RESPONSE OF ORGANIC AND INORGANIC FERTILIZERS ON GROWTH AND YIELD OF RICE (*Oryza sativa* L.)

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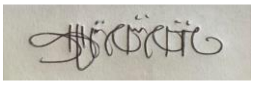

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CERTIFICATE

This is to certify that thesis titled "Response of Organic and Inorganic Fertilizers on Growth and Yield of Rice (Oryza sativa L.)" submitted to ***Department of Soil Science the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar Dhaka,*** *in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE (M.S.)*** *in* ***SOIL SCIENCE*** *embodies the result of a piece of bona fide research work carried out by* ***TANBIN ZAMAN*** *bearing* **Registration no. 15-06380** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course of this investigation has duly been acknowledged by the author.

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Dedicated

to

My Beloved Parents who always pray for me

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RESPONSE OF ORGANIC AND INORGANIC FERTILIZERS ON GROWTH AND YIELD OF RICE (*Oryza sativa*)

By

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ABSTRACT

A pot experiment was conducted at Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh during the period from January 2022 to July 2022 to examine the response of organic and inorganic fertilizers on growth and yield of rice (*Oryza sativa*). The experiment consisted of eight treatments viz. T_0 (Control, no nutrient application), T_1 (100% RDCF: $N_{120}P_{20}K_{40}S_{20}Zn_{2.5}$ Kg ha^{-1}), T_2 (100% Cow dung: 10 t ha^{-1}), T_3 (100% Poultry Manure: 5 t ha^{-1}), T_4 (50% RDCF + 50% Cow dung), T_5 (50% RDCF +50% Poultry Manure), T_6 (25% RDCF + 75% Cow dung), T_7 (25% RDCF + 75% Poultry Manure). The pot experiment was laid out with two factors following randomized complete Block design (RCBD) with three replications. A significant variation was found among the treatments while different nutrient levels (organic and inorganic) applied in different combinations. The treatment T_4 (50% RDCF + 50% Cow dung) exhibited the highest plant height at 30, 60, 90 DAT and at harvest (55.35, 72.30, 85.24 and 99.00 cm respectively). The treatment T_4 (50% RDCF + 50% Cow dung) also showed the highest number of tillers $hill^{-1}$ (26.49, 31.33, 36.58 and 28.67 respectively), whereas control treated pot T_0 (no nutrient application) showed the minimum results. Again, the treatment T_4 (50% RDCF + 50% Cow dung) showed the highest Grains $Panicle^{-1}$ (98.16), Panicle Length (17.33 cm), 1000 Seed Weight (21.08 g), Grain Yield (5.95 t ha^{-1}), Straw Yield (8.42 t ha^{-1}), Biological Yield (8.79), Harvest Index (50.33%) followed by T_5 (50% RDCF +50% Poultry Manure) and T_7 (25% RDCF + 75% Poultry Manure) in some case whereas the control treatment T_0 (no nutrient application) performed the lowest results on the respected parameters. So, the treatment T_4 (50% RDCF + 50% Cow dung) can be considered as suitable treatment for rice production (BRRI dhan28) to obtain higher grain yield.

Keywords: Organic and inorganic fertilizers, Grains $Panicle^{-1,}$ Panicle Length, Seed Weight, Grain Yield, Straw Yield, Biological Yield, Harvest Index**.**

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Chapter I

INTRODUCTION

Rice (*Oryza sativa* L) belonging to family Gramineae, one of the world's most widely consumed grain plays an important role in combating global hunger. After wheat and corn, rice is the third most produced agricultural crop in the world. For over half of the world's population, rice is the primary staple food, with Asia, Sub-Saharan Africa, and South America being the largest consumers of it. *Oryza Sativa*, the primary species of rice, is believed to have originated in Asia from the Gramineae family. United States Department of Agriculture (USDA) estimates that the World Rice Production 2022-2023 will be 503.27 million metric tons, around 0.42 million tons less than previous month's projection. Rice Production last year was 515.05 million tons. This year's 503.27 estimated millions of tons could represent a decrease of 11.78 million tons or 2.29% in rice production around the globe. As of 2022, the top 10 producers of rice are located in Asia. Together, China and India account for more than half of the rice produced globally. Asia contributed 92–89% of the total world rice area in the year 1964 and 2013, respectively (Bandumula, 2018). About 90% of the world's rice is grown and produced (143 million ha of area with a production of 612 million tons of paddy) in Asia (FAO, 2009). Rice is the staple food in our country. Rice is the backbone of Bangladesh's agriculture; here, like in many other countries, 'food security' almost entirely depends on 'rice security' (Brolley, 2015); it alone contributes about 4.5% to the GDP (BBS, 2020). In 2021, rice production for Bangladesh was 56.9 million tons. Rice production of Bangladesh increased from 15.1 million tons in 1972 to 56.9 million tons in 2021 growing at an average annual rate of 2.89%. Bangladesh has again ranked third in rice production all over the world. Bangladesh ranks 4th in both area and production of rice and also 6th in per hectare production of rice yield (Sarkar *et al.*, 2016). With this, Bangladesh held the third position for four consecutive years.

Generally, variety is the vital constituent for producing higher yield of rice depending upon their differences in genotypic characters, input requirements and off course the prevailing environmental conditions during the entire growing season of rice. In Bangladesh, BRRI, BINA, IRRI and different seed companies has been introduced high yielding rice variety and it gains positive monumentation in rice production for the specific three distinct growing seasons (Haque and Biswas, 2011). Improving and increasing the world's rice supply will also depend upon the development and improvement of rice varieties with better yield potential, and to adopt various conventional and biotechnological approaches for the development of high yielding varieties that having resistance against different biotic and abiotic stresses (Khush, 2005). High yielding rice varieties produced yield around 10 to 20% more than conventional rice varieties on similar biotic and abiotic condition due to the heterotic effect (Li *et al.*, 2009; Zhou *et al.*, 2012). Very recently various new rice varieties were developed by BRRI with exceptionally high yield potential. Now a day's different high yielding rice variety are available in Bangladesh which have more yield potential than different local varieties (Akbar, 2004). The growth process of rice plants under different agro climatic condition differs due to the specific rice variety (Alam *et al.*, 2012). Hossain and Deb (2003) reported that although farmers got about 16% yield advantage from hybrids compared to the popularly grown inbred varieties but it may not be stable. Compared with conventional cultivars, the high yielding varieties have larger panicles resulting in an average increase of rice grain is 7.27% (Bhuiyan et al., 2014). Rice is grown in three distinct seasons namely Aus (mid-March to mid-August), Aman (mid-June to November) and Boro (mid-December to mid-June). Aus, Aman and Boro rice cover about 8.35%, 30.75% and 33.14% of the total crop areas of Bangladesh (BBS, 2017). BRRI dhan 28 is a high yielding verity which was developed at the Bangladesh Rice Research Institute through hybridization in 1994.

Bangladesh is an agriculture-based country. Rice is the major growing crop in our country. Rice plays a vital role in the livelihood of the people of Bangladesh. In post green revolution era total rice production are either stagnating/declining day by day mainly due to different factors that are related to crop production (Prakash, 2010). The reasons for low productivity of rice includes erratic rainfall, drought, weed, insect pest diseases, unavailability of quality seeds, non-adoption of recommended production and plant protection technology but the major reason attributed to prevalence of local rice varieties instead of high yielding varieties (Mandira *et al.*, 2016). Cultivation is always vulnerable due to biotic and abiotic stresses. Growth and development of the crops including rice depend on biotic factors such as atmosphere, temperature, light, humidity, nutrients etc. Many abiotic factors such as heat, cold, drought, salinity and heavy metal contamination reduce the growth and development of the crops. Organic manure can supply a good amount of plant nutrients thus can contribute to crop yields. Thus, it is necessary to use fertilizer and manure in an integrated way in order to obtain sustainable crop yield without affecting soil fertility. The integrated approach by using the organic and inorganic sources of nutrients helps to improve the efficiency of nutrients. Mineralization and immobilization are biochemical in nature and are mediated through the activities of microorganisms. The rate and extent of mineralization determines crop availability of nutrients. The transformation of N, P, S and Zn in soil depends on the quality and quantity of organic matter as well as soil fertility and microbial activity.

Cropping intensity 191% (BBS, 2017) is increasing in Bangladesh without adequate and balanced use of fertilizer managements and with little or no use of organic manures. Higher is the crop yield, higher is the nutrient removal from soil. Nutrient deficiency in this country's soils has arisen chronologically N, P, K, S, Zn and B (Islam, 2008; Jahiruddin and Satter, 2010). As a result, soil fertility is causing deterioration and crop productivity is declining. Soil organic matter supplies a substantial quantity of some macro and micronutrients for the growing plants and it improves soil health. Sarkar (2004) showed that Effect of residual cowdung and fertilizer managements was significantly positive on the availability of nitrogen, phosphorus, potassium, sulphur, copper, zinc, manganese and nutrient content of soil. It also contributes to soil fertility and productivity through its positive effect on the chemical, physical and biological properties of the soil. But, the organic matter content in most of the soils of Bangladesh is below 1.5%. About 45% of net cultivable areas of Bangladesh contain less than 1% OM (FRG, 2012).

Objectives:

The research work was carried out to achieve the following specific objectives-

- To evaluate the effects of different levels of inorganic fertilizers and organic manures on the growth and yield contributing characters of rice (BRRI dhan28)
- To find out the suitable doses of organic and inorganic fertilizers for the better yield of BRRI dhan28

Chapter II

REVIEW OF LITERATURE

Integrated use of organic manure and nitrogen fertilizer is the essential factor for sustainable soil fertility and crop productivity. Sole and combined use of cowdung, vermicompost, and inorganic fertilizer increase plant growth, yield contributing characters and yield, as each of these is the store house of plant nutrients. Experimental evidences that the use of cowdung, vermicompost, and nitrogen, phosphorus, potassium and sulphur have an intimate effect on the yield and yield attributes of rice. The available relevant reviews that are related to the effect of level of various organic manure and nitrogen fertilizer on the yield and yield attributes of rice are reviewed below.

2.1 Effect of cowdung on growth and yield of rice

Rajput and Warsi (1991) conducted a field experiment and reported that rice yield was increased to 34.44 kg ha^{-1} with the application at FYM of 10 t ha^{-1}.

Indulker and Malewar (1991) stated that application of 10 t ha^{-1} FYM alone produced grain yield of 2.19 t ha^{-1} and the untreated control gave 2.06 t ha^{-1}.

Sharma and Mitra (1991) reported a significant increase in N, P and K uptake and also the nutritional status of soil with 5 t ha^{-1} of FYM of rice based cropping system.

Gurung and Sherchan (1993) reported that the application of cowdung with chemical fertilizers produced significantly higher grain yield than that of chemical fertilizers alone.

