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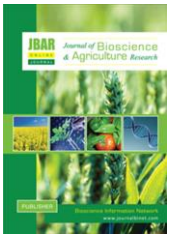

Performance and productivity of boro rice varieties cultivated in saline area of Satkhira

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ABSTRACT

A field experiment was conducted with Boro rice (cv. Binadhan-10 and BRRIdhan 28) at Kaligonj, Satkhira to evaluate performance of two rice varieties under different nutrient management practices in a saline soil. The rice varieties, such as BRRI dhan28 and Binadhan 10 were tested under 3 levels of nutrients (T_1= Recommended dose of N, P, K, S, Zn, T_2 = T_1 + additional Gypsum @ 125 Kg ha^{-1} and T_3 = T_1 + additional Gypsum @ 190 Kg ha^{-1}) and the treatments were assigned in a split plot arrangement with 3 replications. The study revealed that different rice varieties and nutrient levels along with their interaction have significant effect on growth and yield of rice. Effect of varieties found highest for grain (6.38 t ha^{-1}) and straw (6.60 t ha^{-1}) yield in case of Binadhan-10 and considering the mean effect of different nutrient level is insignificant for both varieties. Due to interaction effect of both variety and nutrient levels, the maximum grain yield was found as 6.61 t ha^{-1} under the treatment combination V_2T_2 i.e. Binadhan-10 along with recommended dose of N, P, K, S and Zn with 125 kg gypsum ha^{-1}. Between these two varieties Binadhan-10 showed better performance compared to BRRI dhan28 at saline condition.

Key Words: Salinity, BRRI dhan28, Binadhan-10, Boro rice and Gypsum

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I. Introduction

Rice is one of the most important food crops feeding for more than one third population of the world (Tania et al., 2014). Soil erosion, salinization, water stagnation and human settlements reduce rice cultivation area in an alarming speed in many countries (Maclean et al., 2002). Every year Bangladesh subjected to several types of disaster, these are generate environmental problems (Haider and Hossain, 2013). Salinity is one of the major constrains for crop production especially in the southern part of Bangladesh. Sea level rise affects coastal agriculture, especially rice production in two ways, one is salinity intrusion degrades soil quality which in turned into reduced rice production and another is when the rice fields are converted into shrimp ponds, total rice production decreases

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accordingly (Sarwar and Khan, 2007). The larger area of south western district of Bangladesh are affected by salinity problem which is extended further by area and intensity after occurring of destructive cyclones called Aila and Sidr. According to the observation in the southern part of the country, degree of salinity is comparatively higher in the dry season and lower level of salinity found in wet season. The increasing trend of salinity with time found from the month November-December until the set of monsoon rain. Generally lower salinity levels observed in the month of July-August due to the rain water which causes lowering down of the salt concentration (Rashid and Shama, 2014).

The farmers are facing a major problem of salinity in crop production at Satkhira. In the study area, farmers irrigate their crop land by stored surface water and ground water by shallow tube well. In the southern part of the Bangladesh, farmers grow a popular high yielding Boro variety BRRI dhan28 in saline areas with a lower yield compared with that grown in non saline areas (Rashid and Shama, 2014). Due to the variable physiological mechanism of adjusting to osmotic pressure, rice varieties differ in response to the salinity level and considering growth stages of rice, the young seedlings and flowering plants are much sensitive in comparison to vegetative stage i.e. tillering (Flower and Yeo, 1981). Considering the salinity problem in crop production, Bangladesh Institute of Nuclear Agriculture (BINA) released a salt tolerant modern rice variety Binadhan-10, which can tolerate salinity up to 8-10 dS m^{-1} (BINA, 2012). Therefore, a study was conducted to observe performance and productivity of the salt tolerant variety (Binadhan-10) in comparison to a widely cultivated high yielding variety (BRRI dhan28) along with different nutrient management practices in saline area, so that the local farmers can adopt suitable variety in salinity stress condition.

II. Materials and Methods

The experiment was conducted at farmers field in Kalikapur village under the Kaliganj upazila of Satkhira (22°27'N latitude and 89°2.5'E longitude) during the Boro season of 2015 (January to May, 2015). The land belongs to AEZ 13, Ganges Tidal Floodplain and the soil was silty clay loam in texture, having pH 6.35, total N 0.11%, % Organic carbon 0.96, available P 6.0 ppm, available K 73.54 ppm and available S 12.50 ppm (Table 01).

