POULTRY LITTER COMPOST AND NPK FERTILIZERS INDUCED GROWTH AND YIELD PERFORMANCE OF BORO RICE AT ROOFTOP FARMING

Rahman, M.*, M. Alauddin[1], T. T. Turna[2] and M. K. Rahman[2]

Centre for Climate Change and Environmental Research (C3ER), BRAC University, Mohakhali, Dhaka-1212, Bangladesh; [1]Department of Soil Science, Charfasson Govt. College, Bhola, Bangladesh; [2]Department of Soil, Water and Environment, University of Dhaka, Dhaka-1000, Bangladesh

*Corresponding author: moomrahman@gmail.com

Abstract

The effects of inorganic fertilizers and decomposed poultry litter on the growth and yield performance of boro rice (*Oryza sativa* L.) were assessed by conducting a pot experiment on the rooftop of a building in Charfasson town, Bhola. The experiment was laid out in a completely randomized design (CRD), having eight treatments with three replications each. Different agronomic parameters were measured at 30-day intervals after sowing of seeds and yield parameters after harvesting. The highest height (82.67 cm) at 90d, number of leaf (37.67) at 120d**,** longest leaf (39.67 cm) at 90d, and length of panicle (27.17 cm), number of grains/panicle (153.33), weight of grain/panicle (3.74 g), fresh weight of grains (62.35 g/pot), dry weight of grain (51.53 g/pot), dry weight of root (13.43 g/pot), rice yield (51.53 g/pot) or (5.67 t ha^{-1}), highest B:C ratio (4.51), respectively, were found in the treatment T_7: (3.0 t PL ha^{-1} + $N_{100}P_{25}K_{90}$ kg ha^{-1}). The results of treatments T_7 and T_8 are statistically identical. The overall best growth performance and yield of boro rice were achieved in T_7: (3.0 t PL ha^{-1} + $N_{100}P_{25}K_{90}$ kg ha^{-1}) treatment on a rooftop farming system on the south coast of Bangladesh.

***Key words*:** Boro rice; Charfasson; Growth and yield; Poultry litter.

INTRODUCTION

Rice (*Oryza sativa* L.) constitutes one of the most important staple foods for over half of the world's population. People consume it in large quantities worldwide, regardless of race or political affiliation (Moe *et al*. 2017**)**. More than 759.6 Mt of rice were produced globally in 2017 (FAO 2018). Asian countries produce and consume 90% of the world's rice. India and China account for half of the area in rice farming. However, Asia's mean yields are lower than global mean yields (Akter *et al.* 2020). Rice contains 7-8% protein, which is more digestible, biologically valuable, and nutritious, as well as less crude fibre and fat (1 to 2%) and it alone provides around 20% of the world's dietary energy, more than maize or wheat (Anisuzzaman *et al*. 2022).

Rice (*O. sativa* L.) is the staple food of the people of Bangladesh. Unfortunately, the rice yield is lower in Bangladesh than in other rice growing countries like South Korea and Japan (Islam *et al*. 2013). Intensification of agricultural land use, which is presently 190% has increased remarkably along with the high expansion of modern crop varieties (Bilkis *et al*. 2015). Among the three rice seasons, Boro rice covers about 56.66% of total rice area and it contributes to 43.24% of the total rice production in the country (Akter *et al*. 2020).

Proper fertilizer management is essential to increase rice yield, but using fertilizers with chemically imbalanced NPK ratios has led to problems with the soil like acidification, loss of organic matter, deterioration of the structure, and decreased biological activity and fertility. Inorganic fertilizers contribute to Bangladesh's successful crop production but regular application of inorganic fertilizer to soil has a negative impact and gradually reduces soil fertility. However, a balanced

fertilizer usage is required to enhance productivity and maintain soil health (Akter *et al*. 2020). Thus, sustainable crop production is difficult using chemical fertilizer alone and similarly it is impossible to get higher crop yield by using organic manure only. The integrated use of organic and inorganic fertilizers might be helpful for sustainable crop production.

Poultry farmholders use concentrated feeds to feed their poultry birds. As a result, the poultry excreta are rich in nutrients. As the poultry excreta are not used as fuel, these can be a good source of nutrients for field crops (Rashid *et al*. 2012). Poultry litter has been proven to be a good source to supplement chemical fertilizers in rice cropping pattern which contains not only N, but also other elements like P, K, S, Ca, Mg, and micronutrients. Approximately 75% of the total N and the majority (90-100%) of the P and K in poultry litter are available for the plant during the year of application (Hossain *et al*. 2010). In addition, global environmental pollution can also be controlled considerably by reducing the use of fertilizer and increasing the use of manures (Akter *et al*. 2020). Decomposed poultry litter may be a potential source of nutrients for rice cultivation, which may enhance soil fertility through its effect on soil physico-chemical properties. A large quantity of poultry litter (chick litter and layer dropping) is produced annually in our country and it is a great environmental hazard. To minimize ecotoxicity and to reduce air pollution a scientific management of poultry litter is essential. In recent past, considerable attention has been given to rooftop farming using organic sources of nutrient for various crops (Alam *et al*. 2023, Rifhat *el al*. 2023, Prity *et al.* 2023, Alauddin *et al.* 2022, Alauddin *et al.* 2021, Chowdhury and Rahman 2021, Rikza *et al.* 2021) in Bangladesh. Therefore, the objective of this study was to evaluate the growth and yield of boro rice through improved nutrient management using decomposed poultry litter and NPK fertilizers at rooftop farming system.

