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Performance of T. Aman rice varieties as influenced by integrated nutrient management practices

M. R. Rahman[1], M. A. Momin[2], A. Ahmed[3]*, M. M. Rashid[3], M. K. Alam[4], M. A. Islam[5], M. J. Alam[6]

[1]Upazila Agriculture Officer, Department of Agricultural Extension, Bagmara, Rajshahi-6250, Bangladesh
[2]Senior Liaison Officer, Bangladesh Rice Research Institute, Joydebpur, Gazipur-1701, Bangladesh
[3]Senior Agronomist, BRAC Agricultural Research and Development Centre, Joydebpur, Gazipur-1701, Bangladesh
[4]Land Management Group, School of Veterinary and Life Sciences, Murdoch University, Western Australia-6150, Australia
[5]Upazila Agriculture Officer, Department of Agricultural Extension, Kaliganj, Satkhira-9440, Bangladesh
[6]Agriculture Extension Officer (AEO), Department of Agricultural Extension (DAE), Bagmara, Rajshahi-6250, Bangladesh
*Corresponding author: *ashickahmed1981@gmail.com*

Abstract

Cowdung plays an important role to improve soil fertility and conserve soil productivity. The objective of this present study to evaluate the influence of integrated nutrient management practices on the performance of three transplant *Aman* rice varieties. This experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh. The treatments included were three varieties viz. BRRI dhan31 (V_1), BRRI dhan39 (V_2), and BRRI dhan41 (V_3) and five different integrated nutrient managements viz. recommended dose of chemical fertilizers (RF) (F_1), Cowdung @ 10 t ha^{-1} (F_2), 50% RF + Cowdung @ 5 t ha^{-1}(F_3), 75% RF + Cowdung @ 2.5 t ha^{-1} (F_4) and 100% RF + Cowdung @ 5 t ha^{-1} (F_5).The experiment was laid out in a randomized complete block design with three replications. It was found that variety and integrated nutrient managements had significant effect on all the crop characters except panicle length and 1000-grain weight. The performance of 50% RF + Cowdung @ 5 t ha^{-1} was found to be superior to any other nutrient management and BRRI dhan31 was found to be the best among the varieties. So, it can be concluded that BRRI dhan31 with 50% RF + Cowdung @ 5 t ha^{-1} emerged as the best one in terms of grain yield.

Keywords: Cowdung, integrated nutrient management, crop characters, grain yield.

Introduction

Bangladesh is an agro-based country and thus most of our economic activities are related to agriculture. More than 80% of the population is directly dependent on agriculture. In Bangladesh, rice dominates over all other crops and covers 75% of the total cropped area and 92% peasants grow rice (Rekabder, 2004).

The total area and production of rice in Bangladesh are about 10.53 million hectares and 26.53 million metric tons, respectively (BBS, 2006). About 76.69% of total cultivable land in Bangladesh is used for rice production, which contributes 21.12% total agricultural production and engages about 48% of total agricultural forces (BBS, 2007). Bangladesh earns about 23.87% of its gross domestic product (GDP) from agriculture (Krishi Diary, 2009).

The climatic condition of Bangladesh is favourable for rice cultivation. More than 80% of the total cultivable land is used for rice cultivation. Rice is a particularly important food for a larger population of the world. It is cultivated in the countries of all continents (Excepta Antarctica) from 53º N to 40º S latitude (Lu and chang, 1980).

The crop production in Bangladesh is dominated by intensive rice cropping and the most dominated cropping pattern is Boro-T.aman rice. Out of the total production in this country about 48%, 45%, and 7% come from Boro, Aman and Aus, crop respectively (BBS, 2000). Although Bangladesh ranks 4th in the world both in acreage and production of rice (FAO, 2000), it ranks 39th in the yield (IRRI, 1995). Annual food grain deficit in Bangladesh is about 2.19 million tons per year (AIS, 1997) which could be minimize either by bringing more land under cultivation and by increasing the rice yield per unit area. The latter is the only possible means for minimizing food deficit as the population pressure on agricultural land is increasing day by day. To ensure the food security for the present and future generation, the agricultural scientists and farmers are under pressure for producing more and more rice.

