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EFFECT OF FERTILIZER ON THE GROWTH AND YIELD OF MODERN FINE RICE VARIETIES IN ACID SOIL

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Abstract

Pot experiments were conducted at the net house of Department of Soil Science, Sylhet Agricultural University campus, Sylhet during the period from November 2015 to May 2016 and November 2016 to May 2017 to find out the effect of fertilizer on the growth, yield and yield contributing characters of fine boro rice varieties. Two varieties (BRRI dhan50 and BRRI dhan63) and two fertilizer treatments (NPKSZn recommendation and 50% of NPKSZn recommendation) were included in the experiment. The recommended fertilizer dose was NPKSZn @ 138-22.4-63.5-13.5-1.3 kg ha^{-1}. The experiment was laid out in a two factors Completely Randomized Design (CRD) with three replications and continued for consecutive two years. During 2015-16 the tallest plant (70.65 cm) and the higher no. of tillers $hill^{-1}$ (13.73) was produced by BRRI dhan63 but during 2016-17 the higher no. of tillers $hill^{-1}$ (15.54) was produced by BRRI dhan63. The tallest plant (70.86 cm and 57.67 cm) and the highest no. of tillers $hill^{-1}$ (14.11 and 20.06) was produced due to application of NPKSZn as per recommendation. The higher grain yield of 39.20 g pot^{-1} and 78.21 g pot^{-1} and straw yield of 66.86 g pot^{-1} and 95.18 g pot^{-1} were recorded from the variety BRRI dhan63. The grain yield was significantly affected due to fertilizer application. The lower grain yield of 41.58 g pot^{-1} and 56.68 g pot^{-1} were observed in the NPKSZn fertilizers as 50% of recommendation. The higher grain yield 48.02 g pot^{-1} and 86.00 g pot^{-1} were recorded in NPKSZn due to recommended fertilizer application. The highest grain yield was also obtained due to effect of in the interaction of BRRI dhan63 with application of recommended NPKSZn fertlizer.

Keywords: Fertilizer, growth, yield and fine rice.

Introduction

Soil fertility has been engaging the attention of soil scientists and agronomists of the country since late fifties. Till the introduction of fertilizer responsive high yielding varieties in sixties, it was mostly subsistence agriculture with very low yields without showing any stress on soil fertility. The data from agricultural research station before 1965 hardly showed any significant response to added P and K. Even with N, the responses were not significant (Islam, 2008). After the introduction of high yielding varieties and launching intensive cropping for maximum crop production per unit area and per unit time, rapid depletion of soil fertility has been observed almost all over the country. The most widely deficient nutrients in the soils are nitrogen, phosphorus, potassium and sulphur. Zinc deficiency is prevalent in calcareous soils and in light textured soils where cropping intensity has been increased. Acid soils are important issue because of its adverse effect on soil fertility and crop productivity. Geomorphologically acid sulphate soils, peat soils, acid basin clays, terrace soils and hill soils are slightly to strongly acidic in reaction. It is estimated that soils of 0.25 m ha lands across the country are very strongly acidic (pH<4.5), 3.70 m ha lands are strongly acidic (pH 4.5-5.5) and 2.74 m ha lands are slighty acidic (pH 5.6-6.5). Acid soils may constraints crop production in more than 30% of lands in this country. Acid soils possess toxic concentration of Al^{3+}, Fe^{3+} and Mn^{2+}, lower conc. of P and low availability of bases which together cause reduction in crop yield (FRG-2012). Until 1980, the farmers of Bangladesh used to supply three nutrients (N, P and K) to the soil. Proper soil fertility management is of prime importance in an endeavor to increase crop productivity as well as sustainable agriculture. Soil is the principal supplier of plant nutrients. Plant derives 13 essential nutrients out of 17 from the soil. Among the soil nutrients N, P and K are the primary macronutrients, S is secondary macronutrient and Zn is micronutrient that all play a key role to increase the production of rice. In the present study, the effect of fertilizers on the growth and yield of modern boro fine rice varieties in pot culture were evaluated.

