PERFORMANCE OF DIFFERENT RICE VARIETIES AS INFLUENCED BY ORGANIC AND INORGANIC NUTRIENT MANAGEMENT PRACTICES

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CERTIFICATE

This is to certify that the thesis entitled **"PERFORMANCE OF *BORO* RICE VARIETIES AS INFLUENCED BY ORGANIC AND INORGANIC NUTRIENT MANAGEMENT PRACTICES"** submitted to the Department of Soil Science, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTERS OF SCIENCE (M.S.)** in **SOIL SCIENCE**, embodies the result of a piece of bonafide research work carried out by **MIRZA NADIA SULTANA**, Registration No. **19-10195** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of this investigation has been duly acknowledged.

December, 2021
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Dedicated to
My
Beloved Parents

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The Author

PERFORMANCE OF DIFFERENT RICE VARIETIES AS INFLUENCED BY ORGANIC AND INORGANIC NUTRIENT MANAGEMENT PRACTICES

ABSTRACT

The experiment was carried out at the research field of Sher-e-Bangla Agricultural University, Dhaka during the period from November 2020 to May 2021 to study the performance of 3 different types of rice varieties which are influenced by different level of organic and inorganic nutrient management practices. The experiment comprised of five treatment combinations *viz*., T_1 (RFD: $N_{120}P_{16}K_{100}S_{10}Zn_2$ kg ha^{-1}), T_2 (75% RFD + Cowdung 2.5 t ha^{-1}), T_3 (50% RFD + Cowdung 5 t ha^{-1}), T_4 (100% RFD + Cowdung 5 t ha^{-1}) and T_5 (cowdung 10 t ha^{-1}) with three rice varieties *viz*., V_1 (BRRI dhan28), V_2 (BRRI dhan34) and V_3 (BRRI dhan81) laid out in Randomized Complete Block Design (RCBD) with three replications. Different treatments of organic and inorganic nutrients combination showed significant variation on maximum parameters of the study. Treatment T_4 (100% RFD + Cowdung 5 t ha^{-1}) showed the best performance on different growth, yield contributing parameters, yield parameters and nutrient status of post harvest soil followed by T_2 (75% RFD + Cowdung 2.5 t ha^{-1}) whereas the treatment T_5 (cowdung 10 t ha^{-1}) performed lowest. Similarly, V_3 (BRRI dhan81) gave best results on different studied parameters and performed highest yield followed by V_1 (BRRI dhan28) whereas V_2 (BRRI dhan34) showed least performance. Regarding, ccombined effect of different treatments of organic and inorganic nutrients combination and variety, significant variation was found on most of the studied parameters. The highest plant height (104.50 cm), number of tillers $hill^{-1}$ (20.78), number of effective tillers $hill^{-1}$ (18.22), length of flag leaf (36.32 cm), panicle length (24.93 cm), number of filled grains $panicle^{-1}$ (166.70), number of un-filled grains $panicle^{-1}$ (18.55), grain yield (7.15 t ha^{-1}), straw yield (8.22 t ha^{-1}) and harvest index (46.48%) were recorded from the treatment combination of T_4V_3 while T_4V_1 showed the highest 1000 grain weight (21.51 g) whereas the least performance was recorded from the treatment combination of T_5V_2. ph of post-harvest soil showed non-significant variation among the treatment combinations but available P and S content influence significantly. As there is some addition of cowdung, so, organic carbon content showed be more in the treatments are also showed be significant. The maximum available phosphorus and Sulphur content of post harvest soil (25.72 and 30.90 ppm, respectively) were achieved from T_4V_3 whereas the minimum (18.26 and 24.04 ppm, respectively) were found from T_5V_2. From the above result, it was found that, among the treatment combinations of organic and inorganic treatments with variety, T_4V_3 (100% RFD + Cowdung 5 t ha^{-1} with BRRI dhan81) can be considered as the best followed by T_4V_1 (100% RFD + Cowdung 5 t ha^{-1} with BRRI dhan28).

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ABBREVIATIONS AND ACRONYMS

AEZ	=	Agro-Ecological Zone
BBS	=	Bangladesh Bureau of Statistics
BCSRI	=	Bangladesh Council of Scientific Research Institute
cm	=	Centimeter
CV %	=	Percent Coefficient of Variation
DAS	=	Days After Sowing
DMRT	=	Duncan's Multiple Range Test
et al.,	=	And others
e.g.	=	exempli gratia (L), for example
etc.	=	Etcetera
FAO	=	Food and Agriculture Organization
g	=	Gram (s)
i.e.	=	id est (L), that is
Kg	=	Kilogram (s)
LSD	=	Least Significant Difference
m^2	=	Meter squares
ml	=	MiliLitre
M.S.	=	Master of Science
No.	=	Number
SAU	=	Sher-e-Bangla Agricultural University
var.	=	Variety
^oC	=	Degree Celceous
%	=	Percentage
NaOH	=	Sodium hydroxide
GM	=	Geometric mean
mg	=	Miligram
P	=	Phosphorus
K	=	Potassium
Ca	=	Calcium
L	=	Litre
µg	=	Microgram
USA	=	United States of America
WHO	=	World Health Organization

CHAPTER I

INTRODUCTION

Rice constitutes one of the most important staple foods for over half of the world's population (FAO, 2003). It is widely consumed by people throughout the world, irrespective of their race, religion, or political association (Ohajianya and Onyenweaku, 2002). Currently, global crop production requires inputs of roughly 105 million tons of nitrogen (N), 20 million tons of phosphorus (P), and 23 million tons of potassium (K) (FAO, 2013). Rice is an excellent source of carbohydrates providing up to 50-60% of the daily calories ingested by more than 2.5 billion people across the world (Metwally *et al*. 2011).

During all year round, rice is cultivated in three seasons as *aus*, *aman* and *boro* in Bangladesh. *Aman* is generally cultivated from June-July to October-November, *boro* from December-January to April-May, and *aus* from March-April to June-July. According to the report of BBS (2020), rice cultivation belonged to about 11.42 m hectares land and produced of 36.60 million tons rice. Among total rice production area, *aus* occupied 10.95 m hectares of land and produced 27.56 million metric tons rice, *aman* covered 55.62 m hectares of land and produced 14.204 million metric tons rice, accordingly, *boro* season produced19.646 million metric tons rice from 47.63 m hectares of land (BBS, 2020). Besides, Bangladesh is the 3th largest country of the world based on the rice cultivation (FAO, 2022). Alam (2012) also reported that rice covers about 82% of the total cropped land of Bangladesh. It accounts for 92% of the total food grain production in the country and provides more than 50% of the agricultural value addition employing about 44% of total labour forces.

Variety is the main key factor for maximization of yield and it plays vital role for successful crop production. In spite of appropriate management practices including nutrition and irrigation etc. a variety may be performed lower yield

due to its varietal performance (Laila and Sarkar, 2020). Significant variation was found due to varietal difference on yield of rice.

Nutrient supply is another most limiting factor next to the water for crop production. Sustaining rice production has become a great challenge, particularly in areas where rice productivity declines in spite of following recommended nutrient management practices. Nutrient management by integrating organic sources of nutrients along with inorganic fertilizers may play an important role in improving and sustaining rice productivity (Gangmei and George, 2017), moreover, chemical fertilizers will play a major role as these contribute about 50% to the increase in food grain production for ever increasing population of our country (Mahajan and Gupta, 2009). Successful nutrient management can optimize crop yields, increase profitability and minimizes nutrient losses (Yadav *et al*., 2019).

Imbalanced nutrient management under intensive cropping system and decreased soil organic matter are the key factors responsible for decline in soil quality parameters (Kang *et al*., 2005) such as deterioration of the physical, chemical and biological health of soils, and declined factor productivity, due to much higher annual removal of nutrients by crops and cropping systems than the amount added through fertilizers and resulted negative nutrient balance (Singh *et al*., 2018). Continuous use of inorganic fertilizers leads to deterioration in soil chemical, physical, and biological properties, and soil health (Mahajan *et al*., 2008). The negative impacts of chemical fertilizers, coupled with escalating prices, have led to growing interests in the use of organic fertilizers as a source of nutrients (Satyanarayana *et al*., 2002; Mahajan *et al*., 2008).

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 (Mahmud *et al*., 2016). The integrated nutrient

supply system is the most logical concept for managing longterm soil fertility and productivity (Ramesh *et al*., 2009). Use of chemical fertilizers and organic manures has been found promising in arresting the decline trend in soil-health and productivity through the correction of marginal deficiencies of some secondary and micro-nutrients, micro-flora and fauna and their beneficial influence on physical and biological properties of soil (Singh *et al*., 2018). Integrated nutrient management system can bring about equilibrium between degenerative and restorative activities in the soil eco-system (Upadhyay *et al*., 2011).

Keeping these facts in mind, research has been launched to study the performance of different rice varieties as influenced by organic and inorganic nutrient management practices with the following objectives:

1. To investigate the effect of different levels of integrated nutrient management option on the yield of rice varities
2. To find out the best combination of organic and inorganic nutrient management practice

CHAPTER II

REVIEW OF LITERATURE

One of the major reasons of yield reduction of rice is varietal performance. The another most important reason is nutrient management. So, proper selection of variety with proper nutrient management practices are most important factors needed to be considered in rice cultivation. Some of the important and informative works and research findings related to the variety and nutrient management done at home and abroad have been reviewed under the following headings:

2.1 Varietal effect on growth and yield of rice

From a field experiment Khatun *et al*. (2020) found the maximum number of filled spikelet in Binadhan17 (164.89 penical^{-1}) and that was significantly different from other five cultivars. Maximum 1000-seed weight was observed in Binadhan-17 (27.25 g). Highest grain yield was obtained from Binadhan-17 (6.13 t ha^{-1}) that was significantly different from other cultivars. Lowest grain yield observed in BRRI dhan39 (4.49 t ha^{-1}) that was statistically similar to BRRI dhan33 (4.57 t ha^{-1}) and Binadhan-7 (4.86 t ha^{-1}). Percent of sterile spikelet was highest in BRRI dhan39 (12.9%) and that was statistically similar with Binadhan-16 (11.96%) and BRRI dhan33 (12.36%).

Laila and Sarkar (2020) reported that yield and yield components of rice were significantly influenced by cultivar and among three cultivars *viz*. BRRI dhan34, Binadhan-13 and Kalizira; the highest and the lowest value of grain yield (3.89, 2.80 t ha^{-1}) and straw yield (5.29, 4.03 t ha^{-1}) were found in Binadhan-13 and Kalizira, respectively. In case of nutrient managements, the highest yield and yield component were obtained from 50% less than the recommended dose of inorganic fertilizers + vermicompost @ 3 t ha^{-1} treatment. The highest number of total tillers hill^{-1}, effective tillers hill^{-1},

number of grains panicle^{-1}, panicle length, grain yield and straw yield were obtained from Binadhan-13 compared to BRRI dhan34 and Kalizira.

Salam *et al*. (2019) carried out an experiment in *boro* season with the objective of testing agronomic status and adaptability of four modern rice varieties in comparison with the popular mega variety BRRI dhan28 at two farmer's fields. The varieties were BRRI dhan67, BRRI dhan81, BRRI dhan84 and BRRI dhan86. BRRI dhan28 was chosen as a control due to its wide acceptability among the farmers. It was observed that germination rate, plant height, effective tiller number were significantly higher in BRRI dhan67 than the other varieties but insignificant with BRRI dhan28. All the yield components spikelets per panicle, filled grain and 1000-grain weight were also significantly higher in BRRI dhan67 in compared to the other varieties but insignificant with BRRI dhan28. The highest grain yield was observed in BRRI dhan67 in both plots (7.89 and 7.29 t/ha) and showed significant differences among all other varieties. Harvest Index of BRRI dhan67 (51.02±4.2, 57.84±8.6)% indicated that this variety is the best yielder among the varieties.

Halder *et al*. (2018) conducted an experiment to find out the effect of cultivar and planting density on the yield and yield attributing characters of local aromatic rice. The experiment consisted of three local aromatic rice cultivars (Chinigura, Shakhorkhora and Kalizira). The results revealed that the variety Shakhorkhora cultivar produced the highest number of grains per panicle (131) and 1000-grain weight (13.8 g), consequently higher grain (2.63 t ha^{-1}), followed by Kalizira (2.56 t ha^{-1}) and straw yield (4.21 t ha^{-1}).

Mahmood (2017) conducted an experiment to evaluate the performance of hybrid boro rice (genotypes) in coastal area of Bangladesh. The experiment consisted of five rice varieties such as Arize Tej, Tea Sakti, Shathi and BRRI Dhan 28. Data were collected on morphological characters such as plant height, number of leaves plant^{-1} and leaf area hill^{-1}, number of effective tillers hill^{-1}, number of non effective tillers hill^{-1}, panicle length, number of filled grains

panicle^{-1}, number of unfilled grains panicle^{-1}, 1000 grain weight, grain yield, straw yield, biological yield and harvest index (%) were recorded. Among the five varieties the Arize Tej gave the highest performance for the mentioned parameters. From the above investigated results, it was observed that the Arize Tej was the most efficient for better growth and higher yield of hybrid boro rice genotypes grown in coastal area of Bangladesh.

Murshida *et al*. (2017) evaluated three rice varieties (cv. BRRI dhan28, BRRI dhan29 and Binadhan-14) in *boro* season and reported that at 100 DAT, the highest plant height, maximum number of tillers hill^{-1}, dry matter of shoot hill^{-1} and dry matter of root hill^{-1} were obtained from BRRI dhan29 and the lowest values were found in Binadhan-14. The highest grain yield was obtained from BRRI dhan29 and the lowest value was recorded from Binadhan-14.

Chowdhury *et al*. (2016) conducted an experiment with a view to find out the effect of cultivar and level of nitrogen on the yield performance of fine aromatic rice. The experiment consisted of three cultivars *viz*. Kalizira, Binadhan-13 and BRRI dhan34. Cultivar significantly influenced the yield of aromatic rice. The highest grain yield (3.33 t ha^{-1}) was obtained from Binadhan-13 followed by BRRI dhan34 (3.16 t ha^{-1}) and the lowest grain yield was found in Kalizira (2.11 t ha^{-1}).

Sarkar *et al*. (2016) reported that among three rice varieties *viz*. BRRI dhan34, BRRI dhan37 and BRRI dhan38; the tallest plant (142.7 cm), the highest number of effective tillers hill^{-1} (10.02), number of grains panicle^{-1} (152.3), panicle length (22.71cm), 1000-grain weight (15.55g) and grain yield (3.71 t ha^{-1}) were recorded in BRRI dhan34 compared to BRRI dhan37 and BRRI dhan38.

Yield test of 41 entries, 32 new hybrids, 8 male parents restore lines and 1 inbred cultivar, was conducted by Huang and Yan (2016) on the farm of University of Arkansas at Pine Bluff (UAPB). Results showed that the yields

of 7 hybrids were 25.7%-30.7% higher than check Francis. Hybrid 28s/BP23R had the highest yield, 10846.6 kg/hectare and over check by 30.7%. The yield of hybrid 28s/PB-24, was 10628.9 kg/hectare and over check by 28.1%. The yields of hybrid 28s/PB-22 and 33A/PB24 were 10549.8 and 10539.8 kg/hectare and over check by 27.1% and 27.0%, respectively.

Saha *et al*. (2015) conducted a study to evaluate the extent of variability among the small grain rice (*Oryza sativa* L.) genotypes for yield and yield components. Twenty four popular rice genotypes were evaluated for yield and yield contributing characters. BRRI dhan34 was used as check cultivar. Highest grain yield per plant was observed in Chinikanai-1, which was followed by Kalijira PL-9, Kalijira PL3 and Badshabhog. Chinikanai-1 had the highest number of grains per panicle. After evaluation of yield components, four genotypes namely Chinikanai-1, Kalijira PL-9, Kalijira PL-3 and Badshabhog were selected as outstanding genotypes, which can be used as potential breeding materials for sub-tropical environment of Bangladesh.

Chamely *et al*. (2015) conducted an experiment and evaluated three *boro* rice varieties *viz*., BRRI dhan28 (V_1), BRRI dhan29 (V_2) and BRRI dhan45 (V_3). The tallest plant (80.88 cm) and the highest number of total tillers hill^{-1} (13.80) were observed in BRRI dhan29 and the highest total dry matter (66.41 g m^{-2}) was observed in BRRI dhan45. The shortest plant (78.15 cm) and the lowest number of tillers hill^{-1} (12.41) were recorded from BRRI dhan45. The highest grain yield (4.84 t ha^{-1}) was recorded from BRRI dhan29.

Hasan *et al.* (2014) carried out an experiment to study the performance of two *aman* rice cultivars (BRRI dhan31 and BRRI dhan41) under different planting methods (line sowing with sprouted seeds by drum seeder, haphazard transplanting and transplanting in line). The highest no. of total tillers m^{-2} (421.12), effective tillers m^{-2} (410.65) and grain yield (5.08 t ha^{-}1) were recorded due to effect of the interaction of line sowing method with sprouted seeds by drum seeder and the cultivar BRRI dhan41.

