Turkish Journal of Agriculture - Food Science and Technology, 12(2): 236-242, 2024
DOI: https://doi.org/10.24925/turjaf.v12i2.236-242.6553

Turkish Journal of Agriculture - Food Science and Technology

Available online, ISSN: 2148-127X | www.agrifoodscience.com | Turkish Science and Technology Publishing (TURSTEP)

Influence of Date of Transplanting and Level of Nitrogen on the Yield of Nizershail Rice Grown in *Boro* Season

Md. Abdus Salam[1,a], Urmi Rani Das[1,b], Md. Moshiur Rahman[1,c], Swapan Kumar Paul[1,d,*]

[1]*Department of Agronomy, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh*
[*]*Corresponding author*

A R T I C L E I N F O

Research Article

Received : 23.11.2023
Accepted : 12.01.2024

Keywords:
Nizershail rice
Boro season
Nitrogen
Transplanting date
Yield

A B S T R A C T

Proper nitrogen (N) management is vital for gaining potential yield benefits of a variety. Adjusting transplanting time enables the plant taking benefit from natural conditions favorable for its growth. In light of these, an investigation was carried out in the *Boro* season at the Agronomy Field Laboratory, Bangladesh Agricultural University from November 2022 to April 2023 to investigate the impact of various transplanting dates and N levels on the yield of Nizershail rice. The study involved four dates of transplanting viz. 16 December, 31 December, 15 January, 30 January and four nitrogen (N) levels viz. 0, 50, 100 and 150% of the recommended dose (RD) of N from urea where the recommended dose was 90 kg urea per ha. The trial was replicated thrice using Randomized Complete Block Design (RCBD). Results showed that the tallest plant, the uppermost grains/panicle and 1000 grains weight were detected in 16 December transplanting and the maximum grain yield was observed in 31 December transplanting. For N, total tillers and effective tillers/hill, grains/panicle, the highest grain and straw yields were found from 100% RD of N and the highest panicle length and sterile spikelets/panicle were found from 150% RD of N. In interactions, the maximum effective tillers/ hill and straw yield were observed from 100% RD of N in combination with 15 January transplanting. The maximum 1000 grains weight and the grain yield were obtained from 100% RD of N in combination with 16 December transplanting. From the result, it may be assumed that to get the maximum yield of Nizershail rice in *Boro* season could be transplanted between 16 December to 15 January with 100% RD of N from urea.

[a] salamma71@bau.edu.bd https://orcid.org/0000-0002-4288-7442
[b] urmimitu72@gmail.com https://orcid.org/0009-0000-2115-586X
[c] rahmanag63@bau.edu.bd https://orcid.org/0000-0001-6601-8682
[d] skpaul@bau.edu.bd https://orcid.org/0000-0002-0163-3251

Introduction

Rice provides the majority of the calories and micronutrients needed by about half of the global population. According to the opinion of Chowdhury and Hasan (2013), about 75% of the required caloric supply and 55% of total protein intake are met from rice in the usual diet of the people. The rice-based agricultural system of Bangladesh have a great effect on the agrarian economy of this country and is the only source of cash income for many farmers. Half of Bangladesh's agrarian GDP and one-sixth of the nation's overall domestic income are derived from the rice industry (BRKB, 2021). Bangladesh produces 3.21 t/ha of rice on average (BBS, 2021). Compared to other nations that grow rice, this yield is substantially lower. In Bangladesh, the usual yield of *Aman* rice is 2.57 t/ ha but *Boro* rice yield is 4.15 t/ha which is much higher than *Aman* season. In Bangladesh, Nizershail rice is very popular for its good taste. Though the price of Nizershail rice is higher than Pajam or other fine rice but the farmers are nowadays very reluctant to cultivate this rice due to its lower yield which is grown only in *Aman* season in Bangladesh. Since yield of *Boro* season's rice is much higher than that of *Aman* season, therefore if it is possible to grow Nizeshail rice in the *Boro* season, its yield will increase. Using the photoperiodic induction phenomenon Nizershail rice can be cultivated in the *Boro* season. There are some short-day varieties of rice, if they remain in short day condition in planting time, this effect prevails and produces flower in long day condition. This phenomenon is called photoperiodic induction. As, if Nizershail rice is transplanted in December, the short-day induction is remained in the plants and produces flower in April and the rice is harvested in April or May. By adopting the phenomenon of photoperiodic induction, it would be possible to grow Nizershail rice in the *Boro* season and yield will increase. Using the photoperiodic induction phenomenon in rice cultivation could make a breakthrough in fine rice production in the country. Nutrients have the potential to greatly boost the rice yield. Nitrogen is the nutrient that most restricts rice crop growth and yield; therefore, it must be required in higher amounts than other nutrients. It gives crop plants the highest yield response, encouraging quick vegetative development, bolstering plant activity and maintaining a vibrant green colour. Nitrogen management is crucial for rice production. Appropriate growth of the plant's aerial and subsurface components is ensured by balanced fertilization, which also contributes to the plant's increased dry matter content. Applying more or less fertilizer than is recommended is not cost-effective because doing so will lower the output in both cases. Therefore, care must be taken to apply fertilizer at the proper time, amount and kind. Rice crops typically have a N consumption efficiency of 25% to 35%, with rare exceptions when it approaches 50% (Singh et al., 2000). Urea is a major base of N that affects rice yield and N use efficiency. It accelerates the rate of absorption, improves the soil's overall health and eventually increases rice yield. It is well-known that crop diversity affects how different crops react to N. For improved production, the right amount of N and timely transplantation are required. Therefore, this study was designed to achieve the response transplanting time and N on the performance of Nizershail rice in the *Boro* season.

