# EFFECT OF BORON AND POULTRY MANURE ON THE GROWTH AND YIELD OF WHEAT (BARI gom 25)

**A THESIS**

**BY**


**SUDAN CHANDRA BARMA**

**Student No. 1605031**

**Semester: January-June, 2017**

**Session: 2016-2017**


**MASTER OF SCIENCE (M.S.)**

**IN**

**SOIL SCIENCE**


**DEPARTMENT OF SOIL SCIENCE**

**HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJPUR-5200**


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**Submitted to the Department of Soil Science**

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**in partial fulfillment of the requirements for the degree of**

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**DECEMBER, 2017**

**DEDICATED**

**TO**

**MY BELOVED**

**PARENTS**

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***The Author***

# ABSTRACT

An experiment was conducted in the Soil Science research field of Hajee Mohammad Danesh Science and Technology University, Dinajpur during the period of September 2016 to February 2017 in order to investigate the effects of different levels of boron (B) and poultry manure (PM) on the yield and yield contributing charecteristics of wheat. Twelve fertilizer treatments were used and which were $T_1=PM_0B_0$, $T_2=PM_0B_4$, $T_3=PM_0B_8$, $T_4=PM_0B_{12}$, $T_5=PM_5B_0$, $T_6=PM_5B_4$, $T_7=PM_5B_8$, $T_8=PM_5B_{12}$, $T_9=PM_{10}B_0$, $T_{10}=PM_{10}B_4$, $T_{11}=PM_{10}B_8$ and $T_{12}=PM_{10}B_{12}$. Recommended doses of N, P, K, S and Zn were applied in all the treatments. The experimental results revealed that plant height, spike length, number of tillers hill$^{-1}$, number of spikelets spike$^{-1}$, 1000-grain weight, straw weight, grain weight, nitrogen and boron content in the soil were significantly influenced by B and PM. The highest plant height (89.50 cm) was observed in $T_7$ treatment and the lowest (63.50 cm) was found in the control. The maximum number of tillers (4.67) was produced in the treatment $T_7$ and minimum number (2.00) was found in the control. The highest number of grain (11.00) was found in the treatment $T_{12}$ which was statistically identical with $T_7$ treatment. The lowest number of grain (8) was observed in the control treatment. Grain yield and straw yield of wheat plants were significantly influenced with the application of B along with PM. It was found that the application of 8 kg B ha$^{-1}$ with 10 t PM ha$^{-1}$ produced the highest grain (5.62 t ha$^{-1}$) and straw (4.16 t ha$^{-1}$) yield. The control treatment produced the lowest grain (3.09 t ha$^{-1}$) and straw (2.13 t ha$^{-1}$) yield. The findings of the study showed that the performance of the treatment $T_7$ ($PM_5B_8$) was the best among the other treatments in respects of plant height, tillers hill$^{-1}$, number of grain spike$^{-1}$, spike length, grain yield and straw yield of wheat. Therefore, the overall results indicate that the application of 8 kg B ha$^{-1}$ with 10 t PM ha$^{-1}$ can be more efficient and economic for wheat production.

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# LIST OF ABBREVIATIONS

| | | |
|---|---|---|
| AEZ | = | Agro-ecological zone |
| @ | = | At the rate of |
| Agric. | = | Agriculture |
| Agril. | = | Agricultural |
| ANOVA | = | Analysis of Variance |
| BARI | = | Bangladesh Agricultural Research Institute |
| BBS | = | Bangladesh Bureau of Statistics |
| BINA | = | Bangladesh Institute of Nuclear Agriculture |
| C.V. | = | Co-efficient of Variation |
| cm | = | Centimeter |
| DIPA | = | Directorate of Information and Publications of Agriculture |
| DMRT | = | Duncan's Multiple Range Test |
| e.g. | = | For example |
| *et al.* | = | And authors |
| FAO | = | Food and Agriculture Organization |
| Fig | = | Figure |
| g | = | Gram |
| Kg | = | Kilogram |
| LSD | = | Least Significant Difference |
| M.S | = | Master of Science |
| NS | = | Non significant |
| PM | = | Poultry manure |
| RCBD | = | Randomized Complete Block Design |
| S.E. | = | Standard error |
| S.I. | = | Serial |
| UNDP | = | United Nations Development Programme |
| USDA | = | United States Department of Agriculture |
| Viz. | = | Namely |

# CHAPTER I

# INTRODUCTION

# CHAPTER I
# INTRODUCTION

Wheat (*Triticum aestivum L.*) is the most important cereal crop of the world. It ranks first both in area and production. About one third of the total population of the world live on it. But in Bangladesh it possesses the second as a staple food. The cultivated area under wheat in Bangladesh is about 0.51 million hectares producing 0.89 million tons with an average yield of 1.8 t $ha^{-1}$ (BBS, 2011). Among the cheapest source of food wheat provides calories of 72% & protein in the normal human consume routine. In addition of this, its 100g grain contains 326-335 calories, 11.57-14.0 g water, 9.4-14.0 g protein, 1.8-2.5 g fat, 69.175.4 g total carbohydrate, 1.8-2.3 g fiber, 1.7 g ash, 36-46 mg calcium, 354-400 mg phosphorus, 3.0-4.3 mg iron, 370-435 mg potassium, 0.43-0.66 mg thiamine, 0.110.12 mg riboflavin and 4.3-5.3 mg niacin (Ken., 2004; Rehm and Schmitt., 2010).

The yield of wheat in Bangladesh is very low than the other developing countries. The low yield of wheat in Bangladesh is attributable to a number of reasons, viz., the traditional cultural practices and improper fertilizer management. The use of fertilizers as a means of supplementing the natural food supplies in the soil is very important among the various factors involved in the crop production as well as in proper maintenance of soil fertility. As because, the country needs to feed the increasing population which is evidently, the most challenging problem for the nation. High yields are the result of environmental, technological, management, capital, and input conditions. High wheat yields require increases in N application and the excessive addition of this nutrient can contribute to water source pollution (Semenov *et al*., 2007).

Boron (B) is an essential micronutrient for crop like wheat. It plays a vital role in the physiological process of wheat plant such as cell elongation, cell maturation, sugar translocation, meristematic tissues development, protein synthesis and ribosome formation (Gupta, 1979 and Kakar *et al*., 2000).

Due to Boron deficiency in plants results 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 is also decreased with low boron supply (Sillanpae, 1982). Boron (B) 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 an excellent organic fertilizer, as it contains high nitrogen, phosphorus, potassium and other essential nutrients. In contrast to chemical fertilizer, it adds organic matter to soil which improves soil structures, nutrient retention, aeration, soil water holding capacity and water infiltration (Deksissa *et al.*, 2008). It is also indicated that poultry manure more readily supplies P to plants than other organic manure sources (Garg and Bahla, 2008). Organic fertilizers including farmyard manure, sheep manure and PM may be used for the crop production as a substitute of the chemical fertilizers because the importance of the organic manures cannot be overlooked. Worldwide, there is growing interest in the use of organic manures due to depletion in the soil fertility. Economic premiums for certified organic grains have been driving many transition decisions related to the organic farming (Delate and Camber Della, 2004). Continuous use of fertilizers creates potential polluting effect in the environment (Oad *et al.*, 2004). Synthesis of chemical fertilizers consumes a large amount of energy and money.

Poultry manure is a valuable fertilizer and can serve as a suitable alternate to chemical fertilizer. 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 PM 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) and further improve soil physical and chemical properties (Eghball, 2002). At the same time, its application could have some environmental issues, including antibiotics (Gao and Pedersen, 2009), and the risk of spreading weed seed (Larney and Blackshaw, 2003). It is also an organic fertilizer that can apply in any type of soil and is ecofriendly and have no toxicity.

