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EFFECTS OF FERTILIZERS ON GROWTH AND YIELD OF BORO RICE VARIETIES AT DEKAR HAOR IN SUNAMGANJ DISTRICT

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Abstract

An experiment was conducted from November 2018 through April 2019 at Noagaon village of South Sunamganj Upazila in Sunamganj District to observe the effects of fertilizers on the growth and yield of boro rice varieties. Two factors experiment was conducted using three rice varieties viz. V_1=BRRI dhan28, V_2=BRRI dhan29 and V_3=BRRI dhan58; and two fertilizers levels viz. F_1= $N_{138}P_{22.4}K_{63.5}S_{13.5}Zn_{1.3}$kg ha^{-1} (FRG-2012) and F_2=$N_{57}P_{12}K_{12}$kg ha^{-1} (Farmers' practice) where Randomized Complete Block Design (RCBD) was followed and replicated thrice. Growth and yield data were recorded. Results of the experiment showed that growth performance was higher in V_1 followed by V_2. The highest spikelets $panicle^{-1}$ (253.23) and grains $panicle^{-1}$ (162.57) were recorded from V_2. F_1 also gave a higher performance in no. of spikelets $panicle^{-1}$ (189.81) and grains $panicle^{-1}$ (132.74) over F_2. The highest 1000 grains weight (22.55 g) was observed in V_2 and higher (22.28 g) found in F_1. The highest grain yield of 7.66 t ha^{-1} was produced in V_2, and the lowest yield (6.08 t ha^{-1}) was produced in V. The higher yield of 7.18 t ha^{-1}obtained from F_1 over F_2(6.23 t ha^{-1}). V_2 produced the 14 % higher grain yield (8.17 t ha^{-1}) with the application of F_1 over F_2. The highest BCR (1.54) was found when V_2 was treated with F_1, and the lowest BCR (1.19) was observed in$V_1$with F_2. In comparison to initial soil nutrients status as well as the organic matter was increased in post-harvest soil when applied balanced fertilizers.

Keywords: Variety, *Haor*, Balanced fertilizer, BCR, Nutrient status.

Introduction

Bangladesh has achieved startling national economy as increasing trends which is strongly corroborated by the crop production of the country. The crop sector of Bangladesh is dominated by intensive rice (*Oryza sativa* L.) cultivation due to compatibility of soil and climatic conditions. Over the last few years, Bangladesh has acquired solo rice production in the agricultural sector, estimated at about 36.60 million metric tons covering 11.42 million hectares, and ranked fourth in the world's rice production (BBS, 2020). Boro is the most important and stand-alone largest crop (About 55 % of total rice) in Bangladesh with respect to the volume of production. It has been persistently contributing to higher rice production in the last successive years. The total area under boro rice covered 4.8 million hectares with a production of 19.64 million metric tons during 2019-2020 (BBS, 2020). In *haor* (a specialized wetland ecosystem), crop agriculture is chiefly dominated by boro rice monoculture. Farmers of the *haor* area commonly cultivate local boro (0.47 %), HYV *boro* (82.43 %), and Hybrid (17.10 %), especially BRRI dhan28, BRRI dhan29 (*Haor* Master Plan, 2012). Flash flood in some northern and northeast districts is very unfortunate to the boro crop that can damage the standing crops anytime. Thousands of boro growers in Sunamganj remain in fear of losing their crops due to early flash floods. Researchers tried for several years to adapt BRRI dhan58 among the farmers of that area. BRRI dhan58 can be harvested 7-10 days earlier than BRRI dhan29 ,which can ignore the flash flood with better production due to balanced fertilizer application. Short duration with proper fertilization of boro is now the prime concern of the *haor* farmers. It is also needed to focus on increasing the production through the scientific way of fertilizers application.

