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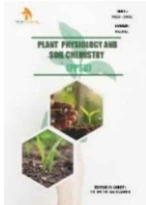

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RESEARCH ARTICLE

YIELD OF TRANSPLANT *AMAN* RICE CULTIVARS AS INFLUENCED BY NITROGEN MANAGEMENT AND SEEDING DENSITY IN THE NURSERY

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ABSTRACT

The research study was carried out from July to December 2019 at the Bangladesh Agricultural University's (BAU) Farm Management Section in Mymensingh with the goal of determining how nitrogen management and nursery seeding density affected the yield of transplant Aman rice cultivars. Factor A: Rice variety (2)-BRRI dhan49 (V_1), BRRI dhan71 (V_2) and Factor B: Nitrogen management (3)-Control nitrogen (No nitrogen) (N_0), 100% Recommended dose of nitrogen (100% recommended dose N: 165 kg ha^{-1}) (N_1) and 75% of Recommended dose of Nitrogen+2.5 t poultry manure ha^{-1} (N_2) and Factor C: Seeding density in the nursery (3)- 40 g seeds m^{-2} (S_1), 60 g seeds m^{-2} (S_2) and 80 g seeds m^{-2} (S_3). Results showed that BRRI dhan71 transplanted with 75% recommended dose of nitrogen ha^{-1}+2.5 tone poultry manure ha^{-1} and 60 g seeds m^{-2} produced tallest plant (132.80 cm) and BRRI dhan49 transplanted with 100% recommended dose of nitrogen ha^{-1} and 40 g seeds m^{-2} produced the shortest plant (101.13 cm). Interaction of BRRI dhan71 transplanted with 100% recommended dose of N and 60 g seeds m^{-2} provided the highest number of total tillers hill^{-1} (13.89), effective tiller hill^{-1} (13.12), 1000-grain weight (23.73 g), grain yield (5.81 t ha^{-1}), straw yield (6.46 ha^{-1}) and biological yield (12.28 t ha^{-1}) and interaction of BRRI dhan71 transplanted with no nitrogen and 40 g seeds m^{-2} provided the lowest numbers of total tillers hill^{-1} (8.38), effective tiller hill^{-1} (7.38), 1000-grain weight (19.56 g), grain yield (3.05 t ha^{-1}), straw yield (4.23 ha^{-1}) and biological yield (7.28 t ha^{-1}). So, it can be concluded that the variety BRRI dhan71 and 100% recommended dose of nitrogen ha^{-1} with 60 g seeds m^{-2} may be used to obtain the highest grain yield of transplant *aman* rice.

KEYWORDS

Yield, Transplant, Cultivars, Nitrogen Management, Seeding Density

1. INTRODUCTION

Providing food for most people worldwide, rice (*Oryza sativa* L.) is the most important cereal crop in the world. Forty-nine percent of the calories consumed by humans come from rice, seventeen percent from wheat, and nine percent from maize. Consequently, around one-fourth of all calories consumed worldwide come from rice (Farhat et al., 2023). Bangladesh's rice plant thrives in a special habitat because of its nearly uneven terrain, wet climate, and plentiful monsoon season. Seventy-seven percent of Bangladesh's entire cultivable land is used for the massive cultivation of rice during the three seasons of *Aus*, *Aman*, *and Boro* (AIS, 2019). Among these seasons, *Aman* rice occupies about 137 lacs acres' area, *Boro* rice occupies about 117 lac acres and *Aus* rice occupies about 2.7 lac acres of cultivated land which produce 27 lac Mt in *Aus*, 137 lac Mt *aman* and 196 lac Mt rice in *Boro* season (BBS 2020). In terms of both rice area and production, Bangladesh comes in third place. However, the average yield is rather low when compared to the top rice-producing countries. However, the average yield is rather low when compared to the top rice-producing countries (BRRI, 2017).

