

**EFFECT OF ORGANIC AND INORGANIC FERTILIZERS ON THE GROWTH  
AND YIELD OF WHEAT**

**A THESIS**

**BY**

**KANIJ FARJANA**

**Student ID: 1905014**

**Session: 2019-2020**

**Semester: January-June 2020**

**MASTER OF SCIENCE**

**IN**

**AGRONOMY**



**DEPARTMENT OF AGRONOMY**

**HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY**

**DINAJPUR-5200**

**JUNE 2020**

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**June, 2020**

*DEDICATED  
TO MY  
BELOVED PARENTS*

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*The Author*

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## ABSTRACT

The experiment was conducted at Agronomy Research Field, HSTU, Dinajpur during November 2019 to April 2020 to assess the effect of organic and inorganic fertilizers on the growth and yield of wheat. The experiment consisted with one factors namely: T<sub>1</sub>: Control (Recommended dose) T<sub>2</sub>: 75% RD+10 t ha<sup>-1</sup> Farah Compost (FC), T<sub>3</sub>: 75% RD + 10 t ha<sup>-1</sup> Kazi Compost (KC), T<sub>4</sub>: 50% RD + 15 t ha<sup>-1</sup> FC, T<sub>5</sub>: 50% RD + 15 t ha<sup>-1</sup> KC, T<sub>6</sub>: 25% RD+ 20 t ha<sup>-1</sup> FC, T<sub>7</sub>: 25 % RD+20 t ha<sup>-1</sup> KC FC, T<sub>8</sub>: 25 t ha<sup>-1</sup> FC, T<sub>9</sub>: 25 t ha<sup>-1</sup> KC. The experiment was laid out in a Randomized Complete Block Design with three replications. The treatments were randomly distributed to the plots within a block. Parameters like plant height, tillers plant<sup>-1</sup>, spike length, grains spike<sup>-1</sup>, 1000-grain weight, grain yield, straw yield, biological yield and harvest index were influenced by organic and inorganic fertilizers. Plant height of wheat at different growth stages the results revealed that at 25.50, and 75 DAS the tallest plant (24.79 cm, 47.82 cm and 71.08 cm, respectively) were recorded from treatment T<sub>2</sub> while the shortest plant height was recorded from treatment T<sub>7</sub>. The results revealed that at 25.50, and 75 DAS the highest dry matter weight was recorded from treatment T<sub>2</sub> while the lowest dry matter weight were recorded from treatment T<sub>7</sub>. Length of spike was significantly affected by different fertilizer management. The longest spike (19.74 cm) was obtained when the plot treated with T<sub>2</sub> treatment which was statistically similar with T<sub>3</sub> the plot treated in T<sub>7</sub>. Spikelet spike<sup>-1</sup> was significantly varied due to different fertilizer. The maximum spikelet spike<sup>-1</sup> (17.00) was obtained when the plot was treated with T<sub>2</sub> treatment which was statistically similar with T<sub>3</sub> (16.26) while the minimum number of spikelets spike<sup>-1</sup> (13.00) was obtained when the plot was treated in T<sub>7</sub>. Grains spike<sup>-1</sup> was significantly differed due to different fertilizer management. The maximum grains spike<sup>-1</sup> (41.00) was obtained when the plot was treated with T<sub>2</sub> treatment which was statistically similar with T<sub>3</sub> (39.69) while the minimum grains spike<sup>-1</sup> (32.93) was obtained when the plot was treated with T<sub>7</sub>. Fertilizer management had significant effect on the 1000 grain weight. The highest 1000 grain weight (49.52 g) was obtained when the plot was treated with T<sub>2</sub> treatment which was statistically similar with T<sub>3</sub> (48.96g) while the lowest 1000 grain weight (39.92g) was obtained when the plot was treated with T<sub>7</sub>. Grain yield was significantly influenced by different fertilizer managements, the maximum grain yield (4.8 t ha<sup>-1</sup>) was produced when the plot was fertilized with in T<sub>2</sub> treatment which was statistically similar with T<sub>3</sub> (4.63 t ha<sup>-1</sup>) while the lowest grain yield (3.25 t ha<sup>-1</sup>) was obtained when the plot was treated with T<sub>7</sub>. Considering the results, the highest yield was observed from T<sub>2</sub> treatment.

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## LIST OF ABBREVIATIONS

AEZ	-	Agro-ecological zone
BARI	-	Bangladesh Agricultural Research Institute
CV	-	Coefficient of variation
DAS	-	Days after Sowing
DMRT	-	Duncan's Multiple Range Test
LSD	-	Least Significant Difference
MoP	-	Muriate of Potash
RCBD	-	Randomized Complete Block Design
TSP	-	Triple Super Phosphate
Var.	-	Variety
LAI	-	Leaf area index
FYM	-	Farmyard manure
RD	-	Recommended Dose
AZRC	-	Arid Zone Research Centre
GM	-	Green manure
WS	-	Wheat straw
HI	-	Harvest Index
TSW	-	Thousand Seed Weight
BWMRI	-	Bangladesh Wheat and Maize Research Institute
FC	-	Farah Compost
KC	-	Kazi Compost

# CHAPTER I

## INTRODUCTION

Wheat (*Triticum aestivum* L.) belongs to family Poaceae, is one of the major cereal crops, which is widely grown around the world under diverse climatic conditions and has been the staple food of the major civilizations in Europe, Asia and North Africa. Currently, wheat is the most widely grown crop in the world, on more than 218 million ha, and its world trade is greater than for all other crops combined. Wheat occupies a central place in human nutrition providing 20% of the daily protein and food calories. In terms of food security, it is the second most important food crop in the developing world after rice, because an estimated 80 million farmers rely on wheat for their livelihoods. Wheat is the most important source of carbohydrate in a majority of countries, and globally, it is the leading source of vegetal protein in human food, having a protein content of about 13%, which is relatively high compared to other major cereals. Wheat, eaten as a whole grain, is also a source of micronutrients and dietary fibre, it contains minerals, vitamins and fats (lipids), and with a small amount of animal or legume protein added is highly nutritious (Giraldo, 2019). Increasing global demand for wheat is based on the ability to make unique food products and the increasing consumption of these with industrialization and westernization. In particular, the unique properties of the gluten protein fraction allow the processing of wheat to produce bread, other baked goods, noodles and pasta, and a range of functional ingredients. These products may be more convenient to produce or consume than traditional foods, and form part of a “western lifestyle” (Shewry, and Hey, 2015). One cup whole wheat grain contains 33% Protein, 29% Carbohydrate, 5% Fat. About 65% of wheat crop is used for food, 17% for animal feed and 12% in industrial applications (FAO, 2013). It has been predicted that demand for wheat in the developing world is projected to increase 60% by 2050 from now (CIMMYT, 2013).

In Bangladesh the position of wheat is second in respect of total area of land (816 thousand acres) and production (1017 thousand M ton) (BBS, 2020), and the average yield of wheat is only 3.04 t ha<sup>-1</sup> (BBS, 2020). The average yield of wheat in Bangladesh is low comparing with the developed countries of the world which is due to substandard methods of cultivation, imbalanced nutrition, poor plant protection measures and lack of high yielding varieties. So, there is an ample opportunity to increase production of wheat

per unit area through adoption of modern and improved agronomic practices such as optimum seed rate, timely sowing and judicious application of irrigation, fertilizer and other inputs.

Balanced fertilization and better cultural practices are needed to obtain higher yield as the potential of crops increase. This led to the necessity of better methods of soil fertility diagnosis, when fertilizer is applied.

After green revolution, scenario of agriculture has faced many problems such as stagnation or even decrease in production and productivity of major crops under deterioration of soil fertility and increasing cost of production. These constraints have cropped-up partially as a result of continuous cropping without proper nutrient management and indiscriminate use of agrochemicals on soil and crops (Sharma and Subehia, 2014; Thind *et al.*, 2016). Beside this, the increased temperature and reduced winter period in Bangladesh put pressure on wheat cultivation reducing its potential yield (IPCC, 2014). Hossain and Teixeira da Silva (2013) projected that wheat production in Bangladesh might drop by 32% by 2050 due to an increase in temperature. Hence heat tolerant variety would be an option to keep wheat in cropping system (Farooq *et al.*, 2011; Hossain and Teixeira da Silva, 2012).

Conservation of available moisture for crop is a technique which the farmers follows to attain the maximum possible yield. Due to global warming temperature increasing day by day in wheat growing season in Bangladesh, aggressive the moisture depletion due to least organic matter content depleted by extensive decomposition rate. Therefore, organic amendment incorporation rate may enhance the organic matter content of the soil leading towards the excessive moisture conservation and plant nutrient availability. The soil temperature is inversely correlated with the organic matter content, so the moisture depletion rate might be decrease with the increased organic matter (Subhan *et al.*, 2017). Many researchers have found that organic manures applied in integration with the inorganic fertilizers gave higher yield than sole chemical fertilizers (Sarwar *et al.*, 2008). Increase organic matter concentrations in soil have showed to enhance the yield of cereals, improve soil properties i.e. soil density, soil aeration and enhance the soil water holding capacity for plant growth and root development (Zia *et al.*, 1998). Compost is an important source of plant nutrients as it contains greater organic matter content. Compost

along with increment of soil organic matter also improves the physico-chemical attributes of soil and it ultimately results in increased yield of crop (Subhan *et al.*, 2017).

Compost or poultry manure can be a valuable and inexpensive fertilizer and source of plant nutrients. Positive effects of organic manure on soil structure, aggregate stability and water-holding capacity were reported in several studies (Odlare *et al.*, 2008). However, the use of organic manures alone might not meet the plant requirement due to presence of relatively low content of nutrients. Application of organic manure with chemical fertilizer accelerates the microbial activity, increases nutrient use efficiency (Narwal and Chaudhary, 2006) and enhances the availability of the native nutrients to the plants resulting higher nutrient uptake. Therefore, in order to make the soil well supplied with all the plant nutrients in the readily available form and to maintain good soil health, it is necessary to use organic manures in combination with inorganic fertilizers to obtain optimum yields (Ramalakshmi *et al.*, 2012). Keeping these facts in mind, research has been launched to study the effect of organic and inorganic fertilizer on the growth and yield of wheat.

Use of chemical fertilizers in combination with organic manure is essential to improve the soil health (Prasad *et al.*, 2010). Moreover, mineral fertilizer requirement cannot be completely fulfilled by the fertilizer industry due to wide margin between production capacity and crop demand. A large quantity of mineral fertilizers, especially micronutrients is currently being imported. The high cost of mineral fertilizers, low use efficiency and less availability makes it difficult to manage crop production. The continued use of chemical fertilizers causes health and environmental hazards such as ground and surface water pollution by nitrate leaching (Pimentel, 1996). So, reducing the amount of NPK fertilizers applied to the field without NPK deficiency will be the main challenge in field management. Therefore, to maintain fertility and productivity of soil at sustainable level for long duration, there is need to adopt the concept of integrated nutrient management (INM).

Integrated nutrient management can be the best alternate approach for better crop production and sustainable soil health (Kumar *et al.*, 2013; Subehia and Sepehya, 2012). Integrated nutrient management involves the integrated use of mineral fertilizers together with organic manure in suitable combination compliments each other to optimize input use and maximize production and sustain the same without impairing the crop quality or

soil health, help in improving soil properties and reduce nutrient leaching, thereby increase the efficacy of mineral fertilizers (Lamps, 2000; Bodruzzaman *et al.*, 2010; Tadesse *et al.*, 2013).

The application of different fertilizers and manures influences the physical and chemical properties of soil and enhance the biological activities. It is also positively correlated with soil porosity and enzymatic activity. Organic fertilizer enhances soil porosity by increasing regular and irregular pores and causes a priming effect of native soil organic matter. Application of both chemical and organic fertilizers is needed for the improvement of soil physical properties and quick supply of essential plant nutrients for higher yield. The combined effect of organic manure and inorganic fertilizer on crop yield was also reported by many workers (Davarynejad *et al.*, 2004; Singh *et al.*, 2018).

Therefore, the present study was undertaken to formulate an input package with a combination of organic and inorganic fertilizer, so that it will be technically effective and feasible, economically viable, socially acceptable and environmentally sound for wheat production. Considering the present situation the present piece of research work was undertaken with following objectives-

- To observe the effect of chemical fertilizer on the performance of wheat.
- To observe the effect of organic fertilizer on the performance of wheat.
- To observe the effect of different combination of chemical and organic fertilizer on wheat.
- To find out the best combination of chemical and organic fertilizer for higher yield of BARI Gom 32.

## CHAPTER II

### REVIEW OF LITERATURE

Integration of organic and inorganic fertilizers bear great significance for sustaining the soil productivity. Inorganic sources mainly include chemical fertilizers, while major organic sources are crop residues, FYM, compost, poultry manure, green manure, oil cakes, bio-fertilizers, vermicompost, bio-gas slurry etc. to improve soil health. An attempt was made in this section to collect and study relevant information available regarding the use of inorganic and organic fertilizers on wheat to justify the implementation of the present research work and the findings would come out from experimentation.

#### 2.1 Plant height

Experiment was showed by Singh *et al.* (2018) at the experimental Farm of the Department of Agriculture, Lovely Professional University, Jalandhar, Punjab (India) during 2017-18. The treatments were viz., T<sub>0</sub>: Control, T<sub>1</sub>: 75% RDF, T<sub>2</sub>: 50% RDF +6 t FYM ha<sup>-1</sup> + 1 t Poultry Manure ha<sup>-1</sup>, T<sub>3</sub>: 50% RDF + 0.4 t Sewage Sludge ha<sup>-1</sup> +0.25 t Bone Meal ha<sup>-1</sup>, T<sub>4</sub>: 50% RDF + 6 t FYM ha<sup>-1</sup> + 1.5 t Vermicompost ha<sup>-1</sup>, T<sub>5</sub>: 25% RDF + 6 t FYM ha<sup>-1</sup> + 1.5 t Vermicompost ha<sup>-1</sup> + 25% Bone meal, T<sub>6</sub>: 25% RDF+ 1.5 t Vermicompost ha<sup>-1</sup> + 0.4 t Sewage Sludge ha<sup>-1</sup> + 1 t Poultry Manure ha<sup>-1</sup> and T<sub>7</sub>: 6 t FYM ha<sup>-1</sup> + 1 t Poultry Manure ha<sup>-1</sup> + 0.4 t Sewage Sludge ha<sup>-1</sup> + 0.25 t BoneMeal ha<sup>-1</sup>. The result of the experiment expressed that the plant height ranged from 34.64 to 49.82 cm at 40 DAS. The highest plant height (49.82 cm) was recorded in T<sub>5</sub>: (50% RD + 1.5 kg KC) followed by R<sub>3</sub>T<sub>5</sub> (50% RD + 1.5 kg KC) i.e. 46.22 cm while the lowest value (34.64 cm) was recorded in R<sub>3</sub>T<sub>9</sub> (2.5 kg FC). As compared to R<sub>3</sub>T<sub>7</sub>, showed plant height at 40 DAS.

Subhan *et al.* (2017) conducted an experiment at Arid Zone Research Centre (AZRC) to investigate the water use efficiency and response of winter wheat (*Triticum aestivum L.*) crop to organic and inorganic fertilizers on a heavy textured soil. The treatments used in the experiment include compost @ 5 t ha<sup>-1</sup>, cattle manure @ 5 t ha<sup>-1</sup>, compost + cattle manure each @ 2.5 t ha<sup>-1</sup>, NPK @ 150:120:90 and control (without amendments), replicated four times. The results revealed that significantly the tallest plant of 95.5 cm

recorded where inorganic fertilizer was applied @ 5 150:120:90 kg NPK ha<sup>-1</sup>. The shortest plants with height of 64 cm were found in the control.