Integrated nutrient management approach could give higher yield in a suitable way. Among the plant nutrients nitrogen is the key element which can augment the production of rice to a great extent. Urea, has been found to be a very effective nitrogenous fertilizer, N gives good yield (BRRI, 1998). Phosphorus is the second major nutrient and it plays a critical role in the life cycle of plants. Phosphorus content of most of the Bangladesh soils is generally not adequate for good crop yield. Potassium is one of the primary and the third major food element for plant growth. Its function appears to be catalytic in nature and its deficiencies may greatly reduce crop yield. Sulphur is increasingly being recognized as the fourth major element for plant growth and it also plays a unique role in plant metabolism. In Bangladesh, sulphur deficiency in rice was first detected in BRRI farm, Joydebpur, Gazipur (Islam, 1978). Zn increases the metabolic functions of plants. It is essential in formation of chlorophyll and carbohydrate by plants. Organic manure contains a wide range of nutrients. Its qualities are known to be variable in response to the origins of the initial materials. It maintains the soil fertility status and soil health. Organic matter influences soil microbial activities. So, the use of organic matter can improve the quality of soil. Since soils in many locations lack necessary nutrients, fertilizers will often be less cost effective and assured the way to provide what is needed. Almost all soils of Bangladesh are deficient in organic matter because of its rapid decomposition due to warm climate, continuous intensive cropping, cultivation of high yielding varieties and the little and no adding of organic matter. Most of the soils of Bangladesh have less than 1.5% of organic matter and in some cases, it is less than 1%.

Cowdung may play a vital role in soil fertility improvement as well as supplying primary and secondary and micronutrients for crop production. Cowdung contains 0.35%N, 0.20%P2O5 and 0.10%K2O and other nutrients in small quantity. In addition, it can improve the physical, chemical and biological properties of soil and thus helps increase and conserve the soil productivity. In addition global environmental pollution can be controlled considerably by reducing the use of chemical fertilizer and increasing the use of manures like cowdung. It is true that sustainable production of crops cannot be maintained by using only chemical fertilizer and similarly it is not possible to obtain high crop yield by using organic manure alone (Bair,1990). Moreover, suitable combination of organic and inorganic sources of nutrients is necessary for a sustainable agriculture that will provide food with good quality and maintain sound environment. In the light of the above discussion, the present study was undertaken with the objective to observe the effect and select proper package of cowdung based integrated nutrient management practices in order to obtain higher yield of rice cv. BRRI dhan31, BRRI dhan39 and BRRI dhan41.

Materials and Methods

Location and Agro-ecological region

The experimental site is located at 24.75ºN latitude and 95.50ºE longitude at a mean elevation of 18m above the sea level. The site falls under Old Brahmaputra Floodplain Agro-Ecological Zone (AEZ-9) (UNDP and FAO, 1988).

Soil

The soil of the experimental land belongs to the Sonatola Series of non-calcareous dark grey floodplain soil, which is more or less neutral in reaction, low in organic matter in content. The experimental field was a medium high land with well drained condition. Morphological, physical and chemical characteristics of the soil of the experimental site have been presented in Table 1.

Table 1. Morphological, physical and chemical characteristics of the soil (0-15cm) of the experimental plot.

A. Morphological characteristics

Soil tract : Old Brahmaputra Alluvium
Soil series : Sonatola
Parent material : Old Brahmaputra River Borne Deposit

B. Physical characteristics

Sand (2.00-0.5) : 25.2%
Silt (0.5-0.002) : 72.0%
Clay (below 0.002mm) : 2.8%
Textural class : Silt loam

C. Chemical characteristics

Soil characteristics	Analytical data
pH	6.8
Organic carbon (%)	0.93
Total nitrogen (%)	0.13
Available phosphorous (ppm)	13.9
Available potassium (ppm)	16.3
Exchangeable potassium(ppm)	0.28

Source: Department of soil Science, Bangladesh Agricultural University, Mymensingh.