Table 01. Physio-chemical properties of the initial soil sample

Characteristics	Value
Physical characteristics	
% Sand	22.14
% Silt	46.00
% Clay	31.86
Textural class	Silty clay loam
Chemical characteristics	
EC (dsm^{-1})	7.86
pH	6.35
Organic carbon (%)	0.96
Total N (%)	0.11
Available P (ppm)	6.0
Exchangeable K (ppm)	73.54
Available S (ppm)	12.50

The salinity leve of initial soil was 7.86 dSm^{-1}; that considered as very slight saline to slight saline soil (Sinha et al., 2014). Monthly soil salinity data of the field area under this study presented in the figure 01.

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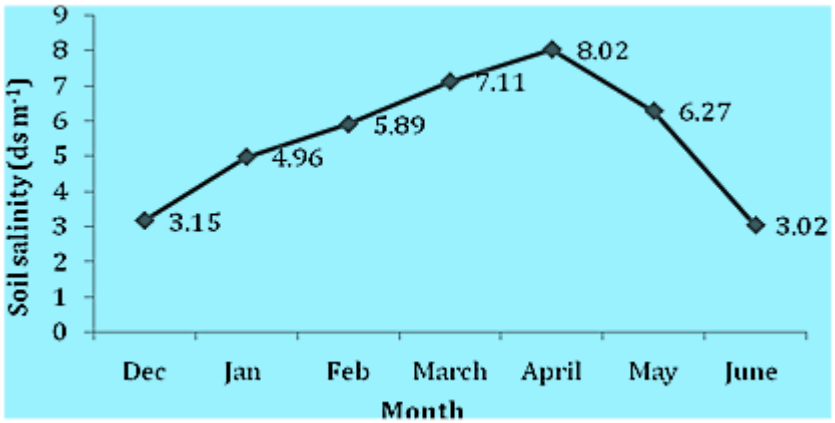

Figure 01. Soil salinity levels(dS m^{-1}) of field during growing season of rice.

EC value (dSm^{-1}) ranged between 3.02 and 8.02. Trend showed that the salinity of soil increases from December (3.15 dSm^{-1}) to April (8.02 dSm^{-1}) and then decreases to 3.02 dSm^{-1} in the month of June; this was might be due to the rainfall which causes lowering the salt concentration of soil. The experiment was laid out in a split-plot design with three replications, where two varieties of rice were assigned in main plots viz. V_1: BRRI dhan28, V_2: Binadhan-10 and three nutrient levels were assigned in sub-plots *viz*. T_1= Recommended dose of N, P, K, S and Zn , $T_2 = T_1$ + additional Gypsum @ 125 kg ha^{-1}, $T_3 = T_1$ + additional Gypsum @ 190 kg ha^{-1}. Full dose of TSP, MoP, Zinc sulphate and Gypsum were applied during final land preparation (BARC, 2012). Urea was applied in three equal splits at 10 days after transplanting (DAT), 25 DAT (maximum tillering stage) and 40 DAT (panicle initiation stage or booting stage). Tillage and intercultural operations and other management practices were performed as when required. The crop characters - plant height, panicle length, number of tiller $hill^{-1}$, number of grains $panicle^{-1}$ and grain and straw yield data were recorded at maturity during rice harvest. The analysis of variance for every crop characters and yield was done following the principle of F-statistics using MSTAT-C software and the mean results in case of significant F-value were adjudged by the Duncan's Multiple Range Test (DMRT) at 5% level of significance.

III. Results and Discussion

Plant height

Plant height of the two varieties measured at maturity. From the Table 02, it was observed that plant height of the crop influenced by variety. The tallest plant (93.70 cm) was observed in Binadhan-10 and shortest (80.69) in BRRIdhan 28. Considering the mean effect of nutrient levels (Table 03) in case of plant height was insignificant. In combined effect variety and nutrient levels tallest plant (97.40 cm) was found in Binadhan-10 with recommended fertilizer dose (RFD) and shortest (80.23 cm) found in BRRI dhan28 with RFD and additional Gypsum @ 190 kg ha^{-1} (Table 04). Soil salinity is considered as one of the major factors that reduce plant growth in many regions in the world. Soils in the arid and semiarid regions have excessive concentrations of soluble salts, which adversely affect plant growth. According to Mahmood et al. (2009) plant height of rice reduced with increasing salinity levels. But the highest plant height was recorded in Binadhan-10 compared to BRRI dhan28 because of salt tolerance character.

