J. Sylhet Agril. Univ. 2(2):195-201, 2015 **ISSN: 2308-1597**

FIELD PERFORMANCES OF DIFFERENT ORGANIC MANURES ON YIELD, YIELD ATTRIBUTES AND NUTRIENT UPTAKE OF BORO RICE CULTIVATED IN OLD BRAHMAPUTRA FLOODPLAIN SOILS OF BANGLADESH

S Bilkis*[1], M R Islam[2], M Jahiruddin[2] and M M Rahaman[2]

[1]*Assistant Registrar, Sylhet Agricultural University, Sylhet, Bangladesh*
[2]*Department of Soil Science, Bangladesh Agricultural University, Mymensingh, Bangladesh*

Abstract

With the concept of "Improvement and sustenance of crop yield and soil fertility through efficient nutrient management with integrated use of manures and fertilizers", the present study was conducted to evaluate the field performances of different types of manures such as cowdung (CD), cowdung slurry (CD slurry), trichocompost (TC), vermicompost (VC), poultry manure (PM) and poultry manure slurry (PM slurry) in Boro rice at Bangladesh Agricultural University (BAU) farm during 2011 - 2012. Cowdung, CD slurry, TC and VC were added to soil at 5 t ha^{-1}, and PM and PM slurry were applied at 3 t ha^{-1}. Addition of manures and fertilizers (IPNS treatments) significantly increased the grain and straw yields of rice and significantly influenced different yield attributes. Nutrient uptake by Boro rice was significantly affected by different treatments. Trichocompost and vermicompost containing treatments produced higher crop yield followed by poultry manure slurry and cowdung slurry. Integrated use of manures and fertilizers gave on an average 8.3% - 33.8% grain yield increase in Boro rice over sole chemical fertilizers treatment.

Keywords: Cowdung slurry, poultry manure slurry, trichocompost, vermicompost, nutrient uptake.

Introduction

Over the last 2 - 3 decades, enormous pressure has been exerted on the land resources of Bangladesh to meet the demand of its vast population (160 million people at present) for food, fiber and fuel. Intensification of agricultural land use which is presently 190% (BBS, 2013) has increased remarkably along with high expansion of modern crop varieties. Among the three types of rice, Boro rice covered about 57% of total rice area which contributed about 43% of the total rice production in Bangladesh (BBS, 2008). Soil fertility depletion is a major constraint for higher crop production in Bangladesh. Increasing cropping intensity, use of modern varieties (HYVs and hybrids), cultivation of high biomass potential crops (e.g. maize), nutrient leaching (due to wetland rice cultivation, monsoon rainfall, sandy textured soils) and unbalanced application of fertilizers, with no or little addition of organic manure have resulted in nutrient mining from Bangladesh soils (Islam, 2008; Rijpma and Jahiruddin, 2004). Higher is the crop yield, higher is the nutrient removal from soil. Thus, with advancement of time, soil fertility has declined chronologically. N, P, K, S, Zn and B deficiency have arisen in this country's soils (Islam, 2008; Jahiruddin and Satter, 2010). Unbalanced use of chemical fertilizers has affected soil health, causing a substantial decrease in soil organic carbon (Rahman *et al*. 2008). About 45% of net cultivable areas of Bangladesh have less than 1% organic matter (FRG, 2012). The organic matter content of this country's soil has depleted by 5 to 36% during the period of 1967 - 1995 (Ali *et al.*, 1997). Use of organic manure to meet the nutrient requirements of crop would be an inevitable practice in the years to come for sustainable agriculture since organic manure not only improves the soil physical, chemical and biological properties (Heitkamp *et al.,* 2011), but also enhance productivity and crop quality (Premsekhar and Rajashree, 2009). Many researchers have reported the importance of organic manure as a source of nutrients and a means of soil rejuvenation (Ghuman and Sur, 2006; Adeleye *et al*., 2010; Kumar *et al*., 2012; Jeptoo *et al*., 2013). Organic matter acts as a reservoir of plant nutrients, chiefly N, P and S and it improves physical, chemical and biological properties of soil (Brady and Weil, 2012).

