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Evaluation of Salt Tolerant Winter Rice Variety for Coastal Region of Bangladesh

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ABSTRACT

In the coastal region of Bangladesh farmers' usually cultivate local or other high yielding variety of rice though do not get satisfactory yield. A farmers' participatory block demonstration was conducted at Kaligonj, Satkhira under both saline and non-saline area during Boro season, 2015-16 to evaluate the performance of newly released high yielding rice variety. Salt tolerant BRRI dhan67 was compared to BINA dhan-10 in the saline environment and premium quality BRRI dhan63 was compared to popular variety BRRI dhan28 in the non-saline area in Boro-Fallow-T. Aman cropping system. Results revealed that BRRI dhan67 gave higher yield, gross margin and gross return than BINA dhan-10 in the saline area whereas in the non-saline area the performance of BRRI dhan63 was better than existing popular variety BRRI dhan28. Farmers' also preferred BRRI dhan67 and BRRI dhan63 to BINA dhan-10 and BRRI dhan28, respectively. In a nutshell, it can be said that BRRI dhan67 can be grown successfully in saline area while BRRI dhan63 in non-saline condition of Satkhira region.

Introduction

Rice (*Oryza sativa* L.) is the most important cereal crops of the world and more than half of world population used as a staple food. Rice provides about 76% of the total calories and 66% of the protein intake of the people's diet (Bhuiyan et al., 2002). There is more than 110 countries in the world occupying rice almost 160 million hectares, 700 million tons rice producing every year (IRRI, 2010). Rice yield must be increased in Asia by about 25% from 2000 to 2020 with the increased yield of 4.9 t/ha from the present yield of 3.9 t/ha for meeting the demand of increased population (Dobermann et al., 2004). The cultivable area is decreasing gradually due to the huge population while average rice yield in Bangladesh is only 4.34 t ha^{-1} (BRRI, 2011). However, rice yield should be increased by the use of high yielding salt tolerant varieties, proper agronomic management practices, and by applying recommended fertilizer doses in the coastal belt. Similarly, Shirazy et al., (2015) reported that, proper fertilizer management practices (N, P, K) with the application of some micronutrients like Cu, Zn and S can also be very beneficial for the better production in the coastal area.

In Bangladesh, salinity occurs mainly along the coastal region especially in the South-West coastal region of Bangladesh. The coastal saline areas are spread in 64 upazillas of 13 districts (Chowdhury, 2012) and Satkhira is one of the major saline prone areas of Bangladesh. Out of 2.85 million hectares of the coastal and off shore area 0.83 million hectares which covered less than 30% of the total cultivable land of our country (Haque, 2006). Salinity stress is one of the most serious environmental stresses limiting the productivity of agricultural crops. In the world context, salinity affects more than 25% of worth land (Levigneron et al., 1995; Chahine et al. 2013), and desertification and salinization are rapidly increasing on a global scale declining average yields for most major crop plants by more than 50% (Bray et al., 2000). In Aman season, salinity level remains slightly low, around 2-6 dS/m whereas during Boro season up to 16 dS/m or more (Shirazy et al., 2016). The average crop yield is very low in the region, which is obviously due to salinity problems, low soil fertility and drought in the dry season. Although rice is the predominant crop of Bangladesh and modern rice cultivars tolerant to saline soils are few in number. However, there is ample scope and need for expansion of the modern varieties. So that, farmers participatory demonstration was undertaken with a view to evaluate newly released BRRI rice varieties, at Satkhira region.

Materials and methods

In the coastal area there are two types of land condition, saline and non-saline where salinity effects found in mainly Boro season (October-March). In Aman season (June-October) there is no heavy salinity indeed. So that in Boro-Fallow-T. Aman cropping system farmers generally grow BINA dhan-10 in salt affected land and BRRI dhan28 in non-saline area during Boro season.

Planting material

Seedling of BRRI dhan28, BRRI dhan63, BRRI dhan67 and BINA dhan-10 were used as planting

material of this experiment and all the material was provided by Rice Farming Systems Division of BRRI.

Experimental site

The experiment was conducted at the Hizla village of Kaligonj Upazilla under Satkhira district (22°19' and 22°33' north latitudes to 88°58' and 89°10' east longitudes) of Bangladesh during Boro season, 2015-16 at farmer's field.

Rice variety used

In Boro-Fallow-T. Aman cropping system BRRI dhan67 and BINA dhan-10 were tested in the saline region while BRRI dhan63 and BRRI dhan28 in the non-saline area.