One of the key factors influencing rice yields is nitrogen fertilizer. It has a positive impact on farmers' growth, yield, and yield variables (Djaman et al., 2016). Proteins, chlorophyll, and nucleic acids all require nitrogen for structural and functional reasons (Tilahun, 2019). Since increasing nitrogen would result in higher yields (Fan et al., 2012), producers typically apply a higher rate of N toxin than is advised, which can raise the cost of the product and have a detrimental impact on the sustainability of the product system. N toxin's advanced cure leaves store susceptible to circumstances, nonentity, and lodging. (Salam et al., 2022; Kumar, 2016). Effective nutrient management lowers fertilization costs while also increasing crop output (Siddika et al., 2024; Sapkota et al., 2021). Due to the challenge of growing high yielding varieties, Bangladesh's rice yield is significantly lower than that of other rice-producing nations. This can be attributed to a number of factors, but the primary one is that nurseries are not adequately managed to produce robust seedlings for the invariant stage and improved seedling establishing (Mia et al., 2024). Among the different factors of nursery operation, acceptable nutrition, more sowing consistence and broadcasting seedlings at the applicable age are regarded as important factors to gain vigorous daises after broadcasting (Lal and Roy, 1996). By raising the nursery's fertility level, the length and dry weight of the seedlings, the number and length of roots, and the growth of the seedlings all dramatically increased (Islam et al., 2024). Enhancing subsequent plant growth and final grain output has been demonstrated to depend on increased seedling vigorousness and nutrient concentration in the early growth stage of the rice plant (Adhikari et al., 2013).

In the rice crop, larger seeding rates at the nursery level have a detrimental impact on yield and yield components, whereas lower seeding rates at the nursery result in higher yields (Hossain et al., 2024; Singh et al., 1987). Compared to 160 g m^{-2}, a significantly better grain yield was observed with a reduced seeding density of 40 g m^{-2} (Sarker et al., 2011). Two major conclusions can be drawn from this overview: first, nitrogen levels and the proper seeding density in nursery management are clearly influenced by a variety of parameters and may differ in various production systems. The second is that, apparently because there isn't always a clear correlation between nursery management and grain productivity, farmers usually don't seem to give it any thought.

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2. Materials and Methods

2.1 Experimental site and Design

Location-wise, the experimental site is 18 meters above sea level at 24°75' N latitude and 90°50' E longitude. It is located in the Old Brahmaputra Floodplain Agro-ecological Zone (AEZ 9) and is classified as non-calcareous dark gray floodplain soil (UNDP and FAO, 1988). Three replications of the randomized complete block design (RCBD) were used to set up the experiment. A block in the experiment was represented by each replication. Each block had 18 (2x3x3) unit plots, and 18 treatment combinations were randomly assigned to each plot. The experiment was divided into 54-unit plots. The unit plot measured three meters by two meters. Plots were separated by 50 cm and blocks by 1 m, respectively.

2.2 Experimental treatments

The study consisted of the following factors and treatments - Factor A: Rice cultivars (2): BRRI dhan49 (V_1), BRRI dhan71(V_2). Factor B: Levels of nitrogen (3): Control nitrogen (no nitrogen) (N_0): 100% recommended dose of nitrogen (Recommended dose N: 165 kg N ha^{-1}) (N_1), 75% recommended dose of nitrogen + 2.5 tone poultry manure ha^{-1} (N_2). Factor C: Seed density in the nursery (3): 40 g seed m^{-2} (S_1), 60 g seed m^{-2} (S_2), 80 g seed m^{-2} (S_3).

2.3 Preparation of seedling nursery and Experimental land

To raise seedlings, a plot of high ground was chosen at the BAU Agronomy Field Laboratory in Mymensingh. A country plough was used to puddle the soil, and a ladder was used to clean and level it. On June 27, 2019, the sprouting seeds were then planted in the nursery beds. Initially, a tractor-drawn disc plough was used to clear the experimental land. After repeatedly plowing and cross-plowing the soil with a country plough, the land was completely puddled, and laddering was used to level it.

2.4 Application of fertilizers and manures

Fertilization was applied to the land in accordance with treatment guidelines. The following unit plots were fertilized with varying amounts of poultry dung based on treatments at the time of the last land preparation. Each unit plot's necessary amounts of nitrogen, phosphorus, potassium, sulfur, and zinc were determined on a ha^{-1} basis and applied as triple super phosphate, muriate of potash, gypsum, and zinc sulphate, respectively. As specified by the treatment, urea was applied in three equal splits. At 15, 30, and 45 days after transplantation (DAT), urea was the most popular substance in three equal splits.

2.5 Transplanting

In the well-puddled plot, thirty-day-old seedlings were moved on July 25, 2019. In case of nursery having seeds of 80 g m^{-2}, three to four seedlings were transplanted hill^{-1}, In case of nursery having seeds of 60 g m^{-2}, two seedling hill^{-1} were transplanted and that of nursery having 40 g seed m^{-2} only one healthy seedling was transplanted hill^{-1}. The distances between the rows and hills were 20 cm and 15 cm, respectively.

