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PERFORMANCE OF *AMAN* RICE VARIETIES UNDER DIFFERENT NUTRIENT MANAGEMENT

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Abstract

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during July to December 2017 to investigate the combined effect of poultry manure with inorganic fertilizers on the yield of BINA developed transplant *Aman* rice varieties. The experiment comprised three varieties *viz.* Binadhan-15, Binadhan-16 and Binadhan-17 with five nutrient management *viz.* Control (no application of manures and fertilizers), 100% recommended dose of inorganic fertilizer (Urea-TSP-MoP-Gypsum-Zinc sulphate @ 150-110-70-60-5 kg ha^{-1}) (RF), Poultry manure @ 5 t ha^{-1}, 75% RF + poultry manure @ 5 t ha^{-1}, 50% RF + poultry manure @ 5 t ha^{-1}. The experiment was laid out in a randomized complete block design with three replications. Number of total tillers $hill^{-1}$ (13.37), number of effective tillers $hill^{-1}$ (6.76), grains $panicle^{-1}$ (107.86 cm), grain yield (6.97 t ha^{-1}), straw yield (8.36 t ha^{-1}), and harvest index (45.47%) were found to be the highest in Binadhan-17 and the highest weight of 1000-grain (27.32 g) was recorded in Binadhan-16. Among the nutrient management, 75% RF + poultry manure @ 5 t ha^{-1} exhibited its superiority to other treatments in terms of number of total tillers $hill^{-1}$(11.74), grains $panicle^{-1}$ (115.26), 1000-grain weight (23.49 g), grain yield (6.57 t ha^{-1}) and harvest index (48.20%). The highest grain yield (7.10 t ha^{-1}) was found in Binadhan-17 with 75% RF + poultry manure @ 5 t ha^{-1} and the lowest grain yield (5.32 t ha^{-1}) was found in Binadhan-16 with control treatment. From the study, it can be concluded that Binadhan-17 fertilized with 75% recommended dose of inorganic fertilizer + poultry manure @ 5 t ha^{-1} appears as the promising practice to obtain the highest grain yield.

Introduction

Agriculture is the mainstay of the economy in terms of GDP as well as the improvement of livelihood of the majority people in Bangladesh. Rice (*Oryza sativa* L.) is the staple food and has been being grown in this country from time immemorial. The production of milled rice reached around 38.78 million tons and it contributes to about 92% of the total food grains produced in the country (BBS, 2020). Rice is cultivated in 75.03% of our agricultural land (BBS, 2020) but the average yield of rice in Bangladesh is lower (3.04 t ha^{-1}) than the highest rice-producing country China with 12.9 t ha^{-1} rice yield (Sinha *et al.*, 2018). There are three rice-growing seasons in Bangladesh *viz. Aus*, *Aman*, and *Boro*. Among them, transplant *Aman* rice contributed the most to the total yield and it covers the second largest area of 56 lac hectares with a production of 131 lac tons of rice (BBS, 2020). In rice production, suitable variety selection is very important because, the higher yield depends mostly on the varietal performance.

Bangladesh has a bright prospect for higher rice production but due to the lack of improved variety, judicious use of fertilizers, and different management practices could be responsible for the lower yield. The productivity of crops decreases due to nutrient mining, soil organic matter depletion, and reduction of soil aggregates (Rahman and Yakupitiyage, 2006). Excess fertilizer application influences nutrient loss, surface water and groundwater contamination, soil acidification or basification, reduction in useful microbial communities, and increased sensitivity to harmful insects.

There are evidences that organic manures enhanced rice production and increased the yield and quality of agricultural produce with maintaining soil health more fertile (Nayak *et al.*, 2020). Although compared to inorganic fertilizers, organic manures have some shortcomings such as supplying low nutrient content in a short time, slow decomposition etc. Therefore, a suitable approach to nutrient management is required to keep the production of rice to a notable amount and increase the nutrient use efficiency of soil (Paul *et al.*, 2021).