***Corresponding author: S Bilkis,** *Assistant Registrar, Sylhet Agricultural University, Sylhet, Bangladesh. Email: sbilkis26@gmail.com*

Maintenance of soil fertility is important for obtaining higher and sustainable yield due to large turnover of nutrient in the soil-plant system. Integrated nutrient management (INM) is very important considering residual effect of the manure. The present study was initiated to develop an ecofriendly integrated use of organic and inorganic fertilizers for sustainable crop productivity and soil fertility.

Materials and Methods

Experimental site and initial soil characters of the location: The experiment was conducted at the Soil Science Field Laboratory of Bangladesh Agricultural University (BAU), Mymensingh for the years 2011 - 12. The experimental site was situated at 24.75^0 N Latitude, 90.5^0 E Longitude. The site is about 18 m above the mean sea level and has a subtropical climate, which is influenced by the southwestern monsoon. The average annual rainfall is 2000mm with more than 80% of it occured from mid June to the end of the September. The soil belongs to Sonatala series under the AEZ-9 (Old Brahmaputra Floodplain) (UNDP and FAO, 1988). The soil was silty clay loam in texture having pH 6.14, organic matter content 2.35%, total N 1.0 mg g^{-1}, available P 3.61 ppm, exchangeable K 0.12 me%, available S 12.6 ppm and CEC 12.5 me%. BRRI dhan29 was used as the study crop for Boro rice. The experiment was laid out in a randomized complete block design with three replications.

Treatments: The manures used in the experiments were cowdung (CD), cowdung slurry (CD slurry), poultry manure (PM), poultry manure slurry (PM slurry) trichocompost (TC) and vermicompost (VC). Each manure was used with chemical fertilizers (CF) on Integrated Plant Nutrition System (IPNS) and high yield goal (HYG) basis with 8 treatments (Table 1). The doses of N, P, K, S and Zn were 150, 20, 60, 20 and 03 kg ha^{-1} and the fertilizer doses were calculated as outlined in the Fertilizer Recommendation Guide (FRG, 2005). Total amount of P, K and S fertilizers was applied as basal during final land preparation and urea was applied in 3(three) equal splits. Zn and B was applied in 3 equal splits. Rotten cowdung, decomposed poultry manure and compost were applied 7(seven) days before transplanting.

Table 1. Treatment combinations of organic manure and chemical fertilizers.

Treatment name	Treatment combinations
T_1	Control (no manure or fertilizer)
T_2	HYG based 100% chemical fertilizer (CF)
T_3	CD + CF (IPNS basis)
T_4:	CD slurry + CF (IPNS basis)
T_5	PM + CF (IPNS basis)
T_6	PM slurry + CF (IPNS basis)
T_7	TC + CF (IPNS basis)
T_8	VC + CF (IPNS basis)

Sowing, planting and harvesting details:

Seedling age	: 50 days	**Seedling rate**	: 3 seedlings $hill^{-1}$
Planting date	: Jan. 24 2012	**Harvesting date**	: May 20 2012
Plant spacing	: 20cm × 20cm	**Crop duration**	: (115+50) days

Intercultural operations: Three weedings at 15, 25 and 55 days after transplanting were made to keep the field weed free. Irrigation was done whenever required. Granular insecticide “Vitafuran” was applied to the field during urea fertilizer application to control stem borer.

Data collection: At maturity, the crop was harvested and the different data were recorded. Grain yield was recorded at 14% moisture basis and straw yield at sun dry basis.