In view of the limited information on the aforesaid problems, the present piece of research work was undertaken with PM and B application in wheat using the cultivar BARI gom 25 with the following objectives:

1. To assess the impact of poultry manure and boron on the yield contributing characteristics of wheat
2. To investigate the effect of poultry manure and boron on the grain and straw yield of wheat

CHAPTER II

# REVIEW OF LITERATURE

# CHAPTER II
# REVIEW OF LITERATURE

Boron (B) is an important plant nutrient. Appropriate rate of B application may enhance the grain yield of wheat. But only few studies have so far been conducted on the response of wheat to B fertilizer. The importance of wheat cultivations is being increasingly emphasized and role of this nutrient in mustard growth, yield and quality are well documented mostly in our country and outside the country. Even through poultry manure contains more amount of nutrients then other manures, the research work on poultry manure is less when compared to farm yard manure which have been studied extensively, since poultry population is concentrated only in certain areas and hence the manure availability also. In this context, a review of available literatures in respect of effect of FYM and poultry manure on yield and quality of crops, nutrients availability, residual effects and composting assumes importance. Some of the findings relevant to the present study have been reviewed below.

An experiment was conducted by Muhmood *et al.* (2014) to assess the effect of boron on seed growth, seedling vigor and wheat yield. The experiment consisted of five treatments following recommended dose (RD) of NPK (control), RD of NPK + 0.5 kg $ha^{-1}$ boron, RD of NPK + 1.0 kg $ha^{-1}$B, RD of NPK + 1.5 kg $ha^{-1}$ Boron and RD of NPK + 2.0 kg $ha^{-1}$ B. These all doses were used. Three replications of RCBD. Findings came out as boron without effect on yield mechanisms, except, grain $spike^{-1}$ and 1000 grain weight that later, were improved significantly with the used of its application. Through the application of B Content Wheat Leaf increased. Maximum grain and straw yield (4.86 and 9.15 Mg $ha^{-1}$, respectively) was recorded with 2.0 kg Boron $ha^{-1}$ with suggested quantity of NPK. Boron showed no effect on seed germination; however, seedling vigor i.e. shoots and root length improved with B application.

A field experiment was tested by Ali *et al.* (2013) to check the result of wheat (*Triticum aestivum* L.) as observed through the application of boron and zinc fertilizers under the irrigation premises. The experimental treatment contained the following treatments control plot; 3 stages of Boron i.e. Level 0.0, level 1.0, level 2.0-kg B $ha^{-1}$, 3 levels of Zn i.e. level 0.0, level 5.0, level 10.0-kg Zn $ha^{-1}$. Wheat CV Shatabdi contained 4 replications of RCBD. Urea was applied on plots to fertilize them with DAP and potassium sulphate, urea, DAP and potassium sulphate. Control plots were not treated with fertilizer. Results showed that having mix combination of 2.0 kg B $ha^{-1}$ and 5 kg Zinc $ha^{-1}$ provided main effect on grain production and its mechanisms that the no: of tillers $m^{-2}$, length of spikes, grains number $spike^{-1}$ and thousand grain weight. The enhancement was noted in drymatter production that showed grain production 14.5% and 9.4% on control by the mixture of 2.0 kg Boron $ha^{-1}$ and 5.0 kg Zinc $ha^{-1}$. Such a remarkable increase in Boron concentration of grains, 129.6% and 47.6% with one mixture of 2.0 kg Boron, 5.0 kg Zinc $ha^{-1}$ was noticed at control. A major increase was noticed in the zinc content level through 15.2 to 37.4 milligram with the use of 10.0 kg Zinc $ha^{-1}$. At the end, a significant enhancement was collected in the yield of wheat with concurrent and improved Zinc nutrient for eradication of disease i.e. Deficiency of zinc throughout pre-urban and rural societies.

An experiment on a green house influence of potassium and boron on some traits in wheat (*Triticum aestivum* L.) was tested by Zare *et al.* (2013) the experiment had the following treatments of a wheat variety CV Darab-2: four levels of B (0, 20, 40 and 60 mg) and four levels of K (0, 25, 50 and 75 mg): along with the apparatus, CRD in factorial arrangement in three times replications. The results came up as, when K element was applied that the traits of all elements were increased except biological yield. On contrary, by increasing B levels all of traits were decreased. It was noticed that soils comprising a high amount of boron concentration were considered to may be cause B toxicity. B1 × K4 and B4 × K1 interaction showed the highest and lowest seed yield (8.92 and 1.15-ton $ha^{-1}$, respectively), indicating that K stimulates photosynthesis carrying assimilates of carbohydrates to the storages organs. This research concluded that weight of thousand seed had the larger association with seed yield.

An Experiment was conducted by Moghadam *et al.* (2012) on wheat yield mechanisms to evaluate the influence of zinc, boron and copper foliar application. The experimental treatment consisted of a RCBD (factorial) with three replications i.e. Zinc, Boron and Copper and doses of foliar application, viz-a-vis 0, 1 and 2 $Lha^{-1}$: two varieties, namely Gaskojen and Pishtaz. These experiments were carried out under good watered conditions. There was significant type of elements on the number of spikes $plant^{-1}$, grain $spike^{-1}$, grain in $m^{-2}$, (Harvest Index %) and (kg $ha^{-1}$) yield of grains but found no effect on thousand grain weight. Boron and Zinc proved to be higher amounts provider in mentioned traits than Copper, although in Chena ran, and Zinc in Mashhad found to be more effective. Yield was increased with foliar application dose, the number of spike $plant^{-1}$, grain in square meter, so that highest of these were in dose of L $ha^{-1}$. Generally, the location of varieties sought to be different in evaluation of traits. The significant difference was seen between Chena ran and Mashhad, followed by Gaskojen and Pishtaz in yield and yield components. The findings in this study can be proved to be beneficial for better management practices of wheat. In addition to this, it is also recommended that more attention should be paid to Zn and B nutrient in mentioned locations for better yield.

An experiment was conducted by Moeinian *et al.* (2011) and stated that boron transport and transfer in plant is reletively low and thus its concentration in lower plants is higher. Most of boron transport is through xylem vessel. Boron is mostly concentrated in anther, stigma and overy. According to boron effect in increasing sugar and hydrocarbons transport through phloem.

Debnath *et al.* (2011) conducted a field experiment was conducted in order to utilize the optimal amount of B use for obtaining the greater produce of wheat in floodplain soil of Old Brahmaputra. His experiment consisted the following treatments i.e. 5 rate of boron, including .0- 0.75, 1.50-2.25 and 3.00 kg $ha^{-1}$; with four replications of RCBD. Together with boron, every usage had got 115 kg Nitrogen, 25 kg Phosphorus, 75 kg Potash and 15 kg Sulphur $ha^{-1}$. Urea, Triple Super Phosphate, Murate of Potash, gypsum and boric acid used for Nitrogen, Phosphorus, Potash, Sulphur, and Boron. To all 20 plots, during final land preparation, 1/3 amount of urea and full amount of all other fertilizers were practical as basal. Furthermore, the rest of the splits were applied accordingly to following; quite after 30 days of sowing, the second split of urea was applied at crown root period while the third split was applied after 56 days at booting phase. Wheat crop needs technical method in sowing so that growing can become more eminent. In this regard, seeds are sown continuously at distance of 20 cm in separate lines at a prescribed rate of 125 kg $ha^{-1}$. The results come out the following; as the treatment B received at 2.25 kg $ha^{-1}$ and showed the production at much highest grain yield i.e.4.22 $ha^{-1}$ that was identical in quantity with 1.75 kilogram of B $ha^{-1}$. However, boron rate was received at 1.90 kg $ha^{-1}$ the maximum wheat yield. On the other hand, the lowest grain yield 2.84 $ha^{-1}$ was measured with controlled usage. A helpful relation between yield of grain and no: of grains $spike^{-1}$ was observed. A positive effect of boron on Nitrogen, Phosphorus, Potash, Sulphur and Boron uptake received by the crop which, certainly, was more influenced by crop yield and less influenced by nutrient concentration.