The combined application of organic manures and inorganic fertilizers in rice fields provides favorable soil physical conditions with favorable microbial activity and nutrient availability (Gill and Walia, 2014). Coupled application of chemical fertilizer with manure can curtail doses of the chemical fertilizers increasing grain yield of rice (Sarkar *et al.*, 2014; Pal *et al.*, 2016; Adhikari *et al.*, 2018; Paul *et al.*, 2019; Paul *et al.*, 2020).

The present study was undertaken to evaluate the yield-ability of three newly released *Aman* rice varieties under various nutrient management practices integrating organic manure with the chemical fertilizer application.

Materials and Methods

The investigation was carried out at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during July to December 2017. The experimental site is located at 24.75°N latitude and 90.50°E longitude at an altitude of 18 m. The site belongs to the non-calcareous dark grey floodplain soil under the Agro-ecological Zone of the Old Brahmaputra Floodplain (AEZ-9). The experiment comprised three varieties *viz.* Binadhan-15, Binadhan-16 and Binadhan-17 with five nutrient management *viz.* Control (no application of manures and fertilizer), 100% recommended dose of inorganic fertilizer (Urea-TSP-MoP-Gypsum-Zinc sulphate @ 150-110-70-60-5 kg ha^{-1}) (RF), Poultry manure @ 5 t ha^{-1}, 75% RF + poultry manure @ 5 t ha^{-1}, 50% RF + poultry manure @ 5 t ha^{-1}. The method of the experiment was a randomized complete block design (RCBD) with three replications. The size of the unit plot was 10 m^2 (4.0 x 2.5 m).

Seeds of rice varieties of Binadhan-15, Binadhan-16 and Binadhan-17 were collected from Bangladesh Institute of Nuclear Agriculture (BINA). Seeds were soaked in water for 24 hours and stored in gunny bags. The seeds started sprouting after 72 hours and were ready for sowing. The sprouted seeds were sown in the nursery bed on 12 July 2017. The field was prepared by power tiller with three times ploughing and cross ploughing followed by laddering. The layout of the field was made on August 16, 2017 according to the experimental specification immediately after final land preparation. Weeds and stubble were removed and cleaned from individual plots. The land was fertilized as per treatment specifications. At the time of final land preparation, respective unit plots were fertilized with different levels of fertilizers according to treatments. The poultry manure was thoroughly mixed with the soil. Triple super phosphate, muriate of potash, gypsum and zinc sulphate was applied at final land preparation as per treatment. Urea was applied at three equal instalments at 15, 30 and 45 days after transplanting (DAT). Thirty-five-

day old seedlings were carefully uprooted from the nursery bed and transplanted in the well-puddled field on 17 August 2017 at the rate of three seedlings hill^{-1} maintaining 25 cm x 15 cm spacing. To ensure normal growth intercultural operations were done timely. The plots were kept weed free up to 40 DAT by hand pulling as and when needed but afterward no weeding was done. The bunds around the individual plots were repaired as and when necessary, so that water along with nutrient elements did not move between plots.

At harvest, five hills (excluding border hills) were selected randomly from each unit plot excluding border rows and central 2.0 m × 2.5 m harvest area and uprooted to record data on crop characters and yield components. After sampling, central 2.0 m × 2.5 m area was harvested. Harvesting of three varieties was done at different dates. Harvesting of Binadhan-15, Binadhan-16 and Binadhan-17 were done on 21 November, 24 November and 17 November 2017, respectively. The harvested crop was threshed separately and the threshing was done manually. The cleaned grains were dried at 14% moisture. Straws were also dried properly. Finally grain and straw yields were converted to t ha^{-1}.

Analysis of variance (ANOVA) was done to investigate the significant differences in the recorded parameters resulting from experimental treatments. Mean differences were adjudged by Duncan's Multiple Range Test (DMRT) following Gomez and Gomez (1984). Statistical analyses were performed using the software package MSTAT-C.

