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Response of BRRI dhan30 to different fertilizer packages in saline areas

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Abstract

The balance use of fertilizer for sustainable crop production is possible by measuring the need of crop's demand after soil test. The objective of this study was to investigate the fertilizer requirement of BRRI dhan30 for better production in saline soil during the transplant aman seasons. There were six treatment combinations such as T_1 = 100% of STB (Soil test base) fertilizers ($N_{103}P_6K_{50}Zn_{1kg/ha}$), 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, T_6 = T_1 + 25%NPK of STB fertilizers, T_7 = 75% of STB fertilizers and T_8 = Control. The experiment was laid out in a randomized complete block design with three replications. The yield contributing characters and yields of BRRI dhan30 were significantly affected due to different treatments. Number of effective tillers hill^{-1}, panicle length, filled grains panicle^{-1}, and 1000-grain weights were higher in the treatment T_6 (T_1 + 25%NPK) fertilizers. In all the experimental location, the highest grain yields (4.88, 5.02, 4.98 and 5.06 t/ha, respectively) were obtained in the treatment T_6 (T_1 + 25%NPK fertilizers). As a result, 25% increase of N, P and K fertilizers in STB fertilizer doses might be recommended for BRRI dhan30 cultivation in saline areas of Bangladesh.

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Introduction

Bangladesh is the fourth rice producing (BRRI, 2007) country and third largest consumer of rice in the world and it alone provides 76% of calorie and 66% of total protein requirement of daily food intake (Bhuiyan *et al.,* 2002). But the yield per unit of rice at farmer's level is much lower than the potential yield. The average yield of rice (3.47 tha^{-1}) is quite low compared to other rice growing countries like China, Japan, Korea and USA where yields are 6.23, 6.79, 6.59 and 7.04 tha^{-1}, respectively (FAO, 2004). The reasons for low yield of rice mainly associated with the lacking and use of modern varieties, judicious management of fertilizers, irrigation and other intercultural operations.

In Bangladesh over 30% of the net cultivable area lies 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 which reduces the crop productivity in the area (SRDI, 2009). Due to unfavorable soil, water and climatic conditions local and often late rice varieties are cultivated during T. Aman seasons. Scientists are trying to introduce high yielding rice varieties like BRRI dhan30 during T. Aman season in prevailing soil, water and climatic condition of coastal belt. Bangladesh Agricultural Research Council (BARC) has provided STB fertilizer doses of the mentioned 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. Under saline conditions, the mineral nutrition of most plants can be expected to be detrimentally affected. The interactions between K^+ and Na^+ may be emphasized under such conditions and ultimately decrease plant growth (Noaman, 2004). Saqib *et al.* (2000) reported a significant reduction in all growth parameters considered and an increased concentration of Na^+ and Cl^-, decreased concentration K^+ and decreased K^+ : Na^+ ratio. Therefore, for sustaining food security, a high priority should be given to minimizing the detrimental effects of environmental stresses on crop production by (1) applying modern breeding techniques and biotechnological tools and (2) increasing physical and chemical fertility as well as maintaining productivity of cultivated soils by adequate and balanced supply of mineral nutrients (Cakmak, 2005). Considering the above points, the present study was undertaken i) to determine the fertilizer requirements for BRRI dhan30 in saline soil, and ii) to verify and update the existing soil test based fertilizer recommendation of BRRI dhan30.

Materials and methods

Location

The experiment was conducted at the farmer's fields of Moshiali (N-22°55´55.9˝, E-89°29´01.0˝), Teligati (N-22°53´49.3˝, E-89°29´08.8˝), Gobindakathi (N-22°49´25.0˝, E-89°19´34.6) and Ghagramari (N-22°41´36.6˝, E-89°31´52.4˝) villages Under Fultala, Khulna Metro, Dumuria and Batiaghata Upazila, respectively of Khulna district.

Soils

The soils of experimental fields were belonging to Alluvial Floodplain soil under the Ganges Tidal Floodplain under (Agro-ecological Zone 11 and 13). Initial soil samples were collected from 0-15cm depth and made free from the plant roots and unnecessary materials and dried under shade. Then the soils were ground and mixed up thoroughly and sieved through 2mm sieve. Physical and chemical properties of soils were analyzed for assessing soil fertility and STB fertilizer recommendation according. Soil samples were also collected from the experimental plots on mid of the months of the experimental period for monitoring salinity.

