EFFECT OF POULTRY MANURE AND NPK FERTILIZERS ON THE GROWTH AND YIELD OF WHEAT (BARI Gom 26)

A THESIS

BY

MD. TOUHIDUL ISLAM
Student No. 1605347
Semester: July-December, 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

DECEMBER, 2017

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Submitted to the Department of Soil Science
Hajee Mohammad Danesh Science and Technology University, Dinajpur
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE (M.S.)

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DECEMBER, 2017

DEDICATED

TO

MY BELOVED PARENTS

ACKNOWLEDGEMENTS

All praises for Almighty the most merciful and the supreme ruler of the universe Who has blessed the author with life, time and energy and enabled him to complete the present research work and to prepare this manuscript for the degree of Master of Science (MS) in Soil Science.

With profound pleasure and privilege, I would like to express my deepest sense of gratitude and indebtedness to my honorable teacher and supervisor Professor Dr. Shah Moinur Rahman, Department of Soil Science, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur for his constant and scholastic guidance, untiring assistance, valuable suggestion, continuous inspiration and immense help throughout the tenure of this research work and preparation of this thesis.

Deep appreciation and profound regards to my co-supervisor Dr. Md. Mansur Rahman, Professor, Department of Soil Science, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur for his valuable guidance, untiring supervision, cordial support, high encouragement and co-operation in carrying out research and preparing the thesis.

I also express my respect and thankfulness to all teachers of the Department of Soil Science, HSTU, Dinajpur for their good advices and co-operation during the period of this study.

Cordial appreciations and thanks are extended to all the staffs of the Department of Soil Science, HSTU, and Dinajpur for their helps and co-operation.

Finally, I express my gratefulness and deepest appreciation to my beloved parents and friends for their blessings, immeasurable sacrifice, endless prayer and continuous inspirations throughout my academic life to reach me this level of higher education.

The Author

ABSTRACT

An experiment was conducted at central research field of Hajee Mohammad Danesh Science and Technology University, Dinajpur during the period of October 2016 to March 2017 in order to investigate the effects of different levels of nitrogen (N) phosphorus (P) potasium (K) and poultry manure (PM) on the yield and yield contributing characteristics of wheat (BARI Gom 26) in the design of Randomized Complete Block Design (RCBD). Five fertilizer treatments were used and which were $T_1 = PM_0(NPK)_0$, $T_2 = PM_0(NPK)_{100}$, $T_3 = PM_{100}(NPK)_0$, $T_4 = PM_{100}(NPK)_{50}$, $T_5 = PM_{100}(NPK)_{33}$. The experimental results revealed that plant height, spike length, number of tillers hill^{-1}, number of spikelet's spike^{-1}, 1000-grain weight, straw weight, grain weight were significantly influenced by PM and NPK fertilizers. The highest plant height (96.95cm) was observed in T_4 treatment and the lowest (74.80cm) was found in the control. The maximum number of tillers (10.25) was produced in the treatment T_4 and minimum number (3.75) was found in the control. The highest number of grain (57.42) was found in the treatment T_4 which was statistically identical. The lowest number of grain (20.40) was observed in the control treatment. Grain yield and straw yield of wheat plants were significantly influenced with the application of PM along with NPK fertilizers. It was found that the application of NPK fertilizers at 75-70-50 kg ha^{-1} with 8 t PM ha^{-1} produced the highest grain (5.24 t ha^{-1}) and straw (4.95 t ha^{-1}) yield. The control treatment produced the lowest grain (3.08 t ha^{-1}) and straw (3.15 t ha^{-1}) yield. The findings of the study showed that the performance of the treatment T_4 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 NPK fertilizers at 75-70-50 kg ha^{-1} with 8 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

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INTRODUCTION

Wheat (*Triticum aestivum* L.) is commonly cultivated as a cereal crop in the world. Wheat is a staple food for more than one third of the world population (Anonymous, 2007-08). In Bangladesh, it is the second major cereal crop after rice. The average yield of wheat in this country is quite low as compared to that of wheat growing countries of the world like China and Japan Cereal crops contribute about 80% to the total food coming from plants. Wheat contributes largest part among all cereals. Cereals are an important dietary protein source throughout the world, because they constitute the main protein and energy supply in most countries (Bos *et al*., 2005). Wheat is second after rice as a source of calories in the diets of consumers in developing countries and is first as a source of protein which is consumed by humans and is grown in diverse environments around the world (Braun *et al*., 2010). Among the cheapest source of food wheat provides calories of 72% and protein in the normal human consume routine. In addition of this, its 100 g grain contains 326-335 calories, 11.57-14.0 g water, 9.4-14.0 g protein, 1.8-2.5 g fat, 69.1-75.4 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, 0.11-0.12 mg riboflavin and 4.3-5.3 mg niacin (Ken., 2004; Rehim and Schmitt, 2010).

Wheat was an important cultivated cereal in South-Western Asia, its geographical centre of origin. Wheat was cultivated in ancient Greece and Egypt in pre-historic times. The central Asia, Near East, Mediterranean and Ethiopian regions are the world's most important centers of diversity of wheat and its related species (Kundu and Nagarajan, 1996; Perrino and Porcedu, 1990). Wheat is more widely cultivated than any other crop after rice. In Bangladesh, the total area under wheat crop has been estimated 10,99,158 acres (4,44,805 hectares) compared to 10,79,411 acres (4,36,814 hectares) of the last year (BBS, 2016). With rapidly increasing population, the demand of food is increasing. So there is great need to increase the productivity of wheat. Average yield rate of wheat has been estimated 32.86 mounds per acre (3.03 m t h^{-1}) which is 1.78% lower than that of last year (BBS, 2016).

Fertilizers are usually applied to soil for increasing or maintaining crop yields to meet the increasing demand of food (Haynes *et al.*, 1998). Continuous application of chemical fertilizers causes soil health problems even if applied in balanced proportion (Zia *et al.*, 2000). One of the possible options to reduce the use of chemical fertilizer could be using of organic matter.

Organic matter plays an important role in maintaining soil fertility. A good soil have at least 2.5% organic matter, but in Bangladesh most of have less than 1.5% and some soils even less than 1% organic matter (Anonymous, 2005). Since fertile soil is the fundamental resource for higher production, its maintenance is a prerequisite for long term sustainable crop production of crops cannot be maintained by using chemical fertilizers alone and similarly, it is not possible to obtain higher crop yield by using only organic manure (Bair, 2000).

The organic matter content as well as the fertility status of Bangladesh soil is decreasing day by day (BARC, 2012). It is now essential to increase organic matter content through combined application of organic and inorganic fertilizer. Integration of organic and inorganic fertilizers has shown commitment not only in sustaining the productivity and soil health but also in meeting a part of costly inorganic fertilizer requirement of crops (Rabindra *et al.*, 1990; Hegde and Swievedi, 1993). Only the solution is to combined use these materials for agricultural lands.

Poultry manure (PM) is an excellent organic fertilizer because it contains high nitrogen (N), phosphorus (P), potassium (K) 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 PM 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).

PM 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 eco-friendly and have no toxicity.

Keeping the above stated in view, the present study was undertaken to find out the effect of PM and different combination of NPK fertilizers on crop growth and yield performance of wheat (BARI Gom 26) with following specific objectives:

i. To study the effects of PM and NPK fertilizers on the growth and yield of wheat (BARI Gom 26).

ii. To sort out the best combination of PM and NPK fertilizers for maximum growth and yield of BARI Gom 26.

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

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 PM 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 PM 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.

