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EFFECT OF DIFFERENT FERTILIZER PACKAGES ON YIELD AND YIELD ATTRIBUTES OF BINA DHAN7 IN SALINE SOILS

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Abstract

During Kharif-2, 2013 an experiment was conducted to investigate the fertilizer requirement of BINAdhan-7 in saline soils of Khulna district. There were six treatment combinations such as T_1 = 100% of soil test based (STB) fertilizers ($N_{103}P_6K_{50}Zn_{1kg/ha}$), T_2 = T_1 + 25% N of STB fertilizers fertilizers, T_3 = T_1 + 25%NP of STB fertilizers, T_4 = T_1 + 25% NK of STB fertilizers, T_5 = T_1 + 25% PK of STB fertilizers, T_6 = T_1 + 25%NPK of STB fertilizers, T_7 = 75% of STB fertilizers and T_8 = Control. The yield attributes nutrient uptake and grain and straw yields were significantly affected due to different treatments. Number of effective tillers/hill, panicle length, filled grains/panicle, and 1000-grain weight were highest in the treatment T_6 (T_1 + 25% more NPK of STB). The highest N, P, K, S and Zn uptake was also found in treatment T_6. As a result the highest grain (4.73 t/ha) and straw (6.10 t/ha) yield were obtained in the treatment T_6. Considering the yield attributes, uptake of different nutrients and yield, inclusion of 25% more N, P, and K chemical fertilizers in STB recommended doses might be suggested for BINA dhan7 cultivation in saline areas of Khulna district.

Introduction

In Bangladesh over 30% of the net cultivable areas lie in the coastal zone. Out of 2.80 million hectares of coastal and offshore lands, about 1.056 million hectares are affected by varying degrees of salinity. The salinity of Khulna district is very high resulting significant yield loss depending on the level of soil salinity.

Further, from the recent soil salinity map it has been found that some of the new land of Satkhira, Patuakhali, Barguna, Barisal, Jahalakathi, Pirojpur, Jessore, Narail, Gopalganj and Madaripur districts are affected by different degrees of soil salinity which reduces the crop productivity in the area (SRDI 2009). Soil salinity is a major concern to agriculture because it affects almost all plant nutrients. Salinity creates a problem due to its effect on crop species which are predominantly sensitive to the presence of high concentration of salts in the soil.

Bangladesh Institution of Nuclear Agriculture (BINA) has developed BINA dhan7 and BINA dhan8 as salt tolerant rice varieties. Of these BINA dhan7 is popular in Khulna region due to its short duration (around 110 days from seed sowing to ripening) can be harvested before salinity rises to extreme condition. Therefore, BINA dhan7 is being introduced in saline areas of Khulna. Bangladesh Agricultural Research Council (BARC) has provided STB fertilizer doses for this variety (FRG 2012). But often STB fertilizer doses cannot produce the optimum yield of the respective crops in different saline areas due to high salt concentration. Salinity imposes ionic toxicity to plants, leading to nutrition disorder. Salt stress disturbs cytoplasmic K^+/Na^+ homeostasis, causing an increase in Na^+ to K^+ ratio in the cytosol (Zhu 2003). Accumulation of

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excess Na^+ and Cl^- causes ionic imbalances that may impair the selectivity of root membranes and induce K^+ deficiency. It has been reported that salt stress causes increased uptake of Na^+ and Cl^-, and decreased uptake of essential cations particularly K^+ (Khan *et al.* 2003). Thus, although the available status of a nutrient in a soil might not be in a deficient range *per se*, its application might compensate for the decreased uptake by plants resulting from the antagonistic effect of excess uptake of certain ions.

Considering the above points, for fine tuning the recommended fertilizer doses in different saline areas the present study was undertaken to determine the fertilizer requirements for BINA dhan7 in saline soil at Khulna and to verify and update the existing soil test based fertilizer recommendation.

Materials and Methods

The experiment was set up at the farmer's field at Moshiali village under Fultala Upazila of Khulna district ($22^0$55´ 58.8´´ N latitude and $89^0$29´11.3´´ E longitude) under agro-ecological Zone (AEZ) 11. Initial soil sample was collected from 0-15cm depth of the experimental plot was analyzed in laboratory by standard procedure. Soil samples were also collected from the experimental plot on mid of the months during experimental period (June to December).

