brassica crops including mustard-rapeseed in Bangladesh. This experiment was conducted at the Department of Plant Pathology and Seed Pathology Centre (SPC), Bangladesh Agricultural University, Mymensingh, Bangladesh to evaluate the efficacy of eighteen plant extracts, eighteen *Trichodesma* isolates and one *Bacillus* isolate against *Alternaria brassicicola* in *in vitro* condition. The efficacies of plant extracts and biological agents were evaluated by the measurement of percent inhibition of radial mycelial growth of *A. brassicola.* The highest percentage of mycelial inhibition (100%) was recorded in case of two plant extracts namely Cumin seed and Clove seed extract followed by Alamanda leaf extract (93.%) at 10 days after inoculation (DAI). On the other hand, five *Trichoderma* isolates (HI, N51, R1, N41 and R50) out of eighteen *Trichoderma* isolates showed 100% growth inhibition in the *in-vitro* dual culture assay at 5 and 7 DAI. The ITS regions were amplified of five different *Trichoderma* isolates, resulting in PCR products of around 650 base pairs (bp), which were sequenced directly. The sequences were subjected

to BLAST analysis against the NCBI database. All the five isolates were used in this antagonistic test were identified as *Trichoderma asperellum*. Blast homology search revealed 96-100% sequences identity with the corresponding nucleotide sequences of ITS genes of different *Trichoderma asperellum*. On the other hand, the *Bacillus* isolate was also showed 66.0% growth inhibition at 7 DAI in the *in-vitro* dual culture assay and the *Bacillus* isolate was identified as *Bacillus subtilis* by molecular analysis using 16S rDNA primer and showed 94% homology with *Bacillus subtilis* strain BHR3P2B5-M after sequencing of that conserved region.

Analysis of genetic variation of pathotypes, resistance screening and eco-friendly management of *Pyricularia oryzae pv. triticum/ Magnaporthe oryzae pv. triticum* causing wheat blast in Bangladesh

Muhammed Ali Hossain*, Md. Rashidul Islam, Fatema Tuz Zohura, Rajia Sultana, Biprojit roy and Md. Al-Imran Hasan

Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail : alihossain.bau@gmail.com*

Abstract

Wheat blast caused by *Magnaporthe oryzae* Pathotype *triticum* (MoT), a destructive disease of wheat since 2016 in Bangladesh. This research work was conducted to know the pathotypic and genetic diversity of *Magnaporthe oryzae* Pathotype *triticum* (MoT) causing wheat blast disease and its management through resistance sources as well as non-chemical means. A total of 20 MoT isolates obtained from three different wheat growing districts in Bangladesh. These MoT isolates showed variation based on the colony morphology and colony colour on Potato Sucrose Agar (PSA) media and conidial shape. Quite considerable genetic variability have been found among the 20 MoT isolates as they showed 5-11 DNA polymorphic bands with 12 ISSR primers used in this research work. In addition, cluster analysis showed MoT isolates identified in this study were distributed in four different clusters. Cluster I consisted of 15 isolates and Cluster II had 3 isolates, whereas cluster III and IV had 1 isolate each. This clustering result also indicate that MoT isolates are also diverse at genetic level. Based on the resistance screening results of this study it may be concluded that for resistance breeding programme for wheat blast disease, there is no potential resistant wheat cultivar exist in Bangladesh. This research work was also carried out to evaluate the efficacy of twelve plant extracts and five *Trichodesma* isolates against MoT in *in vitro* condition. The efficacies of plant extracts and biological agents were evaluated by the measurement of percent inhibition of radial mycelial growth of MoT. The highest percentage of mycelial inhibition (93.75%) was recorded in case of four plant extracts namely Tulsi, Mehendi, Datura and Garlic followed by Black cumin seed extracts (90%) at 10 days after inoculation. On the basis of *in vitro* test, five plant extracts were selected to conduct a pot experiment to evaluate the blast incidence and severity and some yield contributing parameters in treated and control pots. Minimum percentage of blast incidence and severity were recorded in case of Garlic clove extract (16.28 and 3.5) treated pots. Garlic clove extracts also showed the best performance for some yield contributing parameters like ear length (9.20 cm), number of ear/pot (13.25), number of healthy ear/pot (13.0), number of total and healthy spikelets/ear (34.20 and 33.40), number of total and healthy grains/ear (23.00 and 21.80) and weight of 1000 total and healthy grains/pot (56 and 52 gm) followed by Black cumin among the plant extracts used in this experiment. Out of five *Trichoderma* isolates, the maximum percent of radial mycelial growth inhibition of MoT was achieved by *Trichoderma* isolate N51 (58.24%) followed by isolate N41 (53.85%) in the *in-vitro* dual culture assay. However, garlic clove extract and *Trichoderma*-based formulated product will be very effective for the eco-friendly management of blast disease and increase the yield of wheat in Bangladesh.

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Screening of next generation fungicides for the control of *Pyricularia oryzae* causing rice blast disease

Muhammed Ali Hossain[1*], Rajia Sultana[2], Md. Atikur Rahman [3], M. Bahadur Meah[4], Md. Amir Hossain[5]

[1234] Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh and [5] Department of Plant Breeding, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail : alihossain.bau@gmail.com*

Abstract

Rice blast disease caused by *Pyricularia oryzae* is an important disease of rice. Bioassay of sixteen chemical fungicide(s) was done against *Pyricularia oryzae in vitro* following poison food technique in the Plant-Microbe Interaction Lab, Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh. Total inhibition (100%) of mycelial growth of *Pyricularia oryzae* was obtained by Tebuconazol 50% + Trifloxistrobin 25% (Nativo 75WG), Blastin (Trifloxistrobin 25% + Tebuconazol 50%), Carbendazim (Autostin 50 WDG), Folicur EW 250 (Tebuconazol 25%), Contaf 5EC (Hexaconazol 50%), Indofil M 45 (Mancozeb 80%), Awal 72 WP (Zineb 68%+ Hexaconazole l4%) and Proven (Propiconazol) containing fungicides at the lowest (0.0125%) concentration. Other fungicides were either partially effective or ineffective. Five fungicides viz. Nativo 75WG, Autostin 50 WDG, Folicur EW 250, Contaf 5EC and Companion were selected based on their *in vitro* performance and sprayed in the field onto foliage of rice plants in two different concentrations (0.1% and 0.2%) to evaluate the inefficacy in reducing rice blast incidence and severity and increasing yield contributing parameters. Among the fungicides used, Nativo 75 WG @ 0.2% concentration showed best performance in reducing blast incidence (4.31% and 0.00% for leaf and neck blast respectively) and severity (12.4% and 12.6% at 52 and 59 DAT respectively) as well as increasing the yield parameters such as plant height, the number of tiller per hill, the number of effective tiller per hill, number of infected panicle, number of non-infected panicle and thousand grain weight followed by Autostin 50 WDG @ 0.2% concentration.

Enhancement of rice productivity by integrated management of its diseases through foliar application of micronutrients

Md. Atiqur Rahman Khokon* and Md. Zahangir Alam

Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: atiq.ppath@bau.edu.bd*

Abstract

Effects of different micronutrients were evaluated for the management of blast disease of rice BRRI dhan49 under field condition from August, 2017 to December, 2017. The experiments were carried out in the farmer's field in Satkhira. Different concentration of Zn and B fertilizer solutions were applied on the foliage of rice and disease incidence, severity of blast were recorded. The highest incidence percentage (4.690%, 27.50% and 70.47%) of rice blast were found at 60, 90 and 120 DAT in control plots and the lowest percentage of rice blast incidence (1.320%, 1.140%) were observed at 60 DAT on treatments T_5 (Foliar application of Zn fertilizer @5 kg/ha) and T_6 (Foliar application of B and Zn fertilizer @2 kg/ha and 4 kg/ha), at 90 DAT the lowest percentage of rice blast incidence (4.543%, 3.670%) were found in T_6 (Foliar application of B and Zn fertilizer @2 kg/ha and 4 kg/ha) and T_7 (Foliar application of B and Zn fertilizer @3 kg/ha and 5 kg/ha) and at 120 DAT the lowest blast incidence percentage (13.87%, 14.13%) were observed in T_6 (Foliar application of B and Zn fertilizer @2 kg/ha and 4 kg/ha) and in T_7 (Foliar application of B and Zn fertilizer @3 kg/ha and 5 kg/ha). On the other hand in case of disease severity (%), the highest severity percentage (18.52%, 58.92%) of rice blast were found at 60 and 90 DAT in control plots and the lowest severity percentage were found at 60

DAT in T_3 (6.170%), T_2 (7.410 %) T_4 (7.410 %) and T_5 (7.410 %), at 90 DAT the lowest severity percentage were found in T_6 which was 45.67%.

Bio-stimulation by endotrophic arbuscular mycorrhizae for management of wilt complex of brinjal

Md. Atiqur Rahman Khokon
Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
E-mail: atiq.ppath@bau.edu.bd

Abstract

Investigations were executed in pot to assess the potentiality of endotrophic arbuscular mycorrhizae (*Glomus mosseae*) for management of brinjal wilt complex caused by *Fusarium oxysporum*, *Ralstonia solanacearum* and *Meloidogyne* sp. Application of mycorrhizae significantly influenced several growth parameters such as plant height, shoot length, root length, fresh weight and dry weight at 30 DAT, 60 DAT and 90 DAT. The plants treated *G. mosseae* along with *Fusarium oxysporum* show lower disease incidence (10.35, 10.74 and 3.69 %) which is close to positive control (0.2%Knowin (carbendazim) 50 WP) (15.73, 11.36 and 2.65 %) but significantly different when the plants inoculated with *Fusarium oxysporum* alone (40.55, 65.44 and 89.34%) at 30, 60 and 90 DAT respectively. The application of *G. mosseae* resulted in increase in root morphology (root length (15.50, 20.66, 22.33 cm respectively), root fresh weight (2.32, 7.91, 9.43 g respectively), root dry weight (0.24, 2.22, 2.58 g respectively), percent root colonization (25, 58, 72% respectively). The plants treated with the combination of *R. solanacearum* suspension with *G.mosseae* inocula showed lower disease incidence (16.51, 11.93 and 4.68%) than the plants inoculated with only *R. solanacearum* suspension (31.42, 43.58 and 80%) at 30, 60 and 90 DAT, respectively. The application of *G. mosseae* resulted in more increase in root morphology root length (16.71, 16.89, 18.91 cm respectively), root fresh weight (5.68, 6.51, 7.2 g respectively), root dry weight (0.64, 0.65, 0.83 g) at 30, 60 and 90 DAT, respectively. Abundance of root colonization percentage was higher (36.67%, 60%, and 76.7 % respectively) in *G.mosseae* inocula inoculated soil than the combination of *R. solanacearum* with *G. mosseae* inoculated soil (23.33%, 43.33% and 61.67%) at 30, 60 and 90 DAT, respectively. Bacterial population was higher in only *R.solanacearum* suspension inoculated soil than 500 ppm $CrosinAG_{10ASP}$ solution+*R. solanacearum* suspension and *G. mosseae* inocula+*R. solanacearum* suspension inoculated soil. Arbuscular mycorrhizae inoculation significantly reduced the incidence of wilt disease by 67.27%, 78.93% and 91.60% respectively compared to wilt caused by *Meloidogyne* sp. alone. Root morphology such as root length (21.83, 23.83, 23.50 cm respectively), root fresh weight (4.64, 5.39, 34.66 g respectively), root dry weight (0.5, 0.63, 0.72 g respectively) at all time interval. Mycorrhizal spore (11.85%, 13.46%, 16.75%) and number of mycorrhized root (36.4%, 29.9%, 24%) reduced compared to simultaneous application of mycorrhiza and *Meloidogyne* sp. Number of galls (50.43%, 40.9%, 46.28%) and number of eggmasses (30.4%, 48.93%, 59.75%) was reduced significantly than *Meloidogyne* sp. inoculation alone.

Genetic diversity analysis of rice blast pathogen for developing sustainable management

Md. Atiqur Rahman Khokon* and Md. Zahangir Alam
Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: atiq.ppath@bau.edu.bd*

Abstract

Different aspects of management of blast disease were investigated. Induction of resistance by elicitors was investigated. The efficacy of elicitors (0.1% salicylic acid, 0.1% benzoic acid, 0.1% chitosan) was

assayed in pot experiment with BRRI dhan 28. Disease incidence and severity of blast was effectively suppressed more by salicylic acid followed by benzoic acid and chitosan. Total phenol content (µg/g) was significantly increased in the rice leaves when elicitors are applied at 7 DAI, 14 DAI and 21 DAI. Maximum total phenol (2885.147 µg/g) obtained from the treatment chitosan and lowest (1708.193 µg/g) from the control. Determination of MDA (Malondialdehyde activity) and H_2O_2 content of rice leaves was done after the application of elicitors at 7 DAI, 14 DAI and 21 DAI. Maximum MDA (120.145mol/g) and H_2O_2 content (98.525 mol/g) observed at treatment chitosan whereas lowest (32.425 mol/g and 7.650 mol/g) content observed at control. Rhizopheric *Pseudomonas fluorescens* were identified and characterized at molecular level and their growth suppressing ability was evaluated in the laboratory. The isolate Pf-4, Pf-8, Pf9, Pf-10 showed the highest *in vitro* inhibitory effect (100%) against *M. oryzae*. Rice seed treated with these bacterial isolates were examined for their effect on germination and vigor index. No significant effect of treatments was found for germination of rice seed but vigor index was highly influenced by these treatments. Pf-16 and Pf-10 showed highest vigor index (2274.8) and (2211.666). Effective bacterial bio-control agents were further characterized as *P. fluorescens* by molecular analysis using 16S rDNA. Best antagonistic isolates Pf-8, Pf-9, Pf-10 showed 97% homology with *Pseudomonas plecoglossicida* strain LB 24, 98% homology with *Pseudomonas putida* strain LB22, 97% homology with *Pseudomonas plecoglossicida* strain kmW1200907 respectively. Optimization of culture concentration of *B. subtilis* and *P. fluorescens* was done to examine their effect on suppression on *M. oryzae*. In case of *B. subtilis* BS-21, BS-31 and BS-11 isolates showed better results (73.29%, 71.27% and 67.32% inhibition over control). *Pseudomonas fluorescens* PF-8, PF-16 and PF-5 isolates showed better results (79.01%, 78.10% and 78.08% inhibition over control). In combined application, PF-5 and BS-21 isolates showed the best result (79.72% inhibition over control). It is apparent that *B. subtilis* BS-21 or *P. fluorescens* PF-8 are better performers to suppress *M. oryzae* under *in-vitro* condition. It is revealed that elicitors, culture filtrates of rhizepheric bacteria could be potential alternative of chemical fungicide for blast disease management of rice.

Evaluation of wheat mutants against blast caused by *Magnaporthe oryzae Triticum* under confined field condition

Mohammad Shahjahan Monjil
Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
E-mail: smonjil@yahoo.com

Abstract

The experiment was carried out to evaluate the reaction of some wheat varieties of Bangladesh against *Magnaporthe oryzae* pathotype *Triticum* (MoT) by a resistance screening. None of the wheat cultivars was resistant to the isolate of *MoT* but the cultivars differed in degree of resistance as measured by the percent disease incidence and percent disease severity. For obtaining a sustainable resistance wheat cultivar against blast disease, a thorough screening of gamma radiated germplasms was conducted at Bangladesh Institute of Nuclear Agriculture Research Firm, Mymensingh. The experiment consists of 23 mutant M_2 germplasms (BGG 1 to BGG23) and 7 gamma radiated local germplasms (M_1) include BARI Gom25, BARI Gom26, BARI Gom29, BARI Gom30, BARI Gom33, BARI Gom21 (Sotabdi) and BARI Gom24 (Prodip) using four doses of radiation for each variety such as 150Gy, 200Gy, 250Gy and 300Gy. In case of the number of plants plot^{-1}, BARI Gom29 (200Gy) treated plot produced more plants pot^{-1} (203.0) and BARI Gom33 applied plots produced the lowest of 4.00 plants pot^{-1}. BARI Gom25 (200Gy) showed higher significant observation on healthy seeds spike^{-1} (37.40) and its yield (0.94 g spike^{-1}). However, BARI Gom25 (150Gy) applied spike showed least significant effect on number (19.6) and yield (0.380 g spiket^{-1}) of healthy seed. At 105 and 115 DAS, BARI Gom25 (150Gy), BARI Gom30 (250Gy) and BGG-10 showed lower number of infection while these were

highly effective for reducing the infection of blast diseases in wheat field during study. However, earlier stage at 85 DAS, BARI Gom30 (250Gy), BARI Gom30 (250Gy), BGG-10 did not showed any infection by number, incidence or severity of blast diseases in wheat field during study while BARI Gom30 (250Gy), BARI Gom30 (250Gy) and BGG-10 showed lower disease incidence and severity at 115DAS except severity at 115 DAS.

Biological management of late blight and early blight diseases of tomato in field condition

Mohammad Shahjahan Monjil
Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
E-mail: smonjil@yahoo.com

Abstract
Efficacy of some bioagents, bioactive compound like neem oil and chitosan as elicitor was evaluated against late blight and early blight diseases of tomato in field condition. For this experiment fifteen treatments were applied to the tomato field. Treatments were T1= *Trichoderma* based BAU-Biofungicide, T2= *Beauveria*, T3=*Trichoderma* +*Beauveria*, T4=*Pseudomonas florescence*, T5= Neem Oil+ T1+Detergent, T6= Neem Oil+ T2+Detergent, T7 = Neem Oil+ T3+Detergent, T8 = Neem Oil+ T4+Detergent, T9 = Neem Oil + Detergent, T10= Detergent, T11 = Chitosan (Elicitor), T12 = Indofil M 45 (Fungicide as positive control), T13= Capture (Insecticide), T14= Fungicide+Insecticide (T12+T13) and T15= Control (Negative control). Effect of these treatments on tomato yield and number of infected fruits having late blight and early blight of tomato variety BARI Tomato 14 was assessed. Highest number of fruits and highest fruit weight (kg) were recorded in T1 (BAU-Biofungicide) followed by T8 (Neem Oil+T4+Detergent), T11 (Chitosan), T4 (*Pseudomonas florescence*) and T14(Fungicide + Insecticide). In case of early blight of tomato lowest number and weight of infected fruits were recorded by four treatments, viz., T1 (BAU-Biofungicide), T8 (Neem Oil+ T4+Detergent), T12 (Fungicide) Indofil M 45 and T14 (Fungicide + Insecticide). Lowest percent late blight infection on tomato leaves was recorded by T4 (*Pseudomonas florescence*) followed by T11 (Chitosan), T8 (Neem Oil+ T4+Detergent), and T1 (BAU-Biofungicide). Lowest percent early blight of tomato leaves was recorded by T11 (Chitosan). Second lowest early blight of tomato leaves was recorded by T1 (BAU-Biofungicide) and T12 (Indofil M 45) followed by T4 (*Pseudomonas florescence*) and T14 (Fungicide+Insecticide). In all respect highest disease records and lowest yield were observed in untreated control treatment. Overall four treatments viz., T1= *Trichoderma* based BAU-Biofungicide, T4=*Pseudomonas florescence*, T8= Neem Oil+T4+Detergent and T11= Chitosan were effective to increase yield and decrease late blight and early blight diseases of tomato.

Management of postharvest soft rot of potato caused by *Erwinia carotovora* by bacterial bioagents and their potential mode of action

Mohammad Shahjahan Monjil
Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
E-mail: smonjil@yahoo.com

Abstract
Postharvest management of bacterial soft rot caused by *Erwinia carotovora* was carried out during July, 2018 to June, 2019 on popular potato variety Diamant for four months. Thirteen treatments were considered for the experiment viz., T = Chitosan @ 0.01%, T_2= *Bacillus subtilis* @ 0.2%, T_3= Tilt (Propiconazole) @ 0.2%, T_4= Vitavax @ 0.02% of seed weight, T_5= Neem (*Azadirachta indica*) leaf extract @ 5%, T_6= Mehogani (*Swietenia macrophylla*) leaf extract @ 5%, T_7= Biskatali (*Polygonum*

hydropiper) leaf extract @ 5%, T_8= BAU-Biofungicide @ 2%, T_9= BINA-Biofungicide @ 2%, T_{10}= Gamma ray (30 Gy), T_{11}= Gamma ray (50 Gy), T_{12}= Gamma ray (100 Gy) and T_{13}= Control (Untreated). Effect of different treatments on number of infected potato, weight of infected potato (kg), Percent (%) infected potato, Percent (%) affected part of infected potato, Percent (%) of weight of infected potato were assessed in storage. One month (30 days) after storage, maximum infection was found associated with the Control treatment followed by Neem leaf extract and Biskatali leaf extract. Zero infection was observed in Chitosan, Vitavax, Tilt, *Bacillus subtilis*, Mehogani leaf extract, BAU-Biofungicide, BINA-Biofungicide, Gamma ray (50 Gy) and Gamma ray (100 Gy) treatments. Highest weight of infected potato was observed in Control. Similar trends of results were observed at 48, 65,83 and 100 days after storing. At 100 days after sorting highest number of infected potatoes were found in the Control treatment followed by Gamma ray (30 Gy), Mehogani leaf extract, Chitosan, Vitavax and *Bacillus subtilis*. Lowest infection was recorded in BINA-Biofungicide followed by BAU-Biofungicide and Gamma ray (100 Gy), Neem leaf extract. Thus, it can be concluded that BINA-Biofungicide, Neem leaf extract, BAU-Biofungicide and Gamma ray can be effective to control bacterial soft rot of potato in storage.

Monitoring the population changes of late blight pathogen, *Phytophthora infestans* in Bangladesh

Md. Rashidul Islam* and Md. Huzzatul Islam
Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: rashidul.islam@bau.edu.bd*

Abstract
Late blight caused by *Phytophthora infestans* (Mont.) De Bary, an oomycete limits the production of potato worldwide. Experiments were conducted to monitor the population changes of *P. infestans* isolates in Bangladesh in terms of their phenotypic and genotypic changes. A total of 42 *P. infestans* isolates were identified in 2018 and a total of 15 P. infestans isolates were identified in 2019 from late blight infected potato leaf samples by PCR using *P. infestans* specific (PINF) and ITS5 primers. Phenotypes of *P. infestans* isolates were analyzed using virulence, mating type and metalaxyl sensitivity assay. Virulence assay on detached potato leaf and on tuber (cv. Diamant) conceded that the *P. infestans* isolates obtained from different growing areas showed incommensurable levels of virulence. Mating type determination of *P. infestans* isolates revealed the presence of only A2 mating type in Bangladesh. Metalaxyl resistant/sensitivity assay of *P. infestans* isolates obtained from major potato growing areas showed most *P. infestan*s isolates were found metalaxyl resistant. Genotypes of *P. infestans* isolates were assessed using mitochondrial (mt)-DNA haplotyping and microsatellite analyses. Mt-DNA analyses attested that all *P. infestans* isolates obtained from different potato growing areas are Ia haplotype. Simple sequence repeat (SSR) analyses of samples collected on FTA cards corroborated that all *P. infestans* samples are Blue 13_A2 genotypes which is a dangerous European genotypes. The results revealed that *P. infestans* population remains unchanged during the years 2018 and 2019.

Development of molecular markers for early detection of citrus greening bacterium, *Candidatus* Liberibacter asiaticus

Md. Rashidul Islam* and Sumona Khanom
Department of Plant pathology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: rashidul.islam@bau.edu.bd*

Abstract
Citrus greening (Huanglongbing; HLB) is caused by phloem-limited bacteria, *Candidatus* Liberibacter asiaticus (*C*Las) in Asia. HLB is one of emerging diseases of citrus in Bangladesh and has been known

in East Asia for over a century. The actions for management of citrus greening include: use of disease-free nursery stock, early detection of both asymptomatic and symptomatic trees and subsequent removal and control of Asian citrus psyllid bug by insecticide sprays. *C*Las has been identified worldwide from the symptomatic plant samples using a number of molecular techniques such as polymerase chain reaction (PCR), real-time PCR, nested PCR, and loop-mediated isothermal amplification markers. However, these markers are unable to detect the *C*las in very early stage of infection or from the plants without any symptoms expression. Hence, it is essential to develop a early detection technique for *C*Las from asymptomatic plants just after infection to produce greening free citrus planting materials. Although, the complete sequence of the *C*Las genome provides the basis for studying functional genomics of *C*Las and molecular mechanisms of *CaLas*-plant interactions, the functional characterization of *C*Las effectors remains a slow process. Like other plant pathogens, *C*Las modulate a variety of host cellular functions for infection progression by delivering effector proteins into host cells. Till now 16 putative *C*Las effectors were identified via bioinformatics, and transiently expressed in *Nicotiana benthamiana*. In this study, sixteen effectors viz. CLIBASIA_00460, CLIBASIA_00525, CLIBASIA_02215, CLIBASIA_04025, CLIBASIA_04040, CLIBASIA_04330, CLIBASIA_04425, CLIBASIA_04560, CLIBASIA_05115, CLIBASIA_530, CLIBASIA_2470, CLIBASIA_3230, CLIBASIA_3695, CLIBASIA_4320, CLIBASIA_5320 and CLIBASIA_5315 were screened for the early detection of *C*Las from both symptomatic and asymptomatic plants. Two effectors viz.**:** CLIBASIA_00460 and CLIBASIA_04425, were found effective for the detection of *C*Las even at very low titer out of sixteen effectors. Therefore, it can be concluded that effector based molecular markers can be used for early detection of HLB pathogen, *C*Las.

Identification of plant growth promoting bacteria in controlling *Xanthomonas oryzae* pv. *oryzae in vitro*

Md. Rashidul Islam*, Md. Mahfujur Rahman, Md. Abdullah-Al Zobaer and Chonchol Kumar

Department of Plant pathology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: rashidul.islam@bau.edu.bd*

Abstract

Bacterial blight (BB) caused by *Xanthomonas oryzae* pv. *oryzae* (*Xoo*) is one of the most widespread and destructive diseases of rice. Experiments were conducted to identify the plant growth promoting (PGP) bacteria from rice phylloplane and rhizosphere controlling bacterial blight pathogen, *X. oryzae* pv. *oryzae* during two consecutive rainfed (aman) and two consecutive irrigated (boro) seasons. A total of seventy two bacterial isolates were identified that inhibit the growth of *X. oryzae* pv. *oryzae* out of around one thousand bacterial isolates. The results revealed that the bacterial isolates inhibit the growth of *X. oryzae* pv. *oryzae* by 45-80%. The assessment of plant growth promoting determinants showed that most of the bacterial isolates are capable of producing siderophore, solubilizing the insoluble phosphate and producing indole acetic acid (IAA). Plant growth promotion assay using twenty five bacterial isolates showed that most of the bacterial isolates can enhance the root growth, shoot growth and vigour index. The dry and fresh weight was also increased by the PGP bacteria. Sequence analyses of 16S rDNA revealed that most of the bacterial isolates are belong to *Pseudomonas*, *Bacillus* and *Serratia* genera. These results collectively indicate the possibility of using PGP bacteria in controlling BB of rice under net house and field condition.

Determination of seed and field health standard for blast and bacterial leaf blight (BLB) disease of rice

Md. Rashidul Islam[1*], Md. Mahmudul Hasan Chowdhury[2] and Purnima Dey[3]
[1]Professor, Department of Plant Pathology and [2]Senior Scientific Officer and [3]Senior Scientific Officer (Special Grade)Seed Pathology Centre, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
**E-mail: rashidul.islam@bau.edu.bd*

Abstract
Rice blast caused by *Pyricularia oryzae* Cavara and bacterial leaf blight (BLB) caused by *Xanthomonas oryzae* pv. *oryzae* Ishiyama are the two important diseases of rice. The maximum acceptable limit of a seed borne pathogen in a seed lot is called seed health standard and the maximum acceptable limit of a seed borne disease in seed crop field is termed as field health standard. Experiments were carried out to determine the seed and field health standard of blast and BLB of rice by detecting blast and BLB pathogen in the seed samples collected and field health standard for blast and BLB disease was determined by growing crops from the same seed samples tested. Field survey was conducted to collect the rice seed samples from the blast infected rice fields in two locations of Jamalpur and Sherpur district during the boro season (2016-2017). Different levels of neck blast infection (6-100%) were observed during boro season in the field. In pot experiment, 12-14% panicle blast infection was recorded in plants grown from seed samples collected from blast infected field with 6-90% panicle blast infection. However in the field, 3-5% panicle blast infection was recorded in plants grown from seed samples collected from blast infected field with 6-90% panicle blast infection. Therefore, apparently seeds with no blast infection can be fixed as seed health standard and field with no blast infection can be fixed as field health standard. The seed and field health standard for BLB pathogen, *X. oryzae* pv. *oryzae* was determined in four varieties viz. BINA dhan 7, BINA dhan 11, BRRI dhan49 and BRRI dhan52. Seed infection with *X. oryzae* pv. *oryzae* was determined following YDC plate method. The results revealed that the maximum (12%) seed infection was noticed in case of BINA dhan 7 while the minimum (6.00%) seeds were found to be infected with *X. oryzae* pv. *oryzae* in case of BINA dhan 11 and BRRIdhan52 followed by BRRI dhan 49 in which 8% seeds infected with *X. oryzae* pv. *oryzae*. Field heath standard was determined in the same four varieties viz. Binddhan7, Binadhan11, BRRI dhan 49 and BRRI dhan52 by growing seedlings from the seeds infected with *X. oryzae* pv. *oryzae*. The results conceded that maximum (70%) BLB incidence was recorded in case of BINA dhan 7 while the minimum (35%) BLB incidence was recorded in BRRI dhan 49 followed by BINAdhan 11 and BRRI dhan 52. These results collectively indicated that seed with zero infection can be fixed as seed health standard and field with no infection with BLB can be considered as seed health standard.

Molecular based detection of citrus greening causal organism, *Candidatus Liberibacter* asiaticus, an emerging threat for citrus cultivation in Bangladesh

Md. Rashidul Islam*, Md. Shahanur Alam and Md. Mahbubul Haque
Department of Plant Pathology, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
**E-mail: rashidul.islam@bau.edu.bd*

Abstract
Citrus greening (official name: huanglongbing, HLB) caused by '*Candidatus Liberibacter* spp. [*Ca.L. asiaticus*' (Las), '*Ca. L. africanus'* (Laf) and '*Ca.L. americanus*' (Lam)] is the most destructive disease of citrus worldwide. An experiment was conducted to detect the citrus greening casual organism *Ca.L.*

asiaticus' (Las) by PCR and to assess the status of citrus greening disease in sweet orange (malta) (*Citrus sinensis*) in nine selected growing areas. The highest incidence of citrus greening was noticed in Rangamati while the lowest incidence was recorded in Panchagarh followed by Khagrachari, Thakurgaon and Habiganj. However, elevated level of citrus greening incidence was perceived in Chattagram followed by Sylhet and Moulavibazar. The citrus greening severity in different locations was ranged from 1-2 (based on a 3-point scale where 0 representing no apparent HLB symptom, 1 suspect HLB symptoms, and 2 likely HLB symptoms). The maximum citrus greening severity was enumerated in Rangamati followed by Bandarban and Moulavibazar where the minimum citrus greening severity was recorded in Panchagarh followed by Habiganj. However, the medium level of citrus greening severity ranged from 1.46 to 1.68 that was calculated in Khagrachari, Thakurgaon, Chattagram and Sylhet. Molecular based detection was carried out by polymerase chain reaction (PCR) with primer pairs Las606 (Forward) and LSS (Reverse) designed based on the 16SrDNA sequences and primer pairs A2 and J5 designed based on the *rpl*KAJL-*rpo*BC operon (β-operon) of CLas. PCR with primer pairs Las606 (Forward) and LSS (Reverse) showed a fragment size about 500 bp with DNA extracted from sweet orange leaves infected with *Candidatus L.* asiaticus collected from Sylhet Moulvibazar, Habiganj, Bandarban, Rangamati, Thakurgaon, Chattagram and Panchagarh. However, PCR with primer pairs A2 and J5 resulted band size of about 703bp in case of samples obtained from Sylhet, Moulvibazar, Habiganj, Bandarban, Rangamati, Chattagram, Thakurgaon and Panchagarh. Transmission study conceded that *Ca.L.asiaticus* was transmitted through grafting of root stock (Malta) and scion (pumelo). The presence of *Ca.L.asiaticus* also confirmed its transmission through Asian citrus psyllid bug, *Diaphornia citri.*

Role of micronutrients on growth and yield of Bangi (Cucumis melo L.) in Charland Agriculture

A.K.M. Golam Sarwar*, Jannat-E-Tajkia and Sontosh C. Chanda
Department of Crop Botany, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh.
**E- mail : drsarwar@bau.edu.bd*

Abstract
Bangi, an important short duration summer fruit crop, is rich in vitamins and minerals, facilitated to protect from hidden hunger. To expedite the growth and fruit yield attributes of Bangi through micronutrient application for the Charland Agriculture, the experiment was conducted at the farmer's (Charland) field in two locations viz. Sadar and Belkuchi Upazilas of Sirajgong district. The crop was cultivated following farmer's management practices in mada(s)/pits (spacing 3.5 m row-row X 3.5 m plant-plant) in RCBD design with 3 replications. Two fertilizer doses – i. control (farmers practice; cow dung + NPK) and ii. improved practice (farmers practice + micronutrients), were used as experimental treatments. The application of micro-nutrients enhanced plant length and other growth descriptors and fruit yield as well; however, locations did not affect on the studied descriptors except the number of secondary branches plant–1 and leaf characters. The plant length varied from 148.6 cm to 321.7 cm, the fruit yield (number) plant–1 almost quadrupled and size more than double due to improved practice (with micronutrients) resulting 4–5 times increased the farmer's profit compared to conventional (farmers) practices. Further research on the effect of micronutrients on nutritional quality enhancement (Biofortification) and self-life is suggested for better understanding and nutritional quality improvement processes of Bangi through nutrient management.

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Screening of hybrid rice cultivars against low temperature induced spikelet sterility

A.K.M. Golam Sarwar* and Md. Ruhul Kuddus
*Laboratory of Plant Systematics, Department Crop Botany, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: drsarwar@bau.edu.bd*

Abstract
A field experiment was conducted at Field Laboratory of the Department Crop Botany, Bangladesh Agricultural University, to assess and compare the effect of low temperature on pollination biological features and yield among different hybrid rice cultivars; and to find out suitable cultivar(s) for early transplanting (November 2018) in Boro season among the existing hybrid rice cultivars of Bangladesh. Twelve rice cultivars *viz*. BRRI hybrid dhan2, BRRI hybrid dhan3, BRRI hybrid dhan5, SL-8H, Hybrid LP-70, Agomoni JBS-17 (4), WIN-302, WINALL Hybrid 2, Nobin IS-1, Ispahani 1, Dubar IS-2 and Ispahani 2, were used as experimental materials. The experiment was laid out in a randomized complete block design with three replications. The standard rice cultivation procedure was followed. Yield and yield contributing descriptors e.g., plant height, number of effective tillers, panicle length, number of primary and secondary branch, number of grains panicle^{-1}, etc. differed significantly. Early transplanting has negative impacts on the spikelet sterility descriptors, however, grain yield varied from 3.44 to 5.90 tha^{-1}. Among the cultivars, BRRI hybrid dhan5 and Nobin IS-1 might be recommended for the maximum grain yield potential at earlier transplanting.

Feasibility Study of Fibre Production from Flax Genotypes of Bangladesh

A.K.M. Golam Sarwar* and Jannat-E-Tajkia
*Laboratory of Plant Systematics, Department Crop Botany, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: drsarwar@bau.edu.bd*

Abstract
The present investigation was carried out to examine the yield performance and feasibility of fibre production of twenty six flax accessions during *Rabi* 2018-19 at the Plant Systematics Laboratory, Department of Crop Botany, Bangladesh Agricultural University and Agricultural Research Station, On-Farm Research Division, Bangladesh Agriculture Research Institute, Rangpur. All the parameters studied varied significantly among the genotypes Seeds pod^{-1}, plants pod^{-1} and 1000-seed weight. The highest plant height was recorded in the genotypes BD-10709 (70.33 cm). Pods plant^{-1} was counted highest in BD-10708 (142.0) and the lowest was found in BD-10699 (38.0) and BD-10699 (38.0). The accessions BD 107089 gave the highest (135.0) number of effective pods plant^{-1} while the lowest was observed in BD-10699 (26.33). BD-10708 produced the statistically highest (513) number of seeds while it was found lowest in BD-10699 (152.33). Considering the grain yield, BD-10708 produced significantly the highest seed yield (182.90 g) whereas the lowest was measured in BD-10699 (49.79g). A local genotype Ulipur was also relatively poor performer regarding seed yield. All the collected accessions showed a little suitability for only (economic/commercial) fibre production. However, these accessions could be used for further breeding programme to develop dual purpose, seed/oil and fibre yielding, flux cultivars.

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Effect of Planting Date, Fertilizer Dose and Plant Spacing on High Value Flax Fibre Production

A.K.M. Golam Sarwar* and Md. Sabibul Haque
*Laboratory of Plant Systematics, Department Crop Botany, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: drsarwar@bau.edu.bd*

Abstract
Three experiments were conducted to observe the effect of different planting dates, fertilizer doses and plant spacing on five (selection based on last year's experiment) flax genotypes under (farmer's) field condition at Shoreartol, Alamnagar, Rangpur during October to March in 2018-19. The experimental treatments included five planting dates *viz*. 20 October, 10 November, 30 November, 20 December and 10 January; three fertilizer doses *viz*. recommended, recommended + 25% more N & K, and recommended + 50% more N & K; three plant spacing *viz*. 15cm x 10cm, 20cm x 10cm and 30cm x 10cm; and flax genotypes *viz*. BARI Tishi-1, BD-10708, BD-1903, China and Tangail. The flax crop was raised following standard procedure. Among the planting dates, spacing and fertilizer doses, flax crops performed better at 10th November planting and 15cm x 10cm (for fibre) and 30cm x 10cm (for seed) spacing with recommended fertilizer dose. For fibre yield some additional flax genotype (current year's) collections were also included in this experiment. The largest amount of fibre was extracted BARI Tishi-1 (11.54 g) followed by Canada (10.83 g). The lowest was weighted in Chilmari (4.14 g) followed by BD-1903 (4.31 g). The analysis of fibre quality parameters has not been finished yet.

Genotypic difference in photosystem II efficiency, photosynthesis, pollen viability and antioxidant activities of tomato under heat stress

Md. Sabibul Haque* and Mst. Tanziatul Husna
Department of Crop Botany, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: mshaqcb@bau.edu.bd*

Abstract
Heat stress due to global climate change is a serious threat to crop production. Tomato is an important and popular vegetable crop and the crop is very sensitive to heat stress. A two factorial pot experiment with CRD having four replications was conducted in the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh to investigate the physiological and biochemical responses in tomato plants to heat stress. The two experimental factors were i) Tomato cultivars (BARI Hybrid Tomato-5, BARI Tomato-14 and BARI Tomato-15) and ii) Heat stress (control and heat). The plants of three tomato cultivars were exposed to heat stress (38°C for four days) at flowering stage. All the physiological parameters such as relative greenness/SPAD, maximum photochemical efficiency of PSII (F_v/F_m), photosynthetic and transpiration rate were significantly declined by heat stress. The similar results were observed in total chlorophyll and carotenoids contents in all tomato cultivars under heat treatment. The antioxidative enzymes (ascorbate peroxidase and catalase) activities were significantly increased in plants grown in heat treatments compared to the plants grown in control. The tolerance of cultivars varied significantly in response to heat stress. The percent reduction (over control) value in photosynthetic rate in BARI Hybrid Tomato-5, BARI Tomato-14 and BARI Tomato-15 were 45, 42 and 25%, respectively. The lowest percent reduction in total chlorophyll content was observed in in BARI TOMATO-15 in comparison to other cultivars. The percent increased (over control) values of catalase enzyme activities under heat stress in BARI Hybrid Tomato-5, BARI Tomato-14 and BARI Tomato-15 were 49, 58 and 96%, respectively. The cultivar BARI Tomato-15 showed better heat tolerance among the three cultivars studied based on the performances in SPAD, F_v/F_m, photosynthesis, pigment contents and antioxidative enzymes activities.

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Photophysiological and Biochemical Changes in Maize Shoot as Influenced by the Salinity and Drought

Md. Nesar Uddin*, Md. Mahir Faisal, Md. Shahab Uddin and Mousumi Jahan Sumi

Department of Crop Botany, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: nesar.uddin@bau.edu.bd*

Abstract

Salinity and drought are two major abiotic stresses that hamper crop growth and yield worldwide. This research attempted to show the comparative responses of drought stress (soil water tension: 434.3±12.4 mBar) and osmotic phase of salinity (NaCl to develop 12 dS m^{-1}) maintaining a control treatment (without NaCl; soil water tension: 178.7±11.8 mBar) on some growth, photo-physiological and biochemical parameters in eight maize genotypes, namely Bornali (composite), BARI maize-7 (composite), BARI hybrid maize-5, BARI hybrid maize-7, BARI hybrid maize-8, BARI hybrid maize-9, BARI hybrid maize-12 and BARI hybrid maize-13. Exactly 10 d stresses were examined in a pot experiment in which four replicates were distributed in a complete randomized design, and plants were harvested after one month of age. Shoot fresh weight declined from 22.7−63.5% and 16.8−42.4% in eight maize genotypes under salinity and drought stress, respectively. Salinity caused a reduction in the rate of photosynthesis from 26.9−90.5% while drought reduced the same from 10.7−57.7%. Seemingly, the rate of transpiration declined from 70.0−92.1% under salinity, and drought decreased the same from 52.9−80.4%. On the other hand, salinity and drought caused a reduction in the stomatal conductance from 47.6−94.3% and from 2.4−71.7%, respectively. Eight maize hybrids showed almost unaltered responses on Fv/Fm ratio) due to salinity and drought. Neither chlorophyll-a orb nor their sum being influenced by salinity and drought. Salinity and Drought-induced increase in carotenoids content ranged from 33.2−646.5% and 8.6−169.6%, respectively. The increase in the amount of phenolics ranged from 2.0−77.2% and 5.5−66.7% due to salinity and drought, respectively. Shoot growth of drought-resistant BARI Hybrid Maize-13 declined by only 17% under drought stress, and its unaltered physio-biochemical parameters supported drought-stress mechanisms.

Evaluation of rice genotypes for submergence tolerance based on morpho-physiological traits

Md Alamgir Hossain-2* and Md. Mosharaf Hossain

Department of Crop Botany, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: alamgircbot@bau.edu.bd*

Abstract

Submergence stress is one of the most important constraints for the productivity of rice in Bangladesh. A pot experiment was conducted at the Net House, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh, during Aman season from July 2018 to December 2018 to study the changes in water-soluble carbohydrates in rice plant under submergence stress. The experiment consisted of two factors— Rice cultivars (Bina dhan-11, Bina dhan-12, as submergence tolerant and BRRI dhan49 as susceptible) and Submergence stress for 14 days at vegetative stage. Submergence stress was imposed by dipping the pot grown plants into a water tank about 90 cm depth of water for 14 days. After 14 days plants were removed from tank. The plants were sampled at 0, 5, 10, 14 and 40 days after submergence to measure the contribution of shoot reserves, leaf greenness and shoot dry mass for their survival. Tolerant rice cultivars Bina dhan-11 and Bina dhan-12 had high initial soluble carbohydrate than the susceptible one, BRRI dhan49. Under submerged condition the tolerant cultivars showed slow depletion of water soluble carbohydrate compared to susceptible one. Higher

carbohydrate contents in tolerant cultivars might act as buffer stock during submergence for their better survival and growth.

Screening of wheat genotypes for drought tolerance based on physiological and biochemical attributes

Md Alamgir Hossain and Mohammed Mohi-Ud-Din
Department of Crop Botany, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: alamgircbot@bau.edu.bd*

Abstract
Fifty-six wheat genotypes selected from the previous experiment were evaluated in the filed for the phenotypic trait analysis in this year. Drought tolerance of these wheat genotypes were also evaluated through 30 pairs of simple sequence repeats (SSR) microsatellite markers covering all 21 hexaploid wheat chromosomes and representing 30 loci with a drought tolerant check variety Sonoita F81. Results revealed that all the phenotypic traits were diminished by drought, but the magnitude was controlled by the tolerance level of the wheat varieties. From 56 wheat genotypes, 11 were high drought tolerant (HDT) [gene diversity 0.69], 41 were moderate drought tolerant (MDT) [gene diversity 0.68], and 4 were found to be low drought tolerant (LDT) [gene diversity 0.45]. Conversely, SSR marker derived three groups confined the DTI of 0.92, 0.88 and 0.84 for Group A, Group B and Group C, respectively. On the basis of drought tolerance index (DTI) of phenotypic data and SSR marker data, 14 genotypes were selected for the physiological trait evaluation. Results clearly revealed that, phenotypic traits and SSR markers could be used in evaluating drought tolerance in common wheat genotypes under low soil moisture conditions.

Microscopic investigation of wood formation: focusing artificial application of water in *Tectona grandis* in Bangladesh

Shahanara Begum
Dept. of Crop Botany, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
E-mail: shahanarab@bau.edu.bd

Abstract
The availability of water on the soil is an important regulating factor for determining the cambial growth in trees. Water stress can affect cambial growth, directly, through the effects on cambial cells and their derivatives or indirectly, through an effect on photosynthesis and plant hormone production. To evaluate the hypothesis that cambial growth is regulated by the precipitation during dry season in tropical and sub-tropical trees, an experiment was conducted during hot summer, where severe drought is a common problem. With application of high irrigation water for a certain period, cambial growth was initiated and continued on the stems of *Tectona grandis* seedlings during hot-summer. By contrast, when low irrigation water was applied, cambial growth was not initiated during-hot summer. The inability of cambium to initiate cell division in response to lack of water might be the result of an adaptive change or may be a secondary effect of physiological changes in the whole plant during hot-summer. From this study, it is suggested that the supply of adequate amount of water is one of the most important limiting factors that regulate the cambial growth during hot-summer in *Tectona grandis* seedlings grown in Bangladesh.

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Fluctuation in the levels and localization of starch and lipids in cambium of hardwood trees

Shahanara Begum
Dept. of Crop Botany, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
E-mail: shahanarab@bau.edu.bd)

Abstract
Environmental factors, such as temperature, provide appropriate physical conditions for the growth and development of trees. Studies of the physiology and dendrochronology of cambial activity indicate that temperature is closely associated with the radial growth of tree stems. In this study, the effects of increases in the ambient temperature on cambial reactivation and xylem differentiation in the stems of jackfruit trees (*Artocarpus heterophyllus)*, have been studied in relation with its storage substances. The timing of cambial reactivation and xylem differentiation in 2018-2019 has been observed by light microscopy. There were clear differences between winter and spring. When spring came cambial reactivation occurred followed by xylem differentiation in jackfruit trees. Reserve materials might be important for wood formation in trees. The localization of starch, lipids and protein were observed in phloem, cambium and outer part of xylem. The optical images of anatomical features and localization of reserve materials obtained by light microscopy showed the availability and utilization of such materials within the stem of jackfruit trees. Starch grains in the parenchyma cells are more abundant in the outer xylem than in the inner part of xylem and phloem cells. Both axial and ray parenchyma cells of outer xylem contain starch granules. Lipid and protein droplets are uniformly distributed in the outer xylem. The phloem parenchyma cells have large mass of lipid bodies whereas those are almost absent in cambium and xylem ray parenchyma cells. The results suggest that, in *Artocarpus heterophyllus*, the temperature in the stem is a limiting factor for reactivation of cambium. An increase in temperature might induce the conversion of storage starch to sucrose for the activation of cambial cell division and secondary xylem.

Physicochemical Investigation of Important Minor Indigenous Fruits of Bangladesh: A Defensive Shield for Combating 'Hidden Hunger' and Nutrition Security

MSA Fakir*, MN Uddin and M Akter
Department of Crop Botany, Bangladesh Agricultural University, Mymensingh-2002, Bangladesh
**E-mail: fakirmsa@gmail.com*

Abstract
Minor fruits are rich source of minerals, vitamins and phytochemicals of health benefit. The objective of the study was to determine dry matter content, proximate compositions (crude protein, crude fibre, crude fat, ash) of seven minor fruits namely 'bon chalta' (*Dillenia pentagyna*), 'bilati gab' (*Diospyros discolor*), 'dephall' (*Garcinia xanthochymus*), 'china cherry' (*Muntingia calabura*), 'dumur' (*Ficus racemosa*), 'karamcha' (*Carissa carandas*) and 'bilimbi' (*Averrhoa bilimbi*). Fruits were collected from the Botanical Garden, Bangladesh Agricultural University. Percent dry matter content in the fruits ranged from 5.38 (*Averrhoa bilimbi*) to 19.71 (*Muntingia calabura*). For proximate composition, crude protein was higher in *Diospyros discolor* (25.9%), crude fibre and ash was higher in *Ficus racemosa* (19.58 and 9.09%, respectively), and crude fat was maximum in *Carissa carandus* (24.42%). Thus, the species, *Diospyros discolor, Carissa caranda and Muntingia calabura* fruit appeared better for nutrient content.

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Screening of salt tolerant sunflower genotypes for cultivation in the coastal region of Bangladesh

Dr. Md. Abdul Awal*, Dr. Md. Shahidur Rahman and Mobassira Tabassum
Department of Crop Botany, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: awalma7@bau.edu.bd*

Abstract
Salinity is a major constraint for crop production in the coastal region of Bangladesh. A good salinity tolerant germplasm could successfully offset the barrier posed by the increasing concentration of salinity therein. Although sunflower has salinity tolerance nature to some extent but its higher tolerant's cultivar can be treated as a promising candidate for cultivation in the coastal region. A relatively high soluble salt concentration in soil in those areas might have a negative effect on seed germination and then on plant population, crop growth and hence on grain yield. Under these conditions, a search for salt-tolerant sunflower genotypes and their cultivation is a way to alleviate the impacts of salinity on germination, growth and grain yield of this crop. Therefore, the study is designed for screening of sunflower genotypes to identify the salt-tolerant ones based on germination and seedling performance tests along with growth and yield. More than thirty sunflower accessions/lines/cultivars were investigated through seed germination in the Plant Ecology Laboratory, Department of Crop Botany, BAU, Mymensingh. Twenty five representative seeds of each genotype were germinated in dark at room temperature treated with five salt concentrations viz. 0, 100, 150, 250 and 300 mM of NaCl solution in petridishes of 9 cm diameter fitted with two layers of Whatman No. 1 filter paper. Each treatment will be replicated thrice with a factorial randomized block design. Seed germination was recorded daily basis and analyzed to found cumulative seed germination (%), germination index (GI), standardized germination reduction (%), threshold salt concentration, etc. Some genotypes like Hysun-33, BARI Sunflower-2, FH-689, FH-732, FH-738, etc. primarily shown salt tolerance in terms of germination trial. Next work will be performed on seedling growth for screening of salt tolerance.

Measurement of adaptation gaps among the stakeholders to climate change shocks in *Haor* agriculture

Md. Abdul Awal and Md. Shahidur Rahman
Department of Crop Botany, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
**E-mail: awalma7@bau.edu.bd*

Abstract
In spite of huge cost on adaptive researches and extension works many farmers don't utilize the innovations/technologies those released for their use i.e., the technologies are either not so befitted or those were not properly disseminated to farmers. Sometimes, researchers could not select suitable research items from farmers; hence sustainability of research outcomes (i.e. technologies) may be poor. Therefore, some adaptation gaps are common between research institutes, policy makers and rural communities, and ultimate target to get proper yield against climate shocks couldn't reach to a satisfactory level. Recently huge crop loss of Boro rice is occurred in *Haor* areas due to early/flash flood; therefore, a research is undertaken to investigate whether any adaptation gap to save production against early flood occurrence is exist. Data are collecting through stakeholder consultation from respective officials especially DAE personnel, and focus group discussion and questionnaire survey from *Haor* farmers. Preliminary result reveals that most of the farmers in *Haor* areas are duly communicated by the local agriculture and extension office where the farmers are advised to cultivate BR28, BR29 etc. rice varieties in Boro season and those of BRRI Dhan 51, BRRI Dhan 52 etc. in the

Aman season. Most of the farmers use rice seed to cultivate their land from local market and thus varietal purity is getting lost day by day. Around fifty percent farmers believe that cool injury of rice is the main barrier for advancing Boro season, and submergence tolerant rice variety could tackle the flood incidence to some extent especially in the Aman season. A majority of the farmers would like to get the insurance policy in the *Haor* region for getting compensation of production loss especially for Boro rice from early flood or flash flood. They are willing to provide rice immediately after harvest as premium of the insurance. Therefore, policy makers may think on insurance to save rice production from early flood in *Haor* areas.

Microgreens: A homestead vegetable production option to enhance food and nutrition security in the rural-urban continuum in Bangladesh

M.A. Hossain* and M.A. Sakil
Department of Crop Botany, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: alamgir.cbot@bau.edu.bd*

Abstract
A series of experiments was carried out in the department of Crop Botany during October 2018 to date. It was composed of two phases, i) Investigation the best growing medium by assessing morpho-physiological parameters (germination percentage, normal seedlings, vigor index, shoot length, hypocotyl length, seedling height, fresh weight and dry weight) and ii) Evaluation of bio-chemical parameters (proximate analysis, bio-active compounds, mineral content and anti-oxidant capacity) of four selected Brassica microgreens under laboratory condition. In morpho-physiological investigation, four media (tissue, foam, soil, soil plus cow dung) were used as treatments under Completely Randomized Design (CRD) with four replications repeating thrice. Results revealed that soil plus cowdung medium commenced the highest% germination, normal seedlings, vigor index, hypocotyl length, shoot length, seedling height, fresh weight and dry weightfor mustard, leaf mustard, radish and cabbage respectively, over the other media. Bio-chemical investigation was also carried out under Completely Randomized Design (CRD) with four replications repeating twice. Among four Brassica microgreens, leaf mustard microgreens showed the highest protein and less carbohydrates content along with moderate moisture. In case of bio active compounds, leaf mustard microgreens contained the highest total chlorophyll content. Electrolytes (Na & K) and micro nutrients (Fe, Zn) were the highest in leaf mustard microgreens. It also contained moderate amounts of S, P, Ca and Mg. Anti-oxidant capacity of leaf mustard (vitamin C content and DPPH radical scavenging activity) was the highest than that of other Brassica microgreens. Based on results, it may be concluded that mixture of soil plus cowdung medium may be better in microgreens production than the other media and leaf mustard microgreensmay provide the highest bio-active compounds, proteins, minerals and anti-oxidant activity among the four Brassica microgreens tested in the current study.

Improving dietary intake of omega-3 fatty acids for pre-school children and lactating mothers through farmers friendly Chia seed production in Bangladesh

M.A. Hossain* and M. M.Karim
Department of Crop Botany, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail : alamgir.cbot@bau.edu.bd*

Abstract
A baby is born with 100 billion brain cells and their connectivity (so-called brain development) is accomplished by docosahexaenoic acid (DHA, 22:6), an omega-3 fatty acid. Interestingly, our body

can synthesize DHA only when á-linolenic acid (ALA, 18:3) is taken as a dietary supplement**.** Dietary ALA is particularly important since bioconversion of ALA to DHA is greater during pregnancy, lactating period and childhood than in the adults and men. Chia (*Salvia hispanica* L.) seeds contain the highest (60-64%) level of ALA. We cultivated Chia at different locations of Bangladesh. Yield is very promising. Results of proximate analyses showed that Chia seed contained high amount of Ca, fibre, protein and fatty acid, especially omega-3 fatty acid. Results clearly showed that there is a great potentiality of its cultivation and adaptation in our production system. Finally, large scale Chia seed production would be an important approach for supplying ALA to the pregnant & lactating mothers, pre-school children and the adults in a sustainable manner for getting a healthy nation. The Principal Investigator first introduced Chia as a new medicinal plant in Bangladesh in 2011 and successfully completed Chia cultivation at BAU for his own interest. In 2019, a new variety of the crop was released as **"BAU Chia-1"** from Bangladesh Agricultural University under the approval of Ministry of Agriculture.

Development of farmer's friendly Chia seed production technology in Bangladesh for increasing dietary intake of omega-3 fatty acid

Hossain M.A.* and Karim M.M.
Department of Crop Botany, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail : alamgir.cbot@bau.edu.bd*

Abstract

Chia (*Salvia hispanica* L.) seeds contain high amount of omega-3 fatty acids, proteins, minerals and vitamins. Therefore, they can serve as a potential ingredient for both human food and livestock feeds. This stimulate interest for its commercial production from the local farmers. The objective of the study was to compare the effect of different planting methods on growth and yield of Chia and find out the suitable methods of planting for maximizing yield. Several experiments were carried out at the field laboratory of the Department of Crop Botany, Bangladesh Agricultural University (BAU), Mymensingh, during the period from October 2017 to April 2018. Treatments (Zero tillage, Broadcasting, Transplanting method) were replicated three times. Data on plant height and width, fresh and dry weight of plants, length of inflorescence, the number of inflorescences, amount of seeds and husks per plant were collected and analyzed. Chia plants which were transplanted had the highest (15.4 g) seeds per plant. On the contrary, zero tillage had the lowest (4.5 g) seeds per plant. But broadcasting method had the highest yield in terms of kg/ha and it's about (795 kg/ha) followed by transplanting (632 kg/ha) and zero tillage had the lowest yield (258 kg/ha). Yield variation occurred due to plant density. Taken together, it might be concluded that plant growth and seed yield were favored to broadcasting method and transplanting method would be suggested to the areas where land is free after 1st week of November.

Polyhouse Technology for Raising Quality Seedlings Averting Winter Cold Injury and Harvesting High Yield of Boro-Rice

Md. Habibur Rahman Pramanik
Department of Crop Botany, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail : habiburp@yahoo.com

Abstract

The experiments were carried out at the field lab and Plant Ecology lab of the Department of Crop Botany, BAU, Mymensingh and Rangpur Sadar Upazilla from 1July 202018 to 30 June 2019 to produce quality seedlings averting winter cold injury on Boro-rice seedlings through use of portable

polyhouse covers. Seeds of different rice varieties were sprouted and equal amount of seeds for each variety were sown in a well puddle land having unit plot size each of $1m^2$. The experiment was laid out in RCBD with three replications. Immediately after sowing of seeds, the seedbeds were covered by portable small polyhouses (white, yellow, green and blue) keeping open seedbeds aside as control. Results reveal that initial low soil & air temperature in the morning inside or outside the polyhouse increased with advancement of the day till 2:00 PM followed by a decline but air temperature inside all the polyhouses (white, yellow, green and blue) increased significantly compared to outside. Light intensity inside the colored polyhouses measured a Point Quantum Sensor varied significantly. Seedlings under polyhouse cover were 35-80% taller than those in open field. Seedling mortality was lower under polyhouse cover compared to control. Leaf chlorosis was scanty in the seedlings grown under polyhouses but it was prominent in the seedlings grown in open field. Seedling dry matter appeared to be double for the polyhouse covers compared to control plants except that from green polyhouse cover. The results lead to the conclusion that warm condition inside polyhouses (white, yellow, green and blue) might enhance physiological processes in the covered seedlings compared to those in open field and thereby enhanced the quality seedlings through increasing height, chlorophyll & dry matter contents. However, seedling growth under white and yellow polyhouse covers was superior to that in green and blue polyhouses. Seedlings grown in open field and under polyhouse covers were also transplanted in rice field to assess the impacts of seedlings from polyhouses on the growth and yield of Boro-rice. Irrespective of variety flowering and maturity time was enhanced by 10-15 days and grain yield also increased by 10-20% probably for the quality and healthiness of the seedlings from polyhouse covers compared to those from open field both in Mymensingh and Rangpur sites.

High temperature tolerant rice development by using fatty acid desaturase mutant

Israt Jahan Shelley

Department of Crop Botany, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: shelleyisratcb@bau.edu.bd

Abstract

High temperature is one of the important abiotic stresses that cause spikelet sterility in rice. Due to global warming which has been projected to increase air temperature by 2°C to 4° C in 21st century, the rice production especially *boro* rice in Bangladesh might be dropped significantly. Therefore, breeding for rice varieties incorporating with heat tolerance potential/traits is urgently necessary to cope with the future consequences of climate change. Recently fatty acid desaturation level is rampantly used for temperature stress tolerance in different crops. The *sll1,*a rice root mutant that produces short lateral roots due to mutation in stearoyl-acyl carrier protein fatty acid desaturase gene (*SLL1:* Os04g0379900). This gene is also found highly expressed in anthers (ricexpro.dna.affrc.go.jp). It is hypothesized that the anthers of *sll1* mutant contain higher level of saturated fatty acid; consequently those can resist high temperature stress during anthesis through membrane stability. Therefore, the research has been designed to introgress *sll1* mutant gene in some popular *boro* varieties *viz.* BRRI dhan 28 and Binadhan 14 for the development of high temperature tolerant variety through the reduction of spikelet sterility in rice. The *sll1* mutant was used as nonrecurrent parent and BRRI dhan 28 and Binadhan 14 as recurrent parent. Crosses were carried out in *boro* season (2017-2018 and 2018-2019) among the varieties. However, a very few F1 seeds were harvested in the first year as the flowering among the parents were unsynchronized. In the following year flowering time was synchronized using different dates of planting and crosses were done. In addition to that new cross combinations were made using Nipponbare, a moderately high temperature tolerant variety as donor parent. Sufficient amount of F1 seeds were harvested from different cross combinations and those seeds are now growing for the next generation and continuing the research for valuable findings.

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Regeneration of Year Round Fruit Producing Jackfruit Plantlets *In Vitro* for Micropropagation of True to Type plantlets

M. Obaidul Islam* and Jannat-E-Tajkia
Department of Crop Botany, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
**E-mail : obaidul7_mo@yahoo.com*

Abstract
An experiment was carried out with year round fruit producing jackfruit to establish in vitro plantlet regeneration protocol using tissue culture techniques. After searching around we found a plant in BAU campus which produces fruit 2 times per year (Prof. Dr. Zakir House). Shoot buds of 5 inches long were collected as source materials and sterilized for in vitro culture. Soon after collection the shoot buds were washed with running tap water for two minutes and then rinsed with distilled water for 3 times. Inside air flow cabinet the materials were deep in 10% savlon solution for 5 minutes and washed by distilled water for 3 times. Then buds were deep in 30% ethanol for 30 second and washed with sterilized water for 3 times. Then buds were treated with NaOCl (0.1 % active chlorine) for 3, 4, 5, 6, and 7 minutes and then washed well for 5 times with double distilled water to sterilize bud explants. Among treatments 5 minutes were found the best for explants sterilization (90%) and followed by 4 minutes (70%). Under or over duration of sterilization was resulted over contamination or necrosis of explants in culture. Finally apical meristem of 1.0 cm were cut as explant and was cultured in MS medium supplemented with auxin and cytokinin at different concentration and combination. Direct shoot regeneration of 50% explants were obtained in medium supplemented with 2-3 mg/L of BAP.

Utilization of Biological Nitrification Inhibition (BNI) Function for Increasing Nitrogen Use Efficiency in Cereal Production Systems

Rahman, T. [1,2], Hossain, M.A.[1,2], Sagar, A.[1,2], Mia, M.A.[1,2] and Hossain, AKMZ [1,2*]
[1] Department of Crop Botany, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh and [2]Plant Physiology Lab, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh, Bangladesh
**E-mail: zakir@bau.edu.bd*

Abstract
The massive amount of N applied to the agricultural systems leaks into the environment and has a cascading effect on human health; ecosystem diversity and global warming with negative impacts on the environment. Biological nitrification inhibition (BNI) is the natural ability of certain plant species to release nitrification inhibitors from their roots that suppress nitrifier activity, thus reducing soil nitrification and N_2O emission. Several sorghum species from Bangladesh and abroad were surveyed for BNI capacity in roots using hydroponics. Among the tested sorghum varieties, none of the varieties showed detectable BNI capacity except hybrid sorgo from Japan. Several soil incubation studies were conducted to characterize the stability and ability of MHPP in the soil. The results revealed that MHPP is highly stable in the soil even up to 60 days and the significant amount of MHPP was found in the incubated soil. The Physiological studies on the mechanisms of BNI-compounds release revealed that the form of NH_4^+ has the trigger (stimulatory) effect on BNI compound release from sorghum; and NH_4^+ uptake, Plasma membrane H^+-ATP-ase activity and rhizosphere acidification may be functionally inter connected with BNI release in sorghum. Another experiment was also conducted to investigate the nitrogen use efficiency of rice crops after cultivating sorghum crops for 30 days. The results indicated that the inhibitor released from sorghum may effectively inhibit nitrification process and improves nitrogen use efficiency by improving growth and yield parameters of rice.