Muhammad *et al.* (2011) studied a field experiment in order to dig out the physiology and yield efficiency of wheat variety of Gomal-8. He used the amalgamated levels of Zinc, Copper, Iron, Manganese and Boron in dissimilar recipes. The study revealed; "application of boron at 2 kg $ha^{-1}$ formed higher leaf area index at 0.33 and 3.49 and leaf area duration 2.30 and 48.90 at 49 and 98 days after sowing". The results showed that same method enhanced crop growth rate 33.40 g $m^{-2}$ per day, quantity of grains 46.50 per spike and grain yield 3.67-ton $ha^{-1}$ of wheat. Moreover, copper use at 8 kg $ha^{-1}$ formed the maximum no: of tillers i.e. 249 $m^{-2}$ and statistically at $grain^{-1}$ yield 3.62-ton $ha^{-1}$ that was similar to Boron application. It was noticed that higher net adjustment rate 3.19 milligram $m^{-2}$ $day^{-1}$ was measured aftercopper was practiced at the rate of six kg $ha^{-2}$. In different micronutrients, Zinc application produced minimum quantity of 37.75 $spike^{-1}$ however, the use of iron did not improve plant growth. The study proved that Boron application improved the wheat grains and yield while the use of copper and manganese had also positive effect on wheat productivity.

Nadim *et al.* (2011) studied an experiment to find out the effect of micronutrients on wheat growth and yield. The experimental treatment consisted of a wheat Gomal-8; following different points of Zinc, Coper, Iron, Manganese and Boron with different amalgamation containing four replication of RCBD Different doses of Zinc, Copper, Iron, Manganese and Boron were applied alone and in combination in the method of $FeSO_4$, $CuSO_4$, $MnSO_4$, $ZnSO_4$ and Borax. Basal fertilizer dose of NPK at 150-120-90 kg $ha^{-1}$ in formula of Urea, DAP and Potassium Sulphate, recommended seed rate of 100 kg $ha^{-1}$ was used. The results showed that application of boron at two kg $ha^{-1}$ created maximum leaf area index 0.33 and 3.49 and leaf area duration 2.30 and 48.90 at 49 and 98 days after sowing. The same method also enhanced growth rate of crop33.40-gram $m^{-2}$ per day, quantity of grains (46.50 $spike^{-1}$) and grain yield 3.67 t $ha^{-1}$ of wheat. Furthermore, the practice of copper at 8 kg $ha^{-1}$ produced the maximum quantity of tillers 249 $m^{-2}$. Statistically, it was at $grain^{-2}$ yield 3.62 t $ha^{-1}$. Similar to that of boron application higher net assimilation rate 3.19 mg $m^{-2}$per day was recorded when copper was practiced at six kg $ha^{-1}$. Among different micronutrients, zinc application produced minimum no: of grains that was 37.75 $spike^{-1}$. On the other hand, the usage of iron did not improve plant growth. The study showed that boron application improved the wheat grains and yield while the use of copper and manganese had also positive effect on wheat productivity.

An experiment was conducted by Ali *et al.* (2009) at Agriculture Research Farm of NWFP Agricultural University Peshawar during winter season in 2004-2005. This was to check the effect of foliar application of zinc and boron on yield and yield components of wheat. The experiment contained the following; Solution of zinc, boron and zinc + boron were used foliar spray, each applied at tillering stage, jointing and booting stage. The process had only water application as control, while no application of spray brought under experiment. During both of the aforementioned seasons, a tremendous increase was noted in no: of spikes $m^{-2}$, grains spike$^{-2}$, thousand grain weight, biological yield and grain yield for foliar application of zinc and B as compared to both control treatments. The combination of zinc and boron application lead to increasing grains spike$^{-1}$ during 2004-05 it was 56 and during 2005-06 it was 48.2 following 52.2 as mean over years), thousand grain weight (52.2 as mean over years), biological yield (8750 kg ha$^{-1}$ during 2004-05 and 11389 kg ha$^{-1}$ during 2005-06 with 10069.4 kg ha$^{-1}$ as mean value) and grain yield (2833 kg treatments resulted in minimum no: of spikes m$^{-2}$, grain spike$^{-1}$, thousand grain weight, biological yield and grain yield, during both of the growing seasons. This experiment showed foliar request of zinc and boron had improved grain yield and yield components of wheat, and thus, it is recommended for increased crop production.

Agbede *et al*. (2008) stated that the poultry manure is the organic waste material from poultry consisting of animal faces and urine. Poultry manure is an excellent fertilizer material because of its high nutrients contents, especially for nitrogen which helps to the number of tiller plant$^{-1}$. It also increased soil and plant nutrient status, increases soil organic mater and water holding capacity.

Fagimi and Ode bode (2007) reported that poultry droppings applied at the rate of 10 t/ha and 20 t/ha, increased plant height, number of leaves and fruit yield of Pepper, while the incidence and severity of Pepper Venial Mottle Virus (PVMV) was reduced.

DIPA (2006) reporeted that the nutrient composition of poultry droppings is 1.0-1.8% N, 0.4-0.8% P and 0.5-1.9% K.

Stefan (2003) indicated that fresh poultry dropping contain 70% water, 1.4% N, 1.1% $P_2O_5$ and 0.5% $K_2O$ while dried poultry manure contains 13% water, 3.6% N, 3.5% $P_2O_5$ and 1.6% $K_2O$.

Izunobi (2002) reported that poultry manure, especially those produced in deep litter or battery cage house are the richest known farmyard manure supplying greater amounts of absorbable plant nutrient.

Mullins *et al.* (2002) stated that Poultry manure is used as a source of N, P and K but litter also contains Ca, Mg, S and some micronutrients.

An experient was conducted by Mullins *et al*. (2002) stated that among the different sources of organic manure which have been used in crop production, poultry manure was found to be the most concentrated in terms of nutrient content.

Mullins *et al*. (2002) showed that higher grain yields of rice by incorporation of farm wastes and green manures, with the highest yield by poultry manure was obtained under lowland conditions indicating the superiority of poultry manure.

Asad and Rafique (2000) conducted an experiment at Tehsil Peshawar in order to assess the effect of the following; Zinc, Copper, Iron, Manganese and Boron in order to map out the impact on the yield and yield mechanisms of wheat crop. Different amalgamation of Zinc, Copper, and iron, Manganese, Boron were used at following rate 4.0, 2.0, 5.0, 2.0, 1.0 kg $ha^{-1}$ and 1.0 kg $ha^{-1}$, respectively. It has a basal dose of 100 kg $ha^{-1}$ nitrogen, 75 kg $ha^{-1}$ of P, 50 kg $ha^{-1}$ of K. The fertilizer handlings contained macro nutrients and micro nutrients. These enlarged wheat dry matter, yield of grains, and straw yield meaningfully over control condition. Soil contents of Boron and Zinc were improved both at boot and reaping period and iron only at boot step with the calculation of micronutrients. Plants of Boron usages had presented classical Boron deficiency indications at grain creation phase but not at vegetative point. B application in the dry matter of wheat plants better with the addition of the Boron fertilizer in the soil. Results of the trial confirmed that soil under research was lacking in Boron with the lack of nitrogen, phosphorus or potassium.

According to Brady and Weil (1999) poultry manure mineralizes faster than other animal manure such as cattle or pig dung; hence it releases its nutrients for plant uptake and utilization rapidly.

Sharpley and Smith (1991) reported that poultry manure contains basic nutrients required for enhancing growth and yield of crops.

Savithri *et al*. (1991) reported that application of coir pith based poultry litter at 6.35 t $ha^{-1}$ along with recommended levels of NPK registered highest yield of sorghum.