Result and Discussion

The imposed treatment variety had significant effects on crop characters, yield and yield components of transplant *Aman* rice. The plant height (98.83 cm), number of total tillers hill^{-1} (13.37), number of effective tillers hill^{-1} (6.76), number of grains panicle^{-1} (107.86), and harvest index (45.47%) were recorded highest in Binadhan-17 (Table 1). Binadhan-17 produced the highest grain (6.97 t ha^{-1}) and straw (8.36 t ha^{-1}) yields followed by Binadhan-16 (Figure 1). However, Binadhan-15 showed lowest values of these parameters.

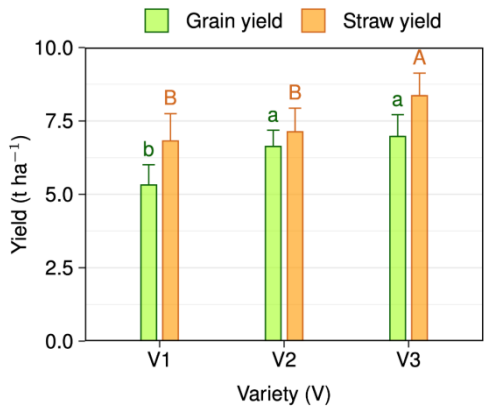

Fig. 1. Effect of variety on grain and straw yield of T. *aman* rice

Due to varietal characters plant height, number of total tillers hill^{-1}, number of grains panicle^{-1}, grain yield, straw yield and harvest index influenced significantly. Effect of variety on total number of tillers hill^{-1} was also reported by Sarkar *et al.* (2014) who observed that total number of tillers hill^{-1} differed among the varieties which might be due to varietal character or heredity. Sarkar *et al.* (2014) found varietal differences of aromatic fine rice in respect of straw yield.

Number of effective tillers hill^{-1} and number of sterile spikelets panicle^{-1} were not significantly influenced in respect of different varieties. Numerically, the highest number of effective tillers hill^{-1} (3.70), the longest panicle (21.53 cm) and the highest number of sterile spikelets panicle^{-1} (14.82) were produced by Binadhan-15, while the lowest results were observed by Binadhan1-17. Islam *et al.* (2014) found variation these parameters based on variety and reported that the reason of difference is the genetic makeup of the variety, which is primarily influenced by heredity. Weight of 1000-grain was significantly affected by variety. The highest weight of 1000-grain (27.32 g) was recorded in Binadhan-16 followed by Binadhan-17 and the lowest 1000-grain weight (21.01 g) was found in Binadhan-15 (Table 1). Weight of 1000-grain varied due to variety was reported elsewhere (Bhowmik *et al.*, 2011; Sarkar *et al.,* 2014; Ray *et al.*, 2015; Adhikari *et al.*, 2018).

Table 1. Effect of variety on crop characters and yield components of transplant *Aman* rice

Variety	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Non-effective tillers hill^{-1} (no.)	Length of panicle (cm)	Sterile spikelets panicle^{-1} (no.)	Grains panicle^{-1} (no.)	1000-grain weight (g)	Harvest index (%)
Binadhan- 15	93.35b	10.08b	6.08	3.70a	21.53a	14.82	102.32b	21.01c	43.82ac
Binadhan- 16	95.85ab	10.35b	6.36	1.96b	20.69bc	13.09	102.46b	27.32a	44.12b
Binadhan- 17	98.83a	13.37a	6.76	1.44c	20.48c	11.34	107.86a	23.63b	45.47a
Level of sig.	*	*	NS	*	*	NS	*	**	**
CV (%)	4.73	3.26	5.13	9.39	4.27	7.17	3.68	5.14	4.56

In a column, mean values with the same letter (s) or without letter do not differ significantly whereas mean values with dissimilar letter differ significantly (as per DMRT).
** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS = Not significant

Nutrient management played important role on crop characters, yield and yield components transplant *Aman* rice (Table 2 and Figure 2). Application of 75% RF + poultry manure @ 5 t ha^{-1} resulted in the highest plant height (96.50 cm), the highest number of total tillers hill^{-1} (11.74), the highest number of grains panicle^{-1} (115.26), the heaviest 1000-grain (23.49 g), the highest grain yield (6.57 t ha^{-1}) and the highest harvest index (48.20%) while the shortest plant (93.90 cm), the lowest values of total tillers hill^{-1} (9.24), grains panicle^{-1} (107.6), 1000-grain weight (21.78 g) and grain yield (5.66 t ha^{-1}), were found in control treatment (Table 2 & Figure 2).