Yadav *et al.* (2017) carried out an investigation during winter season of 2014-15 on wheat at Instructional Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (UP).

A field experiment was conducted by Chopra *et al.* (2016) at Agronomy Farm, Rajasthan College of Agriculture, Udaipur during rabi season in 2013-14 and 2014- 15. The experiment was laid out in a split plot design with 27 treatment combinations which consisted of 3 organic manures (FYM @ 10 t ha<sup>-1</sup>, Vermicompost @ 4 t ha<sup>-1</sup> and Poultry manure @ 5 t ha<sup>-1</sup>), 3 levels of inorganic fertilizers (50% RDF, 75% RDF and 100% RDF) and 3 levels of biofertilizers (Azotobacter, PSB and Azotobacter + PSB) were replicated three times. The results of the study showed that an application of poultry manure @ 5 t ha<sup>-1</sup> significantly increased higher plant height (88.60 cm) over FYM @ 10 t ha<sup>-1</sup> (82.57 cm) and statistically at par with vermicompost @ 4 t ha<sup>-1</sup> (85.84 cm)

## **2.2 Above ground dry matter weight plant<sup>-1</sup>**

An experiment was carried out by Phullan *et al.* (2017) under semi-arid subtropical environment located at an altitude of 14 m of marine level in Sindh province of Pakistan. The experiment was laid out in a split plot design with four organic manures (control, farmyard manure, sesbania and cluster bean) as main split and mineral fertilizer rates (control, 40-30, 60-45, 80-60, 90-70 and 120-90 kg N-P<sub>2</sub>O<sub>5</sub> t ha<sup>-1</sup>) as sub-split replicated four times. The results of the investigation revealed that Shoot dry weight was significantly influenced with the incorporation of organic manures and rates of mineral fertilizers. In case of organic manures, maximum shoot dry weight of 0.263 g plant<sup>-1</sup> (8% over mineral fertilizer) was noted in plots fertilized with farmyard 6 manure. The heaviest shoot dry weight of 0.278 g plant<sup>-1</sup> (26% over control) was noted in plots fertilized with recommended rate of mineral fertilizer (120-90 kg N- P<sub>2</sub>O<sub>5</sub> t ha<sup>-1</sup>). In case of interactive effects of organic manures and mineral fertilizer, the highest shoot dry weight of 0.288 g plant<sup>-1</sup> (4.3% over recommended rate of mineral fertilizer and 38% over control) was noticed, where farmyard manure was integrated with recommended rate of mineral fertilizer.

Chopra *et al.* (2016) A field experiment was conducted at Agronomy Farm, Rajasthan College of Agriculture, Udaipur during rabi season in 2013-14 and 2014-15. The results of the study showed that application of poultry manure @ 5 t ha<sup>-1</sup> recorded significantly higher dry matter accumulation plant<sup>-1</sup> (196.84 g) than both the treatments i.e. FYM @ 10 t ha<sup>-1</sup> (178.66 g) and vermicompost @ 4t ha<sup>-1</sup> (186.91 g), respectively. 2.3 Leaf area Experiment investigated by Singh *et al.* (2018) at the experimental Farm of the Department of Agriculture, Lovely Professional University, Jalandhar, Punjab (India) during 2017-18. The result of the experiment expressed that the dry matter weight per plant ranged from 3.80 g to 8.27g The highest value of dry matter per plant (8.27g) was recorded in R<sub>3</sub>T<sub>7</sub> (25%RD+2kg FC) followed by R<sub>1</sub>T<sub>1</sub> (control RD) of 7.53g while the lowest value (3.80g) was recorded in R<sub>1</sub>T<sub>9</sub> (2.5 kg FC).

### **2.3 Leaf area**

Experiment investigated by Singh *et al.* (2018) at the experimental Farm of the Department of Agriculture, Lovely Professional University, Jalandhar, Punjab (India) during 2017-18. The result of the experiment expressed that the leaf area per plant ranged from 616.341 to 3092.598 cm<sup>2</sup> at 90 DAS. The highest value of leaf area per plant (3092.598 cm<sup>2</sup>) was recorded in R<sub>1</sub>T<sub>5</sub> (50% RD+1.5 kg KC) while the lowest value (616.341 cm<sup>2</sup>) was recorded in R<sub>2</sub>T<sub>7</sub> (25% RD+2 kg FC).

### **2.4 Spikelets spike<sup>-1</sup>**

A field experiment was conducted by Chopra *et al.* (2016) at Agronomy Farm, Rajasthan College of Agriculture, Udaipur during rabi season in 2013-14 and 2014- 15. The results of the study showed that the highest grains spike<sup>-1</sup> (42.40) was recorded from poultry manure @ 5 t ha<sup>-1</sup> whereas the lowest one (39.50) was recorded from FYM @ 10 t ha<sup>-1</sup>.

A research was conducted by Rasul *et al.* (2015) at Bakrajow Agricultural Research Farm during winter growing season of 2013-2014. The experiment comprised of four treatments; T<sub>1</sub>= control, T<sub>2</sub>= 20 t ha<sup>-1</sup> sheep manure, T<sub>3</sub>= 20 t ha<sup>-1</sup> cow manure and T<sub>4</sub>= 20 t ha<sup>-1</sup> poultry manure. They reported that, the tallest plant (86.90 cm) was recorded from 20 t ha<sup>-1</sup> poultry manure and the shortest plant (78.50 cm) was recorded from control (no fertilizer) treatment.

A study was conducted by Tahir *et al.* (2011) at the Department of Agronomy, University of Agriculture, Faisalabad, Pakistan during rabi season 2007-08 to check the

effect of different organic matters along with recommended dose of synthetic fertilizers on the growth and yield components of wheat (*Triticum aestivum L.*).

## 2.5 Grains spike<sup>-1</sup>

Experiment investigated by Singh *et al.* (2018) at the experimental Farm of the Department of Agriculture, Lovely Professional University, Jalandhar, Punjab (India) during 2017-18. The result of the experiment expressed that the number of grains spike<sup>-1</sup> ranged from 46.42 to 72.02. The highest value (72.02) of number of grains spike<sup>-1</sup> was recorded in T<sub>3</sub> (50% RDF + 0.4 t sewage sludge ha<sup>-1</sup> + 0.25 t bone meal ha<sup>-1</sup>) followed by T<sub>1</sub> (75% RDF) of 70.32 while the lowest value (46.42) was recorded in T<sub>0</sub> (control). As compared to T<sub>0</sub>, T<sub>3</sub> showed 25.8% increase in the number of grains spike<sup>-1</sup>.

Experiment was carried out by Subhan *et al.* (2017) at Arid Zone Research Centre (AZRC), D. I. Khan during year 2014-2015 and 2015-16 to investigate the water use efficiency and response of winter wheat (*Triticum aestivum L.*) crop to organic and 8 inorganic fertilizers on a heavy textured soil. The results revealed that the organic amendments showed significant effect on the number of grains spike<sup>-1</sup> of wheat grown during the two consecutive years. The number of grains spike<sup>-1</sup> was found greater (44.5) in the plots receiving inorganic fertilizer (NPK) over the control (33 grains spike<sup>-1</sup>). The commercial fertilizer gave the similar higher number of grain spike<sup>-1</sup> during the second year and it was followed by the organic amendment of compost applied @ 5 t ha<sup>-1</sup>.

Yadav *et al.* (2017) carried out an investigation during winter season of 2014-15 on wheat at Instructional Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (UP). The result exposed that the maximum grains spike<sup>-1</sup> (61.6) was recorded from T<sub>7</sub> (50% RDF + 50% N-FYM + PSB) which was statistically at par with T<sub>2</sub> (100 % RDF), T<sub>4</sub> (75% RDF + 25% N-FYM) and T<sub>6</sub> (50% RDF + 50% N-FYM), and the least (34.00) was found in T<sub>1</sub> (control).

A research was conducted by Rasul *et al.* (2015) at Bakrajow Agricultural Research Farm during winter season of 2013-2014. They reported that, the maximum grains spike<sup>-1</sup> (54.00) was recorded from 20 t ha<sup>-1</sup> cow manure and the minimum grains spike<sup>-1</sup> (49.00) was recorded from control (no fertilizer) treatment.

A study was conducted by Tahir *et al.* (2011) at the Department of Agronomy, University of Agriculture, Faisalabad, Pakistan during rabi season 2007-08 to check the

effect of different organic matters along with recommended dose of synthetic fertilizers on the growth and yield components of wheat (*Triticum aestivum L.*). They reported that, the maximum grains spike<sup>-1</sup> (48.80) was recorded from treatment T<sub>3</sub> [Humic acid 55% (dry basis) + K<sub>2</sub>O 8% (dry basis) @ 10 kg ha<sup>-1</sup> + basal dose of chemical fertilizers (Nitrogen + Phosphorous @ 108 + 57 kg ha<sup>-1</sup>)], and the minimum grains spike<sup>-1</sup> (38.90) was recorded from treatment T<sub>1</sub> [control (only basal dose of chemical fertilizers (Nitrogen + Phosphorous @ 108 + 57 kg ha<sup>-1</sup>))].

In order to evaluate the effects of different levels of inorganic (0, 80, 160 and 240 kg Nitrogen ha<sup>-1</sup>) and organic (0, 30 and 60 Mg municipal waste compost ha<sup>-1</sup>) fertilizers on wheat grain yield, gluten content, protein variability and protein banding pattern on polyacrylamide gel in different growth stages of irrigated wheat, a field experiment was conducted by Abedi *et al.* (2010) at research station of the School of Agriculture, Shiraz University at Bajgah in 2007. Results indicated that the highest grains spike<sup>-1</sup> 9 (19.96) was attained by 60 mg municipal waste compost ha<sup>-1</sup>, and the lowest grains spike<sup>-1</sup> (19.96) was attained by control treatment (0 mg municipal waste compost ha<sup>-1</sup>).

Field trials were carried out by Rehman *et al.* (2008) aiming to determine whether modification to currently recommended inorganic fertilizers application (NPK) in combination with organic fertilizers in the form of farmyard manure (FYM) can improve wheat yield components and biomass under rain fed condition during 2003- 04 and 2004-05 at Cereal Crops Research Institute Pirsabaq, NWFP, Pakistan. 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<sup>-1</sup> and four different levels of FYM (control, 15, 30 and 45 t ha<sup>-1</sup>) using a wheat variety (Haider-2000) were studied. 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 were applied to subplots. Grains spike<sup>-1</sup> of wheat was affected by the levels of FYM, N, P and K in the two growing season. NPK, FYM and FYM x NPK significantly affected grains spike<sup>-1</sup>. Grains spike<sup>-1</sup> were significantly increased with each increment of NPK and the maximum grains spike<sup>-1</sup> (55.8) were recorded in plots which received the highest level of 80-60-60 kg NPK ha<sup>-1</sup> while the minimum grains spike<sup>-1</sup> (50.2) were recorded in control plots. FYM significantly increased grains spike<sup>-1</sup> and the maximum grains spike<sup>-1</sup> (54.4) were recorded at highest level of 45 t FYM ha<sup>-1</sup> while the minimum grains spike<sup>-1</sup> (52.4) were recorded in control plots. Interaction of FYM and NPK showed that the maximum

number of grain spike<sup>-1</sup> (56.8) were recorded in plots which received 45 t FYM ha<sup>-1</sup> and 80-60-60 kg NPK ha<sup>-1</sup>, while the minimum grains spike<sup>-1</sup> (48.8) were recorded from control.

## 2.6 1000 grain weight

Experiment were carried out by Subhan *et al.* (2017) at Arid Zone Research Centre (AZRC), D. I. Khan during year 2014-2015 and 2015-16 to investigate the water use efficiency and response of winter wheat (*Triticum aestivum L.*) crop to organic and inorganic fertilizers in a heavy textured soil. The results revealed that the thousand grain weight in the study significantly affected by cattle manure and compost. Maximum grain weight (36.5 g) in the plots that were receiving cattle manure + 10 compost each @ 2.5 t ha<sup>-1</sup>, the minimum weight (34.5 g) was received from the control treatment.

Yadav *et al.* (2017) carried out an investigation during winter season of 2014-15 on wheat at Instructional Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad, India). The result exposed that the 1000 grain weight (36.6 g) were recorded under treatment T<sub>7</sub> (50% RDF + 50% N-FYM + PSB) which was statistically at par with T<sub>2</sub> (100% RDF), T<sub>4</sub> (75 % RDF + 25% N-FYM and T<sub>6</sub> (50% RDF + 50% N-FYM) while least (35.7 g) was found in T<sub>1</sub> (control).

A field experiment was conducted by Chopra *et al.* (2016) at Agronomy Farm, Rajasthan College of Agriculture, Udaipur during rabi season in 2013-14 and 2014-15. The results of the study showed that the highest 1000 grain weight (43.42 g) was recorded from poultry manure @ 5 t ha<sup>-1</sup> whereas the lowest one (40.01 g) was recorded from FYM @ 10 t ha<sup>-1</sup>.

A research was conducted by Rasul *et al.* (2015) at Bakrajow Agricultural Research Farm during winter growing season of 2013-2014. They reported that, the maximum 1000 grain weight (46.85 g) was recorded from 20 t ha<sup>-1</sup> poultry manure and the minimum 1000 grain weight (42.66 g) was recorded from control (no fertilizer) treatment.

A study was carried out by Tahir *et al.* (2011) at the Department of Agronomy, University of Agriculture, Faisalabad, Pakistan during rabi season 2007-08 to check the effect of different organic matters along with recommended dose of synthetic fertilizers on the growth and yield components of wheat (*Triticum aestivum L.*). They reported that

the maximum 1000 grain weight (43.83 g) was recorded from treatment T<sub>3</sub> [Humic acid 5 % (dry basis) + K<sub>2</sub>O 8% (dry basis) @ 10 kg ha<sup>-1</sup> + basal dose of chemical fertilizers (Nitrogen + Phosphorous @ 108 + 57 kg ha<sup>-1</sup>)], and the minimum 1000 grain weight (37.55 g) was recorded from treatment T<sub>1</sub> [control (only basal dose of chemical fertilizers (Nitrogen + Phosphorous @ 108 + 57 kg ha<sup>-1</sup>))].

A field experiment was conducted by Abedi *et al.* (2010) at research station of the School of Agriculture, Shiraz University at Bajgah in 2007. Results indicated that the highest 1000 grain weight (40.23 g) was attained by 60 Mg municipal waste compost 11 t ha<sup>-1</sup> and the lowest 1000 grain weight (38.69 g) was attained by control treatment (0 Mg municipal waste compost ha<sup>-1</sup>).

Field trials were carried out by Rehman *et al.* (2008) during 2003-04 and 2004-05 at Cereal Crops Research Institute Pirsabaq, NWFP, Pakistan. NPK and FYM significantly affected thousand grain weight. Two years average showed that thousand grain weight significantly increased with the application of NPK as compared to control plots. Thousand grain weight increased with increase in NPK levels and the maximum thousand grain weight (35.16 g) was recorded in plots which received 80- 60-60 kg NPK ha<sup>-1</sup>. Lowest thousand grain weight (32.22 g) was recorded in control. No significant difference was recorded for thousand grain weight between 80-60-60 kg NPK ha<sup>-1</sup>, 80-60-30 kg NPK ha<sup>-1</sup>, 80-30-60 kg NPK ha<sup>-1</sup> and 80-30-30 kg NPK ha<sup>-1</sup>. FYM also significantly increased thousand grain weight. The maximum thousand grain weight (34.69 g) was recorded in plots which received 45 t FYM ha<sup>-1</sup> while the minimum thousand grain weight (33.69 g) was recorded in control plots. No significant difference was recorded among 15 and 30 t FYM ha<sup>-1</sup> for thousand grain weight.