Crop yield reductions are strongly related to soil quality degradation, particularly nutrient depletions, which can be attributed to either insufficient fertilizer use or imbalanced fertilization. The imbalanced fertilizer use in Bangladesh

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agriculture is speeding up nutrient depletion. A number of the survey revealed that the farmers of *haor* areas are used to applying imbalance fertilizers in boro rice cultivation (Ali, 2016; Aziz, 2020; Saha, 2020). Keeping the fact in mind, the present study was undertaken to observe the effects of fertilizers on the growth and yield of boro rice varieties in *haor* areas.

Materials and Methods

The experiment was carried out at *Dekar haor* of South Sunamganj Upazila in Sunamganj District from November 2018 through April 2019. Two factors experiment was conducted using three rice varieties viz. V_1 = BRRI dhan28, V_2 = BRRI dhan29, and V_3 = BRRI dhan58; and two fertilizers levels viz. $F_1 = N_{138}P_{22.4}K_{63.5}S_{13.5}Zn_{1.3}$ kg ha^{-1}(FRG-2012) and $F_2 = N_{57}P_{12}K_{12}$ kg ha^{-1}(Farmers' practice). The experiment was designed with Randomized Complete Block Design (RCBD), and three replications were taken in farmers fields. The experimental sites belong to soils of Sylhet Basin (AEZ-21). The size of the unit plot was 5 m × 4 m i.e. 20 m^2. Seeds were sown on the seedbed on 25 November 2018 for raising nursery seedlings. Seedlings were transplanted on 1 January 2019 at 25 cm × 15 cm spacing. The fertilizers were applied as basal dose except for urea. Urea was applied as a top dressing in three equal splits at 15, 30, and 45 days after transplanting. The experimental field was frequently monitored, and necessary management practices such as five times irrigations, four times weeding, and pesticide application once were performed as per requirement. Five hills were tagged for collecting data viz. plant height (cm), number of total tillers hill^{-1}, total spikelets panicle^{-1} (no.), grains panicle^{-1} (no.), 1000 grains weight (g). The grain and straw yields were recorded on a whole plot basis and converted into a per ha basis. Initial and post-harvest soils were analyzed and calculated following standard methodologies. Economic analysis was done using a simple calculation of the cost of rice production, including material and non-material costs. The benefit cost ratio (BCR) was calculated from the gross return to the cost of production. The data were analyzed by using R package software, and means were adjudged by DMRT (Gomez and Gomez, 1984).

Results and Discussions

Growth parameters

The varieties showed statistically significant variations in plant height on different days after planting (Table 1). The tallest plant was recorded from BRRI dhan28, and the shortest was from BRRI dhan58 on all days after planting (DAT). The tallest plants were of 50.35, 68.87, 95.95 and 99.35 cm measured in the case of BRRI dhan28 followed by BRRI dhan29 at 30, 45, 60 DAT, and at harvest, respectively. The shortest plants were 42.77, 61.73, 71.43, and 92.13 cm found from BRRI dhan58 at 30, 45, 60 DAT, and at harvest, respectively. Growth variations trends might be the reason for the varietal characteristics. During 2016-2017, a Ph.D. research was conducted in a *haor* area where BRRIdhan28 was the tallest plant (104.0 cm), and the lowest height (91.8 cm) was found in BRRI dhan29 which was statistically identical to BRRIdhan58 (Saha,2020). Hasanuzzaman *et al.*, (2009) found similar growth trends in BRRI dhan29 in the experiment. Balanced fertilizers application showed a significant increase in plant height. The taller plants were recorded when treated with FRG-2012, and shorters were found when applied to farmers' standard practices fertilizers. Plant heights of 51.08, 71.63, 93.82, and 104.71 cm were recorded when applied $N_{138}P_{22.4}K_{63.5}S_{13.5}Zn_{1.3}$ kg ha^{-1}(FRG-2012) on 30, 45, 60 DAT and at harvest, respectively. The shortest plants were 42.04, 57.52, 78.43, and 88.30 cm found when fields were treated with common farmers' practice fertilizers ($N_{57}P_{12}K_{12}S_4$kg ha^{-1}). The effects of recommended NPKS rates reported significantly increased in plant height (Singaravel *et al.*, 2007; Aziz, 2020; Saha, 2020). The interaction effect had no significant differences in plant height on different days after planting except 45 DAT. At 45 DAT, the tallest plant was 75.97 cm, found in BRRI dhan28 with balanced fertilizer application (V_1F_1) followed by BRRI dhan29 with balanced fertilizers (V_2F_1). In all cases, BRRI dhan28 with BARC recommended fertilizers produce the highest length of plants over the farmers' practice. Growth performance of BRRI dhan28 was positively responded in case of FRG-based recommended fertilizers application over farmers' practiced fertilizers.