Sarkar and Sarkar (2014) reported that among three rice varieties of BRRI dhan34, BRRI dhan37 and BRRI dhan38; the tallest plant (142.7 cm), the highest number of effective tillers hill (10.02), number of grains panicle (152.3), panicle length (22.71cm), 1000-grain weight (15.55g) and grain yield (3.71 t ha^{-1}) were recorded in BRRI dhan34.

Sokoto and Muhammad (2014) conducted a pot experiment to determine the effect of water stress and variety on productivity of rice. The results indicated significant differences among genotypes. Faro 44 differed significantly from others in plant height, number of leaves $plant^{-1}$, harvest index and grain yield. FARO 44 differed significantly from NERICA 2 and FARO 15 at all the parameters under study.

An experiment was conducted by Hosain *et al.* (2014) at the research farm of Sher-e-Bangla Agricultural University (SAU), Dhaka during *aus* season to observe the effect of transplanting dates on the yield and yield attributes of exotic hybrid rice cultivars. The experiment comprised of three rice cultivars (two hybrids-Heera2, Aloron and one inbred- BRRI dhan48). Hybrid cultivars Heera2 (3.03 t ha^{-1}) and Aloron (2.77 t ha^{-1}) gave the higher spikelet sterility. BRRI dhan48 produced the highest grain yield (3.51 t ha^{-1}).

Akter (2014) investigated the growth, yield and nutrient content of 15 *Boro* rice cultivars. BR15, BRRI dhan29 and BRRI dhan28 were the three rice cultivars having high potentials for grain and straw production during *Boro* season. The highest yield was recorded 5.26 t ha^{-1} which is still very low compared to other rice growing countries of the world. Chola *Boro* and Sada bore are two local land races having potentials for producing higher number of effective tillers and higher 1000 grain weight.

Jisan *et al.* (2014) carried out and experiment consisted of four cultivars *viz*. BRRI dhan49, BRRI dhan52, BRRI dhan56, BRRI dhan57 and four levels of N. Data revealed that cultivar exerted significant influence on yield

contributing characters. Among the cultivars, BRRI dhan52 produced the grains panicle^{-1} (121.5) and 1000-grain weight (23.65 g), whereas the lowest values of these parameters was produced by BRRI dhan57.

Kanfany *et al*. (2014) conducted an experiment with the aim of assessing the performances of introduced hybrid cultivars along with an inbred check cultivar under low input fertilizer levels. There were significant cultivar effects for all traits. The grain yield of rice hybrids (bred by the International Rice Research Institute) was not significantly higher than that of the check cultivar widely grown in Senegal.

Roy *et al.* (2014) evaluated 12 indigenous *Boro* rice varieties and recorded the tallest plant (123.80 cm) in Bapoy and the shortest (81.13 cm) in GS. The maximum tillers hill^{-1} (46.00) was observed in Sylhety *Boro* and the minimum (19.80) in Bere Ratna. The maximum effective tillers hill^{-1} (43.87) was recorded in the variety Sylhety *Boro* while Bere ratna produced the lowest effective tillers hill^{1} (17.73). The highest (110.57) and the lowest (42.13) filled grains panicle^{-1} was observed in the variety Koijore and Sylhety *Boro,* respectively. Thousand grain weight was the highest (26.35 g) in Kali *Boro* and the lowest (17.83 g) in GS one. The highest grain yield (5.01 t ha^{-1}) was found in the variety Koijore and the lowest in GS one (3.17 t ha^{-1}).

Alam *et al.* (2012) carried out an experiment to study the effect of cultivar, spacing and number of seedlings hill^{-1} on the yield potentials of transplant *Aman* rice. The experiment consisted of three high yielding cultivars *viz*. BRRI dhan32, BRRI dhan33 and BR11and reported that cultivar had significant effects on almost all the yield component characters and yield. Cultivar BR11 produced the highest grain yield (5.92 t ha^{-1}).

Sritharan and Vijayalakshmi (2012) evaluated the physiological traits and yield

potential of six rice cultivars *viz.,* PMK 3, ASD 16, MDU 3, MDU 5, CO 47 and RM 96019. The plant height, total dry matter production and the growth attributes like leaf area index, crop growth rate and R:S ratio were found to be higher in the rice cultivar PMK 3 that showed significant correlation with yield. Yield and yield components like number of productive tillers, fertility co-efficient, panicle harvest index, grain weight and harvest index were found to be higher in PMK 3.

Oka *et al.* (2012) conducted an experiment with 15 selected indigenous and 5 newly introduced hybrid rice cultivars and found significant variation among the 20 rice cultivars for all the traits evaluated. The results showed that plant height ranged between 144.01 cm in "Mass (I)" and 76.00 cm in "Chinyeugo". Cv. "E4197" had the highest value of 38±0.02 cm for panicle length and "Chinyereugo" had the highest value of 6.3g ± 0.03 for panicle weight. Leaf area showed the highest value of 63.8cm^2 ± 0.01 in "Mass (I)". Cv. "Co-operative" had high number of seeds panicle^{-1} (139 ± 0.19). "Chinyereugo" had the highest value of 25.9g ±1.4 for 1000-grains weight. The grain of "E4314" was the longest (8.00 mm ± 0.89) of the cultivars studied.

Islam *et al.* (2009) conducted pot experiments during T. *Aman* season in net house at Bangladesh Rice Research Institute (BRRI). Hybrid cultivar Sonarbangla-1 and inbred modern cultivar BRRI dhan31 was used in both the seasons. BRRI dhan3l had higher panicles plant^{-1} than Sonarbangla-1, but Sonarbangla-1 had higher number of grains panicle^{-1}, 1000-grain weight.

Jeng *et al.* (2009) found that the cultivar Tainung 67 had greater yield (7.2 mg ha^{-1}) than SA419 (6.2 mg ha^{-1}). The greater yield of SA419 than Tainung 67 in autumn was due to its higher net assimilation rate and better dry matter partitioning during grain filling. Significant panicle branch effects on the distribution pattern of grain weight were also found between Tainung 67 and SA419 with greater variation for the former than the latter.

Kamal and Anwar (2007) conducted an experiment to determine the effect of cultivar and planting method on the yield of boro rice. Four cultivars *viz*., BINADHAN-5, BINADHAN-6, BRRI dhan28 and BRRI dhan29 were used as plant materials. BINADHAN-5 produced the highest grain yield (4.61 t ha^{-1}) which was the consequence of highest number of effective tillers $hill^{-1}$ and highest number of grains $panicle^{-1}$.

Chowdhury *et al*. (2005) conducted an experiment to study their effect on the yield and yield components of rice cultivars BR23 and Pajam with 2, 4 and 6 seedlings $hill^{-1}$. They reported that the cv. BR23 showed superior performance over Pajam in respect of yield and yield contributing characters i.e. number of productive tillers $hill^{-1}$, length of panicle, l000-grain weight, grain yield and straw yield. On the other hand, the cultivar Pajam produced significantly the tallest plant, total number of grains $panicle^{-1}$, number of filled grains $panicle^{-1}$ and number of unfilled grains $panicle^{-1}$.

Siddiquee *et al.* (2002) conducted a study to evaluate the difference between hybrid and inbred rice in respect of their growth duration, yield and quality in *Boro* season. Among the varieties, Aalok 6201 had the highest grain yield followed by BRRI dhan29 and IR68877H but statistically they were similar. BRRI dhan28 had the lowest grain yield, which was statistically similar to Loknath503.

2.2 Effect of organic manure and inorganic fertilizer combination for growth and yield of rice

Alam *et al*. (2021) conducted an experiment to evaluate the efficacy of different organic and inorganic fertilizers on the growth and yield of boro rice (BRRI dhan29). The experiment had eight treatments with three replications and as follows; T_0: Control, T_1 : 100% $N_{75}P_{12}K_{45}S_9$ (Recommended dose), T_2 : 50% NPKS + 6 t cowdung ha^{-1}, T_3 : 75% NPKS + 3 t cowdung ha^{-1}, T_4 : 50% NPKS + 6 t poultry manure ha^{-1}, T_5 : 75% NPKS + 3 t poultry manure ha^{-1}, T_6 :

50% NPKS + 6 t vermicompost ha^{-1} and T_7 : 75% NPKS + 3 t vermicompost ha^{-1}. At harvest stage, the tallest plant (94.37 cm) and the greatest number of total tiller per hill (22.10) was recorded from T_4. The longest panicle (26.48 cm), maximum number of total grain per plant (178.3), the highest weight of 1000 seeds (21.96 g), the maximum grain yield (10.33 t ha^{-1}) and straw yield (15.67 t ha^{-1}) was also recorded in T_4 treatment. Although the highest biological yield was recorded from T_4 treatment but statistically similar result was found from T_5 treatment.

Laila and Sarkar (2020) conducted an experiment to study the combined effect of vermicompost with inorganic fertilizers on the yield and yield contributing characters of aromatic fine rice cultivars. The experiment comprised of five nutrient managements *viz*. control (no application of manures and fertilizer), recommended dose of inorganic fertilizers (i.e. 150, 95, 70, 60, 12 kg ha^{-1} of Urea, TSP, MOP, Gypsum and Zinc Sulphate respectively), vermicompost @ 3 t ha^{-1}, 25% less than recommended dose of inorganic fertilizer + vermicompost @ 1.5 t ha^{-1}, 50% less than recommended dose of inorganic fertilizer + vermicompost @ 3 t ha^{-1}. Result showed that, yield and yield components were significantly influenced by nutrient management. The highest yield and yield component were obtained from 50% less than the recommended dose of inorganic fertilizers + vermicompost @ 3 t ha^{-1} treatment and gave the highest number of total tillers $hill^{-1}$, effective tillers $hill^{-1}$, number of grains $panicle^{-1}$, panicle length, grain yield and straw yield whereas the lowest was found in control.

Chakraborty *et al*. (2020) carried out a study during the *boro* season to evaluate the effect of integrated nutrient management on two *boro* rice cultivars. The varieties were BRRI dhan28 and BRRI dhan29 and eight kinds of nutrient management *viz*., control (no fertilizers), recommended dose of inorganic fertilizers (120-60-40 N, P_2O_5, K_2O kg ha^{-1} + gypsum 60 kg ha^{-1} and $ZnSO_4$ @ 10 kg ha^{-1}), full dose of poultry manure @ 5 t ha^{-1}, cowdung @ 10 t ha^{-1},

poultry manure @ 2.5 t ha^{-1} + 50% prilled urea and full dose of other inorganic fertilizers, cowdung @ 5 t ha^{-1} + 50% prilled urea and full dose of inorganic fertilizers, poultry manure @ 2.5 t ha^{-1} + 75% prilled urea and full dose of inorganic fertilizers, and cowdung @ 5 t ha^{-1} + 75% prilled urea and full dose of other inorganic fertilizers. In case of nutrient managements, the highest yield and yield component were obtained from poultry manure @ 2.5 t ha^{-1} + 50% prilled urea and full dose of inorganic fertilizers and produced the maximum grain yield (5.70 t ha^{-1}). In the interaction of variety and integrated nutrient management, the highest grain yield (6.83 t ha^{-1}) and straw yield (7.61 t ha^{-1}) was obtained from poultry manure @ 2.5 t ha^{-1} + 50% prilled urea and full dose of inorganic fertilizers with BRRI dhan29 variety.

Devkota *et al*. (2019) showed that application of half of recommended N: P_2O_5: K_2O from the inorganic fertilizer sources along with soil incorporation of 20 cm crop residue produced significantly higher value for plant height, number of tillers per square meter, panicle length and Grain yield.

Moe *et al*. (2019) reported that higher tiller numbers were observed in the CF50PM50 treatment across all growth stages. The maximum tiller number was observed at 40 DAT; 34.73 and 38.22 tillers per hill in the $CF_{50}PM_{50}$ plots in 2017 and 2018, respectively. Tiller numbers declined after 45 DAT in all treatments. At harvest time, the maximum tiller numbers of 18.2 and 22.5 tillers per hill were observed in $CF_{50}PM_{50}$ plots in 2017 and 2018, respectively.

Baghdadi *et al*. (2018) revealed that the combining chemical fertilizers with chicken manure (CM) in a 50:50 ratio and applying 50% NPK+50% CM+BF produced grain and dry matter (DM) yields that were similar to those produced in the 100% nitrogen (N), phosphorus (P), potassium (K) treatment. Among the lone fertilizer treatments, the inorganic fertilizer (100% NPK) treatment produced the highest DM yield and out yielded the 100% CM treatment. However, when CM was combined with NPK, the resulting DM yield was the same as that resulting from 100% NPK (13.68 t/ha). Compared with CM

applications alone, combinations of NPK and CM applications resulted in increased plant height, crop growth rates (CGRs) and leaf area index (LAI), but the values of these parameters were similar to those resulting from 100% NPK application.

Chinnamani *et al*. (2018) also found that under system of rice intensification combined application of 100 % RDF + poultry manure (3 t ha^{-1}) + 3% Panchakavya foliar spray at transplanting, panicle initiation and 50% flowering observed the best integrated nutrient management practice for higher yield and nutrient uptake.

Throughout the crop period, plots treated with organic fertilizers produced DM amounts similar to those from plots treated with CF100. At harvest time, CF50PM50 plots produced the most DM, 15.49 t ha^{-1}. CF50CM50and CF50CP50 also produced significantly more DM in 2017 than in 2018. DM production in the CF50CM50and CF50CP50 treatments was not significantly different from that in the CF100 treatment. Plants treated with CF100 produced more DM than plants treated with organic fertilizers. The CF used is readily soluble and hence can supply nutrients to rice plants within a short time after application (Sarker *et al*., 2017).

Moe *et al*., (2017) observed that there was no statistically significant difference in the number of tillers generated using I_{100} compared with 50% NPK (I_{50}) inorganic fertilizer. However, a larger number of tillers were present in rice plants grown using I_{100} compared with 0% NPK (I_0) fertilizer. The maximum tiller number was produced using I_{75}Op in the dry season (19.22 $hill^{-1}$) and I_{100}Op in the wet season (17.00 $hill^{-1}$)

Sarkar *et al*. (2016) conducted an experiment to study the yield and quality of rice as affected by cultivar and nutrient management. The experiment comprised of eight nutrient managements *viz*. control (no manures and fertilizers), recommended dose of inorganic fertilizers, cow-dung at 10 t ha^{-1}, poultry manure at 5 t ha^{-1}, 50% of recommended dose of inorganic fertilizers +

50% cow-dung, 50% of recommended dose of inorganic fertilizers + 50% poultry manure, 75% of recommended dose of inorganic fertilizers + 50% cow-dung and 75% of recommended dose of inorganic fertilizers + 50% poultry manure. The highest number of effective tillers hill^{-1} (11.59), number of grains panicle^{-1} (157.6), panicle length (24.31 cm) and grain yield (3.97 t ha^{-1}) were recorded in the nutrient management of 75% recommended dose of inorganic fertilizers + 50% cowdung (5 t ha^{-1}). The treatment control (no manures and fertilizers) gave the lowest values for these parameters.

Sohel *et al*. (2016) carried out an experiment to evaluate the integrated effect of cow dung, poultry manure and water hyacinth with chemical fertilizers on the growth and yield of Boro rice (cv. BRRI dhan29). Most of the yield contributing characters influenced positively in treatment having quarter doses of cow dung, poultry manure and water hyacinth over recommended dose. The highest grain yield (5.58 t/ha) and straw yield (7.28 t/ha) were observed in that same treatment T_6 (1/3 Cow dung + 1/3 Poultry Manure + 1/3 water hyacinth + Fertilizers) over other treatments.

Mahmud *et al*. (2016) showed that application of medium level of chemical fertilizer with 4 t ha^{-1} vermi-compost gave the maximum yield. It was observed that over dose of NPKS fertilizers from chemical source decreased rice yield. Results also revealed that the highest plant height, effective tillers hill^{-1}, flag leaf length, length, filled grains panicle^{-1}, 1000-grain weight, grain yield, straw yield and biological yield were obtained from the combination of 4 t ha^{-1} vermicompost with 100 kg ha^{-1} N, 16 kg ha^{-1} P, 66 kg ha^{-1} K, 12 kg ha^{-1} S. It was observed that yield of rice can be increased substantially with the judicious application of organic fertilizer with chemical fertilizer.

Baishya *et al*. (2015) reported that the different sources of organic manure and inorganic fertilizers influenced positively the growth and yield of paddy. Among the nutrient management practices, crop receiving 2.5 t poultry manure ha^{-1} + 125% CDF (75 + 16.5 + 31.3 kg N P and K ha^{-1}) recorded the taller

plants, higher effective tillers, panicle length, grain and straw yield which closely followed by the 2.5 t poultry manure ha^{-1} + 100% CDF (60 +13.1 + 25 kg N, P and K ha^{-1} and 5t FYM ha^{-1} along with 125% CDF (75 + 16.5+ 31.3 kg N P and K ha^{-1}.

Kumar *et al*., (2014) observed that the application of organic and inorganic source of nutrient in combination increased the yield attributes. Application of 125% RDF + 5 t/ha vermin-compost recorded significantly higher yield attributes *viz*. number of panicle/m^2, panicle length, panicle and test weight followed by treatment 100% RDF + 5 t/ha vermin-compost. Moreover, other treatments were significantly superior over control.