Panicle length

Salinity at the reproductive stage significantly reduces fertility, panicle length (PL) and the number of primary branches per panicle (Singh et al., 2010). A significant reduction and stunted growth of rice panicle also mentioned by Joseph and Mohanan (2013). From the Table 02, it was observed that the length of the panicle varied significantly. Binadhan-10 produced longer panicle (24.60 cm) compared to BRRI dhan28 (20.97 cm). In the different nutrient levels (Table 03) the length of the panicle varied from 22.35 to 23.31 cm which were insignificant among all three treatments. In case of combined

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effect of variety and nutrient levels (Table 04), treatment combination V_2T_1 i.e., Binadhan-10 with recommended fertilizer dose (RFD) produced longest panicle (25.37 cm) which is similar to V_2T_2 (Binadhan-10 and RFD with additional Gypsum @ 125 kg ha^{-1}). Yeo and Flowers (1986) found that, during reproductive stage of development; salt tolerant genotypes avoid excess salt stress which causes less salt concentration in flag leaves and resulting panicle growth. Due to the salt tolerant characteristic of Binadhan-10 produced longer panicle length.

Number of tiller hill^{-1}

Tillering is an important agronomic trait in rice for the production of grain as well as a model system for the study of branching in monocotyledonous plants. Based on Table 02, the variety Binadhan-10 produced significantly higher number of tiller (20.57) compared to BRRI dhan28 (17.46). In the mean effect of nutrient levels (Table 03) influence significantly number of tiller per hill, the treatment T_3 (RFD with additional Gypsum @ 190 kg ha^{-1}) produced highest number of tiller (19.90) which is similar to T_2 (RFD with additional Gypsum @ 125 kg ha^{-1}). From the interaction of variety and nutrient levels (Table 04), V_2T_2 (Binadhan-10 and RFD with additional Gypsum @ 125 kg ha-^{1}) produced highest number of tiller per hill and lowest in V_1T_1 (BRRI dhan28 with RFD). Earlier Zeng et al. (2002) observed tiller number/plant were reduced with increasing salinity but Bindhan-10 performed better in salt stress condition. Mahmood et al. (2009) found that the number of tillers plant^{-1} was significantly reduced with increasing salinity. Similar results were also observed by Motamed et al. (2008) where salinity significantly affected the number of tillers in rice.

Number of grain panicle^{-1}

According to Khatun et al. (1995), salinity delayed flowering, reduced the number of productive tillers, the number of fertile florets per panicle, grain weight. The number of grain per panicle varied with variety (Table 02). Binadhan-10 (V_2) produced highest number of grain per panicle (118.32) and lowest (109.18) was found in BRRI dhan28 (V_2).). There was no significant effect in grain per panicle was found in different levels of nutrient and variety (Table 03). In case of combined effect of variety and nutrient levels (Table 04), treatment combination V_2T_2 (Binadhan-10 and RFD with additional Gypsum @ 125 kg ha^{-1}) produced highest number of grain 121.65 which is similar to V_2T_3 and lowest found in V_1T_2 (BRRI dhan28 and RFD with additional Gypsum @ 125 kg ha^{-1}). Salinity decreases yield through decreasing filled grains per panicle. Reducing seed set in the panicle, possibly as a consequence of decreased pollen viability or decreased receptivity of the stigmatic surface, or both, has been reported by Abdullah et al. (2001). Rising of salinity level during growth stage of rice retards grain formation reported by Hassan et al. (2012).

Grain yield

Yield is a very complex character which comprise of many components and these yield components are related to final grain yield which are also severely affected by salinity (Aisha et al., 2005). Due to difference in variety, the grain yield of rice varied significantly (Table 02). The highest grain yield (6.38 t ha^{-1}) produced by the variety Binadhan-10 (V_2) where BRRI dhan28 (V_1) produced 4.69 t ha^{-1}. The mean effect of nutrient levels did not show any significance in grain yield production (Table 03), it is varied between 5.45 to 5.63 t ha^{-1}. Considering the interaction effect, treatment combination V_2T_2 (Binadhan-10 and RFD with additional Gypsum @ 125 kg ha^{-1}) produced highest grain yield (6.61 t ha^{-1}) which is similar to V_2T_1 (4.45 t ha^{-1}) i.e., Binadhan-10 with recommended fertilizer dose and lowest grain yield (4.35 t ha^{-1}) found in V_1T_1 which is similar to V_1T_2 (Figure 02). In this study, addition of excess gypsum did not significantly affect the grain yield of rice. According to Darwish et al. (2009), salt stress causes much serious damage in many cellular and physiological functions like photosynthesis, water absorption, nutrient uptake, metabolism, root elongation etc. which causes yield reduction. Similar findings also observed by Zeng and Shannon, 2000. Tolerant genotypes had a capability to better nutrient and water absorption which provide maximum leaf area that resulting in better accumulation of photo-assimilate in plant. Binadhan-10 performed better over BRRI dhan28 in grain production due to its salinity tolerance capacity.

