EFFECT OF ORGANIC AND INORGANIC FERTILIZER APPLICATION ON RICE PRODUCTION (BRRI dhan28)

MD. ASMAUL HAQUE MOLLIK

REG. NO. 20-11109

Email: mollik.sau09@gmail.com
Mobile: 01751-411381

DEPARTMENT OF SOIL SCIENCE

SHER-E-BANGLA AGRICULTURAL UNIVERSITY
DHAKA -1207

JUNE, 2022

EFFECT OF ORGANIC AND INORGANIC FERTILIZER APPLICATION ON RICE PRODUCTION (BRRI dhan28)

BY

MD. ASMAUL HAQUE MOLLIK

REG.NO. :20-11109

A Thesis
Submitted to the Department of Soil Science
Sher-e-Bangla Agricultural University, Dhaka
In partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE (MS)

IN

SOIL SCIENCE

SEMESTER: JANUARY- JUNE, 2022

Approved by:

(Prof. A.T.M.Shamsuddoha)
Supervisor
Department of Soil Science
SAU, Dhaka-1207

(Prof. Dr. Md. Asaduzzaman Khan)
Co-Supervisor
Department of Soil Science
SAU, Dhaka-1207

(Prof. Dr. Mohammad Saiful Islam Bhuiyan)
Chairman
Examination Committee
Department of Soil Science
SAU, Dhaka-1207

DEPARTMENT OF SOIL SCIENCE
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207

CERTIFICATE

This is to certify that the thesis entitled **"EFFECT OF ORGANIC AND INORGANIC FERTILIZER APPLICATION ON RICE PRODUCTION (BRRI dhan28)"** 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 (MS)** in **SOIL SCIENCE**, embodies the result of a piece of bonafide research work carried out by **Md. Asmaul Haque Mollik**, Registration No. 20-11109under 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.

June, 2022
Dhaka, Bangladesh

(A.T.M Shamsuddoha**)**
Professor
Department of Soil Science
SAU, Dhaka

Dedicated to

My

Beloved Parents

ACKNOWLEDGEMENTS

The author seems it a much privilege to express his enormous sense of gratitude to the almighty Allah for there ever ending blessings for the successful completion of the research work.

The author wishes to express his gratitude and best regards to his respected Supervisor, ***A.T.M Shamsuddoha****, Professor, Department of Soil Science, Sher-e-Bangla Agricultural University, Dhaka, for his continuous direction, constructive criticism, encouragement and valuable suggestions in carrying out the research work and preparation of this thesis.*

The author wishes to express his earnest respect, sincere appreciation and enormous indebtedness to his reverend Co-supervisor, **Dr. Md. Asaduzzaman Khan***, Professor, Department of Soil Science, Sher-e-Bangla Agricultural University, Dhaka, for his scholastic supervision, helpful commentary and unvarying inspiration throughout the research work and preparation of the thesis.*

The author feels to express his heartfelt thanks to the honorable Chairman, ***Prof. Dr. Mohammad Saiful Islam Bhuiyan,*** *Professor, Department of Soil Science along with all other teachers and staff members of the Department of Soil Science, Sher-e-Bangla Agricultural University, Dhaka, for their co-operation during the period of the study.*

The author feels proud to express his deepest and endless gratitude to all of his course mates and friends to cooperate and help him during taking data from the field and preparation of the thesis. The author wishes to extend his special thanks to his lab mates, class mates and friends for their keen help as well as heartiest co-operation and encouragement.

The author expresses his heartfelt thanks to his beloved parents, Elder Sister and Brother and all other family members for their prayers, encouragement, constant inspiration and moral support for his higher study. May Almighty bless and protect them all.

The Author

EFFECT OF ORGANIC AND INORGANIC FERTILIZER APPLICATION ON RICE PRODUCTION (BRRI dhan28)

ABSTRACT

An experiment was conducted at Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from November 2021 to May 2022 to examine the effect of organic and inorganic fertilizer application on rice production (BRRI dhan28). The experiment consisted of eight treatments *viz*. T_1 (control; no organic or inorganic fertilizer), T_2 (100% RDCF; $N_{100}P_{15}K_{45}S_{20}Zn_3$ kg ha^{-1}), T_3 (only poultry manure; 100% N), T_4 (only vermicompost; 100% N), T_5 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% poultry manure),T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost), T_7 (25% RDCF; 25% NPKSZn kg ha^{-1} + 75% poultry manure) and T_8 (25% RDCF; 25% NPKSZn kg ha^{-1} + 75% vermicompost). The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. A significant variation was observed among the treatments due to different levels of organic and inorganic nutrient sources. The treatment T_2 (100% RDCF; $N_{100}P_{15}K_{45}S_{20}Zn_3$ kg ha^{-1}) exposed the highest plant height at (92.12 cm) and the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost) showed the highest number of tillers $hill^{-1}$ (17.24) whereas control treatment T_1 (no organic or inorganic fertilizer) showed the minimum results in both plant height and tillers $hill^{-1}$. Again, the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost) produced the highest number of effective tillers $hill^{-1}$ (15.87), flag leaf length (21.64 cm), number of filled grains $panicle^{-1}$ (129.20), panicle length (23.52 cm), grain yield (5.32 t ha^{-1}), straw yield (6.14 t ha^{-1}), biological yield (11.46 t ha^{-1}) and harvest index (46.42%) followed by T_5 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% poultry manure) whereas the control treatment T_1 (no organic or inorganic fertilizer) showed the lowest results in all the parameters. In case of post-harvest soil, different treatments of organic and inorganic fertilizers and their combinations showed no significant variation on pH and organic carbon content but available N, available P, exchangeable K, available S and available Zn content of postharvest soil affected significantly. The treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost) showed highest available N (1.52%), available P (24.52 ppm), exchangeable K (1.216 meq/100g soil), available S (26.44 ppm) and available Zn (0.174 ppm) whereas the lowest available P and available S content was obtained from control treatment T_1 (no organic or inorganic fertilizer). So, the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost) can be considered as a potential onefor higher rice production (BRRI dhan28).

LIST OF CONTENTS

Chapter	Title		Page No.
	ACKNOWLEDGEMENTS		i
	ABSTRACT		ii
	LIST OF CONTENTS		iii
	LIST OF TABLES		iv
	LIST OF FIGURES		V
	LIST OF APPENDICES		Vii
	ABBREVIATIONS AND ACRONYMS		viii
I	**INTRODUCTION**		**1-4**
II	**REVIEW OF LITERATURE**		**5-17**
III	**MATERIALS AND METHODS**		**18-31**
	3.1	Site description	18
	3.2	Climate	18
	3.3	Soil	18
	3.4	Treatments	19
	3.5	Plant materials and collection of seeds	19
	3.6	Seed sprouting	19
	3.7	Preparation of nursery bed and seed sowing	20
	3.8	Preparation of experimental land	20
	3.9	Experimental design and layout	20
	3.10	Fertilizer application	22
	3.11	Uprooting of seedlings	22
	3.12	Transplanting of seedlings in the field	22
	3.13	Intercultural operations	23
	3.14	Harvesting, threshing and cleaning	23
	3.15	General observation of the experimental field	24
	3.16	Recording of data	24
	3.17	Procedures of recording data	25
	3.18	Statistical analysis	31
IV	**RESULTS AND DISCUSSION**		**32-46**
	4.1	Growth parameters	32
	4.1.1	Plant height	32

LIST OF CONTENTS (Cont'd)

Chapter	Title		Page No.
IV	**RESULTS AND DISCUSSION**		
	4.1.2	Number of tillers $hill^{-1}$	33
	4.2	Yield contributing parameters	35
	4.2.1	Number of effective tillers $hill^{-1}$	35
	4.2.2	Number of non-effective tillers $hill^{-1}$	35
	4.2.3	Flag leaf length (cm)	36
	4.2.4	Number of filled grains $panicle^{-1}$	37
	4.2.5	Number of unfilled grains $panicle^{-1}$	38
	4.2.6	Panicle length (cm)	39
	4.2.7	Weight of 1000 seeds	40
	4.3	Yield parameters	40
	4.3.1	Grain yield ha^{-1}	40
	4.3.2	Straw yield ha^{-1}	42
	4.3.3	Biological yield ha^{-1}	42
	4.3.4	Harvest index	43
	4.4	Analysis of postharvest soil	43
	4.4.1	pH content of postharvest soil	43
	4.4.2	Organic carbon content of postharvest soil	43
	4.4.3	Available nitrogen (N) content of postharvest soil	44
	4.4.4	Available phosphorus (P) content of postharvest soil	44
	4.4.5	Exchangeable potassium (K) content of postharvest soil	44
	4.4.6	Available sulphur (S) content of postharvest soil	45
	4.4.7	Available (Zn) content of postharvest soil	46
V	**SUMMERY AND CONCLUSION**		**47-49**
	REFERENCES		**50-56**
	APPENDICES		**57-60**

LIST OF TABLES

Table No.	Title	Page No.
1.	Effect of organic and/or inorganic fertilizers on plant height of BRRI dhan28 at different growth stages	33
2.	Effect of organic and/or inorganic fertilizer on number of tillers $hill^{-1}$ of BRRI dhan28 at different growth stages	34
3.	Effect of organic and/or inorganic fertilizer on effective and non-effective tillers $hill^{-1}$ and flag leaf length of BRRI dhan28	35
4.	Effect of organic and/or inorganic fertilizer on filled grains and unfilled grains $panicle^{-1}$, panicle length and 1000 seed weight of BRRI dhan28	38
5.	Effect of organic and/or inorganic fertilizer on yield parameters of BRRI dhan28	42
6.	Effect of organic and/or inorganic fertilizer on quality of post harvest soil (pH, organic carbon, available phosphorus, available sulphur)	45

LIST OF FIGURES

Figure No.	Title	Page No.
1.	Layout of the experimental plot	21
2.	Experimental site	57

LIST OF PLATES

Plate No.	Title	Page No.
1	Seed Sprouting	61
2	Seed Sowing	61
3	Seedling Observation	61
4	Final Land Preparation	61
5	Layout Preparation	61
6	Seedling Uprooting	61
7	Seedling Transplanting	62
8	Irrigation	62
9	Maximum Tillering	62
10	Ripening Stage	62
11	Harvesting	62
12	Threshing & Dry Weight	62

LIST OF APPENDICES

Appendix No.	Title	Page No.
I.	Agro-Ecological Zone of Bangladesh showing the experimental location	57
II.	Monthly records of air temperature, relative humidity and rainfall during the period from November 2021 to May 2022	58
III.	Characteristics of experimental soil analyzed at Soil Resources Development Institute (SRDI), Farmgate, Dhaka	58
IV.	Effect of organic and/or inorganic fertilizers on plant height of BRRI dhan28 at different growth stages	59
V.	Effect of organic and/or inorganic fertilizer on number of tillers hill^{-1} of BRRI dhan28 at different growth stages	59
VI.	Effect of organic and/or inorganic fertilizer on effective and non-effective tillers hill^{-1} and flag leaf length of BRRI dhan28	59
VII.	Effect of organic and/or inorganic fertilizer on filled grains and unfilled grains panicle^{-1}, panicle length and 1000 seed weight of BRRI dhan28	60
VIII.	Effect of organic and/or inorganic fertilizer on yield parameters of BRRI dhan28	60
IX.	Effect of organic and/or inorganic fertilizer on quality of post-harvest soil (pH, organic carbon, available N, available P, exchangeable K, available S and available Zn)	60

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 Agricultural 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 is a fundamental staple food for human nutrition and a primary source of sustenance for 75% of the global population, providing up to 50-60% of daily calorie intake for more than 2.5 billion people (Saha *et al*., 2017; Metwally *et al*., 2011). It is also an essential source of zinc, providing nearly half of the dietary zinc for children and women (Kabir *et al*., 2018). Additionally, rice contributes to 21% of global calorie consumption and 76% of total calorific intake in the South-East Asian region (Fitzgerald *et al*., 2009), making it a significant factor in the economy and culture of billions of people worldwide (Shao *et al*., 2020).

In Bangladesh, rice cultivation dominates agriculture, covering about 78% of total cropped area, with boro rice alone accounting for 54.56% of the total rice area and 41.94% of the total rice production (AIS, 2017; BBS, 2016). About 80% of arable land in Bangladesh is utilized for rice cultivation, and the country ranks third in both area and production and sixth in per-hectare production of rice (Sarkar et al., 2016). In 2018-2019, rice occupied an area of 28,213 thousand acres, producing 36,603 thousand metric tons (BBS, 2020), with boro rice occupying the highest area coverage among the three growing seasons (45% of gross cropping area).

Despite its significance, the average yield of rice in the country is about 3.21 t ha^{-1}(BBS, 2020) which is quite low compared to other rice-growing countries, such as China, Japan, and Korea, which have average rice production of over 6 t ha^{-1} (FAO, 2021). Increasing average rice production is essential to feed the large population of Bangladesh, which can be achieved by bringing more land under cultivation or increasing yield per unit area. However, soil fertility deterioration has become a major constraint to higher crop production, caused by increasing land use intensity without adequate and in balanced use of chemical fertilizers and organic manures (Farid *et al*., 2011), resulting in stagnating or declining crop productivity.