## **2.7 Grain yield**

Experiment was investigated by Singh *et al.* (2018) at the experimental Farm of the Department of Agriculture, Lovely Professional University, Jalandhar, Punjab (India) during 2017-18. The result of the experiment expressed that grain yield varied from 3.62 to 6.0 t ha<sup>-1</sup>. The highest grain yield (6.0 t ha<sup>-1</sup>) was recorded in T<sub>3</sub> (50% RDF + 0.4 t sewage sludge ha<sup>-1</sup> + 0.25 t bone meal ha<sup>-1</sup>) followed by T<sub>1</sub> (75% RDF) i.e. 5.62 t ha<sup>-1</sup>. The lowest value (3.62 t ha<sup>-1</sup>) was recorded in T<sub>0</sub> (control). T<sub>3</sub> showed 12.86% increase in grain yield as compared to T<sub>0</sub>.

Study on the integrated effect of organic and chemical fertilizer levels on bread wheat was conducted by Chekollé (2017) in 2013 cropping season at high lands of Adi-golo and Mekan districts of Tigray, Ethiopia with the objective of determining the optimum integration of organic and inorganic fertilization for bread wheat production. The field experiment consists four level of N/P<sub>2</sub>O<sub>5</sub> (0/0, 23/23, 46/46 and 69/69 kg ha<sup>-1</sup>) and five level of farmyard manure (0, 4, 6, 8 and 10 t ha<sup>-1</sup>) arranged in factorial RCBD with three replications. The statistical analysis revealed significant ( $p \leq 0.05$ ) main and combined effect of farmyard manure and NP fertilizers on grain yield of 12 bread wheat. The maximum grain yield was obtained in treatment receiving combined application of 46/46 kg ha<sup>-1</sup> N/ P<sub>2</sub>O<sub>5</sub> + 6 tone ha<sup>-1</sup> of farmyard manure for Adi-golo and 46/46 kg ha<sup>-1</sup> N/ P<sub>2</sub>O<sub>5</sub> + 10 t ha<sup>-1</sup> of farmyard manure for Mekan areas, respectively. However, the lowest grain yield was recorded on plots without any fertilizer application. Hence, this organic and inorganic fertilizing system integration generated 144% and 47% yield increment compared to the control treatment and the NP fertilizer recommendation, respectively at Adi-golo. Similarly, 162.5% and 12.8% yield increment was obtained from combined application of organic and inorganic fertilizer compared to the control treatment and NP fertilizer recommendation, respectively at Mekan areas.

Experiments were carried out by Subhan *et al.* (2017) at Arid Zone Research Centre (AZRC), D. I. Khan during year 2014-2015 and 2015–16 to investigate the water use efficiency and response of winter wheat (*Triticum aestivum L.*) crop to organic and inorganic fertilizers in a heavy textured soil. The results revealed that the commercial fertilizer, organic manures and compost showed significant influence on grain yield of wheat during the two experimental years. Grain yield was found maximum 3887.5 kg ha<sup>-1</sup> in plots receiving the stated dose of NPK. It was followed by the treatment of compost @ 5 t ha<sup>-1</sup>, cattle manure + compost each @ 2.5 t ha<sup>-1</sup> and cattle manure @ 5 t ha<sup>-1</sup>. The least quantity of grains was recorded in the plots receiving no amendments. In the next year, the similar trend was observed. The maximum yield of 3969.8 kg ha<sup>-1</sup> was received from the plots where standard dose of NPK was applied. The least value of grain yield was found in control, with the value of 974.3 kg ha<sup>-1</sup>.

The present study was demonstrated by Kumari *et al.* (2017) in 2013 at the Bihar Agricultural College Research Farm, Sabour, Bhagalpur, Bihar, India. The experiment consisted of 12 treatment combinations viz; control (T<sub>1</sub>) (no fertilizer no organic manure); 50% recommended dose of fertilizers (RDF) to both rice and wheat (T<sub>2</sub>); 50%

RDF to rice and 100% RDF to wheat (T<sub>3</sub>); 75% RDF to both rice and wheat (T<sub>4</sub>); 100% RDF to both rice and wheat (T<sub>5</sub>); 50% RDF + 50% N through farm yard manure (FYM) to rice and 100% RDF to wheat (T<sub>6</sub>); 75% RDF + 25% N through FYM to rice and 75% RDF to wheat (T<sub>7</sub>); 50% RDF + 50% N through wheat straw to rice and 100% RDF to wheat (T<sub>8</sub>); 75% RDF + 25% N through wheat straw to rice and 75% RDF to wheat (T<sub>9</sub>); 50% RDF + 50% N through green leaf manure (GLM) (*Sesbania aculeata*) to rice and 100% RDF to wheat (T<sub>10</sub>); 75% RDF + 25% N through (GLM) to rice and 75% RDF to wheat (T<sub>11</sub>); farmer's fertilizers practice to rice and wheat (70 kg N + 13.2 kg P + 8.3 kg K ha<sup>-1</sup>) (T<sub>12</sub>). They revealed that the grain yield of wheat varied from a minimum of 7.71 q ha<sup>-1</sup> under control (T<sub>1</sub>) to a maximum of 46.83 q ha<sup>-1</sup> with the treatment receiving 100% RDF through chemical fertilizers in wheat after 50% N substitution with FYM in rice (T<sub>6</sub>). Treatments receiving 50% RDF + 50% N substituted through farm yard manure (FYM), green manure (GM) and wheat straw (WS) enhanced the productivity of wheat grain by 11.47, 9.55 and 6.31 %, respectively over 100% RDF whereas, treatments T<sub>3</sub>, T<sub>7</sub>, T<sub>8</sub>, T<sub>9</sub> and T<sub>11</sub> were at par with 100% RDF (T<sub>5</sub>) and rest of the treatments were significantly (P<sub>y</sub> (significantly (P<0.01) inferior to treatment T<sub>5</sub>.

Yadav *et al.* (2017) carried out an investigation during winter season of 2014-15 on wheat at Instructional Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (UP). The result exposed that the maximum grain yield (4.19 t ha<sup>-1</sup>) was recorded from T<sub>7</sub> (50% RDF + 50% N-FYM + PSB) which was statistically at par with T<sub>2</sub> (100% RDF), T<sub>4</sub> (75% RDF + 25% N-FYM), and T<sub>6</sub> (50% RDF + 50% N-FYM), and while the least (1.79 t ha<sup>-1</sup>) was found in T<sub>1</sub> (control).

A field experiment was conducted by Chopra *et al.* (2016) at Agronomy Farm, Rajasthan College of Agriculture, Udaipur during rabi season in 2013-14 and 2014- 15. The results of the study showed that the highest grain yield (5.04 t ha<sup>-1</sup>) was recorded from poultry manure @ 5 t ha<sup>-1</sup> whereas the lowest one (4.40 t ha<sup>-1</sup>) was recorded from FYM @ 10 t ha<sup>-1</sup>.

A research was conducted by Rasul *et al.* (2015) at Bakrajow Agricultural Research Farm during winter growing season of 2013-2014. They reported that the maximum grain yield (6.75 t ha<sup>-1</sup>) was recorded from 20 t ha<sup>-1</sup> poultry manure and the minimum grain yield (5.42 t ha<sup>-1</sup>) was recorded from control (no fertilizer) treatment.

In order to Evaluation of different fertility systems and cultivars on wheat In Khuzestan conditions, a field experiment was conducted by Jala-Abadi *et al.* (2012) at the experimental field of Ramin Agriculture and Natural Resources University in Ahwaz, south-western of Iran, during 2008-2009 growing season. Four type of organic and inorganic treatments were used, which were as following: S<sub>1</sub>= inorganic-1 (80 kg ha<sup>-1</sup> N, 75kg ha<sup>-1</sup> superphosphate (15.5% P<sub>2</sub>O<sub>5</sub>) and 75 kg ha<sup>-1</sup> potash), S<sub>2</sub>= 14 inorganic-2 (control) (140 kg ha<sup>-1</sup> N, 150 kg ha<sup>-1</sup> superphosphate (15.5% P<sub>2</sub>O<sub>5</sub>) and 150 kg ha<sup>-1</sup> potash), S<sub>3</sub>= chicken manure (8 t ha<sup>-1</sup>) and S<sub>4</sub>= chicken manure (8 t ha<sup>-1</sup>) + Nitroxin (1lit ha<sup>-1</sup>) + Barvar-2 (1 kg ha<sup>-1</sup>). Nitroxin is a commercial product of bio fertilizer contains Azotobacter and Azospirillum produced by Asia Bio Technology Institute, Iran. Barvar-2 is a commercial product of bio fertilizer contains *Pseudomonas putida* and *Bacilla lentus* produced by Green Biotech, Iran. Six genotypes with different growth durations were used. The genotypes included three bread wheat (Veenak, Chamran and Star) and three durum wheat (D-79-15, Karkheh and SP-50). The results revealed that the highest grain yield was in integrated chicken manure with bio-fertilizer (7042.5 kg ha<sup>-1</sup>). But this treatment (S<sub>4</sub>) did not vary significantly with chicken manure (S<sub>3</sub>) (6486.9 kg ha<sup>-1</sup>) and control (S<sub>2</sub>) (6530.9 kg ha<sup>-1</sup>). The lowest grain yield of 6142.9 kg ha<sup>-1</sup> was obtained under inorganic-1 system (S<sub>1</sub>).

A study was conducted by Tahir *et al.* (2011) at the Department of Agronomy, University of Agriculture, Faisalabad, Pakistan during rabi season 2007-08 to check the effect of different organic matters along with recommended dose of synthetic fertilizers on the growth and yield components of wheat (*Triticum aestivum L.*). They reported that the maximum seed yield (4.14 t ha<sup>-1</sup>) was recorded from treatment T<sub>3</sub> [Humic acid 55 % (dry basis) + K<sub>2</sub>O 8 % (dry basis) @ 10 kg ha<sup>-1</sup> + basal dose of chemical fertilizers (Nitrogen + Phosphorous @ 108 + 57 kg ha<sup>-1</sup>)], and the minimum seed yield (3.67 t ha<sup>-1</sup>) was recorded from treatment T<sub>1</sub> [control (only basal dose of chemical fertilizers (Nitrogen + Phosphorous @ 108 + 57 kg ha<sup>-1</sup>))].

A field experiment was conducted by Abedi *et al.* (2010) at research station of the School of Agriculture, Shiraz University at Bajgah in 2007. Results indicated that the highest seed yield (5360.90 kg ha<sup>-1</sup>) was attained by 60 Mg municipal waste compost ha<sup>-1</sup> and the lowest 1000 grain weight (3025.80 kg ha<sup>-1</sup>) was attained by control treatment (0 Mg municipal waste compost ha<sup>-1</sup>).

## 2.8 Straw yield

Experiment were carried out by Subhan *et al.* (2017) at Arid Zone Research Centre (AZRC), D. I. Khan during year 2014-2015 and 2015-16 to investigate the water use efficiency and response of winter wheat (*Triticum aestivum L.*) crop to organic and inorganic fertilizers on a heavy textured soil. The results revealed that the straw yield 15 of wheat showed significant difference among the treatments in both of the study years. In the initial year, straw yield of 7769.25 kg ha<sup>-1</sup> was observed in the plots where inorganic fertilizers were applied. The treatments receiving compost @ 5 t ha<sup>-1</sup>, cattle manure + compost each @ 2.5 t ha<sup>-1</sup> and cattle manure @ 5 t ha<sup>-1</sup> gave significantly higher straw yield over the control. Similar trend was found in the subsequent year of experiment with the maximum straw yield of 3969.8 kg ha<sup>-1</sup> through synthetic fertilizer application.

Yadav *et al.* (2017) carried out an investigation during winter season of 2014-15 on wheat at Instructional Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (UP). The result exposed that the maximum straw yield (6.07 t ha<sup>-1</sup>) was recorded from T<sub>7</sub> (50 % RDF + 50 % N-FYM + PSB) which was statistically at par with T<sub>2</sub> (100 % RDF), T<sub>4</sub> (75 % RDF + 25 % N-FYM), and T<sub>6</sub> (50 % RDF + 50 % N-FYM) and while the least (2.65 t ha<sup>-1</sup>) was found in T<sub>1</sub> (control).

The present study was demonstrated by Kumari *et al.* (2017) in 2013 at the Bihar Agricultural College Research Farm, Sabour, Bhagalpur, Bihar, India and they revealed that the straw yield of wheat varied from a minimum of 11.45 q ha<sup>-1</sup> under control (T<sub>1</sub>) to a maximum of 59.44 q ha<sup>-1</sup> with the treatment receiving 100% RDF through chemical fertilizers in wheat after 50% N substitution with FYM in rice (T<sub>6</sub>).

A field experiment was conducted by Chopra *et al.* (2016) at Agronomy Farm, Rajasthan College of Agriculture, Udaipur during rabi season in 2013-14 and 2014- 15. The results of the study showed that the highest straw yield (9.69 t ha<sup>-1</sup>) was recorded from poultry manure @ 5 t ha<sup>-1</sup> whereas the lowest one (8.23 t ha<sup>-1</sup>) was recorded from FYM @ 10 t ha<sup>-1</sup>.

A study was conducted by Tahir *et al.* (2011) at the Department of Agronomy, University of Agriculture, Faisalabad, Pakistan during rabi season 2007-08 to check the effect of different organic matters along with recommended dose of synthetic fertilizers

on the growth and yield components of wheat (*Triticum aestivum L.*). They reported that the maximum straw yield ( $4.75 \text{ t ha}^{-1}$ ) was recorded from treatment T<sub>3</sub> [Humic acid 55 % (dry basis) + K<sub>2</sub>O 8 % (dry basis) @  $10 \text{ kg ha}^{-1}$  + basal dose of chemical fertilizers (Nitrogen + Phosphorous @  $108 + 57 \text{ kg ha}^{-1}$ )], and the minimum 16 straw yield ( $3.94 \text{ t ha}^{-1}$ ) was recorded from treatment T<sub>1</sub> [control (only basal dose of chemical fertilizers (Nitrogen + Phosphorous @  $108 + 57 \text{ kg ha}^{-1}$ ))].

## 2.9 Biological yield

Experiment were carried out by Subhan *et al.* (2017) at Arid Zone Research Centre (AZRC), D. I. Khan during year 2014-2015 and 2015-16 to investigate the water use efficiency and response of winter wheat (*Triticum aestivum L.*) crop to organic and inorganic fertilizers on a heavy textured soil. The results revealed that the TDM yield of wheat was significantly affected by the imposition of treatments during the two experimental years. In the initial year the highest TDM ( $11656.75 \text{ kg ha}^{-1}$ ) was found in the plots receiving synthetic fertilizer (NPK) and the lowest was in control ( $3520.5 \text{ kg ha}^{-1}$ ). In the succeeding year of the experiment almost similar trend was found, with significantly maximum biomass of  $12435 \text{ kg ha}^{-1}$  in the treatment of NPK @  $150:120:90 \text{ kg ha}^{-1}$ . It was followed by the treatments receiving compost @  $5 \text{ t ha}^{-1}$ , cattle manure @  $5 \text{ t ha}^{-1}$ , and cattle manure + compost each @  $2.5 \text{ t ha}^{-1}$ . The least quantity of biomass was found in control, with the value of  $2325 \text{ kg ha}^{-1}$ .

A field experiment was conducted by Chopra *et al.* (2016) at Agronomy Farm, Rajasthan College of Agriculture, Udaipur during rabi season in 2013-14 and 2014- 15. The results of the study showed that the highest biological yield ( $14.73 \text{ t ha}^{-1}$ ) was recorded from poultry manure @  $5 \text{ t ha}^{-1}$  whereas the lowest one ( $12.63 \text{ t ha}^{-1}$ ) was recorded from FYM @  $10 \text{ t ha}^{-1}$ .