Ranjitha *et al*., (2013) observed that significantly maximum grain and straw yield of rice was recorded with the application of 50 %recommended dose of nitrogen through urea + 50 % recommended dose of nitrogen through vermicompost. It was also noticed that straw yield of rice was 3.7, 15.9 and 20.7 % higher when NPK applied with farm yard manure, vermicompost and poultry manure, respectively as compared to NPK alone.

Sharma (2013) revealed that the growth, development, yield attributes of rice was found to be best when 50% N through farm yard manure and 50% NPK was applied in rice-wheat cropping system. Moreover Ali *et al*., (2009) reported that significantly highest grain and straw yield of rice (5.52 t ha^{-1} and 6.73 t ha^{-1} respectively) was obtained in 70% of recommended dose of chemical fertilizers and 3 tones poultry manure ha^{-1} than 70% NPKS alone and the control.

Krishnakumar and Haefele (2013) reported that application of nitrogen at 90 kg level as 50% through Rice straw compost + 50% nitrogen as poultry manure registered higher growth, grain and straw yield. However, with regard to N management, LCC 4 and 5 based On N applications recorded higher grain yield as a result of higher soil available nutrients during the critical growth stages.

Larijani and Hoseini (2012) also found that more tiller number (28%), more panicle/m^2 (60%), number of filled grains/m^2 (20.6%), spikelet per panicle (19.6%) and more grain yield (30.6%) with combined use of organic and chemical fertilizer compared with chemical fertilizer alone.

According to Siavoshi *et al*. (2011); plant height, number of tillers per hill, spikelet number per panicle, grain yield and 1000-grain weight increased with the application of organic and chemical fertilizers and this could be due to the increase in the absorption of available nutrients. They also stated that the difference in plant height was due to the variation of major nutrients in fertilizer sources. A similar result was observed by Ibrahim *et al*. (2008) in ascertaining the combined effect of organic manure with compost on rice. Differences in growth and yield observed in rice plants could also be due to the variation in absorption of essential nutrients by the plants (Amanullah 2016). However, incorporation of compost into the soil at different rates influenced plant growth, especially plant height. Compost application at the rate of 4 t h-1 increased plant height by 4 cm compared to plants under control treatment.

Farid *et al*. (2011) carried out a field experiment using 8 treatments *viz*. T_0: control, T_1: 100% NPKS, T_2: 70% NPKS + Dhaincha @ 10 t ha^{-1}, T_3: 70% NPKS + Dhaincha @ 8 t ha^{-1}, T_4: 70% NPKS + Poultry manure @ t ha^{-1}, T_5 : 70% NPKS + Poultry manure @ 3 t ha^{-1}, T_6: 70% NPKS + Cowdung @ 8 t ha^{-1} and T_7: 70% NPKS + Cowdung @ 5 t ha^{-1}. Grain and straw yields as well as the yield attributing parameters like plant height, number of effective tillers $hill^{-1}$, panicle length, and number of field grains per panicle were significantly influenced due to different treatments except 1000 grain weight. The maximum grain yield was 4.49 t ha^{-1} recorded in T_4 treatment and minimum grain yield of 2.69 t ha^{-1} in T_0 (control). The dhaincha or cowdung along with 70% NPKS increase the grain yield significantly over 70% NPKS application.

Mehedi *et al*. (2011) further conclude that sesbania at 20 t ha^{-1} + 75% recommended dose of chemical fertilizer proved to be the best combination to

get reasonable yield. Greater tiller number, filled grains per panicles , 1000-grain weight and an optimum yield of rice was obtained by application of 120: 60: 45 kg N: P2O5:K2O ha^{-1} in combination with farm yard manure than the individual sources of NPK and control (Satyanarayana *et al*., 2002).

Application of 100% recommended dose of nitrogen from urea significantly influenced the yield of rice in 1st year of experiment but during the 2nd year of experiment application of 50 % recommended dose of nitrogen from vermicompost and the rest through chemical fertilizer (urea) produced significantly highest grain and straw yield of rice in rice-wheat cropping system (Koushal *et al*., 2011).

Organic fertilizer with inorganic fertilizer increased the fertilizer use efficiency and improved the physical and chemical properties of soil and it would be a reason towards increased yield (Barik *et al*., 2008). Increasing the levels of nutrients enhances the nutrient availability thereby increases yield attributes such as number of effective tillers $hill^{-1}$ number of spikelet's $panicle^{-1}$, percentage of filled grains and test weight.

Virdia and Mehta (2008) reported that application of press-mud @ 20 t/ha along with recommended dose of fertilizer gave the highest grain yield which was on par with press-mud @ 15 t/ha + RDF in 2000 and 2005 and with or FYM @ 10 t/ha + RDF. This might be due to improvement in nutrient supply with more organics, which improves soil physic-chemical and biological properties by providing essential food to microbes (Sutaliya and Singh, 2005).

Khan *et al*., (2007) observed the combined fertilizer application of NPK: GM: Zn (soil application) at a rate of 120-90-60 kg ha^{-1} : 10 t ha^{-1} : 10kg ha^{-1} gave significantly maximum plant height, number of tillers, number of panicles, number of spikelet's, 1000 grain weight, yield and straw yield of paddy rice as compared to NPK alone and the control.

Yadav *et al*., (2005) further reported that rice yield was maximum with 25% N substitution through green leaf manure +100% NPK fertilizer in rice-wheat cropping system.

Application of panchagavya @ 3% significantly increased grain yield (17.7 q/ha), number of seed per pod (12.1) and 100 grain weight (4.0g) as compared to application of recommended dose of fertilizer. The result revealed that the yield components viz., productive tillers hill^{-1}, panicle length, filled grain panicle^{-1}, seed test weight, grain yield and straw yield were found significantly higher in the treatment of panchgavya spray @ 3% Yadav and Kumar (2000).

2.3 Combined effect of variety and organic and inorganic nutrient treatments on growth and yield of rice

Laila and Sarkar (2020) conducted an experiment to study the combined effect of vermicompost with inorganic fertilizers on the yield and yield contributing characters of aromatic fine rice cultivars. The experiment comprised three cultivars *viz*. BRRI dhan34, Binadhan-13 and Kalizira and five nutrient managements *viz*. control (no application of manures and fertilizer), recommended dose of inorganic fertilizers (i.e. 150, 95, 70, 60, 12 kg ha^{-1} of Urea, TSP, MOP, Gypsum and Zinc Sulphate respectively), vermicompost @ 3 t ha^{-1}, 25% less than recommended dose of inorganic fertilizer + vermicompost @ 1.5 t ha^{-1}, 50 % less than recommended dose of inorganic fertilizer + vermicompost @ 3 t ha^{-1}. The highest number of total tillers hill^{-1}, effective tillers hill^{-1}, number of grains panicle^{-1}, panicle length, grain yield (4.04 t ha^{-1}) and straw yield (6.20 t ha^{-1}) were obtained from the interaction of Binadhan-13 and 50% less than the recommended dose of inorganic fertilizers + vermicompost @ 3 t ha^{-1}. The lowest values related to yield were found in Kalizira with control condition. Binadhan-13 along with 50% less than the recommended dose of inorganic fertilizers + vermicompost @ 3 t ha^{-1} might be a promising practice for aromatic fine rice cultivation.

Sarkar *et al*. (2014) conducted an experiment to study the yield and quality of aromatic fine rice as affected by variety and nutrient management during the period from June to December 2013. The experiment comprised three aromatic fine rice varieties *viz*. BRRI dhan34, BRRI dhan37 and BRRI dhan38, and eight nutrient managements *viz*. control (no manures and fertilizers), recommended dose of inorganic fertilizers, cowdung at 10 t ha^{-1}, poultry manure at 5 t ha^{-1}, 50% of recommended dose of inorganic fertilizers + 50% cowdung, 50% of recommended dose of inorganic fertilizers + 50% poultry manure, 75% of recommended dose of inorganic fertilizers + 50% cowdung and 75% of recommended dose of inorganic fertilizers + 50% poultry manure. The experiment was laid out in a randomized complete block design with three replications. The tallest plant (142.7 cm), the highest number of effective tillers $hill^{-1}$ (10.02), number of grains $panicle^{-1}$ (152.3), panicle length (22.71cm), 1000-grain weight (15.55g) and grain yield (3.71 t ha^{-1}) were recorded in BRRI dhan34. The highest grain protein content (8.17%) was found in BRRI dhan34 whereas the highest aroma was found in BRRI dhan37 and BRRI dhan38. The highest number of effective tillers $hill^{-1}$ (11.59), number of grains $panicle^{-1}$ (157.6), panicle length (24.31 cm) and grain yield (3.97 t ha^{-1}) were recorded in the nutrient management of 75% recommended dose of inorganic fertilizers + 50% cowdung (5 t ha^{-1}). The treatment control (no manures and fertilizers) gave the lowest values for these parameters. The highest grain yield (4.18 t ha^{-1}) was found in BRRI dhan34 combined with 75% recommended dose of inorganic fertilizers + 50% cowdung, which was statistically identical to BRRI dhan34 combined with 75% of recommended dose of inorganic fertilizers + 50% poultry manure and the lowest grain yield (2.7 t ha^{-1}) was found in BRRI dhan37 in control (no manures and fertilizers). The highest grain protein content (10.9 %) was obtained in the interaction of BRRI dhan34 with recommended dose of inorganic fertilizers which was as good as that of BRRI dhan38 and 75% of recommended dose of inorganic fertilizers + 50% poultry

manure. The highest aroma was found in BRRI dhan38 combined with 75% recommended dose of inorganic fertilizers + 50% cowdung.

Sarkar *et al*. (2016) conducted an experiment to study the yield and quality of aromatic fine rice as affected by cultivar and nutrient. The experiment comprised three aromatic fine rice cultivars *viz*. BRRI dhan34, BRRI dhan37 and BRRI dhan38, and eight nutrient managements *viz*. control (no manures and fertilizers), recommended dose of inorganic fertilizers, cow-dung at 10 t ha^{-1}, poultry manure at 5 t ha^{-1}, 50% of recommended dose of inorganic fertilizers + 50% cow-dung, 50% of recommended dose of inorganic fertilizers + 50% poultry manure, 75% of recommended dose of inorganic fertilizers + 50% cow-dung and 75% of recommended dose of inorganic fertilizers + 50% poultry manure. The highest grain yield (4.18 t ha^{-1}) was found in BRRI dhan34 combined with 75% recommended dose of inorganic fertilizers + 50% cow-dung, which was statistically identical to BRRI dhan34 combined with 75% of recommended dose of inorganic fertilizers + 50% poultry manure and the lowest grain yield (2.7 t ha^{-1}) was found in BRRI dhan37 in control (no manures and fertilizers).

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted to find out the Performance of 3 different rice varieties which was subjective by application of different level of organic and inorganic nutrient management practices during the period from November 2020 to May 2021. This chapter deals with a brief description on experimental site, climate, soil, land preparation, layout, experimental design, intercultural operations, data recording and their analyses. The details of experimental materials and methods are described below:

3.1 Site description

The experiment was conducted the experimental farm of Sher-e-Bangla Agricultural University, Dhaka, under the Agro-ecological zone of Modhupur Tract, AEZ-28. The land area is situated at 23°41′N latitude and 90°22′E longitude at an altitude of 8.6 meter above sea level. The experimental site is shown in the AEZ Map of Bangladesh in Appendix I.

3.2 Climate

The experimental area is under the sub-tropical climate that is characterized by high temperature, high humidity and heavy rainfall with occasional gusty winds in kharif season (April-September) and less rainfall associated with moderately low temperature during the Rabi season (October-March). The weather data during the study period of the experimental site is shown in Appendix II.

3.3 Soil

The farm belongs to the general soil type, Shallow Red Brown Terrace Soils under Tejgaon Series. Top soils were clay loam in texture, olive-gray with common fine to medium distinct dark yellowish brown mottles. The experimental area was flat having available irrigation and drainage system. The

land was above flood level and sufficient sunshine was available during the experimental period. Soil samples from 0-15 cm depths were collected from experimental field.

3.4 Planting material

BRRI dhan28, BRRI dhan34 and BRRI dhan81 were used in this study as plant materials.

3.5 Treatment of the experiment

The experiment consisted of two factors:

Factor A: Integrated nutrient management – 5

1. T_1 = Recommended fertilizer dose – RFD ($N_{120}P_{16}K_{100}S_{10}Zn_2$)
2. T_2 = 75% RFD + Cowdung 2.5 t ha^{-1}
3. T_3 = 50% RFD + Cowdung 5 t ha^{-1}
4. T_4 = 100% RFD + Cowdung 5 t ha^{-1}
5. T_5 = Cowdung 10 t ha^{-1}

Factor B: Variety – 3

1. V_1 = BRRI dhan28
2. V_2 = BRRI dhan34
3. V_3 = BRRI dhan81

There were total 15 (5×3) combination as a whole *viz.*, T_1V_1, T_1V_2, T_1V_3, T_2V_1, T_2V_2, T_2V_3, T_3V_1, T_3V_2, T_3V_3, T_4V_1, T_4V_2, T_4V_3, T_5V_1, T_5V_2 and T_5V_3.

3.6 Experimental design and layout

The two factors experiment was laid out in Randomized Complete Block Design (RCBD) with three modern rice varieties and five levels of organic and inorganic nutrient combinations. Three replications were maintained in this experiment. The total number of unit plots was 45 (15×3). The size of each unit plot was 3.00 m × 1.25 m. The whole experimental area was divided into three

equal blocks, each representing a replication and each block was divided into 15 equal plot.

3.7 Growing of crops

3.7.1 Seed collection and sprouting

This variety's seeds were obtained from the Bangladesh Rice Research Institute (BRRI), Gazipur, Bangladesh. Clean seeds were soaked in water in a pail for 24 hours to produce seedlings. The imbibed seeds were then removed from the water and placed in gunny bags. After 48 hours, the seeds sprouted and were ready for planting in the seed bed in 72 hours.

3.7.2 Preparation of nursery bed and seed sowing

As per BRRI recommendation seedbed was prepared with 1 m wide adding nutrients as per the requirements of soil. Sprouted seeds were sown in the seed bed on November 2020 in order to transplant the seedlings in the main field.

3.7.3 Raising of seedlings

The sprouted seeds were sown in beds as uniformly 20 November 2020. Irrigation was gently provided to the bed when needed. No fertilizer was used in the nursery bed.

3.7.4 Land preparation

The plot selected for conducting the experiment was opened on the 17 December 2020 with a power tiller, and left exposed to the sun for a week. After one week the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain good puddle condition. The experimental plot was partitioned into unit plots in accordance with the experimental design on 24 December 2020.

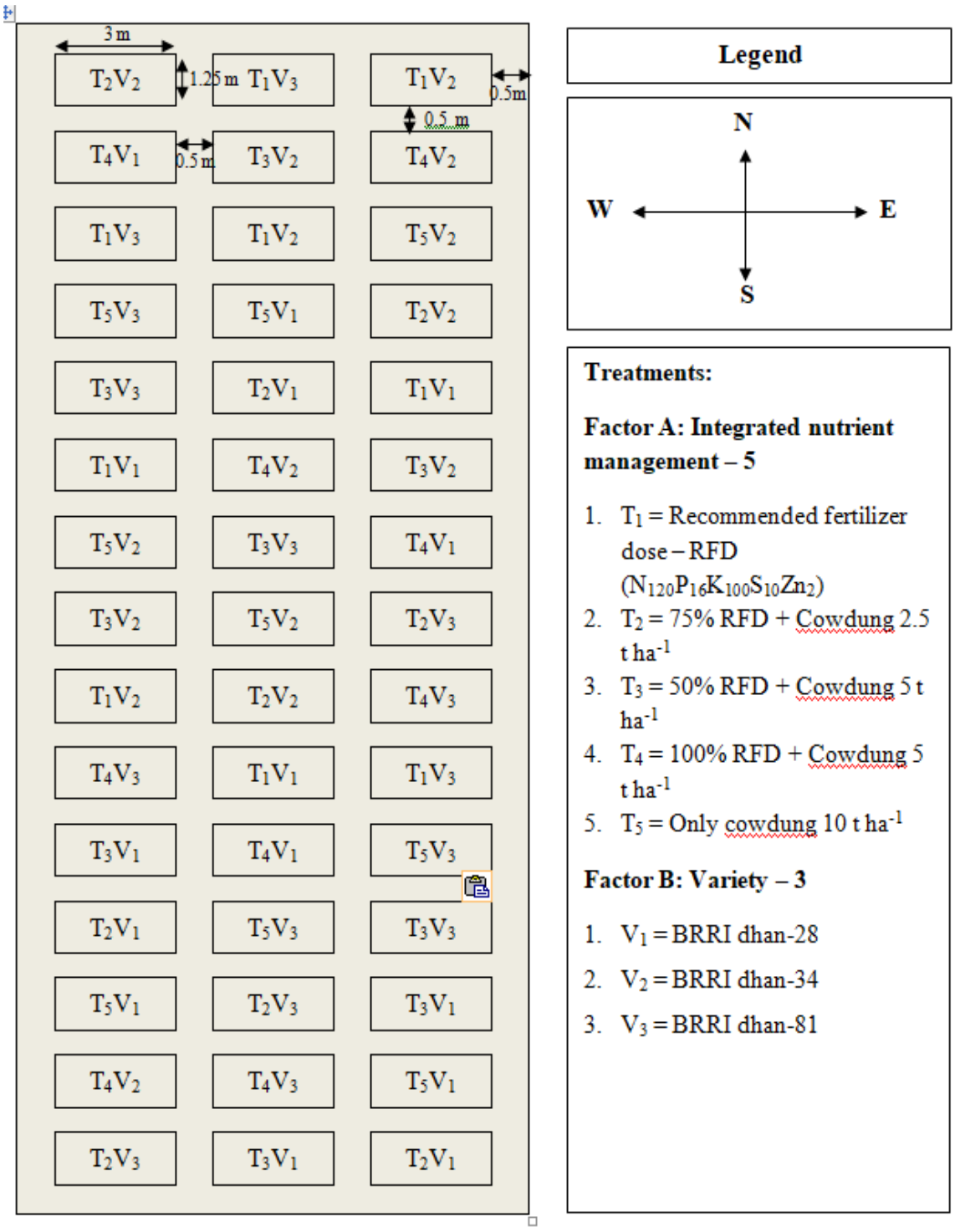

Figure 1. Layout of the experimental field

3.7.5 Fertilizers and manure application

The fertilizers N, P, K, S and Zn were in the form of Urea, TSP, MP, gypsum and $ZnSO_4$, respectively. Decomposed cowdung as organic manure was used in the study and applied as per treatment. The doses of inorganic fertilizers and/or organic manure were applied as per treatment. The following doses of fertilizer were applied as recommended doses for cultivation of rice as follows:

Nutrients	Fertilizer	Recommended doses ha^{-1}
---	Cowdung	10 t
N (120 kg ha^{-1})	Urea	260 kg
P (16 kg ha^{-1})	TSP	90 kg
K (100 kg ha^{-1})	MoP	200 kg
S (10 kg ha^{-1})	Gypsum	53 kg
Zn (2 kg ha^{-1})	$ZnSO_4$	11 kg

The fertilizers N, P, K, S and Zn in the form of urea, TSP, MP, gypsum and $ZnSO_4$, respectively were applied. The entire amount of TSP, MoP, gypsum and $ZnSO_4$ were applied during the final preparation of plot land. Urea was applied in three equal installments at after recovery, tillering and before panicle initiation. In the experimental plot, fertilizers were applied according to the treatment.

