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Integrated use of poultry manure with prilled urea and urea super granules for improving yield and protein content of aromatic rice (cv. BRRI dhan50)

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Abstract

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from December 2013 to May 2014 to evaluate the integrated use of poultry manure with prilled urea and USG for improving the growth, yield and protein content of aromatic *Boro* rice (cv. BRRI dhan50). The experiment was laid out in a randomized complete block design with three replications. The experiment comprised 14 treatments viz. control (no manure and no fertilizer), recommended dose of prilled urea (115 kg N ha^{-1}), urea super granules (USG) 1.8 g (55 kg N ha^{-1}), USG 2.7 g (80 kg N ha^{-1}), poultry manure (PM) 2.5 t ha^{-1}, PM 5 t ha^{-1}, recommended dose of prilled urea + PM 2.5t ha^{-1}, recommended dose of prilled urea + PM 5 t ha^{-1}, 50% of recommended dose of prilled urea + PM 2.5 t ha^{-1}, 50% of recommended dose of prilled urea + PM 5 t ha^{-1}, USG 1.8 g + PM 2.5 t ha^{-1}, USG 1.8 g + PM 5 t ha^{-1}, USG 2.7 g + PM 2.5 t $ha^{-1}$and USG 2.7 g + PM 5 t ha^{-1}. The experiment was laid out in a randomized complete block design with three replications. Morphological characteristics, yield contributing characters and yield of aromatic *Boro* rice (cv. BRRI dhan50) were significantly influenced by integrated use of poultry manure with prilled urea and USG. USG 2.7 g + PM 5 t ha^{-1} gave the highest plant height, number of tillers $hill^{-1}$ and total dry matter production at all sampling dates while their corresponding lowest values were recorded in control. The highest yield contributing characters viz. number of effective tillers $hill^{-1}$ (13.08), grains $panicle^{-1}$ (124.26g) and 1000-grain weight (21.41g) were recorded in USG 2.7 g + PM 5 t ha^{-1} and the lowest values were recorded in control. The highest grain yield (5.33 t ha^{-1}) and protein content (7.49%) were obtained at USG 2.7 g + PM 5 t ha^{-1} which was as good as recommended dose of prilled urea (115 kg N ha^{-1}) + PM 5 t ha^{-1}, USG 2.7 g + PM 2.5 t ha^{-1}, USG 1.8 g + PM 5 t ha^{-1}, recommended dose of prilled urea (115 kg N ha^{-1}) + PM 2.5 t ha^{-1} while the lowest one (2.00 t ha^{-1}) was obtained in control plots. The integrated use of poultry manure (5 t ha^{-1}) with USG 1.8 g (55 kg N ha^{-1}) appeared as the promising practice because of reducing considerable amount of prilled urea or USG in aromatic *Boro* rice (cv. BRRI dhan50) cultivation in terms of grain yield and grain protein content.

Key words: Aromatic *Boro* rice, prilled urea, USG, poultry manure, growth, yield, protein content

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Introduction

There are two types of rice varieties (coarse non-aromatic and fine aromatic) grown in Bangladesh. Aromatic rice is rated best in quality and fetch much higher market price than non-aromatic rice. It is very popular in Asia and has recently gained wider acceptance in the USA, Europe, the Middle East and Australia because of their good flavour and texture. It plays a vital role in international rice trading. In Bangladesh, a number of aromatic fine rice cultivars are grown viz. Chinisagar, Badshabhog, Kataribhog, Kalizira, Tulsimla, Dulabhog, Basmati, Banglamoti (BRRI dhan50), BRRI dhan34, BRRI dhan37 and BRRI dhan38 (Sarkar *et al*., 2014). Most of the scented rice varieties in Bangladesh are of traditional type, photoperiod sensitive, and cultivated during the *Aman* season. Majority of these indigenous aromatic

rice cultivars are low yielding but its higher price and low cost of cultivation generate higher profit margins compared to other varieties. Aroma development in rice grain is influenced by both genetic and environmental factors. The biochemical basis of aroma was identified as 2-acetyl-1-pyrroline (Tanchotikul and Hsieh, 1991). The grain quality of fine rice genotypes is governed not only by the genotypic make up but also affected by applied nitrogen level (Mannan *et al.*, 2009).