A research was conducted by Rasul *et al.* (2015) at Bakrajow Agricultural Research Farm during winter growing season of 2013-2014. They reported that the maximum biological yield ( $15.67 \text{ t ha}^{-1}$ ) was recorded from  $20 \text{ t ha}^{-1}$  poultry manure and the minimum biological yield ( $11.29 \text{ t ha}^{-1}$ ) was recorded from control (no fertilizer) treatment.

A field experiment was conducted Jala-Abadi *et al.* (2012) at the experimental field of Ramin Agriculture and Natural Resources University in Ahwaz, south-western of Iran,

during 2008-2009 growing season. The results revealed that the inorganic system produced significantly lower biological yield ( $1631.94 \text{ kg ha}^{-1}$ ) than the other fertility treatments and the mixed organic treatment produced more biological yield ( $1900.69 \text{ kg ha}^{-1}$ ) than the control and chicken manure treatments.

A study was conducted by Tahir *et al.* (2011) at the Department of Agronomy, University of Agriculture, Faisalabad, Pakistan during rabi season 2007-08 to check the effect of different organic matters along with recommended dose of synthetic fertilizers on the growth and yield components of wheat (*Triticum aestivum* L.). They reported that the maximum biological yield ( $8.70 \text{ t ha}^{-1}$ ) was recorded from treatment T<sub>3</sub> [Humic acid 55 % (dry basis) + K<sub>2</sub>O 8 % (dry basis) @  $10 \text{ kg ha}^{-1}$  + basal dose of chemical fertilizers (Nitrogen + Phosphorous @  $108 + 57 \text{ kg ha}^{-1}$ )], and the minimum biological yield ( $7.77 \text{ t ha}^{-1}$ ) was recorded from treatment T<sub>1</sub> [control (only basal dose of chemical fertilizers (Nitrogen + Phosphorous @  $108 + 57 \text{ kg ha}^{-1}$ ))].

Field trials were carried out by Rehman *et al.* (2008) during 2003-04 and 2004-05 at Cereal Crops Research Institute Pirsabaq, NWFP, Pakistan. Statistical analysis of the data showed that FYM, NPK and FYM x NPK significantly affected biological yield. Minimum biological yield ( $8813 \text{ kg ha}^{-1}$ ) was recorded in control plots. Biological yield increased as the NPK levels increased and the maximum biological yield ( $10008 \text{ kg ha}^{-1}$ ) was recorded in plots which received  $80\text{-}60\text{-}60 \text{ kg NPK ha}^{-1}$ . Significant increase in biological yield with different levels of FYM was recorded and the maximum biological yield ( $10000 \text{ kg ha}^{-1}$ ) was recorded at the highest level of  $45 \text{ t FYM ha}^{-1}$  while the minimum biological yield ( $9272 \text{ kg ha}^{-1}$ ) was recorded in control plots. Similarly interaction of FYM and NPK showed the maximum biological yield of  $10340 \text{ kg ha}^{-1}$  in plots where  $45 \text{ t FYM ha}^{-1}$  and  $80\text{-}60\text{-}60 \text{ kg NPK ha}^{-1}$  were used, while the minimum biological yield of ( $8468 \text{ kg ha}^{-1}$ ) was recorded in plots where no NPK and FYM were applied.

## **2.10 Harvest Index**

Experiment were carried out by Subhan *et al.* (2017) at Arid Zone Research Centre (AZRC), D. I. Khan during year 2014-2015 and 2015-16 to investigate the water use efficiency and response of winter wheat (*Triticum aestivum* L.) crop to organic and inorganic fertilizers on a heavy textured soil. The inorganic amendments showed significant effect on harvest index (HI) of wheat during the first experimental year, while

the cattle manure gave higher value of HI during the second year of the experiment. Comparing the results of two years. The treatment receiving inorganic fertilizer gave the highest HI (33.35%) over the rest of the treatments in year 2014-15. In the next year (2015-16) the result were completely inverse with the highest harvest 18 index of 40.05 % in the treatment receiving cattle manure @ 5 t ha<sup>-1</sup>, which was statistically at par with plots receiving compost @ 5 t ha<sup>-1</sup>. The least quantity was recorded in the plots receiving inorganic fertilizer.

A field experiment was conducted by Chopra *et al.* (2016) at Agronomy Farm, Rajasthan College of Agriculture, Udaipur during rabi season in 2013-14 and 2014- 15. The results of the study showed that the highest harvest index (35.06%) was recorded from poultry manure @ 5 t ha<sup>-1</sup> whereas the lowest one (34.36%) was recorded from FYM @ 10 t ha<sup>-1</sup>.

A field experiment was conducted Jala-Abadi *et al.* (2012) at the experimental field of Ramin Agriculture and Natural Resources University in Ahwaz, south-western of Iran, during 2008-2009 growing season. The results revealed that the highest index (39.68%) was recorded with application chicken manure (S<sub>3</sub>). The lowest harvest index (34.92%) was noted with control (S<sub>2</sub>). A study was conducted by Tahir *et al.* (2011) at the Department of Agronomy, University of Agriculture, Faisalabad, Pakistan during rabi season 2007-08. They reported that the maximum harvest index (49.48 %) was recorded from treatment T<sub>3</sub> [Humic acid 55 % (dry basis) + K<sub>2</sub>O 8% (dry basis) @ 10 kg ha<sup>-1</sup> + basal dose of chemical fertilizers (Nitrogen + Phosphorous @ 108 + 57 kg ha<sup>-1</sup>)] and the minimum harvest index (47.62 %) was recorded from treatment T<sub>1</sub> [control (only basal dose of chemical fertilizers (Nitrogen + Phosphorous @ 108 + 57 kg ha<sup>-1</sup>))].

## CHAPTER III

### MATERIALS AND METHODS

The materials used and the methodologies followed in this experiment to achieve the intended objectives are described in detail in this chapter. For convenience, this chapter has been divided into several sections such as location, soil, climate, crop, land preparation, experimental design, treatments, fertilizer application, seed sowing, intercultural operations, harvesting, data collection and statistical analysis.

#### 3.1 Location of the experimental field

The experiment was conducted in at the Agronomy research field, Department of Agronomy, Hajee Mohammad Danesh Science and Technology University, Dinajpur during November 2019 to April 2020. The geographical position of the area is between 25°44.574" N and 88°40.344" E and 40 m above sea level. The Agro Ecological Zone (AEZ) of the area is the Old Himalayan Piedmont Plain (AEZ-1). This zone has largest wheat area and also produces largest amount of wheat in the country (Appendix-I).

#### 3.2 Climatic conditions

The climate was subtropical with low temperature and minimum rainfall during November to April, 2020 that is the main feature of the *Rabi* season. The average maximum temperature was 30.34 °C and average minimum temperature was 21.21 °C. The average mean temperature was 25.17 °C. The experiment was done during the *Rabi* season. Temperature during the cropping period ranged from 11.1 to 34.8 °C. The humidity varies from 55 to 79 %. The day length was 10.5-11.0 hours only and there was no rainfall from the beginning of the experiment to harvesting (Appendix-II).

#### 3.3 Soil type

The soil of the experimental field belongs to the Old Himalayan Piedmont Plain (AEZ-1). Soil of the experimental plot was sandy loam with good drainage capacity. The experimental plot was medium high land with the pH range from 5.5 to 7.5. Soils of the experimental sites were analyzed before sowing of wheat and presented in the Appendix-II.

### **3.4 Duration of the experiment**

The experiment was conducted during the period from November 2019 to April 2020.

### **3.5 Planting material**

BARI Gom-32 wheat seeds were used as planting material in this experiment. Seeds were collected from seed Bangladesh Wheat and Maize Research Institute (BWMRI), Nashipur, Dinajpur-5200, Bangladesh

### **3.6 Properties of the material**

The variety of wheat was BARI Gom-32. It is a popular and newly developed variety of Bangladesh Agricultural Research Institute. The variety possesses medium sized plant (95-100 cm), short life span (102-108 days) and number of tillers plant<sup>-1</sup>: 4-5. This variety is resistant to leaf rust and leaf blight. Certified seeds were used in this study.

### **3.7 Treatments**

The experiment comprised the following 9 treatments

- T<sub>1</sub> = Control (Recommended Dose)
- T<sub>2</sub> = 75% RD +10 t ha<sup>-1</sup> Farah Compost (FC)
- T<sub>3</sub> = 75% RD + 10 t ha<sup>-1</sup> Kazi Compost (KC)
- T<sub>4</sub>=50% RD+15 t ha<sup>-1</sup> FC
- T<sub>5</sub>=50% RD+15t ha<sup>-1</sup> KC
- T<sub>6</sub>=25% RD+20 t ha<sup>-1</sup> FC
- T<sub>7</sub>=25%RD+20 t ha<sup>-1</sup> KC
- T<sub>8</sub>=25 t ha<sup>-1</sup> FC
- T<sub>9</sub>=25 t ha<sup>-1</sup> KC

### **3.8 Experimental design, layout and treatment combinations**

The experiment was laid out in a randomized complete block design (RCBD). There were 9 treatment combinations, each treatment replicated three times. The treatments were randomly distributed to the plots within a block. Thus, the number of plots was 3 × 9 = 27. The unit plot size was 1 m<sup>2</sup> (1m x 1m). Irrigation and drainage channel was made

with maintaining 50 wide and 30 cm between blocks and 25 cm wide and 25 cm depth between plots.

<b>R<sub>1</sub></b>	<b>R<sub>2</sub></b>	<b>R<sub>3</sub></b>
V <sub>1</sub> T <sub>5</sub>	V <sub>1</sub> T <sub>9</sub>	V <sub>1</sub> T <sub>2</sub>
V <sub>1</sub> T <sub>6</sub>	V <sub>1</sub> T <sub>6</sub>	V <sub>1</sub> T <sub>8</sub>
V <sub>1</sub> T <sub>1</sub>	V <sub>1</sub> T <sub>4</sub>	V <sub>1</sub> T <sub>9</sub>
V <sub>1</sub> T <sub>4</sub>	V <sub>1</sub> T <sub>5</sub>	V <sub>1</sub> T <sub>6</sub>
V <sub>1</sub> T <sub>2</sub>	V <sub>1</sub> T <sub>1</sub>	V <sub>1</sub> T <sub>4</sub>
V <sub>1</sub> T <sub>8</sub>	V <sub>1</sub> T <sub>3</sub>	V <sub>1</sub> T <sub>1</sub>
V <sub>1</sub> T <sub>9</sub>	V <sub>1</sub> T <sub>8</sub>	V <sub>1</sub> T <sub>5</sub>
V <sub>1</sub> T <sub>7</sub>	V <sub>1</sub> T <sub>2</sub>	V <sub>1</sub> T <sub>3</sub>
V <sub>1</sub> T <sub>3</sub>	V <sub>1</sub> T <sub>7</sub>	V <sub>1</sub> T <sub>7</sub>

**Figure 1: Layout of the experimental plot**

### **3.9 Experimental procedure and crop management**

#### **3.9.1 Land preparation**

The plot selected for the experiment was opened in the last week of 5 November 2010 with a power tiller, and was exposed to the sun for a week after which the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain a good tilth. Weeds and stubbles were removed and finally a desirable tilth of soil was obtained for sowing of seed. The final land preparation was done on 15 November 2019. The layout was done as per experimental design on 16 November 2019.

#### **3.9.2 Fertilizer application**

The recommended doses of Urea, TSP, MoP, gypsum, and compost like as Kazi compost and Farah compost were applied during final land preparation. The doses of urea, TSP, MoP, gypsum were 0.2 t ha<sup>-1</sup>, 0.17 t ha<sup>-1</sup>, 0.05 t ha<sup>-1</sup>, 0.12 t ha<sup>-1</sup>, respectively kazi compost and Farah compost were applied as respectively. The rest 1/3<sup>rd</sup> urea was applied as top dressing at crown root initiation stage (20 DAS) and 1/3<sup>rd</sup> urea was applied (40

DAS) followed by irrigation. For each plot urea, TSP, Mop, Gypsum were  $0.2 \text{ t ha}^{-1}$ ,  $0.17 \text{ t ha}^{-1}$ ,  $0.05 \text{ t ha}^{-1}$ ,  $0.12 \text{ t ha}^{-1}$  respectively. Recommended doses of fertilizer with kazi compost were applied for 9 plots. Recommended doses of fertilizer with Farah compost were applied for 9 plots. Kazi compost only used for 3 plots, Farah compost only used for 3 plots and RD were used for 3 plots.

### **3.9.3 Seed sowing**

Seeds were sown in line on 17 November 2019 as per treatments. The recommended seed rate ( $140 \text{ kg ha}^{-1}$ ) of wheat variety was used. The seeds were placed in 20 cm apart lines as per treatments. After that the seeds were covered with loose friable soil.

### **3.9.4 Intercultural operations**

Intercultural operations were done to ensure normal growth of the crop. Plant protection measures were followed as and when necessary. The following intercultural operations were done.

#### **3.9.4.1 Irrigation and weeding**

No irrigation was applied before emergence of the seedling. After emergence three irrigations were given at crown root initiation (20 DAS), maximum tillering stage (40 DAS) and heading stages (60 DAS). During irrigation care was taken so that water could not flow from one plot to another or overflow the boundary of the plots. Excess water of the field was drained out. The plots were infested with some common weeds, which were removed by uprooting them from the field three times during the cropping season. Weedicide Affinity was used to control weeds.

#### **3.9.4.2 Insect and pest control**

There was no infection of diseases in the field but termite, click beetle, stem borer and aphid were observed in the field and to control these insects Diazinon @  $1.7 \text{ kg ha}^{-1}$  for control earlier three insects and Malathion 57 EC @  $1 \text{ L ha}^{-1}$  were used for aphids.

#### **3.9.4.3 Harvesting**

The crop was harvested at maturity on 16 March 2020. The harvested crop from each plot was bundled separately and brought to the threshing floor. The crops were threshed,

cleaned and processed on 18 March 2020. Then sundry weight of both grain and straw was recorded for every plot and the weight in  $\text{g plot}^{-1}$  was converted to  $\text{t ha}^{-1}$ .

### **3.10 Data collection**

Data were collected on the yield and yield components of the crop. The yield data included grain and straw yields and the yield components included plant height, number of effective tillers  $\text{plant}^{-1}$ , spike length, number of grains  $\text{spike}^{-1}$  and 1000-grain weight. These data were taken when the crop attained maturity. With this point of view five plants were randomly collected from each plot. From these plants spike length, the numbers of grains  $\text{spike}^{-1}$  and 1000-grain weight were noted. Other parameters like plant height, number of effective tillers  $\text{plant}^{-1}$  were also recorded. Data on grain and straw yields were noted down on each plot.

#### **3.10.1 Plant height (cm)**

The height of the wheat plants was recorded at 25, 50, 75 Days after sowing (DAS) and at harvesting time. From the ground level up to tip of the flag leaf was counted as height of the plant. The average of 10 plants was considered as the height of the plant for each plot.

#### **3.10.2 Above ground dry matter weight $\text{plant}^{-1}$ (g)**

The weight of dry matter of the wheat plants was recorded at 25, 50, 75, DAS and at harvesting time. Five sample plants were cut at the ground level from each plot unbiasedly and then dried them in an electric oven maintaining  $80^{\circ}\text{C}$  for 72 hours. Then the plants were weighed in an electric balance and averaged them to have above ground dry matter weight  $\text{plant}^{-1}$ .

#### **3.10.3 Leaf area ( $\text{cm}^2$ )**

The leaf area index of the wheat plants was recorded at 25, 50, 75, DAS and at harvesting time. Five sample plants were cut at the ground level from each plot unbiasedly. Leaf area index was measured by destructing method using CL-202 Leaf Area Meter (USA). Then the mean was calculated.