3.7.6 Transplanting of seedling

Seedlings were carefully uprooted from the nursery bed and transplanted on 25 December, 2020 in well puddled plot with spacing of 20 cm × 20 cm. One seedling was transplanted in each hill. After one week of transplanting all plots were checked for any missing hill, which was filled up with extra seedlings of the same source whenever required.

3.8 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.

3.8.1 Irrigation and drainage

Irrigation was given to maintain a consistent level of standing water up to 6 cm during the early phases of seedling establishment, and thereafter the quantity of drying and wetting was maintained throughout the whole vegetative period. There was no water stress during the reproductive and ripening phases.

3.8.2 Weeding

Weeding was done to keep the plots weed-free, which resulted in enhanced seedling growth and development. The weeds were mechanically pulled at 20 DAT (days after transplanting) and 40 DAT.

3.8.3 Insect and pest control

Furadan5G was used in the plot at 25 and 45 DAT. Leaf roller (*Cnaphalocrosis medinalis*) was discovered and treated with Malathion 10 EC @ 1.12 L ha^{-1} through sprayer at 40 and 60 DAT, but no disease infection was recorded in the field.

3.9 Harvesting, threshing and cleaning

Depending on the variety, the crop was harvested after 80-90% of the grains had become straw in colour. Harvesting was done on 13 May 2021. The harvested crop was wrapped individually, correctly labelled, and sent to the threshing floor. For each plot, the grains were dried, winnowed, and weighed. The weight was changed to contain 14% moisture.

3.10 Recording of data

The following data were collected during the study period:

3.10.1. Growth characters

1. Plant height (cm)
2. Number of total tillers m^{-2}
3. Number of effective tillers m^{-2}
4. Flag leaf length (cm)

3.10.2 Yield contributing parameters

1. Panicle length (cm)
2. Number of filled grains $panicle^{-1}$
3. Number of unfilled grains $panicle^{-1}$
4. 1000 grain weight (g)

3.10.3 Yield parameters

1. Grain yield (t ha^{-1})
2. Stover yield (t ha^{-1})
3. Harvest index (%)

3.10.4 Nutrient status in post harvest soil

1. pH
2. Organic carbon content (%)
3. Available phosphorus content (ppm)
4. Available sulphur content (ppm)

3.11 Procedures of recording data

A brief outline of the data recording procedure is given below:

3.11.1 Plant height

The height of plant was recorded in centimeter (cm) at the time of harvest. Data were recorded as the average of same 5 plants pre-selected at random from the

inner rows of each plot. The height was measured from the ground level to the tip of the longest panicle.

3.11.2 Number of total tillers m^{-2}

Total tillers which had at least one leaf visible were counted. It includes both productive and unproductive tillers. It was counted from the average of same 5 hills pre-selected at random from the inner rows of each plot.

3.11.3 Number of effective tillers m^{-2}

The total number of effective tillers $hill^{-1}$ was counted from 5 selected hills at harvest and average value was recorded.

3.11.4 Length of flag leaf (cm)

Flag leaf length was measured by counting length from base to tip of the leaf and it was measured from the flag leaf of 10 selected plants and mean values were recorded

3.11.5 Panicle length (cm)

The length of panicle was measured with a meter scale from 10 selected panicles

3.11.6 Number of filled grains $panicle^{-1}$

The total number of filled grains was collected randomly from selected 5 plants of a plot and then average number of filled grains $panicle^{-1}$ was recorded.

3.11.7 Number of unfilled grains $panicle^{-1}$

The total number of unfilled grains was collected randomly from selected 5 plants of a plot and then average number of unfilled grains $panicle^{-1}$ was recorded.

3.11.8 Weight of 1000 grain (g)

One thousand cleaned dried grains were counted randomly from each plot and weighed by using a digital electric balance when the grains retained 14% moisture and the mean weight was expressed in gram.

3.11.9 Grain yield

Grain yield was determined from the central 1 m^2 area of each plot and expressed as t ha^{-1} on 14% moisture basis. Grain moisture content was measured by using a digital moisture tester.

3.11.10 Straw yield

Straw yield was determined from the central 1 m^2 area of each plot, after separating the grains. The sub-samples were oven dried to a constant weight and finally converted to t ha^{-1}.

3.11.11 Biological yield

Biological yield was determined using the following formula

Biological yield = Grain yield + Straw yield

3.11.12 Harvest index (%)

It denotes the ratio of grain yield to biological yield and was calculated with the following formula.

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

3.11.13 Soil pH and nutrient analysis (post harvest soil)

3.11.13.1 pH of post harvest soil

Soil pH was measured with the help of a glass electrode pH meter, the soil water ratio being maintained at 1: 2.5 as described by (Akul *et al.* 1982).

3.11.13.2 Soil Organic carbon content

Organic carbon in the soil sample was determined by the wet oxidation method. The underlying principle was used to oxidize the organic carbon with an excess of 1N $K_2Cr_2O_7$ in presence of conc. H_2SO_4 and conc. H_3PO_3 and titrate the excess $K_2Cr_2O_7$ solution with IN $FeSO_4$. To obtain the content of Organic carbon was calculated by multiplying the percent organic carbon by 1.73 (Van Bemmelen factor) and the results were expressed in percentage.

3.11.13.3 Available phosphorus

Available P was extracted from the soil with 0.5 M $NaHCO_3$ solutions, pH 8.5 (Olsen *et al.,* 1954). Phosphorus in the extract was then determined by developing blue color with reduction of phosphomolybdate complex and the color intensity was measured calorimetrically at 660 ηm wavelength and readings were calibrated with the standard P curve (Akul *et al.,* 1982).

3.11.13.4 Available sulphur

Available sulphur was extracted from the soil with Ca $(H_2PO_4)_2$. H_2O (Fox *et al.,* 1964). Sulphur in the extract was determined by the turhidimetric method as described by Hunt (1980) using a Spectrophotometer (LKB Novaspce. 4049).

3.12 Statistical analysis

The data collected on different parameters were statistically analyzed with using the MSTAT computer package program. Least Significant Difference (LSD) technique at 5% level of significance was used by DMRT to compare the mean differences among the treatments (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

Results obtained from the present study have been presented and discussed in this chapter with a view to study the performance of rice varieties as influenced by organic and inorganic nutrient management practices. The results have been discussed, and possible interpretations are given under the following headings.

4.1 Growth parameters

4.1.1 Plant height (cm)

Effect of organic and inorganic nutrients combinations

Different levels of organic and inorganic nutrients combinations showed significant influence on plant height of rice (Figure 2 and Appendix IV). It was observed that the treatment T_4 (100% RFD + Cowdung 5 t ha^{-1}) gave the highest plant height (97.89 cm) that was significantly different to other treatments followed by T_2 (75% RFD + Cowdung 2.5 t ha^{-1}) and T_1 (RFD: $N_{120}P_{16}K_{100}S_{10}Zn_2$ kg ha^{-1}) whereas the lowest plant height (81.18 cm) was found from the treatment T_5 (cowdung 10 t ha^{-1}). Similar result was also observed by the findings of Devkota *et al*., (2019), Baghdadi *et al*. (2018) and Mahmud *et al*., (2016); who reported maximum plant height from inorganic and inorganic nutrients association compared to organic manure or inorganic fertilizer alone.

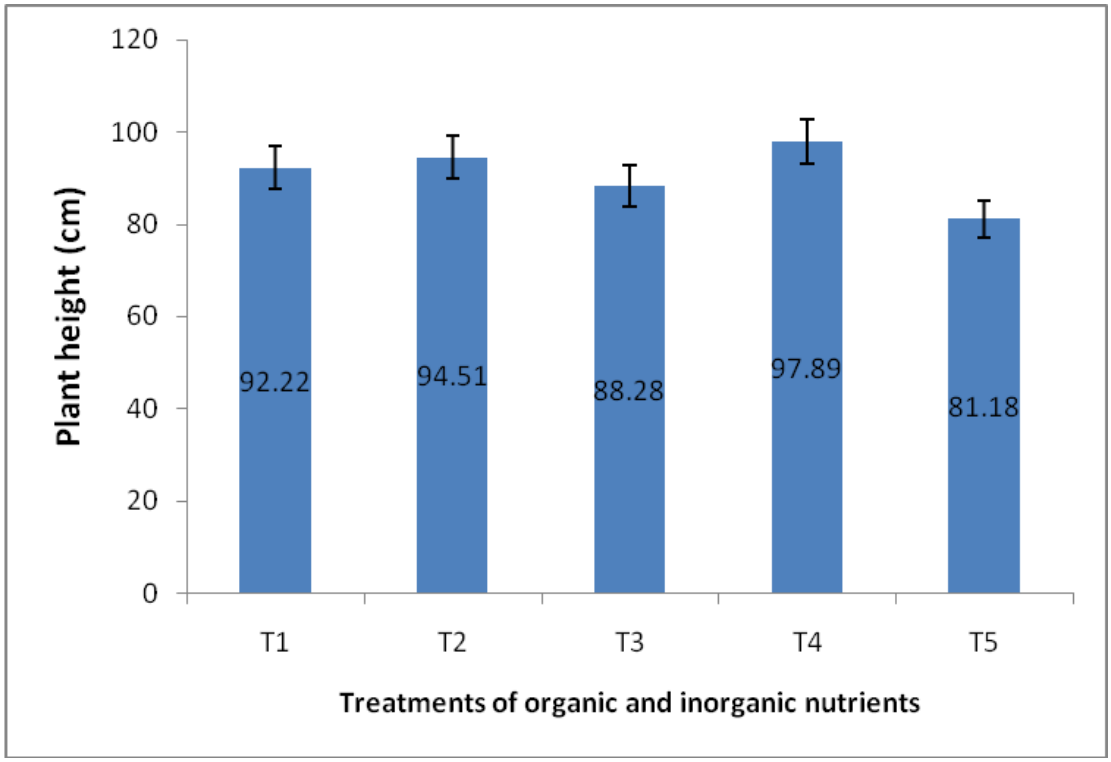

Figure 2. Effect of organic and inorganic nutrients on plant height of rice ($LSD_{0.05}$ = 2.619)

T_1 = Recommended fertilizer dose – RFD ($N_{120}P_{16}K_{100}S_{10}Zn_2$), T_2 = 75% RFD + Cowdung 2.5 t ha^{-1}, T_3 = 50% RFD + Cowdung 5 t ha^{-1}, T_4 = 100% RFD + Cowdung 5 t ha^{-1} and T_5 = Cowdung 10 t ha^{-1}

Effect of variety

Different rice varieties showed significant variation on plant height at harvest (Figure 3 and Appendix IV). Results indicated that the highest plant height (96.21 cm) was achieved from the variety V_3 (BRRI dhan81) which was statistically identical to the variety V_1 (BRRI dhan28) (95.00 cm) whereas the lowest plant height (81.24 cm) was found from the variety V_2 (BRRI dhan34). Significant variation on plant height among different varieties of rice was also observed by Salam *et al*. (2019) and reported that plant height was significantly higher in BRRI dhan67 than the varieties of BRRI dhan81, BRRI dhan84 and BRRI dhan86. Similar result was also observed by the findings of Mahmood (2017) and Murshida *et al*. (2017).

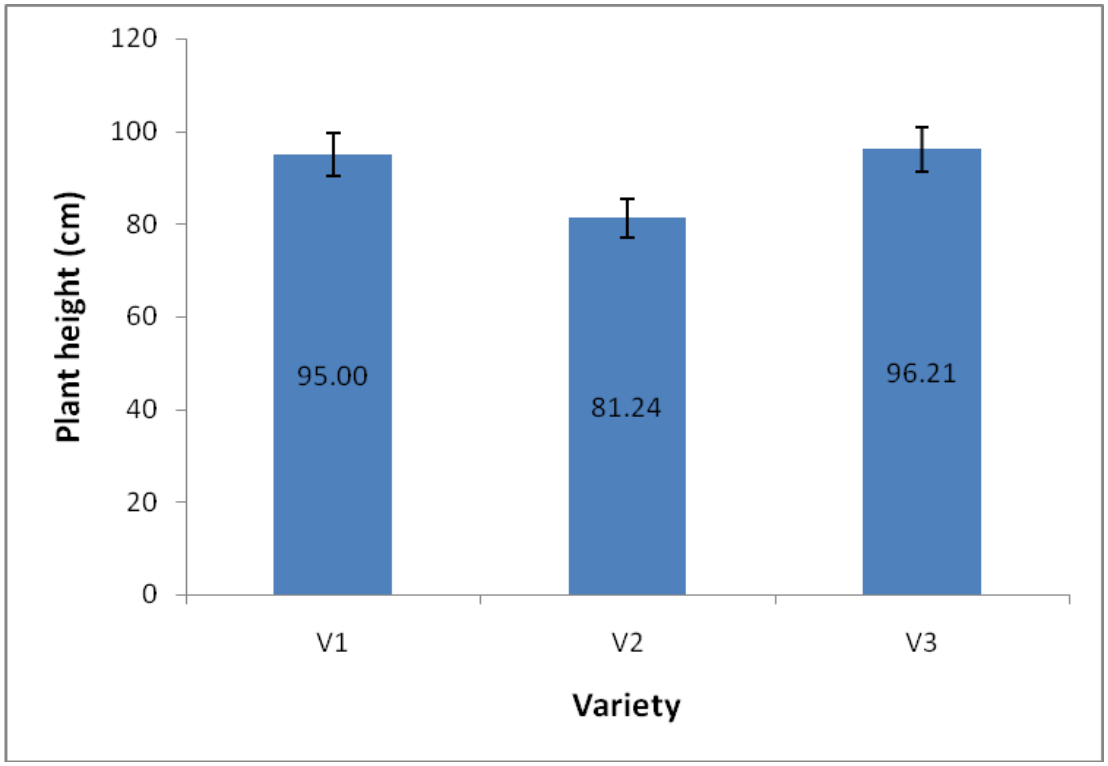

Figure 3. Effect of different rice varieties on plant height ($LSD_{0.05}$ = 1.723)

V_1 = BRRI dhan28, V_2 = BRRI dhan34 and V_3 = BRRI dhan81

Combined effect of organic and inorganic nutrients combinations and variety

Plant height of rice at harvest varied significantly due to combined effect of organic and inorganic nutrients combinations and variety (Table 1 and Appendix IV). The treatment combination of T_4V_3 showed the highest plant height (104.50 cm) which was statistically similar to the treatment combination of T_4V_1 and statistically similar to T_2V_3. Again, the treatment combination T_5V_2 gave the lowest plant height (72.72 cm) that was significantly different to other treatment combinations.