Application of excess inorganic fertilizer leads to higher pest and disease attacks and also destroys the soil microorganisms. Hence, sustainable farming looks for making the best use of natural resources without damaging the environment and indigenous agricultural knowledge is a vital part of the process of making agriculture sustainable (Ramprasad *et al.*, 2009).The application of poultry manure to soil is considered as a good management practice in any agricultural production system because of the stimulation of soil microbial growth and activity, subsequent mineralization of plant nutrients, and increased soil fertility and quality (Arancon *et al.*, 2006). Roy *et al.* (2015) reported that inorganic fertilizers along with manure greatly influence the yield contributing characters and yield of *Boro* rice. Application of poultry manure along with inorganic fertilizers increased grain yield, protein content and aroma in aromatic fine rice (Sarkar *et al.*, 2014). Hasan *et al.* (2004) also stated that BRRI dhan34 fertilized with 75% NPKS + poultry manure at 5 t ha^{-1} produced the highest grain yield than Kalizira. Though rice is one of the most important crops of the world, enough information regarding the varieties of fine rice and their response to poultry manure and nitrogen are scarce in the world literature (Islam *et al.*, 2012). Judicious nutrient management increases crop yield and at the same time reduces fertilization cost. Therefore, the present study was undertaken to observe the effect of poultry manure with prilled urea and USG on the growth, yield and grain protein content of aromatic *Boro* rice (cv. BRRI dhan50).

Materials and methods

A field experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, Bangladesh. The land was medium high with sandy loam texture having pH 6.4. BRRI dhan50, a high yielding aromatic rice variety of *Boro* rice, developed by the Bangladesh Rice Research Institute, was used as the test crop. The experiment comprised fourteen treatments viz. Control (no manure and no fertilizer), recommended dose of prilled urea (115 kg N ha^{-1}), urea super granules (USG) 1.8 g (55 kg N ha^{-1}), USG 2.7 g (80 kg N ha^{-1}), poultry manure (PM) 2.5 t ha^{-1}, PM 5 t ha^{-1}, recommended dose of prilled urea + PM 2.5 t ha^{-1}, recommended dose of prilled urea + PM 5 t ha^{-1}, 50% recommended dose of prilled urea + PM 2.5 t ha^{-1}, 50% of recommended dose of prilled urea + PM 5 t ha^{-1}, USG 1.8 g + PM 2.5 t ha^{-1}, USG 1.8 g + PM 5 t ha^{-1}, USG 2.7 g + PM 2.5 t ha^{-1} and USG 2.7 g + PM 5 t ha^{-1}.The experiment was laid out in a randomized complete block design with three replications. The size of unit plot was 4.0 m × 2.5 m. The distances between blocks and plots were 1 m and 75 cm, respectively. The land was fertilized as per treatment specification. At the time of final land preparation, each unit plot was fertilized with combined level of poultry manure in the respective plots according to treatment. The amount of phosphorus, potassium, sulphur and zinc required for total land was calculated on hectare basis and applied in the form of triple superphosphate (TSP), muriate of potash (MoP), gypsum and zinc sulphate, respectively. Full dose of TSP, MoP, gypsum and zinc sulphate were applied at final land preparation. Urea was applied in three equal splits as top dressingat 10, 30 and 50 days of transplanting (DAT). As per experimental specification USG were placed at 8 cm depth at 15 DAT in the center off our hills in every alternate rows according to treatment specification. Five hills (excluding border hills) from each plot were randomly selected, uprooted and properly tagged before harvesting for recording necessary data on yield contributing characters. The harvested crop of each plot was bundled separately, tagged properly and brought to the clean threshing floor. The bundles were dried in open sunshine, threshed and then seeds were cleaned. The grain and straw weights for each plot were recorded after proper sun drying. The grain yield was adjusted

to14% moisture content. Grain and straw yield per plot were converted to ton per hectare. Grain protein content (%) was estimated by Micro-Kjeldahl method (AOAC, 1984) at the Agri-Varsity Humboldt Soil Testing Laboratory of Soil Science Department, Bangladesh Agricultural University, Mymensingh. The collected data were analyzed statistically following the ANOVA technique and the mean differences were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984) using a statistical computer package program MSTAT-C.

