SELECTION OF ORGANIC FERTILIZERS RESPONSIVE TRANSPLANTED AROMATIC AMAN RICE CULTIVARS

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SELECTION OF ORGANIC FERTILIZERS RESPONSIVE TRANSPLANTED AROMATIC AMAN RICE CULTIVARS

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This is to certify that thesis entitled, "SELECTION OF ORGANIC FERTILIZERS RESPONSIVE TRANSPLANTED AROMATIC AMAN RICE CULTIVARS" submitted to the Department of Soil science, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfilment of the requirement for the degree of MASTER OF SCIENCE (MS) in SOIL SCIENCE, embodies the result of a piece of bona-fide research work carried out by NURSHAD JAHAN, Registration no. 19-10226 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 acknowledge.

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DEDICATED TO

MY

BELOVED PARENTS

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SELECTION OF ORGANIC FERTILIZERS RESPONSIVE TRANSPLANTED AROMATIC AMAN RICE CULTIVARS

ABSTRACT

A pot experiment was conducted during the period from June to December 2021 in Aman season at Sher-e-Bangla Agricultural University, Dhaka to investigate the effect of the different organic fertilizer on the growth and yield of transplanted aromatic aman rice varieties.The experiment was laid out in Completely Random Design (CRD) with 2 factor and four replications. Factor A: Different rice varieties (7) viz: V_1: Kaloshila, V_2: Chinigura, V_3: Gobindobhog, V_4: Kataribhog, V_5: Tulshimala, V_6: Kalijira, V_7: BRRI dhan34 and Factor B: Application of different organic manures (3) viz: T_1: 150 g CD pot^{-1}, T_2: 150 g VC pot^{-1} and T_3: 30 g MOC pot^{-1}. For the purpose of evaluating the experiment's outcomes, data on various parameters were evaluated. Experimental result revealed that in comparison to other rice varieties, BRRI dhan34 (V_7) rice variety performed best in different organic fertilizer treatments and recorded the highest average plant height (121.08 cm), effective tiller number hill^{-1} (10.00), grain weight pot^{-1} (17.81 g) and straw weight pot^{-1} (37.40 g) comparable to other varieties. Different organic manure application influenced the growth and yield attributes of transplanted aromatic aman rice varieties, and the highest average plant height (120.39 cm), effective tiller number hill^{-1}of rice (9.36), grain weight pot^{-1} of rice (20.58 g) and straw weight pot^{-1} of rice (44.92 g) were obtained in 150 g vermicompost treated pot (T_2). In case of combination, the highest average plant height (128.50 cm), effective tiller number hill^{-1} (14.25), grain weight pot^{-1} (24.56 g) and straw weight pot^{-1}of rice (54.60 g) were observed in V_7T_2 combination treatment. Therefore, cultivating BRRI dhan34 in combination with the application of 150 g VC pot^{-1} for rice production resulted in a higher grain weight than the other organic treatments and was suitable for organic rice production comparable to other treatment combination.

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ABBREVIATIONS

Full word	Abbreviations	Full word	Abbreviations
Agriculture	Agric.	Milliliter	Ml
Agro-Ecological Zone	AEZ	Milliequivalents	Meqs
And others	et al.	Triple super phosphate	TSP
Applied	App.	Milligram(s)	Mg
Asian Journal of Biotechnology and Genetic Engineering	AJBGE	Millimeter	mm
Bangladesh Agricultural Research Institute	BARI	Mean sea level	MSL
Bangladesh Bureau of Statistics	BBS	Metric ton	MT
Biology	Biol.	North	N
Biotechnology	Biotech.	Nutrition	Nutr.
Botany	Bot.	Pakistan	Pak.
Centimeter	Cm	Negative logarithm of hydrogen ion concentration (-log[H+])	pH
Completely randomized design	CRD	Plant Genetic Resource Centre	PGRC
Cultivar	Cv.	Regulation	Regul.
Degree Celsius	°C	Research and Resource	Res.
Department	Dept.	Review	Rev.
Development	Dev.	Science	Sci.
Dry Flowables	DF	Society	Soc.
East	E	Soil plant analysis development	SPAD
Editors	Eds.	Soil Resource Development Institute	SRDI
Emulsifiable concentrate	EC	Technology	Technol.
Entomology	Entomol.	Tropical	Trop.
Environment	Environ.	Thailand	Thai.
Food and Agriculture Organization	FAO	United Kingdom	U.K.
Gram	G	University	Univ.
Horticulture	Hort.	United States of America	USA
International	Intl.	Wet table powder	WP
Journal	J.	Serial	Sl.
Kilogram	Kg	Percentage	%
Least Significant Difference	LSD	Number	No.

CHAPTER I

INTRODUCTION

Rice (*Oryza sativa* L.) is the most important food crop and a primary food source for more than one-third of world's population (Sarkar *et al.,* 2017). Worldwide, rice provides 27% of dietary energy supply and 20% dietary protein (Mohidem *et al.*, 2022). It constitutes 95% of the cereal consumed and supplies more than 80% of the calories and about 50% of the protein in the diet of the general people of Bangladesh (Hossain *et al*., 2008). In Bangladesh, majority of food grains comes from rice. Rice has tremendous influence on agrarian economy of the country. Annual production of rice in Bangladesh is about 36.28 million tons from 11.52 million ha of land (BBS, 2021). According to the U.S. Department of Agriculture (USDA) report in 2021 rice production for the 2020-21 marketing year is expected to rise to 36.3 million tons in Bangladesh as further cultivation of hybrid and high yield variety plantings increase. The country is expected to import 200,000 tons of rice in the 2020-21 marketing year to ease food security tensions brought on by the COVID-19 pandemic situation (USDA, 2021).

There are three distinct growing seasons of rice in Bangladesh, according to changes in seasonal conditions such as *Aus, Aman* and *Boro*. More than half of the total production (55.50 %) is obtained in *Boro* season occurring in December–May, second largest production in *Aman* season (37.90 %) occurring in July-November and little contribution from *Aus* season (6.60 %) occurring in April-June (Al Mamun *et al*., 2021).

Among three growing seasons (Aus, Aman and Boro) aman rice occupies the highest area coverage. The aman rice crop occupies 67 per cent of the cropped area of 85.77 ha. In 2020, the amount of land used for high yielding varieties (HYV) is 44.47 lakh (4.44 million) ha, hybrid 2.40 lakh (0.24 million) ha, local varieties 7.15 lakh (0.75 million) hectares and for broadcast aman 3.12 lakh (0.31 million) ha of cultivable land. The total land under the aman crop was 57.14 lakh (5.71 million) ha (Magzter, 2021). Almost 78 % of the land is occupied by the HYV varieties supported by the Department of Agricultural Extension with fertilizers, pesticides and laboratory seeds, while only 12.5 per cent are local/traditional varieties cultivated by the farmers on their own initiatives in low lands

(BBS, 2017). In Bangladesh the average yield of rice is almost less than 50% of the world average rice grain yield. The national mean yield (2.60 t ha^{-1}) of rice in Bangladesh is lower than the potential national yield (5.40 t ha^{-1}) and world average yield (3.70 t ha^{-1}) (Jahan *et al.*, 2015). The lower yield of rice has been attributed to several reasons such as lack of high yielding cultivars, balance use of fertilizers, adoption of proper plant protection measures, soil Stalinization, fluctuation of the market prices, lack of knowledge, of the handling of agronomic management's practices etc.

Recently in Bangladesh, BRRI, BINA, IRRI, and diverse seed organizations have been presented high-yielding rice varieties and it acquires positive monumental in rice production for the particular three distinct growing seasons (Islam *et al*., 2020). Improving and expanding the world's supply will likewise rely on the development and improvement of rice varieties with better yield potential, and to adopt different traditional and biotechnological approaches for the advancement of high yielding varieties that have resistance against various biotic and abiotic stresses (Kumar *et al*., 2018). Recently various new rice varieties were developed by BRRI with exceptionally high yield potential. Nowadays different high-yielding rice varieties are available in Bangladesh which has more yield potential than different conventional varieties (Kader *et al*., 2020). The growth process of rice plants under different agro-climatic conditions differs due to the specific rice variety (Shelley *et al*., 2016). Compared with conventional varieties, the high-yielding varieties have larger panicles resulting in an average increase of rice grain is 7.27% (Bhuiyan *et al*., 2014). These high-yielding and hybrid rice variety, however, needs further evaluation under the different adaptive condition to interact with different agro-climatic conditions.

In Bangladesh farmers generally use inorganic fertilizers for crop production due to easy access and scarcity of organic fertilizers. Improper and imbalanced use of fertilizers causes detrimental effect of soil properties. The use of organic manure in conjunction with chemical fertilizers has the potential to improve soil fertility and crop output. Integrated plant nutrition systems, particularly using organic manure, could improve crop productivity in intensive cropping systems. Organic manure has lately been discovered to be an excellent source of plant nutrients in the soil. Farmyard manure (FYM) and inorganic N and P fertilizers were used together to improve chemical and physical qualities, which could lead to increased and sustainable rice production (Tadesse *et al*., 2013). Organic manure can provide a good amount of plant nutrients, which can help increase rice yield. As a result, in order to achieve a sustainable crop yield without depleting soil fertility, it is necessary to fertilize and manure in a coordinated manner. Most cultivated soils in the world have less than 1.5% organic matter, although a good agricultural soil should have at least 2% organic matter. The use of organic manure in conjunction with chemical fertilizers can significantly boost rice output and soil productivity (Kakar *et al*., 2020). In a rice–rice cropping pattern, the integrated use of chemical and organic manure is critical for long-term crop productivity and soil fertility (Bilkis *et al*., 2018). Soil organic matter boosts crop output by improving the physicochemical characteristics of the soil. Organic waste, farmyard manure, compost, mustard oil cake and chicken manure have recently received attention as the most effective techniques for boosting soil fertility and thus crop output. However, the use of organic manure alone might not meet the plant requirement dueto presence of a relatively low content of nutrients. The application of organic manure with chemical fertilizer accelerates the microbial activity, increases nutrient use efficiency, and enhances the availability of the native nutrients to the plants, resulting in a higher nutrient uptake (Anisuzzaman *et al*., 2021). Therefore, in order to make the soil well supplied with all the plant nutrients in the readily available form and to maintain good soil health, it is necessary to use organic manure in combination with inorganic fertilizers to obtain optimum yields.

Therefore, the present research work was undertaken to investigate the effect of the different organic fertilizer on the growth and yield of transplant aman rice varieties with the following objectives: -

i. To assess the response of different aromatic varieties on growth and yield contributing characteristics of transplanted aromatic aman rice.
ii. To study the effect of different organic manures on yield dynamics of transplanted aromatic aman rice cultivars.

CHAPTER II

REVIEW OF LITERATURE

An attempt was made in this section to collect and study relevant information available regarding to investigate the effect of the different organic fertilizer on the growth and yield of transplanted aromatic aman rice variety, to gather knowledge helpful in conducting the present piece of work.

Haque *et al.* (2022) conducted a field experiment to reduce the chemical fertilizers with the integrated use of vermicompost and chemical fertilizers in *T. aman* rice cultivation. The research was conducted at the Soil Science Division, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh during the *T. aman* season of 2019-20 at BINA farm Mymensingh. Six treatments were used in the experiment. These were T_1: Native soil fertility, T_2: 100% N from Chemical Fertilizer (CF), T_3:70%N from CF, T_4: 30% N from vermicompost-3 + 70% N from CF and T_5:30% N from vermicompost-4 + 70% N from CF and T_6: 100% PKS only. The experiments were conducted in a Randomized Complete Block Design with three replications. The test crop was *T. aman* rice (Binadhan-17). The treatment T_5 gave maximum grain yield (5.5 t ha^{-1}) of *T. aman* rice followed by 5.4 t ha^{-1} that did by the treatment T_4. But the treatments T_5, T_4 and T_2 gave identical grain yields of *T. aman* rice. Similar results were observed in case of straw yields of *T. aman* rice. The maximum total N, P, K and S uptake were also noted with the treatment T_5 (30% N from vermicompost-4 + 70% N from CF) followed by the treatment T_4 (30% N from vermicompost-3 + 70% N from CF) which were comparable with the treatment T_2 (100% chemical fertilizer). The result indicated that 30% N from either vermicompost-3 or vermicompost-4 with 70% N from CF gave comparable yields to the sole application of 100% N from CF alone. Therefore, overall 30% chemical fertilizers (N, P, K and S) could be saved with the integrated use of vermicompost-3 or vermicompost-4 following IPNS in the cultivation of *T. aman* rice.