Climate

The experimental site is situated under sub-tropical climate, which is characterized by high temperature, high humidity and heavy rainfall with occasional gusty wind during April-September (Kharif season) and scanty rainfall associated with moderate low temperature during October-March (Rabi season). Meteorological information (temperature, relative humidity, rainfall etc.) of the experimental site during the study period are presented in Table 2.

Table 2. Monthly record of air temperature, relative humidity, rainfall and total sunshine during the period from July to December, 2011

Month	Air temperature (0C)			Rainfall (mm)	Relative humidity (%)	Sunshine (hrs)
	Maximum	Minimum	Average			
June	30.05	25.65	28.55	683.2	87.13	99.10
July	29.12	26.29	28.67	433.6	86.60	106.50
August	31.05	26.20	28.63	354.9	90.61	94.10
September	32.55	26.08	29.31	13.00	84.70	172.63
October	31.18	22.98	23.84	169.00	87.00	189.90
November	29.63	16.67	21.15	0.00	83.10	265.80
December	25.52	15.70	20.61	0.00	87.55	142.80

Source: Weather Yard, Department of Irrigation and Water Management, Bangladesh Agricultural University, Mymensingh.

Experimental factors and treatments

Factor A: Variety (3)
BRRI dhan31 (V1)
BRRI dhan39 (V2)
BRRI dhan41 (V3)

Factor B: Integrated nutrient management (5)

Recommended fertilizer (RF); (180- 80- 70- 60- 10 kg ha^{-1} Urea, TSP, MOP, Gypsum and $ZnSO_4$, respectively) (F1)
Cowdung (CD) @ 10 t ha-1 (F2)
50 % RF + Cowdung @ 5 t ha-1 (F3)
75 % RF + Cowdung @ 2.5 t ha-1 (F4)
100 % RF + Cowdung @ 5 t ha-1 (F5)

Experimental design and layout

The experiment was laid in a randomized complete block design with three replications. The whole experimental area was divided into three blocks each representing one replication and every block was sub-divided into15 plots. Thus total number of plots was 45. The size of each unit plot was 5 m2 (2.5m × 2m). Block to block distance was 1.0m and plot to plot distance was 0.75m.

Conduction of the experiment

Preparation of nursery bed and seed sowing

A piece high land was selected at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh for preparing three beds for raising seedlings. The land was puddle with country plough, cleaned and leveled with ladder. Then the sprouted seeds of all the three varieties were sown in the nursery beds on 11July 2011 in 3 separate beds. Proper care was taken to raise the seedlings in the nursery. No fertilizer and manure were applied in the nursery bed.

Preparation of main field for transplanting

The experimental land was first opened with a power tiller. Then it was puddled thoroughly by repeated ploughing and cross ploughing with country plough and subsequently leveled by laddering. The field layout was made on 10 August 2011 according to experimental specification immediately after final land preparation. Individual plots were cleaned by removing weeds and stubble and finally leveled by ladder.

Fertilizer application

Each plot was fertilized as per experimental specifications. The recommended fertilizer included urea, triple superphosphate, muriate of potash, gypsum and zinc sulphate @180, 80, 70, 60 and 10 kg ha^{-1}, respectively. Except urea, all the chemical fertilizers were applied before final land preparation. Urea was top dressed in three equal splits at 15, 30 and 45 days after transplanting (DAT). Cowdung, where applicable were incorporated into the soil just after first ploughing.

The uprooting and transplanting of seedlings

Nursery bed was made wet by application of water both in the morning and evening on the day before uprooting the seedlings. Seedlings were uprooted carefully from the seed bed. To avoid any mechanical injury seedling were kept on soft mud under shade. Thirty day old seedlings were transplanted on 11 August 2011 at the rate of 3seedlings hill-1 maintaining the spacing of 25cm × 15cm.

Intercultural operations

The following intercultural operations were done for ensuring the normal growth and development of the crop.

Gap filling

Seedlings in some hills died off and those were replaced by gap filling after 7 days of transplanting with seedlings from the same source.

