

Growth and Yield of Boro Rice Varieties as Affected by Fertilizers Packages in *Haor* Areas of Bangladesh

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Abstract—A field experiment was conducted aiming to observe the growth and yield of boro rice varieties affected by fertilizers packages at Dekarhaor under Sunamganj district in Bangladesh during November 2017 to April 2018. Two factor experiment with three boro rice varieties $V_1 = \text{BRRI dhan28}$, $V_2 = \text{BRRI dhan29}$ and $V_3 = \text{BRRI dhan58}$; and two fertilizers packages viz. $F_1 = N_{150}P_{24}K_{99}S_{18}Zn_{2.6}$ (FRG-2012) and $F_2 = N_{57}P_{12}K_{12}S_4$ (Farmers' practice) was studied. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Data were taken on growth, yield and yield contributing characters of varieties and analysis was done using R statistical package. The longest plant was of 98.23 cm, observed in BRRI dhan28 at 75 DAT. Recommended fertilizers application also showed longer plant height at 75 DAT. Significant variation was recorded on number of total tillers hill⁻¹ among the varieties. Increased number of total tillers hill⁻¹ was of 15.87 due to recommended package of fertilizers application. Interactions effect of varieties and fertilizer on number of total tillers hill⁻¹ also showed significant variation. Among three varieties the highest productive tillers hill⁻¹ was (13.03) observed in BRRI dhan28 and the lowest (10.33) in case of BRRI dhan29. Recommended dose of fertilizer application also produced higher number of productive tillers hill⁻¹ (12.84) than farmers' practice. The highest number of grains panicle⁻¹ (105.57) was recorded in BRRI dhan28 and the lowest (104.70) in BRRI dhan29. Grains panicle⁻¹ (109.87) was higher when treated with recommended package of fertilizers application. In respect of 1000-grain weight, BRRI dhan29 produced the highest value of 22.67 g and BRRI dhan28 was of 21.00 g. Higher weight of 1000 grains (22.67 g) also obtained when practiced recommended fertilizers package. Yield was the highest (7.28 t ha⁻¹) in BRRI dhan29 and the lowest yield (4.23 t ha⁻¹) was observed in BRRI dhan58. Grain yield (5.98 t ha⁻¹) was higher in case of recommended dose of fertilizers over farmers' practice.

1. Introduction

Rice is the main food crop in terms of area, production and its contribution to the national economic development of Bangladesh. It is observed that about 51.88 % people are engaged in agriculture [1]. Crop sector of Bangladesh is

dominated by intensive rice (*Oryza sativa* L.) cultivation as soil and climatic conditions are suitable. Over the last few years, Bangladesh has acquired startling production in the agricultural sector and rice plays the most momentous role. Boro is the most important and single largest crop in Bangladesh in respect of volume of production. It has been persistently contributing to higher rice production in last successive years. In *haor*, crop agriculture is chiefly characterized by boro rice monoculture. Among the rice production in *haor* boro contributes 60 %, Aman 33 % and Aus 7%. Farmers of the *haor* area commonly are used to cultivate local boro (0.47 %), HYV boro (82.43 %) and Hybrid (17.10 %) especially BRRI dhan28, BRRI dhan29 [2]. Total rice growing area in the year 2017-2018 was 11.62 million hectares in Bangladesh which produced total 36.28 million metric tons. Total area under boro rice covered 4.8 million hectares with production of 19.58 million metric tons [3]. Due to flash flood in some northern and north-east districts, (boro) crop under 296701 hectare of land was fully damaged for 2016-17. Thousands of boro growers in Sunamganj were in fear of losing their crop due to attack by neck blast disease during 2017-2018. So, it is essential to adopt more accurate scientific steps for increasing the production level of rice. Crop yield reductions are strongly related with soil quality degradation, particularly nutrient depletions [4,5], which can be attributed to either insufficient fertilizer use or imbalanced fertilization [6,7]. The imbalanced fertilizer use in Bangladesh agriculture is speeding up nutrients depletion [8,9]. So there is a scope to enhance the rice production by adopting location based varieties with proper fertilizers package application in this region which will contribute to the national rice production. Keeping the fact in mind, a study was taken to observe the growth and yield of boro rice varieties affected by fertilizers packages in boro rice in *haor* area.