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Phytochemical Analysis of Medicinal Plant Parts of BAU Botanical Garden

Tunazzina, N.A. [1,2], Rahman, T.[1,2], Sagar, A.[1,2], Mia, M.A.[1,2], Hossain and AKMZ [1,2*]

[1] Department of Crop Botany, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh and [2]Plant Physiology Lab, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: zakir@bau.edu.bd*

Abstract

The medicinal plants have been primary and important source of healthcare in fight against various physical health problems. Medicinal plants contain many essential components, bioactive compounds. The most important of these bioactive compounds are alkaloids, flavonoids, tannins and phenolic compounds. The main target of the study was to analyze presence or absence of alkaloids, saponins, terpinoids, tannin, flavonoids and phenolics as well as evaluate the phytochemical constituents as total alkaloid, flavonoids, phenolics, tannin, chlorophyll a, chlorophyll b, chlorophyll (a+b) and total carotenoids. Six different samples from four selected plants Bohera (*Terminalia bellirica,* Family: Combretaceae), Noni phol (*Morinda citrifolia,* Family: Rubiaceae), Choijal (*Piper chaba,* Family: Piperaceae) and Pathor kuchi (*Bryophyllum pinnatum,* Family: Crassulaceae) were collected from The Botanical garden of Bangladesh Agricultural University. In first experiment the samples were analyzed for qualitative test and in second experiment the samples were evaluated quantitatively. The result of qualitative analyses of samples shows that higher amount of Alkaloids were found in all samples where saponins absent in *Piper chaba* (stem and leaf),Terpinoids was found in all the samples except *Bryophyllum pinnatum* and other phytochemicals like Tannin, Flavanoids, Phenolics were also found in all samples. In quantitative analysis highest percent of alkaloid content (1.27 g/100 g sample) was found in the sample of *Terminalia bellirica* leaf and other phytochemical like total flavonoid, total soluble phenoilcs and tannin were also found in *Morinda citrifolia* (3.1g/100 g sample), *Morinda citrifolia* (3.60 mg GAE/g extract) and *Morinda citrifolia* (2.97 mg GAE/g extract) respectively. The samples were also evaluated for the phytochemical pigments. The highest chlorophyll a, chlorophyll b and chlorophyll (a+ b) contents were detected in *Morinda citrifolia* (Leaf) which was (1.01 mg/g FW), (0.573 mg/g FW) and (1.583mg/g FW) respectively. The highest amount of carotenoids (0.013 mg/g FW) was detected in *Terminalia beleirica* (leaf).

Evaluation of Sunflower Varieties for Salinity Tolerance Based on Morpho-physiological Attributes

Setu, M.S.A.[1,2], Haque, M.S. [1,2], Rahman, T.[1,2], Sagar, A.[1,2], Mia, M.A.[1,2] and Hossain, AKMZ [1,2*]

[1] Department of Crop Botany, Bangladesh Agricultural University, Mymensingh- 2202, Banglades and [2]Plant Physiology Lab, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: zakir@bau.edu.bd*

Abstract

Soil salinity is a big threat to the world and major concern to agricultural productivity. Adoption of salt tolerant variety is more important because salt affected soils cover a huge area especially in coastal and offshore area which remains unploughed. For this reason, a pot experiment was conducted at net house, Department of Crop Botany, BAU, Mymensingh to evaluate salt tolerant sunflower varieties based on morpho-physiological characteristics of four sunflower varieties during vegetative stage. The four sunflower varieties were Big sunflower, Hysun 33, Kironi and Hysun 36 and the salinity levels were control, 4 dSm^{-1}, 8 dSm^{-1} and 12 dSm^{-1}. There were 48 (4×4×3) observations in a Completely Randomized Design (CRD) including three replications. The four varieties were grown in plastic pot of

10L size with well manured soil for 30 days and different levels of salinity treatment were started from 15 DAS to 18 DAS. Data were collected in 12th day after imposing salinity. Different morpho-physiological parameters *viz.*, shoot length, root length, number of leaves per plant, leaf area, stem diameter, root fresh and dry weight, shoot fresh and dry weight, SPAD value, F_v/F_m, photosynthesis, transpiration, stomatal conductance, leaf proline content and chlorophyll content were measured in different salinity levels. In vegetative stage at pot culture, above parameters showed significant variation with salinity levels among varieties except stem diameter and F_v/F_m. All the parameters decreased with increasing salinity levels but leaf proline content. Tolerant variety Hysun 33 showed better performance considering tolerant indicators while the poor performance was exhibited by Big sunflower. Thus, based on overall observations, it might be concluded that Hysun 33 appeared to a salt tolerant variety.

Drought Tolerance of Groundnut Cultivars Based on Physiological and Biochemical Attributes

Kabir, M.A. [1,2], Haque, M. S. [1,2], Rahman, T.[1,2], Sagar, A.[1,2], Mia, M.A.[1,2] and Hossain, AKMZ [1,2*]

[1] Department of Crop Botany, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh and [2]Plant Physiology Lab, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: zakir@bau.edu.bd*

Abstract

Charlands are highly dynamic and no systemic crop cultivation is practiced in this area due to unavailability of seeds of early & short duration drought tolerant crop varieties. For this, it is necessary to find out short duration drought tolerant crops varieties for charland areas. Groundnut (*Arachis hypogeea* L.) is an important oilseed crop in Bangladesh. So, he study was aimed to find out the effect of drought in physiological and biochemical responses in groundnut. An efficient and simple screening technique was used for selection of Groundnut varieties for drought tolerance. In this experiment, six high yielding hybrid groundnut varieties such as BARI Chinabadam-8, BARI Chinabadam-9, BARI Chinabadam-10, BinaChinabadam-4, BinaChinabadam-8 and Dhaka-1 were used for screening against drought. The experiment was conducted in hydroponic growth chamber at Plant Physiology Laboratory, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh during the period from July to September 2019, to investigate the effect of PEG on growth of groundnut based on morphological and biochemical parameters. The experiment was laid out in completely randomized design with three replications. In hydroponic experiment, seven days old groundnut seedlings were transplanted in hydroponics tray, comprised of two levels of PEG concentration i.e. 0 (control) and 10%. Different morphological and biochemical parameters viz., root length, shoot length, number of leaves/plants, fresh & dry mass production and proline content were measured. Results indicated that germination percentage, root and shoot length, leaf number, fresh & dry mass and proline content were influenced by PEG stress which indicate that some cultivars of groundnut seedlings were highly susceptible to concentrated PEG. However, among tested varieties, BARI Chinabadam-9 showed the best performance and Dhaka-1 showed the highest sensitivity to PEG stress based on the above parameters studied.

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Morphological Characterization and Screening of Blast Resistant Genes in Rice

Priya Ghosh[1], Jesmin Nahar[1], Muhammed Ali Hossain[2] and G H M Sagor[1*]
*[1]Dept. of Genetics & Plant Breeding, [2]Dept. of Plant Pathology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail : sagorgpb@gmail.com*

Abstract
Rice (*Oryza sativa*) is a major cereal contributes significantly to global food security. Biotic stresses including the rice blast (*Magnaporthe oryzae*), causes severe yield losses that significantly impair rice production worldwide. The development of resistant cultivars via the introduction of major R genes into elite varieties is the most economical and environmentally friendly way to overcome this disease. To date around 100 blast resistance genes have been identified and many of them have been cloned and characterized. Though many resistant varieties of *M. Oryzae* have been developed, the resistance is not long lasting because the high pathogen plasticity make single resistance gene break down after three to five years of cultivar release. The attempt was made to do morphological characterization and diversity analysis of forty seven local rice germplasm which showed significant variability among the genotypes for different morphological characters under study. The phenotypic coefficient of variation (PCV) was higher than the corresponding genotypic coefficient of variation (GCV) for all the traits indicating that there was an influence of the environment. Some characters such as leaf length, leaf angle, flag leaf area, flag leaf angle, grain length, number of filled grain, 1000-grain weight are very much important characters contributing yield of the rice plants. The leaf morphology also varies significantly from each genotype which suggests the blast infection pattern may also differ from each other. Moderate heritability with high genetic advance of these characters also suggests the accumulation of additive gene effects and direct selection for those characters are economically feasible. Conidial isolation also showed a wide range of variability among the morphology and growth of fungus in different region of Bangladesh. A modified protocol for genomic DNA extraction using CTAB method from rice leaf samples has also been developed and the good quality of DNA being extracted from samples.

Genetic Association and Path Coefficient Analysis Among Yield and Nutritional Traits of Tomato (*Lycopersicon esculentum* L.)

Shaila Sharmin, Afsana Hannan and G H M Sagor*
Dept. of Genetics & Plant Breeding, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: sagorgpb@gmail.com*

Abstract
The present study was conducted following randomized complete block design with three replication to evaluate the varietal performance and genetic variability of twenty five tomato genotypes for yield and nutritional important characteristics. A wide range of variation was observed among the characters studied which have a great interest for tomato breeders. Heritability for (broad sense) soluble solid in green and red tomato, total phenolic content, fruit diameter and seed/fruit was 93.23%, 98.58%, 99.92%, 99.37% and 96.15% respectively and for those traits, phenotypic influence was negligible. Leaf chlorophyll content and total phenolic content showed positive significant correlation with soluble solid (sugar) whereas p^H showed negative correlation. Yield/plant was found highly significant and positively correlated with individual fruit weight, fruit diameter, seed/fruit, and plant height whereas soluble solid, leaf chlorophyll content, total phenolic content showed negative correlation. Path analysis studies done to study the cause and effect relationship which revealed that soluble solid showed positive direct effect with leaf chlorophyll content, p^H of fruit juice and days to first flowering

and negative direct effects with individual fruit weight, fruit diameter, plant height, fruit /bunch, whereas yield/plant showed positive direct effects with all above traits except soluble solids in red tomato, which clearly indicate inverse correlation between yield and nutritional components of tomato fruit. Further, principal component analysis using eleven important traits was also performed and found four principal components which contribute 66.3% of the total variability. Individual fruit weight, days to first fruiting, pH of red fruit and fruit/branch were found to be the most important traits in PC1, PC2, PC3 and PC4, respectively. As soluble solid content, yield and its component traits have high heritability, therefore, improvement is also possible using breeding approaches.

Involvement of Polyamine Oxidase 5 *(PAO5)* genes for salt and drought stress response in *Arabidopsis thaliana*

Nur-E-Ferdousy, Afsana Hannan and GHM Sagor*
Dept. of Genetics & Plant Breeding, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: sagorgpb@gmail.com*

Abstract

Polyamine oxidases are monomeric proteins of about 55 kDa that bear a non-covalently bound molecule of FAD as a cofactor which are responsible for polyamines catabolism. The present study was planned to reveal the role of polyamine oxidases at both physiological and stressed condition. Five polyamine oxidase mutants namely *pao1, pao2, pao3, pao4, pao5* and wild type Col-0 of *Arabidopsis thaliana* were used in this study. Plants were subjected to salt and water deficient stress. Salt condition was induced using 0, 25, 50 and 100 mM NaCl containing MS media and water deficient stress was observed by percent water loss at 0, 15, 30, 45 minutes time interval by placing the plants on dry filter paper. Data on different parameter such as germination percentage, root length, shoot length, number of true and cotyledon leaf, leaf area, and chlorophyll content were taken under both physiological and stressed condition. Among the plants *pao5* mutants exhibited the highest tolerance under both salt and water deficient stress comparing wild type and other mutants. The phenomenon was also confirmed using *PAO5* promoter::GUS transgenic plants. At physiological condition, *PAO5* promoter activity was observed throughout the plant but intensity is very low, likely, the intensity started to increase gradually once exposed to stress and after 9 hours salt treatment the intensity was very high in both true and cotyledon leaf and root also. Then, to reveal the underlying mechanism of stress tolerance, ROS accumulation and antioxidant properties of *pao5* mutants were measured. *Atpao5* showed lower level of ROS content under both stressed and non-stressed condition but antioxidant activity was comparatively higher compare to wild type plants. Thus, it may suggest that lack of *AtPAO5* gene have crucial role in stress tolerance through maintaining the level of T-Spm and antioxidant mechanism in *Arabidopsis thaliana*.

Biochemical mechanism of drought stress in wheat: Investigating genotypic potentials of wheat cultivars for synthesizing endogenous osmoprotectants and ROS scavengers

Reshma Akhter, Rounok Ara and Sharif Ar Raffi*
Dept. of Genetics and Pland Plant Breeding, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E- mail : saraffi@bau.edu.bd*

Abstract

Ten wheat genotypes were screened to assess the effects of drought through considering biochemical responses to understand the drought tolerance mechanisms in wheat. The experiment was conducted in hydroponics solution at the Plant Stress Breeding Lab (PSBL), Dept. of Genetics and Plant Breeding,

BAU during the period of November 2018 to March 2019. The experiment were laid out using three level of drought treatments; 0% (control), 3% PEG and 6% PEG with three replications in RCB design. Drought stress was induced at the 47th day of transferring seedlings and kept for 42 days up to reproductive stages. From this experiment, all biochemical traits were affected due to drought stress compared to control but there was no genotype which performed consistently better than others on the basis of all traits against drought condition compared to control. Expectedly, genotypes demonstrated significant variation for all the biochemical traits. Plants developed enzymatic and non-enzymatic antioxidant systems by producing CAT, APX, POD, MDA, H_2O_2 and proline. These molecules were variable at significant rate among the different drought stress level as well as among the genotypes. They are helpful to keep balance of osmotic conc. inside the cell of plants and scavenging ROS's molecules in responses to lower water availability. Therefore, increase activity of CAT, APX, POD, MDA, proline in leaf as well as reduced level of H_2O_2 is the drought tolerance mechanisms in wheat plants. Several genotypes performed better against drought stress compared to control such as Sonalika for CAT content; BARI Gom 29 for APX content; BARI Gom 29 for POD content; BARI Gom 30 for H_2O_2 content; Sonalika for MDA content; BARI Gom 21 for proline content. No significant linear relationship has found among the biochemical traits except between CAT and POD at 3% PEG treated plants. The genotypes which performed better at drought stress compared to control for a trait, may be selected as gene source for future drought stress breeding program to develop drought tolerant wheat variety.

Development of Synthetic Hexaploid Wheat (SHW): A new avenue of improving cultivated wheat for grain quality, biotic and abiotic stress tolerances

Sorowardi Hossain, Abdul Halim, M. Javidul Haque Bhuiyan and Sharif Ar Raffi*

*Dept. of Genetics and Pland Plant Breeding, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh and Dept. of Biochmistry and Molecular Biology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh, *E- mail : saraffi@bau.edu.bd*

Abstract

Wheat is the second most important cereal crop of Bangladesh after rice, and grown in Rabi season. It is an introduced crop, therefore, its genetic variability in terms of germplasm diversity is absent in Bangladesh. Consequently, wheat often suffers with epidemic stress infestation and yield reduction, due to lack of variability and narrow genetic base, which in turn become the bottleneck for wheat improvement for different traits. Interestingly, ancestors (*Triticum turgidum* and *Aegilops tauschii*) wheat have composed with variability for different agronomic and stress tolerance traits, which can be transferred to wheat, if crosses made to develop synthetic Hexaploid wheat. It is therefore, a noble way to bring genetic variability in wheat for different traits. The project is aimed to develop synthetic Hexaploid wheat from distant parents through wide hybridization, therefore, a specialized lab with controlled growth room facilities comprising temperature, humidity and light regulations techniques, a lab space with basic lab storage and preservation facilities provided with recommend physical environment, chemicals to conduct hybridization, and for detection of distant hybrids have been established in previous year. After receiving seeds of the ancestor species (*Triticum turgidum* and *Aegilops tauschii*) from CIMMYT, Mexico, plants were grown in lab since November, 2018. After altering light wave length frequency by providing red light, plants started flowering from April, 2019 and were subjected for hybridization. Among the parents, *Triticum turgidum* was used as female parent, and *Aegilops tauschii* as pollen parent. A total of four batches, comprising 10 plants per batch of each parents were grown to facilitate pollen availability for hybridization. Emasculation of panicle of female parent was done when the 1/3 of the panicle emerged from the flag leaf. Pollination were

done in the next day by the pollen collected from the panicle of pollen parent. Standard procedure was followed for emasculation and hybridization. The emasculation and hybridization were conducted during the month of April, and May, 2019. Cross pollinated panicles were covered with transparent bag to avoid unwanted pollination and attack of aphid. Then seeds were harvested in May to June, 2019, oven dried at 30^0C and kept in refrigerator for future use. The progress of the research project has been in the right track and will meet up the milestones for successful completion of the research project within allotted time frame.

Germplasm enhancement and genetic purity for biotic stress resistance and short duration in rapeseed and mustard

Md. Abir Ul Islam, Naima Sultana, Romana Sharmin Ripa, Jaber Bin Azim, Setu Rani Saha and Arif Hasan Khan Robin*

Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: gpb21bau@bau.edu.bd*

Abstract

Rapeseed and mustard are two important oilseed species in Bangladesh those belong to the family Brassicaceae. Bangladesh has been facing acute shortage of edible oil. Our internal production can meet only about 21% of our consumption. Problems associated with such low yield are lack of quality genotypes with horizontal disease resistance and high yielding short duration varieties. Objective of this study was to strengthen oilseed *Brassica* germplasm with biotic resistance and genetic purity to select for short duration genotypes. A total of 25 new genotypes have been included in the existing germplasm collections of the Department of Genetics and Plant Breeding. Altogether 240 genotypes were grown and screened. Genotypes were planted with proper isolation distance, bagged and tagged to maintain genetic purity. In the first year, we have selected 48 short duration genotypes out of 240 genotypes. These genotypes were selected based on days to 50% flowering and days to maturity. Significant genotypic variations were observed among 48 short duration genotypes among 19 morphological traits studied except 1000 seed weight. The morphological diversity in short duration genotypes indicated that selection for short duration with high yield could be possible. Diallel mating would be conducted to develop new variants with short duration. The 48 selected short duration genotypes were screened for *Alternaria* blight. Among them five genotypes were resistant, 22 were susceptible, and 21 were highly susceptible. In addition, ten interspecific crosses were conducted between *Brassica rapa* × *B. napus* and *B. rapa* × *B. juncea* with reciprocal crosses and the developing embryos were rescued. Developing embryos at the cotyledonary stage resulted in 4.0 % higher regeneration compared to the torpedo stage. Regeneration from developing embryos was 1.8 % higher in half-MS media compared to MS media. Molecular screening for *Alternaria* blight and short duration is in progress.

Detection of an indispensable novel gene *I* against *Bean common mosaic virus* in country bean genotypes for safe vegetable production

Md. Ashraful Haque*, Islama Rahman, Jannatul Nayem Shugandha, Rokeya Khatun, Bilkis Akhter, Bishakha Saha, Rifat Sultana and Nabila Hoque

Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail : ashraf_gpb2000@bau.edu.bd*

Abstract

The field experiment was conducted at the Experimental Farm of the Department of Genetics and Plant Breeding, BAU, Mymensingh, with 20 country bean genotypes in RCBD design and three replication

to assess variability, heritability, genetic advance, correlation coefficient and path coefficient for 15 yield and yield contributing traits. Genetic analysis of yield contributing traits indicated highly significant differences among the genotypes. DS113 is the best genotype considering number of seed per pod, whereas KBS-5 is the best as number of raceme per plant. Phenotypic variation was greater than that of genotypic variations for all the traits. The greater portion of total phenotypic variation was due to the genotypic variation. Heritability values were higher for days to 50% flowering (98.23), days to maturity (98.73), 100 dry seed weight (98.64) and so on. Majority of the traits exhibited wide range between the minimum and maximum values of genetic advance. A few pairs of traits showed significant correlation among them *viz.* days to maturity(0.956),days to 50% flowering(0.198), number of raceme per plant(0.584) to yield. Path analysis revealed both direct positive and negative effects of the yield contributing traits on seed yield. Path analysis values were higher for number of flower buds per raceme (0.1373), green pod length (1.2347), number of raceme per plant (0.7365). Second experiment was Conducted at Biotechnology Laboratory of Department of Genetics and Plant Breeding, BAU, Mymensingh.Two sets of SCAR primers named "ROC11" and "SG6" were used in order to detect the presence of *I* and/or *bc-3* gene which confers partial resistance to *Bean common mosaic virus* synergistically. Neither *I* nor *bc* gene can govern resistance independently against BCMV. ROC11 primer detected only four genotypes viz. DSN-25, DSN-26, SMALL RED and DSN-27 found to carry *I* and/or *bc-3* gene among the twenty genotypes indicated the presence of dominant allele of *bc-3* gene. The genotypes DSN-25, DSN-26, SMALL RED and DSN-27are resistant genotypes linked to *I* and/or *bc-3* gene and were promising for yield and related traits. Extensive trials at several locations are required for releasing *BCMV* resistant country bean variety.

Quality Breeding approaches for Tomato yellow leaf curl disease resistance

Md. Ashraful Haque*, Aleya Ferdausi, Susmoy Bhowmik, Shahed Md. Saiful Islam, Bishakha Saha, Rifat Sultana, Jannatul Nayem Shugandha, Nabila Hoque and Islama Rahman

Dept of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail : ashraf_gpb2000@bau.edu.bd*

Abstract

Experiments were conducted in the field with selected twenty five tomato (*Solanum lycopersicum*L.) genotypes to study the field performance and genetic variability for yield and yield contributing characters in the field laboratory of Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh. Molecular experiments were conducted for resistance against *Tomato yellow leaf curl virus* (TYLCV) using three sets of SSR marker in the Molecular lab of the Genetics and Plant Breeding department, BAU, Mymensingh. The design was laid out following Randomized Complete Block Design (RCBD) with three replications. The duration of the experiment was started from October 2018 to April 2019 (field experiment) and up to September 2019 (molecular experiment). The parameters studied in this experiment was plant height, days to branching, days to first flowering, days to fruit appearance, days to fruit maturity, number of fruit clusters per plant, total no. of fruit per plant, individual fruit weight, fruit diameter and yield per plant. The results of the field experiment showed that the genotype BINA-10 and 456 line possessed highest plant height (109.73 cm) and the minimum days (13.00) required for branching respectively. The highest number of days to flowering (34.67), highest no. of fruit cluster per plant (11.67), the highest number of fruits (86.33) and highest individual fruit weight (58.27g) were recorded in BINA-4. BAHAR has highest fruit diameter (20.00 cm). Late maturity found in genotype C-71 (81.67 days) and the highest yield obtained from genotype 458(3090.00g). Genetic analysis of yield contributing traits showed higher phenotypic coefficient of variations (PCV) than genotypic coefficient of variations (GCV) indicated the presence

of less environmental influence on varietal performance. Highest estimates of GCV & PCV were observed for fruit yield per plant (53.86 and 53.32 respectively) followed by number of fruits per plant (45.55 and 44.66 respectively) and individual fruit weight (32.31 and 31.13 respectively). Fruit yield per plant showed negative and insignificant correlation with plant height. In path co-efficient analysis positive direct effects were found in days to branching followed by days to flowering, days to fruit appearance, number of fruits per plant, individual weight and fruit diameter. Genotypes were classified into five clusters by Ward's method where highest yield were found in cluster IV considering the mean value. In principal component analysis, the main four principal components accounted for 85.75% of total variability. In molecular assay, three sets of SSR markers were used but only one set detected the presence for *TYLCV* resistance gene. The result of molecular screening detected only one genotype (V1006136) having expected fragment when compared with 100bp DNA ladder. The biochemical assessment revealed that the genotype V1006136 having high amount of Ascorbic acid (39.50 mg/100g) and 0.6 ug/mg proline (FW).The findings may be helpful for future tomato breeding programme against TYLCV.

Genetic dissection of soybean genotypes for resistance against *Soybean yellow mosaic virus*

Md. Ashraful Haque*, Nabila Hoque, Islama Rahman, Afsana Yeasmin Sweety, Fatematuz Zohura, Bishakha Saha, Rifat Sultana, Jannatul Nayem Shugandha, Md. Shafikul Islam

Dept of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail : ashraf_gpb2000@bau.edu.b)*

Abstract

A series of experiments were conducted with 26 selected soybean genotypes for their screening against Yellow mosaic virus disease based on field performance, viral assays and SSR marker linked to *Rsv1-h* gene. Soybean genotype collection and its subsequent experimentations were performed in the GPB-farm laboratory and in Molecular laboratory of Bangladesh Agricultural University, Mymensingh during the period October 2017 to July 2019. Morphological data were recorded at field maturity to study field performance and genetic analyses of the selected materials. The genotype DAVIS had shown the tallest (76.73 cm) plant height, maximum number of branches (5.76) and highest number of pods plant^{-1} (47.63). The genotype BRAGG was recorded having the least number of days to 50% flowering (51 days) and minimum days required to maturity (98.55 days). The maximum pod length (3.93 cm) was observed in DES-10 and maximum number of seeds pod^{-1} (2.90) was produced from the genotype G-2261.The genotype MINA HAI showed the highest seed weight (14.19 g) and highest seed yield (1211.10 kg ha^{-1}). In this study, among all the traits 100 seed weight (g) exhibited highest estimates of phenotypic co-efficient of variation (PCV) and genotypic co-efficient of variation (GCV) (32.40% and 31.86% respectively). Highest heritability was recorded for 100 seed weight (96.70) and the highest value of genetic advance was found in yield (447.76).The highest value in genetic advance as per cent of mean was found for the traits 100 seed weight (64.53%). Pod length and 100 seed weight had highly significant positive correlation with yield plant^{-1}**.** Based on Nei's (1972) genetic distance using Unweighted Pair Group Method of Arithmetic Means (UPGMA), Cluster II was from different origins and showed highest genetic distance (30.00), also isolated in the grouping. On the other hand, Cluster III was from same origin and showed the lowest genetic distance (2.00) contained same morphological characters such as days to flowering, plant height, pod length, number of seeds pod^{-1}. Net house assay upon sap inoculation facilitated determining the trend of AUDPC (Area Under Disease Progress Curve) under controlled condition. TBIA (Tissue Blot Immunoassay) was carried out using rabbit antiserum for SYMV that did not conflict with non target virus. No mismatch of TBIA was noticed with AUDPC or molecular assay. Younger leaves were collected from these infected plants and

were used as source materials for virus specific molecular analyses. Three sets of SSR marker were used to detect the presence of gene(s) responsible for *Soybean yellow mosaic virus* resistance. BARCSOYSSR_13_1115, BARCSOYSSR_13_1119 & BARCSOYSSR_13_1173 primer sets were used for the confirmation of the desired genes in all 26 genotypes. The result indicated that the genotypes Mina-hai, G-2261, PB-1 and GC-83005-9 showed the presence of *Rsv1-h* gene which is reported to be indispensible for resistance against *Symv*. The four soybean genotypes having *Rsv1-h* gene might be mosaic virus tolerant and could be used as source material for future advanced breeding purpose.

Improved Crop Management and strengthened Seed Supply System for Drought prone rainfed lowlands in South Asia

Md. Ashraful Haque* & Lutful Hassan
Dept of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: ashraf_gpb2000@bau.edu.bd*

Abstract
Five rice varieties namely BRRI dhan51, BRRI dhan52, BARRI dhan71, Binadhan-10 & Binadhan-11 seeds were taken as seed multiplication materials. The seed multiplication production program was conducted at the Genetics and Plant Breeding Experimental farm, Bangladesh Agricultural University, Mymensingh during the period from July to December 2018. In this rice seed multiplication project different crop management measures such as weeding, insecticide and fungicide application have been taken. One ton Rice seed for each variety was harvested separately with appropriate care and moisture content. After processing the seeds were stored in BADC storage for distribution to the farmer's in the next season.

Impact of salinity-induced ROS accumulation on pollen and spikelet fertility and yield of rice and beneficial roles of exogenous ascorbic acid in modulating salt stress tolerance

Md. Musfiqur Rahman, Sharif Ar Raffi and Mohammad Anwar Hossain*
Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: anwargpb@bau.edu.bd*

Abstract
Salt tolerance is a complex polygenic trait largely depends upon plant developmental stages. Rice is a relatively salt-sensitive crop however seedling and reproductive stages being the most sensitive stages. Two separate experiments were conducted using seven diverse rice genotypes in the glass and shade house of Bangladesh Institute of Nuclear Agriculture, Mymensingh to investigate the phenotypic variability for salt tolerance at seedling and reproductive stages and explore the modulation of salt stress tolerance by exogenous ascorbic acid (AsA). These experiments were conducted following completely randomized design with three replications and four treatments (*viz*., control, 2mM AsA, salinity (EC= 10.0 dS/m) and salinity + 2mM AsA). In experiment I, seedlings were grown in hydroponic condition and 14-day-old seedlings were subjected to salt stress (EC= 10.0 dS/m) for 96 h with or without AsA pre-treatments. In experiment II, seedlings were grown in perforated pot and at the end of stage 4 (young panicle about to emerge) extra leaves of the plants were cut off except flag and first penultimate leaf. The pruned plants were subjected to salt stress with or without AsA application. Significant variation was observed due to genotypes (G), treatments (T) and G × T interaction for most of the studied traits. Salinity at seedling stage resulted in a significant decrease in

root and shoot traits whereas the levels of H_2O_2 and lipid peroxidation (MDA) increased significantly. Salinity at the reproductive stage resulted in a significant decrease in yield and yield related traits whereas the level of H_2O_2 increased significantly. AsA application (either at seedlings or reproductive stage) was found to reverse the negative impact of salt stress by modulating root, shoot growth characteristics and yield related traits and by decreasing H_2O_2 and MDA levels. Breeding efforts should aim to improve salt tolerance by manipulating endogenous AsA content.

Development of drought stress tolerant rice to ensure food security of Bangladesh

Noushin Chowdhury, Aleya Ferdausi and Mohammad Anwar Hossain*
Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: anwargpb@bau.edu.bd*

Abstract
Rice (*Oryza sativa* L.) is highly sensitive to drought stress and lack of reliable screening technique and robust morphological and biochemical determinants restrict to develop drought tolerant variety. An experiment was conducted with two drought tolerant (Binadhan-19, BRRI dhan83) and two drought susceptible (BRRI dhan26, BRRI dhan48) rice varieties under the rainout shelter of Bangladesh Institute of Nuclear Agriculture, Mymensingh, during the period of March to June 2019 to identify morphological and biochemical determinants linked to reproductive-phase drought tolerance. The experiment was conducted following a randomized complete block design with three replications where moderate drought stress was applied (by maintaining 10-12% soil moisture) at the reproductive stage. Data on days to maturity, plant height, effective tillers hill^{-1}, panicle length, no. of filled grains panicle^{-1}, no. of unfilled grains panicle^{-1}, spikelet fertility, spikelet sterility, 100-seed weight, lipid peroxidation (MDA), total chlorophyll and yield panicle^{-1} were recorded. Significant variation (p<0.01) was observed due to genotype, treatment and genotype × treatment interactions for all of the studied traits. Drought stress caused a significant decrease for most of the studied traits whereas the no. of unfilled grains panicle^{-1}, spikelet sterility and MDA level increased significantly. The highest decrease in yield panicle^{-1} was observed in susceptible varieties (81.37 and 76.30% in BRRI dhan26 and BRRI dhan48, respectively) whereas the lowest decrease was observed in tolerant varieties (49.46 and 53.73% in Binadhan-19 and BRRI dhan83, respectively). Stress tolerance indices were also clearly separated the tolerant and susceptible varieties. Based on the results of the study it can be concluded that morphological and biochemical determinants along with the stress tolerances indices can be considered all together to identify drought stress tolerant genotype. However, further studies are required to identify the causal genes and genomic regions conferring drought stress tolerance in rice.

Collection, screening and characterization of rice varieties in relation to salt tolerance using morphological and molecular analyses

Md. Abdus Sogir, Md. Rasel and Aleya Ferdausi[1]*
Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: aferdausi.gpb@bau.edu.bd*

Abstract
Salinity stress is a major problem for crop production in the coastal regions of Bangladesh. Scientists also predicted most of the coastal regions in Bangladesh will be submerged by sea water within 2050. The most possible solution of this problem is to increase the productivity of rice by developing new genotypes that can tolerate salinity stress with high yielding capacity. In our continuing research, about

sixty local rice genotypes were collected from different coastal regions of Bangladesh. Germinated seedlings of all genotypes were placed in fresh water hydroponic media for days. Then nutrient solution Peters Professional (1g/L water) was used in hydroponic media by adjusting the pH 5.5-6.0 for next seven days. The seedlings were grown under different salt treatments i.e. 08, 10, 13 and 15 dS m^{-1} including control. On the basis of morpho-physiological clustering, tolerance ability and SES (IRRI) scoring, after seven days of salt treatment, six highly tolerant and fifteen tolerant genotypes were observed at 8 dS m^{-1}; fourteen tolerant at 10 dS m^{-1} and four tolerant at 13 dS m^{-1}. Moreover, after fourteen days of salt treatment, twenty salt tolerant genotypes were recorded at 08 dS m^{-1}; eleven tolerant at 10 dS m^{-1} and two tolerant at 13 dS m^{-1}. Among them Rajashail, Pokkali, Holdegota 2, Khoiya were identified as promising salt tolerant genotypes at 13 dS m^{-1}. Rajashail and Khoiya were also showed moderately tolerant ability at 15 dS m^{-1}. This finding is intriguing as any rice variety tolerant to 15 dS m^{-1} has might not been reported or released to date. Therefore, the screened genotypes from seedling stage will be used for field screening at reproductive stage based on morpho-physiological, molecular and biochemical analyses for confirmation of their salt tolerant ability and these local resources could be outstanding materials for future breeding of rice.

Collection and characterization of potential germplasm of rapeseed mustard and participatory salt tolerant short duration variety development for increasing cropping intensity in southern Bangladesh

Lutful Hassan*, Dr. Ferdousi Begum and Abdul Hannan Khan

Depertment of Genetics & Plant Breeding, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh

**E-mail : lhassan.gpb@bau.edu.bd*

Abstract

An attempt was undertaken to develop salt tolerant and short duration rapeseed mustard varieties for cultivation in southern coastal areas of the country with a view to increase cropping intensity and elevate income of the farmers by utilizing the salt affected lands in the southern coastal belt. With this end in view out of twenty seven upazilas the present study selected 13 upazilas ie, three upazillas of Khulna (Koyra, Paikgacha and Terokhada), three upazilas of Patuakhali (Bauphal, Dashmina and Galachipa), and those of two upazilas of Borguna (Amtali and Bamna) (Total-8) were considered under the direct supervision of Bangladesh Agricultural University, Mymensingh (BAU) and other three upzilas of Bagerhat (Kachua, Mollahat and Mongla), two upazilas of Shatkhira district (Assasuni and Devhata) (Total-5) are under the supervision of Bangladesh Agricultural Research Institute (BARI). Howerer, during the first (2017-2018) year activities present study conducted base line survey with collaborating partners in selected twenty seven upazilas. A total of 1620 (60 in each upazila x 27 upazila=1620 farmers) beneficiary farmers were selected and out of selected farmers training were provided only for 720 farmers (a total of 24 training camp were arranged and executed) in 13 upazilas (three upazilas of Khulna, three upzilas of Bagerhat, two upazilas of Borguna, three upazilas of Patuakhali and two upazilas of Shatkhira districts). The present study collected 25 potential germplasms from coastal zone and screeing them in the BAU research farm. On the basis of analysis we isolated and selected 5 advanced promising lines along with two recommended variety namely BD-6950, BD-7104, BD-10115, Jun-536, BJDH-12 (Table-12). Multiplying the seeds of isolated and selected advanced promising lines during the period from November 2018 to February 2019. Data collections on seed production are in progress. Characterization and field performance evaluation of the potential lines were also being conducted. Data collection on characteristics, yield and yield contributing characters are in progress. Selection of best performing lines using Brassica breeding materials were done. Results are in progress. Field visit and PRA for pre-evaluation were conducted in

three upazilas (Mogla, Mollahat and Kachua) during 10 to 12 December 2018. The PRA results clearly indicated that there is a potential scope to bring more fallow crop land under salt tolerant mustard cultivation. Moreover most of the farmers (90%) reported that they desire salt tolerant short duration rapeseed mustard seed for cultivation and if sufficient salt tolerant short duration high yielding rape seed mustard seed became are available in time, which may help to improve their livelihood. During second year (2018-2019) activities training will be conducted in remaining 14 upazilas. A total of 840 (60 farmers each of 14 upazilas 60x14=840) farmers will receive training (24 training camp will be arranged and executed) to achieve knowledge and about the aim and objective of the project, improved cultivation technology of salt tolerance, short duration and high yielding advanced promising lines of rapeseed and mustard. A total of 140 demo farmers will be selected from among the targeted beneficiary farmers for conducting demonstration trial in using the identified 5 advanced promising lines and one checked variety BARI Sarisha-14. Each of the demo farmers will be provided with a total amount of 1.8 kg seeds of the advanced promising lines and recommended variety BARI Sarisha-14. They will also be provided with fertilizers. Field days will be organized in the demonstration field for dissemination of the seeds and cultivation technology of the identified 5 advanced promising lines of rapeseed and mustard. For understanding the field performance of the isolated/selected promising lines an experiment will be conducted at GPB experimental farm of BAU October 2019 to February 2020. Molecular marker aided breeding for salinity and short duration will be conducted in BAU and BARIs lab. For choosing the best performing line a pot culture experiment will be conducted at GPB field laboratories creating artificial salinity in the pots. Seed production of the promising lines/varieties will be done for using the produced seeds in the next year project activities.

Screening of local rice varieties for salinity tolerance through hydroponic culture

Lutful Hassan* and Md. Ariful Islam

Depertment of Genetics & Plant Breeding, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
**E-mail : lhassan.gpb@bau.edu.bd*

Abstract

Rice (*Oryza saliva* L.) is one of the most important cereals in the world, plays a vital role in ensuring world food security as it is the staple food of the 50% of the total world population. It is the agricultural commodity with the third-highest worldwide production, after sugarcane and maize, according to FAOSTAT (2015). FAO (2014) reported that about 95 countries in the world are producing rice. Among them, China and India are in the top most positions (first and second respectively) in terms of production and Bangladesh holds the fourth position. According to USDA (2015), in Bangladesh, about 34500 thousand MT rice was produced by cultivating in about 11790 thousand Ha of land in the fiscal year of 2014-15. After the Green Revolution of the 1970s, an increase production of rice was recorded but afterwards the increasing rate of the production of rice became slow and steady, especially in the rice cultivating countries (Maclean *et al.,* 2002). Environmental obstacles are also increasing day by day which is complicating the agricultural production in a huge margin as agriculture is highly dependent to environment. Due to different abiotic stresses e.g. drought, flood, salinity; agricultural production is hampered quite frequently. Among these abiotic stresses soil salinity become quite important because the amount of saline area around the globe is increasing gradually due to higher use of ground water for irrigation, rising of the seas level as a result of global warming. Nowadays, soil salinity is a talked-topic in the world because almost all of the agricultural crops cannot grow well under higher soil salinity. Rice is continuously growing the saline or coastal areas but it is considered as moderately sensitive to salinity (Mori and Kinoshita, 1987). Soil salinity is considered as the one of the most important abiotic factors which influences the production of rice. At present, salinity is the second most widespread soil problem in the rice growing areas of the world after

drought (Gregorio *et al.,* 1997). Different cultivars of rice showed different degrees of salinity tolerance at their different growth stages (Sabouri and Biabani, 2009). As it was found that 1-2 leaf stage is very sensitive to salinity and tolerance level increases with the growth of rice plant but the reproductive stage in more sensitive to salinity (Pearson *et al.,* 1996; IRRI, 2010). Seedling stage is sensitive to salinity and susceptible to NaCl salinity at concentration up to 50 mol m^{-3} (Akber and Yabuno, 1974). Salinity at reproductive stage causes delayed flowering, reduction in the number of effective tillers, the number of grains per panicle, the grain weight and grain yield (Khatun *et al.,* 1995). Different important phenotypic behavior which regulate the production, are reported to be affected due to salinity. All yield contributing characters like fertility, tiller numbers, panicle number and panicle length were significantly reduced under salinity. Among these contributing characters sterility was found to be major cause of yield losses under saline condition (Gregorio *et al.,* 2002). More than 900 million ha of worldwide land are severely affected by salt and approximately 20% of irrigated areas (about 45 million ha) were likely to suffer from various degrees of salinization problems. In Asia, 21.5 million hectares of land areas are covered by salinity and projected to cause up to 50% loss of fertile land by the mid of 21st century (FAO, 2010) and Bangladesh is not an exception. In Bangladesh, coastal areas constitute about 2.5 million hectares which amount to about 11% of the total cropland of the country. The coastal saline soils are covering portions of 8 AEZ and scattered in 64 upazillas of 13 Districts of the country (Seraj and Salam, 2000). Therefore, developing salt tolerant rice varieties have been considered as the most effective strategies to increase rice production in saline areas of Bangladesh. As responses of rice to soil salinity varies with the growth sage and the types of the varieties such as, seedling (2-3 leaf stage) and reproductive stage is found to be highly susceptible to salinity. Gregorio *et al.* (1997) reported that screening of rice genotypes at seedling stage is highly acceptable as it is done on the basis of a simple selection criterion. Controlled condition provides the benefit of reducing environmental effects and hydroponic culture reduces the chance of other soil related difficulties during screening program. Recently a huge amount of progress has been obtained in molecular marker analysis and it provides some opportunities to analyze both simple inherited traits as well as the quantitative traits, and to identify the individual genes controlling the target trait. Molecular or DNA marketers can be used to identify or tag QTLs and evaluate their influences to the phenotype by selecting for favorable alleles at these loci through Marker Assisted Selection (MAS). Proper identification of molecular markers facilitates the selection of rice varieties for salinity tolerance having low heritability expressivity.

Food and nutritional security: Production and dissemination of stress tolerant and nutritional rice varieties to the farm families

Lutful Hassan

Depertment of Genetics & Plant Breeding, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
**E-mail : lhassan.gpb@bau.edu.bd*

Abstract

Bangladesh is a developing country. So, it is faced with the greatchallenge of food and nutritional insecurity. In spite of achieving self-sufficiency in foodproduction, a huge number of people experience the food insecure situation inthis country. Since long time ago, scientists are striving to feed the growingpopulation of Bangladesh. Hence, rice is our staple food but the traditional rice varieties have more or less drawbacks in stress tolerance and nutritional insufficiency.So, an attempt is undertaken to produce and disseminate of stress tolerant and nutritional rice varieties to the farm families. The proposed project work will be located at two upazillas of Mymensingh district. The main research objective is to multiply of short duration the stress tolerant along with nutritionally rich HYV of T. aman and Boro rice seed by the farmer's and distributing of those quality seed free to selected farmer's of the upazillas of Mymensingh district. In the first year, collection of stress tolerant high

yielding rice seed materials and selection of farmer's from the selected upazillas, training of farmers, distribution of seeds and data recording on management practices, insect pest and disease reactions, yield and yield contributing characters in all the selected locations, data analysis, report preparation, submission and presentation will be done. In second year, similar works will be done like previous year. On the completion of the project, the introduction of nutritional rice the food and nutritional security will be addressed. Finally, the newly developed technology will be sustainable can contribute significantly in precision agriculture and agricultural production system. Food and nutritional security are measure of the availability of food and individuals' ability to access it. Household food security exists when all members, at all times, have access to enough food for an active, healthy life

Collection and characterization of potential germplasm of rapeseed mustard and participatory salt tolerant short duration variety development for increasing cropping intensity in southern Bangladesh

Lutful Hassan
Depertment of Genetics & Plant Breeding, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail : lhassan.gpb@bau.edu.bd)

Abstract
Salinity is an alarming problem which causes serious losses in crop production especially in oilseed crop. In order to develop salt tolerant and short-lived rapeseed mustard varieties for southern coastal areas of the country, an effort was made to increase cropping intensity and increase the income of farmers through the use of salt-affected land in the southern coastal belt. A total of twenty seven upazilas were selected for the study among 13 upazilas were considered under the direct supervision of Bangladesh Agricultural University, Mymensingh (BAU). During the first (2017-2018) year activities, five advanced promising lines along with two recommended variety namely BD-6950, BD-7104, BD-10115, Jun-536, BJDH-12 (Table-12) among 25 promising genotypes were selected. Data collections on seed production are in progress. During second year (2018-2019) activities, a total of 840 farmers from rest 14 upazilas will receive training to achieve knowledge and about the aim and objective of the project, improved cultivation technology of salt tolerance, short duration and high yielding advanced promising lines of rapeseed and mustard.

Screening of local rice varieties for salinity tolerance through hydroponic culture

Lutful Hassan
Depertment of Genetics & Plant Breeding, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail : lhassan.gpb@bau.edu.bd)

Abstract
Rice contributes most in food system but it is affected by various stresses cause significant losses in production. Salinity considered serous abiotic stress which adversely affect the rice production. An experiment was conducted in hydroponic culture to obtain salt tolerant local rice varieties. A total of 30 rice genotypes including 24 local varieties and 6 HYVs and three level of salinity treatments (control, EC-6 dSm^{-1} and EC-10 dSm^{-1}) following RCBD with three replication were used in the experiment. Data on different morphological traits were collected and analyzed by MSTAT-C software program.

Pokkali, Nonabokri, Hogla, Otabamonkhir, Changai and Gunshi were found comparatively tolerant to salinity than HYVs. These landraces can be used as parents to enhance the HYVs salt tolerances. I addition, the adopted rapid screening method can be of great help in screening large number of salt tolerant lines in the shortest possible time.

Capacity Development of Rural Women for Household Food and Nutrition Security: A Field Level Investigation in Kishoreganj Haor Areas

Shonia Sheheli*, M Zulfikar Rahman and Nazmus Sakkib,
*Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh, *E-mail : ssheheli@yahoo.com*

Abstract
The research was conducted to (i) find out the existing status of haor women in managing household food and nutrition security; (ii) determine the need for capacity development of haor women towards household food and nutrition security and (iii) explore the relationships between some selected characteristics of the women with their need for capacity development. A total of 100 haor women were interviewed by using a structured interview schedule from Char Tarail and Rauty union under Tarail upazila of Kishoregonj district at their houses and/or farm sites during February to July 2019 and it was drown from a population 453 using simple random sampling technique. Additionally, Focus Group Discussion (FGD) was conducted to identify different aspects of need related to their food and nutrition security. Moreover, a case study was conducted to achieve in-depth ideas about women's need for capacity development towards household food and nutrition security. Possible solutions on different aspects were also explored through FGD. Pearson's Product Moment Correlation Coefficient (r) was computed to explore relationships between the selected characteristics of haor women and their extent of need for capacity development towards household food and nutrition security. In this research, extent of need for capacity development of haor women towards household food and nutrition security was focus variable. Eleven (11) selected characteristics of haor women viz.: age, level of education, family size, household farm size, annual income, credit received, training exposure, organizational participation, extension media consultation, ability to compete with uncertainty and role of haor women in managing food and nutrition security were considered as the explanatory variables. From the present investigation it is evident that 76% of the women had lower status in managing household food and nutrition security. All of the respondents had high need for capacity development towards household food and nutrition security The women had the highest extent of need (91 percent) for capacity development in physical facilities then decision making ability (88 percent) and the lowest extent of need for skill development (76 percent). Among the selected characteristics of household farm size, annual household income, training exposure, organizational participation showed positive and significant relationships with their extent of need for capacity development of haor women.

Identification of Training Need and Capacity Building of Farmers on Organic Vegetable Cultivation: an empirical study

Mohammad Golam Farouque* and Most. Shamsia Kowsari
*Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail : farouque25@bau.edu.bd*

Abstract
Due to an increase in the cost of production compared to the stagnation of rice yield, rice farming is currently a non-profitable enterprise for farmers. Organic farming is considered as a production system

that maintains soil health, ecosystems, and human health which aims at social, environmental and economic sustainability and animal welfare by minimizing the use of external resources, maximizing the use of locally-derived renewable resources. The major objectives of the project are: identify the training need of farmers regarding organic vegetable cultivation; ii. build capacity of farmers on organic vegetable cultivation; iii. explore the personal and socio-demographic factors that may influence upon capacity building of farmers; identify the constraints faced by the farmers in relation to organic vegetable cultivation. A total of 200 vegetable growers from four villages under Islampur upazila (Jamalpur) and Karimgonj upazila (Kishoregonj) are considered as the population of the study with whom the project activities are conducted. Data were collected using semi-structured interview schedule through face-to-face interview and focus group discussions to get information about farmers' training needs of vegetable cultivation using organic technique. The majority (78%) of the vegetable growers confessed the excessive use of agrochemicals especially pesticides for vegetables cultivation. In addition, an overwhelming majority (92%) of them were reported with very high need of training concerning 'judicious use of pesticides' for vegetables cultivation. The aspects such as 'appropriate ways of land preparation' and 'right quantity of fertilizer applications' were reported by a significant proportion (81%) of growers. For building capacity, 4 training programs so far been conducted involving 120 vegetable growers in study areas. The factors such as 'level of education', 'extension contact' and 'use of ICTs' had very strong influence upon capacity building of vegetable growers.

Capacity Building of Farmers on Low-external-inputs Vegetable Cultivation for Enhancing Food Safety and Security

Mohammad Golam Farouque[*] and Md. Nasir Uddin

*Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. *E-mail : farouque25@bau.edu.bd*

Abstract

Low-external-input farming reduces the use of external inputs like pesticides, herbicides, and synthetic fertilizers and replaces them with internal inputs. The study aimed to: i) investigate the present status of using different inputs especially fertilizers and insecticides to cultivate vegetables such as - potato, tomato, brinjal, cabbage, cauliflower, cucurbits and beans; ii) build capacity of farmers on cultivating above-mentioned vegetables using low-external-inputs techniques; iii) explore the constraints faced by the farmers regarding low-external-inputs vegetable cultivation. The study has been implementing in different areas of Daudkandi upazila under Cumilla district and Sherpur upazila under Bogura district where vegetables are cultivated intensively using agrochemicals injudiciously. Data were collected from a sample of 250 vegetable farmers using semi-structured interview schedule through face-to-face interview. In addition, four (4) Focus Group Discussions (FGDs) were conducted (2 from each district) using checklist for getting a deep understanding of how much and what extent the vegetable farmers use agrochemicals (pesticides, herbicides, and synthetic fertilizers) to cultivate different vegetables. The findings showed that more than three-fourth (77 percent) of the studied farmers use higher amount of agro-chemicals and their frequency of application was also found higher than the recommended ones. For building vegetable farmers' capacity on low- external-input farming, two (2) awareness building campaign, 20 training programs (involving 500 vegetable farmers) were conducted and a total of 30 demonstration plots having vegetables such as- potato, tomato, brinjal, cabbage, cauliflower, cucurbits and beans were undertaken at farmers' field. Among the constraints faced by the vegetable farmers regarding low-external-input farming, the important ones were- lack of information and knowledge on low-external-input vegetable cultivation, excessive dependency on local agro-chemical dealers, and lack of regular monitoring by the Sub-Assistant Agriculture Officers (SAAOs) to their respective blocks.

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Effect of Training on the Skill Development of Potato Farmers in a Selected Area of Shibganj Upazila Under Bogra District

Mohammad Jiaul Hoque
Dept. of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
E-mail: jiaul_agext@bau.edu.bd

Abstract
The study was carried out to determine and describe the effect of training on the skill development of Potato Farmers in a Selected Area of Shibganj Upazila Under Bogra District and to explore the relationships between the selected characteristics of the potato farmers and their training effects. The village, namely Tatulgara under Buriganj union of Shibganj upazila under Bogra district was the locale of the study. Eighty potato farmers (out of the total of 535) were randomly selected as a sample of the study. Data were collected from the sample potato farmers by using a pre-tested interview schedule through personal interview method during 1 August to 2 September, 2016. Training need of the potato farmers was the focus variable and selected eleven characteristics of the potato farmers constituted the explanatory variables of the study. Pearson's product moment correlation coefficient (r) was computed to explore the relationship. Among the potato farmers, perceived effect of trainings by potato farmer were High (51.25%), Medium (46.25%) and Low (2.5%).Potato farmers need high training on six aspects, these are: ways of potato disease control, preventive measure of disease control, proper identification the disease of potato plant, proper dose of the pesticide application in the potato field, proper dose of the insecticide application in the potato field, method of potato pest control. Correlation analysis indicated that two characteristics of the potato farmers, namely household size and experience of potato cultivation had significant positive relationships with their training need. Level of education, communication exposure, social mobility and knowledge on potato cultivation had significant negative relationships with their training need. The concerned GOs e.g. Ministry of Agriculture (MoA), Department of Agricultural Extension (DAE), CBOs and NGOs should arrange more and more need based training campaign for the potato farmers that might be influencing the quality potato production.

Establishment of Need-based Training Approaches for Agricultural Extension Workers to Develop their Skills on Agricultural Extension Activities

M. Jiaul Hoque* and Mr. Debashish Sarker Dev
Dept. of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : jiaul_agext@bau.edu.bd*

Abstract
The Sub-Assistant Agriculture Officer perception for their improving skills was determined and was found to vary a great extent. What characteristics inf1uenced this variation in their improving perceptions was determined by using Pearson's Product Moment Correlation Coefficient test between their perception for improving their skills and profile characteristics and it was found that tenure of service, age and communication exposure of the respondents were highly associated with their perceptions for improving their skills. Among the 15 statements for the training with five basic components of training these are subject matter of training, trainers, trainee, environment and training method were the most important points for the perception of SAAO. As the SAAO varied in their perception for improving their skills they were categorized into three major groups low, medium and high in this trait. Among the eleven characteristics age and tenure of service had positive significant

relationship. It means increase age and tenure service had related with improving skill development. So training must be needed for young. Education, cosmopoliteness, number of training received, duration of training received, organizational participation and rural background had on significant relationship.

Training Needs of the *Haor* People on Farm Resource Management in a Selected Areas of Kishoregonj Disctrict

Sumaon Kumar Halder, Mohammed Nasir Uddin* and Mohammad Jiaul Hoque
*Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail : nasirbau@gmail.com*

Abstract
The study was undertaken mainly to determine the extent of training needs of the *haor* people on farm resource management and offer training. Attempt was also made to explore the relationship between the training needs of the Haor people and their selected characteristics; while identifying the factors influencing the training needs on farm resource management along with different problems faced by them. The study was conducted in four villages under Nikli Upazila of Kishoreganj district. Data were collected from a sample of 100 *haor* people through personal interview using a pre-tested structured questionnaire from 02 October to 23 October, 2018. Training needs of the farmers on farm resource management was the focus variable and twelve selected characteristics of the respondents constituted the explanatory variables. Appropriate scores and scales were used to measure the mentioned variables. Both descriptive and inferential analyses were used to analyze the collected data. The finding indicates that the majority (88 percent) of the respondents belonged to high training needs category while 12 percent of them belonged to medium training needs category but none of them belonged to low training needs category. Training was provided to 100 haor people based on the identified training needs. Correlation analysis indicated that organizational participation, extension media contact, social mobility and knowledge on *haor* resource management had significant relationships with their training needs while others variables did not show any relationship. Level of education, annual family income, extension media contact, social mobility and knowledge on *haor* resource management were identified as influential factors as confirmed by the linear regression model. Besides, scarcity of storage facilities, poor knowledge on resource management, lack of cold storage, were identified as the major problems. Respective authority should emphasize the identified training needs and problems to take initiatives for improving socioeconomic conditions of the *haor* people.

Disseminating Good Agricultural Practices (GAPs): are the farmers interested

Debashis Roy
Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, E-mail: droyagext@bau.edu.bd

Abstract
Food safety has been gaining importance over the years. Promotion and adoption of good agricultural practices (GAPs) in this regard helps improve safe and quality agricultural products. The objectives of the study were to assess interest of the vegetable farmers towards GAPs and to explore factors contributing to their interest. A survey was performed with 100 vegetable farmers in Nakla Upazila of Sherpur District. Simple random sampling technique was employed to select the vegetable farmers. Interest of the farmers was assessed by developing twenty eight relevant statements in a five-point rating scale. The data were analyzed using descriptive statistics, co-efficient of correlation, multiple

linear and stepwise regressions. The findings revealed that more than four-fifth of the vegetable farmers (62 percent) showed high interest towards GAPs followed by moderate interest (37 percent). Among 28 practices, selection of comparatively high land for vegetable cultivation (mean = 4.77) was most widely reported and the farmers were highly interested to adopt this practice. Disease and pest free healthy seeds selection (mean = 4.73) was the second top practice to which the farmers were interested. On the contrary, the farmers demonstrated least interest to the use of biopesticide to control pests (mean = 2.90). The findings showed that education, farm size, access to information sources, experience in vegetable cultivation, organizational participation, training on vegetable cultivation and knowledge on GAPs were significantly associated with the interest of the vegetable farmers towards GAPs. Additionally, access to information sources, training on vegetable cultivation and knowledge on GAPs were identified as influential factors that effected farmers' interest towards GAPs. In conclusion, the vegetable farmers showed positive interest in GAPs. The study identified some important issues for the development practitioners and policy makers working on GAPs promotion to ensure food quality and safety.

Farmers' Awareness and Use of Internet Based Sources in Receiving Technological Information

M. Hammadur Rahman

Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh, E-mail: hammad@bau.edu.bd

Abstract

The main purpose of the study was to understand the extent of awareness of farmers on use of ICT in farm practices. At the same time, important factors were identified those could contribute to farmers' awareness on use of ICT. The study was conducted in the existing CIG of upazilas of Mymensingh district - Ishwarganj and Fulpur. Data were collected from 200 CIG farmers in the selected upazilas during the period from 03 July to 05 September, 2018 by using a pre-tested structured interview schedule. Farmers' awareness was measured by checking extent of their uses of seven selected ICT services as cell phone, smart phone, personal computer, services from AICC, services from UDC, Krishi Call Centre and mobile apps. A number of characteristics of the farmers were selected as the factors for explaining farmers' awareness on use of ICT. Appropriate scales were developed and used in order to measure the concerned variables. Correlation and regression tests were conducted to test the hypotheses of the study. The results showed that 23.7 percent had "moderate awareness" on use of ICT in farm practices while 60 percent and 12.7 percent of the farmers had "low" and "very low awareness" on use of ICT based facilities in their farm practices. Farmers' characteristics such as education, knowledge about ICTs, ability to use ICTs, access to ICT facilities, attitude towards ICT had significant positive relationship with the awareness on use of ICT; while age, household size and annual income had significant negative relationship with the awareness on use of ICT. Results of multiple regression analysis revealed that the influential factors on the farmers' awareness on use of ICT were household size, knowledge about ICT, ability to use ICT and attitude towards ICT. The R^2 value indicated that, four explanatory variables together explained 80.0 percent variation in farmers' awareness on use of ICT. The study also identified some constraints faced by the farmers while using ICT services in receiving agricultural information.

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Effect of Different Application Methods of *Chitosan* on Growth, Yield and Quality Attributes of Tomato at Post-harvest Storage

Md. Zakir Hossen
Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
E-mail: zakirhm_ac@bau.edu.bd

Abstract

A pot experiment was conducted to study the effect of different application methods of chitosan on growth, yield and quality of tomato. The experiment was laid out in completely randomized design (CRD) with four replications and twelve treatments combinations viz., T0= Control, T1= Soil application of chitosan (SAC) @80 ppm, T2= SAC @120 ppm, T3= Foliar spraying of chitosan (FSC) @60 ppm, T4= FSC @80 ppm, T5= FSC @100 ppm, T6= Combination of T1 and T3, T7= Combination of T1 and T4, T8= Combination of T1 and T5, T9= Combination of T2 and T3, T10= Combination of T2 and T4, and T11= Combination of T2 and T5. The study results revealed that there were significant variations among the treatments on number of leaves, numbers of flower cluster, flowering duration, fruit length and yield of tomato. The highest yield of tomato was obtained from the treatment T6, while the lowest was obtained from control treatment. Vitamin-C and lycopene content of tomato fruits varied from 2.19-4.09 and 2.38-3.58 mg $100g^{-1}$ sample, respectively. Among the major minerals, the highest amounts of Ca, Mg, Na, K, S and P were obtained from T7 (0.69%), T3 (0.58%), T8 (0.38%), T1 (0.62%), T4 (0.15%) and T6 (0.33%) treatments, respectively. Study results inferred that the treatment T4 was more effective concerning most of the growth and biochemical parameters of tomato. On the other hand, there were four treatments of chitosan [viz. T0 (control), T1 (0.10%), T2 (0.20%) and T3 (0.30%)] and two storage conditions [viz. in refrigerator (4^0C) and room temperature (≈23-25^0C)] to study the effect of chitosan coating on physiological responses and nutritional qualities of tomato fruits at postharvest storage. The matured light yellow tomato fruit samples were collected at 10, 20, 30 and 50 days after postharvest storage to assess physiological parameters viz. shelf life and weight loss as well as to determine lycopene and mineral constituents viz. Ca, Mg, P, S, Na and K. The mean weight loss of tomato fruits were 0.64, 1.28, 1.59 and 2.28% at 4^0C, while it was 0.88, 1.84, 2.60 and 4.80% at room temperature at 10, 20, 30 and 50 days after postharvest storage, respectively. The shelf life of tomato fruits ranged between 58.3-100.0, 50.0-100.0, 33.3-75.0 and 16.7-66.8% at 4^0C, while the ranges were 66.8-100.0, 50.0-100.0, 33.3-75.0 and 0.0-41.8% at room temperature at 10, 20, 30 and 50 days after postharvest storage, respectively. As regards to weight loss and shelf life, the study results inferred that chitosan coating with 0.2% solution is useful at postharvest storage of fruits. The study results revealed that storage temperatures (4^0C and ≈23-25^0C) had no effect on the total contents of different mineral element of tomato fruits but lycopene content reduced almost twice at refrigerated condition. On the other hand, the effect of chitosan coating on Ca, Mg, P, S, Na and K contents of tomato fruits at different days after postharvest storage were highly significant at both conditions. Finally, the study results concluded that 0.2% chitosan based coatings in tomato fruits proved to extend the shelf life by decreasing the decay incidence and weight loss, and refrigerated condition is better than that of room temperature.

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Impact of Industrial Wastewater Irrigation on Heavy Metal Accumulation in Soil and Health Risk Assessment through Dietary Intake of Rice Grown in that Soil.

Md. Zakir Hossen
Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
E-mail: zakirhm_ac@bau.edu.bd

Abstract

The study was conducted to determine heavy metal contents in industrial wastewater and contaminated soils of Bhaluka, Mymensingh and to assess health risk for population through consumption of rice grown in wastewater irrigated sites of that area. Total 9 wastewater, 12 contaminated soil and 9 rice samples were collected directly from the farmer's field of Bhaluka area and analyzed for this study. Considering EC, salinity and TDS, 56 to 89% wastewater samples were found problematic for long term irrigation, while the samples pH range were within the permissible limit. The study results revealed that all wastewater samples were found unsuitable for irrigation in respect of CO_3, HCO_3 and K. Among the heavy metals studied, Pb, Cd and Fe concentrations in all wastewater samples and Mn content in 5 samples were found above the acceptable limit for irrigation. The concentration of Zn, Cr, Cu, Pb, Ni, Cd, Mn and Fe in wastewater irrigated soils of Bhaluka industrial area ranged from 50.48 to 448.56, 47.22 to 83.65, 19.13 to 328.23, 42.37 to 77.96, 22.93 to 43.86, 0.70 to 1.40, 161.5 to 341.7 and 38105 to 65399 μg g^{-1}, respectively. Considering geoaccumulation index, the I_{geo} values for Pb and Cd for all locations of the study area exhibited positive values ($0.495< I_{geo}<1.624$), that means I_{geo} class: 1-2, indicating moderately polluted soil quality. On the other hand, as regards to enrichment factor (EFc), 9 locations for Pb, 5 for Cd, 1 for Zn and 1 for Cu had EFc values > 5.0, indicate contaminated soil quality. The mean concentration of Zn, Cr, Cu, Ni, Cd, Mn and Fe in rice grain grown in wastewater irrigated soils was 54.46, 12.56, 5.45, 8.01, 1.37, 14.82 and 94.1 μg g^{-1}, respectively. The daily metal intakes (DMI) for female > male and among the metals, DMI followed the sequence as Fe > Zn > Mn > Cr > Ni > Cu > Cd. The study results found that the daily intakes of all metals were higher than that of upper tolerable intake level, which indicates serious adverse effects have been associated with intake of rice grown in wastewater irrigated soils. The calculated target hazard quotient (THQ) values for Cr and Cd in all grain samples ranged from 16.12-35.44 and 5.04-11.67, respectively for both male and female, and the same values for Mn surpassed 5.0 for female in 6 sites and for male in 4 sites indicate that the exposed population are unsafe. THQ values for Ni in all sites and Zn 6 sites surpassed 1, which indicates exposed population are in level of concern interval. Finally, the study results concluded that Cr, Cd and Mn concentrations in rice grown in wastewater irrigated agricultural fields of Bhaluka area are unsafe for human consumption.

