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Article

Interaction of variety and urea fertilizer and its impact on salt-tolerant Boro rice in the coastal area of Bangladesh

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Abstract: Salt-tolerant Boro rice response under the interaction of variety and urea fertilizer was assessed in the southern coastal region of Bangladesh for developing coastal agriculture in Bangladesh. A field experiment was carried out at the research field of Agriculture department, Noakhali Science and Technology University (NSTU), Noakhali-3814 in a Randomized Complete Block Design (RCBD) with two varieties viz. BINA dhan-8, BRRI dhan-67 and three doses of urea viz. 250 kg/ ha., 150 kg/ ha. and 120 kg/ ha. were used as treatments where each treatment was replicated three times. Data were collected on plant height (cm), tiller/hill, grain/panicle, 1000 grain weight (g), grain yield (t/ha.), straw yield (t/ha.) and harvest index (%). All the parameters were influenced significantly by the interaction of variety and different doses of urea fertilizer and better performance was obtained from the variety BINA dhan-8 and the doses of 250 kg urea/ ha. Finally, the present study suggests that for obtaining higher yield salt-tolerant BINA dhan-8 variety may be cultivated with 250 kg urea/ ha. in the southern coastal region of Bangladesh.

Keywords: Boro rice; coastal region; variety; urea; interaction

1. Introduction

Bangladesh is an agrarian country. About 76% of the total population of the country live in rural areas and 47.5% of the total manpower is involved in agriculture (BBS, 2016). Agriculture sector contributes more than 15% to the national GDP (Gross Domestic Product) of Bangladesh and 43% of the total population get employment opportunities through agriculture sector. The rice sector alone contributes 50% of the agricultural GDP and 16.67% of the national income in Bangladesh (BBS, 2018). In Bangladesh, rice is the most extensively cultivated cereal crop. It provides about 75% of the calories and 55% of the protein in the average daily diet of the people of our country (Bhuiyan *et al.*, 2002). It also supplies nearly 48% of rural employment, about 2/3rd of total calorie intake and about 50% of the total protein intake of an average person in the country (BBS, 2013). Bangladesh is one of the most important rice-growing countries of the world. Among the rice-growing countries, Bangladesh occupies fourth position in rice production and third position in rice consumption in the world (FAOSTAT, 2012; FAPRI, 2009; BRRI, 2012). In order to obtaining food security in Bangladesh, one of the main way is to increasing rice production. In fact, 'Rice security' is the synonym of 'Food security' in Bangladesh (Brolley, 2015).

About 80% of total cropped area of this country is used for rice production with annual production of 4,37,29,000 metric tons in total acreage of 1,10,59.000 ha. (IRRI, 2006). The annual cultivated area of rice is

15.03 million hectares and the annual production about 38.34 million metric tons in Bangladesh (BBS, 2016). There are three rice growing seasons in Bangladesh named as Aus, Aman and Boro. Among them only Boro rice covers about 58% of total rice growing area and provides 56% of total food grain (BBS, 2015). Boro rice plays a vital role for food production and the economy of Bangladesh and hence, it can be considered as one of the most important rice crops for Bangladesh on the basis of high yield and contribution to rice production (Chamely *et al.,* 2015).

About 30-50% of net cropped area of Bangladesh remains fallow in Rabi and Kharif-1 season, mainly due to soil and water salinity. Introduction of new salt tolerant varieties in the fallow lands of the coastal regions might be the scholastic technique for improvement of system productivity (Ahmed *et al.,* 2017). Besides, the population of our country is increasing and cultivable land area is decreasing every year mainly due to urbanization and industrialization. Therefore, attempts should be taken to increase the yield per unit area through use of comparatively high yielding varieties along with judicial fertilizer management (Salam *et al.,* 2011; Janaiah *et al.,* 2002).

Variety itself is a genetic factor which contributes a lot in producing yield and yield components of a particular crop. Yield components are directly related to the variety and neighboring environments in which it grows (Mikkelsen *et al.,* 1995). Farmers can get (20-30) % more yield per unit land area by using HYV (High Yielding Variety) of rice developed by BRRI (Bangladesh Rice Research Institute) instead of local indigenous low yielding rice varieties (Shahjahan, 2007).