Materials and Methods

Experimental Site

The field trial was carried out from November 2022 to April 2023 at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, Bangladesh to assess the influence of transplanting date and N doses on the yield ability of Nizershail rice.

Planting Material

Nizershail, one of the good old introduced varieties of transplant *Aman* rice, has been tested for trial crops in this study. It was introduced from Nigeria long ago. It is a late variety in *Aman* season, tall, fairly lodging resistant with wide adaptability. It is highly photosensitive which grains are small, milk-white and palatable. Because of good taste, this rice is sold at a higher market demand. It takes 165-175 days in *Aman* season to mature. The cultivar yields 2.5 to 3.0 t/ha on average.

Experimental Treatments

The trial had two sets of treatments, which were as follows: Factor A: Date of planting (4)- 16 December (D_1), 31 December (D_2), 15 January (D_3) and 30 January (D_4) and Factor B: Level of N (4)- Control (no N), 50% recommended dose (RD) of N (21 kg N/ha), 100% RD of N (42 kg N/ha) and 150% RD of N (63 kg N/ha). The prilled urea was used a source of nitrogen and the recommended dose was 90 kg urea (42 kg N/ha).

Experimental Design and Layout

The experiment was set up using a randomized complete block design (RCBD) with three replications. The experimental area consisted of four blocks, each of which represented a replication. Subsequently, sixteen plots (four transplant dates × four N levels) were created from each block. Thus, a total of 48 (16 × 3) plots were created. The unit plot was 4.0 × 2.5 meters.

Growing of Crops

Healthy and vigorous Nizershail seeds rice were collected and chosen seeds were placed in gunny bags after being submerged in water for a whole day. After 48 hours, the seed began to sprout, and after 72 hours, nearly all of the seeds had done so. The high land was chosen at the Agronomy Field Laboratory, Bangladesh Agricultural University for raising seedlings. After using a ladder to level the field, a country plough was used to completely puddle it. The sprouting seeds were sown on the wet nursery bed on November 20, 2022. Healthy seedlings were raised in the nursery bed. The land was extensively prepared by using a tractor-drawn rotavator to till it once, then ploughing by country plough four times, and finally laddering and removing weeds, stubbles and crop residues. The layout of the field was made. Forty-eight plots were prepared by making bounds around individual plots. The whole experimental unit plots were distributed into blocks and prepared properly, each representing a replication. The whole quantity of triple supper phosphate, muriate of potash, gypsum and zinc sulphate were applied at final land preparation at the rate of 50, 70, 50, 10 kg/ha, respectively. Nitrogen was top-dressed as urea at 15, 30, and 45 DAT in 3 equal splits. Water was added to the nursery beds the day before the plants were taken out. To avoid manually harming the roots, 25-day-old seedlings were carefully lifted up and placed into a 25 cm × 15 cm spacing. The seedlings were transplanted over four separate days.

Sampling, Harvesting, Data Collection and Processing

When the crop reached maturity, it was harvested when 90% showed golden yellow colour. The crops were harvested on 27 April 2023. Without the border hills five hills from each plot were selected randomly and hand-picked to collect data on yield components and then harvest full plot. Each plot was harvest, tagged, threshed, cleaned, and dried (14% moisture content). Straws were properly sun-dried. Finally, the grain and straw yields from the plot were noted and adjusted to t/ha.

Statistical Analysis

Collected data were tabulated for statistical analysis. The software program Statistix 10 was used to carry out an ANOVA. The mean variations among the treatments were adjudged by DMRT (Gomez and Gomez, 1984).

Results and Discussion

Effect of Date of Transplanting

Plant height was significantly affected by the date of transplanting (Table 1). The tallest plant height was obtained (113.11 cm) on 16 December transplanting and the shortest one (105.53 cm) was recorded in the 30 January transplanting which was statistically equal to the 31 December and 15 January transplanting. Rice transplanted on 16 December resulted in tallest plant. This might be due to sufficient time to stay in the field of rice plants which facilitated the plants to improve their photosynthesis activities which in turn caused the tallest plants. Alike results were also depicted by Soomro et al. (2001) and Nila et al. (2018) who found taller plants in early transplanting than in late transplanting. Plant height tends to decrease due to delay in transplanting (Table 1).

