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Effect of Fertilizers with Agronomic Management on the Growth and Yield of Boro Rice (*cv.* BRRI Dhan29) in *Haor* Area of Bangladesh

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Authors' contributions

This work was carried out in collaboration between all authors. Author SA designed the study, performed the statistical analysis, wrote the protocol and first draft of the manuscript. Authors MAK and MAA managed the analyses of the study. Author SA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The experiment was conducted at the farmers' fields of Bahadurpur village in *Dekar haor* area under the Lakshmanshri union of Sadar upazila of Sunamganj district during November 2015 to May 2016 to observe the effect of fertilizer and agronomic management on growth, yield and yielding parameters of BRRI dhan29 in *haor* area. The experimental site was located under the Agroecological Region Sylhet Basin (AEZ-21) where the soil was moderately acidic. The experiment was designed with seven treatments including T_1 = Farmers' practiced based fertilizer (180-42-42 kg ha^{-1} of urea-TSP-MoP), T_2 = Bangladesh Agricultural Research Council (BARC) Recommended Dose based fertilizer (300-112-127-75-11 kg ha^{-1} of urea-TSP-MoP-Gypsum-$ZnSO_4$), T_3 = T_2 + Wet Irrigation, T_4 = T_2 + Wet and Dry Irrigation, T_5 = T_2 + Proper Seedling Age, T_6 = T_2 + PSA (Proper Seedling Age), T_7 = IPNS (Integrated Plant Nutrient System) + Proper Seedling Age + Integrated Pest Management. The test crop was BRRI dhan29. The experiment was laid out in a randomized complete block design (RCBD) with five farmers' replications. Data were taken on

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growth, yield and yield parameters of BRRI dhan29 and analysed with the help of MSTAT-C program. The plant height varied significantly and found the longest plants due to T_7 except for 25 days after transplanting. The highest number of tillers hill^{-1} were recorded in (T_7) IPNS (Integrated Plant Nutrient System) + Proper Seedling Age + Integrated Pest Management. The highest grain yield (7.95 t ha^{-1}) and straw yield (9.85 t ha^{-1}) were recorded from IPNS (Integrated Plant Nutrient System) + Proper Seedling Age + Integrated Pest Management over farmers' practice-based fertilizers (T_1). Post-harvest soils showed a higher nutrient content in comparison to initial soil due to the application of balanced fertilizers.

Keywords: Agronomic management; BRRI dhan29; fertilizer; Haor.

1. INTRODUCTION

Geographically, most of the *haors* are situated in seven districts of the North-East Bangladesh. There are as many as 373 small or large *haors* in Bangladesh [1]. A *haor* is a wetland ecosystem in the northeastern part of Bangladesh which is a shallow depression also known as a back swamp due to its resemblance with a bowl or saucer-shaped. In a country where one-third of all area can be termed as wetlands, the *haor* basin is an important wetland ecosystem. There are many *haors* (basin-like structure) where water remains either stagnant or in flash flooding condition during the months of late May to, and mainly boro rice is grown in the Rabi season. Rice *(Oryza sativa* L.*)*, the staple food of Bangladesh, dominates all other crops and covers 74.85% of the total cropped area. Among the three rice seasons, boro rice covers about 41.94% of entire rice area, and it contributes to 54.57% of the total rice production of the country. Boro is an essential crop that covers 11.79 million acres in 2016 [2]. Rice production system is depended on various management practices such as irrigation and fertilizer applications, crop management practices, use of new high yielding varieties and modern technologies. Among them, fertilizer is significant input. If the soil nutrient status is not enough to meet up the plant demands, it is necessary to supply the required as well as adequate nutrient to the soil. Judicious use of fertilizers can markedly increase the yield and also improves the quality of rice [3]. Balanced fertilization with NPKS and other micronutrients are indispensable to sustainable rice production. Therefore, timely supply and availability of fertilizer should receive top priority to sustain/increase boro rice production. Thus, the objectives of the study are to observe the effect of fertilizer and agronomic management on growth, yield and yield contributes of BRRI dhan29 as well as the post-harvest nutrient status of soils.

