ACADEMIC INN INTERNATIONAL

ISSN NO : 2523-1189

Journal of Agricultural and Rural Research

open access

EFFECT OF BORON AND POULTRY MANURE ON SOIL FERTILITY AND YIELD PERFORMANCE OF WHEAT (BARI GOM 25)

S.C. Barma, A.K.M.M Hossain, M.C.D. Sharmma, and S.K. Pramanik

To cite the article: S.C. Barma, A.K.M.M., Hossain, M.C.D., Sharmma and S.K. Pramanik (2019), effect of boron and poultry manure on soil fertility and yield performance of wheat (BARI gom 25), *Journal of Agricultural and Rural Research*, 3(2): 69-77.

Link to this article:
http://aiipub.com/journals/jarr-190612-010077/

Article QR

Journal QR

EFFECT OF BORON AND POULTRY MANURE ON SOIL FERTILITY AND YIELD PERFORMANCE OF WHEAT (BARI GOM 25)

*S.C. Barma[1], A.K.M.M Hossain[2], M.C.D. Sharmma[3] and S.K. Pramanik[4]**
**Corresponding author E-mail: pramaniksk100@gmail.com*

ARTICLE INFO

Article Type: Research
Received: 12, June. 2019.
Accepted: 10, July. 2019.
Published: 11, July. 2019.

***Keywords**:*
Boron, Poultry manure, Wheat, Yield, Soil fertility, Eco-friendly

ABSTRACT

An experiment was carried out in Randomized Complete Block Design to investigate the effects of different levels of boron (B) and poultry manure (PM) on the yield and yield components of wheat (BARI gom 25). Four levels of boron (0, 4, 8, and 12 kg ha^{-1}) and three levels of poultry manure (0, 5 and 10 t ha$^{-1)}$ were used as experimental treatments. Plant height, tillers plant^{-1}, spike length, grains spike^{-1}, 500-seed weight, grain yield and biological yield were significantly increased by application of B and PM. The tallest plant (99.50 cm), maximum tillers plant^{-1} (5.67), most prolonged spike (13.17 cm) maximum grains spike^{-1} (49.00), maximum 500-seed weight (36.37 g), highest grain yield (4.72 t ha^{-1}) and highest biological yield (9.76 t ha^{-1}) were observed in T_7 treatment. The T_7 treatment also improved the soil fertility by improving organic matter content, N, P, K, S and B content of the soil. The performance of treatment T_7 (8 kg B ha^{-1} + 10 t PM ha^{-1}) was the best among the other treatments in respects to all parameters studied and it can be more economical and eco-friendly for sustainable wheat production.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the staple food of the people of Bangladesh, next to rice grown over an area of 0.45 million hectares with an annual production about 1.35 million metric tons and the average yield 3.03 t ha^{-1} (BBS, 2016). The yield of wheat in Bangladesh is very low than the other developing countries. The low yield of wheat in Bangladesh is attributable to several reasons, viz., the traditional cultural practices and improper fertilizer management. Bangladesh is a small country with a large population, and its population is increasing day by day. So, the production of cereal crop like wheat should be increased to meet the demand of the escalating population (Islam *et al.*, 2016). In the year of 2018, winter wheat crop, harvested in April, is estimated at 1.30 million metric tons, slightly below the five-year average due to a contraction in plantings as farmers preferred to shift to more remunerative crops as paddy (FAO, 2018). Annual food grain deficit could be minimized either by bringing more area under cultivation or by increasing the yield per unit area.

Soil fertility deterioration has become a major constraint to higher crop production in Bangladesh.

[1] S.C. Barma, MS in Soil Science, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh.
[2] A.K.M.M. Hossain, Professor, Department of Soil Science, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh.
[3] M.C.D. Sharmma, MS in Agricultural Chemistry, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh.
[4] S.K. Pramanik, Lecturer, Department of Agricultural Botany, Anowara College of Bioscience, Suihari, Dinajpur, Bangladesh.