The transplanting date also exerted a significant effect on total tillers/hill (Table 1). The uppermost total tillers/hill (16.58) was produced when rice was transplanted on 30 January and the lowermost total tillers/hill (11.72) was obtained on 16 December transplanting (Table 1). The transplanting date had a considerable impact on the effectiveness of the tillers/hill (Table 1). The highest effective tillers/hill (10.94) was produced in 15 January transplanting and the lowest effective tillers/hill (5.16) was obtained on 30 January transplanting (Table 1). Comparable results were also described elsewhere (Khalid, 2006; Islam et al., 2008 and Paul et al., 2020) who also found the highest effective tillers/hill on 15 January transplanting. Being Nizershail a highly photosensitive rice variety it exerted photoperiodic induction and it produced panicles up to the transplanting of 15 January. For that reason, on 30 January transplanting Nizershail rice produced the lowest effective tillers/hill due to increased day length which was beyond the critical day length at the time of 30 January transplanting (Sen and Banerjee, 1967). Panicle length was not significantly influenced by the transplanting date. This result was supported by Hossain et al. (2008) and Roy et al. (2019) who also stated that panicle length was not influenced by the transplanting of *Boro* rice. The transplanting date had a substantial impact on the number of grains/panicle. The maximum grains/panicle (69.34) was recorded when rice was transplanted on 16 December which was statistically identical to 15 January (69.26) and 31 December (66.83). The current results are consistent with those of Hossain et al. (2008) and lslam et al. (2014). The results of the study indicate that grains/panicle increased from 16 December to 15 January transplanting, thereafter drastically reduced on 30 January transplanting. This might be due to the fact that being Nizershail rice is a highly photosensitive cultivar it perhaps produced flowers below the critical day length i.e., short day condition which was up to 15 January transplanting. After the 15 January transplanting, the day length increased and Nizershial rice being a highly photosensitive cultivar remained vegetative stage due to the increased day length. Though 30 January transplanting produced the highest effective tillers/hill but due to photoperiodic induction the highest grains/panicle was recorded on 16 December transplanting. The flowering of the Nizershail rice plant occurred in mid-March to late March in long day condition. The principle of flowering is that when the rice plant was transplanted from 16 December to 15 January the short-day condition prevailed. This short-day induction is remained in the rice plants and produced flowers in March in long day condition and the rice was harvested in April. This happened due to photoperiodic induction (Best, 1961; Katayama, 1963; Gwinner, 1977). The lowest grains/panicle (52.05) was obtained on 30 January transplanting. This was because no flowering happened due to a higher photoperiod at the time of transplanting which was above the critical day length that prohibited flowering. The transplantation date had a considerable impact on sterile spikelets/panicle. The maximum sterile spikelets/panicle (14.91) was produced when rice was transplanted on 30 January and the minimum sterile spikelets/panicle (6.19) was obtained on 16 December transplanting (Table 1). The timing of transplanting had a considerable impact on 1000-grain weight. A maximum weight of 1000-grain was obtained (23.08 g) in 16 December transplanting which was statistically equal to 31 December (22.93) transplanting and a minimum 1000-grain weight was obtained (21.42 g) in 30 January transplanting. A decreasing trend was found in 1000-grain weight with the delay of transplanting (Table 1). The transplanting date exerted a significant impact on grain yield. The uppermost grain yield (3.96 t/ha) was achieved from 31 December transplantation which was at par with 16 December (3.58) and 15 January (3.49 t/ha) transplanting. The maximum grain yield acquired by 31 December transplantation owing to mainly the highest grains/panicle and lowest sterile spikelets/panicle. Moreover, statistically identical and highest grain yield was obtained from 16 December to 15 January transplanting and thereafter grain yield reduced drastically. The probable cause is that Nizershail is a highly photosensitive rice cultivar and it produced flowers when the day length at transplanting was below the critical day length. When the Nizershail rice was transplanted in 15 December to 15 January in short day length condition, this short-day induction remained in rice plant and it produced flowers in long day condition. Transplanting beyond 15 January, panicle bearing tillers drastically reduced and grain yield also reduced after 15 January transplantation. The lowest grain yield (0.87 t/ha) was acquired when transplanted on 30 January (Table 1 and Figure 1). The lowermost grain yield was achieved in 30 January transplanting due to minimum effective tillers/hill, grains/panicle, maximum sterile spikelets/ panicle and least weight of 1000-grain. The transplanting date has a substantial impact on straw yield. The uppermost straw yield (6.01 t/ha) was obtained from the 15 January transplantation which was statistically equal to the transplanted 30 January (5.31) while the lowermost straw yield (4.77 t/ha) was found in the transplanted on 16 December (Table 1).