Kant and Kumar (1994) reported that the increasing rates of amendments with FYM increased the number of effective tillers $hill^{-1}$ significantly, number of grains $panicl^{-1}$, weight of 1000 grains also increased over the control. At the maximum level of FYM (30 t ha^{-1}) the increase of 48% tillers $hill^{-1}$, 14% number of grain $panicle^{-1}$ and 4.5% weight of 1000 grains over the control were recorded.

They also reported that higher rate of FYM (30 t ha^{-1}) resulted 22.00% increase in grain yield over the untreated plots.

Thakur and Patel (1998) conducted field experiments during kharf season to study the effect of split application of 60 or 80 kg N ha^{-1} on growth, yield and nitrogen uptake by rice with and without 5 t FYM ha^{-1} and proposed that both N rates increased yields attributes, yield, plant N content and N uptakes of rice compared with N or application of FYM alone. N rates and use of split doses had no effect. The highest grain yield (3.84 t ha^{-1}) was recorded with the application of 80 kg N ha^{-1} in three split doses with 5 t ha^{-1} FYM during both the years, 60 kg N in three split doses with 5 t ha^{-1} FYM gave seed grain 3.85 t ha^{-1}.

A field experiment was conducted by Gupta *et al.* (1999) on clay loam soil in 1993 in Jummu and Kasmir using rice cv. PC- 19 as test crop with 0-100 kg P_20_5 ha^{-1} and 0 or 10 t FYM. The crop also received a basal dressing of N, K and Zn. Grain yield was highest with 100 kg P_20_5+ FYM (5.20 t ha^{-1}).

Mannan *et al.* (2000) reported that manuring with cowdung up to 10 t/ha in addition to recommended inorganic fertilizers with late N application improved grain and straw yields and quality of transplant aman rice over inorganic fertilizer alone.

Saitoh *et al.* (2001) conducted an experiment to evaluate the effect of organic fertilizers (cowdung and poultry manure) and pesticides on the growth and yield of rice and revealed that the yield of organic manure treated and pesticide free plots were 10% lower than that of chemical fertilizer and pesticide treated plot due to a decreased in the number of panicle. Yearly application of manure increased the total carbon and nitrogen content in soil.

2.2 Effect of compost on growth and yield of rice

Anzai *et al.* (1989) found out the effect of successive application of rice straw compost on the growth and yield of rice with low and high soil nitrogen levels, respectively. The growth rice in the soil supplemented with rice straw compost was retarded initially and restored after the panicle formation stage. The yield was lower than that in the soil supplied with chemical fertilizer due to decrease in the percentage of ripened grains. Successive applications of 30-ton compost ha^{-1} produced a greater number of grain m^{-2} but a lower percentage of ripened grains and yield than that where chemical fertilizer was applied.

Vermicompost was tasted in pot experiment for its ability to replace a proportion of the urea fertilizer applied to rice. Compared with N fertilizer alone, supplying one-third or one-quarter of N as vermicompost increased plant height, grain yield and yield components of rice (Rini and Srivastava, 1997).

A study in typical clayey rice soil (Aeric Albaquept) of Bangladesh was conducted by Farid *et al.* (1998) incorporation of compost or rice straw and subsequent decomposition increased and maintained organic matter level at 2.5% that was higher than that in traditionally managed rice soil (<2%)

Application of composted coir pith improves the soil available K status and increase the uptake of K by grain and straw yield of rice. Application of 50 kg N with green leaf manure gave the highest grain and straw yield in both seasons, followed composted coir pith (Chitira and Janaki, 1999).

Composis from organic wastes, such as segregated waste, green botanical waste and food processing waste are becoming available in increasing quantities. These supply a complex mixture of nutrients in organic and mineral forms and are also used as soil condition to maintain and improve soil structure (HDRA, 1999).

Tamaki *et al.* (2002) observed that the correlation between growth and yield and duration of organic farming (compost mixed with straw) in comparison with conventional farming. In organic farming plant height of rice was shorter and short number $hill^{-1}$ was lesser than in conventional farming, but both of these values increased as the duration of organic farming increased. The maximum tiller number was smaller and panicle number was also smaller there in organic farming. However, both the panicle number and panicle length increased as the duration organic farming increased. The grain-straw ratio was higher in organic farming than the conventional farming. These results suggest that the growth and yield of rice increased with continuous organic farming and the yield increased with increase in panicle number ha^{-1} and grain number $panicle^{-1}$.

Keeling *et al.* (2003) determined the green waste compost and provided with additional fertilizers and showed consistently that the response of rice rape to compost and fertilizer applied together than the response to the individual additives, but only very stable compost was used (>10 months processing). Experiments with 15 N-labeled fertilizer showed that rice was able to utilize the applied N-more efficiently when cultivated with the stable compost.

Elsharaeay *et al.* (2003) found the effect of compost of some plant residues i.e., rice straw and cotton stalk on some physical and chemical properties of the sandy soil. Application of cotton stalks or rice straw composts significantly improved the physical properties of the tasted soil, i.e., bulk density, hydraulic conductivity and moisture content namely field capacity, wilting point and available water, concerning the effect of compost application on the availability of N, P and K in the cultivated soil, rice straw was better than cotton stalks.

Aga *et al.* (2004) assessed the effect of compost on the growth and yield of rice. Plant growth characters such as plant height were highest with application of 15 t compost ha^{-1}. Grain yield increased significantly with the graded levels of compost application @ 10 t ha^{-1} but the response decreased with the increase of compost from 10 to l5 t ha^{-1}.

2.3 Effect of nitrogen fertilizer on growth and yield of rice

Of the 16 essential nutrient elements nitrogen is the major and primary elements for the growth and development and better yield of crops. Plants response best to nitrogen compared to other nutrient elements. Urea has been found to be very effective nitrogenous fertilizers. Nitrogen is playing pivotal role at yield and yield attributes of rice.

BRRI (1992) reported that both grain and straw yields of rice were increased significantly up to 80 kg N ha^{-1}. Application of nitrogen from 120 to 160 kg nitrogen ha^{-1} significantly reduced the yield which was assumed to be due to excessive vegetative growth follower by lodging after flowering.

Ahmed and Hossain (1992) observed that plant height of wheat was 7939, 82.3 and 84.4 cm with 45, 90 and 135 kg N hi^{-1}, respectively. Plant height increased with increasing nitrogen doses.

Awasthi and Bhan (1993) reported that increasing levels of nitrogen up to 60 kg ha^{-1} influenced LAI and dry matter production of rice.

Patel and Upacthaya (1993) found that plant height of rice increased significantly with increasing rate of N up to 150 kg ha^{-1}.

Kumar *et al.* (1995) observed a field experiment with four levels of nitrogen (0, 60, 120 and 180 kg N ha^{-1}) and reported that productive tillers increased significantly with the increase of N doses from 0-120 kg N ha^{-1}, but differences in productive tillers between 120 and 180 kg N ha^{-1}were not significant.

Effective tillers m^{-2} responded significantly to the application of N fertilizer. Effective tillers increased significantly with increase the level of N fertilizer up to 80 kg N ha^{-1}. (Behera, 1995).

Patel and Upadhyay (1993) conducted an experiment with 3 levels of N (90, 120 and 150 kg ha^{-1}) and reported that total and effective tillers m 2 increased significantly with increasing rates of N up to 120 kg ha^{-1}.

Andrade and Amorim (1996) observed that increasing level of applied N increased plant height, panicle m^{-2}, grains $panicle^{-1}$ and grain yield significantly.

Palm *et al.* (1996) conducted a field trial at Waraseoni in the 1989-90 rainy season and observed that yield of rice cv. R. 269 was the highest (4.47 t hi^{-1}) when 100 kg N ha^{-1} was applied 30% basally, 40% at tillering and 30% at panicle initiation stage.

Khanda and Dixit (1996) reported that the increased levels of applied nitrogen significantly influenced the grain yields. They found that maximum grain and straw yields of 4.58 and 6.21 t ha^{-1} were obtained from 90 kg N ha^{-1}, respectively.

Adhikary and Rhaman (1996) reported that rice grain yield ha^{-1} in various treatments of N showed significant effect. The highest yield was obtained from 100 kg N ha^{-1} (4.52 t ha^{-1}) followed by 120 kg N ha^{-1} (4.46 t ha^{-1}) and 80kg N ha^{-1} (4.40 1 ha^{-1}).

Verma and Achraya (1996) observed that LAI increased significantly at maximum tillering and flowering stages with increasing levels of nitrogen.

Dwibvedi (1997) noticed that application of nitrogen significantly increased in growth, yield and yield components, grain yield, straw yield as well as harvest index with 60 kg N ha^{-1}.

BRRI (1997) reported during boro and transplant aman to determined rice seed yield. The experiment was laid out with four nitrogen levels 0. 50, 100 and ISO kg ha^{-1} and noted that seed yield increased gradually with the gradual increase of nitrogen.

Islam (1997) studied the effect of nitrogen and phosphorus on the growth, yield and nutrient uptake of deep-water rice. They observed that nitrogen and phosphorus fertilization significantly increased the number of fertile tillers m^{-2} and also that of grains $panicl^{-1}$, which in turn resulted in significant increase in grain yield. The application of 60 kg N ha^{-1} alone gave 22% yield benefit over control.

Singh *et al.* (1998) studied the performance of three hybrids KHR 1, Pro Agro 103 and MGR I using Jaya and Rasi as standard checks at four levels of N (0, 60, 120, and 180 kg ha^{-1}). They observed that the varieties responded linearly to the applied N level up to 120 kg ha^{-1}.

Kumar and Sharma (1999) conducted a field experiment with 4 levels of nitrogen (0, 40, 80 and 120 kg N ha^{-1}) and observed that dry mailer accumulation in rice increased from 0-40 kg N ha^{-1} at 40 DAS, 0-120 kg N ha^{-1} at 60 DAS. 0-80 kg ha^{-1} at 80 DAS. Nitrogen application also hastened the growth and resulted in higher percentage of total dry mailer accumulation in early stage of crop growth.

Bellido *et al.* (2000) evaluate a field experiment with 4 levels of nitrogen (0, 50, 100 and 150 kg N ha^{-1}) and reported that the amount of total dry matter was significantly greater at the N fertilizer rates of 100 and 150 kg nitrogen ha^{-1}

Chopra and Chopra (2000) cited that seed yield increased linearly up to 80 kg N ha^{-1}.

Castro and Sarker (2000) conducted field experiment to see the effects of N applications as basal (80, 60, and 45kg N ha^{-1}) and top dressing (10, 30 and 45 kg ha^{-1}) on the yield and yield components of Japonica rice and obtained high effective tiller, percentage of ripened grains and high grain yields from 45 kg N ha^{-1} (basal) and 45 kg N ha^{-1}(top dressing).