Results and discussion

Growth parameters

Integrated use of poultry manure with prilled urea and urea super granules (USG) significantly influenced plant height, number of tillers hill^{-1} and total dry matter production at all sampling dates. Plant height increased progressively with the advancement of time and growth stages. At 80 DAT, the tallest plant (72.00cm) was obtained in T_{14} (USG 2.7 g + PM 5 t ha^{-1}), which was statistically identical with T_8 (recommended dose of prilled urea + PM 5 t ha^{-1}) and T_{12} (USG 1.8 g + PM 5 t ha^{-1}), and the shortest one (58.00 cm) was obtained in T_1 (control) (Table 1). Poultry manure incorporation with chemical fertilizer increased plant height (Islam *et al.*, 2014). The author reported that 50% BRRI recommended chemical fertilizers + poultry manure 2.5 t ha^{-1} produced the tallest plants compared to both application of manures and recommended fertilizers. Number of tillers gradually increased in course of time and reached maximum at 65 DAT and thereafter declined. The highest number of tillers (3.50, 6.66, 17.08, 25.16 and 22.25 at 20, 35, 50, 65 and 80 DAT, respectively) was recorded in T_{14} (USG 2.7 g + PM 5 t ha^{-1}). At 80 DAT, the highest number of tillers (22.25) was obtained in T_{14} (USG 2.7 g + PM 5 t ha^{-1}) and the lowest one (8.41) was obtained in T_1 (control) treatment (Table 2).

Table 1. Effect of integrated use of poultry manure with prilled urea and USG on plant heigh (cm) of aromatic *Boro* rice (cv. BRRI dhan50) at different days after transplanting

Treatment	Plant height(cm)				
	Days after transplanting (DAT)				
	20	35	50	65	80
T_1	14.91^{d}	21.91^{d}	30.33^{c}	41.58^{f}	58.00^{f}
T_2	18.66^{abc}	24.41^{bcd}	34.41^{bc}	49.83^{abc}	66.33^{abcd}
T_3	17.75^{bc}	23.08^{cd}	36.25^{b}	47.25^{bcde}	61.50^{cdef}
T_4	18.83^{ab}	24.66^{abcd}	37.41^{ab}	49.41^{abcd}	67.08^{abc}
T_5	16.66^{cd}	25.56^{abc}	35.66^{bc}	45.16^{def}	61.00^{def}
T_6	18.75^{abc}	24.91^{abc}	34.16^{bc}	44.91^{ef}	60.16^{ef}
T_7	18.58^{abc}	24.50^{bcd}	35.33^{bc}	50.50^{abc}	65.75^{bcde}
T_8	19.62^{ab}	24.83^{abcd}	35.66^{bc}	51.91^{a}	67.83^{ab}
T_9	17.78^{bc}	27.58^{a}	37.41^{ab}	50.33^{abc}	63.58^{bcdef}
T_{10}	17.91^{abc}	24.58^{bcd}	38.16^{ab}	49.08^{abcde}	64.66^{bcde}
T_{11}	17.66^{bc}	24.16^{bcd}	36.08^{b}	46.58^{cde}	62.41^{bcdef}
T_{12}	19.08^{ab}	23.25^{cd}	36.33^{b}	51.50^{ab}	67.91^{ab}
T_{13}	18.91^{ab}	25.83^{abc}	38.91^{ab}	49.16^{abcde}	66.00^{bcd}
T_{14}	20.00^{a}	27.08^{ab}	42.75^{a}	52.41^{a}	72.00^{a}
CV (%)	6.94	7.16	8.97	5.42	5.28
Level of sig.	**	*	*	**	**

In a column, figures with same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT. ** = Significant at 1% level of probability; NS = Non-significant, T_1 (Control), T_2 (Recommended dose of prilled urea, 115 kg N ha^{-1}), T_3 (USG 1.8 g), T_4 (USG 2.7 g), T_5 (Poultry manure 2.5 t ha^{-1}), T_6 (Poultry manure 5 t ha^{-1}), T_7 (Recommended dose of prilled urea + Poultry manure 2.5 t ha^{-1}), T_8 (Recommended dose of prilled urea + PM 5 t ha^{-1}), T_9 (50% Recommended dose of prilled urea + PM 2.5 t ha^{-1}), T_{10} (50% Recommended dose of prilled urea + PM 5 t ha^{-1}), T_{11} (USG 1.8 g + PM 2.5 t ha^{-1}), T_{12} (USG 1.8 g + PM 5 t ha^{-1}), T_{13} (USG 2.7 g + PM 2.5 t ha^{-1}), T_{14} (USG 2.7 g + PM 5 t ha^{-1}).