Table 1. Effect of transplanting date on the yield components and yield of Nizershail rice

DT	PH	TTH	ETH	NETH	PL	GP	SSP	GW	GY	SY
16 December	113.11a*	11.72c	8.94b	2.78b	20.75	69.34a	6.19c	23.08a	3.58a	4.77b
31 December	108.53b	12.67bc	8.63b	3.66b	21.47	66.83a	7.58c	22.93a	3.96a	5.02b
15 January	107.39b	13.83b	10.94a	3.42b	25.51	69.26a	11.09b	22.55b	3.49a	6.01a
30 January	105.53b	16.58a	5.16c	10.86	22.25	52.05b	14.91a	21.42c	0.87b	5.31ab
Sig. level	**	**	**	**	NS	**	**	**	*	*
CV (%)	3.91	16.46	11.90	13.92	18.79	18.73	17.97	1.86	9.22	10.96

DT: Date of transplanting; PH: Plant height (cm); TTH: Total tillers/hill(no.); ETH: Effectivetillers/hill (no.); NETH: Non-effectivetillers/hill(no.); PL: Panicle length (cm); GP: Grains/panicle(no.); SSP: Sterile spikelets/panicle(no.); GW: 1000-grain weight (g); GY: Grain yield (t/ha); SY: Straw yield (t/ha); * Figures within the column having the same letter(s) are not significantly different; ** = Significant at 1% level of probability; * = Significant at 5% level of probability, NS = Not significant

Table 2. Effect of nitrogen levels on the yield contributing characters and yield of Nizershail rice

NL	PH	TTH	ETH	NETH	PL	GP	SSP	GW	GY	SY
N_0	108.05	13.61ab	8.33ab	5.28	21.52	66.03	8.06	22.55	2.80b	4.86b
N_1	109.14	12.91b	7.64b	4.97	21.63	65.21	9.84	22.50	2.77b	5.18b
N_2	109.11	14.94a	9.28a	5.69	21.43	66.50	10.72	22.40	3.34a	6.25a
N_3	108.25	13.33ab	8.64ab	4.78	25.40	59.23	11.14	22.54	2.99ab	4.83b
Sig. level	NS	*	*	NS	NS	NS	NS	NS	*	*
CV (%)	3.91	16.46	11.90	13.92	28.79	18.73	37.97	1.86	9.22	10.96

NL: Nitrogen level; PH: Plant height (cm); TTH: Total tillers/hill(no.); ETH: Effectivetillers/hill (no.); NETH: Non-effectivetillers/hill(no.); PL: Panicle length (cm); GP: Grains/panicle(no.); SSP: Sterile spikelets/panicle(no.); GW: 1000-grain weight (g); GY: Grain yield (t/ha); SY: Straw yield (t/ha); * Figures within the column having the same letter(s) are not significantly different; *= Significant at 5% level of probability, NS = Not significant; N_0 = 0 kg N/ha (Control), N_1 = 50% RD (21 kg N/ha), N_2 = 100% RD (42 kg N/ha), N_3= 150% RD (63 kg N/ha)

Table 3. Interaction effect of transplanting date and nitrogen level on the yield contributing characters and yield of Nizershail rice

DTNL	PH	TTH	ETH	NETH	PL	GP	SSP	GW	GY	SY
D_1N_0	112.11ab	12.55bc	9.89a-c	2.67c	21.32b	70.86a-c	4.91e	23.00ab	3.61b-d	4.35b
D_1N_1	111.78ab	10.22c	7.66c-e	2.55c	19.70b	59.42b-e	5.47e	23.13a	2.66d	4.30b
D_1N_2	111.22a-c	11.77bc	9.00bc	2.77c	20.46b	68.62a-d	8.97b-e	23.14a	4.58a	5.36b
D_1N_3	117.33a	12.33bc	9.22a-c	3.11c	21.53b	78.44ab	5.40e	23.06ab	3.47b-d	5.05b
D_2N_0	109.44b-d	11.55bc	8.44cd	3.11c	21.00b	67.96a-d	6.33de	22.87ab	3.61b-d	4.73b
D_2N_1	110.44a-d	12.66bc	8.78c	3.89c	22.04b	68.98a-d	9.16b-e	22.93ab	4.26ab	4.97b
D_2N_2	107.22b-d	14.78ab	10.33a-c	4.43c	21.23b	66.08a-e	7.89b-e	22.80ab	4.04a-c	5.64b
D_2N_3	107.00b-d	11.67bc	7.77c-e	3.23c	21.60b	64.31a-e	6.95c-e	23.13a	3.93a-c	4.75b
D_3N_0	104.22cd	12.44ab	9.88a-c	2.56c	21.38b	70.53a-c	8.53b-e	22.58ab	3.21cd	5.18b
D_3N_1	110.66a-d	11.77bc	9.66a-c	3.11c	22.56b	82.78a	8.74b-e	22.51ab	3.13cd	5.61b
D_3N_2	110.66a-d	16.66a	12.22a	4.55c	21.56b	74.50a-c	13.21a-c	22.39bc	3.94a-c	8.08a
D_3N_3	103.99d	14.44ab	12.00ab	3.44c	36.52a	49.24de	13.85ab	22.71ab	3.67a-c	5.18b
D_4N_0	106.44b-d	17.88a	5.11ef	12.78a	22.37b	54.78c-e	12.47a-d	21.75cd	0.77e	5.16b
D_4N_1	103.66d	16.99a	4.44f	10.33ab	22.21b	49.66de	16.00a	21.43d	1.02e	5.82b
D_4N_2	107.33b-d	16.55a	5.55d-f	11.00ab	22.47b	56.82c-e	12.82a-c	21.25d	0.80e	5.91a
D_4N_3	104.66cd	14.88ab	5.55d-f	9.34b	21.96b	46.94e	18.37a	21.24d	0.89e	4.35b
Sig. level	*	*	*	*	*	*	*	*	*	*
CV (%)	3.91	11.90		13.92	28.79	18.73	37.97	1.86	9.22	10.96