Chen *et al*. (2021) conducted a study to know the effect of genetic and molecular factors determining grain weight in rice and reported that rice grain weight is one of the key parameters affecting single plant yield output, and it varies due to genetic make-up and varietal variances.

Islam *et al.* (2021) conducted field experiment, to evaluate the effect of zinc fertilization and well decomposed cow dung on the spikelet sterility, yield, zinc concentration in grains and plants of aromatic rice (cv. *Tulshimala*). In this experiment, two levels of well decomposed cowd dung (CD) of 0, 10 t ha^{-1}, and four doses of zinc fertilization viz. 0, 2.16, 4.32, 6.48 kg ha^{-1} of zinc were used following eight treatment combinations. The experiment was laid out in a factorial randomized complete block design (RCBD) with replication thrice. The data revealed that zinc fertilization remarkably increased the grain yield of *Tulshimala* by reducing the spikelet sterility percentages in both conditions of CD and the efficiency of zinc fertilization was superior in manuring (CD) condition to non-manuring condition. However, zinc fertilization at the rate of 4.32 kg ha^{-1} of zinc produced the maximum grain yields under manuring and non-manuring conditions. Zinc fertilization increased the concentration of Zn in the rice plants and grains without and with CD. The strong linear relationship between the grain yield and zinc concentration in the rice plants and grains was found with in this study. Zinc fertilization increased the grain yield and quality by decreasing sterility percentage under CD. Hence, for increasing productivity towards food security in future generation, integrated use organic and inorganic fertilizers should be used.

Islam *et al.* (2021) conducted a research was to investigate the effect of fertilizer management on growth and yield performance of aromatic fine rice varieties and reported that varieties and fertilizer treatments were significantly influenced by plant height. Tulshimala produced the tallest plant 161.44 cm and the smallest 144.55 cm by BRRI Dhan34. It was evident that plant height differed significantly from varieties due to genetic variation, nutrient uptake, photosynthesis rate, etc.

Sarker *et al.* (2021) conducted an experiment at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during November 2016 to May 2017 to study the effect of weed management strategies on the yield of aromatic fine rice in

Boro season and reported that Chinigura produced significantly the highest yield (3.46 t ha^{-1}) which was statistically similar with Kataribhog-1, Kataribhog-2, BRRI dhan34,Badshabhog, BRRI dhan38 and BRRI dhan50. Lowest (2.00 t ha^{-1}) was observed from Madhumala which was statistically identical with Chiniatap-2. The higher grain yield in Chinigura could be attributed to higher panicle length, filled grains $panicle^{-1}$ and 1000-seed weight compared to other varieties.

Ruan *et al*. (2021) reported that vermicompost is an excellent organic fertilizer, but the application of vermicompost in fragrant rice production has not yet been reported. Seedling nursery is an important component of rice production. The present study firstly applied vermicompost in fragrant rice production through nursery raising. The seedlings of three fragrant rice cultivars were raised in matrix with different rations of vermicompost (the treatment without vermicompost was taken as the control), and the growth parameters and physiological characters of seedlings were investigated. The results showed that, compared with the control, the application of vermicompost significantly ($p < 0.05$) increased the plant height, stem diameter, fresh weight, and dry weight of fragrant rice seedlings by 11.22–24.73%, 38.34–65.87%, 16.74–30.46%, and 16.61–35.16%, respectively. Nursery raising with vermicompost significantly ($p < 0.05$) enhanced the net photosynthetic rate by 5.99–12.93%, relative to the control. Higher contents of chlorophyll a, chlorophyll b, carotenoids, and total chlorophyll were recorded in vermicompost treatments than in the control. Compared with the control, vermicompost treatments also increased root length, surface area, mean diameter, root volume, root tip number, and root activity of fragrant rice seedlings by 12.42–27.82%, 15.04–38.65%, 12.64–23.12%, 42.41–63.58%, 18.62–24.95%, and 12.01–26.29%, respectively. Moreover, nursery raising with vermicompost enhanced the activities of antioxidant enzymes including superoxide, peroxidase, and catalase by 7.97–24.21%, 17.11–44.99%, and 7.37–15.95%, respectively, relative to the control. Moreover, 7.92–29.40% lower malondialdehyde contents were recorded in vermicompost treatments compared with the control. Therefore, nursery raising with vermicompost could be a good agronomy practice in machine-transplanted fragrant rice.

Akondo *et al.* (2020) conducted a field experiment with six rice varieties to determine their growth and yield performance and reported that among the varieties Binadhan-16 had significantly highest number of filled spikelet’s/panicle (108.43). Whereas minimum number of filled spikelet’s/panicle (60.60) was observed in Binadhan-11. Variation in grain filling may have occurred due to genetic, environmental or cultural management practices adopted.

Khatun *et al.* (2020) conducted a field experiment with six rice varieties to determine their growth and yield performance. Experimental result revealed that all the growth and yield contributing attributes varied significantly among the six rice varieties. The results revealed that Maximum 1000-grain weight was observed in Binadhan-17 (27.25 g) that was statistically similar to Binadhan-11 (26.45 g) and Binadhan-16 (26.88 g). Minimum 1000-grain weight observed in Binadhan-7 (21.94 g) that was statistically different from other varieties

Latif *et al.* (2020) reported that 1000 grains weight were significantly differ due to the varietal performance. The highest 1000-grain weight (26.33 g) was obtained in BR14 than BRRI dhan28 (22.60 g) and BRRI dhan29 (22.43 g).

Salam *et al.* (2020) reported that plant height was significantly influenced by cultivars. The tallest plant (91.34 cm) was recorded from BRRI dhan28 and the shortest one (84.66 cm) was produced in BRRI dhan74 which was statistically identical to BRRI dhan29.

Paul *et al.* (2019) undertaken a study to detect short-statured rice plants with aromatic and long to medium slender grain where twelve advanced rice lines (derived from the local rice germplasm) with a local check Kataribhog were evaluated. Experiment rest showed that the highest total tiller numbers hill^{-1}at harvest was observed in the local aromatic rice genotype SAU ADL10 (18.75) whereas the minimum tiller numbers hill^{-1} (6.58) was obtained from SAU ADL12.

Shawon *et al.* (2019) carried out an experiments on Aus rice at the Agronomy Research Field of Sylhet Agricultural University, Sylhet and in the farmer’s field of Jaintapur and Gowainghat Upazila, Sylhet to find out the competitiveness of Aus rice varieties against weed infestation. The experiments were carried out within the period of April to August 2014. Five commercial rice varieties viz. BR3, BRRI dhan48, hybrid variety Aloron, BRRI dhan43, Iratom-24 along with three (3) local cultivars Aina Miah, Doom and Kanihati were included in the research field trial. On the other hand, survey of thirty farmer's field along with researcher's managed trial were conducted to know the weed situation. In farmer's field, 5 (five) variety namely BR3, hybrid variety Aloron, BRRI dhan55, BRRI dhan48 and cultivar Aina Miah were included. Here each variety or cultivar considered as treatment. The experiment was laid out in randomized complete block (RCBD) design with three replications. Weed Competitive Index (CI) was calculated on the basis of average yield of all varieties and weed biomass. Result indicated that eight weed species were recorded in the research field trial, whereas 28 weed species were recorded in the farmer's field trial. The most prominent weeds in the experiment were Monochoria virginals, Digit aria sangunalis, Leersia hexandra, Cynodon dactylon etc. The highest weed competitive index was recorded in Aloron (2.27) and the lowest was recorded in Doom (0.42) in the research field. On the other hand, in farmer's field trial the highest weed competitive index (2.05) was recorded in BRRI dhan48 which was followed by variety Aloron (1.71). The highest grain yield (4.04 t ha-1) was produced by the hybrid variety Aloron which was statistically identical with the variety BRRI dhan48 (3.19 t ha^{-1}) and Iratom-24 (3.06 t ha^{-1}). The hybrid variety Aloron produced the maximum panicle length (24.53 cm) and highest (103.53) grains $panicle^{-1}$ and lowest (41.87) panicle length was in variety BRRI dhan43. The lowest yield (1.07 t ha^{-1}) was recorded in local cultivar Doom which was at par with BRRI dhan43 (1.32 t ha^{-1}) and local cultivar Kanihati (1.53 t ha^{-1}).

Uppu and Shiv (2019) conducted a 2-year study to determine the effect of integrated nutrient management on yield and quality of basmati rice varieties in non-traditional area with 54 plots in split plot design. Variety HUBR 10-9 produced 18.8% higher mean grain yield and superior quality parameters than HUBR 2-1. Mean milling, head rice recovery, amylase content and alkali digestion value noted higher with HUBR 10-9 by 4.1%, 4.1%, 8.5% and 15.1% over HUBR 2-1, respectively. Addition of 75% recommended dose of fertilizers with 25% recommended dose of nitrogen as farmyard manure produced higher mean values by 3.1%, 4.2% and 4.0% for hulling, milling and head rice recovery respectively over 100% recommended dose applied as inorganic sources. Combined use of bio-inoculants (blue green algae plus Azospirillum) exhibited higher values for yield and quality parameters. HUBR 10-9 be grown using 75% recommended dose of fertilizers with 25% nitrogen as farmyard manure and blue green algae plus Azospirillum for enhancement in yield and quality in non-traditional areas of eastern Uttar Pradesh. Further investigation required under diverse conditions.

Atman *et al.* (2018) conducted a study on rice paddy area at the Simarasok Village, West Sumatra Province, Indonesia, aimed at investigating the effect of dosage of cow dung as organic fertilizer on growth, yield component and production of organic rice. The experiment was arranged using a Complete Randomized Block Design with four treatments and six replications. The treatment was organic fertilizer of cow dung composted using local microbial organisms with four dosage levels, namely: a) 2 tons/ha; b) 4 tons/ha; c) 6 tons/ha; and d) 8 tons/ha. The rice variety used was the Kuriak Kusuik and the observed variables included: leaf color score, plant height, maximum number of tillers, number of productive tillers, panicle length, number of grains per panicle, percentage of empty grain, weight of 1000 grains, and grain yield. The result showed that the dosage of organic fertilizer of cow dung had significant effect on leaf color score at 56 days after planting (DAP), number of productive tillers, number of grains per panicle, and grain yield. In contrast, plant height, maximum number of tillers, panicle length, weight of 1,000 grains, and empty grain were not significantly affected. It was found that there was a positive relationship between the dosages of organic fertilizer of cow dung with the grain yield. The addition of cow dung as the organic fertilizer as much as 1 ton/ha to the soil could cause an increase in the yield of grain by 0.097 ton/ha.

Dangi *et al.* (2018) reported that variety significantly affects the growth attributes of plant such as height, number of tillers per square meter, number of leaves per hill at different growth stages of rice. They observed significantly higher number of tillers per square meter, number of leaves per hill were achieved at harvest maturity in rice cultivars IR-64, BPT-5204 and IET 24780 than other varieties i.e. IET 23824, Sahbhagi, Chittimuthyalu and Kalanamak.

Sci *et al*. (2018) also reported high straw biomass from combined application of organic and inorganic fertilizer compared to other treatments due to the presence of adequate amounts of both nitrogen and soil moisture that increase accessibility and uptake of $NH4^{+}$. They added that increase in nitrogen absorption goes along with absorption of both phosphorus and potassium, which promotes high tiller numbers and leaves (straw yield).

Mahmud *et al.* (2017) found that BRRI dhan56 produced the tallest plant of 128.53 cm. whereasBRRI dhan57 produced the shortest plant of 110.04 cm which is statistically similar to Binadhan-7 (110.51 cm).

Radzi *et al.* (2017) conducted an study to investigate the effects of different doses of vermicompost organic fertilizer on the growth and yield of rice MR219. The experimental treatments were arranged in Complete Randomized Design including four vermicompost application level. The treatments included four levels of vermicompost organic fertilizer (30%, 50%, 70% and 100%) and four levels of urea chemical fertilizer (100%, 30%, 50 and 70%). At time vegetative and physiological maturity, plant height, number of leaves, number of tiller, fresh and dry weight and also yield were measured. The results indicated that the combined application of NPK fertilizer and organic fertilizer vermicompost had significant effects on growth parameter for plant height, number of leaves, number of tiller, fresh and dry weight. The plant applied with 70% vermicompost and 30% NPK shows the higher means for plant height and number of leaves. The plant applied with 50% vermicompost and 50% NPK shows higher means number of tiller, fresh weight and dry weight than other treatment. The maximum mean of yield recorded by the treatment of 70% vermicompost and 30% NPK fertilizer, but there is no significant difference between the treatment. Thus it can be concluded that the application of vermicompost organic fertilizer, can be reduced chemical fertilizer urea up to 70 percent.