Table 2. Effect of integrated use of poultry manure with prilled urea and USG on number of tillers hill^{-1}of aromatic *Boro* rice (cv. BRRI dhan50) at different days after transplanting

Treatments	Number of tillers hill^{-1}				
	Days after transplanting (DAT)				
	20	35	50	65	80
T_1	2.25^{e}	3.00^{d}	7.58^{d}	9.25^{d}	8.41^{e}
T_2	2.75^{bcde}	4.58^{bcd}	11.75^{bcd}	23.08^{ab}	19.08^{abcd}
T_3	2.91^{abcd}	5.00^{abc}	13.25^{abc}	21.25^{abc}	18.33^{abcd}
T_4	3.00^{abc}	4.91^{abc}	12.16^{bcd}	22.66^{ab}	20.16^{abc}
T_5	2.33^{de}	3.91^{cd}	9.66^{cd}	17.33^{bc}	14.83^{d}
T_6	2.83^{bcde}	4.41^{bcd}	12.58^{abc}	15.25^{cd}	16.00^{cd}
T_7	2.66^{bcde}	4.41^{bcd}	11.50^{bcd}	23.66^{ab}	20.08^{abc}
T_8	3.16^{ab}	5.66^{abc}	13.58^{abc}	22.33^{abc}	21.16^{ab}
T_9	2.66^{bcde}	4.91^{abc}	11.00^{bcd}	17.75^{bc}	16.50^{cd}
T_{10}	2.66^{bcde}	4.50^{bcd}	11.16^{bcd}	21.66^{abc}	17.58^{bcd}
T_{11}	2.41^{cde}	4.25^{bcd}	10.58^{cd}	18.50^{abc}	16.16^{cd}
T_{12}	2.91^{abcd}	5.16^{abc}	13.41^{abc}	20.16^{abc}	19.66^{abc}
T_{13}	3.25^{ab}	5.91^{ab}	15.25^{ab}	23.25^{ab}	20.37^{abc}
T_{14}	3.50^{a}	6.66^{a}	17.08^{a}	25.16^{a}	22.25^{a}
CV (%)	13.08	21.92	22.74	21.16	18.24
Level of sig.	*	*	*	**	**

In a column, figures with same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT. ** =Significant at 1% level of probability, NS = Non-significant, T_1 (Control), T_2 (Recommended dose of prilled urea, 115 kg N ha^{-1}), T_3 (USG 1.8 g), T_4 (USG 2.7 g), T_5 (Poultry manure 2.5 t ha^{-1}), T_6 (Poultry manure 5 t ha^{-1}), T_7 (Recommended dose of prilled urea + Poultry manure 2.5 t ha^{-1}), T_8 (Recommended dose of prilled urea + PM 5 t ha^{-1}), T_9 (50% Recommended dose of prilled urea + PM 2.5 t ha^{-1}), T_{10} (50% Recommended dose of prilled urea + PM 5 t ha^{-1}), T_{11} (USG 1.8 g + PM 2.5 t ha^{-1}), T_{12} (USG 1.8 g + PM 5 t ha^{-1}), T_{13} (USG 2.7 g + PM 2.5 t ha^{-1}), T_{14} (USG 2.7 g + PM 5 t ha^{-1}).

The above findings are in agreement with that of Hossain (2012) and Islam *et al.* (2014). The maximum dry matter production (0.126, 0.125, 3.39, 14.65 and 32.52 g hill^{-1} at 20, 35, 50, 65 and 80 DAT, respectively) was recorded in the plot where crop was fertilized with T_{14} (USG 2.7 g + PM 5 t ha^{-1}) while T_1 (control) produced the lowest dry mater (Table 3). Integrated effect of manures and inorganic fertilizers influenced plant growth in terms of plant height and tillers hill^{-1} resulting in higher dry matter accumulation than sole application of chemical fertilizers or manures. Fertilizer applied in conjunction with organic manure produced similar or even the highest dry matter and N uptake than sole inorganic sources. Similar results were also reported by Islam *et al.* (2014) in case of transplant *Aman* rice.