Al Amin *et al.* (2017) conducted an experiment at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh in Rabi season (dry season) of 2014 to study the effect of mulching and organic manure on growth and yield performance of wheat. They used five mulching practices viz. M_1 = 1 irrigation at 17-21 days after sowing (DAS), M_2 = 2 irrigations at 17-21 and 55-60 DAS, M_3 = 3 irrigations at 17-21, 55-60 and 75-80 DAS, M_4 = control, M_5 = straw mulch (6 t ha^{-1}) and five organic manure managements viz. O_1 = recommended chemical fertilizer (NPKS @ 100-23-20-16 kg ha^{-1}), O_2 = poultry manure @ 6 t ha^{-1} (100% PM), O_3 = vermicompost @ 8 t ha^{-1} (100% VC), O_4 = 50% chemical fertilizer + 50% VC and O_5 = 50% chemical fertilizer + 50% PM were used as experimental variables. The experiment was conducted in split-plot design with three replications. The results found that mulching had significant influence on all attributes. The highest values of all attributes were found in straw mulch treatment. It was observed that organic manure had significant influences on all characters. The highest values of yield and yield attributes were found in O_5 (50% chemical fertilizer + 50% PM) treatment. It was observed that effective tillers $hill^{-1}$, grain yield and straw yield were significantly affected by combined effect of mulching and organic manure. The highest values obtained from mulching and O_5 (50% chemical fertilizer + 50% PM) treatment. Therefore, it can be inferred from the results of the study that highest production could be obtained from mulching and O_5 (50% chemical fertilizer + 50% PM) treatment.

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

Akhtar *et al*. (2011) reported that fertilizer application along with compost increased the yield, N and P uptake by wheat compared to the fertilizer alone.

Toor *et al*. (2009) conducted an experiment on the effect of application of PM, farm yard manure and urea on available nutrient status of soil in wheat and observed that PM was more effective than farm yard manure for available N and P.

Abbasi and Tahir demonstrated that the application of farmyard manure or PM and other organic substrates either alone or in combination with inorganic fertilizers had positive effects on wheat productivity. However, many studies have also shown that manure application changes the levels of soil macronutrients and their availability, which may affect the soil micronutrient levels. Long-term organic fertilization using manure or manure plus NPK fertilizers can significantly increase the soil organic C, total N, NH_4^+–N, total S, and soil available P levels. Thus, the concentrations of available Zn, Fe, and Mn in the soil were found to increase significantly with the organic matter contents. In particular, the presence of PO_4^{2-}, $H_2PO_4^-$, or HPO_4^{2-} anions in soil solution can lead to the precipitation of $Zn_3(PO_4)_2$ with Zn ions, thereby immobilizing Zn and decreasing its mobility in the soil with increasing manure application. Some studies have even shown that manure can increase the accumulation of heavy metals in soil.

Agbede *et al*. (2008) viewed that PM is the organic waste material from poultry consisting of animal feces and urine. PM is an excellent fertilizer material because of its high nutrient content, especially for N. Its proper application increased soil and plant nutrient status, increases soil organic matter and water holding capacity. Manures decompose (mineralize) in the soil releasing nutrients for crop uptake. PM contains 3-5% N, 1.5-3.5% P, 1.5-3% K and considerable amount of micronutrients and its p^H is 6-7. PM application registered over 53% increase of N level in the soil, from 0.09% to 0.14%.

Beri *et al*. (1995) observed that greater decline in wheat yield at a low rate of N application (0.5 t ha^{-1} declines at 60 kg N t ha^{-1}) than at a high rate of N application (0.08 t ha^{-1} declines at 180 kg N t ha^{-1}).

Bhattacharyya *et al.* (2010) recorded about 27% higher wheat yield in NPK (120 kg N ha^{-1}, 26 kg P ha^{-1}, 33 kg K ha^{-1}) and FYM (10 t ha^{-1}) treated plots than in NPK plots (2.4 t ha^{-1}).

Fagimi and Ode bode (2007) reported that poultry droppings applied at the rate of 10 t ha^{-1} and 20 t ha^{-1}, increased plant height, number of leaves and fruit yield of Pepper, while the incidence and severity of Pepper Venial Mottle Virus (PVMV) was reduced.

BBS (2010) reported that the organic matter in various forms and at various stages of decomposition has been used in soil in tons ha^{-1} for improvement of crop productivity. The use of inorganic chemical fertilizers is essential for crop nutrition in order to maximize productivity. The crop yields especially of wheat are stagnant for the last couple of years. The use of organic manures along with chemical fertilizers may be effective for further increase in crop yield.

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

Sarkar and Singh (1997) found that organic fertilizer alone or in combination with inorganic fertilizer increased the level of organic carbon in the soil as well as the total N, P and K content in the soil.

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 PM contains 13% water, 3.6% N, 3.5% P_2O_5 and 1.6% K_2O.

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

Meisner *et al.* (2010) recorded that application of 10 t FYM ha^{-1} along with 75% of the local fertilizer recommendation produced grain yield of wheat equivalent to 100% of the inorganic fertilizer treatment (100 kg N ha^{-1}, 26 kg P ha^{-1}, 33 kg K ha^{-1}). The application of 10 t ha^{-1} FYM along with 100% local recommendation of NPK (120 kg N ha^{-1}, 26 kg P ha^{-1}, 25 kg K ha^{-1}) produced wheat grain yield as high as produced by 150% NPK.

Shah *et al.* (2010) was evaluated in a field experiment at Nuclear Institute for Food and Agriculture (NIFA), Peshawar during December 2004 to May 2005 to integrated use of organic and inorganic fertilizers on the yield of wheat. The organic sources used were farmyard manure, PM and city waste. These were integrated in different proportions with mineral nitrogenous fertilizer to supply 120 kg N ha^{-1}. All the organic fertilizers were applied at sowing time and mineral fertilizer (urea) was applied in three splitter sowing, tillering and booting stages in equal amount. The results showed that integrated use in different proportion increased the plant height, spike length, grain per spike and 1000-grain weight. Maximum grain yield of 3.5t ha^{-1} was obtained from treatments where 25% N was applied from FYM 25% N from PM or city waste and 50% from mineral source and in treatment where 25% N was applied from FYM, 25% from city waste and 50% from mineral fertilizer. Application of half N from urea with 25% N from either FYM and 25% PM or city waste proved beneficial and reduced 50% fertilizer cost.

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

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

Kamal *et al.* (2012) stated that organic fertilizer is effective in restoring the productivity of degraded soil.

Kindred *et al*. (2008) stated that N is the third most important environmental factor for wheat production which influences yield and quality of grain. Appropriate amount of N increases number of productive tillers, leaf area index and grain yield. N as a structural part of chlorophyll increases plant ability to synthesize photosynthetic proteins. Crop production is significantly influenced by a number of nutrients particularly with N. Sufficient amount of N promotes vigorous growth and dark green color. N availability at critical growth stages is of supreme importance. Among the agronomic practices, the rate and technique of N fertilization has been used effectively to improve protein contents and grain quality.

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

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

Rehman *et al.* (2008) was conducted experiment during 2003-04 and 2004-05 under rain fed conditions at Cereal Crops Research Institute Pirsabaq, NWFP, Pakistan. They use nine different combinations of NPK (control, 40-30-30, 40-30-60, 40-60-30, 40-60-60, 80-30-30, 80-30-60, 80-60-30 and 80-60-60 kg ha^{-1} and four different levels of FYM (control, 15, 30 and 45 t ha^{-1}) and a wheat variety (Haider-2000). Experiment was laid out in randomized complete block (RCB) design with split plot arrangement replicated four times. FYM was allotted to main plots while combinations of NPK fertilizers were applied to sub-plots.

Different levels of NPK and FYM alone or in combination had significant effect on emergence m^{-2}, spikes m^{-2}, grains $spike^{-1}$, biological yield (kg ha^{-1}) and thousand grain weight. Maximum emergence m^{-2} (83.5), grains $spike^{-1}$ (55.8) thousand grain weight (35.16) and biological yield (10008 kg ha^{-1}) were recorded at 80-60-60 NPK ha^{-1}. Maximum spikes m^{-2} (201.6) were recorded at 80-60-30 kg NPK ha^{-1}. Farmyard manure at 45 t ha^{-1} produce the maximum spikes m^{-2} (191.2), grains $spike^{-1}$ (54.4), thousand grain weight (34.69) and biological yield (10000 kg ha^{-1}), while no significance difference was recorded for these parameters between 30 and 45 t FYM ha^{-1}. It is concluded that 80-60-60 kg NPK $ha^{-1}$and 30 t FYM ha^{-1} have produced maximum wheat yield components and biomass under rain fed condition.

Hosam EL-Din (2007) observed that the application of farmyard manure at different rates significantly increased yield and its components. He added that organic fertilization reduce soil pollution and sustain soil fertility through their effect on physical, chemical and biological properties of soil.