Analysis of soil sample

Electrical conductivity (EC) and pH of the soil samples were determined from 1:1 and 1:2.5 soil-water extract, respectively by glass-electrode method (Jackson, 1962; Andersoen and ingram, 1966). Total nitrogen (TN) was determined by Micro-kjeldahl distillation method (Bremner and Mulvany, 1982), available phosphorus (P) by revised Olsen method (Olsen *et al.,* 1954; Olsen and Sommers, 1982), percent organic matter (%OM) by wet oxidation method (Walkley and Black,1934), available sulphur (S) by calcium biphosphate extraction method (Fox *et al,.* 1964),

available zinc (Zn) by DTPA extraction method (Lindsay *et al.,* 1978), exchangeable potassium (K) by ammonium acetate extraction method (Coleman *et al.,* 1959; Knudsen *et al.,* 1982), Soil texture according to USDA system by hydrometer method (Day, 1965). pH, EC and nutritional status of soils were classified according to FRG -2012, BARC.

Crop cultivation.

The land was prepared thoroughly by ploughing and cross ploughing with a power tiller. Weeds and stubbles of the previous crop were removed from the plot. After uniform leveling, the experiment was laid out in a Randomized Complete Block Design (RCBD) with 3 replications. The treatments were randomly distributed to the plots in each block. As sources for N, P, K, and Zn different types of chemical fertilizers-urea, triple super phosphate, muriate of potash, and zinc sulfate-heptahydrate were used. Except urea, other fertilizers were applied to the individual plots during final land preparation according to the treatments used. Urea was applied at 15, 30 and 50 day after transplanting. Thirty days old healthy seedlings of BRRI dhan30 were transplanted in the in the experimental plots. The spacing of transplanting was 20cm × 20cm, 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.

After transplanting, 5 to 6cm water was maintained in each plot throughout the growing period.

Data collection

Five hills were randomly selected from each plot at maturity to record the yield contributing characters like, number of effective tiller hill^{-1}, panicle length, number of filled grain panicle^{-1} and weight of 1000-grains. The crop was harvested at full maturity, bundled separately and brought to the threshing floor. After threshing of the crop, grain and straw from each unit plot was sun dried and weighed. The results were expressed as tha^{-1} on 14% moisture basis.

Statistical analysis

The variance analysis was done by M-State-C statistical software. We used Duncan's Multiple Range Test (DMRT) with 5% probability for Comparisons of average values.

Results and discussion

Soil properties

At Moshiali, Teligati and Ghagramari villages soil pH and EC was slightly alkaline and moderately saline, respectively while at Gobindakathi soil pH and EC was strongly alkaline and slightly saline, respectively. Similarly, at Moshiali, Teligati and Ghagramari villages %OM, %TN and available P was medium, low and low, respectively whereas at Gobindakathi that was low, very low and very low, respectively (Table 1).

Table 1. Physical and chemical characteristics of the initial soil of the experimental plots.

Location	Textural class	pH	EC (dS/m)	OM (%)	Total N(%)	P (ppm)	K(meq/ 100gsoil)	S (ppm)	Zn (ppm)	B (ppm)
Moshiali	Clay	8.1	8.92	2.40	0.141	7.36	0.33	45.45	1.18	0.49
		Slightly Alkaline	Moderately Saline	Medium	Low	Low	High	Very High	Optimum	Optimum
Teligati	Clay	7.7	9.24	2.23	0.120	7.01	0.18	71.57	1.32	0.72
		Slightly Alkaline	Moderately Saline	Medium	Low	Low	Medium	Very High	Medium	High
Gobind-akathi	Clay	8.5	6.73	1.46	0.086	4.85	0.43	54.39	0.93	0.64
		Strongly Alkaline	Slightly Saline	Low	Very Low	Very Low	Very High	Very High	Medium	High
Ghagra-mari	Clay	7.7	10.35	2.67	0.155	5.91	0.38	158.70	0.73	0.68
		Slightly Alkaline	Moderately Saline	Medium	Low	Very Low	Very High	Very High	Low	Very High

At all the villages, available S was very high. At Teligati, Gobindakathi and Ghagramari villages available B was high, while at Moshiali it was optimum. At Gobindakathi and Ghagramari, exchangeable K was very high, while in Moshiali and Teligati it was high and medium, respectively. At Moshiali and Ghagramari available Zn was optimum and low, respectively whereas in Teligati and Gobindakathi available Zn was medium (Table 1).

Soil salinity

The soil salinity (EC) ranged from 1.28 to 10.90dS/m, 0.80 to 8.30dS/m, 1.13 to 6.73dS/m and 1.28 to 10.90dS/m during the year was recorded 2.18, 2.87, 3.56 and 2.40 dS/m (very slightly saline) in January, 2013 at Moshiali, Teligati, Gobindakathi and Ghagramari villages respectively which slightly decreased in February, 2013 at Moshiali, Teligati, Gobindakathi, while slightly increased in February, 2013 at Ghagramari.