2. Materials and Methods

The experiment was conducted at Noagaon village of South Sunamganjupazila (sub-district) in Sunamganj district during November 2017 to April 2018 using three rice varieties viz. V_1 = BRR1 dhan28, V_2 = BRR1 dhan29 and V_3 = BRR1 dhan58 and two fertilizers packages viz. F_1 = $N_{150}P_{24}K_{99}S_{18}Zn_{2.6}$ (FRG-2012) and F_2 = $N_{57}P_{12}K_{12}S_4$ (Farmers' practice). Two factor experiment was laid out with Randomized Complete Block Design (RCBD) and replicated thrice. The experimental sites belong to soils of Sylhet Basin (AEZ-21). The size of unit plot was 5 m × 4 m i.e. 20 m². Seeds were sown on the seedbed on 25 November, 2017 for raising nursery seedlings. Seedlings were transplanted on 1 January, 2018 at 25 cm × 15 cm spacing. The fertilizers were applied as basal dose except urea. Urea was applied as top dressing in three equal splits at 15, 30 and 45 days after transplanting. Diazinon at 1.2 ha⁻¹ was used once on 25 February, 2018 to control insects. The experimental field was frequently monitored and necessary management practices such as 4-5 irrigations, 3-4 weedings, pesticide application was performed as per requirement. Five hills were tagged for collecting the growth data viz. plant height, number of total tillers hill⁻¹, yield data viz. productive tillers hill⁻¹, non-productive tillers hill⁻¹, grains panicle⁻¹, sterile spikelets panicle⁻¹, 1000-grain weight, grain yield and straw yield were recorded timely. Harvesting was done on 19-28 April 2018. The grain and straw yields were recorded from whole plot basis. The data was analyzed using R package software and means were adjudged by DMRT (Gomez and Gomez, 1984).

3. Results and Discussion

The plant heights of boro rice varieties were significantly affected at 60 DAT and at harvest. The tallest plants were of 79.13 and 98.23 cm, attained at 60 DAT and at harvest, respectively for BRR1 dhan28. The shortest plants (67.13 and 85.83 cm, respectively) were showed by BRR1 dhan29 at 60 DAT and at harvest. Hasanuzzaman *et al.* [10], found similar height in BRR1 dhan29 in their experiment. Plant height had significant variation due to fertilizers packages application at 45, 60 DAT and at harvest. The tallest plants of 39.16, 52.00, 78.93 and 95.16 cm were observed when applied the recommended package of fertilizers (FRG'12) at 30, 45, 60 DAT and at harvest, respectively. The shortest plants (37.18, 45.13, 69.53 and 85.49 cm, respectively) were recorded at 30, 45, 60 DAT and at harvest in farmers' practiced treatment. At harvest, interaction effect of varieties and fertilizer packages on plant heights significantly differed. The highest length of plant was of 106.87 cm found in respect of BRR1 dhan28 with recommended fertilizers application. The lowest length (79.80 cm) was recorded in BRR1 dhan29 with farmers' practiced treatment. Significant effect of chemical fertilizers has also been observed on plant height of rice by many others in the past [11].

Table 1: Effects of varieties, fertilizer packages and their interactions on plant height of boro rice in *haor* area

Treatments	Plant height (cm)			
	30 DAT	45 DAT	60 DAT	At harvest
BRR1 dhan28	39.77	50.20	79.13a	98.23 a
BRR1 dhan29	35.93	46.17	67.13b	85.83b
BRR1 dhan58	38.80	49.33	76.47a	86.90b
Level of significance	NS	NS	**	**
Fertilizers packages				
FRG'12	39.16	52.00a	78.93a	95.16a
Farmers' practice	37.18	45.13b	69.53b	85.49b
Level of significance	NS	**	**	**
Varieties x Fertilizers packages				
V_1F_1	40.47	54.07	84.93	106.87a
V_1F_2	39.07	46.33	73.33	89.60b
V_2F_1	36.47	48.53	70.00	91.87b
V_2F_2	35.40	43.80	64.20	79.80c
V_3F_1	40.53	53.40	81.87	86.73bc
V_3F_2	37.07	45.27	71.07	87.07bc
Level of significance	NS	NS	NS	*
CV (%)	7.81	5.76	5.12	5.70

** indicates significant at 0.5%, *** indicates significant at 1%, 'NS' indicates non-significant, V_1 - BRR1 dhan28, V_2 - BRR1 dhan29, V_3 - BRR1 dhan58, FRG'12-Fertilizer recommendation guide, 2012, DAT-Days after transplanting, CV-Coefficient of Variance