Toxic Metal Exposure through Major Food Stuffs and Point Source Evaluation for Adopting Remediation Strategies

Zakir H.M*. and Quadir Q.F.
Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: zakirhm_ac@bau.edu.bd*

Abstract

The study was conducted to determine toxic metal contents in common food stuffs of Bangladesh and to identify their possible contamination sources to develop remediation strategies. In total, 97 (54 from Mymensingh and 43 from Chottogram) different types of food samples were collected and processed

for chemical analysis. Zinc, Cu and Ni concentration in proteins, grains and vegetables samples ranged from 30.39-135.20, 12.52-55.24, 24.18-154.39 mg kg^{-1} in Mymensingh; 0.07-19.59, 1.29-13.82, 15.38-37.15 mg kg^{-1} and trace-7.89, trace-6.02, 3.13-14.67 mg kg^{-1} in Chottogram, respectively. However, present study results revealed trace amount of Pb for all the studied samples including grains, proteins and vegetables except coarse rice sample collected from Mymensingh city. Target hazard quotients (THQ) values for Cu surpassed 5.0 for both male and female, and the same values for Zn also surpassed 5.0 for female in both locations indicate that the exposed population is unsafe due to consumption of rice. In case of brinjal, THQ values for Cu were less than 5 ($1 < THQ < 5$) for male and female in both cities indicates that the exposed population is in a level of concern interval. Similarly, THQ value of Ni was also within the same limit for female in Chottogram city indicates that the exposed population is in a level of concern interval. On the other hand, in case of proteins, THQ values for all studied metals were <1, means the exposed population is assumed to be safe at both the locations. As regard to contamination sources, the mean concentrations of Zn, Cu, Ni and Pb obtained from poultry feeds of Mymensingh city ranged from 20.01-153.34, 0.05-32.87, trace-1.62 and 14.58-21.97 mg kg^{-1}, respectively. In case fish feeds, the concentrations of Zn, Cu, Ni and Pb varied from 39.26-611.32, 7.87-20.73, trace-0.056 and 1.05-17.52 mg kg^{-1}, respectively. Study results revealed that among the sources, feeds are important for heavy metal contamination in food items. Finally, the baseline information generated by this project will help the policymakers to formulate appropriate food safety policies in Bangladesh.

Chemical perspective of wheat blast disease outbreak and its integrated management strategy in Bangladesh

K.M. Mohiuddin*, Md. Zahirul Islam Sarker, Md. Saljar Rahman Chowdhury, Md. Arifur Rahman and Kamrun Nahar

Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: mohiuddin.achem@bau.edu.bd*

Abstract

A research was undertaken to explore the nutritional perspective of the wheat blast epidemics in Bangladesh. Blast infected mature wheat plants and allied prior to harvest soil samples were collected from 24 severely infected fields from six locations of Gangni upazilla under Meherpur district located in the western part of Bangladesh in January 2017. The average concentrations of P, K, S, Ca, Mg, Zn, Fe, Mn, Cu, B, and Si in the wheat plant samples were 0.182%, 0.499%, 0.405%, 0.32%, 0.34%, 55.63 $\mu g g^{-1}$, 456.61 $\mu g g^{-1}$, 29.42 $\mu g g^{-1}$, 5.49 $\mu g g^{-1}$, 31.37 $\mu g g^{-1}$, and 1.66%, respectively. Among the mineral nutrients S, Ca, Mg, Fe and Mn concentrations were within the reference adequate range, whereas the P concentration in 50% of the plant samples was deficient with other samples in a critical range. The concentrations of K of all the plant samples and Cu in more than 33.5% of samples were within the deficient range. The Si concentration of the half portion of analyzed plant samples was below the adequate range. However, boron concentration of around 50% samples was within the toxic range. The average concentration of available P, K, S, Ca, Mg, Zn, Fe, Mn, Cu, B, and Si in the collected soil samples were 86.5 $\mu g g^{-1}$, 0.26 meq per 100g, 1.65 $\mu g g^{-1}$, 14.0 meq per 100g, 1.6 meq per 100g, 1.91, 4.05, 1.38, 0.85, 0.24, and 2.12 $\mu g\ g^{-1}$, respectively. Among them, based on the interpretation of soil test values available, the concentrations of S, Fe, Mn and B in most of the samples were within very low level. The concentrations of available P, K, Ca, Mg, Zn and Cu in soil samples were higher than the critical limit. Findings of this study indicate that certain plant nutrients such as P, K, Cu, B and Si could have played a vital role in wheat blast disease incidence. However, more research is needed in order to design wheat blast management plan from a nutritional viewpoint.

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Quality of warm groundwater of Dhola union under Kishoreganj district for drinking and irrigation usage: Appraisal of mass media reported problematic groundwater

K.M. Mohiuddin*, Jannatun Naim, Md. Arifur Rahman and Kamrun Nahar
Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: mohiuddin.achem@bau.edu.bd*

Abstract
An investigation was carried out to evaluate the quality of groundwater for irrigation and drinking usage. Total 39 groundwater samples were collected from shallow tube wells of Dhola union of Tarail upazila under the district of Kishoreganj to determine major ionic constituents. The chemical analyses included Temperature, pH, EC, TDS, cations (Ca, Mg, K, Na, Fe, Mn, Pb, Cd, Cr, Cu, Zn) and anions (CO_3, HCO_3, Cl, SO_4 & PO_4). The average Temperature, pH, EC, TDS, were 38.18^0C, 8.27, 1204 µS cm^{-1}, 602 mg L^{-1}. The average concentration of Ca, Mg, K, Na, CO_3, HCO_3, Cl, SO_4 & PO_4 were 0.62, 1.15, 0.02, 1.09, 0.75, 3.38, 2.96, 3.39 and 0.05 meq $L^{-1,}$ respectively. The content of Mn, Pb, Cr, Cu, Zn were below the detection limit of flame AAS. Electrical conductivity (EC) and Sodium Adsorption Ratio (SAR) indicated that most of the samples possessed high salinity (C3) and low alkalinity (S1) hazards expressing as C3S1. Although, Total dissolved solids (TDS) values of all the samples were not problematic for irrigation usage but 20 samples were unsuitable for drinking. Sodium adsorption ratio (SAR) values of all the samples were excellent class. Based on Soluble Sodium Percentage (SSP), 22 water samples were classified as good and remaining 17 were permissible. Residual Sodium Carbonate (RSC) of most of the samples were marginal but 14 were unsuitable. According to permeability index (PI), all the water samples were unsuitable for irrigation usage. Hardness (H_T) of maximum samples was categorized as moderately hard in quality. The detected CO_3, HCO_3, Cd and Fe ions exceeded the permissible limit for long-term irrigation where Mg and K ions exceeded the limit for drinking purpose. These ions were considered as chemical contaminants in the water samples. The detected chemical contaminants assessed from the groundwater samples of the experimental area indicated that it should not be used for long-term irrigation and drinking purpose.

Appraisal of Ionic Contamination in Some Polluted River Waters for Irrigation Usage towards Food Safety: Impact of Industrial Discharge

M. Mokhlesur Rahman*, F. Naj Hossain and U. A. Nazmun Jannat
Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail : mmr@bau.edu.bd*

Abstract
Ionic contamination has become environmental problem due to long-term untreated industrial effluent disposal in river water ecosystem when applied to soil as irrigation water. Considering this issue, an attempt was made to explore ionic contamination in river water samples during dry season. Sampling sites were selected from crop fields irrigated with water samples of two rivers *viz*., Bangshi and Dhaleshwari. Twenty water samples of each river were collected from the upstream to downstream of rivers to determine ions for categorizing these water samples based on their applicability for irrigation. The chemical analyses included pH, EC, TDS, cations (Ca, Mg, K, Na, Cd, Cr, Cu, Mn & Zn) and anions (CO_3, HCO_3, Cl & PO_4). pH values of water samples ranged from 6.4 to 7.6 indicating slightly acidic to alkaline in nature. All the samples were under fresh water in quality. River water samples were medium salinity (C2) hazards and were low alkalinity (S1) hazard expressing as C2S1. Regarding SAR

values, samples were excellent and as per SSP values, samples were good and permissible classes. Water samples were free from RSC and belonged to suitable class. Water samples were moderately hard to hard in quality. Regarding PI values, water samples were class-II and III implying 75% and 25% of maximum soil permeability, respectively. The concentrations of Ca, Mg, K, Na, Cd, Cu, Zn, HCO_3, Cl and PO_4 in water samples were below acceptable levels and these ions were not problematic for irrigation. Among the detected ions in water samples, Cr and Mn ions were above the permissible limits for long-term irrigation and these ions were treated as chemical contaminants. From the present findings, it is concluded that the detected metal ions *viz.*, Cr and Mn as chemical contaminants in river water should be considered for long-term irrigation system towards food safety.

Mechanism of Arsenic solubilisation in the rhizosphere of barnyard grass for remediation of arsenic contaminated soil

Razia Sultana*, Taslima Sultana and Shah Mohammad Naimul Islam[1]

*Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and [1]Institute of Biotechnology and Genetic Engineering, Bangabandhu Sheikh Mujibur Rahman Agricultural University, *E-mail : razs@bau.edu.bd*

Abstract

Phytoremediation of arsenic (As) contaminated soil is a low-cost environmentally friendly technology to clean up the As from soil and barnyard grass has been reported as a potential candidate for As phytoremediation. The present research was aimed to find out the mechanism how As become more available to plant in the rhizosphere of barnyard grass in comparison to rice. The hypothesis was microbial interaction with plant root to make As available to plant. Bulk soil and plant with rhizosphere soil were collected from Vanga, Poranpur and Nagarkanda upazilla of Faridpur district. A total of eighty three (83) bacteria were isolated from the rhizosphere and bulk soil from the three locations based on the morphological characteristics in the NB agar media. The isolated strains were highly tolerant to As in the growth media. All the strains were able to tolerate arsenite (As V) up to 7500 ppm (100mMol), whereas, 64 isolates were survived up to 15000 ppm (200mMol). In the arsenite (AsIII) resistance test, all the stains were able to tolerate As (III) upto 100 mMol and 62 isolates were able to tolerate As(III) up to 15000 ppm (200mMol). Among the strains 25 isolates were selected based on their better growth on As contaminated media. The isolates were tested for their arsenic oxidation and reduction potentiality and five strains Viz. PB8, PB9, PB11, NB5 and VB5 were found to be able to oxidized arsenite (AsIII) to less toxic arsenate (AsV), whereas, PS2, PS3, VS6, NB1, PB17, PB20 and PB27, were reduced arsenate (AsV) to arsenite (AsIII). It is very interesting to note that all the As oxidizing bacteria were found in the rhizosphere of barnyard grass but not in rice or in bulk soil, indicated that few noble bacteria in association with barnyard grass are able to oxidize As to its less toxic form, which then transported to above ground part of the plant.

Response of wheat to sulphur fertilization in relation to grain protein quality, amylose and amylopectin contents

Md. Akhter Hossain Chowdhury*, Md. Arifur Rahman and Biplob Kumar Saha

*Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh *E-mail: akhterbau11@gmail.com*

Abstract

Wheat is an important food crop in Bangladesh and there is a wide gap between potential and actual yield obtained by the farmers. Sulphur is an important secondary nutrient which helps in plant growth

and metabolisms especially by improving activities of proteolytic enzymes and is also required for the synthesis of S containing amino acids like cysteine, cystine and methionine. Sulphur deficiency of wheat can easily be overcome by the use of elemental S or S containing fertilizers like ammonium sulphate, zinc sulphate, potassium sulphate and gypsum. A pot experiment was undertaken to investigate the effects of different sources and levels of S on the yield, yield attributes, protein quality, amylose and amylopectin contents of wheat and interrelationships among the nutrient uptake. The experiment started from mid-November 2019 at the farmers field *Bolashpur*, Mymensingh following completely randomized design with three replications. Two sources of fertilizers i.e., gypsum and zinc sulphate are being used in this study. Soils from the agricultural farm of Bangladesh Agricultural University were collected from 0-15 cm depth for pot experiment. Initial soil analyses revealed that the soil was sandy clay loam in texture. Bulk density, particle density and field capacity of the soil were 1.41, 2.59 g cm^{-3} and 27.11%, respectively. The values of different chemical parameters of used soil *i.e.,* pH, EC (dS m^{-1}), OM (%), total N (%), exchangeable K (cmol kg^{-1}), available P (µg g^{-1}) and available S (µg g^{-1}) were 6.8, 0.65, 1.80, 0.13, 0.16, 12.08 and 11.12, respectively. It is expected that the yield and nutritional analyses of wheat grain for protein, amylose, amylopectin and grain nutrient contents will be completed within March 2020. From this study, the best source and rate for good quality wheat production will be understood.

Zinc and iron enrichment in rice grain by using agronomic means of biofortification

Md. Akhter Hossain Chowdhury*, Md. Arifur Rahman and Kartik Chandra Saha
Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: akhterbau11@gmail.com*

Abstract

Malnutrition due to the deficiency of micronutrients especially for iron and zinc is a threat to the world population, particularly in the developing countries. An investigation was conducted in the laboratory of the Department of Agricultural Chemistry of Bangladesh Agricultural University, Mymensingh to find out grain Zn and Fe concentrations of thirteen rice and twelve lentil varieties of Bangladesh. A pot experiment was also conducted at farmer's field *Bolashpur*, Mymensingh to find out the optimum doses of these nutrients to obtain the highest Zn and Fe concentrations in rice grain following complete randomized design with three replicates. Results revealed that the highest Zn concentration was obtained from BINA dhan8 (25.9 µg g^{-1}) and BARI Masur-6 (62.24 µg g^{-1}), and Fe concentration from BRRI dhan74 (54.3 µg g^{-1}) and BARI Masur-6 (85.0 µg g^{-1}). Results of the pot experiment showed that the application of Zn and Fe significantly influenced their grain concentrations and the yield of rice. The highest grain yield was obtained from the application of Zn @12 kg ha^{-1} and Fe @8.5 kg ha^{-1}. The increasing doses of Zn and Fe positively and significantly influenced their concentrations in rice grain. In case of BRRI dhan29, the maximum grain Zn and Fe concentrations were found in the plants treated with Zn @14 kg ha^{-1} (31.1µg g^{-1}) and Fe @7.5 kg ha^{-1} (192µg g^{-1}). On the other hand, in BRRI dhan74, the highest grain concentrations of Zn (32.3µg g^{-1}) and Fe (195µg g^{-1}) were obtained from the same treatments. The overall results suggest that the application of 12 kg Zn ha^{-1} and 7.5 kg Fe ha^{-1} could be better for increasing Zn and Fe concentrations of rice grain as an agronomic mean of biofortification to reduce their deficiency in human nutrition.

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Effects of different inorganic fertilizers and organic manures on the growth, leaf biomass yield and quality of *Aloe vera* L.

Md. Akhter Hossain Chowdhury*, Taslima Sultana and Md. Arifur Rahman
Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: akhterbau11@gmail.com*

Abstract
A series of experiments were conducted at farmer's field, *Kashiganj*, Tarakanda, Mymensingh to determine N, P, K, S and organic manure requirements. Six different rates each of N, P, K, and S from urea, DAP, TSP, MoP, and gypsum and four rates each of cowdung (CD), poultry manure (PM), biogas slurry (BS), sewage sludge (SS), vermicompost (VC) and farm yard manure (FYM) were used following CRD with three replications. Seedlings were collected from Natore and planted during last week of September, 2018. Application of N, P, K and S fertilizers exerted significant influence on the growth and quality of *A. vera*. The highest values of yield and yield attributes were obtained from the plant fertilized with urea-N @ 150 kg ha^{-1}, DAP-N @ 100 kg ha^{-1}, and P, K and S @ 80, 120 and 45 kg ha^{-1} from TSP, MoP and gypsum, respectively. The highest leaf N, P, K and S concentrations were obtained from their highest addition. About 7.59% more leaf biomass yield was obtained from DAP than urea. Organic amendments significantly influenced yield attributes of *A. vera*. Highest leaf yield was obtained from CD @ 40 t ha^{-1}, PM @ 5 t ha^{-1}, BS @ 10 t ha^{-1}, SS @ 5 t ha^{-1}, VC @ 7.5 t ha^{-1} and FYM @ 15 t ha^{-1}, whereas the highest aloin and total phenolic compounds were found with their highest additions. The performance of organic manures was of the following order: CD >PM >BS >SS >VC >FYM. The application of N, P, K and S @ 100, 80, 120 and 45 kg ha^{-1} from DAP, TSP, MoP and gypsum, respectively, but CD and PM @ 40 and 5 t ha^{-1}, respectively can be suggested for producing higher leaf biomass yield and better quality *A. vera*.

Evaluation of plant growth promoting rhizobacteria (PGPR) for nutrient acquisition in two rice varieties (Binadhan7 AND BRRI dhan49)

Quazi Forhad Quadir*, Imran Ahammad Siddique[1], Shafiul Islam Rion, Md. Delwar Hossain and Atiqur Rahman
Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh and Department of Soil Science, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
**E-mail : qfq@bau.edu.bd*

Abstract
A research was aimed to develop a microbial formulation to improve the productivity and nutritional quality in crops. In doing so, during the reporting period two experiments were conducted, one is to elucidate the colonization pattern of multifunctional rhizobacteria in rice and the other was to evaluate the nutrient dynamics in the rhizosphere of inoculated rice plants. At first thirty-two bacterial strains were tested for their response in zinc-media. Only eleven of them responded positively indicating their ability to solubilize ZnO in zinc-media. These bacteria were pure cultured to determine their zinc-solubilizing-index, where MQ1 was the best strain and the zinc solubilizing index (ZSI) was 2.25 on solid medium. Quantitative analysis of the amount of zinc-solubilized by the 11 strains in nutrient-broth culture were done using AAS. The bacterial isolates MQ1 proved to be best Zn-solubilizers among the isolates studied. The colonization of bacteria in root zone were also investigated by bio-primed rice seeds of Binadhan-20. Eight of 11 isolates (viz. MQ1,MQ2,MQ3,MQ4,OSn8,EC1 and MQL9) were colonized substantially in the rhizosphere of the bio-primed rice seedlings. In the second

experiment, the nutrient release pattern of the root-colonizing multifunctional rhizobacteria in two popular rice varieties (viz. BRRIdhan49 and Binadhan7) were studied in pot-culture. The treatments comprised of bio-priming with no bacteria(B0), IAA producing rhizobacteria(B1), phosphate-solubilizing rhizobacteria(B2) and both IAA producing rhizobacteria and PSB(B3). At first seedlings were inoculated with PGPR and transplanted in the pots. Then porewater were collected from the root-zone of the treated seedlings at 5 and 25 days after transplanting. The porewater was subjected to chemical analysis. The nutrient release pattern was affected by bacterial-treatments. In both varieties B2 released more P; while B3 treatment released more Mn and Fe; and B1 treatment released more Zn than other bacterial treatments. Overall nutrient-release was comparatively higher in Binadhan7 than BRRIdhan49.

Characterization of Plant Growth Promoting traits of Bacteria Isolate from Marine Environments

Atiqur Rahman*, Kifat jahan and Quazi Forhad Quadir
Dept. of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
**E-mail: atiqur.ac@bau.edu.bd*

Abstract
Plant growth promoting rhizobacteria (PGPR), the heterogenous group of rhizosphere inhabiting bacteria promote plant growth through a diverse array of direct and indirect mechanisms. Marine microorganisms possess unique characteristics and produces diversified metabolites of industrial importance due to the complex nature of marine environment. Plant growth promotion by bacteria isolated from marine environment are underexplored area of research. The current research was designed to isolate and characterize bacteria from marine environmental samples as potential PGPR. A total of 82 marine bacteria were isolated from seven marine samples including fish and plant. The isolated bacteria were qualitatively screened for various plant growth promoting traits. Forty-two (42) of the isolated marine bacteria were able to solubilize mineral phosphate in Pikovoskaya's media at varying levels, while 42 of them grew in Winogradsky's N-free mineral media as an indication of potential nitrogen fixing bacteria. Fourteen (14) of the 82 isolates were siderophore producing bacteria, mostly from plants mangrove and weed samples from marine environment, while 10 isolates produced slight to medium levels of IAA when screened with salkowski's reagent test. Thirty-two (32) and Seventeen (17) marine bacteria were able to thrive in media containing 5% and 10% NaCl respectively, indicating their ability to tolerate saline environment. Preliminary plant trial with multifunctional marine bacteria showed enhanced plant growth and mineral uptake over control plants. The results indicate that many of the marine multifunctional bacteria have the potential to promote plant growth via phosphate solubilization, nitrogen fixation, IAA, siderophore and antibiotic production and could be used to formulate biofertilizer for sustainable crop production under changing physico-climatic conditions.

Nutritional Profiling of Genetically Modified Brinjal (*Solanum melongena*) Cultivars in Bangladesh

Sumana Haque, Protyasha Biswas, Nusrat Jahan, Mousumi Akter, Md. Shohidul Alam*
Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh
**E-mail: shohidul.alam@bau.edu.bd*

Abstract
Brinjal (*Solanum melongena L.*) is a very popular vegetable in Bangladesh. Brinjal Fruit and Shoot Borer (*Leucinodes orbonalis*) is a serious pest of brinjal causing 50 to 70% damage and require 25 to

80 sprays of harmful and expensive insecticides to control. Bt brinjal is a trangenic brinjal expressing crystal protein gene (Cry1Ac) from *Bacillus thuringiensis* bacteria to fight against Brinjal Fruit and Shoot Borer. Bt brinjal is cultivated by the Bangladeshi farmers for the last five years with varying degree of adoption and success. To study the nutritional quality of Bangladeshi Bt brinjal cultivars comparing with their respective non-Bt varieties, pot experiment with similar cultural practices was conducted in the net house of the Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh. Seeds of four Bt brinjal cultivars viz. BARI Bt Brinjal 1 (Uttara), BARI Bt Brinjal 2 (Kajla), BARI Bt Brinjal 3 (Nayantara) and BARI Bt Brinjal 4 (ISD006) and their respective non-Bt brinjal cultivars viz. BARI Brinjal 1 (Uttara), BARI Brinjal 4 (Kajla), BARI Brinjal 5 (Nayantara) and BARI Brinjal 6, respectively were collected from Bangladesh Agricultural Research Institute, Gazipur. The proximate compositions (% moisture, % crude fiber, % crude protein, % crude fat, % ash and % carbohydrates) and mineral compositions (N, P, K, Ca, Mg, S, Fe, Zn, Cu and Mn) of brinjal fruit samples were analyzed from Bt and respective non-Bt brinjal cultivars growing in pot experiment. Proximate compositions and mineral nutrient contents were significantly varied with the genotypes. However, no significant difference was found among the Bt and respective non-Bt cultivar. These variation among the genotypes suggested that different brinjal genotypes are different in nutritional composition. However, no variation among Bt and respective non-Bt brinjal cultivars suggesting the expression of Bt gene in genetically modified Bt brinjal is not hampering the nutritional composition.

Processing of Stevia Leaf Powder for Removal of Bad Odour Oil and Bitter Tested Compounds to Make It Pleasant Natural Sweetener for Common People

Hari Pada Seal
Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: haripadaseal@gmail.com

Abstract

Stevia Rebaudiana is a herbaceous perennial, which is normally used as a natural herbal sweetener almost worldwide. Stevia extracts generally contained high percentage of the glycosides of the diterpene steviol. Among them stevioside-V and rebaudioside-A are the principal sweetening compounds and are generally accompanied by smaller amounts of other steviol glycosides. *Stevia Rebaudiana* is emerging recently as the unique non calorie natural sucrose substitute. The established very special characteristic of the steviol glycoside present in stevia leaf powder are i) 100% natural ii) no calories iii) 250-300 times sweeter than sucrose iv) heat stable to 198-200^{0}C v) non fermentable vi) flavor enhancer vii) anti plaque viii) anti calories ix) recommended for diabetics x) non-toxic xi) extremely tested in animals and extensively used by humans with no adverse effect so far. It is not only a sucrose substitute but also have a number of medicinal properties. Stevia leaf powder is as much as 40- 45 times sweeter than sucrose. It is easily cultivable and useable in various food items as non calorie natural sweetener. But it is not pleasant to common people due to the presence of some bad odor oil, deep green color, bitter tested compounds etc. The preparation of crystalline stevioside is still an expensive and somewhat lengthy procedure. Whereas the production and refining of stevia leaf powder is quite inexpensive and simple. For these reasons another remarkable development in the use of stevia products is that crushed stevia leaf is increasingly used now-a-days in many countries as a non sugar natural sweetener by common people particularly by diabetics patient. In our present research work we refined the stevia leaf powder by removing these unpleasant compounds, color etc. keeping intact the concentration of sweetening components and other medicinal compounds with the help of precisely selected organic solvent and using soxhlet extraction. Firstly we have selected two organic solvents for soxhlet extraction. One of the solvent is

most non polar n-hexane and the other is very polar Dichloromethane. Secondly we have extracted the undesirable bad odor oil and other compounds by extraction in a soxhlet apparatus with n-hexane an then with Dichloromethane. The leaf powder thus refined was subjected to detailed thin layer chromatographic analysis. Due to this refining the stevia leaf powder became a pleasant food additive for common people most importantly for diabetic patients.

Development of Sustainable Production Technology for Natural Food Grade Dye from Bixa Orellana (Doi gota) and Related Analysis of Extracts and Final

Hari Pada Seal
Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: haripadaseal@gmail.com

Abstract
Bixa orellana or annatto seed is a very nice source of health friendly, economic natural food colors. We have developed sustainable, economic, simple and health friendly technology for extraction and production of water soluble powder and crystalline form of annatto food color from bixa seed. Economic and health friendly technology for production of oil soluble liquid and powder form of annatto food color were also developed. Recently raw seeds of bixin was processed by a simple heterogeneous reaction keeping the dye pigment as seed coat which make the color pigment water soluble. As a result the processed seed can directly be used as food additives to different food items. This is another form of food color from bixa seed developed by us. Annatto food colors are approved colors by BSTI. The water soluble products were tested for toxicity in the institute of Food Science and Technology under Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka. No significant acute toxic effect was found by the samples. We have seen that five kgs of annatto seed ultimetly gives about 250 gms of water soluable powder or crystilline form of food color. The costs of the developed products, calculated by us, were also found to be within the comfortable limit of the common people. Research work for development of technology for other forms of food color from annatto seeds and the analysis of the finished products are in progress. Detail thin layer chromotographic study of the products were done recently which reveals that the products are free from almost all undesirable gum and other compounds which is consisted with the dye naturally. For identification and quantification of bixin, isolated by us was subjected to UV-Vissible spectroscopic study which reveals satisfactory results. Infrared(IR) and Nuclear Magnetic Resonance(NMR) study for more detail chracterisation of the products are in progress The research work is Thus are very hopeful for the success of the project.

Solvent Extraction, Isolation of Barks and Leaves of *Terminalia arjuna* Bedd

Kartik Chandra Saha
Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: kartikchem@yahoo.com

Abstract
Terminalia arjuna Bedd locally Known as arjun tree, a well-known medicinal plant has extensively been used in Ayurvedic medicines to treat various diseases. This tree is a source of many potent biologically active compounds, planted all over Bangladesh. It is very important to note that synthetic medicines provoke environment pollution and health hazard for all living beings but herbal medicines are economic and eco-friendly. Since plant based drugs cause much lower incidence of adverse

reactions than synthetic drug, so scientist felt the urgency to develop an alternative approach of herbal medication towards management of diseases. The medicinal uses of the crude plant extract were known in this subcontinent from time immemorial. The present study was carried out extraction, isolation of the bark powder of *Terminalia arjuna* with solvents of less to high polarity like n-hexane, 70% ethyl alcohol, acetone and water respectively. The crude extract was examined by thin layer chromatography (TLC) and ethanol extract applied on diseased *C. batrachus* (magur fish) to removal of *Aeromonas* sp under in-vitro condition where 100% fish were recovered. The bark powder (100 g) was extracted with n-hexane in the Sohxlet apparatus for 48 hrs. The extract cooled, filtered and volume reduced by vacuum rotary evaporator. The crude material was examined by thin layer chromatography (TLC) using solvent system hexane: benzene (10:1) and showed major spot having R_f- value 0.28. In-vitro application of hexane extract effectively suppressed the growth of *Salmonella* sp. strains. Our findings revealed that the hexane extract showed higher antimicrobial activity than that of water extract. Multi drug resistance is now a great threat for aquaculture system. Frequently used of inappropriate doses of antibiotic increased the drug resistance capacity of bacteria which affect total production as well as causes to great loss in aquaculture business. It was concluded that the hexane extract of *Terminalia arjuna* bark powder could be used as a natural alternative to the synthetic antibiotics to control *Salmonella* sp.

Productivity analysis of farmer led mango based agroforestry practices in the Madhupur Garh area of Bangladesh

Mohammad Kamrul Hasan*, Md. Abdul Wadud and Md. Tariqul Islam
Department of Agroforestry, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail : mkhasanaf@bau.edu.bd

Abstract
The study was carried out to analyze the economic evaluation of mango based agroforestry practices established in the deforested land in Madhupur Sal forest. A sample of five Mango based agroforestry combinations, as well as 20 farmers in total 100 for the respective combinations, were selected in various villages in Madhupur Sal forest areas through literature review, practical observation, consult with the community and focus group discussion. The selected Mango based agroforestry practices were viz. Mango-Pineapple-Ginger-Papaya-Banana-Turmeric, Mango-Pineapple-Ginger-Papaya-Banana, Mango-Turmeric-Papaya-Aroid, Mango-Lemon-Turmeric and Mango-Pineapple. The area of each Mango based agroforestry practice plot was one Bigha. In order to evaluate the economic performance, data related to tree and crop parameters were collected from the respective plots as well as individual farmers in order to calculate the incurred cost, gross return, net profit, benefit-cost ratio (BCR) and land equivalent ratio (LER). The results revealed that the total calculated cost of production (Tk/ha) and gross return (Tk/ha) from five selected Mango based agroforestry practices were 202421, 186373, 163631, 95817 and 60690 along with 1076344, 956095, 816520, 443633 and 253686 respectively. While the highest (202421Tk/ha) cost of production incurred for Mango-Pineapple-Ginger-Papaya-Banana-Turmeric based agroforestry practice which also gave the highest (1076344Tk/ha) gross return than sole cropping (542886Tk/ha). The BCR and LER of the selected Mango based agroforestry practices were 2.78, 2.57, 2.34, 1.57, 1.03 and 3.27, 2.76, 2.32, 1.93, 1.37 respectively. From the results, it has been found that all the selected Mango based agroforestry practices were profitable than their sole cropping in respect of income, BCR, and LER. Among the selected mango based agroforestry practices Mango-Pineapple-Ginger-Papaya-Banana-Turmeric was economically more productive followed by Mango-Pineapple-Ginger-Papaya-Banana> Mango-Turmeric-Papaya-Aroid> Mango-Lemon-Turmeric> Mango-Pineapple based agroforestry practices in the study area. Therefore, it can be concluded that the economic performances of mango based agroforestry practice is more profitable than the sole cropping system.

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Comparative study of agroforestry and social forestry on vegetation and soil nutrient composition established in the deforested land of Madhupur Sal forest of Bangladesh

Mohammad Kamrul Hasan*, G.M. Mujibar Rahman, Md. Tariqul Islam and Md. Riajuddin Karim
Department of Agroforestry, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail : mkhasanaf@bau.edu.bd)*

Abstract
The research was conducted to asses and compares the impact of agroforestry and social forestry plantation on vegetation and soil nutrient status in the Madhupur Sal forest of Bangladesh measuring a quadrate $10\times10m^2$ size 200 plots of which 80 from each of the Agroforestry (AF) and Social Forestry (SF) sites, and rests from Natural Sal Forest (NSF). Within each quadrate plots, required vegetation parameters along with soil samples at both depth 0-15cm and 15-30cm were collected. The result revealed that a total of 42 woody perennials were recorded of which 29 trees, 8 shrubs and 5 climbers. The species richness and tree basal area were found the highest (30 and $48.45m^2$/ha) in the NSF site followed by AF (10 and $15.04m^2$/ha) and SF (9 and $18.85m^2$/ha) sites. The tree stand density was recorded the highest (1273 trees/ ha) in the SF site followed by the NSF (873 trees/ha) and AF sites (827 trees/ha). The Important Value Index (IVI) indicates that Sal is the dominant tree species in the NSF whereas Akashmoni is the dominant tree in both of the AF and SF sites. The result of soil analysis showed that the amount of total N, available P and exchangeable K was the highest (0.14% and 0.11%, 62.16ppm and 31.63ppm, 0.35meq/100g and 0.24meq/100g) in AF site compare to SF site for both 0-15cm and 15-30cm soil depth. The organic matter (OM) content was found the highest (2.56%) in the NSF site followed by AF (2.45%) and SF sites (1.98%) while at 15-30cm soil depth OM content (1.67%) of SF is higher than both in AF (1.58%) and NSF (1.37%). Therefore, it can be concluded that the reforestation activities i.e. AF and SF programs conducted in the NSF areas have significantly varied in terms of vegetation and soil nutrient status.

Upliftment of Farmers Livelihood and Enrichment of Environment through Improved Agroforestry Practices in Char Land Ecosystem of Bangladesh

G.M. Mujibar Rahman*, Md. Abdul Wadud and Faruk Ahmed
Department of Agroforestry, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: gmmrbau@yahoo.com*

Abstract
During the period July 2018 to June 2019 different research activities were done viz. benchmark survey, sample farmer selection and motivation, research plot selection, fruit and medicinal tree seedling/sapling plantation, farmer's training and experimental study in the farmers plots. Four different char villages in the bank of Old Brahmaputra river of Sadar upazila of Mymensingh district were selected as study site of the project. A benchmark survey was performed with 100 farmers of which 25 from each selected char villages for baseline survey. Data were collected on adoption of agroforestry system, livelihood status, tree species diversity, tree density, existing agroforestry models. From the benchmark it was found that trend of agroforestry system adoption almost similar in all studied char areas but asgroforestry adoption rate increases with increasing age of family head, family income, knowledge of tree benefits and access to information regarding agroforestry which was also

confirm by Odds-ratio analysis. Livelihood status of the farmers of the study areas was observed based on their average family income. Total 45 tree species, 24 crop species, 7 livestocks and 9 existing agroforestry models were recorded in the studied charland areas. Based on benchmark survey and motivation total thirty farmers were selected for practicing agroforestry. All of them were trained up regarding different agroforestry activities. Different fruit and medicinal trees were planted on selected research plots. Some plots also selected where seven years old lombu and mahogony were already planted (NATP Phase-1). Six different experimental study was performed in these newly planted and existing plots. As evidence from the results it was found that yield of all associated vegetables/crops did not varied significantly with newly planted different tree species but in combination with previously planted (seven years old) lombu and mahogony trees yield was varied significantly.

Morpho-molecular characterization of the underutilized vegetable, pigeon pea (Cajanus cajan (L.) Mill Sp.)

Md. Shahidul Islam*, Mahadi Hasan Ratul, Nishat Salsabil[1] and Md. Abdur Rahim[1]
*Department of Biotechnology and [1]Department of Horticulture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail : m.s.islam@bau.edu.bd*

Abstract
Pigeon pea (*Cajanus cajan*) is a drought tolerant, nutritionally rich but an underutilized vegetable (pulse crop) in Bangladesh. Knowledge of intra-specific genetic variation is a prerequisite for the conservation and improvement of pigeon pea germplasm. In order to study the intra-specific genetic variation both morphological and molecular analyses were performed using 16 pigeon pea germplasm. Standard morphological descriptors were examined to estimate morphological characters and eight microsatellite loci were analyzed to investigate DNA level variation. Morphological studies showed the significant variation among the germplasm. In molecular study, we found 7 microsatellite loci were polymorphic and they contained a total of 18 alleles. Loci CCB4, CCB7, CCB10 had three (3) alleles; CCB1, CCB2, CCB5, CCB6 had two (2) alleles and CCB9 was monomorphic. Differences were observed in observed number of alleles, heterozygosities and proportion of polymorphic loci among the germplasm. A private allele, $CCB1_{194}$ was found in PP-9438 germplasm. Estimation of overall genetic differentiation (F_{st} = 0.42) and gene flow (N_m = 0.35) revealed that a high level of genetic variation existed between germplasm with some exceptions. Genetic distance value was the highest (0.70) between PP-MYM and PP-9438 that proved their high genetic dissimilarities. Genetic distance-based UPGMA dendrogram separated 16 germplasm into two clusters where 9 were in one cluster and remaining 7 in another cluster. Dendrogram also showed a strong genetic relationship between phenotypic and molecular characteristics of the germplasm. Germplasm having the lanceolate shaped leaves, yellow colored banner petals and green-black mixed colored pods belonged to the same cluster. The private allele found in the PP-9438 germplasm could be used as diagnostic marker to identify the particular pigeon pea germplasm and wide range of genetic distances among germplasm could help detect potential germplasm for development of new varieties through selective breeding program.

In vitro micropropagation of a valuable medicinal plant, Aloe vera

Sabina Yasmin
Department of Biotechnology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail : sabina.yasmin@bau.edu.bd

Abstract
Aloe vera is an important medicinal herb and is propagated vegetatively. However, its propagation rate is slow and cannot meet the commercial demand. The aim of this study was to optimize the effect of different plant growth regulators on *in vitro* shoot proliferation and root formation of *A. vera*. Shoot

tips were used as explants, which were excised and disinfected with freshly prepared 0.1% $HgCl_2$ solution. Sterilized shoot tips were then inoculated on Murashige and Skoog (MS) medium supplemented with different concentrations of BAP or TDZ (0.5, 1.0, 2.0, and 4.0 mg/l) combined with 0.5 mg/l NAA. MS medium without plant growth regulator was used as control in this study. The highest percentage of shoot proliferation (90%) and minimum number of days to shoot proliferation (5 days) were recorded on MS medium containing 4.0 mg/l BAP + 0.5 mg/l NAA. In the same media composition the highest number of shoots per explant (2.7) and the highest average shoot length (3.49 cm) were also observed. The medium containing a low concentration of TDZ (2 mg/l) with NAA (0.5 mg/l) produced multiple microshoots, whereas the highest TDZ concentration (4 mg/l) with 0.5 mg/l of NAA produced high levels of abnormalities such as clumps of buds, stunted shoots. The highest percentage (80%) of rooting along with maximum number of roots per explant (3.2) was obtained in media supplemented with 1.0 mg/l IBA. In the same culture medium the highest average length of root (5.67 cm) and minimum number of days to root induction (11 days) were noticed. The results of the present study could be effective for rapid micropropagation of elite plants of *A. vera*.

Production of bioethanol from agricultural wastes utilizing fermentation potential of *Saccharomyces cerevisiae*

Dr. Fahmida Khatun

Department of Biotechnology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh Mymensingh, E-mail: fahmida.meem@bau.edu.bd

Abstract

Production of biofuel using agricultural waste materials offer an alternative source to existing environmental, economic and energy problems being faced worldwide. The present study was designed to evaluate the bioethanol production efficiency of *Saccharomyces cerevisiae* from three different agricultural waste materials such as sugarcane bagasse, rice straw and wheat straw. Substrates were pretreated by physical and chemical method. Firstly, substrates were ground to powder form and pretreated with 5% H_2SO_4 + 1% NaOH followed by steaming at 121°C for 15 min. To investigate the effect of different fermentation conditions on bioethanol production, different temperature, pH of the fermentation medium and incubation hours were used and data were recorded accordingly. Fermentation medium were prepared at different pH (3.7, 3.9,4 and 4.6) to see the effect of pH on bioethanol yield. The highest bioethanol concentration (15.04%) was obtained from sugarcane bagasse at pH 4.6 while the lowest concentration (13.01%) was obtained from rice straw at pH 3.7. To analyze the effect of temperature, three different fermentation temperatures (37^0C, 40^0C and 45^0C) were adjusted and the highest concentration (15.21%) of bioethanol was obtained from sugarcane bagasse at 45^0C and the lowest concentration of bioethanol (12.8%) was recorded from wheat straw at 37^0C. Data were also recorded at different time interval (72hr, 96hrs and 120hrs) and the highest concentration of bioethanol (15.29%) was obtained from sugarcane bagasse after 120hrs of fermentation and the lowest amount (13.01%) from wheat straw after 72hrs of fermentation period. Considering all the fermentation conditions, sugarcane bagasse produced the highest amount of bioethanol as compared to rice straw and wheat straw by using fermentation potential of *S. cerevisiae*. The results of this study suggest that, agricultural waste materials can be an important source of biofuel production in Bangladesh.

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Role of anti-oxidant in goat oocytes maturation under *in-vitro* culture condition

Sumitra Saha* and Shuvra Debnath
Department of Biotechnology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail : sumitra@bau.edu.bd*

Abstract
To find out the effect and optimum dose of antioxidant (α-tocopherol) on goat oocytes maturation under *in-vitro* culture condition, slaughterhouse goat ovaries are used. A total of 497 cumulus-oocyte complexes (COCs) are collected from the ovary by aspiration of 2-6 mm diameter follicles. Among 497 COCs, 384 COCs are normal (Grade A and B), and 108 COCs are an abnormal grade (Grade C and D). After grading, only normal COCs are matured in maturation media-199 (M-199) supplemented with different doses of α-tocopherol (100uM, 200uM and 400uM) at 38.50C and 5% CO2 incubator for 48 hours. Maturation media without α-tocopherol is used as the control. Maturation is confirmed by checking the nuclear maturation. The percentages of COCs reached metaphase-II stages are 38.33%, 51.67%, 66.32% and 67.69% for 0uM, 100uM, 200uM and 400uM doses of α-tocopherol, respectively. These results indicate that the maturation rate is increased significantly ($p<0.01$) by supplementing M-199 with100uM α-tocopherol. The rate is increased further ($p<0.01$) by increasing the dose up to 200uM, but no more improvement ($p>0.05$) is occurred when the dose of α-tocopherol increased again. Thus, it can be concluded that 200uM α-tocopherol may be used as a supplement with maturation medium M-199 in in-vitro maturation of goat oocytes.

Intraspecific genetic variation in tropical sugar beet (Beta vulgaris L.) germplasm

Mobassira Tul Jannat and Md Shahidul Islam*
Department of Biotechnology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: m.s.islam@bau.edu.bd*

Abstract
Sugar beet is a sugar producing crop that is alternaive to sugarcane. Knowledge on genetic variation in sugar beet is essential for avoiding homonymies and synonymies as well as ensuring their fitness during the selection for breeding and cultivation. To estimate genetic variation in sugar beet, seeds of 19 varieties were collected from Bangladesh Sugarcrop Research Institute. Genomic DNA from leaf tissues were isolated using CTAB method. Microsatellite DNA tool was used to determine genetic variation and relatedness in sugar beet varieties. Initially, ten loci namely Unigene1965, Unigene2305, Unigene9667, Unigene11422, Unigene 11506, Unigene15403, Unigene15907, Unigene 16898, Unigene 24552 and Unigene 27833 of 2 subsamples of sugar beet genotypes were analysed. Amplification of alleles from four out of ten loci namely Unigene 24552, Unigene 16898, Unigene15907 and Unigene 27833 that reulted good quality bands were finally used to analyse whole 19 sugar beet genotypes. All 4 loci were found to be polymorphic. A total of 27 alleles were amplified from these 4 loci. The allele sizes ranged between 174 to 275 bp. The highest number of alleles (10) was amplified from the locus Unigene 24552 and Unigene 27833 whereas Unigene 16898 and Unigene 15907 loci had 5 and 2 alleles, respectively. All sugar beet varieties were found to be homozygous at loci Unigene 16898 and Unigene 15907 whereas 8 varieties at locus Unigene 24552 and 12 varieties at locus Unigene 27833 were heterozygous. A total of 5 private or diagnosic alleles were found. Two private alleles (Unigene 24552187, and Unigene 27833186) were found in Cauvery, 1 (Unigene 24552182) in Belleza, 1 (Unigene 24552174) in PAC-60008 and 1 (Unigene 24552185) in SV1. A

wide range of genetic distance (0 to 2.48) between different genotypes was found with the highest level between Belleza vs SV1, SV892 vs Danicia and SV887 vs Danicia and the least genetic distance between H1-0473 and SZ35 genotypes. Cluster analysis based on genetic distances segregated 19 sugar beet genotypes into 2 major groups. One group consisted of 7 genotypes whereas the second group contained 12 genotypes. Considering variation in number of alleles, private alleles and genetic distance values, substanial level of genetic variation was found in sugar beet genotypes.

Screening for Aphid Resistance in Country Bean (Lablab purpureusL.) through Morpho-molecular Markers

Shammi Akhtar, Sumitra Saha and Shahidul Haque*
Department of Biotechnology, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: m.s.islam@bau.edu.bd*

Abstract
Abstract: Country Bean [*Lablab purpureus* L. (Sweet)], commonly known as "seem"is an important and popular leguminous crop in Bangladesh. Bean aphid is the most serious pest of bean plants from seedling to pod bearing stage, causing considerable yield loss. This study is designed to analyze the phenotypic diversity to screen high yielding genotypes with aphid resistance, if available. A total of 51 country bean genotypes were evaluated for aphid resistance along with different qualitative and quantitative characters during July 2018 to June 2019 at Horticulture farm, Bangladesh Agricultural University, Mymensingh. The genotypes showed considerable variations for most of the yield and yield contributing characters. Shape, size and color of vein, leaf petiole colour, stem, flower, pod and seed varied among the genotypes. Days to first flowering ranged from 45.2 to 91.3 days indicating the presence of early as well as late variety. Individual pod weight varied from 8.18g (BD-148) to 18.6g (Jashore Local). The highest (508.6) number of pods per plant was recorded from (BD-2914). Similar trend was observed for pod yield per plant. The Highest (7.18Kg) pod yield per plant was obtained from genotype BD-2914 and the lowest (3.20kg) was recorded from local cultivar Fuli. Among the genotypes the highest aphid infestation was observed in BD-2881, BD-10505, Gualgadda, Bichaluri, Jashore local, BARI shem -2, BARI Sheem -7 under natural infestation. The lowest degree of infestation was recorded in Kishamoti, Suri, Bata, Cumilla Local, BD-2914, BD-2918, BD-10512, BARI Sheem -4, BARI Sheem -6, BARI Sheem -10. Therefore, these genotypes can be valuable for the select of aphid resistant genotypes and could be incorporate into future bean breeding program.

Microsatellite marker based genetic diversity analysis for salt tolerance in wheat genotypes

Muhammad Shahidul Haque*, Nihar Ranjan Saha, Sayma Farabi, Md. Hasanuzzaman, Muhammad Abdul Hannan and Muhammad Monirul Islam[1]
Department of Biotechnology, Bangladesh Agricultural University, Mymensingh, Bangladesh; [1]Biotechnology Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh, Bangladesh
**E-mail: haquems@bau.edu.bd*

Abstract
Salinity is one of the major constraints to wheat production in coastal region in Bangladesh and many other countries of the world. Salt affected soils can be better utilized by developing salt tolerant varieties. Genetic diversity for salt tolerance among the germplasm is a prerequisite for developing salt tolerant varieties. Therefore, the present study was conducted to evaluate the level of genetic diversity

among 75 (28 commercial varieties and 47 inbreed lines) wheat genotypes for salinity tolerance based on 21 SSR markers linked to salt tolerance. A total of 202 alleles were detected among the 75 wheat genotypes with an average of 9.6 alleles per locus for salt tolerance screening. Overall mean polymorphism information content (PIC) and Nei's (1973) gene diversity of 0.7599 and 0.7856, respectively were found in this experiment. The coefficient of genetic similarity matrix for all possible 2775 pairs of genotypes ranged from 0.19 to 1.00 with an average of 0.60. Similarity indices based cluster analysis (UPGMA) separated 75 genotypes into six different clusters each of which was further separated into two sub-clusters. It is interesting to note that eight genotypes namely BARI gom-27, BARI gom-28, BARI gom-29, BARI gom-30, BARI gom-31, BARI gom-32, BARI gom-33 and Borkot were present in sub-cluster Ib together with control variety BINA gom-1 which has been released as salt tolerant variety. In other words, these eight genotypes were found to be salt tolerant in molecular studies by salt linked markers. Therefore, the genotypes that clustered with BINA gom-1 are promising to be used for future research to develop more salt tolerance varieties in future. The salt tolerant genotype identified in this study could be used as parents to incorporate salt tolerance in future wheat cultivars by marker assisted selection and breeding.

Eco-friendly Agricultural Practices for Soil Quality Improvement and Sustainable Food Production

M. Hossain, S. Islam, M. S. Hossen and M. A. Baten*
Dept. of Environmental Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : baten_envsc@yahoo.com*

Abstract
Two experiments were conducted at the Environmental Science Field Laboratory, Bangladesh Agricultural University, Mymensingh from September 2018 to March 2019 to investigate the effect of organic and inorganic amendments on soil physical and chemical properties as well as growth, yield and biochemical properties of tomato and carrot. The experiment was conducted at Randomized Completely Block Design (RCBD) with seven treatments and three replications. The experiment consisted of different types of treatments viz, T_0=Control, T_1=Poultry manure, T_2=Human waste compost, T_3=Cow dung, T_4=50% NPK+50 % Poultry manure, T_5=50 NPK+50% Human waste compost, T_6=50% NPK+50 % Cow dung. Soil texture, soil pH, electrical conductivity (EC), organic matter (OM), nitrogen (N), phosphorous (P), potassium (K), sulphur (S) and sodium (Na) were examined to investigate soil physical and chemical properties. From the results, it was observed that most of the chemical properties, such as: OM, N, P, K, S and Na contents were higher in 50% NPK+50% poultry manure treated soil. In case of tomato a higher number of fruits per plant (45.99) and plant height (41.78cm) were obtained from 50% NPK+50% poultry manure applied crop. In considering biochemical characters of tomato, amount of pH was higher at treatment T_1. Percentage of total sugar (18.259), reducing sugar (9.518) and titratable acidity (1.54) were higher at treatment T_2 (human waste compost) where non-reducing sugar (11.549) and vitamin C (28.86) was higher at control (T_0). From this study, it could be concluded that 50%NPK+50% poultry manure (T_4) treatment was profitable and found to be the best for the production of tomato in our experimental site. In case of carrot the highest yield (24.97t/ha) and the lowest (12.36t/ha) was found from the treatment T_4 and T_0 respectively. Maximum plant height (63.5 cm), leaf length (56.67 cm), fresh weight (252.3 g), root length (19.5 cm), root diameter (11.24cm) were obtained from poultry manure treatment (T_1) followed by the human waste compost (T_2) whereas the lowest was found in T_0. Fresh weight of root (122 g) and moisture content (91.2%) were higher in treatment T_4 and T_5. The maximum dry weight of root, branch and crack root were obtained from T_6. Organic and inorganic amendments showed significant variations on some important biochemical properties of carrot. Result showed that the highest chlorophyll- b (0.188 mg/100g) was in T_5, and the highest chlorophyll- a (0.2427 mg/100g), total

chlorophyll (0.318 mg/100g) was found in T_1 whereas highest (29.59 mg/100g) vitamin-C content obtained from human waste compost (T_2) treated plot. The result presented that B-carotene (6.647 mg/100g), reducing sugar (4.253%), total sugar (8.743%) was highest from the 50% cow dung + 50% NPK treatment (T_6) followed by the cow dung treatment (T_3) and the lowest was in T_2. The result suggest that poultry manure, human waste compost and combine applications of organic and inorganic farming are more suitable option for better yield that may enhance the fertility status of soil and improve nutritional quality of carrot.

Physicochemical and Microbial assessment of drinking water of different restaurants at Mymensingh Sadar

Md. Azharul Islam*, Jayanta roy, Shah Tasdika Auyon and Md. Murad Hossain
Department of Environmental Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail- maislam@bau.edu.bd*

Abstract
Water, the most important natural resource in the world, has the unique property of dissolving and carrying in suspension a huge variety of chemicals and hence water can easily become contaminated. To investigate the status of available drinking water in different restaurants of Mymensingh Sadar electrical conductivity (EC), total dissolved solids (TDS), pH, dissolved oxygen (DO), biological oxygen demand (BOD), arsenic (As), iron (Fe) and lead (Pb) were measured. Furthermore, Microbiological assessment of the drinking water samples was carried out. For achieving the microbiological assessment, methods of heterotropic plate count (HPC) and total coliform count (TCC) were applied. Total 84 samples were collected from selected 28 restaurants of the study area. Results revealed that the mean value of EC, TDS, pH, DO, BOD, As, Fe, Pb were 682.38 $\mu S\ cm^{-1}$, 228 ppm, 7.11, 4.98 mg/L, 1.72 mg/L, 0.005 ppm, 0.181 ppm and .0001 ppm respectively. According to the standard of drinking water the EC, TDS, pH, DO, BOD, As, Fe, Pb toxicity were not detected. All of them were present in water within permissible limits. In most cases the concentrations of Pb and in some extent- the concentrations of Fe were considered as toxicants due to the higher concentrations of these metals. Among the studied samples, the highest heterotrophic plate count was measured in water sample of Ganginapar (1.2×10^7 CFU/ml) and the highest total coliform was observed in C. K. Ghosh road (13 coliforms/100ml). Therefore, the examined water quality parameters indicate that water quality of the restaurants at Mymensingh sadar is suitable for drinking. Anyway, there was presence of fecal coliforms that indicates contamination of feces with water. One sample was contaminated with fecal coliform which is very harmful for health and this water is not suitable for drinking. The results showed the presence of different number of coliforms which is far beyond the limit set by WHO and USEPA for drinking water considered to be safe to public health. The study will help us in selection the right options to manage water sources also help us to find out the drinking water quality of selected area. Detailed and close monitoring is needed for safe drinking water – focusing sound environment and human health.

Physicochemical and microbial investigation of different water sources of selected regions in Bangladesh

Md. Azharul Islam*, Md. Shafiqul Islam, Shah Tasdika Auyon and Jayanta Roy
Department of Environmental Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail:- maislam@bau.edu.bd*

Abstract
An unadulterated source of water is the most fundamentally important things for sound environment. Various health problems may occur due to inadequacy and poor quality of water. Safety and quality of

water source is always an important public health concern. Poor sanitation and food sources are integral to enteric pathogen exposure; water is a major source of microbial pathogens in developing regions. This study was designed with a view to assessing physicochemical properties of drinking water collected from selected areas of Bangladesh. In this case, electrical conductivity (EC), total dissolved solids (TDS), pH, dissolved oxygen (DO), biological oxygen demand (BOD), arsenic (As), iron (Fe) and lead (Pb) were measured. Furthermore, Microbiological assessment of the water samples was carried out. For achieving the microbiological assessment, methods of heterotrophic plate count (HPC) and total coliform count (TCC) were applied. The water samples were collected from different restaurants, households, offices during January to June, 2018 and different physicochemical properties of samples have been observed during March to June, 2018. The mean value of EC, TDS, pH, DO, BOD, As, Fe, Pb were 682.38 μS cm^{-1}, 201ppm, 7.11, 4.98 mg/L, 1.72 mg/L, 0.005 ppm, 0.181 ppm and 0.000 ppm respectively. According to the standard of drinking water the EC, TDS, pH, DO, BOD, As, Fe, Pb toxicity were not detected. All of them were present in water within permissible limits except Fe (Gazipur, household) and TDS (Rangpur, Govt. office). All of them were present in water within permissible limits. In most cases the concentrations of Pb and in some cases the concentrations of Fe were considered as toxicants due to the higher concentrations of these metals. Moreover, 50% of the samples showed >10 CFU/100mL and some of them is highly significant in number. The results showed the presence of different number of coliforms which is far beyond the limit set by WHO and USEPA for drinking water considered to be safe to public health. It is recommended that, water supply authority including restaurant, office, household and tea stall owners should take necessary steps for the maintenance of microbial quality of water. Further studies in depth are urgently needed for time interval to investigate the possible responsible cause of contamination.

Characterization of Leachate and Groundwater Pollution at Municipal Solid Waste Landfill of Mymensingh City in Bangladesh

Md. Azharul Islam[1*], Shah Tasdika Auyon[1] and Md. Nuruzzaman[2]

[1] Department of Environmental Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and
[2] Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh
**E-mail: maislam@bau.edu.bd*

Abstract

Open dumping is an important environmental issue in Mymensingh city, which causes of air pollution, soil pollution and water pollution. Landfill also is a dangerous thing for environmental pollution. Leachate pollution is the result of a mass transfer process. Waster entering the landfill reactor undergoes biological, chemical and physical transformations which are controlled, among other influencing factors, by water input fluxes. The leachate corresponds to atmospheric water that has percolated through waste, interacting with bacteriological activity and especially organic substances. Groundwater is an important source of drinking water for humankind. The study was conducted to assess the groundwater pollution causing for landfill and to explore the physicochemical characterization of municipal solid waste and leachate. The study was conducted at Mymensingh city area where one open dumping place and a fertile agricultural land area. Leachate samples were collected from Shamvugonj landfill which is located in the eastern part of Mymensingh town. Three different sites of leachate were selected as samples. Groundwater samples were collected from five boreholes. Chloride was measured by the Mercuric Nitrate Titrimetric Method, Calcium and hardness were measured by the EDTA titrimetric methods. Magnesium was measured by calculation as the difference between total hardness and calcium hardness. Flame photometer was used to determine Sodium (Na) and Potassium (K). The heavy metals and bacteriological analysis of collected water samples were conducted in analytical laboratory of IIFS, BAU, Mymensingh. Results revealed that pH of leachates were not within the standard range but samples from boreholes were within standards. There was no health based guideline value was proposed for pH. EC values of leachates were not

within the standard range. The BH4 and BH5 were within the standard range [450-1000]; but other water samples were not recommended for drinking purpose due to the effect of the leachate seepage into the boreholes. The F and Cl concentrations for the three leachates exceeded the standard limit of 1 and 4-10 mg/L. BH1 was the most affected boreholes by the leachate migration from the landfill. The distribution of Na and K in all boreholes did not pose any significant water quality problem, because these cations were within the standard acceptable limits. In case of Fe, only BH1 was not within the standard limit which indicated that borehole was affected by the migration of leachate from the body of the landfill. Almost similar results observed in case of Ca. On the other hand, the analysis of heavy metal contents showed that all boreholes were contaminated by Pb and affected by the migration of leachate to the groundwater. Zn, Ni, Cr contents in leachates were not within the standard acceptable limit and in boreholes Ni, Zn, Cr were not within the acceptable limits. Necessary steps should be taken by the authority to prevent further contamination from leachate.

Biomonitoring of Wetland Ecosystems Using Benthic Macro-Invertebrates

Md. Badiuzzaman Khan*, Rijhim Chakma, Naznin Nahar and Imran Ahammad Siddique

Department of Environmental Science, Bangladesh Agricultural University,Mymensingh-2202,Bangladesh.
**E-mail : mbkhan@bau.edu.bd*

Abstract

This study was conducted to assess the water quality of the Brahmaputra river, the Turag river and Tanguar haor using benthic macro-invertebrates. Samples were collected from nine locations of the Brahmaputra river in the month of September, October and November whereas five locations from the Turag river and Tanguar haor. Chemicalparameters such as pH, Electrical Conductivity, Dissolved Oxygen, Total Suspended Solid and heavy metals were determined from water samples. Samples of macro invertebrates were collected from the selected sites using a net (25cm X 25cm) and collected macroinvertebrates were preserved in 4% formaldehyde for further identification and sorting. Identification was done by using identification keys described by various researchers. The mean concentration of DO level in the Brahmaputra River in month of September, October and November were 7.28 mgL-1, 7.6 mgL-1 and 7.13 mgL-1, respectively. For Turag river water samples, the values of DO ranged from 8.6to 9.7 mgL-1 with mean value of 9 mgL-1. The concentrations of DO level of Tanguar Haor ranged from 4.27 to 8.56 mgL-1 whereas the mean value was 5.57 mgL-1. Pb, Cr, Cu, Zn, Fe and As content of the Turag river water ranged from 0.0020 to 0.0050 mgL-1, 0.0970 to 0.1550 mgL-1, 0.00220 to 0.0190 mgL-1, 0.0690 to 0.0820, mgL-1, 1.02 to 2.77mgL-1 and 0.004 to 0.009 mgL-1, respectively. Considering DO level, water of both the rivers and haor are suitable for fishes and aquatic organisms. Biological Monitoring Working Party (BMWP) score and Average Score Per Taxon (ASPT) were estimated from the number of taxa to assess the quality of water. The mean ASPT score of the Tanguar haor was 4.932 and the Brahmaputra river in the month of September, October and November ranged within 4-5. According to ASPT score the water of the Brahmaputra river and Tanguar haor are moderate and good, respectively. The mean ASPT score of the Turag river was 2.52 which means the quality of water is poor and highly polluted. From the experiment it could be concluded that Macro-invertebrate based multimetric indices are reliable tools for assessing water quality of the rivers as well as haor ecosystems.

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Assessment of Ecological Health of Aquatic System using Macroinvertebrate-based Multimetric Indices

Md. Badiuzzaman Khan
Department of Environmental Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail : mbkhan@bau.edu.bd

Abstract
A study was carried out to assess the water quality of the river Brahmaputra River, Buriganga River and Dingaputa haor using benthic macro-invertebrate. Samples were collected from 5 locations of the Brahmaputra and the Buriganga rivers and 10 locations of the dingaputa haor. Every location was demarcated into five stations. Chemicals parameters such as pH, Electrical Conductivity, Dissolved Oxygen, Total Suspended Solid and heavy metals were determined from water samples. Samples of macro invertebrates were collected from the selected sites using a net (25cm X 25cm) and Families of macroinvertebrates present were preserved in 4% formaldehyde for further identification and sorting. Identification was done by using identification keys described by various researchers. The concentration of DO level in the Brahmaputra River ranged from 7.9 ppm to 9.7 ppm whereas the mean value was 8.89±0.69 ppm. The concentration of DO level of Dingaputa haor ranged from 4.4 ppm to 5.0 ppm whereas the mean value was 4.63±0.23 ppm. Considering DO level, water of both the rivers and haor are suitable for fishes and aquatic organisms. Biological Monitoring Working Party (BMWP) score and Average Score Per Taxon (ASPT) were estimated from the number of taxa to assess the quality of water. The mean ASPT score of the Brahmaputra, Buriganga and Dingaputa haor is 4.648, 2.44 and 5.487, respectively. According to ASPT score the water of the Brahmaputra and Dingaputa haor and the Buriganga rivers are moderate, good and bad, respectively. From the experiment it could be concluded that Macro-invertebrate based multimetric indices are reliable tools for assessing water quality of the rivers as well as haor ecoystems.

Indoor environmental quality of residential halls of Bangladesh Agricultural University

Md. Shahadat Hossen
Department of Environmental Science, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
M-mail: mshossen@bau.edu.bd

Abstract
Indoor environmental quality (IEQ) is becoming a key aspect considering occupants health. A total of 450 occupants participated in IEQ occupant satisfaction surveys to investigate their satisfaction with thermal comfort, indoor air quality, lighting level, the acoustic quality of students halls. The study was carried out in the monsoon period (July-August) among the five halls of BAU. The respondents were 51% male and 49% female. The average temperature was 31.21°C, where temperature level varies from 30°C to 32°C. Perception of the thermal condition of the students as 46.4% was neutral, 21.1% was hot, 20.0% was cool, 7.3% was very hot, 3.3% very cool. Humidity level ranges from 78% to 83% with an average of 80.8%. Majority of the student's perception on humidity was neutral (53.8 %), some 17.7 % and 14.7 % stated it was very high and low respectively. Thermal discomfort index varies from 25.97 to 30.08 with an average of 27.50, 28.28, 27.70 for the morning, noon and night time respectively indicating hot to very hot condition. Majority of the student's perception of indoor air quality was average and next poor. The students also indicated that the airflow in the halls was dusty and they were dissatisfied with the indoor air quality. The average light intensity of halls was recorded as 189 lux and varied from 14 lux to 72 lux. Majority of the students were satisfied with visual comfort. Average noise intensity of halls was 36.04 dB and varied from 20 dB to 48 dB. Health symptoms like

fatigue, headache, tiredness and aggressiveness are common scenario faced by occupants due to low IEQ condition. As a result, it will affect the academic performance of the students as much time is spent in hostel rooms.

Development of Environment friendly paddy ecosystem for sustainable rice farming through feasible soil organic amendments and suitable irrigation practices

Muhammad Aslam ali
Department of Environmental Science, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
E-mail: litonaslam@yahoo.com

Abstract

Feasible soil organic amendments and optimum irrigation water supply are pre-requisite for sustainable rice production and maintenance of paddy ecosystem balance. To investigate the optimum biochar amendments and effectiveness of alternate wet and dry irrigations on rice yield, water savings and methane emissions field experiments were conducted for two years (July 2017-June 2019) at the Departmental field of Environmental Science, Bangladesh Agricultural University, Mymensingh. The experimental treatments were T_1: F0W1(No NPK) with 5cm standing water level, T_2: F1W1 (NPKS 100%) with 5cm standing water level , T_3: F2W1(NPKS 50% + 15 t biochar/ha with 5cm standing water level ; T_4: F3W1:NPKS(25%) + 20 t/ha biochar/ha with 5cm standing water level ; T_5: F_4W1: No NPKS (0) + 25 t biochar/ha with 5cm standing water level , T_6: F0W2: (No NPK) with AWDI irrigation, T7: F1W2: (NPKS (100%) + 5 t biochar/ha with AWDI, T8: F2W2: NPKS (50%) + 15 t biochar/ha with AWDI, T9: F3W2: NPKS (25%) + 20 t biochar/ha with AWDI, T10: F_4W2: No NPKS (0) + 25 t biochar/ha with AWDI. In the first year the experiment was started in Kharif season (July, 2017) with transplanted Aman rice BINA dhan-17 and in Rabi season (January, 2018) with BINA dhan-10. Two years data on rice growth and grain yield of the cultivars, soil properties and methane emissions under different treatments were recorded properly. At the end of two years trials, it was observed that the combined application of biochar with NPK fertilizers (50% of the recommended doze) increased rice yield, improved soil physic-chemical properties such as soil porosity, organic C status, soil pH, redox status (Eh), total nitrogen, available P, water extractable iron, free iron oxides and exchangeable cations such as K, Ca, Mg, while a discrepancy observed in regards to methane emissions. Under the AWD irrigation situation, the CH_4 emissions significantly decreased in both rabi and kharif seasons. Rice yield varied between the conventional irrigation and AWD irrigation practices. In aman rice growing season (July-November; 2017 and 2018) no significant variation was observed on rice yield between the irrigation water management practices, however, rice yield significantly increased with biochar amendments in AWD irrigation system. Considering the overall conditions, the integrated use of organic biochar with inorganic fertilizers (50% of the recommended NPK) under alternate wet and dry (AWD) irrigation system could be a feasible strategy for sustainable rice farming and reducing greenhouse gas (CH_4) emissions from rice paddy ecosystem.