Singh *et al.* (2000) stated that each increment dose of N significantly increased grain and straw yields of rice over its preceding dose. Consequently, the crop fertilized with 100 kg N ha^{-1} gave maximum grain yield (2647 kg ha^{-1}).

Pully *et al.* (2000) observed that increased yield associated with application of nitrogen stage, although booting stage nitrogen application had no effect or shoot growth or nitrogen uptake. These preliminary results suggested a single application of nitrogen is sufficient to maintain healthy rice growth, alleviating the need for additional N application after flooding. Rice may be responded to N applied as late as booting, but only when the rice is N limited and not severely N stressed.

Geethdevi *et al.* (2000) found that 120 kg N ha^{-1} in the form of urea, 50% 10 nitrogen was applied in four splits resulted in higher number of tillers, filled grains panicl^{-1} and higher grain weight hill^{-1}.

Shrirame *et al.* (2000) conducted an experiment during the kharif 1996 in Nagpur, Maharastra, India on rice cv. TNRH-lO. TNRH-13 and TNRH-l8 were grown at 1, 2 and 3 seedlings hurt one seedling hill^{-1} showed significantly higher harvest index.

Munujan *et al.* (2001) treated 4 levels of nitrogen fertilizer (0, 40, 80, and 160 kg ha^{-1}) application at three levels each planting density (20, 40 and 80 hill m^{-1}) and conducted that the highest grain yield (3.8 t ha^{-1}) was obtained with 180 kg N ha^{-1}, which was similar to the yield obtained at 80 kg N ha^{-1} (3.81 t ha^{-1}).

Sarker *et al.* (2001) obtained the nitrogen responses of a iaponiea (Yumelvitachi) and an Indica (Takanari) rice variety with different nitrogen levels viz. 0, 40, 80, and 120 kg N $ha^{-1.}$ They observed that application of nitrogen increased grain and straw yields significantly but harvest index was not increased significant.

Angayarkanni and Ravichandran (2001) conducted a field experiment in Tamil Nadu, India from July to October 1997 to determine the best split application of 150 kg N ha^{-1} for rice cv. 1R20. They found that applying 16.66% of the recommended N as basal, followed by 33.33% N at 10 DAT, 25% N at 20 DAT and 25% N at 40 DAT recorded the highest grain (6189.4 kg ha^{-1}) and straw (8649.6 kg ha^{-1}) yields, response ratio (23.40) and agronomic efficiency (41.26).

Bayan and Kandasamy (2002) noticed that the application of recommended doses of nitrogen in four splits at 10 days after sowing active tillering, panicle initiation and at heading stages recorded significantly lower dry weight of weeds and increased crop growth viz, effective tillers m^{-2}.

Duhan and Singh (2002) reported that the rice yield and uptake of nutrients increased significantly with increasing N levels. Moreover, the application along with various green manures (GM) showed additive effect on the yield and uptake of micronutrients. Under all GM treatments, the yield and uptake were always higher with 120 kg h^{-1} than with lower level of nitrogen.

Mondal and Swamy (2003) found that application of N (120 kg ha^{-1}) as urea in equal splits during transplanting, tittering, panicle initiation and flowering resulted 11 in the highest number of panicles, number of grains $panicl^{-1}$, 1000-grain weight, straw yield and harvest index.

2.4 Combined effect of chemical fertilizer and organic fertilizer on the growth and yield of rice

The concept of integrated nutrient management is the continuous improvement of soil productivity through appropriate use of fertilizers and organic manure including green manure. Considerable work has been done in India, China, Thailand, Philippines and other countries of the world with respect to the use of green manure (GM), poultry manure (PM) and farmyard manure (FYM) as alternative or supplementary sources of nutrients. In Bangladesh, only limited attempts have been made in this perspective.

Maskina *et al.* (1986) studied the effect of N application on wetland rice in a loamy sand soil amended with cattle manure (60 kg N ha^{-1}) or PM (80 kg N ha^{-1}). The absence of urea N: PM increases the rice grain yield by 98%, which was 2.6 times higher than cattle manure (37%). Rice yield increased linearly with N rates whether or not the soil was amended with organic manure. Urea N equivalent to cattle and PM varied from 21 to 53 kg ha^{-1} and 50 to 123 kg ha^{-1} respectively. Apparent recovery of N from poultry manure ranged from 38 to 82% compared with 51 to 69% from urea and 20 to 25% from cattle manure and pig manure.

Miyazaki *et al.* (1986) found a field experiment with 0-30 t compost ha^{-1} + 0 or 80 kg N ha^{-1} for rice growing on a wet Andosol. Application of 10 and 30 t compost ha^{-1} increased soil ammonium N in the plough layer by 1 and 3 mg per 100 g dry soil, respectively. Compost application increased soil N content, 60% of compost N remained in the soil and 50% of the N released by decomposition was taken up by the rice plants. Increased N uptake increased total DM yield and spikelet number. In cooler year, however, the percentage of ripened grains was lower with 12 heavy applications of compost than in warm years. Compost @ 20 t ha^{-1} gave a relatively stable high rice yield.

The effect of soil fertility and crop performance of different organic fertilizers (rice straw, farm yard manure, water hyacinth compost and tank silt) at different rates and in combination with N fertilizer was studied (Sharma and Mittra, 1991).

Increasing the rates of FYM and water hyacinth compost application up to 15 t ha^{-1} increased rice yield but increasing the rate of rice straw beyond 5 t ha^{-1}did not. Besides chemical fertilizers, organic manure like poultry manure is another good source of nutrient of soil. Experiments on the use and agronomic efficiency of poultry manure showed that 4 t ha^{-1} poultry manure along with 60 kg N ha^{-1}as urea produced grain yield of rice similar to that with 120 kg N ha^{-1}as urea alone (Meelu and Singh, 1991).

Ali (1994) carried out several experiments on integrated nutrient management at different places of Bangladesh. They reported that when Boro rice received total chemical fertilizers followed by Aman rice receiving the same, the combined yield increase over the control was 96 and 86% for grain and straw, respectively. But these figures were 125 and 102% when Boro rice crop was fertilized with 100% chemical fertilizers + 5 t FYM ha^{-1} followed by Aman rice with only 100% chemical fertilizer.

Miah (1994) stated that only the first crop following the application recovered one-fifth to one-half of the nutrient supplied by animal manure, reminder was held as humus to very slow decomposition, 2.4% element being released per annum.

Islam (1995) found a significant yield increase with fertilizers with cowdung compared to fertilizer-N alone in T. Aman rice. In the following rice, the yields with fertilizer-N+ residual of cowdung were higher than fertilizer-N alone.

Flynn *et al.* (1995) studied the residual effect of broiler litter as a supplemental of mineral N and concluded that broiler litter applied in autumn at the rate of 9 t ha^{-1} reduced the mineral N from 44 kg to 22 kg ha^{-1}.

Gupta *et al.* (1995) conducted field trial on different organic manure in India and reported that the application of field manure (10 t ha^{-1}) produced the highest grain yield (4.5 t ha^{-1}) followed by PM and FYM which produced yields of 4.1 and 3.9 ha^{-1} of rice grain respectively. The increase in rice yield with organic manure was 34 to 55% higher over control and 5 to 22% higher over NPK fertilizers.

Gupta *et al.* (1996) concluded that the rate of application of poultry manure could be reduced by 80 kg ha^{-1} of soil with the application of 1% poultry manure (PM). Organic C and available P contents of soil after harvest were increased with PM applications.

Zhang *et al.* (1996) measured various crop response to a mixed municipal solid waste (refuse) bio-solids co-compost (named Nutrin plus) and examined the fate of certain metals associated with Nutri plus compost. There were six treatments cheek, 50, 100 and 200 t compost ha^{-1}, NPKS (75 kg N ha^{-1}, 20 kg P ha^{-1}, 45 kg K ha^{-1}, and 18kg S ha^{-1}), PK (2kg P, 45 kg K ha^{-1}), and three crops: rape, wheat and bearly. The research results showed that the compost slightly increased heavy metal concentrations in the soil but did not cause any phytotoxicity to crops. Yield from 100 and 200 t ha^{-1} application was higher with compost than with NPKS treatment. However, the yield of 50 t ha^{-1} compost application was similar to that of NPKS treatment. The compost apparently was more beneficial in the year of application. The results suggest that Nutri plus compost application generated positive yield response in all three crops. Crop yield increased as the application rate increased.

Singh *et al.* (1996) carried out a field experiment in India where irrigated rice was given 60, 80 or 120 kg N ha^{-1} per year as poultry manure, urea, poultry manure + urea respectively. In the first year, PM did not perform better than urea but in the fourth year, 120 g and 150 kg N as PM produced significantly higher grain yield than the same rate as urea. The PM help to sustain the grain yield of rice during the 3 years while the yield decreased with urea application.

Hossain *et al.* (1997) conducted a field experiment to evaluate the effect of integrated nutrient management on rice cropping in Old Brahmaputra Floodplain soil and found that the grain yield of BR 11 rice increased significantly due to the application of fertilizer alone or in combination with manures over control.

Devi *et al.* (1997) conducted a field trail (1987-93) to develop a system for integrated nutrient supply for a rice-rice cropping sequence. Application of 45:45:45 kg NPK ha^{-1} as mineral fertilizers and 45 kg N ha^{-1} as FYM in the kharif seasons followed by 90:45:45 kg mineral NPK ha^{-1} in the rabi seasons gave the highest yields in all years expect 1993 and application of half of the N in the kharif season or crop residues or green manure gave the highest yield.

Goshal *et al.* (1998) in an experiment with rice found increased grain and dry matter yield when inorganic N fertilizer (50 kg N ha^{-1}) was applied alone or when a combination of organic (10 t FYM ha^{-1} and inorganic N fertilizer 25 kg N ha^{-1}) were applied as compared with organic sources (20 t FYM ha^{-1}) alone.

Mondal and Chettri (1998) conducted field experiment during 1991-93 in West Bangal, India to study integrated nutrient management for high productivity and fertility building under a rice based cropping system with application of S as ammonium sulfate along with green manure in suit and farmyard manure to rice only. The result showed maximum grain yields of rice (4.96 and 5.77 t ha^{-1}) in the wet and dry seasons, respectively.

Yadav (1998) conducted long-term fertilizer experiments on a rice-wheat cropping system at four locations in India. Long-term rice-wheat cropping system resulted in depletion of soil organic carbon and available N and P at two locations but increased in organic carbon, available N and K at the third location. The available P and K content of the soil also increased at the fourth location.

Singh *et al.* (1999) conducted field experiment during the rainy and winter seasons of 1990-91 to 1992-93 at Sari Bhag, Uttar Pradesh, India using recommended rates of N, P. K and Zn (120, 60, 40, 20 kg ha^{-1}) respectively, or 10 15 t ha^{-1} of FYM or rice straw 25 or 50% recommended rates (R.R): N+RRP, K and Zn. Rice yield was the highest with FYM + S50 RRN, followed by the RRN, P. K and Zn.