Table 1. Performance of rice varieties on growth parameters

Variety	Plant height (cm)				Number of tillers hill^{-1}			
	30 DAT	45 DAT	60 DAT	At harvest	30 DAT	45 DAT	60 DAT	At harvest
BRRI dhan28	50.35a	68.87a	95.95a	99.35a	14.05	16.45	15.57	18.35a
BRRI dhan29	46.57b	63.13b	91.00b	98.03a	13.72	16.63	14.90	16.83ab
BRRI dhan58	42.77c	61.73b	71.43c	92.13b	13.95	17.43	15.00	14.17b
Level of significance	**	*	**	*	NS	NS	NS	*
Fertilizers								
$N_{138}P_{22.4}K_{63.5}S_{13.5}Zn_{1.3}$ kg ha^{-1}(FRG-2012)	51.08a	71.63a	93.82a	104.71a	15.86a	18.78a	17.00a	18.04a
$N_{57}P_{12}K_{12}$ kg ha^{-1} (Farmers' practice)	42.04b	57.52b	78.43b	88.30b	11.96b	14.90b	13.31b	14.86b
Level of significance	**	**	**	*	*	*	*	*
Variety × Fertilizers								
V_1F_1	53.33	75.97a	105.13	106.53	13.83	17.27	16.17	18.97a
V_1F_2	47.37	61.77b	86.77	92.17	14.27	15.63	14.97	17.73ab
V_2F_1	51.57	74.47a	98.27	106.37	15.87	19.17	17.47	19.13a
V_2F_2	41.57	51.80c	83.73	89.70	11.57	14.10	12.33	14.53bc
V_3F_1	48.33	64.47b	78.07	101.23	17.87	19.90	17.37	16.03abc
V_3F_2	37.20	59.00bc	64.80	83.03	10.03	14.97	12.63	12.30c
Level of significance	-	*	NS	NS	NS	NS	NS	*
CV (%)	5.82	6.43	3.85	4.18	21.90	20.78	17.81	13.40

'*' indicates significant at 0.5%,'**' indicates significant at 1%, NS' indicates non-significant, V_1 -BRRI dhan28, V_2 - BRRI dhan29, V_3 - BRRI dhan58, F_1 = $N_{138}P_{22.4}K_{63.5}S_{13.5}Zn_{1.3}$ kg ha^{-1}(FRG-2012), F_2 = $N_{57}P_{12}K_{12}$ kg ha^{-1}(Farmers' Practice), CV(%)-Coefficient of Variance (%)

The number of tillers hill^{-1}did not vary at growth stages but varied at harvest. At harvest, the highest no. of tillers hill^{-1} was counted in BRRI dhan28 (18.53), which were statistically similar in BRRI dhan29 (16.83). The lowest (14.17) tiller numbers were found in BRRI dhan58. Application of balanced fertilizers in the field showed significant differences in the number of tillers hill^{-1}. BARC recommended fertilizers @ $N_{138}P_{22.4}K_{63.5}S_{13.5}Zn_{1.3}$kg ha^{-1} gave higher of 15.86, 18.78, 17.00 and 18.04 numbers of tillers hill^{-1}at 30, 45, 60 DAT and at harvest, respectively. Sarfaraz *et al.* (2002) observed that the number of tillers significantly increased with the application of NPKS over control. Islam *et al*. (1996) reported a significant ascending trend in tillers number by applying chemical fertilizers. Lower tiller numbers were of 11.96, 14.90, 13.31 and 14.86 found at 30, 45, 60 DAT and at harvest, respectively. According to Hossain *et al.* (1997), micronutrient deficiency might limit the tillers number. Similarly, non-significant results were observed due to