Table 1. Effect of organic and inorganic nutrients in combination with different rice varieties on growth parameters of rice

Treatments	Growth parameters			
	Plant height (cm)	Number of tillers m^{-2}	Number of effective tillers m^{-2}	Length of flag leaf (cm)
T_1V_1	97.00 c	13.78 cd	12.11 d	29.44 cd
T_1V_2	82.34 ef	11.56 de	9.447 fg	24.14 gh
T_1V_3	97.34 bc	13.78 cd	11.78 d	29.76 cd
T_2V_1	97.44 bc	15.56 bc	13.78 c	30.84 c
T_2V_2	85.14 e	11.67 de	10.11 ef	24.57 fgh
T_2V_3	101.00 ab	16.78 b	15.33 b	33.66 b
T_3V_1	91.35 d	12.78 d	10.00 ef	27.62 de
T_3V_2	80.84 f	9.890 e	7.89 h	23.78 gh
T_3V_3	92.65 d	13.00 d	11.22 de	28.21 de
T_4V_1	104.00 a	17.67 b	15.11 bc	35.83 ab
T_4V_2	85.16 e	11.67 de	10.00 ef	26.00 efg
T_4V_3	104.50 a	20.78 a	18.22 a	36.32 a
T_5V_1	85.22 e	12.45 d	10.78 def	26.72 ef
T_5V_2	72.72 g	9.67 e	8.223 gh	23.05 h
T_5V_3	85.61 e	12.67 d	10.89 def	26.87 e
$LSD_{0.05}$	3.871	2.338	1.454	2.271
CV(%)	10.59	14.64	13.71	10.45

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

T_1 = Recommended fertilizer dose RFD ($N_{120}P_{16}K_{100}S_{10}Zn_2$), T_2 = 75% RFD + Cowdung 2.5 t ha^{-1}, T_3 = 50% RFD + Cowdung 5 t ha^{-1}, T_4 = 100% RFD + Cowdung 5 t ha^{-1} and T_5 = Cowdung 10 t ha^{-1}

V_1 = BRRI dhan28, V_2 = BRRI dhan34 and V_3 = BRRI dhan81

4.1.2 Number of tillers $hill^{-1}$

Effect of organic and inorganic nutrients combinations

Application of different doses of organic and inorganic nutrients combinations showed significant influence on number of tillers $hill^{-1}$ of rice at harvest (Figure 4 and Appendix IV). Results showed that the treatment T_4 (100% RFD + Cowdung 5 t ha^{-1}) showed the highest number of tillers $hill^{-1}$ (16.70) that was significantly different from other treatments followed by T_2 (75% RFD + Cowdung 2.5 t ha^{-1}) whereas the lowest number of tillers $hill^{-1}$ (11.59) was found from the treatment T_5 (cowdung 10 t ha^{-1}) that was statistically identical

to T_3 (50% RFD + Cowdung 5 t ha^{-1}). Alam *et al*. (2021), Devkota *et al*. (2019) and Moe *et al*. (2019) reported decreased plant height with organic or inorganic plant nutrients alone compared to treatment combination of organic and inorganic plant nutrients applied to rice.

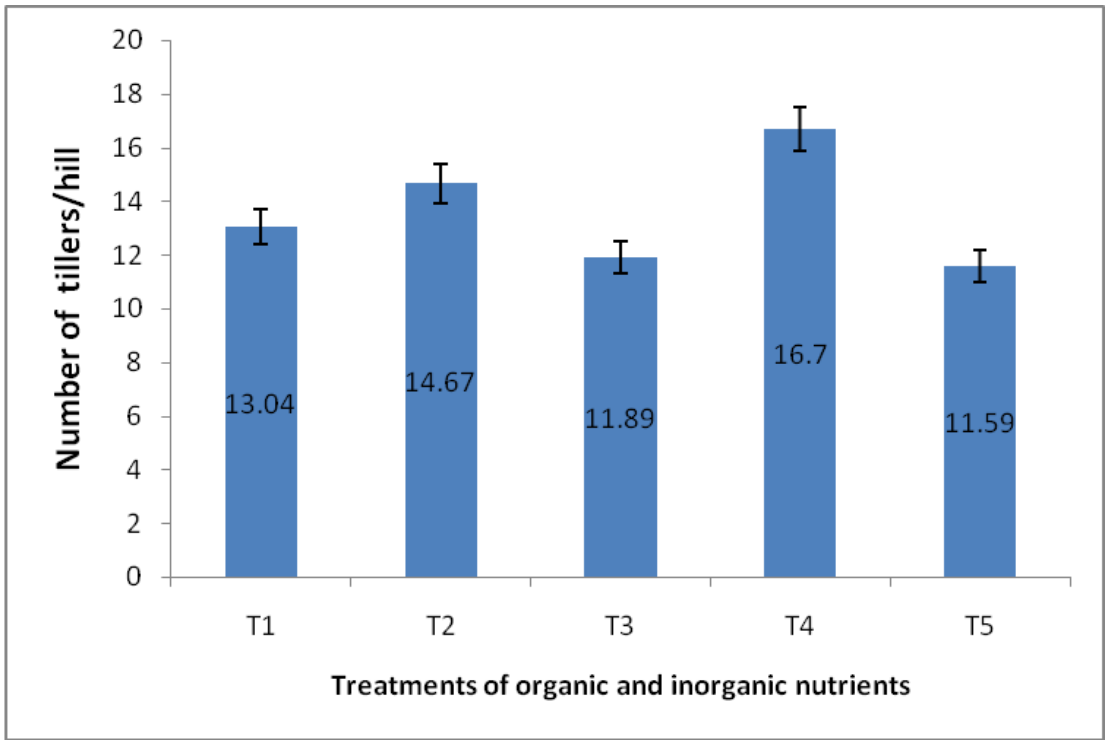

Figure 4. Effect of organic and inorganic nutrients on number of tillers $hill^{-1}$ of rice ($LSD_{0.05}$ = 0.991)

T_1 = Recommended fertilizer dose RFD ($N_{120}P_{16}K_{100}S_{10}Zn_2$), T_2 = 75% RFD + Cowdung 2.5 t ha^{-1}, T_3 = 50% RFD + Cowdung 5 t ha^{-1}, T_4 = 100% RFD + Cowdung 5 t ha^{-1} and T_5 = Cowdung 10 t ha^{-1}

Effect of variety

Different rice varieties showed significant variation for number of tillers $hill^{-1}$ at harvest (Figure 5 and Appendix IV). Results indicated that the highest number of tillers $hill^{-1}$ (15.40) was achieved from the variety V_3 (BRRI dhan81) that was statistically identical to the variety V_1 (BRRI dhan28) whereas the lowest number of tillers $hill^{-1}$ (10.89) was found from the variety V_2 (BRRI dhan34). Similar result was also reported by Laila and Sarkar (2020); they observed significant variation on number of tillers m^{-2} among

different rice varieties which result was also supported by Salam *et al*. (2019) and Mahmood (2017).

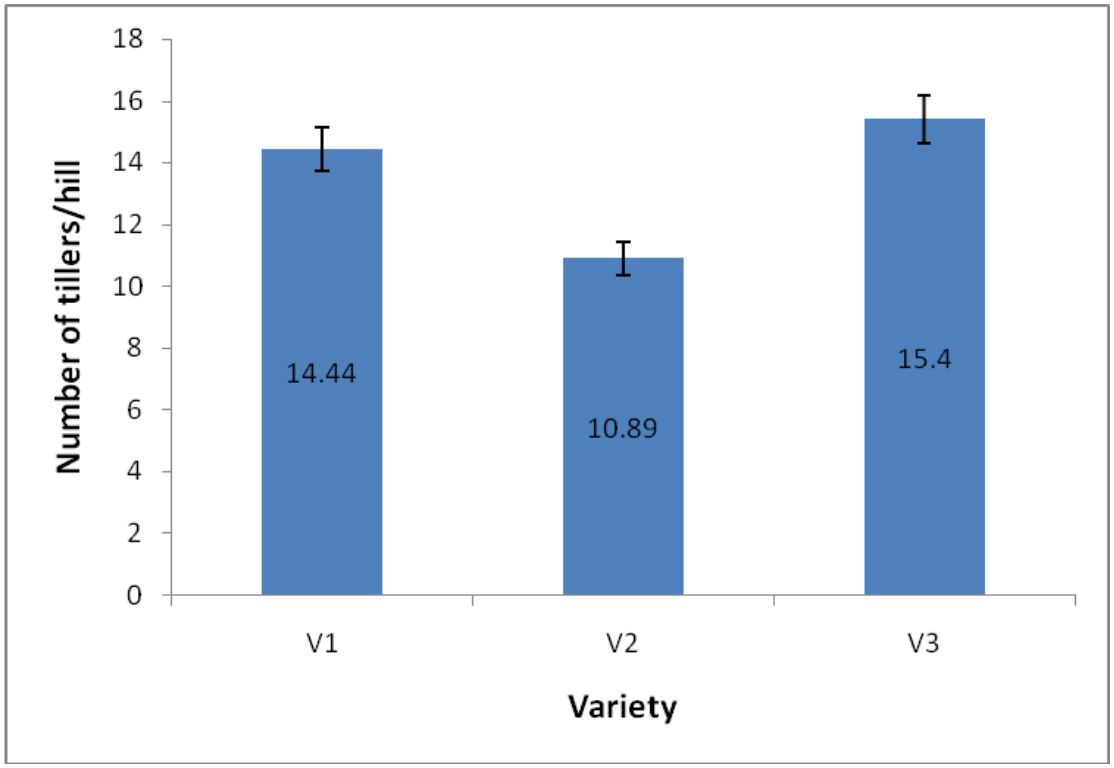

Figure 5. Effect of different rice varieties on number of tillers hill^{-1} ($LSD_{0.05}$ = 1.032)

V_1 = BRRI dhan28, V_2 = BRRI dhan34 and V_3 = BRRI dhan81

Combined effect of organic and inorganic nutrients combinations and variety

Treatment combination of organic and inorganic nutrients combinations and rice varieties showed significant variation on number of tillers hill^{-1} at harvest (Table 1 and Appendix IV). The treatment combination of T_4V_3 showed the highest number of tillers hill^{-1} (20.78) and it was significantly different from other treatment combinations followed by T_4V_1 and T_2V_3. Reversely, the treatment combination of T_5V_2 gave the lowest number of tillers hill^{-1} (9.67) that was statistically identical to the treatment combination of T_3V_2 and statistically similar to T_1V_2, T_2V_2 and T_4V_2.

4.1.3 Number of effective tillers m^{-2}

Effect of organic and inorganic nutrients combinations

Organic and inorganic nutrients combinations gave significant variation on number of effective tillers $hill^{-1}$ at harvest (Figure 6 and Appendix IV). Results showed that the treatment T_4 (100% RFD + Cowdung 5 t ha^{-1}) showed the highest number of effective tillers $hill^{-1}$ (16.70) that was significantly different from other treatments followed by S_3 (50 kg S ha^{-1}) whereas the lowest number of effective tillers $hill^{-1}$ (9.70) was found from the treatment T_3 (50% RFD + Cowdung 5 t ha^{-1}) that was statistically identical to T_5 (only cowdung 10 t ha^{-1}). Laila and Sarkar (2020), Sarkar *et al*. (2016), Baishya *et al*., (2015) and Farid *et al*. (2011) also found similar result with the present study and reported higher effective tiller number with the application of organic and inorganic treatment combination compared to sole application which supported the present findings.

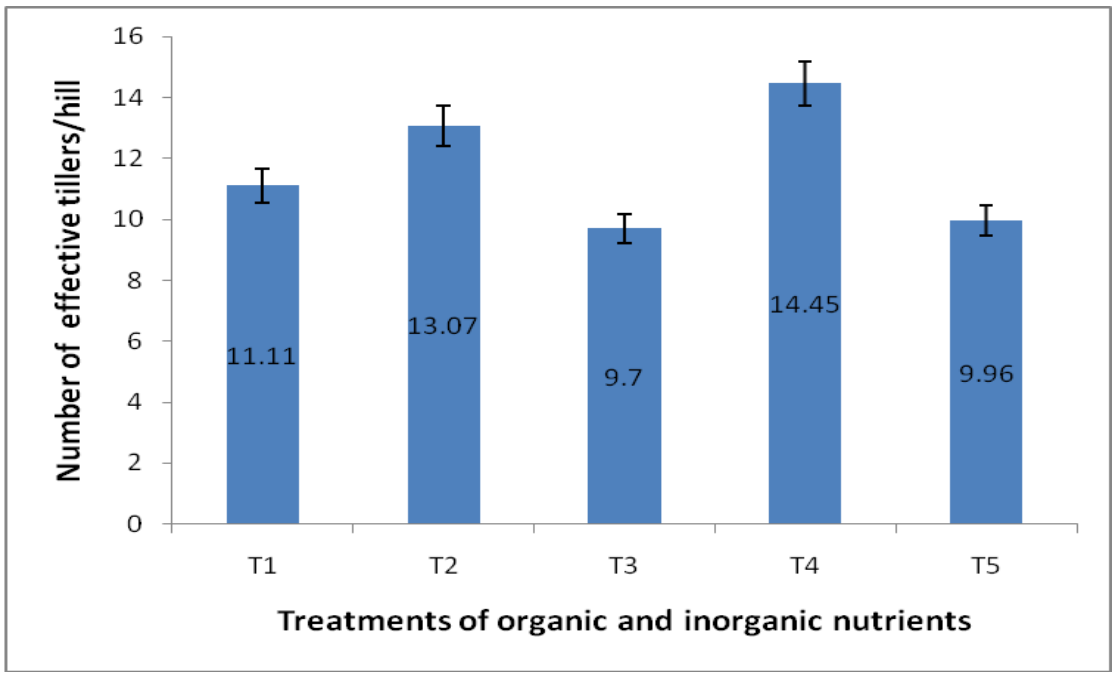

Figure 6. Effect of organic and inorganic nutrients on number of effective tillers $hill^{-1}$ of rice ($LSD_{0.05}$ = 0.834)

T_1 = Recommended fertilizer dose RFD ($N_{120}P_{16}K_{100}S_{10}Zn_2$), T_2 = 75% RFD + Cowdung 2.5 t ha^{-1}, T_3 = 50% RFD + Cowdung 5 t ha^{-1}, T_4 = 100% RFD + Cowdung 5 t ha^{-1} and T_5 = Cowdung 10 t ha^{-1}

Effect of variety

Number of effective tillers hill^{-1} varied significantly due to varietal difference of rice (Figure 7 and Appendix IV). Results indicated that the highest number of effective tillers m^{-2} (13.49) was recorded from the variety V_3 (BRRI dhan81) that was statistically identical to V_1 (BRRI dhan28) whereas the lowest number of effective tillers m^{-2} (9.14) was found from the variety V_2 (BRRI dhan34). The result obtained from the present study was similar with the findings of Laila and Sarkar (2020); who reported significant variation on number of effective tillers m^{-2} due to varietal difference. Supported result was also reported by Salam *et al*. (2019), Mahmood (2017) and Sarkar *et al*. (2016).

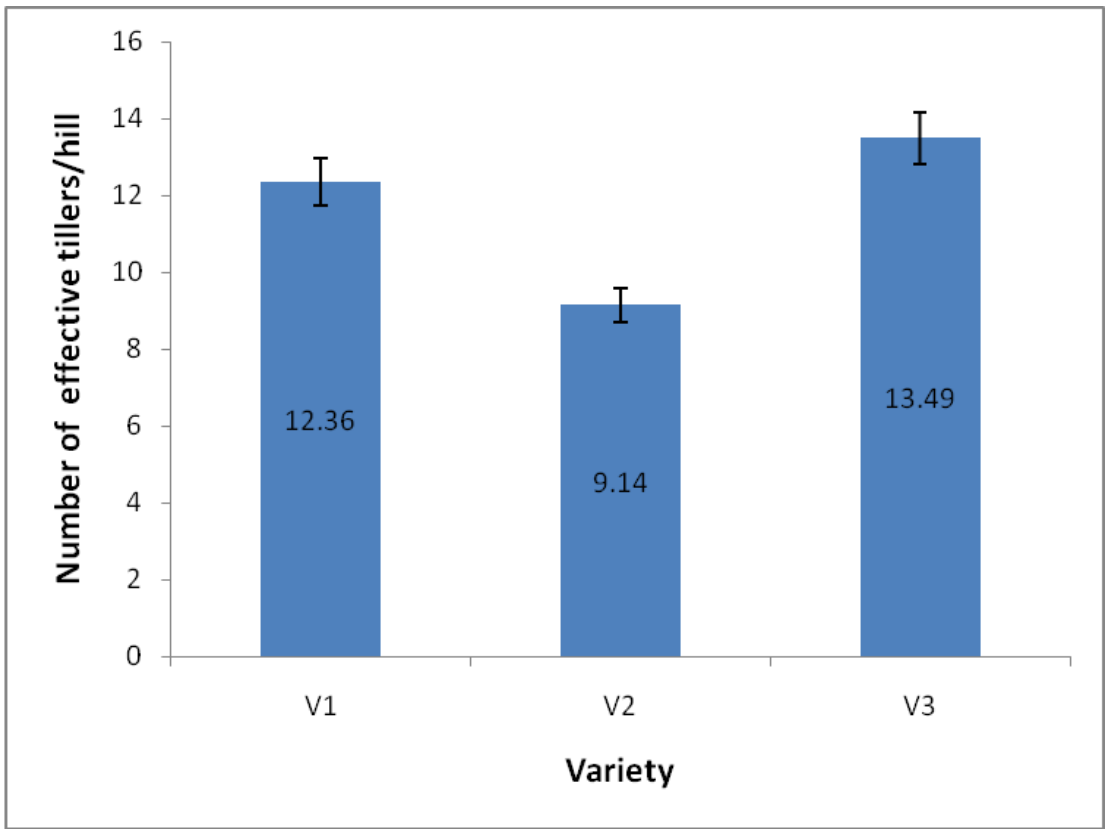

Figure 7. Effect of different rice varieties on number of effective tillers hill^{-1} ($LSD_{0.05}$ = 1.230)

V_1 = BRRI dhan28, V_2 = BRRI dhan34 and V_3 = BRRI dhan81

Combined effect of organic and inorganic nutrients combinations and variety

Treatment combination of different organic and inorganic nutrients combinations with different rice varieties showed significant variation on number of effective tillers m^{-2} at harvest (Table 1 and Appendix IV). Results revealed that the treatment combination of T_4V_3 showed the highest number of effective tillers m^{-2} (18.22) that was significantly different to other treatment combinations followed by T_2V_3. Reversely, the treatment combination of T_3V_2 gave the lowest number of effective tillers m^{-2} (7.89) that was statistically similar to T_5V_2.