The increasing land use intensity without fair and balanced use of chemical fertilizers and with little or no use of organic manures have caused severe fertility deterioration of our soils resulting in stagnating or even declining of crop productivity (Farid *et al.*, 2011). Sustainable production of crops cannot be maintained by using only chemical fertilizers, and similarly, it is not possible to obtain higher crop yield by using organic manure alone (Bair, 1990). Losses of soil organic matter can only be replenished in the short term by application of organic matter such as manure (Glaser *et al.*, 2001). Judicious application of manures and fertilizers can increase the crop yield per unit area and minimize the nutrient imbalance in soil. In this context, a suitable combination of inorganic (Boron) and organic (Poultry manure) source of nutrients may pave the way for sustainable production of wheat in Bangladesh.

Boron is an essential micronutrient for a crop like wheat. It plays a vital role in the physiological process of the wheat plants such as cell elongation, cell maturation, sugar translocation, meristematic tissues development, protein synthesis and ribosome formation (Kakar *et al.*, 2000). Boron deficiency in plants results in terminal bud growth stoppage and death among the young leaves. Sugar transport, seed germination, pollen formation, and development of plant are also affected due to its absence. Seed and grain yield are also decreased with low boron supply (Sillanpae, 1982). Boron scarcity also constrains root elongation, cell division in the developing zone of root tips and leaf growth and decrease in photosynthesis (Dell *et al.*, 1997).

Poultry manure is excellent organic manure, as it contains high nitrogen, phosphorus, potassium and other essential nutrients (Veeramani *et al.*, 2012). In contrast to mineral fertilizer, it adds organic matter to soil which improves soil structures, nutrient retention, aeration, soil moisture holding capacity and water infiltration (Deksissa *et al*., 2008). Economic premiums for certified organic grains have been driving many transition decisions related to the organic farming (Delate and Camber, 2004). Its application registered over 53% increases of N level from 0.09% to 0.14 % in the soil and exchangeable cations increase with manure application (Boateng *et al.*, 2006). In agriculture, the main reasons for applying poultry manure include the organic amendment of the soil and the provision of nutrients to crops (Warren *et al.*, 2006). Moreover, it is a good source of organic nutrients, containing both macro and micronutrients, and its application can improve soil carbon content (Fronning *et al*., 2008). It is also an organic fertilizer that can apply in any type of soil and is eco-friendly and has no toxicity. Keeping the above facts in mind, the investigation was undertaken to find the effect of Boron and Poultry Manure on yield and yield components of wheat cultivar, BARI gom 25.

2. Materials and methods

2.1 Location, duration, experimental design and treatments

The experiment was carried out in the Soil Science research field of Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh during November 2016 to February 2017. The field is located at 25.13°N latitude and 88.23°E longitude at a height of 37.5 m above the main sea level. The land was medium-high belonging to the Old Himalayan Piedmont Plain (AEZ-1), which falls into Non-Calcareous Brown Floodplain soils (UNDP and FAO, 1988). The experiment was laid out in Randomized Complete Block Design with three replications. The individual plot size was 4 m × 2.5 m. There were twelve treatments comprising two factors. The factors were- Factor A: Four levels (0, 4, 8, and 12 kg ha^{-1}) of boron (B) and Factor B: Three levels (0, 5 and 10 t ha^{-1}) of poultry manure (PM). The treatment combinations were: $T_1 = B_0PM_0$, $T_2 = B_4PM_0$, $T_3 = B_8PM_0$, T_4=

$B_{12}PM_0$, $T_5 = B_0PM_5$, $T_6 = B_4PM_5$, $T_7 = B_8PM_5$, $T_8 = B_{12}PM_5$, $T_9 = B_0PM_{10}$, $T_{10} = B_4PM_{10}$, $T_{11} = B_8PM_{10}$ and $T_{12} = B_{12}PM_{10}$. BARI gom 25 was used as test crop and the seeds were collected from the Wheat and Maize Research Institute, Noshipur, Dinajpur.

2.2 Fertilizer application and seeds sowing

Boron-containing fertilizer boric acid (H_3BO_3) and poultry manure were applied as per design and treatments and all other fertilizers were applied according to soil test basis. The full amount of phosphorus, potassium and sulphur and one-third of the nitrogen were applied during final land preparation in the form of triple superphosphate, muriate of potash, gypsum and urea, respectively. Another one-third of nitrogen was applied during first irrigation and the last one-third was applied during second irrigation. Seeds were sown at the rate of 120 kg ha^{-1} continuously in lines maintaining 20 cm spacing between lines. Recommended production technology of wheat was followed and intercultural operations were done when necessary to ensure normal growth of the crop.