2.6 Sampling, harvesting and processing

Starting on DAT 25, five hills (not including boundary hills) were chosen at random from each unit plot and uprooted in order to collect the required data at 15-day intervals. The entire plot was collected at maturity following sampling. Harvests of BRRI dhan71 and dhan49 took place on October 26 and November 13, 2019, respectively. To capture yield and yield contributing character data, five hills were chosen at random. A 1 m^2 central region was chosen for harvest. The central 1 m^2 collected crop was taken to the threshing floor after being individually packaged and appropriately marked. The pedal thresher was used to do the threshing. After being cleansed, the grains were sun-dried until they had a 14% moisture content.

2.7 Yield and yield components

The following data on yield components and yield were recorded: Plant height (PH), Number of total tiller hill^{-1} (TT), Number of effective tiller hill^{-1} (ET), Number of non-effective tiller hill^{-1} (NET), Panicle length (PL), Number of grain panicle^{-1} (GPP), 1000-grain weight (TGW), Grain yield (GY), Straw yield (SY), Biological yield (BY), Harvest index (HI)

2.8 Harvest Index (%)

With the following formula, it was calculated and represents the grain yield to biological yield ratio.

$$HI\ (\%) = \frac{GY}{BY} \times 100$$

Here, BY= GY+ SY.

2.9 Statistical Analysis

The data that was taken down for various parameters was properly tabulated. A statistical analysis of the gathered data on different plant features was conducted. Utilizing the computer application MSTAT, the mean of all treatments was obtained, and the Analysis of Variance (ANOVA) for every parameter under investigation was carried out. Gomez and Gomez (1984) used Duncan's New Multiple Range Test to compare the variations in treatment means.

3. Results and Discussion

3.1 Yield and yield contributing characters of rice

3.1.1 Effect of variety

PH was significantly influenced by variety at 25, 50 DAT. PH in both the varieties increased progressively with the advancement of time from 25 to 50 DAT. BBRI dhan71 was observed as the taller plant at all the DATs. The higher PH (124.15 cm) was recorded in BBRI dhan71 and the lower PH was recorded in BBRI dhan49 (109.05cm) (Figure 1A). TT was significantly affected by variety. The tiller production was increased with the advancement of time from 25 to 50 DAT but TT reduced at harvest DAT. The higher TT (10.92) was recorded in BRRI dhan71 and the lower TT (9.79) was found in BRRI dhan49 (Figure 1B). BRRI dhan71 produced the maximum ET (9.77) and the minimum ET (8.94) was recorded from BRRI dhan49 (V_1) (Figure 1C). In a similar vein, Khalifa (2009) observed that the hybrid rice variety outperformed other kinds when ET was taken into account. PL was not significantly influenced by variety (Figure 1D). Variety had significant effect on GPP. The variety BRRI dhan71 produced the higher GPP (124.71). The lower GPP (99.28) was found in BRRI dhan49 (Figure 1E). Islam et al. (2024) also revealed equivalent research findings. Varietal differences regarding the GPP might be due to their differences in genetic constituents. Rice varieties showed significant effect on TGW. The highest TGW (23.27 g) was found from BRRI dhan71 and the lowest TGW was observed from the variety of BRRI dhan49 (19.43 g) (Figure 1F). The hybrid rice variety outperformed other kinds when taking TGW into account, according to comparable investigations published by Mia et al. in 2023. GY of rice was significantly impacted by variety. BRRI dhan71 produced rice with the highest GY (4.49 t ha^{-1}). On the other hand, BRRI dhan49 (4.18 t ha^{-1}) produced rice with a reduced GY (Figure 1G). GY varied depending on the variety, based on Suprihatno and Sutaryo (1992) and Singh and Singh (1992), who noted that the examined types had variable GY. The higher GY in BRRI dhan71 attributed due to higher ET, higher GPP and heaviest TGW in this cultivar. SY of rice was significantly impacted by variety (Figure 1H).

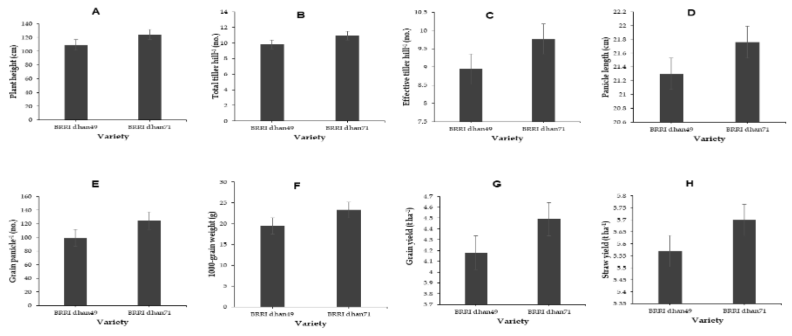

Figure 1: Effect of variety on different parameters.