Liang-Yunjiang *et al.* (1999) observed that a mathematical model which analyzed the effect of application of organic and inorganic fertilizer on yields of rice growing on paddy soils was established. The model was used to study the effect of various factors on yields and to produce a strategy for optimization of management for high rice yields.

Abedin Miah and Mosleahuddain (1999) conducted a long term fertility trail in Sonatala silt-loam soil at Bangladesh Agricultural University farm, Mymensingh to evaluate the effects of continued fertilization and manureing on soil properties and yield of crops. Grain yield of rice increased due to N, P, K and S application but the rate of increase varied in different seasons. Residual S showed remarkable decrease in the yield in Aman season. The yield of Aman showed a decreasing trend over the years but the yield of Aus remained almost static. The NPKSZn treatment maintained its superiority both in T-Aman and Aus rice although the performance of NFYM was very close to NPKSZn treatment. In general, the response of T-Aman to S containing treatments showed a decreasing trend over the years. The availability of P. S and Zn increased in soil due to long continued application. P fertilization also improved the micronutrient status of soil. No considerable changes in K status were noted due to K application. Nutrient balance study showed a severe loss of most of the nutrients through soil degradation.

Singh and Singh (2000) reported that the effect of sewage sludge-based compost in the growth attributes and yield of rice during 1997, in Allhabad, Uttar Pradesh, India. The treatment was control, Jamuna compost at 2520 g ha^{-1} + urea at 986.60 g ha^{-1}, Jamuna compost at 5040 g ha^{-1} + urea at 657.33 g ha^{-1}, Jamuna compost at 7560 g ha^{-1} + urea at 328.60 g ha^{-1}, Jamuna compost at10083 g ha^{-1} + urea at 1315 g ha^{-1}. All the treatment equally received P and 2268.75 g ha^{-1} and potash at 403.33 g ha^{-1}. The plant height was highest at 100% urea application compared to 76.7 cm in Jamuna compost at 105 days after sowing. Similar effect was observed in the number of tillers m^{-2} row length. The fresh and dry weight at rice samples from 100% urea application was 102.8 g and 22.1 g, respectively, in sludge-based Jamuna compost at 75 DAS. The highest grain yield of 44.58 q ha^{-1} was observed in 100% urea application, and it was the least in Jamuna compost

(13.74 q ha^{-1}). However, application of Jamuna compost, alone with urea at 25 and 50%, showed and increase in growth and yield parameters of rice, which was on par with 100% urea application.

Yamagata (2000) a field experiment to determine the growth response of upland rice (*Oryza saliva* L.) and maize (*Zea mays*) to organic nitrogen by amending the soil with an inorganic N source (ammonium sulfate) and with an organic N source. N uptake was highest under the RBS treatment, but the inorganic N concentration in soil was lower when organic and inorganic N was applied together as compared to inorganic N alone. Upland rice also took up more N than maize in a pot experiment with RBS without differences in root spread.

Mannan *et al.* (2000) reported that manuring with cow dung up to 10 t ha^{-1} in addition to recommended inorganic fertilizers with late N application improved grain and straw yields and quality of transplant aman rice over inorganic fertilizer alone.

Rahman (2001) reported that in rice-rice cropping pattern, the highest grain yield of Boro rice was recorded in the soil test basis (STB) N P K S Zn fertilizers treatment while in T. Aman rice the 75% or 100% of N P K S Zn (STB) fertilizers plus GM with or without cow dung gave the highest or a comparable yield. The mean yearly N, P, K, S and Zn uptake by rice (Boro + T. Aman) increased with increasing supply of nutrients. Application of cow dung along with N P K S Zn (STB) resulted in markedly higher uptake of nutrients in Boro rice. In T. Aman rice, application of NPKS (STB) with GM and/or CD showed higher N, P. K, S, Zn uptake than that of NPKS (FRG) and NPK (FP) treatments. The total N content and the available N, P, K, S and Zn status in soils increased slightly due to manuring. The whole results suggested that the integrated use of fertilizers with manure (viz *Sesbania*, cow dung) could be an efficient practice for ensuring higher crop yields without degradation of soil fertility.

Rajni Rani *et al.* (2001) conducted a pot experiment in a glass house of Varanasi, Utter Pradesh, India during kharif season to assess the response of rice to different combinations of vermicompost (VC), poultry manure (PM) and nitrogen fertilizers. Results showed that at integrated treatments significant increase in plant height, number of effective panicles over the treatment having full nitrogen dose through urea.

Channbasavana and Biradar (2001) reported that the application of poultry manure @ 3 t ha^{-1} gave 26% and 19% higher grain yield than that of the control 1998 and 1999, respectively.

Eneji *et al.* (2001) observed that average across the soils, the level of extractable Fe increased by 5% in chicken manure and 71% in cattle manure; Mn by 61 % in chicken manure and 172% in swine manure and Cu by 327% in chicken manure and 978% in swine manure. Mixing these manures before application reduce the level of extractable trace elements.

Singh *et al.* (2001) studied on the effect of poultry manure under irrigated condition with nitrogen in rice-wheat cropping system in an Alfisol of Bilapur, Madhya Pradesh, India. The treatment consisted of poultry manure alone and in combination with nitrogen fertilizer. Root and shoot biomass at different growth stages increased with the application of N and poultry manure alone and combination. Root and shoot biomass were higher in 100% N through poultry manure, followed by 75% N through poultry manure and 25% through urea.

Aal *et al.* (2003) measured then usefulness of supplementing different organic materials viz., water hyacinth compost (HC), town refuse compost (TR) to minimize consuming chemical fertilizers. The results showed that the application of organic materials either alone in combination with chemical fertilizer caused a substantial increase in total N, available P, K and micronutrients (Fe, Mn, Cu, Zn) as well as wheat yield (straw and grain). The importance of organic farming practices in desert sandy soils was emphasized to minimize chemical fertilizer consumption and to avoid environmental pollution.

Davarynejad *et al.* (2004) conducted an experiment to investigate the effect of manure and municipal compost and their enrichment with chemical fertilizers on growth and yield of rice. Results showed that compost alone did not increase grain yield. However, when enriched with different levels of chemical fertilizer the highest amount of grain yield was produced. The yield was comparable to the yield obtained from 40 t ha^{-1} of compost. This indicated that compost might be an appropriate substitute for manure and half of chemical fertilizer needed for soil.

Vijay and Singh (2006) were conducted a field experiment during kharif season of 2003 and 2004 at J.V. college, Baraut, Uttar Pradesh, India, to study the effect of organic manures and fertilizer treatments on growth, yield and yield attributes of rice (*Oryza saliva* cv. Pusa Bashmati). The manure treatment comprises compost. Fertilizer treatments included N at 0, 40, 80 and 120 kg ha^{-1}. Application of compost significantly improved the growth, yield and yield attributes of rice during the years of experimentation. However, the organic manure compost did not show marked variation among the other treatments.

Vanju and Raju (2002) conducted a field experiment on integrated nutrient management practice in rice crop. Different combinations of chemical fertilizer with poultry manure (PM) 2 ha^{-1} gave highest grain and straw yield.

Umanah *et al.* (2003) find out the effect of different rates of poultry manure on the growth. yield component and yield of upland rice cv. Faro 43 in Nigeria. during the 1997 and 1998 early crop production seasons. The treatments comprised 0, 10, 20 and 30 t ha^{-1} poultry manure. There were significant differences in plant height, internodes length, and W. tiller number, panicle number per stand, grain number/panicle, and dry grain yield. There was no significant difference among the treatments for 1000-grain weight.

Channabasavanna (2003) conducted a field experiment to evaluate the efficient utilization of poultry manure with inorganic fertilizers in wetland rice and found that the grain yield increased with each increment of poultry manure application and was maximum at 3 t poultry manure ha^{-1}. Poultry manure at 2 t ha^{-1} recorded significantly higher values for seed yield and its attributes. The study proved the superiority of poultry manure over farmyard manure (FYM). It was evident from the study that one ton of poultry manure was equivalent to 7-ton FYM which produced at per seed yields. Agronomic efficiency of N (AEN) at 75% NPK (112.5:56.3:56.3 kg NPK ha^{-1}) was equivalent to 2 t poultry manure ha^{-1}. The results showed that an increase in poultry manure and fertilizer increased rice seed yield. The AEN decreased with an increase in the application of poultry manure and NPK fertilizer.

Dao and Cavigelli (2003) reported that animal manure had long been used as an organic source of plant nutrients and organic matter to improve the physical and fertility condition of agricultural lands.

Mahavisha *et at.* (2004) investigated a field study during the kharif season of 2001 in Andra Pradcsh, India to investigate the effect of organic fertilizer sources on the growth and yield of rice. The crop growth and yield were higher with 125% recommended fertilizer + poultry manure and 100% RDF + poultry manure compared to the other treatments.

Miah *et al.* (2004) found 5.6-6 t ha^{-1} grain yields with application of 2 t ha^{-1} poultry manure plus 120 kg N ha^{-1} in Boro season.

Saleque *et al.* (2004) conducted a field experiment to determine the effect of different doses of chemical fertilizers alone or in combination with cow dung (CD) and rice husk ash on yield of lowland rice-rice cropping sequence. Cow dung and ash were applied on dry season rice only and found the application of cow dung and ash increased rice yield by about 1 t ha^{-1} per year over that obtained with chemical fertilizer alone, the treatments, which showed positive yield trend, also showed positive total P uptake trend and positive yield trends were attributed to the increasing P supplying power of the soil.

Saleque *et al.* (2004) showed that application of one third of recommended inorganic fertilizers with 5 t cow dung increased the low land rice yield than other treatments and gives yield 8.87t ha^{-1}.

Reddy *et al.* (2005) carried out a field experiment on black clay soils in Gangavati, Karnakata, India, to evaluate the performance of poultry manure (PM) as a substitute for NPK in irrigated rice (cv. IR 64). The application of PM at 5 t ha^{-1} recorded a significantly higher grain yield (5.25 t ha^{-1}) than the control and FYM application at 7.5 t ha^{-1}, significantly improved the soil P and K status, and increased the N content of the soil. Poultry manure at 5 t ha^{-1} resulted in higher gross returns (30592 Rupees ha^{-1}) over other levels of PM and FYM. However, net returns and benefit cost rations were comparable between 5 and 2 t PM ha^{-1} and between 100 and 75% NPK. the application of 2 t PM ha^{-1} and 75% NPK. was found economical.

Miah *et al.* (2006) stated that an application of poultry manure with soil test basis (SIB), IPNS and AEZ based fertilizer gave higher grain yield compared to other organic materials.

XU *et al.* (2008) observed that application of half inorganic fertilizer and half organic manure (swine manure) increase nutrient absorption, panicle number, yield of rice & also increased soil organic matter.