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Materials and Methods

The pot experiments were conducted at the research net house of Sylhet Agricultural University campus, Sylhet during boro seasons of 2015-16 and 2016-17. Two factors experiment include variety (BRRI dhan50 and BRRI dhan63) and fertilizer package (F_1=$N_{138}P_{22.4}K_{63.5}S_{13.5}Zn_{1.3}$ and F_2=$N_{69}P_{11.2}K_{31.7}S_{6.7}Zn_{0.65}$) in the pot culture. The pots were made of cement having three holes at the bottom. Before filling with soil, these holes were covered with jeans cloth to prevent excess leaching of water and loss of soil due to washing away. Each pot was filled with 45 kg field soil. Standing water was maintained 2 - 3 cm in the pot throughout the growing period.

Table 1. Agronomic management in the pot culture

Management practices	Year	
	2015-2016	2016-2017
Seed sowing in seed bed	23 November 2015	25 November 2016
Seed rate (kg ha^{-1})	20	20
Pot preparation	Well pulverized and leveled	Well pulverized and leveled
Pot size	45.72 cm (diameter)	45.72 cm (diameter)
Planting method	Line	Line
Transplanting date	28 December 2015	01 January 2017
Spacing	18 cm × 18 cm	18 cm × 18 cm
Basal	F_1: 0-112-127-75-3.61 F_2: 0-56-63.5-37.5-1.80	F_1: 0-112-127-75-3.61 F_2: 0-56-63.5-37.5-1.80
1st top dress (N)	18 January 2016, 20 DAT*	21 January 2017, 20 DAT
2nd top dress (N)	01 February 2016, 35 DAT	04 February 2017, 35 DAT
3rd top dress (N)	22 February 2016, 55 DAT	24 February 2017, 55 DAT
Weeding (no.)	2	2
Water management	Standing water was maintained 2 - 3 cm in the field throughout the growing period.	Standing water was maintained 2 - 3 cm in the field throughout the growing period.
Insect/disease control	-	Marshal 10 ml10 l^{-1} water
Harvesting date	20 April 2016	22 April 2017

*=Days after transplanting

The pH of the initial soil was around 5.27, soil organic carbon 0.90%, soil organic matter 1.55%, available P 6.5 ppm, available S 17.67 ppm, available Zn 0.137 ppm and exchangeable K was 0.14 meq $100g^{-1}$ soil. Soil texture, pH, organic matter, available P, S, Zn and exchangeable K, were determined following standard methods (Black, 1965; Jackson, 1962; Walkley and Black, 1935; Olsen, *et al.,* 1954 and Page, *et al.,* 1982). Plant height (cm) and number of tillers $hill^{-1}$ were recorded for growth parameters. Data were recorded with 15 days interval starting from 15 days of transplanting up to 75 DAT and at harvest. Data on yield and yield contributing characters were collected after harvest. The plant heights were measured and tillers were counted from all hills of each pot. All four hills were collected from each pot to record the agronomic characters. The grain and straw yields were recorded from each pot. The experiments were conducted following completely randomized design and mean separation of data was done by DMRT (Gomez and Gomez, 1984).

Results and Discussion

Plant heights were measured at different days after transplanting (DAT) during 2015-16 varied significantly between two varieties (Table 2). The taller plant (70.65 cm) was produced by BRRI dhan63 at all growth stages. Plant height responded significantly due to application of two fertilizer doses (Table 2). The taller plant (70.86 cm) was produced for application of NPKSZn (recom.) when measured at harvest. Plant height varied significantly due to effect of interaction of varieties and application of fertilizer doses.

Table 2. Plant height of boro fine rice at different DAT as affected by variety, fertilizer and their interaction in acid soil during 2015-2016 and 2016-17