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3.1.2 Effect of nitrogen management

Regardless of growth phases, nitrogen control had a major impact on PH. It is found that the treatment N_2 produced the tallest plant (121.19 cm) and the shortest plant (112.93 cm) was obtained from N_0 (no nitrogen) treatment (Figure 2A). The treatment N_1 produced the highest TT (11.58). The treatment N_2 produced the lowest TT (9.88) (Figure 2B). Maximum ET (10.77) was recorded from N_1 and the minimum ET (8.48) was recorded from N_2 which were statistically similar with N_0 (no nitrogen) (Figure 2C). Treatment N_1 produced numerically the longest panicle (21.94 cm) and N_2 produced the shortest panicle (20.57 cm) (Figure 2D). The treatment N_1 produced the highest number of grains panicle (126.24) and the lowest GPP (97.82) was recorded N_0 treatment (Figure 2E). The TGW of rice during the aman season was not profoundly affected by seeding density (Figure 2F). The highest GY was recorded from 100% recommended dose of N (5.23 t ha^{-1}). On the other hand, the lowest GY (3.13 t ha^{-1}) was produced from control nitrogen (Figure 2G). Additionally, Mia and Salam (2023) revealed equivalent findings from their studies. The highest SY was recorded from 100% N recommended dose of N (6.08 t ha^{-1}), which was statistical similar with 75% recommended dose of N+2.5 tone poultry manure ha^{-1}. On the other hand, the lowest SY (4.96 t ha^{-1}) was produced from no nitrogen (Figure 2H).

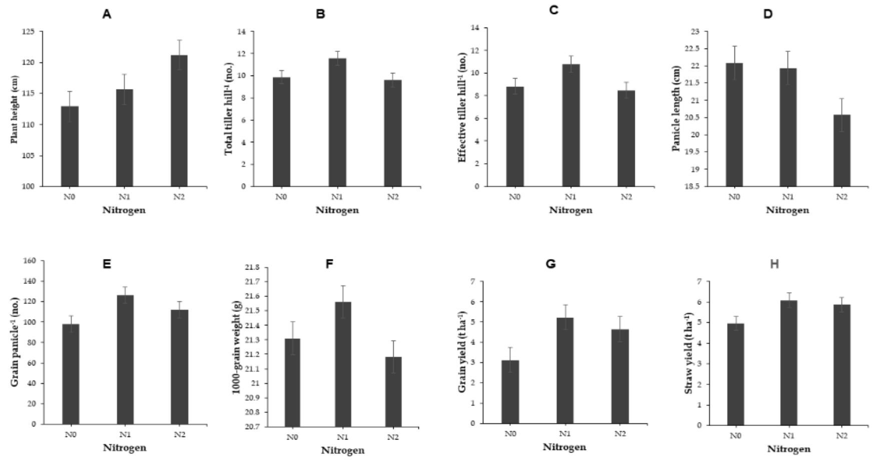

Figure 2: Effect on nitrogen on different parameters.

N_0= Control nitrogen, N_1= 100% recommended dose of N ha^{-1}, N_2= 75% recommended dose of N+2.5 tone poultry manure ha^{-1}

3.1.3 Effect of seeding density

Seeding density showed significant effect on PH. The tallest plant (119.15 cm) was found from S_2, whereas the shortest plant (114.12 cm) from S_3 (Figure 3A). The maximum TT (10.89) was observed from S_2 and the lowest TT (10.15) was produced from S_3 (Figure 3B). ET was significant affected by seeding density. The maximum ET (9.79) was recorded from S_2. On the other hand, the minimum ET (9.05) was found from S_1 (Figure 3C). PL had no significant due to seeding density. The GPP of rice during the Aman season was greatly affected by seeding density. (Figure 3D). The maximum GPP (114.80) was observed from S_1 and the minimum GPP (108.7) was observed from S_3 (Figure 3E). During the Aman season, the TGW of rice was not greatly affected by seeding density (Figure 3F). The highest GY (4.51 t ha^{-1}) was found from S_2. On the other hand, the lowest GY (4.21 t ha^{-1}) was recorded from S_3 (Figure 3G). Seeding density has significant effect on SY (t ha^{-1}). The highest SY (5.73 t ha^{-1}) was found from S_3. On the other hand, the lowest SY (5.50 t ha^{-1}) was recorded from S_1 (Figure 3H).