4.1.4 Length of flag leaf

Effect of organic and inorganic nutrients combinations

Different doses of organic and inorganic nutrients combinations showed significant influence on flag leaf length to rice (Figure 8 and Appendix VI). It was observed that the treatment T_4 (100% RFD + Cowdung 5 t ha^{-1}) gave the highest flag leaf length (32.72 cm) that was significantly different to other treatments followed by T_2 (75% RFD + Cowdung 2.5 t ha^{-1}) whereas the lowest flag leaf length (25.55 cm) was found from the treatment T_5 (only cowdung 10 t ha^{-1}) that was statistically similar to T_3 (50% RFD + Cowdung 5 t ha^{-1}). This result was in agreement with the findings of Mahmud *et al.*, (2016) who reported maximum flag leaf length with organic and inorganic nutrients combination compared to sole application.

Effect of variety

Different rice varieties showed significant variation on flag leaf length (Figure 9 and Appendix VI). Results indicated that the highest flag leaf length (15.4 cm) was achieved from the variety V_3 (BRRI dhan81) which was statistically identical to the variety V_1 (BRRI dhan28) whereas the lowest flag leaf length (10.89 cm) was found from the variety V_2 (BRRI dhan34).

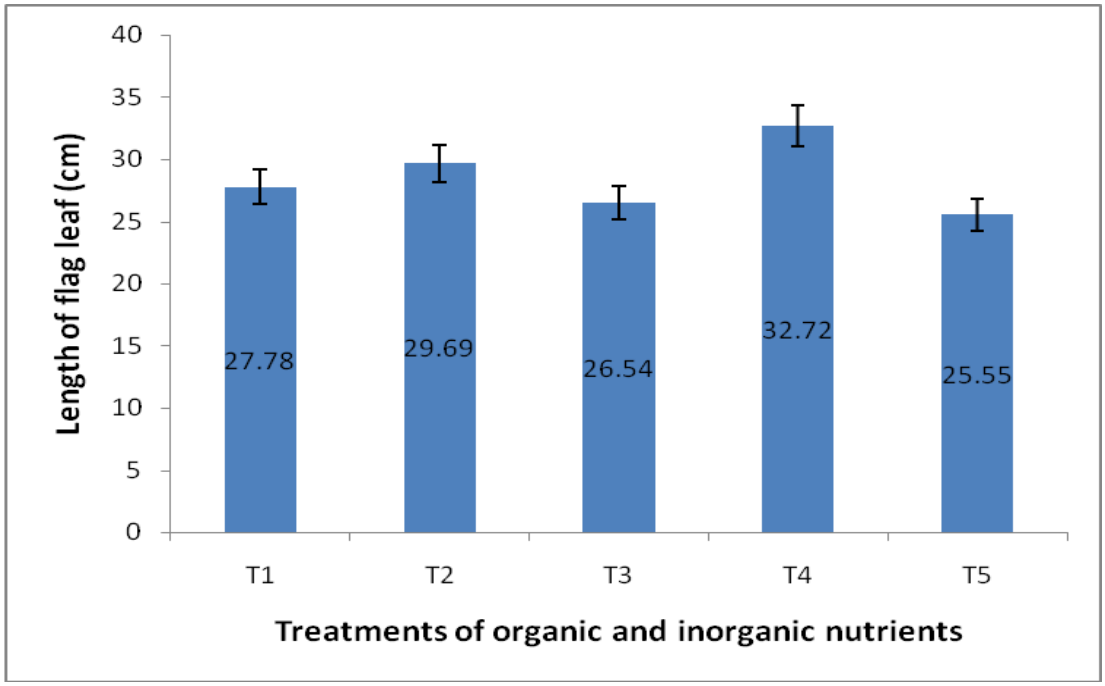

Figure 8. Effect of organic and inorganic nutrients on flag leaf length of rice ($LSD_{0.05}$ = 1.617)

T_1 = Recommended fertilizer dose – RFD ($N_{120}P_{16}K_{100}S_{10}Zn_2$), T_2 = 75% RFD + Cowdung 2.5 t ha^{-1}, T_3 = 50% RFD + Cowdung 5 t ha^{-1}, T_4 = 100% RFD + Cowdung 5 t ha^{-1} and T_5 =Cowdung 10 t ha^{-1}

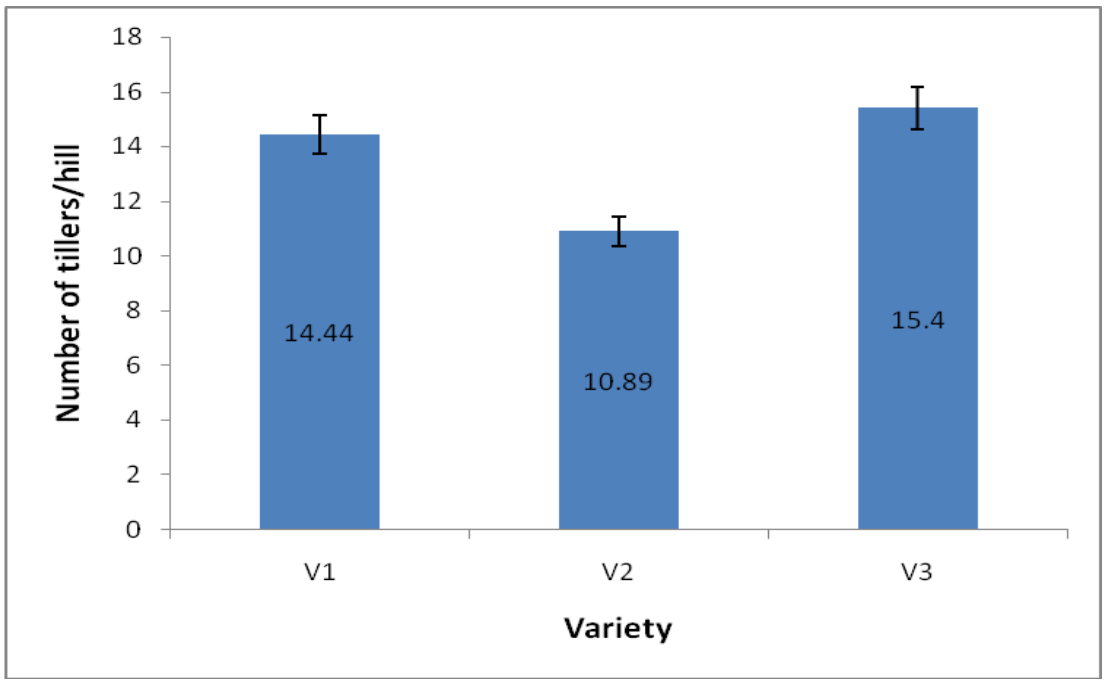

Figure 9. Effect of different rice varieties on flag leaf length ($LSD_{0.05}$ = 1.255)

V_1 = BRRI dhan28, V_2 = BRRI dhan34 and V_3 = BRRI dhan81

Combined effect of organic and inorganic nutrients combinations and variety

Flag leaf length of rice at harvest varied significantly due to combined effect of organic and inorganic nutrients combinations with rice varieties (Table 1 and Appendix VI). The treatment combination of T_4V_3 showed the highest flag leaf length (36.32 cm) which was statistically similar to the treatment combination of T_4V_1 whereas T_5V_2 gave the lowest flag leaf length (23.05 cm) that was statistically similar to the treatment combinations of T_1V_2, T_2V_2 and T_3V_2.

4.2 Yield contributing parameters

4.2.1 Panicle length (cm)

Effect of organic and inorganic nutrients combinations

Among different treatments of organic and inorganic nutrients combinations, panicle length influenced significantly (Table 2 and Appendix V). Results showed that the treatment T_4 (100% RFD + Cowdung 5 t ha^{-1}) showed the highest panicle length (23.95 cm) that was significantly different to other treatments followed by T_1 (RFD: $N_{120}P_{16}K_{100}S_{10}Zn_2$ kg ha^{-1}), T_2 (75% RFD + Cowdung 2.5 t ha^{-1}) and T_3 (50% RFD + Cowdung 5 t ha^{-1}) whereas the lowest panicle length (21.39 cm) was found from the treatment T_5 (cowdung 10 t ha^{-1}). Mahmud *et al*. (2016) and Baishya *et al*., (2015) reported that the different sources of organic manure and inorganic fertilizers influenced positively the growth and yield of paddy and obtained maximum panicle length compared to sole application of organic or inorganic nutrients.

Effect of variety

Non-significant variation was found on panicle length among different rice varieties (Table 2 and Appendix V). However, it was observed that the variety V_3 (BRRI dhan81) gave the highest panicle length (23.27 cm) whereas the variety V_2 (BRRI dhan34) gave the lowest panicle length (22.21 cm). This

result was not similar with the findings of Laila and Sarkar (2020) who reported significant variation on panicle length among different rice varieties.

Combined effect of organic and inorganic nutrients combinations and variety

Among different treatment combinations organic and inorganic nutrients combinations with different rice varieties, significant variation on panicle length was recorded (Table 2 and Appendix V). The treatment combination of T_4V_3 showed the highest panicle length (24.93 cm) which was significantly identical to the treatment combination of T_4V_2. Again, the treatment combination of T_5V_2 gave the lowest panicle length (20.89 cm) that was statistically similar to T_2V_3.

4.2.2 Number of filled grains panicle^{-1}

Effect of organic and inorganic nutrients combinations

Different doses of organic and inorganic nutrients combinations showed significant influence on number of filled grains panicle^{-1} of rice (Table 2 and Appendix V). It was observed that the treatment T_4 (100% RFD + Cowdung 5 t ha^{-1}) gave the highest number of filled grains panicle^{-1} (151.80) that was statistically identical to the treatment T_2 (75% RFD + Cowdung 2.5 t ha^{-1}) whereas the lowest number of filled grains panicle^{-1} (125.40) was found from the treatment T_5 (cowdung 10 t ha^{-1}). Mahmud *et al*. (2016) and Mehedi *et al*. (2011) found similar result with the present study and reported higher number of filled grains panicle^{-1} with organic manure in combination with inorganic fertilizers which supported the present study.

Effect of variety

Different rice varieties showed significant variation on number of filled grains panicle^{-1} (Table 2 and Appendix V). Results indicated that the highest number of filled grains panicle^{-1} (149.10) was achieved from the variety V_3 (BRRI dhan81) that was significantly different to other varieties followed by V_1

(BRRI dhan28) whereas the lowest number of filled grains panicle^{-1} (120.20) was found from the variety V_2 (BRRI dhan34). This result was also agreed with the findings of Salam *et al*. (2019), Mahmood (2017), Roy *et al.* (2014) and Chowdhury *et al*. (2005); they reported significant difference of number of filled grains panicle^{-1} among different rice varieties.

Combined effect of organic and inorganic nutrients combinations and variety

Number of filled grains panicle^{-1} of rice varied significantly due to combined effect of organic and inorganic nutrients combinations and variety (Table 2 and Appendix V). The treatment combination of T_4V_3 showed the highest number of filled grains panicle^{-1} (166.70) which was statistically similar to the treatment combination of T_2V_3 and T_4V_1 whereas T_5V_2 gave the lowest number of filled grains panicle^{-1} (112.40) that was statistically similar to T_1V_2.

4.2.3 Number of un-filled grains panicle^{-1}

Effect of organic and inorganic nutrients combinations

Organic and inorganic nutrients combinations at different doses gave significant variation on number of un-filled grains panicle^{-1} (Table 2 and Appendix V). Results showed that the treatment T_5 (cowdung 10 t ha^{-1}) showed the lowest number of un-filled grains panicle^{-1} (8.37) that was significantly different to other treatments whereas the highest number of un-filled grains panicle^{-1} (13.96) was found from the treatment T_2 (75% RFD + Cowdung 2.5 t ha^{-1}) that was statistically identical to the treatment T_4 (100% RFD + Cowdung 5 t ha^{-1}).

Effect of variety

Number of un-filled grains panicle^{-1} varied significantly due to varietal difference of rice (Table 2 and Appendix V). Results indicated that the lowest number of un-filled grains panicle^{-1} (9.09) was recorded from the variety V_2

(BRRI dhan34) that was significantly different to other varieties whereas the highest number of un-filled grains panicle^{-1} (12.58) was recorded from the variety V_3 (BRRI dhan81) that was statistically identical to the variety V_1 (BRRI dhan28). Mahmood (2017) and Chowdhury *et al*. (2005) also reported similar results with present study and reported significant difference among different rice varieties on number of un-filled grains panicle^{-1}.

Combined effect of organic and inorganic nutrients combinations and variety

Different organic and inorganic nutrients combinations with different rice varieties showed significant variation on number of un-filled grains panicle^{-1} (Table 2 and Appendix V). Results revealed that the treatment combination of T_5V_2 showed the lowest number of un-filled grains panicle^{-1} (5.55) which was statistically similar to the treatment combination of T_3V_3. Again, the treatment combination of T_4V_3 showed the highest number of un-filled grains panicle^{-1} (18.55) that was significantly different to other treatment combinations followed by T_2V_1 and T_2V_3.

4.2.4 Weight of 1000 grains

Effect of organic and inorganic nutrients combinations

Different doses of organic and inorganic nutrients combinations to rice showed significant influence on 1000 grains weight (Table 2 and Appendix V). However, the treatment T_4 (100% RFD + Cowdung 5 t ha^{-1}) showed the highest 1000 grains weight (20.33 g) that was statistically identical to T_2 (75% RFD + Cowdung 2.5 t ha^{-1}) whereas the lowest 1000 grains weight (19.98 g) was found from the treatment T_1 (RFD: $N_{120}P_{16}K_{100}S_{10}Zn_2$ kg ha^{-1}). Similar result was obtained from the findings of Mahmud *et al*. (2016), Farid *et al*. (2011) and Siavoshi *et al*. (2011) and reported that 1000-grain weight increased with the application of organic and chemical fertilizers and this could be due to the increase in the absorption of available nutrients.

Effect of variety

Different rice varieties had significant influence on 1000 grains weight (Table 2 and Appendix V). It was observed that the highest 1000 grains weight (21.29 g) was found from the variety V_1 (BRRI dhan28) that was significantly different to other varieties followed by V_3 (BRRI dhan81) whereas the lowest 1000 grains weight (19.11 g) was found from the variety V_2 (BRRI dhan34). This finding was agreed with the findings of Khatun *et al*. (2020), Halder *et al*. (2018), Sarkar *et al*. (2016), Sarkar and Sarkar (2014) and Jisan *et al.* (2014); they found significant variation on 1000 grains weight of rice among different rice varieties.

Combined effect of organic and inorganic nutrients combinations and variety

Treatment combination organic and inorganic nutrients combinations and variety showed significant variation on 1000 grains weight of rice (Table 2 and Appendix V). The treatment combination of T_4V_1 showed the highest 1000 grains weight (21.51 g) and it was statistically similar to T_2V_1. On the other hand, the treatment combination of T_5V_2 gave the lowest 1000 grains weight (18.97 g) that was statistically identical to T_3V_2.