2. MATERIALS AND METHODS

The experiment was conducted in five farmers' fields at Bahadurpur village under union Lakshanshri of Sadar upazila of Sunamganj district during November 2015 to May 2016. The experimental site lies between 24º34'' and 25º12'' North latitudes and between 90º 56'' and 91º 49'' East longitude. The climate of sunamganj district is warmer in the summer and cooler in the winter. The annual maximum temperature was maximum 31.0°C and minimum 15.6°C and the mean monthly relative humidity was 73.43% in 2015-16. Heavy rainfall occurs during the monsoon season, and an annual rainfall of 3250 mm was also recorded during 2015-16. Seven treatments were attempted with fertilizers and agronomic practices in the five farmers' fields. The treatments were - T_1 = Farmers' practiced based fertilizer (180-42-42 kg ha^{-1} of urea-TSP-MoP), T_2 = Bangladesh Agricultural Research Council (BARC) Recommended Dose based fertilizer (300-112-127-75-11 kg ha^{-1} of urea-TSP-MoP-Gypsum-$ZnSO_4$), T_3 = T_2 + Wet Irrigation, T_4 = T_2 + Wet and Dry Irrigation, T_5 = T_2 + Proper Seedling Age, T_6 = T_2 + PSA (Proper Seedling Age), T_7 = IPNS (Integrated Plant Nutrient System) + Proper Seedling Age + Integrated Pest Management. The test variety was BRRI dhan29. Seeds were sown on the seedbed on 30 November, 2015 for raising nursery seedlings. Seedlings were transplanted on 1 January 2016 at 25 cm × 15 cm spacing. The fertilisers were applied as basal dose except for urea. Urea was applied as top dressing in three equal splits at 15, 30 and 45 days after transplanting. Diazinon @ 1.2 l ha^{-1} was used once on 25 February 2016 to control insects. Irrigation was done as per treatments. Five hills were tagged for counting the tillers and measuring the plant heights. Harvesting was done on 2 May 2016. Ten sample hills were collected for each variety from several farmer's plot to record the agronomic characteristics. The grain and straw yields were

recorded from one sq.m area. The initial and post-harvest soil samples were collected from each experimental field before the land preparation was done and after harvesting from 0-15 cm soil depth. The samples were collected by an auger from different spots covering the whole plot and were mixed thoroughly to make a composite sample. The samples were then air dried and sieved through a 10 mesh sieve and stored in a clean plastic container for analysis from Soil Resource Development Institute (SRDI), Sylhet. The recorded data was compiled for statistical analysis. Analysis of variance was done with the help of computer package, MSTAT-C [4].

3. RESULTS AND DISCUSSION

Plant height of BRRI dhan29 was significantly taller due to the application of fertilizers as per fertilizer recommendation guide and IPNS at all dates of data collection except 25 days after transplanting. The tallest plant was observed in T_7, and the shortest plant was observed in farmers practice at all days after transplanting (DAT) (Table 1). Kamuruzzaman et al. [5] conducted an experiment in farmers' field at Sadar upazila of Sunamganj district and reported the tallest plant from Bangladesh Agricultural Research Council (BARC) Recommendation guide base fertilizers in comparison to farmers' practice. Herve et al. [6] and Banu et al. [7] also observed similar results.

A number of tillers hill^{-1} was significant on 40, 65, 90 days after transplanting (DAT) and at harvest. The highest number of tillers T_7 at 90 days after transplanting (DAT) due to the application of balanced fertilizers and the lowest number of tillers hill^{-1} in respect of T_1 at harvest. The number of total tillers hill^{-1} was the highest at 90 days after transplanting (DAT), after that they were declined except T_2 and T_7 (Table 2). This finding was similar to the findings of Kamuruzzaman et al. [5] and Choudhury [8].