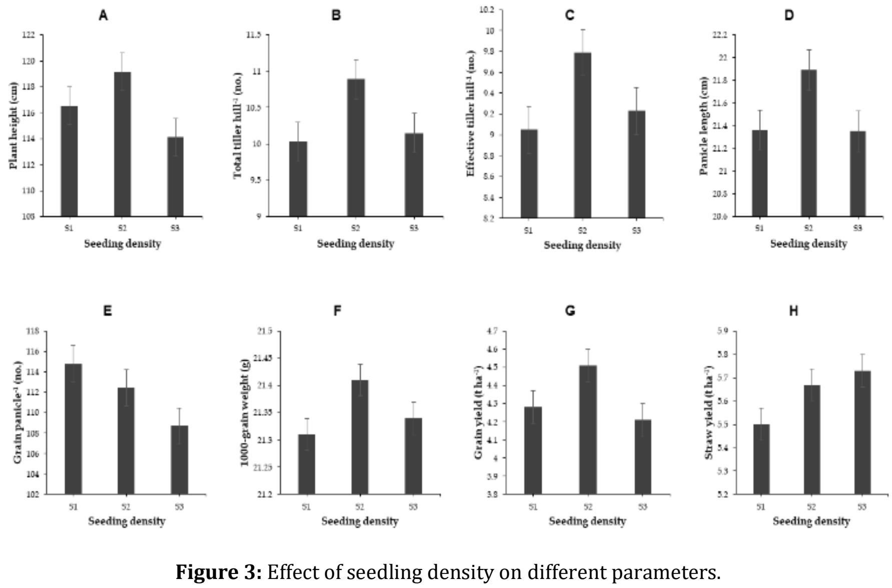

Figure 3: Effect of seedling density on different parameters.

S1= 40 g seeds m-2, S2= 60 g seeds m-2, S3= 80 g seeds m-2

3.1.4 Interaction effects of variety and nitrogen management

The level of nitrogen management and variety has a major effect on PH. The tallest plant (129.40 cm) was found from V2N2 and the shortest plant (106.40 cm) was found in V1N0 (Table 1). The highest TT (12.49) was recorded from V2N1. The maximum ET (11.60) was observed from the V2N1 and the minimum ET (8.29) was observed from the V1N0 (Table 1). The longest panicle (22.90 cm) was observed in the interaction of V2N0 and the shortest panicle (20.24 cm) was observed in V2N2 (Table 1). BRRI dhan71 and 100% recommended dose of N produced the highest (144.68) GPP and the lowest (88.77) was found in interaction of V1N0 (Table 1).

The highest TGW (23.39) was observed from the V2N1, which was statistically similar with the V2N1, V2N2 and the lowest TGW (19.15 g) was observed from the V1N2, which was statistically similar with V1N0 and V1N1 (Table 1). Among the treatments, the highest GY (5.56 t ha-1) was observed in BRRI dhan71with 100% N of recommended dose and the lowest GY (3.11 t ha-1) was observed in V1N0, which was statistically similar with V2N0 (Table 1). The highest SY (6.12 t ha-1) was observed in BRRI dhan71 with 100% recommended dose of N and the lowest SY (4.74 t ha-1) was observed in V1N0 (Table 1). Among the treatments, the highest HI (47.59%) was observed in BRRI dhan71 with 100% recommended dose of N and the lowest HI (37.91%) was observed in V2N0, which was statistically similar with V1N0 (Table 1).

Table 1: Interaction effect of variety and nitrogen management on yield parameters