The use of inorganic fertilizers has been widely adopted to improve rice yield, but it has also led to soil degradation and environmental problems. In contrast, organic manure has been shown to improve soil health, enhance crop productivity, and reduce fertilizer costs. The integration of organic manure with inorganic fertilizers is a promising approach to enhance rice yield and soil fertility sustainably.

The use of inorganic fertilizers has increased rice yield; however, overreliance on them has led to environmental problems and soil fertility depletion. The integrated use of organic manure with inorganic fertilizers has been suggested as a sustainable and efficient approach to improve soil fertility and crop yield. In this context, vermicompost and poultry manure are promising organic sources of nutrients that can enhance soil fertility and increase rice yield. The integration of organic manure with inorganic fertilizers is a promising approach to enhance crop yield and sustain soil fertility (Shao *et al*., 2020).

Vermicompost and poultry manure are two types of organic manures that have been demonstrated to have significant positive effects on the growth and yield of rice. Vermicompost has been shown to improve soil structure, water-holding capacity, and nutrient availability, leading to an increase in rice yield. Similarly, poultry manure has been found to be an excellent source of nitrogen, phosphorus, and potassium, which are essential for the growth and development of rice.

Several studies have investigated the effects of integrated use of organic manure and inorganic fertilizers on rice growth and yield. Yang *et al*. (2021) found that the combined use of vermicompost and inorganic fertilizers increased rice yield by 18.5% compared to inorganic fertilizer alone. Kabir *et al*. (2018) reported that the combination of poultry manure and inorganic fertilizers significantly increased rice yield and improved soil fertility.

Saha *et al*. (2017) and Talukder *et al*. (2016) reported that the combined application of vermicompost and chemical fertilizer significantly increased the growth, yield, and yield-contributing characteristics of rice compared to using only chemical fertilizer. The study suggests that vermicompost can be a viable option for improving the yield of rice and reducing the need for chemical fertilizers. Tareque*et al*. (2019) showed that the combined use of vermicompost and poultry manure significantly increased the yield and yield attributes of rice compared to using only poultry manure or inorganic fertilizers.

Shao *et al*. (2020) suggests that the integrated use of organic and inorganic fertilizers can be an effective way to increase rice yield while reducing the negative environmental impacts of inorganic fertilizers. The integrated use of organic and inorganic fertilizers significantly increased rice yield and nitrogen use efficiency compared to using only inorganic fertilizers.

Organic fertilizers such as cowdung, vermicompost, poultry manure, organic waste, crop residues and compost will not only increase grain yields but also increase the efficiency of applied nutrients due to their favourable effect on the physical, chemical and biological properties of soil (Hussainy 2019). However, extensive application of nitrogen fertilizer, whether in the form of organic matter or chemicals, can negatively affect the soil because excess nitrogen is converted to nitrates which are detrimental to the soil and human health (Mukherjee 2013).

According to Hussainy (2019), utilizing organic fertilizers such as cowdung, vermicompost, poultry manure, organic waste, crop residues, and compost can enhance both grain yields and nutrient efficiency by improving the physical, chemical, and biological characteristics of soil. Nevertheless, excessive nitrogen fertilizer application, whether from organic or chemical sources, can be harmful to both soil and human health since surplus nitrogen converts into nitrates, which are detrimental to both (Mukherjee 2013).

Keeping these above fact in mind, the present study was designed to study the effect of organic and inorganic fertilizer application on rice production (BRRI dhan28) with the following objectives:

1. To observe the effectiveness of combined application of organic manure and inorganic fertilizer on rice production.
2. To find out the suitable value of organic manure as a substitute of chemical fertilizer.

CHAPTER II

REVIEW OF LITERATURE

Investigations on the comparative effectiveness of organic and inorganic fertilizer application on rice production have been progressed in many countries of the world. The proper agronomic practices accelerate its growth and influence its yield. Therefore, available findings of the effect of organic and inorganic fertilizer application on rice production relevant to the present study have been briefly reviewed under the following heads.

2.1 Effect of organic and inorganic fertilizer application on rice production

Alam *et al*. (2021) carried out a study 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 *viz*. 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.

Anisuzzaman*et al*. (2021) conducted an experiment using a pot study to examine the impact of organic and inorganic fertilizers on the growth and yield components of 65 rice genotypes. Three treatment combinations were utilized: T_1 with 5 t ha^{-1} chicken manure (CM), T_2 with 2.5 t ha^{-1} CM + 50% CFRR, and T_3 with 100% (150 N: 60 P_2O_5: 60 K_2O kg ha^{-1}) and chemical fertilizer recommended rate (CFRR). At the harvest stage, grain and straw samples were gathered for chemical analysis, and physical parameters were measured. The findings revealed that the application of organic manure with chemical fertilizer significantly affected most of the growth and yield components. The application of chemical fertilizer alone or in conjunction with organic manure increased the growth, yield component traits, and nutrient content (N, P, and K) of all rice genotypes significantly. The performance of the 2.5 t ha^{-1} CM + 50% CFRR treatment, as well as the 100% CFRR, was superior to that of the other treatments. The judicious application of organic manure with chemical fertilizer can substantially increase the yield of rice genotypes. Mixed fertilization (organic + inorganic) not only increased crop yields but also promoted soil health and decreased chemical fertilizer input, among other benefits.

Sunarpi*et al*. (2021) carried out a study to determine the effect of a combination of organic and inorganic fertilizers on the growth and yield of rice. The three treatments used in this study were P_0N_0 with no organic and inorganic fertilizers; P_0N_{100} with a dose of 100% inorganic fertilizer and $P_{50}N_{50}$ with a dose of 50% organic fertilizer and 50% inorganic fertilizer. The results showed that the combination of organic fertilizers (50%) and inorganic fertilizers (50%) can increase the growth and yield of rice in the screen house compared to control plants and plants which given only 100% inorganic fertilizers. In summary, the combination of organic and inorganic fertilizers can reduce the use of inorganic fertilizers.

Shi *et al*. (2020) conducted a study to determine the effect of organic and inorganic fertilizers on the growth, yield, and quality of rice under different tillage systems in China. They used the rice variety ‘Zhongjiazao 17’ and applied organic fertilizer (rice straw) at a rate of 8.5 tons per hectare along with inorganic fertilizer (urea, triple superphosphate, and muriate of potash) at recommended rates. The study showed that the combined application of organic and inorganic fertilizers had a positive effect on the growth, yield, and quality of rice under both conventional and reduced tillage systems.

Chakraborty *et al*. (2020) conducted an experiment 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. The experiment was laid out in a split plot design with three replications. Result showed that, yield and yield components of boro rice were significantly influenced by variety, nutrient management and interaction of variety and nutrient management. In respect of grain yield, BRRI dhan29 produced the maximum yield (5.46 t ha^{-1}). BRRI dhan28 showed poor performance with all characters and gave the minimum yield (4.07 t ha^{-1}). 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. So, BRRI dhan29 with 2.5 t ha^{-1} poultry manure + 50% prilled urea and full dose of the recommended inorganic fertilizers might be a promising practice for boro rice cultivation.

Abdul-Rahman (2019) conducted a pot experiment to evaluate the effect of compost as an organic fertilizer and NPK as an inorganic fertilizer used in the growing of rice varieties. In this study the effect of compost as an organic fertilizer and NPK inorganic fertilizer was evaluated on the growth of rice plants. The experiment was with the levels of fertilizers at the full rate of inorganic fertilizer (NPK = 90:60:60 kg/ha), compost 12 t/ha, ½ (compost 12 t/ha) + ½ (inorganic fertilizer) and control. The three rice varieties were APO, IR 55419 and UPL R1 7. The full rate of inorganic fertilizer NPK = 90:60:60 kg/ha was used as a check for comparison. A significant difference was obtained between the control, inorganic and organic fertilizers as well as between the APO and IR 55419 varieties. It can be concluded from the findings that use of a quality rice variety and the application of compost, sole or as a complement to chemical fertilizer, has the potential of producing a high yield compared to a full rate of inorganic fertilizer.

Jahan *et al*. (2019) evaluated the effects of combined application of organic and inorganic fertilizers on the growth, yield, and quality of rice (BRRI Dhan28 variety). The study was conducted in a randomized complete block design with three replications, with four treatments (control, recommended dose of inorganic fertilizer, 50% RDF + 50% vermicompost and 75% RDF + 25% vermicompost). The study revealed that the combined application of organic and inorganic fertilizers (50% RDF + 50% vermicompost) significantly increased the filled effective tillers per hill, panicle length, grains per panicle, grain yield, straw yield, biological yield, harvest index and quality of rice in comparison to individual fertilizer application.

Moe *et al*. (2019) investigated the effects of integrated organic and inorganic fertilizers on the growth and yield of indica rice variety Manawthukha and japonica rice variety Genkitsukushi. Two rice varieties were assigned with the integrated treatments of no-N fertilizer (N_0), 50% chemical fertilizer (CF) (CF_{50}), 100% CF (CF_{100}), 50% CF + 50% poultry manure (PM) ($CF_{50}PM_{50}$), 50% CF + 50% cow manure (CM) ($CF_{50}CM_{50}$), and 50% CF + 50% compost (CP) ($CF_{50}CP_{50}$). CF_{100} was equivalent to N at 85 kg/hm^2. Manure was applied based on the estimated mineralizable nitrogen (EMN) level, which is dependent on total N (%) of each manure type. At the same N level, $CF_{50}PM_{50}$ application in both rice varieties resulted in higher SPAD values, plant height and tiller number than CF_{100}. $CF_{50}PM_{50}$ containing total N more than 4% supplied synchronized N for the demands of the rice plants, resulting in maximum dry matter, yield and yield components. $CF_{50}CM_{50}$ and $CF_{50}CP_{50}$ treatments containing total N less than 4% resulted in lower yields which were similar to CF_{100}.

Kusuma *et al*. (2019) evaluated the effect of organic and inorganic fertilizers on the yield and quality of rice. They used the rice variety ‘Ciherang’ and applied organic fertilizer (vermicompost) at a rate of 5 tons per hectare along with inorganic fertilizer (urea, triple superphosphate, and muriate of potash) at recommended rates. The study showed that the combined application of organic and inorganic fertilizers significantly increased the grain yield and quality of rice.

Singh *et al*. (2018) carried out an experiment to study the effect of integrated nutrient management on growth and yield of rice (*Oryza sativa* L.). Growth attributes such as plant height (96.8 cm), number of tiller m^{-2} (332), LAI (4.22) and dry matter accumulation (1285.7 gm^{-2}) were found highest with the treatment T_5 (50% RDF + 50% N through FYM) but remained at par with all the treatment where either 25 or 50% N was substituted through organic sources (T_6 to T_{10}). The differences in growth attributes were statistically alike between 100% RDF and treatments supplicated either 25 or 50% N through organic sources (T_6 to T_{10}). Maximum number of days taken to 50% flowering (98.7 days) and maturity (136.5 days) were recorded with T_5 (50 % RDF+50% N as FYM) but remained at par with all the treatment where either 25 or 50% N was substituted through organic sources (T_6 to T_{10}) and also with 100% inorganic source only.

Ghosh *et al*. (2017) evaluated the effect of combined application of organic and inorganic fertilizers on the growth, yield, and quality of rice (IR-36 variety). The study was conducted in a randomized block design with three replications, with four treatments (control, recommended dose of inorganic fertilizer, 50% RDF + 50% organic fertilizer, and 75% RDF + 25% organic fertilizer). The results showed that the combined application of organic and inorganic fertilizers had a positive effect on the growth, yield, and quality parameters of rice.

Ahmed *et al*. (2017) conducted a study to evaluate the effect of combined application of organic and inorganic fertilizers on the growth and yield of rice (BRRI dhan49 variety). The study was conducted in a randomized complete block design with six treatments: control, recommended dose of inorganic fertilizer (RDF), 50% RDF + 50% organic fertilizer (vermicompost), 75% RDF + 25% organic fertilizer (vermicompost), 100% RDF + 0% organic fertilizer, and 0% RDF + 100% organic fertilizer (vermicompost). The results showed that the combination of organic and inorganic fertilizers had a significant positive effect on tiller number, panicle length, filled grain per panicle, 1000 grain weight and grain yield. The treatment with 75% RDF + 25% organic fertilizer produced the highest grain yield.

Kamara and Ewansiha (2017) investigated the effect of organic and inorganic fertilizers on the yield and yield components of rice in Nigeria. They used the rice variety 'ITA 150' and applied organic fertilizer (cow dung) at a rate of 5 tons per hectare along with inorganic fertilizer (urea, single superphosphate, and muriate of potash) at recommended rates. The results showed that the combined application of organic and inorganic fertilizers significantly increased the grain yield and yield components of rice.

Mollah *et al*. (2017) investigated the effect of organic and inorganic fertilizers on the yield and quality of rice in Bangladesh. They used the rice variety 'BRRI dhan 28' and applied organic fertilizer (cow dung) at a rate of 5 tons per hectare along with inorganic fertilizer (urea, triple superphosphate, and muriate of potash) at recommended rates. The results showed that the combined application of organic and inorganic fertilizers significantly increased the yield and quality of rice.