Table 2. Effect of different fertilizer doses on the yield and yield contributing characters of BRRI dhan30.

Treatment	Effective Tillers^{-1} hill (no.)	Panicle length (cm)	Filled grains Panicle^{-1} (no.)	1000-grain weight (gm)	Grain yield (tha^{-1})	Straw yield (tha^{-1})
Moshiali, Fultala						
T_1	10.67ab	24.85a	109.04a	24.45ab	4.16b	6.42ab
T_2	11.00ab	23.53a	95.17ab	24.67a	4.75a	6.95a
T_3	11.67ab	23.94a	120.01a	24.15b	4.78a	6.89a
T_4	11.67ab	24.83a	101.67ab	24.11b	4.79a	6.66ab
T_5	10.67ab	24.99a	112.30a	24.13b	4.61a	6.33ab
T_6	12.67a	24.90a	117.49a	24.60a	4.88a	6.86a
T_7	9.33bc	24.97a	99.83ab	24.12b	3.82b	5.84b
T_8	7.33c	22.87b	83.26b	22.40c	2.98c	4.04c
CV (%)	11.78	4.73	12.79	3.28	5.23	7.97
Teligati, Khulna metro						
T1	12.00abc	24.46ab	107.75a	23.56b	4.23b	6.40a
T2	14.00ab	24.32abc	98.26a	23.77a	4.83a	6.77a
T3	11.67abc	24.83ab	102.45a	23.84ab	4.92a	6.57a
T4	14.67ab	23.90bc	94.24a	23.73ab	4.87a	6.07a
T5	16.34a	24.10abc	110.17a	23.70ab	4.35b	6.06a
T6	15.67ab	25.02a	100.43a	24.16a	5.02a	6.80a
T7	11.00bc	23.47c	95.28a	23.42b	3.67c	5.14a
T8	8.67c	21.51d	86.96b	22.62c	2.66d	3.09b
CV (%)	19.73	2.15	12.76	4.99	6.09	16.19
Gobindakathi, Dumuria						
T1	10.67ab	25.29a	108.52ab	23.15ab	4.18b	5.95ab
T2	11.33ab	25.74a	104.87ab	23.19ab	4.80a	6.16a
T3	11.67ab	25.45a	110.99ab	23.75a	4.86a	6.11ab
T4	11.33ab	25.60a	113.38ab	23.19ab	4.97a	6.36a
T5	11.00ab	25.80a	120.67a	22.85ab	4.30b	6.10ab
T6	14.00a	25.84a	116.20ab	23.66a	4.98a	6.38a
T7	9.67b	23.36b	100.66ab	22.48b	3.60c	5.21b
T8	8.33b	21.62b	93.53b	21.96c	2.81d	4.02c
CV (%)	18.14	4.11	11.80	4.70	3.33	8.20
Ghagramari, Batiaghata						
T1	14.00ab	22.80ab	113.98bc	23.09ab	4.36b	5.32ab
T2	16.00ab	22.75ab	122.64abc	23.46a	4.93a	5.50ab
T3	15.00ab	23.63ab	119.17abc	23.18ab	4.96a	5.75a
T4	15.33ab	24.38a	131.65ab	23.30ab	4.98a	5.95a
T5	15.00ab	22.60b	119.95abc	23.17ab	4.48b	5.28ab
T6	16.33a	24.39a	137.32a	23.47a	5.06a	6.08a
T7	12.67bc	22.50b	113.14bc	22.75b	3.58c	4.87bc
T8	9.67c	20.44c	104.17c	22.01c	3.26d	4.30c
CV (%)	12.14	3.72	9.73	2.41	3.81	8.22

From February, soil salinity showed an overall sharp increasing tendency in the following months and reached at their peak during May to June at Moshiali, Teligati, Gobindakathi and Ghagramari, respectively. After attainment of peak salinity, it significantly decreased in the following months was recorded 1.97ds/m (non- saline), 2.49dS/m (very slightly saline), 1.59dS/m (non- saline) and 1.66dS/m (non-saline) in July at Moshiali, Teligati, Gobindakathi and Ghagramari respectively. From July soil salinity gradually decreased in the following months attained their lower levels 1.28dS/m, 0.80dS/m, 1.13ds/m and 1.34dS/m (non-saline) at Moshiali, Teligati, Gobindakathi and Ghagramari, respectively during September to November.

After attaining their lower levels soil salinity again sharply increased to the following months (Figure 1). The distribution pattern of soil salinity mostly depends on the rainfall pattern of the respective region. Similar distribution pattern of soil salinity in different months was also reported by SRDI (2014) through investigating several soils of Khulna region.