Cultivation procedure

Each variety and farmer was considered as a treatment and replication, respectively. Every variety of saline area was set on ten farmers' field and varieties of the non-saline area were set on thirty farmers' field. Each experimental field was 33 decimal in size. The seeds of tested varieties were sown in 1st week of December 2015 and transplantation was done at 2nd week of January, 2016. After final land preparation by using power tiller, fertilizers TSP (Triple Super Phosphate) as a source of P, MOP (Muriate of Potash) as a source of K, $ZnSO_4$ as a source of Zn, Boric acid as a source of Boron were applied @ 60 kg ha^{-1}, 80 kg ha^{-1}, 65 kg ha^{-1} and 10 kg ha^{-1}, respectively. Urea as a source of N was applied in 3 equal splits at 15 DAT (Days after transplantation), 30 DAT and 50 DAT. Salinity was measured by using EC meter at 30, 45, 60, 75 DAT and at maturity stage. Salinity range was 1-6 dS/m or more (1:5 with H_2O) for the whole of the season in the entire experimental field. Proper care was taken of seedlings on seedbed and 40 days old seedlings were transplanted at 20×15 cm spacing. All intercultural operations were carried out following standard procedures as recommended by BRRI (Adhunik dhaner chash, 2015). Irrigation, insect, pest and weed control were done when necessary. Harvesting was done at 80% physiological maturity at farmer's field. The participating farmers conducted all the field operations.

Data collection

Collected yield data were converted into t ha^{-1} at 14% moisture level and economic data were presented as \$ ha^{-1}. Farmers' preference test was done before harvesting of rice at the field without any biasness.

Experimental design and statistical analysis

This experiment was laid out in Randomized Complete Block Design (RCBD). Yield data were analyzed through Crop Stat7.2 computer package program (IRRI, 2009). Least Significant Difference (LSD) method was used for comparison of treatment means at 5% level of significance.

Results and discussion

Grain yield and economic return of BRRI dhan67 and BINA dhan-10 in the saline area

The grain yield of winter rice varieties significantly differed under saline condition at studied area of Satkhira (**Table 1**). Grain yield in BRRI dhan67 was 5.32 t ha^{-1} while it was 4.88 t ha^{-1} in BINA dhan-10 under saline condition. It was evident that around 10% yield increase in cultivating BRRI dhan67 compared to BINA dhan-10 in Satkhira saline zone. In recent study of Rashid et al. (2018), it was observed that in the coastal area of Satkhira by using suitable salt tolerant rice varieties the production can be increased by 10-30%.

Economic analysis revealed that the total variable cost was slightly higher in BRRI dhan67 cultivation than BINA dhan-10 (**Table 1**). The higher grain yield and market price for better grain quality of BRRI dhan67 resulted in the higher gross margin (\$ 280 ha^{-1}) than BINA dhan-10. Benefit cost ratio (BCR) was 1.29 for BRRI dhan67 while 1.01 for BINA dhan-10 which indicates the higher economic return from BRRI dhan67. So the farmers are highly interested in cultivating BRRI dhan67 under the salt prone area of Kaliganj, Satkhira. Also, farmers got more profit by selling suitable price where market demand is higher for BRRI dhan67.

Preference test of BRRI dhan67 and BINA dhan-10 in the study area

Farmer's preference test was conducted in front of participating farmers and they scored different parameters of rice by their choices (**Table 2**). Among all the preference parameters BRRI dhan67 got highest score 70 out of 80 where BINA dhan-10 got 60. Especially the farmers' prefer BRRI dhan67 for showing the tolerance to salinity and filled grain per panicle to BINA dhan-10. Important parameter of filled grain/panicle, plant height, lodging tolerance BRRI dhan67 got 9, 9 and 8, respectively while BINA dhan-10 got 8, 7 and 8 in the respected parameters. On the grain yield preference farmers gave 9 out of 10 for BRRI dhan67 whereas 8 for BINA dhan-10. Bangladesh Rice Research Institute released BRRI dhan67 for Boro season having tolerance against EC 8-10 dS/m of soil salinity level at the vegetative and reproductive stage. BRRI dhan67 is especially recommended for brackish shrimp field of coastal saline-prone areas of Bangladesh. The performance of grain yield and other characteristics of BRRI dhan67 is highly significant than other salt tolerant Boro varieties (Islam et al., 2014).