the interaction effect of varieties and fertilizers except at harvest. At harvest, the highest number of tillers (19.13) was found in the case of BRRI dhan29 with $N_{138}P_{22.4}K_{63.5}S_{13.5}Zn_{1.3}$ kg ha^{-1}fertilizers application (V_2F_1) followed by BRRI dhan28 with balanced fertilizers (V_1F_1) and BRRI dhan58 with balanced fertilizers application (V_3F_1).

Yield and yield attributes

Varieties had a significant difference in respect of total spikelets $panicle^{-1}$ (no.), grains $panicle^{-1}$(no.), grain yield (t ha^{-1}), and straw yield (t ha^{-1}) (Table 2). The highest number of total spikelets (253.23) was recorded in case of BRRI dhan29, which was followed by BRRI dhan58 (157.82) and the lowest (124.60) was in BRRI dhan28. Similar trends were observed in grains $panicle^{-1}$. Razzaque (1996) found the grains $panicle^{-1}$ significantly increased due to the application of chemical fertilizers. Numerically the highest (22.55 g) weight of 1000 grains was observed in the case of BRRI dhan29. Balanced fertilizers application also gave a higher (22.28 g) result over farmers' practice fertilizers (21.67).

Table 2. Performance of rice varieties on yield and yield attributes

Variety	Total spikelets $panicle^{-1}$(no.)	Grains $panicle^{-1}$ (no.)	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
BRRI dhan28	124.60c	87.90c	21.71	6.08b	8.53a
BRRI dhan29	253.23a	162.57a	22.55	7.66a	9.23a
BRRI dhan58	157.82b	126.17b	21.67	6.37ab	7.25b
Level of significance	**	**	NS	*	*
Fertilizers					
$N_{138}P_{22.4}K_{63.5}S_{13.5}Zn_{1.3}$ kg ha^{-1}(FRG-2012)	189.81a	132.74	22.28	7.18	9.02a
$N_{57}P_{12}K_{12}$ kg ha^{-1}(Farmers' practice)	167.28b	118.35	21.67	6.23	7.67b
Level of significance	*	NS	NS	NS	**
Variety × Fertilizers					
V_1F_1	125.66cd	86.13	21.91	6.58	10.06a
V_1F_2	123.55d	89.67	21.53	5.59	7.01b
V_2F_1	285.68a	180.65	23.17	8.17	9.84a
V_2F_2	220.77b	144.49	21.93	7.14	8.62ab
V_3F_1	158.10c	131.43	21.78	6.77	7.15b
V_3F_2	157.53c	120.90	21.56	5.97	7.37b
Level of significance	*	NS	NS	NS	*
CV (%)	10.38	13.66	4.56	17.65	10.85

*' indicates significant at 0.5%,'**' indicates significant at 1%, NS' indicates non-significant, V_1 -BRRI dhan28, V_2 - BRRI dhan29, V_3 - BRRI dhan58, F_1 = $N_{138}P_{22.4}K_{63.5}S_{13.5}Zn_{1.3}$ kg ha^{-1} (FRG-2012), F_2 =$N_{57}P_{12}K_{12}$ kg ha^{-1} (Farmers' Practice), CV(%)-Coefficient of Variance (%)