2.3 Yield and yield components

Different traits viz. plant height, number of tillers $plant^{-1}$, spike length, number of grains $spike^{-1}$ 500-seed weight, grain yield and biological yield of wheat were recorded properly after harvesting. Grain yield was adjusted to 12% moisture content.

2.4 Soil sample analysis for different parameters

The post-harvest soil samples were used for the analysis of pH, organic matter, nitrogen (N), phosphorous (P), potassium (K), sulfur (S) and boron (B) content. Determination of soil pH was done by Potentiometric method and organic matter content of the soil was determined according to Walkley and Black (1934). N content, available P content and exchangeable K content of the soil was determined according to Bremner and Mulvancey (1982), Olsen *et al.* (1954) and Page *et al.* (1982), respectively. Available sulfur was determined by extracting the soil sample with 0.01M Ca $(H_2P0_4)_2$. The S content was estimated turbidimetrically and the intensity of turbidity was measured by spectrophotometer at 420 nm wavelength. Boron was determined by the hot water extraction method using a dilute calcium chloride solution (Berger and Truog, 1939).

2.5 Statistical analysis

Data were analysed following the ANOVA technique using MSTAT-C program and the means were compared by Duncan's Multiple Range Test.

3. Results and Discussion

3.1 Yield components

Various yield components of wheat such as plant height, number of tillers $plant^{-1}$, spike length, number of grains $spike^{-1}$ and 500-seed weight were significantly influenced by the treatment combination of boron (B) and poultry manure (PM) (Table 1 and 2). Application of boron and poultry manure positively increased the various yield components of BARI gom 25 compared to that found in control. The tallest plant (99.50 cm) was produced in the treatment T_7 which was closely followed by the treatment T_{12}, whereas the shortest plant (73.50 cm) was recorded in control (T_1). Boron is transported through the xylem vessel and increases sugar and hydrocarbons which helps in the higher growth of the plant.

The maximum tiller $plant^{-1}$ (5.67) was found in the treatment T_7 which was statistically similar to those found in the treatments T_6 and T_{12}. The minimum tiller number (3.00) was observed in the control treatment (T_1). Agbede *et al*. (2008) recorded a similar result. They stated that the poultry manure is an excellent fertilizer material because of its high nutrients contents, especially for nitrogen which increases the number of tiller plant $^{-1}$. The spike length of wheat varied from 9.17 to 13.17 cm. The longest and statistically superior spike (13.17 cm) was recorded in the treatment combination of B_8PM_5, whereas the shortest spike (9.17 cm) was recorded in control treatment.

The maximum number of grains spike^{-1} (49.00) was observed in T_7 treatment which was statistically identical with the treatments T_{10}, T_{11} and T_{12}, whereas the minimum number of grains spike^{-1} (46.00) was found in T_1 treatment which was statistically similar to the treatments T_2.

The highest 500-grain weight (36.37 g) was recorded from the treatment T_7 which was superior to the other treatments, and the lowest 500-grain weight (23.63 g) was recorded in control.

Some other researchers also reported that combined application of manures and fertilizers increased the plant height and tillers plant^{-1} (Khan *et al.*, 2007), spike length (Singh *et al.*, 2001) and grains spike^{-1} (Satyannarayana *et al.*, 2002). Liza *et al.* (2014) also support the findings of the present study that organic and inorganic fertilizers influence grain weight and yield of wheat.

Table 1. Effect of boron and poultry manure on yield contributing characters of wheat

Treatments	Plant height (cm)	Number of tillers plant^{-1}	Spike length (cm)	Number of grains spike^{-1}
T_1	73.50 cd	3.00 d	9.17 f	46.00 d
T_2	78.67 d	3.67 cd	10.33 e	46.12 d
T_3	86.50 abcd	3.67 cd	10.73 de	46.67 cd
T_4	82.80 bcd	4.33 bc	10.83 de	47.33 bcd
T_5	87.80 abcd	4.00 bc	10.37 e	48.00 abc
T_6	**94.83 ab**	**5.00 ab**	10.77 de	47.33 bcd
T_7	**99.50 a**	**5.67 a**	**13.17a**	**49.00 a**
T_8	91.4 abc	4.33 bc	11.33 cd	**48.33 ab**
T_9	82.53 bcd	4.33 bc	11.90 bc	47.67 abc
T_{10}	**94.70 ab**	4.00 bc	10.53 e	**48.34 ab**
T_{11}	94.13 abc	4.67 bc	11.67 bc	**48.29 ab**
T_{12}	**98.20 ab**	**5.00 ab**	12.13 b	**48.67 ab**
Level of significance	*	*	**	**
CV %	10.59	16.16	5.47	8.06