Madhumita *et al.* (1991) recorded highest grain yield of maize by application 5 ton of poultry manure + 28 kg $P_2O_5$ $ha^{-1}$ as single superphosphate.

Kostchi *et al*. (1989) observed that application of poultry manure improved the availability of some minerals in the soil, and especially the transfer of nutrients from rangeland to the crop plant.

More and Ghonsikar (1988) was obtained by increase in the yield of wheat due to application of poultry manure along with super phosphate.

More and Ghonsikar (1988) reported that the P content in wheat was significantly higher due to the application of poultry manure with super phosphate.

Prasad *et al.* (1984) reported that addition of poultry manure alone or in combination with N, P, K, Zn and Fe increased the uptake of Zn and Fe by wheat and rice.

Rayar (1984) stated that increase in available N was noticed when poultry manure; swine manure and FYM were applied to the soil.

Ketker (1984) stated that the combination of nitro-gen from different organic manures was comparable on equivalent N basis in which poultry manure proved to be a better source of nitrogen.

Prasad *et al*. (1984) reported that maximum grain yield of rice was recorded with the application of poultry manure.

An experiment was conducted by Mountney (1983) and reported that nutrient values of poultry manure varied considerably depending upon the conditions under which it is processed. The ratio of litter to manure and the moisture content caused considerable variation among manures from different houses.

# CHAPTER III

# MATERIALS AND METHODS

# CHAPTER III

# MATERIALS AND METHODS

The materials and methods those were used in performing the research work are briefly described in this chapter which are presented under the following heads: site and soil, climate, experimental material, land preparation, fertilizer application, seed sowing, intercultural operation, harvesting, threshing, data collection, plant sample collection, plant analysis and statistical analysis.

### 3.1 Site and soil

A field experiment was conducted in the Soil Science research field in Hajee Mohammad Danesh Science and Technology University Dinajpur during November, 2016 to February, 2017. The field is located at 25.13$^{o}$N latitude and 88.23$^{o}$E longitude at a height of 37.5m 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 general characteristics of the soil are presented in Table 1.

**Table 1. Morphological, physical and chemical characteristics of the soils of Soil Science Research field of HSTU**

| **Morphological characteristics** | |
|---|---|
| Location | HSTU research field |
| AEZ | Old Himalayan Piedmont Plain |
| General soil type | Non Calcareous Brown Floodplain Soil |
| Drainage | Well drained |
| Topography | Medium high land |
| Textural class | Sandy loam |
| **Chemical characteristics** | |
| pH (soil: water = 1:2.5) | 5.87 |
| Organic matter (%) | 1.72 |
| Total N (%) | 0.09 |
| Available P (µg g $^{-1}$) | 14.60 |
| Exchangeable K (meq 100 g $^{-1}$ soil) | 0.20 |
| Available S (µg g $^{-1}$ soil) | 12.36 |

## 3.2 Climate

In the experimental area, usually the rainfall was heavy during summer season (April to September) and scanty in winter (October to March) season. Winter season starts with low temperature and plenty sunshine. The atmospheric temperature increases from February as the season proceeds towards summer.

## 3.3 Test crop

The test crop under the study was BARI gom 25 (*Triticum aestivum*). This variety has gained popularity among the farmers of Bangladesh for its high yield potential. Healthy, vigorous, plumy and well-matured seeds were selected as test crop.

## 3.4 Treatments

Treatment combination were as follows

| | |
|---|---|
| $T_1 = PM_0B_0$ | $T_7 = PM_5B_8$ |
| $T_2 = PM_0B_4$ | $T_8 = PM_5B_{12}$ |
| $T_3 = PM_0B_8$ | $T_9 = PM_{10}B_0$ |
| $T_4 = PM_0B_{12}$ | $T_{10} = PM_{10}B_4$ |
| $T_5 = PM_5B_0$ | $T_{11} = PM_{10}B_8$ |
| $T_6 = PM_5B_4$ | $T_{12} = PM_{10}B_{12}$ |

Here,

| | |
|---|---|
| $PM_0$ = 0 t Poultry Manure $ha^{-1}$ | $B_0$ = 0 kg Boron $ha^{-1}$ |
| $PM_5$ = 5 t Poultry Manure $ha^{-1}$ | $B_4$ = 4 kg Boron $ha^{-1}$ |
| $PM_{10}$ = 10 t Poultry Manure $ha^{-1}$ | $B_8$ = 8 kg Boron $ha^{-1}$ |
| | $B_{12}$ = 12 kg Boron $ha^{-1}$ |

**Table 2. Nutrient elements, their sources and doses used in the experiment**

| Nutrient elements | Source | Dose (S) |
|---|---|---|
| Nitrogen | Urea (46% N) | 180 kg $ha^{-1}$ |
| Phosphorus | TSP (20.56% P) | 140 kg $ha^{-1}$ |
| Potassium | MP (42.22% K) | 40 kg $ha^{-1}$ |
| Zinc | $ZnSO_4$ (65% Zn) | 8 kg $ha^{-1}$ |
| Sulphur | Gypsum (18% S) | 110-120 kg $ha^{-1}$ |
| Poultry manure | | 0, 5 and 10 t $ha^{-1}$ |
| Boron | Borax (11% B) | 5-7 kg $ha^{-1}$ |

** On soil test basis

### 3.5 Land preparation

Land preparation was started 7 days before seed sowing. The land was first opened by a tractor and the land was prepared thoroughly by ploughing and cross ploughing with a power tiller. Every ploughing was followed by laddering to obtain a good tilth. Weeds and stubbles were collected and removed from the field. Field layout was done on 01 November 2016, according to the design adopted. Finally, individual plots were prepared with spade on 15 November 2016.

### 3.6 Design and layout of the experiment

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications (Fig. 1). The treatments were randomly distributed to the plots.

The layout of the experiment was as follows:

Total number of plots = 12 fertilizer treatments × 3 replications = 36

Individual plot size = 4 m × 2.5 m = 10 $m^2$

Space between unit plots = 0.5 m

Space between replication = 1 m

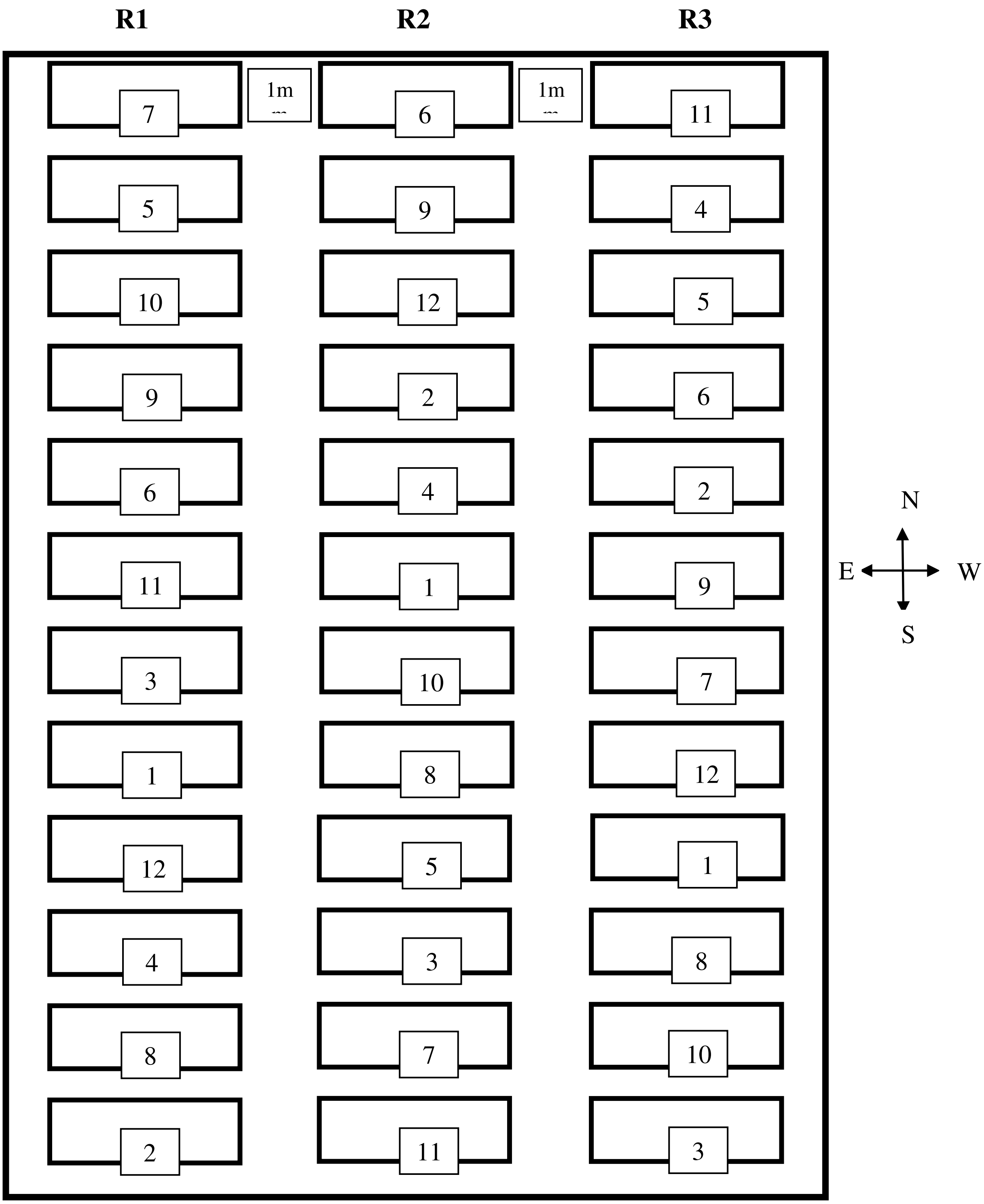


Fig. 1. Randomized Complete Block Design (RCBD)

### 3.7 Collection of seeds

The seeds were collected from the Wheat Research Center Noshipur, Dinajpur.

### 3.8 Fertilizer application

Boron containing fertilizer boric acid ($H_3BO_3$) and poultry manure (PM) were applied as per design and treatments and all other fertilizers were applied according to soil test basis. The full amount of phosphorus, potassium, Sulphur, Zinc and one third of the nitrogen were applied during final land preparation in the form of triple super phosphate, muriate of potash, gypsum and urea, respectively. Another one third of nitrogen was applied first irrigation and the last one third second irrigation. The common doses N, P, K, S, Zn are mentioned in the table 2.

### 3.9 Date of sowing

Seeds were sown at the rate of 120 kg $ha^{-1}$ (BINA, 1998). Seeds were sown in the plots 20 November, 2016. Sowing was made continuously in lines and seeds were covered by soil. The spacing between lines was 20 cm.

### 3.10 Seeds Germination

Germination of seeds started from 4 day of sowing. On the $6^{th}$ to $7^{th}$ day all the seeds were germinated.

### 3.11 Intercultural operation

Intercultural operations were done to ensure normal growth of crop. All the seedlings of the crop emerged out within 6-7 days after sowing. Irrigation was given three on $7^{th}$ December 2016, $25^{th}$ January 2017 and $5^{th}$ February 2017 in order to maintain enough suitable moisture in the field.

### 3.12 Harvesting and threshing

The crop was harvested at maturity on $20^{th}$ February 2017. The sample plants from each unit plot were uprooted at random prior to harvest, which were dried properly for collecting data on yield components. Per plot yields of grain and straw were recorded after drying the plants in the sun followed by threshing and cleaning.

**3.13 Data collection**

The data as per objectives of the study were collected as follows:

i. Plant height

ii. Spike length

iii. Number of tillers $hill^{-1}$

iv. Number of spikelets $spike^{-1}$

v. 1000 grain weight

vi. Grain weight

vii. Straw weight

**3.14 Collection of plant samples**

Plant samples were collected from the plot during harvesting. Ten plants from each plot were carefully uprooted through random selections with the help of a nirani. The fresh weight of plant samples was recorded and then dried in air followed by oven drying at $65^0$ C for 48 hours and the dry weight of the plants were noted.

**3.15 Straw weight**

The sun dried weight of straw was recorded and the mean values were determined.

**3.16 Preparation of plant and soil samples for chemical analysis**

Grain and straw samples of all crops were separated and collected at the time of threshing. The plant grain and straw samples were oven dried at 65-$70^0$C for 48 hours. The dried plant samples were finely ground by using a Willy-Mill with stainless contact points to pass through a 60-mesh sieve. The post-harvest soil samples were stored for analysis of pH, organic matter, and N, P, K and S contents. The plant samples were stored for analysis of N, S contents. The standard methods used for plant and soil samples analysis were as follows:

### 3.17 Soil sample analysis for different parameters

| Elements | Methods |
|---|---|
| N | Micro-Kjeldahl method (Bremner and Mulvancey, 1982). The soil sample was digested with conc. $H_2S0_4$ in presence of catalyst mixture ($K_2SO_4$: $CuSO_4$: Se = 10: 1: 0.1). Nitrogen in the digest was estimated by distillation with 10N NaOH followed by titration of the distillate trapped in $H_3BO_3$ indicator solution with 0.01 N $H_2S0_4$. |
| P | Available phosphorus was extracted from the soil with 0.5 M sodium bicarbonate solution, pH 8.5 (Olsen *et al.,* 1954). Phosphorus in the extract was then determined by developing blue color with $SnCl_2$ reduction of phosphomolybdate complex and the color intensity was measured colorimetrically at 660 nm wave lengths (Page *et al.,* 1989). |
| K | Exchangeable potassium was determined by the ammonium acetate extraction method using flame photometer as described by Page *et al.* (1989). |
| S | Available sulphur was determined by extracting the soil sample with 0.01M Ca $(H_2P0_4)_2$. The S content in the extract was estimated turbidimetrically and the intensity of turbid was measured by spectrophotometer at 420 nm wavelength. |

### 3.18 Statistical analysis

All the collected data were subjected to statistical analysis following the ANOVA technique and the mean were compared by Duncan’s Multiple Range Test (DMRT).

# CHAPTER IV

# RESULTS AND DISCUSSION

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The present experiment was conducted to determine the effect of boron (B) and poultry manure (PM) on yield and yield contributing characters of wheat. The result has been discussed and possible explanations have been given under the following headings.

**Yield and yield contributing characters**

Yield contributing characters such as plant height, spike length, number of tillers hill$^{-1}$, number of grain spike$^{-1}$, 1000 grain weight, straw yield, grain yield ha$^{-1}$ were recorded in every trial.

## 4.1 Effect of boron and poultry manure on the growth of wheat

### 4.1.1 Plant height

The plant height of wheat was significantly influenced by the different treatments (Table 3). The application of boron (B) and poultry manure (PM) significantly increased the plant heights of wheat compared to that found in control. The plant height increased progressively with the application of increasing level of B and PM. The highest plant height (89.50 cm) was recorded in the treatment $T_7$ ($PM_5B_8$) which was closely followed by the treatment $T_{12}$. The lowest plant height (63.50 cm) was recorded in control ($T_1$). Boron transport through the xylem vessel and increasing sugar and hydrocarbons which helps in the higher growth of the plant. Similer results were recorded by Moeinian *et al.* (2011).

### 4.1.2 Spike length

The application of B and PM effect the length of spike significantly (Table 3). The spike length varied from 5.17 to 9.17cm. The highest and statistically superior spike length 9.17 cm was recorded in the treatment combination of

$PM_5B_8$ ($T_7$). On the other hand, the lowest spike length 5.17 cm obtained in the treatment $T_1$.