Plant sampling and chemical analysis: The grain and straw samples were collected, dried, ground for analyzed for N, P, K, S contents following standard methods. For N determination, H_2SO_4 digestion was followed (Page *et al.*, 1982) and for other nutrients HNO_3-$HClO_4$ digestion was done. Phosphorus was determined colorimetrically using molybdovanadate solution yellow colour method (Yoshida *et al.,* 1976) and the S concentration by turbidity method (Chapman and Pratt, 1964). The K concentration in the acid digest was determined directly by flame photometer (Yoshida *et al.* 1976). Then the nutrient uptake was calculated with the following equations:

$$\text{Uptake} = \text{Yield} \times \text{Concentration}$$

Statistical analysis: Statistical analysis of the data on crop characters and plant analysis was done using computer based statistical program Mstat-C (Michigan State University, East Lansing, MI, USA) following the basic principles stated by Gomez and Gomez (1984). Significant effects of treatments were determined by analysis of variance (ANOVA) and the mean comparisons of the treatments at 5% level of significance were evaluated by Duncan's Multiple Range Test (DMRT). Microsoft EXCEL package (Microsoft Corporation, Pullman, WA, USA) was used for correlation and regression analysis.

Results and Discussion

Effects on yield attributes and yield of Boro rice: Effects of different treatments on the growth and yield parameters viz. plant height, tillers plant^{-1}, panicle length, grains panicle^{-1} and 1000-grain weight are described below.

Plant height: Significant variation was recorded for plant height of Boro rice (cv. BRRI dhan29) due to application of different manure and chemical fertilizers (Table 2). The plant height ranged from 78.6 cm to 101.5 cm across the treatments. The tallest plant (101.5 cm) was observed in trichocompost + CF (T_7) treatment which was statistically similar with T_5, T_6 and T_8 and the shortest plant (78.6 cm) was found in the control (T_1).

Tillers hill^{-1}: The number of tillers hill^{-1} showed significant variation due to different treatments used (Table 2). The highest number of tillers hill^{-1} (14.8) was found in T_7 treatment. Treatment T_7 was statistically similar with T_3, T_4, T_5, T_6, T_8 treatment in producing tillers hill^{-1}. T_7 treatment and all other treatments except control showed statistically similar result. The lowest number of tillers hill^{-1} was produced by the T_1 (control) treatment.

Table 2. Effects of integrated use of manures and fertilizers on plant height, tiller plant^{-1}, panicle length, grains panicle^{-1} and 1000-grain weight of Boro rice (BRRI dhan 29).

Treatments	Plant height (cm)	Tillers hill^{-1} (no.)	Panicle length (cm)	Grains panicle^{-1} (no)	1000-grain weight (g)
T_1: Control	78.6d	8.8c	20.6b	87.83c	19.15b
T_2: HYG - CF	94.7c	13.0b	23.7a	129.5b	20.72a
T_3: CD + CF	94.1c	13.4ab	23.7a	135.3ab	20.70a
T_4:CD slurry + CF	96.1bc	14.3ab	24.3a	137.9ab	21.08a
T_5: PM + CF	100.1ab	14.8a	23.1a	137.5ab	21.08a
T_6:PM slurry + CF	96.9abc	14.7a	23.8a	139.2ab	21.03a
T_7: TC + CF	101.5a	14.8a	24.3a	144.7a	21.17a
T_8: VC + CF	98.6abc	14.8a	24.1a	141.0ab	21.07a
CV (%)	2.80	6.23	3.36	5.25	2.36
Significant level	**	**	**	**	**
SE (±)	1.536	0.519	0.454	3.991	0.157

*T_3-T_8 IPNS basis treatments; Means followed by same letters in a column are not significantly different at 5 % level by DMRT; SE (±) = Standard error of means, CV = Coefficient of variation,** = Significant at 1% level; HYG = High Yield Goal, CF = Chemical Fertilizer, IPNS = Integrated Plant Nutrition System; CD = Cowdung, CD slurry = Cowdung slurry, PM = Poultry manure, PM slurry = Poultry manure slurry; TC = Trichocompost, VC = Vermicompost*

Panicle length: Panicle length of rice was not significantly influenced by the different treatments (Table 2). The panicle length varied from 20.6 to 24.3 cm over the treatments. The highest panicle length was recorded from CD slurry and it was statistically similar with other treatments except control.