Huang *et al.* (2005) reported that straw mulch increased wheat (*Triticum aestivum* L.) yields significantly during both dry (1997) and wet (1998) years. It increased biomass and grain yield of spring wheat by 37 and 52%, respectively, in 1997, and by 20 and 26%, respectively, in 1998. Straw mulch also significantly decreased evapo-transpiration ($P< 0.05$), soil water depletion ($P< 0.01$), and increased water-use efficiency ($P< 0.001$).

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

Channabasanagowda *et al*. (2007) studied that vermicompost @ 3.8 t ha^{-1} + PM @ 2.45 t ha^{-1} recorded significantly higher plant height (86.30 cm), number of leaves (40.50) and higher number of tillers (94.60) at 90 DAS and it also recorded higher number of ear heads per meter square (160.10), 1000 seed weight (42.73 g) and seed yield (3043 kg ha^{-1}), vigor index (3223), seedling dry weight (311.27 mg) and protein content (13.41%) of wheat compared to other treatments.

Channabasanagowda *et al*. (2008) stated that organic farming is a production system which provides or largely excludes the use of synthetic inorganic fertilizers, pesticides and growth regulators. Organic manures in combination with each other render greater beneficial effects on plant growth and yield.

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 fertilizers registered highest yield of sorghum.

Sarwar (2005) found that grain yield and yield components of wheat were significantly increased with the application of different organic materials in the form of compost.

Tayebeh *et al.* (2007) reported a positive effect of organic fertilizer on soil structure that lead to better root development and more nutrients uptake. They also concluded that compost not only slowly releases nutrients but also prevent the loss of chemical fertilizers through desertification, volatilization and leaching by binding to nutrients and releasing with the passage of time.

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

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

Namvar *et al*. (2012) investigated that the inoculation with bio-fertilization had significant effect on plant height, grain weight $spike^{-1}$, number of spikes m^{-2}, number of grains $spike^{-1}$, 1000 grain weight, grain and straw yields and crude protein percentage in wheat plants.

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

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

Prasad *et al.* (1984) reported that addition of PM 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 PM; swine manure and FYM were applied to the soil.

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

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

Lal (2005) reported that huge amounts of organic materials are in the form of farm waste, city waste, sewage sludge, poultry litter and agro-industrial wastes. The various forms of organic manures are also being used in the fields for sustainable crop yield. But due to varying composition and water level and bulky nature, their application and transportation is a very big question in this fuel conscious world.

Singh (2006) conducted a field experiment to study the influence of integrated nutrient supply system comprising inorganic fertilizers and organics (FYM, GM and rice straw) on rice-wheat cropping system. He found that the total uptake of N, P and K by both crops increased significantly with combined use of organic and inorganic fertilizers.

Yadav *et al.* (2003) stated that application of 10 t h^{-1} FYM alone or in combination with inorganic fertilizer improved the N and P uptake by wheat compared with application of inorganic fertilizers alone.

Haque *et al.* (2001) reported that increased grain yield with the application of manures and fertilizers in an integrated way.

An experiment was conducted by Mountney (1983) and reported that nutrient values of PM 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.

Nambiar (1991) viewed that integrated use of organic manure and chemical fertilizers would be quite promising not only in providing greater stability in production, but also in maintaining better soil fertility.

Terrance *et al*. (2004) stated that the organic matter in various forms and at various stages of decomposition has been used in soil in tons ha^{-1} for improvement of crop productivity.

Millner *et al*. (1998) reported that composting provides an effective and environment friendly procedure of organic waste disposal because it is more economical and environment friendly. It also conserves natural resources and improves cycling of non-renewable resources. Keeping in view the present energy crises it is an excellent option for energy conservation because a lot of energy is utilized in fertilizer sector.

Khaliq *et al*. (2004) reported that combine use of organic and inorganic sources of nutrients not only supply essential nutrients but also have some positive interaction to increase nutrient use efficiency in late sown wheat. In late sown wheat, manure and N management practices can give good results. One of the possible options to maximize the crop production in late sown wheat by using of organic manure.

Hammad *et al*. (2011) reported that application of manure in combination with fertilizer releases more nutrients. Combine use of chemical and organic N sources can play an important role in soil fertility. Integrated use of PM and N in late sown wheat results in higher yield and improve other components of yield.

Hammad *et al*. (2011) conducted a trial in which different combinations of PM and inorganic fertilizers were used. It was concluded that yield and other yield components of wheat were significantly increased with the combine application of PM and inorganic fertilizer.

Kiani *et al*. (2005) conducted an experiment in which differentϖ combinations of organic and inorganic sources were used. It consists of 100%, 50% and 25% N from PM and N. It was concluded that combine use of organic and synthetic fertilizer have significant improvement with 35 % increase in wheat yield of late sown wheat.

Shah and Ahmad (2006) investigated that by the application of N from PM and urea @ 120 kg per hectare from two sources in ratios 0:100, 25: 75, 50: 50, 75: 25, 100: 0 and 0:0. It was found that treatment in which N was applied from manure and urea in the ratio of 25:75 gave the highest seed yield.

Xin *et al*. (2009) studied the effects of combined application of inorganic and organic fertilizers on grain yield and qualitative traits of wheat. They applied chicken manure and urea. They concluded that combine application of organic and inorganic fertilizers increased grain yield as well as quality traits such as starch improvement in wheat grain.

Xu *et al.* (1997) observed that application of organic matters affected soil p^H value as well as nutrient level and yield.

Meelu and Singh (1991) showed that 4 t ha^{-1} PM along with 60 kg N ha^{-1} as urea produce grain yield of crop similar to that with 120 kg N ha^{-1} as urea alone.

Sarvanan (1987) reported that depleted soil fertility is a major constrain to higher crop production in Bangladesh. Applications of both chemical and organic fertilizers need to be applied for the improvement of soil physical properties and supply of essential plant nutrients for higher yield.

Jiang *et al*. (2010) stated that manure application can increase the crop yield and SOM, as well as improving the soil quality.

Reddy *et al*. (2010) reported that in comparison with all other available manures, PM is considered the best one due to its better decomposition rate and timely availability of nutrients.

Maynard (1984) reported that PM is superior to the other farmyard manure as a source of N supply. All the N in PM is not in available from initially. Hence, soils treated with PM are less susceptible to N leaching since the vegetables grown utilize nitrate as they are produced.

Pong and Laty (2000) stated that the biological manure has many attributes. It supplies a wide variety of nutrients along with organic matters that improves the physical characteristics of soil. Its beneficial effects on plant growth are sometimes difficult to duplicate with other materials. There is also a positive interaction between the combination of organic manures and NPK fertilizers.

Khaliq *et al*. (2006) stated that in the long term use, organic manures hold great promise for improving soil characteristics. Because of rapidly rising energy costs and the uncertain availability of chemical fertilizers, in the developing countries, the need for using organic manures was realized. Present study was designed to evaluate the effect of organic manure with chemical fertilizers on the yield of wheat.

Zahoor (2014) was examined in the experimental research farm agricultural university, Peshawar during December 2009 to May 2010 to study the effect of integrated use of urea and farm yard manure (FYM) on nitrogen uptake and yield of wheat (*Triticum aestivum* L). They used organic and inorganic fertilizers for crop productivity and sustainability. The result of those experiment showed that application of 10 t FYM ha^{-1} before sowing increased the number spike m^{-2}, grain yield, grain spike^{-1}, 1000 grain yield compared with control. It was proved from the experimental results that the uses of FYM with urea before sowing have the potential to enhance the yield of wheat.

Zhang *et al.* (1998) concluded that organic manures increased labile, moderately stable and stable organic P contents in soil.

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 at the central 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.