### 4.1.3 Number of tillers hill$^{-1}$

A significant change in number of tillers was noticed with the application of B and PM. The number of tiller hill$^{-1}$ enhanced with increasing doses of B and PM. The maximum tiller hill$^{-1}$ (4.67) was found in the treatment $T_7$ which was statistically similar with those found the treatments $T_6$ and $T_{12}$. The lowest tiller number (2.00) was observed in the control treatment ($T_1$). Agbede *et al.* (2008) 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 $^{-1}$.

### 4.1.4 Number of grains spike$^{-1}$

The maximum number of grain spike$^{-1}$ significantly increased with the application of B and PM. The effect of different levels of B and PM was significant as observed on number of grain spike$^{-1}$. The number of grain spike$^{-1}$ increased with increasing B and PM levels. The maximum number of grain spike$^{-1}$ (11) was noticed at $T_7$ treatment which was statistically identical with the treatments of $T_{12,}$ $T_{11}$ and $T_{10}$. The lowest number of spike$^{-1}$ (8) was found in $T_1$ treatment which was similar to the treatments $T_{12}$ (Table 3).

### 4.1.5 1000 grain weight

Boron and poultry manure greatly influenced the 1000 grain weight of wheat (Table 3). The weight of 1000 grain increased with increasing levels of PM up to 5 t ha$^{-1}$ and B up to 8 t ha$^{-1}$. The highest 1000 grain weight (41.30 g) was recorded from the treatment $T_7$ which was superior to the other treatments. The lowest weight (23.63 g) was recorded under control. These results suggest that combined use of appropriate doses of B and PM produced maximum 1000 grain weight than the use of same dose of B or PM along.

**Table 3. Effect of boron and poultry manure on the growth parameters of wheat**

| Treatments | Plant height (cm) | Spike length (cm) | Number of tillers hill$^{-1}$ | Number of grains spike$^{-1}$ | 1000 seed weight g$^{-1}$ |
|---|---|---|---|---|---|
| $T_1$ | 63.50 cd | 5.17 f | 2.00 d | 8.00 d | 23.63 g |
| $T_2$ | 68.67 d | 6.33 e | 2.67 cd | 8.12 d | 25.10 fg |
| $T_3$ | 76.50 abcd | 6.73 de | 2.67 cd | 8.67 cd | 27.87 ef |
| $T_4$ | 72.80 bcd | 6.83 de | 3.33 bc | 9.33 bcd | 32.20 cd |
| $T_5$ | 77.80 abcd | 6.37 e | 3.00 bc | 10.00 abc | 30.33 de |
| $T_6$ | 84.83 ab | 6.77 de | 4.00 ab | 9.33 bcd | 32.57 cd |
| $T_7$ | 89.50 a | 9.17 a | 4.67 a | 11.00 a | 41.30 a |
| $T_8$ | 81.4 abc | 7.33 cd | 3.33 bc | 10.33 ab | 36.40 b |
| $T_9$ | 72.53 bcd | 7.90 bc | 3.33 bc | 9.67 abc | 35.88 b |
| $T_{10}$ | 84.70 ab | 6.53 e | 3.00 bc | 10.34 ab | 34.50 bc |
| $T_{11}$ | 84.13 abc | 7.67 bc | 3.67 bc | 10.29 ab | 36.57 b |
| $T_{12}$ | 88.20 ab | 8.13 b | 4.00 ab | 10.67 ab | 37.37 b |
| LSD | 14.11 | 0.65 | 0.90 | 1.316 | 2.860 |
| CV % | 10.59 | 5.47 | 16.16 | 8.06 | 5.15 |

In the column, figures having similar letter(s) do not differ significantly at 5% level of probability.

Here,

$T_1$ =control

$T_2$ = 4 kg B ha$^{-1}$ + 0 t PM ha$^{-1}$

$T_3$ =8 kg B ha$^{-1}$ + 0 t PM ha$^{-1}$

$T_4$ = 12 kg B ha$^{-1}$ + 0 t PM ha$^{-1}$

$T_5$= 0 kg B ha$^{-1}$ + 5 t PM ha$^{-1}$

$T_6$= 4 kg B ha$^{-1}$ + 5 t PM ha$^{-1}$

$T_7$= 8 kg B ha$^{-1}$ + 5 t PM ha$^{-1}$

$T_8$ = 12 kg B ha$^{-1}$ + 5 t PM ha$^{-1}$

$T_9$ = 0 kg B ha$^{-1}$ + 10 t PM ha$^{-1}$

$T_{10}$ = 4 kg B ha$^{-1}$ + 10 t PM ha$^{-1}$

$T_{11}$ = 8 kg B ha$^{-1}$+ 10 t PM ha$^{-1}$

$T_{12}$ = 12 kg B ha$^{-1}$ + 10 t PM ha$^{-1}$

### 4.1.6 Straw yield

The different levels of B and PM application showed significant variation of straw yield of wheat (Table 4). The straw yield varied from 2.13 to 4.16 t $ha^{-1}$ (Table 4). The highest straw yield of 4.16 t $ha^{-1}$ was recorded in the treatment combination of $PM_5B_8$ ($T_7$). On the other hand, the lowest straw yield of 2.13 t $ha^{-1}$ was obtained in the control treatment ($T_1$).

### 4.1.7 Grain yield

The grain yield of wheat was significantly influenced by the different treatments. Application of PM along with different levels of B showed the variation for grain yield t $ha^{-1}$ (Table 4). The highest yield (5.62 t $ha^{-1}$) was recored in the treatment $T_7$ ($PM_5B_8$) which was closely followed by $T_{12}$ treatment (5.17 t $ha^{-1}$) and the lowest grain yield (3.09 t $ha^{-1}$) was recorded in the control treatment (Table 4). Similler result was found by Nadim *et al.* (2011) who showed that boron application improved the grains yield of wheat.

**Table 4. Effect of boron and poultry manure on the grain yield and straw yield BARI gom 25**

| Treatment | Grain yield (t ha$^{-1}$) | Straw yield (t ha$^{-1}$) |
|---|---|---|
| $T_1$ | 3.09 h | 2.13 e |
| $T_2$ | 3.80 g | 2.43 de |
| $T_3$ | 3.87 fg | 2.62 de |
| $T_4$ | 4.05 efg | 2.86 cde |
| $T_5$ | 3.72 g | 2.72 cde |
| $T_6$ | 4.72 cd | 2.88 bcde |
| $T_7$ | 5.62 a | 4.16 a |
| $T_8$ | 4.85 bc | 3.75 ab |
| $T_9$ | 4.15 efg | 3.58 abc |
| $T_{10}$ | 4.32 def | 3.29 bcd |
| $T_{11}$ | 4.43 cde | 3.15 cde |
| $T_{12}$ | 5.11 b | 3.19 bcde |
| LSD | 0.44 | 0.79 |
| CV % | 6.07 | 15.15 |

In the column, figures having similar letter(s) do not differ significantly at 5% level of Probability

## 4.2 Chemical Properties of the soil collected after harvesting

### 4.2.1 Soil pH

The pH of the post-harvest soil varied significantly by the different treatments (Table 5). The post-harvest soil was slightly acidic. The value of post harvest soil pH ranged from 5.89 to 6.85. The control treatment showed slightly increases in soil pH than the initial soil. There were no significant differences among the different treatments of the post-harvest soil.

### 4.2.2 Organic matter content in soil

The effect of B and PM was significant on organic matter (OM) content in the soil. The application of B and PM affects on the increased the organic matter status in the soil. Organic matter content of the post-harvest soil was higher in $T_{6,}$ $T_{7,}$ $T_{12}$ treatments compared to the initial soil and the lowest content in the treatment $T_1$ (Table 5). The heighest amount of organic matter was found in $T_7$ treatment which was statistically similler to $T_6$ and $T_{12}$.

