Effect of Transplanting Dates on Yield and Yield Components of Nerica rice mutants at drought prone areas of Bangladesh

Abstract

To investigate the effect of various transplanting dates on yield and yield attributing characteristics of Nerica rice mutants at drought prone areas, Ishurdi and Chapai Nawabgonj during aman season. Two advanced Nerica mutant lines (N_4/350/P-4(5), N_{10}/350/P-5-4) were evaluated compared with one check variety (Binadhan-17) with three dates of transplanting (D1=July 20, D2=July 30 and D3=August 10). The experiments were laid out on randomized complete block design (RCBD) with three replications. Twenty five days old seedlings were transplanted with optimum 20 x 20 cm row to row and plant to plant distance. The unit plot size was 3 m×4 m. The recommended doses of fertilizer were applied. The effect of dates of transplanting on grain yield of D3 was the highest (5.10 t ha^{-1}) whereas D2 produced the lowest grain yield (4.24 t ha^{-1}). Among the mutant lines/varieties, Binadhan-17 produced the highest grain yield (4.94 t ha^{-1}) followed by N_4/350/P-4(5) (4.57 t ha^{-1}). The interaction effect of date and variety showed that Binadhan-17 produced the maximum yield (5.56 t ha^{-1}) at D3 followed by N_4/350/P-4(5) mutant (4.92 t ha^{-1}). The interaction effect of date and location, D3 transplanting date produced the maximum yield (5.23 t ha^{-1}) at Ishurdi which was followed by transplanting (4.96 t ha^{-1}) at Chapai Nawabgonj. The interaction effect of variety and location Binadhan-17 produced maximum yield (5.06 t ha^{-1}) in Ishurdi followed by Binadhan-17 in Chapai Nawabgonj (4.82 t ha^{-1}). The interaction effect of date, variety and location transplanting date D3, Binadhan-17 produced maximum yield (5.70 t ha^{-1}) in Ishurdi followed by transplanting date D3, Binadhan-17 in Chapai Nawabgonj (5.43 t ha^{-1}). The data recorded on crop duration from transplanting to maturity revealed that the advanced mutant line N_4/350/P-4(5) required the least average 108 days and the Binadhan-17 required maximum average 119 days. Therefore, 10th August was found to be the best date of transplanting and Binadhan 17 showed the best performance at Ishwardi in Bangladesh.

Key words: NERICA, Mutant, Transplanting time, Drought, Yield

Introduction

Rice (*Oryza sativa* L.) is an important crop of Bangladesh ranking first as a staple food. Bangladesh is the world's 4th largest producer of rice, after China, India and Indonesia. In Asia, it is the main item of the diet of 3.5 billion people. Therefore, increase in population will require 70 percent more rice in 2025 than is consumed today (Kim and Krishnan, 2002). Among the crop production tools, proper time and method of sowing are the prerequisites that allow the crop to complete its life phase timely and successfully under a specific agro-ecology. In rice, the optimum leaf areas for seedlings, optimum leaf shapes to maximize photosynthetic efficiency, deep, well-developed root systems, leaf area index (LAI) at flowering and crop growth rate (CGR) during panicle initiation have been identified as the major determinants of yield (Sun *et. al.*, 1999). A combination of these growth variables explains variations in yield better than any individual growth variable (Ghosh and Singh, 1998). For successful rice production, timely planting, appropriate control of vegetative growth throughout the duration of the crop, suitable transplanting densities for optimum tillering and control of leaf growth by controlling water, fertilizer and chemical inputs are essential for improving the growth variables responsible for high yield (Ghosh and Singh, 1998).

New Rice for Africa (NERICA) is an inter-specific cultivar of rice developed by African Rice Centre (WARDA) in 1996 with a view to attain self-sufficiency in rice production and economic development. The cultivar was developed by crossing between *Oryza glaberrima* and *Oryza sativa* (Dingkuhn *et. al.*, 2004). The key features of NERICA rice offered by the parent *Oryza glaberrima* are early maturity (90–110 days), drought tolerance, resistance to rice gall midge, rice yellow mottle virus and blast disease, and profuse early vegetative growth (Somado *et. al.*, 2008).