Weeding

Weed infestation appeared to be a severe problem during the early stages of crop establishment. In order to keep the crop weed free it required three manual weeding through hand pulling. The first weeding was done at 15 days after transplanting and the crop was subsequently weeded out in every 15 day intervals up to 45 DAT.

Irrigation and drainage

Experimental plots were irrigated as and when necessary. Flood irrigation was given to maintain a constant level of standing ware up to 6 cm in the early stage to enhance tillering and 10-12 cm in the later stage to discourage late tillering. Excess water drained out from the plots before 15 days of harvest to enhance maturity of the crop.

Bund repair

The bunds around individual plots were repaired as and when necessary to stop water movement between plots.

Plant protection measures

The experimental field was found free from significant incidence of insect pests and diseases during the growing period of the crop. So, no plant protection measure was taken.

Harvesting and processing

The crop was harvested at full maturity i.e. when 80% of the grain became matured. Five hills (excluding border hills and the hills of central 1.5 m2 harvest area) were selected randomly from each experimental plot before harvesting to record necessary data. After maturity, the central 1.5 m2 area for each plot was harvested on 25 November 2011 (BRRI dhan39) and 6 December 2011 (BRRI dhan31) and 17 December 2011 (BRRI dhan41). The harvested crop of each plot was separately bundled, properly tagged and then brought to the clean threshing floor. The crop was threshed with a pedal thresher. Grains were then sun dried and cleaned. Straws were also sun dried properly. Finally, grain and straw yields were recorded and converted to ton per hectare.

Data collection procedure

Data on individual plant parameters were recorded from 10 randomly selected hills of each plot and those on grain yield, straw yield, biological yield and harvest index were recorded from the whole plot at harvest.

The grains obtained from each plot (including same from sample plants) were threshed, cleaned, dried and then weighed carefully. Grain yield was then adjusted to 14% moisture content and converted to t ha-1

Straw obtained from each plot including the same from sample plants were sun dried and weighed to record the straw yield plot-1 and finally converted to t ha-1.

Biological yield

Grain yield and straw yield altogether were regarded as biological yield. The biological yield was calculated with the following formula:

Biological yield = Grain yield + straw yield.

Harvest index (%)

Harvest index is the ratio of economic yield to biological yield expressed as percentage and calculated with the following formula (Gardner et al., 1985).

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

Statistical Analysis

The recorded data were statistically analyzed using "Analysis of Variance Technique" with the help of a computer package programme MSTAT and the mean differences were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

Results and Discussion

Plant height (cm)

Plant height was significantly influenced by variety (Table 6). The tallest plant (128.6cm) was produced by BRRI dhan41 and the shortest one (96.8 cm) by BRRI dhan39 and the plant height of variety BRRI dhan39 was of intermediate height (Table 3). BRRI (2000) reported that plant height differed significantly among varieties.

Application of nutrient management showed significant effect on plant height (Table 6). The tallest plant (116.3 cm) was found in F_4 (75% RF + Cowdung @ 2.5t ha^{-1}) followed by F_5 (100%RF + Cowdung @ 5 t ha^{-1}), F_1 (RF) and F_2 (Cowdung @ 10 t ha^{-1}). The shortest one (110.4 cm) was found in F_3 (50%RF + Cowdung @ 5t ha^{-1}) (Table 4). It is clear that the plant height at harvest increased due to increased application of chemical fertilizers. Similar results were also obtained by Kobayashi *et al.* (1989) and Reddy *et al.* (1988). Increased levels of fertilizers might be associated with stimulating effect of fertilizers on various physiological processes including cell division and elongation of the plant.

There was significant effect of interaction between variety and integrated nutrient management on plant height (Table 6). The tallest plants (131.1 cm) were found in the combination of BRRI dhan41 × 75% RF + cowdung @ 2.5 t ha^{-1}and the shortest one (95.5 cm) was in the combination of BRRI dhan39 and 50%RF + Cowdung @ 5 t ha^{-1} followed by BRRI dhan39 with RF (Table 5).