In a column, means having a similar letter(s) did not differ significantly at 5% level of significance. * Significant at 5% probability level. ** Significant at 1% probability level. $T_1 = B_0PM_0$, $T_2 = B_4PM_0$, $T_3 = B_8PM_0$, $T_4 = B_{12}PM_0$, $T_5 = B_0PM_5$, $T_6 = B_4PM_5$, $T_7 = B_8PM_5$, $T_8 = B_{12}PM_5$, $T_9 = B_0PM_{10}$, $T_{10} = B_4PM_{10}$, $T_{11} = B_8PM_{10}$ and $T_{12} = B_{12}PM_{10}$.

3.2 Grain yield and biological yield

The grain yield and biological yield of BARI gom 25 were significantly influenced by the different treatment combinations of boron and poultry manure. (Table 2). The maximum grain yield (4.72 t ha^{-1}) was recorded in the treatment T_7 which was closely followed by T_{12} treatment (4.21 t ha^{-1}), whereas the minimum grain yield (3.15 t ha^{-1}) was recorded in the control treatment. A similar result was also reported by Nadim *et al.* (2011) who showed that boron application improved the grains yield of wheat. The biological yield of wheat varied from 8.13 to 9.76 t ha^{-1}. The maximum biological yield (9.76 t ha^{-1}) was recorded in the treatment combination of B_8PM_5 (T_7). On the other hand, the minimum biological yield (8.13 t ha^{-1}) was obtained in the control treatment (T_1). These findings are well corroborated with that of Islam *et al.* (2014), Malika *et al.* (2015) and Akter *et al.* (2012) who reported that integrated use of manures and fertilizers increased the grain and straw yield of rice and wheat.

Table 2. Effect of boron and poultry manure on 500-seed weight, grain and biological yield of wheat

Treatments	500-seed weight (g)	Grain yield (t ha^{-1})	Biological yield (t ha^{-1})
T_1	23.63 g	3.15 g	8.13 de
T_2	24.10 g	3.19 fg	8.19 de
T_3	27.87 f	3.27 efg	8.22 de
T_4	30.20 de	3.25 efg	8.46 cde
T_5	30.33 de	3.55 cde	8.32 cde
T_6	32.57 b	3.82 cd	8.48 bcde
T_7	**36.37 a**	**4.72 a**	**9.76 a**
T_8	33.10 b	3.95 bc	9.35 ab
T_9	32.88 b	3.25 efg	9.18 abc
T_{10}	31.50 bc	3.42 def	8.89 bcd
T_{11}	33.57 b	3.53 cde	8.75 cde
T_{12}	**36.33 a**	4.21 b	8.79 bcde
Level of significance	*	*	**
CV %	5.15	6.07	15.15

In the column, means having a similar letter(s) did not differ significantly at 5% level of significance. * Significant at 5% probability level. ** Significant at 1% probability level. $T_1 = B_0PM_0$, $T_2 = B_4PM_0$, $T_3 = B_8PM_0$, $T_4 = B_{12}PM_0$, $T_5 = B_0PM_5$, $T_6 = B_4PM_5$, $T_7 = B_8PM_5$, $T_8 = B_{12}PM_5$, $T_9 = B_0PM_{10}$, $T_{10} = B_4PM_{10}$, $T_{11} = B_8PM_{10}$ and $T_{12} = B_{12}PM_{10}$.