Grains panicle^{-1}: The number of grains panicle^{-1} varied significantly with different treatments (Table 2). It ranged from 87.8 to 144.7 across the treatments. The maximum number of grains panicle^{-1} (144.7) was recorded from T_7 treatment (trichocompost + CF). The second highest number of grains panicle^{-1} (107.8) was obtained from T_5 (PM + CF) treatment. However, cowdung, cowdung slurry, poultry manure, poultry manure slurry and vermicompost produced statistically similar number of grains panicle^{-1}.

Thousand grain weight: The 1000-grain weight of rice was significantly influenced by different treatments. The highest 1000- grain weight was recorded by T_7 which was statistically similar with all other treatments except the control (Table 2).

Grain yield: The grain yield of Boro rice was significantly influenced by different treatments ranged from 2.61 t ha^{-1} - 6.44 t ha^{-1} (Table 3). The highest grain yield (6.44 t ha^{-1}) was obtained from T_7 treatment (trichocompost + CF) which was statistically similar with T_4 (6.10 t ha^{-1}), T_5 (6.20 t ha^{-1}), T_6 (6.30 t ha^{-1}) and T_8 (6.34 t ha^{-1}). All the manure treated plots produced higher yield compared to absolute chemical fertilizer (T_2) and control. The control treatment (T_1) produced the lowest grain yield.

Straw yield: Like grain yield, the straw yield of Boro rice was markedly influenced by different treatments (Table 3). The highest straw yield (6.79 t ha^{-1}) was obtained from T_7 treatment (trichocompost + CF) which was statistically similar with T2, T_4 (CD slurry + CF), T_5 (PM + CF), T_6 (PM slurry + CF) and T_8 (VC + CF) treatments. The lowest straw yield (2.93 t ha^{-1}) was recorded in control (T_1). There was a good correlation between grain and straw yields of Boro rice (r = 0.988).

Table 3. Effects of integrated use of manure and fertilizers on the grain and straw yields of Boro rice (BRRI dhan 29).

Treatments	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1: Control	2.61c	2.93c
T_2: HYG - CF	5.44b	6.09ab
T_3: CD + CF	5.49b	6.04b
T_4: CD slurry + CF	6.10ab	6.21ab
T_5: PM + CF	6.20a	6.71ab
T_6: PM slurry + CF	6.30a	6.43ab
T_7: TC + CF	6.44a	6.79a
T_8: VC + CF	6.34a	6.63ab
CV (%)	6.78	9.0
Significant level	**	**
SE (±)	0.220	0.323

*T_3-T_8 IPNS basis treatments; Means followed by same letter in a column are not significantly different at 5 % level by DMRT; SE (±) = Standard error of means, CV = Coefficient of variation; ** = Significant at 1% level*

Combination of inorganic fertilizers and organic manure (called IPNS) produced significantly higher grain and straw yields compared to the sole 100% chemical fertilizer used. Addition of organic manure with chemical fertilizers is therefore needed to sustain the yield through increased nutrients' availability and nutrient use efficiency. Trichocompost recorded the highest yield because of their higher nutrient concentration, disease resistency, enzymatic activity and hormones containing ability. Vermicompost, poultry manure slurry and poultry manure treatments also produced better yield, as because it supplied organic C to soil on one way and some growth hormones and concentrates feed to poultry birds increased the growth of plants on the other way. Ullah *et al.* (2008) noted that the treatment where poultry slurry was used showed higher yield of different crops (tomato, cabbage, cauliflower, potato, maize, boro rice and wheat). The poultry manure treatment produced higher yield compared to cattle manure treatment. Between slurry and original manure, the slurry treatment produced statistically higher yield. This result showed a positive contribution of manure to soil health and hence crop yield.

The other plant parameters such as plant height, tillers hill^{-1}, panicle length, grains panicle^{-1} and 1000-grain weight showed a positive significant relation with the grain yield of Boro rice. This study is an indicative that manure -

fertilizer combination has played a good role in plant growth and yield of rice which agrees with the previous work (Hoque, 2014; Najar and Khan, 2013; Nath *et al.*, 2011).