Panicle numbers hill^{-1}

Results showed that variety had significant effect on panicle no. hill^{-1} (Table 6). The highest number of panicle no. hill^{-1} (9.2) was found in BRRI dhan31 variety and the lowest one (8.8) was found in BRRI dhan39 variety (Table 3). The results are in agreement with those reported by Chowdhury *et al*. (1993) who stated that effective tillers hill^{-1} is the genetic makeup of the variety which is primarily influenced by heredity.

Integrated nutrient management has significant effect on the panicle no. hill^{-1} (Table 6). The highest number of panicle no. hill^{-1} (10.3) was found in 50%RF + cowdung @ 5 t ha^{-1} which is identical with 100 % RF + Cowdung @ 5 t ha^{-1} (9.8) and the lowest one (7.6 and 8.3) was found in Cowdung @ 10 t ha^{-1} and RF dose, respectively (Table 4). These results are in partial agreement with Kant and Kumar (1994), who reported that increasing rate of amendment with organic manure, increased the panicle no. hill^{-1} significantly.

Analysis of variance reveals the panicle no. hill^{-1} was significantly affected by the interaction between variety and integrated nutrient management (Table 6). The highest panicle no. hill^{-1} was found in the treatment combinations of V_2 x F_5, V_1 x F_3 and V_1 x F_4, respectively and the lowest panicle no. hill^{-1} was found in the treatment combinations of V_2 x F_1, V_2 x F_2 and V_1 x F_2, respectively (Table 5). The present findings closely resemble to those of Apostol (1989) who found that organic and inorganic fertilizers increased effective tillers hill^{-1}.

Panicle length

Panicle length was not significantly influenced by the variety (Table 6). Apparently, the longest panicle (26.1) was obtained from BRRI dhan41 and the shortest one (24.7) was obtained from BRRI dhan39 variety (Table 3). This variation as assessed might be mainly due to genetic characteristics which are influenced by heredity.

Length of panicle was not significantly influenced by integrated nutrient management (Table 6). The longest panicle (26.0) was found in 75%RF + Cowdung @ 2.5 t ha^{-1} and the shortest one (25.1) was found in 100%RF + Cowdung @ 5 t ha^{-1} (Table 4).

Panicle length was not significantly influenced by the interaction between variety and integrated nutrient management (Table 6). The longest panicle (27.1) was found in the combination of BRRI dhan41 with 75%RF + Cowdung @ 2.5 t ha^{-1} and the shortest one (23.7) was found in the combination of BRRI dhan41 variety with 100%RF + Cowdung @ 5 t ha^{-1} (Table 5).

Number of grains panicle^{-1}

Variety differs significantly in respect of number of grains panicle^{-1} (Table 6). Variety BRRI dhan41 produced the highest number of grains panicle^{-1} (158.0) and the lowest one (134.2) was produced by the variety BRRI dhan39 (Table 3). BRRI (1994) also reported that the number of grains panicle^{-1} was influenced significantly due to variety as it is mostly governed by heredity.

Number of grains panicle^{-1} differed significantly due to integrated nutrient management (Table 6). The highest number of grains panicle^{-1} (155.1) was found in 100% RF + Cowdung @ 5 t ha^{-1} followed by 75 % RF + Cowdung @ 2.5 t ha^{-1} (152.4) and the lowest one (133.3) was obtained from RF (Table 4).

The effect of interaction of variety and integrated nutrient management on number of grains panicle^{-1} was significant (Table 6). The highest number of grains panicle^{-1} was found in the combinations of V_3 x F_4, V_3 x F_1 and V_1 x F_5, respectively and the lowest one (107.7) was found in the combination of BRRI dhan31 with RF (Table 5).

Number of sterile spikelets panicle^{-1}

There were significant differences among the varieties in respect of number of sterile spikelet panicle^{-1} (Table 6). BRRI dhan31 variety produced the highest number of sterile spikelet panicle^{-1} (17.2) and the lowest one (11.5) was found in BRRI dhan39 (Table 3). BINA (1993) reported differences in number of sterile spikelet panicle^{-1} due to varietal differences. This variation might be due to genetic characteristics of the varieties.