3.3 Chemical properties of the soil collected after harvesting

The combined effect of B and PM was significant on organic matter, nitrogen (N), phosphorous (P), potassium (K), sulfur (S) and boron (B) content but was insignificant on pH of post-harvest soil. (Table 3 and 4). Soil analysis revealed that the post-harvest soil was slightly acidic (5.89 to 6.85). The control treatment showed slight increases in soil pH compared to other treatment combinations. Organic matter content of the post-harvest soil was higher in T_7 treatment which was statistically at par with treatment T_6 and T_{12}. Lower organic matter was found in the control treatment. B and PM increased the total nitrogen of soil in different treatments. Soil nitrogen of the post-harvest soil was slightly higher than the initial soil. The total nitrogen percent of post-harvest soils was more or less similar. The highest soil nitrogen was found in both T_6 and T_7 treatments and the lowest soil nitrogen was found in the T_1 treatment. The maximum phosphorus content (58.25 ppm) was found in the treatment T_{12} which was followed by treatment T_6 (82.48 ppm), whereas the minimum phosphorus content (42.48 ppm) was observed in the control treatment (T_1). Boron and poultry manure application increased the exchangeable potassium content of the post-harvest soil than the initial soil. The values of the exchangeable potassium were travelling around from 0.14 to 0.30 meq 100 g^{-1} soil. However, the maximum value of exchangeable potassium content of the post-harvest soil was observed in treatment T_{12} followed by T_8 treatment. The available sulphur content in the studied soil ranged from 15.48 to 26.15 ppm. However, the highest sulphur content (26.15 ppm) was found in the treatment T_5 which was statistically similar to those in T_2 and T_4 treatments, on the contrary, the lowest sulphur (15.48 ppm) was observed in the treatment T_1. The available boron content in the studied soil ranged from 0.25 to 0.46 µg g^{-1} soil. However, the maximum boron content (0.46 µg g^{-1} soil) was observed in T_{12} treatment which was closely followed by those in T_{11} and T_6 treatments, whereas the minimum boron content (0.25 µg g^{-1} soil) was observed in the treatment T_1.

Table 3. Effect of boron and poultry manure on the soil pH, organic matter, total N and available P content of the post-harvest soil

Treatments	Soil pH	Organic matter content (%)	Total N (%)	Available P (ppm)
T1	6.80	1.28 fg	0.12 ab	42.48 g
T2	5.90	1.63 de	0.14 ab	68.25 de
T3	5.89	1.79 d	0.13 ab	69.79 cd
T4	6.78	2.10 c	0.15 ab	71.20 bcd
T5	6.85	2.14 c	0.16 ab	48.54 fg
T6	6.64	**2.82 a**	**0.17 a**	**82.48 ab**
T7	**6.81**	**3.01 a**	**0.17 a**	58.25 ef
T8	6.70	1.29 fg	0.15 ab	49.69 fg
T9	6.54	1.49 ef	0.13 ab	75.29 bcd
T10	6.70	2.50 b	0.15 ab	71.30 bcd
T11	6.71	2.13 c	0.14 ab	72.98 bcd
T12	6.68	**2.98 a**	0.13 ab	**89.85 a**
Level of significance	NS	*	*	**
CV %	12.40	8.63	15.22	9.00

In the column, means having a similar letter(s) did not differ significantly at 5% level of significance. Not significant at 5% probability level. * Significant at 5% probability level. ** Significant at 1% probability level. $T_1 = B_0PM_0$, $T_2 = B_4PM_0$, $T_3 = B_8PM_0$, $T_4 = B_{12}PM_0$, $T_5 = B_0PM_5$, $T_6 = B_4PM_5$, $T_7 = B_8PM_5$, $T_8 = B_{12}PM_5$, $T_9 = B_0PM_{10}$, $T_{10} = B_4PM_{10}$, $T_{11} = B_8PM_{10}$ and $T_{12} = B_{12}PM_{10}$.

Table 4. Effect of Boron and poultry manure on the exchangeable K, available S and B content of the post-harvest soil

Treatments	Exchangeable K (meq 100 g^{-1} soil)	Available sulfur (ppm)	Available B (μg g^{-1} soil)
T_1	0.14 f	15.48 c	0.25 ef
T_2	0.20 cde	**23.46 a**	0.26 ef
T_3	0.19 def	**22.12 ab**	0.37 bcd
T_4	0.16 ef	**25.29 a**	0.35 bcd
T_5	0.20 cde	**26.15 a**	0.29 def
T_6	0.21 cde	18.75 e	**0.42 ab**
T_7	0.25 abcd	19.26 e	0.36 bcd
T_8	**0.29 ab**	18.75 de	0.31 cde
T_9	0.24 bcd	16.18 cd	0.29 def
T_{10}	0.21 cde	15.89 c	0.39 abc
T_{11}	0.22 cde	17.18 bc	**0.42 ab**
T_{12}	**0.30 a**	**21.27 ab**	**0.46 a**
Level of significance	*	**	*
CV %	14.56	16.62	14.70