The highest grain and straw yields were found in the trichocompost treatment. The second highest yield was recorded by vermicompost treatment. Poultry manure slurry and poultry manure had better performances compared to cowdung, cowdung slurry and 100% chemical fertilizer treatment. It is clearly exhibited that the treatment T_7 (trichocompost+ CF)) produced remarkably higher yield over 100% fertilizer treatment (T_2), with the results of 21.1% higher grain yield of Boro rice.

Effect on Nutrient uptake: The nutrient uptake was calculated from the yield and nutrient concentration (Table 4).

Nitrogen uptake: The N uptake by Boro rice was significantly affected by different treatments (Table 4). The N uptake (grain + straw) ranged from 43.26 kg ha^{-1} – 145.8 kg ha^{-1} across the treatments. The highest N uptake (145.8 kg ha^{-1}) was recorded by T_7 (TC+CF) treatment. Cowdung, cowdung slurry, PM, PM slurry and vermicompost receiving treatments showed higher N uptake in comparison with absolute chemical fertilizer (T_2) and control (T_1) treatment.

Potassium uptake: The K uptake values ranged from 42.28 kg ha^{-1} - 121.8 kg ha^{-1} (Table 4). The highest K uptake (121.8 kg ha^{-1}) was recorded in T_7 treatment which was statistically similar to the T_8 (120.7 kg ha^{-1}) and T_5 (116.8 kg ha^{-1}) treatments. The lowest K uptake was noted in the control.

Table 4. Effects of integrated use of manure and fertilizers on the N, K, P and S uptake by Boro rice (BRRI dhan 29) in the rice-fallow-rice cropping pattern.

Treatments	N uptake (kg ha^{-1})	K uptake (kg ha^{-1})	P uptake (kg ha^{-1})	S uptake (kg ha^{-1})
T_1: Control	43.26d	42.28d	4.96d	2.77e
T_2: HYG - CF	103.2c	105.2bc	13.99b	9.64cd
T_3: CD + CF	99.04c	103.9bc	11.93c	9.51d
T_4: CD slurry + CF	121.7b	100.4c	13.74bc	9.56d
T_5: PM + CF	129.3b	116.8a	18.39a	11.12ab
T_6: PM slurry + CF	129.3b	114.0ab	16.72a	10.12bcd
T_7: TC + CF	145.8a	121.8a	18.66a	12.08a
T_8: VC + CF	130.6b	120.7a	17.15a	11.03abc
CV (%)	5.59	6.08	7.65	8.04
Significant level	**	**	**	**
SE (±)	3.638	3.618	0.638	0.440

*T_3-T_8 IPNS basis treatments; Means followed by same letter in a column are not significantly different at 5 % level by DMRT; SE (±) = Standard error of means, CV = Coefficient of variation; ** = Significant at 1% level; HYG = High Yield Goal, CF = Chemical Fertilizer, IPNS = Integrated Plant Nutrition System, CD = Cowdung, CD slurry = Cowdung slurry, PM = Poultry manure, PM slurry = Poultry manure slurry, TC = Trichocompost, VC = Vermicompost*

Phosphorus uptake: There was significant effect of the treatments on the P uptake by rice crop (Table 4). The P uptake varied from 4.96 kg ha^{-1} - 18.66 kg ha^{-1}. The T_7 resulted in the highest P uptake (18.66 kg ha^{-1}) which was statistically similar with T_5, T_6 and T_8 treatments. All other manure treated plots except CD showed higher P uptake as compared to T_2 (CF) treatment.

Sulphur uptake: Application of manure and fertilizer significantly influenced the S uptake by Boro rice in (Table 4). The S uptake values ranged from 2.77 kg ha^{-1} – 12.08 kg ha^{-1} across the treatments. The highest S uptake was noted in T_7 (12.08 kg ha^{-1}) which was similar with T_5 and T_8 treatments. The T_1 showed the lowest S uptake as compared to T_2 and other treatments. Generally, manure treated plots displayed better performances over sole chemical fertilizers treated plot.