Taheri *et al.* (2017) conducted a field experiment to assess the impact of cow manure and its vermicompost on the improvement of rice grain yield and quality in Rasht, Iran in 2015 and 2016. The experimental factors were devoted to cow manure (0, 10 and 20 t ha–1) and vermicompost (0, 5 and 10 t ha^{-1}). The results revealed that the application of cow manure and vermicompost increased leaf chlorophyll and grain yield components such as the number of fertile tillers and the number of grain, but, it decreased by 1000–grain weight. The highest grain yield was obtained from the application of 30 t ha^{-1} cow manure + 10 t ha^{-1} vermicompost in the first year (3537 kg ha^{-1}) and in the second year (3958 kg ha^{-1}). In addition, the application of cow manure and vermicompost increased the grain's N, P and K content by 8–20%, 22–23% and 20–33%, but decreased the starch content by 3–7%. Although the combined application of various rates of cow manure and vermicompost improved plant growth and nutrient uptake, the influence of vermicompost on the grain yield and quality of gain was much stronger. In poor areas of the world that experience reduction in rice yield mainly due to lack of soil organic matter, and the farmers cannot buy vermicompost to improve soil fertility, we recommend the combined application of manure and vermicompost, which leads to increased grain qualitative traits and milling percentage, resulting in higher nutritional value of grains and higher grain yield.

Lukman *et al.* (2016) carried out an experiment to evaluated the effect of Nitrogen, Phosphorus and Potassium (NPK 20-10-10) and cow dung on the performance of rice at two locations (Sokoto and Talata Mafara) in the Sudan savanna zone of Nigeria, during the 2012/2013 dry season. The treatments consisted of nine different combinations of cow dung and NPK fertilizer with an absolute control, using rice (FARO 44) as a test crop. The treatments were laid out in a Randomize Complete Block Design (RCBD) and replicated three times. The combined application of cow dung and NPK fertilizer significantly ($p < 0.05$) increased most of the results obtained with regards to locations compared to the control plots. The growth and yield parameters of rice considered were significantly ($p < 0.05$) affected by the treatments except one thousand grain weight. Application of 8 t ha^{-1} of cow dung in combination with 400 kg ha^{-1} NPK 20:10:10 gave the highest grain yield (5.77 t ha^{-1}) at Sokoto, while application of 12 t ha^{-1} of cow dung in combination with 300 kg ha^{-1} NPK 20:10:10 gave the highest grain yield (6.50 t ha^{-1}) at Talata Mafara. In conclusion, it is recommended that application of 12 t ha^{-1} of cow dung in combination with 300 kg ha^{-1} NPK 20:10:10 resulted in the best soil nutrient enrichment and yield of rice in Sokoto and Talata Mafara. The result showed that judicious application of cow dung with NPK fertilizers could be a useful practice for better performance of Rice in the study areas compared to the control plots which significantly recorded the least.

Mahmud *et al*. (2016) carried out an experiment to study the combined effect of vermicompost and chemical fertilizers on the nutrient content in grain, straw and post harvest soil of boro rice cv. BRRI dhan29, a field experiment was conducted in December, 2013 to June, 2014 at Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. Sixteen combinations of 4 vermicompost level @ 0, 1, 2, 4 t ha^{-1} and 4 NPKS levels i.e. 0-0-0-0, 50-8-33-6, 100-16-66-12, 1 150-24-99-18 kg ha^{-1} , respectively were applied in a Randomized Complete Block Design (RCBD) with three replications. Results showed that the highest dose of vermicompost and chemical fertilizer increased the concentration of P, K and S by rice grain and straw significantly at the harvesting stage. Combined application of vermicompost and chemical fertilizer failed to increase the total N content of post-harvest soil. Combination of vermicompost and chemical fertilizers also increased the organic matter, P, K and S status of post harvest soil significantly.

Thakuria and Thakuria (2016) conducted a field experiments were in the organic block of Assam Agricultural University, Jorhat (Assam) during 2012-13 under rain fed condition to evaluate the effects of different timings of fresh cow dung application on the productivity of scented rice and its residual effect on succeeding linseed crop. The results revealed that all the timings of fresh cow dung application significantly increased grain and straw yields of scented rice over the control. Among different timings, application of fresh cow dung as 5 t/ha at planting + 2.5 t/ha each at 30 and 45 days after planting (DAP) recorded the highest grain and straw yields but did not differ significantly with the application as 3.4 t/ha + 3.3 t/ha + 3.3 t/ha at 15, 30 and 45 DAP in case of grain yield and with 2.5t/ha each at 7, 15, 30 and 45 DAP in case of straw yield. The residual effect of fresh cow dung on succeeding linseed crop was similar with that of scented rice, however, fresh cow dung applied in four splits as 2.5 t/ha each at 7, 15, 30 and 45 DAP in scented rice produced the highest seed and Stover yields of linseed. The trend of available nutrient contents in soil after harvest of both the crops was almost similar with that of the yield of rice and linseed.

Kumar *et al*. (2015) found that the Sahbhagidhan, the check variety had optimum plant height (92.5 cm), panicle length (21.60 cm), more spikelet per panicle (93) and spikelet fertility (94.5%) but had lesser number of panicles per unit area (227), lower harvest index (35.75%) and reduced grain yield.

Gohain (2014) summarized that among the different local rice cultivars, Masah red recorded the highest plant height (183 cm), followed by Rongashye (175 cm) and Nyakmok (154 cm). Cultivar Melugushye was the shortest (96 cm), followed by Kshai-chushu ghee (126 cm). Cultivar Ronga she, Masah red and Jamaghu recorded highest number of panicles/m^2, panicle weigh and number of grains/panicle. Rongashye recorded highest grain yield (20.07 q/ha), followed by Masah (19.63 q/ha) and Jamaghu (18.89 q/ha). Kebe and Melunyushye could not respond well to improved packages of practices and recorded the lowest grain yield of 6.30 q/ha and 8.89 q/ha, respectively.

Sarkar (2014) reported that number of filled grains/panicles influenced significantly due to variety.

Singh *et al*. (2014) conducted an experiment during kharif 2011 and 2012 at the research farm of College of Post Graduate Studies, Central Agriculture University, Umiam, Meghalaya in order to explore the effects of varying planting geometries of different rice cultivars in puddle condition. Three cultivars of rice - Arize 6444, Shahsarang1 and Mynri were tested under four different planting geometries viz; 20cm × 25cm, 20cm × 20cm, 20cm × 15cm and 20cm × 10cm on weed dynamics, weed dry weight. The experiment was laid out in a factorial randomized block design (FRBD) with three replications. Data were collected pertaining to weeds infestation, growth and yield related attributes of rice. The results revealed that maximum weed suppression was observed in closest plant spacing (20cm × 10cm) in case of at 30 and 60 days after transplanting (DAT), while wider plant spacing (20cm × 20cm) proved effective regarding yield and yield related attributes. Statistically maximum leaf area index (LAI) of 9.06 and crop growth rate (CGR) of 3.96 g m-2 d-1 were recorded in widest spacing of 20cm × 25cm. Weed population and weed dry matter were not affected significantly by the cultivars.

Sudarsono *et al*. (2014) conducted an experiment to investigating the effect of cow manure application rate on organic rice growth and yield in the first cropping season. The study was conducted from January to April 2012 in Blora, Central Java, Indonesia. The experiment was arranged in Randomized Complete Block Design, consisting of four treatments and four replications. There were two types of control treatments i.e. organic fertilizer treatments (statistically analyzed) and conventional fertilizer (not statistically analyzed). The treatments were corn biomass, corn biomass+cow manure (7.5 tons ha^{-1}), corn biomass+cow manure (10 tons ha^{-1}) and cow manure (10 tons ha^{-1}) with square spacing of 20 cm × 20 cm. The organic control treatments were corn biomass+sheep manure (7.5 tons ha^{-1}) with spacing of 20 cm× 20 cm and corn biomass+cow manure (7.5 tons ha^{-1}) with double-row spacing of 40 cm × 25 cm x 15 cm. For every treatment, the rate of corn biomass was 3 tons ha^{-1}. All organic treatments were also added with 3 tons rice hull ash ha^{-1}. The application of cow manure (10 tons ha^{-1}) with square spacing or corn biomass+cow manure (7.5 tons ha^{-1}) with double-row spacing resulted in better performance than those of other treatments.

Tripathi *et al*. (2014) revealed that CST-13 genotype registered its superiority over Sarjoo- 52 in respect of yield attributes and yield and nutrient. The mean yield response of CRS-13 was 25.8% more over Sarju-52.

Bejbaruah *et al*. (2013) carried out a study to test whether nitrogen use efficiency (NUE) and crop yield can be enhanced by split application of vermicompost. There is no published information on split application of vermicompost (VC) in rain fed rice. An experiment with rice (cv. Pankaj) was conducted on loam soil in Giridih, India, during 2008 and 2009. Vermicompost, a rich source of readily available nutrients, has high microbial activity and contains growth hormones. Study comprises one of three split applications of vermicompost at different growth stages of rice (i.e., maximum tillering, panicle initiation, and flower). Split application of vermicompost resulted higher yield parameters such as panicles (294 m^{-2}), filled grains per panicle (138), and total spikelet's per panicle (142), grain yield (3.91 t ha^{-1}), and NUE, but only if vermicompost was applied at two or three doses. Higher availability of nitrogen (N) in soil with split applications coincides with higher NUE, and thus, split application not promoted N losses. Split application of vermicompost enhances the sustainability of rice cropping system.

In order to assess the performance of local aromatic rice cultivars *viz:* Kalijira, Khaskani, Kachra, Raniselute, Morichsail, and Badshabhog, Nahida*et al.* (2013) conducted an experiment. In terms of crop growth characteristics, yield, and yield-contributing traits, rice cultivars vary significantly. The findings showed that Kalijira produced the most effective tillers hill^{-1} (13.0), whereas Morichasail produced the least effective tillers hill^{-1} (7.13). The genetic make-up of the variety, which is mostly impacted by genetics, is the cause of the differences in effective tillers hill^{-1}.

Mahamud *et al.* (2013) reported that the variation in filled grains panicle$^{–1}$ was recorded due to genotypic differences of varieties.

Tyeb *et al.* (2013) conducted a experiment at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during July to December 2011 to evaluate the effect of spacing on the performance of four rice cultivars in aman season. The experiment consisted of four spacing viz. 25cm×15cm, 25cm×20cm, 20cm×20cm, 20cm×10cm and four rice varieties viz. BRRI dhan41, BRRI dhan46, BRRI dhan51 and BRRI dhan52. The experiment was laid out in randomized complete block design with three replications. The highest plant height (118.79cm), number of total tillers hill (16.04), number of effective tillers hill (13.19), number of grains panicle (144.48), grain yield (5.04 t ha), straw yield (6.29 t ha) and biological yield (11.33 t ha) were recorded from BRRI dhan52; while the lowest number of total tillers hill (13.08), number of effective tillers hill(9.29), number of grains panicle (127.46), grain yield (4.22 t ha), straw yield (5.65 t ha) and biological yield (9.88 t ha) were recorded from BRRI dhan41. The highest grain yield (5.21 t ha), number of total tillers hill (17.17), number of effective tillers hill (13.46) and grains panicle (153.54) were obtained from the spacing 25cm×15cm. The highest grain yields of all tested varieties were recorded in all combination with spacing 25cm×15cm. BRRI dhan52 could be transplanted with 25cm×15cm spacing as promising for optimization yield in aman season

Verma *et al*. (2013) carried out an experiment to evaluate the combined effect of amended media and vermiwash ongrowth and flowering of landscape gerbera grown under greenhouse condition. CPV and Soil amended with vermicompost, hydrogen and HBM had significant positive effects on growth and flowering of gerbera. Appearance of first true leaf in newly transplanted plants (3.67 d), number of leaves per plant at first flower appearance (16.33), appearance of first true leaf after harvest (4.00 days), leaf area per leaf (82.80 cm^2), maximum number of primary roots (42.00), minimum days taken for appearance of first flower bud (49.67), minimum days taken for first flower harvest (71.67), flower head diameter (10.11 cm),days taken to flower senescence in plants (20.33), fresh and dry weight of plant was recorded on CPV+PHG+VC with 20% vermiwash sprayed. Compared to all other treatments chlorophyll content and relative water content significantly higher with vermicompost 20%, PHG 0.25% and HMB 1.0%with vermiwash 20% sprayed. The beneficial effects of amended media were associated with change in physical and chemical properties and hormone like effect of vermiwash which increase the growth of the plants. Therefore, it can be concluded that, plant performance was best in the media containing CPV+ PHG+ VC with 20% vermiwash concentration.