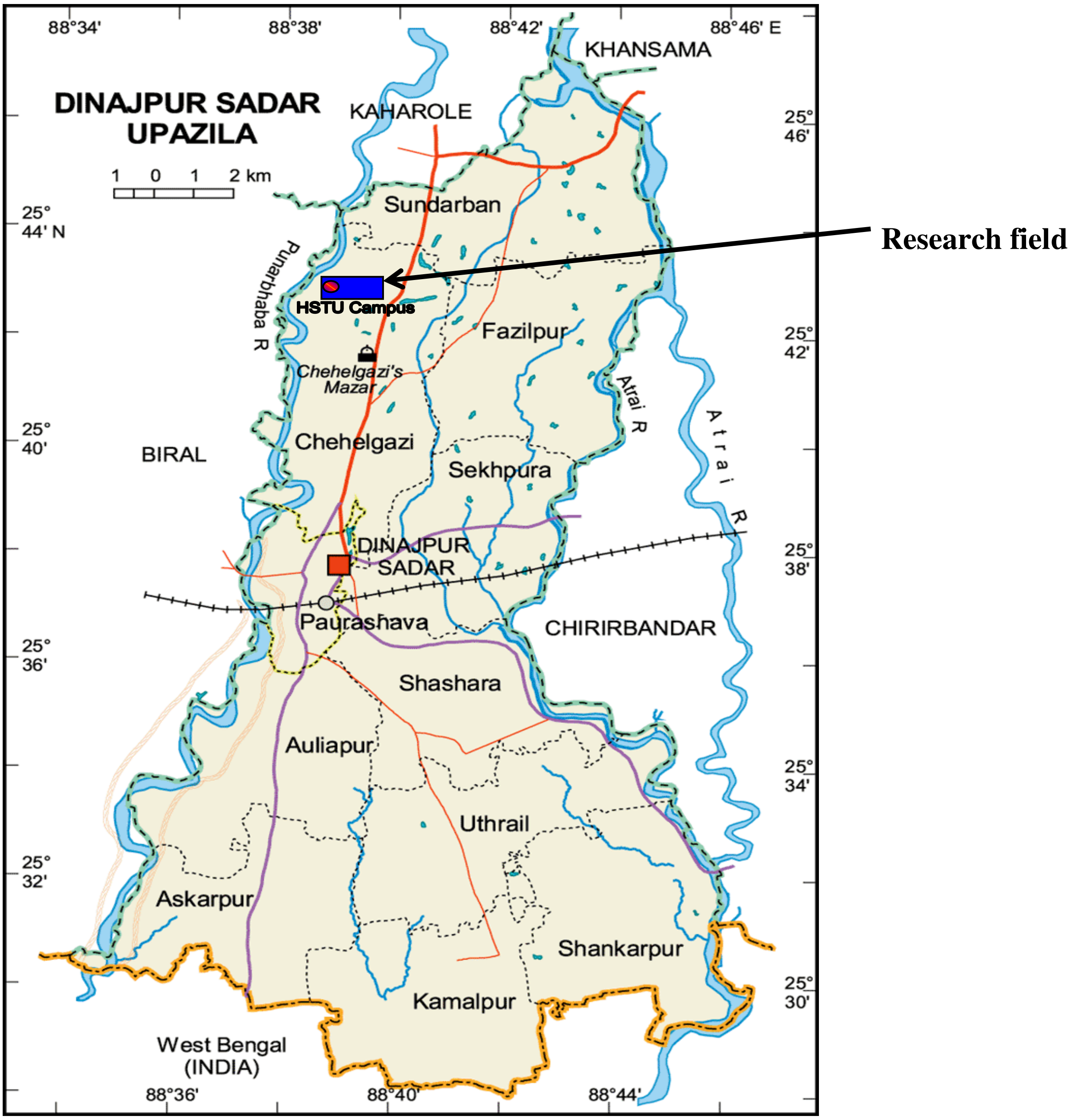

Fig. 3.1: Location of the experimental site

(Map of Dinajpur Sadar Upazila showing the research field)

Table 1. Morphological, Physical and Chemical characteristics of the soils of Central Research Field of HSTU

Morphological and physical 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)	5.49
Organic matter (%)	1.55
Total N (%)	0.09
Available P (ppm)	48.64
Exchangeable K (meq 100 g^{-1} soil)	0.21
Available S (ppm)	13.75

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 26 (*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

$T_1 = PM_0(NPK)_0$

$T_2 = PM_0(NPK)_{100}$

$T_3 = PM_{100}(NPK)_0$

T_4= $PM_{100}(NPK)_{50}$

T_5 = $PM_{100}(NPK)_{33}$

Where the treatments were required,

T_1= Control (No fertilizers)

T_2 = 0 t ha^{-1} PM+150-140-100 kg ha^{-1} Urea, TSP, MoP

T_3 = 8 t ha^{-1} PM+ 0 kg ha^{-1} Urea, TSP, MoP

T_4 = 8 t ha^{-1} PM+75-70-50 kg ha^{-1} Urea, TSP, MoP

T_5 = 8 t ha^{-1} PM+50-46.6-33.3 kg ha^{-1} Urea, TSP, MoP

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

Nutrient elements	Source	Dose (S)
Nitrogen (N)	Urea (46% N)	150 kg ha^{-1}
Phosphorus (P)	TSP (20.56% P)	140 kg ha^{-1}
Potassium (K)	MoP (42.22% K)	100 kg ha^{-1}
Poultry manure (PM)	Poultry farm	8 t ha^{-1}

** On recommended dose 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 four replications (Fig. 3.2). The treatments were randomly distributed to the plots.

The layout of the experiment was as follows:

Total number of plots = 5 fertilizer treatments × 4 replications = 20

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

Space between unit plots = 0.5 m

Space between replication = 1 m

The layout of the experimental field has shown in Fig. 3.2.

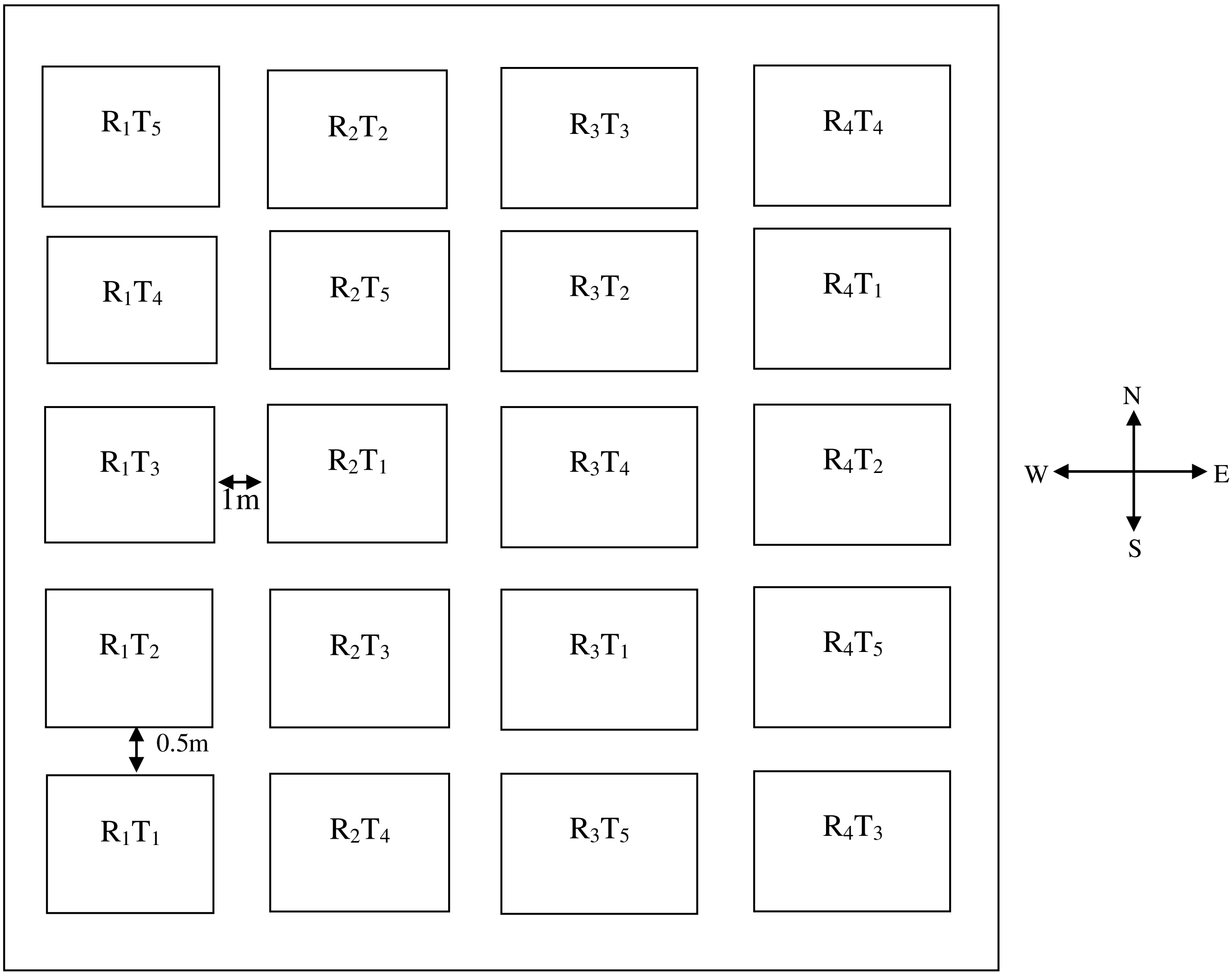

Fig. 3.2: Layout of the experiment

3.7 Collection of Seeds

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

3.8 Fertilizer Application

NPK containing fertilizers Urea, TSP, MoP and PM were applied as per design and treatments according to recommended basis. The full amount of P, K and one third of the N were applied during final land preparation in the form of TSP, MoP and Urea, respectively. Another one third of Urea was applied after first irrigation and the last one third after second irrigation. The common doses N, P, K 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 22 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 29^{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 spikelet's spike^{-1}
v. 1000 grain weight
vi. Grain yield
vii. Straw yield

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 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 65-70^0C 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 and K contents.