Rahman *et al.* (2009) conducted a field experiment to study the effect of urea N in combination with poultry manure and cow dung in rice and found application of manures and different doses of urea N fertilizer significantly increased the yield components and grain and straw yields.

2.5 Effect of soil fertility and properties for integrated use of fertilizers and manure

Organic materials are widely used to maintain soil fertility and improve soil properties in intensive cropping systems especially in traditional agriculture. Total N, exch. K and available P in soil increased by green manuring. The application of FYM increased organic C, total N, available P, Exchangeable K and CEC than GM (IRRI, 1979).

Application of NPK at 100-150% based on the initial soil test showed appreciable improvement in available soil N, P and K. Organic C content was highest under FYM treatment. Depletion of P was highest under 100% treatment and K under 100% N and P treatment (Singh and Nambiar, 1984).

Bair (1990) stated that sustainable production of crop cannot be maintained by using chemical fertilizers only and similarly it is not possible to obtain higher crop yield by using organic manure alone. Sustainable crop production might be possible through the integrated use of organic manure and chemical fertilizers.

Prasad and Kerketta (1991) conducted an experiment to assess the soil fertility, crop production and nutrient removal for cropping sequences in the presence of recommended doses of fertilizers and cultural practices along with 5 t ha^{-1} compost applied to the crops. There was an overall increase in organic C, increase in total N (83.9%), available N (69.9%), available P (117.3%) and CEC (37.7%).

Bhandari et al. (1992) reported that an application of fertilizers or their combined use with organic manure increased the organic C status of soil. The NPK fertilizers at 100% level and their combined use with organic N also increased the available N and P by 5.22 kg and 0.8-3.8 kg ha^{-1} from their initial values.

Meelu *et al.* (1992) reported that organic C and total N increased significantly when *Sesbania* and *Crotolaria* were applied in the preceded rice crop for two wet seasons.

Nahar *et al.* (1995) had examined the soil condition after one crop cycle (rice wheat). Addition of organic matter during the rice crop doubled the organic C content compared to its original status. Total and available N content were also significantly improved by addition of organic matter, but had less impact on soil exchangeable cations.

Medhi *et al.* (1996) reported that incorporation of organic and inorganic sources of N increased soil solution NH_4-N to a peak and then declined to very low levels.

Palm *et al.* (1996) stated that organic materials influence nutrient availability nutrients added through mineralization - immobilization pattern as energy sources for microbial activities and as precursors to soil organic matter and by reducing P sorption of the soil.

Nimbiar (1997) views that integrated use of organic manure and chemical fertilizers would be quite promising not only in providing greater stability in production, but also in maintaining healthy soil fertility status. Intensive crop production systems have witnessed serious problems associated with loss of soil fertility as a result of excessive soil mining of plant nutrients and consequently reduction in productivity. Application of external source of plant nutrients is a key element in optimal management of soil organic matter, crop residues and manure for ensuring the bio-availability, the cycling and the balance of nutrients in the soil - plant systems.

Mathew and Nair (1997) reported that cattle manure when applied alone or in combination with chemical fertilizer (NPK) increased the organic C content, total N, available P and K in rice soils.

Sarker and Singh (1997) reported that organic fertilizers when applied alone or in combination with inorganic fertilizers increase the level of organic carbon in soil as well as the total N, P and K contents of soil.

Xu et al. (1997) observed that application of organic matters affects soil pH value as well as nutrient level.

Ravankar *et al.* (1999) reported that organic carbon, total N and available P_20_5, K_20, S and Zn in the soil were higher in the plots where nutrients were applied through organics than the inorganic sources.

Santhi *et al.* (1999) observed that application of 100% NPK plus FYM decreased the bulk density and increased the water holding capacity of soil. The decreased in bulk density in FYM treated plots might be ascribed to better aggregation. The water holding capacity was increased due to the improvement in structural condition of soil that was brought about mainly by the application of FYM in combination with NPK fertilizers.

Hemalatha *et al.* (2000) revealed that green manure significantly increased the soil fertility status, organic carbon, available soil N, P and K at post-harvest soil.

Zaman *et al.* (2000) reported that chemical properties like organic matter content CEC, total N, exchangeable K, available P and S were favorably influenced by the application of organic sources of nitrogen and potassium while the organic sources mostly did not show positive effect. Soil pH decreased slightly compared to the initial status. The literature review discussed above indicates that organic manure can supply a good amount of plant nutrients and thus can contribute to crop yields. The properties of soils are also influenced by the inclusion of organic manure and crop residues in the soil fertility management system either directly or through residual action. The integrated approach by using the organic and inorganic sources of nutrients helps improve the efficiency of nutrients.

Chapter III

MATERIALS AND METHODS

The experiment was conducted in front of the department of soil science of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from January 2022 to July 2022 to response of organic and inorganic fertilizers on growth and yield of rice (BRRI dhan28). This chapter includes materials and methods that were used in conducting the experiment. The details are presented below under the following headings –

3.1 Experimental site and soil

The experiment was conducted in typical rice growing silt loam soil in front of the department of soil science at the Sher-e-Bangla Agricultural University, Dhaka during the January 2022 to July 2022. The morphological, physical and chemical characteristics of the soil are shown in the Table 1 and 2.

Table 1. Morphological characteristics of the experimental field

Morphological features	characteristics
Location	SAU, Dhaka.
Agro-ecological zone	Madhupur Tract (AEZ- 28)
General soil Type	Shallow Red Brown Terrace Soil
Land Type	High land
Soil series	Tejgaon
Parent material	Madhupur Terrace.
Topography	Fairly leveled
Drainage	Well drained
Flood level	Above flood level
Cropping pattern	N\A

Table 2. Physical and chemical characteristics of the soil

Physical and chemical properties of the initial soil characteristics	Value
Particle size analysis	
Sand (%)	16.75
Silt (%)	55.60
Clay (%)	27.65
Textural class	Silt Loam
Consistency	Granular and friable when dry.
pH (1: 2.5 soil- water)	5.8
CEC (cmol/kg)	17.9
Organic C (%)	0.686
Organic Matter (%)	1.187
Total N (%)	0.08
Exchangeable K (meq/100 gm soil)	0.12
Available P (mg/kg)	19.85
Available S (mg/kg)	14.40

3.2 Climate

The climate of the experimental area is characterized by high temperature, high humidity and medium rainfall with occasional gusty winds during the kharif season (March-September) and a scanty rainfall associated with moderately low temperature in the rabi season (October-February). the weather information regarding temperature. rainfall, relative humidity and sunshine hours prevailed at the experimental site during the cropping season January 2022 to July 2022 have been presented in Appendix 1.

3.3 Planting material

BRRI dhan28 was used as the test crop in this experiment. This variety was developed at the Bangladesh Rice Research Institute through hybridization or in 1994. It is recommended for Rabi, Boro season and Mid to Late November. Average plant height of the variety is 90-95 cm at the ripening stage. It requires about 155-160 days completing its life cycle with an average grain yield of 6 t ha^{-1} (BRRI. 2016).

3.4 Pot preparation

The soil of the pot was first prepared on 3 March 2022. At first soil clods were broken and made it fine soil by hand then the soil put in the pot and poured the water till saturated condition. This is kept overnight without any disturbances. Before transplanting each pot was cleaned by removing the weeds, stubbles and crop residues. Finally, each pot was prepared by puddling. (Appendix II)

3.5 Experimental design and layout

The pot experiment was laid out two factors following randomized complete block design (RCBD) with three replications. Three extra replications were planted which were used for taking growth data. The size of the individual pot was 22 cm diameter and 25cm on height and total numbers of pots were 28. Organic manure was assigned as the main factor and fertilizer was assigned as sub-factor.

3.6 Initial soil sampling

Before land preparation, initial soil samples were collected from different pots of the experiment. The composite soil sample were air-dried, crushed and passed through a 2 mm (8 meshes) sieve. After sieving, the soil samples were kept in a plastic container for physical and chemical analysis of the soil.

3.7 Treatments

Two different types of organic manure (cowdung and poultry manure) were used in the study. The experiment consisted of 8 treatments. The treatments were be as follows:

T_0: Control

T_1: 100% RDCF ($N_{120}P_{20}K_{40}S_{20}Zn_{2.5}$ Kg ha^{-1})

T_2: 100% Cow dung (10 t ha^{-1})

T_3: 100% Poultry Manure (5 t ha^{-1})

T_4: 50% RDCF + 50% Cow dung

T_5: 50% RDCF +50% Poultry Manure

T_6: 25% RDCF + 75% Cow dung

T_7: 25% RDCF + 75% Poultry Manure

3.8 Fertilizer application

The amounts of N, P, K, S and Zn fertilizers required per pot were calculated as per the treatments. Full amounts of TSP, MP and gypsum were applied as basal dose before transplanting of rice seedlings. Urea was applied in 3 equal splits: one third was applied at basal before transplanting. one third at active tittering stage (30 DAT) and the remaining one third was applied at 5 days before panicle initiation stage (60 DAT).

Two different types of organic manure viz. cowdung and poultry manure were used. The rates of manure were 10, 5 and 2.5 t ha^{-1} for cowdung & 5, 2.5 and 1.25 t ha^{-1} for poultry manure per pot were calculated as per the treatments respectively. Cowdung and poultry manures were applied before four days of final land preparation. Chemical compositions of the manures used have been presented in Table 3.

Table 3. Chemical compositions of the cowdung and poultry manure (Oven dry basis)

Sources of organic manure	Nutrient content					
	C (%)	N (%)	P (%)	K (%)	S (%)	C:N
Cowdung	36	1.48	0.29	0.75	0.21	24
Poultry manure	29	2.19	1.98	0.81	0.34	8

3.9 Raising of seedlings

The seedlings of rice were raised wet-bed methods. Seeds (95% germination) @ 5 kg ha^{-1} were soaked and incubated for 48 hour and sown on a well-prepared seedbed. During seedling growing no fertilizers were used. Proper water and pest management practices were followed whenever required.

3.10 Transplanting

Forty days old seedlings of BRRI dhan28 were carefully uprooted from the seedling nursery and transplanted on 5 March 2022 in well puddled pot. Four seedlings per hill were used each pot. After one week of transplanting all pots were checked for any missing hill. which was filled up with extra seedlings whenever required.

3.11 Intercultural operations

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

3.11.1 Irrigation

Necessary irrigations were provided to the pots as and when required during the growing period of rice crop.

3.11.2 Weeding

The pots were infested with some common weeds, which were removed by uprooting them from the field three times during the period of the cropping season.

3.11.3 Netting

By using net plant protection from various insects, pests and birds.

3.12 Crop harvest

The crop was harvested at full maturity when 80-90% of the grains were turned into straw colored on 13 July 2022. The crop was cut at the ground level and pot wise crop was bundled separately and brought to the threshing floor.