Farid *et al.* (2011) carried out a field experiment at the Bangladesh Agricultural University Farm during the T. Aman season to study the combined effect of cowdung, poultry manure, dhaincha and chemical fertilizers on the yield and nutrient uptake of BRRI dhan 41. The experiment was set up in a randomized complete block design with three replications. 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 T4 treatment and minimum grain yield of 2.69 t ha^{-1} in To (control). The dhaincha or cowdung along with 70% NPKS increase the grain yield significantly over 70% NPKS application. The relative performances of organic manures were in the order of PM>DH>CD.

Tharmaraj *et al*. (2011) carried out an experiment to study the influence of vermicompost and vermiwash on physic-chemical properties of rice cultivated soil. The vermiproduct treated plants display quicker and higher growth rate and productivity than the control plots. Among the treated group, the development rate was high in the combination of vermicompost and vermiwash treated plants, than the vermicompost and vermiwash un-treated plants.

Davari and Sharma, (2010) reported that permutation of FYM + wheat residues + bio-fertilizers and vermicompost + wheat residues + bio-fertilizers brought about greater increase in grain yield (51-58%) over control, 18-22% over FYM and vermicompost alone and 6-10% over FYM + wheat residues and vermicompost + wheat residues.

Mirza *et al.* (2010) reported that among the manures i.e., poultry manure, green manure, cow dung and vermicompost, application of vermicompost @ 8 t ha^{-1} produced better grain yield compared to other organic manures.

Morteza (2010) carried an experiment in 2008 and 2009, in randomized block design based on 4 replications. Highest total number of tillers were observed in plots treated with 2 t/ha organic fertilizer (11.19), it was followed by organic fertilizer $^{+}$NPK (11.03) and NPK alone (10.66) and minimum of that was for 0.5 ton/ha organic fertilizer (9.75) against untreated control (9.63).

Urkurkar *et al.* (2010) reported rice yield of 3.66 t/ha when 100% N was given through cowdung manure, neem cake and composted crop residues. This was exceptionally near to that of 100% N through chemical fertilizer.

Manivannan and Sriramachandrasekharan (2009) reported that Combined application of vermicompost (50% N) and urea (50% N) resulted in the highest number of panicles m^{-2}, a number of grains $panicle^{-1}$, panicle length and 1000 grain weight which was on a par with that of poultry manure (50% N) and urea (50% N). Improved growth coupled with the transport of photosynthetic towards reproductive structure might have increased the yield attributes and yield due to organic addition.

Amitava *et al*. (2008) reported that organic sources offer more balanced nutrition to the plants, especially micro nutrients which has caused better tillering in plants grown with Vermicompost and FYM.

Muhammad *et al.* (2008) reported that the variation in plant height due to different nutrient sources and their variation in the availability of major nutrients. The available nutrients might have helped in enhancing leaf area, which thereby resulted in higher photo-assimilates and more dry matter accumulation impact on plant height of rice.

Singh (2008) reported that the available nutrients might have helped in enhancing leaf area, which resulted in higher photo-assimilates and more dry matter accumulation and increased plant height.

Ebaidand El-refaee (2007) reported that the increase in grain yield components can be due to the fact that available more water enhanced nutrient availability which improved nitrogen and other macro- and micro-elements absorption as well as enhancing the production and translocation of the dry matter content from source to sink.

Miller (2007) reported that organic sources offer more balanced nutrition to the plants, especially micro nutrients which positively affect plant height and number of tiller in plants.

Nayak *et al*. (2007) reported a significant increase in effective tillers $hill^{-1}$ due to application of chemical fertilizer with organic manure.

Barik *et al.* (2006) reported that application of vermicompost alone or in combination with 75% or 50% of recommended NPK fertilizers resulted in higher number of effective tillers $plant^{-1}$ as compared to farm yard manure treated plots alone or in combination with respective levels of NPK fertilizers and attributed this to the higher availability of NPK and also to other nutrients, higher occurrence of different beneficial microorganisms, production of growth promoting hormones antibiotics, enzymes etc., which helps in improvement of soil health compared to farmyard manure in chromium contaminated soil.

Sudhakar *et al.* (2002) studied that Earthworms can live in decaying organic wastes and can degrade it into fine particulate materials, which are rich in nutrients. Vermicomposting is the application of earthworms in producing vermifertilizer, which helps in the maintenance of a better environment and results in sustainable agriculture. Earthworms make the soil porous and help in better aeration and water infiltration. Vermicompost can be prepared from different organic materials like sugarcane trash, coir pith, press mud, weeds, cattle dung, bio digested slurry etc. Increased availability of nutrients in vermicompost compared to non-ingested soil resulted in significantly better growth and yield of rice has been reported by several workers.

Sheeba and Kumarasamy (2001) reported that the organic carbon and cation exchange capacity increased significantly in the manure treatments and in the treatments that received N with or without P and K. Nitrogen turnover was increased by *Rhizobium* inoculation or N application to sun hemp. Green maturing significantly increased soil organic C, total and available N, available P and K and water-holding capacity.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted at Sher-e-Bangla Agricultural University, Dhaka to investigate the effect of the different organic fertilizer on the growth and yield of transplanted aromatic aman rice varieties. Materials used and methodologies followed in the present investigation have been described in this chapter.

3.1 Experimental period

The experiment was conducted during the period from June to December 2021 in Aman season.

3.2 Description of the experimental site

3.2.1 Geographical location

The experiment was conducted in the Agronomy field of Sher-e-Bangla Agricultural University (SAU). The experimental site is geographically situated at 23°77′ N latitude and 90°33′ E longitude at an altitude of 8.6 meter above sea level (Anon., 2004).

3.2.2 Agro-Ecological Zone

The experimental site belongs to the Agro-ecological zone (AEZ) of "The Modhupur Tract", AEZ-28 (Anon., 1988 a). This was a region of complex relief and soils developed over the Modhupur clay, where floodplain sediments buried the dissected edges of the Modhupur Tract leaving small hillocks of red soils as 'islands' surrounded by floodplain (Anon., 1988 b). For better understanding about the experimental site has been shown in the Map of AEZ of Bangladesh in Appendix-I.

3.2.3 Soil

The soil of the experimental pot belongs to the General soil type, Shallow Red Brown Terrace Soils under Tejgaon soil series. Soil pH ranges from 5.4–5.6 (Anon., 1989). 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 the Sher-e-Bangla

Agricultural University (SAU) Farm, field. The soil analyses were done at Soil Resource and Development Institute (SRDI), Dhaka. The morphological and physicochemical properties of the soil are presented in Appendix-II.

3.2.4 Climate and weather

The climate of the experimental site was subtropical, characterized by the winter season from November to February and the pre-monsoon period or hot season from March to April and the monsoon period from May to October (Edris *et al.*, 1979). Meteorological data related to the temperature, relative humidity and rainfall during the experiment period of was collected from Bangladesh Meteorological Department (Climate division), Sher-e-Bangla Nagar, Dhaka and has been presented in Appendix-III.

3.3 Planting material

Kaloshila, Chinigura, Gobindobhog, Kataribhog, Tulsimala, Kalijira and BRRI dhan34 transplanted aromatic aman rice varieties were being used as test crops for this experiment.

Table 1. Characteristics of rice varieties

Name of variety	Developed by	Year of Release	Growing season	Thousand seed weight (g)	Average yield (t ha^{-1})
Kaloshila	Local variety	Local variety	*Aman*	10-12	2.5-3
Chinigura	Local variety	Local variety	*Aman*	12-14	2.5-3
Gobindobhog	Local variety	Local variety	*Aman*	10-12	2.5-3
Kataribhog	Local variety	Local variety	*Aman*	10-12	2.5-3
Tulshimala	Local variety	Local variety	*Aman*	10-12	2.5-3
Kalijira	Local variety	Local variety	*Aman*	10-12	1-2
BRRI dhan34	BRRI	1997	*Aman*	10-12	3-3.5

3.4 Selection of earthen pot

Earthen pots of having 12 inches diameter, 12 inches height with a hole at the centre of the bottom were used. Silt soil was used in the experiment. Twelve kilogram sun-dried soils were put in each pot. After that, pots were prepared for seed sowing.

3.5 Organic manures

In this experiment different levels cow dung, vermicompost, mustard oil cake were used as organic manure. The nutrient content (*viz*: NPK) of different sources of organic manure were given below-

Sources of Manure	Nitrogen content (N %)	Phosphorous content (P %)	Potassium content (K%)
Cow dung (CD)	1.04	0.78	0.15
Vermicompost (VC)	1.6	0.6	0.8
Mustard oil cake (MOC)	4.93	0.53	0.65

(Source: BRRI fertilizer recommendation guide, 2019.)

3.6 Experimental treatment

There were two factors in this experiment namely different aman rice varieties and application of different organic manures as mentioned below:

Factor A: Different transplanted aromatic aman rice varieties (7) *viz;*

V_1: Kaloshila,

V_2: Chinigura,

V_3: Gobindobhog,

V_4: Kataribhog,

V_5: Tulshimala,

V_6: Kalijira

V_7: BRRI dhan34

Factor B: Application of different organic Fertilizers (3) *viz;*

Treatments	Dose of organic fertilizers
T_1	150 g CD pot^{-1}
T_2	150g VC pot^{-1}
T_3	30g MOC pot^{-1}

3.7 Experimental design

The experiment was laid out in Completely Random Design (CRD) with 2 factor and four replications. Total 84 unit pots were made for the experiment with 21 treatments having 4 replication.

3.8 Detail of experimental preparation

3.8.1 Seed collection and sprouting

Kaloshila, Chinigura, Gobindobhog, Kataribhog, Tulsimala, Kalijira and BRRI dhan34 variety seed were collected from Bangladesh Rice Research Institute (BRRI), Gazipur, Bangladesh. Healthy and disease free seeds were selected, following standard technique. Seeds were immersed in water in a bucket for 24 hrs. These were then taken out of water and kept in gunny bags. The seeds started sprouting after 48 hrs which were suitable for sowing in 72 hrs.

3.8.2 Raising of aman seedlings

A typical system was followed in raising of seedlings in the earthen pot. 100 seeds of specific variety were sown in the pot which was before filed with soils. Light irrigation was delicately given to the pot as and when required.

3.8.3 Preparation of the plastic pot for experimentation

The upper edge diameter of the pots was 30 cm (r= 15 cm). While filling with soil, the upper one inch of the pot was kept vacant so that irrigation can be provided using a hose pipe.

3.8.4 Fertilizer application

Chemical fertilizer application

Chemical fertilizer *viz;* Urea, TSP, Mop, Gypsum and Zinc sulphate were used as the source of Nitrogen, Phosphorus, Potassium, Sulphur and Zinc and were required @ 150, 100, 70, 60 and 10 kg ha^{-1} (BARI, 2019). All of the fertilizers except urea were applied as basal dose at the time filling pot with soil. Urea (150 kg ha^{-1}) was applied in equal three splits. The first dose of urea was applied at 21 days after transplanting (DAT). The second dose of urea was added as top dressing at 45 days (active vegetative stage) after transplanting and third dose was applied at 60 days (panicle initiation stage) after transplanting recommended by BRRI fertilizer recommendation guide, 2019.

Organic manure application

Different manure fertilizers were applied according with per treatment requirement and mixing with soil properly before filling pot with soil.

3.9 Seedling uprooting and transplanting in the pot

Seedlings of thirty days old were uprooted carefully from the seedbed and transplanted in the pots. There were 3 $hillpot^{-1}$ and one seedling was used $hill^{-1}$.

3.10 Intercultural operations

3.10.1 Application of irrigation water

Irrigation water was added to each pot according to the critical stage. It was given by using water pipe.