DTNL: Date of transplanting × Nitrogen levels; PH: Plant height (cm); TTH: Total tillers/hill(no.); ETH: Effectivetillers/hill (no.); NETH: Non-effectivetillers/hill(no.); PL: Panicle length (cm); GP: Grains/panicle(no.); SSP: Sterile spikelets/panicle(no.); GW: 1000-grain weight (g); GY: Grain yield (t/ha); SY: Straw yield (t/ha); * Figures within the column having the same letter(s) are not significantly different; *= Significant at 5% level of probability; D_1 = 16 December, D_2 = 31 December, D_3 = 15 January, D_4 = 30 January; N_0 = 0 kg N/ha (Control), N_1 = 50% RD of N (21 kg N/ha), N_2 = 100% RD of N (42 kg N/ha), N_3= 150% RD of N (63 kg N/ha)

Effect of level of nitrogen

Different amounts of N had no significant effect on the plant height of Nizershail rice (Table 2). Numerically the maximum height of plants (109.14 cm) was obtained with 50% recommended dose (RD) of N (21 kg N/ha). The least plant height (108.05 cm) was observed in 0 kg N/ha (control) treatment. Plant height showed a tendency to decrease with the expansion in the level of N (Table 2). This could have happened as a result of applying N, which controls vegetative development. Total tillers/hill was significantly impacted by the N dose (Table 2). The maximum total tillers/hill (14.94) was produced in 100% RD of N (42 kg N/ha) which was statistically equal to 0 kg N/ha and 150% of the RD of N (63 kg N/ha). The least total tillers/hill (12.91) was obtained when fertilized with 50% RD of N (21 N/ha) (Table 2). The tillers/hill was increased up to certain rates of N. The level of N had a significant influence on tillers/hill. The highest effective tillers/hill (9.28) was documented in 100% RD of N (42 kg N/ha) which was significantly equal to 0 kg N/ha (8.33) and 150% of RD of N (63 kg N/ha). The minimum effective tillers/hill (7.64) was produced in 50% RD of N (21 kg N/ha). Numerically the lengthiest panicle (25.40 cm) was found in 150% RD of N (63 kg N/ha) and the shortest panicle (21.43 cm) was found in 100% RD of N (42 kg N/ha) which indicated that N did not exert any significant effect on panicle length (Table 2). A similar research finding was also reported by Gewaili et al. (2018) who found that the level of N had no significant effect on panicle length. The amount of N did not significantly affect the number of grains/panicle. Numerically the maximum grains/panicle (66.50) was found in 100% RD of N (42 kg N/ha) and the minimum one (59.23) was found in 150% RD of N (63 kg N/ha) (Table 2). The sterile spikelets/panicle and 1000-grain were not significantly affected by N level (Table 2). The level of N exerted a significant influence on grain yield. The highest grain yield (3.34 t/ha) was recorded by 100% RD of N (42 kg N/ha) which was statistically equal to 150% of RD of N (63 kg N/ha). Similar research results were also described by Mankotia et al. (2007) and Jahan et al. (2014) who observed the highest grain yield of rice with 100% RD of N from prilled urea. The lowest grain yield (2.77 t/ha) was obtained in 50% RD of N (63 kg N/ha) (Table 2 and Figure 2). The level of N had a significant effect on straw yield. The maximum straw yield (6.25 t/ha) was recorded from 100% RD of N (42 kg N/ha) while the lowermost straw yield (4.83 t/ha) was obtained by 150% RD of N (63 kg N/ha) (Table 2).