Plant characters, yield components, yield and grain protein content

Plant characters, yield components and yield were significantly influenced by integrated use of poultry manure with prilled urea and USG (Table 4). The tallest plant (82.25 cm) and the highest number of total tillers hill^{-1} (15.66) were obtained in T_{14} (USG 2.7 g + PM 5 t ha^{-1}) treatment, which was statistically identical with T_8 (recommended dose of prilled urea + PM 5 t ha^{-1}) treatment and the shortest one (68.50 cm) was found in T_1 (control) treatment. The combined use of inorganic fertilizers and poultry manure produced the tallest plant and higher number total tillers hill^{-1} (Table 4). The results are in agreement with that of Azim *et al.* (1999) and Islam *et al.* (2014). The author reported that plant height increased due to combined application of poultry manure, cow dung and inorganic fertilizers. Sarkar *et al.* (2014) found that organic and chemical fertilizers increased the number of total tillers hill^{-1}. The highest number of effective tillers hill^{-1} (13.08) and the highest number of grains panicle^{-1} (124.26) were observed in T_{14} (USG 2.7 g + PM 5 t ha^{-1}), which were statistically identical with T_8 (recommended dose of prilled urea + PM 5 t ha^{-1}) treatment and the lowest values were recorded in T_1 (control) treatment (Table 4). Similar results also reported by Islam *et al.* (2015) and Kant and Kumar (1994). The author

found that number of grains panicle^{-1} increased with combined application of poultry manure and inorganic fertilizers. These findings are in agreement with that of Thakur (1991) who found that placement of nitrogen at 60 kg N ha^{-1} through USG produced higher number of panicles unit^{-1} area, panicle weight, number of grains panicle^{-1} and 1000-grain weight. The longest panicle (21.36 cm) and sterile spikelets panicle^{-1} (22.03) was recorded in T_{14} (USG 2.7 g + PM 5 t ha^{-1}) treatment which was statistically identical with T_{13} (USG 2.7 g + PM 2.5 t ha^{-1}) and the shortest one (16.77) was found in T_1 (control), which was statistically identical with T_3 (USG 1.8 g) treatments (Table 4). Similar results were also reported by Islam *et al.* (2014). Sarkar *et al*. (2014) reported the similar trend in case of aromatic *Aman* rice. The highest 1000-grain weight (21.41 g) was found in T_{14} (USG 2.7 g + PM 5 t ha^{-1}) treatment, which was statistically identical with T_7 (Recommended dose of prilled urea + PM 2.5 t ha^{-1}) and T_8 (Recommended dose of prilled urea + PM 5 t ha^{-1}) treatments and the lowest one was found (17.65 g) in T_1 (control) (Table 4). Islam *et al.* (2015) reported similar results due to combined application of poultry manure and nitrogenous fertilizer.

Table 3. Effect of integrated use of poultry manure with prilled urea and USG on total dry matter of aromatic *Boro* rice (cv. BRRI dhan50) at different days after transplanting