In the previous reports, such combined application of organic and inorganic fertilizers was observed to influence plants characters and the number of grains panicle^{-1} (Jahan *et al.,* 2017, Sarkar *et al.*, 2014 and Rahman *et al.*, 2006). Number of effective tillers hill^{-1} and number of sterile spikelets panicle^{-1} were not significantly influenced by nutrient management and recorded the highest number of effective tillers hill^{-1} (6.78). The longest panicle (21.97 cm) in poultry manure @ 5 t ha^{-1} and the highest number of sterile spikelets panicle^{-1} (15.91) was observed in control treatment. Nitrogenous fertilizer increased the effective tillers was reported by Ray *et al.* (2015). Hossain *et al.* (2010) reported the highest sterility due to lack of nitrogenous fertilizers. Numerically, the highest number of non-effective tillers hill^{-1} (5.22) was found in 50% RF + poultry manure @ 5 t ha^{-1} while the lowest number of non-effective tillers hill^{-1} (1.44) was found in 100% recommended dose of inorganic fertilizer treatment. The highest straw yield (7.08 t ha^{-1}) was found in 100% RF and the lowest one (6.09 t ha^{-1}) was found in control treatment. Rahman *et al.* (2006) carried out an experiment and reported that nitrogen level significantly influenced yield components.

Table 2. Effect of nutrient management on crop characters and yield components of transplant *Aman* rice

Nutrient management	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Non-effective tillers hill^{-1} (no.)	Length of panicle (cm)	Sterile spikelets panicle^{-1} (no.)	Grains panicle^{-1} (no.)	1000-grain wt. (g)	Harvest index (%)
N_1	93.90bc	9.24	6.67	1.95b	20.63c	15.91	107.6b	21.78cd	48.17
N_2	94.08abc	10.00	6.56	1.44b	20.81bc	14.13	109.02b	23.24ab	46.76
N_3	95.46ab	10.33	6.78	1.56b	21.97a	13.76	111.80b	22.29cd	47.09
N_4	96.50a	11.74	6.44	1.67b	21.36ab	14.48	115.26a	23.49a	48.20
N_5	94.61ab	10.63	6.74	5.22a	21.19abc	14.47	113.00ab	22.59bc	47.62
Level of sig.	**	NS	NS	*	**	NS	*	**	NS
CV (%)	4.73	3.26	5.13	9.39	4.27	7.17	3.68	5.14	4.56

In a column, mean values with the same letter (s) or without letter do not differ significantly whereas mean values with dissimilar letter differ significantly (as per DMRT).
** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS = Not significant.
N_1 = control, N_2 = 100% recommended dose of inorganic fertilizer, N_3 = Poultry manure @ 5 t ha^{-1}, N_4 = 75% recommended dose of inorganic fertilizer + poultry manure @ 5 t ha^{-1}, N_5 = 50% recommended dose of inorganic fertilizer + poultry manure @ 5 t ha^{-1}