Interaction effect of transplanting date and level of nitrogen

The interaction between the date of transplantation and the amount of N had a major impact on plant height (Table 3). The longest plant (117.33 cm) was obtained from 150% RD of N with transplanting on 16 December which was statistically equal to 0 kg N/ha with 16 December transplanting (112.11), 50% RD of N with 16 December (111.78) and 100% RD of N with 16 December (111.22). The dwarf plant (103.66 cm) was obtained from 50% RD of N with the 30 January transplanting (Table 3). Total tillers/hill was significantly impacted by the interaction of the N level and the transplanting date. The maximum total tillers/hill (17.88) was produced in 0 kg N/ha with 30 January transplantation date which was statistically equal to both combination with 100% RD of N and 15 January (16.66), 50% RD of N with 30 January (16.99), 100% RD of N with 30 January (16.55) and at par with 100% RD of N with 31 December (14.78), 0 kg N/ha with 15 January (12.44), 150% RD of N with 15 January (14.44), 150% RD of N with 30 January (14.88) transplanting. The minimum total tillers/hill (10.22) was acquired by 50% RD of N (control) in combination with 16 December transplanting (Table 3). The planting date and N levels together had a major impact on the number of effective tillers/hill (Table 3). The highest effective tillers/hill (12.22) was found from 100% RD of N with 15 January transplantation that statistically comparable to 15 January transplanting with 150% RD of N (12.00). The least effective tillers/hill (4.44) was found from 50% RD of N with 30 January transplanting (Table 3). Transplanting date in combination with levels of N had a significant effect on panicle length. The lengthiest panicle (36.52 cm) was acquired from 150% RD of N with 15 January transplanting. The small panicle (19.70 cm) was obtained in 50% RD of N in combination with 16 December transplanting which was statistically identical to other treatment combinations (Table 3). The interaction of transplanting date and levels of N exerted significant result on grains/panicle. The maximum grains/panicle (82.78) was obtained by 50% RD of N with 15 January transplantation. The lowest grains/panicle (46.94) was obtained by 30 January transplanting fertilized with 150% RD of N (Table 3). The maximum sterile spikelets/panicle (18.37) was obtained by 30 January transplanting with 150% RD of N which was statistically equal to 50% RD of N with 30 January transplanting (16.00). The lowest sterile spikelets/panicle (4.91) was found by 0 kg N/ha with 16 December transplantation (Table 3). The finding was at par with the finding of Ali (2010) who obtained the lowest sterile spikelets/panicle with 15 December transplanting and 100% RD of N from prilled urea. Transplanting date in combination with levels of N exerted significant consequences on the weight of 1000-grain. The top 1000-grain weight (23.14 g) was gained from 16 December transplanting with 100% of the RD of N which was at par with 16 December transplanting with 50% of the RD of N (23.13 g), 31 December transplanting with 150% of the RD of N (23.13 g). The least 1000-grain weight was noted (21.24 g) by 30 January transplanting with 150% of the RD of N (Table 3). The interaction of the transplanting date and level of N exerted significant results on grain yield. The maximum grain yield (4.58 t/ha) was gained by 16 December transplanting with 100% of the RD of N which was statistically equal to 31 December transplanting with 50% of the RD of N (4.26 t/ha), 31 December transplanting with 100% of the RD of N (4.04), 15 January with 100% of the RD of N (3.94 t/ha) and 31 December transplanting with 150% RD of N (3.93 t/ha). This research report partially corroborates the findings of Ali (2010) who obtained the maximum grain yield of *Boro* rice cv. BRRI dhan45 was transplanted on 30 December with 100% RD of N. The lowest grain yield (0.77 t/ha) was obtained from the control treatment of N with 30 January transplanting (Figure 3 and Table 3). The interaction of transplanting date and levels of N had significant results on straw yield. The highest straw yield (8.08 t/ha) was obtained on 15 January transplanting with 100% RD of N. The lowest straw yield (4.30 t/ha) was noted on 16 December transplanting with 50% RD of N (Figure 3 and Table 3).