All the treatments viz. trichocompost, vermicompost, poultry manure, cowdung, their slurry and exclusive fertilizer had significant influence on the nutrient uptake by straw and grain. In all cases, the lowest amounts of N, P, K, and S uptake were observed in the control. It was recognized that organic manure releases nutrients slowly and it is reflected on the nutrient concentration as well as nutrient uptake. Similar observation was made by others in the past (Saidu *et al.*, 2012, Ayoola and Makinde, 2007). Tricochompost, vermicompost, poultry manure and poultry manure slurry had comparable higher N, P, K and S uptake compared to the other treatments. Better performance of poultry manure in terms of NPK uptake was also reported by Kader *et al*. (2010). The increased uptake of nutrients due to NPKS fertilization and organic manure application was due to addition of nutrients and proliferous root system developed under balanced nutrient application resulting in better absorption of water and nutrients along with improved physical environment (Pathak *et al.,* 2005; Laxminarayana, 2006; Kler and Walia, 2006).

Integrated use of organic manures and chemical fertilizers reduce the rate of chemical fertilizers which showed significant effects on the yield attributes and yield of rice as well as nutrient uptake. The present study thus indicates that use of manure, especially trichocompost, vermicompost, poultry manure slurry and cowdung slurry integrated with chemical fertilizers, can help to improve crop yield. Among the manures used, trichocompost and vermicompost produced higher yield of Boro rice.

References

Adeleye E O, Ayeni L S and Ojeniyi S O. 2010. Effect of poultry manure on soil physico-chemical properties, leaf nutrients content and yield of yam (*Discorea rotundata*) on Alfisol in South Western Nigeria. J. Anim. Sci. 6(10):871-878.

Ali M M, Saheed S M and Kubota D. 1997. Soil degradation during the period 1967-1995 in Bangladesh. I. Carbon and nitrogen. Soil Sci. Plant Nutri. 43(4):863-878.

Ayoola O T and Makinde E A. 2007. Fertilizer treatment effects on performance of cassava under two planting patterns in a cassava- based cropping system in South - West Nigeria. Res. J. Agril. Biol. Sci. 3(1):13-20.

BBS (Bangladesh Bureau of Statistics). 2008. The Year Book of Agricultural Statistics of Bangladesh. Statistics Division, Ministry of Planning, Govt. Peoples Repub. Bangladesh, Dhaka, Bangladesh. 71p.

BBS (Bangladesh Bureau of Statistics). 2013.The Year Book of Agricultural Statistics of Bangladesh. Statistics Division, Ministry of Planning, Govt. Peoples Repub. Bangladesh, Dhaka, Bangladesh.

Brady N C and Weil R C. 2012. The Nature and Properties of Soils. 14^{th} Edn (Revised). Published by Dorling Kin Dersley (India) Pvt. Ltd., licensees of Pearson Education in Asia, India. pp. 513-517.

Chapman C A and Pratt P F. 1964. Methods of Analysis for Soil, Plant and Water. Div. Agric. Sci.,University of California, USA.

FRG (Fertilizer Recommendation Guide). 2005. Bangladesh Agricultural Research Council (BARC), Dhaka, Bangladesh.

FRG (Fertilizer Recommendation Guide). 2012. Bangladesh Agricultural Research Council (BARC), Dhaka, Bangladesh.

Ghuman B S and Sur H S. 2006. Effect of manuring on soil properties and yield of rain fed wheat. J. Indian. Soc. Soil Sci. 54(1):6-11.

Gomez K A and Gomez A A. 1984. Statistical Procedures for Agricultural Research, John Wiley and Sons, New York.

Haque M A. 2014. Mineralization of bioslurry and its integrated use with fertilizers in the rice based cropping systems. PhD thesis, Department of Soil Science, Bangladesh Agricultural University, Mymensingh, Bangladesh.