The plant samples were stored for analysis of N contents. The standard methods used for plant and soil samples analysis were as follows:

3.17 Soil Sample Analysis for Different Parameters

N-Test: 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-Test: Available P was extracted from the soil with 0.5 M sodium bicarbonate solution, pH 8.5 (Olsen *et al.,* 1954). P 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-Test: Exchangeable K was determined by the ammonium acetate extraction method using flame photometer as described by Page *et al.* (1989).

S-Test: Available S 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

CHAPTER IV

RESULTS AND DISCUSSION

The present experiment was conducted to determine the effect of poultry manure (PM) and NPK fertilizers 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 PM and NPK fertilizers 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 PM and NPK fertilizers significantly increased the plant height of wheat compared to that found in control. The plant height increased progressively with the application of increasing level of PM and NPK fertilizers. The highest plant height (96.95 cm) was recorded in the treatment T_4 which was statistically identical with the treatment T_3 and T_5. The lowest plant height (74.80 cm) was recorded in control (T_1). PM which helps in the higher growth of the plant. Similar results were also reported by Mandal (1987), Mandal and Das (1988) and Rahman (1989). Gunes (2003) who reported marked increased in number of grains spike^{-1} of wheat for application of PM.

4.1.2 Spike length

The application of PM and NPK fertilizers effect the length of spike significantly (Table 3). The spike length varied from 6.90 to 10.52 cm. The highest and statistically superior spike length 10.52 cm was recorded in the treatment of T_4.

On the other hand, the lowest spike length 6.90 cm obtained in the treatment T_1. It is evident from the results that number of total plants m^{-2} was influenced by PM fertilizer. Positive effects of PM application on plants of wheat were reported by Mishra *et al*. (1989).

4.1.3 Number of tillers hill^{-1}

A significant change in number of tillers was noticed with the application of PM and NPK fertilizers. The number of tiller hill^{-1} enhanced with increasing doses of PM and NPK fertilizers (Table 3). The maximum tiller hill^{-1} (10.0) was found in the treatment T_4 which was statistically similar with those found in the treatment T_5. The lowest tiller number (3.0) was observed in the control treatment (T_1). Agbede *et al*. (2008) stated that the PM 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 Spikelet spike^{-1}

The highest number of spikelet spike^{-1} significantly increased with the application of PM and NPK fertilizers (Table 3). The effect of PM and different levels of NPK fertilizers was significant as observed on number of spikelet spike^{-1}. The number of spikelet spike^{-1} increased with increasing PM and NPK fertilizers levels. The maximum number of spikelet spike^{-1} (20.0) was noticed at T_4 treatment which was statistically identical with the treatments of T_3 and T_5. The lowest number of spikelet spike^{-1} (9.0) was found in T_1 treatment.

4.1.5 Number of grains spike^{-1}

The maximum number of grain spike^{-1} significantly increased with the application of PM and NPK (Table 3). The effect of PM and different levels of NPK fertilizers was significant as observed on number of grain spike^{-1}. The number of grain spike^{-1} increased with increasing PM and NPK fertilizers levels. The maximum number of grain spike^{-1} (57.0) was noticed at T_4 treatment which was statistically superior to the treatments of T_3 and T_5. The lowest number of grains spike^{-1} (20.0) was found in T_1 treatment.

4.1.6 1000 grain weight

Poultry manure and NPK fertilizers influenced significantly the 1000 grain weight of wheat (Table 3). The weight of 1000 grain increased with increasing levels of PM up to 8 t ha^{-1} and NPK fertilizers up to 75-70-50 kg ha^{-1}. The highest 1000 grain weight (50.23 g) was recorded from the treatment T_4 which was superior to the other treatments. The lowest weight (44.72 g) was recorded under control. These results suggested that combined use of appropriate doses of PM and NPK fertilizers produced maximum 1000 grain weight than the use of same dose of PM or NPK fertilizers along. These results explained that the weight of 1000 grain depends on the PM fertilization. Such results are in conformity with the findings of Mete *et al*. (2005) and Soylu *et al*. (2005) who reported that the weight of 1000 grain increased significantly with the increased PM fertilization.

Table 3. Effect of PM and NPK fertilizers on the growth parameters of wheat

Treatments	Plant height (cm)	Spike length (cm)	Number of tillers hill^{-1}	Number of Spikelet spike^{-1}	Number of grains spike^{-1}	1000 seed weight (g)
T_1	74.80 c	6.90 d	3.75 d	9.00 c	20.40 e	44.72 b
T_2	85.15 b	8.60 c	7.00 c	14.75 b	25.73 d	45.57 b
T_3	95.00 a	9.25 bc	7.75 bc	19.00 a	41.65 c	46.70 ab
T_4	96.95 a	10.52 a	10.25 a	20.25 a	57.42 a	50.23 a
T_5	93.30 a	9.55 b	9.25 ab	19.00 a	50.90 b	46.73 ab
LSD	4.966	0.7641	1.979	2.879	4.374	4.115
CV %	3.62	5.54	16.90	11.39	7.24	5.71

In the column, figures having similar letter(s) do not differ significantly at 5% level of probability.
CV% = Coefficient of variation
LSD = Level of Significance

Where the treatments were required,

T_1= Control (No fertilizers)
T_2 = 0 t ha^{-1} PM+150-140-100 kg ha^{-1} Urea, TSP, MoP
T_3 = 8 t ha^{-1} PM+ 0 kg ha^{-1} Urea, TSP, MoP
T_4 = 8 t ha^{-1} PM+75-70-50 kg ha^{-1} Urea, TSP, MoP
T_5 = 8 t ha^{-1} PM+50-46.6-33.3 kg ha^{-1} Urea, TSP, MoP

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 NPK fertilizers showed the variation for grain yield t ha^{-1} (Table 4). The highest yield (5.24 t ha^{-1}) was recorded in the treatment T_4 which was closely followed by T_5 treatment (4.46 t ha^{-1}) and the lowest grain yield (3.08 t ha^{-1}) was recorded in the control treatment (Table 4). Similler result was found by Nadim *et al.* (2011) who showed that PM application improved the grains yield of wheat.

4.1.8 Straw yield

Poultry manure and different levels of NPK contains fertilizers application showed significant variation of straw yield of wheat (Table 4). The straw yield varied from 4.95 to 3.15 t ha^{-1} (Table 4). The highest straw yield of 4.95 t ha^{-1} was recorded in the treatment T_4. On the other hand, the lowest straw yield of 3.15 t ha^{-1} was obtained in the control treatment (T_1).

