Journal of Agroforestry and Environment

Volume 15, Issue 2, 2022

Journal DOI: https://doi.org/10.55706/jae
Journal homepage: www.jagroforenviron.com

Growth Performances of BRRI dhan55 under Integrated Nutrient Management

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Received: 19/12/2022

Accepted: 31/12/2022

Available online: 09/01/2023

Abstract: Integrated nutrient management is vital for the development and growth of rice (*Oryza sativa* L.), but they are rarely used nowadays due to the widespread use of inorganic fertilizers. So, the current research was executed to determine the effect of organic amendments on different growth parameters of BRRI dhan55. A field investigation was managed at the Plant Pathology field lab, Sylhet Agricultural University, from November 2018 to April 2019. Different combinations of organic amendments (T_1= Recommended Fertilizer Dose, RFD which includes TSP 100g 10 m^{-2}, MoP 100g 10 m^{-2}, Gypsum 50g 10 m^{-2}, Zinc 15g 10 m^{-2}, T_2= RFD with vermicompost 2kg 10 m^{-2}, T_3= RFD with vermicompost 4 kg 10 m^{-2}, T_4= RFD with cowdung 2 kg 10 m^{-2}, T_5= RFD with cowdung 4 kg 10 m^{-2}, and T_6= RFD with Biochar 4 kg 10 m^{-2}) were used in a RCBD (Randomized Complete Block Design) with three replications. The existing results showed that RFD with biochar treatments showed better performance in terms of the initial weight of grain (50.70 g), clean grain weight (48.55 g), and number of non-effective grains per panicle (27.67) and tiller per hill (12.07). T_2 (RFD with vermicompost 2 kg 10 m^{-2}) treatments demonstrated better results in parameters such as weight of grain from a single panicle (4.04 g), single panicle grain weight (3.90 g), panicle length (24.77 cm), and grain per panicle (153.00). Biomass (34.56 g) and above-ground length parameters (90.00 cm) performed better with the T_4 treatment (RFD with 2 kg 10 m^{-2} of cowdung). T_6 treatments were showed the highest grain yield (10.71 t ha^{-1}) followed by T_3 treatments. Therefore, the present results recommended that organic amendments could be a better supplement than inorganic amendments for the growth performance of BRRI dhan55.

Keywords: Rice; *Oryza sativa*; Vermicompost; Biochar; Cowdung.

INTRODUCTION

In Asia, rice (*Oryza sativa* L.) is the primary staple meal (Rao et al., 2018). The yield of rice must increase above existing levels in order to feed the expanding population (Pan et al., 2013). Because of the recent rapid economic expansion, there are fewer workers available for agricultural output (Pan et al., 2017). With around 370 kcal of energy per 100 g of grains, rice is the main food grain crop of Bangladesh. With a total yearly production of 33.89 million metric tons, rice is grown on approximately 84% of the country's cropped land (BBS, 2015). Having an eight-month dry season and a four-month wet season, Bangladesh features a monsoon climate in addition to a hot, humid subtropical climate (Ahmad et al., 2014). There are three main production seasons of rice in Bangladesh: Aus, which is the spring season, and Boro, which is the dry season and is fully irrigated. Aman is the wet season. Irrigated dry season Boro rice, the most fruitful of the three rice seasons, is the main crop (Ahmed et al., 2013). When Boro rice is cultivated with high-yielding conventional varieties, the optimum yield is 3.86 tons ha^{-1}, and when it is grown with hybrid kinds, the average yield is 4.75 tons ha^{-1}. Bangladesh produces a relatively small amount of rice on average, 3.0 t ha^{-1} which is extremely little (BBS, 2015).