Islam *et al*. (2016) conducted a field experiment in combination with chemical fertilizers and manure. The treatments were T_0 (control), T_1 ($N_{100}P_{15}K_{45}S_{20}$ (Recommended dose), T_2 (50% NPKS+5 t ha^{-1} CD), T_3 (70% NPKS+3 t ha^{-1} CD), T_4(50% NPKS+4t ha^{-1} PM), T_5 (70% NPKS+2.4 t ha^{-1}PM), T_6 (50% NPKS+10 t ha^{-1} DH) and T_7 (70% NPKS+6 t ha^{-1} DH). Application of 50% of NPKS fertilizers plus 10 t ha^{-1}dhaincha produced maximum grain yield (5085 kg ha^{-1}) which was identical to that obtained with 70% of NPKS with 6 t ha^{-1}dhaincha. In case of straw yield, the treatment T_7 (70% NPKS+6 t ha^{-1} DH) produced the highest yield (5470 kg ha^{-1}) and then (5250 kg ha^{-1}) yield obtained from T_6 (50% NPKS+10 t ha^{-1} DH) treatment. The grain yield increases over control ranges between 115 to 176%. The overall findings of this study indicate that the integrated use of fertilizer and manure should be encouraged to address the deteriorating soil fertility and increased crop yield.

Biswas *et al*. (2016) conducted an experiment to evaluate the integrated use of poultry manure with prilled urea and USG for improving the growth, yield and protein content of aromatic Boro rice (cv. BRRI dhan50). The experiment comprised 14 treatments *viz*. control (no manure and no fertilizer), recommended dose of prilled urea (115 kg N ha^{-1}), urea super granules (USG) 1.8 g (55 kg N ha^{-1}), USG 2.7 g (80 kg N ha^{-1}), poultry manure (PM) 2.5 t ha^{-1}, PM 5 t ha^{-1}, recommended dose of prilled urea + PM 2.5 t ha^{-1}, recommended dose of prilled urea + PM 5 t ha^{-1}, 50% of recommended dose of prilled urea + PM 2.5 t ha^{-1}, 50% of recommended dose of prilled urea + PM 5 t ha^{-1}, USG 1.8 g + PM 2.5 t ha^{-1}, USG 1.8 g + PM 5 t ha^{-1}, USG 2.7 g + PM 2.5 t ha^{-1} and USG 2.7 g + PM 5 t ha^{-1}. USG 2.7 g + PM 5 t ha^{-1} gave the highest plant height, number of tillers $hill^{-1}$ and total dry matter production at all sampling dates while their corresponding lowest values were recorded in control. The highest yield contributing characters *viz*.

number of effective tillers hill^{-1} (13.08), grains panicle^{-1} (124.26g) and 1000- grain weight (21.41g) were recorded in USG 2.7 g + PM 5 t ha^{-1} and the lowest values were recorded in control. The highest grain yield (5.33 t ha^{-1}) and protein content (7.49%) were obtained at USG 2.7 g + PM 5 t ha^{-1} which was as good as recommended dose of prilled urea (115 kg N ha^{-1}) + PM 5 t ha^{-1}, USG 2.7 g + PM 2.5 t ha^{-1}, USG 1.8 g + PM 5 t ha^{-1}, recommended dose of prilled urea (115 kg N ha^{-1}) + PM 2.5 t ha^{-1} while the lowest one (2.00 t ha^{-1}) was obtained in control plots.

Mahmud *et al*. (2016) carried out an experiment to study the effect of vermicompost and chemical fertilizers on the growth and yield components in rice (BRRI dhan29). The treatments of vermicompost were given in 4 levels (0.0, 1.0, 2.0 and 4.0 t ha^{-1}) and 4 levels of chemical fertilizers (0-0-0-0, 50-8-33-6, 100-16-66-12 and 150-24-99-18 kg N, P, K and S ha^{-1}, respectively). Results showed that application of medium level of chemical fertilizer with 4 t ha^{-1} vermicompost 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, panicle 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.

Puli *et al*. (2016) carried out an experiment to study the effect of organic and inorganic sources of nutrients on rice consisted of 4 treatments *viz*. M_1 (recommended dose of fertilizers (RDF) - Control), M_2 (10 t farmyard manure (FYM) ha^{-1} + RDF), M_3 (1.5 t vermicompost ha^{-1} + RDF), M_4 (Green manuring + RDF). The yield of crop was significantly increased with the application of 100% NPK in combination with FYM @ 10 t ha^{-1}. However, it was at par with green manuring along with the application of 100% RDF (NPK).

Sohel *et al*. (2016) conducted a field experiment to evaluate the integrated effect of cowdung, poultry manure and water hyacinth with chemical fertilizers on the growth and yield of Boro rice (cv. BRRI dhan29). Among the yield contributing characters studied plant height, effective tillers hill^{-1}, panicle length and filled grains panicle^{-1} were varied significantly by the different treatments. Most of the yield contributing characters influenced positively in treatment having quarter doses of cowdung, 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 treatmentT6 (1/3 Cow dung + 1/3 Poultry Manure + 1/3 water hyacinth + Fertilizers) over other treatments.

Das *et al*. (2015) investigated the effect of combined application of organic and inorganic fertilizers on the growth and yield of rice (IR-36 variety). The study was conducted in a split-plot design with three replications, with fertilizer treatments (control, recommended dose of inorganic fertilizer, and combined application of inorganic and organic fertilizers) as the main plot, and water management (continuous flooding and intermittent flooding) as the sub-plot. The results showed that the combination of organic and inorganic fertilizers had a positive effect on the yield of rice, plant height, and number of tillers per plant. The treatment with combined application of organic and inorganic fertilizers produced the highest yield.

Redda and Abay (2015) conducted an experiment to evaluate the effect of integrated application of inorganic fertilizers and FYM on yield and yield components of upland rice (variety: NERICA-3). The experiment consisting of four levels of inorganic fertilizers (0, 25, 50 and 75 kg/ha) and three levels of FYM (0, 6 and 9 t/ha). The results revealed that application of 9 t/ha FYM with 75 kg/ha of IF (inorganic fertilizer) resulted in grain yield of 44.4 q/ha and delayed flowering and maturity by about 14.67 days and 20.33 days respectively.

Sarker *et al*. (2015) conducted an experiment consisted of T_1: 100% Inorganic fertilizer (Recommended dose) + 5 ton poultry manure (PM)/ha , T_2: 75 % N of recommended dose + 5 ton PM/ha, T_3: 50 % N of recommended dose + 5 ton PM/ha, T_4: 25 % N of recommended dose + 5 ton PM/ha, T_5: 75 % S of recommended dose + 5 ton PM/ha, T_6: 50 % S of recommended dose + 5 ton PM/ha, T_7: 25 % S of recommended dose + 5 ton PM/ha, T_8: 100% Inorganic fertilizer and T_9: 5 ton PM/ha treatments to study the effect of various combinations of organic manure and inorganic fertilizer on the growth, yield, chlorophyll and nutrient content of rice var. BRRI dhan33. The most of the growth parameters (plant height, leaf length and diameter, leaf number and total tiller plant^{-1}) results were found better in 100% Inorganic fertilizer + 5 ton PM ha^{-1} which was statistically similar with 75 % of recommended dose of S + 5 ton PM ha^{-1}, 75 % of recommended dose of N + 5 ton PM ha^{-1} and followed by 50 % of recommended dose of S + 5 ton PM ha^{-1}, respectively while the lowest from 5 ton/ha PM treatment. Number of effective tillers plant^{-1}, panicle length, number of rachis plant^{-1}, filled grain plant^{-1} and fresh weight of plant were highest in 100% Inorganic fertilizer + 5 ton PM/ha and it was either statistically similar or closely followed by 75 % of recommended dose of S + 5 ton PM ha^{-1}. Higher grain yield (4.18 t ha^{-1}) was recorded in T_1 which was statistically similar with T_5 (4.13 t ha^{-1}) whereas lowest grain yield (3.67 t ha^{-1}) was from sole PM.

Islam *et al*. (2015) investigated the effect of combined application of organic and inorganic fertilizers on the growth and yield of hybrid rice (BRRI Hybrid Dhan1 variety). The study was conducted in a split-plot design with three replications, with two main plots (control and recommended dose of inorganic fertilizer) and two sub-plots (combined application of inorganic and organic fertilizers). The results showed that the combined application of organic and inorganic fertilizers significantly increased the grain yield and biomass of hybrid rice compared to the individual application of either organic or inorganic fertilizers.

Arif *et al*. (2014) evaluated the farmyard manure, poultry manure, rice straw, sesbania, compost and mungbean residues alone and in combinations with 50% of recommended dose of fertilizer (RDF) on the yield of rice. Recommended dose of fertilizer (150-90-60 kg NPK/ha) and control treatments were also included in the experiment. Maximum number of fertile tillers per plant (16.79), number of panicles per hill (8.41), 1000- grain weight (21.12 g), biological yield (10.19 t/ha), grain yield (4.47 t/ha) and harvest index (43.76%) were recorded from the plots receiving poultry manure @ 10 t/ha in combination with 50% of RDF. This was followed by 100% RDF.

Gathala*et al*. (2014) conducted a study to determine the effect of combined application of organic and inorganic fertilizers on rice yield, soil properties, and nutrient uptake under rice-wheat system in the Indo-Gangetic plain (Pusa Basmati 1 variety). The study was conducted in a randomized complete block design with three replications, with six treatments (control, recommended dose of inorganic fertilizer, and combinations of inorganic and organic fertilizers) in each block. The study showed that the combined application of organic and inorganic fertilizers resulted in a significantly higher grain yield and nutrient uptake in comparison to individual fertilizer applications.

Sarkar *et al*. (2014) evaluated 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 to study the yield and quality. 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).

Islam *et al*. (2013) carried out a study to evaluate the effect of fertilizer and manure with different water management on the growth, yield and nutrient concentration of BRRI dhan28. Two irrigation levels (I_0= Alternate wetting and drying, I_1= Continuous flooding) were combined with 8 fertilizer treatments (T_0: control, T_1: 100% RDCF, ($N_{100}P_{15}K_{45}S_{20}Zn_2$), T_2: 10-toncowdung/ha, T_3: 50% RDCF + 5-toncowdung/ha, T_4: 8-ton poultry manure/ha, T_5: 50% RDCF + 4-ton poultry manure/ha, T_6: 10 ton vermicompost/ha, T_7: 50% RDCF + 5 ton vermicompost/ha). The T_5 (50% RDCF + 4-ton poultry manure/ha) treatment showed the highest effective tillers/hill, plant height, panicle length, filled grains per panicle, 1000 grain weight, grain yield and straw yield. The higher grain and straw yields were obtained from organic manure plus inorganic fertilizers than full dose of chemical fertilizer and manure. The highest grain (5.93 kg/plot) and straw yields (6.42 kg/plot) were recorded from I_0T_5 (Alternate wetting and drying + 50% RDCF plus 4-ton poultry manure/ha) and the lowest was found in I_1T_0 (Continuous flooding + control treatment) treatment combination. The levels of organic matter and nutrient concentration were increased in the post-harvest soils due to added manure plus inorganic fertilizer.

Farid *et al*. (2011) carried out a field experiment to study the combined effect of cowdung, poultry manure, dhaincha and chemical fertilizers on the yield and nutrient uptake of BRRI dhan 41. The treatments were 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}. It was observed that the 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).

CHAPTER III

MATERIALS AND METHODS

The experiment was carried out at the experimental field under the Department of Soil Science of Sher-e-Bangla Agricultural University, Dhaka during the period November 2021 to May 2022 to study Effect of organic and inorganic fertilizer application on rice production (BRRI dhan28). Details of different materials used and methodologies followed to conduct the studies are presented in this chapter.

3.1 Site description

The experiment was conducted at the Sher-e-Bangla Agricultural University research field, 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 kharifseason (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 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. The analyses were done by Soil Resources and Development Institute (SRDI), Dhaka. The physicochemical properties of the initial soil are presented in Appendix III.

3.4 Treatments

Single factor experiment consisting seven treatments of organic and inorganic combination including control was considered for the present study which was as follows:

1. T_1 = control (0% organic or inorganic)
2. T_2 = 100% RDCF ($N_{100}P_{15}K_{45}S_{20}Zn_3$ kg ha^{-1})
3. T_3 = only poultry manure- 5.4 t/ha (100% N)
4. T_4 = only vermicompost 8 t/ha (100% N)
5. T_5 = 50% RDCF (50% NPKSZn kg ha^{-1}; 50% N) + 50% poultry manure (2.7 t/ha)
6. T_6 = 50% RDCF (50% NPKSZn kg ha^{-1}) + 50% vermicompost (4 t/ha)
7. T_7 = 25% RDCF (25% NPKSZn kg ha^{-1}) + 75% poultry manure(4.05 t/ha)
8. T_8 = 25% RDCF (25% NPKSZn kg ha^{-1}) + 75% vermicompost (6 t/ha)

N.B. Analytical Value of Poultry Manure and Vermicompost

Organic Matter	Nitrogen %	Phosphorus %	Potassium %	Sulphur %
Poultry Manure	1.90	1.60	1.65	1.55
Vermicompost	1.25	1.28	1.45	1.02

3.5 Plant materials and collection of seeds

The rice variety BRRI dhan28 was used as plant materials for the present study. The seeds of this variety were collected from Bangladesh Rice Research Institute, Joydebpur, Gazipur, Bangladesh.