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In vivo screening for low glycemic index common rice varieties in Bangladesh through regular and modified recipes

Enamul Kabir, Md. Dilshad Karim, Md. Dilshad Karim and Muhammad Javidul Haque Bhuiyan

*Department of Biochemistry and Molecular Biology, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh, *E-mail : abir062003@gmail.com*

Abstract

In vivo experiment was conducted to screen for low GI common rice varieties. A total of 13 rice varieties comprised with high yielding, aromatic, local, hybrid, inbred, established low GI rice (as control) were cooked by 2 recipes; viz. regular (rice cooker) and modified (rice cooked with 3% extra virgin coconut oil followed by overnight freezing and then serving). In 3 consecutive days, glucose (50g) and rice (50g) cooked with 2 recipes were fed to 10 healthy individuals after overnight fasting. Glucose level (mmol/dL) was measured at 0, 15, 30, 45, 60, 90 and 120 minutes of feeding. Data were arranged in MS-excel programme for determining area under curve (AUC) and GI for 3 cases. We found 3 rice varieties that could be treated as low GI rice. Modified recipe can also induce lower GI compare to their respective GI found in regular recipe in some cases.

Nutritional Food Component Accumulation in *Shitakundia Seem* at Various Stages of Seed Development

Md. Golam Mortuza

Department of Biochemistry and Molecular Biology, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh, E-mail : gmortuza@bau.edu.bd

Abstract

The study was aimed to determine the nutrient composition and functionality of tender green pod, immature seed, fully mature seed and dry seeds of this bean to find out the suitable part at particular developmental stage to be fortified in manufactured feedstuffs. Nutrient composition and amino acid composition were determined by AOAC and functionality was measured using a modification of the centrifugation technique of Lin and Humbert. Results of proximate composition (crude protein, crude fat, crude fibre, ash and carbohydrate) amino acid profile and functionality study (lowest gelation concentration, water- and fat- absorption capacity, foaming capacity and foaming stability) varied remarkably among the flours obtained from various developmental stages of the bean. Considering all aspects, it can be concluded that the kernel obtained from fully matured seed and dry seed of this bean can be a good source for protein supplementation for poor segment of the malnourished people.

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Qualitative estimation of bioactive compound and identification of stevioside in stevia leaf powder by Thin Layer Chromatography (TLC) and High Performance Chromatography (HPLC)

Md. Khairul Hassan Bhuiyan[1*], Shiuly Sultana[2], Arjina Khatun[2], Md. Shahidul Haque[2]

*Department of Physics[1] and Department of Biotechnology[2] ,Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. *E-mail: bhuiyan.phy@bau.edu.bd*

Abstract

Stevioside, a major sweet component of leaves of *Stevia rebaudiana* (Bertoni), is about 300 times sweeter than sucrose where phytochemicals of *Stevia rebaudiana* offers traditional medicinal treatment of various ailments. The present study was aim to evaluate the bioactive compounds, quantify and identify the stevioside through TLC and HPLC from *Stevia rebaudiana.* This study was developed the phytochemical parameters to quantify the bioactive compounds present in different solvent extract obtained from *Stevia rebaudiana*. Preliminary qualitative estimation of the extracts revealed the presence of glycosides, carbohydrates, alkaloids, terpenoids, steroids, flavanoids, tannins, resins, organic acids, emodins etc are found in the stevia extraction. The highest amount of total carbohydrates (560 mg/g), and total reducing sugars (85 mg/g) was observed in stevia leaves. Using thin layer chromatography (TLC) different components like glycosides, alkaloids flavonoids, terpenoides, phenol & tannin are isolated & identified. The R_f values of the developed spots in the different solvent systems are noted. Finally, the stevioside are identified and quantified also through HPLC. In HPLC analysis, the percentage stevioside content of commercial stevia powder and different solvent extracts (cold water, hot water, ethanol, methanol, acetone) of stevia leaves were found to be 40.6%, 10.9%, 14.8%, 10.7%, 18.7%, and 15.4% respectively **(** 5mg/mL stevia extracts powder**).** Further work is necessary to search out the active ingredients present in this extracts having anti-diabetic efficacy.

Screening Water logging Tolerant Brinjal Genotypes through Induced Mutation and Advanced Techniques

Muhammad Humayun Kabir, Shaila Shermin Tania and Partha Pirtom Das

Department of Seed Science & Technology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: humayunhort70@gmail.com

Abstract

The project was under taken with an objective to identify brinjal genotypes which are tolerant to excess soil moisture conditions. An experiment viz, pot culture was conducted during 2018-2019 at BINA farm, Mymensingh. Nine genotypes were screened at maximum vegetative growth stage by pot culture experiment to identify tolerant types for excess soil moisture condition by imposing excess moisture for 72 hours duration. Two genotypes Baisha begun and Shrabonti were survived in waterlogging condition. Observations of the genotypes which survived in excess soil moisture were recorded and showed that the genotypes differed significantly for the characters under study. The genotypes Baisha begun and Shrabaoti which recorded the highest survival percentage were selected under water logged condition. The single fruit per plant 136.44gm was recorded in Baisha Begun which was irradiated to 75 Gy gama irradiation to survive in excess soil moisture condition. In the present study, Baisha begun was identified to have tolerance to waterlogged condition under 75 Gy gama irradiation This tolerant genotypes can be used as parents for further study.

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Genetic differentiation of buffalo populations in Bangladesh

Md Omar Faruque[1*], Shuvra Debneth[1], Yi Zhang[2] and Abdullah Ibne Omar[2]
[1]Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and [2]National Engineering Laboratory for Animal Breeding, Key Laboratory of Animal Genetics and Breeding and Reproduction of MOA, China Agricultural University, Beijing, China
**E-mail : faruque_mdomar@yahoo.com)*

Abstract
This study is being conducted on buffaloes in Bangladesh and nine countries of Asia to find out the genetic differentiation and selection sweeps in Asian water buffaloes. DNA samples are being collected from main breeds/populations of water buffaloes of ten countries, DNA sequencing as well as SNP genotyping are being conducting in China Agricultural University, Beijing. The partial results on genetic differentiation of Bangladeshi water buffaloes based on Admixture analysis are being addressed here.So far, DNA from 20 swamp buffaloes, 21 primitive river buffaloes (*Bubalus bubalis arnee*), 8 pure Murrah, 9 improved indigenous river buffaloes and 12 crossbred (indigenous river X Murrah/ Nili-Ravi) buffaloes was extracted, sequenced and genotyped. Admixture analysis reveals the genetic background of different Bangladesh buffalo populations. Considering Murrah and Chinese buffalo as the reference of pure river type and swamp type respectively, Lulpur population shared the same genetic background of Murrah, whereas Bangladesh swamp buffalo population and primitive river type buffalo population are subject to historical introgression. The Bangladesh swamp buffalo is primarily swamp type but has introgression from river type buffalo. The primitive river type buffalo is primarily river type but has introgression from swamp buffalo.

Comparative Growth Performances of Aseel and Indigenous Chicken Under Semi-Intensive System

M.O. Faruque*, M.A. Haque and K. Nahar
*Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, * E-mail : faruque_mdomar@yahoo.com*

Abstract
This study is being conducted on Aseel in Sarail Upazila of Brahmanbaria district and on Indigenous chicken in Nagar of Barigram Upazila of Natore district to produce pedigree flock for higher adaptation and growth rate. Pedigree flock covering consecutive three generations with full records on growth up to 90 days and meat yield has already been produced. The results on growth rate, meat yield and tested genetic markers of G_1 (2^{nd} generation) are being addressed here.All the experimental chickens were leg banded/ wing banded and allowed scavenging except Aseel cocks. Aseel cocks were fed in confinement. Control and natural mating was practiced for Aseel in Sarial. In Nargar, random and natural mating was practiced. Weight of all chickens at hatch, at day 60 and day 90 were recorded. Routine vaccination for New Castle Disease, Fowl Pox, Fowl Cholera and routine deworming was practiced for all the experimental chickens. The weight at hatch, at day 60 and day 90 of Aseel and Indigenous chicken were 30.58 ±0.03 g (n = 624) and 22.25 ±0.02 g (n = 840), 372.62 ±0.28 g (n = 345) and 216.51±0.40 g (n = 437), 565.57 ±0.88 g (n = 202) and 408.19±0.72 g (n = 260), respectively. The hatch weight, weight at day 60 and day 90 of Aseel were significantly higher ($P < 0.01$) than those of Indigenous chicken.Average dressing% of Aseel and Indigenous chicken at day 90 was 54.87±35% and 54.18±0.45%, respectively. The differences in dressing% of two genotypes of chickens were not significant ($p > 0.05$). There was variation in dressing% of chickens of both genotypes for high and low growth rate. Genetic markers viz., GHR 2, GHR 5, IFG 1 and IFG 11 were proved positive in PCR amplification. RFLP study is in progress. Aseel can be used for future breeding program to develop meat type strain in Bangladesh.

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Popularization of Artificial Insemination in Black Bengal Goat

M. A. M. Yahia Khandoker* and MR Islam
*Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail : yahiakhabg@gmail.com*

Abstract
The research was carried out in Artificial Insemination Center and Reproductive Biotechnology Laboratory, Department of Animal Breeding and Genetics, Bangladesh Agricultural University. The experiment was performed to maintaining superior quality Black Bengal breeding bucks, production of frozen semen and popularizing artificial insemination (AI) by using frozen semen. Five breeding bucks at weaning age were purchased from DLS. Three bucks are in trail condition to ejaculation of semen. From each buck, 5 ejaculates were evaluated. The range of ejaculate volume, individual motility, sperm concentration, live spermatozoa and normal spermatozoa were as 0.31 to 0.51 ml, 78 to 80%, 2.46 to 3.10 billion/ml, 83 to 87% and 82 to 86%, respectively. The initial semen characteristics are desirable for frozen semen production. Trail of frozen semen production is continuing with regular basis in Reproductive Biotechnology Laboratory, Department of Animal Breeding and Genetics, Bangladesh Agricultural University. The research work is still going on to production of frozen and artificial insemination will be performed at BAU surrounding villages.

Maintenance of reproductive biotechnology laboratory and *in vitro* production of embryo

M. A. M. Yahia Khandoker* and M. Y. Ali
*Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh, *E-mail : yahiakhabg@bau.edu.bd*

Abstract
The present research project is conducting to maintain the reproductive biotechnology laboratory and for*in vitro* production of embryo.Repairing of CO_2 incubator, laminar airflow, water bath and dryer been finished. Required chemicals and reagents, culture dishes, pasture pipette, syringe with needles, glass slides, cover slips, gloves etc been purchased. Last year, three masters student conducted their research work for their MS thesis. The titles were; i) Morphometric and histochemical study of cattle and goat reproductive organ;ii) Evaluation of bovine ovaries and follicles by histological study intended for *in vitro* production of embryos; and iii) Evaluation of goat ovaries and follicles by histological study intended for *in vitro* production of embryos. The reproductive organs weredivided based on presence or absence of corpus luteum (CL)in the ovary. The weight,length and width of the ovary been measured. The weights of goat left and right ovary was 0.58±0.06 and 0.89±0.11g but in case of cattle, the weights of left and right ovary were 1.77±0.41 and 2.20±0.57g.Average weights of the bovine ovaries with and without CL were 2.93±0.38 and 1.52±0.30g, respectively where ovary weight was significantly ($p<0.05$) higher in CL present group than CL absent group. Depending on the follicular diameter, 2-6 mm follicles with CL and without CL were 9.83±2.23 and 15.90±1.73, respectively.In contrast, the histological study revealed that the total number of follicles in goat ovaries with corpus luteum was 10.07±2.47 among which the primary, secondary, antral and graafian follicles were 4.44±1.59, 4.05±1.61, 0.92±0.21 and 0.14±0.06, respectively. While the total number of follicles in ovaries without corpus luteum was 11.10±3.39 among which the primary, secondary, antral and graafian follicles were 4.44±1.59, 1.45±0.83, 6.27±1.31 and 0.42±0.25, respectively.It might be conclude that CL absent ovaries would be the potential source for quality follicle and oocytes for further progression of *in vitro* embryo production experiment.

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Reciprocal Crossing between Pekin and Nageswari Duck to Produce F_1 Crossbreds for Better Meat Production

MSA Bhuiyan*, AKFH Bhuiyan and MT Ahmed
*Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail : msabhuiyan@gmail.com*

Abstract
The present study was conducted to investigate the growth, morphology, morphometry and meat yield performances of F_1 crossbreds between Nageswari and Pekin ducks. A total of 160-day old ducklings was procured for this experiment and were being reared in 4 different pens from day old to 20th weeks of age in deep litter system. Management, feeding practice and vaccination schedule were same throughout the experimental period. Growth performances were highly significant among the 4 genotypes (P<0.001) from day old to 20th week of age. The average live weights of Pekin, Nageswari, P♂ x N♀ and N♂ x P♀ crossbred genotypes at 10th week of age (marketing age) were 1877.13± 48.14, 1352.92 ± 27.87, 1733.82 ± 36.82 and 1871.85 ± 28.80g, respectively. Notably, average live weights during 10th to 16th week of age were non-significant between Pekin and N♂xP♀ crossbreds which indicates possible replacement of exotic Pekin by N♂ x P♀ crossbreds for better meat production. The crossbred genotypes P♂ x N♀ and N♂ x P♀ gained about half kilogram more live weight than Nageswari ducks during 10-12th week of age. The morphology and plumage pattern of crossbred ducks were almost similar to Nageswari breed due to dominant inheritance of Black allele. Genotype had significant differences for morphometric measurements except neck and wing length. Meat yield characteristics had significant variations for most of the studied traits among the four different genotypes while most of them had insignificant differences (P>0.05)between Pekin and N♂ x P♀ crossbreds. Moreover, the N♂ x P♀ crossbreds had 50% native inheritance which contributed for better adaptation in agro-climatic condition of Bangladesh. Altogether, our results revealed that N♂ x P♀ genotype could be a valid alternative against the exotic Pekin duck for higher meat production with better adaptability in semi-intensive management system of Bangladesh.

Molecular Detection and Utilization of Candidate Genes Polymorphisms Associated with Increased Prolificacy in Indigenous Sheep of Bangladesh

MSA Bhuiyan*, MM Hossain, R Basrin, MA Mousumee and R Khanom
*Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail : msabhuiyan@gmail.com*

Abstract
This study was conducted to detect genetic polymorphisms (SNPs) in the selected fragments of four candidate genes related with prolificacy traits in sheep and their possible associations with litter size in indigenous sheep of Bangladesh.In total, 257 blood samples were collected fromunrelated mature individuals of Coastal region, Jamuna river basin and Sundarban delta region those who had at least 3 parities information and then DNA extraction and quantification were performed.A total of six primer pairs either selected based on the previously reported information or synthesized to amplify one or two fragments of four prolificacy related candidate genes. A set of PCR products (10-12 samples) from each gene fragment were sequenced both in forward and reverse directions through commercial sequencing service provider. PCR-RFLP method was employed for genotyping of all polymorphic loci except the c.218A>G SNP locus of *INHBA* gene due to absence of restriction site and therefore, direct sequencing was performed particularly for genotyping of that locus. Single marker association analysis

between polymorphic loci and prolificacy trait was performed using mixed model equation implemented by SAS ver. 9.3.1. The concentration of extracted DNA varied between 25.1-244.9 ng/µl and purity of those samples was ranged from 1.78-2.00. All six PCR amplicons were amplified successfully in indigenous sheep of Bangladesh. Sequence analysis revealed the SNPs c.746A>G and c.218A>G in *BMPR1B*and *INHBA* genes were polymorphic. However, 3 other mutations in *GDF9* (c.260G>A and c.1111G>A)and *BMP15* (c.718C>T) genes were monomorphic, and one mutation in *BMP15* (c.871C>T) was absent in the studied populations. The two polymorphic SNPs in *BMPR1B*and *INHBA* genes (c.746A>G and c.218A>G, respectively) had significant association with litter size in indigenous sheep of Bangladesh. The mean litter size of ++, +B and BB genotypes of *BMPRIB* gene were 1.19± 0.07, 1.44± 0.09 and 2.13± 0.09, respectively. On the other hand, the mean litter size of AA, AG and GG genotypes of *INHBA* gene were 2.11 ± 0.39, 1.70 ± 0.30 and 2.83 ± 0.40, respectively. Locations also had significant association with litter size trait. The mean litter size of Jamuna river basin sheep population (2.83 ± 0.40) was significantly higher than those of Sundarban delta (1.71 ± 0.09) and Coastal region populations (1.09 ± 0.04) for *BMPR1B* genotypes. Besides, the mean litter sizes were found to be 3.09± 0.11, 2.67 ± 0.33 and 1.00 ± 0.00, respectively in the flocks of Jamuna river basin, Sundarban delta region and Coastal region for *INHBA* genotypes. More particularly, mutant alleles for these two polymorphisms ($FecB^{BB}$ and GG) associated with increased prolificacy were predominantly higher in Jamuna river basin flocks compared to Coastal and Sundarban delta region flocks. In conclusion, considering cost, convenience and SNP distribution, c.746A>G polymorphism of *BMPR1B* gene could be used as a molecular marker in MAS program for improving prolificacy traits of Indigenous sheep at population level.

Improving Lamb Production Potentiality of Native Sheep through Selection and Genetic Enhancement

MM Hossain[1], AKFH Bhuiyan[1], MSA Bhuiyan[1*] and MA Jalil[2]

*[1]Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Mymensingh-2202 and [2]Goat & Sheep Production Research Division, BLRI, Savar, Dhaka, *E-mail: mmhabg@gmail.com*

Abstract

Sheep stand third in number among ruminant species in Bangladesh and are reared by the farmer mainly for meat production. Although, the productivity of the native sheep are very low compared to improved sheep around the world but they possess many positive attributes. They are capable of bi-annual lambing with multiple births and tolerant to various common diseases. Little attention has been paid till now for increasing their productivity. Present research work is being carried out to improve lamb production potentiality of native sheep through a systematic breeding using of multitier gene flow and genomic information through high throughput genotyping. During the first year, initial field visits to the sheep populated areas and baseline survey on the phenotypic characteristics of native sheep has been conducted. A farmer's society in Bhuanpur, has been established. Ten rams selected based on the phenotypic characteristics have been already distributed among the farmers of the baseline flock for genetic improvement. Foundation of elite sheep breeding flock has been established at BLRI, where selection of ewes and ram from the existing flock of BLRI has been performed. A total of one hundred seventeen DNA samples from the blood of selected native sheep has been purified to perform throughput genotyping analysis using 50k SNP bead chip. A modern Animal Genomics and Breeding Lab has been established at BAU through necessary construction and renovation where DNA and relevant genetic analysis are being carried out. In addition, a trial ram station has been constructed to support ram testing services for future ram selection and distribution program. After accomplishment of all project activities, the proposed research will enhance the genetic merit and sustainable conservation of native sheep of Bangladesh as well as improve the livelihood of rural sheep owners in Bangladesh.

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Study on the production potential of Black Bengal goat and income generation activities using frozen semen under community-based participatory rearing system

Husain SS[1*], Islam MR[2] and Ali MY[3]
Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Bangladesh
**E-mail-sshusain53@gmail.com*

Abstract
The work of the project has been conducted at the Bhabokhali village along the side of Brahmaputra River with a view to investigate the production potentiality of Black Bengal goat using frozen semen under community-based rearing system and the socio-economic enhancement trend of contact registered farmers. Twenty-one Black Bengal does were distributed to the goat keepers particularly female as experimental material. Goats were collected from the previous USAID ended up project, from Government Goat Development Farm, Savar and market. All goats were of six to eight months of age. Different productive and reproductive traits of Black Bengal goats were recorded. Goats were inseminated with the frozen semen of selected Black Bengal bucks. Data on different parameters were analyzed using Statistical Analysis System (SAS). The productive performance of Black Bengal goat were 0.94±0.01 kg, 4.12±0.04 kg, 7.00±0.10 kg, 37.51±0.63 g/d, 32.29±0.95 g/d, and 251.25±2.95ml/d, respectively for birth weight of kids, body weight at 3-month and 6- month of age, average daily gain at 3-month and 6-month of age and daily milk yield. The reproductive performance of the goat were 1.82±0.10, 1.50±0.09, 146.33±0.64 days, 95.87±2.95 days, 201.60±3.01 days, 7.65±1.97 kg, 45%, 15.65%, respectively for the litter size, service per conception, gestation period, post-partum heat period, age and weight at first heat, conception rate and kid mortality. The estimated heritability for birth weight, 3-month and 6-month weight were 0.19±0.03, 0.35±0.07 and 0.10±0.05. Therefore, the AI program with frozen semen of Black Bengal buck would be beneficial to the farmers under community-based participatory rearing system. The annual total cost of production of Black Bengal goat was Tk. 2500, while gross return and net profit per goat keepers per year were Tk. 16000 and Tk. 13500, respectively. The results clearly indicated that the socio-economic condition of registered goat keepers was increased drastically.

Evaluation of Adaptability, Fertility, Prolificacy and Growth Performance of Boer Goat under Hot Humid Climate of Bangladesh

Auvijit Saha* Apu and . Md. Ruhul Amin
*Department of Animal Breeding and Genetics, Bangladesh Agricultural University Mymensingh-2202, Bangladesh, *E-mail: auvijit.bau@gmail.com*

Abstract
Boer goat has gained worldwide recognition for its excellent body conformation, fast growing rate and good carcass quality. It is considered as one of the most desirable goat breeds for meat production. Previous research works in different countries showed that the productive and reproductive performances varied based on agro-climatic condition. Therefore, the present study was aimed to evaluate the adaptability, fertility, prolificacy and growth rate of boer goat under hot humid climatic condition of Bangladesh. A total of 20 boer goats were selected for this research work of which five (5) were boer breeding bucks and fifteen (15) were boer does. After importation to our country, they were maintained in the farming condition of Bangladesh and from our study it was revealed that boer goats were excellent to cope with our environment and managemental condition. Boer breeding bucks were also trained and semen was collected successfully from them by AV method. It was found that

average semen volume was 0.71±0.08 ml, sperm concentration 2984.00±15.82×106/ml, live sperm 84.26±1.23% and individual sperm motility 76.17±1.13%. The fertility was reported 58.23% through AI to the heated does. The average litter size was 1.78 of which 65.67% had multiple births. Birth weights of male kids (3.6±0.19 kg) were higher than female kids (3.1±0.19 kg) and the average daily gain was 94.44±0.73 and 86.03±0.79 g/day in male and female boer goats upto 3-months of age, respectively. These results have suggested that boer goats can be adapted in our hot humid climatic condition with higher fertility, prolificacy and growth rate. In this context, it is recommended that boer goat can be introduced in our country to minimize the scarcity of animal protein and ensure the food security of Bangladesh.

Characterization, Conservation and Improvement of Indigenous Aseel Chicken of Bangladesh

A. S. Apu[1*] and S. C. Das[2]

*[1]Department of Animal Breeding and Genetics and [2]Department of Poultry Science, Bangladesh Agricultural University,Mymensingh-2202,Bangladesh, *E-mail: auvijit.bau@gmail.com*

Abstract

Bangladesh has a rich heritage of indigenous chicken germplasm which is composed of Non-descriptive Deshi, Aseel, Naked Neck, and Hilly chicken. Among them Aseel is a rare variety found only in Brahmanbaria district and some parts of Chittagong Hill Tracts. It is mainly used for cock fighting. However, the number of Aseel chicken is significantly decreased day by day and now at the risk of extinction. From this point of view, the present research work has been undertaken for the characterization, conservation and improvement of Aseel chicken of Bangladesh. A benchmark survey was conducted to collect information on population structure, distribution pattern of the Aseel chicken in Brahmanbaria district and and it was found that 74% Assel chicken was found in Sarail upazilla whereas sadar, Nasirnagar and Ashuganj upazilla of Brahmanbaria district had the rest 26% Aseel chicken. All the cocks were reared under intensive management system whereas others such as hens, pullets, cockerels and chicks were reared under semi-intensive management system. On the other hand, a nucleus breeding flock (NBF) has been established in Bangladesh Agricultural University AI center where selected Aseel chicken of different ages from their home tract (Brahmanbaria) was brought into the NBF. From the present study, it was found that different morphological variants like shank colour and beak color of aseel chicken was yellow, ear lobe colour red and comb type was pea in both sexes. Age at first lay was found 244.29±8.62 days, average egg weight 46.38±0.07 g, clutch size 3.87±0.06 and hatchability was 72.23±8.63%. This is on-going research work. Selective breeding will be performed in the NBF for the improvement of this valuable genetic resource and recording of the performances will be continued for the appropriate documentation of the potentiality of this genetic resource.

Impact of Community Based Breeding Program for the Sustainable Genetic Improvement of Black Bengal goat

Auvijit Saha Apu*, Syed Sakhawat Husain and Md. Younus Ali

*Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: auvijit.bau@gmail.com*

Abstract

Black Bengal goat is a potential genetic resource in Bangladesh. But due to acute shortage of genetically superior Black Bengal breeding bucks, a large number of heated does remain unserved.

Therefore, the productive and reproductive life is being shortened. From this point of view, the present study is being carried out to introduce community based breeding program and analyze its impact on the genetic improvement of Black Bengal goat. In this study, a baseline survey was conducted to identify the promising goat rearers, their socio-economic status and problems regarding goat rearing. Based on the survey results, a total of 30 goat rearers in three areas were selected, trained and build up community with them. Besides these, screening and selection of potential breeding bucks has been performed and distributed three bucks to the three potential farmers in the community. The management and performance of bucks and does were monitored closely. From the results of the present study, it was observed that scarcity of breeding bucks has been decreased in these areas and no heated does remain unserved. The analysis of the growth performance showed that the male kids attained higher body weight (1.28±0.04 kg) than that of female kids (1.06±0.02 kg). Subsequently with the passage of time, males reached higher body weight than females. Average daily body weight gain up to 12 months of age was also significantly higher in male (42.82±0.67 g/day) than females (36.03±0.38 g/day). From the reproductive performances, it was reported that the age at sexual maturity was 199.32±2.41 days; service per conception 1.17±0.04, litter size was 1.76±0.08. This is an on-going research work. The results obtained so far suggested that community based breeding program not only reduced the scarcity of good quality breeding bucks but also improved the productive and reproductive performances of Black Bengal goats.

Red Chittagong Cattle Breeding and Revealing Their Genetic Architecture Using High Density Single Nucleotide Polymorphism Array

AKFH Bhuiyan*, MSA Bhuiyan, SMJ Hossain[1], GK Deb[1] and MFH Miraz[1]

Department of Animal Breeding & Genetics, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh and [1]Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka

**E-mail: bhuiyanbau@gmail.com*

Abstract

The Red Chittagong Cattle (RCC) is a valuable cattle genetic resource of Bangladesh. The objectives of this project were to assess the performance of pure and graded RCC with a view to make available young bulls to national breeding service providers and to investigate the genetic diversity and genomic architecture of RCC using high density SNP markers. Data on a total of 822 pure RCC of different ages and sexes available in BAU, BLRI, DLS, BRAC, ADL etc. except rural farmers of greater Chattogram district and elsewhere have so far been collected, a standard database developed and uploaded in National RCC website. Alongside, a total of 162 Local Non-descript cows have been bred with pure RCC semen produced at the BAU AI Centre to produce graded RCC in Mymensingh district which are also being tracked. Standard RCC Herd Book has been developed and data on pedigree and traits of economic are being kept on all identified RCCs and graded RCC. For molecular study, 114 blood samples from pure and unrelated RCC have already been collected from BLRI, ADL, Chattogram and Mymensingh. Besides, 167 blood samples were collected from Pabna, North Bengal Grey, Munshiganj, Sahiwal and Indigenous cattle. The concentration of extracted DNA samples ranged between 32.6 to 279.8 ng/µl whereas purity of those samples varied between 1.67 and 2.00. In total, 210 samples have already been sent to commercial sequencing service company for genotyping by Illumina 50K SNP bead chip and are waiting for genotyping results. On the other hand, 8 ear tissue samples were collected from pure and unrelated RC cows and bulls. The extracted DNA samples are ready for whole genome sequence using Illumina NGS technology. Twelve potential pure young RCC bulls with known pedigree records have been screened and their fortnightly body weight, growth and andrological data are being recorded at the BAU AI Centre for making meritorious yearling RCC bulls.

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Development of Meat-Type Duck through Reciprocal Crossing Suitable for Semi-Scavenging System in Bangladesh

MSA Bhuiyan[1*], MS Ali[2] and D Nandita[1]

*[1]Department of Animal Breeding and Genetics, BAU, Mymensingh 2202, Bangladesh and [2]Department of Poultry Science, BAU, Mymensingh 2202, Bangladesh, *E-mail: msabhuiyan@gmail.com*

Abstract

The aim of this project is to develop a meat type crossbred ducks suitable under semi-scavenging and agro-climatic conditions of Bangladesh. A total of 200-day old ducklings (100 Pekin and 100 Nageswari) were collected and has been maintained at BAU AI center since January 2019 to know their actual growth and production performances under optimum feeding and management condition. Rigorous selection was performed twice at the age of 9th and 16th week based on their growth performance and phenotypic features. Finally, fifty Nageswari and fifty Pekin ducks (40 ducks and 10 drakes from each breed) has been maintained as nucleus flock. As expected, pekin ducks are heavier than Nageswari ducks in all stages of growth. The live weights of Nageswari ducks at 1st, 10th and 20th week of age were 49.42±0.54, 1254.55±17.64 and 1461.31±22.21g, respectively while the live weights of Pekin ducks at the corresponding ages were 57.24±0.52, 1770.74±28.91 and 2018.92±39.23 g, respectively. The average age and weight at first egg of Nageswari duck were found to be 123 days and 1417.58±11.55g, respectively. Pekin ducks attain puberty 2 weeks later where the age and weight at sexual maturity were found 134 days and 2014.38±52.67g, respectively. Hen day egg production at 25th week was significantly higher in Nageswari (78.77±0.81%) than Pekin (55.10±1.58%) duck. In contrast, egg weight was remarkably higher in Pekin duck (69.42±3.92g) compared to Nageswari duck (61.71±2.37) at 25th week of age. The mortality rates up to 26th week of age was found less than 2.0 % for both genotypes. A total of 200 eggs were set in incubator for obtaining pure and crossbred ducklings of first generation (F_1). This will eventually lead to select potential birds from the flocks with appropriate genetic proportions for the development of better meat producing duck without declining egg production potentials.

Induced inflammatory stress mediated response in the physiology of oocyte maturation and *in vitro* embryonic development of indigenous cattle

Md. Munir Hossain

Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, E-mail: mmhabg@gmail.com

Abstract

Mammalian oocytes and embryos are delicately sensitive to infection and endotoxin exposer. Cells manifest specific responses to inflammation but these stressors initiate downstream signaling events leading to embryo demise, failure to implant and infertility. Present study was conducted to determine the effect of inflammation induced by lipopolysaccharide (LPS) during the maturation of oocyte on bovine early embryonic development. *In vitro* maturation (IVM) of 898 selected COCs aspirated from 410 slaughterhouse ovaries was done for 24 hours in supplemented TCM-199 with Earle's salts medium at 38.5ºC in a humidified atmosphere of 5.5% CO_2 with LPS (N=401) and without LPS (control, N=497). *In vitro* fertilization (IVF) of both group of oocytes and *in vitro* culture (IVC) of presumptive zygotes obtained from both oocyte with LPS and control were performed separately for 8-9 days post IVF. The result revealed a significantly lower diameter of LPS treated oocytes (5.844 ± 0.611 µm vs 10.58 ± 0.873 µm, P=0.0006) in LPS treated oocytes at MII stage compared to that of control group. Similarly, a significant (P=0.0029) average increase in cumulus expansion of LPS group (126.0 ± 10.83 µm) was found to be lower in LPS treated COCs than that of the control COCs

group (200.3±13.45 µm). Further, significant lower fertilization rate (73.34 ± 0.8197% vs 77.27 ± 3.967%, P=0.004), lower average cleavage rate (73.05 ± 0.8486% vs 80.66 ± 2.85%, P=0.1313) and lower blastocyst rate (20.55 ± 1.43% vs 29.64 ± 1.99%, P=0.0047) was observed in LPS treated group compared to that of control group. Result of the study implies that induced inflammation lowers oocyte growth and maturation and impairs IVP in cattle. So, the infection related inflammation and associated stress should be avoided during IVC to reduce the negative impact on IVC and to improve the outcome of *in vitro* production of bovine embryos.

Devising embryo biopsy system and separation of male and female bovine embryo in vitro through DNA technology

Md. Munir Hossain* and AKFH Bhuiyan

Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

**E-mail : mmhabg@gmail.com*

Abstract

There has been an increasing demand to multiply the genetics of valuable cow and accelerate genetic improvement through embryo transfer in Bangladesh. However, intensive studies need to be carried out to optimize the procedure for making this technique readily available in Bangladesh. The present research was proposed with the goal to standardize the procedures of in vitro production of cattle embryo with known sex, to make the technology readily adoptable to the cattle industry. The experiment is being carried out to optimize the culture conditions for in vitro maturation, in vitro fertilization and in vitro embryo culture using media ready to use with standard supplementation. Once optimized, high quality embryos at 2-cell stage will be microsurgically bisected using microneedle immediately after digestion of zona pellucida of embryo using pronase enzyme or through mechanical disruption. Separated blastomeres from the same embryo will be cultured in well-in-well dish for the assessment of developmental competency. At day-5 stage, one half of cultured bisected embryos will be analyzed for the determination of the sex by PCR. For the sexing of embryo, DNA will be extracted from biopsied cells of the embryo by appropriate genomic DNA isolation kit and will be further amplified through a duplex PCR using the primes for the DNA sequence which differs between sexes. Culturing second half of the biopsied blastomeres from the same embryo will be continued in vitro up to day-7 and developmental rate as well as viability will be assessed. Result of this study and devising procedure for the in vitro production of bovine embryo and analysis of microsurgical bisection of in vitro produced embryos in combination with PCR based sex determination will provide a rapid and reliable approach to be adopted for increasing the number of calves with predetermined sex from embryo transfer programs in Bangladesh.

Beefing up Indigenous Cattle Embryo Production In Vitro through Primary Co Culture System

Md. Munir Hossain* and Mohammad Al-Mamun[1]

*Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and [1]Department of Animal Nutrition, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh,*E-mail: mmhabg@gmail.com*

Abstract

Co-cultures are suggested for the production of embryos because of the beneficial effects of cellular monolayers of various somatic cell types on mammalian embryonic development. Co-culture enhances secretion of tropic factors such as nutrients, substrates, growth factors, and cytokines and removal of potentially toxic substances from culture medium by co-cultured cells during in vitro embryo

production (IVP). In this regard, different somatic cell types could be used for co-culture including granulosa cells, oviductal cells, uterine cells, fetal bovine endometrial fibroblasts etc. Present study aimed to identify the effect of somatic cells on the in vitro development of bovine embryos. For this, bovine ovaries were collected from local slaughterhouse, cumulus oocyte complexes (COCs) were aspirated from the ovaries, in vitro maturation (IVM) of selected COCs and in vitro fertilization (IVF) of matured oocytes was performed with frozen semen. Bovine embryos (presumptive zygotes) were co-cultured with two different primary cells namely endometrial epithelial and oviductal epithelial cells in vitro. Cleavage rate of presumptive zygote co-cultured with endometrial cells, oviductal cells and without any co-culture was found as 59, 74 and 44%, respectively. Blastocyst rate of embryos co-cultured with endometrial cells, oviductal cells and without any co-culture was found as 29, 36 and 14%, respectively. It has been observed that presumptive zygote co-cultured with oviductal epithelial cells shows significantly higher embryo cleavage and embryo developmental potential compared to co-culture with other cell types. In Bangladesh, lack of sequential ready to use culture media, different altitude, single gas (CO2) incubator, lack of standard laboratory condition hinders the success of in vitro embryo production. So, introducing embryo co-culture system with oviductal epithelial cells could be an avenue to overcome this limitation for IVP of indigenous cattle embryos.

Effect of oocyte quality and molecular regulation of PDIA3 gene in the outcome of in vitro maturation, fertilization of bovine oocyte and embryonic development

Md. Munir Hossain

Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, E-mail: mmhabg@gmail.com

Abstract

Maternal PDIA3 transcript in oocyte has been shown to play an important function in gamete fusion and early embryonic development supporting its utility as a potential tool for predicting the in vitro developmental competence. This study has been conducted with the aim to provide more empirical evidence concerning the cellular and functional role of PDIA3 in oocyte competence and in vitro embryonic development. Based on cytoplasmic lipid content,oocytes were grouped in to high cytoplasmic lipid content (HCLC) and low cytoplasmic lipid content (LCLC) group. Cumulus oocyte complexes (COCs) from HCLC and LCLC groups were matured (IVM), fertilized (IVF) in vitro and subsequentlyin vitro culture (IVC) was performed. Expression abundance of PDIA3 was evaluated and compared among immature oocyte, mature oocyte of both groups and blastocyst-stage embryo derived from oocytes with HCLC and LCLC.Analysis has revealed significant differential regulation of PDIA3 gene in HCLC and LCLC group of COCs during oocyte maturation. Expression of PDIA3 in the COCs at maturation stage found to be significantly higher compared to the immature one. Higher expression of PDIA3 in the HCLC group indicates its important role in the oocyte maturation which revealed the observed higher in vitro embryonic developmental thereby. Similarly, significant differential regulation of PDIA3 gene between the blastocysts derived from HCLC and LCLC group of COCs has been observed. Expression of PDIA3 in the blastocyst derived from HCLC found to be significantly higher compared to that of blastocyst from LCLC group. The result indicates that the selected oocytes based on their cytoplasmic lipid content associated to the abundance of PDIA3 gene transcript and thereby possess higher potentiality in the preimplantation embryo development in vitro. So, selection of oocyte according to the cytoplasmic lipid content could lead to improve bovine in vitro embryo production (IVP).

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Characterization of poultry manure biochar: a tool for soil fertility, bioenergy supplementation and environmental conservation

MZ Mahbub, S Debnath and MM Rahman*
Department of Animal Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
** E-mail: mmrahman.as@bau.edu.bd*

Abstract
Livestock populations increase every year in order to fulfill the demand of the increasing human population. With increasing livestock populations, large amounts of manure are produced daily that can be useful resources if utilized properly. Pyrolysis is an alternative solution to the management of large amounts of manure, while simultaneously producing renewable and sustainable energy by converting biomass into high-value products such as biooil, syngas and biochar in the absence of oxygen at high temperatures (300–800 °C). For this purpose, a reactor was designed for the pyrolysis of poultry litters (layer and broiler) at different operational conditions. Result showed that 38 and 35% biochar was produced from broiler and layer litter respectively at 400 °C temperature. Bio-oil production was found 21 and 25% respectively from broiler and layer litter. An effective calorific value of broiler and layer liter bio-oil (9900 and 9,950 kcal/kg, respectively) was observed that can be utilized as bio-fuel. The density and viscosity of produced bio-oil from broiler and layer litter was same (1.008 and 0.91). FTIR value of layer litter biochar revealed that the hydroxyl, acid and alkaline groups were activated at 3400 cm^{-1}, 2800 cm^{-1} and 1500 cm^{-1} position. Layer litter biochar might be used as soil amendment and the bio-oil might be used as bio-fuel. It may be concluded that poultry manure is a good source of biochar and bio-oil that might be helpful to increase soil fertility and for the supplementation of bio-energy.

Estrus Synchronization of Buffaloes Using pgf2α and Gnrh Based Protocols

Md. Mahmudul Hasan Pasha, Biman Chandra Roy, Avijit Kumar Modak, Md. Nuronnabi Islam, Ireen Akhter, Shonkor Kumar Das[1] and Mohammad Moniruzzaman*
*Department of Animal Science and [1]Department of Anatomy and Histology, Bangladesh Agricultural University, Mymensingh 2202,Bangladesh, *E-mail : monir.as@bau.edu.bd*

Abstract
Estrus synchronization is a valuable tool for controlled breeding of animals in silent estrus. The aim of the present study was to compare the efficacy of PGF2α and GnRH based protocols of estrus synchronization in local buffaloes in Jamalpur region of Bangladesh. An initial experiment was done with 6 buffalo cows at Goat, Sheep and Horse farm, BAU to know the working dose of PGF2α in synchronizing estrus. Three animals treated with 2ml of PGF2α and other three received 5ml of PGF2α. All the animals received double PGF2α injection 11 days apart. In 5ml group all three animals were in estrus but in 2ml group, no animal showed estrus. Finally, 5ml of GnRH (Day -15) was injected in a group of 08 buffalo cows in Jamalpur Sadar. The PGF2α injection (5ml) was given 9 days (Day -6) later. The second GnRH injection was given 2 days after PGF2a (Day -4) and in PGF2α group, synchronization was initiated by injection of 5 ml of PGF2alpha (Day -15). The second PGF2α injection was administered 12 days later (Day -4). In GnRH group, all buffaloes were inseminated artificially 16 hrs after the last GnRH administration. Buffaloes were inseminated artificially 90 hrs after the last PGF2α administration. The synchronization rate was assessed by visual observation for estrus signs and per rectal examination at the time of AI. All animals were examined per rectally for

confirmation of pregnancy at 60 days post-insemination. The results showed that numerically higher synchronization response occurred in GnRH treated buffaloes than PGF2α treated group. However, the results did not differ significantly ($p>0.05$). In terms of conception rate, the results did not show significant difference between the groups ($p>0.05$). In conclusion, both GnRH and prostaglandin based protocols can be used to synchronize estrus of local buffaloes in Bangladesh.

Fermented Rice in Cost Effective Healthy Beef Production

SMA Islam, LR sarker, MRI khan* and HM Murshed
Department of Animal Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : rikhanbau@yahoo.com*

Abstract
Cooked Fermented rice is one of the traditional food items in South East Asia. Its nutritional values are appreciated due to the positive change during fermentation process. Therefore, cooked fermented broken rice fermentation might be used for beef cattle fattening. A series of research with cooked broken rice fermentation at different temperature (37, 28, 20°C), oxygen availability (aerobic and anaerobic), seasons (summer and winter), moisture level (1:1, 1:2), with or without bakery yeast (*Saccharomyces cerevisiae*) had been conducted in the Department of Animal Science Laboratory, Bangladesh Agricultural University. Samples were collected at different time intervals (6 hours intervals upto 48 hours) for physical (smell, texture and observation) and chemical (pH, CP and minerals) analyses. Initial pH was 7.3 and it reduced to pH 5 and 4.49 at aerobic and anaerobic condition respectively after 24 hours fermentation at room temperature (28°C) in summer and it was decreased (pH 4.35) at incubation temperature (37°C). Addition of bakery yeast enhances the fermentation process. Initial CP was 6.2% and it increased with incubation time and addition of yeast (12.1%) and without yeast (10.2%) also. Better fermentation with good aroma was observed in anaerobic condition with the addition of bakery yeast for 12 hours. After 30 hours of fermentation in all conditions, the unpleasant smell started to develop, rice particle started to be fragile and produced gas at high amount both in aerobic and anaerobic conditions. Considering the above parameters, anaerobic fermentation of cooked broken rice with 1:1 water level for 18 to 24 hours, we found the best results at summer temperature (28-37°C) and 24 to 30 hours at winter temperature (20-25°C). Although more analyses and feeding trial are required to know the changes of important minerals (Ca, P, Mg, K, Fe) and suitability of fermented rice for beef fattening.

Preparation of low cost feed for ruminant using wet rice straw and bio-gas slurry

LR Sarker and MRI Khan*
Department of Animal Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : rikhanbau@yahoo.com*

Abstract
This study was executed for preparation of ensilage with wet rice straw (WRS) treated with biogas slurry (BGS) and molasses to increase the nutritional, preservation qualities as well as for preparation of low cost ruminant feed. This experiment was conducted at the Department of Animal Science, Bangladesh Agricultural University (BAU), Mymensingh. Chopped wet straw was preserved in plastic containers under airtight condition at room temperature based on the treatments as T_0 (100% WRS only), T_1 (0% BGS), T_2 (5% BGS), T_3 (10% BGS) and T_4 (15% BGS) with 5% molasses as DM basis in each treatment except T_0 to investigate physical quality, chemical composition, *in vitro* organic matter digestibility (IVOMD) and metabolizable energy (ME) content at 0, 30, 45, 60 and 90 days. The

highest CP content was found to be 7.70% in T_4 and highest DM and EE content were found to be 31.42 and 4.86% in T_0, respectively. The lowest CP and DM content were found to be 4.02 and 21.94% in T_0, respectively and lowest EE content was found to be 3.13% in T_4. The CP and DM were increased ($P<0.05$) and EE were decreased ($P<0.05$) with the increasing of ensiling time from 0 to 90 days. The highest OMD and ME content were found to be 48.46% and 6.98 MJ/Kg DM in T_4 and the lowest OMD and ME content were found to be 34.31 and 4.84% in T_0, respectively. The pH value was also decreased ($P<0.05$) with the increasing of BGS and ensiling time. Considering all the physical and chemical properties, among all the treatments, T_2 and T_3 are acceptable for preparing ensilage. Ensilage of WRS with biogas slurry will not only reduce waste disposal and pollution problem, but also provide inexpensive feed components for ruminants.

Feed Safety and Nutrition of Cattle in Bangladesh: Using Total Mixed Rations for Beef Production in Intensive System (zero grazing)

Md. Tanvir Kamal[1], Mohammad Al-Mamun[2], Mohammad Mujaffar Hossain[1], Mohammed Abdur Razzaque[3] and Md. Abul Hashem[1]*

*[1] Department of Animal Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh ,[2] Department of Animal Nutrition, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and [3]Desert Agriculture and Ecosystem Program, Kuwait Institute for Scientific Research (KISR), P.O. Box. 24885, Safat 13109 Kuwait, Kuwait, *E-mail: hashem_as@bau.edu.bd*

Abstract

Feed and food safety are the main issues in public health in Bangladesh. Statistics shows that total meat production from different species in Bangladesh was 7.154 million tones (t)/year (2016-17). Cattle, poultry, and goats/sheep produced 48%, 40%, and 12% meat, respectively. The safety of livestock products is directly related to feeds. Heavy metals, pesticides, fungal toxins, and antibiotics etc. in meats and milk are derived from feeds. Our study investigated the quantitative presence/absence of heavy metals, antibiotics, pesticides and dexamethasone in livestock feeds, cattle feed and their residues in beef of four district of Bangladesh. Feeds and meats were analyzed by ELISA for dexamethasone, Atomic Absorption Spectrophotometer (AAS) for heavy metals, by HPLC for antibiotics and GC-MS for pesticide residues. Heavy metal residues in feed were in lower concentrations except cadmium, yet below the maximum residue level (MRL). Organs (liver, lung, heart, kidney and muscle) contained a higher level of copper. Antibiotics of liver, lung, heart, kidney and muscle were below MRL values set by EU. Dexamethasone residues were not detected in liver, lung, heart, kidney and muscle samples of beef cattle. Pesticide residues were found in feeds of imported origin. Aldrin was found in higher levels in Saudia and Meghna feed at 77 and 336 µg/kg, respectively. These values were significantly higher than 20 µg/kg which is recommended by WHO/FAO. Contaminants existed at different levels in the cattle feed of Bangladesh. Therefore, results of this study indicate the need to formulate balanced total mixed rations (TMRs) with safe levels of toxicants/contaminants, leading to safe meat production.

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Assessment of Quality and Safety of Raw and Processed Meats through Conventional and Image Technology

Md. Faizur Rahman, Md. Abdullah Iqbal and Md. Abul Hashem*
Department of Animal Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: hashem_as@bau.edu.bd*

Abstract
The experiment was conducted for assessing quality and safety of beef and broiler breast meat through conventional analytical and image technology. An imaging system has been established in the laboratory. A total of 80 beef and broiler (40 each) sample has been taken for the experiment. Different proximate components, pH, drip loss, cooking loss, biochemical and microbiological parameters were estimated using conventional analytical technology. Color values of beef and broiler breast meat were measured by direct measurement with colorimeter and by imaging analysis with a digital camera. The meat images were analyzed with image processing Matlab software. RGB color values were converted to L, a, b through Matlab software. Descriptive statistics and correlations were done for imaging and reference data. In beef strong significant ($p<0.05$) positive correlation were found between imaging L value and instrumental L value ($r=0.41$); imaging 'a' value and instrumental a* value ($r=0.81$, $p<0.05$) for beef sample. Medium correlation were found between imaging 'a' value and ether extract value ($r=0.36$); imaging 'b' value and instrumental a* value ($r=0.24$); imaging 'b' value and instrumental b* value ($r=0.21$); imaging 'b' value and TYMC ($r=0.22$); imaging 'b' value and TVC ($r=0.3$) in beef sample. In broiler medium correlation were found between imaging L value and pH value ($r=0.28$); imaging 'a' value and instrumental b* value ($r=0.22$); imaging 'a' value and POV ($r=0.24$); imaging 'b' value and TBARS ($r=0.22$) in broiler meat. For finding RMSE and R^2 value calibration and validation are being developed for reference and imaging data.

Effect of gamma irradiation on shelf life and quality of Broiler meat

FJ Rima[1], M Sadakuzzaman[1], MA Hossain[1], MS Ali[2] and MA Hashem[1*]
[1]*Department of Animal Science, Bangladesh Agricultural University Mymensingh-2202, Bangladesh and* [2]*Department of PoultryScience, Bangladesh Agricultural University Mymensingh-2202, Bangladesh*
**E-mail: hashem_as@bau.edu.bd*

Abstract
The experiment was conducted on fresh broiler meat treated with ^{60}Co gamma irradiation having dose of 0 (T_0), 1 (T_1), 2 (T_2) and 3.5 kGy (T_3)) and stored 0, 30 and 60 days at -20°C to estimate the effect on proximate, sensory, physicochemical, biochemical and microbial changes in broiler meat. Factorial experiment (4x3) in completely randomized design (CRD) replicated three times per cell was applied to study the variation among treatment combination. Color was changed significantly ($p<0.05$) with higher irradiation doses. DM, EE, CP was increased, and Ash and pH was decreased significantly ($p<0.05$) with higher irradiation doses. Thiobarbituric acid reactive substances (TBARS), Peroxide value (PV), Free fatty acid (FFA), cooking loss was increased significantly ($p<0.05$) with irradiation level and storage period. Total viable count (TVC), Total coliform count (TCC), Total yeast and mold count (TYMC) was significantly ($p<0.05$) reduced with irradiation level. Considering all traits it can be concluded that irradiation significantly decreased microbial population and maintain nutritional quality of broiler meat. The irradiation dose 2.0 kGy showed most acceptable for microbial population reduction, maintains overall acceptability and for shelf life extension of broiler meat comparison to non-irradiated meat sample.

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Combined effect of irradiation and kalogiral extracts on the quality and safety of mutton

Md. Abul Hashem* and Md. Sadakuzzam
Department of Animal Science, Bangladesh Agricultural University, Mymensingh-2202.Bangladesh.
**E-mail: hashem_as@bau.edu.bd*

Abstract
The present study was undertaken to assay the effects of gamma irradiation on fresh mutton compared with non-irradiated mutton. Fresh indigenous mutton samples having 3.5 kg each were taken. The samples were divided into four treatment groups and kalogira extract at the rate of 2% as herbal source was added in all treatment group except control. The treatments were 0.00 kGy (T_1), 1.5 kGy (T_2), 2.00 kGy (T_3) and 4.00 kGy (T_4). Proximate analysis (DM, CP, EE, and Ash), physico-chemical and bio-chemical tests (pH value, cooking loss, PV, TBARS and FFA), sensory tests (color, flavor, tenderness, juiciness, overall acceptability) and microbial test (TVC, TCC and TYMC) were done to evaluate the effect of irradiation on shelf life and quality of mutton. The meat was stored up to 2 months and evaluated at 0^{th} day, 30^{th} day and 60^{th} day. Irradiation increased DM, EE and decreased Ash significantly ($p<0.05$) of mutton. CP was significantly ($p<0.05$) decreased with treatment. PV, TBARS, FFA values and Cooking loss were increased significantly ($p<0.05$) with treatment. But raw pH was decreased significantly ($p<0.05$) with irradiation. There were significant ($p<0.05$) differences in color and flavor with treatment. There were no significant ($p>0.05$) differences in tenderness, juiciness and overall acceptability with treatment. TVC (logCFU/g), TCC (logCFU/g) and TYMC (logCFU/g) were decreased significantly ($p<0.05$) with treatment. As a result, it can be concluded that irradiation increased shelf life of mutton to maintain nutritional quality of meat. Among the treatments, the highest irradiation dose (4.0 kGy) showed best results in terms of overall acceptability, microorganism control and for shelf life extension of mutton.

Effect of irradiation, butylated hydroxanisol (BHA) and Kalogira extract (*Nigella sativa*) on the quality of beef meat at different days of Interval

Md. Abul Hashem*, Md. Mujaffar Hossain and Sadakuzzam
Department of Animal Science, Bangladesh Agricultural University, Mymensingh-2202.Bangladesh.
**E-mail: hashem_as@bau.edu.bd*

Abstract
The study was conducted to find the effects of irradiation, butylated hydroxanisol (BHA) and Kalogira extract (*Nigella sativa*) on the quality of beef meat at different days of interval. For this there were five treatments namely control (T1-0%), synthetic antioxidant (T2-0.01%) and *Nigella sativa* seed extract @ T3-0.1%, T4-0.2% and T5-0.3%. The beef samples were exposed to gamma ray @ 6 kGy in all treatment groups except control and kept at-20˚C. Days of intervals of experiment were on 0, 15^{th}, 30^{th}, and 60^{th} days. Dry matter, CP, EE and ash content of all the treatment groups differ significantly ($p<0.05$). FFA values, TBARs, PV were decreased significantly ($p<0.05$) at different treatment levels. Color, odor, tenderness, juiciness, overall acceptability, raw p^H, cooked p^H were increased at different treatment levels significantly ($p<0.05$). The cooking loss (%) with the advancement of different days of intervals were differ significantly ($p<0.05$). In case of microbiological assessment, TCC (*log*CFU/g) and TYMC (*log*CFU/g) was decreased significantly ($p<0.05$) at different treatment levels comparison to control. The addition of BHA and Kalogira extract significantly reduced the aerobic plate count and

storage time had negative effect on the total bacterial counts and the coliform group for all samples. But TVC (*log*CFU/g) increased significantly due to handling contamination comparatively with increasing the storage period. From the findings, it may be concluded that kalogira (*Nigella sativa*) seed extract had a potential source of antioxidants and antimicrobial activities that has similar effects as the synthetic antioxidant BHA.

Validation of good practices of on- farm lamb production systems

MA Hashem*, MM Rahman and MW Rahman[1]

*Department of Animal Science and [1]Rural Sociology, Bangladesh Agricultural University, Mymensingh-2202.Bangladesh, *E-mail: hashem_as@bau.edu.bd*

Abstract

The experiment was conducted at Sherpur Sadar and Nalitabari Upazilas to investigate the present socio-economic status and potentialities of lamb production in Sherpur district of Bangladesh through field survey. Average family size was 5.58, male and female ratio was 3:1, and average age was 45.23 years, respectively. Education level of farmers was 46.9, 13.3, 8.3, 1.7 and 30% primary, secondary, higher secondary, graduate and illiterate, respectively. Out of 60 respondents 90% were involved in farming, 1.7% service holder, 6.7% housewife and 1.7% businessman. Homestead and fodder land were 28.92 and 11.85 decimal per household, respectively. Average body weight (BW), wither height(WH), rump height(RH), body length(BL), sternum height(SH), body depth (BD), bi-costal diameter(BCD), ear length (EL), rump width (RW), head width (RH), rump length (RL), head length (HL), heart girth (HG), cannon bone circumference (CC) and muzzle diameter (MD) were 12.28±2.75 kg, 49.42±3.78, 54.04±3.88, 49.38±4.57, 28.06±3.00, 53.09±4.40, 15.07±2.58, 8.66±3.32, 15.72±2.33, 12.87±2.20, 14.30±2.29, 18.23±2.30, 55.02±4.71, 9.22±1.01 and16.65±1.73cm, respectively. According to sex BW, WH, RH, SH, BD and CC were found significantly differed ($p<0.001$) and EL was found significantly differed at ($p<0.05$). According to age group BW, WH, RH, BL, BD, RW, HL, HG, and MD were found significantly differ at ($p<0.001$). Average monthly income and expenditure was BDT 10123 and 11476, respectively. The male partner of households was dominant over female partner in different decision making status. The regression co-efficient of family size, land size and yearly livestock income was -9843.99, 404.27 and 1.02, respectively. It is predicted that one unit increases in land size and yearly livestock income increases 404.27 and 1.02 unit in family yearly income, respectively, whereas, one unit increase in family size, -9843.99 unit decreases in yearly family income, holding all other variables constant. Identified problems were lack of high performance ram, lack of slaughter house, veterinary doctors and staff, better communication and cooperative marketing facilities, high cost of veterinary medicine and concentrate feed and problems of market actors.

Effect of feeding systems on lamb carcass and meat quality

HM Murshed, MN Sagor, SMA Islam and SME Rahman*

Department of Animal Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : ehsan_bau@yahoo.com*

Abstract

The study was carried out to observe the effect of feeding systems on lamb carcass and meat quality. The proposed research plan is being undertaken with the objectives to determine the carcass and meat characteristics of native sheep. Three feeding systems were applied. Incase of growth rate significant difference ($P<0.05$) were seen among the groups. Highest weight was found in intensive group and it was 18 kg and lowest weight was 11 kg. Some blood parameters (Total protein, Albumin, Glucose and Urea) were analyzed and these showed significant difference ($P<0.05$) among the groups. In case of

meat quality nutritional and microbiological parameters were examined. There was significant difference in nutritional parameters CP (22%) was highest in Intensive group. But in case of microbiological aspects TVC, TCC and YMC negligible difference observed. In our experiment intensive group shows best performance in all aspects. But while cost benefit analysis is observed than semi intensive and free-range system also has got importance because these are the systems can be applied for low input farming systems. In case of commercial farms intensive system should be applied.

Effect of liquid hot water treatment on lignocellulosic content and biogas production from maize stover

A K M Ahsan Kabir[1*], Shahnaj Naznine[1], Sharifa Aktar[1], Md Ruhul Amin[1] and Yongming Sun[2]

[1]Department of Animal Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and [2]Guangzhou Institute of Energy Conversion, Chinese Academy of Sciences, Guangzhou, China
**E-mail : ahsankabiras@bau.edu.bd)*

Abstract

Energy grasses are the type of plants cultivated as raw materials for livestock feeding. There are many potential energy grasses, which are found as left over in livestock farm and suitable for biogas production. Maize stover is one of them. Maize stover has a great potential as animal feed and biomass substrate for anaerobic digestion due to its abundance and highly carbohydrate content. Owing to the inherent limitation of lignocellulosic substrates, the digestion of maize stover is greatly hindered. However, the natural binding characteristics of lignocellulosic biomass can be enhanced by modifying the structure of cellulose – hemicellulose – lignin matrix with application of pre-processing and pre-treatment methods. A number of different pretreatment techniques involving physical, chemical and biological approaches have been investigated over the few recent past decades. This study aimed to know the lignocellulosic content of maize stover obtained after cultivation of corn cobs and to examine the effect of liquid hot water treatment on digestion of the lignocellulosic content and its' biogas production potentials as fresh and co-digestion techniques. The samples were treated with liquid hot water at 160 ^{o}C and 180 ^{o}C for an hour. The result showed that lignocellulosic content was increased in liquid hot water treated maize stover compared to fresh. Moreover, we used cow dung and maize stover with a ratio of 0:1, 1:3, 1:1, 3:1 and 1:0 in a lab batch testing biogas plant. The results showed that the co-digestion with a ratio of 1:1 obtained the highest total biogas production of 22.58 L/Kg/d. Compared to the single digestion 28.44% more biogas production were obtained with 1:1 co-digestion. Thus it may conclude that liquid hot water treatment increases the digestibility of lignocellulosic fiber content and co-digestion with a ratio of 1:1 may be applied for more biogas production from maize stover.

Investigate rabbit production system under rural condition at Madhupur upazila in Bangladesh

Md. Ruhul Amin

Department of Animal Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail : aminmr64@bau.edu.b

Abstract

The study was conducted to investigate existing rabbit rearing system according to types of rabbit kept, their housing and management system, sources and availability of feed resources, feeding system, diseases and their preventive measures, status of rabbit reproductive system, problems and prospect of rabbit production in Madhupur upazila under Tangail district in Bangladesh. For these purpose, 60

rabbit rearing households were selected. The survey work and the chemical analysis were done during the month from July to October, 2018. Data was collected by the researcher himself through direct interview method using a structured questionnaire. The data was then processed, tabulated, analyzed and summarized in accordance with the objectives of the study. About 83.33% of the rabbit owners are found to be landless. Labor selling was their main occupation and average annual income was Tk. 99957.40. They reared rabbit besides others livestock such as cattle, goat, chicken, pigeon having an average number of 3.39, 3.59, 7.28, 4.75, respectively. About 75% farmers reared rabbit in both bamboo and wooden cage. They kept their rabbit in kitchen (80%) with poor ventilation. The age at sexual maturity is 180 days. Litter size, male female ratio, annual kit production per doe, gestation period (days), kidding interval (days), birth weight (gm), weaning age (weeks), weaning wt (gm) were 4.86, 1:4, 43.67, 27.67, 30.18, 32.45, 5.97, 268.18, respectively. The CP (%) of ipil-ipil, cabbage, red amaranthus, durba grass, mandar tree leaves, wheat bran and rice polish were 21, 17, 27, 15, 25, 17 and 7%, respectively. It was reported that, CF (%) of ipil-ipil, cabbage, red amaranthus, durba grass, mandar tree leaves, wheat bran and rice polish were 13.6, 8.45, 7.75, 15.3, 10.85, 9.65 and 26%, respectively. The EE (%) of ipil-ipil, cabbage, red amaranthus, durba grass, mandar tree leaves, wheat bran and rice polish were 13.3, 3.2, 8.7, 2.55, 3.1, 1.97 and 7.05%, respectively. From the present study, it may be concluded that rabbit production in Madhupur upazila is limited mainly due to high mortality, inadequate supply of quality feed, inadequate knowledge of rabbit nutrition and management, lack of training facilities, lack of veterinary services, disease outbreak, threat to predators, religious sentiment etc. However, rabbit rearing in Madhupur area are found to be a good source of income generation for the poor and destitute women.

Effect of Soybean Based Milk Replacer on Post-weaning Performance of Black Bengal Goat

Sabiha Afroz, Asma Khatun, Md. Hasanur Alam, Md. Nuronnabi Islam, Md. Ruhul Amin and Mohammad Moniruzzaman*

Department of Animal Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : monir.as@bau.edu.bd*

Abstract

The present study was aimed to know the effect of feeding soybean based milk replacer on post-weaning growth, blood parameters, survival rate, and reproductive performance of milk replacer fed and naturally suckled goat kids. The experiment was conducted at Charsottrapur, Boira and Kewatkhali village in Mymensingh Sadar. Twenty-four Black Bengal kids were allocated to two groups; one group of kids (n=12, male=6, female=6) were reared artificially with milk replacer while the others (n=12, male=6, female=6) were reared naturally keeping together with their dam. Milk replacer was prepared with powder milk and soybean powder (50:50). After weaning, liveweights of kids were recorded weekly. Blood samples were collected twice over the experimental period to determine hematological parameters. Data were presented as the mean ± SD (standard deviation) and subjected to one-way ANOVA. The significance of difference among means was determined using Tukey's HSD test. Initial liveweight of two groups did not show significant difference. Final liveweight did not differ significantly between artificially fed males (13.3 ± 0.75kg) and naturally suckled male kids (12.6 ± 0.85kg) kids. Final liveweight did not differ significantly between artificially fed females (12 ± 0.87kg) and natural suckled female kids (11.21 ± 0.62 kg). Wither height, heart girth and circumference of the neck showed significantly ($p < 0.05$) higher in artificially fed male grouped than naturally reared male kids. Body length and heart girth were significantly ($p<0.05$) higher in artificially fed female kids than naturally reared female kids. RBC, WBC and hemoglobin were significantly higher ($p< 0.05$) in artificially reared female kids than naturally suckled female kids. Reproductive performance and survivability did not differ significantly between two groups. In

conclusion, soybean based milk replacer can be fed to kids as an alternative to goat milk without harmful effects on post-weaning growth, survival and reproductive performances.