The average rice yield in the country and particularly in Drought prone areas of Bangladesh are far behind what can be obtained from the potential of the crop. It may be attributed to many reasons. However, it is possible to double the average yield by adopting scientific crop production technologies. The scientists assumed that the low productivity could be due to climatic change and soil variation compared to its origin. For this reason mutation is applied to develop mutant lines to improve yield of NERICA lines in Bangladesh. Mutants have made it possible to identify critical elements for developing high yield potential varieties exhibiting desirable traits such as semi dwarfism, early maturity, greater number of panicles/plant and increased fertility. The technique has been successfully utilized by Bangladesh Institute of Nuclear Agriculture (BINA) and many other research institutes on different crops (Das *et. al.*, 1999; Azad *et. al.*, 2012).

Transplanting date is an important factor, which affects tremendously the grain yield of transplanted aman rice (Chowdhury *et. al.*, 2000). Time of transplanting has profound influence on the performance of different cultivars of photo and thermo-sensitive nature (Takahashi *et. al.*, 1967) and the time between July 15 and August 15 is the best for transplantation of high yielding cultivars of transplant aman rice specially photosensitive cultivars in Bangladesh (Islam, 1986). It is essential to identify the optimum time of transplanting to get satisfactory yield from Nerica mutants. The objective of the study was to observe how yield performances of Nerica mutants rice were affected by different dates of transplanting and investigate the effect of transplanting time on yield and yield contributing characters within the context of climate change in Bangladesh.

Materials and methods

The experiment was carried out at the Experimental Field of the Department of Agronomy, Bangladesh Institute of Nuclear Agriculture (BINA) Sub-station Ishurdi (Latitude: 24.1234077, Longitude: 89.076996) and Chapai Nawabgonj (Latitude: 24.6045946, Longitude: 88.2933188) during aman season of 2017. Two advanced Nerica mutant lines (N_4/350/P-4(5), N_{10}/350/P-5-4) were evaluated compared with one check variety (Binadhan-17) with three dates of transplanting (D1=July 20, D2=July 30 and D3=August 10). The experiment was laid out in a factorial Randomized Complete Block Design with three replications. The unit plot size was 3m x 4m. Row and hill spacing was (20×15) cm. The plots of Aman rice were fertilized with N, P, K, Zn and Boron respectively according to the recommendation of Bangladesh Agriculture Research council (BARC, 2012). The whole amount at triple super phosphate, muriatic of potash, gypsum, boron and zinc sulphate (separately) were applied to the soil at the time of final land preparation. Urea was applied in three equal splits. Thirty days old seedlings were transplanting in the experimental plots. The maturity of crops was determined when some 70% of the seeds became attain their characters color. The weight of grains was adjusted to 14% moisture content. Grain and straw yield were them converted to t ha^{-1}. From the 10 randomly harvested hills, the following data were recorded, plant height, number of total tillers hill^{-1}, number of effective tillers hill^{-1}, number of non-effective tillers hill^{-1}, number of grain panicle^{-1}, number of unfilled grains panicle^{-1}, 1000 grain weight, grain yield (t ha^{-1}), straw yield (t ha^{-1}) which were subjected to analysis of variance (ANOVA) and the treatment means were compared using the least significant different (LSD) test.

Results and Discussion

Effects of different transplanting times on yield of two advanced Nerica mutant lines were evaluated at three different transplanting dates in two locations during aman season in 2017. The experiments were conducted at BINA Sub-station Farms in Ishurdi and Chapai Nawabgonj.

The transplanting date had a significant effect on effective tillers hill-1, filled grains panicle^{-1}, unfilled grains panicle^{-1}, 1000 seed weight (g), Grain yield (t ha^{-1}), straw yield (t ha^{-1}). The highest number of effective tillers per hill (12.1), panicles length (23.9), filled grains per panicle (131.4) and grain yield (5.10 t/ha) were recorded when the varieties were transplanted on July 20, July 20, August 10 and August 10 respectively (Table 1). On the other hand, the number of effective tillers per hill (11.6), panicles length (24.0), filled grains per panicle (150.8) and grain yield (4.94 t/ha) were recorded from N4/350/P-4(5), Binadhan-17, Binadhan-17 and Binadhan-17 respectively (Table 1). The mean grain yield of the check variety BINA dhan 17, irrespective of transplanting dates, was 4.94 t/ha and was significantly different from that of the N4/350/P-4(5) (4.57 t/ha) and N10/350/P-5-4 (4.51 t/ha). The interaction analysis results showed that the maximum grain yield of the Binadhan 17 was obtained when transplanted on August 10 (5.56