3.10.2 Weeding

The crop was infested with some common weeds, which were controlled by uprooting and removed them three times from the pot during the period of experiment. Weeding was done on 25 June and 25 July 2021.

3.10.3 Plant protection measures

The crop was attacked by yellow rice stem borer (*Scirpopagain certulas*) at the panicle initiation stage which was successfully controlled with Sumithion @ 1.5 L ha^{-1}. Yet to keep the crop growth in normal, Basudin was applied at tillering stage @ 17 kg ha^{-1} while Diazinon 60 EC @ 850 ml ha^{-1} were applied to control rice bug and leaf hopper. Application of insecticide was applied at 23th October 2021. Crop was protected from birds during the grain filling period by using net and covering the experimental site.

3.11 General observations of the experimental field

Regular observations were made to see the growth and visual differences of the crops, due to application of different treatment were applied in the experimental pot. In general, the plant looked nice with normal green plants. Incidence of stem borer, green leaf hopper, leaf roller was observed during tillering stage and there were also some rice bug were present in the experimental pot. But any bacterial and fungal disease was not observed. The flowering was not uniform.

3.12 Crop sampling and data collection

Pot from each replication were selected and marked with sample card. Different data were recorded from selected plants at various growth stage.

3.13 Harvesting, threshing and cleaning

The rice plant was harvested depending upon the maturity of grains and harvesting was done manually from each plot. Maturity of crop was determined when 80–90% of the grains become golden yellow in color. Harvesting date was 1-12 December 2021 according with varieties maturity. Harvesting was done in the morning to avoid shattering. Prior to harvesting, randomly selected plant from each replication pot were separately harvested for recording yield attributes and other data. The harvested plants were tied into bundles and carried to the threshing floor of the Soil Field Laboratory. Threshing was done by pedal thresher. The grains were cleaned and sun dried to moisture content of 12%. Straw was also sun dried properly. Finally grain and straw yields pot^{-1} were recorded.

3.14 Field operation

The different field operations performed during the course of present investigation are given below in chronological order in list form

Table2. List of schedule of field operations done during the course of experimentation.

Operations	Working Dates
Pot preparation for seed sowing	28th may 2021
Sowing seeds in the pot	1th June 2021
Selection of the pot	6th June 2021
1st dose fertilizer application and fill the pot	6th June 2021
Transplanting of seedling	14th July 2021
2nd dose fertilizer application	28th August 2021
Intercultural Operations	**Working Dates**
Weeding	25 June and 25 July 2021
Insecticide application	23th October 2021
Harvesting and threshing	1-12th December 2021

3.15 Data collection

The data were recorded on the following parameters:

i. Plant height (cm)
ii. Number of effective tiller hill^{-1}
iii. Grains weight pot^{-1}
iv. Straw yield pot^{-1} (g)

3.16 Procedure of data collection

i. Plant height (cm)

The height of rice plant from each pot was determined by measuring the distance from the soil surface to the tip of the leaf from each hill^{-1} and finally averaged. Mean plant height of rice plant were calculated and expressed in cm.

ii. Number of effective tillers hill^{-1}

The total number of effective tillers hill^{-1} was counted as the number of panicle bearing tillers per hill. Data on effective tiller per hill were recorded from 3 randomly selected hill at harvesting time and average value was recorded.

iii. Grains weight pot^{-1}

Grain yield from each pot were taken expressed as g/pot on about 12% moisture basis. Grain moisture content was measured by using a digital moisture tester.

iv. Straw yield hill^{-1} (g)

Straw obtained from each pot were sun dried and weighted carefully and finally converted to g/hill.

3.17 Data analysis technique

The collected data were compiled and analyzed statistically using the analysis of variance (ANOVA) technique with the help of a computer package program name Statistic 10 Data analysis software and the mean differences were adjusted by Least Significant Difference (LSD) test at 5% level of probability (Gomez and Gomez, 1984).

CHAPTER IV

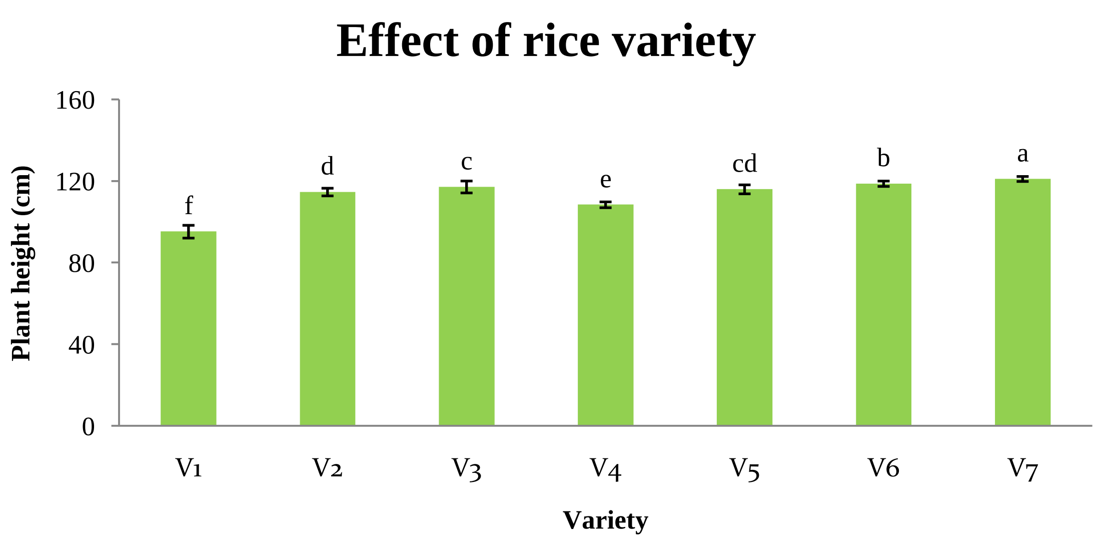
RESULTS AND DISCUSSION

Results obtained from the present study have been presented and discussed in this chapter with a view to study the effect of the different organic fertilizer on the growth and yield of transplanted aromatic aman rice varieties. The results have been discussed, and possible interpretations are given under the following headings.

4.1 Plant height (cm)

4.1.1 Effect of rice variety on plant height (cm)

Different rice varieties had significant effect on the plant height of rice (Figure 1). The results of the experiment showed that the highest plant height (121.08 cm) was obtained from BRRI dhan34 (V_7) however the 2nd highest plant height 118.75 cm was found in kalijira (V_6) treatment followed by Gobindobhog (V_3) 117.17 cm treatment.



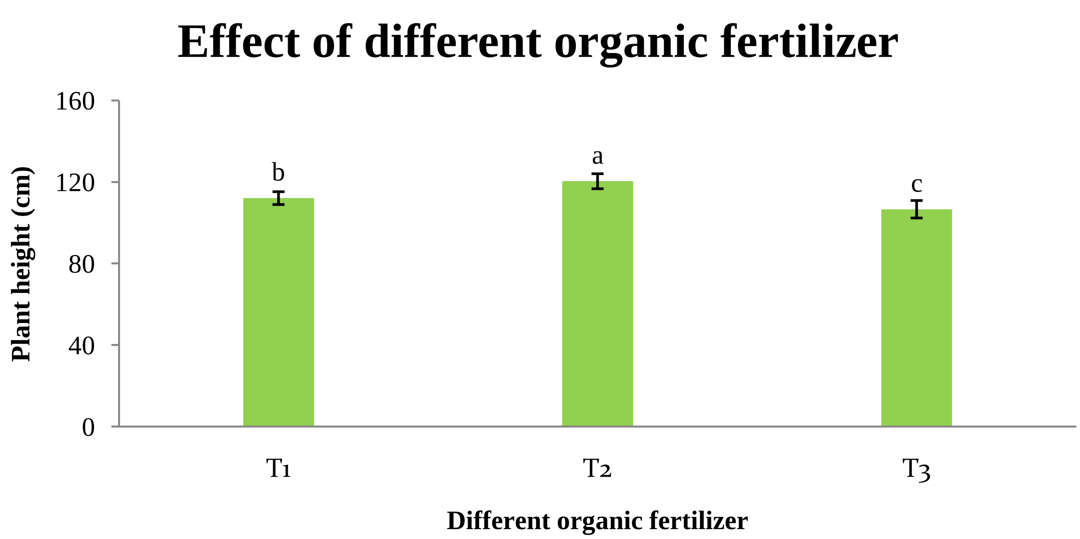
In the bar graphs means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. Here, V_1= Kaloshaila, V_2= Chinigura, V_3= Gobindobhog, V_4= Kataribhog, V_5= Tulsimala V_6= Kalijira and V_7= BRRI dhan34.

Figure 1. Effect of variety on average plant height of transplanted aromatic aman rice (LSD$_{(0.05)}$= 1.44)

While Kaloshaila (V_1) rice variety obtained the lowest plant height (95.25 cm). The genetic make-up and varietal performance of the rice varieties may be factors in the variations in the plant height among the many rice cultivars. Islam *et al.* (2021) reported that height of a plant is determined by genetical character and under a given set of environment different variety will acquire their height according to their genetic makeup.

4.1.2 Effect of different organic fertilizer on plant height (cm)

In this experiment different organic fertilizer treatment significantly influenced plant height of rice (Figure 2). Experimental result reveal that the highest plant height (120.39 cm) was observed in T_2 (150 g VC pot^{-1}) treatment. While the lowest average plant height (106.64 cm) was observed in T_3 (30 g MOC pot^{-1}) treatment.



In the bar graphs means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. Here, T_1: 150 g CD pot^{-1}, T_2: 150 g VC pot^{-1} and T_3: 30 g MOC pot^{-1}.

Figure 2. Effect of different organic fertilizer on average plant height of transplanted aromatic aman rice (LSD $_{(0.05)}$ = 0.94)

The increase in plant height due to adequate availability of various nutrients attributed to better nutritional environment for plant growth at active vegetative stages as result of enhancement in multiplication, cell elongation and cell expansion in the plant body which ultimately increased the height of plant. Muhammad *et al.* (2008) reported that the variation in plant height was due to different nutrient sources and their variation in the availability of major nutrients. The available nutrients might have helped in enhancing leaf area, which thereby resulted in higher photo-assimilates and more dry matter accumulation impact on plant height of rice.

4.1.3 Combined effect of variety and different organic fertilizer on plant height (cm)

Combined effect of variety and organic fertilizer showed significant effect on plant height of rice (Figure 3). Experimental result showed that the highest plant height (128.50 cm) was observed in V_7T_2 combination treatment. While the lowest plant height (86.25 cm) was obtained from V_1T_3 treatment combination.

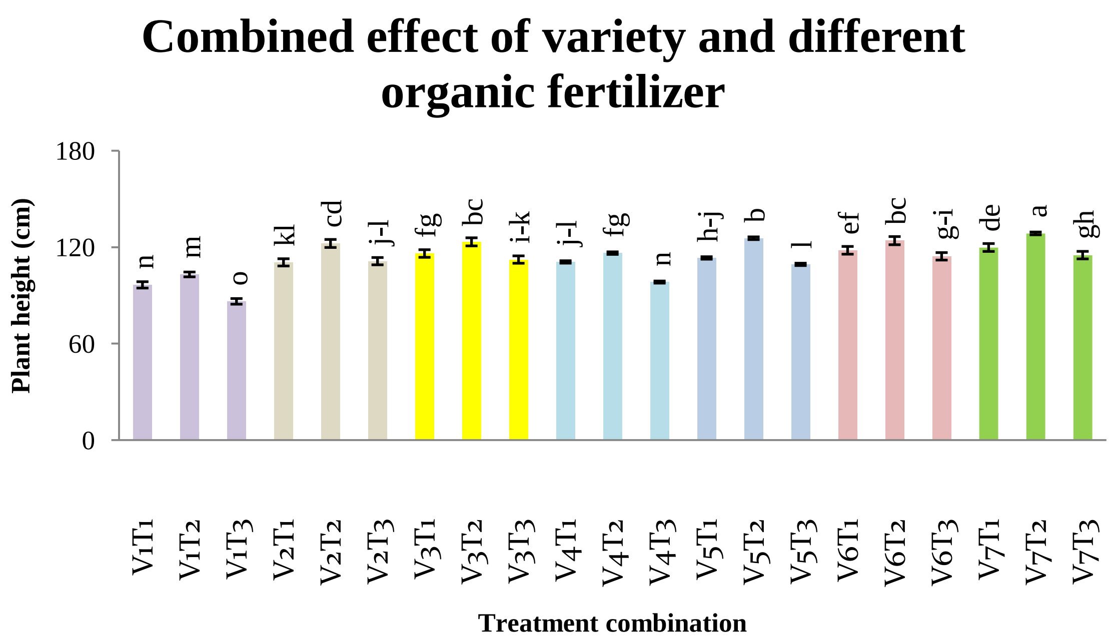


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Figure 3. Combined effect of variety and different organic fertilizer on average plant height of transplanted aromatic aman rice (LSD $_{(0.05)}$ = 2.50)

4.2 Effective tiller number hill^{-1}

4.2.1 Effect of rice variety on effective tiller number hill^{-1}

Different rice varieties had significant effect on the average effective tiller number hill^{-1}of rice (Figure 4). The results of the experiment showed that the highest average effective tiller number hill^{-1} (10.00) was obtained from BRRI dhan34 (V_7) however the second highest effective tiller number hill^{-1} (8.25) was obtained from Kataribhog (V_4) treatment. While Kaloshaila (V_1) rice variety obtained the lowest average effective tiller number hill^{-1} (3.52). The genetic make-up and varietal performance of the rice varieties may be factors in the variations in the effective tiller number hill^{-1} among the many rice cultivars. Tyeb *et al.* (2013) showed that BRRI dhan52 produced the most effective tillers hill^{-1} (13.19), whereas BRRI dhan41produced the least effective tillers hill^{-1} (9.29). The genetic make-up of the variety, which is mostly impacted by genetics, is the cause of the differences in effective tillers hill^{-1}.