#### **3.10.4 Tillering (no.)**

The number of tillers hill<sup>-1</sup> was recorded at 25, 50, 75, DAS and harvesting time. Data were recorded as the average of 10 hills selected at random from the inner rows of each plot.

#### **3.10.5 Spike length (cm)**

The length of spike was measured with a meter scale from 10 randomly selected spikes and the average value was recorded.

#### **3.10.6 Number of grains spike<sup>-1</sup> (no.)**

The total number of spike plant<sup>-1</sup> was estimated by counting the number of spikes from 10 plant and then averaged to have number of spike plant<sup>-1</sup>.

#### **3.10.7 Thousand grain weight (g)**

One thousand cleaned dried grains were randomly collected from the seed stock obtained from each plot and were sundried properly at 12 % moisture content and weight by using an electric balance.

#### **3.10.8 Grain yield (t ha<sup>-1</sup>)**

Grains obtained from each unit plot were sun-dried and weighed carefully. The dry weight of grains of the plot used to record grain yield plot<sup>-1</sup> and converted this into t ha<sup>-1</sup>.

The harvested for yield measurement. The crop of each plot was bundled separately, tagged properly and brought to threshing floor. The bundles were dried in open sunshine, threshed and then grains were cleaned. The grain and straw weights for each plot were recorded after proper drying in sun.

#### **3.10.9 Straw yield (t ha<sup>-1</sup>)**

The crop of each plot was bundled separately, tagged properly and brought to threshing floor. The bundles were dried in open sunshine. The straw weights for each plot were recorded after proper drying in sun. The dry weight of straw of the plot was used to record the final straw yield plot<sup>-1</sup> which was finally converted to t ha<sup>-1</sup>.

### **3.10.10 Biological yield (t ha<sup>-1</sup>)**

Grain yield and straw yield together were regarded as biological yield of wheat. The biological yield was calculated with the following formula:

$$\text{Biological yield} = \text{Grain yield} + \text{Straw yield}$$

### **3.10.11 Harvest index (%)**

Harvest index was determined by dividing the economic yield (grain yield) to the biological yield from the same area and then multiplied by 100.

$$\text{Harvest Index (\%)} = \frac{\text{Grain yield (t ha}^{-1}\text{)}}{\text{Biological yield (t ha}^{-1}\text{)}} \times 100$$

### **3.11 Data analysis**

The data obtained for different characters were statistically analyzed using MSTAT-C computer statistical package. To observe the significant difference among the treatment. The mean values of all the characters were calculated and analyses of variance were performed. The significance of the difference among the treatment means was estimated by the Duncan Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

## CHAPTER IV

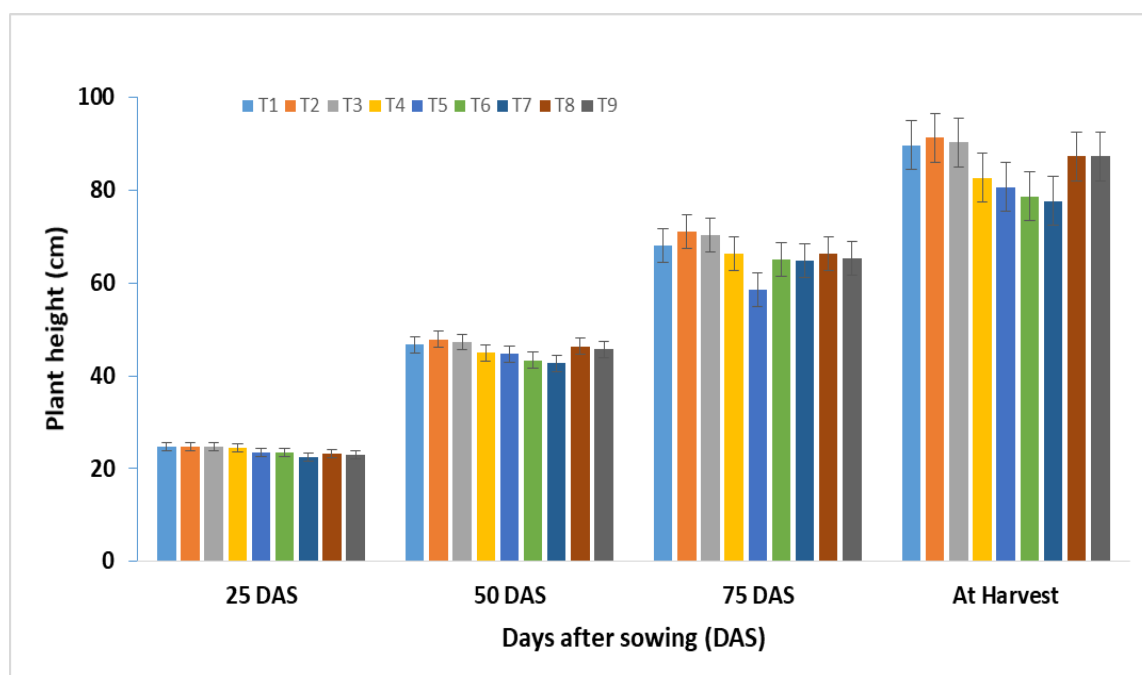
### RESULTS AND DISCUSSION

The experiment was conducted to study the feasibility of replacing chemical fertilizer by using organic fertilizer in wheat. Data on different growth, yield contributing characters and yield were recorded. The analyses of variance (ANOVA) of the data on different parameters are presented. The results have been presented and discussed with the help of Tables and Graphs and possible interpretations given under the following headings:

#### 4.1 Plant height

Plant height varied significantly at 25, 50, 75 and at harvest for different chemical and organic fertilizer and their combinations. At 25 DAS, the longest plant (24.79 cm) was recorded from T<sub>2</sub> (75 % RD +10 t ha<sup>-1</sup> Farah Compost), which was statistically similar with T<sub>3</sub> (75 % RD + 10 t ha<sup>-1</sup> Kazi Compost), T<sub>1</sub> (all chemical fertilizer as recommended dose), T<sub>4</sub> (50 % RD+15 t ha<sup>-1</sup> Farah Compost), (24.69 cm, 24.67 cm, 24.53 respectively), while the shortest plant (23.13 cm) was obtained from T<sub>7</sub> (25 % RD +20t ha<sup>-1</sup> Kazi Compost). (Figure 2). At 50 DAS, the longest plant (47.82 cm) was recorded from T<sub>2</sub>, which was statistically similar with T<sub>3</sub>, and T<sub>1</sub> treatments, whereas the shortest plant (42.67 cm) was showed from T<sub>7</sub>. At 75 DAS, the longest plant (71.08 cm) was recorded from T<sub>2</sub>, which was statistically at per with T<sub>3</sub>, and T<sub>1</sub> and the shortest plant (64.87 cm) was found from T<sub>7</sub>. At harvest, the longest plant was attained from T<sub>2</sub> (91.33 cm), which was statistically similar with T<sub>3</sub>, and T<sub>1</sub> (90.33 cm, and 89.67 cm, respectively and the shortest plant (77.67 cm) was recorded from T<sub>7</sub> (Figure 2). Combination of compost and chemical fertilizers created a favorable condition for the growth and development of wheat plant for that combination of compost and partial chemical fertilizers. The combination of organic and inorganic fertilizer was showed highest plant height. Application of all chemical fertilizer in recommended doses also ensured the essential macro and micronutrients for the vegetative growth of the wheat and the ultimate results were statistical similar results of plant height. The improvement in nutritional status of plant might have resulted in greater synthesis of amino acids and protein and other growth promoting substances which seems to have enhanced the meristematic activity and increased cell division and enlargement and their elongation resulting in higher plant height. The results of present investigation were in close conformity with findings of

several researchers (Singh *et al.* 2018; Yadav *et al.* 2017; Chopra *et al.* 2016; Rasul *et al.* 2015; Muhammad *et al.* 2014; Singh *et al.* 2012; Tahir *et al.* 2011 and Sarwar *et al.* 2007).



T<sub>1</sub> = Control (Recommended Dose)

T<sub>2</sub> = 75% RD + 10 t ha<sup>-1</sup> Farah Compost (FC)

T<sub>3</sub> = 75% RD + 10 t ha<sup>-1</sup> Kazi Compost (KC)

T<sub>4</sub> = 50% RD + 15 t ha<sup>-1</sup> FC

T<sub>5</sub> = 50% RD + 15 t ha<sup>-1</sup> KC

T<sub>6</sub> = 25% RD + 20 t ha<sup>-1</sup> FC

T<sub>7</sub> = 25% RD + 20 t ha<sup>-1</sup> KC

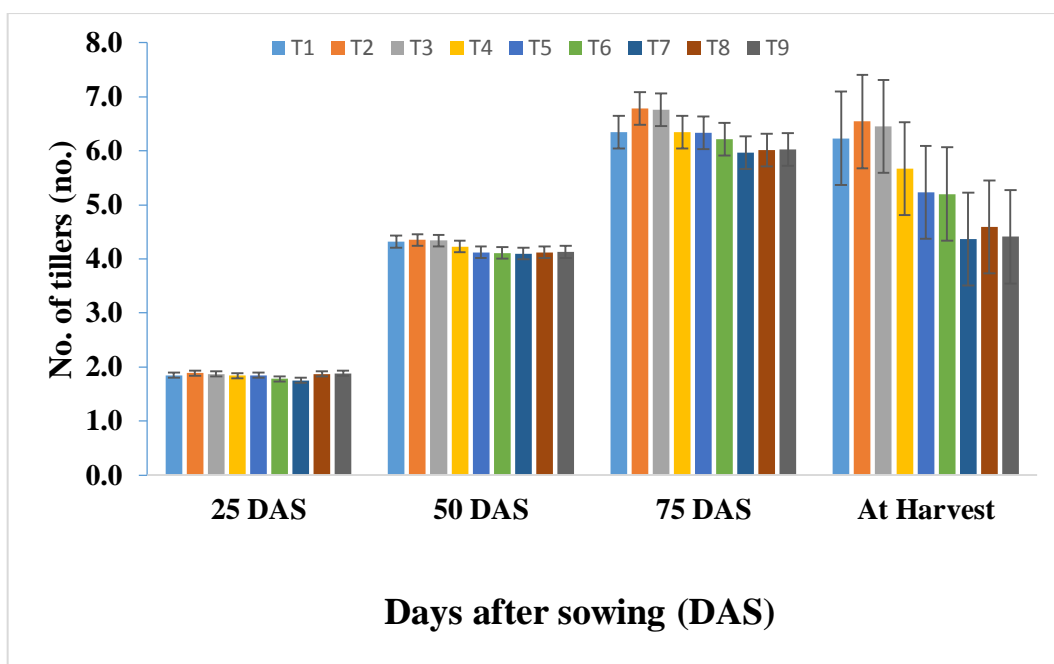
T<sub>8</sub> = t ha<sup>-1</sup> FC

T<sub>9</sub> = 25 t ha<sup>-1</sup> KC

**Figure 2: Effect organic and inorganic fertilizers management on plant height of wheat at different days after sowing (at 25, 50, 75 DAS and harvest, respectively)**

#### 4.2. Number of tillers hill<sup>-1</sup>

Statistically significant variation was recorded for number of tillers hill<sup>-1</sup> at 25, 50, 75 DAS, and at harvest for different chemical and organic fertilizers and their combinations (Figure 3).



T<sub>1</sub> = Control (Recommended Dose)  
 T<sub>2</sub> = 75% RD +10 t ha<sup>-1</sup> Farah Compost (FC)  
 T<sub>3</sub> = 75% RD + 10 t ha<sup>-1</sup> Kazi Compost (KC)  
 T<sub>4</sub> = 50% RD+15 t ha<sup>-1</sup> FC  
 T<sub>5</sub> = 50% RD+15 t ha<sup>-1</sup> KC  
 T<sub>6</sub> = 25% RD+20 t ha<sup>-1</sup> FC  
 T<sub>7</sub> = 25%RD+20 t ha<sup>-1</sup> KC  
 T<sub>8</sub> = 25 t ha<sup>-1</sup> FC  
 T<sub>9</sub> = 25 t ha<sup>-1</sup> KC

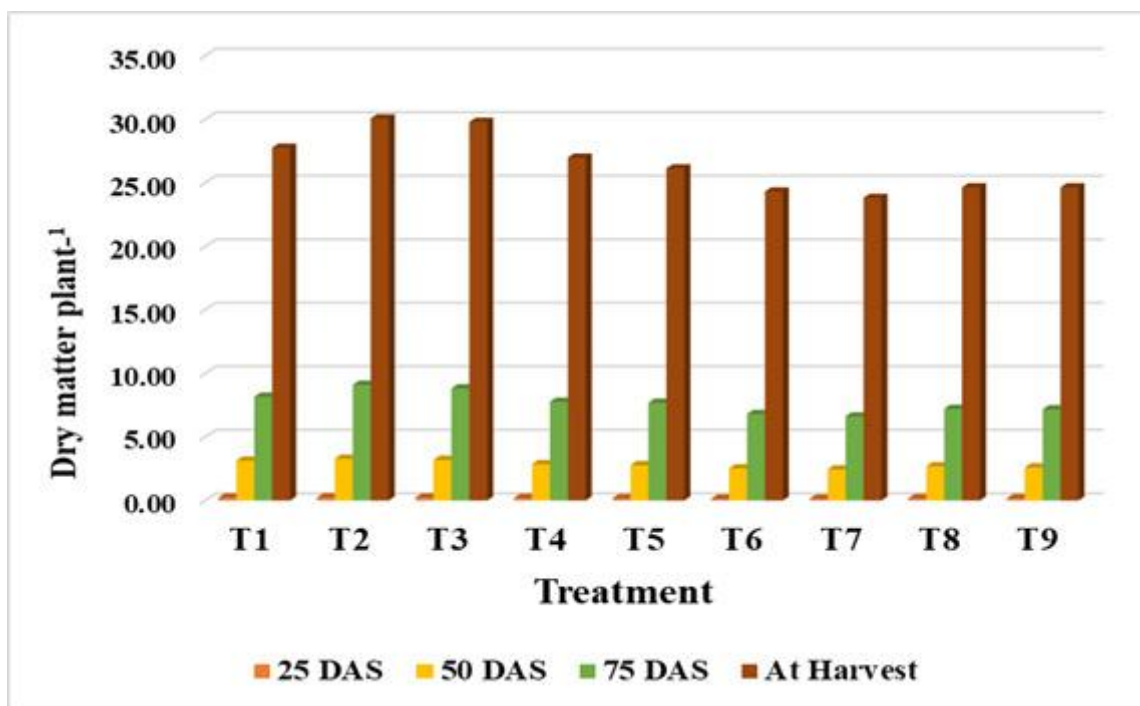
**Figure 3: Effect organic and inorganic fertilizers management on number of tillers hill<sup>-1</sup> of wheat at different days after sowing (at 25, 50, 75 DAS and harvest, respectively)**

At 25 DAS, the highest number of tillers (1.89 cm) was recorded from T<sub>2</sub> (75 % RD +10 t ha<sup>-1</sup> Farah Compost), which was statistically similar with T<sub>3</sub> (75 % RD + 10 t ha<sup>-1</sup> Kazi Compost), T<sub>1</sub> (all chemical fertilizer as recommended dose), T<sub>5</sub> (50 % RD+15 t ha<sup>-1</sup> Kazi Compost), and T<sub>4</sub> (50 % RD+15 t ha<sup>-1</sup> Farah Compost), (1.87, 1.85, 1.85, and 1.84 respectively), while the lowest number of tillers (1.75 cm) was obtained from T<sub>7</sub> (25 % RD +20 t ha<sup>-1</sup> Kazi Compost) (Figure 3). At 50 DAS, the highest number of tillers (4.32 cm) was recorded from T<sub>2</sub>, which was statistically similar with T<sub>3</sub>, whereas the lowest number (5.97 cm) was showed from T<sub>7</sub>. At 75 DAS, the highest number of tillers (6.78) was recorded from T<sub>2</sub>, which was statistically at per with T<sub>3</sub>, and T<sub>1</sub> and the lowest number of tillers (5.97) was found from T<sub>7</sub>. At harvest, the highest number of tillers was attained from T<sub>2</sub> (6.54), which was statistically similar with T<sub>3</sub> (6.45), and the lowest number (4.37) was recorded from T<sub>7</sub> (Figure 3). Combination of compost and chemical fertilizers created a favorable condition for the growth and development of wheat plant for that combination is favorable to produce tillers numbers of wheat cultivation. The

combination of organic and inorganic fertilizer was showed highest plant height. Application of all chemical fertilizer in recommended doses also ensured the essential macro and micronutrients for the vegetative growth of the wheat and the ultimate results were statistical similar results of tillers number per hill.