Yield contributing characters of BRRI dhan30

Table 2 represents yield contributing characters and yield of BRRI dhan30 at Moshiali, Teligati, Gobindakathi and Ghagramari significantly affected by different treatments.

The number of effective tillers hill^{-1} due to different treatments varied from 7.33 to 12.67, 8.67 to16.34, 8.33 to 14.00 and 9.67 to 16.33 at Moshiali, Teligati, Gobindakathi and Ghagramari villages, respectively. The highest number of effective tillers hill^{-1} at Moshiali (12.67), Gobindakathi (14.00) and Ghagramari (16.33) villages were found in the treatment T_6 (T_1+25%NPK), while in Teligati it was found 16.34 in the treatment T_5 (T_1+25%PK). The highest number of effective tillers hill^{-1} found in the treatments T_5 and T_6 at different villages were statistically similar to those recorded in all other treatments except T_7 (75%STB) and T_8 (control) treatment.

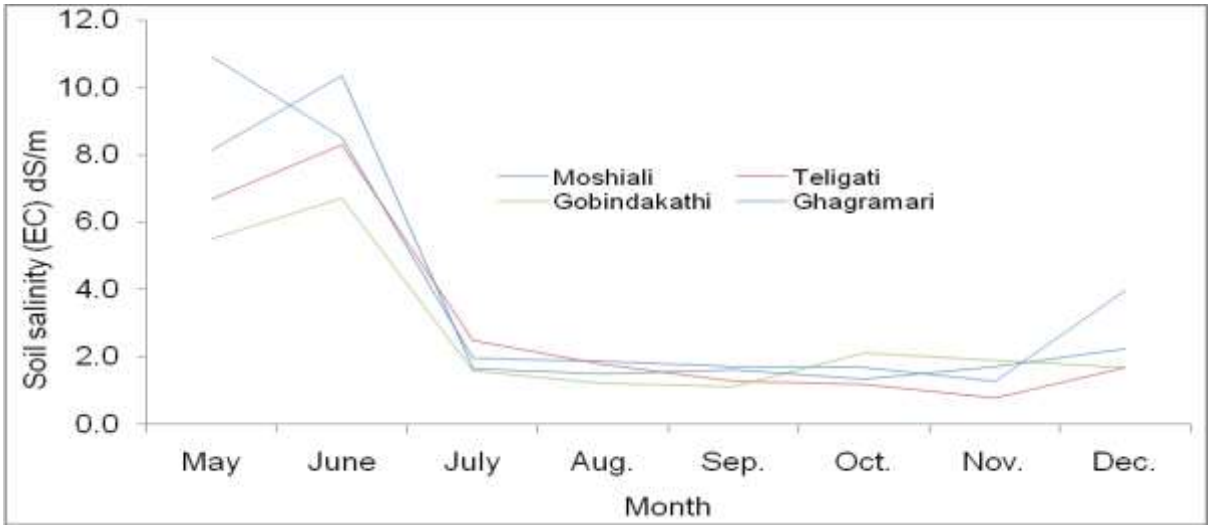

Fig. 1. Month wise soil salinity during during the experimental period at Moshiali, Teligati, Gobindakathi and Ghagramari.

Panicle length varied 22.87 - 24.99, 21.51 - 25.02, 21.62 - 25.84 and 20.44 - 24.39cm at the mentioned villages, respectively. Except Moshiali the tallest panicles were found in the treatment T_6. The tallest panicles at Moshiali was found in the treatments T_5 and T_6 at Moshiali and Gobindakathi villages were statistically similar to those recorded in all other treatments except T_7 and T_8 treatment. At Teligati, the tallest was panicle found in the treatment T_6 was statistically similar to those recorded in T_1 (100% STB), T_2 (T_1+25%N), T_3 (T_1+25%NK) and T_5 treatments respectively, while at Ghagramari the tallest panicle was found in the treatment T_6 was statistically similar to those recorded in T_1, T_2, T_3 and T_4 (T_1+25%NP) treatments respectively.

The number of filled grains panicle^{-1} of different treatments ranged from 83.26 to 120.01, 86.96 to 110.17, 93.53 to 120.67 and 104.17 to 137.32 at the mentioned villages, respectively. The highest number of filled grains panicle^{-1} at Teligati (110.17) and Gobindakathi (120.67) were found in the treatment T_5 (T_1+25%PK). At Moshiali, highest number of filled grains panicle^{-1} was (120.01) found in the treatment T_3 (T_1+25%NK) and at Ghagramari it (137.32) was found in the treatment T_6 (T_1+25%NPK). The highest number of filled grains panicle^{-1} found in the treatments T_3 and T_5 at Moshiali, Teligati and Gobindakathi villages were statistically similar to those recorded in all other treatments except T_8 treatment.