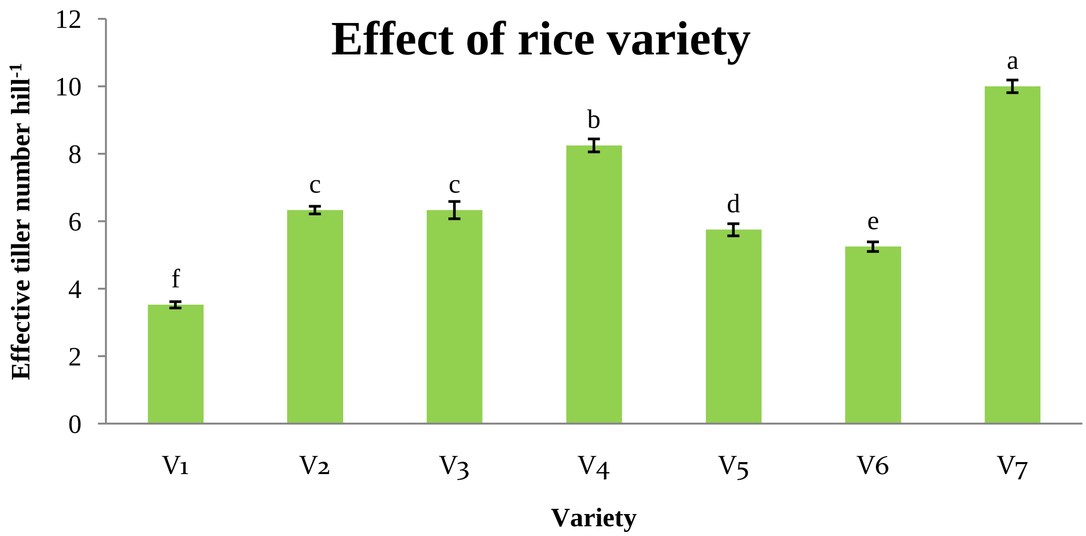

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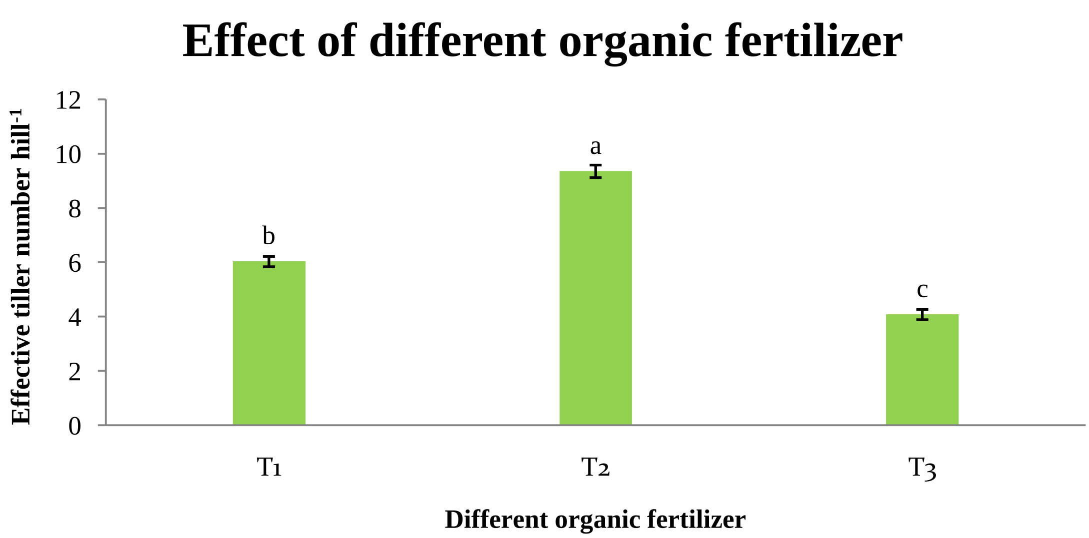
Figure 4. Effect of variety on average effective tiller number hill^{-1}of transplanted aromatic aman rice (LSD$_{(0.05)}$=0.36)

4.2.2 Effect of different organic fertilizer on effective tiller number hill^{-1}

In this experiment different organic fertilizer treatment significantly influenced average effective tiller number hill^{-1}of rice of rice (Figure 5). Experimental result revealed that the highest average effective tiller number hill^{-1}of rice (9.36) was observed in T_2 treatment. Whereas the lowest average effective tiller number hill^{-1} (4.08) was obtained from T_3 treatment. The variation of number of effective tillers hill^{-1} might be attributed to the optimum and constant supply and availability of nutrients from organic sources, which aid in improved nutrient absorption, eventually promoting cell division and therefore increasing all growth features. The result was similar with the findings of Radzi *et al.* (2017) reported that application of vermicompost significantly increase effective tillers hill^{-1} of rice.



In the bar graphs means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. Here, T_1: 150 g CD pot^{-1}, T_2: 150 g VC pot^{-1} and T_3: 30 g MOC pot^{-1}.

Figure 5. Effect of different organic fertilizer on average effective tiller number hill^{-1} of transplanted aromatic aman rice (LSD $_{(0.05)}$ = 0.23)

4.2.3 Combined effect of variety and different organic fertilizer on effective tiller number hill^{-1}

Combined effect of variety and organic fertilizer showed significant effect on average effective tiller number hill^{-1} of rice (Figure 6). Experimental result showed that the highest average effective tiller number hill^{-1} (14.25) was observed in V_7T_2 treatment combination. While the lowest average effective tiller number hill^{-1} (2.33) was obtained from V_1T_3 treatment combination.

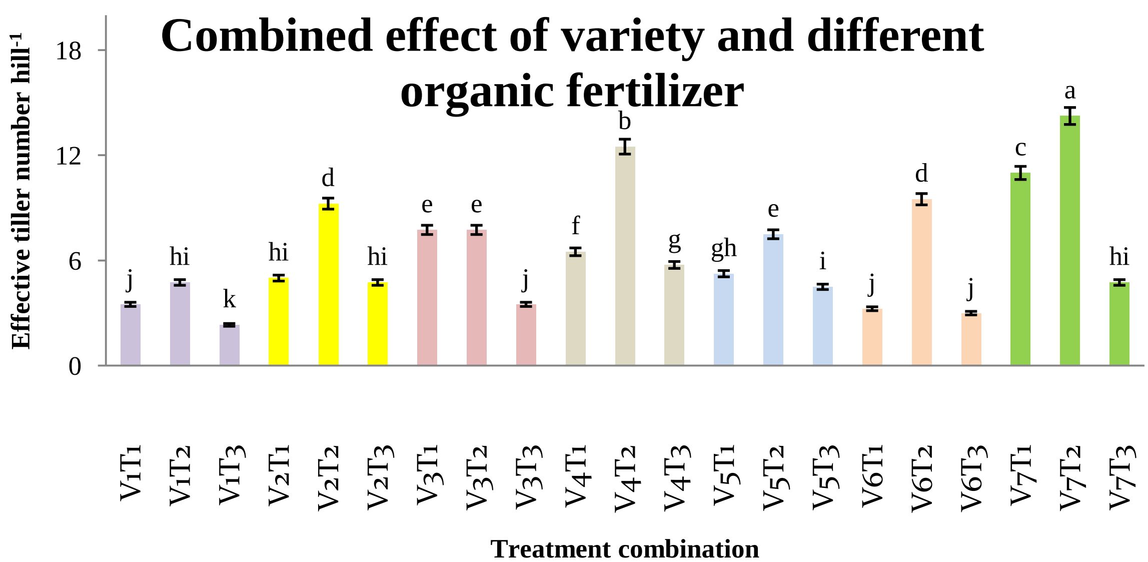


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Figure 6. Combined effect of variety and different organic fertilizer on average effective tiller number hill^{-1} of transplanted aromatic aman rice (LSD $_{(0.05)}$ = 0.62)

4.3 Grain weight pot^{-1} (g)

4.3.1 Effect of rice variety on Grain weight pot^{-1} (g)

Different rice varieties had significant effect on the average grain weight pot^{-1} of rice (Figure 7). The results of the experiment showed that the highest average grain weight pot^{-1} (17.81 g) was obtained from BRRI dhan34 (V_7) however the second highest average grain weight pot^{-1} (17.48 g) was obtained from Kataribhog (V_4). While Tulsimala (V_5) rice variety obtained the lowest average grain weight pot^{-1} (15.03 g). The genetic make-up and varietal performance of the rice varieties may be factors in the variations in the effective tiller number hill^{-1} among the many rice cultivars. Shawon *et al.* (2019) reported that grains weight differs among different rice varieties weight due to morphological and varietal variation.

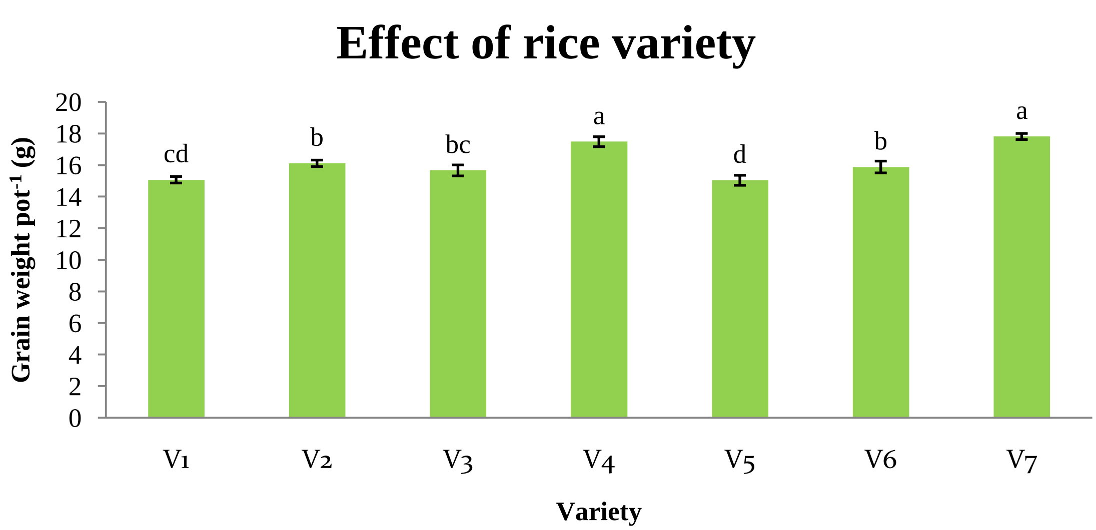

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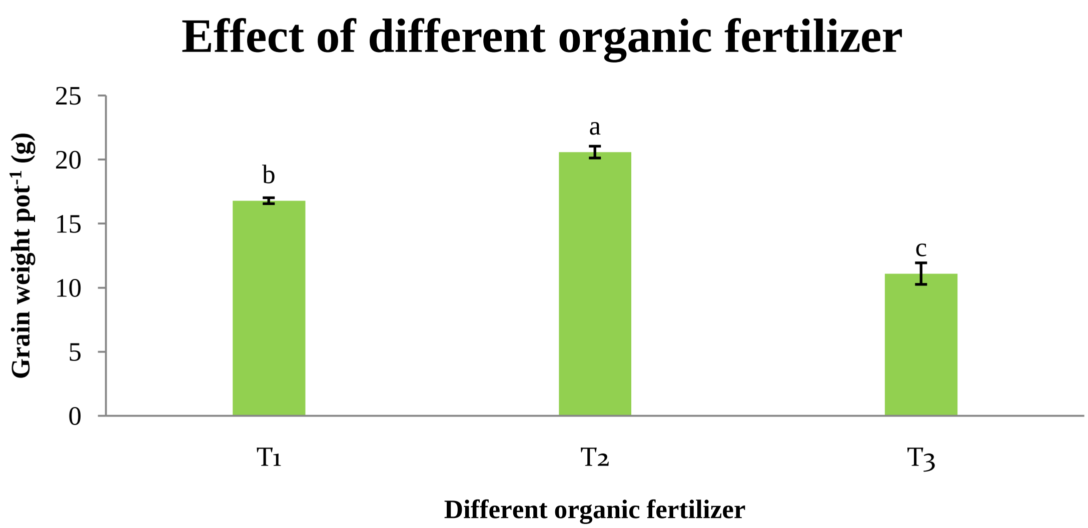
Figure 7. Effect of variety on average grain weight pot^{-1} of transplanted aromatic aman rice (LSD $_{(0.05}$ =0.60)