In the column, figures having a similar letter(s) do not differ significantly at 5% level of probability. * Significant at 5% probability level. ** Significant at 1% probability level. $T_1 = B_0PM_0$, $T_2 = B_4PM_0$, $T_3 = B_8PM_0$, $T_4 = B_{12}PM_0$, $T_5 = B_0PM_5$, $T_6 = B_4PM_5$, $T_7 = B_8PM_5$, $T_8 = B_{12}PM_5$, $T_9 = B_0PM_{10}$, $T_{10} = B_4PM_{10}$, $T_{11} = B_8PM_{10}$ and $T_{12} = B_{12}PM_{10}$.

4. Conclusions

Integrated use of inorganic fertilizer (Boron) and organic manure (Poultry manure) improve the soil health and nutrient status that in turns improve crop yields. The overall results indicate that the yield of wheat varied considerably among the different treatments of boron and poultry manure. Chemical fertilizer, boron in combination with poultry manure (8 kg B ha^{-1} + 10 t PM ha^{-1}) produced the maximum grain and biological yield of wheat and it took a superior position in all other parameters studied including yield components of wheat and fertility status of the soil. Therefore, it can be concluded that poultry manure (10 t ha^{-1}) in combination with chemical fertilizer, boron (8 kg ha^{-1}) can be used successfully in an integrated way for sustainable and eco-friendly wheat cultivation.

References

1. Agbede T.M., Ojeniji S.O. and Adeyemo A.J. (2008). effect of poultry manure on soil physical and chemical prooerties, growth and grain yield of sorghum in Southeast Nigeria. Ame-Eurasia Journal of Sustainable Agriculture, 2(1): 72-77.
2. Akter S., Islam M.R., Rahman M.M. and Hoque M.M. (2012). Influences of nitrogen supplied from inorganic and organic sources on the yield, nutrient uptake and nitrogen use efficiency of BRRI dhan29. Bangladesh Journal of Crop Science, 22-23: 151-158.
3. Bair W. (1990. Characterization of the environment for sustainable Agriculture: Issues, Perspectives and Prospects in Semi-Arid Tropics. Singh R.P. Ed. Hyderabad, India. Indian Society of Agronomy, 1: 90-112.
4. BBS. (2016). Yearbook of agricultural statistics of Bangladesh, Bangladesh Bureau of Statistics, Ministry of planning, Government of the people’s Republic of Bangladesh. 47 p.
5. Berger K.C. and Truog E. (1939). Boron determination in soil and plants. Industrial and Engineering Chemistry, Analytical Edition, 11(10): 540-545.
6. Boateng S., Zickermann A.J. and Kornaharens M. (2006). Effect of poultry manure on growth and yield of maize. West African Journal of Applied Ecology, 9: 1-11.
7. Bremner J.M. and Mulvaney C.S. (1982). Methods of soil analysis. Nitrogen-Total. Part 2. 2nd ed. Agron. Monogr. 9. ASA and SSSA, Madison, WI. 595-624.
8. Bremner J.M. and Mulvaney C.S. (1982). Nitrogen-total, In Methods of Soil Analysis Part 2, Page AL, Miller RH, Keeney DR (Editors): American Society of Agronomy, Inc, Publisher, Madison, Wisconsin USA. pp. 595-624.
9. Deksissa T., Short I. and Allen J. (2008). Effect of soil amendment with compost on growth and water use efficiency of Amaranth. Proceedings of the UCOWR/NIWR annual conference: International water resources: challenges for the 21st century and water resources education, July 22-24, 2008, Durham, NC.
10. Delate K. and Camber D.C.A. (2004). Agro- ecosystem performance during transition to certified organic grain production. Agronomy journal, 96(5): 1288-1298.
11. Dell B. and Haung L.B. (1997). Physiological response of plants to low boron. Plant soil, 193: 103-120.
12. FAO. (2018). Food and Agriculture Organization of the United Nations. Statistical Databases on Cereal Production.
13. Farid M.S., Mamun M.A.A., Matin M.A. and Jahiruddin M. (2011). Combined effect of cowdung, poultry manure, dhaincha and fertilizers on the growth and yield of rice. Journal of Agroforestry and Environment, 5 (1): 51-54.