Treatment	Total dry matter(g)				
	Days after transplanting (DAT)				
	20	35	50	65	80
T_1	0.07^{d}	0.072^{e}	2.00^{f}	7.69^{c}	13.84^{e}
T_2	0.09^{abcd}	0.082^{cde}	2.78^{abcdef}	12.43^{abc}	15.54^{de}
T_3	0.08^{cd}	0.076^{de}	3.37^{ab}	12.27^{abc}	19.20^{cde}
T_4	0.11^{abcd}	0.106^{abcd}	2.36^{cdef}	13.12^{abc}	28.12^{abc}
T_5	0.07^{d}	0.074^{e}	2.15^{ef}	10.05^{bc}	17.83^{cde}
T_6	0.09^{abcd}	0.090^{bcde}	2.13^{ef}	9.55^{c}	19.80^{cde}
T_7	0.09^{bcd}	0.081^{cde}	2.92^{abcdef}	11.68^{abc}	25.52^{abcd}
T_8	0.15^{abc}	0.113^{abc}	2.22^{cdef}	11.40^{abc}	22.95^{abcd}
T_9	0.08^{bcd}	0.079^{de}	3.15^{abc}	9.43^{c}	21.60^{bcde}
T_{10}	0.08^{bcd}	0.078^{de}	2.43^{bcdef}	9.55^{c}	22.64^{abcde}
T_{11}	0.08^{cd}	0.076^{cde}	2.20^{def}	9.44^{c}	20.63^{bcde}
T_{12}	0.10^{abcd}	0.100^{abcde}	3.11 ^{abcd}	14.58^{ab}	22.93^{abcde}
T_{13}	0.11^{ab}	0.123^{ab}	3.02^{abcde}	14.79^{ab}	30.41^{ab}
T_{14}	0.13^{a}	0.125^{a}	3.39^{a}	14.65^{a}	32.52^{a}
CV (%)	21.538	21.055	21.13	24.66	28.03
Level of sig.	*	*	*	*	*

In a column, figures with same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT, ** =Significant at 1% level of probability, NS = Non-significant, T_1 (Control), T_2 (Recommended dose of prilled urea, 115 kg N ha^{-1}), T_3 (USG 1.8 g), T_4 (USG 2.7 g), T_5 (Poultry manure 2.5 t ha^{-1}), T_6 (Poultry manure 5 t ha^{-1}), T_7 (Recommended dose of prilled urea + Poultry manure 2.5 t ha^{-1}), T_8 (Recommended dose of prilled urea + PM 5 t ha^{-1}), T_9 (50% Recommended dose of prilled urea + PM 2.5 t ha^{-1}), T_{10} (50% Recommended dose of prilled urea + PM 5 t ha^{-1}), T_{11} (USG 1.8 g + PM 2.5 t ha^{-1}), T_{12} (USG 1.8 g + PM 5 t ha^{-1}), T_{13} (USG 2.7 g + PM 2.5 t ha^{-1}), T_{14} (USG 2.7 g + PM 5 t ha^{-1}).

Grain yield varied from 2.00 t ha^{-1} to 5.33 t ha^{-1}. The highest grain yield (5.33 t ha^{-1}) was obtained from T_{14} (USG 2.7 g + PM 5 t ha^{-1}) treatment, which was statistically identical with T_4 (USG 2.7 g), T_8 (Recommended dose of prilled urea + PM 5 t ha^{-1}), T_{12} (USG 1.8 g + PM 5 t ha^{-1}) and T_{13} (USG 2.7 g + PM 2.5 t ha^{-1}) treatments and the lowest one (2.00 t ha^{-1}) was obtained from T_1 (control) (Table 4). Due to application of recommended dose of USG with poultry manure enhanced yield contributing characters viz. number of effective tillers hill^{-1}, number of grains panicle^{-1} and 1000-grain weight thus subsequently increased grain yield. Saha (2012) reported similar results due to combined application of poultry manure and nitrogenous fertilizer in case of transplant *Aman* rice. Islam *et al*. (2015) also

found that 50% BRRI recommended inorganic fertilizer + PM 2.5 t ha^{-1} produced the highest grain yield in transplant *Aman* rice (cv. BRRI dhan49). Bony *et al.* (2015) also reported that USG @ 3.6 g / 4 hills in *Boro* rice increased yield contributing characters and yield significantly. The highest straw yield (8.33 t ha^{-1}) was obtained from T_{14} (USG 2.7 g + PM 5 t ha^{-1}) treatment which was statistically identical with T_{13} (USG 2.7 g + PM 2.5 t ha^{-1}) and the lowest one (2.66 t ha^{-1}) was obtained from T_1 (control) treatment. Increasing plant height and more number of total tillers $hill^{-1}$ increased straw yield. Das (2011) also reported similar results due to combined application of poultry manure and nitrogenous fertilizer in case of *Boro* rice. The highest biological yield (13.66 t ha^{-1}) and the highest harvest index (47.61%) were recorded in T_{14} (USG 2.7 g + PM 5 t ha^{-1}) treatment and the lowest values were recorded in T_1 (control) treatment.