Table 4. Effect of PM and NPK fertilizers on the grain yield and straw yield BARI Gom 26

Treatments	**Grain yield (t ha^{-1})**	**Straw yield (t ha^{-1})**
T_1	3.075 d	3.15 d
T_2	3.487 c	3.725 c
T_3	3.737 c	3.875 c
T_4	5.238 a	4.945 a
T_5	4.458 b	4.375 b
LSD	0.2624	0.5927
CV %	4.10	4.59

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

CV% = Coefficient of variation

LSD = Level of Significance

Where the treatments were required,

T_1= Control (No fertilizers)

T_2 = 0 t ha^{-1} PM+150-140-100 kg ha^{-1} Urea, TSP, MoP

T_3 = 8 t ha^{-1} PM+ 0 kg ha^{-1} Urea, TSP, MoP

T_4 = 8 t ha^{-1} PM+75-70-50 kg ha^{-1} Urea, TSP, MoP

T_5 = 8 t ha^{-1} PM+50-46.6-33.3 kg ha^{-1} Urea, TSP, MoP

4.1.9 Protein content in grain

The protein content in grain of wheat was insignificantly influenced by the different treatments. Application of PM along with different levels of NPK fertilizers showed the variation in protein content (Table 5). The highest protein percentage in grain was recorded in both the treatments of T_3 and T_4 (14%) which was closely related by T_5 treatment (13.5%) and the lowest protein percentage (10.5%) was recorded in the control treatment (Table 5).

Table 5. Effect of PM and NPK fertilizers in protein content in grain of BARI Gom 26

Treatments	Protein (%)
T_1	10.5
T_2	11
T_3	14
T_4	14
T_5	13.5

Where the treatments were required,

T_1= Control (No fertilizers)

T_2 = 0 t ha^{-1} PM+150-140-100 kg ha^{-1} Urea, TSP, MoP

T_3 = 8 t ha^{-1} PM+ 0 kg ha^{-1} Urea, TSP, MoP

T_4 = 8 t ha^{-1} PM+75-70-50 kg ha^{-1} Urea, TSP, MoP

T_5 = 8 t ha^{-1} PM+50-46.6-33.3 kg ha^{-1} Urea, TSP, MoP

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 6). The post-harvest soil was slightly acidic. The value of post harvest soil pH ranged from 5.62 to 5.95. 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. The study proved that soil reaction remained more or less same in the post-harvest soils compared to initial soil.

4.2.2 Organic matter content in soil

The effect of PM and NPK fertilizers was significant on organic matter (OM) content in the soil. The application of PM and NPK fertilizers affects on the increased of the organic matter status in the soil. Organic matter content of the post-harvest soil was higher in T_4 (1.95), T_5 (1.78), T_3 (1.70) treatments compared to the initial soil (1.55) and the lowest content in the treatment T_1 (Table 6). The highest amount of organic matter was found in T_4 treatment it is similar to T_3 and T_5. So, there was no significant difference among the treatments of the post-harvest soil due to the application of PM.

4.2.3 Total N in soil

The application of PM and NPK fertilizers has non significant effect on total N in soil. Due to the application of PM and NPK fertilizers increased the total soil N content in different treatments. Soil N of the post-harvest soil was higher than the initial soil. The highest soil N was found in T_4 treatments and the lowest soil N was found in the T_1 treatment (Table 6).

Table 6. Effect of PM and NPK fertilizers 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	5.78	1.10 c	0.05 a
T_2	5.62	1.27 c	0.06 a
T_3	5.95	1.70 b	0.07 a
T_4	5.71	1.95 a	0.10 a
T_5	5.88	1.78 bc	0.08 a
LSD	0.2436	0.1757	0.04872
CV %	2.76	8.11	15.88

In the column, figures having similar letter(s) do not differ significantly at 5% level of probability.
CV% = Coefficient of variation
LSD = Level of Significance

Where the treatments were required,

T_1= Control (No fertilizers)
T_2 = 0 t ha^{-1} PM+150-140-100 kg ha^{-1} Urea, TSP, MoP
T_3 = 8 t ha^{-1} PM+ 0 kg ha^{-1} Urea, TSP, MoP
T_4 = 8 t ha^{-1} PM+75-70-50 kg ha^{-1} Urea, TSP, MoP
T_5 = 8 t ha^{-1} PM+50-46.6-33.3 kg ha^{-1} Urea, TSP, MoP

4.2.4 Available P in soil

Available phosphorus content of the post-harvest soil varied significantly by the different treatments (Table 7). The maximum P content (71.80 ppm) was found in the treatment T_4 which was followed by T_3 (67.28 ppm) and T_5 (62.70 ppm) treatments. The lowest P content (49.72) was observed in the control treatment (T_1). The phosphorus content in the treatments T_3 and T_5 was statistically similar.

4.2.5 Exchangeable K in soil

The exchangeable K content of the post-harvest soil was influenced by the different treatments. The values of the exchangeable K were rambling around from 0.28 to 0.45 meq 100 g^{-1} soil (Table 7). The utmost value of 0.45 meq 100 g^{-1} soil was observed in the treatment T_5 which was identical to T_3 and T_4 treatments. The lowest value of 0.28 meq 100 g^{-1} soil was found in the T_1 treatment.

4.2.6 Available S in soil

The post-harvest soil which content available S was different for the different treatments. The available S content in the studied soil ranged from 2.17 to 2.78 ppm (Table 7). The highest S content (2.78 ppm) was found in the treatment T_4 which was statistically not similar to those in T_3 and T_5 treatments. The lowest S (2.17 ppm) was observed in the treatment T_1.

Table 7. Effect of PM and NPK fertilizers on the available P, S and exchangeable K content of the post-harvest soil

Treatments	Available P (ppm)	Exchangeable K (meq 100 g^{-1} soil)	Available S (ppm)
T_1	49.72 c	0.28 b	2.17 c
T_2	53.95 c	0.32 b	2.35 c
T_3	67.28 ab	0.40 a	2.48 b
T_4	71.80 a	0.44 a	2.78 a
T_5	62.70 b	0.45 a	2.44 b
LSD	7.431	0.04872	0.2578
CV %	7.90	9.16	6.84

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

CV% = Coefficient of variation

LSD = Level of Significance

Where the treatments were required,

T_1= Control (No fertilizers)

T_2 = 0 t ha^{-1} PM+150-140-100 kg ha^{-1} Urea, TSP, MoP

T_3 = 8 t ha^{-1} PM+ 0 kg ha^{-1} Urea, TSP, MoP

T_4 = 8 t ha^{-1} PM+75-70-50 kg ha^{-1} Urea, TSP, MoP

T_5 = 8 t ha^{-1} PM+50-46.6-33.3 kg ha^{-1} Urea, TSP, MoP

4.2.7 Correlation results of research

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 PM was positively correlated with the grain yield. When apply PM fertilizer then grain yield increases. Again the application of PM fertilizer then increases the number of tillers.

4.2.7.1 Grain yield and plant height

The interrelationship between plant height and grain yield showed positive and significant correlation (Fig. 4.1). The correlation value of (r = 0.6011). The line of regression X (Plant height) on Y (Grain yield) having Y = (6.542X + 61.79) revealing that the grain yield dependent on the character of plant height, because the positive slope indicates that the grain yield and plant height was directly correlated as well as increasing the plant height increased the grain yield of wheat.

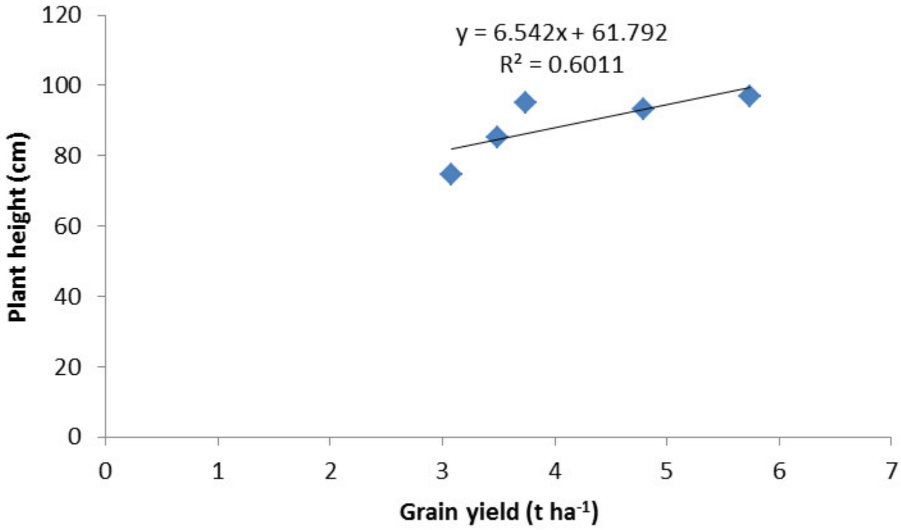

Fig. 4.1 Relationship between plant height and grain yield of wheat (BARI Gom 26).