Table 2. Effect of organic and inorganic nutrients in combination with different rice varieties on yield contributing parameters of rice

Treatments	Yield contributing parameters			
	Panicle length (cm)	No. of filled grains panicle^{-1}	No. of un-filled grains panicle^{-1}	1000 seed weight (g)
Effect of organic and inorganic nutrients				
T_1	22.86 b	135.60 b	11.07 b	20.20 b
T_2	22.67 b	147.40 a	13.96 a	20.31 a
T_3	22.71 b	130.30 c	9.63 c	20.09 c
T_4	23.95 a	151.80 a	13.18 a	20.33 a
T_5	21.39 c	125.40 d	8.37 d	19.98 d
$LSD_{0.05}$	0.310	4.800	1.145	0.101
CV(%)	4.86	14.57	7.15	3.50
Effect of variety				
V_1	22.67	145.10 b	12.07 a	21.29 a
V_2	22.21	120.20 c	9.09 b	19.11 c
V_3	23.27	149.10 a	12.58 a	20.14 b
$LSD_{0.05}$	1.318^{NS}	3.67	0.890	0.075
CV(%)	4.86	14.57	7.15	3.50
Combined effect of organic and inorganic nutrients and variety				
T_1V_1	23.63 b	142.00 cd	12.00 cd	21.33 bc
T_1V_2	23.03 cd	118.30 gh	8.33 ef	19.10 hi
T_1V_3	21.90 fg	146.60 c	12.89 bc	20.18 ef
T_2V_1	23.21 bc	155.40 b	14.44 b	21.45 ab
T_2V_2	23.53 bc	126.10 fg	12.78 bc	19.25 h
T_2V_3	21.27 hi	160.80 ab	14.67 b	20.23 ef
T_3V_1	22.56 de	136.30 de	7.67 f	21.18 c
T_3V_2	23.18 bc	116.90 h	10.67 d	19.02 i
T_3V_3	22.40 ef	137.70 de	6.78 fg	20.06 fg
T_4V_1	22.34 ef	161.30 ab	12.89 bc	21.51 a
T_4V_2	24.58 a	127.40 f	8.11 ef	19.22 h
T_4V_3	24.93 a	166.70 a	18.55 a	20.26 e
T_5V_1	21.60 gh	130.20 ef	13.33 bc	21.00 d
T_5V_2	20.89 i	112.40 h	5.55 g	18.97 i
T_5V_3	21.67 gh	133.70 ef	10.00 de	19.99 g
$LSD_{0.05}$	0.547	8.329	2.011	0.167
CV(%)	4.86	14.57	7.15	3.50

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

T_1 = Recommended fertilizer dose RFD ($N_{120}P_{16}K_{100}S_{10}Zn_2$), T_2 = 75% RFD + Cowdung 2.5 t ha^{-1}, T_3 = 50% RFD + Cowdung 5 t ha^{-1}, T_4 = 100% RFD + Cowdung 5 t ha^{-1} and T_5 = cowdung 10 t ha^{-1}

V_1 = BRRI dhan28, V_2 = BRRI dhan34 and V_3 = BRRI dhan81

4.3 Yield parameters

4.3.1 Grain yield (t ha^{-1})

Effect of organic and inorganic nutrients combinations

Among different treatments of organic and inorganic nutrients combinations, grain yield influenced significantly (Table 3 and Appendix VI). Results showed that the treatment T_4 (100% RFD + Cowdung 5 t ha^{-1}) showed the highest grain yield (6.52 t ha^{-1}) that was statistically identical to T_2 (75% RFD + Cowdung 2.5 t ha^{-1}) whereas the lowest grain yield (4.51 t ha^{-1}) was found from the treatment T_5 (cowdung 10 t ha^{-1}). Higher grain yield was also achieved from inorganic fertilizers in combination with organic manure by the findings of Sohel *et al*. (2016), Mahmud *et al*., (2016) and Baishya *et al*., (2015) which supported the present study. They also reported that grain weight was increased with the application of organic and chemical fertilizers and this could be due to the increase in the absorption of available nutrients.

Effect of variety

Grain yield of rice varied significantly among different varieties (Table 3 and Appendix VI). It was observed that the variety V_3 (BRRI dhan81) gave the highest grain yield (6.58 t ha^{-1}) and it was statistically identical to V_1 (BRRI dhan28) whereas the variety V_2 (BRRI dhan34) gave the lowest grain yield (3.60 t ha^{-1}). Khatun *et al*. (2020), Laila and Sarkar (2020), Halder *et al*. (2018), Sarkar *et al*. (2016), Sarkar *et al*. (2016) and Jisan *et al.* (2014) also reported similar result with the present study and observed significant variation on grain yield of rice due to varietal difference.

Combined effect of organic and inorganic nutrients combinations and variety

Among different treatment combinations of organic and inorganic nutrients combinations and variety, significant variation on grain yield was recorded

(Table 3 and Appendix VI). The treatment combination of T_4V_3 showed the highest grain yield (7.15 t ha^{-1}) that was statistically identical to T_2V_3 and T_4V_1 and statistically similar to T_2V_1. On the other hand, the treatment combination of T_5V_2 gave the lowest grain yield (2.02 t ha^{-1}) that was significantly different from other treatment combinations.

4.3.2 Straw yield (t ha^{-1})

Effect of organic and inorganic nutrients combinations

Application of organic and inorganic nutrients combinations treatment applied to rice showed significant variation on straw yield (Table 3 and Appendix VI). Treatment T_4 (100% RFD + Cowdung 5 t ha^{-1}) gave the highest straw yield (7.83 t ha^{-1}) that was statistically identical toT_2 (75% RFD + Cowdung 2.5 t ha^{-1}) whereas the minimum straw yield (6.24 t ha^{-1}) was registered by the treatment T_5 (only cowdung 10 t ha^{-1}). Alam *et al*. (2021), Laila and Sarkar (2020) and Sohel *et al*. (2016) also found similar result with the present study and reported higher straw yield from inorganic fertilizer in combination with organic manure.

Effect of variety

The recorded data on straw yield varied significantly due to varietal performance of rice (Table 3 and Appendix VI). The maximum straw yield (7.89 t ha^{-1}) was registered from the variety V_3 (BRRI dhan81) that was statistically identical to V_1 (BRRI dhan28) whereas the minimum straw yield (5.46 t ha^{-1}) was recorded from the variety V_2 (BRRI dhan34). Laila and Sarkar (2020), Halder *et al*. (2018) and Chowdhury *et al*. (2005) also reported significant variation of straw yield among rice varieties which supported the present findings.

Combined effect of organic and inorganic nutrients combinations and variety

Straw yield of rice varied significantly due to combined effect of organic and inorganic nutrients combinations and variety (Table 3 and Appendix VI). Results indicated the treatment combination of T_4V_3 gave the maximum straw yield (8.22 t ha^{-1}) which was statistically identical to T_2V_3 and T_4V_1 and also statistically similar to T_1V_3 and T_2V_1. Again, the treatment combination T_5V_2 gave the minimum straw yield (4.16 t ha^{-1}) which was statistically similar to the treatment combinations of T_3V_2.

4.3.3 Harvest index

Effect of organic and inorganic nutrients combinations

Different doses of organic and inorganic nutrients combinations showed significant influence on harvest index (Table 3 and Appendix VI). It was observed that the treatment T_4 (100% RFD + Cowdung 5 t ha^{-1}) gave the highest harvest index (45.27%) that was statistically identical to T_2 (75% RFD + Cowdung 2.5 t ha^{-1}) whereas the lowest harvest index (40.32%) was found from the treatment T_5 (only cowdung 10 t ha^{-1}). Baghdadi *et al*. (2018) also found similar result with the present study and reported maximum harvest index from 100% NPK with organic manure.

Effect of variety

Different rice varieties showed significant variation on harvest index (Table 3 and Appendix VI). Results indicated that the highest harvest index (45.35%) was achieved from the variety V_3 (BRRI dhan81) which was statistically identical to the variety V_1 (BRRI dhan28) whereas the lowest harvest index (38.47%) was found from the variety V_2 (BRRI dhan34). Supported result was also observed by Salam *et al*. (2019), Mahmood (2017) and Sokoto and Muhammad (2014); they found significant variation on harvest index of rice among different varieties.

Combined effect of organic and inorganic nutrients combinations and variety

Harvest index of rice at harvest varied significantly due to combined effect of organic and inorganic nutrients combinations and variety (Table 3 and Appendix VI). The treatment combination of T_4V_3 showed the highest harvest index (46.48%) that was statistically identical toT_2V_3 andT_4V_1 and statistically similar to T_2V_1. Again, the treatment combination of T_5V_2 gave the lowest harvest index (32.67%) that was significantly different from other treatment combinations.

Table 3. Effect of organic and inorganic nutrients in combination with different rice varieties on yield parameters of rice

Treatments	Yield parameters		
	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
Effect of organic and inorganic nutrients			
T_1	5.30 b	6.88 b	42.68 b
T_2	6.32 a	7.68 a	44.95 a
T_3	4.94 c	6.56 c	41.58 c
T_4	6.52 a	7.83 a	45.27 a
T_5	4.51 d	6.24 d	40.32 d
$LSD_{0.05}$	0.307	0.261	0.684
CV(%)	10.78	6.07	4.97
Effect of variety			
V_1	6.38 a	7.76 a	45.05 a
V_2	3.60 b	5.46 b	38.47 b
V_3	6.58 a	7.89 a	45.35 a
$LSD_{0.05}$	0.250	0.208	0.936
CV(%)	10.78	6.07	4.97
Combined effect of organic and inorganic nutrients and variety			
T_1V_1	6.30 cd	7.80 abc	44.68 bc
T_1V_2	3.06 h	4.83 g	38.50 e
T_1V_3	6.54 bc	8.00 ab	44.87 bc
T_2V_1	6.85 ab	8.10 ab	45.82 ab
T_2V_2	5.05 g	6.77 f	42.65 d
T_2V_3	7.07 a	8.17 a	46.39 a
T_3V_1	6.03 cde	7.51 cde	44.52 c
T_3V_2	2.56 h	4.48 gh	35.62 f
T_3V_3	6.24 cd	7.69 bcd	44.60 bc
T_4V_1	7.10 a	8.19 a	46.40 a
T_4V_2	5.32 fg	7.07 ef	42.92 d
T_4V_3	7.15 a	8.22 a	46.48 a
T_5V_1	5.64 ef	7.21 ef	43.85 cd
T_5V_2	2.02 i	4.16 h	32.67 g
T_5V_3	5.88 de	7.35 de	44.44 c
$LSD_{0.05}$	0.532	0.446	1.253
CV(%)	10.78	6.07	4.97

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

T_1 = Recommended fertilizer dose RFD ($N_{120}P_{16}K_{100}S_{10}Zn_2$), T_2 = 75% RFD + Cowdung 2.5 t ha^{-1}, T_3 = 50% RFD + Cowdung 5 t ha^{-1}, T_4 = 100% RFD + Cowdung 5 t ha^{-1} and T_5 =Cowdung 10 t ha^{-1}

V_1 = BRRI dhan28, V_2 = BRRI dhan34 and V_3 = BRRI dhan81

4.4 Post harvest soil status

4.4.1 pH

Effect of organic and inorganic nutrients combinations

Application of different doses of organic and inorganic nutrients combinations showed non-significant influence on pH of post harvest soil (Table 4 and Appendix VII). However, results showed that the highest pH of post harvest soil (6.33) was given by the treatment T_4 (100% RFD + Cowdung 5 t ha^{-1}) whereas the lowest pH of post harvest soil (6.27) was found from the treatment T_5 (cowdung 10 t ha^{-1}) treated soil.

Effect of variety

Different rice varieties showed non-significant variation for pH of post harvest soil (Table 4 and Appendix VII). However, results indicated that the highest pH of post harvest soil (6.32) was achieved from the variety V_3 (BRRI dhan-81) whereas the lowest pH of post harvest soil (6.26) was found from the variety V_2 (BRRI dhan-34).

Combined effect of organic and inorganic nutrients combinations and variety

Treatment combination of organic and inorganic nutrients combinations and variety showed non-significant variation on pH of post harvest soil (Table 4 and Appendix VII). However, the treatment combination of T_4V_3 showed the highest pH of post harvest soil (6.36) whereas the treatment combination of T_5V_2 gave the lowest pH of post harvest soil (6.23).

Table 4. Effect of organic and inorganic nutrients in combination with different rice varieties on pH and nutrient status of post harvest soil

Treatments	pH and nutrient status of post harvest soil			
	pH	Organic carbon (%)	Available phosphorus (ppm)	Sulphur (ppm)
Effect of organic and inorganic nutrients				
T_1	6.29	0.57	20.80 d	26.60 c
T_2	6.32	0.61	23.27 b	27.88 b
T_3	6.30	0.64	21.27 c	25.86 d
T_4	6.33	0.68	24.14 a	28.93 a
T_5	6.27	0.70	20.54 d	25.36 d
$LSD_{0.05}$	0.101^{NS}	0.127^{NS}	0.369	0.613
CV(%)	6.92	6.45	4.06	3.77
Effect of variety				
V_1	6.31	0.64	22.37 a	27.81 a
V_2	6.26	0.62	19.90 b	24.72 b
V_3	6.32	0.65	23.74 a	28.25 a
$LSD_{0.05}$	0.103^{NS}	0.113^{NS}	1.386	1.382
CV(%)	6.92	6.45	4.06	3.77
Combined effect of organic and inorganic nutrients and variety				
T_1V_1	6.25	0.56	18.45 i	27.20 de
T_1V_2	6.27	0.55	20.40 h	24.86 hi
T_1V_3	6.31	0.56	23.55 cd	27.72 d
T_2V_1	6.34	0.61	24.14 bc	28.97 c
T_2V_2	6.27	0.61	20.77 gh	25.17 gh
T_2V_3	6.34	0.62	24.89 ab	29.49 bc
T_3V_1	6.31	0.65	22.21 ef	26.57 ef
T_3V_2	6.26	0.63	18.94 i	24.07 i
T_3V_3	6.31	0.65	22.66 de	26.93 def
T_4V_1	6.35	0.68	25.58 a	30.42 ab
T_4V_2	6.27	0.67	21.12 fgh	25.46 gh
T_4V_3	6.36	0.68	25.72 a	30.90 a
T_5V_1	6.29	0.70	21.48 fgh	25.86 fgh
T_5V_2	6.23	0.70	18.26 i	24.04 i
T_5V_3	6.30	0.71	21.88 efg	26.18 efg
$LSD_{0.05}$	0.136^{NS}	0.132^{NS}	1.117	1.075
CV(%)	6.92	6.45	4.06	3.77

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

T_1 = Recommended fertilizer dose RFD ($N_{120}P_{16}K_{100}S_{10}Zn_2$), T_2 = 75% RFD + Cowdung 2.5 t ha^{-1}, T_3 = 50% RFD + Cowdung 5 t ha^{-1}, T_4 = 100% RFD + Cowdung 5 t ha^{-1} and T_5 = cowdung 10 t ha^{-1}

V_1 = BRRI dhan28, V_2 = BRRI dhan34 and V_3 = BRRI dhan81

4.4.2 Organic carbon content

Effect of organic and inorganic nutrients combinations

Application of different doses of organic and inorganic nutrients combinations showed non-significant influence on organic carbon content of post harvest soil (Table 4 and Appendix VII). However, the highest organic carbon content of post harvest soil (0.70%) was given by the treatment T_5 (cowdung 10 t ha^{-1}) whereas the lowest organic carbon content of post harvest soil (0.57%) was found from the treatment T_1 (RFD: $N_{120}P_{16}K_{100}S_{10}Zn_2$ kg ha^{-1}).

Effect of variety

Different rice varieties showed significant variation for organic carbon content of post harvest soil (Table 4 and Appendix VII). However, the highest organic carbon content of post harvest soil (0.65%) was achieved from the variety V_3 (BRRI dhan81) whereas the lowest organic carbon content of post harvest soil (0.62%) was found from the variety V_2 (BRRI dhan34).

Combined effect of organic and inorganic nutrients combinations and variety

Treatment combination of organic and inorganic nutrients combinations and variety showed non-significant variation on organic carbon content of post harvest soil (Table 4 and Appendix VII). However, the treatment combination of T_5V_3 showed the highest organic carbon content of post harvest soil (0.71%) whereas the treatment combination of T_1V_2 gave the lowest organic carbon content of post harvest soil (0.55%).

4.4.3 Available phosphorus (P) content

Effect of organic and inorganic nutrients combinations

Different doses of organic and inorganic nutrients combinations showed significant influence on P content of post harvest soil (Table 4 and Appendix VIII). It was observed that the treatment T_4 (100% RFD + Cowdung 5 t ha^{-1})

gave the highest available P content of post harvest soil (24.14 ppm) that was significantly different from other treatments followed by T_2 (75% RFD + Cowdung 2.5 t ha^{-1}) whereas the lowest available P content of post harvest soil (20.54 ppm) was found from the treatment T_5 (cowdung 10 t ha^{-1}) that was statistically identical to T_1 (RFD: $N_{120}P_{16}K_{100}S_{10}Zn_2$ kg ha^{-1}).

Effect of variety

Different rice varieties showed significant variation on available P content of post harvest soil (Table 4 and Appendix VII). Results indicated that the highest available P content of post harvest soil (23.74 ppm) was achieved from the variety V_3 (BRRI dhan81) which was statistically identical to the variety V_1 (BRRI dhan28) whereas the lowest available P content of post harvest soil (19.90 ppm) was found from the variety V_2 (BRRI dhan34).

Combined effect of organic and inorganic nutrients combinations and variety

Available P content of post harvest soil of rice varied significantly due to combined effect of organic and inorganic nutrients combinations and variety (Table 4 and Appendix VII). The treatment combination of T_4V_3 showed the highest P content of post harvest soil (25.72 ppm) that was statistically identical to T_4V_1 and statistically similar to T_2V_3. Again, the treatment combination of T_5V_2 gave the lowest available P content of post harvest soil (18.26 ppm) that was statistically identical to T_1V_1 and T_3V_2.