Table 1. Grain yield and economic return of BRRI dhan67 and BINA dhan-10, Satkhira, 2016

Variety	Farmer no.	Grain yield (t ha^{-1})	Total variable cost ($ ha^{-1})	Gross return ($ ha^{-1})	Gross margin ($ ha^{-1})	Benefit Cost Ratio
BRRI dhan67	10	5.32	964	1244	280	1.29
BINA dhan-10	10	4.88	945	956	11	1.01
$LSD_{0.05}$	-	0.32	-	-	-	-
CV		6.38				

Table 2. Preference ranking of salt tolerant Boro varieties, 2016

Parameter	BRRI dhan67	BINA dhan-10
Plant height	9.0	7.0
Panicle/m^2	8.5	7.0
Filled grain/panicle	9.0	8.0
Unfilled grain/panicle	8.5	8.0
Lodging tendency	8.0	8.0
Paste infestation	9.0	7.0
Grain yield	9.0	8.0
Salt tolerance	9.0	7.0
Total Score	70.0	60.0

N.B. Parameter contains higher mark higher quality and vice-versa

Grain yield and economic return of BRRI dhan63 and BRRI dhan28 in the non-saline area

In non-saline area of Satkhira there was no significant difference in Grain yield between BRRI dhan63 (5.52 t/ha) and popular variety BRRI dhan28 (5.16 t/ha) (**Table 3**). Though, there is no statistical difference but 5% yield increase was found for cultivating BRRI dhan63 instead of BRRI dhan28.

In addition, both the gross margin and gross return were higher in BRRI dhan63 than BRRI dhan28. The cultivation of this premium quality rice earned the higher gross margin of $ 303 ha^{-1}. The higher market price for its grain quality resulted in higher gross margin. There was a prominent difference of BCR between two variety BRRI dhan63 (1.35) and BRRI dhan28 (1.10) which indicates the higher economic return from BRRI dhan63. Similar findings were observed in the BRRI annual report 2016-17.

Preference test of BRRI dhan63 and BRRI dha28 in the study area

In preference test, all the farmers gave the score by their individual choice and without any force (**Table 4**). Famers gave the highest mark to BRRI dhan63 (69 out of 80) than BRRI dhan28 (64 out of 80) especially for grain quality and price. They gave same score for plant height, filled grain/panicle and unfilled grain/panicle for both the variety @ 8.5, 8 and 8, respectively. But in other parameters such as panicle/m^2, lodging tolerance, pest infestation, grain yield and grain quality, BRRI dhan63 got the higher score than BRRI dhan28. Thus, farmers of Satkhira had been showed their interest for its faster adoption and demanded to make available seeds of this new variety for cultivating in the future.

Table 3. Grain yield and economic return of BRRI dhan63 and BRRI dhan28, Satkhira, 2016

Variety	Farmer no.	Grain yield (t ha^{-1})	Total variable cost ($ ha^{-1})	Gross return ($ ha^{-1})	Gross margin ($ ha^{-1})	Benefit Cost Ratio
BRRI dhan63	30	5.52	1032	1385	303	1.35
BRRI dhan28	12	5.16	1064	1175	102	1.10
$LSD_{0.05}$	-	0.24	-	-	-	
CV		7.59				

Table 4. Preference ranking of premium quality Boro varieties, 2016

Parameter	BRRI dhan63	BRRI dhan28
Plant height	8.5	8.5
Panicle/m^2	9.0	8.0
Filled grain/panicle	8.0	8.0
Unfilled grain/panicle	8.0	8.0
Lodging tendency	9.5	9.0
Paste infestation	8.0	7.0
Grain yield	9.0	8.0
Rice quality	9.0	7.5
Total Score	69.0	64.0

N.B. Parameter contains higher mark higher quality and vice-versa

Conclusion

From the varietal performance of agro-economic productivity and farmers' preference test in the coastal region, it was observed that BRRI dhan63 and BRRI dhan67 gave satisfactory yield. In addition, these two varieties also preferred by the farmers for getting higher market price than other varieties. Hence, their economic condition faces more crises by cultivating existing rice variety, so that improved salt tolerant and premium quality high yielding varieties have enough scope to meet their demand as well as economic solvency. That is why farmers were highly interested for cultivating newly released salt-tolerant variety BRRI dhan67 in the salt affected land and BRRI dhan63 in non-saline areas of Satkhira. It is not the end of doing something better for the coastal area. So that, further research could be studied for getting higher production and more profit in the saline zone with varietal performance and fertilizer management practices.

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