Table 1. Physical and chemical properties of initial soil of the experimental site.

Textural class	pH	EC (ds/m)	OM (%)	Total N (%)	K (meq/ 100g soil)	P	S	Zn	B
						ppm			
-	8.7	4.52	0.89	0.052	0.09	14.60	41.31	0.56	0.63
Clay loam	Strongly alkaline	Slightly alkaline	Very low	Very low	Very low	Medium	Very high	Low	Medium

Similarly, water samples were also collected from irrigation water sources near the experimental plot for monitoring water salinity. Irrigation water salinity was classified according to methods of irrigation water quality assessment by Wilcox 1954/1955. BINA dhan7 was used as the test crop in this experiment. The land was prepared thoroughly by puddling and cross puddling with a power tiller. After uniform leveling, the experiment was laid out in a RCBD. Fertilizers were applied to each plot as per treatment. Except urea, other fertilizers were applied to the individual plots during final land preparation. Urea was applied in three equal splits following 10 days after transplanting (DAT), 20 DAT (maximum tillering stage), and 35 DAT (panicle initiation stage). Thirty days old healthy seedlings were transplanted in the plots keeping the spacing 20 cm × 15 cm, and three seedlings were transplanted in each hill. Intercultural operations like irrigation, weeding and insect and pest control were done as and when necessary following standard procedures. The crop was harvested at full maturity. Five hills were randomly selected from each plot at maturity to record the yield contributing characters like, number of effective tiller/hill, panicle length, number of filled grain/panicle and weight of 1000-grains. After threshing of the crop, grain and straw from each unit plot was dried and weighed. The results were expressed as t/ha on 14% moisture basis.

Collected grain and straw sample from each plot was dried in an oven at 65^0C for about 24 hrs after which they were ground by a grinding mill. Later the ground samples were sieved through 20-mesh sieve. The prepared samples were then chemically analyzed for N, P, K, S and Zn

following di acid digestion procedure (Jones and Case 1990; Watson and Issac 1990). Total nutrient uptake by BINA dhan7 was calculated by multiplying the yield data with respective nutrient concentrations in grain and straw. Total uptake has been calculated as the sum total of grain and straw uptake.

The analysis of variance for various growth components, grain and straw yields and nutrient uptakes were done following the F-test. Mean comparisons of the treatments were made by the DMRT.

Results and Discussion

The soil salinity (EC) ranged from 1.38 to 2.99 dS/m (non-saline to very slightly saline) during June to December (Fig. 1). In June, soil salinity was recorded 2.05 dS/m (very slightly saline) which slightly increased in July (2.64 dS/m, very slightly saline). From July soil salinity gradually decreased up to October and attained to its lower level (1.38 dS/m, non-saline), then from October, soil salinity started to increase in the following months which was recorded 2.99 dS/m (very slightly saline) in December.

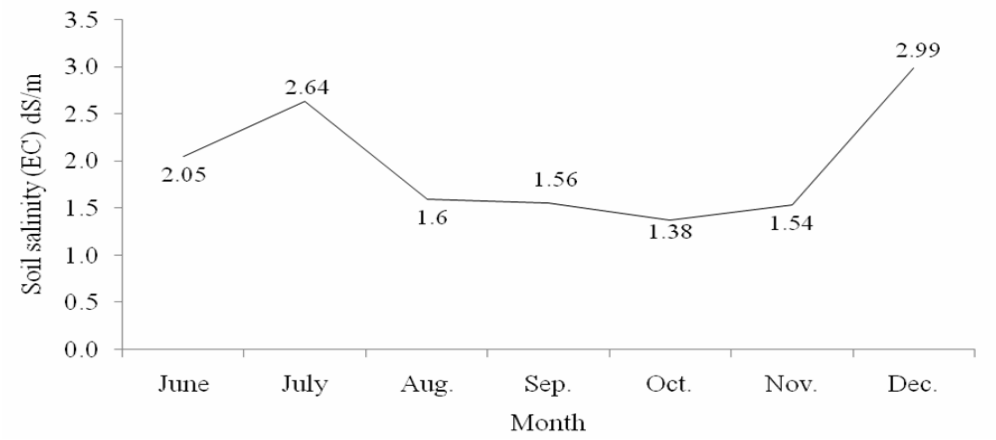

Fig. 1. Month wise (June to December) soil salinity of the experimental plot.