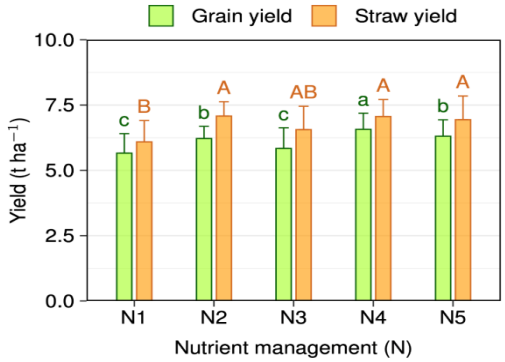

Fig. 2. Effect of nutrient management on grain and straw yield of T. *aman* rice

The interaction effect between variety and nutrient management was significant on crop characters, yield and yield components of transplant *Aman* rice (Table 3 and Figure 3). Numerically, the tallest plant (99.78 cm), the highest number of total tillers hill^{-1} (13.22), the highest number of grains panicle^{-1} (125.63), the highest grain yield (7.10 t ha^{-1}) and the highest straw yield (8.58 t ha^{-1}) were obtained in Binadhan-17 × 75% RF + poultry manure @ 5 t ha^{-1} treatment, but the shortest plant (89.33 cm) was found in Binadhan-16 × poultry manure @ 5 t ha^{-1}, the lowest number of total tillers hill^{-1} (9.85) was produced in Binadhan-15 × control, the lowest number of grains panicle^{-1} (96.26) was produced in Binadhan-16 × 100% RF treatment and the lowest grain yield (5.32 t ha^{-1}) was produced in Binadhan-16 × Control. The lowest values of effective tillers hill^{-1} (7.11) and straw yield (6.46 t ha^{-1}) were produced in Binadhan-16 Poultry manure @ 5 t ha^{-1} (Table 3 & Figure 3).

Pal *et al.* (2016) and Islam *et al.* (2014) depicted that combined application of chemical fertilizers with manures in a balanced amount influences yield components and yield. Similar trend was reported by Qian *et al.* (2011) who mentioned that combined application of organic and inorganic fertilizers increased grain yield of rice. Number of non-effective tillers hill^{-1} was significantly influenced by the interaction of variety and nutrient management. The highest

number of non-effective tillers hill^{-1} (2.78) was produced in Binadhan-17 × control treatment, while the lowest number of non-effective tillers hill^{-1} (1.00) was produced in Binadhan-17 × Poultry manure @ 5 t ha^{-1}. No significant variation was found in panicle length, the number of sterile spikelets panicle^{-1}, 1000-grain weight and harvest index by the interaction of nutrient management and variety (Table 3).

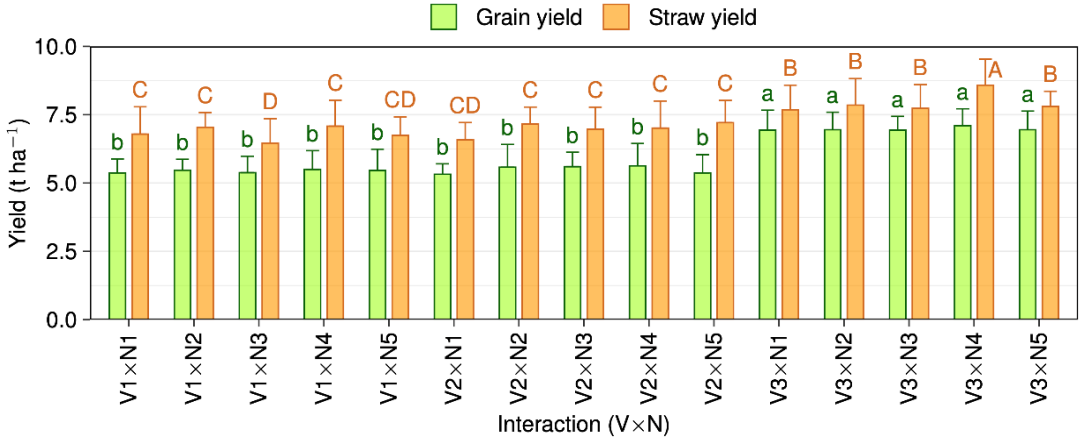

Fig. 3. Effect of interaction between variety and nutrient management on grain and straw yield of T. *aman* rice

Numerically, the longest panicle (22.22 cm) was observed in Binadhan-16 × 50% RF + poultry manure @ 5 t ha^{-1} and the shortest panicle (20.98 cm) was found in Binadhan-16 × 100% recommended dose of inorganic fertilizer.