3.13 Field components

1. Plant Height
2. Tillers Hill^{-1}
3. Leaf length
4. Grains Panicle^{-1}
5. Panicle Length
6. Seed Weight
7. Grain Yield
8. Straw Yield
9. Harvest Index

3.13.1 Plant height

The height of plant was recorded in centimeter (cm) at the time of 30, 60, 90 days and at harvesting stage. Beginning from the ground level up to tip of the flag leaf was counted as height of the plant. The average height of two hills was considered as the height of the plant for each pot. (Appendix III)

3.13.2 Tillers per hill

The number of tillers hill^{-1} was recorded at the time of 30, 60, 90 and at harvest days by counting total tillers. The average number of tillers of two hills was considered as the total tiller no hill^{-1}

3.13.3 Leaf length

The length of flag leaf was measured as the average of 2 plants selected at random from all plants of each pot. The length was measured from the base to tip of the flag leaf.

3.13.4 Grain per panicle

The total numbers of grain were collected randomly from two hills of a pot by adding filled and unfilled grain and then average numbers of grain per panicle was recorded.

3.13.5 Panicle length

The length of panicle was measured with a meter scale from two hills and the average value was recorded as per plant.

3.13.6 Seed weight

One thousand seeds were counted randomly from two hills the total cleaned harvested seeds and then weighted in grams and recorded.

3.13.7 Grain yield

Two hills pot^{-1} were harvested for grain yield measurement. The crop of each pot was bundled separately, tagged properly and brought to threshing floor and brought to threshing floor. The bundles were dried in open sunshine, threshed and then grains were cleaned. The grain and straw weights for each pot were recorded after proper drying in sun after that the weight was converted to t ha^{-1}.

3.13.8 Straw yield

Two hills pot^{-1} were harvested for straw yield measurement. The crop of each pot was bundled separately, tagged properly and brought to threshing floor. The bundles were dried in open sunshine, threshed and then grains were cleaned. The grain and straw weights for each pot were recorded after proper drying in sun after that the weight was converted to t ha^{-1}.

3.13.9 Harvest index

Harvest index was calculated from the grain and straw yield of rice for each pot and expressed in percentage

$$HI = \frac{\text{Economic yield (grain weight)}}{\text{Biological yield (Total dry weight)}}$$

3.14 Statistical analysis

The data obtained for different parameters were statistically analyzed to find out the significant difference of different treatments on yield and yield contributing characters of BRRI dhan28. The mean values of all the characters were calculated and analysis of variance was performed by the F (variance ratio) test. The significance of the difference among the treatment means was estimated by the randomized Complete Block design (RCBD) at 5% level of probability (Gomez and Gomez, 1984).

Chapter IV

RESULTS AND DISCUSSION

The experiment was conducted to response of organic and inorganic fertilizers on growth and yield of rice (*Oryza sativa*). Data on different growth parameter and yield was recorded. The analyses of variance (ANOVA) of the data on different parameters are presented in Appendix IV-VI. The results have been presented and possible interpretations given under the following headings:

4.1 Yield contributing characters and yield of rice

4.1.1 Plant height

Statistically significant variation was recorded for plant height of BRRI dhan28 due to the application of various organic manure and inorganic fertilizer at 30, 60, 90 DAT and at harvest (Appendix IV).

Table 4. Effect of various organic manure and inorganic fertilizers on plant height of BRRI dhan28

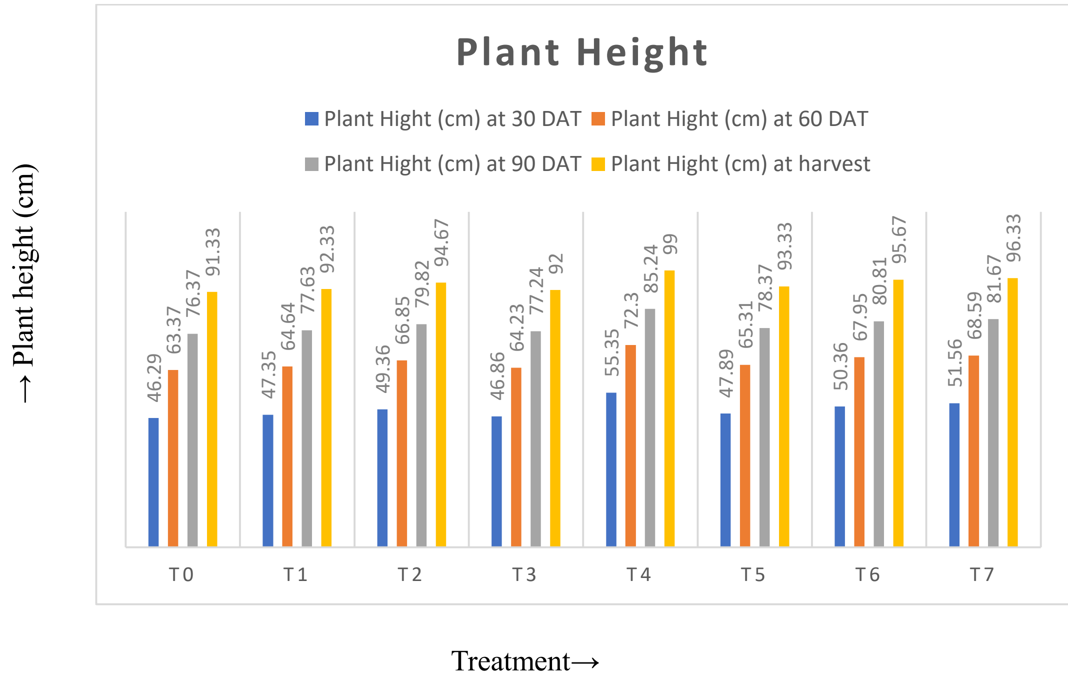
Treatment	Plant Hight (cm) at 30 DAT	Plant Hight (cm) at 60 DAT	Plant Hight (cm) at 90 DAT	Plant Hight (cm) at harvest
T_0	46.29 d	63.37 d	76.37 d	91.33 d
T_1	47.35 cd	64.64 bcd	77.63 bcd	92.33 cd
T_2	49.36 bcd	66.85 bcd	79.82 bcd	94.67 bcd
T_3	46.86 cd	64.23 cd	77.24 cd	92.00 cd
T_4	55.35 a	72.30 a	85.24 a	99.00 a
T_5	47.89 bcd	65.31 bcd	78.37 bcd	93.33 bcd
T_6	50.36 bc	67.95 bc	80.81 bc	95.67 abc
T_7	51.56 ab	68.59 ab	81.67 b	96.33 ab
LSD	4.06	4.11	4.09	3.92
CV	4.75	3.56	2.97	2.40

[Here, T_0: Control, T_1: 100% RDCF ($N_{120}P_{20}K_{40}S_{20}Zn_{2.5}$ Kg ha^{-1}), T_2: 100% Cow dung (10 t ha^{-1}), T_3: 100% Poultry Manure (5 t ha^{-1}), T_4: 50% RDCF + 50% Cow dung, T_5: 50% RDCF +50% Poultry Manure, T_6: 25% RDCF + 75% Cow dung, T_7: 25% RDCF + 75% Poultry Manure]

At the different days after transplanting (DAT) the highest plant height (55.35 cm. 72.30 cm. 85.24 cm and 99.00 cm) was recorded from T_4(50% RDOCF + 50% Cowdung) which was statistically similar (51.56 cm, 68.59 cm, 81.67 cm and 96.33 cm) with T_7(25% RDCF + 75% Poultry Manure) treatment at 30, 60, 90 DAT and at harvest respectively.

On the other hand, at the same DAT the lowest plant height (46.29 cm, 63.37 cm. 76.37 cm and 91.33 cm) was observed from T_0 as control condition which was closely followed (46.86 cm, 64.23 cm. 77.24 cm and 92.00 cm) by T_3 as 100% Poultry Manure and also T_1 and T_2 treatments (Table 4 and Figure 1).

Effect of various organic manures and inorganic fertilizers on plant height at 30 DAT, 60DAT, 90 DAT and at Harvest of BRRI dhan28 are show in Figure 1 bellow.



[Here, T_0: Control, T_1: 100% RDCF ($N_{120}P_{20}K_{40}S_{20}Zn_{2.5}$ Kg ha^{-1}), T_2: 100% Cow dung (10 t ha^{-1}), T_3: 100% Poultry Manure (5 t ha^{-1}), T_4: 50% RDCF + 50% Cow dung, T_5: 50% RDCF +50% Poultry Manure, T_6: 25% RDCF + 75% Cow dung, T_7: 25% RDCF + 75% Poultry Manure]

Figure 1. Effect of various organic manure and inorganic fertilizer on plant height at 30 DAT, 60DAT, 90 DAT and at Harvest of BRRI dhan28

From the data it was revealed that all the treatments produced significantly taller plants compared to the control treatment. The combined application of fertilizers with manure increased the plant height compared to single application of recommended dose of fertilizers. Plant height was significantly influenced by the application of organic manure and chemical fertilizers reported by Babu *et al.* (2001) earlier from an experiment. Similar results also reported by Rajani Rani *et al*. (2001). Singh *et al.* (1999), Hossain *et al*. (1997) and Sharma and Mitra (1991) also observed similar results.

4.1.2 Number of tillers per hill

Number of tillers per hill of BRRI dhan28 at growth stages showed statistically significant variation due to the application of various organic manure and inorganic fertilizer at 30, 60, 90 DAT and at harvest (Appendix V).