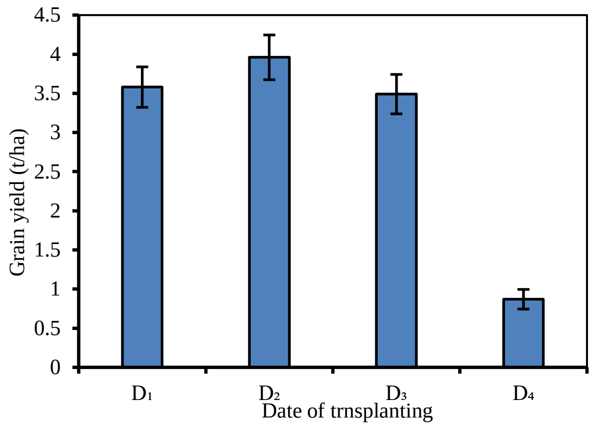

Figure 1. Effect of transplanting date on grain yield of Nizershail rice

D_1 = 16 December, D_2 = 31 December, D_3 = 15 January, D_4 = 30 January

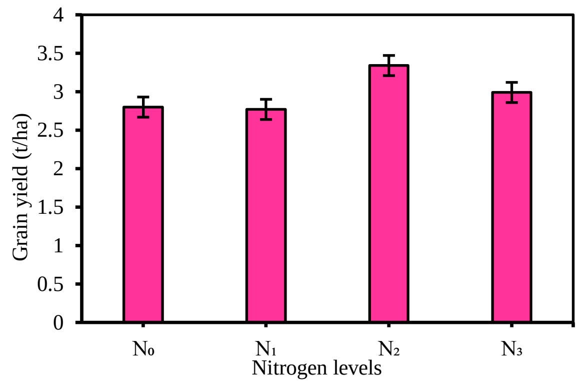

Figure 2. Effect of nitrogen levels on grain yield of Nizershail rice

N0 = 0 kg N/ha, N1 = 50% of RD of N (21 kg N/ha), N2 = 100% of RD of N (42 kg N/ha), N3= 150% of RD of N (63 kg N/ha)

Conclusion

From the results, it may be concluded that Nizershail rice should be transplanted from 16 December to 15 January with 100% of the RD of N from (90 kg/ha) urea and the recommended dose of TSP, MoP and gypsum fertilizers for maximizing the yield of Nizershail yield in *boro* season.

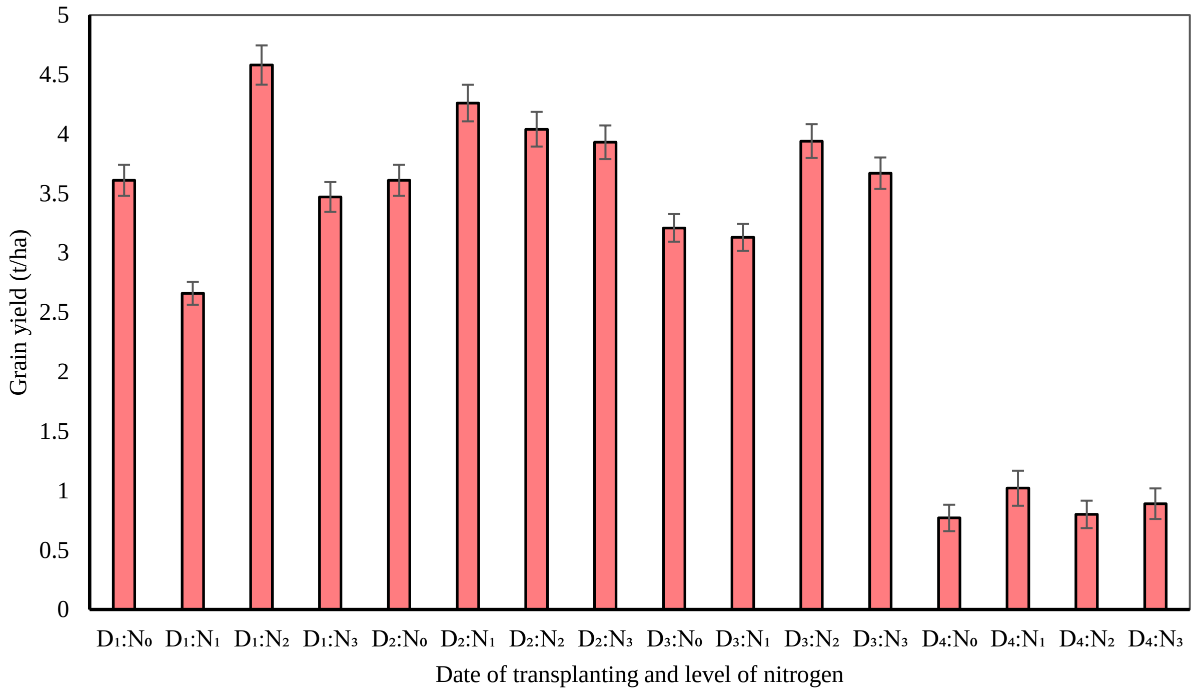

Figure 3. Interaction effect transplanting date and level of nitrogen on grain yield of Nizershail rice
D1 = 16 December, D2 = 31 December, D3 = 15 January and D4 = 30 January
N0 = 0 kg N/ha, N1 = 50% RD of N (21 kg N/ha), N2 = 100% RD of N (42 kg N/ha), N3= 150% RD of N (63 kg N/ha)

Acknowledgments

The authors are very much grateful to Grants for Advanced Research in Education (GARE), Ministry of Education, Government of the People's Republic of Bangladesh for financial support through the research project entitled "Agronomic biofortification of zinc in Nizershail rice grown both in transplant *Aman* and *Boro* seasons under changing climate" (Project ID: LS20222035) to carry out the research work.

References

Ali, M. T. (2010). Effect of planting dates and nitrogen doses on the growth and yield of boro rice cv. BRRI dhan45. MS Thesis, Department of Agronomy, Shcr-c-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh. P, 70.