Table 3. Interaction effect of variety and nutrient management on crop characters and yield components of transplant *Aman* rice

Variety nutrient management (V×N)	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Non-effective tillers hill^{-1} (no.)	Length of panicle (cm)	Sterile spikelets panicle^{-1} (no.)	Grains panicle^{-1} (no.)	1000-grain weight (g)	Harvest index (%)
$V_1 \times N_1$	94.41bcd	9.85c	7.33	1.52ab	21.62	21.92	107.07abc	22.00	44.16
$V_1 \times N_2$	94.11bcd	10.89bc	7.67	1.22b	21.3	22.33	98.22bc	23.00	43.72
$V_1 \times N_3$	97.44ab	10.22bc	7.11	2.11ab	21.57	22.08	107abc	21.82	45.43
$V_1 \times N_4$	98.89ab	11.33abc	8.89	1.44ab	21.83	19.17	100.78bc	22.75	43.72
$V_1 \times N_5$	94.11bcde	10.22bc	8.00	2.22ab	21.26	20.50	98.52bc	22.30	44.75
$V_2 \times N_1$	92.11bcde	10.33bc	8.78	1.56ab	21.89	22.42	107.33abc	23.00	44.70
$V_2 \times N_2$	96.78abc	10.78bc	8.89	1.89ab	21.28	22.17	96.26c	24.5	43.80
$V_2 \times N_3$	89.33bcde	10.67ab	9.67	1.00b	22.04	21.00	108.6abc	25.30	44.55
$V_2 \times N_4$	95.56bcd	11.67ab	10.33	1.33b	21.27	16.33	122.52a	26.93	44.54
$V_2 \times N_5$	89.44bcde	10.56bc	8.11	1.44ab	22.22	20.25	103bc	27.07	42.68
$V_3 \times N_1$	94.89bcd	11.56ab	8.89	2.78a	22.01	20.50	117.04ab	20.70	47.43
$V_3 \times N_2$	95.00abc	12.33ab	10.11	2.22ab	20.98	16.75	122.59a	22.45	46.95
$V_3 \times N_3$	97.44ab	12.01ab	11.56	1.56ab	21.03	16.33	120.11ab	22.10	47.27
$V_3 \times N_4$	99.78a	13.22a	11.11	2.22ab	21.72	13.83	125.63a	23.20	45.28
$V_3 \times N_5$	98.11de	12.11ab	10.11	2ab	21.16	15.58	119.44ab	22.89	47.11
Level of sig.	*	*	NS	**	NS	NS	*	NS	NS
CV (%)	4.73	3.26	5.13	9.39	4.27	7.17	3.68	5.14	4.56

In a column, mean values with the same letter (s) or without letter do not differ significantly whereas mean values with dissimilar letter differ significantly (as per DMRT).
** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS = Not significant.
V_1 = Binadhan- 15, V_2 = Binadhan- 16, V_3 = Binadhan- 17
N_1 = control, N_2 = 100% recommended dose of inorganic fertilizer, N_3 = Poultry manure @ 5 t ha^{-1} , N_4 = 75% recommended dose of inorganic fertilizer + poultry manure @ 5 t ha^{-1}, N_5 = 50% recommended dose of inorganic fertilizer + poultry manure @ 5 t ha^{-1}

And the highest number of sterile spikelets $panicle^{-1}$ (22.42) was produced in Binadhan-16 × control treatment, but the lowest one (13.83) was produced in Binadhan-17 × 75% RF + poultry manure @ 5 t ha^{-1}. The highest harvest index (47.43%) was observed in Binadhan-17 × control treatment, while the lowest one (42.68%) was found in Binadhan-16 × 50% RF + poultry manure @ 5 t ha^{-1} treatment. Apparently, the highest weight of 1000-grain (27.07 g) was recorded in Binadhan-16 × 50% RF + poultry manure @ 5 t ha^{-1} treatment and the lowest (20.70 g) weight of 1000-grain was recorded in Binadhan-17 × control (Table 3).

From the above discussion it may be concluded that the variety Binadhan-17 fertilized with 75% of the recommended dose of inorganic fertilizer + poultry manure @ 5 t ha^{-1} influenced growth and yield of transplant *Aman* rice.

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