Fertilizers have contributed substantially to the spectacular increase in the yield of rice. Among all nutrient elements, Nitrogen (N) is the most important fertilizer element for the improvement of rice yield and the Nitrogen (N) is frequently reported as deficient in agricultural soils of Bangladesh (Islam, 1990). Nitrogen fertilizer has positive influence on the production of effective tiller per plant, yield and yield attributes (Jashim *et al.,* 1984; BRRI, 1990). On the other hand, deficiency of N decreases tillering, grain/ panicle and ultimately grain yield of rice (Peng *et al.,* 2003). Therefore, optimum doses of N can play a vital role on the growth and development of rice plant (Hasanuzzaman *et al.,* 2009). It is very important to identify the suitable doses of nitrogen (N) fertilizer for efficient management and better yield of rice. Significantly highest yield of rice was recorded between ranges of 90-250 kg/ ha. (Marazi *et al.,* 1993; Daniel and Wahab, 1994; Bali *et al.,* 1995; Meena *et al.,* 2003).

A suitable combination of variety and rate of Nitrogen (N) is necessary for better yield of rice (BRRI, 1990). Considering the above discussions, the present study was undertaken to observe the varietal performance of Boro rice, to find out the effect of Nitrogen (N) fertilizer on the yield of Boro rice and for assessing the interactive effect of variety and Nitrogen (N) fertilizer in the coastal region of Bangladesh.

2. Materials and Methods

2.1. Time and location

The experiment was conducted at the research field of Agriculture department, Noakhali Science and Technology University (NSTU), Noakhali-3814 from November 2018 to May 2019. The experimental field is under the agro-ecological region of the Young Meghna Estuarine Floodplain (AEZ-18). The land was almost level having sandy loam soil and moderately alkaline (SRDI, Noakhali), with pH value 7.5 and electrical conductivity 0.91 dS/m. A pH Meter (Hach sensION+ PH1 Basic Portable pH Meter) and an EC meter (sensION+ EC7) were used to measure pH and electrical conductivity respectively. The experimental area is under the tropical climate with an average annual temperature of 25.6 °C and the average annual rainfall about 3,302 mm (Weather Station, Maizdee, Noakhali).

2.2. Experimental design

Two factors included in the experiment were as follows: Factor A: Variety (2); V_1- BINA dhan-8, V_2 - BRRI dhan-67 and Factor B: Treatments (3); T_1- 250 kg Urea/ ha, T_2- 150 kg Urea/ ha, T_3- 120 kg Urea/ ha. Seeds of BINA dhan-8 were collected from Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh-2202 and BRRI dhan-67 were collected from Bangladesh Rice Research Institute (BRRI), Gazipur, Bangladesh. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The size of each unit plot was 3.0 m × 2.0 m, having an area of 6 m^2. So, the total number of the unit plot was 18 (3×3×2). A spacing of 50 cm and 80 cm was maintained between the replications and unit plot respectively.

2.3. Seedlings establishment

The seeds were soaked in the water for 24 hours and then were taken out of the water, covered with wet gunny bags and then kept for sprouting. After 48 hours' seeds were started sprouting and almost all seeds were

sprouted after 72 hours. Pre-germinated seeds of the two variety were broadcasted uniformly in a well-prepared nursery bed on 16 December 2018.

2.4. Final land preparation

Plowing and cross-plowing was done by a tractor to prepare the land and subsequently laddering to level the land. The field was fertilized with Triple Super Phosphate (TSP), Muriate of Potash (MoP) and Gypsum at the rate of 120 kg, 80 kg and 60 kg per hector respectively during land preparation. Urea was applied (as per treatment) as top dressing in three equal splits at 15, 30 and 45 days after transplanting (DAT).

2.5. Seedlings transplanting

Before uprooting the seedlings, nursery bed was slightly irrigated for easier uprooting. Uprooting of seedlings were done carefully from the nursery bed and were transplanted in the unit plots on 25 January 2019 where spacing was maintained at 25 cm × 15 cm (row to row and plant to plant) at the rate of 1-2 seedlings/hill. Hand weeding was done at 20 and 35 days after transplanting (DAT). The field was irrigated from the nearest water source (pond) by irrigation devices when necessary. A regular observation was made to ensure better growth of plants.