Variety × Nitrogen	PH (cm)	TT (no.)	ET (no.)	PL (cm)	GPP (no.)	TGW (g)	GY (t ha^{-1})	SY (t ha^{-1})	BY (t ha^{-1})	HI (%)
V_1N_0	106.40d	9.22d	8.29d	21.27bc	88.77d	19.41b	3.11d	4.74d	7.85e	39.72c
V_1N_1	107.78cd	10.66b	9.95b	21.74abc	107.80c	19.73b	4.90b	6.03ab	10.93b	44.80b
V_1N_2	112.98c	9.50d	8.59cd	20.91bc	101.26c	19.15b	4.54c	5.95ab	10.50c	43.25b
V_2N_0	119.45b	10.54bc	9.35bc	22.90a	106.87c	23.22a	3.15d	5.17c	8.32d	37.91c
V_2N_1	123.60b	12.49a	11.60a	22.15ab	144.68a	23.39a	5.56a	6.12a	11.69a	47.59a
V_2N_2	129.40a	9.72cd	8.37cd	20.24c	122.59b	23.21a	4.75bc	5.79b	10.55bc	44.99ab
LSD $_{(0.05)}$	5.58	0.84	1.01	1.57	6.65	0.89	0.33	0.32	0.39	2.77
Level of Significance	**	**	**	**	**	*	**	**	**	**
CV%	5.00	8.55	11.36	7.62	6.21	4.17	7.95	6.02	4.12	6.74

Figures with the same letter (s) or no letter in a column do not change significantly, whereas figures with different letters do (according to DMRT). NS stands for not significant, ** for significant at the 1% level of probability, and * for significant at the 5% level of probability. V1=BRRI dhan49, V2= BRRI dhan71, others details are same as shown in Fig. 2.

Table 2: Interaction effect of variety and seeding density on yield parameters

Variety × Seeding density	PH (cm)	TT (no.)	ET (no.)	PL (cm)	GPP (no.)	TGW (g)	GY (t ha^{-1})	SY (t ha^{-1})	BY (t ha^{-1})	HI (%)
V_1S_1	106.56d	9.38d	8.46c	20.42c	98.34c	19.51b	4.15b	5.43b	9.58c	43.11ab
V_1S_2	112.38c	10.22bcd	9.26bc	22.95a	100.82c	19.40b	4.27b	5.61ab	9.89bc	42.78ab
V_1S_3	108.21cd	9.79cd	9.11bc	20.55c	98.66c	19.38b	4.12b	5.67ab	9.80bc	41.87b
V_2S_1	126.51a	10.68b	9.65ab	22.31ab	131.25a	23.10a	4.42b	5.56ab	9.98b	43.71ab
V_2S_2	125.91a	11.57a	10.33a	20.84bc	124.14b	23.42a	4.75a	5.73ab	10.49a	44.72a
V_2S_3	120.03b	10.51bc	9.35abc	22.14ab	118.73b	23.30a	4.29b	5.80a	10.09ab	42.07ab
LSD $_{(0.05)}$	5.58	0.84	1.01	1.57	6.65	0.89	0.33	0.32	0.39	2.77
Level of Significance	**	**	**	**	**	**	**	**	**	*
CV%	5.00	8.55	11.36	7.62	6.21	4.17	7.95	6.02	4.12	6.74

Others details are same as shown in Fig. 2, 3 and Table 1.

3.1.6 Interaction effects of nitrogen management and seeding density

There was a noticeable change in PH as a result of the interplay between seeding density and nitrogen control. The tallest plant (122.90 cm) was recorded from the N2S2 and the shortest plant (107.99 cm) was obtained from the N0S3 (Table 3). Interaction of different level of nitrogen management and seeding density significant influence on the production of TT. The N1S3 gave the maximum TT (12.72). On the other hand, N0S1 gave the minimum TT (10.06) (Table 3). The maximum ET (12.02) was observed from the N1S2 and the minimum effective number of tiller hill-1 (7.73) was observed from the N0S1 (Table 3). The longest panicle (23.29 cm) was observed in the N1S2 and the shortest panicle (19.70 cm) was observed in N2S2 (Table 3). The maximum GPP (130.78) was observed from the N1S1 and the minimum GPP (95.40) was found from the N0S1, which was statistically similar with N0S2, N0S3 and N2S3 (Table 3). Interaction effect of nitrogen management and seeding density had significant effect on GY.

The highest GY (5.54 t ha-1) was observed from the N1S2 and the lowest GY (3.07 t ha-1) was observed from the N0S1, which was statistically similar with N0S2 and N0S3 (Table 3). The highest SY was observed from the N1S2 and the lowest SY (4.51 t ha-1) was observed from the N0S1, which was statistically similar with N0S2 (Table 3). The highest BY (11.85 t ha-1) was observed from the N1S2 and the lowest BY (7.59 t ha-1) was observed from the N0S1, which was statistically similar with N0S2 (Table 3). The highest HI (46.80%) was observed from the N1S1, which was statistically similar with N1S2. The lowest HI (36.84%) was observed from the N0S3 which was statistically similar with N0S2 (Table 3).