The 1000-grain weight of different treatments ranged 22.40 - 24.67, 22.62 - 24.16, 21.96 - 23.75 and 22.01 - 23.47g at the mentioned villages, respectively. The highest 1000-grain weight (24.16 and 23.47g) were found in the treatment T_6 (T_1+25%NPK) at Teligati and Ghagramari villages, but it was found 24.67g in the treatment T_2 (T_1+25%N) at Moshiali and 23.75g in the treatment T_3 (T_1+25%NK) at Gobindakathi. The highest 1000-grain weight found in the treatments T_3 and T_6 at Gobindakathi and Ghagramari villages were statistically similar to those recorded in all other treatments except T_7 (75% STB) and T_8(control) treatment. The highest 1000-grain weight found in the treatment T_2 at Moshiali was statistically similar to those recorded in the treatments T_1 (100%STB) and T_6. At Teligati the effect of treatment T_6 was statistically similar to treatments T_2 (T1+25%N), T_3 (T1+25%NP), T_4 (T1+25%NK) and T_5 (T1+25%PK). The minimum number of effective tillers hill^{-1} (7.33, 8.67, 8.33 and 9.67), the shortest panicles (22.87, 21.51, 21.62 and 20.44), the lowest numbers of filled grains panicle^{-1} (83.26, 86.96, 93.53 and 104.17) and the lowest 1000-grain weight (22.40, 22.62, 21.96 and 22.01g) were found in the treatment T_8 (control). In agreement with this, Ashfaq *et al.* (2001) 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. These results were also in agreement with the reports of Yoseftabar (2012) who reported that tiller number, fertile tiller, total grain and 1000-grain weight increased significantly with nitrogen and phosphorus fertilizer.

Yeild of BRRI dhan30

The grain and straw yields due to various treatments ranged 2.98 - 4.88 and 4.04 - 6.95 at Moshiali, 2.66 - 5.02 and 3.09 - 6.80 at Teligati, 2.81 - 4.98 and 4.02 - 6.38, at Gobindakathi and 3.26 - 5.06 and 4.30 - 6.08 tha^{-1} at Ghagramari village, respectively (Table 2). The highest grain yields (4.88, 5.02, 4.98 and 5.06) were found in the treatment T_6 at all the villages. The highest grain yields found in the treatments T_6 at Teligati, Gobindakathi and Ghagramari villages were statistically similar to those recorded in the treatments T_2, T_3 and T_4. At Moshiali, statistically similar effect was found in the treatment T_6, T_2, T_3, T_4 and T_5. In the same way, the highest straw yields (6.80, 6.38 and 6.08) were found in the treatment T_6 at Teligati, Gobindakathi and Ghagramari villages, respectively which was statistically similar to those recorded in the treatments T_1, T_2, T_3, T_4 and T_5. At Moshiali, the highest straw yield 6.95 tha^{-1} was obtained in the treatment T_2 that was statistically similar to those recorded in the treatments T_1, T_3, T_4, T_5 and T_6.

The lowest grain (2.98, 2.66, 2.81 and 3.26 tha^{-1}) and straw (4.04, 3.09, 4.02 and 4.30 tha^{-1}) yield were obtained in the treatment T_8 (control) which was statistically different from all other treatments. Present findings support earlier studies of Ali *et al.* (2013) who observed that the application of recommended dose (RD) + 25% NPK of RD gave the highest yield of rice. Hoshain (2010) observed that no effective tiller hill^{-1}, grains panicle^{-1}, grain yield and straw yield were significantly increased with the increasing rates of N. Higher yield of rice with higher dose of K over the present recommended rate was reported by many workers (Krishnappa *et al.*, 2006; Bahmaniar *et al.*, 2007).

Conclusion

An increase of N, P and K fertilizer doses from STB recommended doses significantly increased grain yield of BRRI dhan30. It also increased straw yields and other yield contributing growth parameters like effective tillers hill^{-1}, panicle length, filled grains panicle^{-1} and 1000 grain weight. Considering grain and straw yield and yield contributing parameters greatest performance was shown by T_6 (T_1 + 25%NPK fertilizers) treatment which resulted 16.06 - 19.14% grain yield increase over T_1 (100%STB fertilizers). As a result 25% increased dose of N, P and K fertilizers in STB fertilizer can be suggested for production of BRRIdhan-30 in saline soils. Verification and updating the existing soil test based fertilizer recommendation of different rice varieties is needed in other saline districts also.

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