Canal water salinity ranged from 0.73 to 1.30 dS/m (safe to harmful with none to moderate restriction in usage) during June to December (Fig. 2). In June, it was recorded 1.04 dS/m (harmful with moderate restriction in usage), which gradually decreased up to November and attained to its lower level (0.73 dS/m, safe and no restriction in usage). Then from November canal water salinity increased to 1.13 dS/m (harmful with moderate restriction in usage) in December. Similarly, pond water salinity ranged from 0.69 to 1.70 dS/m. In June it was recorded 1.70 dS/m (harmful with moderate restriction in usage) which gradually decreased up to October and attained to its lower level (0.69 dS/m, safe and no restriction in usage). Then from October pond water salinity gradually increased up to December (0.91 dS/m, harmful with moderate restriction in usage). Similar distribution pattern in different months of soil and water salinity was reported by SRDI (2014) through investigating several soils and rivers of the respective Khulna region which depends on the rainfall pattern.

The yield components include number of effective tillers/hill, panicle length, filled grains/panicle and 1000-grain weight were significantly influenced by different treatments (Table 2). The number of effective tillers/hill due to different treatments varied from 9.00 to 18.67. The highest number of tillers/hill (18.67) was found in the treatment T_6 (T_1 + 25% NPK of STB

fertilizers) which was statistically similar to 18.33 recorded in T_3 (T_1 + 25% NP of STB fertilizers) and T_4 (T_1 + 25% NK of STB fertilizers) treatments significantly higher than 17.00 recorded in T_1 (100% STB fertilizers) treatment. The minimum number of tillers/hill (9.00) was found in the treatment T_8 (control). Panicle length varied from 18.81 cm in T_8 (control) to 23.37 cm in T_6 (T_1 + 25% NPK of STB fertilizers) treatment. The values for panicle length of all the treatments were higher than that of control. The panicle length of T_1 (100% STB fertilizers) to T_7 (75% STB fertilizers) treatments were about 1.31 to 4.56 cm taller than that of treatment T_8 (control). The number of filled grains/panicle of different treatments ranged from 55.98 to 94.49. The highest number of filled grains/panicle of 94.49 was obtained from T_6 (T_1 + 25% NPK of STB fertilizers) treatment, which was statistically similar to 92.53 and 93.87 recorded in T_3 and T_4 treatments, respectively significantly higher than 85.95 recorded in T_1 treatment. The lowest number of filled grains/panicle (55.98) was obtained from the treatment T_8 (control). The 1000-grain weight ranged from 22.59 to 24.61 g. All the treatments showed significant increase in 1000-grain weight over control. The highest 1000-grain weight (24.61 g) was recorded from T_6 treatment was statistically similar to those obtained in all other treatments except T_7 (75% of STB fertilizers) and T_8 (control). The lowest 1000-grain weight (22.59 g) was obtained in T_8 (control) treatment. Sarfaraz *et al.* (2002) found that the number of tillers/m, 1000-grain weight, grain and straw yields were significantly increased with the application of NPK and S fertilizers compared to the control. Bahmaniar *et al*. (2007) reported that nitrogen application increased number of tiller, length of panicle, number of grains/panicle and 1000-grain weight. Potassium also had positive effects on all of above mentioned yield components.