#### **4.3 Dry matter weight plant<sup>-1</sup>**

Different fertilizer managements showed a significant variation on above ground dry matter weight plant<sup>-1</sup> for all growth stages. The results revealed that at 25.50, and 75 DAS the highest dry matter weight (0.25 g cm, 3.30 g cm and 9.11g, respectively) were recorded from treatment T<sub>2</sub> [75% RD (recommended doses fertilizer + 10 t ha<sup>-1</sup> FC (Farah compost) while the lowest dry matter weight (0.25g, 3.30g cm and 9.11g respectively) were recorded from treatment T<sub>7</sub> [25% RD (recommended doses fertilizer + 20 t ha<sup>-1</sup> FC (Farah compost). At 120 (harvesting) DAS, the highest dry matter weight was obtained at treatment T<sub>2</sub> (30.08 cm) which was statistically similar with T<sub>3</sub> (29.82g respectively) and the lowest one in treatment T<sub>7</sub> (24.67g) (Figure 4). Similar result was reported (Ahmad *et al.*, 2008). Nyangani (2010) reported that incorporation of organic manures and rate of mineral fertilizers significantly influenced dry matter accumulation of wheat. Increases in fresh weight of wheat with the incorporation of organic fertilizers have also been reported by Chopra *et al.* (2016) Combined effect of variety and fertilizer management showed significant variation on above ground dry matter weight plant<sup>-1</sup> for all growth stages. The improvement in nutritional status of plant might have resulted in greater synthesis of amino acids and protein and other growth promoting substances which seems to have enhanced the meristematic activity and increased cell division and enlargement and their elongation resulting in higher plant height and tillers numbers consequently dry matter weight increased as well.



T<sub>1</sub> = Control (Recommended Dose)  
 T<sub>2</sub> = 75% RD + 10 t ha<sup>-1</sup> Farah Compost (FC)  
 T<sub>3</sub> = 75% RD + 10 t ha<sup>-1</sup> Kazi Compost (KC)  
 T<sub>4</sub> = 50% RD + 15 t ha<sup>-1</sup> FC  
 T<sub>5</sub> = 50% RD + 15 t ha<sup>-1</sup> KC  
 T<sub>6</sub> = 25% RD + 20 t ha<sup>-1</sup> FC  
 T<sub>7</sub> = 25% RD + 20 t ha<sup>-1</sup> KC  
 T<sub>8</sub> = 25 t ha<sup>-1</sup> FC  
 T<sub>9</sub> = 25 t ha<sup>-1</sup> KC

**Figure 4: Effect of different fertilizers management on the above ground dry matter weight plant<sup>-1</sup> of wheat at different days after sowing (25, 50, 75 DAS and at harvest, respectively)**

#### 4.4 Leaf area index (cm<sup>2</sup>)

Different fertilizer managements had significant influenced on leaf area of wheat at all the growth stages. The results revealed that at 25 DAS, the highest leaf area index (438.51 cm<sup>2</sup>), was recorded from treatment T<sub>2</sub> which was statistically similar with T<sub>3</sub>, T<sub>1</sub>, and T<sub>4</sub> (437.60, 437.56 and 435.56 cm<sup>2</sup>, respectively), while the lowest leaf area index was obtained from T<sub>6</sub> (384.34 cm<sup>2</sup>) which was statistically similar with T<sub>7</sub> (387.00 cm<sup>2</sup>), at 50 DAS, the highest leaf area index was recorded from treatment T<sub>2</sub> (1028.00 cm<sup>2</sup>), which was statistically similar with T<sub>3</sub>, and T<sub>1</sub> (1019.30 and 1007.70 cm<sup>2</sup>, respectively), while the lowest leaf area index was showed from T<sub>7</sub> (823.40 cm<sup>2</sup>) which was statistically similar with T<sub>6</sub> (845.30 cm<sup>2</sup>), at 75 DAS, the highest leaf area index (1440.10 cm<sup>2</sup>), was recorded from treatment T<sub>2</sub> which was statistically similar with T<sub>3</sub>,



treatment which was statistically similar with T<sub>3</sub> (18.94 cm) while the shortest spike (14.93 cm) was obtained when the plot treated [25%RD (recommended doses fertilizer + 20 t ha<sup>-1</sup>. FC (Farah compost) in T<sub>7</sub> (Table 1). Application of all chemical fertilizer as per recommended doses gave longest spike with ensuring optimum vegetative growth as well as reproductive growth of wheat followed by the combination of cowdung, compost and chemical fertilizers half in recommended doses.

**Table 1: Effect of chemical and organic fertilizers and their combinations on Length of spike (cm), No. of spikelet spike<sup>-1</sup>, No. of grains spike<sup>-1</sup> and thousand grain weight (g) of wheat**

Treatments	Length of spike (cm)	No. of spikelet spike <sup>-1</sup>	No. of grains spike <sup>-1</sup>	1000 grain weight(g)
T <sub>1</sub>	18.78ab	16.08 ab	39.42ab	48.43a
T <sub>2</sub>	19.74a	17.00 a	41.00 a	49.52a
T <sub>3</sub>	18.94ab	16.26 ab	39.69ab	48.96a
T <sub>4</sub>	16.92cd	14.70 cd	35.19 cd	44.18bc
T <sub>5</sub>	15.85de	14.31 d	35.59 cd	43.00bc
T <sub>6</sub>	15.48e	13.66 de	33.12 d	40.11d
T <sub>7</sub>	14.93e	13.00 e	32.93 d	39.42 d
T <sub>8</sub>	18.31bc	15.66 bc	36.61 bc	45.730 b
T <sub>9</sub>	18.04bc	15.56 bc	36.19 bc	45.153 b
CV (%)	4.71	3.99	5.2	3.70
LS	**	**	**	**
LSD	1.4146	1.0453	2.2429	2.8669

In a column, figure bearing same, or no letter (s) do not differ significantly at 5% level of significance by Duncan's Multiple Range Test

\*\* = Significant at 1% level of probability

\* = Significant at 5% level of probability

LS = Level of significance

CV = Co-efficient of variance

LSD = Least Significant Difference

#### Legend

T<sub>1</sub> = Control (Recommended Dose)

T<sub>2</sub> = 75% RD +10 t ha<sup>-1</sup> Farah Compost (FC)

T<sub>3</sub> = 75% RD + 10 t ha<sup>-1</sup> Kazi Compost (KC)

T<sub>4</sub> = 50% RD+15 t ha<sup>-1</sup> FC

T<sub>5</sub> = 50% RD+15 t ha<sup>-1</sup> KC

T<sub>6</sub> = 25% RD+20 t ha<sup>-1</sup> FC

T<sub>7</sub> = 25%RD+20 t ha<sup>-1</sup> KC

T<sub>8</sub> = 25 t ha<sup>-1</sup> FC

T<sub>9</sub> = 25 t ha<sup>-1</sup> KC

#### 4.6 Spikelet's spike<sup>-1</sup> (no.)

Different chemical and organic fertilizers and their combinations showed significant variation for number of spikelets spike<sup>-1</sup>. The maximum number of spikelets spikes<sup>-1</sup> was recorded from T<sub>2</sub> (17.00), which was statistically at par with T<sub>3</sub>, and T<sub>1</sub> (116.26 and 16.06, respectively) and followed by T<sub>8</sub> and T<sub>9</sub> (15.66 and 15.56), whereas the minimum number was recorded from T<sub>7</sub> (13.00) (Table 1). It was revealed that all chemical fertilizer as recommended dose produced maximum number of spikelets spike<sup>-1</sup> but combination of manure with chemical fertilizers gave the similar results. The advantage of organic manures is quite obvious, as these provide a steady supply of nutrients leading better growth of plants. Moreover, the increased availability of P and K in addition to other plant nutrients released by the organic manures might have contributed in enhancing the yield-attributes (spikelets spike<sup>-1</sup>). The positive impact of availability of individual plant nutrients and hemic substances from manure and balanced supplement of NPK through inorganic fertilizers might have induced cell division, expansion of cell wall, meristematic activity, photosynthetic efficiency and regulation of water intake into the cells, resulting in the increasing of yield parameters (Sharma *et al.*, 2013). Singh *et al.* (2018) reported that organic manure (sewage sludge and bone meal) can improve physical, chemical and biological properties of soil. It helps to reduce soil erosion and improves the soil quality as a plant growth medium which helped to trigger the production of spikelets of wheat. The results of our study were in close agreement with the results obtained by Chopra *et al.* (2016) and Tahir *et al.* (2011) who stated that the no. of spikelets spike<sup>-1</sup> increased by the application of organic matters along with synthetic fertilizers.

#### 4.7 Grains spike<sup>-1</sup> (no.)

Grains spike<sup>-1</sup> was significantly differed due to different fertilizer management. The maximum grains spike<sup>-1</sup> (41.00) was obtained when the plot treated within T<sub>2</sub> treatment which is statistically similar with T<sub>3</sub> (39.69) while the minimum grains spike<sup>-1</sup> (32.93) was obtained when the plot in T<sub>7</sub> (Table 1). The increase in grains spike-1 may result from increase in the various components of grain set, the number of spikelets per spike, the frequency of spikelets bearing grains, the number of differentiated florets, the survival of florets, the frequency of grain setting by florets (Peltonen-Sainio *et al.*, 2007). The nutrient elements supplied by both organic and inorganic sources in balanced form

that might have increased the production of fertile spikelets resulting increasing the number of grains spike<sup>-1</sup>. The findings of present investigation were in line with the findings of Singh *et al.* (2018); Subhan *et al.* (2017); Rasul *et al.* (2015); Tahir *et al.* (2011); Abedi *et al.* (2010) and Khan and Hussain (2001) who found that the application of organic manure along with inorganic fertilizer significantly increased the number of grains per spike.

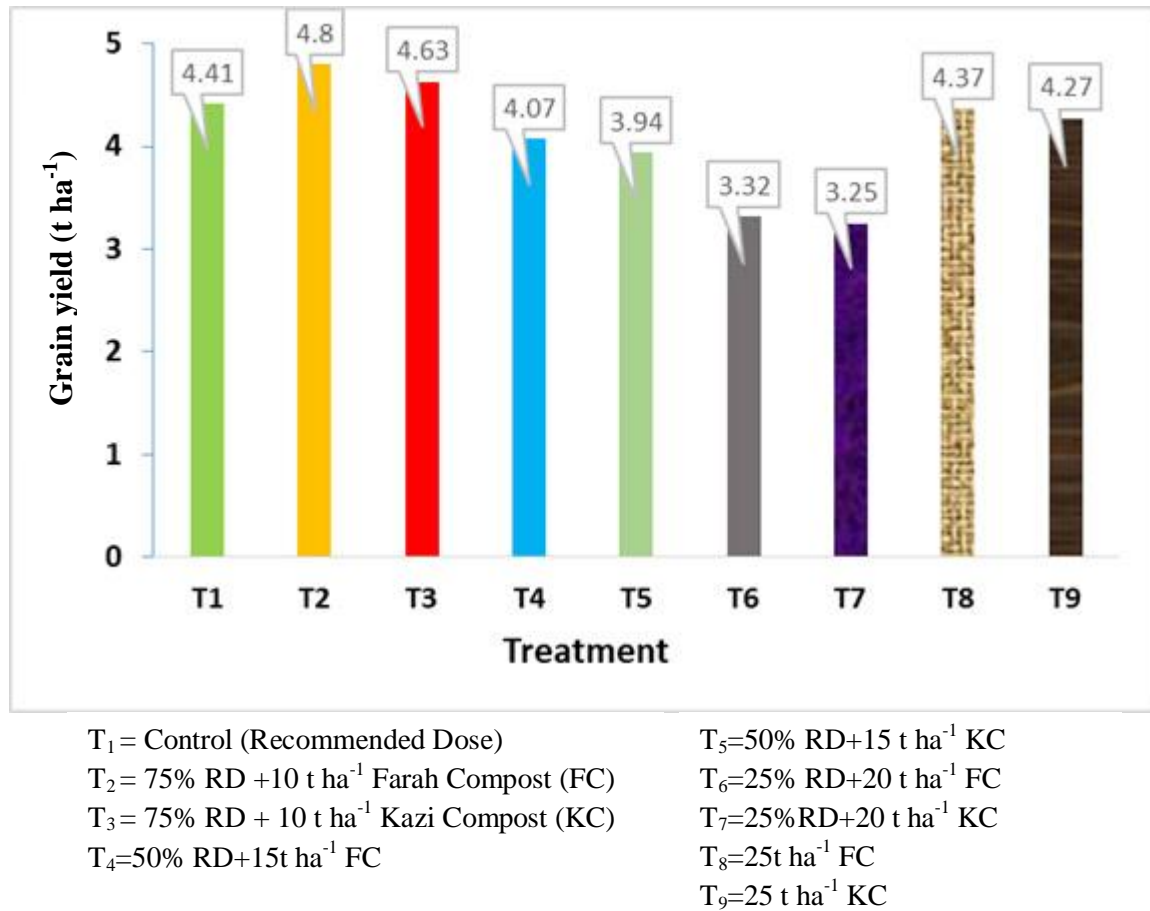
#### **4.8 1000 grain weight (g)**

Fertilizer management had significant effect on the 1000 grain weight of wheat shown in the Table 1. The highest 1000 grain weight (49.52 g) was obtained when the plot treated in T<sub>2</sub> treatment which is statistically similar with T<sub>3</sub> (48.96g) while the lowest 1000 grain weight (39.92g) was obtained when the plot treated in T<sub>7</sub> (Table 1). Jala-Abadi *et al.* (2012), and Turk and Tawaha (2002) concluded that the higher 1000 grain weight could have been due to higher rates of photosynthesis and photosynthates partitioning from source to sink (to the grains). This higher photosynthesis rate and photosynthates partitioning might have resulting from the balanced supply of essential nutrients from both organic and inorganic sources. Subhan *et al.* (2017) and Rehman *et al.* (2008) also recorded highest thousand grain weight by the application of FYM along with chemical fertilizers. The results of the study strongly supported by Rasul *et al.* (2015); Devi *et al.* (2011); Tahir *et al.* (2011); Brown and Petrie (2006); Hossain *et al.* (2002) and Bakash *et al.* (1999) who reported that grain yield was significantly increased by the application of organic matter along with fertilizers.