Effect of L-carnitine on in vitro development of buffalo embryo

Rebeka Sultana, I. Akter, AK. Modak, Md Hasanur Alam, Md. Nuronnabi Islam, A. Khatun, Amin MR and M. Moniruzzaman*

Department of Animal Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : monir.as@bau.edu.bd*

Abstract

L-carnitine is known to accelerate the transportation of long chain fatty acids into the mitochondria for β-oxidation to increase adenosine triphosphate (ATP) production. This study investigated the effects of L-carnitine on developmental potential of buffalo oocytes in vitro. Cumulus oocyte complexes (COCs) were aspirated from ovarian follicles of slaughtered buffaloes. COCs were matured in TCM-199 medium supplemented with 0, 0.25, 0.375, 0.5 mg/mL of L-carnitine for 24 hrs in a humidified incubator at 38.5ºC under an atmosphere of 5% CO2 in air. Following maturation, the COCs were fertilized in Brackett and Oliphant's (BO) medium for 18 hours. The presumed zygotes were co-cultured in Research Vitro Cleave medium (RVCL) for 8 days to produce buffalo embryos. The data were analyzed for one way analysis of variance (ANOVA) and the significant difference among means was determined using Duncan's test. Oocytes treated with L-carnitine showed higher maturation rate than control. The rate of cleaved oocytes developed to blastocyst stage was significantly higher ($p < 0.05$) in 0.375 and 0.5 mg/mL of L-carnitine supplemented medium than without (0 mg/ml) L-carnitine and 0.25 mg/mL of L-carnitine group. In conclusion, the supplementation of L-carnitine during IVM improved nuclear maturation and subsequent embryo development after IVF in buffalo oocytes.

Adoption of embryo transfer technology in indigenous buffaloes in Bangladesh

A.K. Modak, I. Akter, M.N. Islam, MMH Pasha, BC Roy, Md Hasanur Alam, A. Khatun, M.A. Hashem and M. Moniruzzaman*

Department of Animal Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: monir.as@bau.edu.bd*

Abstract

Embryo transfer technology (ETT) is one of the most important reproductive biotechnologies where genetic materials could be utilized for the faster improvement of livestock. ETT has been practiced as an important genetic tool satisfactorily in many countries of the world for cattle and is being trying to adopt in buffalo. This study was undertaken to develop a protocol for ETT by using *in vitro* produced embryos. Cumulus oocyte complexes (COCs) were matured in the incubator for 24 hours at 38.5°C temperature with 5% CO_2 in air followed by *in vitro* fertilization and cultured up to blastocyst stage for 8 days. Produced embryos were vitrified and cryopreserved in liquid N_2 successfully for further used. After conducting a survey, 30 buffaloes were selected in Kanihari, Trishal and Tulshir Char, Jamalpur areas for preparing the recipients. After 3 days of Prostaglandin (PGF) F2 alpha hormone administration, fifteen buffaloes were selected on the basis of their heat status and others qualifications. After seven days of heat detection, fifteen numbers of *in vitro* produced buffalo embryos were transplanted to fifteen qualified buffaloes using embryo transfer gun. After 60 days of ETT, recipient buffaloes were diagnosed to assess the pregnancy. Among 15 recipients 4 buffalo cows were observed as pregnant in first diagnosis. However, early embryonic death was recorded while pregnancy was diagnosed at 3 months. In this study, buffalo embryos were produced successfully, but the protocols for ETT should be optimized to get expected results.

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Recycling broiler processing plant waste as feed for poultry

Khan Md. Shaiful Islam
Department of Animal Nutrition, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail : kmsislam1@yahoo.com

Abstract
Experiment was conducted with 98 one-day-old straight run Cobb 500 broiler chicks for a period of 4 weeks to study the effects of poultry viscera meal instead of protein concentrate (Pro-Pack) in broiler diet on live weight gain, feed intake, feed conversion ratio, carcass characteristics of broiler. The broiler chicks were divided into three groups each of 32, replicated to four sub-groups each of 8 birds using completely randomized design (CRD). First group of chicks were considered as 1 (5.0% Protein Concentrate) and in other groups of birds were considered as 2 (2.5% Protein Concentrate + 2.5% Poultry Viscera Meal) and 3 (5.0% Poultry Viscera Meal). Feed and water were supplied to the broiler *ad libitum*. Initial weight was recorded at the first day of the experiment and live weight, feed intake were also recorded at weekly interval throughout the experiment. At the end of the 28days feeding trial, the live weights of broilers were 1093g, 1035g and1015g in treatment group 1, 2 and 3 respectively. Body weight and body weight gain were similar for all the groups. But, group 3 showed numerically nearest weight gain of other groups. There were no differences on feed intake among the groups. Feed conversion ratio was lower in group 1and higher in group 2. Cumulative feed conversion ratio of group 1 was also lower than other group during feeding trial. Dressed yield (%) of poultry viscera meal treated group was also nearest to control group. It may be concluded that, Cumulative weight gain was more in protein concentrate group but the production cost was high. If we use poultry viscera meal, it will reduce the production cost. As the cumulative weight gain of broiler has no differences, so poultry viscera meal can be used instead of protein concentrate in the context of Bangladesh.

Fermentation of rice bran using rumen liquor and its effect on the performance of broiler

S Hossain and K M S Islam*
Department of Animal Nutrition, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : kmsislam1@yahoo.com*

Abstract
Rice bran was fermented anaerobically with buffer solution added carbonated rumen liquor at 1:1 ratio for 48 hours. A part of fermented rice bran after 24 hours was further use for similar fermentation instead of rumen liquor, which was repeated twice. So, 4 types of rice bran 1(unfermented), 2(48 hours fermented using rumen liquor), 3 (48 hours fermented using fermented rumen liquor of 2) and 4 (48 hours fermented rice bran using fermented rice bran from 3). Four types of rice bran was included in 04 groups of birds a 7% level in the diet. Diets were offered to the birds on two phases like starter and grower. Feed and water were offered on *ad libitum*. The feeding trial conducted for 28 days. Crude protein of unfermented rice bran (14.7%) was lower than all the fermented rice bran (16.7, 16.8, 16.5% respectively). But, crude fiber was decreased in fermented rice bran (7.1, 7.4 and 7.5) than unfermented (9.3%). Phytate phosphorus was decreased after fermentation in all the fermented rice bran (, , , ,) than unfermented rice bran ( ). Live weight gain was higher ($p<0.05$) in fermented rice bran (1118, 1122 and 1113g) different from unfermented rice bran group (1040g). Total feed intake was not different from other dietary groups. Feed conversion ratio was s ($P<0.05$) different of unfermented group (2.07) than fermented groups (1.95, 1.94 and 1.96) of birds. In conclusion it seems that, fermentation of rice bran with rumen liquor would be further used for fermentation maintaining

the fermentation pattern indicating increased protein, decreased phytate phosphorus and crude fibre. The improvement was reflected showing better performance of the birds in fermentation groups.

Comparison of Bangladesh and Global Dairy: The Role of Interdisciplinary Research Network

Mohammad Mohi Uddin
Department of Animal Nutrition, Bangladesh Agricultural University, Mymesingh-2202, Bangladesh
E-mail : mohammad.uddin@bau.edu.bd

Abstract
Bangladesh dairying has been transforming from traditional family-oriented to the market-oriented dairying which leads to the necessity of analysis of the trends and drivers on dairy sector growth, competitiveness and import reduction potential of the Bangladesh dairying. Therefore, the objective of this study is to compare Bangladesh dairying with Global dairying using Interdisciplinary Research Approach (IRA). The IRA consists of the use of International Farm Comparison Network (IFCN) methods and Integrated Dairy Research Network (IDRN) database. The IDRN database consists of 639 variables at farm level and 25 variables for dairy sector analysis. The results show that Bangladesh produces 8.08 million ton of milk which is 1.08% of the total global milk production and ranking in 23rd position in the world milk production. The average number per farm was found 2.38 which is lower than the global average (3.1 cows/farm). The average milk production was 1.3 ton/cow/year against the world average of 2.2 ton/cow/year. The world dominant farm type is family farm which is also reflected in the Bangladesh. The household, family and business farms for Bangladesh were found 38%, 45% and 17%, respectively while that for global were 18%, 57% and 25%, respectively. The average cost of milk production in Bangladesh was found 3229 BDT/100 kg milk while for the average cost of milk production globally is 2615 BDT/100 kg milk showing that Bangladesh has 23% higher production cost than the global. In relation to milk price, Bangladesh has +37% higher than the global milk price. The results of the present study revealed that Bangladesh has potential scope to increase its competitiveness by benchmarking Bangladesh with global dairying. However, this kind of holistic analysis requires substantial data which could be done by applying IDRN interdisciplinary methodological approach in sustainable manner.

Benchmarking cost of milk production in typical dairy farms in selected regions of Bangladesh: Implications for milk market price and livelihood improvement policy

Mohammad Mohi Uddin
Department of Animal Nutrition, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail : mohammad.uddin@bau.edu.bd

Abstract
Bangladesh is at 36th position in the world milk production; while, in the cost of milk production ranking Bangladesh is 46th (for small scale farms) and 21st (for large scale farms) among the highest cost countries. The objective to benchmark the cost of milk production only so that farmers can compare the COMPO with milk price in order to see the real profit of the farms. This study used the International Farm Comparison Network (IFCN) methodology which is based on two pillars: 1) Typical Farm Approach (TFA) and 2) Technology Impact Policy Impact Calculations (TIPI-CAL) model. Three farm types were identified such as household farms, family farms and business farms. Two regions were selected for setting up of typical farms. The data were collected using the Panel Approach. In total 12 typical farms (6 from Bogura and 6 from Sirajgonj) were selected. The average milk yield per day per cow was found for Bogura to be 3.88 kg/d/cow while that for Sirajgonj it was

5.11 kg/d/cow. However, the average milk production was found 1914 kg ECM/cow/year in Sirajgonj while that for Bogura was 1451 kg ECM/cow/year. The average cost of milk production only (COMPO) in all typical farms was found to be 34.30 BDT/kg ECM while that for Sirajgonj was higher (35.80 BDT/ kg ECM) than Bogura (32.80 BDT/kg ECM) indicating a regional competitiveness advantage for Bogura over Sirajgonj. On the other hand, the milk price in Sirajgonj and Bogura was 35.1 BDT /kg ECM and 32.1 BDT/kg ECM respectively which was lower than the production cost indicating an overall negative entrepreneur's profit (EP) in both the regions. This implies that current small scale household farming system is no more profitable and sustainable and they might need either to decrease the cost of milk production or increase milk production.

Effect of Physical and Chemical Value Addition to Rice Straw and Their Effect on Milk Production

Mohammad Mohi Uddin*, Md. Salauddin Palash, Amrin Akter, Md. Mazharul Islam

Department of Animal Nutrition, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh,
**E-mail: mohammad.uddin@bau.edu.bd*

Abstract

The study was conducted in Sirajganj district in Bangladesh with the objectives of on-farm evaluation and demonstrating the effects of value added rice straw on milk yield, milk composition and feed intake of lactating dairy cows. A survey was carried out and 235 dairy farms were individually interviewed with structured questionnaires. Twelve milking cows used for the feeding trial, milk yield bases having an initial mean milk yield of 6.42± 0.78 kg.The cows were assigned to four treatments. Four treatments were considered: T_0 (control): loose rice straw + green grass + concentrate; T_1: chopped rice straw + green grass + concentrate; T_2: Urea molasses treated rice straw without chopped + green grass + concentrate and T_3: Urea molasses treated rice straw with chopping + green grass + concentrate. Highly significant differences were observed between treatments in daily feed intake and daily milk yield gain. T_2 was significantly ($P<0.05$) higher than T_0, T_1 and T_3 where, the least square mean of total DM intake was 13.44± 0.26, 12.96 ± 0.38, 12.47±0.16 and 12.06 ± 0.31 for T_2, T_0, T_3 and T_1 respectively. Total crude protein intake from rice straw also significant ($P<0.05$) differences, T_2 and T_3 were higher than T_0 and T_1. The daily milk yield was high in T_3 (8.12±0.30 kg per day) and followed by T_0 (7.30±0.23 kg per day), T_1 (6.61±1.35kg per day) and T_2 (6.78±0.09 kg per day). The partial budget analysis indicated a daily net return increases where T_0 (8.6 BDT/cow/day) was lesser by 37.0, 62.5 and 63.0 BDT/cow/day over T_1, T_2 and T_3 respectively. This indicates that supplementary feeding of value added rice straw (Chopped, urea molasses treated straw without and with chopping) had significant contribution to the development of dairy business in the study area.

Use of bioactive components from plantain herb to modulate animal originated products: meat and milk

E Hossain, MRA Redoy, AAS Shuvo, MA Rahman, SFU Apu and M. Al-Mamun*

Department of Animal Nutrition, Bangladesh Agricultural University Mymensingh-2202, Bangladesh
**E-mail: mamunshimu@yahoo.com*

Abstract

This present research was conducted to quantify the bioactive components of plantain herb (*Planatago lanceolata* L) and its impact on productive performance, plasma metabolites and meat quality of broiler; and in milk production, plasma and milk antioxidant level of dairy cows. The bioactive

components in plantain herb like acteoside, aucubin and catalpol were 1.21%, 3.29% and 0.049%, respectively. *In-Vivo* feeding trials were conducted on broiler and dairy cows at farmer's level in Manikganj. For boiler trial, a total of 4000-day old broiler chicks (Cobb-500) were randomly distributed into four dietary treatment groups having four replications with 250 birds/replication. Dietary treatments were; T_1=Commercial diet containing antibiotic growth promoters, T_2= T_1+1.0% fresh plantain supplementation on DM basis, T_3= Formulated feed without antibiotic growth promoters and T_4= T_3+1.0 % fresh plantain supplementation on DM basis. All the treatment diets were *iso*-energetic and *iso*-nitrogenous. The results showed higher live weight gain in T_4 treatment group compared to other groups. Moreover, better feed conversion ratio was found in herb supplemented groups. Abdominal fat content was (P=0.007) lower in T_4 treatment group compared to other treatment groups. Besides, Plasma total glycerides (TGs), total cholesterol, low density lipoprotein (LDL) were lower in T_4 treatment group compared to T_1 treatment group. High density lipoprotein (HDL) was higher in T_4 group compared to others. For dairy cows, a total of 16 second to third lactation crossbred Holstein cows (305.7±21.2 kg) were selected and randomly allotted to 2 treatments. The experiment lasted for 45 d, and dietary treatments were as follows: a) CON, control diet; Rice straw and concentrate based diet was supplied *ad libitum* b) PL, CON + 1 kg fresh plantain/day. Compared with control (CON), milk yield was 28% greater in PL group compared to CON. Plantain supplementation boosted both serum and milk antioxidants level compared to CON. Moreover, Vitamin A content in milk was also fortified (48 vs 53 mg/100 mL) in PL compared to CON. So, it would be concluded that supplementation of plantain herb improved production performance, plasma metabolites and meat quality of broiler as well as improved plasma and milk antioxidant level of crossbred Holstein cows.

Mitigation of enteric methane emission using medicinal herbs

E Hossain, MA Rahman, MRA Redoy, AAS Shuvo, MA Alam and M. Al-Mamun*

Department of Animal Nutrition, Bangladesh Agricultural University Mymensingh-2202, Bangladesh
**E-mail: mamunshimu@yahoo.com*

Abstract

With a view to assessing the impacts of pineapple wastes (*Ananas comosus*), garlic leaves (*Allium sativum*), moringa leaves (*Moringa oleifera*) and their mixture on growth performance, abdominal fat contents, blood plasma parameters and methane emission of native sheep. Fifteen native sheep were divided randomly in 5 dietary treatments having 3 sheep per group. Dietary treatments were as follows: i. CL-Diet: roadside grass and concentrate mixture based total mixed ration pellet having CP-16.72% and ME- 2560 Kcal/kg; ii. PW-Diet: CL-Diet + 10 gram/day pineapple wastes (peels, core, tops, and leaves); iii. GL-Diet: CL-Diet + 10 gram/day garlic leaves; iv. ML-Diet: CL-Diet + 10 gram/day moringa leaves; HM-Diet: CL-Diet + 10 gram/ day herbal mixture (3 gram pineapples wastes + 3 gram garlic leaves + 4 gram moringa leaves). There was no difference of body weight of native sheep due to herbal supplementation. But numerically, ML-Diet showed 3-5% higher live weight gain compared to others treatment group. Abdominal fat content was significantly (P=0.02) 8.33%, 9.0% 19.44%, and 52.77% lower in GL-Diet compared to PW-Diet, HM-Diet, ML-Diet and CL-Diet, respectively. The result revealed that cholesterol, low density lipoprotein (LDL), triglycerides (TGs) were numerically higher in CL-Diet compared to herbal supplemented groups. Besides, the blood urea nitrogen and high-density lipoprotein were higher 7.0% and 9.0%, respectively in all herbal supplemented group compared to control. Moreover, total methane production was lower 12.00 % in PW-Diet, 12.50 in HM-Diet, 16.36% in ML-Diet and 18.02% in GL-Diet compared to control. So, garlic or moringa supplementation might be used for improving body weight, BUN, HDL and lowering the methane emission from native sheep.

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Screening of phytochemicals of native herbs in Bangladesh for safe livestock production

MA Rahman, MRI Ripon, MA Alam, MRA Redoy and M. Al-Mamun*
Department of Animal Nutrition, Bangladesh Agricultural University Mymensingh-2202, Bangladesh
**E-mail: mamunshimu@yahoo.com*

Abstract
This research was running and funded by Krishi Gobeshona Foundation (KGF) with the notable objectives, to determine phytochemical profiling of selected medicinal forage herbs in Bangladesh by thin layer chromatography (TLC), to quantify the level of bioactive component of selected medicinal forage herbs, to determine the level, and modification of bioactive component in selected medicinal forage herbs at different storage and processing stages and to know the effect of selected herbs on nutrients the digestibility, plasma metabolites, milk yield, and milk fatty acid profiles in dairy cows. Through review of literature, the following medicinal forage herbs like aloe-vera (*Aloe-vera L)*, ivy-gourd (*Coccinia grandis)*, moringa (*Moringa oleifera*), garlic (*Allium sativum*), pineapple (*Ananas comosus*), dondo colos (*Leucas aspera*), neem (*Azadirachta indica*), pippali *(Piper longum),* mint *(Mentha spp*), lemon grass *(Cymbopogon citratus*) and thankuni *(Centella asiatica)* were selected and cultivation is running at Shahjalal Animal Nutrition Field Laboratory under the Department of Animal Nutrition. Through TLC, the phytochemicals of these selected forage herbs determined, and result showed that Neem content terpenoids, steroids, saponins, tannins, flavonoids, alkaloids, glycosides, phenol and in moringa all phytochemicals were present except phenol. The result revealed that lemon grass, thankhuni, aloe-vera, ivy-gourd, mint, garlic, pineapple, dondo colos, and pippali all of selected medicinal forage herbs had phytogenic properties. The freeze dryer was procured, and the all herb's sample were dried for the determination of specific bioactive components against specific herbs. In addition, the different forms of sample like shade dried, sun dried, oven dried at 50-60^{0}C are ready for the determination of bioactive components and feeding trial. In this project, I am hopeful that I would be able to develop a phytogenic feed additive package for dairy cows that triggers the milk production and ω-3 fatty acids contents of milk.

Suitable drying method of herbs for broiler production

MA Rahman, MRA Redoy, AAS Shuvo, MA Kabir, M. Al-Mamun*
Department of Animal Nutrition, Bangladesh Agricultural University Mymensingh-2202, Bangladesh
**E-mail: mamunshimu@yahoo.com*

Abstract
This research is ongoing with the fund of National Agricultural Technology Program-2 (NATP-2). The present research was conducted to assess the effects of different forms (Shade dried herbs and blenched forced dried herb mixture) of medicinal forage herbs and as an alternative to antibiotic growth promoter on feed intake, growth performance, plasma metabolites and meat fatty acid level of broilers. An- On farm broiler feeding trial was conducted at farmer's level in Manikganj by using 1008-day old broiler chicks (Cobb-500) through completely randomized design. The experiment was randomized into three treatments and each treatment composed of three replication and each replication contain 112 broiler birds. The first treatment T_0 was formulated diet + 0.1% antibiotics growth promoter considered as control, second treatment T_1 was formulated diets + 1.0% shade dried herb mixture and the last one T_2 was formulated diet + 1.0% blenched forced dried herb mixture. The herb mixture was composed of plantain herb (*Planatago lanceolata* L), ivy-gourd (*Coccinia grandis*), garlic (*Allium sativum*), spearmint (*Mentha spicata*). The result showed that the feed intake was higher in T_1 treatment then followed by T_0 and T_2 treatments, respectively. Significantly (P = 0.009) 6-7% higher live weight gain was found in T_1 treatment compared two other treatments. Significantly (P =

0.03) better FCR was calculated in T_1 treatment, then T_0 and T_2 treatments, respectively. Numerically, blood urea nitrogen and high density lipoprotein (HDL) were higher in T_1, then T_0 and T_2 treatment, respectively. Significantly (P=0.02) triglycerides (TGs) were 13.0% higher in T_0, treatment compared to herb mixture supplemented treatments. Besides fatty acid level was observed higher (P=004) in herb supplemented treatments compared to control. From this research, it might be concluded that 1.0% shade dried herb mixture might be used as an alternative to antibiotic growth promoter for safe and functional broiler production.

Effect of calf starter on the growth performance of dairy calf

Mohammad Shohel Rana Siddiki*
Department of Dairy Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: msrsiddiki@bau.edu.bd*

Abstract
The study was conducted to evaluate the growth performance of dairy calf using calf starter which is very important to a calf with a good healthy start. In the first year, ten dairy new born heifer calves (Holstein/HF cross and Sindhi-Sahiwal/SS cross) were selected for this study feeding with calf starter. The Bangladesh Agricultural University Dairy Farm calf pen will use for their housing. A balanced calf starter (CP=23%) was formulated for calf feeding Calves given water free choice and calf starter and about 45-50 gms or a small handful of calf starter along with the milk seven days after birth. Continue to slowly increase the starter until the calf is eating 0.50 to 0.750 kg a day for three consecutive days. Weekly measurements of body weight (BW), withers height (WH), hip height (HH), hip width (HW), and heart girth (HG) were measured and recorded. In addition, fecal scoring was determined weekly based on fecal fluidity, consistency and odor. After 17 weeks, BW, HG, WH, HH and The length from point of shoulder to pin bone were increased higher in HF cross than SS cross. Based on fecal scoring, fecal fluidity and consistency were normal, but fecal odor was slightly offensive at the beginning of life and gradually terns to normal odor. It could be concluded from 1st year that feeding calf starter help to get well-grown vigorous calf in HF cross. In the 2nd year, 6 HF cows were selected and divided as 3 control (**without** calf starter & existing farm feeding) and as 3 as calf starter feeding group. From the result, it revealed that calf starter feeding group showed high body weight and measurement. Therefore, It could be concluded that feeding calf starter help to get well-grown vigorous calf with minimizing health problems and make the dairy business profitable.

Effect of Freeze Drying of Lactic Acid (yoghurt) Culture for on-Field Use

Mohammad Shohel Rana Siddiki*, Md. Zakirul Islam and MA Samad Khan
Department of Dairy Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: msrsiddiki@bau.edu.bd*

Abstract
The study was conducted to utilize freeze dried yoghurt culture properly. The research work was carried out at Dairy Microbiology and Biotechnology Laboratory in the Department of Dairy Science and Animal Nutrition Laboratory, Department of Animal Nutrition, Bangladesh Agricultural University, Mymensingh, Bangladesh (BAU). Raw milk was collected from BAU Dairy Farm and prepared yoghurt. Then, yoghurt is freeze dried to make yoghurt powder by freeze dryer (Yamato, Japan) and preserved at 7°C for 15 days. After that, the sub-culture was prepared using stored freeze dried culture in skim milk for checking the desirable fermentation. The viability of bacteria was indicated by smooth and firm coagulation of skim milk. The yoghurt was made by using sub-culture of freeze dried culture and evaluated by organoleptic and chemical analysis. Fifteen days stored

lyophilized culture was produced smooth and firm coagulation in sterilized skim milk. Fermentation of lactose was demonstrated as a result of sufficient acid production for coagulated, solidified the milk. A panel of expert judges were evaluated the yoghurt and give acceptable scores bearing smell and taste: 43.67±1.53, body and consistency: 24.67±0.58, color and texture: 14.66±0.58 and Overall score 83.00±2.00. Average percentage of total solids, fat, SNF, protein, ash, lactose, acidity and pH were 13.71±0.183, 4.75±0.250, 8.96±0.093, 3.80±0.264, 0.72±0.025, 4.43±0.153, 1.08±0.076 and 4.47±0.208, respectively. Therefore, The cultures of yoghurt (dahi) are possible to lyophilize and can preserve for 2 weeks in normal refrigerated condition for use in the manufacture of quality dahi. This technique is feasible to use on-field application.

Feeding and management package for improved productive and reproductive performance of lactating dairy animals under farm condition

Ummul Wara, Afrin Zannat, Md. Abid Hasan Sarker, Md. Sadakatul Bari, Md. Rezwanul Habib and Mohammad Ashiqul Islam*

Department of Dairy Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : m.a.islam@bau.edu.bd*

Abstract

An on-farm full lactation long experiment in a completely randomized design was conducted to exemplify the effects of feeding and whole management package on growth,milk production and composition, lactation persistency and reproductive performance of crossbred cows.Six Holstein-Friesian (21 day's pre-partum) crossbred cows were equally divided into two groups. Each cow received 5.0 Kg concentrate during the post-partum and 3 kg in pre-partum period, The nutrient supplied by the ration were 2.67 and 2.41 MCal NE/Kg DM and 15.10 and 21.26%, respectively in the control and treatment ration against the requirement of 2.1 MCal NE/Kg DM and 20.9% CP. About 35.0 kg/cow/dayGerman grass was provided as basal dietwith 24 hours water availability. In treated group green grass was supplied in chopped form and proper milking andhouse sanitation was maintained. BAUDF management procedure was provided to the control group. Results revealed that body weight (309 – 325 kg/cow) and body condition scores (3.25 – 3.47) differs non-significantly ($p>0.05$) between the group.Calf birth weight was found 12% higher ($p=0.148$) in treatment group compared to the control group. On the other hand, milk yield was recorded 26 % higher ($p=0.000$) with remarkable lactation persistency in treated cows. All the milk quality attributes were found similar between the groups ($p>0.05$)and the fat content of the milk ranges from 46 – 49 g/kg milk and the solids-not-fat (SNF) content were found 80 – 81 g/kg milk.Moreover, the post-partum heat period was remarkably (25 days) reduced in treated group than that of the control group and all the cows in this group returned to heat within 60 days post-partum which was 33.33% in the control group. In conclusion, feeding and management package during pre-partum and whole lactation had positive impact on milk yield, lactation persistency and reproductive performance of crossbred dairy cows.

Profitable Dairying by High Yielding Fodder Cultivation through Maximum Utilization of Land in Bangladesh

Md. Zakirul Islam,Mohammad ShohelRanaSiddiki and Md. Harun-ur-Rasid*

Department of Dairy Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: harunds@bau.edu.bd*

Abstract

This experiment was aimed at assessing the biomass yield and nutritive quality of various suitable fodders per unit of land per year as well as soil properties by varying seed rates and doses of fertilizer

application. The treatments were organized into a factorial design and distributed according to a completely randomized design with three replications. Five (05) different fodders and combinations were selected for the study viz. Deshi Maize, Hybrid Maize, Maize-Soybean Intercropping, Soybean, and Jumbo. Three seed rates (15; 20; and 25 kg/acre) and three doses of inorganic fertilizer (0 kg; 35 kg urea, 25 TSP, 15 kg MP; 45 kg urea, 35 kg TSP and 20 kg MP/ acre) along with 750 kg/acre basal doses of organic manure (cow dung) were applied at land preparation. The data regarding production characteristics based on the morphology of different fodder crops revealed that the plant height, stem circumference, and leaf area significantly deferred (p=0.000) among the treatment groups but leaf number (p=0.940). The height plant height, stem circumference, and leaf area were recorded for the fertilization at the rate of 45:35:20=Urea:TSP: MP kg/acre and 25kg/ acre seed rate for maize, maize-soybean intercropping and jumbo grass. Among the five different fodders, the number of the leaf was found non-significant irrespective of the fertilization and seed rate. There was also the non-significant effect that was found in the case of inorganic fertilizer and interaction with seed rate on the leaf/stem ratio (p=0.170 and p=0.230, respectively) but the higher trend of inorganic fertilization slightly increased the ratio (p=0.00). On the contrary, the biomass yield for all the fodder groups was significantly differed (p=0.000) except Soybean (p=0.160). The maximum biomass yield was found in the case of Maize-Soybean intercropping (17 ton/acre) in the fertilizer and seed rate combinations of 35:25:15=Urea:TSP: MP kg/acre and 20kg/ acre, respectively. Besides, the biomass yield from DeshiMaize was found less than one-third compared to the yield of hybrid maize (p=0.000). Thus, the best combination of fertilizer could be noted at 35:25:15=Urea:TSP: MP kg/acre and 20kg/ acre to obtain better results in terms of biomass yield. It might recommend that better fertilizer management and choice of fodder crops can improve the ultimate productivity as perannual cultivation per unit of land.

Enumeration and Characterization of Dominant Microorganisms in Goat's Milk

Md. Zakirul Islam, Md. Rezwanul Habiband and Md. Harun-ur-Rashid*

Department of Dairy Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh,
**E-mail: harunds@bau.edu.bd*

Abstract

The study was focused on the characterization and selection of dominant Lactic Acid Bacteria (LAB) from raw goat milk in Bangladesh. A total of 50 strains of LAB were isolated and identified from six (06) samples. The isolates were examined *in-vitro* to explore probiotic properties based on tolerance to the gastrointestinal tract, NaCl, bile salt, low pH along with EPS production, gas production, proteolytic activity, diacetyl production as well as milk fermentation test. The isolated strains were shared by rods (50%) and cocci (50%). The strains were identified based on their morphological, physiological and biochemical characteristics, the lactic acid isomer produced, the ability to ferment sugars, using API 50 CH strip and 16S rDNAamplicons. The distribution of the isolates revealed the existence of six genera: *Lactobacillus* (50%), *Streptococcus* (6%), *Leuconostoc* (22%), *Lactococcus* (8%), *Enterococcus* (6%), and *Pediococcus* (8%). The dominant species was found as *Lactobacillusacidophilus*, *Lb. delbrueckii* subsp. *bulgaricus* and *Lec. mesenteroides* subsp. *dextranicum* each was with 14% in total frequency. The in-vitro results found that the survivability of the strains in response to intestinal juice (>95%, for 17 strains), pancreatic juice (>90% for 27 strains), bile (>80% for 39 strains), low pH (>90% for 25 strains) besides the positive results for gas production (19 strains), proteolytic activity (22 strains), diacetyl production (37 strains) and strong milk coagulation was possessed by 24 isolates. In conclusion, the dominant isolates were more likely to be the best with probiotic attributes.

Development of Pure Starter Culture by Isolating Lactic Acid Bacteria from Natural Flora for the Manufacture of Novel Functional Dairy Foods

Md. Zakirul Islam, Mohammad Ashiqul Islam and Md. Harun-ur-Rashid*
Department of Dairy Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: harunds@bau.edu.bd*

Abstract
We assessed the quality of traditional fermented milk '*Dahi'* collected from four areas (Khulna, Gopalgonja, Faridpur, and Jamalpur) in Bangladesh. Traditionally made 16 *Dahi* samples were obtained randomly from four (04) different areas and initially analyzed for chemical and microbial qualities. Of the four area samples examined, the Khulna area sample had the highest total solids content (38.24%) and the Faridpur area sample had the lowest total solids content (29.82%). The Khulna area samples also showed a greater extent both in acidity (0.92%) and mineral content (1.08%). Total sugar content was significantly differed ($p \leq 0.01$) among the *Dahi* samples. The maximum sugar contained in *Dahi* was found in Gopalgonja samples with 28%. The other proximate components such as fat and protein were found non-significant ($p > 0.05$) although the highest mean value was observed in Faridpur area samples 4.88 and 4.74%, respectively. On the other hand, the chemical and microbial parameters were very similar between Khulna and Jamalpur area samples. The microbial analysis revealed that Gopalgonja and Jamalpur area samples were free from molds. The yeast count was significantly differed ($p < 0.05$) among the samples but total viable count and mold. On the contrary, a total of 82 isolates were identified from the traditional *Dahi* samples. The isolated strains were shared by rods (37%) and cocci (73%). The strains were identified based on their morphological, physiological and biochemical characteristics, the lactic acid isomer produced and the ability to ferment sugars (22). The distribution of the isolates revealed the existence of six genera: *Streptococcus* (50%), *Lactobacillus* (27%), *Leuconostoc* (05%), *Lactococcus* (05%), *Enterococcus* (09%), and *Pediococcus* (04%). It can be concluded that the identification at the species level is on-going. Furthermore, the manufacturing of yogurt by using isolated lactic acid bacteria as pure starter culture and develop functional yogurt for consumers in Bangladesh will be performed within the time frame.

Protein sources in the lactating animals ration in relation to blood profile, milk production and quality, reproduction and economic viability

Afrin Zannat, Somia Afrin, Md. Abid Hasan Sarker, Md. Sadakatul Bari, Md. Rezwanul Habib and Mohammad Ashiqul Islam*
Department of Dairy Science, Bangladesh Agricultural University, Mymensingh-2202,Bangladesh
**E-mail: m.a.islam@bau.edu.bd*

Abstract
Eight Holstein-Friesian crossbredcows (30 days pre-partum) were selected in a completely randomized design to characterize the feeding impact of different protein sources in an iso-nitrogenous and iso-energy concentrate mixture. After parturition selected cows were equally divided into four groups and received concentrate mixture (5.0 Kg/d/cow) with soybean, mustard oil cake and, fishmeal and mustard oil cake as protein ingredient and the fourth diet was the BAU dairy farm formulation.All the cows during pre-partum period received equal amount(3 Kg/cow/d)of concentrate mixtures containing all the protein ingredients. About 35.0 kg/cow/day German grass after chopping was provided as basal

diet and fresh drinking water was supplied adlibitum basis. The response of feeding soybean meal, mustard oil cake and fish meal with respect to blood profile were found similar among the cows.However, with regards to milk production, fish meal fed cows produce 0.8 kg more (p=0.000) milk/cow/day with remarkable lactation persistency. Soybean meal and mustard oil cake fed cows produced statistically similar (p>0.05) amount of milk like the fish meal fed cows and they also differ non-significantly (p>0.05) with control diet cows. All the milk components were found similar in all four types of diet (p>0.05). Cows in control group incur BDT 1.50/= less to produce one liter of milk than other groups. But the cows in soybean meal, mustard oil cake and fish meal fed group have BDT 123, 126 and 132/= profit margin from milk per day, respectively which was BDT 127/= in control cows.The average post-partum heat period was found 55 days. In conclusion, feeding fish meal was found better with regards to milk production and other two protein ingredients also showed promises in the improvement of the milk production.

Detection of milk adulteration on the basis of casein, whey protein and NPN

Sanuara Islam, Md. Sadakatul Bari, Md. Rezwanul Habib, Md. Harun-ur-Rashid and Mohammad Ashiqul Islam*

Department of Dairy Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: m.a.islam@bau.edu.bd*

Abstract

The effort in this work is to develop a new method of detecting the adulteration of milk on the basis of its nitrogen distribution. The hypothesis is based on that – addition of any other materials to milk, supposed to alter its nitrogen distribution. The milk nitrogen was fractionated in different parts (non-casein nitrogen and non-protein nitrogen) by using acetic acid and sodium-acetate, and Trichloro acetic acid, respectively and estimated by the Kjeldahl method. In this part of the work, milk was first diluted by adding different level of water and then solids like sugar and wheat flour were added to compensate this dilution. The addition of 15%, 20% and 25% of water to the milk causes a significant (p=0.000) reduction of their specific gravity compared to the original fresh milk (Table 1). It also reveals that the specific gravity of 15% added water was significantly different from the specific gravity of 25% water added milk, however, 20% water added milk differ non-significantly (p>0.05) from both of them. The specific gravity of sugar and flour added milk were statistically found similar to the fresh milk. Only the 25% addition of water causes a significant (p=0.028) reduction in the total protein content of the milk compared to the fresh one. All other types of milk were found similar among them and also compared to the fresh milk and 25% water added milk. True protein, casein and fat content followed the similar trend as it was in the case of total protein. The whey protein and non-protein nitrogen content of different adulterated milk were found similar to the fresh milk (p>0.05).From the results obtained, it seems that casein could be used to detect the adulteration of milk but to be more precise, need to obtain data on a large scale of sample.

Development of a Novel Stabilizer mix for Improving the Quality of Ice Cream

Raihan Habib* and Md. Farouq Imam[1]

Department of Dairy Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and
[1]Department of Agricultural Statistics, Bangladesh Agricultural University, Mymensingh
**E-mail : raihanh46@yahoo.com*

Abstract

This research project was aimed at developing a novel stabilizer mix using locally available ingredients like china grass and tapioca starch. Notable industrial stabilizers like locust bean gum; xanthan, sodium

alginate, and guar gum) and modified stabilizers like china grass and tapioca starch on stability of foam and the increase in volume of ice cream were evaluated. The viscosity of a stabilizer at various levels was investigated to evaluate their effect on collapsing of foam, hence increasingly stabilized foam. One day after being aged, ice cream containing 10% butter fat and dissimilar stabilizers was observed to estimate the impact of hydrated stabilizers on the product viscosity. The increased volume of product after being whipped was evaluated. The consequences depicted that the viscosities increased in the subsequent order: sodium alginate > modified china grass > xanthan >, guar gum> locust bean gum > modified tapioca starch. Generally , it was assumed that sodium alginate and modified china grass gave more viscosity and stabilized foam to product and modified tapioca starches exhibited no noteworthy disparity ($p>0.01$) in the volume. It was also found that the use of locally available stabilizer like china grass reduced the cost of making ice cream by 12%.

Detecting taste threshold for broiler type chickens using one-cup drinking method

Bapon Dey*, Shuvosree Sarkar and Hasan Mohammad Murshed
Department of Poultry Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : dey_bau@yahoo.com)*

Abstract

The sense of taste has a key role in nutrient sensing and food intake in animals. A standardized and simple method for the determination of tastant-detection thresholds is required for chemosensory research in poultry. The elucidation of the sense of taste in chicken offers opportunities to create and improve feedstuffs for chickens and to contribute to the understanding of the mammalian sense of taste. In this study, we have tested five different taste compounds to elucidate the sensitivity of chicken system using one-cup 10 minutes drinking experiments. We found that chickens have very good taste responses and showed a significant aversive effect for 20 mM caffeine ($P<0.01$) and 50 mM citric ($P<0.05$) acid solutions. On the other hand, chicken showed a better preference for sucrose and mono-sodium glutamate in the 10 min drinking test. But, the preferences for sodium chloride were much concentration-dependent. The findings of behavioral tests may suggest that chickens have a strong acuity for a taste like other mammals and this information will help to elucidate the role of taste perception in feed-intake regulation, feed choice, and acceptance in broiler type-chickens.

A comprehensive method for the improvement of eggshell quality in late laying hens

Bapon Dey[1]*, Anita Roy[1] and Amrita Pondit[2]
*[1]Department of Poultry Science and [2]Department of Microbiology and Hygiene, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh, *E-mail: dey_bau@yahoo.com.*

Abstract

Improved understanding of the factors that affect the performance and quality of the eggshells produced by commercial laying hens is essential for the production of the highest quality eggs because defects in shell quality can cause significant losses to the commercial egg industry. In older hens, calcium uptake from the diet is not as good as it is in younger animals. The combination of a lower uptake of calcium and an increase in egg weight increases the number of eggshell quality problems. In this study, we used dietary supplementation of sodium bicarbonate ($NaHCO_3$) salt for improving the eggshell quality in older hen's ages between 65 to 75 weeks old. We found, 65 to 75 weeks of age, the hens had little response to $NaHCO_3$ supplementation and showed a positive trend on eggshell thickness and strength.The eggshell thickness had significantly ($P<0.05$) higher in the 3g/kg $NaHCO_3$ treated group compared with the control group that fed the hand-mix layer mash

feed. Additionally, the internal egg quality parameters improved in the dietary groups treated with $NaHCO_3$, although data did not show a significant improvement. Taken together, it may be concluded that dietary supplementation with 3 g/kg $NaHCO_3$ improves calcium absorption and eggshell quality of laying hens during the late production period.

Production of antibiotic free safe eggs by using different antibiotic alternatives in layer diet

Md. Elias Hossain* and Musabbir Ahammed
Department of Poultry science, Bangladesh Agricultural University, Mymensingh-2202,Bangladesh
**E-mail : mehossain_bau@yahoo.com*

Abstract
This research was conducted for the production of antibiotic free safe eggs by using different antibiotic alternatives in layer diet. A total of 200 Hyline brown hens at 18 weeks of age were used into five dietary treatments with four replications. In case of experiment 1, different treatments were, control (basal diet), antibiotic (basal diet + antibiotic), neem-0.25% (basal diet + 0.25% neem leaf powder), moringa-0.25% (basal diet + 0.25% moringa), black cumin-0.25% (basal diet + 0.25% black cumin). In case of experiment 2, different treatments were, control (basal diet), antibiotic (basal diet + antibiotic), garlic-0.25% (basal diet + 0.25% garlic powder), green tea-0.25% (basal diet + 0.25% green tea), zingar-0.25% (basal diet + 0.25% zingar). Egg production, egg weight, shell thickness, shell percentage, albumen index, Haugh unit, yolk index yolk color were tested among the treatment groups. In case of experiment 1, supplementation of moringa showed higher egg production followed by black cumin and neem compared to the control and antibiotic group. Egg quality such as shape index, albumen index, yolk index, shell thickness, haugh unit values were higher in neem group compare to the other groups. In case of experiment 2, supplementation of zingar group showed higher egg production followed by garlic and green tea compared to the control and antibiotic group. Egg quality such as shape index, albumen index, yolk index, shell thickness, Haugh unit values were higher in supplemented group compare to the control and antibiotic groups. It was concluded from the study that supplementation of different medicinal plants improve egg production and egg quality parameters compare to the antibiotic group. It is suggested that moringa, neem, zinger, green tea, black cumin and garlic can be used in layer diet as alternatives to antibiotic for the production of safe eggs.

Effects of hot weather on broiler production under different levels of welfare bestowed rearing system

Musabbir Ahammed
Department of Poultry Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail : musabbir.bau@gmail.com

Abstract
This study was conducted to compare the performance of broiler, welfare parameters and air quality at different levels of welfare under hot climatic condition. A total of 240 day-old Indian River broiler chicks were assigned for a period of 28 days rearing period. Different levels of welfare were provided as experimental treatment. Treatment-1 control, conventional rearing system with regular stocking density (SD) (1.0 sqft/bird); TTreatment-2 lower level of welfare provided lower SD (1.86 sqft/bird); Treatment-3 medium level of welfare provided lower SD (1.86 sqft/bird) with outdoor access and straw bales both in indoor and outdoor and Treatment-4 higher level of welfare provided lower SD (1.86 sqft/bird) with outdoor access, perching and straw bales both in indoor and outdoor. All facilities for expressing natural behavior of broilers, house was designed to meet up the standard welfare requirements recommended by RSPCA. Body weight, body weight gain, feed intake, welfare

parameters (foot pad score, hock burn, breast blister) and air quality were recorder throughout the experimental period. At the end of feeding trial carcass quality parameters of broilers were also determined. The results indicated that there were no significant differences in performance parameters among treatments. But the welfare parameters of birds and ammonia concentration inside the house were influenced significantly ($P<0.05$) among different treatments. No symptoms of hock burn and foot pad score were observed in higher levels of welfare groups compared to control and lower level group. The amount of O2 and CO2 were more or less similar in both control and treated group whereas NH3 was significantly ($P<0.05$) lower in higher level of welfare group. Abdominal fat content of the birds enjoyed higher level of welfare was significantly ($P<0.05$) lower compared to others. Considering the growth performance and other parameters it is concluded that medium level of welfare bestowed rearing system could be a good option as an alternative rearing for fast growing modern broilers in Bangladesh condition.

Quality and safety assurance of broiler meat production under small and medium farming in Bangladesh

Afifa Afrin, Sukumar Saha[1] and Shubash Chandra Das*

Department of Poultry Science, Bangladesh Agricultural University, Mymenisngh 2202 and [1]Department of Microbiology and Hygiene, Bangladesh Agricultural University, Mymenisngh 2202

**E-mail: das_poultry@bau.edu.bd*

Abstract

In recent days a large segment of the consumers have negative attitudes and perceptions towards the broiler meat because they believe that the products are polluted with antibiotic residues, heavy metals, hormones or other harmful feed additives and are not safe for consumption. Small and medium scale broiler farmers are being provoked or forced by local agents, dealers, medicine company's representatives, so called consultants etc. in use of unnecessary drugs and feed additives such as antibiotics, multivitamins, growth promoters, specific vitamins, minerals, vaccines, liver tonic etc. in broilers. Indiscriminate use of various medicines and drugs within the span of 28 days of rearing causes not only poor quality of broiler meat but also incurs production cost remarkably. Therefore, the present study was undertaken to ensure the safe production of broiler meat under small and medium scale farming and also to ensure the quality of broiler meat and commercial broiler feeds.The overall activities proposed under the project have been split out into 3 independent trials. First, baseline survey was conducted at different poultry pocket areas namely Fulbariaupazilaof Mymensingh district, JamalpurSadar, Sariakandi and Dhunotupazilaof Boguradistrict where almost 100 broiler farms have been visited to understand the existing scenario of small and medium scale broiler farming in the country. The second trial on growth performance of broilers at small and medium scale farming fed three different diets namely control i.e. existing commercial feed but no extra additives, control plus some selective necessary additives and finally control plus additives commonly used by farmers will be observed in second quarter of the project. Afterwards, the broiler meat qualities and microbial load in three treatment groups of birds will be compared under small and medium scale farming. Finally, cost-benefit analysis would be calculated for each type of diet.

Comparative Study on the Growth Performance of Three Varieties of Guinea Fowl (pearl, white, lavender) Under Intensive Rearing

Farzana Sultana and Shubash Chandra Das*

Department of Poultry Science, Bangladesh Agricultural University, Mymensingh 2202,Bangladesh

**E-mail: das_poultry@bau.edu.bd*

Abstract

The present study was conducted to compare the growth performance among three varieties of guinea fowl namely Pearl, White, and Lavender in intensive system and also to recommend which of the

guinea fowl varieties is most suitable and profitable for small and medium scale rearing under local environment of Bangladesh. A total of 120 day-old keets, (40 from each variety) were brooded at BAU Poultry Farm. At hatching the keets were separated on the basis of their plumage colors as shown by their distinct difference incolor of the feathers of keets into three genotypes i.e. Pearl, White and Lavender. In case of intensive rearing system, guinea fowl keets were reared with commercial feed containing 24% CP, 3000 kcal/kg ME and the birds were kept without outdoor access. Although, the data forfeed intake, body weight, body weight gain for three varieties of guinea fowl were statistically non-significant, at the end of 20 weeks rearing, White variety numerically attained highest live body weight (1482.5 g/bird) followed by Lavender (1449 g/bird/). The lowest body weight however was found in Pearl (1269 g/bird). Weekly weight gains were highest (102.0g/bird) in Lavender while White variety attained moderate weight gain (99g/bird) and Pearl variety showed the lowest (86.0 g/bird). Feed conversion ratio (FCR) among the three color types were statistically significant.The overall survivability was 90.83% .Considering the growth performance White type was superior to other color types used in the experiment.

Use of medicinal plants in layer diet for the production of safe eggs

Md. Elias Hossain
Dept. of Poultry science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail : mehossain_bau@yahoo.com

Abstract

This study was conducted to know the effect of dietary neem leaf powder (*Azadirachta indica*) and garlic powder (*Allium sativum*) on the laying performance, egg quality parameters and blood biochemical parameters of laying hens. A total of 64 Shaver 579 hens at 102 weeks of age were used into four dietary treatments with four replications. Different diets were control (basal diet), antibiotic (basal diet +antibiotic), neem-0.25% (basal diet + 0.25% neem leaf powder), garlic-0.25% (basal diet + 0.25% garlic powder). Inclusion of neem and garlic in the diets of laying hens did not show significant ($P>0.05$) variation with respect to body weight and egg production. Besides, egg weight showed significant ($P<0.05$) differences during 4th weeks of experimental period. No significant ($P>0.05$) difference was found on egg shell thickness of bird fed neem-0.25% and garlic-0.25%. Albumen quality was improved ($P<0.05$) in the treatment groups. Yolk cholesterol was significantly ($P<0.05$) reduced in neem and garlic group compare to the antibiotic group. In the serum biochemical parameter, cholesterol was decreased ($P<0.05$) and HDL was increased ($P<0.05$) in neem and garlic group in comparison with other treatment groups. Whereas, non significant differences ($P>0.05$) in GPT, GOT, Glucose and TG among different dietary groups were found. Supplementation of neem and garlic had no effects ($P>0.05$) on dressing parameters. It was concluded from the study that supplementation of neem and garlic had no negative effect on egg production, egg quality characteristics, blood biochemical parameters and dressing parameters. Moreover, the ingredients tested in this study decreased yolk and serum cholesterol level than that of antibiotic. It is suggested that both neem and garlic can be used in layer diet as alternatives to antibiotic for the production of safe eggs.

Production of safe broiler meat by use of different antibiotic alternatives

Md. Elias Hossain
Dept. of Poultry science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail : mehossain_bau@yahoo.com

Abstract

This study was conducted to evaluate the possibility of probiotic, organic acid, enzyme and medicinal plant (neem) as alternative feed additives to antibiotics in broiler diet and also to observe the growth

performance, feed efficiency, dressing percentage, blood biochemical parameters of broiler. A total of 432 Cobb-500 broiler chicks were selected for 6 treatments, with 4 replications and 18 broilers per replication for 35 days. The dietary groups were; control (basal diet; no additives), antibiotic (basal diet + antibiotic 0.02%), probiotic (basal diet +1gm/2liter water), organic acid (basal diet+ 1ml/1 liter water), enzyme (basal diet + 1 ml/1 liter water), and neem (2 ml extract/ 1 liter water). All birds were housed in a gable type open sided house. Body weight, growth rate, serum biochemical parameters, dressing parameters were recorded in different treatment groups. Highest final body weight and body weight gain were found in probiotic supplemented group followed by organic acid group which resembles to the antibiotic group. Dressing parameters indicated no improvement in different treatment group through using feed additive, although no negative effect was found. There were no differences in HDL, TG, GPT, GOT, creatinine value among the different groups. However, lower level of cholesterol content was found in neem and organic acid group compared to other dietary groups. With regard to profit feed additive groups showed higher profitability compare to the other groups. The results indicated that addition of probiotic, organic acid, enzyme and neem extract had positive effect on growth performance, serum biochemical parameters and profitability and no negative effect on meat yield, bone development and carcass parameters. Based on the results of the present study it can be suggested that probiotic, organic acid, enzyme and medicinal plant could be potential feed additives in broiler diet with no adverse effect on broiler performances.

Development of different value added meat products from poultry and beef

MS Ali*, MA Hashem[1], U Habiba[1], M Khanom and A Akhter[1]

*Department of poultry Science and [1]Animal Science , Bangladesh Agricultural University, Mymensingh-2202.Bangladesh, *E-mail : mdshawkatali@hotmail.com*

Abstract

Three experiments were conducted to produce value added sausage and nuggets from beef and chicken meat and evaluate their proximate, surface color (CIE *L**, *a**, *b**), physico-chemical, biochemical and microbial properties at 0, 15 and 30 days of storage period. In first experiment, sausages were prepared from beef without flour, beef with 10% rice flour, beef with 10% wheat flour and beef with 10% corn flour. All parameters were analyzed at 0, 15 and 30 days of storage time. Significant differences were found in pH, DM (%), CP (%), EE (%) and Ash (%) content in different sausages. Crude protein (%) and DM (%) increased, while Ash (%) and EE (%) decreased with increase of storage time. The storage period had significant effect on different biochemical (FFA, POV and TBARS value) test. In all cases the values were increased with increase of storage time. No significant differences in *L** value were found among beef sausages and storage time. On the other hand, different types of sausages had a significant effect on *a** and *b** values. All the parameters were significantly lower in control sausage except off-flavour, which was significantly higher in control sausage. From this experiment, it might be concluded that addition of different types of flour increases the overall acceptability of beef sausage. In second experiment, nuggets were prepared from broiler meat with 10% wheat flour, 20% wheat flour, 10% barley grist and 20% barley grist. The proximate compositions of different nuggets were analyzed and significantly higher DM (%) was found in chicken nuggets with 20% barley grist, while CP (%) and EE (%) were significantly higher in 10% wheat flour group. DM (%) and CP (%) content increased with increasing of storage time. The storage period have significant effect on different biochemical (FFA, POV and TBARS value) test. The values were increased with increase of storage period. Significantly highest lightness value was found in nuggets with 20% wheat flour and lowest value was found in nuggets with 20% barley grist. Significantly higher redness value was found in nuggets with 20% barley grist. During sensory evaluation, the flavor, juiciness, tenderness and overall acceptability of chicken nugget with 20% barley grist was significantly lower than other three

treatments. In third experiment, nuggets were prepared from broiler meat with 10% wheat flour, 20% wheat flour, 10% Oat meal and 20% Oat meal. Significant differences were found in crude protein (%), ether extract (%) among different nuggets, as well as among different storage time. Significantly higher DM (%), Ash (%) and EE (%) was found in nuggets with 20% oat meal, while higher crude protein (%) were found in nuggets with 10% wheat flour. Crude protein (%) and DM (%) increased, while Ash (%) and EE (%) decreased with increase of storage time. The storage period had significant effect on different biochemical (FFA, POV and TBARS value) test. In all cases the values were increased with increase of storage time. No Significant differences in *b** value were found among chicken meat nuggets and storage time. On the other hand, different types of nuggets and storage period had a significant effect on *L** and *a** value. In sensory analysis, no significant differences were found in flavor, off-flavor, juiciness, tenderness and overall acceptability among four types of sausages. From this experiment, it might be concluded that addition of oat meal as a source of dietary fiber increased the overall acceptability of chicken nuggets and the best result was found broiler meat nuggets with 10% oat meal.

Effect of feeding a novel additive mixture of local origin on older hen performance

Md. Shahidur Rahman*, Sayeda Sultana and Quazi Forhad Quadir[1]

*Department of Poultry Science and [1]Department of Agricultural Chemistry, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail : msrahman.poultry@bau.edu.bd*

Abstract

The modern layer strains of chicken is usually culled at 80-100 weeks of age because of the uneconomic egg production rate and inferior qualities of egg. The current study was undertaken to investigate the effects of feeding a locally available natural feed stuffs-based novel additive mixture to 81 weeks old laying hen on egg production performances, egg qualities and reproductive organ status. The novel additive mixture was prepared from the 14 locally available feed stuffs those already have proven effects on arrays of physiological, production and reproduction aspects of birds. A total of 64 hens were equally and randomly distributed to the conventionally formulate commercial feed, and 0%, 0.5% and 1% novel additive mixed feeds. The hens under each type of feed was subdivided into four replicated groups of four hens in each in cage lying system. The data collected under the experiment was tested by one-way of ANOVA followed by Tukey's mean comparison test in the Minitab computer software of version 2017. Results indicated that the novel additive mixture was not harmful for the hen's life and body maintenance. The 1% additive level increased feed intake, maintained a comparable feed conversion efficiency (FCR) and egg weight with commercial feed through maintaining a trend of longer time egg production, larger yolk production, higher albumen index and Haugh Unit creation and thicker and heavier egg shell production. The 0.5% additive mix was found to be the worst, even compared to the 0% additive mixed feed (control), in terms of almost all the parameters measured. Hence, the current study reveals that the newly developed mixture is not yet in a point of commercialization and need further research to identify the negative effect exerting stuffs present in the mixture that become traceable at 0.5% additive level, and reformulate and retested the mixture again.

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Production performance and profitability of rearing turkeys in Bangladesh

Md. Altaf Hossain, Mr. Auvijit Saha Apu[1] and Shubash Chandra Das*

Department of Poultry Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and [1]Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Mymensingh-2202,Bangladesh, E-mail : das_poultry@bau.edu.bd

Abstract

Against the standard requirement of meat (55 kg /head/year), per capita consumption in Bangladesh is around18 kg, of which poultry contributes only 7 kg that indicates a scope to increase poultry meat production in the country. Turkey, one of the promising species of poultry, has been introduced recently in Bangladesh by some enthusiastic farmers, most probably from neighboring countries. The farmers started to rearing turkey in small scale mostly just for hobby but later it became source of income as well as animal protein. So far, few thousands of farmers have stared rearing of small scale turkeys having 25-200 birds/household. Adaptability of birds with local environment is so far so good with few exceptions of some disease incidence. Rearing of small scale turkeys can open new avenues for the farmers. The birds have unique quality of scavenging, ability to consume huge green grasses and vegetables that eventually would reduce the overall production cost. Since there is no specific guideline on rearing turkeys, farmers are facing problems in housing, feeding, light control, disease management etc. Further, consumers are not familiar with the quality of turkey meat. Thus, the marketing of products is also a problem currently facing by the farmers. Specific nutrients specification for turkey, necessary vaccine and medicine are not available in the market. Keeping all the facts in mind, present study was undertaken to observe the egg and meat production performance, profitability of small and medium scale rearing and also to evaluate the meat quality of heritage turkeys available in the country.

Construction of recombinant plasmid encoding short peptide

Md Bazlur Rahman Mollah*, Mahmuda Akhter, Md Raziul Islam and Md Kamruzzaman[1]

*Department of Poultry Science and [1]Department of Animal Nutrition, Bangladesh Agricultural University, Mymensingh-2202,Bangladesh, *E-mail : mbrmollah.ps@bau.edu.bd*

Abstract

Bioactive peptides can be defined as small fragments of proteins which often provide some physiological benefits to the organisms. They act as potential modifiers in different metabolic pathways. Thus, these peptides play a major role in the development of various functional foods. Amino acids are organic compounds that combine to form peptide and proteins. Amino acids and proteins are the building blocks of life. Like other mono-gastric animals, poultry birds cannot synthesize all the amino acids within their body. Therefore, several amino acids such as lysine, methionine, threonine and tryptophan must be supplied in their diet for optimum growth and production. Bangladesh poultry industry is exclusively depended on the imported synthetic amino acids and every year we are spending substantial amount of foreign currency for importing feed grade amino acids mainly for commercial poultry. Feed grade amino acids can be synthesized by both chemical and biological means. Recent advancement and access of molecular biological methods has paved the way for synthesis of amino acids through recombinant DNA (rDNA) technology. rDNA refers to any DNA that has been created artificially from two or more sources. In this study, we are employing rDNA technology to construct recombinant plasmid vector containing (ATG-AAG-ACC-

$TGG)_{5\text{-}8}$-TAG DNA sequence for the synthesis of methionine-lysine-tryptophan polymer. By this time, we have constructed four rDNAs containing different combination of methionine-lysine-tryptophan monomer and cloned into PGEM-T vectors. Transfection of the vectors into BL21 cells and characterization of these synthetic constructs by DNA sequencing, SDS (sodium dodecyl sulfate) and Native poly acrylamide gel electrophoresis is ongoing. In addition, optimization of *in vitro* single cell protein production to express these newly constructed rDNAs is in progress.

Standardization of energy and protein levels in the diet of BAU-Bro color chicken

Md Bazlur Rahman Mollah*, Sharmin Akhter Namni, Suma Rani Bishwas and Humayun Kabir[1]

*Department of Poultry Science and [1]Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail : mbrmollah.ps@bau.edu.bd*

Abstract

Determination of nutrient requirements of a newly developed strain is crucial to efficiently use the genetic potential for specific production goals. Dietary nutrients density, specially energy and protein are the most critical nutritional factor in commercial production, not only because it has a significant effect on growth performance, carcass quality, and health of poultry, but also because of economic inputs and outputs. Previously, we have developed BAU-Bro color chicken from locally available genetic resources. Identification of optimum levels of energy and protein is necessary for improvement of growth of BAU-Bro color chicken and cost effective production. Thus, the present study was conducted to determine the influence of dietary energy and protein concentrations on growth performance of BAU-Bro color chicken from 14 to 42 day of age. 15-d-old chicks were randomly assigned to 3 dietary metabolizable energy (ME) (2900, 3000 and 3100 kcal/kg) and 3 crude protein (CP) concentrations (19, 20, and 21%) in a 3 × 3 factorial arrangement. Body weights were measured at 14, 21, 28, 35 and 42 days of age. Carcass characteristics were evaluated on 42 day. As dietary CP increased from 19 to 21%, breast meat yield increased by 4.05% on d 42 ($P < 0.01$). Conversely, increasing metabolizable energy from 2900 to 3100 kcal/kg increased dressing percentage, breast skin, and subcutaneous fat, but decreased breast meat yield (% but not weight) on 42 ($P < 0.01$). The best body weight gain and feed conversion ratio was obtained when chicks were fed a 20% CP and 3000 kcal/kg energy diet. These results provide a framework for subsequent modeling of protein and energy inputs and the corresponding outputs of growth performance and carcass components BAU-Bro color chicken. The findings of the study will help to develop cost effective feeding regime for BAU-Bro color chicken.

Value Addition of Low fat Chicken Sausages with Different Types of Flour

MS Ali, . M Habib[1], M Rokib and MG Sarower

*Department of poultry Science and [1]Graduate Training Institute, Bangladesh Agricultural University, Mymensingh-2202 Bangladesh, *E-mail : mdshawkatali@hotmail.com*

Abstract

Two experiments were conducted to evaluate the effect of cereal flours on low-fat chicken sausages. In first experiment sausages were prepared: control; broiler breast meat without any flour, sausages with 10% rice flour & sausages with 10% wheat flour and in second experiment sausages were prepared: control; broiler breast meat sausage without any flour, sausage with 10% corn flour & sausages with 10% barley flour. All parameters were analyzed at 0, 15th and 30th days of storage period. In both

experiments highly significant ($p<0.01$) differences were found in DM (%) and CP (%). Significantly ($p<0.01$) lower DM (%) and higher CP (%) was found in both control sausages and DM (%) and CP (%) content was increased with the increase of storage time. The storage period has a significant ($p<0.01$) effect on different biochemical (FFA, POV, and TBARS value) and microbial (TVC, TCC, and TYMC) tests. The values were increased with the increase in storage period in both experiments. Different types of sausage and storage period have an effect on redness (a*) value. In both experiments, significantly lower flavor, juiciness, and tenderness were found in control sausages. However, overall acceptability did not differ among the sausages in both experiments. The results of this study revealed that low-fat chicken sausages can be made with different cereal flours without lowering the overall acceptability.

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Trengthen the Renewable Energy Technologies for Sustainable Agricultural Production in Bangladesh

Humayun Kabir
Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail : hkabir75@yahoo.com

Abstract
The research aimed to explore renewable energy technologies for crop production through solar irrigation practice in selected areas of Bogura, Rangpur and Jashore district in Bangladesh. Total 120 households (60 of solar irrigation users and 60 of non-solar users) were purposively selected from three districts. Data were collected through face to face interview. Cobb-Douglas production function and descriptive statistics were used to explore the relationship between inputs and output. Social acceptability and perception of solar irrigation technology were measured through using *Likert* scale model. Social acceptability of solar irrigation practice was positive in three districts. The Cobb-Douglas production found that, the solar irrigation cost, seed cost, harvesting cost and transportation cost have significant effect on solar irrigation based boro rice production and seed cost, labour cost, harvesting cost, transportation cost have significant effect on non-solar irrigation based boro rice production in Rangpur and Bogura, and in Jashore, the solar irrigation cost, ploughing cost and fertilizer cost had significant effect on solar based *Boro* rice production and ploughing cost, fertilizer cost, harvesting cost had significant effect on non-solar based *Boro* rice production.. Net Return and BCR for solar based per hectare rice production in Rangpur, Bogura and Jashore were Tk 28580.66, Tk 21943.71, 57411.00 Tk, and 1.49, 1.46, and 1.46 respectively and for non solar based per hectare rice production in Rangpur, Bogura and Jashore were Tk. 27745.40, Tk, 22144.64 and 22400.00 Tk, and 1.46, 1.43 and 1.31 respectively. *Boro-Aman-Fallow* occupied the most dominant cropping pattern for both types of irrigation practices in the study area. The solar irrigation practice is much convenient for sustainable crop production because it is economically viable, socially acceptable and environmental friendly.

Empowerment of Rural Women through Livestock Initiatives

Rahat Ahmed Juice
Department of Agricultural Economics, Agricultural University, Mymensingh-2202, Bangladesh
E-mail: juicesarker6@gmail.com

Abstract
The study was accomplished to determine the extent of empowerment of rural women through livestock initiatives, to determine the factors influencing the extent of empowerment of rural women, and to identify the problems faced by the rural women during participating in livestock activities. Two Villages of Baera Union (Baera and Fakirakanda) of Mymensingh Sadar Upazila of Mymensingh District were selected as a study area. Data were collected from 100 rural women who were engaged with livestock activities as the sample (18% of the total population) and 100 women selected as a control group who were not engaged in livestock activities by using a random sampling method. Face to face interview was conducted through using questionnaire during May and June 2018. The data were analyzed using descriptive statistics, Pearson's product-moment correlation coefficient (r), multiple regression analysis and paired t-test. The major findings indicated that 75% of respondents had a medium level of empowerment and 61% control group women had a low level of empowerment. A significant difference exists between the two groups observed from t-value 8.342**. Education, livestock farming experience, individual contribution to the annual family income, training experience and extension media contact, and knowledge on livestock activities had a significant positive association with women empowerment. Regression analysis revealed that education, training

experience and knowledge on livestock activities were the influential factors on rural women empowerment. Majority of the rural women faced a high level of problems. Economic insufficiency to do livestock farming, the high mortality rate of domestic animals, lack of proper training facilities, time-consuming, lack of proper extension services, and insufficient marketing facilities were the major problems faced by rural women. So, addressing all the important problems through focusing influential factors is the urgent need to improve the livestock farming situation which will ultimately lead to improving women empowerment status at a higher level.