3.6 Seed sprouting

Healthy seeds were stored in water bucket for 24 hours and then it was kept tightly in gunny bags. The seeds started sprouting after 48 hours and were sown after 72 hours.

3.7 Preparation of nursery bed and seed sowing

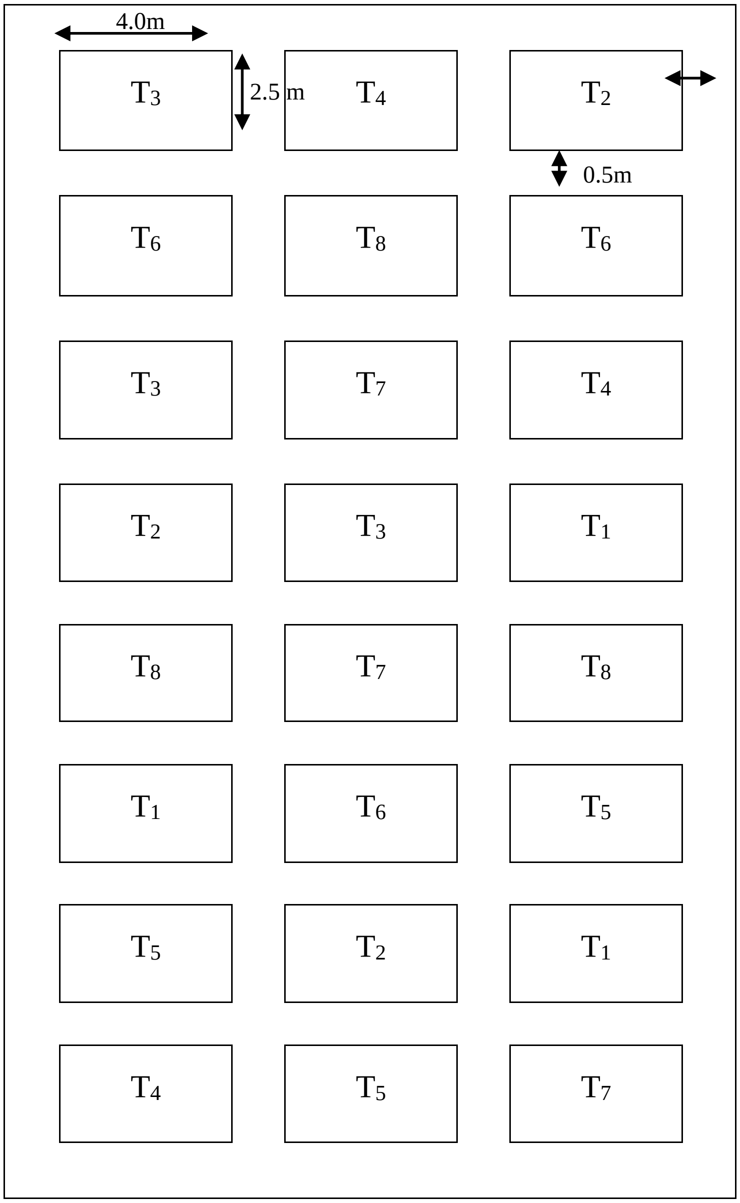
As per BRRI recommendation, seedbed was prepared with 1 m wide adding nutrients as per requirements of soil. Seeds were sown in the seed bed on 30 November, 2021 in order to transplant the seedlings in the main field.

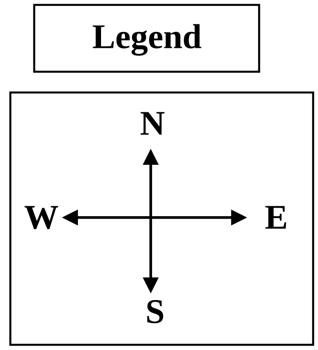
3.8 Preparation of experimental land

The plot selected for the experiment was opened in the first week of January 2022 with a power tiller, and was exposed to the sun for a week, after which the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain a good tilth. Weeds and stubble were removed, and finally obtained a desirable field for transplanting of the seedlings. Finally, the land was prepared for transplanting of seedlings on 9 January 2022.

3.9 Experimental design and layout

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications (block). At first the experiment plot was divided in to three equal blocks. Each block was then divided into 8 sub plots where different treatments were assigned. Thus, the total number of unit plots was 8×3=24. The size of the unit plot was 4m × 2.5m. The distance maintained between the row was 0.5m and between column was 0.5m. The treatments (varieties) were randomly assigned to the plots within each block. The layout of the experimental design is shown in Figure 1.





Treatments

T_1 = control (0% organic or inorganic)

T_2 = 100% RDCF ($N_{100}P_{15}K_{45}S_{20}Zn_3$ kg ha^{-1})

T_3 = only poultry manure (100% N)

T_4 = only vermicompost (100% N)

T_5 = 50% RDCF (50% NPKSZn kg ha^{-1}) + 50% poultry manure

T_6 = 50% RDCF (50% NPKSZn kg ha^{-1}) + 50% vermicompost

T_7 = 25% RDCF (25% NPKSZn kg ha^{-1}) + 75% poultry manure

T_8 = 25% RDCF (25% NPKSZn kg

Fig.1. Layout of the experimental plot

3.10 Fertilizer application

The following doses of fertilizer were applied for cultivation of crop as recommended by BRRI, 2016.

Fertilizer	Recommended doses ha^{-1}	Experimental treatments
Poultry manure	5.4 t	As per treatment
Vermicompost	8 t	As per treatment
Urea	260 kg	As per treatment
TSP	88 kg	As per treatment
MoP	112 kg	As per treatment
Zinc sulphate	7 kg	As per treatment
Gypsum	111 kg	As per treatment

The fertilizers N, P, K, S and Zn in the form of urea, TSP, MP, gypsum and zinc sulphate, respectively were applied. The entire amount of TSP, MP, and gypsum and zinc sulphate was applied during the final preparation of land. Mixture of poultry manure or vermicompost was applied at the rate of 5.4- or 8-ton ha^{-1}, respectively during 15 days before transplanting. Urea was applied in three equal installments at seedling establishment, tillering and before panicle initiation.

3.11 Uprooting of seedlings

The nursery bed was made wet by application of water one day before uprooting the seedlings. The seedlings were uprooted on 9 January, 2022 without causing much mechanical injury to the roots.

3.12 Transplanting of seedlings in the field

The seedlings were transplanted in the main field on 10^{th} January, 2022 with a spacing 15 cm from hill to hill and 20 cm from row to row.

3.13 Intercultural operations

After establishment of seedlings, various intercultural operations were accomplished for better growth and development of the rice seedlings.

3.13.1 Irrigation and drainage

Flood irrigation was given to maintain a constant level of standing water up to 3 cm at the early stages to enhance tillering and 4-5 cm in the later stage to discourage late tillering. The field was finally dried out at 15 days before harvesting.

3.13.2 Gap filling

Gap filling was done for all of the plots at 10 days after transplanting (DAT) by planting same aged seedlings.

3.13.3 Weeding

The crop was infested with some common weeds, which were controlled by uprooting and remove them three times from the field during the period of experiment. Weeding was done after 16, 34 and 54 days of transplanting.

3.13.4 Plant protection

There were some incidences of insects specially stem borer which was controlled by Furadan 5G @ 10 kg ha^{-1} at 30 days after transplanting. Brown spot of rice was controlled by spraying tilth.

3.14 Harvesting, threshing and cleaning

The rice plant was harvested depending upon the maturity of the plant on 13 May 2022 and harvesting was done manually from each plot. The harvested crop of each plot was bundled separately, properly tagged and brought to threshing floor. Enough care was taken for harvesting, threshing and also cleaning of rice seed. Fresh weight of grain and straw were recorded plot wise. The grains were cleaned and finally the weight was adjusted to a moisture content of 12%. The straw was sun dried and the yields of grain and straw plot^{-1} were recorded and converted to ton ha^{-1}.

3.15 General observation of the experimental field

The field was observed time to time to detect visual difference among the treatments and any kind of infestation by weeds, insects and diseases so that considerable losses by pest was minimized.

3.16 Recording of data

The following data were recorded during the study period:

3.16.1 Growth parameters

1. Plant height (cm)
2. Number of tillers hill^{-1}

3.16.2 Yield contributing parameters

1. Total number of effective tillers hill^{-1}
2. Number of non-effective tillers hill^{-1}
3. Flag leaf length (cm)
4. Number of filled grains panicle^{-1}
5. Number of unfilled grains panicle^{-1}
6. Panicle length (cm)
7. 1000 grain weight (g)

3.16.3 Yield parameters

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

3.16.4 Soil analysis

1. pH
2. Soil Organic carbon content
3. Available Nitrogen
4. Available phosphorus
5. Exchangeable Potasium
6. Available sulphur
7. Available Zinc

3.17 Procedures of recording data

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

3.17.1 Plant height

The height of plant was recorded in centimeter (cm) at the time of 50, 90 DAT and at 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 plant.

3.17.2 Number of tillers hill^{-1}

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 plants pre-selected at random from the inner rows of each plot. Number of tillers hill^{-1} was recorded at 50, 90 DAT and at harvest.

3.17.3 Number of effective tillers hill^{-1}

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

3.17.4 Number of non-effective tillers hill^{-1}

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

3.17.5 Flag leaf length (cm)

Flag leaf length was measured with a meter scale from 5 pre-selected plants from the inner rows of each plot.

3.17.6 Number of filled grains panicle^{-1}

The total number of filled grains was collected from panicles of randomly selected 5 hills of a plot and then average number of filled grains panicle-1 was recorded.

3.17.7 Number of unfilled grains panicle^{-1}

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

3.17.8 Panicle length (cm)

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

3.17.9 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 12% moisture and the mean weight was expressed in gram.

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

Grain from each plot area was thoroughly sun dried till constant weight was attained. Then yield per hectare was determined based on net plot area.

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

After separation of grains from plants of each plot the straw was sun dried till a constant weight is obtained and expressed as t ha^{-1}.

3.17.12 Biological yield (t ha^{-1})

Biological yield was calculated by the summation of grain yield and straw yield.

Biological yield = grain yield + straw yield

3.17.13 Harvest index (%)

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

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

Biological yield = Grain yield + Straw yield

3.17.13 Soil analysis

The soil samples were analyzed by the following standard methods as follows:

3.17.13.1 **pH**

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)

3.17.13.2 **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 1N $FeSO_4$. 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

3.17.13.3 Analysis of N, P, K and Zn of post harvest soil

Chemical analysis was done in the Soil Science Laboratory following the procedure of nutrient content measurement in fruit regarding nitrogen (N), phosphorus (P), potassium (K) and zinc (Zn).

Preparation of soil samples for chemical analysis

Soil samples were collected at the time of final harvest. The samples were dried in an oven at 70°C for 72 hours and finally grounded by using a Wiley-Mill with stainless contact points to pass through a 60-mesh sieve. The samples were stored in plastic vials.

Digestion of samples with sulphuric acid forN

For the determination of nitrogen an amount of 0.2 g oven dry, ground soil sample were taken in a micro kjeldahl flask. 1.1 g catalyst mixture (K_2SO_4: $CuSO_4.5H_2O$: Se in the ratio of 100: 10: 1), and 5 ml conc. H_2SO_4were added. The flasks were heating at 120^0C and added 2.5 ml 30% H_2O_2then heated was continued at 180^0C until the digests became clear and colorless. After cooling, the content was taken into a 100 ml volumetric flask and the volume was made up to the mark with de-ionized water. A reagent blank was prepared in a similar manner. Nitrogen in the digest was estimated by distilling the digest with 10 N NaOH followed by titration of the distillate trapped in H_3BO_3indicator solution with 0.01NH_2SO_4.

Digestion of samples with nitric-perchloric acid for P, K and, Zn

A sub soil sample weighing 0.5 g was transferred into a dry, clean 100 ml digestion vessel. Ten ml of di-acid (HNO_3: $HClO_4$in the ratio 2:1) mixture was added to the flask. After leaving for a while, the flasks were heated at a temperature slowly raised to 200^0C. Heating were stopped when the dense white fumes of $HClO_4$occurred. The content of the flask was boiled until they were becoming clean and colorless. After cooling, the content was taken into a 100 ml volumetric flask and the volume was made up to the mark with de-ionized water. P, K, Zn and B were determined from thisdigest.

Determination of nitrogen (%)

Oven dried of soil samples were grinded in a Mill passed through 40 mesh screen, mixed well and stored in plastic vials. For the determination of N an amount of 1 g oven dry grined sample were taken in a micro Kjeldahl flask. One gram catalyst mixture (K_2SO_4; $CuSO_4.5H_2O$ in the ratio of 100:10:1) and 10 ml conc. H_2SO_4 were added. The flasks were heated at 160°C and added 2 ml H_2O_2 than heating was continued at 360°C until digests become clear and colorless.

After cooling the content was taken into a 100 ml volumetric flask and the volume was made up to the mark with de-ionized water. A reagent blank was prepared in a similar manner. Nitrogen in the digest was estimated by distilling with 10N NaOH followed by titration of the distillate trapped in H_3BO_3 indicator solution with 0.01N H_2SO_4.