The highest grain yield was 7.66 t ha^{-1} recorded in BRRI dhan29 followed by BRRI dhan58 (6.37 t ha^{-1}), and the lowest (6.08 t ha^{-1}) was recorded in BRRI dhan28. Banu *et al.*, (2009) reported that the recommended fertilizer dose produced the highest grain yield over the farmers' practice fertilizers. In respect of straw yield, BRRI dhan29 produced the

highest yield of 9.23 t $ha^{-1,}$ which was followed by BRRI dhan28 (8.53 t ha^{-1}) and the lowest was found in the case of BRRI dhan58 (7.25 t ha^{-1}). Similar results were reported by Kashem *et al.,* (2016). The varieties showed a clear and startling positive response to applying BARC recommended fertilizers in *Haor* areas. Saha *et al.,* (2009) observed that the straw yield of boro rice was generally higher with the application of BARC recommended fertilizers compared with farmers' practice fertilizers. Ali *et al.* (2009) found that the application of 100% NPKS increased both the grain and straw yield of boro rice.

Interaction effect of variety and fertilizers packages found non-significant in case of grains panicle, 1000 grains weight and grain yield. Total spikelets $panicle^{-1}$ was found to be significant where BRRI dhan29 produced the highest number of spikelets $panicle^{-1}$ (285.68) with recommended fertilizers application (V_2F_1), and the lowest (123.55) was found in BRRI dhan28 with farmers' practice fertilizers (V_1F_2). Number of grains $panicle^{-1}$ was observed 86.13, 89.67, 180.65, 144.49, 131.43 and 120.90 due to V_1F_1, V_1F_2, V_2F_1, V_2F_2, V_3F_1 andV_3F_2, respectively. 1000-grains weight was showed 21.91, 21.53, 23.17, 21.93, 21.78 and 21.56 g due to V_1F_1,V_1F_2, V_2F_1, V_2F_2,V_3F_1 andV_3F_2,respectively.Grain yield of 6.58, 5.59, 8.17, 7.14, 6.77 and 5.97 t ha^{-1} were obtained due to V_1F_1,V_1F_2, V_2F_1, V_2F_2, V_3F_1 andV_3F_2,respectively. Straw yield showed significant variation where the highest yield (9.84 t ha^{-1}) was found in the case of BRRI dhan29 with recommended fertilizers (V_2F_1). Moreover, the lowest (7.01 t ha^{-1}) straw yield was for BRRI dhan28 with farmers' practice fertilizers application (V_1F_2). BARC recommended fertilizers used in the experiment and showed clear positive trends toward the boro rice performance. All yield parameters were found in higher trends due to FRG-2012 fertilizers application over the farmers' practice.

Cost of production

The cost of production varied from Tk.70205 to Tk. 79420 ha^{-1} due to fertilizer application (Table 3).

Table 3. Cost of production and return with BCR of rice due to balanced fertilizer application in *haor* areas

Treatments	Cost of production (Tk. ha^{-1})	Gross return (Tk. ha^{-1})	Net return (Tk. ha^{-1})	BCR
Variety				
BRRI dhan28	79420	91200	11780	1.15
BRRI dhan29	79420	114900	35480	1.45
BRRI dhan58	79420	95550	16130	1.20
Fertilizer				
$N_{138}P_{22.4}K_{63.5}S_{13.5}Zn_{1.3}$ kg ha^{-1} (FGR, 2012)	79420	107700	28280	1.36
$N_{57}P_{12}K_{12}$kg ha^{-1}(Farmers' practice)	70205	93450	23245	1.33
Variety × Fertilizer				
V_1F_1	79420	98700	19280	1.24
V_1F_2	70205	83850	13645	1.19
V_2F_1	79420	122550	43130	1.54
V_2F_2	70205	107100	36895	1.53
V_3F_1	79420	101550	22130	1.28
V_3F_2	70205	89550	19345	1.28

Market price of rice was Tk. 15 kg^{-1}, straw price was Tk. 2.5 kg^{-1} V_1 - BRRI dhan28, V_2 - BRRI dhan29, V_3 - BRRI dhan58, $F_1 = N_{138}P_{22.4}K_{63.5}S_{13.5}Zn_{1.3}$ kg ha^{-1} (FRG-2012), $F_2 = N_{57}P_{12}K_{12}$ kg ha^{-1}(Farmers' Practice)