The highest number of total tillers hill⁻¹ was of 16.27, recorded for both BRR1 dhan28 and BRR1 dhan29 at 60 DAT. The highest number of total tillers was of 14.00 in BRR1 dhan28 and the lowest (11.53) in BRR1 dhan29. Application of recommended fertilizers package at 60 DAT had also significant variation over farmers' practiced fertilizers application. Higher tiller number (15.87) was obtained with national recommended package of chemical fertilizers and lower (13.49) was recorded in farmers' practiced. According to Hasanuzzaman *et al.* [10], at initial stage of growth, fertilizers application at recommended package produced the highest tillers number hill⁻¹. The highest total tillers number (14.13) was recorded for BRR1 dhan28 with recommended fertilizers application and the lowest (9.60) was observed in BRR1 dhan29 with fertilizers application at recommended package at harvest. Sarfaraz *et al.* [12], conducted a field experiment with the application of NPKS in rice. They observed that the number of tillers, significantly increased with the application of NPKS over control.

Table 2: Effects of varieties, fertilizer packages and their interactions on tillers hill⁻¹ of boro rice in *haor* area

Treatments	Number of tillers hill ⁻¹			
	30 DAT	45 DAT	60 DAT	At harvest
BRR1 dhan28	10.43	14.67	16.27a	14.00a
BRR1 dhan29	10.00	14.00	16.27a	11.53b
BRR1 dhan58	7.83	11.23	11.50b	11.67b
Level of significance	NS	NS	**	*

Fertilizers packages				
FRG'12	9.84	13.80	15.87a	12.38
Farmers' practice	9.00	12.8	13.49b	12.42
Level of significance	NS	NS	*	NS
Varieties x Fertilizers packages				
V ₁ F ₁	11.33	15.13	19.07	14.13a
V ₁ F ₂	9.53	14.20	13.47	13.87a
V ₂ F ₁	9.87	14.33	16.80	9.60b
V ₂ F ₂	10.13	13.67	15.73	13.47a
V ₃ F ₁	8.33	11.93	11.73	13.40a
V ₃ F ₂	7.83	10.53	11.27	9.93b
Level of significance	NS	NS	NS	**
CV (%)	20.61	17.83	14.45	12.85

** indicates significant at 0.5%, *** indicates significant at 1%, 'NS' indicates non-significant, V₁ -BRRRI dhan28, V₂ - BRRRI dhan29, V₃ - BRRRI dhan58, FRG-Fertilizer recommendation guide, DAT-Days after transplanting, CV-Coefficient of Variance

The highest number of productive tillers hill⁻¹ (13.03) was attained by BRRRI dhan28 among the varieties. The number of productive tillers hill⁻¹ appreciably increased (12.84) due to recommended fertilizers over farmers' practiced (9.82) fertilizers package. Islam *et al.* [13], also reported a significant increasing trend in tillering by applying chemical fertilizers.

Varieties were responded statistically insignificant way on producing non-productive tillers hill⁻¹. Similar results were found in Kashem *et al.* [14]. In case of fertilizer treatments, there was found a clear and startling indication to apply recommended fertilizers package. The national recommended fertilizers application produced lower number (0.97) of non-productive tillers hill⁻¹ where farmers' practiced fertilizers package produced higher number (1.47). The results might be the cause of proper fertilizers application. The interaction effect of varieties and fertilizers had no significant effect.

Number of grains panicle⁻¹ was not statistically significant but numerically the highest number (105.57) was recorded in BRRRI dhan28 and the lowest (102.27) was for BRRRI dhan58. Fertilizers packages also showed non-significant relation but the higher value (109.87) was obtained due to applying recommended fertilizers package over farmers' practiced (98.49). There was no significant variation among the interactions of varieties and fertilizer treatments in grains panicle⁻¹. But Razzaque [15] found the grains panicle⁻¹ significantly increased due to the application of chemical fertilizers. Sterile spikelets panicle⁻¹ also found non-significant variation among the varieties. Apparently, effect of fertilizers packages on spikelet sterility was insignificant but the higher value was showed due to recommended fertilizers package over farmers' package. Interaction effect was as similar as in grains panicle⁻¹.