MATERIAL AND METHODS

Collection and analysis of soil samples

Soil samples (0-15 cm depth) were collected from the Research Farm of Charfasson Govt. College, Bhola, Bangladesh. A pot experiment was carried out on the rooftop at Charfasson Upazila of the south coast of Bangladesh to evaluate the growth and yield performance of boro rice (*O. sativa* L.) under poultry litter compost and NPK fertilizers in the winter season (2021-2022).

The soil had a pH of 8.10 (1:2.5 w/v H_2O). Organic carbon 0.65% was determined by Wet Oxidation method (Walkley and Black 1934), available nitrogen 0.24% by Kjeldahl extraction method (Marr and Cresser 1983), available phosphorus 0.09% (Jackson 1958), available potassium 1.40% (Pratt 1965), available Sulfur 0.18% (Bardsley and Lancaster 1965), sand 11.3%, silt 51.04% and clay 37.66%, textural class- silty clay loam. The particle size analysis of the soils was done by the Hydrometer method and textural classes were determined by Marshall's triangle coordinate curve (Bouyoucos 1962).

Composition of poultry litter waste

Chemical composition of poultry waste is as follows: Organic carbon 20.40 and 25.16, nitrogen 1.55 and 1.26, phosphorus 2.37 and 1.16, potassium 2.57 and 1.87, sulfur 0.53 and 0.58, zinc 0.07 and 0.04 and copper 0.04 and 0.06%, cadmium 3.40 and 3.00, lead 26 and 25, chromium 8.05 and 6.05, nickel 12.25 and 8.90, and arsenic 3.18 and 2.35 ppm in chick litter and layer dropping, respectively (Abedin 2022).

Experimental design and treatments

The experiment was laid out in a completely randomized design (CRD) having eight treatments with three replications each. The treatments were T_1: Control, T_2: 3.0 t PL ha^{-1}, T_3: 50% RDF ($N_{50}P_{12.5}K_{45}$ kg ha^{-1}) (Recommended Dose of Fertilizer), T_4: $N_{100}P_{25}K_{90}$ kg ha^{-1} RDF, T_5: 150% RDF ($N_{150}P_{37.5}K_{135}$ kg ha^{-1}), T_6: 4.5 t PL ha^{-1} + 50% RDF ($N_{50}P_{12.5}K_{45}$ kg ha^{-1}), T_7: 3.0 t PL ha^{-1} + 100% RDF ($N_{100}P_{25}K_{90}$ kg ha^{-1}), and T_8: 1.5 t PL ha^{-1} + 50% RDF ($N_{150}P_{37.5}K_{135}$ kg ha^{-1}), respectively. Each pot was filled with 10.0 kg of soil. Basal doses ($N_{25}P_{6.25}K_{22.5}$ kg ha^{-1}) were applied in each treatment.

Seed collection, preparation and sowing

Seeds (BRRI dhan 29) were collected from the Fulbaria seed market, Dhaka. The doses were selected according to the Fertilizer Recommendation Guide of Bangladesh Agricultural Research Council (BARC 2018).

At the time of initial pot soil preparation, poultry litter compost was applied, and final pot soil preparation, N, P and K were applied as urea, triple super phosphate, and muriate of potash, respectively. Five seeds were sown per pot. Finally, three seedlings were allowed to grow per pot. During the experiment, the mean temperature was 14 to 31ºC, relative humidity was 77 to 83%, and day length 11 to 12 hours were recorded (BMD 2022). Intercultural practices, *i.e.* weeding, spading, watering, pesticide, *etc*. were applied as and when needed.