Heitkamp F, Raupp J and Ludwig B. 2011. Soil organic matter pools and crop yields as affected by the rate of farmyard manure and use of biodynamic preparations in a sandy soil. Org. Agric. 1:111-124.

Islam M S. 2008. Soil fertility history, present status and future scenario in Bangladesh. Bangladesh J Agril and Envir. (Special issue) 4**:**129-152.

Jahiruddin M and Satter M A. 2010: Research priority in agriculture and development of vision document-2030 and beyond. Land and soil resource management. Bangladesh Agricultural Research Council. Dhaka.

Jeptoo A, Aguyoh J N and Saidi M. 2013. Improving Carrot Yield and Quality through the Use of Bio-Slurry Manure. Sust. Agric. Res. 2(1**)**:164-172.

Kader M A, Sleutel S, Begum S A, Moslehuddin A Z M and Neve S D. 2013. Nitrogen mineralization in sub-tropical paddy soils in relation to soil mineralogy, management, pH, carbon, nitrogen and iron contents. Eur. J. Soil Sci. 64:47–57.

Kler D S and Walia S S. 2006. Organic, integrated and chemical farming in wheat under maize-wheat cropping system. Indian J. Agron. 51:6-9.

Kumar M, Baishaya L K, Ghosh D C, Gupta V K, Dubey S K, Das A and Patel D P. 2012. Productivity and soil health of potato (*Solanum tuberosum* L.) field as influenced by organic manures, inorganic fertilizers and biofertilizers under high altitudes of Eastern Himalayas. J. Agri. Sci. 4(5)**:**223-234.

Laxminarayana K. 2006. Effect of integrated use of inorganic and organic manures on soil properties, yields and nutrient uptake of rice in Ultisols of Mizoram. J. Indian Soc. Soil Sci. 54:120-123.

Najar I A and Khan A B. 2013. Management of fresh water weeds (macrophytes) by vermicomposting using *Eisenia fetida*. Environ. Sci. Pollut. Res. DOI: 10.1007/s11356-013-1687-9.

Nath G, Singh D K and Singh K. 2011. Productivity enhancement and nematode management through vermicompost and biopesticides in brinjal (*Solanum melongena* L.). World. Appl. Sci. J. 12(4):404-412.

Page A L, Miller R H and Keeney D R. 1982. Methods of Soil Analysis. American Society of Agronomy, Inc. and Soil Science Society of America, Inc. Madison, Wisconsin.

Pathak S K, Singh S B, Jha R N and Sharma R P. 2005. Effect of nutrient management on nutrient uptake and changes in soil fertility in maize-wheat cropping system. Indian J. Agron. 50:269-273.

Premsekhar M and Rajashree V. 2009. Influence Organic Manures on Growth, Yield and Quality of Okra. American.-Eurosian J. Sust. Agri. 3(1):6-8.

Rahman S M E, Islam M A, Rahman M M and Oh D H. 2008. Effect of cattle slurry on growth, biomass yield and chemical composition of maize fodder. Asian-Austr. J. Am. Sci. 21:1592-1598.

Rijpma J and Jahiruddin M. 2004. Strategy and Plan for use of soil nutrient balance in Bangladesh. Final Report of Short-term Assignment. SFFP/DANIDA.

Saidu A, Abayomi, Yakeen A, Aduloju and Morolake O. 2012. Evaluation of complementry use of organic and inorganic fertilizers on the performance of upland rice (Oryza sativa L.). Int. J. Adv. Bio. Res. 2(3):487-491.

Ullah M M, Sen R, Hasan M K, Isalm M B and Khan M S. 2008. Project report on bio-slurry management and its effect on soil fertility and crop production, Bangladesh Agricultural Research Institute. Gazipur.

Yoshida S, Forno A D, Cock J A and Gomez K A. 1976. Physiological Studies of Rice. 2nd Eds. Int. Rice Research Institute, Manila, Philippines.