Table 3: Interaction effect of nitrogen management and seeding density on yield parameters

Nitrogen × Seeding density	PH (cm)	TT (no.)	ET (no.)	PL (cm)	GPP (no.)	TGW (g)	GY (t ha^{-1})	SY (t ha^{-1})	BY (t ha^{-1})	HI (%)
N_0S_1	114.31cd*	10.06cde	7.73e	22.51ab	95.40d	21.25	3.07e	4.51d	7.59f	40.57cd
N_0S_2	116.47abc	10.44bcd	9.13cd	22.70ab	98.19d	21.36	3.09e	4.83d	7.92f	39.03de
N_0S_3	107.99d	10.45bcd	9.60bc	21.05bc	99.86d	21.33	3.22e	5.53c	8.75e	36.84e
N_1S_1	113.23cd	10.74bc	10.51b	21.02bc	130.78a	21.59	5.25ab	5.95ab	11.20b	46.80a
N_1S_2	118.07abc	11.27b	12.02a	23.29a	123.79ab	21.66	5.54a	6.30a	11.85a	46.77a
N_1S_3	115.77bc	12.72a	9.79bc	21.52abc	124.14ab	21.43	4.90bc	5.97ab	10.88bc	45.01ab
N_2S_1	122.07ab	10.06cde	8.92cde	20.56c	118.21bc	21.08	4.53cd	6.03ab	10.56cd	42.85bc
N_2S_2	122.90a	10.44bcd	8.23de	19.70c	115.47c	21.2	4.91bc	5.88bc	10.80bc	45.44ab
N_2S_3	118.60abc	10.45bcd	8.30de	21.47abc	102.09d	21.26	4.50d	5.71bc	10.21d	44.06ab

Table 3 (cont): Interaction effect of nitrogen management and seeding density on yield parameters

LSD (0.05)	6.83	1.03	1.24	1.92	8.15	1.11	0.40	0.39	0.48	3.40
Level of Significance	**	**	**	**	**	NS	**	**	**	**
CV%	5.00	8.55	11.36	7.62	6.21	4.17	7.95	6.02	4.12	6.74

Others details are same as shown in Fig. 2, 3 and Table 1.

3.1.7 Interaction effects of variety, nutrient management and seeding density

Variety, nutrient management and seeding density exerted significant effect on PH. The tallest plant (132.80 cm) was recorded from the V2N2S2. The shortest plant (101.13 cm) was recorded from V1N1S1 (Table 4). The maximum TT (13.89) was recorded from the V2N1S2. On the other hand, the V1N0S1 (BRRI dhan49 with no nitrogen and 40 g seeds m-2) gave the minimum TT (8.38) (Table 4). The highest ET (13.12) was recorded from the V2N1S2 and the lowest ET (7.48) was observed from the V1N0S1 (Table 4). The longest panicle (24.60 cm) was observed in the V2N0S1 and the shortest panicle (18.26 cm) was observed in V2N2S2 (Table 4). The maximum GPP (159.70) was observed from the V2N1S1 and the minimum GPP (85.41) was observed from the V1N0S1 (Table 4). The highest TGW (23.73 g) was observed from the V2N1S2 which was statistically similar with V2N0S1, V2N0S2, V2N0S3, V2N1S1, V2N1S3, V2N2S1, V2N2S2, and V2N2S3 and the lowest TGW (19.26 g) was observed from the V1N2S2, which was statistically similar with V1N0S1, V1N0S2, V1N0S3, V1N1S1, V1N1S2, V1N1S3, V1N2S1, and V1N2S3 (Table 4). The highest GY (5.81 t ha-1) was observed from the V2N1S2 which was statistically similar with V1N1S1, whereas the lowest GY (3.00 t ha-1) was observed from the V1N0S2. (Table 4). The highest SY (6.46 t ha-1) was observed from the V2N1S2 and the lowest SY (4.23t ha-1) was observed from the V1N0S1 (Table 4). The highest BY (12.28 t ha-1) was observed from the V2N1S2 and the lowest BY (7.28 t ha-1) was observed from the V1N0S1 (Table 4). The highest HI (48.48%) was observed from the V2N1S1 and the lowest HI (35.54%) was observed from the V2N0S3 (Table 4).