Table 5. Effect of various organic manure and inorganic fertilizer on number of total tillers per hill of BRRI dhan28

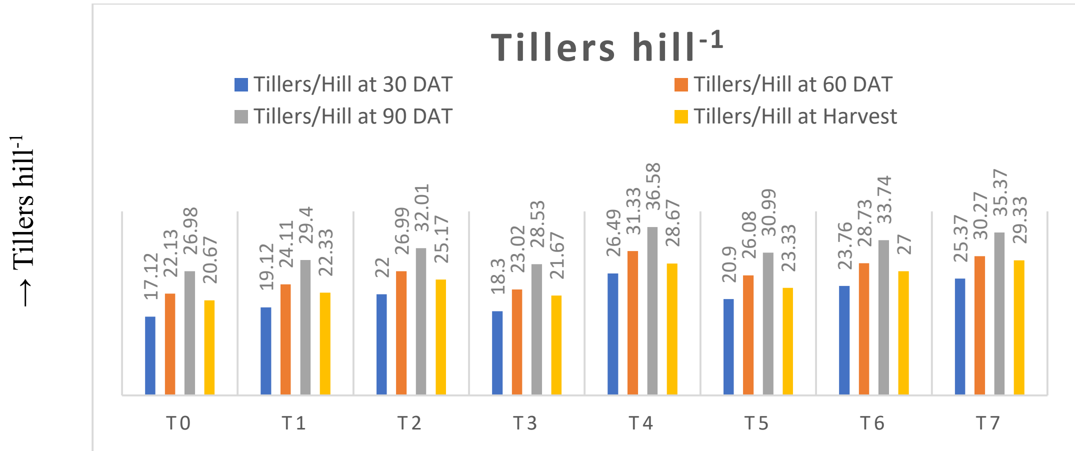
Treatment	Tillers/Hill at 30 DAT	Tillers/Hill at 60 DAT	Tillers/Hill at 90 DAT	Tillers/Hill at Harvest
T_0	17.12 f	22.13 f	26.98 g	20.67 d
T_1	19.12 ef	24.11 ef	29.40 ef	22.33 bc
T_2	22.00 cd	26.99 cd	32.01 cd	25.17 ab
T_3	18.30 f	23.02 f	28.53 fg	21.67 cd
T_4	26.49 a	31.33 a	36.58 a	28.67 a
T_5	20.90 de	26.08 de	30.99 de	23.33 bc
T_6	23.76 bc	28.73 bc	33.74 bc	27.00 bc
T_7	25.37 ab	30.27 ab	35.37 ab	29.33 ab
LSD	2.07	2.25	1.90	2.17
CV	5.54	4.89	3.46	4.01

[Here, T_0: Control, T_1: 100% RDCF ($N_{120}P_{20}K_{40}S_{20}Zn_{2.5}$ Kg ha^{-1}), T_2: 100% Cow dung (10 t ha^{-1}), T_3: 100% Poultry Manure (5 t ha^{-1}), T_4: 50% RDCF + 50% Cow dung, T_5: 50% RDCF +50% Poultry Manure, T_6: 25% RDCF + 75% Cow dung, T_7: 25% RDCF + 75% Poultry Manure]

At the different days after transplanting (DAT) the maximum number of tillers per hill (26.49, 31.33, 36.58 and 12.67) was observed from T_4 (50% RDOCF + 50% Cowdung) which was statistically similar (25.37, 30.27, 35.37 and 10.33) with T_7 (25% RDCF + 75% Poultry Manure) at 30, 60, 90 DAT and at harvest respectively (Table 5).

Again, at the same DAT the minimum number of total tillers per hill (17.12, 22.13, 26.98 and 5.67) was observed from T_0 as control condition which was closely followed (18.30, 23.02, 28.53 and 7.67) by T_3 as 100% poultry manure (Table 5 and Figure 2). It was revealed that all the treatments produced significantly maximum number of tillers compared to the control treatment.

Effect of various organic manure and inorganic fertilizer on total tillers per hill at 30 DAT, 60DAT, 90 DAT and at Harvest of BRRI dhan28 show in Figure



[Here, T_0: Control, T_1: 100% RDCF ($N_{120}P_{20}K_{40}S_{20}Zn_{2.5}$ Kg ha^{-1}), T_2: 100% Cow dung (10 t ha^{-1}), T_3: 100% Poultry Manure (5 t ha^{-1}), T_4: 50% RDCF + 50% Cow dung, T_5: 50% RDCF +50% Poultry Manure, T_6: 25% RDCF + 75% Cow dung, T_7: 25% RDCF + 75% Poultry Manure]

Figure 2. Effect of various organic manure and inorganic fertilizer on total tillers per hill at 30 DAT, 60DAT, 90 DAT and at Harvest of BRRI dhan28

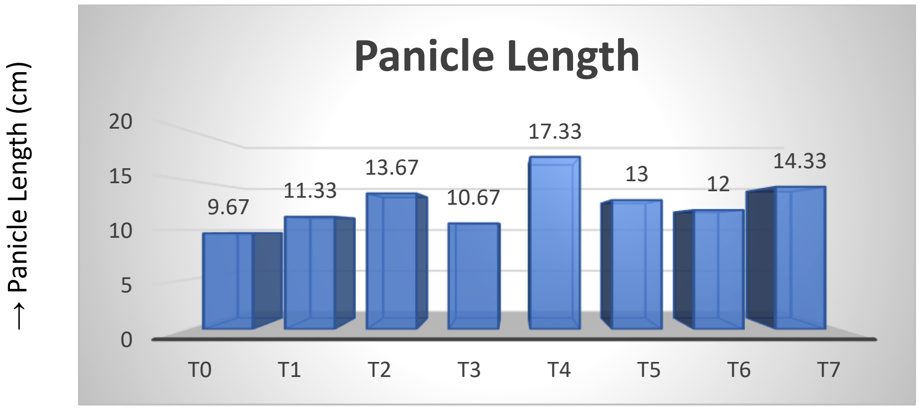
4.1.3 Panicle Length

Panicle length of BRR1 dhan28 showed statistically significant variation due to the application of various organic manure and inorganic fertilizer (Appendix VI).

The highest Panicle length (17.33 cm) was found from T_4 (50% RDCF + 50% cowdung) which was statistically similar (14.33 cm) with T_7 (25% RCDF + 75% Poultry Manure). On the other hand, the minimum Panicle length (9.67 cm) was observed from T_0 as control condition which was closely followed (10.67 cm, 11.33 cm, 12.00 cm and 13.00 cm) by T_3, T_1 T_6 and T_5 as 100% Poultry Manure, 100% RDCF, 25% RDCF + 75% cowdung, 50% RDCF + 50% poultry manure (Table 6 and Figure 3).

Haque (1992) and Azim (1999) noted a significant increase in panicle length due to the application of organic manure and chemical fertilizers. Babu *et al.* (2001), Ahmed and Rahman (1991) and Apostol (1989) also reported similar results.

Effect of various organic manure and inorganic fertilizer on panicle length show in Figure



[Here, T_0: Control, T_1: 100% RDCF ($N_{120}P_{20}K_{40}S_{20}Zn_{2.5}$ Kg ha^{-1}), T_2: 100% Cow dung (10 t ha^{-1}), T_3: 100% Poultry Manure (5 t ha^{-1}), T_4: 50% RDCF + 50% Cow dung, T_5: 50% RDCF +50% Poultry Manure, T_6: 25% RDCF + 75% Cow dung, T_7: 25% RDCF + 75% Poultry Manure]

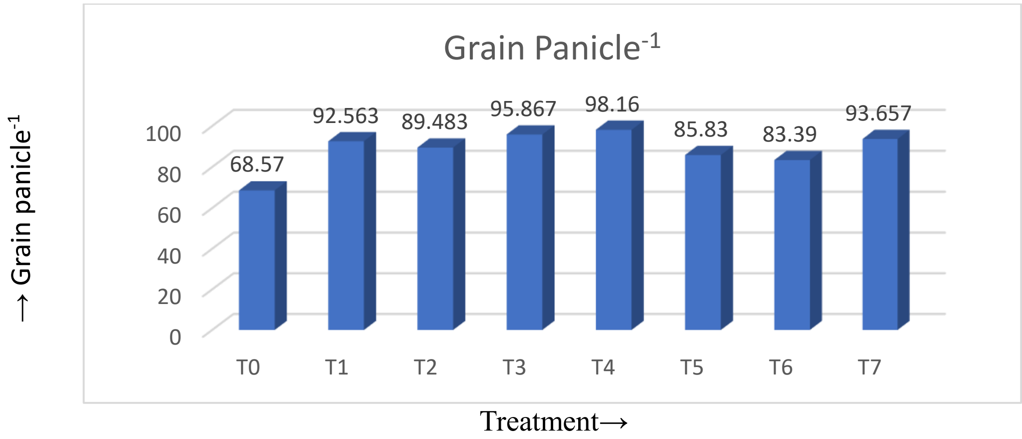
Figure 3. Effect of various organic manure and inorganic fertilizer on panicle length of BRRI dhan28

4.1.4 Grain per panicle

A statistically significant variation was recorded for number of total grains per panicle of BRRI dhan28 due to the application of various organic manure and inorganic fertilizer (Appendix VI).

The maximum grain per panicle (98.16) was found from T_4 (50% RDCF + 50% cowdung). On the other hand, the minimum grain per panicle (68.57) was recorded from T_0 as control condition (Table 6 and Figure 4). The effect of manure on increasing the number of grains panicle^{-1} was more pronounced as compared to fertilizers. This might he due to more availability of nutrient from the manure. Grains panicle^{-1} significantly increased due to the application of organic manures and chemical fertilizers (Razzaque. 1996). These results are also in agreement with Haque (1999) and Azim (1996).

Effect of various organic manure and inorganic fertilizer on grains per panicle show in Figure



[Here, T_0: Control, T_1: 100% RDCF ($N_{120}P_{20}K_{40}S_{20}Zn_{2.5}$ Kg ha^{-1}), T_2: 100% Cow dung (10 t ha^{-1}), T_3: 100% Poultry Manure (5 t ha^{-1}), T_4: 50% RDCF + 50% Cow dung, T_5: 50% RDCF +50% Poultry Manure, T_6: 25% RDCF + 75% Cow dung, T_7: 25% RDCF + 75% Poultry Manure]

Figure 4. Effect of various organic manure and inorganic fertilizer on grains per panicle of BRRI dhan28

4.1.5 Seed Weight

Weight of 1000 seeds of BRR1 dhan28 showed statistically signilicant variation due to the application of various organic manure and inorganic fertilizer (Appendix VI).

The highest seed weight (21.08 g) was found from T_4 (50% RDCF + 50% cowdung) which was statistically similar (19.67 g) with T_7 (25% RCDF + 75% Poultry Manure). On the other hand, the minimum seed weight (16.00 g) was observed from T_0 as control condition which was closely followed (16.92 g) by T_3 as 100% Poultry Manure (Table 6).

Abedin *et al.* (1999) reported that the combined application of organic manure and chemical fertilizers increased the 1000-grain weight of rice. Apostol (1989) observed that application of organic manure and chemical fertilizer increased 1000-grain weight of rice. Haque (1992) also recorded that 1000-grain weight were increased by the application of organic manure. Statistically similar thousand-grain-weight was observed in maximum treatments.