2.6. Collection and analysis of data

Randomly ten hills (excluding border hills) were selected from each unit plot and uprooted before harvesting for data collection. The harvested crop of each unit plot was bundled separately, tagged properly, brought to the threshing floor and then threshed by a pedal thrasher. Grain and straw were sun-dried at 14% moisture level and cleaned. Data were collected on plant height (cm), tillers/hill, grain/panicle, 1000 grain weight (g), grain yield (t/ha), straw yield (t/ha) and harvest index (%). Plant height (selected ten plants) was measured from the base to the tip of the longest panicle. Tiller comprising at least one visible leaf were counted. Spikelet that contain any food material was considered as grain and the number of grain in each panicle was counted. One thousand clean dried seed from the seed lot of each unit plot were counted separately and weight by an electrical balance. The recorded grain and straw yield per plot was finally converted to t/ha. Harvest index (%) was calculated with the following formula. Harvest index (%) = (Grain yield ÷ Biological yield) × 100

Where, Biological yield = Grain yield + Straw yield.

Data recorded for growth, yield and yield contributing characters were compiled and tabulated in proper form for statistical analysis. Analysis of variance was done with the help of MSTAT-C computer package program developed by Russel (1986). The mean differences among the treatments were adjudged by DMRT test (Gomez, 1984).

3. Results and Discussion

3.1. Impact of variety on the yield and yield component of salt-tolerant Boro rice

Variety had a non-significant effect on yield and yield attributes of Boro rice (Table 1).

The highest plant height (95.36 cm) was observed in BINA dhan-8 compared with BRRI dhan-67 (85.57 cm) and this result is consistent with some other researcher (Sarker *et al.,* 2013; Shel *et al.,* 2015; Islam *et al.,* 2015; Alam *et al.,* 2012). Khisha (2002) also found the highest plant height (129.94 cm) in BINA dhan-5, which is higher than those of Sonar Bangla-1 and BRRI dhan-29.

BRRI dhan-67 produced more tiller/hill (18.12) than BINA dhan-8 (13.22) which is similar with the findings of other researcher (Islam *et al.,* 2015; Tyeb *et al.,* 2013; Sarker *et al.,* 2013). BINA (1998) conducted a field trial during the Boro season of 1997-98 and found that the hybrid rice Alok-6201 gives higher number of tiller/hill than the modern variety IRATOM-24.

Highest number of grain/ panicle was found in BINA dhan-8 (131.08) in comparison with BRRI dhan-67 (107.9). Tyeb *et al.* (2013) reported that variety BRRI dhan-52 produced more number of grain/ panicle than other varieties. Hasan *et al.* (2002) also observed highest number of grain/ panicle in BRRI dhan-34 than Alok-6201.

Thousand grain weight (g) was found maximum in BRRI dhan-67 (31.42) than BINA dhan-8 (22.55). Islam *et al.* (2015) found the higher 1000-grain weight (25.49 g) in BR-11 and the lower one (21.33 g) in BRRI dhan-49.

BINA dhan-8 and BRRI dhan-67 showed less variation in grain yield (t/ha) and straw yield (t/ha). BINA dhan-8 gave highest grain yield (7.24) and straw yield (7.6) than BRRI dhan-67. Sultana *et al.,* (2012) also found highest harvest yield in BRRI dhan-51 compared to BR-11 and BRRI Dhan-52. Similarly, Rajaul (2005) observed the highest straw yield (5.54 t/ha) in BRRI dhan-29 and lowest (5.43 t/ha) in BRRI dhan-28 that supports our result.

More or less similar result obtained from BINA dhan-8 and BRRI dhan-67 for harvest index (%). Among the varieties BRRI dhan-67 (48.87) showed slightly higher result than BINA dhan-8 (48.79). Arshad (2009) reported that the highest harvest index (41.9%) was obtained by BRRI dhan-40 and the lowest one (40.08%) was obtained from BRRI dhan-41.

3.2. Impact of urea fertilizer on the yield and yield component of salt-tolerant Boro rice

Different doses of urea fertilizer had a non-significant effect on yield and yield contributing characters of Boro rice (Table 2).