In the case of variety, the gross return of rice production ranged from Tk. 112525 to Tk. 137075. The gross return ranged from Tk.83850 to Tk. 122550 for different interaction effects. The highest net return (Tk. 35480) was recorded in BRRI dhan29, whereas the lowest net return (Tk. 11780) came from BRRI dhan28. Among varieties, the highest BCR (1.45) was recorded in BRRI dhan29 while the lowest BCR (1.15) was found in BRRI dhan28. The highest BCR was 1.54, found when BRRI dhan29 was treated with balanced fertilizers (V_2F_1), and the lowest BCR (1.19) was

observed from BRRI dhan28 with the application of farmers' practice fertilizers (V_1F_2). The main difference among the BCR might be the positive response of balanced fertilizers on the varieties used in the field over farmers' practice.

Nutrient status of initial and post-harvest soil

Soil nutrient in the experimental field was analyzed to observe both initial and post-harvest soil fertility status (Table 4). The pH value in initial soil was 5.27, while pH in post-harvest soil was 5.2 when applied with BARC recommended fertilizer. The initial soil organic matter was 1.55%, while the organic matter in post-harvest soil was recorded higher (1.66%) due to the application of balanced fertilizer. Lower organic matter (1.63%) in post-harvest soil was recorded with farmers' practice fertilizers. The organic matter status (OM) slightly increased in post-harvest soil.

Table 4. Nutrient status of post-harvest soil due to application of balanced fertilizers

Soil/Treatment	pH	OM (%)	Total N(%)	Available P(ppm)	K (meq 100 g^{-1} soil)	Available S(ppm)	Available Zn(ppm)
Initial soil	**5.27**	**1.55**	**0.089**	**6.50**	**0.14**	**17.67**	**0.137**
Post-harvest soil							
$N_{138}P_{22.4}K_{63.5}S_{13.5}Zn_{1.3}$ kg ha^{-1}(FRG-2012)	5.2	1.66	0.102	11.20	0.20	26.24	2.35
$N_{57}P_{12}K_{12}$kg ha^{-1}(Farmers' practice)	4.9	1.63	0.082	7.16	0.17	17.1	0.84

F_1 = $N_{138}P_{22.4}K_{63.5}S_{13.5}Zn_{1.3}$ kg ha^{-1} (FRG-2012), F_2 = $N_{57}P_{12}K_{12}$ kg ha^{-1}(Farmers' Practice); OM=Organic matter, N= Nitrogen, P=Phosphorous, K= Potassium, S= Sulphur and Zn= Zinc

The total N in initial soil was 0.089%, whereas the total N in post-harvest soil due to the application of balanced fertilizers and farmers' practice fertilizer was recorded at 0.102% and 0.082%, respectively. The available P of the initial soil was 6.50 ppm. The available P in post-harvest soil was found higher (11.20 ppm) when applied with balanced fertilizers. The exchangeable K, available S, and available Zn in initial soil was 0.14 meq/100 g, 17.67 ppm, and 0.137 ppm, respectively. Higher exchangeable K (0.20 meq/100 g), available S (26.24 ppm), and available Zn (2.35 ppm) values were observed in balanced fertilized post-harvest soil while these values in farmers' practiced post-harvest soil were 0.17 meq/100 g, 17.1 ppm, and 0.84 ppm, respectively. After using BARC-recommended balanced fertilizers, the nutrient status of post-harvest soil showed positive trends to improve fertility status over farmers' practice fertilizers. Organic matter and N-P-K-S-Zn were in an increasing trend, while pH was almost stable in post-harvest soils in comparison to initial soil. Similar results were also reported by Saha (2020). Kumar and Yadav (2008) reported that balanced and high doses of NPK fertilizers are required to maintain soil fertility.

Conclusion

The BRRI dhan29 produced the highest grain yield, which was statistically similar to BRRI dhan58 with field duration advantage. Results also revealed that the BARC recommended balanced fertilizers application was gave a higher yield over farmers' practice fertilizers.

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