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Straw yield

The significant differences between cultivars have been observed in rice tolerance to salinity both in vegetative and reproductive stages (Eynard et al., 2005). Siddique et al. (2015) mentioned that reduced straw yield under salinity condition might be due to inhibited photosynthesis under salinity stress that caused less amount of nutrient uptake by the plant. From the Table 02, it was observed that the straw yield of rice differed with variety. The highest straw yield produced by Binadhan-10 (7.93 t ha^{-1}) as compared to BRRI dhan28 (6.06 t ha^{-1}). The mean effect of nutrient levels did not show any significance over straw yield (Table 03). Considering the combined effect of variety and nutrient levels (Figure 03), the highest straw yield (8.02 t ha^{-1}) observed in the treatment i.e., Binadhan-10 with RFD followed V_2T_2 (Binadhan-10 and RFD with additional Gypsum @ 125 kg ha^{-1}) and lowest (5.66 t ha^{-1}) found in the treatment combination V_1T_2 (BRRI dhan28 and RFD with additional Gypsum @ 125 kg ha^{-1}) followed by V_1T_1. The main restrictive impact of salinity on the crop growth are attributed to ion toxicity, osmotic shock and nutritional imbalance which causes reduced photosynthesis and physiological disorder (Ali and Awan, 2004), that may causes reduced celll development and differentiation of tissues which retards stem elongation as a result straw yield is reduced.

Table 02. Variation between two varieties for growth and yield of rice in saline area of Satkhira

Treatment	Plant height (cm)	Panicle length (cm)	No. of tiller $hill^{-1}$	No. of grain $panicle^{-1}$	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
V_1	80.69b	20.97b	17.46b	109.18b	4.69b	6.06b
V_2	93.70a	24.60a	20.57a	118.32a	6.38a	7.93a
Level of significance	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*	*0.05*
%CV	*12.10*	*7.26*	*5. 41*	*6. 33*	*9.98*	*8. 56*

V_1 = Control (BRRI dhan28), V_2 = Binadhan-10

Table 03. Main effect of nutrient levels on growth and yield of rice in saline area of Satkhira

Treatment	Plant height (cm)	Panicle length (cm)	No. of tiller $hill^{-1}$	No. of grain $panicle^{-1}$	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1	89.42	23.31	17.95b	111.40	5.45	6.97
T_2	87.09	22.35	19.18ab	115.05	5.53	6.81
T_3	85.08	22.69	19.90a	114.80	5.63	7.20
Level of significance	*NS*	*NS*	*0.05*	*NS*	*NS*	*NS*
%CV	*12.10*	*7.26*	*5. 41*	*6. 33*	*9.98*	*8. 56*

T_1= Recommended dose of N, P, K, S, Zn, T_2 = T_1 + additional Gypsum @ 125 kg ha^{-1}, T_3 = T_1 + additional Gypsum @ 190 kg ha^{-1}

Table 04. Interaction effect of variety and nutrient levels on growth of rice in saline area of Satkhira

Treatment	Plant height (cm)	Panicle length (cm)	No. of tiller $hill^{-1}$	No. of grain $panicle^{-1}$
V_1T_1	81.43d	21.25c	15.75c	109.61c
V_1T_2	80.42d	20.33c	17.02c	108.45c
V_1T_3	80.23d	21.32c	19.60b	109.48c
V_2T_1	97.40a	25.37a	20.15ab	113.20bc
V_2T_2	93.77b	24.37ab	21.35a	121.65a
V_2T_3	89.93c	24.07b	20.21ab	120.13ab
Level of significance	*0.05*	*0.05*	*0.05*	*0.05*
%CV	*12.10*	*7.26*	*5. 41*	*6. 33*

V_1 = Control (BRRI dhan28), V_2 = Binadhan-10; T_1= Recommended dose of N, P, K, S, Zn, T_2=T_1+ additional Gypsum @ 125 kg ha^{-1}, T_3=T_1 + additional Gypsum @ 190 kg ha^{-1}