t/ha). In comparison, the maximum yield of the N4/350/P-4(5) was produced when transplanted on August 10 (4.92 t/ha) and followed by N10/350/P-5-4 (4.80 t/ha). Crop duration of Binadhan-17 was 119 days (transplanted on August 10), N10/350/P-5-4 was 109 days (transplanted on August 10) and N4/350/P-4(5) was 108 days (transplanted on August 10). Binadhan 17 produced highest filled grain per panicle (153.2) and total grain yield (5.06 t/ha) at Ishwardi sub-station which was followed at Chapai Nawabgonj (148.4 and 4.82) respectively. The interaction effect among the transplanting dates, variety and locations showed that the highest number of filled grain per panicle (175.0) was found from Binadhan 17 when it was transplanted on august 10 at Ishwardi sub-station of BINA. Similarly, the highest grain yield (4.70) was recorded from Binadhan 17 when it was transplanted on August 10 at Ishwardi sub-station of BINA which was followed at BINA sub-station Chapai Nawabgonj farm (4.93) (Table 1). Nadeem *et. al.*, (2010) also reported similar results.

Table 1. Effect of date of transplanting on the yield and yield contributing characters of Nerica rice mutants/variety in aman season at drought prone areas of BINA Sub-station, Ishurdi and Chapai Nawabgonj

Treatments	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1} (no.)	Panicle length (cm)	Filled grains panicle^{-1} (no.)	Unfilled grains panicle^{-1} (no.)	1000 seed wt. (g.)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Crop Duration (Days)
Dates of transplanting										
July. 20 (D_1)	98.9	14.1	12.1	23.9	111.3	16.5	21.3	4.68	6.64	
July. 30 (D_2)	102.3	11.7	10.9	23.4	130.3	13.5	21.5	4.24	5.91	
Aug. 10 (D_3)	103.1	11.2	10.3	23.5	131.4	13.5	22.1	5.10	5.87	
$LSD_{0.05}$	NS	NS	1.0	NS	8.2	4.2	0.7	0.63	0.77	
Mutants/Variety										
N_4/350/P-4(5) (V_1)	100.9	12.9	11.6	23.3	114.6	13.5	22.8	4.57	6.20	108
N_{10}/350/P-5-4 (V_2)	98.8	12.2	11.0	23.4	107.6	15.4	21.2	4.51	5.86	109
Binadhan-17 (V_3)	104.6	11.8	10.7	24.0	150.8	14.5	21.0	4.94	6.35	119
$LSD_{0.05}$	NS	NS	0.8	NS	5.6	4.2	NS	0.31	0.31	-
Location										
Ishurdi (L_1)	101.3	12.8	11.7	24.1	124.2	14.0	21.5	4.79	6.23	
Chapai Nawabgonj(L_2)	101.6	11.9	10.5	23.1	124.5	15.0	21.8	4.56	6.05	
Level of sig.	NS	*	*	NS	NS	NS	NS	NS	NS	
Dates ×Variety										
D_1V_1	96.6	15.6	13.4	23.7	99.8	16.7	22.0	4.39	6.51	
D_1V_2	95.3	14.7	12.4	23.3	101.4	16.9	21.4	4.59	6.40	
D_1V_3	104.7	11.9	10.6	24.7	132.7	15.9	20.7	4.87	7.00	
D_2V_1	102.0	11.8	11.2	23.3	114.5	11.9	22.3	4.41	5.78	
D_2V_2	100.8	11.3	10.5	23.3	108.7	14.3	21.2	4.12	5.85	
D_2V_3	104.2	11.9	11.0	23.7	167.7	14.2	20.9	4.19	5.98	
D_3V_1	104.2	11.3	10.2	23.1	129.5	12.0	24.0	4.92	6.32	
D_3V_2	100.3	10.7	10.1	23.7	112.7	15.0	21.3	4.80	5.34	
D_3V_3	104.8	11.6	10.5	23.7	152.2	13.4	21.0	5.56	6.08	
$LSD_{0.05}$	NS	NS	1.3	NS	9.8	7.2	0.8	0.54	0.53	
Dates × Location										
D_1L_1	98.0	15.0	13.0	24.5	110.2	16.3	21.0	4.79	6.74	
D_1L_2	99.8	13.2	11.2	23.3	112.4	16.7	21.7	4.57	6.54	
D_2L_1	102.3	12.0	11.6	23.8	130.2	12.9	21.2	4.35	5.96	