Table 6. Effect of various organic manure and inorganic fertilizer on yield contributing characters and yield of BRRI dhan28

Treatment	Panicle Length (cm)	Grain panicle^{-1}	1000 Seed Weight (g)	Grain Yield (t/ha)	Straw Yield (t/ha)	Biological Yield (t/ha)	Harvest Index (%)
T_0	9.67 c	68.57 g	16.00 d	1.75 e	4.67 d	3.21 e	31.50 e
T_1	11.33 bc	92.56 c	17.75 bcd	3.77 d	5.67 cd	4.72 cd	36.67 cde
T_2	13.67 abc	89.48 d	18.67 bc	4.72 bc	6.58 bc	5.65 bc	40.00 bc
T_3	10.67 bc	95.87 b	16.92 cd	3.87 cd	4.83 d	4.35 de	33.33 de
T_4	17.33 a	98.16 a	21.08 a	5.95 a	8.42 a	7.19 a	50.33 a
T_5	13.00 bc	85.83 e	18.17 bcd	4.67 bc	6.00 bcd	5.33 bcd	38.33 bcd
T_6	12.00 bc	83.39 f	18.33 bc	4.54 bcd	6.67 bc	5.61 bc	41.67 bc
T_7	14.33 ab	93.66 c	19.67 ab	5.35 b	7.33 ab	6.34 ab	43.00 b
LSD	2.69	3.71	1.68	1.03	1.48	1.11	5.33
CV	18.81	5.07	7.14	11.35	14.60	9.30	7.93

[Here, T_0: Control, T_1: 100% RDCF ($N_{120}P_{20}K_{40}S_{20}Zn_{2.5}$ Kg ha^{-1}), T_2: 100% Cow dung (10 t ha^{-1}), T_3: 100% Poultry Manure (5 t ha^{-1}), T_4: 50% RDCF + 50% Cow dung, T_5: 50% RDCF +50% Poultry Manure, T_6: 25% RDCF + 75% Cow dung, T_7: 25% RDCF + 75% Poultry Manure]

4.1.6 Grain yield

Due to the application of various organic manures and inorganic fertilizer grain yield of BRRI dhan28 showed statistically significant differences (Appendix VI).

The highest grain yield (5.95 t/ha) was obtained from T_4 (50% RDCF + 50% cowdung). On the other hand, the lowest grain yield (1.75 t/ha) was found from T_0 as control condition (Table 6). Application of NPKSZn + cowdung or poultry manure increasing the grain yield of BRR1 dhan28 as compared to only poultry manure and only cowdung. Devivedi and Thakur (2000) reported the grain yield was signiticantly increased due to application of organic manure and chemical fertilizers. This is also in agreement with the findings of Rajni Rani *et al.* (2001), Haque *et al.* (2001), Ahmed and Rhaman (1991).

4.1.7 Straw yield

Straw yield of BRRI dhan28 varied significantly due to the application of various organic manure and inorganic fertilizer (Appendix VI).

The highest straw yield (8.42 t/ha) was obtained from T_4 (50% RDCF + 50% cowdung) which was statistically similar (7.33 t/ha) with T_7 (25% RCDF + 75% Poultry Manure). On the other hand, the lowest straw yield (4.67 t/ha) was found from T_0 as control condition which was closely followed (5.67 t/ha) by T_2 as100% cowdung (Table 6). Ahmed and Rahman (1991) reported that the application of organic manure and chemical fertilizers increased the straw yields of rice. These findings are well corroborated with the work of Islam (1997) and Khan (1998). It is clear that organic manure in combination with inorganic fertilizers encouraged vegetative growth of plants and thereby increasing straw yield.

4.1.8 Biological yield

Biological yield of BRRI dhan28 varied significantly due to the application of various organic manure and inorganic fertilizer.

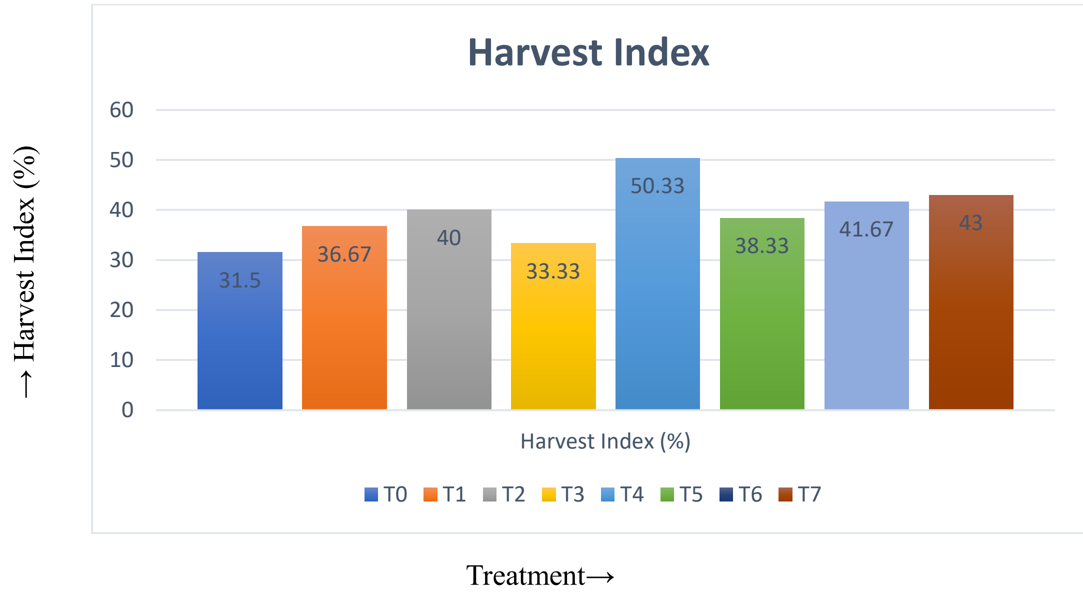
The highest biological yield (7.19 t/ha) was obtained from T_4 (50% RDCF + 50% cowdung) which was statistically similar (6.34 t/ha) with T_7 (25% RCDF + 75% Poultry Manure). On the other hand, the lowest biological yield (3.21 t/ha) was found from T_0 as control condition which was closely followed (4.35 t/ha) by T_3 as100% Poultry Manure (Table 6).

4.1.9 Harvest index

Harvest index of BRRI dhan28 showed statistically significant variation due to the application of various organic manure and inorganic fertilizer (Appendix VI).

The highest harvest index (50.33 %) was found from T_4 (50% RDCF + 50% cowdung) and the lowest harvest index (31.50 %) was observed from T_0 as control condition which was closely followed (33.33 %) by T_3 as 100% Poultry Manure (Table 6 and Figure 5).

Effect of various organic manure and inorganic fertilizer on harvest index show in figure



[Here, T_0: Control, T_1: 100% RDCF ($N_{120}P_{20}K_{40}S_{20}Zn_{2.5}$ Kg ha^{-1}), T_2: 100% Cow dung (10 t ha^{-1}), T_3: 100% Poultry Manure (5 t ha^{-1}), T_4: 50% RDCF + 50% Cow dung, T_5: 50% RDCF +50% Poultry Manure, T_6: 25% RDCF + 75% Cow dung, T_7: 25% RDCF + 75% Poultry Manure]

Figure 5. Effect of various organic manure and inorganic fertilizer on harvest index of BRRI dhan28

Chapter V

SUMMARY AND CONCLUSION

The experiment was conducted at rearch field in front of the department of soil science of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from January 2022 to July 2022 to response of organic and inorganic fertilizers on growth and yield of rice (BRRI dhan28). BRRI dhan28 was used as the test crop in this experiment. The experiment consisted of 8 treatments. Such as T_0 (Control), T_1 (100% RDCF: $N_{120}P_{20}K_{40}S_{20}Zn_{2.5}$ Kg ha^{-1}), T_2 (100% Cow dung 10 t ha^{-1}), T_3 (100% Poultry Manure 5 t ha^{-1}), T_4 (50% RDCF + 50% Cow dung), T_5 (50% RDCF +50% Poultry Manure), T_6 (25% RDCF + 75% Cow dung), T_7 (25% RDCF + 75% Poultry Manure). The experiment was laid out in a complete randomized design with three replications. At 30, 60, 90 DAT and at harvest the tallest plant (55.35cm. 72.30 cm. 85.24 cm and 99.00 cm) was recorded from T_4 and the lowest (46.29 cm, 63.37 cm. 76.37 cm and 91.33 cm) was observed from T_0. At 30, 60, 90 DAT and at harvest the maximum number of tillers per hill (26.49, 31.33, 36.58 and 28.67) was recorded from T_4 again the minimum (17.12, 22.13, 26.98 and 20.67) was observed from T_0. The maximum number grain per panicle (98.16) was recorded from T_4 and the minimum (68.57) was observed from T_0. The highest length of panicle (17.33 cm) was recorded from T_4 and the lowest length of panicle (9.67 cm) was observed from T_0. The highest weight of 1000 seeds (21.08 g) were recorded from T_4 and the lowest (16.00 g) was observed from T_0. The highest grain yield (5.95 t/ha) was recorded from T_4 again the lowest (1.75 t/ha) was observed from T_0. The highest straw yield (8.42 t/ha) was recorded from T_4, and the lowest (4.67 t/ha) was observed from T_0. The highest biological yield (7.19 %) was recorded from T_4 and the lowest biological yield (3.21 %) was observed from T_0. The highest harvest index (50.33 %) was recorded from T_4 and the lowest harvest index (31.50 %) was observed from T_0. From the above discussion it can be concluded that application of 50% RDCF + 50% Cowdung was most favorable for improving yield and yield contributing characters of BRRI dhan28.

Before recommend findings of the present study. the following recommendations and suggestions may be made:

- Such study is needed in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability and other performance.
- Another combination of RDCF and others organic manures with different combination may be included for further study.

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APPENDICES

Appendix I. Monthly record of air temperature, rainfall and relative humidity of the experimental site during the period from December 2007 to April 2008

Year	Month	Temperature (°c)		Rainfall (inch)	Relative humidity (%)
		Max.	Min.		
2022	March	33	21	1.3	50
	April	34	24	3.4	80
	May	34	25	7.0	100
	June	32	26	9.2	100
	July	30	26	9.7	100

Appendix II. Pot preparation

Appendix III. Measuring plant height

Appendix IV. Analysis of variance of the data on plant height BRRI dhan28 as influenced by various organic manure and inorganic fertilizer

Source of variation	Degrees of freedom	Mean square			
		Plant height (cm) at			
		30 DAT	60 DAT	30 DAT	harvest
Treatment	7	27.237	25.650	25.296	20.191
Error	16	5.506	5.646	5.591	5.125

Appendix V. Analysis of variance of the data on number of tillers per hill of BRRI dhan28 as influenced by various organic manure and inorganic fertilizer

Source of variation	Degrees of freedom	Mean square			
		Number of tillers per hill at			
		30 DAT	60 DAT	30 DAT	harvest
Treatment	7	34.554	34.202	34.197	13.653
Error	16	1.434	1.687	1.203	2.323

Appendix VI. Analysis of variance of the data on yield contributing characters and yield of BRRI dhan28 as influenced by various organic manure and inorganic fertilizer

Source of variation	Degrees of freedom	Mean square					
		Panicle Length (cm)	Grain panicle^{-1}	1000 Seed Weight (g)	Grain Yield (t/ha)	Straw Yield (t/ha)	Harvest Index (%)
Treatment	7	17.50	198.13	7.40	5.26	4.75	105.34
Error	16	4.20	4.04	0.85	0.25	0.65	8.71