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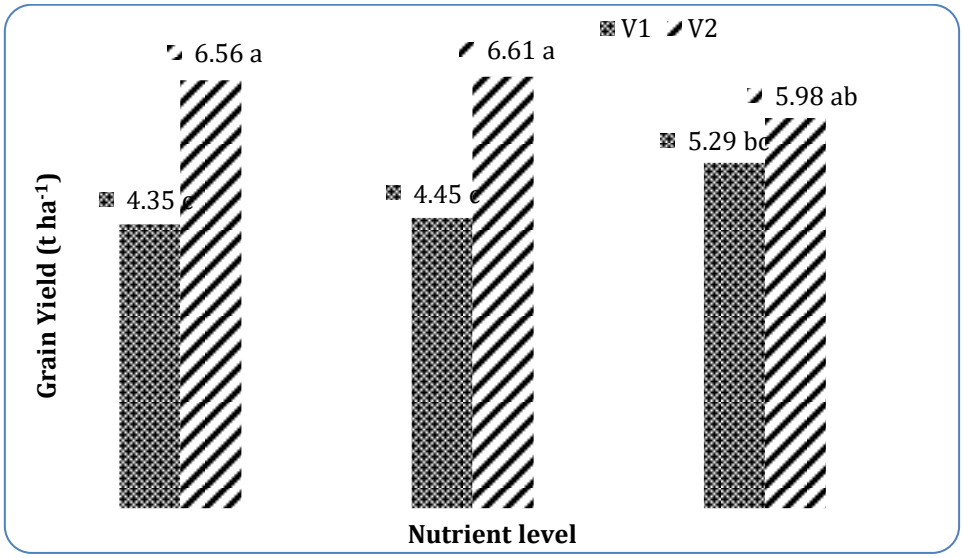

Figure 02. Interaction effect of Variety and Nutrient levels on grain yield of rice in saline area.

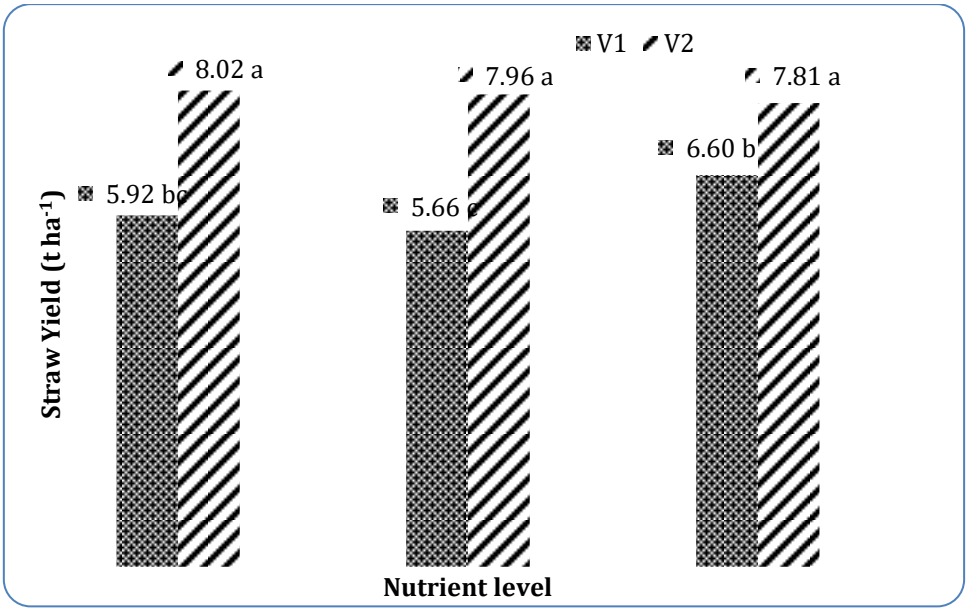

Figure 03. Interaction effect of Variety and Nutrient levels on straw yield of rice in saline area.

V_1 = Control (BRRI dhan28), V_2 = Binadhan-10; T_1= Recommended dose of N,P,K,S,Zn , T_2 = T_1 + additional Gypsum @ 125 kg ha^{-1}, T_3 = T_1 + additional Gypsum @ 190 kg ha^{-1}

IV. Conclusion

It was observed that, for salt tolerant characteristic Binadhan-10 performed better in saline condition. Different nutrient management approaches with recommended fertilizer dose gave higher yield of Binadhan-10 compared to BRRI dhan28. While addition of excess gypsum did not significantly affect the grain yield of rice. So, farmers of salt affected area in Sathkira could prefer Binadhan-10 for better yield and productivity of rice.

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