The most significant and widely grown food crop is rice which provides one in three individuals with half of their daily nutrition. The high yielding varieties, intensive farming, and inorganic fertilizers take the lead in providing food for these large populations. Our soil is degrading to an alarming level as a result of the excessive and improper use of complex organic substances in stabilized, humus-like chemical fertilizers in the soil, which is also contributing to ecosystem imbalance and environmental pollution (Satyanarayana et al., 2002; Mahajan et al., 2008; Hasanuzzaman et al., 2010). As a result of the stimulation of a downturn in soil properties (physical and chemical), as well as in soil microbial growth (Mahajan et al., 2008). Organic materials are better sources of plant nutrition because they don't harm crops or the soil (Pieters, 2004). It is known that using earthworms in vermicomposting produces products that resemble hummus and stabilizes complicated organic materials (Benitez et al., 2000). Vermicompost application to soil is recognized as a desirable strategy in any production system due to the enhancement of microbial activities of soil, plant nutrients mineralization, and rose soil fertility (Arancon et al., 2006, Ferraras et al., 2006). Vermicompost is a material created by earthworms using organic waste (Blouin et al., 2019). Vermicompost has good physical, chemical, and biological qualities that can increase the fertility of the soil and reduce crop diseases, according to a prior study (Patnaik et al., 2020). According to Fernandez et al. (2011), vermicompost has a high microbial functional diversity and the potential to be used for the treatment of chemical pollution in agricultural production. Jahanbakhshi et al. (2019) demonstrated the value of vermicompost as an organic fertilizer with a suitable CN (carbon to nitrogen) ratio, pH, and salinity. Jaouni et al. (2019) also suggested that vermicompost could enhance the jujube coconut fruit's chemical makeup and boost its nutritional and therapeutic potential. The productiveness of crop fields has been steadily deteriorating due to constant cropping, nutrient mining, and indiscriminate chemical fertilizer use in Bangladesh. In this light, biochar-primarily carbon-enriched materials with a negligible quantity of plant nutrients might be the finest organic manures for restoring depleted soils. Biochar is produced from organic waste under circumstances of high pyrolysis temperature and oxygen limitation. A product of anaerobic pyrolysis made from organic materials-biochar can be used to restore soil carbon for a prolonged period of time by lowering greenhouse gases emission from the soil to the troposphere. It is resistant to easy degradation. Additionally, using biochar will lessen the need for chemical fertilizers when growing rice, and changing the paddy ecosystem may reduce GHG emissions. In the highly sensitive dry tropical agroecosystem of India, the of FYM and rice husk biochar in combination with less inorganic fertilizer and fewer water inputs was found to help sustain wheat crop output (Singh et al., 2019). Additionally, Singh et al. (2021) found such appropriate farming techniques depending on certain agroecosystems may be successful in helping humans adapt to climate change.

A carbon-rich organic substance called biochar is produced by pyrolyzing biomass (Borchard et al., 2012). Another definition for it is "the carbonaceous residue from pyrolysis, especially naturally occurring burns under low oxygen conditions" (Xu et al., 2012). Biochar stores nutrients in the soil and absorbs moisture, which lowers the need for mineral fertilizer and shields crops from the effects of drought. Utilizing biochar in farming soils, such as paddy fields, reduces CH_4 emissions while boosting soil microbial activity. Additionally, because biochar-amended soils have higher germination rates, fewer seeds are needed. Notably, biochar is advantageous for all kinds of agricultural systems (Brunn et al., 2011). There was a lot of work done in rice fields to find out the effects of various organic and inorganic fertilizer combinations, but very few experiments were found in rice cultivation with only organic fertilizer. The goal of the current study was to determine how different organic fertilizer doses (including vermicompost, cowdung, and biochar in addition to the prescribed fertilizer dose) affected several yield-contributing factors in a rice field.

MATERIALS AND METHODS

Study area: The investigation was carried out between November 2018 and April 2019 at the Sylhet Agricultural University's Plant Pathology Field Lab in Sylhet, Bangladesh, which is located at 24°53'56.54"N latitude and 91°52'19.13"E longitude (Figure 1).

At higher elevations, Sylhet's characteristic tropical monsoon climate transitions into a humid subtropical climate. The rainy season starts in April and is extremely hot and humid with frequent, severe rains and thunderstorms, in contrast to the short dry season that starts in November and lasts until February. Between May and September, precipitation totals an average of 4,200 mm, or about 80% of the entire year (Talucder 2015).

Materials: A test crop of the rice cultivar BRRI dhan55 was utilized. The Bangladesh Rice Research Institute (BRRI) created this variety in 2011. The boro season is the best time to use it. The wet bed method was used to raise the rice seedlings. In November 2018, a hand spade was used to dig up the chosen seed bed.1 kg Seeds bigha^{-1} (95% germinated) were soaked and nurtured for 48 hours; 95% of them germinated. On January 10, 2019, seedlings that were thirty days old were painstakingly removed from the seedling nursery and transplanted. From the surrounding Sylhet area sawmills, sawdust was gathered. Biochar was prepared from the collected sawdust. Sawdust was measured out and let to dry for a few days in the sun to create biochar. After drying, 40 kg of dry material was recovered from about 50 kg of sawdust. These dry materials were pyrolyzed in a kiln for an extended period of time to create biochar. Twenty kg of biochar were produced after pyrolysis (Mustakim et al., 2022). Vermicompost (from *E. fetida*-cowdung) was collected from the soil science laboratory of Sylhet Agricultural University. Well decomposed cowdung was collected from Jonaki village near Sylhet Agricultural University.