Non-significant differences observed for plant height (cm) among different treatments. Here highest plant height found from T_1 (93) and lowest from T_3 (85.8) which indicates increasing rate of urea increased plant height. Islam *et al.* (2008) conducted an experiment with 40, 60, 80, 100 and 120 kg N/ ha. on BRRI dhan-33 and observed that increasing rate of N increased plant height which is consistent with our result and some other research findings (Prakash *et al.,* 2014; Shekara *et al.,* 2010; Ahmed *et al.,* 2005; Zhilin *et al.,* 1997; Sendra *et al.,* 1993).

Similar with plant height, number of tiller/ hill increased slightly with the increasing of urea fertilizer. Maximum number of tiller/ hill was observed at T_1 (12.61) and minimum at T_3 (11.26). Similar results also found from some other researcher (Shekara *et al.,* 2010; Chander and Pandey, 1996).

On the contrary, number of grain/ panicle decreased with the increasing rate of urea fertilizer. Here, highest number of grain /panicle observed from T_3 (123.35) and lowest from T_1 (116.65). Rajarathinam and Balasubramaniyan (1999) also noticed an appreciable reduction in grain/ panicle at 250 kg N/ ha. which is similar with our result as well as Yosida and Parao (1976).

Similarly, 1000 grain weight (g) also reduced with the increasing rate of Urea fertilizer. The maximum 1000 grain weight found from 120 kg urea/ ha. (31) and lowest from 250 kg urea/ ha. (24.66) which is consistent with the result of Azam *et al.* (2009). He reported that the highest 1000-grain weight (24.70 g) obtained at 55 kg N/ ha. and lowest (24.09 g) 1000-grain weight observed at 110 kg N/ ha.

Highest Grain yield (t/h) and Straw yield (t/h) was found from 250 kg urea/ ha. (7.45 and 7.92 respectively) and lowest from 120 kg urea/ ha. (5.51 and 6.48 respectively) and a decreasing trend also found with the increase of rea fertilizer. Maqsood *et al.* (1997) carried out an experiment at Faisalabad during 1994 and 1995 on rice cv. Basmati-385 by applying 0-100 kg N/ ha. and found that yield increased with increasing N rate in both the years. BRRI (1995) conducted several experiments at different stations on BR-11 and BR-14 and reported that application of 100 kg N/ ha. increased straw yields of rice. However, from many investigations BRRI (1995) revealed that straw yield is strongly influenced by nitrogen fertilization.

Harvest index (%) increased with the increase of rea application up to 150 kg rea/ ha. and then decreased with the increase of rea application. Sarker *et al.* (2001) observed that application of nitrogen increased harvest index up to 120 kg N/ ha.

3.3. Interactive effect of variety and urea fertilizer on the yield and yield component of salt-tolerant Boro rice

The interactive effect of variety and urea had significant influence on yield and yield contributing characters of salt-tolerant Boro rice excluding number of tiller/ hill and number of grain/ panicle (Table 3).

Plant height (cm) significantly influenced by the interaction effect of variety and urea. The highest plant height (98.63) observed at V_1T_1 combination (BINA dhan-8 and 250 kg urea/ ha.), on the other hand lowest (81.26) at V_2T_3 combination (BRRI dhan-67 and 120 kg urea/ ha.).

The interactive effect of variety and urea on number of tiller/ hill was found non-significant. Same as plant height, maximum number of tiller/ hill (15.13) found from the combination of V_1T_1 (BINA dhan-8 and 250 kg urea/ ha.) and minimum number of tiller/ hill (9.40) from V_2T_3 (BRRI dhan-67 and 120 kg urea/ ha.).

Non-significant interactive effect also found on grain/ panicle. In case of grain/ panicle, highest value (136.23) obtained from V_1T_3 (BINA dhan-8 and 120 kg urea/ ha.) and the lowest (105.53) from V_2T_1 (BRRI dhan-67 and 250 kg urea/ ha.).

1000 grain weight (g) varied significantly by the interaction of variety and Urea fertilizer. Maximum weight of thousand grain (30.27) observed at the combination of V_2T_3 (BRRI dhan-67 and 120 kg urea/ ha.) and the minimum weight of thousand grain (19.20) obtained from V_1T_1 (BINA dhan-8 and 250 kg urea/ ha.).