Existence of Female Labour in Agriculture: New Dimension of Gendered Role and Contribution to the Economy

Sadika haque
Department of Agricultural Economics, Agricultural University, Mymensingh-2202, Bangladesh
E-mail : sadikahaque@bau.edu.bd

Abstract
The objective of the study was to explore the status of female labour in agriculture in the northern Bangladesh. To get insight, one researcher had been living in the community for 3 months to see the dynamics of their life. We have included the information of 23 women who had no land but regularly worked in the others' land from Pirganj, Rangpur. The women were aged between 15-60 years. As soon as the girls get married, they can join to work at agricultural labour force. It could be mentioned here that those women are the most marginalized of the society. They are not always employed. Some of the days, they have to search work, which is another work. Normally they receive the work-related information from their co-workers. The female labours work in a situation where there is no formal rule and wage gap is socially accepted. On the days, they get work, they work as labour for 9 hours, at household for 6 hours, 2-3 hours for watching TV or chatting and 6-7 hours, for sleeping. They feel, before 20 years, the rural women, regardless of poor or rich, used to work for 12-16 hours at household arena. In a year, about 100 -120 days, they used to be under work pressure, based on agricultural seasons but now the whole year, they are in physical and mental pressure. Their personal life style and social relations have also changed. Previously, each woman could demand for foods, clothes or even cosmetics to their husbands/sons, but now they have to manage by themselves. They earn small amount of money but they have lost the harmony in their life. So, it is a matter of question, the poor labour are actively contributing to economy but they how the economy is paying for them.

Comparative Economics of Jute Production under Ribbon Retting and Conventional Retting Technique in Bangladesh

Abu Hayat Md. Saiful Islam
Department of Agricultural Economics, Bangladesh Agricultural University (BAU), Mymensingh-2202.Bangladesh
Email: saiful_bau_econ@yahoo.com

Abstract
The present study was designed to determine the cost, return and profitability of jute growers under conventional retting method and ribbon retting method in some selected areas of Rnagpur Division. Primary data were collected from 150 jute growers under conventional retting method and 80 were under ribbon retting method. A stratified random sampling technique was followed. Data and information were collected by using pre-testing questionnaire from Bhatibari, Harati, Gokunda and Rajpur under Lalmonirhat Sadar Upazila of Lalmonirhat district. Both descriptive and statistical analyses were applied in this study. The study showed that, jute production is profitable under both conventional and ribbon retting method. The benefit cost ratio (BCR) was higher in case of jute

production under ribbon retting method (1.31) than conventional retting method (1.26). The Cobb-Douglas production function analysis shows that out of six inputs, the effects of using human labour, power tiller and fertilizer were significant and indicated positive effect on jute production under conventional retting method. On the other hand, human, power tiller, seed and fertilizer were significant and indicated positive effect on jute production under ribbon retting method. In this study, resource use efficiency measure which is the ratio of marginal value product (MVP) and marginal factor cost (MFC) was used to show the efficient resource allocation to attain the goal of profit maximization. Results indicate that none of the ratio of MVP and MFC was equal to one which indicates that both the farmers group in the study area have failed to show their efficiency in resources use. The study also identified some problems and prospects of jute ribbon retting method and suggested some recommendations to improve the present production situation so that per hectare profit from jute production would possibly be increased.

Technical Characteristics and Economic Performance of Commercial Tilapia Hatcheries in Bangladesh

Abu Hayat Md. Saiful Islam
Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
Email: saiful_bau_econ@yahoo.com

Abstract
The study was designed to evaluate the relative hatchery efficiency in the selected areas of Bangladesh. In total, 50 hatcheries were randomly selected for the study. Descriptive statistics, activity budgets, Cobb-Douglas production function model were employed to test the set of hypotheses of the study. The major findings of the study reveal that both mono-sex tilapia hatchery system and tilapia dominant mixed hatchery system were profitable. The estimated benefit cost ratio (BCR) for mono-sex tilapia hatchery and tilapia dominant mixed hatchery was 1.13 and 1.57 respectively. The result shows that tilapia dominant mixed hatchery system was more profitable than mono-sex tilapia hatchery. In the Cobb-Douglas production function most of the variables included in the model were significant in explaining the gross return of tilapia hatcheries. Water management cost, quantity of labor and quantity of feed, was statistically significant at 1%; lime and salt cost, hormone and antibiotic cost and hatchery type was significant at 5%; and only cost of hapa was significant at 10%. From the result of functional analysis we can see that a little change in the use of labour and feed of tilapia fingerling production can cause a greater change in the gross return, so there is a scope of further improvement in this consideration. There is a scope to increase the profit level by applying more doses of the concerned inputs under the present technology. However, the tilapia dominant mixed hatchery owners are more efficient than mono-sex tilapia hatchery owners. The study also identified some crucial problems such as lack of capital, high price of input, lack of institutional credit and poor communication, transport and marketing facilities, low price of fingerlings, etc. Probable solutions and suggested policy recommendations were also made based on the findings of the study.

Incorporating salt-tolerant wheat and pulses into smallholder farming systems in southern Bangladesh

Md. Taj Uddin
Department of Agricultural Economics, Bangladesh Agricultural University (BAU), Mymensingh-2202.Bangladesh
E-mail : tajbau@yahoo.com

Abstract
The study was carried out to understand the context for practice change in dry season cropping in Southern Bangladesh, and establish its evolution as a response to the project. A total of 500 farmers

(i.e., 200 from non-saline areas and 300 from saline areas) were investigated following stratified random sampling technique from seven districts of Southern Bangladesh which were: Barguna, Patuakhali, Khulna, Satkhira, Barisal, Bhola and Jhalokathi. An amalgam of descriptive statistics, mathematical and statistical analyses was used to analyze the data. Descriptive statistics revealed that majority of the farmers in non-saline and saline areas followed the cropping pattern of Fallow – *Aman* rice – Pulses and Fallow – *Aman* rice – Fallow, respectively. Cropping intensity was higher in non-saline areas (220. percent) compared to saline areas (101.7 percent). Profitability of major crops was much higher in non-saline areas compared to saline areas. Based on the poverty indicators, the proportion of deprived households was 41.7 and 56.0 percent in non-saline and saline areas, respectively. The study recommended that in saline areas, rain water reservoirs should be developed in cooperative way and availability of electricity should be ensured to use light irrigation pumps in the crop field from the nearest fresh water reservoir. In addition, canal reform should be done and leasing arrangement of water canals should be stopped to get farmers' access for irrigation purpose. Moreover, salt-tolerant and short duration pulse and wheat should be introduced in order to improve livelihood of saline farm households in Bangladesh.

Water Saving Technologies in Bangladesh Crop Farming: Socioeconomic and Environmental Perspective

Md. Taj Uddin

Department of Agricultural Economics, Bangladesh Agricultural University (BAU), Mymensingh-2202, Bangladesh, E-mail: tajbau@yahoo.com

Abstract

The study was conducted to evaluate the socioeconomic and environmental impacts of water saving technologies (WST) on *Boro* rice farming in Bangladesh. A total of 480 farmers (80 focal and 400 control) were selected as sample from Mymensingh, Comilla, Bogra and Gaibandha districts. For analyzing the data, a combination of descriptive, mathematical and statistical techniques were used. The study revealed that 62.5 and 37.5 percent focal farmers adopted alternative wetting and drying (AWD) and system of rice intensification (SRI) methods, respectively. The profitability and productivity of *Boro* rice as well as water productivity was comparatively higher for focal farmers compared to control farmers. It was also found that focal farmers' water requirement was significantly lower than control farmers. Most of the focal farmers (78.8 percent) experienced improved environmental quality after adopting WST. Logit regression model depicted that educational level of household head, farming experience, extension contact and knowledge on WST were found having significant influence in adopting WST by the farmers. The study also revealed that focal farmers' income from rice crops was almost 6.0 percent higher than control farmers. Considering the research findings, some crucial policy recommendations have been arisen which are: i) nourishment of farmers' knowledge about water saving irrigation technologies; ii) arrangement of training programs by different local, national and international institutions; iii) regular extension contact from the view point of extension agents; iv) ensuring the availability of sufficient machineries in the market through import from abroad by the government; v) enhancing direct financial support as well as subsidy programmes by the government to the farmers; vi) accessibility of the farmers to institutional credit; and vii) restricting the overuse of groundwater and use of chemical fertilizers to protect the environment from being damaged.

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Organic Shrimp Farming in Bangladesh: Economic, Environmental and Sustainability Issues

Md. Taj Uddin
Department of Agricultural Economics, Bangladesh Agricultural University (BAU), Mymensingh-2202. Bangladesh, E-mail: tajbau@yahoo.com

Abstract
The study assessed the economic, environmental and sustainability issues of organic shrimp farming in Bangladesh. Following stratified random sampling technique, 60 farmers were interviewed from several villages of Assasuni upazila under Satkhira district. The study revealed that productivity of organic shrimp per hectare was 383 pound and benefit cost ratio was 1.91 which meant that organic shrimp farming was highly profitable. Educational level of household head, *gher* size and knowledge on organic shrimp production had positive and significant influence in adopting organic shrimp production by the farmers. Cause-effect-mitigation analysis pointed out that organic shrimp farming could mitigate the adverse effects on environment caused by traditional shrimp farming. Appropriate climate and environment for organic shrimp culture was found as major strength and comparative profitability than traditional shrimp production was found as major opportunity of organic shrimp production. The study confirmed sustainability of organic shrimp production from the standpoint of consuming energy, protecting environment, economic feasibility and social/political equity. The study recommends that farmers should be trained to follow the work instructions and principles of organic shrimp production and the application of good management practices (GMPs) should be ensured for reducing the disease outbreak risk.

Value Chain Analysis of Honey in Bangladesh: Production Practices and Livelihood Status Perspective

Md. Taj Uddin
Department of Agricultural Economics, Bangladesh Agricultural University (BAU), Mymensingh-2202 Bangladesh, E-mail : tajbau@yahoo.com

Abstract
The study assessed honey value chain, analyze the stakeholders' activities along with their livelihood status and identify the problems in relation to production, value addition and marketing of honey in Bangladesh. Primary data were collected from Basail, Modhupur and Kalihati upazila of Tangail district, Gurudashpur upazila of Natore district and Birol upazila of Dinajpur district. A total of 7 input suppliers, 61 beekeepers, 5 processors, 1 trader, 5 retailers and 6 consumers were interviewed for data collection. Face-to-face interview, focus group discussions (FGD) and key informant interviews (KII) were conducted to collect primary data. Data were analyzed using value addition method and descriptive statistics to achieve the objectives. The study revealed that *Apis melifera* is the major honey bee reared and the average number of boxes per beekeeper is 50, harvested honey per box is around 35 kg in one year while the benefit-cost ratio (BCR) is 1.83. The study identified six honey value chain actors in the study areas; i.e., input supplier, producer, processor, wholesaler, retailer and consumer. Among the actors, processor added the highest value. It was found that most of the beekeepers are marginal and small land holders. Their average own land size is 0.9 acres, average family size is 4 and there is very limited provision of grading, processing and labeling of the product at producer's point. Most of the stakeholders have no institutional training, average experiences of the stakeholders is 5 years and only 24% have taken training from BSCIC and other institutions. SWOT analysis indicated favorable environment for beekeeping as strength, inadequate market infrastructure as weakness, high

demand for honey both in domestic and international markets as opportunities, and dominancy of the middlemen as threat, respectively. The study recommended that improved market management should be ensured from the production point to consumer level.

Economic Viability and Production Efficiency of Rice: A Macro Level Study in Bangladesh

Md. Taj Uddin
Department of Agricultural Economics, Bangladesh Agricultural University (BAU), Mymensingh-2202 Bangladesh, E-mail : tajbau@yahoo.com

Abstract
Rice is the main crop and staple food of people in the country. Average rice production was profitable and Bangladesh has a comparative advantage in domestic production of rice than that for import substitution. However, the goal of the project is to assess the economic viability of Aus, T. Aman and Boro rice for three farm types in the different ecosystem of Bangladesh by evaluating the profitability, risks, production efficiency and constraints of rice cultivation to generate important information for different stakeholders. Four out of 14 agricultural regions namely Dhaka, Bogra, Faridpur and Rangamati will be selected for the survey. In total, 8 districts will be selected from 4 regions, two from each of the regions. Purposive sampling technique will be used in selecting the locations namely districts and upazillas with due consideration of different rice ecosystems *(e.g., saline coastal, drought prone, submergence, haor, char, hilly and favorable).* Two stage sampling frame-work will be used for selecting the respondents for this survey. Fifty Aus rice growers, 150 T. Aman rice growers and 150 Boro rice growers will be interviewed from each upazilas of a district. In total, 2800 farm households will be interviewed from 4 agricultural regions taking 700 from each region. The study will be generated a comprehensive set of data for the various stakeholders including policy planners for formulating the suitable policies to expedite the growth of rice production for meeting the growing demand of staple food grain of population in the future. The project activity will be appeared to be beneficial to the environment as well as whole agriculture system.

Potential Economic Benefits and Willingness to Pay for *Haor* Ecosystem Restoration in Netrokona district of Bangladesh

A. K. M. Abdullah Al-Amin
Department of Agricultural Economics, Bangladesh Agricultural University (BAU), Mymensingh-2202 Bangladesh, E-mail : abdullah.alamin@bau.edu.bd

Abstract
The present study investigates the benefits of wetland ecosystems and local communities' perception and restoration interest in the changing climatic situations. Unlike the existing literature's, using six focus group discussions and a questionnaire survey of 360 households the present study gives a clear evidence of changes of wetland ecosystems, the responses of local communities towards the environmental conservation and their determinants in three distant places from the Dingapota wetland of Bangladesh. We found that the wetland ecosystem provides substantial ecosystem services and about 91.43% of the total income comes from the wetland directly and indirectly. The study also reveals that among the twenty nine identified species, three species of reptiles and one species of fish have already extinct and the availability of aquatic species has dramatically decreased, in addition to this, the risk of climate change during the last ten years has reached in high position. In the mode of restoration responses we found significant differences. A total of 70% respondents were willing to pay

for the environmental conservation, in which 25% respondents preferred to pay liquid money whereas 45% were interested to volunteer a given number of days per annum. The respondents who are sure about their payment are sensitive to the order of presenting the bid amounts and the household's propinquity to the wetland play a significant positive role to their willingness to pay. In environmental valuation process the household's uncertainty was captured through four payment cards format. The results of the interval regressions show that human capital, physical capital and financial capital have significant mixed impact on households' willingness to pay, whilst the social capital and climatic factors negatively influence the respondents' incentive to pay. The findings of our study will have noteworthy policy implications for wetland conservation.

The Financial Analysis of Using Solar Panel and its Impact on Farmers' Income and Livelihood in Some Selected Areas of Bangladesh

Mohammad Saidur Rahman and A. K. M. Abdullah Al-Amin*
*Department of Agricultural Economics, Bangladesh Agricultural University (BAU), Mymensingh-2202. Bangladesh, *E-mail : abdullah.alamin@bau.edu.bd*

Abstract
The environment friendly renewable energy (solar energy) acts as a blessing for the development of Bangladesh. To mitigate the energy crisis, the government takes initiative to enhance the use of solar panel in the rural areas and providing constant supply of electricity. Considering the significance of the solar household system, the present study explores the core economics of using solar energy and its impact on rural livelihoods and future prospect in Bangladesh. A total of 240 households were selected as sample of this study of which each 60 households were taken from Motherganj upazila of Jamalpur, Roumari Upazila of Kurigram, Fulchori Upazilla of Gaibandha and Charvadrason Upazilla of Faridpur district. The data were collected during the month of February to April 2018 and 2019. To fulfill the objectives of the study, both descriptive statistics and financial analysis were done. Results showed that among the 240 respondents, there were different aged people and age groups of 30-45 years have the maximum frequency of 105, which is almost 47.75% of the total sample surveyed. Their educational status revealed that about 72.48% were below S.S.C level while 5.83% are S.S.C passed. Farming was the main occupation of the respondents. About 62.08 percent household heads were farmers, 7.08 percent were laborers and were in service. The financial analysis showed that solar household system is economically feasible in the study areas. On an average, the cash inflow was Tk.3520.00 and average salvage value was Tk. 4570.83. Assuming 12% discount rate NPV was Tk. 17867.55, BCR was 1.99 and IRR was 32% which was greater than the opportunity cost of capital. Therefore, the adoption of solar panel was economically viable for the study areas and the outcomes of this study will help the policy makers and others to accelerate the use of solar energy.

Economics of Biogas Plant Uses and Its Impact on Rural Livelihoods in a Selected Area of Bangladesh

Mohammad Ataur Rahman* and Nusrat Sultana Runa[1]
Department of Agricultural Finance, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and [1]Department of Agricultural Finance, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: marahman@bau.edu.bd*

Abstract
Biogas is a reliable, easily available and economically feasible source of alternative and renewable energy which can be managed by locally available sources and simple technology in the rural villages

of Bangladesh. The study was undertaken to assess the socio-economic characteristics of sample households, investigate the impact of biogas plant on livelihoods, and determine the NPV, BCR, IRR and NBI of biogas plant in Bangladesh. To achieve the objectives multi-stage cluster sampling technique was used to collect data from 50 respondents who were using biogas plant in Mymensingh district of Bangladesh. Survey method was followed to collect data from the respondents. To identify the socio-economic characteristics, simple statistical techniques were employed. To examine the impact of biogas plant on livelihoods, livelihood approach was used and financial analytical techniques were used to assess NPV, BCR, IRR and NBI. Socio-economic characteristics showed that 54% of the respondents were belonged to middle-aged group (30-50 years) and 24% respondents' occupation were business. About 36% of the respondents had the education up to higher secondary and an average family size of the respondents was 3.78. On an average about 8% of the respondents had middle income (Tk.100001-150000), about 92% had high (Tk.>150000) income level. Education, health, nutrition, capacity to work, skill and knowledge increased in 66%, 78%, 70%, 64%, 58% and network and connection, mutual support, common rules, women empowerment and leadership increased in 62%, 64%, 62%, 60%, 54%, respectively after using the biogas plant. The study represents NPV, BCR, IRR and NBI were TK.20247.64, 1.50, 19.26% and Tk. 2632.19, respectively. The results indicate that the future prospect of biogas plant is positive . Finally, it may be conclude that biogas plant has a great potentiality in Bangladesh context as there are a lot of waste materials and it will reduce the energy crisis of our country. It was very suitable for rural people and had positive impact on livelihoods.

Technical Efficiency and Food Security of Cucumber Farmers in a Selected Area of Bangladesh

M. Ataur Rahman[1]*, Md. Shoheb Talukder[2] and Mezamun-Ara Mukta[3]

[1]Department of Agricultural Finance, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, [2]Department of Agricultural Finance, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and [3] Department of Agricultural Finance, Bangladesh Agricultural University, Mymensingh2202, Bangladesh

**E-mail: marahman@bau.edu.bd*

Abstract

Low productivity of cucumber is mostly due to the inability of the farmers to utilize the available technologies fully, resulting in lower efficiencies of production. Profitability and Stochastic Frontier Analysis (SFA) are used to estimate profitability and technical efficiency and "Modified" OECD scale is used to measure calorie intake level of the 60 cucumber farming households from Sorchapur and Nakagau villages under Phulpur upazila of Mymensingh district. The study has indicated that cucumber cultivation is profitable agribusiness, but have technical inefficiency problems. The socioeconomic analysis showed that 50% of the respondents were aged between 30-45 years, 55% households have medium family size, 60% of the respondents were illiterate and 71.67% respondent's primary occupation was agriculture. The average cucumber cultivated area was 50.18 decimal**.** The profitability analysis showed that the average per hectare per season yield was Kg. 45290, total cost of production was estimated Tk. 509847; while the gross margin and net return were Tk. 231877 and Tk. 169503, respectively. The study also showed that on an average, the mean technical efficiency of cucumber was 0.7367 represented that 26.33 % inefficiency existed in the study area. About 11.67% of the sample households was consumed an average 1539.24 k.cal/person/day, that indicated they were ultra poor (<1600 k.cal). About 15 % of the sample households was consumed an average 1797.13 k.cal/person/day, they were in the hard-core poor group and 20.00 % of the households consumed an average 2277.53 k. cal./person/day, they were in the absolute poor group (1805- 2122k.cal). Beside the three poor groups, about 53.33% of the sample households consumed an average 2346.69 k.cal/person/day, and they were non-poor. These findings suggest that cucumber production in the research location would be significantly improved through training the farmers to be technically efficient and government should take necessary steps for ensuring their food security.

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Assessment of Farm Level Postharvest Losses by Evaluating Postharvest Practices of Tomato and Brinjal in Bangladesh

Mashrufah Khatun
Department of Agricultural Finance, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail : emuagf@bau.edu.bd

Abstract
The study quantifies farm level postharvest loss of tomato and brinjal in Jamalpur and Rangpur districts of Bangladesh. It also demonstrates farmer's knowledge, attitude and practices (KAP) on safety, quality and postharvest management and determinants of postharvest lossesof Brinjal and Tomato. A total of 144 farmers were considered for the study from purposively selected four villages.Total postharvest loss was quantified by evaluating quantitative and qualitative losses. The results showed that still 25.39% of the respondents did not have sufficient knowledge on safety and quality issues of tomato and brinjal cultivation. Improve knowledge and attitude were not enough as 38.40% of the farmers didn't practice safety and quality measures in their production purposes. The result of attitude towards safe and hygienic tomato and brinjal was also positive but 40.93% never practiced in cultivation. Farm level postharvest loss of brinjal was 13.90% of total production where full damages accounts for 9.16% alone. Infested by insect and rotten were the primary causes of full damages of brinjal in the survey area. The 4.73% of the total postharvest loss was due to partial damages of brinjal where skinning and bruising constitutes the maximum share. Farm level tomato postharvest loss was found 12.45% per farm of which 8.86% was due to full damages of tomato and the rest 3.59% was due to partial damages of tomato. Due to postharvest losses brinjal and tomato farmers have to incur financial loss of Tk. 709.05 and Tk. 152.45 per decimal of brinjal and tomato cultivation respectively. Total harvested amount, farmer's education, packaging and selling place were found significant factors for postharvest loss of brinjal in the survey area. On the other hand, total harvested amount, family member and selling price were some of the important factors for tomato postharvest loss in the survey area.

Perception of and Adaptation to Climate Change by Wheat Producing Farmers in North-West Part of Bangladesh

Zarin Tasnim, Md. Akhtaruzzaman* Khan and Sourav Mohan Saha
Department of Agricultural Finance, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail : azkhan13@bau.edu.bd*

Abstract
Wheat is an important cereal crop in Bangladesh and it is one of the most vulnerable crops due to climate changes since it is highly sensitive to higher temperature and other climatic variables. But, lack of enough knowledge about climate change is an impediment for farmers in choosing an effective coping mechanism. Therefore, this study attempted to assess wheat farmers' perceptions of climate change, identify farmers preferred adaptation strategies, determine the factors influencing adaptation strategies and barriers of effective adaptation in the North-West part of Bangladesh. The study used primary data from 160 wheat farmers of Dinajpur and Thakurgoan district. Descriptive and multinomial logit (MNL) model were employed to achieve the objectives of the study. The result showed that farmers experienced frequent drought due to higher temperature, decreased and irregular precipitation, reduced availability of ground and surface water, increased heat waves, decreased cold wave and shorter winter season over the last two decades. More irritation, shifting to other crops, changes in fertilizers and insecticides usage, shift to off-farm income etc. are the major adaptation

strategies adapted by wheat farmers to mitigate the adverse effect of climate change. Farming experience, access to climate change information and extension services, access to subsidy and availability of electricity for irrigation were significant factors influencing farmers' adaptation to climate change. Lack of information about potential climate change, lack of knowledge about appropriate adaptation measures, low price from wheat production, shortage of labor and limited information about drought-tolerant varieties represented adaptation barriers. Strengthening extension services including the accessibility of climate change information and training on adaptation strategies, development of drought-tolerant and short maturity varieties are critically important to set up an effective coping mechanism to climate change.

Milk production by smallholder farmers in Mymensingh Region: Impact on livelihood, food and nutrition security

Khandaker Md. Mostafizur Rahman
Department of Agricultural Statistics, Agricultural University, Mymensingh-2202, Bangladesh
E-mail : kmrahman2001@bau.edu.bd

Abstract

This study aims at assessing the potentiality of increasing milk production by smallholder farmers in Mymensingh region. This study was carried out in smallholder farmers producing milk in three upazila (sub-district), namely Gauripur, Phulpur and Fulbaria of Mymensingh towards attaining poverty alleviation and food security. To attain the objective both descriptive and functional analyses are carried out. The functional analyses are estimation of stochastic translog cost frontier function to estimate farm specific and average economic efficiency of milk producers and exponential model to estimate poverty line towards estimating cost of basic needs. Total income per household is BDT 353039 where the overall share of cattle income to total income is 17.18 %.Milk production has an important role in generating employment and enhancing livelihood opportunities of rural people. It has positive impact of improving the nutritional status of people. Total amount of yearly milk production per household is2962litre. People consume 28 food items where rice, vegetables and milk are major food and amount consumed are 380 g, 103 g and 231 g. Daily per capita food, calorie and protein intakes are respectively 1334 g, 2313 Kcal and 77 g protein of which 231 g food, 153 Kcal calorie and 5 g protein received from milk. Daily per capita food consumption is influenced by family size, calorie received from milk and region. Increase of per capita milk consumption increased the calorie and protein intakes. Yearly income, milk production, food consumption and nutrition intakes increased and poverty reduced in the successive year compared to previous year 1917-18. Overall absolute and hard core poverty indices in the year 2018-19 on the basis of DCI are respectively 46% and 23% and they are respectively 51% and 36% on the basis of CBN method. Food security condition increased with the increase in weekly cost on family food and decrease with the increase in family size. The major constrains identified for milk production are high cost of concentrates, low price of milk, inadequate capital, scarcity of feed, fodder and pasture land, limited coverage of veterinary services, housing problem, appropriate breed and AI problem etc. The average economic efficiency of milk production is 83% which implies that milk production cost can be reduced by 17% to produce the same level of milk output. As a policy option, milk production should be increased by offering different government support programs since milk production contributes to attain poverty alleviation and food security.

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Measures of Livelihood Activities and Food Security of Farm Household

Md. Abdul Quddus
Department of Agricultural Statistics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail : aqdds1957@gmail.com

Abstract
The present study was undertaken to determine the effect of socioeconomic factors and livelihood activities on food security status of farm households. Three different regions: plain land in Trisal Upazila, Char land in Mymensingh Sadar and hilly land in Haluaghat Upazila were selected for study area. About 225 households head were interviewed with a structured questionnaire through house-to-house visit. Household food security status was measured by using the household dietary diversity score (HDDS) assessed on the basis of 19 nutritionally important foods consumed within a specific time recall period. Households were classified into three categories: severe food insecure if food consumption frequency score (FCFS) was< 20, moderately food secure if FCFS was 20-38, and food secured if FCFS was > 38. Correlation and logistic regression techniques were used to determine the effects. Crop farming (31.1%) and crop and non-crop farming (28.4%) were the most prevalent livelihood activities among the respondents. Proportions of the other livelihood activities adopted by the households were non-farm activities (9.8%), crop farming and non-farm activities (18.2%) and crop, non-crop and non-farm activities (12.4%). Below one-third (32.5%) of the households were food secure and 21.5% were severely food insecure. Farm households were mostly food secure based on highly consumed foods like cereals and vegetables. Higher proportion of the households was severe food insecure in protein foods. Households gaining higher monthly income were 27% less likely to be food insecure whereas increase of family member in the household were 1.22 times more likely to be food insecure. Respondents having secondary education were 70% less likely and respondents having higher education were 79% less likely to be food insecure compared to illiterate respondents. A positive correlation at 1% level of significance was found to exit between livelihood activities and income as well as food security. Thus, livelihood diversified households are more income stable and food secure then reverse household.

Impact of Haor Agriculture in Farmers' Livelihood and Rural Markets Development in Netrokona District of Bangladesh

Mohammad Ismail Hossain* and A.K.M. Abdullah Al-Amin
Department of Agribusiness and Marketing, Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: ismailho12@yahoo.co.in*

Abstract
The study was conducted in Mohanjong Haor upazila to examine the sources of income of the haor households, demographic attributes. A total of 200 households were interviewed taking 40 households from 5 selected villages. Furthermore, within rural hats, 50 market actors were selected purposively. Thus, gives a total sample 250. Both primary and secondary data were used in the study. The study revealed that the education level of the highest 43% sample farmers were in primary level and 56% farmers were only engaged with agriculture. On the basis of farm category, small farmers were found highest (34%) in the study areas. The highest numbers of farmers (28%) come from the age group 40 to 49 and the lowest number of farmers (10%) comes from the age group 20 to 29 years. The highest level of education was up to primary (43%) and the lowest level of education was Bachelor and above (2%). The highest percentages (56%) respondents were engaged only agriculture. Around 52%

households had sanitary latrine facilities against 48% people in the haor area cannot use sanitary latrine. Seventy-eight percent (78%) people had safe drinking water facilities, 95% household use the facilities of electricity, 84% household bought new cloths for their family during religious festivals, 81% offering gift to relatives during various social events, 76% household send their children to school and the participation of haor people in any organization and cooperative society is very poor and it was 7%. The average number per household of the bullock/ox, cow, calf, buffalo, goat, poultry, and duck were 1.98, 1.71, 1.47, 1.50, 2.12, 5.99, 2.7 and 3.10 respectively. The percentage of most dominant cropping pattern only Boro based cropping pattern; Boro-Fallow-T. Aman covered 56.7%. Early flash flood, hailstorm and thunderstorm, embankment broken, excessive rainfall & inundation and drought were the major risk and uncertainty found in the study areas. Construction of house, establishment of embankment, cultivation of short duration variety and migration were the major adaptation strategy of the haor community.

Measuring growth performance of some selected agricultural crops in Bangladesh

Md. Mahbub Hasan[1], Sarah Yasmin[2]* and Md. Maniruzzaman[2]

Department of Agribusiness and Marketing, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: jesy099@yahoo.com

Abstract

The study attempted to estimate the growth rates of area, production, and yield of pulse, oilseeds and sugarcane in Bangladesh using secondary data covered the period from using 1997-98 to 2017-18 through exponential log model and correlation coefficient. Here, the whole period was divided into two sub period such as period I (1997-98 to 2017-2018) and period II (2008-9 to 2017-18). However, findings of the study represented high correlation between area and production of pulse, and sugarcane and low correlation between area and production of oilseed. During whole period, it showed that overall production on area of pulse and sugarcane have been increased except oilseeds (r=0.112). Growth rates of area which was negative but significant for pulse, oilseeds and sugarcane that were 2.9, 0.04 and 3.6 per cent respectively. The growth rates of area were also negative for the period I. But, in period II, pulse and oilseeds growth rates were found significantly positive that were 6.3 and 3.1percent respectively. Growth rates of production which was significantly negative for pulse, and sugarcane that were 1.0, and 3.4 per cent respectively and positive for oilseeds that was 5.4 percent for the whole period. In period I, production growth rates of pulse and sugarcane were negative but in period II, production growth rates were found significantly positive for pulse and sugarcane that were 8.7 and 3.8 percent respectively. Growth rates of yield which was significantly positive for pulse, oilseeds and sugarcane during the overall period of the study. In period I, pulse and oilseeds yield growth rates were found positive with a rate of 1.4 and 4.9 percent respectively. Analyzing the growth rates of area, production and yield of pulse, sugarcane and oilseeds may guide the farmers allowing judicious allocation of area which would increase the production of these crops in Bangladesh.

Value Chain Analysis of Fish Seed Farms in Some Selected Areas of Mymensingh District

Nazia Tabassum*, Dilshad Zahan Ethen and Eshrat Jahan Mahfuza

*Department of Agribusiness and Marketing, Bangladesh Agricultural University (BAU), Mymensingh-2202, Bangladesh, *E-mail : naziabau@yahoo.com*

Abstract

Fish is the most important source of animal protein for the human population. The potential of fish culture production from ponds, floating cages and various other small water bodies in Bangladesh is

great. The supply of quality fish seed is a key factor to the expansion of fish farming. So this study is an attempt to analyse the prevailing value chain of fish seed farms in some selected areas of Mymensingh district in Bangladesh. The specific objectives of this study are: to map the typical value chain of fish seed farms, to examine the marketing system of fish seed farms, to determine the net value addition of fish seed production, and to discover problems impacting different actors in value chain and identify potential interventions to address such problem. Four Upazillas of Mymensingh district namely Mymensingh Sadar, Gauripur, Muktagasa and Trishal were selected to meet the objectives of the study. Data were collected from fish seed farm owners (Hatchery and Nursery owners) and traders covering a sample of total 310. Both carp fish and cat fish were selected to analyse. Five important fish seed species were selected namely Rui, Catla, Mrigel, Shing and Pabda for this study. Data were collected during the period from July to October, 2019 through face to face interview by using structured survey schedule. A purposive random sampling technique was used in collecting data. Two sets of interview schedules for fish seed farm owners and fish seed traders were prepared in such a way that all the information relating to the inputs of fish seed, value chain and marketing system was covered. The draft interview schedule was pre-tested amongst a few respondents. Both descriptive statistics and analytical technique will be followed in order to realize the research objectives. Though data collection is done but the analysis work is still going on to fulfill the objectives of the research.

Gender role and its impact on women empowerment through small agricultural farming in Sherpur district

Md. Shajahan Kabir

Department of Rural Sociology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail : mskabir786@gmail.com

Abstract

The study was carried out the factors which influences rural women's income after involvement in small-scale agricultural farming, their contribution to the household, as well as their empowerment status. This research was conducted in Jinaigati upazila of Sherpur district in Bangladesh. A total of 210 respondents from this upazilla of Sherpur were selected purposively using simple random sampling. The quantitative and analytical tools used to attain specific objectives included various descriptive statistics, multiple regression co-efficient, used to identify the factors of influencing women's income and empowerment through small-scale agricultural farming. The Study revealed that dairy rearing and vegetables production has changed annual income in 116.05% and 145.56% respectively. And there has been significant change occurred with the poultry rearing activities which is 154.31% after involvement with small scale poultry farming. Contribution of rural women in family expenditure is excellent. It has also showed that women have significant contribution on children's education, Medicare care and social activities. Problem Confrontation Index (PCI) used through different problems identified scores. In accordance with the results of the educational level of woman, other sources of income, experience and training, access to credit, decision-making ability have an positive impact on rural women's income and empowerment. These variables were statistically significant. From the Problem Confrontation Index, it was found that lack of capital was the first ranked problem, need-based training the second ranked problem, high interest rate the third ranked problem, in sufficient farm size the fourth ranked problem, and lack of quality of seed the fifth ranked problem. Finally, their active economical participation in small-scale farming assists them to overcome prejudice, socio-economic barriers, and highest empowerment attainment in the context of Bangladesh—and, if the government takes proper initiative in terms of gender policy, then rural women's income and livelihood status will be increased remarkably.

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Understanding gender-related barriers to sustainable nutrient management and ways to enhance women's participation

M. Wakilur Rahman*, Hasneen Jahan, Davina Boyd & Jane Hutchison
Department of Rural Sociology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: wakilrsbau@gmail.com*

Abstract
Gender-related barriers to sustainable nutrient management were explored through survey of men managing farms, their spouses and women managing farms and additional small group interviews (SGIs). A total of 21 SGIs, covering 58 people in 34 HHs, including 10 women managing a farm, were conducted. The findings offer various insights into decision-making regarding chemical fertilizer use on field crops; current sources of agricultural information and training, including those most trusted; experiences of interactions with extension service providers, especially with the formal extension system; interest in accessing additional information/training; and perceived barriers to accessing information and/or participating in training. Regarding chemical fertilizers, men are the main decision makers, nevertheless some discuss fertilizer matters with their wives. Discussion with wives also depends on: the husband's perception of her knowledge; her own experience and or interest; her ability to visit and observe crops in the field; the value he places on good family relations. It is also revealed that current access to relevant and appropriate nutrient management resources (training, information and extension) is limited. Access is poor for men and women, but women face additional barriers as the resources available are not promoted or tailored to women. Although men and women did not necessarily express a need for more resources, most people expressed an interest in learning more, and all survey respondents indicated that a lack of knowledge and skills were barriers to changing practice. Financial constraints appear to be a barrier to individuals applying the recommended fertilizer dose along with a lack of site-specific recommendations to help farmers. The study makes recommendations to overcome barriers (including the gender-related barriers) to adoption of more profitable and sustainable fertilizer practice by farmers and proposes further gender research to capture learnings from the strategies in order to inform ongoing efforts to promote sustainable nutrient management.

Impact of Haor Agriculture in Farmers' Livelihood and Rural Markets Development in Netrokona District of Bangladesh

Mohammad Ismail Hossain* and A.K.M. Abdullah Al-Amin[1]
*Department of Agribusiness and Marketing and [1]Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: ismailho12@yahoo.co.in*

Abstract
The study was conducted in Mohanjong Haorupazila to examine the sources of income of the haor households, demographic attributes. A total of 200 households were interviewed taking 40 households from 5 selected villages. Furthermore, within rural hats, 50 market actors were selected purposively. Thus, gives a total sample 250. Both primary and secondary data were used in the study. The study revealed that the education level of the highest 43% sample farmers were in primary level and 56% farmers were only engaged with agriculture. On the basis of farm category, small farmers were found highest (34%) in the study areas.The highest numbers of farmers (28%) come from the age group 40 to 49 and the lowest number of farmers (10%) comes from the age group 20 to 29 years. The highest level of education was up to primary (43%) and the lowest level of education was Bachelor and above (2%). The highest percentages (56%) respondents were engaged only agriculture. Around 52%

households had sanitary latrine facilities against 48% people in the haor area cannot use sanitary latrine. Seventy-eight percent (78%) people had safe drinking water facilities, 95% household use the facilities of electricity, 84% household bought new cloths for their family during religious festivals, 81% offering gift to relatives during various social events, 76% household send their children to school and the participation of haor people in any organization and cooperative society is very poor and it was 7%. The average number per household of the bullock/ox, cow, calf, buffalo, goat, poultry, and duck were 1.98, 1.71, 1.47, 1.50, 2.12, 5.99, 2.7 and 3.10 respectively. The percentage of most dominant cropping pattern only Boro based cropping pattern; Boro-Fallow-T. Aman covered 56.7%. Early flash flood, hailstorm and thunderstorm, embankment broken, excessive rainfall & inundation and drought were the major risk and uncertainty found in the study areas. Construction of house, establishment of embankment, cultivation of short duration variety and migration were the major adaptation strategy of the haor community.

The Importance of Gender Roles in Agricultural Technology: A Case of Rural Farmers in Bangladesh

Md. Shajahan Kabir
Department of Rural Sociology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: mskabir786@gmail.com

Abstract

The present study provides a systematic estimate of male female participation in agricultural production and using agricultural technology and examines their influence in the adoption of modern technology and their participation in hired labor market. Farm-level input-output data of male female groups is taken through surveys in three upzillas in Jamalpur district of Bangladesh. Area was selected purposively and the study was used the simple random sampling technique to select 190 sample respondents for household survey through the semi-structured questionnaire. Both qualitative and quantitative data analysis techniques were utilized. Agriculture cereal crops producers' annual income has changed in 58.76% and 65.86 % annual income has changed in vegetable production. And there has been significant change occurred with the livestock rearing activities which are 118.79% after adoption in new technology. It is confirmed by 61% of respondents that they kept indigenous breeds. It is revealed that male-headed households are the greater adopters and users of modern equipments in land preparation 55% male and 36% of female headed households do same. About 53% of female headed households adopt and use more indigenous implements in land preparation compared to 28 % of male headed households. About 65.2% respondents mentioned women as users of indigenous agricultural technologies. Only 22.8% of respondents mentioned men as having greater preference and use of these types of technologies, compared to women. Women rendered a great deal of contribution in making decision on post-harvest operation, rearing poultry, goat and cattle, purchasing of agricultural inputs, etc. In conclusion, it seems clear that agrarian reforms and technological change have great effects on gender concerned. The provisions of the reforms have only recognized only men as the heads of rural farmer households and therefore as the sole recipient of agricultural inputs, such as deeds to land, credit, productive assets and extension services.

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Design and Development of Cone-penetrometer for Field Use in Agricultural Soils

M. Z. Abedin* and **M.B. Hossain**
*Department of Farm Structure and Environmental Engineering, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: mzabedin95@yahoo.com*

Abstract
The cone penetrometer is used as a standard instrument to measure the penetration resistance of soil in tillage studies. The major factors affecting cone penetration resistance or cone-index (in a scale of 100) of a particular soil are the penetration depth, shear strength, moisture content, bulk density, degree of compaction, micro-structural state of soil, etc. This study was conducted to design and develop a cone-penetrometer for predicting penetration resistance of agricultural soils. The experimental test data were collected from a controlled soil-bin of silt loam soil processed at different moisture contents with varying compaction levels. Simulations were accomplished with four different sets of experimental data and the predicted outputs were compared with the experimental results. The relationship between moisture content, dry density and cone-penetration resistance in 3D space for a given soil at a particular penetration depth enables a useful evaluation of soil states (bulk density and pore space) and make practical implication of cone penetration test results.

Use of Rice Husk Ash in Low-cost Building Blocks

Md. Siddikur Rahman
Department of Farm Structure and Environmental Engineering, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh, E-mail: siddik@bau.edu.bd

Abstract
The present study represents the experimentation on the properties of sand cement block containing rice husk ash which focused on compressive strength, water absorption, density and heat passing rate in relation to different level of replacement of cement and sand with rice hush ash. Rice husk ash has been taken at 5%, 10%, 15%, 20% by volume of sand and cement. Local sand having fineness modulus 1.63 and commonly available Portland cement were used. The proportion of cement and sand was 1:6 and two types of sand-cement blocks were prepared. Solid block size was 250mm × 125mm × 75mm and hollow block of same size with an opening size 175mm × 50mm. The blocks were cured for 28 days. Water absorption was found to increase with increasing the percentage of rice husk ash. Water absorption of hollow block is higher than that of solid blocks. And the water absorption of blocks replaced by sand is more than that of cement replacement. The density of blocks decreased with the increase of rice husk ash content. The compressive strength of blocks containing rice husk ash resulting significant reduction in specimen strength compared to cement mortar specimen. The reduction of compressive strength of blocks becomes larger when the percentages of rice husk ash increase to 20%. The compressive strength of solid blocks is higher than that of hollow blocks. The strength of cement replaced blocks is more than that of sand replaced blocks. The blocks containing 10% rice husk ash presented better strength. So, it is allowed to be used in masonry work. The main characteristics needed are lightweight. From the results, it is observed that the higher percentage of rice husk ash used was decreased the compressive strength and density and increased water absorption.

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Performance Evaluation of Grain Drying Yard Constructed by Waste Ceramic Aggregates

Md. Titumir Hasan, Mohammad Raihanul Islam and Md. Siddikur Rahman*
Department of Farm Structure and Environmental Engineering, Bangladesh Agricultural University, Mymensingh, Bangladesh
**E-mail: siddik@bau.edu.bd*

Abstract
Drying operation of crop grains is the principal operation in the agricultural sector. In the third world country the crop grains is drying mostly over the normal concrete pavement. This study introduce waste ceramic mortar pavement to show the temperature holding capacity between normal concrete and ceramic mortar pavement. Because the temperature holding capacity is the main function for drying the grains based on sun drying system. For maintaining the good quality of crop grains it is necessary to reduce the excess moisture content of crop grains quickly. Otherwise crop grains quality will loss. In this study data logger machine with thermocouple used to show the thermal behavior of waste ceramic mortar pavement and normal concrete pavement. After analysis of data result shows that concrete pavement accumulate more temperature than ceramic pavement.

Design, Construction and Application of Porous Concrete for Slope Protection

Mohammad Raihanul Islam
Department of Farm Structure and Environmental Engineering, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, E-mail: mrislam.fs@gmail.com

Abstract
Slope protection in Bangladesh is very essential for hills, river banks and rural earthen roads. Traditional concrete block is using for slope protection which are not suitable in all cases. These are expensive and heavy weight. In this case porous concrete block can be used which is cost effective & having light weight also. On the other hand vegetation is also possible through its pour space which gives natural strength. As new material physical and mechanical properties of porous concrete such as density, void ratio, permeability and compressive strength was determined to know about the acceptability and usability. Compressive strength was the most important mechanical property. The tests were performed in the concrete and material testing laboratory of Farm Structure & Environmental Engineering Department, Bangladesh agricultural university, Mymensingh, Bangladesh. A uniform size (3/4") coarse aggregate (brick khoa) was prepared for making porous concrete samples. Water cement ratio was 0.5 for preparing porous concrete. No fine aggregate was used for preparing porous concrete. At first cement paste was prepared then mixed with coarse aggregate to prepare porous concrete. Cylindrical samples (3" and 6" diameter) were prepared for the predetermined tests. Traditional concrete (1:2:4) was prepared and tested for comparing the results. To obtain the compressive strength the samples were tested at 3 days, 7days, 28days & 90 days after casting. Compressive strength test was performed by universal testing machine. After 3 days curing the compressive strength of porous and traditional concrete was 379 psi 715 psi respectively. After 90 days of casting the compressive strength of porous & traditional concrete was found 2151 psi & 742 psi respectively. From the above result, though the strength of traditional concrete was more than porous concrete, considering the cost & weight porous concrete can be used for slope protection.

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Green Energy Knowledge Hub at Bangladesh Agricultural University

Md. Monjurul Alam* and Chayan K. Saha[1]
[1]*Department of Farm Power & Machinery, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh*
[2]*Bangladesh Sugarcane Research Institute, Ishurdi 6620, Pabna, Bangladesh*
**E-mail: mmalam.bau@gmail.com*

Abstract
Biogas produced from renewable resources could play a vital role in solving energy and environmental problems for growing number of both livestock and poultry farms in Bangladesh. The Green energy Knowledge Hub with modern biogas lab facilities has been established at the Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh. A baseline survey was conducted to investigate the present status of biogas production, identify constraints and future needs. Poultry and dairy commercial farms from different regions of Bangladesh were randomly selected for conducting the survey. Farmers were not aware about mixing ratio of solid and liquid, specifically manure and water. Biogas production from poultry farms were found higher than the dairy farms. Anaerobic of co-digestion of poultry dropping (PD) with lignocellulosic co-substrates (LCSs) was investigated for optimization. The value between 21 and 32 has been suggested as the optimal range of the C:N ratio for the co-digestion of PD with LCSs. Batch assays were conducted to determine the optimal TS contents on the mesophilic AD of poultry droppings (PD), pressed mud (PM), sugarcane bagasse (SB) and sugarbeet roots and tops (SRT) with TS contents of 5, 8, 11 and 15%, respectively. The results indicate that the initial TS influenced the AD performance significantly and modeling showed that the optimal initial TS content for AD of PD, PM and SB ranged between 12-13%.The only exception was SRT, where an initial TS content of 8% is recommended. The capacity buildings of students and other stakeholders have been enhanced through long and short term training, respectively on biogas production.

Appropriate Scale Mechanization Innovation Hub-Bangladesh

Md. Monjurul Alam[1*], Chayan Kumer Saha[1], Md. Mosharraf Hossain[1], Md. Rostom Ali[1], Md. Ayub Hossain[4], Md. Ashik-E-Rabbani[1], Md. Hammadur Rahman[2], Mohammad Saidur Rahman[3], Shahana Begum[5], Surajit Sarkar[1], Md. Kamrul Hasan[1] and Md. Abdul Mottalib[1]
[1] *Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh*
[2] *Department of Agricultural Extension Education, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh*
[3] *Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh*
[4] *Farm Machinery and Post-harvest Engineering, Bangladesh Agricultural Research Institute, Gazipur, Bangladesh*
[5] *Gender Specialist, ASMIH-Bangladesh, *E-mail: mmalam.bau@gmail.com*

Abstract
Agriculture plays a vital role in the economy of Bangladesh. The Southern Delta region of Bangladesh is lagging behind in adoption of agricultural mechanization due to its agro-ecological characteristics. The main objective of the project is to promote appropriate-scale agricultural mechanization for smallholder farming systems in Southern Delta region of Bangladesh. The project concentrates its adaptive research activities involving rice transplanting, harvesting and conservation agricultural machinery in selected areas in Khulna, Barisal, Patuakhali and Noakhali districts of southern delta for

assessing technical robustness, economic feasibility and end-users acceptance to identity appropriate technologies for this region. The project integrated gender-sensitive participatory approaches into all stages of project cycle. Several experiments were conducted in *Aman* 2018 and *Boro* 2019 at the selected areas for evaluating technical and economic performances of selected agricultural machineries. Appropriate transplanting, harvesting and conservation agricultural machineries were identified based on the technical and economical performances. The research identifies cost savings of 48%, 46% and 58% for using rice transplanter, reaper and mini-combine harvester, respectively over manual operations. Harvesting loss of rice can be reduced by using mini-combine and reaper by 4.8%, 1.82% and 5.08%, 2.07%, respectively during Aman, 2018 and Boro, 2019 in comparison to manual harvesting. Conservation Agriculture (CA) planting methods saved 38% planting cost of mungbean, 53% planting cost of soybean and 50% planting cost of jute than conventional tilling and seeding. Strip tillage (ST) (764 kg/ha) and zero tillage (ZT) (688 ton/ha) did not perform well for mungbean in both Barishal and Patuakhali districts due to draught and soil salinity. Trainings, field days and demonstration programs have been conducted in the areas to build up the capacity of farmers, service providers, mechanics and manufacturers. Uses of appropriate machines have an impact on food security through cost saving and reducing harvesting losses over manual agricultural production operations.

Post-Harvest Loss Reduction Innovation Lab (PHLIL)-Bangladesh Phase II

Md. Monjurul Alam[1*], Chayan Kumer Saha[1], Md. Abdul Awal[1], Md. Rostom Ali[1] and Ismat Ara Begum[2]

[1]Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
[2]Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: mmalam.bau@gmail.com*

Abstract

Rice is the staple food in Bangladesh and the main source of income and employment of the farming households. High moisture causes heat buildup, mold growth and insect infestation due to improper drying and storage that incurred loss and reduces grain quality. The objective of the project is to identify and adopt appropriate drying and storage technologies of paddy for farmers (men and women), farmers' groups and agribusiness entrepreneurs to reduce post-harvest loss and improve grain quality with particular emphasis on involvement of women in post-harvest loss reduction activities. The project concentrates its adaptive research activities in Mymensingh, Netrokna, Bogra, Dinajpur, Jashore, and Barishal districts of Bangladesh. The project also integrated gender-sensitive participatory approaches into all stages of project. Several field demonstrations, FGD, training programs, and ToT were conducted in *Aman* 2018 and *Boro* 2019 at selected areas. The LPG based heating systems for BAU-STR was developed and tested with locally developed blower during *Boro* 2019. The results were compared with rice briquettes based heating system and Vietnamese blower. It is evident from the financial, economical and seed quality analyses that the BAU-STR dryer using LPG as heating unit with locally developed blower would be best option for farmers and seed producers in Bangladesh. Bangladesh Agricultural Development Corporation (BADC), national seed producing organization, supplies above 28% paddy seeds (66% in *Boro* season and 28% in *Aman* season) of the total demand to the farmers of Bangladesh. Two experiments with hermetic storage bags have been designed to conduct at two selected sites in two districts (Balashpur, Mymensingh and Madhupur, Tangail) and will be compared with existing paddy seed storage practices of BADC. The project is expected to introduce best management practices of BADC storage system using hermetic bags.

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Acquisition, Installation and Management of CNC Machines for Appropriate Scale Mechanization and Post-Harvest Technologies

Md. Monjurul Alam
Department of Farm Power & Machinery, Bangladesh Agricultural University, Mymensingh, Bangladesh, E-mail: mmalam.bau@gmail.com

Abstract
Bangladesh Agricultural University (BAU) is the premier seat of higher agricultural education and research in Bangladesh. The main task of the university is to tone up the quality and standard of higher agricultural education and to produce first-rate agriculturists, agricultural scientists and researchers for shouldering the responsibilities of agricultural development of the country. ADM Institute for the Prevention of Postharvest Loss, University of Illinois at Urbana-Champaign, USA has provided funds to support acquisition of a CNC lathe, a CNC laser cutter and a three dimensional printer to be housed in the machine shop under the Department of Farm Power & Machinery (DFPM), Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh. These CNC machines were installed at the workshop of DFPM, BAU and being applied to collaborative work related to appropriate scale mechanization and postharvest crop management technologies. Installed equipments have been used to manufacture machine components of appropriate scale agricultural machinery such as reaper, combine harvester, transplanter and dryer. Undergraduate student of B.Sc. Agricultural Engineering and B.Sc. Food Engineering are doing practical classes in the shop as a part of the course FPM 1202 Workshop Technology. In addition to these, undergraduate and post graduate students are also using these machines for conducting their researches. These advanced machines have opened a new dimension for the agricultural engineering education in Bangladesh.

Bio-energy Potential of Selected Biomasses Available in Bangladesh

C. K. Saha
Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: cksaha@bau.edu.bd

Abstract
Energy is a crucial input for economic development and for improving quality of life. Most of the Bangladesh's rural people depend on biomass, crop residues, plant debris, animal dung and wood for fuel. But it has several disadvantages including deforestation, soil erosion and air pollution. With increasing prices of oil, energy from renewable resources has become necessary. In this context, environment friendly biogas produced from renewable sources/potential biomasses could play a vital role in solving energy and environmental problems. The general objective of this project was to investigate bio-methane production potential of different biomasses available in Bangladesh. Different biomasses like livetsock residues, field crop residues and major processed based crop residues available in Bangladesh were identified and estimated net availability through secondary review/survey. Several experiments were conducted at 35^{o}C using 500ml batch bottles with three replications and incubation period of 60 days where rice straw, rice bran, corn cob, corn straw, corn, water hyacinth, cowdung, poultry litter, goat and sheep feces were used to investigate bio-methane production potential. Batch studies showed that Corn cob produced higher specific volume of biogas production than the other substrates. During this retention period (60 days), the average biogas production was 331 ml, 419 ml, 325 ml, 343 ml and 343 ml in corn, corn cob, corn stalk, rice straw and rice bran, respectively. Goat and sheep feces had moderate VS reduction rate, but with high amount VS, the gas production rate was on the higher side. Water hyacinth had low VS reduction rate but due to presence of plant cells it provided more favorable condition for producing biogas. Poultry

manure had lowest VS reduction rate, but the higher value of pH indicated the accumulation of ammonium nitrogen causing inhibition. Further study is needed to find bio-energy production potential of different biomasses through co-digestion.

Development and Evaluation of a Low-cost Ice Crusher for Raw Fish Storage

Muhammad Ashik-E-Rabbani* and Kaniz Tamanna
Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: ashik@bau.edu.bd*

Abstract

Fish storage in the marginal level is a challenge because of the perishable behavior of fish. An attempt was taken to develop a low cost ice crusher machine in the department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh. On the basis of the design and drawing, the machine was manufactured. Necessary materials to construct the machine were collected from the local market. The test of the machine provided some important parameters with quite satisfactory outcomes. Results indicated that for 10.03kg of ice block, the crushing time was found as 38 sec. The machine cost was estimated as Tk 11048 for construction. A comparative evaluation was also made among the developed crusher, motor operated crusher and traditional crushing by hand on the basis of the performance test and other characteristics. The storage duration of crushed ice sample was found 30% more in the developed crusher with a value of 69 hours storage time than the motor operated crusher machine with 48 hours duration. The machine capacity was 854.85 kg/hr for the developed machine, where as it was 1027 kg/hr for motor operated crushing machine and 100.04 kg/hr for the traditional ice crushing by hand. The overall loss were10.5%, 22.04% and 13% for developed machine, motor operated crusher and traditional hand crushing. The cost was calculated and the values were found as for developed crusher Tk 0.07/kg, for motor operated ice crusher Tk 0.08/kg and for traditional hand crushing Tk 0.5/kg. The breakeven point was also analyzed and it was found 3350 kg/yr in the developed ice crusher and 8820 kg/yr in the motor operated ice crusher. It was found that the developed crusher machine was providing cost saving opportunity rather than requiring electricity like motor operated crusher machine. Based on the whole findings, it can be concluded that as a new developed machine, the overall performance was satisfactory and suitable to use for the marginal fish farmers having scarcity of electricity.

Modification and Evaluation of a Power Operated Seed Cum Fertilizer Applicator for Rural Farmers

Muhammad Ashik-E-Rabbani*, Rajesh Nandi and Samiul Basir
Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: ashik@bau.edu.bd*

Abstract

A power operated maize seeder was designed and fabricated at the Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh. A single-phase DC motor along with two 12V rechargeable battery was attached with the existing manual seeder which was designed & fabricated earlier. Power was transmitted from the motor to the metering device through drive wheel. The seeder was calibrated in the workshop of the Department of Farm Power and Machinery to maintain the desired seed rate and different parameters were tested in the laboratory. In the laboratory test the effective field capacity was found 0.119 ha/hr. The field efficiency, average distance of

dropped seed and missing rate for seed were found as 85.99%, 21.29 cm and 2.78% respectively. In comparison with the manual seeder, the motor operated seeder improved the average distance of dropped seed, missing rate and field efficiency by 8.14%, 44.4%and 6.63% respectively. Result also revealed that the effective field capacity decreased by 21.7% compared to manual seeder due to low forward speed of the power operated seeder. Fabrication cost of the seeder excluding battery was USD 142.85. Financial analysis of the seeder revealed that business by this machine is profitable as the BCR and IRR was found to be 1.73 and 298% with a payback period of 0.34 years if bank interest rate is 12%. Results also revealed that the machine would be profitable if it can sow in more than 4.22 ha of land per year. So, the developed power operated seeder performance was satisfactory and also economically viable for the marginal farmers.

Application of DC Probe Technique to Assess Soil Water Content at Field Level

Md. Rostom Ali
Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: rustom412@yahoo.com

Abstract

Soil moisture and its availability to support plant growth is a primary factor in farm productivity. Too little moisture can result in yield loss and plant death. Too much causes root disease and wasted water. Therefore, irrigation water management is most important for successful agricultural production. Recent technological advances have made soil water sensors/techniques available for efficient operation of irrigation systems. Four-point probe technique is one of the key inspection criterion for measurement of soil moisture content (SMC) in agricultural fields. The technique can be considered to assess the water content of different types of soils rapidly and indirectly. It is simple in construction and easy to handle for conducting the experiment. The experimental set up has already been designed and developed at the Engineering Workshop, Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh to determine soil moisture in the agricultural field. According to the design and development of the four-point probe voltage drop (VD) technique, the outer two probes were used for current input and output, and the inner two probes for measuring the VD. Voltage drop changes with the change of moisture content of soil sample and it increases with decreasing of moisture content. Voltage drop of high moisture based soil sample was found lower than that of the low moisture based soil samples. Dryness of soil sample increased the resistivity of soil sample and voltage drop. Three types of soil like clay, silt and loamy were tested in the study. Voltage drops of clay, silt and loamy soil were varies from 1.41~2.75V, 1.46~2.79V, and 1.51~2.83V for moisture content of 41.4~12.2%, 39.4~12.5%, and 38.3~12.6%, respectively. Finally a relationship between voltage drop and moisture content of soil was developed for determining soil moisture content.

Design and Performance Test of Improved Oil Palm Crusher for Palm Oil Processing

Md. Abdul Awal
Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: awalfpm@bau.edu.bd

Abstract

At present oil palm growers are facing problem to extract crude palm oil in Bangladesh. Processing of palm oil categorized into various forms but basic processing stages are essentially the same including

harvesting, sterilization, bunch stripping, digestion, crushing, clarification and drying. Extracting of palm oil is very difficult by traditional method and oil recovery rate is very low. Although mechanical processing is costly but produces good quality Crude Palm Oil (CPO) and oil recovery rate is high. An electric motor operated oil palm crusher was designed and developed and tested in laboratory under the Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh for processing of crude palm oil from fresh fruit bunch. However, there is no performance test was perform for the crusher. Therefore, the objective of this project was to evaluate the performance of a screw press with respect to its throughput capacity, feed rate, percentage of cake oil content, sediment percentage, percentage of crude oil yield, oil extraction efficiency, and oil quality so as to pronounce on the suitability and the need for any design improvements. The crusher is powered by a three-phase 7.5hp electric motor. Crushing efficiency and crushing capacity are some of the most important parameters for evaluating the crushing performance. This study provides some information on the composition of crude palm oil, palm oil extraction methods, the crushing efficiency, etc. The crusher has an average oil extraction efficiency of 72.84 %. This was obtained from 2.5kg of palm fruit at the steaming time of 2min. The average crushing capacity of the crusher was 12.72 kg/hr. The average crude palm oil percentage in fruit was 19.67%. On an average 200 gm of crude palm oil was extracted from 1 kg of fruit. The average oil cake percentage in palm fruit was 62.2% and the average sediment percentage was 14.04%. Manually, the crushing capacity was 0.84 kg/hr, crude palm oil percentage was 22.14%, oil cake percentage was 44.28%. The break-even point of the crusher was 700 hr. It means that if the crusher is used for more than 700 hr, it will be economically suitable compared to manual crusher. The quality parameters evaluated were Free fatty acid, Iodine value, Peroxide value and Saponification value. Free fatty acid was 1.33%; Iodine value was 50; Peroxide value was 2 meq/kg; and Saponification value was 120. Overall performance of the machine was satisfactory compared to manually operated crusher.

Machine Vision Technique for Identification and Classification of Plant Diseases

Md. Hamidul Islam*, Md. Rostom Ali and Tamim-Ul-Hasan
Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: hamidfpm@bau.edu.bd.

Abstract

The damage caused by pests, pathogens and other agents is important in plant systems as agriculture is the only means to feed the rapidly growing population of the world. Several diseases of plants cause annihilating economic, social and biological losses sometimes is not even visible with naked eyes. The sustainable development of agriculture is definitely correlated with the observation, prevention and cure of plant diseases from insects, pests and other factors hence disease recognition is a major challenge. In this paper, recognition and classification of rice leaf diseases using digital image processing technique is proposed. Rice leaf images were captured using DSLR camera (Cannon 800D) from the farm field and also using our experimental setup. Primarily the bacterial leaf blight, bacterial leaf streak and brown spot diseases infected leaves and healthy leaves of rice plat was acquired. During image processing, at first RGB images were converted into L*a*b images. Later, based on the luminosity, chromaticity and color information binary images were split into diseased and non-diseased part. Then, diseased portion, normal portion and background area segmentation was executed through K-means clustering. The textural features were extracted with the help of GLCM algorithm. ANN was used to train the features thus creates a database of information. Finally, SVM classifier was implemented for the disease characterization. All image processing operations were performed using MATLAB software. Results reveled that proposed method achieved the accuracy of 97.2% for the Bacterial leaf blight, 96.5% for the Bacterial leaf streak, 91% for the Brown spot and 98.5% for the

healthy leaf image. Since food quality and food safety are concerning topic in home and abroad, protected cultivation is becoming familiar in Bangladesh. So, to have a strong and reliable protected cultivation, plant leaf disease detection by digital image processing might be an unavoidable technology.

Machine Vision System for Precision Fertilizer Management in Agriculture

Md. Hamidul Islam*, Md. Rostom Ali and Md. Abu Hanif
*Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: hamidfpm@bau.edu.bd.*

Abstract

Soil quality is critically important for sustainable crop production and environmental sustainability because an excess application of fertilizer, herbicide and other agricultural inputs increase production cost as well as causes soil quality degradation. Existing conventional methods could monitor soil quality from qualitative to quantitative scale based on field and laboratory analysis which is time consuming and costly. To overcome the limitation of existing conventional methods, a machine vision-based soil fertility quantification technique has been proposed in the study for precision fertilizer management in agriculture. The symptoms of nutrient deficiency and toxicity are mainly manifested in the plant leaves and these symptoms are mainly embodied in leaves color and texture. In this research, the relationship among plant leaves color, textural variation and soil nutrient status will be simulated to develop precision fertilizer management system. Proposed methodology consists of collection of soil and plant samples, image acquisition, image processing - color space transformation, filtering, image enhancement, image feature extraction and image feature classification, chemical analysis of soil and plant samples (organic carbon, total nitrogen, P, K and S), development of multivariate quantitative model and statistical analysis. Several tasks such as site selection, soil sampling, chemical analysis of soil (progressing), algorithm and image acquisition system have already been developed and completed. Proposed machine vision based agricultural inputs management system would be able to reduce the production cost and environmental contamination and increase productivity.