The amount of nitrogen was calculated using the following formula:

$$\% N = (T-B) \times N \times 0.014 \times 100/S$$

Where,

T = Sample titration (ml) value of standard H_2SO_4

B = Blank titration (ml) value of standard H_2SO_4

N = Strength of H_2SO_4

S = Sample weight (g)

Determination of P, K and Zn from samples

Phosphorus determination

Phosphorus was digested from the soil sample with 0.5M $NaHCO_3$solutions, pH 8.5(Olsen*etal.*, 1954).Phosphorus in the digest was determined by using 1 ml for soil sample from 100 ml extract was then determined by developing blue color with reduction of phosphomolybdate complex and the color intensity were measured calorimetrically at 660 ηm wavelength and readings were calibrated with the standard P curve (Page *et al*., 1982).

Potassium determination

Five milli-liter of digest sample for the soil was taken and diluted 50 ml volume to make desired concentration so that the absorbance of sample were measured within the range of standard solutions. The absorbance was measured by atomic absorption flame photometer.

Zinc determination

Zinc content was determined from the digest of the soil or fruit samples (with $BaCl_2$solution as described by Page *et al*., 1982. The digested Zn was determined by developing turbidity by adding $ZnCl_2$soil solution. The intensity of turbidity was measured by spectrophotometer at 420 ηm wavelengths (Hunter,1984).

Available sulphur determination

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).

3.18 Statistical analysis

Collected data from the experiment field were statistically analyzed to find out the significant difference among the treatment by using the MSTAT-C computer package program. The mean values of all the characters were calculated and analysis of variance was performed. The significance of the difference among the treatments means was estimated by the Least Significant Difference Test (LSD) at 5% level of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

This study was conducted to explore the comparative effectiveness of organic and inorganic fertilizer application on rice production (BRRI dhan29).Data were collected on different growth, yield and yield contributing parameters and present in this chapter through different Tables and Graph. The results and discussion and also possible interpretations have been given under the following headings:

4.1 Growth parameters

4.1.1 Plant height (cm)

Different doses of organic manure (vermicompost or poultry manure) and inorganic fertilizers (NPKSZn) combinations showed significant influence on plant height of rice (Table 1 and Appendix IV). Results indicated that at harvest, the treatment T_2 (100% RDCF; $N_{100}P_{15}K_{45}S_{20}Zn_3$ kg ha^{-1})gave the maximum plant height (92.12 cm) which was statistically similar with the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost) and T_5 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% poultry manure) (91.60 and 90.47 cm, respectively) whereas the control treatment T_1 (no organic or inorganic fertilizer) gave the minimum plant height (81.40 cm) which was significantly different from other treatments.Similar result was observed by Singh *et al*. (2018), Biswas *et al*. (2016), Mahmud *et al*. (2016) and Islam *et al*. (2013) who observed higher plant height of rice with organic and inorganic fertilizer combination compared to control.

Table 1. Effect of organic and/or inorganic fertilizers on plant height of BRRI dhan28 at different growth stages

Treatments	Plant height (cm)
	At harvest
T_1	81.40 f
T_2	92.12 a
T_3	84.88 e
T_4	85.23 de
T_5	90.47 ab
T_6	91.60 a
T_7	87.14 cd
T_8	88.72 bc
$LSD_{0.05}$	2.223
CV(%)	9.71

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 = control (0% organic or inorganic), T_2 = 100% RDCF ($N_{100}P_{15}K_{45}S_{20}Zn_3$ kg ha^{-1}), T_3 = only poultry manure (100% N), T_4 = only vermicompost (100% N), T_5 = 50% RDCF (50% NPKSZn kg ha^{-1}; 50%N) + 50% poultry manure, T_6 = 50% RDCF (50% NPKSZn kg ha^{-1}) + 50% vermicompost, T_7 = 25% RDCF (25% NPKSZn kg ha^{-1}) + 75% poultry manure, T_8 = 25% RDCF (25% NPKSZn kg ha^{-1}) + 75% vermicompost (75% N)

4.1.2 Number of tillers hill^{-1}

Different rates of organic manures and inorganic fertilizers combinations showed significant influence on number of tillershill^{-1}at harvest (Table 2 and Appendix V). Results showed that at harvest, it was found thatthe highest number of tillers hill^{-1} (17.24) was achieved from the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost) which was statistically similar to the treatmentT_5 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% poultry manure)the lowest number of tillers hill^{-1}(10.84) was found from the control treatment T_1 (no organic or inorganic fertilizer) which differed significantly from other treatments.It is evident that yield of rice can be increase significantly with the combined use of organic manures and chemical fertilizers. Alam *et al*. (2021) also observed higher number of tillers hill^{-1} with vermicompost and inorganic fertilizers treatment. Similar result was also observed by Islam *et al*. (2013) and Mahmud *et al*. (2016).

Table 2. Effect of organic and/or inorganic fertilizer on number of tillers hill^{-1} of BRRI dhan28 at different growth stages

Treatments	Number of tillers hill^{-1}
	At harvest
T_1	10.84 e
T_2	14.92 c
T_3	12.88 d
T_4	13.67 d
T_5	16.48 ab
T_6	17.24 a
T_7	15.48 bc
T_8	15.62 bc
$LSD_{0.05}$	1.068
CV(%)	7.44

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 = control (0% organic or inorganic), T_2 = 100% RDCF ($N_{100}P_{15}K_{45}S_{20}Zn_3$ kg ha^{-1}), T_3 = only poultry manure (100% N), T_4 = only vermicompost (100% N), T_5 = 50% RDCF (50% NPKSZn kg ha^{-1}; 50%N) + 50% poultry manure, T_6 = 50% RDCF (50% NPKSZn kg ha^{-1}) + 50% vermicompost, T_7 = 25% RDCF (25% NPKSZn kg ha^{-1}) + 75% poultry manure, T_8 = 25% RDCF (25% NPKSZn kg ha^{-1}) + 75% vermicompost (75% N)

4.2 Yield contributing parameters

4.2.1 Number of effective tillers $hill^{-1}$

Significant difference was found among different combinations of organic and inorganic fertilizers on number of effective tillers $hill^{-1}$of rice(Table 3 and Appendix VI). It was observed that the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost)gave the highest number of effective tillers $hill^{-1}$(15.87) which was statistically similar to the treatment T_5 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% poultry manure) (15.24). Andthe lowest number of effective tillers $hill^{-1}$(7.92) was in the control treatment T_1 (no organic or inorganic fertilizer.Treatment T_3 (only poultry manure; 100% N) and T_4 (only vermicompost; 100% N) also produced lower number of effective tillers $hill^{-1}$ (11.63 and 12.20, respectively) butitwas significantly higher than control treatment T_1 (no organic or inorganic fertilizer).Biswas *et al*. (2016), Mahmud *et al*. (2016) and Sohel *et al*. (2016) reported the higher effective tillers with the integrated use of organic and inorganic fertilizers compared to control or organic or inorganic fertilizer alone.

4.2.2 Number of non-effective tillers $hill^{-1}$

Application of organic and inorganic fertilizers combinations showed non-significant variation on number of non-effective tillers $hill^{-1}$of rice (Table 3 and Appendix VI). However, the treatment T_8 (25% RDCF; 25% NPKSZn kg ha^{-1} + 75% vermicompost)gave the lowest number of non-effective tillers $hill^{-1}$ (1.14) whereas the control treatment T_1 (no organic or inorganic fertilizer) showed the highest number of non-effective tillers $hill^{-1}$(2.92).Similar result was also observed by the findings of Biswas *et al*. (2016) and Mahmud *et al*. (2016).

4.2.3 Flag leaf length (cm)

Flag leaf length of rice differed significantly due to different doses of organic and inorganic fertilizers treatments(Table 3 and Appendix VI). It was observed that the highest flag leaf length (21.64 cm) was given by the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost)which was statistically similar to the treatment T_5 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% poultry manure) and T_8 (25% RDCF; 25% NPKSZn kg ha^{-1} + 75% vermicompost). Respectively The treatment T_2 (100% RDCF; $N_{100}P_{15}K_{45}S_{20}Zn_3$ kg ha^{-1}) and T_7 (25% RDCF; 25% NPKSZn kg ha^{-1} + 75% poultry manure)also showed comparatively higher flag leaf length (19.04 and 19.18 cm, respectively) but significantly differed withT_5 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% poultry manure).

Table 3. Effect of organic and/or inorganic fertilizer on effective and non-effective tillers $hill^{-1}$ and flag leaf length of BRRI dhan28

Treatments	Yield contributing parameters		
	Number of effective tillers $hill^{-1}$	Number of non-effective tillers $hill^{-1}$	Flag leaf length (cm)
T_1	7.92 f	2.92 a	15.63 d
T_2	13.36 d	1.56 a	19.04 bc
T_3	11.63 e	1.25 a	18.27 c
T_4	12.20 e	1.47 a	18.52 c
T_5	15.24 ab	1.24 a	20.92 a
T_6	15.87 a	1.37 a	21.64 a
T_7	13.88 cd	1.60 a	19.18 bc
T_8	14.48 bc	1.14 a	20.33 ab
$LSD_{0.05}$	0.905	2.153^{NS}	1.403
CV(%)	8.57	4.18	9.73

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 = control (0% organic or inorganic), T_2 = 100% RDCF ($N_{100}P_{15}K_{45}S_{20}Zn_3$ kg ha^{-1}), T_3 = only poultry manure (100% N), T_4 = only vermicompost (100% N), T_5 = 50% RDCF (50% NPKSZn kg ha^{-1}; 50%N) + 50% poultry manure, T_6 = 50% RDCF (50% NPKSZn kg ha^{-1}) + 50% vermicompost, T_7 = 25% RDCF (25% NPKSZn kg ha^{-1}) + 75% poultry manure, T_8 = 25% RDCF (25% NPKSZn kg ha^{-1}) + 75% vermicompost (75% N)

The lowest flag leaf length (15.63 cm) was registered by the control treatment T_1 (no organic or inorganic fertilizer) which was significantly different from other treatments. Higher flag leaf length with combined application of organic manure (vermicompost) and chemical fertilizer compared to sole application of organic or chemical fertilizer was also found by Mahmud *et al*. (2016) which was similar with the present study.

4.2.4 Number of filled grains panicle^{-1}

Different combinations of organic and inorganic fertilizers showed significant variation on number of filled grains panicle^{-1}of rice (Table 4 and Appendix VII). Results revealed that the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost)gave the maximum number of filled grains panicle^{-1} (129.20) which was statistically similar with the treatment T_5 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% poultry manure) (126.50). The minimum number of filled grains panicle^{-1} (110.40) was recorded from the control treatment T_1 (no organic or inorganic fertilizer) which was statistically similar to the treatment T_3 (only poultry manure; 100% N).According to Islam *et al*. (2013) and Sarker *et al*. (2015), combining organic fertilizers with inorganic fertilizers has been shown to improve soil structure, optimize nutrient exchange, and maintain soil health. This indicates a higher grain yield by achieving a greater number of filled grains per panicle.

4.2.5 Number of unfilled grains panicle^{-1}

Organic and inorganic fertilizers combinations at different rates showed significant variation on number of unfilled grains panicle^{-1}of rice (Table 4 and Appendix VII). The lowest number of unfilled grains panicle^{-1} (5.78) was found from the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost) which was statistically similar to T_5 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% poultry manure) (5.87), T_7 (25% RDCF; 25% NPKSZn kg ha^{-1} + 75% poultry manure) (6.33) and T_8 (25% RDCF; 25% NPKSZn kg ha^{-1} + 75% vermicompost) (6.18). The highest number of unfilled grains panicle^{-1}(9.88) was recorded from the control treatment T_1 (no organic or inorganic fertilizer)followed by T_3 (only poultry manure; 100% N) (7.67) and T_4 (only vermicompost; 100% N) (7.36).