Data collection

Different agronomic parameters *viz.* plant height, leaf number and longest leaf were measured at the intervals of 30, 60, 90 and 120 days, and number of tiller/pot (hill) was measured at the intervals of 15, 30, 45 and 60 days after sowing of seeds. Different organs of boro rice plants, *viz.* number of panicle/pot, length of panicle (cm), number of grains/panicle, weight of grain/panicle (g), fresh weight of grains (g/pot), dry weight of grains (g/pot), weight of 1000 grains (g), yield (g/pot), fresh and dry weight of root, shoot, total biomass, and yield (t ha^{-1}) were recorded. Drying of root, shoot and grain was done in an oven at a temperature of 65°C for 72 hours. Benefit/Cost ratio was determined following standard formula, *i.e.* (yield t ha^{-1} × selling rate t Tk. ha^{-1}) and cost of cultivation in Tk. = net return in Tk. and then Benefit-Cost ratio was calculated as cost of cultivation divided by net return. Statistical analysis was done using SPSS and MS Excel. The analysis of variance (ANOVA) was performed by Tukey's Range Test at $p<0.05$.

RESULTS AND DISCUSSION

Plant height and number of leaf

Effects of poultry litter and NPK fertilizers on the height and number of leaf of boro rice plants (*O. sativa* L.) are presented in Table 1. The height and leaf number of plants were significantly ($p<0.05$) higher in poultry litter and NPK than the control treatment. However, the application of combined doses of NPK and poultry litter compost were observed better than the sole dose of poultry litter in both the cases. The maximum height was found 82.67 cm at 90 day, in T_7: (3.0 t PL ha^{-1} + $N_{100}P_{25}K_{90}$ kg ha^{-1}). The minimum heights were found in the control treatment in all cases. The highest number of leaves 37.67 was found in T_7: (3.0 t PL ha^{-1}+ $N_{100}P_{25}K_{90}$ kg ha^{-1}) treatment. Nishi *et al.* (2019) reported that highest height (93.03 cm) and leaf number (23 no./plant) were observed in $N_{12}P_4K_{10}$ kg + 10 t ha^{-1} organic manure treatments in boro rice. Similarly, Turna *et al*. (2023) found

that the vegetative growth parameters of cucumber performed significantly well with the combination of vermicompost and inorganic fertilizers.

Table 1. Effects of poultry litter (PL) compost and NPK on the plant height (cm) and leaf number of boro rice.

Treatments	Days after sowing							
	Plant height (cm)				Leaf number/pot			
	30[d]	60[d]	90[d]	120[d]	30[d]	60[d]	90[d]	120[d]
T_1: Control (-PL & -NPK)	20.67[f]	24.67[d]	49.33[g]	57.33[c]	20.00[c]	33.00[e]	45.33[h]	29.33[d]
T_2: 3.0 t PL ha^{-1} (100% RDF)	25.83[e]	30.67[c]	52.67[f]	60.00[c]	21.33[c]	33.33[e]	56.33[g]	28.67[d]
T_3: $N_{50}P_{12.5}K_{45}$ kg ha^{-1} (50% RDF)	28.67[c]	36.67[b]	59.67[e]	59.50[c]	31.67[b]	59.00[d]	83.33[f]	30.67[c]
T_4: $N_{100}P_{25}K_{90}$ kg ha^{-1} (100% RDF)	30.83[a]	38.33[b]	68.00[d]	64.00[b]	42.00[a]	79.33[b]	99.33[d]	34.67[b]
T_5: $N_{150}P_{37.5}K_{135}$ kg ha^{-1} (150% RDF)	30.00[b]	37.67[b]	74.33[c]	65.67[b]	34.33[b]	74.00[c]	90.67[e]	33.00[b]
T_6: 4.5 t PL ha^{-1}+$N_{50}P_{12.5}K_{45}$ kg ha^{-1}	31.17[a]	39.00[b]	79.00[b]	64.33[b]	32.33[b]	77.00[b]	127.33[c]	31.67[c]
T_7: 3.0 t PL ha^{-1}+ $N_{100}P_{25}K_{90}$ kg ha^{-1}	26.67[d]	44.67[a]	82.67[a]	73.67[a]	17.33[c]	81.67[b]	152.00[b]	37.67[a]
T_8: 1.5 t PL ha^{-1}+ $N_{150}P_{37.5}K_{135}$ kg ha^{-1}	31.50[a]	45.33[a]	80.00[b]	65.67[b]	32.67[b]	97.00[a]	158.00[a]	32.00[b]
LSD at 5%	**3.68**	**6.83**	**12.94**	**5.06**	**8.49**	**23.21**	**41.50**	**2.93**

[abcdefg] Data bearing different superscripts within the same column differ significantly ($p<0.05$).