Number of sterile spikelet panicle^{-1} was significantly influenced by integrated nutrient management (Table 6). The highest number of sterile spikelet panicle^{-1} (16.3) was found in 75% RF + Cowdung @2.5 t ha^{-1} and the lowest one (13.9) was recorded in RF (Table 4).

Interaction between variety and integrated nutrient recorded significant in respect of number of sterile spikelet panicle^{-1} (Table 6). The highest number of sterile spikelet panicle^{-1} (22.2) was found in the combination of BRRI dhan31 with 75% RF + Cowdung @ 2.5 t ha^{-1} and lowest one (11.4) was found in the combination of BRRI dhan39 variety with 50% RF + Cowdung @ 5 t ha^{-1} (Table 5).

Weight of 1000-grains

The analysis of variance (Table 6) reveals that the effect of variety on the weight of 1000-grain was not statistically significant. Heaviest 1000-grains (25.6 g) were found in BRRI dhan41 variety and the lightest 1000-grain weight (23.4g) was found in BRRI dhan31 variety of rice. Varietal differences regarding 1000-grain weight might be due to their differences in genetic makeup (Table 3). These results are in conformity with that of Shamsuddin *et al.* (1988) and Chowdhury *et al.* (1993) who reported that weight of 1000-grain differed among the varieties.

The weight of 1000-grain was not significantly influenced by integrated nutrient management (Table 6). Apparently, the highest 1000-grain weight (24.5g) was recorded from the treatment 100%RF + cowdung @ 5 t ha^{-1} and the lowest one (24.1g) was recorded from the treatment RF (Table 4).

There was not significant effect of interaction between variety and integrated nutrient management on 1000-grain weight (Table 6). But numerically the highest 1000-grain weight (27.6g) was obtained from the combination of BRRI dhan 41 with 100%RF + cowdung @ 5 t ha^{-1} and the lowest one (25.0g) was obtained from the combination of BRRI dhan 39 with RF (Table 5).

Grain yield

Grain yield was significantly influenced by variety (Table 6). The highest grain yield was found in BRRI dhan31 (5.8 t ha^{-1}) and the lowest (4.6 t ha^{-1}) from BRRI dhan39 (Table 3). Dwivedi (1997) and BRRI (2000) also reported grain yield variation among the varieties.

Grain yield was significantly influenced by the different integrated nutrient managements (Table 6). The highest grain yield (6.3 t ha^{-1}) was obtained from the treatment 50% RF + Cowdung @ 5 t ha^{-1} and the lowest (4.7 t ha^{-1}) by 75% RF + Cowdung @2.5 t ha^{-1} (Table 4).

Grain yield was significantly influenced by the interaction between variety and integrated nutrient management (Table 6). The highest grain yield (6.7 t ha^{-1}) was found in BRRI dhan31 with 50% RF + Cowdung@ 5 t ha^{-1} which was statistically identical with the interaction between BRRI dhan31 and Cowdung @ 10 t ha^{-1} (6.4 t ha^{-1}).The lowest one (3.8 t ha^{-1}) was obtained from the combination of BRRI dhan39 with RF (Table 5).

Straw yield

Results showed that variety had significant effect on straw yield (Table 6). The highest straw yield (6.9 t ha^{-1}) was produced in BRRI dhan31 variety and the lowest one (5.9 t ha^{-1}) was produced by the variety BRRI dhan39 (Table 3).

Straw yield was significantly influenced by the integrated nutrient management (Table 6). The highest straw yield (7.3 t ha^{-1}) was obtained from the 50%RF + Cowdung @ 5 t ha^{-1}. The lowest one (5.8 t ha^{-1}) was obtained from RF (Table 4). Rajput and Warsi (1992) also reported that application of organic manure and chemical fertilizers increased straw yield of rice.

Straw yield was significantly influenced by the interaction between variety and integrated nutrient management (Table 6). The highest straw yield (8.0 t ha^{-1}) was found in BRRI dhan31 variety with 50% RF + Cowdung @ 5 t ha^{-1} and the lowest one (5.0 t ha^{-1}) was found in BRRI dhan39 variety with RF (Table 5).