### 4.2.3 Total nitrogen in soil

The application of B and PM has a significant effect on total nitrogen in soil. Due to the application of B and PM increased the total soil nitrogen content in different treatments. Soil nitrogen of the post-harvest soil was higher than the initial soil. The highest soil nitrogen was found both in $T_3$ treatments and the lowest soil nitrogen was found in the $T_7$ treatment (Table 5).

**Table 5. Effect of boron and poultry manure on the soil pH, organic matter and total N content of the post-harvest soil**

| Treatments | Soil pH | Organic matter content (%) | Total N (%) |
|---|---|---|---|
| $T_1$ | 6.80 | 1.28 fg | 0.20 abc |
| $T_2$ | 6.20 | 1.63 de | 0.08 abc |
| $T_3$ | 6.60 | 1.79 d | 0.20 a |
| $T_4$ | 6.78 | 2.10 c | 0.15 abc |
| $T_5$ | 6.85 | 2.14 c | 0.04 bc |
| $T_6$ | 6.64 | 2.82 a | 0.14 abc |
| $T_7$ | 6.81 | 3.01 a | 0.05 abc |
| $T_8$ | 6.70 | 1.29 fg | 0.13 abc |
| $T_9$ | 6.54 | 1.49 ef | 0.19 ab |
| $T_{10}$ | 6.70 | 2.50 b | 0.09 a |
| $T_{11}$ | 6.71 | 2.13 c | 0.15 abc |
| $T_{12}$ | 6.68 | 2.98 a | 0.08 abc |
| LSD | 1.36 | 0.2717 | 0.1305 |
| CV % | 12.40 | 8.63 | 65.22 |

In the column, figures having similar letter(s) do not differ significantly at 5% level of probability

### 4.2.4 Available phosphorus in soil

The phosphorus content of the post-harvest soil varied significantly by the different treatments (Table 6). The maximum phosphorus content (89.85 ppm) was found in the treatment $T_{12}$ which was followed by $T_6$ (82.48 ppm), $T_9$ (75.29 ppm) and $T_{11}$ (72.98 ppm) treatments. The lowest phosphorus content (42.48) was observed in the control treatment ($T_1$). The phosphorus content in the treatments $T_4$, $T_9$, $T_{10}$ and $T_{11}$ was statistically similler.

### 4.2.5 Exchangeable potassium in soil

The exchangeable potassium content of the post-harvest soil was influenced by the different treatments. The values of the exchangeable potassium were traveling around from 0.14 to 0.30 meq 100 $g^{-1}$ soil (Table 6). The utmost value of 0.30 meq 100 $g^{-1}$ soil $^{1}$was observed in the treatment $T_{12}$ which was identical to $T_7$ and $T_8$ treatments. The lowest value of 0.14 meq 100 $g^{-1}$ soil was found in the $T_1$ treatment.

### 4.2.6 Availlable sulphur in soil

The post-harvest soil which content available sulphur was different for the different treatments. The available sulphur content in the studied soil ranged from 15.48 to 26.15 µg $g^{-1}$ soils (Table 6). The highest sulphur content (26.15 µg $g^{-1}$ soils) was found in the treatment $T_5$ which was statistically similar to those in $T_2$, $T_3$ and $T_{12}$ treatments. The lowest sulphur (15.48 µg $g^{-1}$ soil) was observed in the treatment $T_1$.

### 4.2.7 Available boron in soil

The post-harvest soil which content available boron was different for the different treatments. The available boron content in the studied soil varied between 0.25 to 0.46 µg $g^{-1}$ soils (Table 6). The highest boron content (0.46 µg $g^{-1}$ soils) was found in the treatment $T_{12}$ which was statistically similar to those in $T_6$, $T_{10}$ and $T_{11}$ treatments. The lowest boron (0.25 µg $g^{-1}$ soil) was recored in the control treatment ($T_1$).

**Table 6. Effect of Boron and poultry manure on the available P, S, B and exchangeable K content of the post-harvest soil**

| Treatments | Available P (ppm) | Exchangeable K (meq 100 $g^{-1}$ soil) | Available S (ppm) | Available B ( meq 100 $g^{-1}$ soil) |
|---|---|---|---|---|
| $T_1$ | 42.48 g | 0.14 f | 15.48 c | 0.25 ef |
| $T_2$ | 68.25 de | 0.20 cde | 23.46 a | 0.26 ef |
| $T_3$ | 69.79 cd | 0.19 def | 22.12 ab | 0.37 bcd |
| $T_4$ | 71.20 bcd | 0.16 ef | 25.29 a | 0.35 bcd |
| $T_5$ | 48.54 fg | 0.20 cde | 26.15 a | 0.29 def |
| $T_6$ | 82.48 ab | 0.21 cde | 18.75 e | 0.42 ab |
| $T_7$ | 58.25 ef | 0.25 abcd | 19.26 e | 0.36 bcd |
| $T_8$ | 49.69 fg | 0.29 ab | 18.75 de | 0.31 cde |
| $T_9$ | 75.29 bcd | 0.24 bcd | 16.18 cd | 0.29 def |
| $T_{10}$ | 71.30 bcd | 0.21 cde | 15.89 c | 0.39 abc |
| $T_{11}$ | 72.98 bcd | 0.22 cde | 17.18 bc | 0.42 ab |
| $T_{12}$ | 89.85 a | 0.30 a | 21.27 ab | 0.46 a |
| LSD | 10.28 | 0.05329 | 4.878 | 0.07 |
| CV % | 9.00 | 14.56 | 16.62 | 14.70 |

In the column, figures having similar letter(s) do not differ significantly at 5% level of probability.

### 4.2.8 Correlation results

The correlation results among the different parameters are shown in the Fig. 4, and 5. The plant height was positively correlated with the grain yield. When plant height increases then grain yield increases. Again the plant height was positively correlated with the number of tiller. With the increasing of plant height increases the number of tillers. Again the application of boron was positively correlated with the grain yield. When apply boron fertilizer then grain yield increases. Again the application of boron fertilizer then increases the number of tillers.