#### **4.9 Grain yield (t ha<sup>-1</sup>)**

Statistically significant variation was recorded in the grain yield per hectare for different chemical and organic fertilizer and their combinations. The results of the experiment revealed that, the maximum grain yield (4.8 t ha<sup>-1</sup>) was produced when the plot fertilized with T<sub>2</sub> treatment which is statistically similar with T<sub>3</sub> (4.63 t ha<sup>-1</sup>) while the lowest grain yield (3.25) was obtained when the plot (Figure 6). Improvement of yield component such as number of effective tillers hill<sup>-1</sup> and number of grains panicle<sup>-1</sup> in these treatments ultimately resulted in high yield of grains. It is well recognized that crop productivity depends on adequate plant nutrient and organic matter content of the soil. Organic manure plays an important role in improving physical, chemical and biological properties of the soil. Organic manures are content low concentration of plant nutrients

and they have a slow acting nature, organic manure alone may fail to tend the high nutritional requirements of crops (Hossian *et al.*, 2002). Continuous additions of the manures to the soil increase its organic matter content year after year, improving physical and chemical soil properties. This improvement is due to providing of a suitable soil structure, increasing soil cation exchange capacity, increasing the quantity and availability of plant nutrients in addition to furnishing the microbial activities.



**Figure 6: Effect of different fertilizers management on grain yield of wheat**

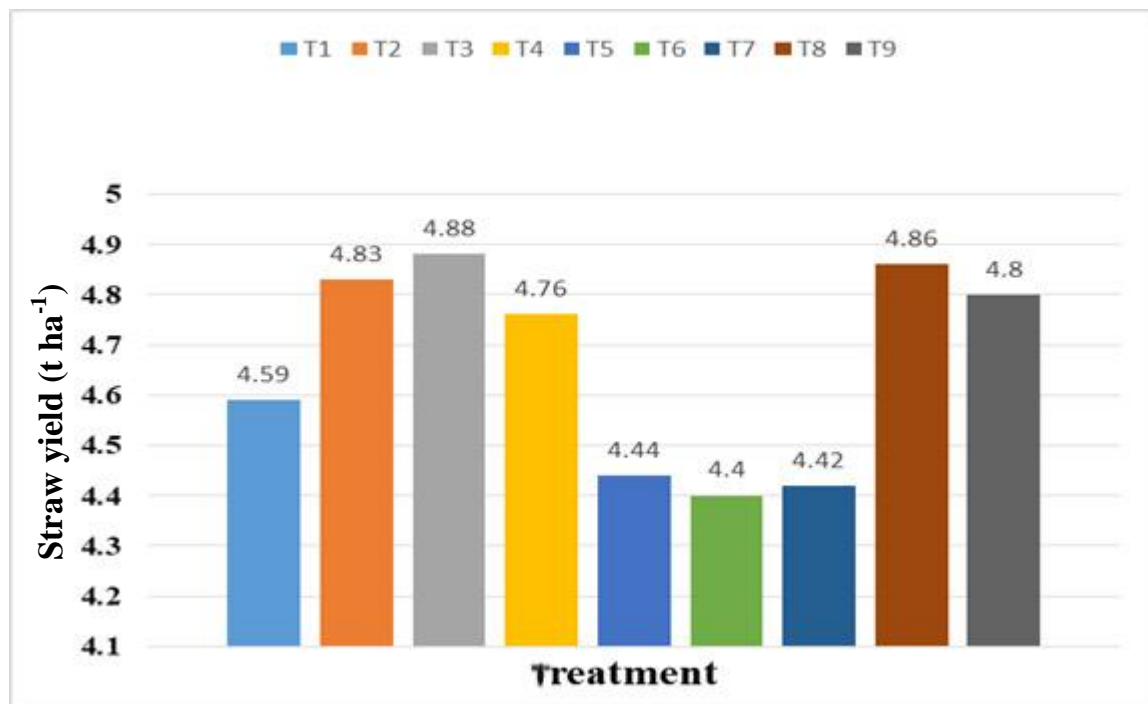
The positive effect of organic fertilizer on soil structure that lead to better root development that result in more nutrient uptake, compost not only slowly releases nutrients but also prevents the losses of chemical fertilizers through denitrification, volatilization and leaching by binding to nutrients and releasing with the passage of time (Arshad *et al.*, 2004). Thus, it is very likely that when we apply enriched compost along with chemical fertilizers, compost prevents nutrient losses. Consequently, integrated use

of chemical fertilizers and organic manure may improve the efficiency of chemical fertilizers and thus reduce their use in order to improve crop productivity as well as sustain soil health and fertility. Chopra *et al.* (2016) reported that organic manures such as compost are renewable and ecofriendly to achieve sustainable productivity with minimum deterioration effect of chemical fertilizers on soil health and environment. Application of organic and mineral fertilizers also affected the nutrient uptake of shoot. Incorporation of organic manures alone and along with mineral fertilizers increased N and P uptake in plant (Salim *et al.*, 1986). P helps in maintaining better source-sink inter relationship by increasing sink capacity by its role in energy transformation. The higher yield may be due to fact that these organic manures supplies direct available nutrients such as nitrogen to the plants and improve the proportion of water stable aggregates of the soil. This was attributed to cementing action of polysaccharides and other organic compounds released during the decomposition of organic matters, thus leading to taller plants, increased tillers and final yield (Hendrix *et al.*, 1994). The significant increase in grain yield under the influence of organic manure was largely a function of improved growth and consequent increase in different yield attributes. The possible reason could be ascribed to the favorable effect on soil properties due to formation of more humus colloidal complex coupled with faceable nutrient content of organic manure (Dhaka *et al.*, 2012). Application of fertilizers has supplied adequate amount of nutrients that helped in expansion of leaf area which might have accelerated the photosynthesis rate and in turn increased the supply of carbohydrates to the plants. Many scientists suggested that the use of organic matter along with chemical fertilizers can give the higher grains yield than obtained with synthetic chemical fertilizers alone (Tahir *et al.*, 2011; Sarwar *et al.*, 2008). Higher soil organic matter concentrations have been proved to enhance the yield and yield components of cereals as well as soil aeration, soil density and maximizing water holding capacity of soil for seed germination and plant root development (Zia *et al.*, 1998). The addition of organic matter also maintains regular supply of macro and micronutrients in soil, resulting in higher yields. Urkurkar *et al.* (2010) reported the integrated use of chemical fertilizers with organic manures *viz.* compost, wheat straw or green manure might have added huge quantity of organic matter in soil and thereby producing increased grain yield. The results of the investigation in line with those reported by Singh *et al.* (2018); Chekollé (2017); Phullan *et al.* (2017); Yadav *et al.* (2017); Rasul *et al.* (2015; Jala-Abadi *et al.* (2012); Devi *et al.* (2011); Abedi *et al.* (2010); Sarwar *et al.* (2008); Khan *et al.* (2007) and Cheuk *et al.* (2003) who

concluded that grain yield of wheat was significantly affected by application of synthetic fertilizer along with organic manure than the sole application of synthetic fertilizers.

#### 4.10 Straw yield ( $t\ ha^{-1}$ )

Straw yield varied significantly with the different levels of fertilizer. Straw yield was significantly highest ( $4.88\ t\ ha^{-1}$ ) at treatment  $T_3$  that followed by treatment  $T_2$  ( $4.83\ t\ ha^{-1}$ ). The lowest straw yield ( $4.42\ t\ ha^{-1}$ ). The lowest straw yield ( $4.42\ t\ ha^{-1}$ ) was found in  $T_6$  treatment (Figure 7). These results were supported by those of Tahir *et al.* (2011) and Sarwar *et al.* (2008) who reported that straw yield of wheat was significantly increased by the application of organic matters along with inorganic fertilizers.



$T_1$  = Control (Recommended Dose)

$T_2$  = 75% RD +10  $t\ ha^{-1}$  Farah Compost (FC)

$T_3$  = 75% RD + 10  $t\ ha^{-1}$  Kazi Compost (KC)

$T_4$  = 50% RD+15  $t\ ha^{-1}$  FC

$T_5$  = 50% RD+15  $t\ ha^{-1}$  KC

$T_6$  = 25% RD+20  $t\ ha^{-1}$  FC

$T_7$  = 25%RD+20  $t\ ha^{-1}$  KC

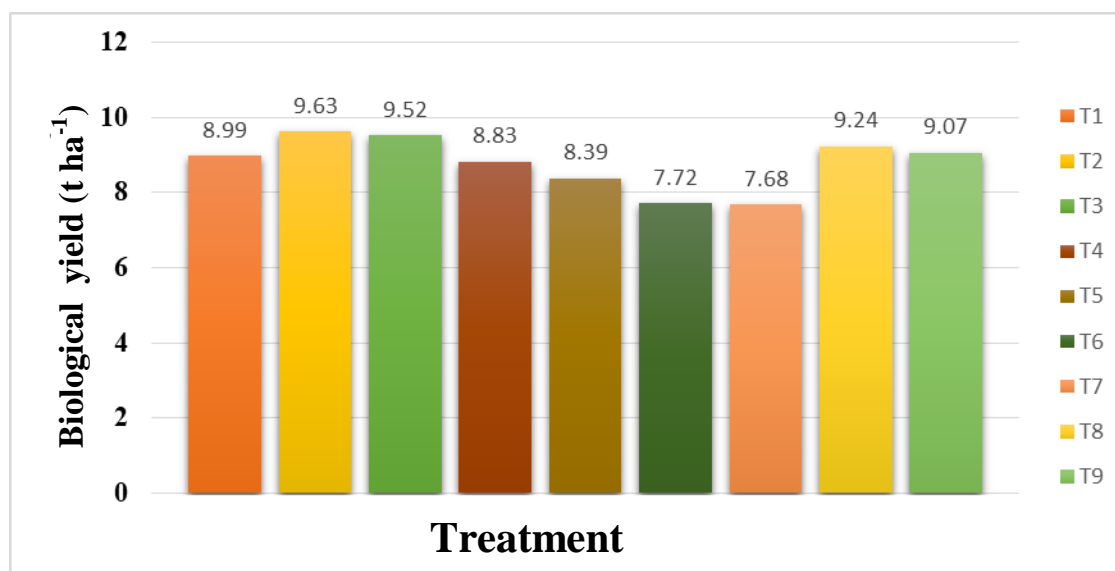
$T_8$  = 25  $t\ ha^{-1}$  FC

$T_9$  = 25  $t\ ha^{-1}$  KC

**Figure 7: Effect of different fertilizers management on straw yield of wheat**

#### 4.11 Biological yield (t ha<sup>-1</sup>)

Biological yield varied significantly with the different levels of fertilizer. Biological yield was distinctly highest (9.63 t ha<sup>-1</sup>) at treatment T<sub>2</sub> which is statistically similar with T<sub>3</sub> (9.52 t ha<sup>-1</sup>). The lowest biological yield (7.68 t ha<sup>-1</sup>) was found in T<sub>7</sub> was obtained when the plot treated in T<sub>7</sub> (Figure 8).



T<sub>1</sub> = Control (Recommended Dose)

T<sub>2</sub> = 75% RD + 10 t ha<sup>-1</sup> Farah Compost (FC)

T<sub>3</sub> = 75% RD + 10 t ha<sup>-1</sup> Kazi Compost (KC)

T<sub>4</sub> = 50% RD + 15 t ha<sup>-1</sup> FC

T<sub>5</sub> = 50% RD + 15 t ha<sup>-1</sup> KC

T<sub>6</sub> = 25% RD + 20 t ha<sup>-1</sup> FC

T<sub>7</sub> = 25% RD + 20 t ha<sup>-1</sup> KC

T<sub>8</sub> = 25 t ha<sup>-1</sup> FC

T<sub>9</sub> = 25 t ha<sup>-1</sup> KC

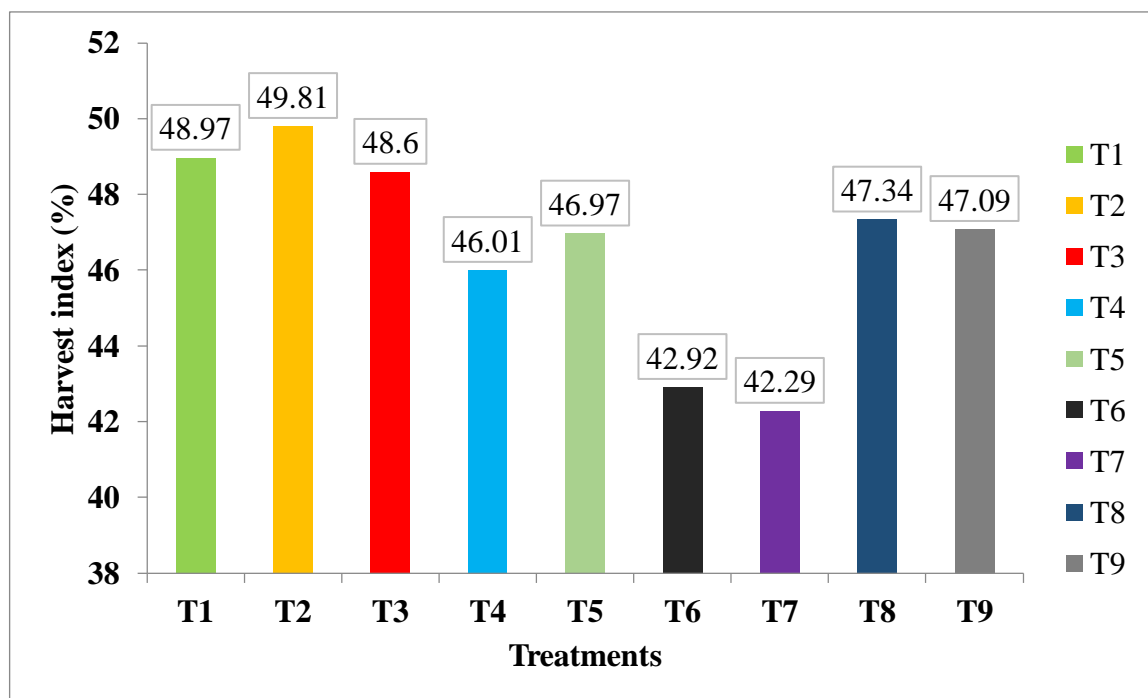
**Figure 8: Effect of different fertilizers management on biological yield of wheat**

Biological yield indicates the total dry matter produced by the plants during its life cycle. Organic manures are an excellent source for multi nutrient supply to crop plants, although in a variable manner are depending on their type and quality (Ahmad *et al.*, 2008). Channabasaganowda *et al.* (2008) reported that the high biological yield may be due to fact that the organic manures supplies direct available nutrients such as nitrogen to the plant and the organic manures improve the proportion of water stable aggregates of the soil. Jala-Abadi *et al.* (2012) reported that the superiority of mixed organic manure may be attributed to balanced and gradual release of plant nutrients and increased nutrient uptake to support growth consequently increased the biological yield of wheat. The findings of our study were in line with those reported by Subhan *et al.* (2017); Rasul *et al.* (2015); and Tahir *et al.* (2011) who concluded that the organic matter along with

the recommended dose of synthetic fertilizers significantly affected the biological yield of the plant.

#### 4.12 Harvest Index (%)

Effect of different fertilizer management exerted significant variation on harvest index. The highest harvest index (49.81%) was recorded from treatment T<sub>2</sub> and the lowest harvest index (42.29%) was recorded from T<sub>7</sub> (Figure 9). Jala-Abadi *et al.* (2012) reported that there was an inverse relationship between application of chemical fertility and harvest index, this may be due to increased rate of photosynthesis and utilization of assimilates obtained by organic fertility systems which turn resulted in heavier grains, there by increased the harvest index. Subhan *et al.* (2017) reported the highest HI (%) by the application of manures along with inorganic fertilizers. Hammad *et al.* (2011) reported higher harvest index by the application of green manures, poultry litter and sewage sludge over the recommended inorganic fertilizer.