Assessing the Impact of Climate Changes on Rice Production in Selected Region of Bangladesh

M.Z. Rahman* and M.A. Ashraf
*Department of Farm Structure and Environmental Engineering, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: zillurbau@yahoo.com*

Abstract

This research work was undertaken to assess the potential impact of environmental factors on rice production (*Aus*, *Aman* and *Boro*) in Kishoregonj district for the last 5 decads. The climatic data were collected from Bangladesh Meteorology Department, and the rice production data were collected from farmers through structured questionnaire, from Agricultural Extension Office and Bangladesh Bureau of Statistics. The collected data were analyzed employing SPSS statistical package and Excel spreadsheets. In summer, the temperature were varied from 31-37^{0}C with its peak value being 37^{0}C in the month of June, and in winter the temperature were 10-23^{0}C with the lowest being 12^{0}C in January. The average rainfall varied from 320-445 mm with the highest (449 mm) in June. It was found that significant for rice yields with positive effects on *Aus* and *Aman* rice and adverse effects on *Boro*. The relative humidity varied from 76-87.5%.However, humidity has a statistically significant effect on the yield of all three rice crops. The climate variables have had significant impact on rice yield over the period under study area, but these effects vary among three different rice yields. The main climatic parameter temperature was

increased about 2.5-3.5^{0}C and rainfall was reduced about 30-60mm. The overall findings of the study indicate that all climate variables have substantial effects on the yields of Aus, Aman and Boro rice. The influences of maximum temperature and rainfall are more prominent compared with that of minimum temperature and humidity on rice yield in Kishoregonj district. However, the outcome of this assessment study can be used to forecast the production and for taking further policy options for rice production. So, Government and different development agencies should concentrate their focus to develop innovative variety so that on growing national food demand can meet through increasing production and adaptability against the adverse impact of climate change.

Relationships of Major Ions Chemistry and Hydrogeochemical Processes with Arsenic Contamination in Bangladesh

Deen Islam
Department of Irrigation and Water Management, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, E-mail: deenislam77@gmail.com

Abstract
This study was conducted to identify the relationships between major ions chemistry, the associated hydrogeochemical processes and arsenic (As) contamination in the groundwater of Bangladesh. Lakshmipur, Faridpur, Munshiganj and Habiganj districts with different levels of As contamination potential and As free Dinajpur district were selected for this study. The study approach included detailed hydrogeochemical analysis of groundwater samples collected from tubewells for major constituents such as Ca, Mg, Na, K, HCO_3, Cl, SO_4, pH and As. Then the collected hydrogeochemical data were subjected to multivariate statistical analysis. Ca and Na were the dominant cations whereas, HCO3 anion dominated in the study areas. Gibbs diagram showed that rock-water interaction was the dominant mechanism controlling the groundwater chemistry. Specific electrical conductivity (SEC) versus Na/Cl relationship revealed that evaporation was not the major process controlling the chemistry of groundwater in Lakshmipur. Piper and Chadha's diagrams revealed the main hydrogeochemical facies of groundwater. It was confirmed from the study that most of the wells fell in Ca-Mg-HCO3 water type. Chloro-alkaline indices of the groundwater samples and (Na-Cl) versus ($Ca+Mg-HCO_3-SO_4$) scatter diagrams indicated that reverse ion exchange process was strongly dominant regardless of As contamination. However, it was confirmed that the hydrogeochemical process controls groundwater chemistry. Relationships regarding weathering processes suggested that silicate weathering was the major hydrogeochemical process in Lakshmipur and Faridpur, which were severe and medium arsenic-contaminated areas, whereas silicate and carbonate weathering both occurred in Munshiganj, Habiganj and As free Dinajpur. From this study, it can be concluded that silicate weathering was the major hydrogeochemical process and the source of As may come from the weathering of As-bearing silicate minerals. Correlation analyses among different major ions, pH and As suggested an indirect relationship between major ions and arsenic.

Water Governance and Management Assessment to Improve the Production Potential in G-K Irrigation Project

Md. Abdul Mojid* and Md. Atikur Rahman
Department of Irrigation and Water management, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: ma_mojid@bau.edu.bd*

Abstract
The present performance of the Ganges–Kobodak (G-K) irrigation project is below the potential level due to inadequate attention in water governance and on-farm water management. So, assessments of

water governance and water management are needed for their improvement to realize the full potential of the project. The objective of this study is to understand the existing water governance and management and to identify the entry points for improvement. Representative areas under tertiary canals comprising head (Mirpur upazila of Kushtia), middle (Alamdanga upazila of Chuadanga) and tail (Shailkupa upazila of Jhenaidah) ends of the project were selected for this study. For each site, one relatively good- and one relatively poor-performing water management groups (WMGs) were selected. In the first year, the primary data for water governance were collected through household survey, Focus Group Discussions (FGDs) and Key Informant Interview (KII) by using structured questionnaires, checklists and guidelines, respectively. The secondary data were collected from the G-K Project Office, Upazila Agriculture Office and other relevant offices. The data were analyzed statistically, mostly by using Likert's scale. The administrative management of the WMGs (conducting regular meeting and ensuring participation) is poor according 100% respondents (n = 145). Transparency of the WMGs in terms of information sharing, selecting member, discriminations, etc. is good (score in Likert scale = 4.37±0.69, cv = 15.75%). However, transparency in preparing annual budget; maintaining bank account, income and expenditure records, sharing information, etc. is very poor (score = 1.08 ±0.16, cv = 14.37%). The operational (handling irrigation, drainage, and social and political influences) and infrastructural (maintaining infrastructures) managements are also very poor with the score of 3.1±1.29 (cv = 41.61%) and 2.77±2.02 (cv = 73.29%), respectively. The conflict management of the WMG is, however, reasonably good (score = 4.22±0.46, cv =10.83%).

Effect of Soil Texture on the Performance of Different Conservation Techniques for Irrigated Rice Cultivation

A.K.M Adham* and Mohammed Mizanur Rahman

Dept. of Irrigation and Water Management, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: adhamiwm@gmail.com*

Abstract

Irrigation is one of the most important inputs to rice cultivation. In Bangladesh, 78% irrigation is dependent on groundwater (GW) resources. For the past two decades, GW level has been significantly declining across the country and on the other hand, surface water is limited in the dry season. This poses a great challenge to meeting burgeoning irrigation demand of the country. Amid this situation, optimal and judicial use of water for irrigation is being thought to be a way out without compromising crop yield. In such context, an experiment was conducted at Field Irrigation Laboratory, Bangladesh Agricultural University, Mymensingh, to investigate the effects of soil texture on the performance of different conservation techniques for 'BRRIdhan 28' during *Boro* season from 4 February to 11 May 2019. First year experiment was conducted on silt loam texured soil and in second year, the experiment will be conducted on other textured soils e.g. loam or sandy loam soil. Different irrigation techniques on boro rice cultivation showed significant variation in water loss, water requirement, field irrigation efficiency, growth characteristics of *Boro* rice, yield and yield contributing characters *viz.* plant height, number of effective tillers per plant, length of panicle, number of filled and unfilled grains per panicle, 1000 grain weight, grain yield, straw yield and harvest index. The average highest yield was (6.70 ± 0.50) t/ha under 15 cm disappearance AWD technique. The average lowest yield was (5.47 ± 0.90) t/ha under conventional. For different treatments, conventional method needed average (127.47 ± 0.69) cm of water and its average water productivity was (0.43 ± 0.03) kg/m^3, whereas the 15 cm disappearance AWD technique required average (102.08 ± 1.04) cm of water and average water productivity was (0.65 ± 0.04) kg/m^3. The study revealed that 10 cm disappearance AWD and 15 cm disappearance AWD saved 19.0 and 28.45, percent irrigation water, respectively over the conventional method. The 2nd year experiment is going on.

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Rice Yield, Water Productivity and Nutrient Loss as Affected by Integrated Water-Soil-Waste Management

M. G. Mostofa Amin*[1], Ajida Akter[1], M.M.R. Jahangir[2] and Tanvir Ahmed[1]
*[1]Department of Irrigation and Water Management, [2]Department of Soil Science, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh, *E-mal: mostofa.amin@bau.edu.bd*

Abstract
Rice is a semi aquatic cereal crop and requires huge amount of water to cultivate. A great quantity of water and nutrient is lost due to inefficient use causing economic and environmental cost, which urges to know the better ways to get higher yield with reduced nutrient loss. A field-lysimeter experiment was conducted at Field Irrigation Laboratory, Bangladesh Agricultural University during 7 February to 11 May 2019 to evaluate the effect of different management treatments on water productivity and nutrient loss in boro rice production. The treatments were: (i) anaerobic condition by maintaining saturated soil (anaerobic), (ii) aerobic condition by maintaining unsaturated soil for a period of time (aerobic), and (iii) aerobic with animal waste (manure) application at 15 t/ha (aerobic+waste). All necessary data on yield and yield attributes, weather, and water balance information (irrigation, percolation and soil water storage) were recorded. Sub-samples of the percolated water in four irrigation events were collected and analyzed for quantifying leaching loss of NH_4-N, NO_3-N and available P. The ponded water samples after a heavy rain event were collected and analyzed to determine runoff loss potential of nutrient. The highest grain yield of 7.17 t/ha was obtained in anaerobic treatment, and this treatment required the highest amount of irrigation (85.1 cm). However, the highest water productivity of 0.84 kg/m^3 was obtained in aerobic treatment followed by aerobic+waste treatment (0.75 kg/m^3). Anaerobic condition caused the highest leaching of available P (0.38 kg/ha), NH_4-N (21.2 kg/ha) and NO_3–N (24.4 kg/ha) and runoff potential of NO_3-N (5.04 mg/L). Aerobic treatment had significantly lower water and nutrient loss with insignificant yield reduction. Aerobic+waste treatment increased P loss, but N loss was not affected by this treatment compared to the non-manured aerobic treatment. The aerobic rice cultivation technique can significantly reduce water and nutrient loss.

Environmental Fate of Water and Nutrient Applied in Agricultural Land as Affected by Water Management Techniques

M. G. Mostofa Amin*[1], S. M. Mubtasim Mahbub[1], Ahmed Al Minhaj[1] and Md. Delwar Hossain[2]
*[1]Department of Irrigation and Water Management and [2]Department of Agronomy, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh,*E-mail: mostofa.amin@bau.edu.bd*

Abstract
As rice and maize are two important cereal crops in Bangladesh, it is important to identify the sustainable water management practices for the rice-maize rotation. Hence, the effects of water management practices on yield, water and nutrient losses were investigated in maize-*aman* rice rotation using lysimeter experiments. The water conservation treatments for maize were: (i) no mulch and no manure application (control), (ii) rice straw mulch application at a rate of 6.0 t/ha, (iii) a plastic sheet mulch rolling over the soil, and (iv) manure application at 18.5 t/ha. The rice experiment included three treatments: (i) rainfed, (ii) irrigation after six days of ponding water disappearance (I6D), and (iii) irrigation after three days of ponding water disappearance (I3D). In maize experiment, soil moisture availability was higher for both mulching and manure amendment compared to control treatment. The treatments also affected soil temperature by altering the thermal conductivity of the soil.

Grain yield of maize was increased by 2–27, 21–29 and 0–35% for straw mulch, plastic mulch and manure application compared to control condition, respectively. At vegetative stage leaching of N and P was not affected, but at later stage the conservation practices had slightly higher nutrient leaching. Aman rice field under rainfed, I6D and I3D treatment received 56.6, 83.3 and 101.1 cm water and had a percolation rate of 37.9, 58.1 and 62.2% of total water received, respectively. Average evapotranspiration loss from the field was 4.2–4.6 mm/day, and this was higher when irrigation was applied more frequently. Treatment I3D had the highest leaching loss of N and P (33 and 1.32 kg/ha, respectively) followed by the I6D and rainfed treatment. Runoff loss potential of P was much lower in I3D treatment compared to rainfed condition because irrigation facilitated the vertical movement of P in the soil.

Investigation of Nitrate Leaching from Rice Cultivation for Different Fertilizer Application Rates in a Lysimeter Study

Atikur Rahman[1*], Srabani Aktar[1], Tithi Rani Saha[1], and Ahmed Khairul Hasan[2]
*[1]Department of Irrigation and Water Management and [2]Department of Agronomy, Bangladesh Agricultural University, Mymensingh –2202, Bangladesh,*E-mail: atikur.iwm@gmail.com*

Abstract
Nitrogen, fertilized in rice fields, subjects to leaching and makes it way to ground- and surface water and is of increasing environmental degradation concern because it causes hypoxia, loss of biodiversity, and habitat degradation in ecosystems. This study investigated the leaching of nitrate nitrogen from a double cropping rice cultivation system under the conditions of usual water management and different fertilizer application rates. Three nitrogen application rates, such as low (100 kg N/ha), medium (200 kg N/ha), and high (300 kg N/ha) were used along with a treatment without any nitrogen application to serve as a control. Nitrate nitrogen leaching was investigated in *Boro* and *Aman* seasons for two rice cultivars, BRRI 29 and BINA 7, respectively. Agronomic and yield characteristics showed better performance with increasing nitrogen application rates, which was expected. It was observed that the leaching of nitrate nitrogen was influenced by the nitrogen application rates and correlated positively. The detail of the results will be presented in the workshop.

Rapid and Low Cost Process Development for Commercial Production of Soya Sauce

Md. Anisur Rahman Mazumder
Department of Food Technology and Rural Industry, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: anis_engg@bau.edu.bd

Abstract
Soy sauce production, *koji* is prepared by the solid-state culture of steamed soybeans and parched wheat with seed spores of *Aspergillus oryzae* for 2-3 days. Hydrolysis by various enzymes, lactic acid fermentation by *Pediococcus halophilus,* and alcohol fermentation by *Zygosaccharomyces rouxii* take place. The resulting mash is pressed and heat-treated to produce soy sauce. The relative glucose consumption rate related to the recirculation flow rate in the reactor plateaued at rates of 6 cm^3min^{-1}. The fermentation was examined at the recirculation flow rate of 5 cm^3min^{-1}. A 20% packing fraction was decided on a practical point of view. After the lag stage of 5 days in batch fermentation, ethanol production progressed exponentially with time and reached a stationary state. A maximal ethanol production rate of 2.5 kg $m^{-3}d^{-1}$ was obtained at the exponential stage. The initial dilution rate in

continuous operation was set at 0.12 d^{-1} after the exponential ethanol production. The continuous fermentation was started after 15 days by supplying feed solution to the reactor. After the transition state due to the change of chemical components of the reactant for 2-3 days, ethanol concentration became almost constant under the dilution rate of 0.14 d^{-1}. As the dilution rate increased from 0.14 to 0.40 d^{-1}, the ethanol concentration in the reactor decreased. This suggests that the fermentation may be limited by the substrate supply, which was affected by the dilution rate. During the operation of the reactor, free yeast cells were observed in the effluent and measured to be about 106 cells/cm^3. Analysis of the soy sauce is ongoing.

Processing of Food Grade Emulsion Based on Soymilk and Whey Protein Isolate

Humyra Nowshin and Md. Anisur Rahman Mazumder*
*Department of Food Technology and Rural Industry, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: anis_engg@bau.edu.bd*

Abstract

The study was concerned with the development of high calorie emulsions based on soy milk liquid and whey protein. Soy milk was extracted at soaking condition 55ºC and 60ºC for 1 h and 2h and blanching condition was 70ºC, 80ºC and 90ºC for 10 min. Among them the better composition was observed at 55ºC for 1h soaking condition for 90ºC blanching condition. The moisture, ash, protein, fat and carbohydrate content were found 93.08 ± 0.03%, 0.81 ± 0.04%, 3.83 ± 0.12 % and 1.09 ± 0.09% for soy milk liquid, whereas for whey protein permeates, the contents are 8.18 ± 0.02%, 7.85 ± 0.01%, 16.1 ± 0.06% and 67.92 ± 0.03%, respectively. Formula A, B, C and D contained 100% soymilk, 100% whey protein, 70% soy milk and 30% whey protein and 30% soy milk and 70% whey protein, respectively. For high calorie liquid emulsion the moisture content was 82.6 ± 0.02%; 79.8 ± 0.26%; 85.72 ± 0.25%; 83.83 ± 0.15 %, ash content was 0.57 ±0.06%; 8.07 ± 0.31 %; 5.87 ± 0.15%; 5.8 ± 0.35 % and protein content was 2.98 ±0.11%; 3.3 ± 0.01%; 2.34 ± 0.02%; 3.4 ± 0.09 % ,fat content was2.22 ± 0.02 %,.61±0.04 %, .71±0.03 %, 1.46±0.04 % for formula A, B, C and D, respectively. The level of nutrient content for the high calorie emulsion was as follows D>A>B>C. There was also improved observed color value of the developed four emulsions according to the formula. The L*, a* and b* values were 72.17%, -3.61%, 12.58% ; 77.93%, -5.97%, 10.62%; 63.84%, -4.73%, 9.16% and 74.44%, -5.58% ,11.09% respectively. The organoleptic taste test showed that formula D (30% soy milk and 70% whey protein) is the best one followed by formula C (70% soy milk and 30% whey protein permeates).

Stabilization of the Isolated Cells on Corn Starch

Mohammad Gulzarul Aziz* and Md. Rezwan Rasik
Department of Food Technology and Rural Industries, Bangladesh Agricultural University, Mymensing-2202, Bangladesh
**E-mail: aziz_ftri@bau.edu.bd*

Abstract

The project was proposed for the evaluation of the growth kinetics and the biomass yield of the locally isolated and the commercial baker's yeast in a batch fermenter. The activities proposed for the were (1) to assess the corn flour and molasses as cheap sources of substrates in supporting the growth of isolated strains, (2) to compare the growth kinetics and biomass yield of the strains at different concentration of the selected cheap substrates and (3) to develop a low cost techniques to stabilize the isolated cells. Among the molasses and the corn flour, both exhibited as ideal substrates for the growth

of yeasts. Growth kinetics of *Baker's yeast* was monitored by measuring optical density at 600nm during fermentation of molasses at three different concentrations (5, 7.5 and 10%) over 0 to 80 hours and the highest growth (9) was found at 10% concentration of molasses. Specific growth rate was slightly affected by the molasses concentration but highly affected by shaking (rpm). Scale up of the fermentation volume (up to 5L) showed the similar growth pattern. During fermentation at higher volume (5L), stationery phase was achieved with 48h of culturing. After fermentation, yeast cells were removed and adsorbed into starch. Leavening study using these yeast cells were carried out and similar leavening performance with commercial cells. Stability of cells was carried out at two water activity using saturated salt solution by observing leavening behaviour upto 30 days of study. Slight leavening loss (10%) was observed during this study.

Detection of Pesticide residues Used on Vegetables at Local Market in Mymensingh

Md Abdul Alim*, Md. Ahmadul Islam and S. M. Ayanul Azam
*Department of Food Technology and Rural Industries, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: maalim07@yahoo.com*

Abstract

The research works were conducted for the assessment of residue level of Dimethoate and Cypermethrin and left over residues of insecticides in environmental vegetable (hyacinth bean, brinjal, broccoli, red amaranth, cauliflower, cabbage and pea) samples. The dissipation rate of Dimethoate was detected up to 11 days after spray (DAS) on hyacinth bean and 13 DAS on broccoli. All of the detected quantities were found above (Maximum residue level) MRL up to 11 DAS on hyacinth bean and 13 DAS on broccoli. The time of degradation was faster in hyacinth bean compared to broccoli. The dissipation rate of Cypermethrin was detected up to 6 days after spray (DAS) on hyacinth bean and 7 DAS on broccoli. The detected quantities were found above (Maximum residue level) MRL up to 4 DAS on both in hyacinth bean and broccoli up to 4 DAS. But in case of broccoli it was 5 DAS for Cypermethrin and 14 DAS for Dimethoate. Out of the 35 collected samples of vegetable (hyacinth bean, brinjal, broccoli, red amaranth, cauliflower, cabbage and pea) from different markets of Mymensingh region, 14.29% were found contaminated with insecticides. Most of the samples contained Diazinon and Dimethoate Acephate residues. Diazinon, Dimethoate and Acephate residues were found as multiple insecticide residues. Multiple insecticide residue represents 5.71% of the total samples and the rest 8.57% contained single insecticides residue. All of the contaminated samples had residue above MRL irrespective of single and multiple residues. Diazinon residues were found in two samples of hyacinth bean. Out of 5 analyzed brinjal samples only one sample had Dimethoate residue. Dimethoate, Acephate and Diazinon multiple insectecides were found in one sample of broccoli. Diazinon and Dimethoate multiple insecticides were found in red amaranth. No residues were found in any sample of cauliflower, cabbage and pea.

Intelligent Irrigation System for Optimal Water Usage

Md. Rakib Hassan* and Jaionto Karmokar
Department of Computer Science and Mathematics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, E-mail: rakib@bau.edu.bd

Abstract

Water is essential for sustaining life and it is one of the most important resources that we have. According to the experts, recent climatic changes and drought conditions have decreased surface water flows in many parts of the world. Approximately, 70% of the water withdrawn from various fresh water sources is used for Agricultural activities. Steady increase in the demand for the agricultural

products to satisfy the need for the growing population contributes to be a main driving factor behind the exorbitant water usage. Efficient irrigation techniques are required to irrigate the agricultural lands to save large amounts of water. Because irrigation is an essential part for any crop production due to the uncertain nature of the rainfall. Since irrigation uses the groundwater, it is extremely necessary to use water in an optimum way. Because over use of irrigation can waste water and lack of irrigation will reduce crop production. Therefore, in this project, our main goal was to eliminate all the limitations of the traditional gardens. Therefore, various tools and methods were used to develop this intelligent irrigation system. For example, various sensors, microcontroller, and programming language were used to monitor the dryness of the soil to measure the need for irrigation. All the collected data were analyzed to automatically control the irrigation system to water the plants in an optimized way. Therefore, plant loss due to lack of irrigation was reduced and excess usage of water was prevented. The gardener can also control the irrigation using his android smartphone through voice command or app. This developed system can monitor and irrigate automatically without the help of the gardener. Therefore, the proposed system will greatly help to increase the plant production and reduce water loss to save ground water.

Automation of BAURES Project Management System

Md. Rakib Hassan
Department of Computer Science and Mathematics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, E-mail: rakib@bau.edu.bd

Abstract

Over the past century, the traditional office has changed dramatically. New technologies such as telecommunications, computers, internet, and many others have improved office efficiency. Many offices today are still stuck in the paper world when it comes to regulated documents. It is estimated that 80% of all business information is stored solely on paper. This is mainly because there are often significant technical, financial and operational barriers to overcome when implementing electronic document management systems, but there are also significant benefits that can be obtained once these systems are in place. The project management of Bangladesh Agricultural Research Systems (BAURES) depended on paper-based system. Therefore, it faced many drawbacks of the paper-based systems. First, paperwork can take up a significant amount of space, and this requirement gets bigger with the number of documents. Second, paper documents are prone to damage which can occur by accidental or natural disasters. Third, cost is also higher for paper-based systems due to the requirement of printers, stationery and other office supplies each month. Fourth, documents can be lost due to mis-handling. Fifth, collaboration on documents is extremely hard when working with paper versions. Sixth, tracking of documents is very hard in paper versions as there is no centralized point of information. Besides, there are other problems of the existing system, such as, lack of security, time consuming and requires sufficient manpower and lot of working hours. The developed automation of BAURES project management or eProject Management (ePM) solves these problems and introduces many benefits. First, it introduced transparency of project management. Second, it eliminated chances of file missing. Third, it provided backup reliability. Forth, file tracking has been introduced. Besides, project management has become faster and more efficient. Thus, ePM has ensured the above benefits and eliminated the problems of the existing paper-based system.

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Ensuring Automated Security in Close Water (Pond) Fish Cultivation

Md. Sayeed Iftekhar Yousuf*, Mohammad Aminul Islam and Machbah Uddin
*Department of Computer Science & Mathematics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: imsayeed@bau.edu.bd*

Abstract

Fish is one of the major agricultural crops and its production plays an important role in the livelihoods and employment of millions of people. There is a proverb for Bangladeshi people known as “Mache Vate Bengali" which indicates the importance of fish in the national diet. It is the main source of protein and micronutrients. Therefore, fish culture and consumption have implications in national food and poverty, growth and nutrition security. Bangladesh is ranked third of the world’s largest inland fish producing countries after China and India. Inland pond culture contributes 86% of fish production, where aquaculture represents the most important part in inland pond culture. During 2003-2004, aquiculture accounted for about 43.5 percent of the total fish production. Aquaculture production has increased significantly in the last few years. The contribution of cultured ponds also increased substantially. One of the major issues of aquaculture is illegal fishing. It causes an imbalance in fish production. In this study, we propose a novel technique to detect and supervise illegal fishing by using automatic video surveillance techniques. In this study, we detect the presence of unwanted (illegal) objects in a protected fisheries area. We have applied image segmentation based on temporal rank-order filtering followed by classification using a convolutional neural network (CNN). We used image processing techniques for detecting the foreground object and deep learning for classification of moving objects. The proposed system is tested using image sequences acquired from a fisheries area. We achieved good precision and accuracy 93.77% and 93.75% respectively. We also compared the accuracy of our system with existing support vector machine (SVM), and decision tree (DT) techniques. Experimental results show the robustness and effectiveness of our system. Hence, the developed system can be used by farmers with a good level of reliability.

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Effects of Dietary Polyunsaturated Fatty Acids and Beta Glucan on Broodfish (*Labeo rohita, Mystus cavasius* and *Ompok pabda*) Immunity and Fry Quality

Zakir Hossain*, Md. Saddam Hossain, Shahanaj Parvin Rumki and Rafia Akter
*Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: zakirh1000@yahoo.com*

Abstract
The aim of this study is to evaluate the effects of PUFAs enriched squid extracted lipids on enhanced maturation, spawning and dietary beta glucan in enhancing immunity of *Mystus cavasius*, *Ompok pabda* and *Labeo rohita*. Treated group was provided supplemental diet enriched with 1% squid extracted lipids as a source of PUFAs and 10% barley powder as a source of beta glucan for four months (March-June) whereas controlled group was fed the same except PUFAs and beta glucan. Treated group attained significantly higher (P<0.01) weight increment compared to the control group and significantly higher (P<0.05) length increment was also found for *O. pabda*. In comparison with the control group, treated group exhibited an advanced gonadal maturation and higher reproductive performances in spawning trial. Though spawning occurred in late August, the fertilization rate (78.67 ± 1.33%), hatching rate (70.21 ± 0.73%) and survival rate (65.54 ± 1.94%) of offspring of *O. pabda* were significantly higher in treated group compared to control group. During spawning season, lipid granules and normal morphological alteration were observed in case of treated fish liver, whereas less lipid granules with more histological alteration of liver were observed in control group of *M. cavasius* and *O. pabda*. Serum Ca^{2+} level in treated female was significantly higher (P<0.05) compared to the controlled female of *L. rohita*, *M. cavasius* and *O. pabda*. Viable sperms in treated group of *O. pabda*, *M. cavasius* and *L. rohita* were significantly higher (P<0.01) compared to control. The AChE activity was significantly higher (P<0.01) in the treated group (63.93 ± 1.48 nmol/min/mg protein) than the controlled (44.43± 2.65 nmol/min/mg protein) fed with no beta glucan and PUFAs for *O. pabda*. The WBCs count (cell ($\times 10^6/mm^3$) in blood of *O. pabda*, *M. cavasius* and *L. rohita* which fed with beta glucan in associated with PUFAs were found significant increased (P<0.05) in number as compared with the control. The study suggests that supplementation of dietary PUFAs and beta glucan improve the spawning performances and immune status of *L. rohita*, *O. pabda* and *M. cavasius.*

Establishment of an Androgenic Herb Instead of Steroid Hormones on Sex Reversal of Tilapia

M. Sadiqul Islam* and M. Helal Uddin[1]
*Department of Fisheries Biology & Genetics and [1]Fisheries Management, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: sadiqul1973@yahoo.com*

Abstract
The use of synthetic hormone in sex reversal is a common phenomenon in tilapia to get all male species due to its faster growth over female. An experiment was conducted to study the effects of pine pollen (*Pinus massoniana*) as organic sex reversal agent on growth and sex reversal of Nile tilapia (*Oreochromis niloticus*). The pine pollen was administered orally at variable doses with the available commercial nursery feed for 28 days to naturally produced sexually undifferentiated fry of tilapia. The doses of pine pollen were 0%, 5%, 10% and 15% per kg of feed which were treated as T1, T2, T3 and T4, respectively. The percentage of male obtained in treatment T2, T3 and T4 were 72.67%, 90.99% and 81.19%, respectively while the control was 52.04%. The percentage of male in T3 (10% pine pollen) was found to be the highest and significantly (p<0.05) higher than that of the expected

percentage of 50% male in a normal population. It was also observed that pine pollen had no significant effect on growth performance and survival rate of tilapia. The result suggested that it would be possible to produce sex reversed male of tilapia as an alternative method with this natural product. In fine, this method may be applicable as a new environmental friendly method for masculinization of tilapia with a greater extent instead of synthetic hormone.

Development of a Saline Tolerant Improved Strain Through Inter-specific Hybridization and Marker-assisted Selection

Md Sadiqul Islam* and Nahid Sultana Lucky
**Department of Fisheries Biology & Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: sadiqul1973@yahoo.com*

Abstract

The molecular characterization of salt-regulatory genes in tilapia was conducted by microsatellite DNA markers. Genomic DNA was isolated from fin sample containing 45 Mozambique tilapia, *O. mossambicus* and 33 Nile tilapia, *O. niloticus*. Three sets of microsatellite primers (Prl1, TFA, and TFB) for three salt-regulatory genes of *O. mossambicus* and *O. niloticus*and amplified by polymerase chain reaction. The alleles were separated by polyacrylamide gel electrophoresis and visualized by ethidium bromide staining. The prl1 locus was found to be monomorphic in both *O. mossambicus* and *O. niloticus* populations and the locus TFB was found to be monomorphic in *O. mossambicus*. The size of prl1 allele in *O. niloticus* was 487bp while that in *O. mossambicus* was 500bp. On the other hand, TFA and TFB locus of *O. niloticus* and TFA locus of *O. mossambicus* were found to be polymorphic. The genotypes in TFA and TFB loci of *O. niloticus* and TFA loci of *O. mossambicus* were 296/320, 166/254 and 310/340, respectively. The average observed heterozygosity (H_o) value was higher (0.485) in *O. niloticus* than that (0.329) of *O. mossambicus*. The 1- H_o/H_e value of both TFA and TFB loci in *O. niloticus* and TFA in *O. mossambicus* were negative which means excess of heterozygosity as a result of the presence of over-dominant selection or the occurrence of outbreeding or Wahlund effect. The, TFA microsatellite locus of *O. mossambicus* and *O. niloticus* was found to be significantly deviated from Hardy-Weinberg expectations. Deviation at TFB locus of *O. niloticus* and *O. mossambicus* were insignificant. Study of the climate change impact on fisheries resources and fishers´ especially women and children in selected climate hotspot zone of Bangladesh

Study of the Climate Change Impact on Fisheries Resources and Fishers´ Especially Women and Children in Selected Climate Hotspot Zone of Bangladesh

Zakir Hossain* and Md. Saddam Hossain
*Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: zakir.fbg@bau.edu.bd*

Abstract

Climate change is a contemporary global threat to the whole world especially in the coastal area like Bangladesh. Bangladesh is extremely vulnerable to climate change impacts because of its geographical location. This research is an attempt to assess the impacts of climate change on fishers′ livelihood, fisheries resources, water quality parameters and primary productivity of selected climate hotspot zones namely Sundarbans impact zone, Meghna estuary, high saline zone-Cox's Bazar, Haor basin-Kishoreganj and Charland-Munshiganj. Total 186 species of brakish water fishes, marine water fishes, fresh water fishes, prawns, shrimps, crabs and lobsters were recorded in Sundarbans. Among them 164

fish species, 11 shrimps, 5 prawns, 5 crabs and 1 lobster were recorded. A total of 61 fish species belonging to 13 orders and 29 families were documented in the Meghna river and a total of 73 species belonging 11 orders and 33 families were documented simultaneously from the Laukhati and Galachipa rivers. A total of 75 fish species belonging to 15 orders and 36 families were documented in the Padma river. A total of 84 fish species of belonging to 36 families under 13 order were recorded in the Bay of Bengal. Fishers' observations compiled from the Sundarbans region indicate increased temperatures and changes in weather patterns, increased extreme events, decreased rainfall as well as coastal erosion, sea level rise and siltation shifts in fish species distribution range and migratory and spawning behaviour. In all regions women and children are affected severely i.e. malnutrition, education, treatment, early marriage etc. Fish kidney, gill and liver were affected by increasing salinity and temperature in the rivers of Sundarbans and Meghna. The present study clearly indicates that there is visible decline of fish species and primary productivity during the last decade for negative impacts of climate change.

DNA Barcoding and Captive Propagation of the Native and Exotic Stripped Snakehead *Channa striatus* (Bloch, 1793)

Foyjunnesa Projna, Mohd. Golam Quader Khan and Md. Samsul Alam*
*Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, * E-mail: samsul.alam@bau.edu.bd*

Abstract

Striped snakehead (*Channa striatus*) has enormous aquaculture importance due to its high market demand. Understanding evolutionary dynamics of population structure and genetic diversity of fish species is of great importance for management and resource conservation. Recently, Viet Nam strain of the species has been introduced into Bangladesh for aquaculture. Therefore, it is essential to develop morphological and molecular markers to distinguish the Bangladesh strain from the Viet Nam strain. In Year-1 (2017-2018) the study of morphological difference between Bangladesh and Viet Nam strain was completed and the study of molecular difference between between the two strains was initiated. In Year-2 (2018-2019), study of molecular genetic variation among five Bangladesh populations such as Bhairab, Mohongonj, Naogaon, Sutiakhali and Muktagacha and one Viet Nam population was completed. For molecular studies, fin clips from live shol samples were collected and total DNA was isolated. The COI gene fragment was amplified by PCR using Fish F1/R1primer set and sequenced for genetic analysis. The PCR fragments were purified and subjected to sequencing by dideoxy method. The sequences were analyzed for detection of diagnostic markers between the two strains as well as for population genetic parameters. A total 18 haplotypes were identified with an overall haplotype diversity of 0.904. The tests for neutrality, Tajima's D test showed a non-significant negative value of -0.36124. Fu's Fs was also found to be negative (-1.26824) in the samples. The negative values of Tajima's D and Fu's Fs indicate recent population expansion. The phylogeny created based on COI gene sequences clearly differentiated the Bangladesh samples from the Viet Nam samples. Seven SNP markers have been identified that are diagnostic and can separate Viet Nam strain and Bangladesh strain. The present study concludes that the *C. striatus* populations in Bangladesh recently had expanded from a bottleneck situation.

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Restoration of Indigenous Koi (*Anabas testudineus*) Through High Quality Seed Production by Line Breeding Trial in Bangladesh

Md. Fazla Rabbi, Md. Borhan Uddin Ahmed Md. Kamal Hossain, Biraj Kumar Datta, Md. Mehfuzul Islam and A.K. Shakur Ahammad*

Department of Fisheries Biology & Genetics, Bangladesh AgriculturalUniversity, Mymensingh-2202, Bangladesh
**E-mail: sahammad09@yahoo.com*

Abstract

An experiment was carried out for quality seed production of indigenous climbing perch, *Anabas tesudineus*using cross breeding technique. Live fish were collected from three geographically distinct natural water bodies in Mymensingh division i.e. Kaillabeel, Mymensingh (Mk); Salakandibeel,Mymensingh (Ms) and Shamganjbeel, Netrokona (Ns). Fishes were reared in cages using commercial feed. Length and weight gain per month was found to be highest in Ns (1.45±0.32cm and 6.34±1.34g) followed by Ms (1.29±0.87cm and 5.41±1.23g), Mk (0.85±0.75cm and 4.43±1.48g). The GSI were recorded highest in April and lowest in June. The water quality parameters, such as (Temperature 29.6±0.6°C, pH 8.9±0.1, DO 5.58±0.45 mg/L, Total alkalinity 117.23± 13.45 mg/L, Ammonia-Nitrogen 0.27 ±0.5 mg/L) were acceptable for fish culture. Three conspecific line groups were produced by cross breeding between Kaillabeel (♀)×Kaillabeel (♂) (Mk × Mk); Salakandibeel (♀) × Salakandibeel (♂) (Ms × Ms), Shamgonjbeel (♀)× Shamgonjbeel (♂) (Ns× Ns) using PG extracts at 6 mg/kg for females and 2 mg/kg for males. The conspecific line groups were considered as Line 1, Line 2 and Line 3, respectively. Similarly, three heterospecific line group (Salakandibeel (♀) × Shamgonjbeel (♂) (Ms × Ns); Kaillabeel(♀) × Salakandibeel (♂) (Mk × Ms); Shamgonjbeel(♀)×Kaillabeel(♂) (Ns × Mk)were produced through cross breeding and considered as Line 4, Line 5 and Line 6, respectively. Among them, Line 4 showed the highest result in case of fertilization (82.43±1.56%), hatching (93.79±1.96%) and survival of larvae (77.54±2.21%) which was significantly ($p<0.05$) different from other line groups. The highest weight gain per month, length gain per month and SGR (% day) were 7.23±1.69g, 1.81±0.05cm and 1.49±0.15 in Line 4. Hyperplastic small diameter muscle fiberswere influenced according to the crossing pattern where small diameter muscle fiber(<20µm) in Line 4 showed significantly ($p<0.05$) higher number during muscle morphometric analysis. Similarly, the number of muscle fiber (21 to 30µm) and large diameter muscle fiber (<30µm) in Line 4 was higher than other treatment which denotes that heterospecific line group especially Line 4 has superior breeding and growth performance than the conspecific line groups.

Molecular Marker Based Characterization of Different Line of Bhagna, *Labeo ariza* Populations for Quality Seed Production

Md. Mehefuzul Islam,Tanzina Ferdousy, Md. Shamsul Alam, and A. K. Shakur Ahammad*

Department of Fisheries Biology & Genetics, Bangladesh AgriculturalUniversity, Mymensingh-2202, Bangladesh
**E-mail: sahammad09@yahoo.com*.

Abstract

Line breeding is a useful technique for advancing particular line's of species as well as its stock improvement with restoration of specific heredity unit. Regards, six different lines (line 1: K♀×K♂, line 2: J♀×J♂, line 3: A♀×A♂, line 4: K♀×A♂, line 5: K♀×J♂ & line 6: A♀×K♂) were produced through collection from three wild sources viz. Kangsha, Jamuna and Atrai river using rotational line crossing system. However, molecular structure of six different lines was assessed using four microsatellite loci Lr3, Lr22, Lr24 and Lr27 to test the genetic variability. Among the experimented

four loci, two monomorphic (Lr3 and Lr22) and two polymorphic loci (Lr24 and Lr27) were found in all the lines. The average observed heterozygosity was found to be highest in line 4: K♀×A♂ (0.817) followed by line 6: A♀×K♂ (0.792), line 5: K♀×J♂ (0.667), line 2: J♀×J♂ (0.500), line 3: A♀×A♂ (0.417) and line 1: K♀×K♂ (0.333), respectively. The highest population differential (0.252), the lowest gene flow (0.744), the highest genetic distance (1.324) and the lowest genetic identity (0.266) between line 1: K♀×K♂ and line 3: A♀×A♂ indicated the genetic purity of the Kangsha and Atrai stock. The line crossing system enabled the mixture of the genetic materials of Kangsha and Atrai stock in line 4: K♀ × A♂ which is the main reason behind the highest genetic diversity of that line. The result indicated that the highest genetic improvement was occurred in line 4: K♀ × A♂ for the previous rotational line crossing system. However, the line 4: K♀ × A♂ can be considered as base population for implementing further stock improvement strategies for Bhagna (*L. ariza)*. The knowledge obtained through the present research may also be used as a baseline for further research to save this species from possible threat of extinction.

Identification And Characterization Of Salt Tolerant Genes In F1 Generation Of Tilapia Hybrid Through Microsatellite Dna Markers

Nusrat Easmin, Bhakta Supratim Sarker, Md. Samsul Alam and M. Sadiqul Islam*
Department of Fisheries Biology & Genetics, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
** E-mail: sadiqul1973@yahoo.com*

Abstract

Identification of the genes for salt tolerance to study the level of prolactin and transferrin gene polymorphisms in F1 generation of *O. niloticus* (♀) × *O. mossumbicus* (♂) was conducted through five microsatellite loci named Prl (L-K), Prl (S-K), Prl-MS01, TFA and TFB . Genomic DNA was isolated from 20 fish (10 male and 10 female) samples. The microsatellite markers were amplified by polymerase chain reaction, separated on polyacrylamide gel electrophoresis and visualized by ethidium bromide staining. All five loci were found to be polymorphic in this hybrid population. Locus Prl (L-K) had the highest numbers of six alleles while the locus Prl (S-K) and Prl-MS01 had the similar and least number of four alleles. Six alleles ranging from (236 to 281) bp were found in the locus Prl (L-K). Where all alleles were present in male hybrid population but three alleles (236bp, 246bp and 271bp) were absent in female population. All alleles were present in Prl (S-K) locus which ranged from 507 to 531bp. On the contrary, among 4 alleles ranging 256 to 288bp in Prl-MS01 locus , the male hybrid population showed two absent alleles (256bp and 288bp) while the female showed no absent allele. Another two microsatellite loci, TFA and TFB in F1 generation were analyzed in this study were also found to be polymorphic. A total of five alleles were found in both TFA (300-380) bp and TFB locus (177 to 215) bp. No alleles were absent in female hybrid for TFA and TFB. But in case of male 300bp was absent at TFA locus whereas 177 and 195bp were absent at TFB. The average observed heterozygosity (H_o) value in male hybrids (0.380) was lower than that in female (0.400) populations. Except the locus PRL (L-K) in both male and female hybrid population, the F_{IS} values were positive in all the loci which means that this population was deficient in heterozygosity at most of the loci while the negative F_{IS} values at Prl (L-K) locus in both male and female population meaning excess of heterozygosity as a result of the presence of over-dominant selection or the occurrence of outbreeding or Wahlund effect. The test for fit to Hardy-Weinberg expectation revealed that both male and female hybridpopulation were found to be deviated from Hardy-Weinberg expectations in 8 out of 10 tests. The deviation from Hardy-Weinberg Equillibrium at locus Prl (S-K) in male hybrid population and at two of loci Prl (S-K) and Prl-MS01 were high ($p<0.0001$). The deviation from Hardy-Weinberg expectation at locus Prl-MS01 ($p<0.01$) and TFA ($p<0.05$) in male hybrid population was relatively low compared to that in female hybrid population at locus Prl-MS01 ($p<0.001$) and TFA ($p<0.01$).

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Studies on Chromosome Number of Ilish bata, *Labeo bata*

Nahid Sultana Lucky
Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, E-mail: nahidlucky@gmail.com

Abstract
Very few species of Bangladesh have undergone chromosome analysis. The structuring and numbering of chromosome (karyotyping) is basic but important tool to undertake various breeding and selection programme. Thus a chromosome study has been done to an economically important native species *Labeo bata* using 1 day old larvae under laboratory of Fisheries Biology and Genetics department. Metaphase chromosome spreads were prepared from newly hatched larvae following the original procedure of Kligerman and Bloom (1977), Chourrout and Itzkovich (1983), Chourrout (1986) and Shao *et* al. (2010) with some modifications. The larvae were transferred to petri dishes containing several colchicine solutions at 0.02%, 0.03%, 0.036%, 0.04%, 0.05% and 0.06% and allowed for swimming 3, 4, 5, 6, 8 and 12 hrs, respectively at around 28^{o}C. Killing of larvae were done by chilled 0.7% NaCl solution in Petri dish for 20 min. Then the head and yolk-sac of the larvae were removed by using fine forceps and needle in the same solution and tissues kept in distilled water (hypotonic solution) for 12 min before fixed in 3: 1 methanol: acetic acid. After 1 - 2 h in the fixative solution the larvae tissues were prepared for slide preparation. For slide preparation the larval tissues were placed in a 5 mm diameter and about 7 mm deep flat-bottomed hole (made in a 10 mm thick Perspex block) with 3 drops of 50% acetic acid. The tissues were ground for 1 minute using a 3 mm diameter glass rod. Ten minutes after grinding, the cell suspension was taken up into a capillary tube and dropped from 30 cm height on to a clean glass slide placed on a hot plate (45^{o}C) and 2-3 circles were made in a slide. Prepared slides were air dried and stained with 5%, 7%, and 10% Giemsa for 20 minutes. Then permanent slides were prepared using DP-X mount. Chromosome spreads were identified around the edge of the circle under 40 x magnifications and the number of chromosome was counted under 100 x (oil immersion) magnification using a compound photographic microscope. Among the different concentrations of colchicine solutions 0.036% for 5 hrs dip showed best result with 7% concentration of Giemsa stain. The total numbers of chromosomes of Labeo bata were counted 2*n*=50.The result of the present study may provide new information in scientific community as well as further improvement of breeding and production of this species.

Induction of Gynogenesis in Koi (*Anabas Testudineus*) for Production of Monosex All-Female Population

Md. Rafiqul Islam Sarder* and Md. Kamal Uddin
*Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh-220, Bangladesh, *E-mail: rafiqulsarder@yahoo.com*

Abstract
The present study was carried out to induce diploid gynogenesis in koi (*Anabas testudineus*) through cold shock treatment in order to produce monosex all-female population as the females of koi have higher growth than the males. Optimal UV-irradiation of sperm was achieved when the sperm suspension containing 8×10^{8} ml^{-1} was exposed to a UV dose of 200μWcm^{-2} for 1 min. Diploid meiotic gynogenetics were produced by cold shock treatment to eggs fertilized with UV-irradiated sperm. The cold shock temperature applied at 7°C for 15 min after 5.5 min of fertilization produced 41.77±0.7% meiotic gynogens where the fertilization and survival rates were 72.92±0.9% and 23.67±0.7%, respectively. The fertilization, hatching and survival rates of normal control group were 80.11±1.0%, 73.19±0.9% and 43.78±1%, respectively. On the other hand, the fertilization, hatching and survival

rates of haploids were 72.52±2.0%, 3.40±0.6% and 0%, respectively. Application of cold shock to the fertilized eggs was effective in preventing the release of the second polar body (meiotic-gynogenesis) and resulted in diploid gynogenetic larvae morphologically identical to control. Haploids were produced by fertilizing eggs with UV-irradiated sperm followed by incubation without applying cold shock. The haploids were deformed and died during hatching or day after hatching which indicated successful denaturation of DNA of sperm. The gynogens were identified by chromosome counting from the larval cells and the karyotype showed that the haploids have 23 (N) chromosomes, and the meiotic gynogenetic diploids and controls have 46 (2N) chromosomes. This study has facilitated to standardize the basic parameters for induction of gynogenesis in koi which will help to produce monosex all-female of the species.

Effects of Exogenous Multi-Enzyme Supplementation to Wheat-Based Diets on Growth Performance, Nutrient Utilization and Intestinal Histology of *Ompok Pabda*

Mohammad Matiur Rahman* and Mabeya Tabassom
*Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: rahman.matiur@bau.edu.bd*

Abstract
A study was conducted to evaluate the effects of supplementation of an exogenous multi-enzyme in feeds substituting different levels of fish meal (FM) with wheat bran (WB) on growth performance and general health status of *Ompok pabda***.** Four diets were prepared by replacing fish meal at the rate of 25%, 50%, 75% and 0% with wheat bran and considered as feed-1, feed-2, feed-3, and feed-4 (control), respectively. First three diets were supplemented with a commercially available exogenous multi-enzyme (β-xylanase and β-glucanase), Natugrain at the level of 0.2% whereas no enzyme was included to feed-4 (control). Each cistern was stocked with fifty (50) *O. pabda* having initial weight of 2.94±0.21 g and each diet was fed to all groups of fish twice a day at 5% of body weight for four months. Sampling procedure was done twice a month for examining the growth of fish. Liver, stomach and intestine of fish were collected for histomorphometric analysis. In initial sampling periods, the growth parameters were found higher in feed-4 (control) compared to other feeds. But after 120 days of rearing, growth parameters were found significantly ($P<0.5$) higher in fish fed with feed-1, feed-2, and feed-4 compared to feed-3. Significantly ($P<0.05$) higher hepatosomatic index (HSI) and lower digestive somatic index (DSI) were also observed in feeds 1, 2, and 4 compared to feed-3. Considering the above result it recommended that as a source of protein replacement of FM up to 50% with WB is possible without any adverse effect on the growth performance and health condition of the carnivorous fish species, *O. pabda.*

Screening of GIFT Tilapia Broodstock in Bangladesh Using Tightly Sex-linked Marker

Khanam Taslima*, Mohsena Begum and Zannatul Ferdous
*Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: taslimak@bau.edu.bd*

Abstract
Tilapias (family Cichlidae) are the second most important group of finfish in global aquaculture by production volume. This species has been the subject of much research on sex determination due to the problems caused by early maturation and reproduction in culture, and because of the complexity in sex

determination system(s). Different major sex-determining loci have been detected in different strains of Nile tilapia. The 'genetically improved farmed tilapia' (GIFT) stock, developed from multiple Nile tilapia (Oreochromis niloticus) populations, is the key resource for tilapia aquaculture. The main sex-determining loci present in GIFT are unknown. Therefore, the research was designed to screen GIFT tilapia broodstock using tightly sex-linked marker which would be useful for applying marker-assisted selection to produce all male tilapia. Fin samples from 39 male and 21 female GIFT tilapia broodstock were collected from a private tilapia hatchery and were screened using Y-linked Amh marker in linkage group (LG) 23. All the female GIFT tilapia broodstock showed a single 439 bp band as we expect due to their chromosome structure (XX); whereas, all male GIFT tilapia broodstock except 4 showed 233 bp deletion from the Y-chromosome (439 and 206 bp band). The exceptions might be due to the sampling error (phenotypically female but called as male) or minor genetic or environmental effects. Thus, the Y-linked Amh marker in LG23 was found to be strongly associated with the phenotypic sex in GIFT fish. This marker will be useful for potential marker-assisted selection to control sex-ratio in GIFT tilapia to control unwanted reproduction during growout,

Molecular Detection of Genetic Purity of *Labeo rohita* Spawn in Selected Hactheries of Mymensingh District Implicated for Its Muscle Development

Tanzina Ferdusy[1], A. K. Shakur Ahammad[2*] and Shamsul Alam[3]
Department of Fisheries Biology & Genetics, Bangladesh AgriculturalUniversity, Mymensingh-2202, Bangladesh
**E-mail: sahammad09@yahoo.com*

Abstract
Identification of *Labeo rohita* is sometimes very ponderous to differentiate based on traditional morphological feature when usual morphological features are lost. Molecular detection provides an authentic method for identification of individuals at species level and develops stock improvement strategies. The present study aimed at to investigate the level of genetic purity of *Labeo rohita* spawn collected from selected hatcheries of Alamin Matsha hatchary, Deshbondhu Nursery and Fisheries Faculty Field Lab Complex by using cytochrome b sequences of mitochondrial DNA. The forward and reverse primer was designed to amplify the target region of cytochrome b gene. Then the PCR products of this gene were analyzed and sequenced by sanger sequencing method using cytochrome b universal primer. Multiple sequence alignment of the sequence that were found from blast search result and compared with respective gene fragments present in GeneBank database revealed some polymorphic site of all sample species which means all of samples are hybrid. A constructed phylogenetic tree has shown relationship among the *Labeo rohita* species which indicated that there was little or no genetic differentiation among hybrid from different hatcheries but has a diverse difference between pure and hybrid species. This study is intended to provide valuable understanding the genetic variation among the wild and hatchery population of *Labeo rohita* that assist in the management and genetic improvement. It also demonstrated the usefulness of mitochondrial DNA based approach in species identification, Further the genetic information at molecular level generated from this study be helpful in future study of population genetics.

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Studies on the Causes of Gonadal Developmental in Small Size Hilsha: Assessment of the Factors Associated with the Early Gonadal Development of Hilsha

Md. Borhan Uddin Ahmed[1], A. K. Shakur Ahammad[1*], Md. Shahjahan[2], Biraj Kumar Datta[1], Md. Fazla Rabbi[1], Mohammad Ashraful Alam[3], Md. Abul Bashar[3], Md. Ataur Rahman[4], Md. Yeamin Hossain[4], and Yahia Mahmud[3]

[1]Department of Fisheries Biology & Genetics and [2]Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

[3]Bangladesh Fisheries Research Institute, Bangladesh

[4]Department of Fisheries, Faculty of Agriculture, University of Rajshahi

**E-mail: sahammad09@yahoo.com*

Abstract

The assessment of age, growth and maturity provide crucial information on numerous aspects of the population dynamics in fish, which can, in turn, be used to determine a sustainable fishing rate and inform effective resource management practices. However, studies on the age, growth pattern and maturity of *Tenualosa ilisha* (commonly referred to as hilsa) are plagued by a lack of essential information; addressing this data gap is the aim of the present study. Six diverse habitats (the Meghna river estuary, Bay of Bengal, the Kali river, the Tetulia river, the Padma river and the Gaglajur haor) across Bangladesh were chosen as sampling sites for hilsa collection. For age determinations, the lunar rings in the otolith of the hilsa fish that are periodically-deposited in accordance with the lunar cycle were used to reflect 14-day increments of time. The length and weight of each fish were recorded prior to otolith extraction. The resulting otoliths were polished to enable the visualization and quantification of their lunar rings with a high-magnification microscope. Except for the Kali River and Gaglajur Haor samples, the age of the fish correlated strongly with both their length and weight ($r > 0.95$; $p < 0.05$). Again, except for those from the Kali River and Gaglajur Haor, all of the samples exhibited positive allometric growth patterns ($b > 3$) with the fish from the Tetulia River being the most positive ($b = 3.48$). The estimated L_m for *T. ilisha* was as 26.04 (~ 26.00) (95% CL= 19.87-33.84) cm TL based on the maximum length-based model and it was confirmed with histological studies. These results would be effective for sustainable management of hilsa fishery in Bangladesh and neighboring countries.

Study of Polymorphism in Growth Related Genes and Identification of Fast Growing Tilapia (*Oreochromis niloticus*) by Marker Assisted Selection

Most. Sadia Zafrin, Mohd. Golam Quader Khan and Md. Samsul Alam*

*Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh, *E-mail:samsul.alam@bau.edu.bd.*

Abstract

Growth enhancement is a desired phenotype for tilapia in the aquaculture industry. Several growth-related genes have been identified which are involved in cell proliferation and somatic growth, including growth hormone (GH), insulin-like growth factors-2 (IGF-2), prolactin-I (PRL-I) and insulin gene. Polymorphisms in the microsatellite loci located in the growth related genes have been found to show association with variations in growth performance in fish. The objectives of the study was to characterize different stocks of Nile tilapia available in Bangladesh based on the microsatellite markers located within the growth-related genes and to select fast growing tilapia using marker assisted selection for aquaculture industry. Fin samples of 43 *O. niloticus* were collected and genomic DNA was isolated. Five microsatellite loci (GH-MS01, IGFII, IGFII-MS01, IGFII-MS03, STR) were analyzed to analyze the genetic variation in four populations of *O. niloticus* . The alleles were

separated by polyacrylamide gel electrophoresis and visualized by ethidium bromide staining. All the five loci were found to be polymorphic. The average number of alleles, 3.8, was found to be highest in FM sample and was the lowest, 2.8, in the Agro-3 sample. The average observed heterozygosity (H_o) value in the Agro-3 sample was the highest (0.140) and that of the Fisheries Management sample was the lowest (0.040). The average expected heterozygosity (H_e) was highest in the BFRI (0.660) sample and lowest (0.432) Agro-3 sample. The Nei's (1972) genetic distance between Agro-3 and Eon sample was the highest (0.972) while that between Eon and BFRI was the lowest (0.332). We have identified that all the loci analyzed are polymorphic. This information would help group the individuals as per their genotype and used for growth performance trials thus would help identify faster growing genotypes. The future study would be to study association between the genotypes with growth performance of tilapia.

Effects of Dietary Soybean Meal on the Digestive Physiology of Silver barb, *Barbonymus gonionotus*

Zakir Hossain* and Md. Saddam Hossain
*Department of Fisheries Biology and Genetics Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail:zakirh1000@yahoo.com*

Abstract

This study was designed to determine the effect of fishmeal (FM) replacement with soybean meal (SBM) in diet on growth, digestive enzyme activity and gut histomorphology of Silver barb (*Barbonymus gonionotus*). Five diets were formulated where SBM0 contained 100% FM, FM substituted with graded levels of a mix of SBM to replace 25% (SBM25), 50% (SBM50), 75% (SBM75) and 100% (SBM100) of FM. Juvenile silver barbs were randomly divided into five treatment groups having 40 individual each group and fed to visual satiation for 90 days. Diet with SBM was increased significant in body weight gain and specific growth rate in fish compared to the fish fed with SBM100. Fish having the similar weight fed the diets SBM50, SBM75 and SBM100 containing higher level of SBM showed significantly longer intestine compared to SBM0. Villus height of stomach and intestine were significantly greater in the fish fed with the diets SBM0, SBM25 and SBM50 compared to SBM100. Muscular thickness was inversely changed with the increasing villus height. Protease activity was increased significantly in stomach, anterior and posterior intestine of fish fed with SBM0 and SBM25 compared to SBM100. In anterior and posterior segment of intestine, significantly higher lipase activity was observed in fish fed with the diets SBM0 and SBM25 compared to diet SBM100. In stomach, amylase activity was also significantly greater in SBM0 compared to SBM100. These results suggest that the replacement of FM upto 75% with SBM could be possible considering the growth performances, gut health and activities digestive enzymes in *B. gonionotus*.

Improvement of Live Fish Transportation Technique Using Natural and Synthetic Anaesthetizing Agents, Aqueous Clove Seed and MS-222

Mohammad Matiur Rahman* and Nafisa Khatun
*Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: rahman.matiur@bau.edu.bd*

Abstract

The study evaluated the effectiveness of clove seed aqueous extract (CAE) and MS222 as viable anaesthetic agents on *Mystus cavasius* and *Cirrhinus cirrhosus*, respectively during transportation. To select suitable concentration, five adult *M. cavasius*/bowl were exposed in triplicates at 30, 45, 60, 75 and 100 mg/L of CAE. At the dose of 30 mg/L of CAE, *M. cavasius* had no anaesthetic effect and at

60 mg/L fish reached stage II within 378.67±3.51 sec. CAE of 40-55 mg/L showed anaesthetic property to achieve only deep sedation. Induction period of deep sedation using the CAE of 40, 45, 50, and 55 mg/L and the subsequent recovery in freshwater were found 473.00 and 55.67 sec; 402.00 and 54.67 sec; 389.33 and 51.67 sec; and 352.33 and 49.67 sec, respectively. CAE of 55 mg/L was found most suitable for transportation in polythene bag with oxygenation for 9 h. *M. cavasius* were then packed in oxygenated polythene bags containing 7 L water for 12 h at three packing densities, viz., 0.25, 0.50, and 1.00 kg with and without addition of 55 mg/L of CAE. Higher stress level in control bag of *M. cavasius* packed at high densities (1 kg) and 55 mg/L of CAE treated fish showed lowest stress level. This study suggested that application CAE reduced the stress response in *M. cavasius* during transportation and the dose of 55 mg/L of CAE in 7 L water is sufficient to transport 1 kg fish for 12 h which is twice in amount than traditional transportation system. In another study, fingerlings of *C. cirrhosus* were individually exposed to 50, 75, 100, and 125 mg/L of MS-222 to evaluate the anaesthetic efficacy and stages of anaesthesia and recovery behaviour of fish were observed. To determine the minimum lower concentration of MS-222 suitable for transportation, fingerlings of *C. cirrhosus* were placed into each of glass aquaria (50 L) filled with aerated fresh water and containing different concentrations of MS-222 such as 5, 10, 15, and 20 mg/L. The lowest dose of MS-222 suitable for transportation of mrigel fingerling observed was 10 mg/L. Thus MS-222 was found promising to be used as anaesthetic for handling and transportation in mrigel fingerlings.

Smart Production of Biofuel and Bioelectricity Through Culture of Spirulina (*Spirulina platensis*) in Supernatant of Digested Rotten Potato (*Solanum tuberosum*)

M. Ahsan Bin Habib
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: ahsanmphd@yahoo.com

Abstract

An experiment was conducted to evaluate culture and growth performance of spirulina (*Spirulinaplatensis*) in supernatant of three different amount of digested rotten potato (DRP), and Kosaric medium (KM) as control. Three different concentrations such as 20, 40 and 60% of DRP were digested under aeration and the reddish white coloured supernatant was collected. Spirulina was inoculated in supernatant of DRP with the addition of 9.0 g/L $NaHCO_3$ and micronutrients, and KM for a period of 14 days. The cell weight of spirulina was attained a maximum of 12.42 ± 0.21 mg/L in KM followed by 8.35 ± 0.21, 6.26 ± 2.34 and 9.51 ± 0.43 mg/L in supernatant of 40, 20 and 60% DRP, respectively on the 10^{th} day of culture. Similar trend was also observed in the cases of optical density, chlorophyll a, total biomass, specific growth rates, light intensity, temperature, pH, dissolved oxygen, salinity and electric conductivity of spirulina. Cell weight of spirulina grown in these media had highly significant ($p<0.01$) correlation with the chlorophyll a content and total biomass. The growth performance of spirulina grown in supernatant of 60% DRP was significantly higher than that of spirulina grown in supernatant of 20 and 40% DRP. The percentage of crude protein (55.15%) of spirulina grown in supernatant of DRP was little bit lower than that of spirulina cultured in KM (58.70%). The crude lipids (17.15%) of spirulina cultured in supernatant of 60% DRP was almost two and half times higher than that of spirulina grown in KM (6.33%). So biofuel form lipids should be produced high from spirulina cultured in supernatant of 60% DRP. Production of dissolved O_2 and readings of electric conductivity in culture media of spirulina were the indication for production of bioelectricity where dissolved O_2 was produced high on 14th day of culture and the EC and bioelectricity were produced high on 10th day of culture. Large scale production of biofuel from lipids and bioelectricity may be produced from the culture of spirulina in supernatant of digested rotten agro-products. This spirulina may be used to produce fish feed replacing fish meal because spirulina contains protein equal of higher that fish meal.

Effects of Stocking Density of Tilapia (*Oreochromis niloticus*) on Bush Bean (*Vigna unguiculata*) Production in Media Based Aquaponic System

Prosun Roy and M. A. Salam*
*Department of Aquaculture, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: masalambau@gmail.com*

Abstract
The experiment was carried out in "BAU Aquaponics Oasis" Laboratory, Department of Aquaculture, BAU, Mymensingh from 5th July, 2018 to 5th October, 2018 for 93 days to compare the effects of stocking density of tilapia on bush bean (*Vigna unguiculata*, cowpea) production. Four treatments such as- T_1, T_2, T_3 and T_4 were used where 30, 40, 50 and 60 fish/200L water was added respectively with three replications each. Media based aquaponic system was selected comprising of 12 plastic water tanks (300L) for tilapia culture and 12 plastic half drums ($99.5\times57\times21cm^3$) for bush bean cultivation. Six saplings of bush bean were planted in each vegetable bed in two rows. The waste water was pumped from fish tank to vegetable bed from 9 AM to 5 PM with an 18-watt submersible water pump. The fish tank was oxygenated with a 35-watt air pump and air stones. Tilapia was fed with commercial floating feed and their sampling was done fortnightly. Water quality parameters were sampled fortnightly. The highest production of bush bean was 42.76 ±11.72 tons/ha/93 days in T_3 followed by 36.05 ±6.00, 32.60 ±6.36 and 25.00 ±7.07 tons/ha/93 days in T_2, T_1 and T_4, respectively. Whereas, the highest tilapia production was 282.40 ±25.73 tons/ha/93 days in T_4. The highest moisture, crude protein and ash content of bush bean were 84.50 ±0.95, 2.17 ±0.07 and 2.56 ±0.06%, respectively in T_1 and the highest crude lipid 0.90 ±0.03% and crude fiber 6.04 ±0.41% of bush bean was in T_4 Moreover, the highest crude lipid 4.69 ±0.70% and crude fiber 1.28 ±0.05% were in T_3. Most of the physico-chemical water quality parameters were within the acceptable range for tilapia culture. Thus, considering fish and bush bean production, present study figured out that 50 fish/200L (T_3) had higher potential than other treatments for producing bush bean.