14. Fronning B.E., Thelen K.D. and Min D.H. (2008). Use of manure, compost and cover crops to supplant crop residue carbon in corn stover removed cropping systems. Agronomy Journal, 100: 1703-1710.
15. Glaser B., Lehman J., Fuhrboter M., Solomon D. and Zech W. (2001). Carbon and nitrogen mineralization in cultivated and natural savanna soils of northern Tanzania. Boil. Fertil, Soils. 33: 301-309.
16. Islam M.R., Shaikh M.S., Siddique A.B. and Sumon M.H. (2014). Yield and nutrient uptake by wheat as influenced by integrated use of manures and fertilizers. Journal of Bangladesh Agricultural University, 12(1): 73-78.
17. Islam M.R., Siraj S., Huda A, Begum M.L.N. and Bilkis S. (2016). Improvement yield and nitrogen uptake of wheat through application of organic and inorganic fertilizers. Progressive Agriculture, 27(2): 149-153.
18. Kakar K.M., Tariq M., Tareen R.M. and Ullah W. (2000). Shoot growth curve analysis of wheat (Triticum aestivum L.) receiving different levels of boron and Iron. Pakistan Journal of Agronomy, 1 (1): 47-48.
19. Khan M.U., Qasim M. and Khan I.U. (2007). Effect of integrated nutrient management on crop yields in rice-wheat cropping system. Sarhad Journal of Agriculture, 23 (4): 1019-1025.
20. Liza M.M.J., Islam M.R., Jahiruddin M., Hasan M.M., Alam M.A., Shamsuzzaman S.M. and Samsuri A.W. (2014). Residual effects of organic manures with different levels of chemical fertilizers on rice. Life Science Journal, 11(12): 6-12.
21. Malika M., Islam M.R., Karim M.R., Huda A. and Jahiruddin M. (2015). Organic and inorganic fertilizers influence the nutrient use efficiency and yield of a rice variety BINA dhan7. Journal of Agricultural Science and Research, 3(7): 192-200.
22. Nadim M.A., Awan I.U., Baloch M.S., Khan E., Naveed K., Zubair M. and Hussain N. (2011). Effect of micronutrients on growth and yield of wheat. Pakistan Journal of Agricultural Science, 48(3): 191-196.
23. Olsen S., Cole R., Watanable C.V., and Dean L.A. (1954). Estimation of available phosphorus in soil by extraction with sodium bicarbonate. United States Dept. Agri. Cire: 929.
24. Page A.L., Miller R.H. and Keeney D.R. (1982). Methods of soil analysis. Pat-2, 2nd ed., American Soc. Agron. Inc.; Modi. Wis. USA.
25. Satyanarayana V., Prasad P.V.V., Murthy V.R.K. and Bodty K.J. (2002). Influence of integrated use of inorganic fertilizers on yield components of irrigated low land rice. Journal of Plant Nutrition, 87(1-3): 90-93.
26. Sillanpae M. (1982). Micronutrients and nutrients status of Soils, a global study. FAO Soils Bulletin, No. 48, Rome.
27. Singh R., Singh S. and Prasad K. (2001). Effect of fertilizer, FYM and row spacing on transplanted rice. Crop Research, 22(2): 296-99.
28. Veeramani P., Subrahmaniyan K. and Ganesaraja V. (2012). Organic manure management on groundnut; A review. Wudpecker Journal of Agricultural Research, 1(7): 238-243.
29. Walkley A. and Black B.I. (1934). An examination of the method for determining soil organic matter, and a proposed modification of the chromic acid titration method. Soil Science, 37(1): 29-38.
30. Warren J.G., Phillips S.B.G., Mullins L., Keahey D. and Penn J.C. (2006). Environmental and production consequences of using alumamended poultry litter as a nutrient source for corn. Journal of Environmental Quality, 35: 172-182.