Table 4. Effect of organic and/or inorganic fertilizer on filled and unfilled grains panicle^{-1}, panicle length and 1000 seed weight of BRRI dhan28

Treatments	Yield contributing parameters			
	Number of filled grains panicle^{-1}	Number of unfilled grains panicle^{-1}	Panicle length (cm)	1000 grain weight (g)
T_1	110.40 e	9.88 a	16.65 e	21.18 a
T_2	119.80 cd	6.84 bc	23.10 b	21.40 a
T_3	114.90 de	7.67 b	19.48 d	21.30 a
T_4	117.80 cd	7.36 b	20.62 c	21.33 a
T_5	126.50 ab	5.87 d	23.18 ab	21.67 a
T_6	129.20 a	5.78 d	23.52 a	21.70 a
T_7	120.40 cd	6.33 cd	22.87 b	21.52 a
T_8	122.80 bc	6.18 cd	22.94 b	21.47 a
$LSD_{0.05}$	5.524	0.964	0.396	1.020^{NS}
CV(%)	10.65	5.27	8.93	3.14

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 = control (0% organic or inorganic), T_2 = 100% RDCF ($N_{100}P_{15}K_{45}S_{20}Zn_3$ kg ha^{-1}), T_3 = only poultry manure (100% N), T_4 = only vermicompost (100% N), T_5 = 50% RDCF (50% NPKSZn kg ha^{-1}; 50%N) + 50% poultry manure, T_6 = 50% RDCF (50% NPKSZn kg ha^{-1}) + 50% vermicompost, T_7 = 25% RDCF (25% NPKSZn kg ha^{-1}) + 75% poultry manure, T_8 = 25% RDCF (25% NPKSZn kg ha^{-1}) + 75% vermicompost (75% N)

4.2.6 Panicle length (cm)

Panicle length of rice differed significantly by different levels of organic and inorganic fertilizers combinations (Table 4 and Appendix VII). Results indicated that the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost)gave the highest panicle length (23.52 cm) which was statistically similar to the treatmentT_5 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% poultry manure) (23.18 cm). Treatment T_2 (100% RDCF; $N_{100}P_{15}K_{45}S_{20}Zn_3$ kg ha^{-1}), T_7 (25% RDCF; 25% NPKSZn kg ha^{-1} + 75% poultry manure) and T_8 (25% RDCF; 25% NPKSZn kg ha^{-1} + 75% vermicompost) also performed better in producing higher panicle lengthbut it was lower than T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost). The lowest panicle length (16.65 cm) was recorded from the control treatment T_1 (no organic or inorganic fertilizer) which was significantly different from other treatments. According to Arif *et al*. (2014), panicle length increased with the application of organic and chemical fertilizers and this could be due to the increase in the absorption of available nutrients. Similar result was also observed by the findings of Jahan *et al*. (2019) who reported that the combined application of organic and inorganic fertilizers (50% RDF + 50% vermicompost) significantly increased the panicle length of rice in comparison to individual fertilizer application.

4.2.7Weight of 1000 seeds

Application of different doses of organic manure and inorganic fertilizers showedno significant variation on 1000 seed weight of rice (Table 4 and Appendix VII). However, result revealed that the maximum 1000 seed weight (21.70 g) was given by the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost)whereas thelowest 1000 seed weight (21.18 g) was found inthe control treatment T_1 (no organic or inorganic fertilizer).Alam *et al*. (2021) and Ahmed *et al*. (2017) also achieved higher 1000 grain weight with combined application of organic and inorganic fertilizers in comparison to individual fertilizer application.

4.3 Yield parameters

4.3.1 Grain yield ha^{-1}

Grain yield of rice differed significantly due to different doses of organic and inorganic fertilizers combinations (Table 5 and Appendix VIII). It was observed that the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost)gave the highest grain yield (5.32 t ha^{-1}) which was statistically identical to the treatment T_5 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% poultry manure) (5.24 t ha^{-1}). Treatment T_7 (25% RDCF; 25% NPKSZn kg ha^{-1} + 75% poultry manure) and T_8 (25% RDCF; 25% NPKSZn kg ha^{-1} + 75% vermicompost) also showed statistically similar resulton grain yield (5.02 and 5.13 t ha^{-1}, respectively) with T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost). The lowest grain yield (3.12 t ha^{-1}) was obtainedfrom the control treatment T_1 (no organic or inorganic fertilizer). These results indicated that integrating organic and inorganic fertilizers enhanced growth parameters and yields of rice. Alam *et al*. (2021), Jahan *et al*. (2019) and Ahmed *et al*. (2017) similar result with the present study who reported combination of organic and inorganic fertilizers had a significant positive effect on effective tiller number, panicle length, filled grain per panicle, 1000 grain weight which resulted higher grain yield compared to sole application of organic or inorganic fertilizers.

Table 5. Effect of organic and/or inorganic fertilizer on yield parameters of BRRI dhan28

Treatments	Yield parameters			
	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
T_1	3.21 d	4.83 c	8.04 e	39.93 d
T_2	4.88 b	5.92 a	10.80 c	45.19 b
T_3	4.03 c	5.22 b	9.25 d	43.57 c
T_4	4.16 c	5.36 b	9.52 d	43.70 c
T_5	5.24 a	6.07 a	11.31 ab	46.33 a
T_6	5.32 a	6.14 a	11.46 a	46.42 a
T_7	5.02 ab	5.97 a	10.99 bc	45.68 ab
T_8	5.13 ab	6.04 a	11.17 ab	45.93 ab
$LSD_{0.05}$	0.318	0.359	0.332	1.106
CV(%)	6.88	8.46	7.79	9.24

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 = control (0% organic or inorganic), T_2 = 100% RDCF ($N_{100}P_{15}K_{45}S_{20}Zn_3$ kg ha^{-1}), T_3 = only poultry manure (100% N), T_4 = only vermicompost (100% N), T_5 = 50% RDCF (50% NPKSZn kg ha^{-1}; 50%N) + 50% poultry manure, T_6 = 50% RDCF (50% NPKSZn kg ha^{-1}) + 50% vermicompost, T_7 = 25% RDCF (25% NPKSZn kg ha^{-1}) + 75% poultry manure, T_8 = 25% RDCF (25% NPKSZn kg ha^{-1}) + 75% vermicompost (75% N)

4.3.2 Straw yield ha^{-1}

Application of different rates of organic and inorganic fertilizers combinations showed significant variation on straw yield of rice (Table 5 and Appendix VIII). Treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost)gavethe higheststraw yield (6.14t ha^{-1}) which was statistically identical with the treatment T_5 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% poultry manure) (6.07 t ha^{-1}), T_7 (25% RDCF; 25% NPKSZn kg ha^{-1} + 75% poultry manure) (5.97 t ha^{-1}) and T_8 (25% RDCF; 25% NPKSZn kg ha^{-1} + 75% vermicompost) (6.04 t ha^{-1}). The minimum straw yield (4.83t ha^{-1}) was registered by control treatment T_1 (no organic or inorganic fertilizer. Similar result was also observed by Alam *et al*. (2021), Anisuzzaman*et al*. (2021), Chakraborty *et al*. (2020) and Jahan *et al*. (2019).

4.3.3Biological yield ha^{-1}

Biological yield of rice differed significantly due to different combinations of organic and inorganic fertilizers (Table 5 and Appendix VIII). It was observed that the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost) gave the highest biological yield (11.46 t ha^{-1}) which was statistically similar to treatment T_5 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% poultry manure) (11.31 t ha^{-1}) and T_8 (25% RDCF; 25% NPKSZn kg ha^{-1} + 75% vermicompost) (11.17 t ha^{-1}). The lowest biological yield (8.04 t ha^{-1}) was obtained with the control treatment T_1 (no organic or inorganic fertilizer) and it was significantly differed to other treatments. Similar result was also observed by Jahan *et al*. (2019) who reported higher biological yield of rice with combined application of organic and inorganic fertilizers compared to control or sole application of organic or inorganic fertilizers.

4.3.4 Harvest index

Harvest index of ricevaried significantly due to different rates of organic and inorganic fertilizers combinations (Table 5 and Appendix VIII). It was observed that the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost)gave the highest harvest index (46.42%) which was statistically similar toT_5 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% poultry manure) (46.33%), T_7 (25% RDCF; 25% NPKSZn kg ha^{-1} + 75% poultry manure) (45.68%) and T_8 (25% RDCF; 25% NPKSZn kg ha^{-1} + 75% vermicompost) (45.93%). The control treatment T_1 (no organic or inorganic fertilizer) showed the lowest harvest index (39.93%) which was significantly differed to other treatments.The result obtained from the present is in aggrement with findings of Jahan *et al*. (2019) and Arif *et al*. (2014).

4.4 Analysis of postharvest soil

4.4.1 pH content of postharvest soil

There is nosignificant influence of different combinations of organic and inorganic fertilizer on pH of post-harvest soil (Table 6 and Appendix IX). However, the highest pH of post-harvest soil (6.30) was recorded by the treatment T_2 (100% RDCF; $N_{100}P_{15}K_{45}S_{20}Zn_3$ kg ha^{-1}) whereas the lowest pH of post-harvest soil (6.23) was found by the control treatment T_1 (no organic or inorganic fertilizer).

4.4.2 Organic carbon content of postharvest soil

Different combinations of organic and inorganic fertilizers Showed no significant variation of organic carbon content of post-harvest soil (Table 6 and Appendix IX). However, the highest organic carbon content of post-harvest soil (0.61%) was found by the treatment T_4 (only vermicompost; 100% N) whereas the lowest organic carbon content (0.52%) was recorded by control treatment T_1 (no organic or inorganic fertilizer).

4.4.3 Available nitrogen (N) content of postharvest soil

Significant influence was observed by the application of different rates of organic and inorganic fertilizer combinations on N content in soil after harvest soil of rice (Table 6 and Appendix IX). It was found that the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost)showed the highest available N content of post-harvest soil (1.52%) which was statistically identical to T_5 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% poultry manure) (24.27 ppm) while the lowest available N content of post-harvest soil (0.52%) was noted incontrol treatment T_1 (no organic or inorganic fertilizer).

4.4.4 Available phosphorus (P) content of postharvest soil

Significant influence was observed by different rates of organic and inorganic fertilizer combinations on available P content in soil after harvest soil of rice (Table 6 and Appendix IX). It was found that the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost)showed the highest available P content of post-harvest soil (24.52 ppm) which was statistically identical to T_5 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% poultry manure) (24.27 ppm) and the lowest available P content of post-harvest soil (19.62 ppm) was obtained with the control treatment T_1 (no organic or inorganic fertilizer).

4.4.5 Exchangeable potassium (K) content of postharvest soil

Significant influence was observed by different rates of organic and inorganic fertilizer combinations on exchangeable K content in postharvest soil (Table 6 and Appendix IX). The treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost)gave the highest exchangeable K content of post-harvest soil (1.216 meq/100g soil) which was followed by T_5 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% poultry manure) (24.27 ppm) whereas the lowest exchangeable K content of post-harvest soil (0.427meq/100g soil) was given by the control treatment T_1 (no organic or inorganic fertilizer) which was statistically identical to the treatment T_3 (only poultry manure; 100% N).

4.4.6 Available sulphur (S) content of postharvest soil

S content in post-harvest soil of rice varied significantly by different combinations of organic and inorganic fertilizer (Table 6 and Appendix IX). It was observed that the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost)showed the highest available S content of post-harvest soil (26.44 ppm) which was statistically identical to T_5 (50% RDCF + 50% poultry manure) (26.36 ppm) and the lowest available S content in soil (20.07 ppm) was observed by the control treatment T_1 (no organic or inorganic fertilizer) that was significantly different from other treatments.

Table 6. Effect of organic and/or inorganic fertilizer on quality of post-harvest soil (pH, organic carbon, nitrogen, available phosphorus, exchangeable potassium, available sulphur and available zinc)

Treatments	Soil analysis (pH, organic carbon, nitrogen, available phosphorus, exchangeable potassium, available sulphur and available zinc)						
	pH	Organic carbon (%)	Nitrogen (%)	Available phosphorus (ppm)	Exchangeable potassium (meq/100g soil)	Available sulphur (ppm)	Available zinc (ppm)
T_1	6.23	0.52	0.42 e	19.62 d	0.427 e	20.07 f	0.053 e
T_2	6.30	0.54	0.58 d	21.45 c	0.571 d	22.56 d	0.059 de
T_3	6.24	0.60	0.86 c	21.33 c	0.436 e	21.18 e	0.065 de
T_4	6.24	0.61	0.63 d	21.42 c	0.784 c	24.36 c	0.112 bcd
T_5	6.27	0.57	1.45 a	24.27 a	1.032 b	26.36 a	0.169 a
T_6	6.28	0.58	1.52 a	24.52 a	1.216 a	26.44 a	0.174 a
T_7	6.25	0.58	0.93 c	23.04 b	0.819 c	24.20 c	0.122 bc
T_8	6.27	0.60	1.18 b	23.28 b	0.841 c	25.28 b	0.148 ab
$LSD_{0.05}$	0.611^{NS}	0.332^{NS}	0.127	0.514	0.133	0.592	0.053
CV(%)	3.88	4.12	4.06	5.03	3.87	6.27	3.24

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 = control (0% organic or inorganic), T_2 = 100% RDCF ($N_{100}P_{15}K_{45}S_{20}Zn_3$ kg ha^{-1}), T_3 = only poultry manure (100% N), T_4 = only vermicompost (100% N), T_5 = 50% RDCF (50% NPKSZn kg ha^{-1}; 50%N) + 50% poultry manure, T_6 = 50% RDCF (50% NPKSZn kg ha^{-1}) + 50% vermicompost, T_7 = 25% RDCF (25% NPKSZn kg ha^{-1}) + 75% poultry manure, T_8 = 25% RDCF (25% NPKSZn kg ha^{-1}) + 75% vermicompost (75% N)

4.4.7 Available (Zn) content of postharvest soil

Zn content in postharvest soil of rice varied significantly by different combinations of organic and inorganic fertilizer (Table 6 and Appendix IX). It was observed that the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost)showed the highest Zn content of post-harvest soil (0.174 ppm) which was statistically similar to T_5 (50% RDCF + 50% poultry manure) (0.169 ppm) and T_8 (25% RDCF; 25% NPKSZn kg ha^{-1} + 75% vermicompost) (0.148 ppm).The lowest Zn content in postharvest soil (0.053 ppm) was in the control treatment T_1 (no organic or inorganic fertilizer) which was statistically similar toT_2 (100% RDCF; $N_{100}P_{15}K_{45}S_{20}Zn_3$ kg ha^{-1}) and T_3 (only poultry manure; 100% N) treatments.