Number of tiller and longest leaf

Effects of poultry litter compost and NPK fertilizers on the number of tiller and longest leaf of boro rice plants are shown in Table 2. The number of tiller and longest leaf of boro rice plants were significantly ($p<0.05$) higher in the treatment of T_8: (1.5 t PL ha^{-1}+ $N_{150}P_{37.5}K_{135}$ kg ha^{-1}) and T_7: (3.0 t PL ha^{-1} + $N_{100}P_{25}K_{90}$ kg ha^{-1}), which was 32.0 and 39.67 cm/plant in 120d and 90d, respectively. Results revealed that the number of tiller and longest leaf of boro rice plants increased with the increasing levels of NPK in most of the cases. The minimum number of tiller and the longest leaf were found in the control treatment. Combined doses showed better results than either poultry litter compost or NPK fertilizers alone. Islam *et al*. (2013) expressed that 50% RDCF + 4 ton PL ha^{-1} showed the highest effective tillers/hill, plant height, panicle length, 1000 grain weight, grain yield and straw yield, respectively.

Table 2. Effects of poultry litter (PL) compost and NPK on the number of tiller and longest leaf of boro rice.

Treatments	Days after sowing							
	Number of tiller/pot				Longest leaf			
	30[d]	60[d]	90[d]	120[d]	30[d]	60[d]	90[d]	120[d]
T_1: Control (-PL & -NPK)	6.33[c]	8.00[b]	10.00[d]	10.00[e]	23.33[b]	27.83[b]	29.00[d]	29.33[d]
T_2: 3.0t PL ha^{-1} (100% RDF)	7.00[c]	7.67[b]	11.00[c]	12.00[d]	27.17[a]	28.17[b]	32.00[c]	28.67[d]
T_3: $N_{50}P_{12.5}K_{45}$ kg ha^{-1} (50% RDF)	9.00[b]	12.00[b]	15.00[c]	16.67[d]	25.00[b]	30.33[a]	36.00[b]	30.50[c]
T_4: $N_{100}P_{25}K_{90}$ kg ha^{-1} (100% RDF)	12.00[a]	15.00[a]	19.67[b]	22.00[c]	23.50[b]	33.17[a]	32.67[c]	34.67[b]
T_5: $N_{150}P_{37.5}K_{135}$ kg ha^{-1} (150% RDF)	11.00[a]	18.00[a]	21.67[b]	28.33[a]	22.67[c]	33.33[a]	36.33[b]	33.00[b]
T_6: 4.5t PL ha^{-1}+$N_{50}P_{12.5}K_{45}$ kg ha^{-1}	9.33[b]	16.00[a]	20.33[b]	27.00[b]	24.00[b]	34.33[a]	33.33[c]	31.67[c]
T_7: 3.0t PL ha^{-1}+ $N_{100}P_{25}K_{90}$ kg ha^{-1}	6.33[c]	16.67[a]	21.00[b]	29.33[a]	20.50[d]	37.50[a]	39.67[a]	37.50[a]
T_8:1.5t PL ha^{-1}+ $N_{150}P_{37.5}K_{135}$ kg ha^{-1}	8.67[b]	21.67[a]	28.33[a]	32.00[a]	24.83[b]	37.33[a]	36.33[b]	32.00[c]
LSD at 5%	**2.00**	**4.87**	**6.07**	**8.38**	**1.94**	**3.73**	**3.31**	**2.90**

[abcde] Data bearing different superscripts within the same column differ significantly ($p<0.05$).

Number of panicle/pot, length of panicle (cm), number of grains/panicle (g), weight of grain /panicle (g)

Number of panicle/pot, length of panicle (cm), number of grains/panicle (g) and weight of grain/panicle (g) are presented in Table 3. Those yield attributes were found significantly ($p<0.05$) higher in different treatments than those in the control. These results were found statistically identical in most of the cases. The highest length of panicle (cm), number of grains/panicle (g) and

weight of grain/panicle (g) (27.17, 153.33 and 3.74), respectively were found in T_7: (3.0t PL ha^{-1}+ $N_{100}P_{25}K_{90}$ kg ha^{-1}) treatment. Moreover, the number of panicle/pot showing the highest value (17.67) was counted in T_8: (1.5 t PL ha^{-1} + $N_{150}P_{37.5}K_{135}$ kg ha^{-1}) treatment.

Table 3. Effects of poultry litter (PL) compost and NPK fertilizerson the yield attributes and yield of Boro rice.