4.2.7.2 Grain yield and spike length

The relationship between the grain yield and spike length were shown in the fig. 4.2. The correlation co-efficient value of (r = 0.7918) and the line of regression X (spike length) on Y (Grain yield) having equation of Y = (1.105X + 4.361) was shown in fig. 4.6. The positive slope indicates that the grain yield depends on the spike length, hence the higher spike length economically increase the grain yield of wheat.

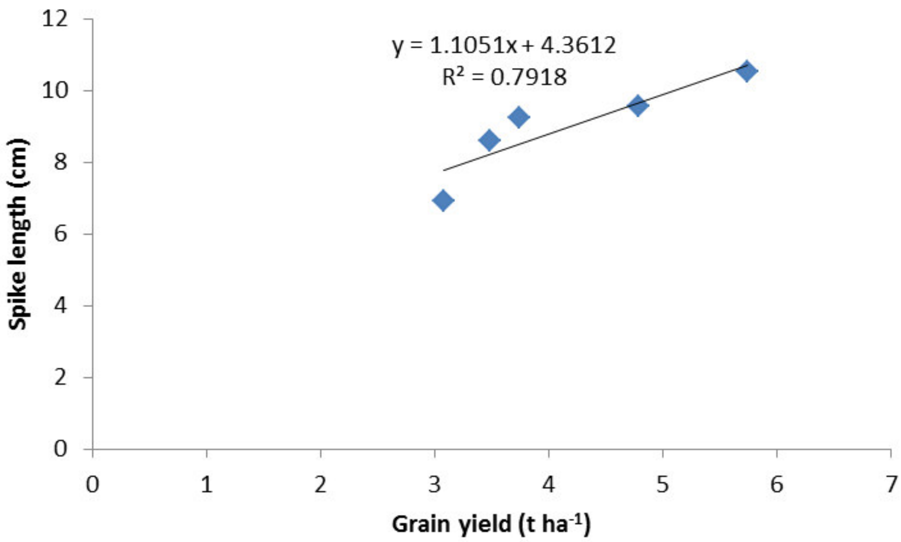

Fig. 4.2 Relationship between spike length and grain yield of wheat (BARI Gom 26).

4.2.7.3 Grain yield and number of tillers hill^{-1}

The relationship between the grain yield and number of tillers hill^{-1} were shown in the fig. 4.3. The correlation co-efficient value of (r = 0.8094) and the line of regression X (number of tillers hill^{-1}) on Y (Grain yield) having equation of Y = 2.074X – 1.039) was shown in fig. 4.3. The positive slope indicates that the grain yield depends on the number of tillers hill^{-1}, hence the higher number of tillers hill^{-1} economically increase the grain yield of wheat.

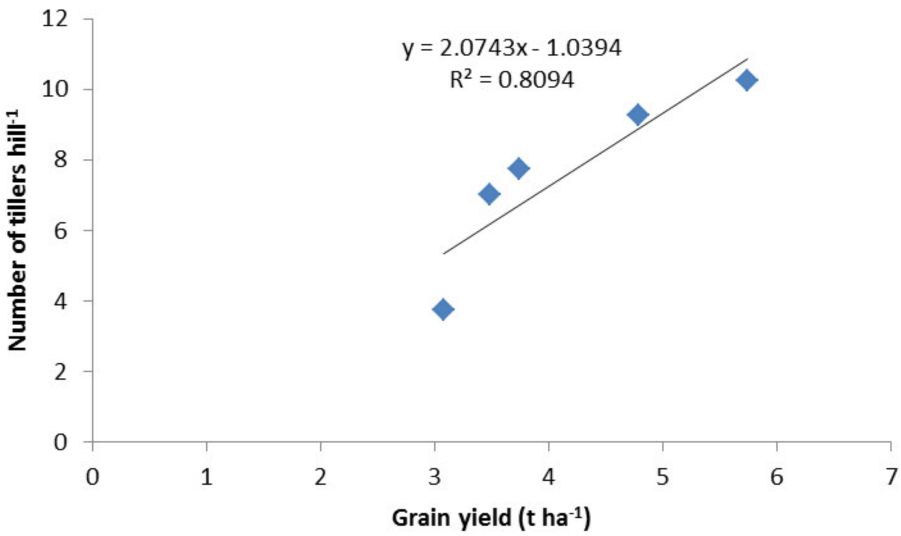

Fig. 4.3 Relationship between number of tillers hill^{-1} and grain yield of wheat (BARI Gom 26).

4.2.7.4 Grain yield and number of grain spike^{-1}

The relationship between the grain yield and number of grain spike^{-1} were shown in the fig. 4.4. The correlation co-efficient value of (r = 0.8785) and the line of regression X (number of tillers hill^{-1}) on Y (Grain yield) having equation of Y = (13.74X – 18.04) was shown in fig. 4.4. The positive slope indicates that the grain yield depends on the number of grain spike^{-1}, hence the higher number of grain spike^{-1} economically increase the grain yield of wheat.

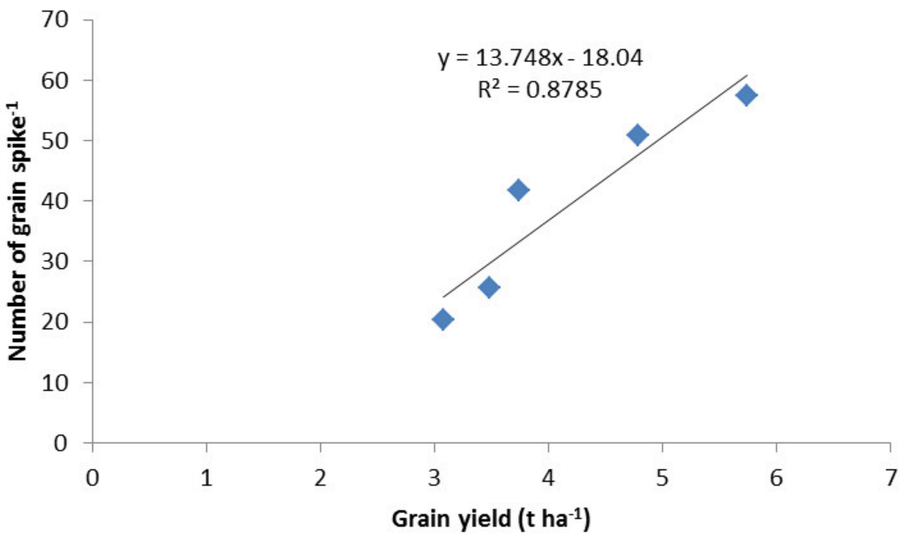

Fig. 4.4 Relationship between number of grain spike^{-1} and grain yield of wheat (BARI Gom 26).

4.2.7.5 Grain yield and 1000 grain weight

The relationship between the grain yield and 1000 grain weight were shown in the fig. 4.5. The correlation co-efficient value of (r = 0.8728) and the line of regression X (1000 grain weight) on Y (Grain yield) having equation of Y = (1.810X + 39.25) was shown in fig. 4.5. The positive slope indicates that the grain yield depends on the 1000 grain weight, hence the higher 1000 grain weight economically increase the grain yield of wheat.

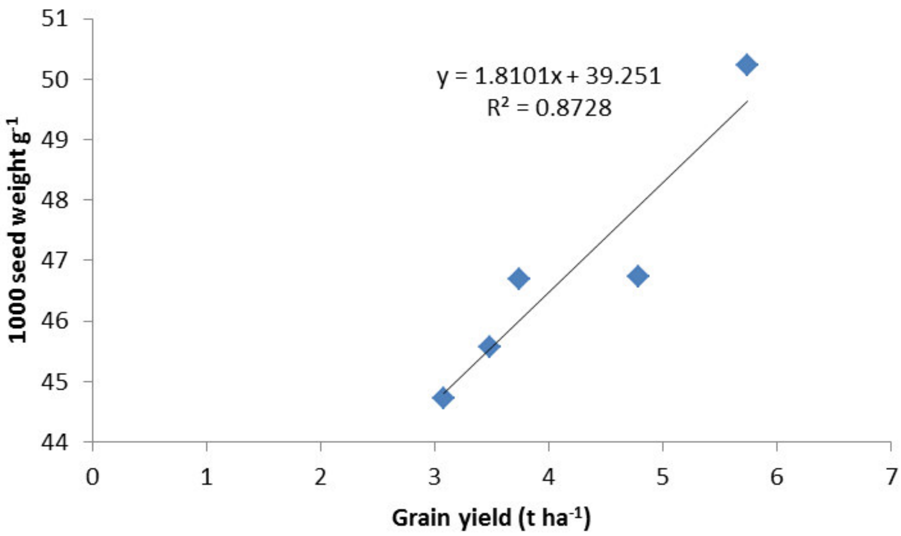

Fig. 4.5 Relationship between 1000 grain weight and grain yield of wheat (BARI Gom 26).