CHAPTER V

SUMMARY AND CONCLUSION

This experiment was carried at the experimental field of Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka-1207 during the period from November 2021 to May 2022 to study the effect of organic and inorganic fertilizer application on rice production (BRRI dhan28). Single factor experiment was considered for the present study with eight treatments *viz*. T_1 = control (No organic or inorganic), T_2 = 100% RDCF ($N_{100}P_{15}K_{45}S_{20}Zn_3$ kg ha^{-1}), T_3 = only poultry manure – 5.4 t/ha (100% N), T_4 = only vermicompost -8 t/ha (100% N), T_5 = 50% RDCF (50% NPKSZn kg ha^{-1}) + 50% poultry manure (2.7 t/ha), T_6 = 50% RDCF (50% NPKSZn kg ha^{-1}) + 50% vermicompost (4 t/ha), T_7 = 25% RDCF (25% NPKSZn kg ha^{-1}) + 75% poultry manure (4.05 t/ha) and T_8 = 25% RDCF (25% NPKSZn kg ha^{-1}) + 75% vermicompost (6 t/ha). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The data on different growth parameter and yield were recorded properly.

Significant variation was found in most of the studied parameters influenced by different organic and inorganic fertilizers combinations. For growth parameters, treatment T_2 (100% RDCF; $N_{100}P_{15}K_{45}S_{20}Zn_3$ kg ha^{-1}) exhibited the highest plant height at harvest (92.12 cm,) but the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost) showed the highest number of tillers hill^{-1} (17.24),whereas control treatment T_1 (no organic or inorganic fertilizer) showed the lowest plant height (81.40 cm) and the lowest number of tillers hill^{-1} (10.84).

Regarding yield contributing parameters and yield, the highest number of effective tillers hill^{-1} (15.87), flag leaf length (21.64 cm), number of filled grains panicle^{-1} (129.20), panicle length (23.52 cm), grain yield (5.32 t ha^{-1}), straw yield (86.14 t ha^{-1}), biological yield (11.46 t ha^{-1}) and harvest index (46.33%) were recorded from the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost) followed by T_5 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% poultry manure).On the contrary, the control treatment T_1 (no organic or inorganic fertilizer) showed the lowest number of effective tillers $hill^{-1}$ (7.92), flag leaf length (15.63 cm), number of filled grains $panicle^{-1}$ (110.40), panicle length (16.65 cm), grain yield (3.21 t ha^{-1}), straw yield (4.83 t ha^{-1}), biological yield(8.04 t ha^{-1}) and harvest index (39.93%). The minimum number of unfilled grains $panicle^{-1}$ (5.78) was also recorded in the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost) whereas the maximum (9.88) was recorded from the control treatment T_1 (no organic or inorganic fertilizer) Again it was found that the Number of non-effective tillers $hill^{-1}$ and 1000 grain weight were not differed significantly among the treatments.

Regarding the status of post-harvest soil pH and organic carbon content were not influenced by different combinations of organic and inorganic fertilizer, however, the maximum pH (6.30) and organic carbon (0.61%) were recorded from T_2 (100% RDCF; $N_{100}P_{15}K_{45}S_{20}Zn_3$ kg ha^{-1}) and T_4 (only vermicompost; 100% N), respectively. The lowest pH (6.23) and organic carbon (0.52%) were recorded from control treatment T_1 (no organic or inorganic fertilizer). The available N, available P, exchangeable K,available S and available Zn content of postharvest soil affected significantly by different rates of organic and inorganic fertilizers combinations and the maximum available N (1.52%), available P (24.52 ppm), exchangeable K (1.216 meq/100g soil),available S (26.44 ppm) and available Zn (0.174 ppm) content of postharvest soil were recorded from the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost) whereas the lowest (0.42%, 19.62 ppm, 0.427 meq/100g soil,20.07 ppm and 0.053 ppm, respectively) were recorded from the control treatment T_1 (no organic or inorganic fertilizer).

From the above results, it can be concluded that the treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost)was very much promising for higher rice production (BRRI dhan28) compared to other treatment combination.

Treatment T_5 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% poultry manure) also showed better performance. The control treatment T_1 (no organic or inorganic fertilizer) showed the least performance. In terms of analysis of post-harvest soil, pH and organic carbon content were not varied significantly among the treatments but available P and S of post-harvest soil affected significantly. The treatment T_6 (50% RDCF; 50% NPKSZn kg ha^{-1} + 50% vermicompost) showed highest available N, available P,available S and available Zn content of post-harvest soil compared to other treatments.

REFERENCES

Abdul-Rahman, A.B.I. (2019). Combined effect of organic and inorganic fertilizers on growth of rice plants. United Nations University Land Restoration Training Programme [final project] https://www.grocentre.is/static/gro/publication/719/document/abdul-rahman2019.pdf

Ahmed, M., Hussain, M. and Ahmad, S. (2017). Effects of organic and inorganic fertilizers on the yield and yield components of rice. International Journal of Agricultural Biology, 19(1): 121-126. doi: 10.17957/IJAB/15.0301

AIS (Agriculture Information Service). (2017). Krishi Diary. Agric. Info. Service, Khamarbari, Dhaka. p. 66.

Akul, B.M., Kathmale, D.K. and Rathod, S.D. (1982). Soil Nutrient Status, Uptake, Yield and Economics of Groundnut-Wheat Cropping Sequence as Influenced by Organic Sources and Fertilizers. *J. Indian Soc. Soil Sci*. **66**(1): 66-75.

Alam, M.M., Arifunnahar, M. and Khatun, M.M. (2021). Effect of different organic and inorganic fertilizers on the growth and yield of boro rice (BRRI dhan29). *Int. J. Res. Sci. Innov. (IJRSI)*. **VIII**(I): 176-180.

Alim, M. (2012). Effect of organic and inorganic sources and doses of nitrogen fertilizer on the yield of boro rice. *J. Environ. Sci. Nat. Resour*. **5**: 273–282

Anisuzzaman, M., Rafii, M.Y. and Jaafar, N.M. (2021). Effect of Organic and Inorganic Fertilizer on the Growth and Yield Components of Traditional and Improved Rice (*Oryza sativa* L.) Genotypes in Malaysia. *J. Agron*. **11**(1830): 2 -22.

Arif, M., Tasneem, M., Bashir, F. and Yaseen, G. (2014). Effect of integrated use of organic manures and inorganic fertilizers on yield and yield components of rice. *J. Agric. Res*. **52**(2): 197- 206.

BBS (Bangladesh Bureau of Statistics). (2016). Statistical Yearbook of Bangladesh. Statistics Division, Ministry of Planning, Govt. of Peoples Republic of Bangladesh. Dhaka. Bangladesh, 71p.

BBS. (2020). Statistical yearbook of Bangladesh. Bangladesh Bureau of Statistics. Statistics Division, Ministry of Planning, Govt. of Peoples Republic of Bangladesh. p. 144.

Belefant, M.H. (2007). Poultry litter induces tillering in rice. Journal of Sustainable Agric.**31**:151–160

Biswas, T., Paul, S.K., Sarkar, M.A.R. and Sarkar, S.K. (2016). Integrated use of poultry manure with prilled urea and urea super granules for improving yield and protein content of aromatic rice (cv. BRRI dhan50). *Progressive Agric*. **27**(2): 86-93.

Chakraborty, S., Rahman, A. and Salam, M.A. (2020). Effect of integrated nutrient management on the growth and yield of boro rice (*Oryza sativa* L.) cultivars. *Arch. Agric. Environ. Sci*. **5**(4): 476-481.

Das, P. K., Mohanty, M., and Barik, N. (2015). Effect of organic and inorganic fertilizers on growth and yield of rice. International Journal of Applied and Pure Science and Agriculture, **1**(4): 145-151.

FAO (Food and Agriculture Organization). (2021). Retrieved from: http://www.fao.org/faostat/en/#data/QCL.

Farid, M.S., Mamun, M.A.A., Matin, M.A. and Jahiruddin, M. (2011). Combined effect of cowdung, poultry manure, dhaincha and fertilizers on the growth and yield of rice. *J. Agrofor. Environ.* **5**(1): 51-54.

Fitzgerald, M.A., McCouch, S.R. and Hall, R.D. (2009). Not just a grain of rice: The quest for quality. *Cell Press*. **3**: 133-39. Sarkar, S.C., Akter, M., Islam, M.R. and Haque, M.M. (2016). Performance of Five Selected Hybrid Rice Varieties in *aman* Season. *J. Plant Sci.***4**(2): 72-79.

Fox, R. ., Olson, R.A. and Rhoades, H.F. (1964). Evaluating the sulfur status of soils by plants and soil tests. *Soil Sci. Soc. Am. Proc*. **28**: 243-246.

Gathala, M. K., Sharma, P. C., Kumar, V. and Sharma, S. K. (2014). Effect of organic and inorganic fertilizers on rice yield, soil properties and nutrient uptake under rice-wheat system in the Indo-Gangetic plain. *Field Crops Res*., **157**: 67-79. doi: 10.1016/j.fcr.2013.11.002

Ghosh, A., Bhattacharya, S., Basak, B. B. and Sarkar, S. K. (2017). Effect of organic and inorganic fertilizers on the growth, yield and quality of rice (*Oryza sativa* L.). *J. Crop Weed*, **13**(1): 119-124.

Gomez, K.A. and Gomez, A.A. (1984). Statistically procedures for agricultural research. 2nd edition. An International Rice Research Institute Book. A wiley-Inter Science Publication, New York, 28. 1984. pp. 442-443.

Hunt, J. (1980). Determination of total sulphur in small amounts of plant material. Analyst. https://doi.org/10.1039/an9800500083.

Hussainy, S. (2019). Integration of different organic manures and nitrogenous fertilizer and its effect on the growth and yield of rice. *J. Pharmacog. Phytochem*. **8**: 415–418.

Ibrahim, M., Hassan, A.U., Iqbal, M. and Valeem, E.E. (2008). Response of wheat growth and yield to various levels of compost and organic manure. *Pakistan J. Bot*. **40**: 2135–2141.

Islam, M. R., Hasan, M. R., Hossain, M. A. and Rashid, M. H. (2015). Effect of organic and inorganic fertilizers on growth and yield of hybrid rice. *Bangladesh J. Agril. Res*., **40**(4): 639-648. doi: 10.3329/bjar.v40i4.26938.

Islam, M.M.A.F., Khan, M.A., Bari, A.S.M.F., Hosain, M.T. and Sabikunnaher. (2013). Effect of Fertilizer and Manure on the Growth, Yield and Grain Nutrient Concentration of *boro* Rice (*Oryza sativa* L.) under Different Water Management Practices. *The Agriculturists*. **11**(2): 44-51.

Islam, S., Parveen, K., Khan, M. I. K., Rahman, M. M. and Ahmad, F. (2016). Integrated use of organic manure with chemical fertilizers on the growth and yield of T. *aman* rice. *J. Sci. Technol. Environ. Informat*. **3**(1): 170-177.

Islam, S.M.M., Paul, S.K. and Sarkar, M.A.R. (2015). Effect of weeding regime and integrated nutrient management on yield contributing characters and yield of BRRI dhan49. *J. Crop and Weed*. **11**: 193-197.

Jahan, M. S., Sikder, S. and Mohiuddin, M. (2019). Effects of organic and inorganic fertilizers on growth, yield and quality of rice. *Int.J. Appl. Sci.Biotechnol*., **7**(2): 156-164. doi: 10.3126/ijasbt.v7i2.24728.

Kabir, M. H., Hossain, M. B., Jahiruddin, M., and Islam, M. R. (2018). Effect of poultry manure and inorganic fertilizers on growth, yield and soil fertility of T. Aman rice (Oryza sativa L.) in Sylhet region. *Bangladesh J. Agril. Res*., **43**(1): 69-81.

Kamara, A. Y. and Ewansiha, S. U. (2017). Effect of organic and inorganic fertilizers on the growth and yield of upland rice (*Oryza sativa* L.) in Benue State, Nigeria. *J. Agril. Sci*., **62**(4): 243-255. doi: 10.2298/JAS1704243K.

Lee, S. K., Shin, Y. C., Lee, Y. K. and Kim, K. Y. (2015). Effects of organic and inorganic fertilizers on soil fertility and productivity of rice paddy fields in Korea. *Korean J. Soil Sci. Fert*., **48**(5): 412-418. doi: 10.7745/KJSSF.2015.48.5.412.

Mahmud, A.J., Shamsuddoha, A.T.M. and Haque, M.N. (2016). Effect of Organic and Inorganic Fertilizer on the Growth and Yield of Rice (*Oryza sativa* L). *Nat. Sci*. **14**(2): 45-54.

Metwally, T.F., Gewaily, E.E., Naeem, S.S. (2011). Nitrogen response curve and nitrogen use efficiency of Egyptian hybrid rice. *J. Agril. Res. Kafr-El-Sheikh Univ*. **37**: 73–84.