Treatments	Number of panicle/pot	Length of Panicle (cm)	Number of grains/ panicle (g)	Weight of grains/ panicle (g)	Fresh weight of grains (g)/pot	Dry weight of grains (g)/pot
T_1: Control (-PL & -NPK)	8.33^{c}	21.67^{c}	85.00^{f}	1.87^{e}	15.59^{g}	12.31^{f}
T_2: 3.0t PL ha^{-1} (100% RDF)	13.00^{b}	23.00^{b}	92.66^{e}	1.50^{f}	19.43^{f}	16.05^{e}
T_3: $N_{50}P_{12.5}K_{45}$ kg ha^{-1} (50% RDF)	12.33^{b}	22.50^{b}	89.33^{e}	1.93^{e}	23.75^{e}	18.61^{e}
T_4: $N_{100}P_{25}K_{90}$ kg ha^{-1} (100% RDF)	14.33^{b}	21.00^{c}	128.00^{b}	2.09^{d}	30.00d	26.56^{d}
T_5: $N_{150}P_{37.5}K_{135}$ kg ha^{-1} (150% RDF)	16.67^{a}	25.67^{a}	105.33^{d}	2.75^{b}	45.88^{c}	38.42^{b}
T_6: 4.5t PL ha^{-1}+$N_{50}P_{12.5}K_{45}$ kg ha^{-1}	16.33^{a}	23.83^{b}	121.67^{c}	2.61^{c}	42.64^{c}	35.33^{c}
T_7: 3.0t PL ha^{-1}+ $N_{100}P_{25}K_{90}$ kg ha^{-1}	16.67^{a}	27.17^{a}	153.33^{a}	3.74^{a}	62.35^{a}	51.53^{a}
T_8: 1.5t PL ha^{-1}+ $N_{150}P_{37.5}K_{135}$ kg ha^{-1}	17.67^{a}	27.00^{a}	129.67^{b}	2.63^{c}	46.52^{b}	38.97^{b}
LSD at 5%	**3.11**	**2.38**	**23.97**	**0.70**	**16.14**	**13.58**

^{abcdefg} Data bearing different superscripts within the same column differ significantly ($p<0.05$).

Bilkis *et al.* (2015) expressed that the addition of manures and fertilizers significantly increased the grain and straw yields of rice as well as significantly influenced different yield attributes. Similarly, Sangeetha *et al.* (2013) reported that the application of enriched poultry manure compost on equal N basis (2.3 t ha^{-1}) observed higher grain yield of rice. Rahman *et al.* (2018) recorded the application of PM 2 t ha^{-1} IPNS based chemical fertilizer or PM plus 3 t ha^{-1} 50% STB (soil test basis) dose gave higher grain yield in Boro season.

Table 4. Effects of poultry litter (PL) compost and NPK fertilizers on biomass and seed grain yield of boro rice.

Treatments	Fresh weight (g/pot)			Dry weight (g/pot)			Dry grain yield (g or ton)		
	Root	Shoot	Total	Root	Shoot	Total	1000 Grain(g)	Yield (g/pot)	Yield (t ha^{-1})
T_1: Control (-PL & -NPK)	11.64^{c}	30.15^{e}	41.79^{g}	7.62^{b}	11.54^{b}	19.16^{d}	22.00^{c}	12.31^{e}	1.35^{b}
T_2: 3.0t PL ha^{-1} (100% RDF)	11.92^{c}	36.30^{d}	48.12^{f}	5.56^{c}	12.16^{b}	17.72^{d}	16.19^{e}	16.05^{d}	1.77^{b}
T_3: $N_{50}P_{12.5}K_{45}$ kg ha^{-1} (50% RDF)	23.41^{b}	43.57^{c}	66.98^{e}	9.90^{a}	16.16^{b}	26.06^{c}	21.61^{c}	18.61^{d}	2.05^{b}
T_4: $N_{100}P_{25}K_{90}$ kg ha^{-1} (100% RDF)	25.99^{b}	84.40^{a}	110.49^{c}	10.77^{a}	23.63^{a}	34.40^{b}	16.33^{e}	26.56^{c}	2.92^{b}
T_5: $N_{150}P_{37.5}K_{135}$ kg ha^{-1} (150% RDF)	34.38^{a}	81.99^{a}	116.37^{b}	13.33^{a}	24.07^{a}	37.40^{a}	26.11^{a}	38.42^{b}	4.23^{a}
T_6: 4.5 t PL ha^{-1}+$N_{50}P_{12.5}K_{45}$ kg ha^{-1}	25.91^{b}	57.80^{b}	83.71^{d}	9.19^{b}	27.09^{a}	36.38^{a}	21.45^{c}	35.33^{b}	3.87^{a}
T_7: 3.0 t PL ha^{-1}+ $N_{100}P_{25}K_{90}$ kg ha^{-1}	35.39^{a}	82.39^{a}	117.78^{b}	13.43^{a}	23.92^{a}	37.35^{a}	24.39^{b}	51.53^{a}	5.67^{a}
T_8: 1.5t PL ha^{-1}+ $N_{150}P_{37.5}K_{135}$ kg ha^{-1}	35.71^{a}	84.42^{a}	140.13^{a}	12.93^{a}	26.53^{a}	39.46^{a}	20.28^{d}	38.97^{b}	4.29^{a}
LSD at 5%	**9.73**	**23.45**	**35.94**	**2.86**	**6.35**	**8.74**	**3.48**	**13.58**	**1.49**

^{abcdefg} Data bearing different superscripts within the same column differ significantly ($p<0.05$).