4.3.2 Effect of different organic fertilizer on Grain weight pot^{-1} (g)

In this experiment different organic fertilizer treatment significantly influenced average grain weight pot^{-1} of rice (Figure 8). Experimental result revealed that the highest average grain weight pot^{-1} of rice (20.58 g) was observed in T_2 treatment. Whereas the lowest average grain weight pot^{-1} (11.09 g) was obtained from T_3 treatment. The supply of adequate nutrients through vermicompost as organic source of fertilizer might have facilitated the production of plant height, leaves number and effective tiller number which might in turn have contributed for the production of higher grain weight pot^{-1}. Bejbaruah *et al*. (2013) reported that application of vermicompost enhances the sustainability of rice cropping system.



In the bar graphs means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. Here, T_1: 150 g CD pot^{-1}, T_2: 150 g VC pot^{-1} and T_3: 30 g MOC pot^{-1}.

Figure 8. Effect of different organic fertilizer on average grain weight pot^{-1} of transplanted aromatic aman rice (LSD $_{(0.05)}$ =0.39)

4.3.3 Combined effect of variety and different organic fertilizer on grain weight pot^{-1} (g)

Combined effect of variety and organic fertilizer showed significant effect on average grain weight pot^{-1} of rice. Experimental result showed that the highest average grain weight pot^{-1} (24.56 g) was observed in V_7T_2 combination treatment. While the lowest average grain weight pot^{-1} (10.66 g) was obtained from V_1T_3 treatment combination (Figure 9).

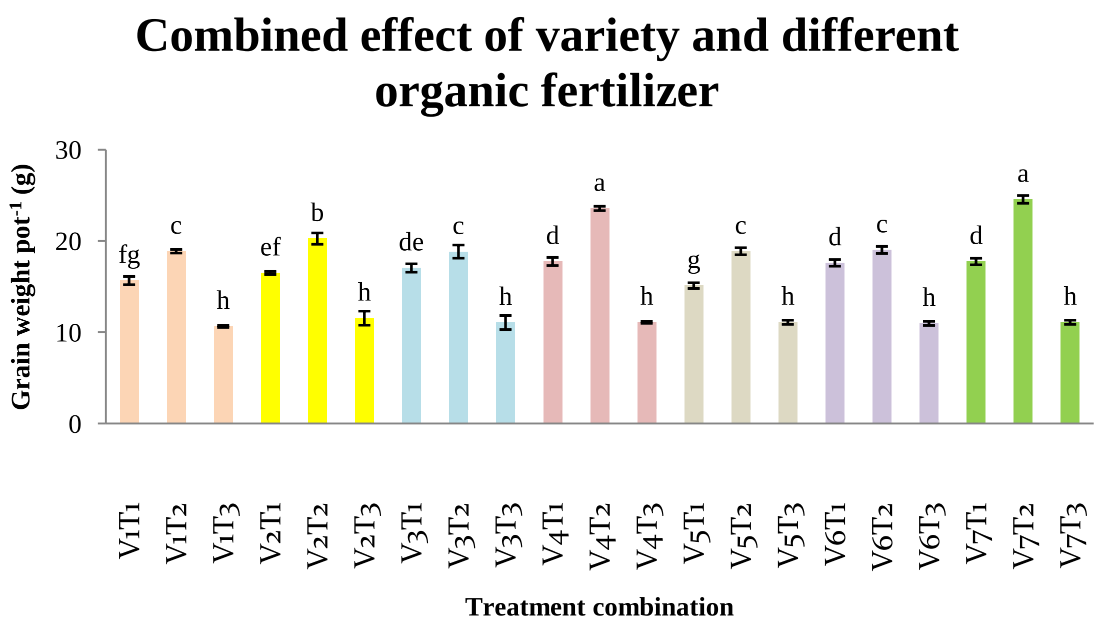


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Figure 9. Combined effect of variety and different organic fertilizer on average grain weight pot^{-1} of transplanted aromatic aman rice (LSD $_{(0.05)}$ = 0.62)

4.4 Straw weight pot^{-1} (g)

4.4.1 Effect of rice variety on Straw weight pot^{-1} (g)

The average straw weight pot^{-1} of rice was significantly affected by different rice varieties (Figure 10). The experiment results revealed that BRRI dhan34 (V_7) rice variety had the highest average straw weight pot^{-1} (37.40 g) which was statistically similar with the V_2 (36.96 g) treatment. While the Kaloshaila (V_1) rice variety had the lowest average straw weight pot^{-1} (26.48 g). Variations in the effective average straw weight pot^{-1} among the many rice cultivars may be influenced by the genetic make-up and varietal performance of the rice varieties. Tyeb *et al.* (2013) reported that the variation in straw yield due to the effect of varietal differences.

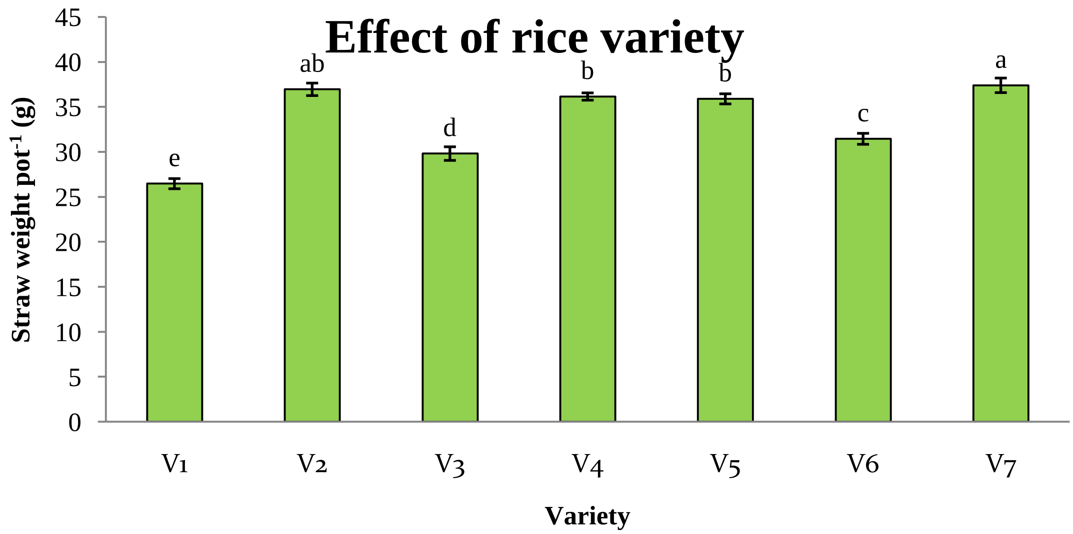

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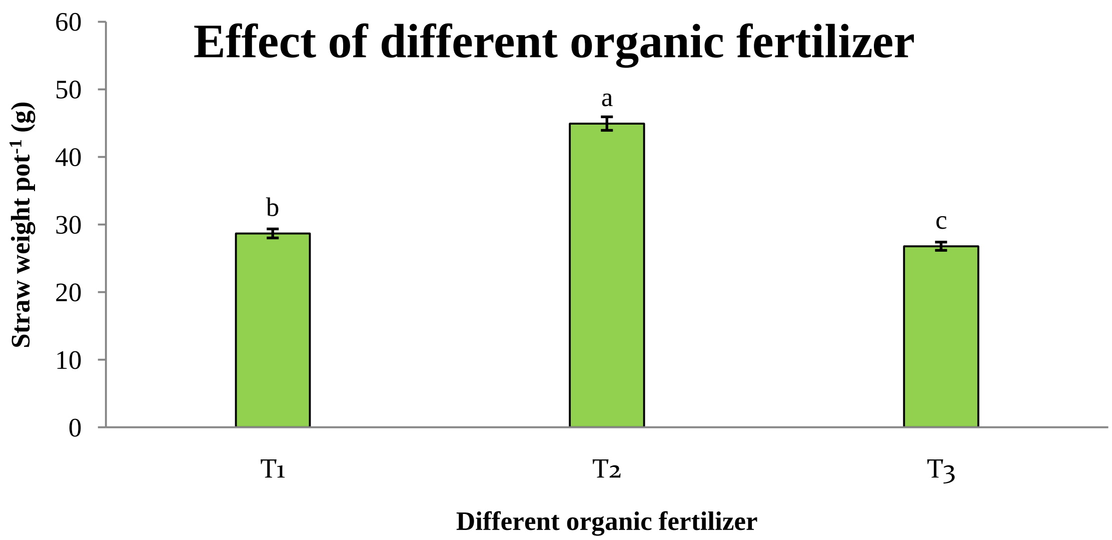
Figure 10. Effect of variety on average straw weight pot^{-1} of transplanted aromatic aman rice (LSD $_{(0.05)}$ = 1.10)

4.4.2 Effect of different organic fertilizer on Straw weight pot^{-1} (g)

In this experiment different organic fertilizer treatment significantly influenced average straw weight pot^{-1} of rice (Figure 11). Experimental result revealed that the highest average straw weight pot^{-1} of rice (44.92 g) was observed in T_2 treatment. Whereas the lowest average straw weight pot^{-1} (26.78 g) was obtained from T_3 treatment. This might be due to adequate supply of nutrient element at the right time from organic sources which helped optimum dry matter partitioning from the source to sink during reproductive stage of plant consequently increase the straw weight of rice. Tharmaraj *et al*. (2011) reported that in rice cultivation the vermiproduct treated plants display quicker and higher growth rate and productivity than the control plots. Among the treated group, the development rate was high in the combination of vermicompost and vermiwash treated plants, than the vermicompost and vermiwash un-treated plants.

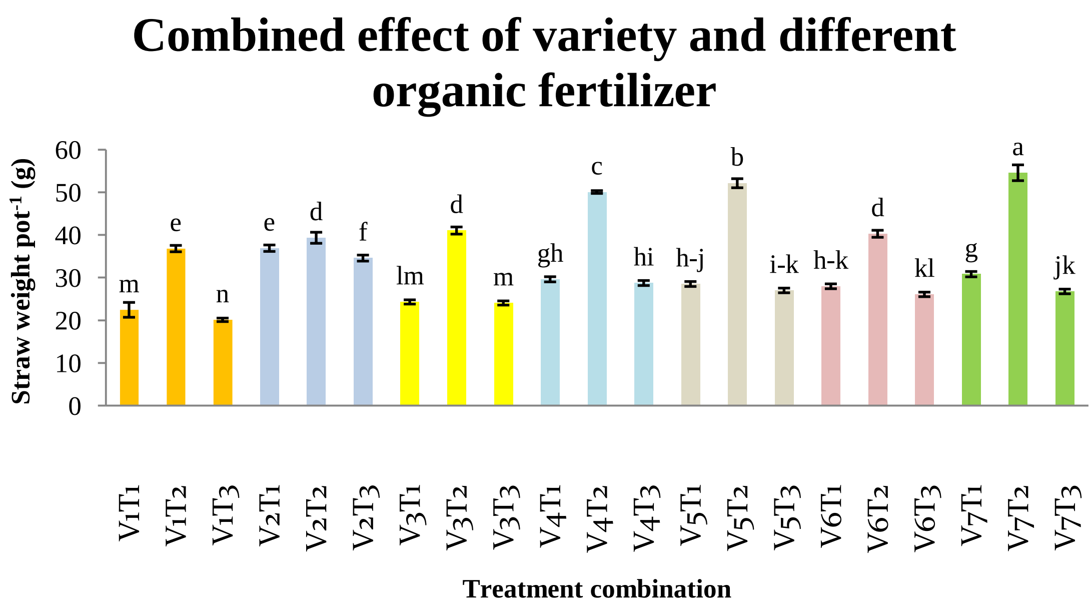


In the bar graphs means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. Here, T_1: 150 g CD pot^{-1}, T_2: 150 g VC pot^{-1} and T_3: 30 g MOC pot^{-1}.