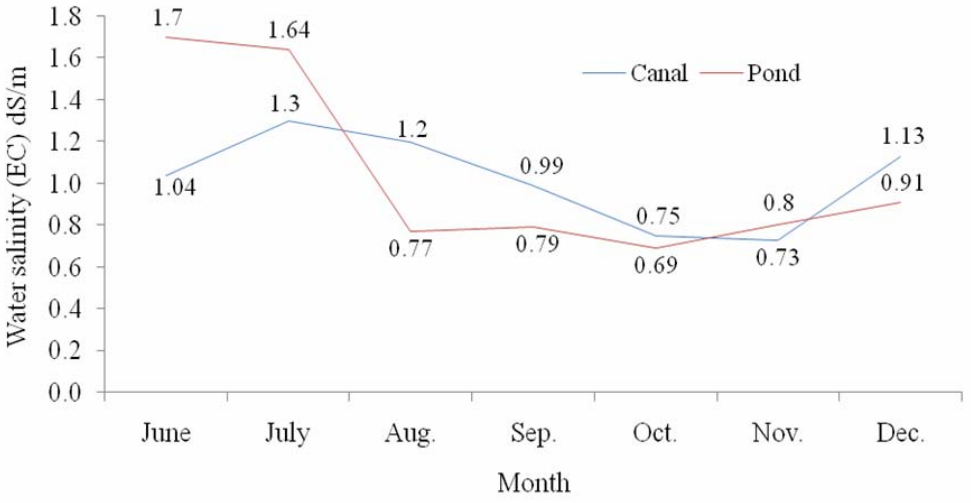

Fig. 2. Month wise (June to December) irrigation water salinity.

Table 2 shows that grain and straw yields of BINA dhan7 were significantly affected by different treatments. The grain yield due to various treatments ranged from 2.22 to 4.73 t/ha. All the treatments showed significantly higher grain yield over control. The highest grain yield (4.73 t/ha) was obtained in the treatment T_6 (T_1 + 25% NPK of STB fertilizers) which was statistically similar to 4.37, 4.47, 4.42 and 4.30 t/ha recorded in T_2, T_3, T_4 and T_5 treatments, respectively significantly higher than 4.02 t/ha recorded in T_1 (100% STB fertilizers) treatment. Significant grain yield increase was obtained from T_2 (T_1 + 25% N of STB fertilizers), T_3 (T_1 + 25% NP of

STB fertilizers), T_4 (T_1 + 25% NK of STB fertilizers), T_5 (T_1 + 25% PK of STB fertilizers) and T_6 (T_1 + 25% NPK of STB fertilizers) treatments than that of T_1 treatment, while significant grain yield reduction was experienced in T_7 (75% STB fertilizers) treatment than that of T_1 (100% STB fertilizers) treatment. The lowest grain yield (2.22 t/ha) was obtained in the treatment T_8 (control) which was statistically different from all other treatments. Grain and straw yields of BINA dhan7 showed similar effect whereas greater performance was obtained in T_6 which showed 113.06 and 18% grain yield increase over control and 100% STB. These results revealed that treatment T_6 was more efficient to produce higher production of BINA dhan7 due to its higher nutrient supply in soil than other treatments. These types of findings were also reported by Chaudhary *et al.* (2011). Hoshain (2010) observed that number of effective tiller, no. of grains/panicle, grain yield and straw yield were significantly increased with the increasing rates of N. Higher yield of rice withhigher dose of K over the present recommended rate was reported by many workers (Krishnappa *et al.* 2006, Bahmaniar *et al.* 2007).

Table 2. Effect of different fertilizer packages on the yield attributing characters and yield of BINA dhan7.

Treatment	Tillers/ hill	Panicle length (cm)	Filled grains/ panicle	1000-grain weight (gm)	Grain yield (t/ha)	Straw yield (t/ha)
T_1	17.00bc	22.40ab	85.95bc	24.14ab	4.02 b	4.75c
T_2	17.67b	22.80ab	88.97b	24.20ab	4.37 ab	5.64ab
T_3	18.33ab	23.05ab	92.53ab	24.24ab	4.47 ab	5.75ab
T_4	18.33ab	23.32a	93.87ab	24.54a	4.42 ab	5.50ab
T_5	17.33b	22.70ab	86.98bc	24.16ab	4.30 ab	5.41b
T_6	18.67a	23.37a	94.49a	24.61a	4.73 a	6.10a
T_7	11.67d	20.12b	71.64d	23.34b	3.57 c	4.30d
T_8	9.00e	18.81c	55.98e	22.59c	2.22 d	2.28e
CV (%)	6.47	5.79	5.38	2.33	3.46	4.18