D_2L_2	102.3	11.3	10.2	23.0	130.4	14.0	21.7	4.14	5.78
D_3L_1	103.4	11.3	10.5	24.0	132.3	12.8	22.2	5.23	6.00
D_3L_2	102.8	11.1	10.1	23.0	130.6	14.2	22.1	4.96	5.82
$LSD_{0.05}$	NS	NS	0.7	NS	4.8	NS	NS	0.29	NS
Variety × Location									
V_1L_1	101.9	13.4	12.3	23.7	112.9	13.2	22.7	4.69	6.30
V_1L_2	100.0	12.4	10.9	23.0	116.3	13.9	22.8	4.46	6.11
V_2L_1	96.4	12.6	11.6	23.8	106.6	14.6	21.1	4.62	5.95
V_2L_2	101.2	11.8	10.4	23.1	108.6	16.2	21.4	4.39	5.77
V_3L_1	105.4	12.2	11.3	24.8	153.2	14.3	20.6	5.06	6.45
V_3L_2	103.7	11.4	10.1	23.2	148.4	14.7	21.3	4.82	6.26
$LSD_{0.05}$	NS	NS	0.7	NS	4.8	1.8	NS	0.29	NS
Dates × Variety × Location									
$D_1V_1 L_1$	94.4	17.3	14.9	24.0	98.0	16.7	21.8	4.50	6.61
$D_1V_1L_2$	98.9	13.9	11.9	23.3	101.7	16.7	22.1	4.28	6.41
$D_1V_2 L_1$	93.0	15.5	13.3	23.7	101.4	16.4	21.1	4.70	6.50
$D_1V_2L_2$	97.7	13.9	11.4	23.0	101.4	17.4	21.7	4.98	6.31
$D_1V_3 L_1$	106.7	12.1	10.9	25.7	131.3	15.9	20.2	4.88	7.10
$D_1V_3L_2$	102.7	11.8	10.3	23.7	134.0	15.9	21.2	4.85	6.89
$D_2V_1 L_1$	103.7	11.8	11.6	23.3	110.0	11.5	22.1	4.52	5.86
$D_2V_1L_2$	100.3	11.8	10.7	23.2	119.0	12.2	22.5	4.30	5.69
$D_2V_2 L_1$	99.0	11.6	11.4	23.7	107.1	14.0	20.9	4.23	5.94
$D_2V_2L_2$	102.7	11.0	9.7	22.9	110.3	14.7	21.0	4.02	5.76
$D_2V_3 L_1$	104.3	12.6	11.9	24.3	173.3	13.2	20.7	4.29	6.07
$D_2V_3L_2$	104.0	11.3	10.1	23.0	162.0	15.2	21.7	4.09	5.89
$D_3V_1 L_1$	107.7	11.2	10.3	23.7	130.7	11.2	24.3	4.92	6.41
$D_3V_1L_2$	100.7	11.5	10.1	22.5	128.3	12.9	23.7	4.79	6.22
$D_3V_2 L_1$	97.3	10.8	10.2	24.0	111.3	13.3	21.2	4.94	5.42
$D_3V_2L_2$	103.3	10.7	10.1	23.3	114.0	16.7	21.5	4.66	5.25
$D_3V_3 L_1$	105.3	12.0	11.1	24.3	175.0	13.7	21.0	5.70	6.18
$D_3V_3L_2$	104.3	11.3	10.0	23.0	149.3	13.1	21.0	4.93	5.99
$LSD_{0.05}$	NS	NS	1.3	NS	8.2	NS	NS	0.50	NS
CV%	4.8	5.4	6.7	2.5	6.2	12.7	3.3	9.13	13.52

Conclusions

The overall results of the experiments led to the conclusion that there was a significant effect of transplanting dates on the yield and yield contributing characters of the NERICA rice mutants with Binadhan 17 studied. The highest grain yield (4.94 t/ha) was produced which was followed by NERICA mutant N4/350/P-4(5) (4.57 t/ha) when transplanted on August 10 whereas July 30 transplanting produced the lowest grain yields (4.24 t ha-1). Among the mutant lines/varieties, Binadhan-17 produced the highest grain yield (4.94 t ha-1) followed by N4/350/P-4(5) (4.57 t ha-1). The interaction between different transplanting dates and varieties was significant. The maximum grain yield of Binadhan-17 was obtained when the crop was transplanted on August 10 at all the sites in Ishwardi (5.70 t/ha) and Chapai Nawabgonj farm (4.93). Therefore, it can be concluded, based on the results from this study, that Binadhan 17 should be transplanted on August 10 to obtain a higher grain yield. However, further studies considering different agro-ecological zones (AEZ) and fertilizer doses in conjunction with transplanting dates of NERICA rice mutants and Binadhan-17 are necessary.

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