Effect of Growth Performance of Nile tilapia (*Oreochromis niloticus*) Fed Diets Containing Moringa Leaf Meal

M. A. Salam
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: masalambau@gmail.com*

Abstract
Aquaculture, the fastest growing industry in the world depends mostly on fish meal based feeds. The price of fish feed is escalating due to decline of natural fish stock and competition of protein sources for human consumption, livestock as well as for aquaculture. Moringa (*Moringa oleifera*) leaf is a potential protein source with adequate amino acids, vitamins, minerals and lots of nutrients. A feeding experiment was carried out to utilize Moringa Leaf Meal (MLM) replacing Fish Meal (FM) in the diets for rohu (*Labeo rohita*) fingerlings to assess its potential on the growth, survival and cost of MLM based fish feed at laboratory condition in the Department of Aquaculture, Faculty of Fisheries, BAU, Mymensingh for 60 days. Three treatments were considered as T_1 (Control-0% MLM replaced by FM), T_2 (10% MLM replaced by FM) and T_3 (20% MLM replaced by FM) with three replications each (R_1, R_2 and R_3). Rohu fingerlings of 11.47(±2.0) g were collected and fed formulated diets in nine plastic drum containing 90 L water/drum. Twenty-five percent water was exchanged daily with underground water and the fingerlings were oxygenated with air tubing and perforated stones. Fingerlings were fed with experimental diets 5% of their body weight at 9 am and 5 pm. Fish sampling

was done at 15 days' interval to observe growth performance of the fingerlings and adjust amount of feed. The water quality parameters were monitored and recorded weekly. After 60 days of rearing 100% survival was achieved in all treatment. The mean length and weight gain of rohu were significantly higher ($p>0.05$) in T_2 and T_3 treatments than T_1. The highest percentage of length and weight gain was achieved with T_2 than T_3 and T_1. Proximate composition of rohu fingerlings showed that crude protein, crude lipid increased but ash and fiber content decreased with the higher inclusion level of MLM. The feed cost was the lowest in T_3, where 20% MLM replaced by FM was used and the highest cost was in T_1 where 0% MLM was used. So it can be concluded that FM replacement with 10% MLM in fish feed is preferable without any adverse effect on the growth performance and welfare of rohu.

Gut Micobiota and Hematological Analysis of Stinging Catfish (*Heteropneustes fossilis)* Cultured under Different Probiotic Supplementation

Gias Uddin Ahmed*, Tanvir Rahman, Rejowana Alam, Md. Abdullah Al Mahamud and Rassidul Hassan

Department of Aquaculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E mail: giasa50@gmail.com*

Abstract

The present study was conducted to evaluate the effects of probiotics on gut microbiota and hematological analysis of the stinging catfish (*Heteropneustes fossilis)* reared under different probiotics supplementation. The experiment was designed with five treatments having three replication ponds, each of 0.75 decimal contained 413 fish and the feeding trials were performed for 90 days. The experimental diets were designed; feed + Soil probiotic (T_1), feed with gut probiotic and starch (T_2), feed with gut, Soil probiotics, water additive and rice starch (T_3), water additive for (T_4) and T_5 control. Gut probiotic added with feed and introduced in the pond twice a day. Water quality parameters were monitored fortnightly. After exposure to probiotics, fish were sacrificed at 0, 30, 45, 60 and 75 day randomly from each treatment. Hemoglobin levels (g/dl) were ranged from 1.90±1.0 to 3.6± 0.28 and highest in T_3 than other treatments. Blood glucose levels were highest in T_3 and lowest in T_1. RBC values were ranged from 0.65±0.25 to 3.55±1.89 and highest in T_4 and the lowest was in T_3. The highest WBC was in T_1 and lowest in T_3. The mean corpuscular hemoglobin (MCH) values were ranged from 6.55±2.0 to 36.55±25.10 in T_2 at 75 day and T_1 at 30 days of experiment. The highest MCH was in T_4 and the lowest in T_2. The highest average bacterial load (1.95×10^6 CFU/ml) was found in gut on TSA media in T_2 while the lowest average load (4.23×10^5 CFU/ml) was found in T_3. The highest bacterial load (8.85×10^4 CFU/ml) was found in gut on MRS media in T_3 while the lowest in (1.52×10^4 CFU/ml) T_2. Incorporation of probiotics modified gut bacteria and hematological parameters of *H. fossilis* and hence, it could be recommended as an eco-friendly health management approach in the catfish farming.

Bacteriological and Physico-chemical Analysis of Disease Affected Freshwater Catfish Ponds

Tanvir Rahman[1*] and Muhammad Mehedi Hasan[2]

*[1]Department of Aquaculture and [2]Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: tanvir.nishi@gmail.com*

Abstract

Studies were conducted to determine the water quality parameters, bacterial load in water and hematology of 15 disease affected catfish ponds located at different upazila under Mymensingh district. Participatory rural appraisal (PRA) technique tools such as personal interview, focus group discussion (FGD) and key informant interview with were done to collect preliminary data. Fish and water samples were collected from diseased catfish *i.e., Pangasianodon hypophthalmus*, *Heteropneoustes fossilis* and *Ompok pabda* ponds and were analyzed in the Fish Disease Laboratory, Faculty of Fisheries, Bangladesh Agricultural University. The microbial loads of pond water were determined by ten-fold serial dilution and cultured in duplicates on Tryptone soya agar (TSA) followed by incubated at 25 °C for 48 h (CFU/mL). Blood samples were analyzed to determine RBC, WBC, hemoglobin, blood glucose level and Mean corpuscular hemoglobin (MCH) of the diseased catfish. Pathogenic bacterial identification was done by conventional biochemical techniques. It was found that the water temperature, pH, dissolve oxygen, total alkalinity and ammonia ranged from 27 to 20.5°C, 8.2 to 7.0, 7 to 5 ppm, 190 to 120 ppm, 0.03 ppm, respectively during the study period. Among 15 ponds the highest and lowest value of temperature was found in *P. hypophthalmus* ponds. The maximum value of alkalinity was observed in *P. hypophthalmus* ponds and minimum was found in *O. pabda* ponds. The ammonia concentration was more or less similar. The highest (2.5×10^5 CFU/mL) and lowest (2.9×10^3 CFU/mL) average bacterial load were found in *H. fossilis* ponds at Tarakanda upazila. The study revealed a maximum number of RBC, WBC and glucose level found in *O. pabda* ponds and minimum in *H. fossilis* and *P. hypophthalmus* ponds. However, significantly higher MCH and hemoglobin was in *P. hypophthalmus* and minimum was observed in *O. pabda*. Nine pathogenic bacterial isolates were collected from epizootic ulcerative syndrome (EUS), hemorrhagic disease and tail and fin rot affected catfish. Biochemical analyses identified pathogenic strains of *Aeromonas hydrophila*, *A. veronii* and *Aeromonas* sp. Most virulent bacteria were screened by the experimental infection of *Bardonymus gonionotus* (5.70 ± 1.20 g). This preliminary study revealed fundamental data on bacterial investigation, hematology and water quality parameters of catfish infection which may contribute towards proper health management of catfish aquaculture in Bangladesh.

Study of Health Management Strategy for Commercial Culturing of High Value Fishes

Md. Ali Reza Faruk*, K.M. Abdul Halim and Tanvir Rahman
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: hasin96@yahoo.com*

Abstract

Culture of high value fishes including gulsa (*Mystus cavasius*), shing (*Heteropneustes fossilis*) and koi (*Anabas testudineus*) is expanding rapidly all over the country because of their high productivity, market demand and profitability. The present study has been continuing to i) understand the constraints of health management of high value fishes, ii) identify and characterize pathogens; and iii) carry out disease treatment trials. Field data were collected through questionnaire interview with 100 commercial fish farmers in Mymensingh and Jessore district. The findings revealed that, the most prevalent clinical signs of diseased fish included ulcerative hemorrhagic lesion, whitish appearance, red spot, ventral and mouth reddening, and fin rot. Disease diagnosis problem was the single most important constraints of health management found in the study areas. Other constraints of health management were associated with the use and application of drugs. A number of bacterial isolates were recovered from diseased fishes and identified as *Aeromonas veronii, Micrococcus luteus* and *Bacillus* sp. through phenotypical, biochemical and molecular studies. The sensitivity of selected bacterial isolates to different antibiotics was carried out using disc diffusion method and varying degree of sensitivity were evident with resistant to some antibiotics. The virulence of isolates was also determined through injecting bacterial suspensions to susceptible fish and most of the isolates were

found virulent. Characterization of the newly recovered bacterial isolates from diseased fish has been continued.

Evaluating Costs and Benefits of Prophylactic Health Products and Novel Alternatives on Intensifying Small-Scale Aquaculture Farmers in Asia (IMAQulate): Effect of Probiotics on the Growth, Gut Microbial Content, Hematology and Histological Changes of Pangasius Ranging from Nursing to Grow-out Stage

Mohammad Mahfujul Haque
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: mmhaque1974@yahoo.com

Abstract

The use of probiotic for disease prevention and improved nutrition in aquaculture is becoming popular due to an increasing demand for environment friendly aquaculture. An experimental study was conducted to assess the effects of in feed probiotic on gut microbial, hematological responsiveness and histological changes of pangasius (*Pangasianodon hypophthalmus*) in nursing to grow-out condition. Nursery stage was divided in two experimental group, treatment (T) and control (C) and fingerling and grow out stage were divided into four experimental group TT, TC, CT and CC. Probiotics was selected as a suitable commercial brand (Sanolife Pro-F) having *Bacillus* strains and a commercial nursery feed (powder form) for nursery and fingerling stage while grow out stage was continued with floating feed. Fish were sampled at the day of 30, 45, 60, 75 and 90 randomly from each treatment and control. Probiotic treated fish gained higher percent weight gain, specific growth rate and survival. Water quality parameters e.g. temperature (ºC), dissolved oxygen (mg/L) and pH were within the acceptable range. At fingerling stage, the highest average gut bacterial load was 2.0×10^6 CFU/mL in TC (in-feed Probiotic then normal feed) and the lowest was 2.6×10^5 CFU/mL in CT (normal feed then in-feed probiotic) in NA agar. The highest average gut bacterial load was 1.02×10^3 in TC and lowest was in 0.76×10^1 CFU/mL CT in MRS agar. At the grow-out stage, the highest average bacterial load in gut was 3.65×10^6 in TT (in-feed probiotic treated condition) and the lowest was 1.3×10^5 CFU/mL in CC (normal feed in control condition) in NA agar. The highest average bacterial load in gut was 3.65×10^6 CFU/mL in TT and the lowest was in 1.3×10^5 CFU/mL in CC in MRS agar. Hemoglobin content (g /dl) 4.05±0.21 was highest in TT and lowest (3.1±0.14) was in CC at the grow-out stage. RBC (cells × 10^6 /mm^3) content (3.97±0.78) was highest in TT at grow-out stage and the lowest (0.59±0.12) was at fingerling stage. At the grow-out, WBC (cells × 10^6 /mm^3) content (189.56±12.0) was highest and the lowest (75.4±17.66) was at the fingerling stage. Remarkable difference in regional distribution and localization along the intestinal length between the treatment and control group of the nursery and grow out stage were found in the intestinal villous height, cellular distribution of goblet cells, and intra-epithelial lymphocytes (IEL). The results from the study suggest that the in-feed probiotics has significant effects on the gut microbiota, hematological parameters and histological changes of fish and therefore, probiotics could be used for promoting growth, controlling diseases, reducing mortality and enhancing eco-friendly production in pangasius aquaculture.

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Novel Molecular Approaches for Advancing Prediction and Mitigation of Disease Outbreaks in Aquaculture for Small Scale Farmers: Water Quality Parameters in Pangasius and Tilapia Aquaculture Ponds

Mohammad Mahfujul Haque
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: mmhaque1974@yahoo.com

Abstract
Aquaculture contributes significantly to world food supplies and food security. Water quality is arguably one of the most critical factors of aquaculture because poor water quality lead to fish stress and risks of fish disease, increased use of chemicals, and ultimately, higher food safety risks for humans and environmental impacts. The essential water quality parameters including temperature, pH and dissolved oxygen (DO) were measured by digital underwater loggers and they have logged data after 10 minutes interval automatically. A total of 12 temperature loggers were installed in 6 pangasius and 6 tilapia ponds, and four pH and DO loggers installed in two pangasius and two tilapia ponds in Muktagacha, Tarakanda and Japalpur Sadar Upazila under Mymensingh and Jamalpur district. The temperature of pangasius and tilapia ponds were 28.64±0.14 °C and 29.51±0.03°C and pH were 7.15±0.01 and 7.50±0.02, respectively indicating favorable condition of aquaculture. The average dissolved oxygen (DO) was moderately higher in tilapia ponds (2.56±0.03 ppm) than pangasius ponds (1.72±0.04 ppm) but remained at below the standard level of animal welfare for farmed fish. A 24-hours day of DO trend was analyzed after downloading the data from the underwater logger. The DO peaked at noon and remained above 5 ppm from 12:00 to 4:00 PM however, it dropped down to zero at midnight to early morning from 2:00 to 6:00 AM. As a result, due to poor DO level from midnight to early morning, the fish are gulping and come to upper layer for taking surface oxygen from the air. The common perception of the farmers is that fish perhaps hungry not gulping for DO and they supply feed in the early morning. As a result, fish cannot take feed at *ad libitum* because of low metabolism rate due to poor oxygen level in the pond water. Thus, a large amount of feed is wasted and decomposed that deteriorates the pond water quality and ultimately increases stress to fish, reduces growth and causes yellow color and off-flavor in flesh.

Upgrading Pangas and Tilapia Value Chains in Bangladesh–BangFish: Understanding the Constraints and Potential of Aquaculture Certification

M. Mahfujul Haque[1*] and Md. Ismail Hossain[2]
*[1]Department of Aquaculture and [2]Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *Email: mmhaque1974@yahoo.com*

Abstract
Individually, pangasius and tilapia are the leading aquaculture species in Bangladesh but their existing farming systems are intertwined with negative environmental impacts; poor scope of value addition in the domestic market because culturally Bangladeshis like fresh fish from wet market; low price and its fluctuation in domestic market; and uncertain profit margin at the farmer level; and no development of export market yet. Therefore, ensuring quality fish production for export trade, adopting standard and certification should be the reality. In upgrading pangasius and tilapia value-chain with respect to

standard and certification adoption/development, the criteria/quality control points on which aquaculture standard and certification generally stands on, are site management (local legal framework), seed production at hatchery, feed management, occupational health and safety, fish welfare, management & husbandry, harvesting, environment & biodiversity management, water use & waste disposal and social criteria. Depending on these quality points, the existing farming practices are being assessed combining with other studies of WP2 under BangFish Project funded by DANIDA. This assessment is being done applying various methodological approaches with the stakeholders of DoF, NGO, processing plants, seafood exporter association etc. The questionnaire surveys with pangasius and tilapia farmers, nursery owners, hatchery owners, commission agents, wholesalers, retailers, input suppliers, feed mill owners, and processing plants owners have been completed. Along with this, laboratory analyses of pond soil, pond water, fish feed and fish flesh have also been done. Using the data, the analytical approach focuses descriptive statistics as per criteria of cultured species (pangasius, tilapia), species combination (mono, poly), farm size (small, medium, large) etc. Based on those criteria, comparative statistical analyses are being carried out to see what category of farms doing better in terms of quality fish production complying with criteria/control points as required by aquaculture standard and certification in the export market.

Status of Biosecurity in Commercial Aquafarms

Md. Ali Reza Faruk*, Kumar Arjun and K.M. Shakil Rana
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: hasin96@yahoo.com*

Abstract
Good biosecurity practices are vital to maintain healthy fish stock in an aqua farm. Biosecurity issues in commercial aqua farms in Bangladesh are not well understood yet and the term is quite new to the farmers. In order to provide baseline information on the status of biosecurity in commercial aqua, questionnaire interview was carried with 100 fish farmers in Mymensingh and Jessore. The status of biosecurity was evaluated through some set criteria like farm protection, management of fish seed, feed, water and sanitation and disinfection systems. The overall biosecurity status of the study areas was quite satisfactory. Most of the farmers used deep tube-well as water in their farms, majority of them dried nets before using, their feed storage condition and monitoring was quite satisfactory. Farmers controlled pest by covering their ponds by polythene bags and nets. Some poor biosecurity measures that were evidenced in the study areas included poor fencing and farm boundary, use of foot bath facilities and use of protective clothing by farm personnel. Only few farms had restriction on visitors. The most common clinical sign of disease in fishes included ventral reddening, fin rot, reddish lesion and ulcerative lesion in the study areas. Farmers never confirmed these disease outbreaks in laboratory. Further studies would focus on biosecurity in commercial fish hatcheries.

Bacteriological and Histopathological Investigation of the Emerging Hemorrhagic Infection of Farmed Gangetic Mystus, Mystus cavasius

Tanvir Rahman
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: tanvir.nishi@gmail.com

Abstract
Studies were conducted to identify the causative agent isolated from Gangetic mystus, Mystus cavasius suffering from a high-mortality outbreak of haemorrhagic bacteraemia in some farms located in Mymensingh district and to check the pathogenic potentiality of the recovered isolate by experimental infection. The bacterium was identified up to genus level using Hi AssortedTM Biochemical Test Kit

and other conventional techniques, and further investigated to determine the growth curve and antibiotic susceptibilities. To determine the virulence, experimental infections were performed using Barbonymus gonionotus, Pangasius sutchi and M. cavasius by intramuscular injection. To find out the association between body weight and susceptibility to infection, another challenge test was performed using various weight groups (3-15 g) of M. cavasius. Tissue samples were collected, fixed in 10% buffered formalin and processed for further histopathological analysis. Results demonstrated that the isolate was Gram-negative rods exhibiting non-wrinkled, smooth and slightly yellowish colony on tryptone soya agar from 8 to 42°C. Biochemical the causative bacterium (Av-1) was Aeromonas sp. having close similarity with Aeromonas veronii and showed variable susceptibilities against different antibiotics but marked resistance to ampicillin. Av-1 was found virulent (LD50 = 2.1 X 106.2) to M. cavasius but less virulent to B. gonionotus and P. sutchi. Moreover, experiment on the influence of fish body weight and susceptibility to infection indicated that M. cavasius weighing less than 15 g were more vulnerable to A. veronii infection. Histopathologically, liver was found more affected by the bacteria followed by skin and muscle, and kidney. This study describes the report of A. veronii that caused mass mortality of cultured M. cavasius in Bangladesh.

Quality Assessment of Available Shrimp Feed for Improving Safe Feed in Khulna Region

Chinmoy Biswas, Md. Fazle Rohani, Zannatul Ferdous and Md. Sazzad Hossain*
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: sazzadbau@gmail.com*

Abstract

The study was conducted to determine the heavy metals (Zn, Cr, Pb, Cd, and As) concentration in 17 fish feed samples collected from different feed companies of Khulna district. The results of the study revealed that the fish feed contained some of the heavy metals in varying proportions. The average Zn concentration in 17 fish feed samples collected from different feed companies were ranges from 52.7313 to 95.2042 mg/kg, in which minimum Zn conc. was found in Aman Feed Grower which was 52.7313mg/kg and maximum Zn conc. was found in Mega Grower Feed which was 95.2042mg/kg. So, the concentration of Zn measured in the fish feed samples was below than the WHO and FAO guideline of 100 mg/kg. The average Cr concentration were ranges from 0.4263to 6.3263 mg/kg, in which minimum Cr conc. was found in Lily Starter Feed which was 0.4263 mg/kg and maximum Cr conc. was found in Agroho Grower Feed which was 6.3263mg/kg. So, the concentration of Cr measured in the fish feed samples was higher than the WHO and FAO guideline of 0.05 mg/kg. Pb, Cd, and As were not found in all fish feed which were collected from different feed companies of Khulna district. The fish feed collected from different feed companies can be contaminated by both natural sources and human activities. The sources of heavy metal in fish feed may be the use of different types of feed additives and food color in feed ingredients, fish feed made from feed ingredients which were contaminated by heavy metal previously, industrial and domestic wastes water discharges, natural geological source etc.

Optimization of Dietary Vitamin Con the Growth and Survival Rate of Monosex Tilapia *Oreochromis niloticus*

Biplob Baroi, Md. Fazle Rohani, Most. Mahmuda, Md. Hamidur Rahman and Md. Sazzad Hossain*
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: sazzadbau@gmail.com*

Abstract

A feeding trial was conducted for 10 weeks (16 September to 25 November, 2018) in 12 experimental cisterns to evaluate the effect of dietary vitamin C on the growth and survival rate of genetically improved farmed tilapia (GIFT). A total of 668 fingerlings of mean initial weight of 5.95 0.7 g were stocked at the same stocking density (35/ m^3). Four different treatments (T_1, T_2, T_3 and T_4) with three replication having different level of vitamin C such as 0 mg vitamin C/kg (Control-T_1), 50 mg vitamin C/kg (T_2), 100 mg vitamin C/kg (T_3) and 150 mg vitamin C/kg (T_4). Feeds were supplied at the rate of 5% for first two weeks, 4% for following two weeks and 3% of the body weight for the rest of the experimental period twice daily in the morning at 9.00 am and in the afternoon at 4.00 pm throughout the study period. Weights and amount of feed supplied was recorded to compute the growth nutrient utilization parameters. At the end of the 70 days study period, the growth performance parameters such as mean final weight (g), weight gain (g), percent weight gain (%), specific growth rate (SGR, %/day) and the best feed utilization in terms of food conversion ratio were best at treatment fed with 150 mg vitamin C/kg. The poorest was found at treatment fed with 0 mg vitamin C/kg. The study suggests that the best growth performance and survival rate of GIFT tilapia can be obtained at 150 mg vitamin C/kg containing feed could be recommended for the improved growth of this species.

Assessment of Heavy Metals in Sediment, Water, Feed and Fish at Different Life Stage of Tilapia in a Selected Fish Farm of Mymensingh District

Md. Hamidur Rahman, Md. Fazle Rohani, Zannatul Ferdous and Md. Sazzad Hossain*
Department of Aquaculture, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: sazzadbau@gmail.com*

Abstract

The study was conducted to determine different heavy metals viz. zinc (Zn), cadmium (Cd), chromium (Cr), lead (Pb) and arsenic (As) concentration in sediment, water, feed and fish at different stages (early, nursery, grower and harvest) of the cultured period of tilapia (*Oreochromis niloticus*) at the Biswas Hatchery and Fishery Agro Ltd. at Trishal, Mymensingh during 14 July to 10 December 2018. Heavy metals were determined by Graphite Furnace Atomic Absorption Spectrometer (GFAAS) in the Interdisciplinary Institute for Food Security (IIFS) Laboratory, Bangladesh Agricultural University, Mymensingh. The average Zn, Cd, Cr, Pb and As concentrations (mg/kg) at starting and the end of the experiment in sediment were 6.5852 and 14.9854, 0.1237 and 0.4530, 0.4734 and 1.3495, 0.6745 and 5.5924, 1.3465 and 1.8996; in water 0.0 and 1.4746, 0.0 and 0.2916, 0.0285 and 0.0327, 0.0656 and 0.0847, 0.0 and 0.0277; in feed 6.9683 and 7.9657, 0.0001 and 0.2373, 0.5338 and 0.6851, 0.0 and 0.0, 0.0 and 0.0; in fish 7.8505 and 18.0859, 0.0 and 0.2507, 0.0 and 0.0196, 0.0 and 0.3612, 0.0 and 0.0154, respectively. The study revealed that Cr concentration at early stage in feed crossed the maximum allowable limit of WHO and FAO, and in sediment, Cr and As surpassed the maximum allowable limit whereas in water and fish all metals were below the allowable limit. At nursery, grower and harvest stages, Cr in feed and in sediment Pb, As and Cr were found above the allowable limit. All metals were below the allowable limit in water and fish in those of three stages. So the result showed that at different stages of culture period water and fish were safe, but sediment and feed were contaminated with few metals. The result revealed that feed and sediment were the main sources of heavy metals in fish which will help the farmers and hatchery owners to produce safe tilapia.

Economical Aspects of Carp and Catfish (*H. fossilis*) Culture Under Species Composition in Relation with Reduced Feeding at BAU Field Lab, Mymensingh

Shahroz Mahean Haque*, Badsha Fahad and Abdul Wahab
Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: shahrozmhaquefm@bau.edu.bau*

Abstract
The experiment was carried out for 120 days during April to August, 2019, at the Fisheries Field Laboratory Complex, Bangladesh Agricultural University, Mymensingh, Bangladesh. The experiment consisted of three treatments each with three replications where fingerlings of Rui (*Labeo rohita*), Silver carp (*Hypophthalmichthys molitrix)* and Catla (*Catla catla*) and Shing (*Heteropneustes fossilis*) were stocked. Experimental ponds were designed as 80/dec Stinging catfish and 40/dec Silver carp in T_1, 80/dec Stinging catfish and 40/dec Rui in T_2 and 80/dec Stinging catfish and 40/dec Catla in T_3 respectively. The aim of this study is to identify the best feasible polyculture mixture (Rui, Catla and Silver carp with Shing) which is economically profitable in response with reduced feeding on body weight of Shing (*H. fossilis*) as Shing was the main culture species. A commercially available pellet feed was given only for shing with same feeding rate in all treatments. The feeding rate was 6%, 5%, 4%, 3% which was consecutively adjusted after each monthly sampling and 3% for the last month of the study period. Feeding frequencies was once a day in all treatments. The average weight gain of shing (*H. fossilis)* and Catla (*Catla catla*) in T_3 (60.21±1.00 g and 3.25.55±3.48 g) was significantly higher ($P<0.05$) than those of T_2 (58.62±0.77 g and 173.04 ±14.49 g) and T_1 (55.75±0.98 g and 183.95±33.58 g) for Rui and Silver carp with Shing respectively. The survival rate was 78.94%, 78.5% and 89.3% for shing and 73.68%, 76.19% and 88.09% for silver carp in T_1, Rui in T_2 and Catla in T_3 respectively. The net production of shing was found in T_3 (1062.96 kg/ha) was significantly higher ($P<0.05$) than those of T_2 (910.70kg/ha) and T_1 (870.26 kg/ha). Net return for Silver carp, Rui and Catla in T_1, T_2 and T_3 respectively was 1340.02±102.52, 1303.42±69.76 and 2835.36±49.32 kg/ha was well. Significantly highest net return (Tk. 563975/ha with benefit cost ratio of 2.99) was achieved from T_3 followed by T_2 (Tk. 340845/ha with benefit cost ratio of 2.66) and T_1 (Tk. 295518/ha with benefit cost ratio of 2.44). The present research findings suggest that reduced feeding practice for Shing (*H. fossilis*) and Catla (*Catla catla*) has positive effect on growth and production of Shing (*H. fossilis*) and the combination is economically viable compared to Rui and Silver carp with Shing.

Clearance of *Escherichia Coli* by Freshwater Pearl Mussel (*Lamellidens marginalis* Lamarck, 1819) in Laboratory Conditions

Md. Firoz Shah[1], Md. Abdullah Al Mamun[1], Muhammad Tofazzal Hossain[2] Mohammad Moniruzzaman[3] and Md. Jasim Uddin[1*]
*[1]Department of Fisheries Management and [2]Department of Microbiology and Hygiene, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, *E-mail: jasimfm@bau.edu.bd*

Abstract
Mussel biofiltration activity plays significant role in improving water quality of the aquatic ecosystems. The presence of *Escherichia coli* in waterbodies can indicate the occurrence of waterborne pathogens and can relate to adversative health consequences during contact recreation. Scientists and environmentalists are seeking for biological remedy to keep *E. coli* concentration of the waterbodies at permissible level. Current research was conducted to investigate the clearance of *E. coli* isolated from

the mussel of the Old Brahmaputra river by three difference size groups of freshwater pearl mussels (*Lamellidens marginals*) in laboratory conditions. Firstly, indigenous *E. coli* was isolated from mussel sample, pure *E. coli* suspension was prepared. Live mussels were also collected from the Old Brahmaputra river, depurated, separated into three size groups and acclimatized for 48 hours. After acclimatization in laboratory condition, three size groups (38.28±2.81 mm, 47.28±1.52 mm, 55.89±2.25 mm) each containing ten mussels were stocked in each aquarium designed for T_2, T_3 and T_4 whereas the other 3 aquaria were stocked only with mussels' shells under T_1. After addition of pure *E. coli* suspension, 3 mL water samples from each aquarium were collected at 1-hour interval for 12 hours for the determination of total *E. coli* count (TEC). A reduction in TEC of 0.15 $\log_{10}$ CFU/mL (29.61%), 0.17 $\log_{10}$ CFU/mL (32.22%) and 0.42 $\log_{10}$ CFU/mL (62.38%) were observed in T_2, T_3 and T_4 respectively after 12 hours of addition while in the control aquarium TEC increased by 1.82 $\log_{10}$ CFU/mL (6512%). Statistical analysis showed that presence of live mussels (T_2, T_3 and T_4) caused significant reduction ($p<0.05$) in TEC over control group (T_1). However, such differences were not significant ($p>0.05$) among the different size groups. It can be concluded that *L. marginalis* is capable of reducing *E. coli* bacteria from the water irrespective of the size groups.

Development of Induced Spawning, Larval Rearing and Cultural Management Techniques of Silon, Silonia Silondia

Md. Idris Miah
Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
E-mail: pdridris952@gmail.com

Abstract

An experiment on development of induced spawning, larval rearing and cultural management techniques of silon, *Silonia silondia* was carried out to determine the optimum dose of PG hormone at the Field Laboratory Complex, Faculty of Fisheries, Agricultural University, Mymensingh during July 2017 to June 2019. A total 120 silon fishes were collected from the Kangsha river located at Jaria-Jhanjail in the Netrokona district on monthly basis from the month of April 2018 to January 2019. Ninety percent fishes were died during transportation and domestication time. During domestication kechki, titpunty, mola and CP feed was used 3 to 5% body weight in the morning10 am in the evening at 5 pm on trial and error basis. Live fishes were carried in Jerrycans half filled with water. Care was taken to change the water intermittently during transpiration. The dead fishes were chilled in ice and transported to the laboratory deep freeze. Length weight, fecundity, gonadosomatic index (GSI), ovadiameter and gonad histology were determined. An investigation on induced breeding of silon was carried out to determine the optimum dose of PG extract at 5 mg per kg body weight in the month of May 2018. No ovulation occurred and the belly was harder. Three MS students was produced from this project.

Toxicity of Neonicotinoid Insecticide Thiamethoxam to Banded Gourami and two Freshwater Zooplanktons

Md. Mohibul Hasan[1], Md. Mahmudul Hasan[1], Shema Biswas[1], Sabikunnahar Kaspia[1], Solaiman Bin Habib[1], Kizar Ahmed Sumon[1], Ramji Kumar Bhandari[2] and Harunur Rashid[1]*
[1]*Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh;* [2]*Department of Biology, University of North Carolina Greensboro, NC, USA,* *E-mail: rashid@bau.edu.bd

Abstract

Pesticides are being widely used in Bangladesh; their remains and residues find way into nearby aquatic habitats through drainage, runoff, spray drift, etc. Thiamethoxam is a neonicotinoid insecticide used widely in Bangladesh to control a broad spectrum of chewing and sucking insect pests on major agricultural crops. In this study, laboratory experiments were conducted to determine 96-hours of median lethal concentration (96-hr LC50) of thiamethoxam to one freshwater fish, banded Gourami (*Tricogaster fasciata*) and two freshwater zooplanktons (*Diaptomus* sp. and *Diaphanosoma* sp.). In addition, behavioral changes of banded Gourami was also studied upon exposure. For LC50 determination, banded Gourami fishes were exposed to 0, 75, 125, 175, 225 and 275 mg/L of thiamethoxam and zooplanktons (*Diaptomus* sp. and *Diaphanosoma* sp.) were exposed to 0, 6.25, 12.5, 25, 37.5, 50, 75 µg/L of thiamethoxam. After 96 hour of exposure the LC50 values of thiamethoxam was determined using Probit analysis. The 96-hr LC50 of banded Gourami, *Diaptomus* sp. and *Diaphanosoma* sp. were determined to be 161.065 mg/L, 13.77µg/L and 4.47µg/L, respectively. Behavioural observations recorded respiratory distress such as gasping for air, loss of swimming balance, discoloration of skin and erratic swimming by banded Gourami exposed to thiamethoxam. The results indicate that thiamethoxam is toxic and fatal to both fish and important zooplankton species living in freshwater, even at low concentrations.

Microplastic Pollution from Surface Waters and Sediments in the South-east Coast of the Bay of Bengal, Bangladesh

Kaniz Fatema[1], Sumaya Mahjabin Moon[1], Turabur Rahman[1], Kazi Shahrukh Elahi[1], Md. Ashraful Islam Sarker[1], Shanur Jahedul Hasan[2], Md. Helal Uddin[1], Kizar Ahmed Sumon[1], Hisayuki Arakawa[3], Ramji Kumar Bhandari[4], Harunur Rashid[1*]

*[1]Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh, Bangladesh; [2]Marine Fisheries and Technology Station, Bangladesh Fisheries Research Institute, Cox's Bazar, Bangladesh; [3]Department of Ocean Sciences, Tokyo University of Marine Science and Technology, Tokyo, Japan; [4]Department of Biology, University of North Carolina Greensboro, Greensboro, NC, USA, *E-mail: rashid@bau.edu.bd*

Abstract

Plastic pollution has become a great concern in this planet. Any plastic particle <5mm in size is known as microplastic. The abundance of microplastics in surface waters and sediments (river and beach sediment) in south-east coast of the Bay of Bengal of Bangladesh were investigated. A 300 µm mesh sized Manta net was used to collect surface water samples from three sites of Moheshkhali channel (Cox's Bazar) and five sites of Karnafully River (Chattagram). Beach sediments were collected from two beaches namely Laboni beach and Crab beach at Cox's Bazar with 50×50 cm quadrates. River sediments were collected from five sites using Ekmen dredge. Highest numbers of microplastics were recorded in water samples near Moheshkhali Island (23333/km^2) and lowest near Sonadia Island (11667/km^2). Laboni beach and Crab beach were recorded with 0-26.4 and 0.4-51.2 microplastics/m^2, respectively. Fragments were dominant in surface water samples from Moheshkhali channel, whereas foams were dominant in Crab beach samples. Fragments and threads were the most abundant microplastics with the range of 140,000-238,334 particles/km^2 in the river water samples along with films, foams and micro-beads. Sediments of Karnaphuli River contained threads, fragments, films and foams, where threads were the most abundant type. Karnaphuli sediments were recorded with 75-225 microplastics/kg. These findings indicate microplastic pollution distributed among coastal waters and sediments of Cox's Bazar and Chattagram with higher pollution in the Karnaphuli River.

Taxonomy, Biodiversity and Seasonal Succession of Noxious Algae in Fish-Ponds and Their Possible Management for Sustainable Aquaculture

Saleha Khan* and Md. Shahjahan
Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: khansaleha64@gmail.com*

Abstract
Harmful algal abundance in ponds and lakes of the country are prevalent round the year with massive blooms in summer. Mortality of fishes, reduced growth, off flavour from decayed algae and bad odour from fish muscle even after cooking are often reported. Considering the above, the occurrence, abundance and seasonal succession of harmful algae in a BAU fish pond and in a farmer's pond were studied in relation to the environmental factors like temperature, pH, transparency, nitrate-nitrogen, phosphate-phosphorus etc. During the monitoring programme, about 41 genera of phytoplankton belonging to Cyanophyceae, Euglenophyceae, Bacillariophyceae, and Chlorophyceae were recorded. Cyanophyceae was found to be the most dominant group. Among Cyanophyceae, the most represented genus was *Microcystis.* Besides this genus, *Anabaena*, *Aphanizomenon*, *Planktothrix, Nostoc, Coelastrum, Cyanodictyon, Snowella, Aphanocapsa, Aphanothece, Chroococcus, Cylindrospermum, Spirulina, Merismopedia* and *Planktolyngbya* were occurred in good numbers. During the study period, surface temperature was found to vary between 18.0 to 31.5^{O}C and pH fluctuated between 6.7 and 8.0. During the non-bloom period, relatively low levels of nitrate-nitrogen and phosphate-phosphorus were observed but during the bloom period, the concentration of nitrate-nitrogen and phosphate-phosphorus was relatively higher. From evidence in hand, nitrate-nitrogen and phosphate-phosphorus seem to be the most important factors for the bloom of harmful algae as the outbreaks of this group of phytoplankton occurred when the concentration of nitrate-nitrogen and phosphate-phosphorus were comparatively higher and decreased markedly accompanied by the decline of these nutrients.

Effects of Photoperiod on Growth and Reproductive Biology of Rohu *Labeo rohita*

Md. Shahjahan
Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: mdshahjahan@bau.edu.bd

Abstract
Among the environmental factors, photoperiod plays an important role in growth and reproduction of fish. This study was conducted to assess the effects of photoperiod on growth and reproductive functions of rohu, *Labeo rohita*. Two experiments were conducted with three different photoperiod treatments, such as 6 hours of light and 18 hours of dark (06L:18D), 12 hours of light and 12 hours of dark (12L:12D), and 18 hours of light and 6 hours of dark (18L:06D), each with three replications. In the first experiment, fingerlings (2.39 ± 0.35 g BW) were exposed in the three photoperiod conditions for 30 days and sampled fishes were sacrificed on 7, 15 and 30 days of exposure to measure growth parameters and major hemato-biochemical parameters (Hemoglobin, Hb; Red blood cell, RBC; White blood cell, WBC and blood glucose). In the second experiment, sexually matured females were exposed in the three photoperiod conditions for 30 days and the sampled fishes were sacrificed on 0, 15 and 30 days of exposure to know GSI and gonadal histology. Final weight gain (g), percent weight

gain and specific growth rate (SGR) were the highest in 12L:12D and the lowest in 18L:06D conditions. Feed conversion ratio (FCR) was the lowest in 12L:12D conditions. In prolonged photoperiod (18L:06D), the Hb and RBC decreased significantly, while WBC and blood glucose level increased significantly during initial days of exposure. The mean GSI values, oocyte diameter and proportions of vitellogenic oocyte were maximum in the fishes of 06L:18D treatment indicating stimulation of vitellogenesis. On the other hand, the same parameters were minimum in the fishes of 18L:06D, revealing the inhibition of vitellogenesis. This study indicates that prolonged photoperiod negatively affect growth and reproductive performances of rohu.

Ecotoxicological Assessment of Sumithion on Plankton Communities by Microcosm Tests

Md. Shahjahan* and Mohammad Shadiqur Rahman
Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: mdshahjahan@bau.edu.bd*

Abstract

In Bangladesh, the organophosphate insecticide fenitrothion is found in different waterbodies and may have potential to contaminate the non-target aquatic organisms. The objectives of the present study were to assess the effects of fenitrothion on certain structural (phytoplankton, zooplankton, macroinvertebrates and periphyton) and functional (organic matter decomposition) endpoints of freshwater ecosystems of Bangladesh in microcosms. Fenitrothion (sumithion 50 EC) was applied in each of the 12 microcosms (PVC tanks having 400 L of dechlorinated tap water) at nominal concentrations of 0, 25, 50 and 100 µg/L at 4-day interval over a period of 4 weeks. Each of the control and treatment was executed in three replicates. Results showed the consistent significant effects for most of the species composition of zooplankton and macroinvertebrates. Univariate analysis showed significant decrease in abundance values ($p < 0.05$) for all identified insects (i.e. *Notonecta* sp., *Gerris* sp., *Ranatra linearis* and Chironomid larvae), because they were negatively affected at all treatments as compared to control for all sampling days during the treatment period (NOEC = < 25 µg/L). No consistent significant effects were observed for most of the phytoplankton taxa and organic matter decomposition and water quality variables. In the present study, we observed several taxa of different endpoints were sensitive to even the lowest concentration of fenitrothion (25 µg/L). Hence, we recommend future acute and chronic studies including more local species when exposed to < 25 µg/L of fenitrothion.

Ecotoxicological Assessment of Fenitrothion on Plankton Communities by Microcosm Tests

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Population Dynamics, Stock Assessment and Management of Rainbow Sardine D*ussumieria acuta* in the Bay of Bengal, Bangladesh

Zoarder Faruque Ahmed* and Mst. Kaniz Fatema
Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: zoarder2000@yahoo.com*

Abstract
Population parameters and maximum sustainable yield of rainbow sardine, *Dussumieria acuta* stock were assessed to build up its sustainable fisheries management regime in the Bay of Bengal. The standard length (SL) and body weight (BW) of 11 monthly samples over the study period ranged from 12.0 to 17.7 cm, and 19.5 to 94.5 g respectively. Growth parameters analysis was done by the direct fit of ELEFAN I model incorporated in FiSAT suite. ELEFAN I analysis of the pooled length frequency data yielded von Bertalanffy growth curve with the following parameters: SL_∞ = 18.38 cm, K = 0.96 $year^{-1}$, C = 0 and WP = 0. The study obtained growth performance of 2.51 and the approximate longevity of 3.13 years. The relationship of pooled data of standard length and body weight was as $BW = 0.087SL^{2.39}$. The von Bertalanffy growth curve fitted with weight-at-age data constructed the equation as $BW_t = 89.64[1- \exp \{-1.03 (t +0.109)\}]^3$. Monthly mean GSI were peak in July and August, which indicated that spawning season of *D. acuta* was during those months. Since mean SL of the smallest length group in pooled data separated by Bhattacharya method is considered SL at recruitment, therefore, *D. acuta* recruited when they were 12.86 cm SL and 1.25 years age to the fishing ground in the Bay of Bengal. Length-based catch curve and life-long approximation of the number of a cohort estimated natural and fishing mortalities and they were 1.47 and 2.97 per year respectively, resulting the exploitation rate of 0.67 during the study period. Finally the study suggested a format of management guide for the sustainable fisheries of the stock involving the present findings as necessary inference.

Hypoxia Retards Gonadal Development of Freshawater Pearl Mussel *Lamellidens marginalis*

Md. Fida Hassan Kafi, Md. Hasibul Islam Rikon, Md. Helal Uddin, Adrita Haque, Kizar Ahmed Sumon, Md. Jasim Uddin and Harunur Rashid*
Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
** E-mail: rashid@bau.edu.bd*

Abstract
Lamellidens marginalis, a bivalve mussel, is commonly known as freshwater pearl mussel. This

biologically important species acts as a bio-filter to maintain water quality parameters through its capability of accumulating aquatic impurities. Moreover, *L. marginalis* is a popular species to produce pearl in freshwater aquaculture systems. On the other hand, low dissolved oxygen (DO; often termed as 'hypoxia') creates oxidative stress to aquatic organisms capable of reducing metabolic activities; thus reduces nutrient supply, growth and hampers gonadal development. The objective of this present study was to assess gonadal development of *L. marginalis* exposed to different oxygen concentrations. Adult *L. marginalis* were reared in aquaria under no addition air supply (T_0, control), one (T_1), two (T_2), three (T_3) or four (T_4) air tone aerator per aquarium supplying DO. DO concentrations were measured at every fifteen-day interval and were recorded to be 0.82±0.05, 1.61±0.06, 3.31±0.07, 5.34±0.04, 5.42±0.06 and 5.44±0.06 mg/L on day-15, -30, -45, -60, -75 and -90, respectively for T_0. For T_1, DO concentrations were recorded to be 7.31±0.37, 7.30±0.26, 7.12±0.19, 7.01±0.40, 7.25±0.18 and 7.22±0.12 mg/L on day-15, -30, -45, -60, -75 and -90, respectively. For T_2, DO concentrations were recorded to be 7.86±0.15, 7.81±0.05, 7.72±0.05, 7.57±0.03, 7.58±0.02 and 7.62±0.03 mg/L on day-15, -30, -45, -60, -75 and -90, respectively. For T_3, DO concentrations were recorded to be 7.90±0.05, 7.93±0.02, 7.81±0.02, 7.46±0.24, 7.75±0.04, 7.76±0.06 mg/L on day-15, -30, -45, -60, -75 and -90, respectively. For T_4, DO concentrations were recorded to be 7.69±0.06, 7.76±0.08, 7.85±0.02, 7.37±0.28, 7.64±0.25 and 7.71±0.13 mg/L on day-15, -30, -45, -60, -75 and -90, respectively. In case of T_0, DO concentrations were <2 mg/L for first 30 days indicating hypoxia, followed by normoxia from day-45. In case of T_1, T_2, T_3 and T_4 DO concentrations were >2 mg/L for 90 days indicating normoxia. On day-15, -30, -45, -60, -75 and -90, DO concentrations in air-stoned aquaria (T_1, T_2, T_3, T_4) were significantly higher than T_0; but there were no significant differences among T_1, T_2, T_3 and T_4. ANOVA results at 5% level of significance indicate that number of air stones in T_1, T_2, T_3 and T_4 did not change DO levels significantly changed during early days of exposure. Visceral masses of exposed *L. marginalis* were collected every 30-day interval for histological analyses and preserved in 10% formalin for fixation. In day-30 histo-sections, oocytes in T_0 were found to be smaller in size, with developing acini and no previtellogenic oocytes were recorded. Previtellogenic oocytes and larger acini were recorded in T_1, T_2, T_3 and T_4 compared to T_0. T_0 ovaries were in early development stages, whereas late development stages were observed in T_1, T_2, T_3 and T_4. In day-60 histo-sections, most of the treatment (T_1, T_2, T_3 and T_4) oocytes were observed to be vitellogenic, with few under-developed oocytes. In day-90 histo-sections, oocytes started to detach from the acini walls, as well as some already started to migrate to germinal duct in case of T_1, T_2, T_3 and T_4. This indicates that ovaries in T_1, T_2, T_3 and T_4 become ripe and were ready to spawn between day-60 and -90. In day-30, secondary spermatocytes were observed in testicular acini in case of T_0, whereas more developed and dense spermatids were evident in T_1, T_2, T_3 and T_4. These results indicate that testes were in late development stages in T_0 and ripe in T_1, T_2, T_3 and T_4. The above results are indicative of the fact that hypoxia (T_0) retarded development of ovary and testes, and on the contrary, relatively faster gonadal developments were observed in normoxia (T_1, T_2, T_3 and T_4 where DO ranges from 7.93±0.02 to 7.01±0.40 mg/L). Findings of the present research confirm the fact that hypoxic conditions are capable of retarding development of reproductive organs of *L. marginalis.*

Ecotoxicological Assessment of Fenitrothion on Plankton Communities by Microcosm Tests

Md. Shahjahan* and Mohammad Shadiqur Rahman
Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: mdshahjahan@bau.edu.bd

Abstract

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were to assess the effects of fenitrothion on certain structural (phytoplankton, zooplankton, macroinvertebrates and periphyton) and functional (organic matter decomposition) endpoints of freshwater ecosystems of Bangladesh in microcosms. Fenitrothion (sumithion 50 EC) was applied in each of the 12 microcosms (PVC tanks having 400 L of dechlorinated tap water) at nominal concentrations of 0, 25, 50 and 100 µg/L at 4-day interval over a period of 4 weeks. Each of the control and treatment was executed in three replicates. Results showed the consistent significant effects for most of the species composition of zooplankton and macroinvertebrates. Univariate analysis showed significant decrease in abundance values ($p < 0.05$) for all identified insects (i.e. *Notonecta* sp., *Gerris* sp., *Ranatra linearis* and Chironomid larvae), because they were negatively affected at all treatments as compared to control for all sampling days during the treatment period (NOEC = < 25 µg/L). No consistent significant effects were observed for most of the phytoplankton taxa and organic matter decomposition and water quality variables. In the present study, we observed several taxa of different endpoints were sensitive to even the lowest concentration of fenitrothion (25 µg/L). Hence, we recommend future acute and chronic studies including more local species when exposed to < 25 µg/L of fenitrothion.

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Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
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Occurrence, Assessment and Management of Japanese Threadfin Bream *Nemipterus japonicus* in the Bay of Bengal

Zoarder Faruque Ahmed* and Mst. Kaniz Fatema
Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh
**E-mail: zoarder@bau.edu.bd*

Abstract

Dealing with about 700 individuals of Japanese threadfin bream, *Nemipterus japonicusus*, a species having enormous commercial importance, collected monthly from the Bay of Bengal revealed that the

standard length (SL) of male and female ranged from 8.5 to 22 and 8 to 21.4 cm, and the body weight (BW) from 17.09 to 276.65 and 14.71 to 300.69 g respectively over a year-long study. Bhattacharya procedure decomposed 4 age-groups on pooled length frequency histogram of each of male, female and unsexed individuals. Since statistics nullified differences between SLs of male and female, and their growth curves (t-test and F-test; $p>0.05$), consequentially present study adopted the growth modelling of unsexed gender. The growth equations provided by three models were as $SL_t = 25.17$ [1- exp {-0.637 (t + 0.014)}] for von Bertalanffy model; $SL_t = 23.4$ exp [-exp {-0.739 (t + 0.863)}] for Gompertz model; and $SL_t = 22.49$ / [1 + exp {-1.025 (t - 1.30)}] for Robertson model respectively, where t is age in years. Growth was best described by the von Bertalanffy equation for the species based on χ^2 values as goodness of fit index among three models. The relationship of pooled data of SL and BW was $BW = 0.035SL^{2.92}$, and the von Bertalanffy equation was fitted as BWt = 431.34 [1- exp {-0.646 (t +0.03)}]^3 in terms of BW (g). The study obtained growth performance 2.61, and the approximate longevity was 4.71 years.

Development of Fish Noodles with Low Cost Silver Carp (*Hypophthalmichthys molitrix*) Meat and Study on Consumer's Preference to It

Fatema Hoque Shikha
Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: shikhafh@bau.edu.bd

Abstract

The study was conducted to prepare natural color and colored fish noodles using silver carp mince with wheat flour to assess quality aspects and consumer's preference to the noodles. Fresh silver carp was brought to the laboratory of the Dept. of Fisheries Technology. After bringing the fish was beheaded, gutted, properly washed. Then the fish was boiled with clean potable water with a little amount of salt and white pepper powder. The boiled muscle was deboned and ground to prepare fish mince. The fish mince was analyzed for proximate composition. Silver carp mince and other ingredients were incorporated into wheat flour with substitution level of 25, 30 and 35% and the noodles were prepared using a noodle maker. The noodles was then oven dried and packed in sealed polythene pack and vacuum sealed packs for further analysis. Cooking quality result showed that- control noodles (prepared without fish muscle) required higher cooking times (3 min for natural colored control noodles and 3.5 min for colored control noodles) than noodles prepared with fish muscle. On the other hand highest percent water absorption was found for the natural color noodles prepared with 35% fish muscle and lowest was found for natural color control noodles. Physicochemical property results showed that- noodles samples stored either in sealed polythene pack or vacuum sealed packs no remarkable changes could be observed in color, flavor and texture even after 305 days of storage. Observation of mold growth on noodles samples showed that until 305 days of storage no mold growth could be found. On the other hand in both packing condition percent moisture content in noodles samples increased with the progress of storage time and rate of moisture increase was little higher in sealed polythene pack samples than vacuum sealed samples. Consumer's acceptance to fish noodles result showed that- most of the respondents scored the product as very good in taste (63.22%), and good in color (60%) flavor (60%). Overall taste (41.33%) also scored as very good. In case of texture 43.33% scored as good and 23.33% scored as average. No respondents scored very bad or bad in respect of any parameter with exception of flavor. Among the respondents 5% scored bad in case of flavor parameter and the mean value of flavor was low (4.26%) among the other sensory parameters. The marketing feasibility of silver carp fish noodles was thoroughly analyzed. Consumers were asked whether they would buy it from the market if available at reasonable and affordable prices. Maximum consumers (85%) responded positively and on the other hand shopkeepers (almost 100%) also respond

very positively. Finally, the consumers were requested to set prices for each 30 g noodles pack. Most of the consumers (44%) said that- the price should be 20 tk for each 30 g noodles pack. On the other hand most of the shopkeepers (50%) agreed with the consumers regarding the unit price. The cost-profit analysis of fish noodles preparation and selling result showed that-the margin of profit was about 36%.

Utilization of Pangas (*Pangasianodon hypophthalmus*) Fish and Fish Industrial Waste: Development of Value Added Fish Products and Quality Assessment of the Products for Human Consumption

Md. Ismail Hossain
Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
E-mail: ihossain.ft@bau.edu.bd)

Abstract

The experiment was conducted to determine the optimal conditions for preparing gelatin from fresh and frozen skin of pangas (*Pangasianodon hypohthalmus*). This study focused on designing a low cost isolation and characterization of gelatin from fish processing industry waste, especially pangas waste. Gelatin preparation method was involved in pre-treatment, extraction and product recovery. Extraction process was carried out with hot water and diluted acid. Recovery treatments included filtration, evaporation and dehydration. Characterization of gelatin included qualitative and quantitative analysis. Results showed that the yield of pangasius gelatin was 20.32% which is higher than other reported gelatin from fish. Pangasius gelatin also indicated physical properties comparable with that of commercial gelatin. In the other step of experiment, attempts were taken to prepare fish glue from pangas skin. Cleaning of fish skin, extraction of glue from skin, purification of glue, concentrating of glue, cooling of glue were done step by step according to standard procedure. Cooled and dried glue was preserved in air tight jars in freezer for further analysis. Data collection and analysis of prepared fish glue from pangas skin is still under process. Activities were also run to prepare fish chips and fish noodles/pasta from the pangas fish muscle collected from fish skeleton after fillet preparation. Fish chips were prepared with pangas muscle along using wheat flour, smashed potato and different spices in the inclusion level of fish muscle 30%, 40% and 50%. Prepared chips were oven dried at 65°C for 4 hours. Properly dried chips were stored in sealed plastic packs and vacuum sealed packs to observe the shelf life. Quality analysis is under process by sensory analysis, biochemical and microbial tests. Data analysis of the obtained results is also in progress. On the other hand fish noodles/ pasta in different shapes were prepared using wheat flour (62.5%, 52.5%, and 42.5%), pangas waste mince (30%, 40%, and 50%) and different ingredients. The prepared noodles/pasta was dried at 60ºC temperature for 4 hours in an electric oven. Cooled noodles/pasta was stored in sealed plastic packs and vacuum-sealed packs to analyze the shelf-life. Here also analytical studies are in progress.

Consumer Risk Assessment of Pesticides in Dry Fish in Bangladesh

A.K M. Nowsad Alam[1], Shamim Ara[1] and Juwena Akter[1] and Md. Delowar Hossain[2]
[1]*Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh and*
[2]*Bangladesh Agricultural Research Institute, Mymensingh, Bangladesh, E-mail: nowsad12@yahoo.com*

Abstract

One of the major problems associated with the dry fish is the indiscriminate use of various pesticides to control pest attack. In field level application during processing, *Nogos, Nuvacron, Endrin, Malathion, Dimacron*, etc. are used, while in storage, granular pesticides like *DDT, Basudin* and

Malathion are preferred. All pesticides are banned for any use in food in Bangladesh, but due to indiscriminate use in dry fish, the residual pesticides have been creating dangerous consequences in consumers' health, including central nervous system disorder to death. In order to combat the challenges, primarily the detection of pesticide residue in dry fish muscles and its associated risks transferred to the consumers have been investigated. The objectives of the research were to study the redidual pesticide contents in major commercial dry fish products obtained from the distribution chains and quantitative risk assessment and risk analysis of the consumers for such dry fish eating. Dry fish samples were collected from the potential sites covering major steps of dry fish distribution channel, *viz.* fish drying yards of Cox's Bazar and Dublarchar of Khulna and wholesale dry fish markets of Chittagong, Dhaka city and Sayedpur of Nilfamari. Five most commonly eaten commercial dry fish products were selected for the determination of pesticide residue and probabilistic risk analyses. These were dry lotia *Herpodon neherius*, dry churi *Trichiurous hamela*, dry Chinese pomphret *Pampus chinensis*, dry katchki *Corica suborna* and dry shol *Channs straita.* Fish consumption data were collected by trained interviewers using a food frequency questionnaire in a face-to-face interview in above locations. Dry fish consumers from three different age groups viz., children (<15 years); adolescent (15-18 years) and adult (>18 years) were taken as interviewee based on variation in daily food intake and body weight. Dry fish consumption was expressed as g/kg body weight/day. Targeted dry fishes were collected from the above locations, samples were prepared and made ready for pesticide residue analyses by GS. All of the mentioned five fresh fishes were also obtained from the wetfish markets of the said locations and dip treatments with selected pesticides were done as suggested in the methodology. After treatment and necessary preparations, the samples were subjected to determination of residual concentration of pesticides of both dip-treated and commercial dry fish samples through gas chromatography (GC) in the laboratory of Bangladesh Agricultural Research Council. Now, with obtained the data, a probabilistic exposure assessment will be conducted using @Risk®7.0 software program for Microsoft Excel 2010 (Palisade Corporation, USA), in which the different dry fish consumption data (kg/kg BW.day^{-1}) and pesticide concentrations (mg/kg) from GC method distributions will be combined into an exposure distribution (mg/kg BW.day^{-1}). Available data of average dry fish consumption (g/day/person) and residual pesticide concentration in dry fish (mg/kg) will be used for exposure analysis and probabilistic risk analyses, like Exposure= {(Concentration of contaminant (mg/kg)×Consumption (kg/day))/(body weight (kg)}, using a Risk Program in Microsoft Excel format (Palisade Corporation, US).

Novel Approach for Development of High Quality Stabilized Mince from Tilapia *(Oreochromis niloticus*) and Pangas (*Pangasianodon hypophthalmus*) to Formulate Secondary Consumer Products

Mousumi Akter and A K M Nowsad Alam*
Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: nowsad12@yahoo.com*

Abstract

To develop stabilized fish mince it is very important to prevent the oxidation during storage. To avoid the negative effect of synthetic antioxidant, various antioxidants from natural sources have been searched. Under this program, the possibility of use of carotenoid from carrot has been under experimentation. Carrot slices were kept in frozen storage at -18ºC and heat treated by blanching at 100 ºC boiling water for 1 min for better release of carotenoids bound by protein and for reduction of water from carrot. To reduce maximum water content, carrot slices were treated with double volume of 2-propanol at refrigeration temperature for 12 hours. About 60% water was removed by this treatment. Carrot slices were heated with four volume of 2-propanol at 60ºC temperature for four hours for extraction of carotene from carrot. Extracted solution was evaporated to obtain carotenoid concentrate.

Carotene content was found to be @ 1.5 ml/100g of carrot. The content of beta-carotene in the petroleum-ether and carotenoid extract solution was determined spectrophotometrically. The absorbency was measured at the wavelength of 450nm using the spectrophotometer. The concentration of beta carotene was found to be 0.665 g/100ml. Carotenoid concentrate has been using in unwashed whole fish mince of pangas to find out the anti-oxidative effect of carotene and to stabilize the whole fish mince during storage.

Production of Crispy Fish Pickle from Pangas (Pangasianodon hypophthalmus) Fish

A K M Nowsad Alam*, Nazmul Hassan and Al- Shahriar
Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: nowsad12@yahoo.com*

Abstract
Pangas (*Pangasianodon hypophthalmus*) catfish is one of the world's fastest growing freshwater species in aquaculture. The fish farmers practicing aquaculture countrywide have reported reduced profit margin of this popular exotic species now a days. Also there is a great scope to increase the fish consumption in the country by developing different types of innovative value added ready-to-eat, ready-to-cook, convenience fish products, demand for which has increased due to social and cultural changes in recent years. Novel crispy fish pickle from the pangas catfish was developed first time through stabilizing the mince with dryoprotectants and natural anti-oxidants and then stored at ambient conditions. In order to produce crispy fish pickles, different mixture of ingredients were used and multi-vitiate heating process were applied. Chemical qualities and nutritive values were determined with the stored product. The products were further evaluated by 9- member trained panelists group using 5-point hedonic scales for taste, flavor, color and consistency as attributes. Results showed that crispy pangas pickle could be stored up to 12 months without losing its fresh flavour and taste.

Production and Quality Assessment of Fish Powder from Pangas (Pangasianodon hypophthalmus) Fish Used in Pangas Soup

A K M Nowsad Alam*, Nazmul Hassan and Al- Shahriar
Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: nowsad12@yahoo.com*

Abstract
Pangas is a relatively fast-growing fish species that has great potential for production and export in Bangladesh. With the aim of supplying ready-to-cook pangas products, like soup or noodles for all classes of consumers, pangas powder was formulated. For pangas powder formulation after necessary treatments, fish was dried and packaged in polythene pouch to store at room temperature. To compare the qualities of pangas soup, two basic powder products, powder from pangas fillet and powder from pangas fillet with skin were prepared. A small pack of 2.0 g pangas powder was used to prepare 1-serving size of soup (250ml) using two types of powders. In case of both pangas fillet and pangas fillet with skin powder, crude protein, lipid, ash and fiber contents were determined. All the proximate composition values were increased in the powder products when compared with fresh fish. Peroxide value in powder from pangas fillet (280C) at '0' month was 2.80±0.10 mEq./kg of oil that reached to 10.30±0.26mEq./kg of oil after 6th month of storage. In case of pangas powder from fillet with skin (280C) it was however, 3.20±0.20 mEq./kg of oil at '0' month that reached to 9.40±0.46 mEq./kg of oil after 6th month of storage. The TVB-N value of powder from pangas fillet at '0' month was

1.28±0.06 mg/100gm and reached to 12.48±0.26 mg/100g after 6th month of storage, while in pangas powder from fillet with skin, it was 1.10±0.04 mg/100gm at '0' month that reached to 10.97±0.21 mg/100g after 6th month of storage. TMA-N value in pangas powder from fillet at '0' month was 0.85±0.01 mg/100g and reached to 3.79±0.01 mg/100g after 6th month of storage. On the other hand, in powder from pangas fillet with skin it was ranged from 0.75±0.01 mg/100g at '0' month to 3.04±0.01 mg/100g after 6th month of storage period. Peroxide, TVB-N and TMA-N values increased progressively throughout the storage period in both the powders. All the sensory attributes were slightly decreased with the progress of storage period but it was within the acceptable limit. Pangas soup prepared from pangas fillet powder were more acceptable by the panelists compared to those prepared from pangas fillet with skin powder.

Production, Bio-chemical and Shelf Life Study of Newly Developed "Ilish Khichuri" from Indian River Shad Ilish (*Tenualosa ilisha*)

A K M Nowsad Alam*, Nazmul Hassan and Al- Shahriar
Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: nowsad12@yahoo.com*

Abstract
Ilish, Tenualosa ilisha (Hamilton, 1822), is a tasty and beneficial fish. The poly-unsaturated fatty acids of ilish, mostly ω-3 fatty acids, reduce the risks of heart disease in human body. However, branched muscular pin bones restrict it from being eaten by a wide variety of consumers like children and modern young, old and disabled or foreigners, who also love tasty ilish. In the new formulations of 'ilish khichuri' a balance was made in the ingredients by treatments and additives for stabilizing lipids and proteins. Frozen-stored stock of standard size (1.0 cm3, 8 g), having similar to ilish tastes and flavours was made from ilish mince. With this frozen ilish stock a 1–serving size of "Ilish khichuri" (250g) was cooked. Before that the stocks were frozen at -40oC for a day and then stored at -20oC for shelf life and quality analysis. A standard recipe for ilish khichuri was developed. The developed stock and cooked khichuri were tasted by a 5 member trained panel in every month using a 5-point hedonic scale of taste, flavor, color, consistency and solubility as attributes. Protein, lipid, ash and fiber contents were found higher in "ilish stock" than fresh ilish fish. Peroxide, TVB-N, TMA-N, TBA and histamine content were found increasing in the stock as the storage time increases but all the studied chemical parameters were within the acceptable limit throughout the storage period. A highly tasty, as perceived by the panelists, was developed by cooking khichuri with the ilish stock. Both protein and lipid contents were substantially improved in khichuri. All the sensory attributes were very appealing and acceptable in both the stock and khichuri.

Identification of Antimicrobial-resistant Genes Associated with Pathogenic Bacteria Isolated from Fish and Fishery Products of Bangladesh

Md. Shaheed Reza*, Jesmin Jaba and Airien Sheikh
Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh
**E-mail: rezams@gmail.com*

Abstract
Antimicrobial resistance is a major concern for public health as it threatens the effective prevention and treatment of infections caused by pathogenic bacteria. As the third largest inland aquaculture producer in the world, the concern is very significant in Bangladesh as the drugs and antibiotics used in

culture systems may be transmitted to human through fish and various fishery products. To improve our understanding of antimicrobial resistance epidemiology in Bangladesh, studies were undertaken to identify antimicrobial resistance through identification of antibiotic-resistant genes associated with pathogenic bacteria isolated from fish and fishery products of the country. A total of 50 fish samples were collected from 5 aquaculture farms of Mymensingh division to isolate *Salmonella* and *Escherichia coli* following the guidelines recommended by FDA and Andrew (1996). As polymerase chain reaction (PCR) is a sensitive and valuable method for detection of virulence genes in pathogenic strains, the screened pathogens were subjected to PCR targeting tetracyclines (tetA, tetB, tetC, tetD, tetE, and tetG), sulfonamides (sul1, sul2, and sul3), chloramphenicol (cat1, cat2, and cat3, cmlA, cmlB, floR) and aminoglycosides (aph(3)11a, aac(3)11a and aac6) for *Salmonella* and shiga toxinogenic (stx) gene, *E. coli* attaching and effacing (eae) gene, heat-labile (lt) enterotoxin (eltB) encoding gene, heat-stable (ST) enterotoxin (estA) encoding gene for *E. coli*. Results were then interpreted by susceptible or resistant percent of isolates to an antimicrobial agent and virulence gene(s) according to standard methods. Out of each of 100 isolates from *Salmonella* and *E. coli* selected for identification of antibiotic resistance genes, tetC was most frequently detected in *Salmonella*, and tetA and tetB in *E. coli*. Other commonly detected genes included sul1 for *Salmonella* and *eae* for *E. coli*. When these isolates were tested for virulence gene(s), we observed that at least one each virulence gene out of 18 for *Salmonella*, and of 5 for *E. coli* were present in the isolates. This study gives an idea about the presence of antibiotic-resistance genes in two important pathogens in Mymensingh region. It is a rapid method, and can be routinely used to investigate these genes in aquaculture systems.