Table 4: Interaction effect of variety, nitrogen management and seeding density on yield parameters

Variety × Nitrogen × Seeding density	**PH (cm)**	**TT (no.)**	**ET (no.)**	**PL (cm)**	**GPP (no.)**	**TGW (g)**	**GY (t ha^{-1})**	**SY (t ha^{-1})**	**BY (t ha^{-1})**	**HI (%)**
$V_1N_0S_1$	105.23def	8.38g	7.48h	20.41d-g	85.41g	19.56b	3.05d	4.23f	7.28k	41.86e-h
$V_1N_0S_2$	111.21de	9.57efg	8.46e-h	23.40abc	89.71fg	19.33b	3.00d	4.66ef	7.66jk	39.15f-i
$V_1N_0S_3$	102.77ef	9.71efg	8.93d-h	20.00d-g	91.18efg	19.33b	3.28d	5.33cd	8.61hi	38.14hi
$V_1N_1S_1$	101.13f	10.36cdef	9.52c-g	19.52fg	101.85cde	20.06 b	4.90bc	5.96ab	10.86c-f	45.13a-e
$V_1N_1S_2$	112.93cd	11.56bc	10.92bc	24.31ab	111.59c	19.60 b	5.26ab	6.15ab	11.41bc	46.18a-e
$V_1N_1S_3$	109.27def	10.06def	9.42c-g	21.38c-f	109.95c	19.53b	4.53c	5.98ab	10.51efg	43.09b-g
$V_1N_2S_1$	113.33cd	9.40efg	8.39fgh	21.32c-f	107.76c	18.90b	4.50c	6.11ab	10.61d-g	42.34d-h
$V_1N_2S_2$	113.00cd	9.52efg	8.40fgh	21.14c-f	101.18c-f	19.26b	4.56c	6.03ab	10.60d-g	43.02c-g
$V_1N_2S_3$	112.60cd	9.59efg	8.99d-h	20.28d-g	94.85d-g	19.30b	4.56c	5.71bc	10.28fg	44.38a-e
$V_2N_0S_1$	123.40ab	9.14fg	7.98gh	24.60a	105.40cd	22.93a	3.10d	4.80de	7.90jk	39.27f-i
$V_2N_0S_2$	121.73bc	11.31bcd	9.81b-f	22.00a-f	106.67c	23.40a	3.18d	5.00de	8.18ij	38.92ghi
$V_2N_0S_3$	113.22cd	11.19bcd	10.27bcd	22.11a-f	108.53c	23.33a	3.16d	5.73bc	8.90h	35.54i
$V_2N_1S_1$	125.33ab	12.18b	11.51ab	22.52a-e	159.70a	23.12a	5.60a	5.95ab	11.55b	48.48a
$V_2N_1S_2$	123.20ab	13.89a	13.12a	22.27a-e	136.00b	23.73a	5.81a	6.46a	12.28a	47.37abc
$V_2N_1S_3$	122.27bc	11.42bcd	10.17b-e	21.66b-f	138.33b	23.33a	5.28ab	5.96ab	11.25bcd	46.93a-d
$V_2N_2S_1$	130.80ab	10.72bcde	9.45c-g	19.80efg	128.67b	23.26a	4.56c	5.95ab	10.51efg	43.37b-g
$V_2N_2S_2$	132.80a	9.52efg	8.06fgh	18.26g	129.77b	23.13a	5.26ab	5.73bc	11.00b-e	47.87ab
$V_2N_2S_3$	124.60ab	8.93fg	7.62h	22.66a-d	109.33c	23.23a	4.43c	5.70bc	10.14g	43.73a-f
LSD (0.05)	9.66	1.46	1.76	2.72	11.53	1.48	0.57	0.56	0.68	4.81
Level of Significance	**	**	**	**	**	*	**	**	**	**
CV%	5.00	8.55	11.36	7.62	6.21	4.17	7.95	6.02	4.12	6.74

Others details are same as shown in Fig. 2, 3 and Table 1.

4. Conclusions

From the study it can be concluded that between two rice varieties BRRI dhan71 provided the best yield and between 3 nutrient management levels, 100% recommended dose of nitrogen provided best yield and between 3 seeding densities, 60 g seeds m^{-2} provided best yield. In interaction BRRI dhan71 transplanted with 100% recommended dose of nitrogen and 60 g seed m^{-2}gave higher yield. From the result of the study, it might be concluded that variety BRRI dhan71 with 100% of recommended dose nitrogen and 60 g seeds m^{-2} in the nursery may be recommended to obtain highest GY of transplant *aman* rice. But further studies are needed of different AEZs to confirm the result of the present study.

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