The uptake of different nutrients significantly affected by different treatments (Table 3). The N uptake varied from 44.59 to 125.34 kg/ha. The highest N uptake (125.34 kg/ha) was recorded in the treatment T_6 (T_1 + 25% NPK of STB fertilizers) which was significantly higher than those recorded in all other treatments. The second highest N uptake (119.21 kg/ha) was recorded in the treatment T_2 (T_1 + 25% N of STB fertilizers) which was statistically identical to those recorded in the treatments T_1 (100% STB fertilizers), T_3 (T_1 + 25% NP of STB fertilizers), T_4 (T_1 + 25% NK of STB fertilizers) and T_5 (T_1 + 25% PK of STB fertilizers) treatments, respectively. The lowest N uptake (44.59 kg/ha) was obtained in the treatment T_8 (control) which was statistically different from all other treatments. Similar results were also noted by Kadu *et al.* (1991). The range of P uptake was 4.20 to 19.20 kg/ha. The maximum P uptake (19.20 kg/ha) was recorded in the treatment T_6 which was significantly higher than 15.40 kg/ha recorded in T_1 treatment and statistically identical to those recorded in all other treatments except T_7 (75% STB fertilizers) and T_8 treatments. The minimum P uptake (4.20 kg/ha) was observed in the treatment T_8 which was statistically different from all other treatments. Similar results were also noted by Tripathi *et al.* (2001) who concluded that increasing levels of P significantly enhanced the yield as well as uptake of P uptake. The K uptake varied from 45.30 to 129.89 kg/ha. The highest K uptake (129.89 kg/ha) was noted in the treatment T_6 (T_1 + 25% NPK of STB fertilizers) which was statistically identical to 122.40, 123.50, 121.20 and 122.10 kg/ha recorded in T_2 (T_1 + 25% N of

STB fertilizers), T_3 (T_1 + 25% NP of STB fertilizers), T_4 (T_1 + 25% NK of STB fertilizers) and T_5 (T_1 + 25% PK of STB fertilizers) treatments, respectively and significantly higher than 116.10 kg/ha recorded in T_1 (100% of STB fertilizers) treatment. The lowest K uptake (45.30 kg/ha) was obtained in the treatment T_8 (control) which was statistically different from all other treatments. Similar findings were also found by Velu *et al.* (1987). The S uptake varied from 2.3 to 11.9 kg/ha. The highest S uptake (11.9 kg/ha) noted in the treatment T_6 which was statistically similar to 10.1 and 10.2 kg/ha recorded in the treatments T_2 and T_3, respectively and significantly higher than 0.28 kg/ha recorded in T_1 treatment. The lowest S uptake (2.3 kg/ha) was obtained in the treatment T_8 (control) statistically different from all other treatments. Sakal (1995) reported that concentration of S in grain and straw and its corresponding uptake increased with increasing rates of sulphur. The Zn uptake varied from 0.14 to 0.41 kg/ha. The highest Zn uptake (0.41 kg/ha) noted in the treatment T_6 which was statistically similar to 0.35 and 0.34 kg/ha recorded in the treatments T_2 and T_3 respectively and significantly higher than 0.28 kg/ha recorded in T_1 treatment. The lowest Zn uptake (0.14 kg/ha) was obtained in the treatment T_8 (control) statistically different from all other treatments.

Table 3. Effect of STB fertilizer application on nutrient uptake of BINA dhan7.

Treatment	N (kg/ha)	P (kg/ha)	K (kg/ha)	S (kg/ha)	Zn(kg/ha)
T_1	112.22 b	15.40 b	116.10c	9.0 b	0.28b
T_2	119.21 b	16.60 ab	122.40ab	10.1ab	0.35ab
T_3	116.17 b	17.50 ab	123.50ab	10.2ab	0.34ab
T_4	114.21 b	16.00 ab	121.20ab	9.4 b	0.30b
T_5	105.07bc	17.00 ab	122.10ab	9.7 b	0.29b
T_6	125.34 a	19.20 a	129.89a	11.9 a	0.41a
T_7	94.64 c	8.60 c	91.70d	6.1 c	0.23c
T_8	44.59 d	4.20 d	45.30e	2.3 d	0.14d
CV (%)	6.57	6.11	5.89	5.13	5.69

Finally, 25% increase of N, P and K fertilizers doses in different combinations over 100% STB fertilizers resulted an increase in nutrient uptake, grain yield and yield contributing parameters of BINA dhan7. It is clear that 100% STB fertilizers with 25% more NPK of 100% STB fertilizers was more efficient than other treatments for better growth, yield and uptake of different nutrients of BINA dhan7. As a result, inclusion of 25% increased dose of N, P and K fertilizers in soil test based recommended fertilizer recommendations ($(N_{126}P_{7.5}K_{62.5}Zn_{1kg/ha}$) can be suggested for production of BINA dhan7 in saline soils.