Table 4. Effect of integrated use of poultry manure with prilled urea and USG on the yield and yield contributing characters of aromatic *Boro* rice (cv. BRRI dhan50)

Treatments	Plant height (cm)	Number of total tillers $hill^{-1}$	Number of effective tillers $hill^{-1}$	Number of non-effective tillers $hill^{-1}$	Panicle length (cm)	Grains $panicle^{-1}$	Sterile spikelets $panicle^{-1}$	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological Yield (t ha^{-1})	Harvest Index (%)	Grain protein content (%)
T_1	68.50^{g}	10.33^{e}	8.16^{e}	2.16	16.77^{f}	96.86^{e}	16.12^{d}	17.65^{f}	2.00^{e}	2.66^{f}	4.16^{f}	38.91^{e}	4.29^{e}
T_2	76.08^{cdef}	10.58^{de}	8.50^{de}	2.08	18.04^{def}	116.59^{abcd}	18.40^{cd}	18.83^{e}	3.83^{bcd}	5.66^{bcd}	9.50^{bcd}	40.12^{de}	4.62^{de}
T_3	72.08^{fg}	11.08^{de}	9.41^{cde}	1.66	17.70^{ef}	104.65^{bcde}	19.62^{abc}	19.70^{cde}	3.91^{abcd}	4.66^{bcdef}	8.58^{bcde}	45.96^{abc}	4.33^{e}
T_4	75.58^{cdef}	12.50^{bcd}	9.66^{cde}	2.83	18.69^{cde}	118.22^{abcd}	21.86^{ab}	20.41^{abcd}	4.66^{ab}	6.16^{bc}	10.83^{abc}	43.29^{abcde}	5.02^{de}
T_5	77.91^{abcde}	11.33^{de}	9.33^{cde}	2.00	19.00^{bcde}	102.10^{de}	20.64^{abc}	20.44^{abcd}	2.50^{de}	3.16^{ef}	5.66^{ef}	44.18^{abcd}	4.70^{de}
T_6	76.58^{cdef}	11.58^{cde}	10.00^{cde}	1.58	17.95^{def}	117.65^{abcd}	18.65^{cd}	19.55^{de}	3.66^{bcd}	4.00^{def}	7.66^{cde}	47.60^{a}	5.12^{cde}
T_7	79.83^{abcde}	11.66^{cde}	9.83^{cde}	1.83	18.33^{de}	116.40^{abcd}	18.75^{cd}	20.74^{ab}	4.50^{abc}	5.16^{bcde}	9.66^{bcd}	46.62^{abc}	4.90^{de}
T_8	82.08^{ab}	14.16^{ab}	11.91^{ab}	2.25	20.00^{abc}	121.58^{a}	18.45^{cd}	20.74^{ab}	4.91^{ab}	6.41^{abc}	11.33^{ab}	43.70^{abcde}	6.66^{ab}
T_9	75.16^{ef}	11.08^{de}	9.25^{cde}	1.83	19.33^{bcd}	111.81^{abcde}	18.39^{cd}	20.44^{abcd}	3.83^{bcd}	4.33^{cdef}	8.16^{bcde}	47.05^{ab}	5.78^{bcd}
T_{10}	77.16^{bcde}	11.50^{cde}	9.50^{cde}	2.00	18.22^{def}	115.77^{abcd}	19.13^{bc}	19.45^{de}	3.66^{bcd}	5.00^{bcde}	8.66^{bcde}	41.81^{cde}	6.41^{abc}
T_{11}	80.50^{abcd}	11.91^{cde}	9.91^{cde}	2.00	18.90^{bcde}	103.96^{cde}	20.22^{abc}	20.10^{bcd}	3.08^{cde}	3.83^{def}	6.91^{def}	44.50^{abcd}	6.50^{ab}
T_{12}	75.50^{def}	12.08^{bcde}	10.16^{bc}	1.91	18.33^{de}	120.96^{ab}	19.21^{bc}	20.63^{abc}	4.58^{ab}	5.16^{bcde}	9.75^{bcd}	47.34^{a}	6.55^{ab}
T_{13}	80.58^{abc}	13.58^{abc}	11.08^{bc}	2.50	20.36^{ab}	119.56^{abc}	18.19^{cd}	19.54^{de}	4.83^{ab}	6.66^{ab}	11.50^{ab}	42.45^{bcde}	7.24^{a}
T_{14}	82.25^{a}	15.66^{a}	13.08^{a}	2.58	21.36^{a}	124.26^{a}	22.03^{a}	21.41^{a}	5.33^{a}	8.33^{a}	13.66^{a}	47.61^{a}	7.49^{a}
CV (%)	3.87	10.26	11.08		4.89	8.76	8.65	3.02	21.52	24.81	22.17	6.52	13.57
Level of sig.	**	**	**	NS	**	*	*	**	**	**	**	*	**