The yield and yield parameters were significantly influenced due to the application of fertilizers and agronomic practices. Integrated Plant Nutrition System + Proper Seedling Age and Spacing + IPM (T_7) also produced the highest number of effective tillers hill^{-1} (16.50), number of grains panicle^{-1} (162.52), panicle length (23.65 cm), 1000-grains weight (24.25 g), grain yield (7.95 t ha^{-1}) and straw yield (9.85 t ha^{-1}) in comparison to Farmers' practice-based fertilizer (T_1) (Table 3). Al Amin et al. [9] also found the similar result. BARC Recommended dose of fertilizers was significantly affected the yield and yield parameters of boro rice (cv. BRRI dhan29). This finding was similar to the findings of Kamuruzzaman et al. [5], BARI [10] and Islam et al. [11].

Initial and post-harvest soils were analysed to observe the status of before and after cropping differences of nutrients present in soil. The pH value was 4.88 of initial soil. Post-harvest soil analysis showed that the pH values were lower than an initial sample. The pH values were decreased slightly might be due to the residual effect of fertilizer in the post-harvest soil. Nutrients such as total N, soil organic matter, available P, exchangeable K, available P and available S of post-harvest soils were higher than initial soils (Table 4). The study region occupies the lower, western side of the Surma-Kushiyara Floodplain. The area is mainly smooth, broad basins with narrow rims of higher land along

Table 1. Effect of fertilizers and agronomic practices on the plant height of BRRI dhan29

Treatment	Plant height (cm)				
	25 DAT	40 DAT	65 DAT	90 DAT	At Harvest
T_1	25.6	41.8	67.6	84.7	85.2
T_2	25.7	43.6	74.6	88.4	90.0
T_3	26.4	43.7	74.0	88.4	91.0
T_4	25.7	44.4	75.0	89.1	91.4
T_5	26.9	47.2	77.5	93.1	95.8
T_6	27.1	47.9	77.7	94.2	86.8
T_7	27.8	48.0	78.2	95.0	97.2
LS	NS	**	**	**	**
LSD	-	2.11	2.10	2.05	1.98

*LS = Level of Significance; NS = Non-significant; ** = Significant at 1 % level of probability; T_1 = Farmers' practice fertilizer (180-42-42 kg ha^{-1} of urea-TSP-MoP); T2 = Bangladesh Agricultural Research Council (BARC) Recommendation Dose (300-112-127-75-11 kg ha-1 of Urea-TSP-MoP-Gypsum-ZnS04); T3 = T2+ Wet Irrigation; T4 = T2 + Wet and Dry Irrigation; T5= T2+Proper Seedling Age; T6= T2+ Proper Seedling Age + Integrated Pest Management; T7 = Integrated Plant Nutrient System + Proper Seedling Age + Integrated Pest Management*

Table 2. Effect of fertilizers and agronomic practices number of tillers hill^{-1} of BRRI dhan29

Treatment	Tillers hill^{-1} (no.)				
	25 DAT	40 DAT	65 DAT	90 DAT	At harvest
T_1	8.1	9.8	15.7	15.9	15.0
T_2	8.2	10.1	18.6	18.1	17.0
T_3	8.6	10.2	18.5	18.6	17.2
T_4	8.4	11.6	18.6	18.7	17.5
T_5	8.6	13.2	19.1	19.7	18.8
T_6	8.9	13.9	19.8	19.9	19.0
T_7	9.1	14.1	20.5	20.2	19.2
LS	NS	**	**	*	*
LSD	-	1.52	1.92	2.19	2.10

*LS = Level of Significance; NS = Non-significant; * = Significant at 5 % level of provability; ** = Significant at 1 % level of provability; T_1 = Farmers' practice fertilizer (180-42-42 kg ha-1 of urea-TSP-MoP); T2 = Bangladesh Agricultural Research Council (BARC) Recommendation Dose (300-112-127-75-11 kg ha-1 of Urea-TSP-MoP-Gypsum-ZnS04); T3 = T2+ Wet Irrigation; T4 = T2 + Wet and Dry Irrigation; T5= T2+Proper Seedling Age; T6= T2+ Proper Seedling Age + Integrated Pest Management; T7 = Integrated Plant Nutrient System + Proper Seedling Age + Integrated Pest Management*