Table 3: Effects of varieties, fertilizer packages and their interactions on yield attributes of boro rice in haor area

Treatments	Effective tillers hill ⁻¹ (no.)	Non-effective tillers hill ⁻¹ (no.)	Grains panicle ⁻¹ (no.)	Sterile spikelets panicle ⁻¹ (no.)
Varieties				
BRRRI dhan28	13.03 a	1.22	105.57	32.73 b
BRRRI dhan29	10.33 b	1.23	104.70	47.97 a
BRRRI dhan58	10.63 b	1.21	102.27	44.00 ab
Level of significance	*	NS	NS	NS
Fertilizers packages				
FRG'12	12.84 a	0.97 b	109.87	39.33
Farmers' practice	9.82 b	1.47 a	98.49	43.80
Level of significance	**	*	NS	NS
Varieties x Fertilizers packages				
V ₁ F ₁	13.67	0.90	105.87	30.80
V ₁ F ₂	12.40	1.54	105.27	34.67
V ₂ F ₁	12.60	0.83	108.53	42.47
V ₂ F ₂	8.07	1.61	100.87	53.47
V ₃ F ₁	12.27	1.17	115.20	44.73
V ₃ F ₂	9.00	1.27	89.33	43.27
Level of significance	NS	NS	NS	NS
CV (%)	14.39	35.52	10.81	26.03

** indicates significant at 0.5%, *** indicates significant at 1%, 'NS' indicates non-significant, V₁ -BRRRI dhan28, V₂ - BRRRI dhan29, V₃ - BRRRI dhan58, FRG-Fertilizer recommendation guide, CV-Coefficient of Variance

Weight of 1000 grains varied significantly among the varieties. BRRRI dhan29 produced the highest weight of 22.67 g followed by BRRRI dhan58 of 22.33 g. Recommended fertilizers package also produced higher grains weight of 22.67 g while in conventional fertilizers application was of 21.33 g. Hossain *et al.* [16] reported that micronutrient deficiency might limit the grain yield of rice by reducing tillering and grain formation. There was no significant variation among the interactions of varieties and fertilizer treatments in 1000 grains weight.

Table 4: Effects of varieties, fertilizer packages and their interactions on yield attributes of boro rice in haor Area

Treatments	1000 -grains weight (g)	Grain yield (t ha ⁻¹)	Straw yield (t ha ⁻¹)
Varieties			
BRRRI dhan28	21.00 b	5.35 b	7.84 b
BRRRI dhan29	22.67 a	7.28 a	10.72 a
BRRRI dhan58	22.33 ab	4.23 c	7.09 b
Level of significance	*	**	**
Fertilizers packages			
FRG'12	22.67 a	5.98 a	9.22 a
Farmers' practice	21.33 b	5.13 b	7.88 b
Level of significance	*	*	*
Varieties x Fertilizers packages			
V ₁ F ₁	20.67	5.85	8.57
V ₁ F ₂	21.33	4.85	7.11

V ₂ F ₁	22.00	7.28	12.11
V ₂ F ₂	23.33	6.89	9.33
V ₃ F ₁	21.33	4.80	6.98
V ₃ F ₂	23.33	3.65	7.20
Level of significance	NS	NS	NS
CV (%)	4.98	11.57	16.83

‘*’ indicates significant at 0.5%, ‘**’ indicates significant at 1%, ‘NS’ indicates non-significant, V₁ -BRR1 dhan28, V₂ - BRR1 dhan29, V₃ - BRR1 dhan58, FRG-Fertilizer recommendation guide, CV-Coefficient of Variance

The highest grain yield was of 7.28 t ha⁻¹, recorded in BRR1 dhan29 and the lowest yield (4.23 t ha⁻¹) was observed in BRR1 dhan58. Higher grain yield (5.98 t ha⁻¹) were showed in case of recommended package of fertilizers over farmers’ practice (5.13t ha⁻¹). Islam *et al.* [13] observed that application of chemical fertilizers increased grain yield of BR11 rice by 34%. Interaction effect of variety and fertilizer on grain yield found non-significant. Grain yield were found 4.40, 4.05, 4.45 3.90, 4.30 and 3.80 t ha⁻¹ due to V₁F₁, V₁F₂, V₂F₁, V₂F₂, V₃F₁ and V₃F₂, respectively. Straw yield followed more or less similar pattern of results as in grain yield stated above.

4. Conclusion

Results revealed that BRR1 dhan29 produced better production with recommended fertilizers package.

5. Acknowledgment

The authors acknowledged the funding by Krishi Gobeshona Foundation (KGF) under the project of “Farm Productivity Improvement in *Haor* Areas through Integrated Farming Systems Approach”.

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