Grain yield and straw yield (t/ ha.) significantly influenced by the interactive effect of variety and urea. Highest grain yield and straw yield (8.05 and 8.95 respectively) gained from V_1T_1 combination (BINA dhan-8 and 250 kg urea/ ha.) and lowest (5.08 and 5.73 respectively) gained from V_2T_3 combination (BRRI dhan-67 and 120 kg urea/ ha.).

Harvest index (%) also affected significantly by the interaction of variety and urea fertilizer. Highest value (52.34) obtained from the combination of V_2T_1 (BRRI dhan-67 and 250 kg urea/ ha.) and lowest value (47.2) obtained from V_1T_1 (BINA dhan-8 and 250 kg urea/ ha.).

Table 1. Impact of variety on the yield and yield component of salt-tolerant Boro rice.

Variety	Plant height (cm)	Tiller/ hill	Grain/ panicle	1000 grain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)
BINA dhan-8	95.36	13.22	131.08	22.55	7.24	7.6	48.79
BRRI dhan-67	85.57	18.12	107.9	31.42	6.06	6.34	48.87
Mean	90.47	15.67	119.49	26.99	6.65	6.97	48.83
std	6.92	3.46	16.39	6.27	0.83	0.89	0.06
Cv (%)	7.65	22.11	13.72	23.24	12.55	12.78	0.12
Level of significance	NS	NS	NS	NS	NS	NS	NS

Table 2. Impact of different doses of urea fertilizer on the yield and yield component of salt-tolerant Boro rice.

Treatment	Plant height (cm)	Tiller/ hill	Grain/ panicle	1000 grain weight (g)	Grain yield (t/h)	Straw yield (t/h)	Harvest index (%)
T_1 (250 kg Urea/ ha.)	93	12.61	116.65	24.66	7.45	7.92	48.47
T_2 (150 kg Urea/ ha.)	92.6	12.03	118.5	25.3	6.88	7.02	49.5
T_3 (120 kg Urea/ ha.)	85.8	11.26	123.35	31	5.51	6.48	45.95
Mean	90.47	11.97	119.50	26.99	6.61	7.14	47.97
std	4.05	0.68	3.46	3.49	1.00	0.73	1.83
cv	4.47	5.66	2.90	12.93	15.08	10.19	3.81
Level of significance	NS	NS	NS	NS	NS	NS	NS

Table 3. Interactive effect of variety and Urea fertilizer on the yield and yield component of salt-tolerant Boro rice.

Treatment	Plant height (cm)	Tiller/ hill	Grain/ panicle	1000 grain weight (g)	Grain yield (t/ha)	Straw Yield (t/ha)	Harvest index (%)
V_1T_1	98.63	15.13	128.75	19.20	8.05	8.95	47.25
V_1T_2	95.43	14.90	130.30	21.47	6.93	7.22	48.02
V_1T_3	89.23	12.03	136.23	22.83	6.0	6.17	48.34
V_2T_1	90.77	11.60	105.53	26.17	6.47	6.93	52.34
V_2T_2	85.57	10.17	106.40	29.93	6.17	6.03	51.24
V_2T_3	81.26	9.40	108.47	30.27	5.08	5.73	48.52
Mean	90.15	12.21	119.28	24.98	6.45	6.84	49.29
std	6.34	2.38	13.93	4.57	0.99	1.18	2.02
Cv (%)	7.03	19.47	11.68	18.28	15.42	17.23	4.10
Level of significance	**	NS	NS	***	***	***	***

NS = Non Significant; *** = Significant at 0.1% level of probability; ** = Significant at 1% level of probability;
* = Significant at 5% level of probability

4. Conclusions

Results showed that, the performance of BINA dhan-8 was better than BRRI dhan-67 in terms of plant growth, grain yield and straw yield. Similarly, among the different doses of urea fertilizer, highest yield obtained from 250 kg urea/ ha. Finally, it can be concluded that, the interaction of BINA dhan-8 and 250 kg urea/ ha. (V_1T_1) was the best combination to obtain higher yield in the southern coastal region of Bangladesh. However, this approach needs to be tested in different coastal region of Bangladesh before making final inference.

Conflict of interest

None to declare.

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