Fresh weight of grains (g/pot) and dry weight of grain (g/pot)

Influence of poultry litter compost and NPK fertilizers on fresh weight of grains (g/pot) and dry weight of grain (g/pot) of boro rice plants are shown in Table 4. Results revealed that the fresh weight of grains and dry weight of grains of boro rice increased gradually with the increased doses of NPK and combined treatments in most of the cases. The highest fresh weight of grains (62.35 g/pot) and dry weight of grains (51.53 g/pot) were found in T_7: (3.0 t PL ha^{-1} + $N_{100}P_{25}K_{90}$ kg ha^{-1}) which were found significantly ($p<0.05$) higher in different treatments than that of the control. Moe (2017) found that in both seasons, with 50% NPK, the N uptake level achieved with poultry manure was

similar to that obtained with 75 and 100% NPK and recorded the highest boro rice grain, respectively. Ahmadu *et al*. (2021) observed that the absolute use of PM significantly increased filled grain number/panicle up to 6 t ha^{-1}.

Fresh and dry weight of root, shoot and total biomass (g/pot)

Effects of poultry litter and NPK fertilizers on fresh weight of root, shoot and total biomass (g/pot) of boro rice plants are shown in Table 4. Results revealed that the fresh weight of root, shoot and total biomass (g/pot) of boro rice gradually increased with the increasing doses of NPK and combined treatments. Similarly, Syed *et al*. (2022) reported that vermicompost significantly improved spinach growth performance and increased yield attributes. The highest fresh weight of root, shoot and total biomass (g/pot) of boro rice (35.71, 84.42 and 140.13) were found in T_8: (1.5 t PL ha^{-1} + $N_{150}P_{37.5}K_{135}$ kg ha^{-1}) treatment.

Dry weight of root, shoot and total biomass (g/pot) of boro rice plants were found significantly ($p<0.05$) higher in different treatments than the control in Table 4. However, statistically identical results were found among the treatments in most of the cases. Results showed the highest dry weight of root, shoot and total biomass (g/pot) of boro rice (13.43, 27.09 and 39.46) which were found in T_7: (3.0 t PL ha^{-1} + $N_{100}P_{25}K_{90}$ kg ha^{-1}), T_6: (4.5 t PL ha^{-1} +$N_{50}P_{12.5}K_{45}$ kg ha^{-1}) and T_8: (1.5 t PL ha^{-1} + $N_{150}P_{37.5}K_{135}$ kg ha^{-1}) treatments, respectively.

Table 5. Effects of poultry litter (PL) compost and NPK fertilizers on Benefit:Cost ratio of boro rice cultivation.

Treatments	Yield (ton/ha)	Selling rate (Tk./ton)	Gross return (Tk.)	Cost of cultivation (Tk.)	Net return (Tk.)	Benefit: Cost ratio
T_1: Control (-PL & -NPK)	3.90	30,000/=	117000/=	77550/=	39450/=	0.51
T_2: 3.0t PL ha^{-1} (100% RDF)	4.86	30,000/=	145800/=	81550/=	64250/=	0.79
T_3: $N_{50}P_{12.5}K_{45}$ kg ha^{-1} (50% RDF)	5.94	30,000/=	178200/=	80250	97950/=	1.22
T_4: $N_{100}P_{25}K_{90}$ kg ha^{-1} (100% RDF)	7.50	30,000/=	225000/=	82950/=	142050/=	1.71
T_5: $N_{150}P_{37.5}K_{135}$ kg ha^{-1} (150% RDF)	11.47	30,000/=	344100/=	85650/=	258450/=	3.02
T_6: 4.5t PL ha^{-1}+$N_{50}P_{12.5}K_{45}$ kg ha^{-1}	10.66	30,000/=	319800/=	84250/=	235550/=	2.80
T_7: 3.0t PL ha^{-1}+ $N_{100}P_{25}K_{90}$ kg ha^{-1}	15.59	30,000/=	467700/=	84950/=	382750/=	4.51
T_8: 1.5t PL ha^{-1}+ $N_{150}P_{37.5}K_{135}$ kg ha^{-1}	11.63	30,000/=	348900/=	86650/=	262250/=	3.03

All inputs and selling rates were considered to local market prices.

1000 grain (g) and yield (t ha^{-1})

Effects of poultry litter and NPK fertilizers on 1000 grain (g) and yield (t ha^{-1}) of boro rice are presented in Table 4. One thousand grain (g) and yield (t ha^{-1}) of boro rice were found significantly ($p<0.05$) higher in different treatments than that of the control. Results indicated that the highest 1000 grain (g) and yield (t ha^{-1}) (26.11 g and 5.67 t ha^{-1}) were found in T_5: ($N_{150}P_{37.5}K_{135}$ kg ha^{-1}) and T_7: (3.0t PL ha^{-1} + $N_{100}P_{25}K_{90}$ kg ha^{-1}) treatments, respectively. Lowest values were found in the control treatment in all the cases. Akter *et al.* (2020) recorded that the application of 2.5 t ha^{-1} DPL (Decomposed poultry litter) can reduce 25% chemical fertilizer without yield reduction in rice. Besides, poultry litter 3 t/ha and 50% of STB chemical fertilizers produced the highest production of rice yield with higher nutrient uptake in AEZ-28 and land type - high land (Hossain *et al*. 2010).