4.4.4 Available sulphur (S) content

Effect of organic and inorganic nutrients combinations

Different doses of organic and inorganic nutrients combinations showed significant influence on available S content of post harvest soil (Table 4 and Appendix VII). It was observed that the treatment T_4 (100% RFD + Cowdung 5 t ha^{-1}) gave the highest available S content of post harvest soil (28.93 ppm) that was significantly different from other treatments followed by T_2 (75% RFD +

Cowdung 2.5 t ha^{-1}) whereas the lowest available S content of post harvest soil (25.36 ppm) was found from the treatment T_5 (cowdung 10 t ha^{-1}) that was statistically identical to T_3 (50% RFD + Cowdung 5 t ha^{-1}).

Effect of variety

Different rice varieties showed significant variation on available S content of post harvest soil (Table 4 and Appendix VII). Results indicated that the highest available S content of post harvest soil (28.25 ppm) was achieved from the variety V_3 (BRRI dhan81) which was statistically identical to the variety V_1 (BRRI dhan28) whereas the lowest available S content of post harvest soil (24.72 ppm) was found from the variety V_2 (BRRI dhan34).

Combined effect of organic and inorganic nutrients combinations and variety

Combined effect of organic and inorganic nutrients combinations and variety showed significant variation on available S content of post harvest soil of rice (Table 4 and Appendix VII). The treatment combination of T_4V_3 showed the highest available S content of post harvest soil (30.90 ppm) that was statistically similar to T_4V_1. Again, the treatment combination of T_5V_2 gave the lowest available S content of post harvest soil (24.04 ppm) that was statistically identical to T_3V_2 and statistically similar to T_1V_2.

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the research field of Sher-e-Bangla Agricultural University, Dhaka during the period from November 2020 to May 2021 to study the performance of different rice varieties as influenced by organic and inorganic nutrient management practices. The experiment comprised of two factors: Factor A (five integrated nutrient combination of organic and inorganic nutrients) *viz.*, T_1 = Recommended fertilizer dose RFD ($N_{120}P_{16}K_{100}S_{10}Zn_2$), T_2 = 75% RFD + Cowdung 2.5 t ha^{-1}, T_3 = 50% RFD + Cowdung 5 t ha^{-1} T_4 = 100% RFD + Cowdung 5 t ha^{-1} and T_5 = cowdung 10 t ha^{-1} and Factor B (three rice varieties) *viz.*, V_1 = BRRI dhan28, V_2 = BRRI dhan34 and V_3 = BRRI dhan81. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Data on different growth parameters, yield and yield contributing characters and also post harvest soil nutrient status were recorded. The collected data were statistically analyzed for evaluation of the treatments effect.

Different treatments of organic and inorganic nutrients combination showed significant variation on maximum parameters of the study. Regarding growth parameters, the highest plant height (97.89 cm), number of tillers $hill^{-1}$ (16.70), number of effective tillers $hill^{-1}$ (14.45) and length of flag leaf (32.75 cm) were recorded from the treatment T_4 (100% RFD + Cowdung 5 t ha^{-1}) but the lowest plant height (81.18 cm), number of tillers $hill^{-1}$ (11.59) and length of flag leaf (25.55 cm) were recorded from the treatment T_5 (only cowdung 10 t ha^{-1}) while the lowest number of effective tillers $hill^{-1}$ (14.45) was found from T_3 (50% RFD + Cowdung 5 t ha^{-1}). Similarly, considering yield contributing parameters and yield of rice, the maximum panicle length (23.95 cm), number of filled grains $panicle^{-1}$ (151.80), 1000 grain weight (20.33 g), grain yield (6.52 t ha^{-1}), straw yield (7.83 t ha^{-1}) and harvest index (45.27%) were recorded from the

treatment T_4 (100% RFD + Cowdung 5 t ha^{-1}) followed by T_2 (75% RFD + Cowdung 2.5 t ha^{-1}) which showed the highest number of un-filled grains $panicle^{-1}$ (13.96) whereas the minimum panicle length (21.39 cm), number of filled grains $panicle^{-1}$ (125.40), number of un-filled grains $panicle^{-1}$ (8.37), 1000 grain weight (19.98 g), grain yield (4.51 t ha^{-1}), straw yield (6.24 t ha^{-1}) and harvest index (40.32%) were recorded from the treatment T_5 (cowdung 10 t ha^{-1}). Considering quality parameters of post harvest soil of rice, different treatments of organic and inorganic nutrients combination showed non-significant variation on pH and organic carbon content but available phosphorus and sulphur content of post harvest soil varied significantly among the treatments. However, the maximum pH (6.33%), available phosphorus (24.14 ppm) and sulphur (28.93 ppm) content of post harvest soil was found from T_4 (100% RFD + Cowdung 5 t ha^{-1}) treatment whereas the minimum pH (6.27), available phosphorus (20.54 ppm) and sulphur (28.25 ppm) content of post harvest soil was found from T_5 (only cowdung 10 t ha^{-1}) treatment. Similarly, the maximum organic carbon content (0.70%) was found from the treatment T_5 (cowdung 10 t ha^{-1}) while the minimum (0.57%) was observed from T_1 (RFD: $N_{120}P_{16}K_{100}S_{10}Zn_2$ kg ha^{-1}) treatment.

Different rice varieties showed significant variation on maximum parameters of the study except panicle length. The variety V_3 (BRRI dhan81) gave the highest plant height (96.21 cm), number of tillers m^{-2} (15.40), number of effective tillers m^{-2} (13.49), length of flag leaf (30.96 cm), number of filled grains $panicle^{-1}$ (149.10), number of un-filled grains $panicle^{-1}$ (12.58), grain yield (6.58 t ha^{-1}), straw yield (7.89 t ha^{-1}) and harvest index (45.35%) followed by the variety V_1 (BRRI dhan-28) which showed the highest 1000 grain weight (21.29g). On the other hand, the variety V_2 (BRRI dhan34) showed the lowest plant height (81.24 cm), number of tillers m^{-2} (10.89), number of effective tillers m^{-2} (9.14), length of flag leaf (24.31 cm), number of filled grains $panicle^{-1}$ (120.20), number of un-filled grains $panicle^{-1}$ (9.09), 1000 grain weight (19.11 g), grain yield (3.60 t ha^{-1}), straw yield (5.46 t ha^{-1}) and harvest index

(38.47%). Different rice varieties showed non-significant variation on pH of post harvest soil, however, the highest pH (6.32%) and organic carbon (0.65%) were recorded from V_3 (BRRI dhan81) whereas the lowest pH (6.26) and organic carbon (0.62%) were recorded from the variety V_2 (BRRI dhan34). Again, available P and S content of post harvest soil varied significantly by different varieties, and the maximum S and P content (23.74 and 28.25 ppm, respectively) were recorded from V_3 (BRRI dhan81) variety followed by V_1 (BRRI dhan28) whereas the minimum (19.90 and 24.72 ppm, respectively) were recorded from V_2 (BRRI dhan34) variety.

Combined effect of different treatments of organic and inorganic nutrients combination and variety showed significant variation on most of the studied parameters. The highest plant height (104.50 cm), number of tillers m^{-2} (20.78), number of effective tillers m^{-2} (18.22), length of flag leaf (36.32 cm), panicle length (24.93 cm), number of filled grains $panicle^{-1}$ (166.70), number of un-filled grains $panicle^{-1}$ (18.55), grain yield (7.15 t ha^{-1}), straw yield (8.22 t ha^{-1}) and harvest index (46.48%) were recorded from the treatment combination of T_4V_3 while T_4V_1 showed the highest 1000 grain weight (21.51 g). On the other hand, T_5V_2 showed the lowest plant height (72.72 cm), number of tillers $hill^{-1}$ (9.67), length of flag leaf (23.05 cm), panicle length (20.89 cm), number of filled grains $panicle^{-1}$ (112.40), number of un-filled grains $panicle^{-1}$ (5.55), 1000 grain weight (18.97 g), grain yield (2.02 t ha^{-1}), straw yield (4.16 t ha^{-1}) and harvest index (32.67%) while the minimum number of effective tillers m^{-2} (7.89) was recorded from T_3V_2. Different treatment combination showed significant variation on available phosphorus and sulphur content of post harvest soil but pH and organic carbon content of post harvest soil was not varied significantly. However, the maximum pH (6.36) and organic carbon content (0.71%) were recorded from T_4V_3 and T_5V_3, respectively whereas the minimum (6.23 and 0.55%, respectively) were recorded from T_5V_2 and T_1V_2, respectively. Similarly, the maximum available phosphorus and sulphur content of post harvest soil (25.72 and 30.90 ppm, respectively) were achieved from

T_4V_3 whereas the minimum (1180.26 and 24.04 ppm, respectively) were found from T_5V_2.

Conclusion

It could be concluded that among the different treatments of organic and inorganic nutrients combination, T_4 (100% RFD + Cowdung 5 t ha^{-1}) showed the best performance compared to other treatments regarding the results of higher growth, yield and yield contributing parameters whereas T_5 (cowdung 10 t ha^{-1}) treatment showed lowest performance. Again, the variety V_3 (BRRI dhan81) seemed the best results in most of the parameters regarding yield and yield contributing parameters whereas V_2 (BRRI dhan34) showed least performance. Similarly, among the treatment combinations of organic and inorganic treatments with variety, T_4V_3 (100% RFD + Cowdung 5 t ha^{-1} with BRRI dhan81) gave the best performance considering yield and yield contributing characters. So, the treatment combination of T_4V_3 (100% RFD + Cowdung 5 t ha^{-1} with BRRI dhan81) would be considered as the best compared to all other treatment combinations followed by T_4V_1 (100% RFD + Cowdung 5 t ha^{-1} with BRRI dhan28).

Recommendation

Further experiment can be conducted in respect of many other varieties of rice including local, HYV and hybrids with other similar doses of organic and inorganic nutrients at different locations of Bangladesh for final recommendation for best variety with best nutrients doses.

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APPENDICES

Appendix I. Agro-Ecological Zone of Bangladesh showing the experimental location

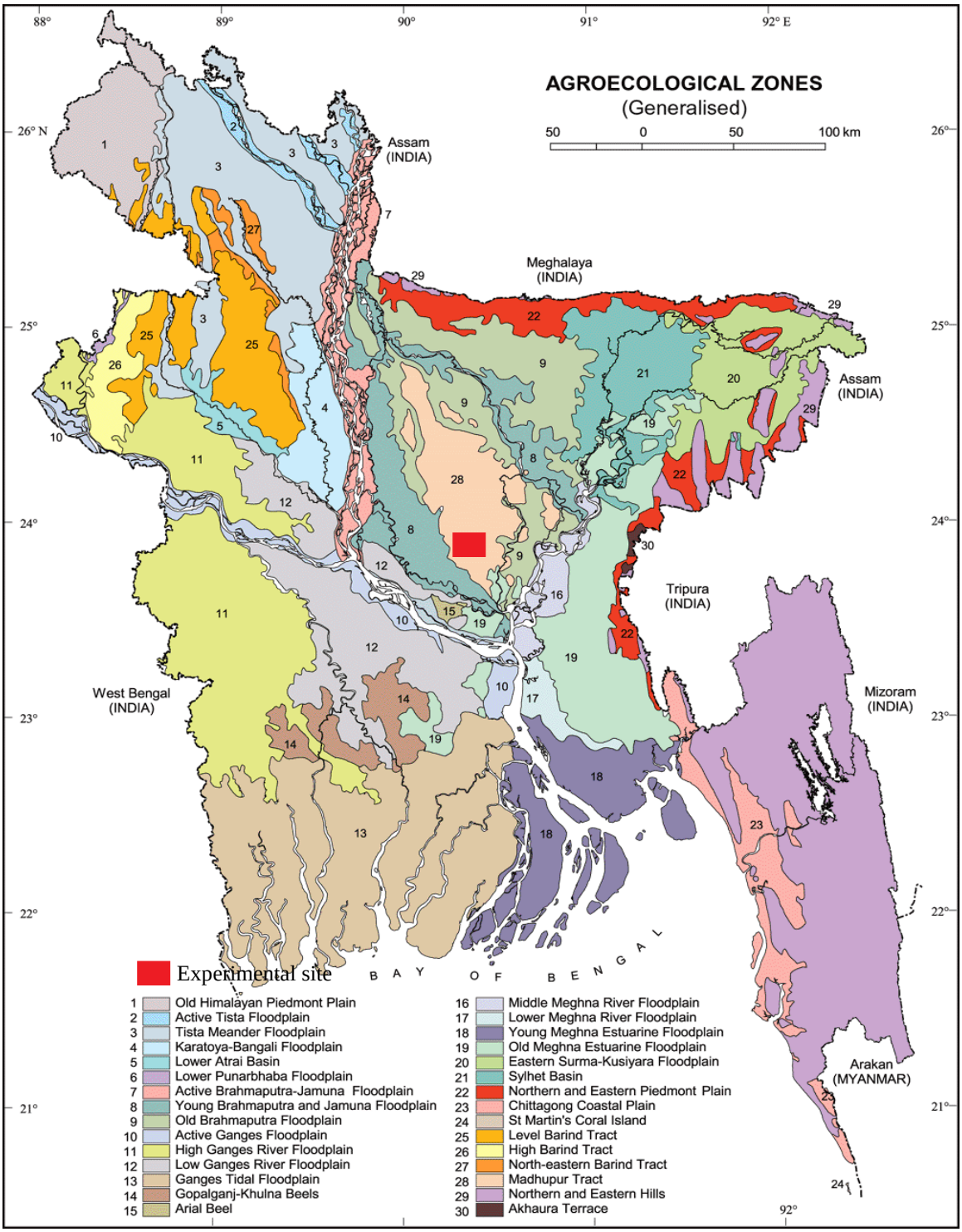

Figure 10. Experimental site

Appendix II. Monthly records of air temperature, relative humidity and rainfall during the period from November 2020 to May 2021.

Year	Month	Air temperature (°C)			Relative humidity (%)	Rainfall (mm)
		Max	*Min*	*Mean*		
2020	November	28.60	8.52	18.56	56.75	14.40
2020	December	25.50	6.70	16.10	54.80	0.0
2021	January	23.80	11.70	17.75	46.20	0.0
2021	February	22.75	14.26	18.51	37.90	0.0
2021	March	35.20	21.00	28.10	52.44	20.4
2021	April	34.70	24.60	29.65	65.40	165.0
2021	May	32.64	23.85	28.25	68.30	182.2

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1212.

Appendix III. Characteristics of experimental soil analyzed at Soil Resources Development Institute (SRDI), Farmgate, Dhaka.

A. Morphological characteristics of the experimental field

Morphological features	**Characteristics**
Location	Agronomy Farm, SAU, Dhaka
AEZ	Modhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained

B. Physical and chemical properties of the initial soil

Characteristics	**Value**
Partical size analysis % Sand	27
%Silt	43
% Clay	30
Textural class	Silty Clay Loam (ISSS)
pH	6.3
Organic carbon (%)	0.60
Organic matter (%)	1.24
Total N (%)	0.03
Available P (ppm)	20
Exchangeable K (me/100 g soil)	0.1
Available S (ppm)	30

Appendix IV. Effect of organic and inorganic nutrients in combination with different rice varieties on growth parameters of rice

Sources of variation	Degrees of freedom	Mean square of growth parameters			
		Plant height (cm)	Number of tillers hill^{-1}	Number of effective tillers hill^{-1}	Length of flag leaf (cm)
Replication	2	7.952	23.807	24.435	0.216
Factor A	4	370.90*	40.575*	37.719*	72.639*
Factor B	2	1037.8*	84.748*	76.536*	196.23*
AB	8	10.279*	5.826**	4.593**	7.926*
Error	28	5.358	1.954	0.756	2.844

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix V. Effect of organic and inorganic nutrients in combination with different rice varieties on yield contributing parameters of rice

Sources of variation	Degrees of freedom	Mean square of yield contributing parameters			
		Panicle length (cm)	No. of filled grains panicle^{-1}	No. of un-filled grains panicle^{-1}	1000 seed weight (g)
Replication	2	1.157	316.92	30.285	0.003
Factor A	4	7.463*	1130.86*	49.615*	0.195**
Factor B	2	4.258NS	3657.34*	53.298*	17.90*
AB	8	2.390**	57.359*	26.888*	0.010**
Error	28	0.107	24.799	1.445	0.010

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix VI. Effect of organic and inorganic nutrients in combination with different rice varieties on yield parameters of rice

Sources of variation	Degrees of freedom	Mean square of yield parameters		
		Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
Replication	2	0.026	0.099	4.357
Factor A	4	6.855*	4.331**	41.068*
Factor B	2	41.48*	27.93*	226.94*
AB	8	0.890**	1.038**	12.219*
Error	28	0.101	0.071	0.561

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix VII. Effect of organic and inorganic nutrients in combination with different rice varieties on pH and nutrient status of post harvest soil

Sources of variation	Degrees of freedom	Mean square of pH and nutrient status of post harvest soil			
		pH	Organic carbon (%)	Available phosphorus (ppm)	Sulphur (ppm)
Replication	2	0.031	0.012	5.406	1.204
Factor A	4	0.323^{NS}	0.114^{NS}	24.43*	23.13*
Factor B	2	1.041^{NS}	0.216^{NS}	61.24*	66.14*
AB	8	0.236^{NS}	0.103^{NS}	4.837**	6.207**
Error	28	0.014	0.012	0.451	0.422

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level