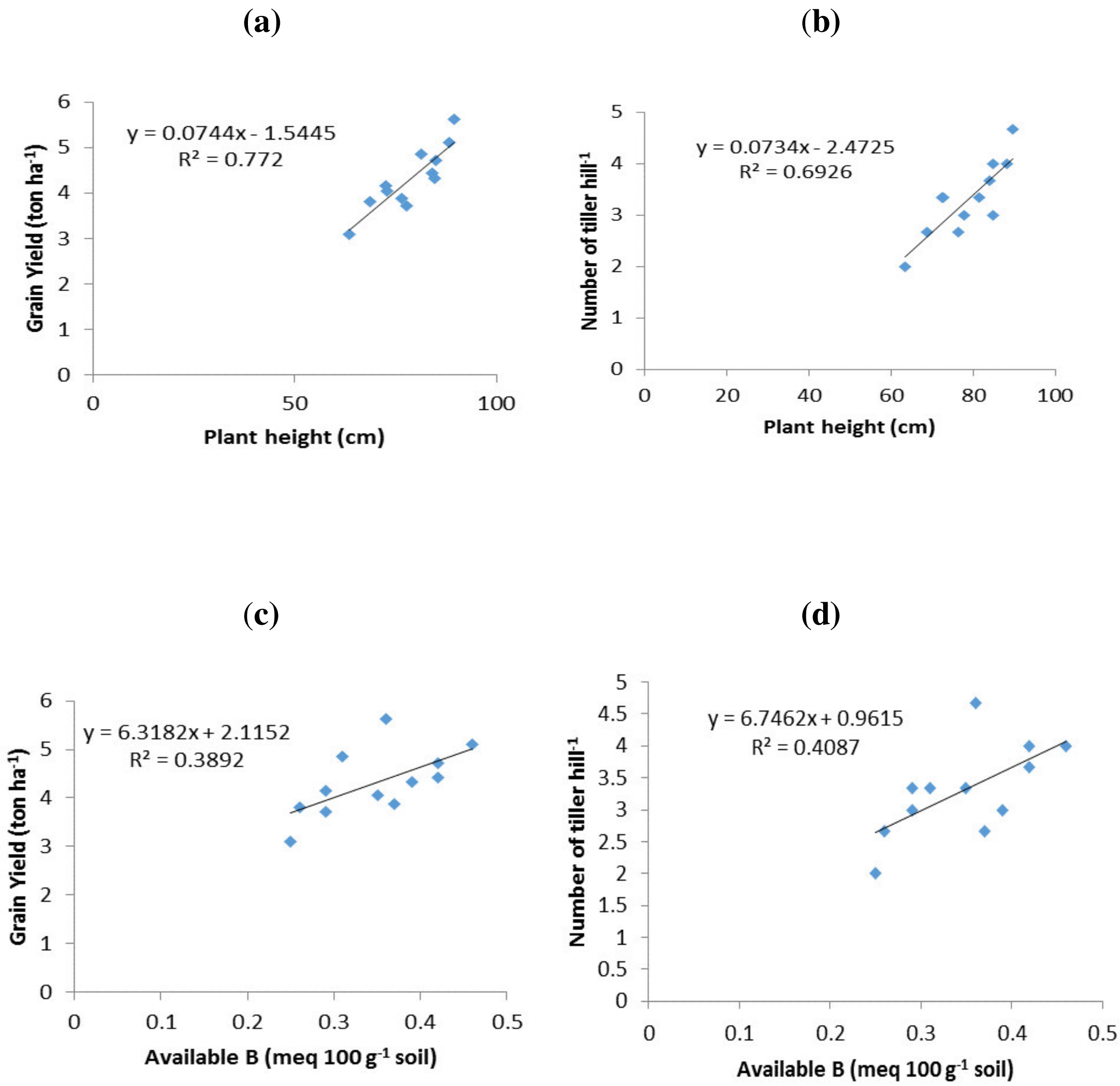


Fig. 4 Relationship between Plant height and grain yield (**a**), plant height and number of tillers (**b**), and available boron and grain yield(**c**), available boron and number of tillers **(d)**

# CHAPTER V

# SUMMARY AND CONCLUSIONS

# CHAPTER V
# SUMMARY AND CONCLUSIONS

The experiment was conducted in Soil Science research field, Hajee Mohammad Danesh Science and Technology University, Dinajpur, during the period of September 2016 to February 2017. The experiment was laid out in a Randomized Complete Block Design (RCBD) with twelve treatments and three replications. The unit plot size was 10 $m^2$ (4 m × 2.5 m). Twelve fertilizer treatments were used and which were $T_1$=$PM_0B_0$, $T_2$=$PM_0B_4$, $T_3$=$PM_0B_8$, $T_4$=$PM_0B_{12}$, $T_5$=$PM_5B_0$, $T_6$=$PM_5B_4$, $T_7$=$PM_5B_8$, $T_8$ =$PM_5B_{12}$, $T_9$ =$PM_{10}B_0$, $T_{10}$ =$PM_{10}B_4$, $T_{11}$ = $PM_{10}B_8$ and $T_{12}$ =$PM_{10}B_{12}$. Recommended doses of N, P, K, S and Zn were applied in all the treatments. They were distributed randomly in individual plots. The total numbers of plots were 36 (12×3). Boron was applied as boric acid at the rate of and N, P, K was applied as urea, triple super phosphate and muriate of potash at the rate of 180, 140 and 40 kg $ha^{-1}$ respectively. Seeds were sown on the 15$^{th}$ November 2016. The crop was allowed to grow until maturity and intercultural operations such as weeding and irrigation were done whenever required in order to support normal growth of the plant. At maturity, the crop was harvested on 12$^{th}$ February, 2017. Plot wise yield and yield components were recorded.

Boron (B) and poultry manure (PM) fertilization significantly increased the plant height and number of primary branch $plant^{-1}$. The highest plant height (89.50 cm) was observed in the treatment combination of $PM_5B_8$ followed by control plot (63.50 cm). The number of tillers $plant^{-1}$ varied significantly by the combination of B and PM. The maximum number of tillers was observed in $T_7$ treatment and minimum in the control treatment $T_1$. The number of grain $plant^{-1}$ also increased by B and PM fertilization and ranged from 11.0 to 8.0. The significant increase was obtained up to $T_7$ treatment. Spike length was also significantly influenced by B and PM application which varied between 5.17 and 9.17 cm with all the treatments.

1000-seed weight was found significant with different levels of B and PM fertilizer and was found maximum in the treatment $T_7$ showing other levels more or less same. Grain yield ranged from 3.09 to 5.62 kg $ha^{-1}$ due to the effect of B and PM application. The lowest grain yield was observed in $T_1$ treatment and the highest was in $T_7$. Grain yield was positively correlated with spike $plant^{-1}$ and effective grain $plant^{-1}$. Straw yield was also significantly positive as an effect of B and PM application. The rate of increase in straw yield continued to treatment combination of $PM_5$ $B_{8.}$

The treatment of $T_7$ followed by $T_{10}$ and $T_{12}$ of BARI gom 25 produced higher values of yield, whereas the lowest was recorded in the treatment $T_1$ followed by $T_2$. However, for maximizing the grain yield of wheat 8 kg B $ha^{-1}$ with 10 t PM $ha^{-1}$ could be applied.

**Recommendation**

Considering the above observation of the experiment further studies in the following may be suggested.

- Further study may be needed to ensure the growth and yield performance of wheat in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability.
- More inorganic and organic fertilizer may be needed to include for future study as sole or different combination to confirm in replacing chemical fertilizer doses.

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# APPENDICES

# APPENDICES

## Appendix I
## Monthly recorded air temperature, relative humidity and rainfall during November, 2016 to February, 2017.

| Year | Month | ** Air temperature ($^oC$) | | | **Humidity (%) | **Rainfall (mm) |
|---|---|---|---|---|---|---|
| | | Maximum | Minimum | Average | | |
| 2016 | November | 26.8 | 12.5 | 19.65 | 87 | 8 |
| | December | 26.4 | 12.1 | 19.25 | 85 | 7 |
| 2017 | January | 25 | 9.7 | | 81 | 4 |
| | February | 12.5 | 28.1 | | 77 | 0 |

**Monthly average

Source: Wheat Research Centre, Nasipur, Dinajpur

# Appendix II

## Schedule of cultural operations in the experimental plot

| Serial no | Cultural operations | Date |
|---|---|---|
| 1 | Opening of the land | 01.11.2016 |
| 2 | Cross ploughing | 01.11.2016 |
| 3 | Breaking of clods, laddering and weeding | 01.11.2016 |
| 4 | 2nd and 3rd (ploughing) | 17.11.2016 |
| 5 | Lime application | 01.11.2016 |
| 6 | Final weed collection | 17.11.2016 |
| 7 | Layout of the experiment | 01.11.2016 |
| 8 | Application of the 2nd /3rd doses of urea and entire of other fertilizers | 17.11.20176 |
| 9 | Sowing of seeds | 19.11.2016 |
| 10 | 1st weeding thinning and irrigation | 10.12.2016 |
| 11 | Application of the 1/3rd doses of urea | 10.12.2016 |
| 12 | 2nd weediong | 27. 12.2016 |
| 13 | 2nd irrigation | 13.12.2016 |
| 14 | 3rd irrigation | 17.01.2017 |
| 15 | Harvesting | 23.03 .2017 |
| 16 | Threshing | 30.03.2017 |
| 17 | Weighing | 30.03.2017 |

# Appendix III

# Some photographs showing different treatments during research work

**Continued**