References

Bahmaniar MA, Ranjbar GA and Ahamafian SH 2007. Effects of N and K applications on agronomic characteristics of two Iranian and landrace rice *(Oryza sativa* L.) cultivars. J. Biol. Sci. **10**(6): 880-886.

Chaudhary SK, Singh JP and Jhair S 2011. Effect of integrated nitrogen management on yield, quality and nutrient uptake of rice *(Oryza sativa* L.*)* under different dates of planting. Indian J. Agron. **56**(3): 228-231. 95

FRG (Fertilizer Recommendation Guide-2012). 2012. Bangladesh Agricultural Research Council, Farmgate, New Airport Road, Dhaka-1215.

Hoshain S 2010. Effect of cowdung and nitrogen (urea) on growth , yield and yield contributing characters of aromatic rice cv. BRRI dhan50. M. S. Thesis. Dept. Agron. BAU, Mymensingh. pp. 4-20.

Jones Jr. JB and Case VW 1990. Sampling, handling, and analyzing plant tissue samples. *In:* Westerman RL (Ed.), Soil Testing and Plant Analysis, 3rd ed. Soil Science Society of America Book Series No. 3. Madison, Wisconsin, USA. p. 409.

Kadu PB, Bhoyar VS and Thakare RS 1991. Effect of NPK-FYM blended manurial mixtures on performance of rice. J. Soil Crops. **1**(2): 172-174.

Khan MSA, Harnid A, Salahuddin ABM, Quasem A and Karim MA 2003. Effect of sodium chloride on growth, photosynthesis and mineral ions accumulation of different types of rice. J. Agron. Crop Sci. **179**: 149-161.

Krishnappa M, Gowda KN, Shankarnarayan V, Maharudrappa K and Khan MM 2006. Effect of graded levels and split application of potassium on its availability and yield of rice. J. Potassium Res. **6**(4):156-161.

Sakal R 1995. Soil sulphur deficiencies and crop response to sulphur in Bihar, India. Sulphur in Agriculture. Sulphur Institute, Washington D.C. pp.19-28.

Sarfaraz M, Mehdi SM and Sadiq M and Hassan G 2002. Effect of sulphur on yield and chemical composition of rice. Sarhad J. Agril. Sci. **18**(4): 411- 414.

SRDI 2009. Saline Soils of Bangladesh Soil Resource Development Institute, Krishi Khamar sarak, Dhaka-1215, Bangladesh.

SRDI 2014. Annual Report. Soil Resource Development Institute, Krishi Khamar sarak, Dhaka- 1215, Bangladesh.

Tripathi BN, Dixit VK and Chaubey CN 2001. Influence of various levels of moisture regimes, puddling and phosphorus application in the yield and nutrient uptake by rice. Bhartiya Krishna Anusandhan Patrika, **16**(1-2): 45-46.

Velu V, Saravan AK and Ramanathan KM 1987. Response of rice to fertilization in Sullen Kay area of Cauvary delta and uptake of nutrients by rice. Madras Agric. J. **74**(8): 418-420.

Watson ME and Isaac RA 1990. Analytical instruments for soil and plant analysis. In: *Soil testing and plant analysis*, 3rd edition. SSSA Book series 3, (ed.) WL Westermaan, Soil Science Society of America, Madison, WI, USA. pp. 691-740.

Wilcox LV 1955. Classification and Use of Irrfigation Waters. US Department of Agriculture. Cire. 969, Washington D.C. USA. p. 19.

Zhu JK 2003. Regulation of ion homeostasis under salt stress. Current Opinion in Plant Biol. **6:** 441-445.

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