Benefit: cost ratio

The variable cost benefit ratios are presented in Table 5. Economic analysis of the yield of boro rice grains showed that the highest cost benefit ratio (4.51) was found in the T_7: (3.0 t PL ha^{-1} + $N_{100}P_{25}K_{90}$ kg ha^{-1}) treatment and the second highest cost benefit ratio (3.03) was found in the T_8: (1.5t PL ha^{-1} + $N_{150}P_{37.5}K_{135}$ kg ha^{-1}) treatment. Cost benefit ratios increased with the increasing rates of NPK fertilizers in most of the cases.

All the treatments of poultry litter compost and NPK fertilizers showed better response in agronomic parameters than those in the control treatment. Among them T_7 and T_8 treatments showed better results but they do not differ significantly in most of the cases. It could be concluded that the combined application of poultry litter compost and NPK fertilizers would be the most suitable dose (T_7 treatment) for boro rice cultivation on the rooftop in the southern part of Bangladesh. Further field research needs to be done considering all the factors including temperature, humidity, edaphic conditions, sunshine hour, wind velocity, salinity level, varieties of seeds and management cost during cultivation.

REFERENCES

Abedin, G. M. J. 2022. *Compost (Organic Fertilizer) Production Technology and Use.* Moyukh Graphic, Noyapalton, Dhaka, Bangladesh. 76 pp .

Ahmadu, I. S., Y. A. Rilwanu, B. A. Babaji, H. N. Kura, L. Goma and M. Yahqub. 2021. Yield and yield components of low land rice (*Oryza sativa*) as affected by different cultivation methods in the Sudan Savanna. *J. Agri. Environ.* **17**(2): 79-88.

Akter, R., M. A. Badshah, A. Sultana, M. J. Turon and M. J. Islam. 2020. Influence of integrated nutrient management and spacing on growth and yield of rice (BIRRI dhan69). *Res. Agric. Livest. Fish.* **7**(1): 25-32.

Alam, M. A., M. Alauddin, M. Rahman, M. Alauddin, M. S. Rahman, G. M. Mohsin and M. K. Rahman. 2023. Vermicompost induced growth and yield performance of capsicum (*Capsicum annuum* L.) at sustainable rooftop farming system. *J. Phytol*. **15**: 94-100.

Alauddin, M., M. K. Rahman and A. H. M. Z. Ali. 2022. Interactive effects of poultry litter compost and chemical fertilizers on macronutrients, oil and protein content in sunflower (*Helianthus annuus* L.). *Dhaka Univ. J. Biol. Sci.* **30**(3): 359-369.

Alauddin, M., A. H. M. Z. Ali and M. K. Rahman. 2021. Effects of poultry litter compost and chemical fertilizers on growth and yield of field grown sunflower (*Helianthus annuus* L.). *Dhaka Univ. J. Biol. Sci*. **30**(1): 49-57.

Anisuzzaman, M., M. Y. Rafii, S. I. Ramlee, N. M. Jaafar, M. F. Ikbal and M. A. Haque. 2022. The nutrient content, growth, yield, and yield attribute traits of rice (*Oryza sativa* L.) genotypes as influenced by organic fertilizer in Malaysia. *Sustainability*. **14**: 5692-5710.

BARC (Bangladesh Agricultural Research Council). 2018. *Fertilizer Recommendation Guide*. BARC Soils Publication Number 49. People Press and Publications, Purana Palton, Dhaka, Bangladesh. 112 pp.

Bardsley, C. E. and J. D. Lancaster. 1965. Sulfur. In: C. A. (ed.). *Methods of Soil Analysis.* American Society of Agronomy, Inc., Madison, Wisconsin, USA. pp. 1102-1114.

Bilkis, S., M. R. Islam, M. Jahiruddin and M. M. Rahaman. 2015. Field performances of different organic manures on yield, yield attributes and nutrient uptake of boro rice cultivated on old Brahmaputra floodplain soils of Bangladesh. *J. Sylhet Agril. Univ.* **2**(2):195-201.

BMD (Bangladesh Meteorological Department). 2022. Forecast of the period November 2020-March 2021. Barishal Station, Barishal, Bangladesh.