DOI: https://doi.org/10.55706/jae1519

Land preparation: Maintaining line to line space of 20 cm and hill to hill space of 15 cm, two seedlings per hill were used. After seven days of transplantation, all blocks were examined for misplaced hills, which were wherever necessary occupied in with more plants. A power tiller was used to plow the ground initially. The soil was eventually prepared by serial plowing, cross plowing, and laddering after being sufficiently soaked with irrigation water. After 40 days, the unwanted residues were sorted out from the test plot. The terrain was eventually leveled. There were 18 plots (5 m x 2 m) on the experimental land. The spacing between blocks was 1 m, and 0.5 m separated the two plots.

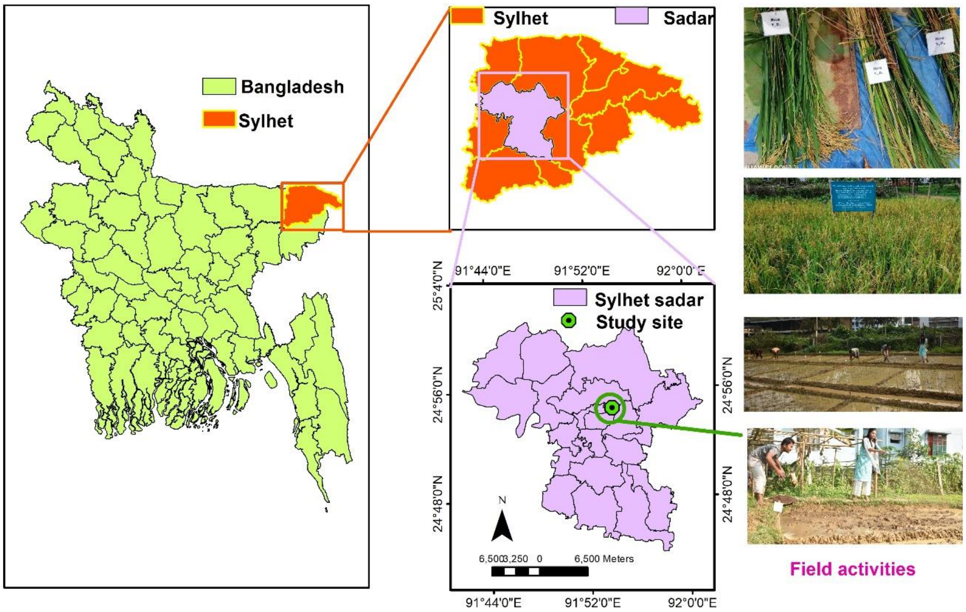

Figure 1. Study area map.

Experimental design and data analysis: The experiment was done with RCBD (Randomized Complete Block Design) with three replications. There were six treatments in this research experiment namely, T_1= Recommended Fertilizer Dose, RFD which includes TSP 100g 10 m^{-2}, MoP 100g 10 m^{-2}, Gypsum 50g 10 m^{-2}, Zinc 15g 10 m^{-2}, T_2= RFD with vermicompost 2kg 10 m^{-2}, T_3= RFD with vermicompost 4 kg 10 m^{-2}, T_4= RFD with cowdung 2 kg 10 m^{-2}, T_5= RFD with cowdung 4 kg 10 m^{-2}, and T_6= RFD with Biochar 4 kg 10 m^{-2}. 100g Urea 10 m^{-2} was applied three times at 10, 30, and 50 days after transplanting. The field data were statistically analyzed by using the statistical R-software program.

RESULTS AND DISCUSSION

This study's results showed that the initial weight of grain (50.70 g $plant^{-1}$) was observed to be highest in treatments RFD with biochar 4 kg 10 m^{-2} (Table 1). RFD with vermicompost 2kg 10 m^{-2} produced the highest weight of grain from a single panicle (4.04 g $plant^{-1}$). Clean grain weight (48.55 g $plant^{-1}$) showed better results in treatment RFD with biochar 4 kg 10 m^{-2} (Table 1). RFD with vermicompost 2kg 10 m^{-2} exhibited the highest result in single panicle grain weight (3.90 g $plant^{-1}$) (Table 1).

Sharma and Banik (2012) stated that organic manures from sources like FYM or vermicompost can replace 30% of the recommended doses of nitrogen without harming the system's productivity or soil fertility. According to Rahman and Barmon (2019), vermicompost application greatly boosted rice productivity and technical efficacy.