Biological yield

Biological yield was significantly influenced by variety (Table 6). The highest biological yield (12.7 t ha^{-1}) was recorded from the BRRI dhan31 and the lowest one (10.6 t ha^{-1}) was obtained from BRRI dhan39 rice variety (Table 3).

Biological yield was significantly influenced by different integrated nutrient managements (Table 6). The highest biological yield (13.6 t ha^{-1}) was obtained from 50% RF + Cowdung @ 5 t ha^{-1} and the lowest one (10.5 t ha^{-1}) was obtained from RF (Table 4).

Table 3. Effect of variety on crop characters, yield and yield components of transplant *Aman* rice

Variety	Plant height (cm)	Panicle no. hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	No. of 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 (%)
V_1	112.7b	9.2a	26.0	142.3b	17.2a	24.5	5.8a	6.9a	12.7a	45.7b
V_2	96.8c	8.8c	24.7	134.2c	11.5c	23.4	4.6c	5.9c	10.6c	43.8c
V_3	128.6a	9.0b	26.1	158.0a	14.1b	25.6	5.3b	6.2b	11.2b	46.1a
S $\bar{X}$	0.39	0.17	0.39	1.04	0.37	0.03	0.03	0.04	0.06	0.2
LSD	**	**	NS	**	**	NS	**	**	**	**

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

Table 4. Effect of integrated nutrient management on plant characters, yield and yield components of transplant Aman rice

Integrated nutrient management	Plant height (cm)	Panicle no. hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	No. of 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 (%)
F_1	112.7b	8.3c	25.6	133.3d	13.9b	24.1	4.7d	5.8d	10.5d	44.7d
F_2	111.8bc	7.6c	25.3	137.6c	15.5ab	24.3	5.6c	6.6c	12.2c	45.9b
F_3	110.4c	10.3a	25.9	145.7b	15.5ab	24.4	6.3a	7.3a	13.6a	46.3a
F4	116.3a	9.4b	26.0	152.4a	16.3a	24.4	5.8b	6.8b	12.6b	46.0ab
F_5	114.3b	9.8ab	25.1	155.1a	15.3ab	24.5	5.6c	6.7bc	12.3c	45.5c
S $\bar{X}$	0.51	0.22	0.5	1.34	0.48	0.04	0.04	0.05	0.07	0.25
LSD	**	**	NS	**	**	NS	**	**	**	**

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

Table 5. Interaction effect of variety and integrated nutrient management on plant characters, yield and yield components of transplant *Aman* rice

Interaction (V×F)	Plant height (cm)	Panicle no. hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	No. of 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 (%)
V_1×F_1	115.0de	9.0bcd	25.3	107.7h	15.1bcd	26.3	5.6c	6.6fg	12.2e	45.9cde
V_1×F_2	109.7f	7.7efg	25.4	138.0f	17.6b	26.5	6.4ab	7.6b	14.0b	45.7cde
V_1×F_3	109.1f	10.9a	26.7	153.2bc	21.3ab	26.5	6.7a	8.0a	14.7a	45.5cde
V_1×F_4	116.3d	10.4a	26.1	151.8cd	22.2a	26.5	6.0b	7.2c	13.2c	45.4cde
V_1×F_5	113.4e	10.0abc	26.4	160.7a	14.8cd	26.5	5.7c	7.2c	12.9cd	44.1f
V_2×F_1	95.5h	7.1g	24.5	129.8g	13.1def	25.0	3.8g	5.0i	8.8i	43.1g
V_2×F_2	97.4gh	7.3fg	24.4	128.4g	12.0ef	25.2	5.0de	5.9h	10.9g	45.8cde
V_2×F_3	95.5h	9.9abc	24.5	124.6g	11.4f	25.3	6.0b	7.1c	13.1c	45.8cd
V_2×F_4	98.6g	8.6de	24.9	142.7ef	12.4def	25.2	5.5c	6.8ef	12.3e	44.7def
V_2×F_5	96.9gh	11.0a	25.1	145.5de	13.5def	25.3	4.9ef	6.1h	11.0g	44.5ef
V_3×F_1	127.5bc	8.8cde	26.9	162.5a	13.4def	27.0	4.7f	5.9h	10.6h	44.3fg
V_3×F_2	128.3bc	8.0d-g	26.2	146.5cde	16.8bc	27.2	5.2d	6.5fg	11.7f	44.4def
V_3×F_3	126.7c	10.0ab	26.7	159.2ab	13.7def	27.5	6.1b	6.8ef	12.9c	47.3ab
V_3×F_4	131.0a	9.1bcd	27.1	162.7a	14.3cde	27.4	6.0b	6.5fg	12.5d	48.0a
V_3×F_5	129.6ab	8.5def	23.7	159.2ab	17.5b	27.6	6.1b	7.2c	13.3c	45.8cd
S $\bar{X}$	0.88	0.39	0.87	2.32	0.83	0.07	0.08	0.08	0.13	0.44
LSD	**	**	NS	**	**	NS	**	**	**	**