Table 3. Effect of fertilizers with agronomic management on yield and yield parameters of BRRI dhan29

Treatment	Effective tillers hill^{-1} (no.)	Grains panicle^{-1} (no.)	Panicle length (cm)	1000-grains wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1	14.50	135.25	20.23	22.27	5.75	8.25
T_2	15.41	150.22	22.24	23.35	6.85	8.95
T_3	15.52	151.24	22.26	23.34	6.82	9.10
T_4	15.53	151.50	22.34	23.41	6.86	9.20
T_5	16.21	160.36	23.42	23.85	7.25	9.50
T_6	16.23	161.25	23.52	24.10	7.34	9.52
T_7	16.50	162.52	23.65	24.25	7.95	9.85
LS	**	**	**	**	**	**
LSD	1.79	3.25	0.83	0.91	0.42	0.58

*LS = Level of Significance; ** = Significant at 1 % level of probability; T1 = Farmers' practice fertilizer (180-42-42 kg ha-1 of urea-TSP-MoP); T2 = Bangladesh Agricultural Research Council (BARC) Recommendation Dose (300-112-127-75-11 kg ha-1 of Urea-TSP-MoP-Gypsum-ZnS04); T3 = T2+ Wet Irrigation; T4 = T2 + Wet and Dry Irrigation; T5= T2+Proper Seedling Age; T6= T2+ Proper Seedling Age + Integrated Pest Management; T7 = Integrated Plant Nutrient System + Proper Seedling Age + Integrated Pest Management*

Table 4. Nutrient status of initial and post-harvest soil of experimental field in *haor* area

Fertilizer treatment	pH	Total N %	OM %	Available P (ppm)	Exchangeable K (meq/100 g)	Available S (ppm)
Post-harvest soil						
T_1	4.33	0.17	2.93	5.06	0.18	30.71
T_2	4.41	0.17	2.95	5.23	0.20	32.68
T_3	4.40	0.18	2.98	5.32	0.21	35.51
T_4	4.33	0.19	2.95	5.89	0.20	33.10
T_5	4.43	0.20	2.94	5.52	0.22	31.72
T_6	4.46	0.21	2.97	5.55	0.21	30.97
T_7	4.37	0.19	3.10	5.51	0.19	31.52
Initial soil						
	4.88	0.12	2.91	4.01	0.17	29.35

OM = Organic matter; T_1 = Farmers' practice fertilizer (180-42-42 kg ha^{-1} of urea-TSP-MoP); T2 = Bangladesh Agricultural Research Council (BARC) Recommendation Dose (300-112-127-75-11 kg ha-1 of Urea-TSP-MoP-Gypsum-ZnS04); T3 = T2+ Wet Irrigation; T4 = T2 + Wet and Dry Irrigation; T5= T2+Proper Seedling Age; T_6= T_2+ Proper Seedling Age + Integrated Pest Management; T_7 = Integrated Plant Nutrient System + Proper Seedling Age + Integrated Pest Management

rivers. Soils of the region are grey, silty clay loams and clay loam in the elevated parts that dry out seasonally and grey clays in the wet basins. Non-calcareous Grey Floodplain soils and Acid Basin Clays are the significant components of the General Soil Types. This study area soil reaction is mainly slightly acidic [12]. The results were observed by Maiti et al. [13] and Singh et al. [14].

4. CONCLUSION

The BARC recommended fertilizers with agronomic management produced the highest yield (7.95 t ha^{-1}) than farmers practices. This indicated that it could be recommended for getting a higher yield of boro rice (*cv.* BRRI dhan29) in the *haor* area with similar soil and environment.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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