The no. of non-effective grains per panicle (27.67) was found to be highest in treatment RFD with biochar 4 kg 10 m^{-2} (Table 1). RFD with cowdung 2 kg 10 m^{-2} resulted in the greatest above-ground length (90.00 cm) (Table 1). According to Muhammad Aslam Ali et al., 2021 rice yield rose while employing the AWDI method with biochar amendments at 15-20 t ha^{-1} with half the required inorganic fertilizers, especially when cultivating dry Boro rice.

Rice below ground length (18.73 cm) was the longest in RFD with vermicompost 4 kg 10 m^{-2} (Table 2). RFD with vermicompost 2 kg 10 m^{-2} showed the best performances in terms of panicle length (24.77 cm) (Table 2). At 2 kg 10 m^{-2}, grain per panicle (153.00) was discovered to be the most common in RFD with vermicompost (Table 2). Any fuel obtained from plants is referred to as biomass. This comprises plant and animal waste as well as crop residues and wood. RFD with cowdung 2 kg 10 m^{-2} demonstrated the highest results in biomass (34.56 g) (Table 2).

DOI: https://doi.org/10.55706/jae1519

Tillering is a crucial characteristic of grain production and, as a result, a crucial component in enhancing rice growth. Effective tillers and non-bearing tillers together make up the total number of tillers on hill $^{-1}$. The number of tillers per hill (12.07) exhibited the best results with RFD with Biochar 4 kg 10 m^{-2} (Table 2). According to Shaoyi et al. (2021), the implementation of vermicompost accelerated the length of the root, surface area, mean diameter, the volume of the root, and no. of root tip's fragrant rice seedlings, as well as increased root activity. The study's findings suggested that growing plants in nurseries with vermicompost would be an effective agronomic strategy for the cultivation of fragrant rice.

Table 1. Effect of various organic amendments along with RFD on yield contributing characters of Boro rice (BRRI [dhan55])

Treatments	Initial weight of grain (gm)	Weight of grain from single panicle (gm)	Clean grain weight (gm)	Single panicle grain weight (gm)	No. of non-effective grain per panicle	Above ground length (cm)
T_1	34.68±18.93	3.23±1.17	33.16±18.26	3.08±1.13	23.00±11.14	84.90±0.96
T_2	37.04±3.04	4.04±0.73	35.71±3.37	3.90±0.76	22.33±6.11	82.70±6.82
T_3	42.04±16.52	2.88±0.49	39.67±15.74	2.68±0.49	22.00±4.58	86.10±2.01
T_4	32.11±14.16	3.15±0.89	30.55±13.90	3.00±0.90	24.67±7.77	90.00±3.61
T_5	31.97±8.84	3.94±0.62	28.19±5.64	3.80±0.66	24.00±7.21	86.67±8.74
T_6	50.70±5.34	3.56±0.27	48.55±4.95	3.39±0.26	27.67±10.26	67.80±29.60
CV (%)	34.86	23.20	34.20	24.20	22.82	16.17

Note: T_1= Recommended Fertilizer Dose, RFD which includes TSP 100g 10 m$^{-2,}$ MoP 100g 10 m$^{-2,}$ Gypsum 50g 10 m$^{-2,}$ Zinc 15g 10 m$^{-2,}$ T_2= RFD with vermicompost 2kg 10 m^{-2}, T_3= RFD with vermicompost 4 kg 10 m^{-2}, T_4= RFD with cowdung 2 kg 10 m^{-2}, T_5= RFD with cowdung 4 kg 10 m^{-2}, T_6= RFD with Biochar 4 kg 10 m^{-2}

Table 2. Effect of various organic amendments along with RFD on yield contributing characters of Boro rice (BRRI [dhan55])

Treatments	Below ground length (cm)	Panicle length (cm)	Grain per panicle	Biomass (gm)	No. of tillers per hill
T_1	12.93±1.80	22.27±0.74	125.67±44.29	27.50±6.93	9.07±0.31
T_2	13.60±4.33	24.77±1.72	153.00±18.25	28.73±5.65	8.57±0.72
T_3	18.73±9.98	23.50±1.25	110.33±11.59	27.00±2.08	11.13±0.64
T_4	14.50±3.91	22.33±2.66	124.67±28.59	34.56±15.36	10.13±1.79
T_5	13.30±2.25	24.00±1.18	150.67±15.04	33.00±20.75	7.68±1.74
T_6	13.13±4.90	23.90±1.73	141.33±12.42	28.14±6.79	12.07±3.18
CV (%)	39.68	7.16	19.38	35.43	17.64