Moe, K., Moh, S.M. and Htwe, A.Z. (2019). Effects of integrated organic and inorganic fertilizers on yield and growth parameters of rice varieties. *Rice Sci*. **26**(5): 309-318.

Mukherjee, S. (2013). Soil conditioner and fertilizer industry. Pages 159-172. In: Mukherjee, S. (eds). The science of clays. Capital Publishing Company, New Delhi, India

Ngakou, A., Dibong, D. S. and Haman, D. (2015). Effect of organic and inorganic fertilizers on growth and yield of upland rice (Oryza sativa L.) in Cameroon. *African J. Agril. Res*., **10**(17): 1943-1953. doi: 10.5897/AJAR2015.9449.

Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L.A. (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate. *Circular*. **939**: 19. Washington, DC: US Department of Agriculture.

Puli, M.R., Prasad, P.R.K. and Babu, P.R. (2016). Effect of organic and inorganic sources of nutrients on rice crop. *Oryza*. **53**(2): 151-159.

Rahman, M.S., Islam, M.R., Rahman, M.M. and Hossain, M.I. (2009). Effect of cowdung, poultry manure and urea-N on the yield and nutrient uptake of BRRI dhan 29. *Bangladesh Res. Publ. J*. **2**: 552-558.

Ravi, V. and Singh, R. K. (2014). Effect of organic and inorganic fertilizers on soil fertility and productivity of rice-wheat cropping system. *J. Crop and Weed*, **10**(2): 197-203.

Redda, A. and Abay, F. (2015). Agronomic performance of integrated use of organic and inorganic fertilizers on rice (*Oryza sativa* L.) in Tselemti District of North-Western Tigray, Ethiopia. *J. Environ. Earth Sci*. **5**(9): 30-41.

Saha, S., Dutta, S., and Ghosh, P. K. (2017). Integrated effect of vermicompost and inorganic fertilizer on rice yield, nutrient uptake and soil fertility. *J. Saudi Soc.Agril. Sci.*, **16**(2): 135-143.

Sarkar, S.K., Sarkar, M.A.R., Islam, N. and Paul, S.K. (2014). Yield and quality of aromatic fine rice as affected by variety and nutrient management. *J. Bangladesh Agril. Univ*. **12**(2): 279–284.

Sarker, D., Mazumder, S., Kundu, S., Akter, F. and Paul, S.K. (2015). Effect of poultry manure incorporated with nitrogenous and sulfur fertilizer on the growth, yield, chlorophyll and nutrient contents of rice var. BRRI dhan33. *Bangladesh Agron. J*. **18**(1): 99-111.

Shao, Y., Chen, L., Zhang, X., Cheng, H., and Li, S. (2020). Effects of integrated application of organic and inorganic fertilizers on rice yield and nitrogen use efficiency in China: A meta-analysis. *J. Cleaner Prod*., **244**:118877.

Siavoshi, M., Nasiri, A. and Lawere, S.L. (2011). Effect of organic fertilizer on growth and yield components in rice (*Oryza sativa* L.). *J. Agril. Sci*. **3**: 217-224.

Singh, N.P., Singh, M.K. and Tyagi, S. (2018). Effect of Integrated Nutrient Management on Growth and Yield of Rice (*Oryza sativa* L.). *Int. J. Curr. Microbiol. App. Sci*. -**7**(Special Issue): 3671-3681.

Sohel, M.H., Sarker, A., Razzak, M.A. and Hashem, M.A. (2016). Integrated use of organic and inorganic fertilizers on the growth and yield of Boro rice (CV. BRRI dhan 29). *J. Biosci. Agric. Res*. **10**(1): 857-865.

Sunarpi, H., Nikmatullah, A. and Sunarwidhi, A.L. (2021). Combination of inorganic and organic fertilizer in rice plants (*Oryza sativa*) in screen houses. 3rd international conference on bioscience and biotechnology. *J. Earth Environ. Sci*. **712**: 12-35.

Talukder, M. S. U., Sarker, M. A. Z., and Hossain, M. M. (2016). Effect of combined application of vermicompost and chemical fertilizer on the growth, yield and yield contributing characters of rice. *Int. J. Recycling Organic Waste Agril*., **5**(2): 111-120.

Tareque, M. I. H., Hossain, M. B., Jahiruddin, M., and Islam, M. S. (2019). Performance of vermicompost and poultry manure on yield and yield attributes of aman rice (*Oryza sativa* L.). *J. Agroforestry Environ*., **13**(2): 37-43.

Yang, C., Yu, H., Liu, Y., Liu, X., Li, B., Li, J., and Li, J. (2021). Effects of vermicompost on yield and quality of rice and on bacterial community structure of soil. *Scientific Reports*, **11**(1): 1-11.

APPENDICES

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

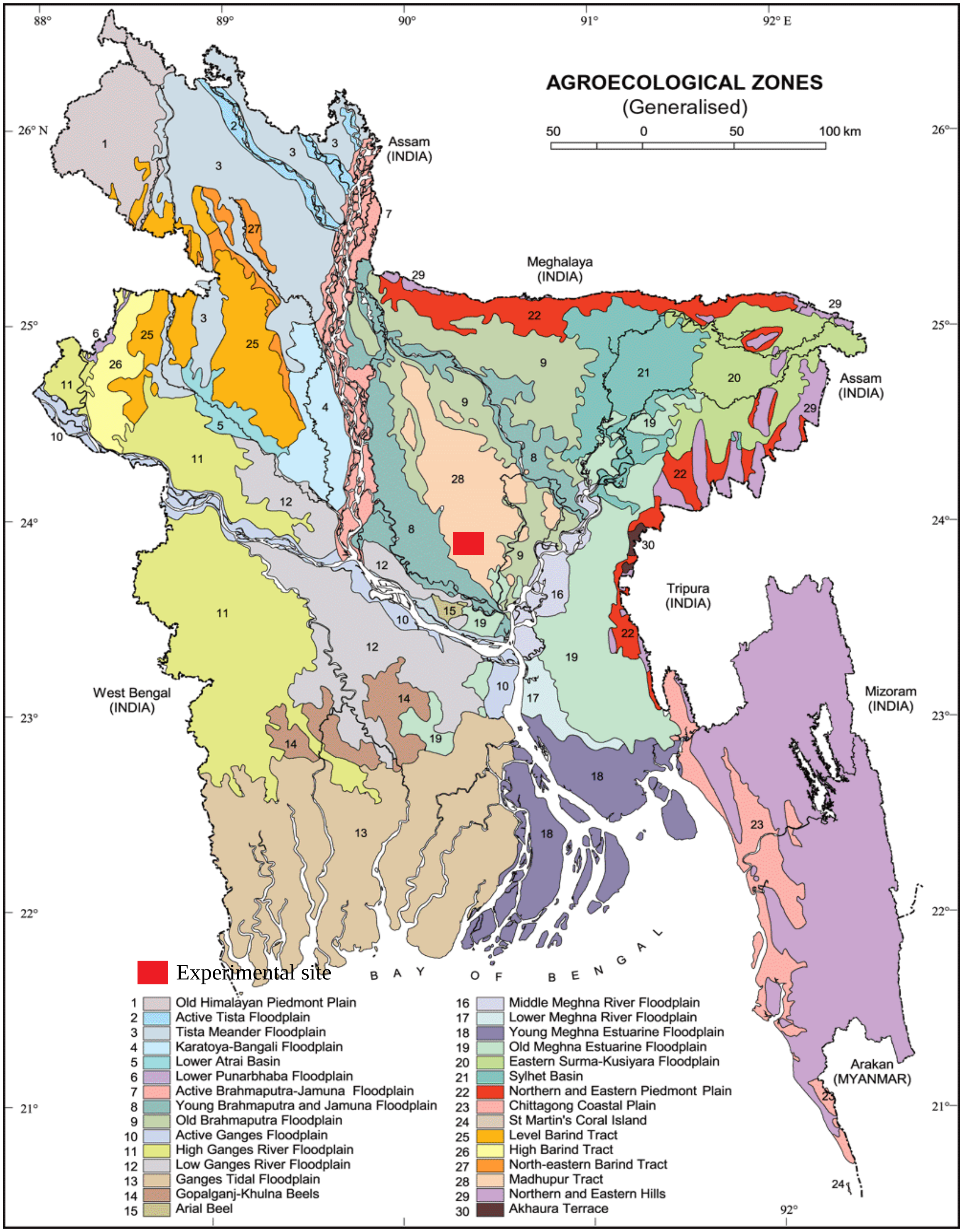


Figure 2. Experimental site

Appendix II. Monthly records of air temperature, relative humidity and rainfall during the period from November 2021 to May 2022.

Year	Month	Air temperature (°C)			Relative humidity (%)	Rainfall (mm)
		Max	*Min*	*Mean*		
2021	November	28.60	8.52	18.56	56.75	14.40
2021	December	25.50	6.70	16.10	54.80	0.0
2022	January	23.80	11.70	17.75	46.20	0.0
2022	February	22.75	14.26	18.51	37.90	0.0
2022	March	35.20	21.00	28.10	52.44	20.4
2022	April	34.70	24.60	29.65	65.40	165.0
2022	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
Cropping pattern	Not Applicable

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
pH	6.3
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20
Exchangeable K (me/100 g soil)	0.1
Available S (ppm)	45

Appendix IV. Effect of organic and/or inorganic fertilizers on plant height of BRRI dhan28 at different growth stages

Sources of variation	Degrees of freedom	Mean square of plant height (cm)		
		50 DAT	90 DAT	At harvest
Replication	2	44.372	52.307	76.244
Treatment	7	101.42*	125.314*	67.711*
Error	14	1.105	2.113	0.537

NS = Not significant   * = Significant at 5% level   ** = Significant at 1% level

Appendix V. Effect of organic and/or inorganic fertilizer on number of tillers $hill^{-1}$ of BRRI dhan28 at different growth stages

Sources of variation	Degrees of freedom	Mean square of nnumber of tillers $hill^{-1}$		
		60 DAT	90 DAT	At harvest
Replication	2	0.376	1.614	4.711
Treatment	7	2.852**	6.372*	9.633*
Error	14	0.102	0.113	0.124

NS = Not significant   * = Significant at 5% level   ** = Significant at 1% level

Appendix VI. Effect of organic and/or inorganic fertilizer on effective and non-effective tillers $hill^{-1}$ and flag leaf length of BRRI dhan28

Sources of variation	Degrees of freedom	Mean square of yield contributing parameters		
		Number of Effective tillers $hill^{-1}$	Number of non-effective tillers $hill^{-1}$	Flag leaf length (cm)
Replication	2	4.837	0.074	8.674
Treatment	7	13.715*	0.311^{NS}	7.122*
Error	14	0.089	0.504	0.214

NS = Not significant   * = Significant at 5% level   ** = Significant at 1% level

Appendix VII. Effect of organic and/or inorganic fertilizer on filled grains and unfilled grains panicle^{-1}, panicle length and 1000 seed weight of BRRI dhan28

Sources of variation	Degrees of freedom	Mean square of yield contributing parameters			
		Number of filled grains panicle^{-1}	Number of unfilled grains panicle^{-1}	Panicle length (cm)	1000 seed weight (g)
Replication	2	207.308	8.902	0.201	0.136
Treatment	7	426.109*	10.814*	15.063*	7.244^{NS}
Error	14	3.317	0.101	0.017	0.113

NS = Not significant * = Significant at 5% level ** = Significant at 1% level

Appendix VIII. Effect of organic and/or inorganic fertilizer on yield parameters of BRRI dhan28

Sources of variation	Degrees of freedom	Mean square of yield parameters			
		Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield	Harvest index (%)
Replication	2	0.027	0.036	0.102	0.349
Treatment	7	2.814**	3.144**	6.317	11.206*
Error	14	0.011	0.014	0.012	0.133

NS = Not significant * = Significant at 5% level ** = Significant at 1% level

Appendix IX. Effect of organic and/or inorganic fertilizer on quality of post-harvest soil (pH, organic carbon, available N, available P, exchangeable K, available S and available Zn)

Sources of variation	Degrees of freedom	Mean square of post-harvest soil properties						
		pH	Organic carbon (%)	Availa-ble nitrogen (%)	Availa-blephos ph-orus (ppm)	Exchang-eable potassium (meq/100 g soil)	Availabl e sulphur (ppm)	Availabl e zinc (ppm)
Replication	2	0.014	0.001	0.011	1.132	0.003	1.314	0.002
Treatment	7	3.211^{NS}	0.207^{NS}	3.214**	13.214*	0.473**	23.107*	0.312**
Error	14	0.002	0.001	0.007	0.102	0.001	0.112	0.001

NS = Not significant * = Significant at 5% level ** = Significant at 1% level

Plate 01: Sprouting

Plate 02: Seed Sowing

Plate 03: Seedling Observation

Plate 04: Final Land Preparation

Plate 05: Layout Preparation

Plate 06: Seedling Uprooting

Plate 07: Seedling Transplanting

Plate 08: Irrigation

Plate 09: Maximum Tillering

Plate 10: Ripening stage

Plate11: Harvesting

Plate 12: Threshing & Dry Weight