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

Table 6. Summary of analysis of variance (Mean square) for different crop characters, yield and yield components of transplant *Aman* rice

Source of variation	df	Mean Square values									
		Plant height (cm)	Panicle no. hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	No. of sterile spikelet panicle^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
Replication	2	10.7	0.19	1.89	1.43	4.04	0.006	0.05	0.04	0.06	2.54
Factor A	2	3798.5**	2.94**	9.59NS	2201.6**	122.7**	17.64NS	4.43**	5.16**	18.87**	8.12**
Factor B	4	29.44**	10.71**	1.48NS	783.3**	6.90**	0.20NS	3.34**	2.70**	11.96**	8.75**
Interaction(A × B)	8	7.47**	2.14**	2.92NS	464.6**	20.61**	0.01NS	0.45**	0.36**	1.45**	4.41**
Error	28	2.30	0.44	2.28	16.10	2.09	0.016	0.01	0.02	0.05	0.57
CV (%)	-	1.36	8.25	6.14	2.79	8.86	2.50	2.63	2.34	1.97	1.69

NS = Not significant, * = Significant at 5% level of probability and ** = Significant at 1% level of probability

Biologiocal yield was significantly influenced by the interaction between variety and integrated nutrient management (Table 6).The highest biological yield (14.7 t ha^{-1}) was obtained from 50%RF + Cowdung @ 5 t ha^{-1} and the lowest one (8.8 t ha^{-1}) was obtained from the combination of BRRI dhan39 with RF (Table 5).

Harvest index

Harvest index was significantly influenced by variety (Table 6). The highest harvest index (46.1%) was recorded from the BRRI dhan41 and the lowest harvest index was (43.8%) was obtained from BRRI dhan39 rice variety (Table 3).

Harvest index was significantly influenced by different integrated nutrient management (Table 6). The highest harvest index (46.3%) was obtained from the treatment 50% RF + Cow dung @ 5 t ha^{-1} which was identical with 75 % RF + Cowdung @ 2.5 t ha^{-1} (46.0). The lowest one (44.7%) was obtained from the treatment RF (Table 4).

Harvest index differed significantly by the interaction effect of variety and integrated nutrient management (Table 6). The highest harvest index (48.0%) was achieved from the combination of BRRI dhan41 with 75% RF + Cow dung @ 2.5 t ha^{-1} and the lowest one (43.1%) was obtained from the combination of BRRI dhan39 variety with RF (Table 5).

Conclusion

In present study, it was found that individually BRRI dhan 31 and 50% RF + cowdung @ 5 t ha^{-1} treatments achieved the highest grain yield (6.9 and 7.3 t ha^{-1}, respectively). Moreover, The treatment combinations of BRRI dhan 31 with 50% RF + cowdung @ 5 t ha^{-1} produced the highest grain yield (6.7 t ha^{-1}) and the same variety with cowdung @ 10 t ha^{-1} also produced identical grain yield (6.4 t ha^{-1}). Hence, it may be concluded that BRRI dhan31 with 50% RF + cowdung @ 5 t ha^{-1} performed better in terms of yield than the other treatment combinations.

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