In a column, figures with same letter(s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT, ** =Significant at 1% level of probability, NS = Non-significant, T_1 (Control), T_2 (Recommended dose of prilled urea, 115 kg N ha^{-1}), T_3 (USG 1.8 g), T_4 (USG 2.7 g), T_5 (Poultry manure 2.5 t ha^{-1}), T_6 (Poultry manure 5 t ha^{-1}), T_7 (Recommended dose of prilled urea + Poultry manure 2.5 t ha^{-1}), T_8 (Recommended dose of prilled urea + PM 5 t ha^{-1}), T_9 (50% of Recommended dose of prilled urea + PM 2.5 t ha^{-1}), T_{10} (50% of Recommended dose of prilled urea + PM 5 t ha^{-1}), T_{11} (USG 1.8 g + PM 2.5 t ha^{-1}), T_{12} (USG 1.8 g + PM 5 t ha^{-1}), T_{13} (USG 2.7 g + PM 2.5 t ha^{-1}), T_{14} (USG 2.7 g + PM 5 t ha^{-1}).

Biological yield exhibited similar behaviour as that of grain yield due to different nutrient management (Table 4). Saha (2012) reported similar results due to combined application of poultry manure and nitrogenous fertilizer in case of transplant *Aman* rice. Islam *et al.* (2015) reported that combined application of poultry manure and nitrogenous fertilizer increased grain yield and harvest index in transplant *Aman* rice. Integrated use of poultry manure with USG had significant influence on grain protein content. Grain protein content ranged from 4.29 to 7.49% due to application of different doses of fertilizers and manures. The highest grain protein content (7.49%) was found in USG 2.7 g + PM 5 t ha^{-1}, which was statistically identical with the application of USG 2.7 g + PM 2.5 t ha^{-1}, USG 1.8 g + PM 5 t ha^{-1},USG 1.8 g + PM 2.5 t ha^{-1}, recommended dose of prilled urea + PM 5 t ha^{-1}, 50% of recommended dose of prilled urea + PM 5 t ha^{-1} and the lowest grain protein content (4.29%) was recorded in control. This result indicated that combined application of manures with inorganic

fertilizers enhanced grain protein content compared to sole application of inorganic fertilizers in aromatic *Boro* rice (cv. BRRI dhan50). Sarkar *et al.* (2014) reported similar increasing trend of grain protein content of aromatic fine rice in *Aman* season. The percentage of grain protein increased with the increase of nitrogen rates was reported elsewhere (Ray *et al*., 2015, Chandel *et al.* 2010 and Mannan *et al.*, 2009).

Conclusion

In this study, USG 2.7 g (80 kg N ha^{-1}) + poultry manure (PM) 5 t ha^{-1}performed best in respect of growth, grain yield and grain protein content of aromatic *Boro* rice (cv. BRRI dhan50) which was as good as recommended dose of prilled urea (115 kg N ha^{-1}) + PM 5 t ha^{-1}, USG 2.7 g + PM 2.5 t ha^{-1}, USG 1.8 g(55 kg N ha^{-1}) + PM 5 t ha^{-1}, recommended dose of prilled urea (115 kg N ha^{-1}) + PM 2.5 t ha^{-1}. So, it can be concluded that aromatic *Boro* rice (cv. BRRI dhan50) may be cultivated with USG 1.8 g (55 kg N ha^{-1}) + PM 5 t ha^{-1} for appreciable grain yield and grain protein content because of reducing considerable amount of prilled urea or USG in combination with PM 5 t ha^{-1}. This practice will in turn be helpful for soil health and environment.

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