BBS (Bangladesh Bureau of Statistics) 2021: Statistical Yearbook of Bangladesh. Bangladesh Bureau of Statistics. Ministry of Planning, Govt. People's Republic. Bangladesh. Pp, 32-41.

Best, K. (1961). Some aspects of photoperiodism in rice (Oryza sativa L.). Elsevier, Amsterdam.

BRKB (Bangladesh Rice Knowledge Bank) 2021: Rice in Bangladesh, Training Division, Bangladesh Rice Research Institute (BRRI), Gazipur.

Chowdhury, M. A. H., & Hassan, M. S. (2013). Hand Book of Agricultural Technology. Bangladesh Agricultural Research Council (BARC). Farmgate, Dhaka-1215, Bangladesh. Pp, 1-3

Gewaili, E. E., Ghoneim, A. M., & Osman, M. M. A. (2018). Effects of nitrogen levels on growth, yield and nitrogen use efficiency of some newly released Egyptian rice genotypes. *Open Agriculture,* 3, 310–318.

Gomez, K. A., & Gomez, A. A. (1984). Statistical Procedures for Agricultural Research. John Willey and Sons. New York, Chichester, Brisbane, Toronto. Pp, 97-129, 207-215.

Gwinner, J. (1977). Einfluss der Lichtintensitat und der Tageslange sowie von niedrigen Temperaturen auf den Reisanbau in den nordlichen Marginalzonen (Influence of low temperature, light intensity and daylength on rice growing in northern marginal areas; a literature review). Hamburg, 186 p.

Hossain, M. Z., Sarkar, M. A. R., & lslam, A. K. M. M. (2008). Effect of age of seedlings on the performance of boro rice under SRI method. *Bangladesh Journal of Crop Science,* 19(1), 21-26.

Islam, M. S., Hossain, M. A., Chowdhury, M. A. H., & Hannan, M.A. (2008). Effect of nitrogen and transplanting date on yield and yield components of aromatic rice. *Journal of Bangladesh Agricultural University,* 6(2), 291-296.

Islam, M. S., Sarkar, M. A. R., Alam, M. J., Kashem, M. A., Rafi, M. Y., & Latif, M. A. (2014). Effect of date of transplanting on yield and yield attributing characters of aromatic fine rice in rainfed condition. *Crop Research,* 15(2), 305–312.

Jahan, M. S., Sultana, S., & Ali, M. Y. (2014). Effect of different nitrogen levels on the performance of aromatic rice varieties. *Bulletin of the Institute of Tropical Agriculture,* 37, 47-56.

Katayama, T. (1962). Photoperiodic responses of Oryza species. IV. Annu. Rep. Natl. Inst. Genet. Japan. 1961(12), 57-58.

Khalid, M. M. R. (2006). Performance of BRRI dhan28, as influenced by date of transplanting and nitrogen fertilization. M.S. Thesis (abstract), Department of Agronomy, Bangladesh Agricultural University, Mymensingh.

Mankotia, B. S., Shekhar, J., Thakur, R. L., & Negi, S. C. (2007). Effect of organic and inorganic resources of nutrient on rice (Oryza sativa)-wheat (Triticum aestivum L.) cropping system. 53(1), 32-36.

Nila, Y. S., Paul, S. K., & Sarkar, M. A. R. (2018). Growth performance of aromatic Boro rice (Oryza sativa L. cv. BRRI dhan50) as influenced by date of transplanting and nutrient management. *Archives Agriculture and Environmental Science,* 3(2), 116- 122.

Paul, S. K., Nila, N.Y., & Sarkar, M. A. R. (2020). Grain yield and quality of aromatic Boro rice (cv. BRRI dhan50) subject to date of transplanting and nutrient management. *Thai Journal of Agricultural Science,* 53 (2), 85−96.

Roy, T. K., Paul, S. K., & Sarkar, M. A. R. (2019). Influence of date of transplanting on the growth and yield performance of high yielding varieties of Boro rice. *Journal of Bangladesh Agricultural University,* 17(3), 301–308.

Sen, P. K., & Banerjee, S. P. (1967). Inheritance of photoperiodic reaction in rice. II. Studies in the F3 and F4 generations of aus (photoinsensitive) and aman (photo-sensitive) crosses. *Indian Journal of Agricultural Sciences,* 37, l-14.

Singh, M. K., Thakur, R., Verma, U. N., Upasani, R. R., & Pal, S. K. (2000). Effect of planting time and nitrogen on production potential of Basmati rice (Oryza sativa) cultivars in Bihar Plateu. *Indian Journal of Agronomy,* 55(8), 300-303.

Soomro, H., Soomro, A., Oad, F. C., Ansari, A. H., & Oad, N. L. (2001). Effect of transplanting dates on yield and its related traits in rice (Oryza sativa L.). *Journal of Biological Sciences,* 5(1), 363- 364.