Figure 11. Effect of different organic fertilizer on average straw weight pot^{-1} of transplanted aromatic aman rice (LSD $_{(0.05)}$ =0.72)

4.4.3 Combined effect of variety and different organic fertilizer on straw weight pot^{-1} (g)

Combined effect of variety and organic fertilizer showed significant effect on average straw weight pot^{-1}of rice (Figure 12). Experimental result showed that the highest average straw weight pot^{-1}of rice (54.60 g) was observed in V_7T_2 treatment combination. While the lowest average straw weight pot^{-1} (20.13 g) was obtained from V_1T_3 treatment combination.



In the bar graphs means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. Here, V_1= Kaloshaila, V_2= Chinigura, V_3= Gobindobhog, V_4= Kataribhog, V_5= Tulsimala V_6= Kalijira, V_7= BRRI dhan34, T_1: 150 g CD pot^{-1}, T_2: 150 g VC pot^{-1} and T_3: 30 g MOC pot^{-1}.

Figure 12. Combined effect of variety and different organic fertilizer on average straw weight pot^{-1} of transplanted aromatic aman rice (LSD $_{(0.05)}$ = 1.91)

CHAPTER V

SUMMARY AND CONCLUSION

A pot experiment was conducted during the period from June to December 2021 in Aman season at Sher-e-Bangla Agricultural University, Dhaka to investigate the effect of the different organic fertilizer on the growth and yield of transplanted aromatic aman rice varieties.The experiment was laid out in Completely Random Design (CRD) with 2 factor and four replications. Factor A: Different rice varieties (7) viz: V_1: Kaloshila, V_2: Chinigura, V_3: Gobindobhog, V_4: Kataribhog, V_5: Tulshimala, V_6: Kalijira, V_7: BRRI dhan34 and Factor B: Application of different organic manures (3) viz: T_1: 150 g CD pot^{-1}, T_2: 150 g VC pot^{-1} and T_3: 30 g MOC pot^{-1}. For the purpose of evaluating the experiment's outcomes, data on various parameters were evaluated. These data revealed significant variance in rice growth, yield, and yield-contributing traits as a result of varieties, different organic manures application and combination of these factors.

In case of different rice varieties, the highest average plant height (121.08 cm), effective tiller number hill^{-1} (10.00), grain weight pot^{-1} (17.81 g) and straw weight pot^{-1} (37.40 g) were obtained from BRRI dhan34 (V_7). While the lowest average plant height (95.25 cm), effective tiller number hill^{-1} (3.52), grain weight pot^{-1} (15.07 g) and straw weight pot^{-1} (26.48 g) were observed from Kaloshaila (V_1) rice variety. However the Tulsimala (V_5) rice variety obtained the lowest average grain weight pot^{-1} (15.03 g).

In case of different fertilizer application treat pot the highest average plant height (120.39 cm), effective tiller number hill^{-1}of rice (9.36), grain weight pot^{-1} of rice (20.58 g) and straw weight pot^{-1} of rice (44.92 g) were obtained in 150 g vermicompost treated pot (T_2). While the lowest average plant height (106.64 cm), effective tiller number hill^{-1} (4.08), grain weight pot^{-1} (11.09 g) and straw weight pot^{-1} (26.78 g) were obtained from T_3 (30 g MOC pot^{-1}) treatment.

In case of combination, the highest average plant height (128.50 cm), effective tiller number hill^{-1} (14.25), grain weight pot^{-1} (24.56 g) and straw weight pot^{-1}of rice (54.60 g) were observed in V_7T_2 combination treatment. While the lowest plant height (86.25 cm), effective tiller number hill^{-1} (2.33), average grain weight pot^{-1} (10.66 g) and average straw weight pot^{-1} (20.13 g) was obtained from V_1T_3 treatment combination.

Conclusion

i. Based on the above findings, the experimental results revealed that different varieties and organic manures application significantly influenced the growth, yield, and yield-contributing traits of transplanted aromatic Aman rice.

ii. In case of different rice varieties BRRI dhan34 (V_7) rice variety performed best and recorded the highest average plant height (121.08 cm), effective tiller number hill^{-1} (10.00), grain weight pot^{-1} (17.81 g) and straw weight pot^{-1} (37.40 g) comparable to other varieties.

iii. Different organic manure application influenced the growth and yield attributes of aromatic aman rice varieties, and the highest average plant height (120.39 cm), effective tiller number hill^{-1}of rice (9.36), grain weight pot^{-1} of rice (20.58 g) and straw weight pot^{-1} of rice (44.92 g) were obtained in 150 g vermicompost treated pot (T_2).

iv. In case of combination, the highest average plant height (128.50 cm), effective tiller number hill^{-1} (14.25), grain weight pot^{-1} (24.56 g) and straw weight pot^{-1}of rice (54.60 g) were observed in V_7T_2 combination treatment

From the above results, it may be concluded that vermicompost used as an organic fertilizers have the potential to increase the growth parameters and yield components of rice. The use of vermicompost as an organic fertilizer along with BRRI dhan34 cultivation for rice production showed positive effects on growth and yield in the crop. As a result, it was determined that cultivating BRRI dhan34 in conjunction with the application of 150 g VC pot^{-1}20 g for rice production resulted in a higher grain weight than the other organic treatments and was suitable for organic rice production.

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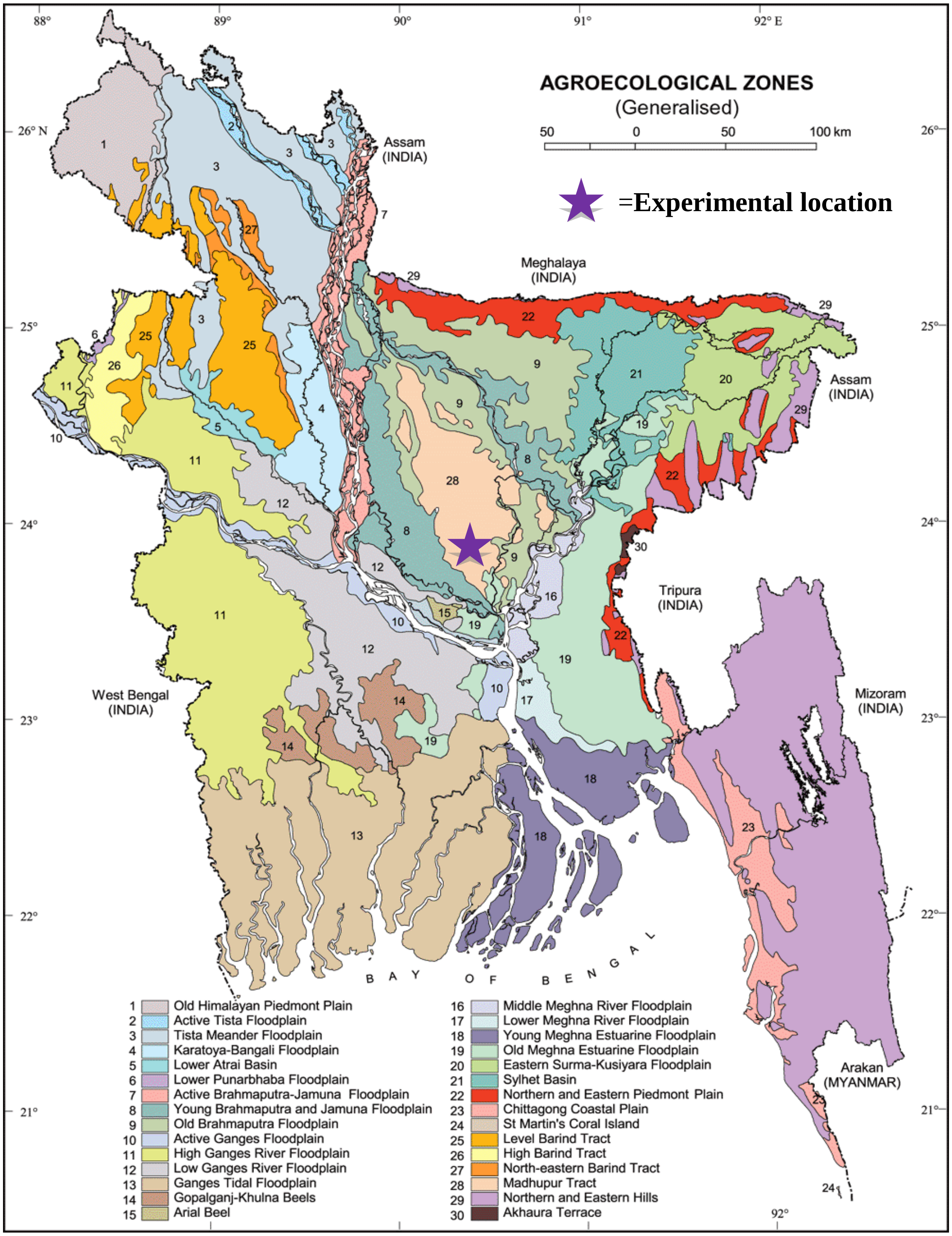
APPENDICES

Appendix I. Map showing the experimental location under study



Appendix II. Soil characteristics of the experimental field

A. Morphological features of the experimental field

Morphological features	Characteristics
AEZ	AEZ-28, Modhupur Tract
General Soil Type	Shallow Red Brown Terrace Soil
Land type	High land
Location	Sher-e-Bangla Agricultural University Agronomy research field, Dhaka
Soil series	Tejgaon
Topography	Fairly leveled

B. The initial physical and chemical characteristics of soil of the experimental site (0- 15 cm depth)

Physical characteristics	
Constituents	**Percent**
Clay	29 %
Sand	26 %
Silt	45 %
Textural class	Silty clay
Chemical characteristics	
Soil characteristics	**Value**
Available P (ppm)	20.54
Exchangeable K (mg/100 g soil)	0.10
Organic carbon (%)	0.45
Organic matter (%)	0.78
pH	5.6
Total nitrogen (%)	0.03

Source: Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka.

Appendix III. Monthly meteorological information during the period from June 2021 to December, 2021

Year	Month	Air temperature (^0C)		Relative humidity (%)	Average rainfall (mm)
		Maximum	Minimum		
2021	June	34°C	27.3°C	76%	134 mm
	July	32.6°C	26.8°C	81%	114 mm
	August	32.6°C	25.5°C	80%	106 mm
	September	32.4°C	25.7°C	80%.	86 mm
	October	31.2°C	23.9°C	76%.	52 mm
	November	29.6°C	19.8°C	53%.	00 mm
	December	28.8°C	19.1°C	47%.	00 mm

Source:Metrological Centre, Agargaon, Dhaka (Climate Division)

Appendix IV. Analysis of variance of the data of plant height, effective tiller hill^{-1}, grain weight pot^{-1} and straw weight pot^{-1}of transplant Aman rice

Mean square of					
Source	Df	Plant height	Effective tiller number	Grain weight	Straw weight pot^{-1}
Replication	3	33.64	16.390	8.758	26.12
Variety (V)	6	927.19**	52.667**	14.494**	214.12**
Treatment (T)	2	1342.01**	199.097**	638.629**	2782.28**
V×T	12	25.47*	11.405*	7.159**	77.58*
Error	60	3.15	0.197	0.546	1.83

**: Significant at 0.01 level of probability

*: Significant at 0.05 level of probability