Note: T_1= Recommended Fertilizer Dose, RFD which includes TSP 100g 10 m$^{-2,}$ MoP 100g 10 m$^{-2,}$ Gypsum 50g 10 m$^{-2,}$ Zinc 15g 10 m$^{-2,}$ T_2= RFD with vermicompost 2kg 10 m^{-2}, T_3= RFD with vermicompost 4 kg 10 m^{-2}, T_4= RFD with cowdung 2 kg 10 m^{-2}, T_5= RFD with cowdung 4 kg 10 m^{-2}, T_6= RFD with Biochar 4 kg 10 m^{-2}

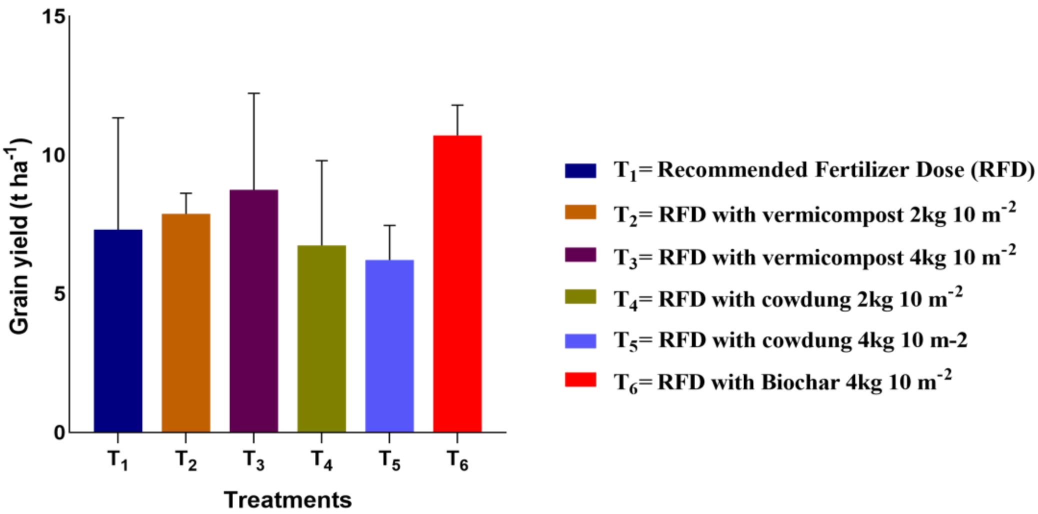

Figure 2. Effect of various organic amendments along with RFD on the grain yield of Boro rice (BRRI dhan55)

DOI: https://doi.org/10.55706/jae1519

According to the results (Figure 2), the highest rice yield (10.71 t/ha) was obtained from T_6 treatments and the lowest rice yield (6.22 t/ha) was obtained from T_5 treatments. Recommended fertilizer dose (T_1) treatments gave 7.31 t/ha rice yield, T_2 treatments gave 7.88 t/ha rice yield, T_3 treatments gave 8.75 t/ha rice yield, and T_4 treatments gave 6.74 t/ha rice yield. According to the BRRI report, the yield of BRRI dhan55 is 7 t/ha. The study result was similar to different previous research. By increasing the number of panicles and grains, the use of biochar can increase rice yield (Zhang et al. 2014; Zhang et al. 2013). With the addition of more biochar, the number of rice panicles and grains rose, and the rice yield increased by 15.26-44.89% (Zhang et al. 2014). According to Morteza et al. (2011), plants treated with 2 t/ha of organic fertilizer had the highest grain yield in 2008 (4335.88 kg/ha), whereas plants treated with chemical fertilizer plus 1.5 tons/ha of organic fertilizer had the highest yield in 2009 (4662.71 kg/ha).

CONCLUSION

According to the findings, all treatments had a significant impact on the growth and development of BRRI dhan55 (Boro rice). The study also confirmed that different doses of vermicompost, cowdung, and biochar treatment along with RFD gave the best results compared to RFD alone. Biochar treatments showed the best results regarding the initial weight of grain, clean grain weight, no. of non-effective grains per panicle, and no. of tillers per hill. Treatments with different doses of vermicompost gave the best results in terms of weight of grain from a single panicle, below-ground length, panicle length, and grain per panicle. To obtain higher growth and yield of rice, organic amendments can be an excellent complement to inorganic fertilizers, as suggested by our results.

Acknowledgment

We thank the Plant Pathology and Seed Science Department, SAU, Sylhet-3100, for providing the field for this experiment. We also thank Md. Kamrujjaman, Md. Moudud Ahmod, and Shamim Reza for helping with biochar and site preparation.

Conflict of Interest

The authors have not declared any conflicts of interest.

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