T<sub>1</sub> = Control (Recommended Dose)

T<sub>2</sub> = 75% RD +10 t ha<sup>-1</sup> Farah Compost (FC)

T<sub>3</sub> = 75% RD + 10 t ha<sup>-1</sup> Kazi Compost (KC)

T<sub>4</sub> =50% RD+15 t ha<sup>-1</sup> FC

T<sub>5</sub>=50% RD+15 t ha<sup>-1</sup> KC

T<sub>6</sub>=25% RD+20 t ha<sup>-1</sup> FC

T<sub>7</sub>=25%RD+20 t ha<sup>-1</sup> KC

T<sub>8</sub>=25t ha<sup>-1</sup> FC

T<sub>9</sub>=25 t ha<sup>-1</sup> KC

**Figure 9: Effect of different fertilizers management on harvest index of wheat**

## CHAPTER V

### SUMMARY AND CONCLUSIONS

The experiment was conducted at agronomy research field, HSTU, Dinajpur during from November 2019 to April 2020 to assess the effect of organic and inorganic fertilizers on the growth and yield of wheat. The experiment consisted with one factors namely T<sub>1</sub>: Control (RD), T<sub>2</sub>: 75% RD+10 t ha<sup>-1</sup> FC, T<sub>3</sub>: 75% RD + 10 t ha<sup>-1</sup> KC, T<sub>4</sub>: 50% RD + 15 t ha<sup>-1</sup> FC, T<sub>5</sub>: 50% RD + 15 t ha<sup>-1</sup> KC, T<sub>6</sub>: 25% RD+ 20 t ha<sup>-1</sup> KC, T<sub>7</sub>:25%RD+20 t ha<sup>-1</sup> FC, T<sub>8</sub>:25 t ha<sup>-1</sup> KC, T<sub>9</sub>:25 t ha<sup>-1</sup> FC.

The planting material of the experiment was wheat (BARI Gom-32). The experiment was laid out in a randomized complete block design (RCBD). There were 12 treatment combinations, each treatment replicated three times. The treatments were randomly distributed to the plots within a block. Thus, the number of plots was  $3 \times 9 = 27$ . The unit plot size was 1 m<sup>2</sup> (1m x 1m). Irrigation and drainage channel was made with maintaining 50 wide and 30 cm between blocks and 25 cm wide and 25 cm depth plot. The treatments were R<sub>1</sub>T<sub>1</sub>, R<sub>1</sub>T<sub>2</sub>, R<sub>1</sub>T<sub>3</sub>, R<sub>1</sub>T<sub>4</sub>, R<sub>1</sub>T<sub>5</sub>, R<sub>1</sub>T<sub>6</sub>, R<sub>1</sub>T<sub>7</sub>, R<sub>1</sub>T<sub>8</sub>, R<sub>1</sub>T<sub>9</sub>, R<sub>2</sub>T<sub>1</sub>, R<sub>2</sub>T<sub>2</sub>, R<sub>2</sub>T<sub>3</sub>, R<sub>2</sub>T<sub>4</sub>, R<sub>2</sub>T<sub>5</sub>, R<sub>2</sub>T<sub>6</sub>, R<sub>2</sub>T<sub>7</sub>, R<sub>2</sub>T<sub>8</sub>, R<sub>2</sub>T<sub>9</sub>, R<sub>3</sub>T<sub>1</sub>, R<sub>3</sub>T<sub>2</sub>, R<sub>3</sub>T<sub>3</sub>, R<sub>3</sub>T<sub>4</sub>, R<sub>3</sub>T<sub>5</sub>, R<sub>3</sub>T<sub>6</sub>, R<sub>3</sub>T<sub>7</sub>, R<sub>3</sub>T<sub>8</sub>, R<sub>3</sub>T<sub>9</sub>. The recommended doses of urea, TSP, MoP, gypsum were 20 g, 17g, 5g, 12g. Each plot was fertilized by Urea, TSP, Mop and the doses were 150, 120, 40 gm respectively. Kazi compost used in 12 plots Farah compost used in 12 plots and recommended doses used in 3 plots. The seeds were sown on 12 November, 2019. The crop was harvested at maturity on after about 120 days of sowing. The growth, yield and yield components were recorded for each plot from randomly selected 5 plants. Parameters like plant height, tillers plant<sup>-1</sup>, spike length, grains spike<sup>-1</sup>, 1000-grain weight, grain yield, straw yield, biological yield, harvest index were influenced by organic and inorganic fertilizers. plant height of wheat at different growth stages The results revealed that at 25.50, and 75 DAS the tallest plant (24.79 cm, 47.82 cm and 71.08 cm respectively) were recorded from treatment T<sub>2</sub> [75% RD (recommended doses fertilizer + 10 t ha<sup>-1</sup> FC (Farah compost) while the shortest plant height(22.49 cm, 42.67 cm and 64.87 cm respectively) were recorded from treatment T<sub>7</sub> [25%RD (recommended doses fertilizer + 20 t ha<sup>-1</sup> FC (Farah compost).At 120 (harvesting) DAS, the highest plant height was obtained at treatment T<sub>2</sub> (91.33 cm) which was statistically similar with T<sub>3</sub> (90.33cm respectively) and the lowest one in treatment T<sub>7</sub> (77.67 cm).Different

fertilizer managements showed a significant variation on above ground dry matter weight plant<sup>-1</sup> for all growth stages. The results revealed that at 25.50, and 75 DAS the highest dry matter weight (0.25g cm, 3.30g cm and 9.11g respectively) were recorded from treatment T<sub>2</sub> [75% RD (recommended doses fertilizer + 10 t ha<sup>-1</sup> FC (Farah compost) while the shortest dry matter weight (0.25g, 3.30g cm and 9.11g respectively) were recorded from treatment T<sub>7</sub> [25%RD (recommended doses fertilizer + 20 t ha<sup>-1</sup> FC (Farah compost). At 120 (harvesting) DAS, the highest dry matter weight was obtained at treatment T<sub>2</sub> (30.08 cm) which was statistically similar with T<sub>3</sub> (29.82g respectively) and the lowest one in treatment T<sub>7</sub> (24.67g). Different fertilizer managements had significant influenced on leaf area of wheat at all the growth stages. The results revealed that at 25.50, and 75 DAS the highest leaf area index (438.51 cm<sup>-1</sup>, 1028.00 cm<sup>-1</sup> and 1440.10cm<sup>-1</sup> respectively) were recorded from treatment T<sub>2</sub> [75% RD (recommended doses fertilizer + 10 t ha<sup>-1</sup> FC (Farah compost) while the lowest leaf area index (387.00 cm<sup>-1</sup>, 823.40 cm<sup>-1</sup> and 1024.50 cm<sup>-1</sup> respectively) were recorded from treatment T<sub>7</sub>. Length of spike was significantly affected due to different fertilizer management. The longest spike (19.74 cm) was obtained when the plot treated with [75% RD (recommended doses fertilizer + 10 t ha<sup>-1</sup> FC (Farah compost) in T<sub>2</sub> treatment which is statistically similar with T<sub>3</sub> (18.94 cm) while the shortest spike (14.93 cm) was obtained when the plot treated [25%RD (recommended doses fertilizer + 20 t ha<sup>-1</sup> FC (Farah compost) in T<sub>7</sub>. Spikelet's spike<sup>-1</sup> was significantly varied due to different fertilizer management. The maximum spikelet's spike<sup>-1</sup> (17.00) was obtained when the plot treated with [75% RD (recommended doses fertilizer + 10 t ha<sup>-1</sup> FC (Farah compost) in T<sub>2</sub> treatment which is statistically similar with T<sub>3</sub> (16.26) while the minimum spikelet's spike<sup>-1</sup> (13.00) was obtained when the plot treated [25% RD (recommended doses fertilizer + 20 t ha<sup>-1</sup> FC (Farah compost) in T<sub>7</sub>. Grains spike<sup>-1</sup> was significantly differed due to different fertilizer management. The maximum Grains spike<sup>-1</sup> (41.00) was obtained when the plot treated with [75% RD (recommended doses fertilizer + 10 t ha<sup>-1</sup> FC (Farah compost) in T<sub>2</sub> treatment which is statistically similar with T<sub>3</sub> (39.69) while the minimum Grains spike<sup>-1</sup> (32.93) was obtained when the plot treated [25%RD (recommended doses fertilizer + 20 t ha<sup>-1</sup> FC (Farah compost) in T<sub>7</sub>. Fertilizer management had significant effect on the 1000 grain weight of wheat shown. The highest 1000 grain weight (49.52 g) was obtained when the plot treated with [75% RD (recommended doses fertilizer + 10 t ha<sup>-1</sup> FC (Farah compost) in T<sub>2</sub> treatment which is statistically similar with T<sub>3</sub> (48.96g) while the lowest 1000 grain weight (39.92g) was

obtained when the plot treated [25% RD (recommended doses fertilizer + 20 t ha<sup>-1</sup> FC (Farah compost) in T<sub>7</sub>.

Grain yield was significantly influenced by different fertilizer managements. The results of the experiment revealed that, the maximum grain yield (4.8 t ha<sup>-1</sup>) was produced when the plot fertilized with [75% RD (recommended doses fertilizer + 10 t ha<sup>-1</sup> FC (Farah compost) in T<sub>2</sub> treatment which is statistically similar with T<sub>3</sub> (4.63 t ha<sup>-1</sup>) while the lowest grain yield (3.25) was obtained when the plot treated [25% RD (recommended doses fertilizer + 20 t ha<sup>-1</sup> FC (Farah compost) in T<sub>7</sub>. Straw yield varied significantly with the different levels of fertilizer. Straw yield was significantly highest (4.88 t ha<sup>-1</sup>) at treatment T<sub>3</sub> that followed by treatment T<sub>2</sub> (4.83 t ha<sup>-1</sup>). The lowest straw yield (4.42 t ha<sup>-1</sup>). The lowest straw yield (4.42 t ha<sup>-1</sup>) was found in T<sub>6</sub> treatment. Biological yield varied significantly with the different levels of fertilizer. Biological yield was distinctly highest (9.63 t ha<sup>-1</sup>) at treatment T<sub>2</sub> which is statistically similar with T<sub>3</sub> (9.52 t ha<sup>-1</sup>). The lowest biological yield (7.68 t ha<sup>-1</sup>) was found in T<sub>7</sub> was obtained when the plot treated [25%RD (recommended doses fertilizer + 20 t ha<sup>-1</sup> FC (Farah compost) in T<sub>7</sub>. Effect of different fertilizer management exerted significant variation on harvest index. The highest harvest index (49.81%) was recorded from treatment T<sub>2</sub> and the lowest harvest index (42.29%) was recorded from T<sub>7</sub>.

From the experimental results, the highest grain yield was observed from T<sub>2</sub> treatment when the plot fertilized with [75% RD (recommended doses fertilizer + 10 t ha<sup>-1</sup> FC (Farah compost) Therefore, for efficient wheat production application of Farah compost are essential. Cultivation of BARI Gom-32 along with recommended dose and Farah compost came out very important for obtaining higher yield of wheat in the Old Himalayan Piedmont Plain (AEZ 1) soils.

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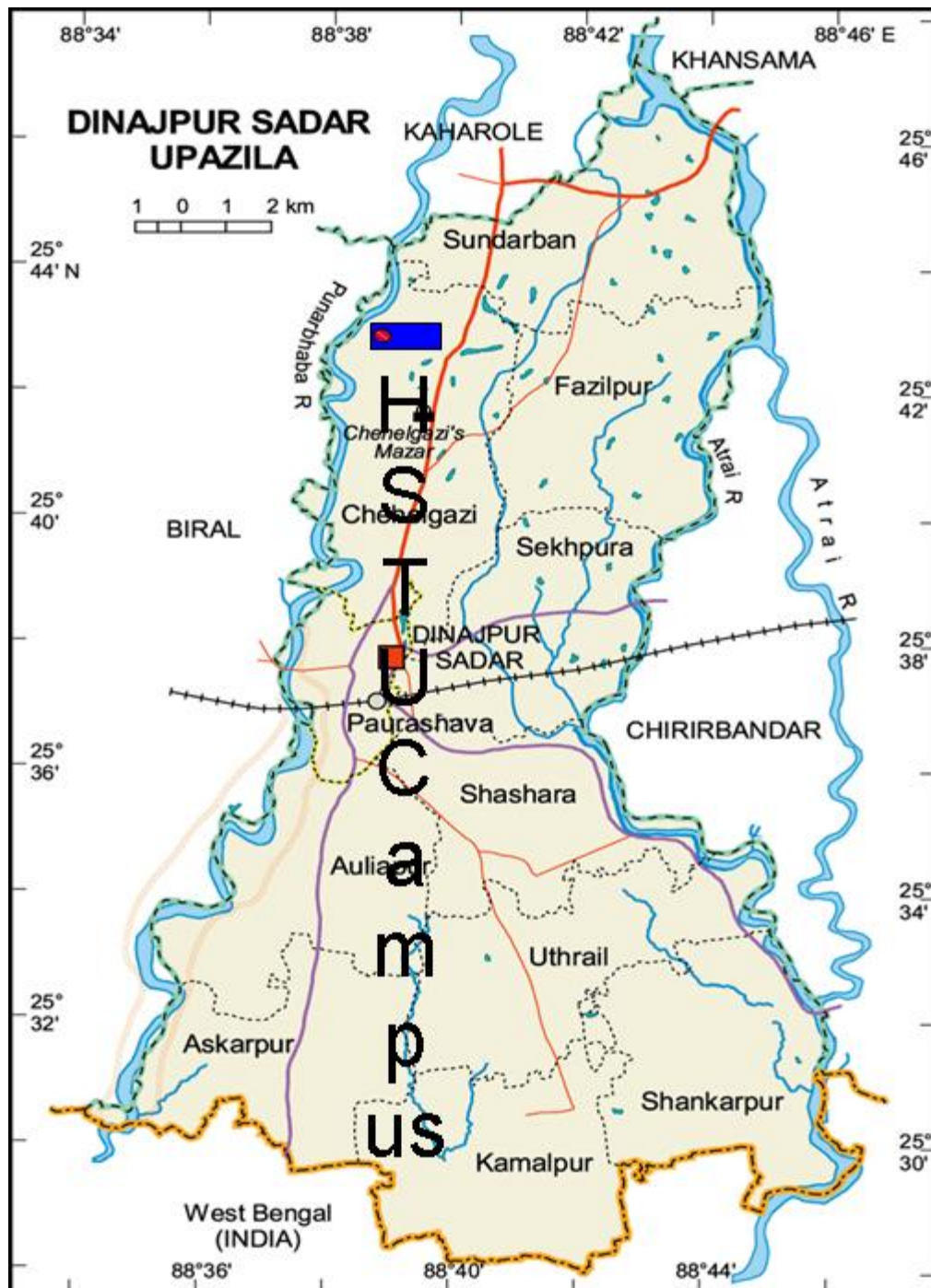
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## APPENDICES

Appendix I. Location of the experimental site (map of Dinajpur Sadar Upazila showing the research plot).



**Appendix II. The physical and chemical properties of soil in the experimental field,  
HSTU, Sadar, Dinajpur-5200.**

<b>Soil characters</b>	<b>Physical and chemical properties</b>
Texture	
Sand (%)	65
Silt (%)	30
Clay(%)	5
Textural class	Sandy loam
CEC (meq/ 100g)	8.07
pH	5.35
Organic matter (%)	1.06
Total nitrogen (%)	0.10
Sodium (meq/ 100g)	0.06
Calcium (meq/ 100g)	1.30
Magnesium (meq/ 100g)	0.40
Potassium (meq/ 100g)	0.26
Phosphorus ( $\mu\text{g/g}$ )	24.0
Sulphur ( $\mu\text{g/g}$ )	3.2
Boron ( $\mu\text{g/g}$ )	0.27
Iron ( $\mu\text{g/g}$ )	5.30
Zinc ( $\mu\text{g/g}$ )	0.90

### Appendix III. Some Photographs of Experimental Site



Land Preparation



Mixing organic and inorganic fertilizer



Netting



Data Collection



Maturity Stage



Harvest