Bouyoucos, G. J. 1962. Hydrometer method improved for making particle size analysis of soils. *Agron. J.* **54**: 461-465.

Chowdhury, S. and M. K. Rahman. 2021. Influence of different organic manures on growth, yield and mineral nutrient accumulation in lettuce (*Lactuca sativa* L.). *Dhaka Univ. J. Biol. Sci.* **30**(2): 159-168.

FAO. 2018. *Rice Market Monitor*. Food and Agriculture Organization (FAO) of the United Nations. Rome, Italy.

Hossain, A. T. M. S., F. Rahman, P. K. Saha and A. R. M. Solaiman. 2010. Effects of different aged poultry litter on the yield and nutrient balance in boro rice cultivation. *Bangladesh J. Agril. Res.* **35**(3): 497-505.

Islam, M. M. A. F., M. A. Khan, A. S. M. F. Bari, M. T. Hossain and Sabikunnahar. 2013. Effect of fertilizer and manure on the growth, yield and grain nutrient concentration of boro rice (*Oryza sativa* L.) under different water management practices. *The Agriculturist*. **11**(2): 44-51.

Jackson, M. L. 1958. *Soil Chemical Analysis*. Prentice-Hall, Inc., Englewood Cliffs, NJ. USA. 498 pp.

Marr, I. L. and M. S. Cresser. 1983. *Environmental Chemical Analysis: The Lithosphere*. Blackie and Son, Ltd. UK., pp. 155-182.

Moe, K., K. Win Mg, K. K. Win and T. Yamakawa. 2017. Effects of combined application of inorganic fertilizer and organic manures on nitrogen use and recovery efficiencies of hybrid rice (Palethwe-1). *Am. J. Plant Sci*. **8**: 1043-1064.

Nishi, K. N., S. Rahman, K. Nakamura and M. K. Rahman. 2019. Influence of vermicompost and NPK on the growth and protein content of boro rice (*Oryza sativa* L.). *J. Biodivers. Conserv. Bioresour. Manag*. **5**(2): 69-74.

Pratt, P. F. 1965. Potassium. In: C. A. Black (ed.). *Methods of Soil Analysis*. Part 2. American Society of Agronomy, Inc., Madison, Wisconsin, USA., pp.1022-1030.

Prity, N. N., M. Syed and M. K. Rahman. 2023. Performance and nutrient content of okra (*Abelmoschus esculentus* L., Moench) fruits as influenced by vermicompost, nitrogen and zinc grown in soil. *J. Biodivers. Conserv. Bioresour. Manag*. **9**(1): 101-108.

Rahman, F., A. T. M. S. Hossain and M. R. Islam. 2018. Integrated effects of poultry manure and chemical fertilizer on yield, nutrient balance and economics of wetland rice culture. *Bangladesh Rice J*. **22**(2): 71-77.

Rashid, M. M. U., M. M Riad, D. Hossain, M. K. Islam and M. Shahjahan. 2012. Effect of integrated use of organic and inorganic fertilizer on nutrient uptake by rice. *Bangladesh J. Agri*. **37**(1): 83-90.

Rifhat, R., S. R. I. Mitu, M. Syed and M. K. Rahman. 2023. Utilization of vermicompost and NPK fertilizers on the growth, yield, nutrient and protein content of mung bean (*Vigna radiata* L.). *J. Biodivers. Conserv. Bioresour. Manag*. **9**(1): 29-39.

Rikza, I. J., K. N. Nishi and M. K. Rahman. 2021. Growth and yield performance of green capsicum (*Capsicum annuum* L.) as influenced by vermicompost application grown at rooftop of Chandpur area. *J. Biodivers. Conserv. Bioresour. Manag*. **7**(2): 13-22.

Sangeetha, S. P., A. Balakrishnan and P. Devasenapathy. 2013. Influence of organic manures on yield and quality of rice (*Oryza sativa* L.) and blackgram (*Vigna mungo* L.) in rice-blackgram cropping sequence. *Am. J. Plant Sci*. **4**: 1151-1157.

Syed, M., K. T. M. Sadi, R. Uddin, A. K. Devnath and M. K. Rahman. 2022. Integrated effects of vermicompost, NPK fertilizers, cadmium and lead on the growth, yield and mineral nutrient accumulation in spinach (*Spinacia oleracea* L.). *J. Biodivers. Conserv. Bioresour. Manag*. **8**(2): 13-24.

Turna, T. T., M. Syed and M. K. Rahman. 2023. Productivity and nutrient composition of cucumber (*Cucumis sativus* L.) grown under intregated application of vermicompost, phosphorus and zinc fertilizers. *Dhaka Univ. J. Biol. Sci*. **32** (2): 201-210.

Walkley, A. and I. A. Black. 1934. An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Sci.* **37**: 29-38.

(Manuscript received on 21 November , 2023)