4.2.7.6 Grain yield and organic matter content

The relationship between the grain yield and organic matter content in soil were shown in the fig. 4.6. The correlation co-efficient value of (r = 0.7965) and the line of regression X (organic matter content) on Y (Grain yield) having equation of Y = (0.295X + 0.327) was shown in fig. 4.6. The positive slope indicates that the grain yield depends on the organic matter content in soil, hence the higher organic matter content in soil economically increase the grain yield of wheat.

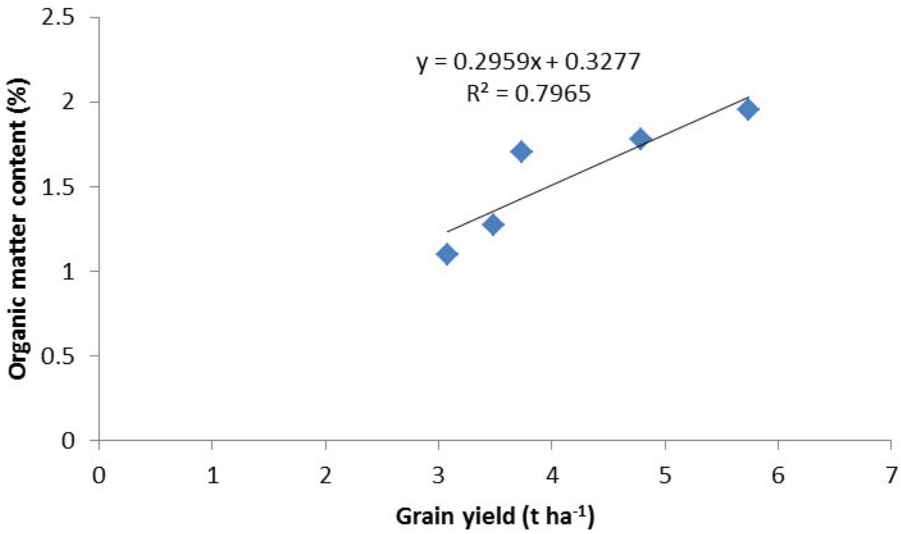

Fig. 4.6 Relationship between organic matter content in soil and grain yield of wheat (BARI Gom 26).

CHAPTER V

SUMMARY AND CONCLUSION

CHAPTER V

SUMMARY AND CONCLUSIONS

The experiment was conducted at central research field, Hajee Mohammad Danesh Science and Technology University, Dinajpur, during the period of November 2016 to February 2017 with a view to evaluating the effect of PM and NPK fertilizers on growth and yield of wheat (BARI Gom 26). The experimental soil belongs to the Old Himalayan Piedmont Plain (AEZ 1). The soil was sandy loam in texture having pH 5.81, organic matter 1.55%, total N 0.09%, available P 48.64 ppm, exchangeable K 0.21 meq g^{-1} and available S 13.75 ppm. The experiment was laid out in a Randomized Complete Block Design (RCBD) having seven treatments with four replications. The unit plot size was 10 m^2 (4 m × 2.5 m). PM and different levels of NPK fertilizers were used as treatment viz. T_1 = Control, T_2 = Full doses of NPK fertilizers, T_3 = Full doses of PM, T_4 = PM + ½ doses of NPK fertilizers, T_5 = PM + 1/3 doses of NPK fertilizers. They were distributed randomly in individual plots. The total numbers of plots were 20. Recommended dose of NPK fertilizers for experiment were 150 kg urea, 140 kg TSP, 100 kg and MoP per hectare. Recommended dose of PM for experiment was 8 t ha^{-1}.

Two thirds of urea and the full amount of the other fertilizers were applied as a basal amount during final land preparation. Rest urea was applied at first irrigation. Seeds were sown on the 22th 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 29^{th} February, 2017. Plot wise yield and yield components were recorded.

Soil samples were collected before fertilizer application and after harvest. Initial and post- harvest soil samples were analyzed for physical and chemical properties of soil. All the data were statistically analyzed by F-test and the mean differences were judged by Duncan's New Multiple Range Test (DMRT). The results of the experiment are summarized below:

The results revealed that the yield components such as, plant height, spike length, no. of tillers hill^{-1}, spikelet's spike^{-1}, grains spike^{-1}, 1000 grain weight of wheat (BARI Gom 26) responded significantly due to application PM and NPK fertilizers.

Poultry manure and NPK fertilization significantly increased the plant height and number of primary branch plant^{-1}. The highest plant height (96.95 cm) was observed in the treatment of T_4 which is statistically identical to T_3 and T_5 followed by control plot T_1 (74.80 cm). The treatment T_4 produced the highest spike length (10.52 cm) which was not statistically identical with all treatments. The lowest spike length (6.90 cm) was found in the treatment T_1. The maximum tillers hill^{-1} (10.25) was found in the treatment T_4 which was statistically identical to T_5 treatment. The lowest tillers number (3.75) was observed in the treatment T_1. The highest spikelet's spike^{-1} (20.25) was recorded in the treatment T_4 which were statistically identical with T_3 and T_5 treatments. The lowest spikelet's spike^{-1} (9.0) obtained in the treatment T_1. The maximum number of grains spike^{-1} (57.42) was noticed at T_4 treatment and lowest number of grains spike^{-1} (20.40) and the treatments may be ranked in the order of $T_4> T_5> T_3> T_2> T_1$. The highest 1000 grain weight (50.23g) was recorded from the treatment T_4 and the treatments may be ranked in the order of $T_4> T_5> T_3> T_2> T_1$. The application of recommended dose of NPK fertilizers in combination with PM remarkably increased the grain and straw yields of wheat (BARI Gom 26). The maximum grain yield of 5.24 t ha^{-1} was found in T_4 treatment which was closely followed by T_5 treatment and the lowest grain yield (3.08 t ha^{-1}) was recorded in the T_1 treatment. The treatment T_4 gave the highest straw yield (4.95 t ha^{-1}) while the T_1 treatment gave the minimum value (3.15 t ha^{-1}).

Application of PM and NPK fertilizers resulted in a considerable influence on the properties of the post-harvest soils such as pH, OM, total N, available P, exchangeable K and available S. Finally it can be concluded from the present study with the recommended dose of NPK fertilizers showed better performance in respect of grain yield and yield contributing characters.

So the combined application of PM with NPK fertilizers will be beneficial for wheat cultivation.

From the results of the study it may be concluded that:

1) Combined application of PM and NPK fertilizers can significantly increases the yield and yield contributing components of wheat and PM with ½ doses of NPK fertilizers also produced the maximum yield of wheat.

2) Application of PM with ½ doses of NPK fertilizers can increase the amount of OM, OC, total N, available P, exchangeable K and available S in soil to some extent.

3) Integrated use of PM and NPK fertilizers can save the use of 50% chemical fertilizer in wheat production.

Recommendation

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

1. To ensure the growth and yield performance of wheat should be needed to include different doses of NPK fertilizers with various combinations of other inorganic or organic fertilizer doses for future study.

2. 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.

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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	2^{nd} and 3^{rd} (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 2^{nd} /3^{rd} 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 $1/3^{rd}$ doses of urea	10.12.2016
12	2^{nd} weediong	27. 12.2016
13	2^{nd} irrigation	13.12.2016
14	3^{rd} irrigation	17.01.2017
15	Harvesting	23.03 .2017
16	Threshing	29.03.2017
17	Weighing	29.03.2017

Appendix III

Some photographs showing different treatments during research work