Treatments	Plant height (cm)					
	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	Harvest
Variety (2015-2016)						
BRRI dhan50	18.00 b	33.50 b	42.31 b	57.40 b	64.61 b	67.85 b
BRRI dhan63	21.43 a	35.25 a	47.10 a	60.81 a	69.96 a	70.65 a
LS	**	**	**	**	**	**
Fertilizer (2015-2016)						
$N_{138}P_{22.4}K_{63.5}S_{13.5}Zn_{1.3}$	19.50	36.05 a	46.93 a	60.40 a	69.71 a	70.86 a
$N_{69}P_{11.2}K_{31.7}S_{6.7}Zn_{0.65}$	19.93	32.25 b	42.48 b	57.81 b	64.86 b	67.63 b
LS	NS	**	**	**	**	**
Variety × Fertilizer (2015-2016)						
V_1F_1	16.50 d	29.50 d	39.23 d	54.40 c	60.30 d	65.46 d
V_1F_2	19.50 c	37.50 a	45.40 c	60.40 b	68.93 c	70.23 b
V_2F_1	22.50 a	35.00 c	48.46 a	61.23 a	70.50 a	71.50 a
V_2F_2	20.36 b	35.50 b	45.73 b	60.40 b	69.43 b	69.80 c
S_x	0.056	0.068	0.054	0.098	0.063	0.099
LS	**	**	**	**	**	**
Variety (2016-17)						
BRRI dhan50	24.44	37.43 b	60.54	68.54 b	69.33 b	55.02
BRRI dhan63	25.72	41.24 a	60.05	69.62 a	71.41 a	57.95
LS	NS	*	NS	**	**	NS
Fertilizer (2016-17)						
$N_{138}P_{22.4}K_{63.5}S_{13.5}Zn_{1.3}$	25.65 a	38.74 b	62.14	69.96 a	70.85 a	57.67 a
$N_{69}P_{11.2}K_{31.7}S_{6.7}Zn_{0.65}$	24.42 b	39.96 a	58.53	68.24 b	69.92 b	55.45 b
LS	NS	**	NS	**	**	**
Variety × Fertilizer (2016-17)						
V_1F_1	24.93 b	35.93	60.93	69.74 b	70.64 ab	56.47 ab
V_1F_2	24.05 c	39.04	60.14	67.33 d	67.95 b	53.63 b
V_2F_1	26.46 a	41.61	63.22	70.14 a	71.05 ab	58.82 a
V_2F_2	24.94 b	40.92	56.94	69.02 c	71.96 a	57.14 ab
S_x	0.283	-	-	-	-	-
LS	**	NS	NS	**	**	**

In a column, figure(s) having common letter(s) do not differ significantly but having different letter(s) indicate significantly different, ** = Significant at 1% level of probability, LS = Level of Significance, V_1 = BRRI dhan50, V_2 = BRRI dhan63, F_1 = NPKSZn (recom.), F_2 = NPKSZn (50% of recom.)

Plant height responded significantly during 2016-17 due to different varieties (Table 2). The taller plant (71.4 cm) was produced by BRRI dhan63 at 75 DAT. Plant height significantly differed due to application of different fertilizer doses (Table 2). The taller plant (57.96 cm) was produced for application of NPKSZn (recom.) measured at harvest. Plant height varied significantly due to interaction of different varieties and application of different fertilizer doses (Table 2).

Number of tillers hill^{-1} showed significant variation during 2015-16 between two varieties (Table 3). The higher number of tillers hill^{-1} (13.73) at harvest was produced by BRRI dhan63. The higher number of tillers hill^{-1} (14.11) was produced due to application of recommended fertilizer dose (Table 3). Tillers hill^{-1} responded significantly due to interaction of varieties and application of fertilizer doses.

Table 3. Tiller production of boro fine rice at different DAT as affected by variety, fertilizer and their interaction in acid soil during 2015-2016 and 2016-17

Treatments	Tillers hill^{-1} (no.)					
	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	Harvest
Variety (2015-2016)						
BRRI dhan50	3.81 a	5.68 a	12.58 b	11.50 b	13.75 b	12.50 b
BRRI dhan63	3.08 b	4.70 b	13.98 a	11.95 a	14.91 a	13.73 a
LS	**	**	**	NS	**	**
Fertilizer (2015-2016)						
$N_{138}P_{22.4}K_{63.5}S_{13.5}Zn_{1.3}$	3.61 a	5.60 a	14.13 a	12.78 a	15.56 a	14.11 a
$N_{69}P_{11.2}K_{31.7}S_{6.7}Zn_{0.65}$	3.28 b	4.78 b	12.43 b	10.66 b	13.10 b	12.11 b
LS	**	**	*	**	**	**
Variety × Fertilizer (2015-2016)						
V_1F_1	4.23 a	4.46 c	11.90 d	10.86 c	12.00 d	11.00 d
V_1F_2	3.40 b	4.30 d	13.26 b	12.13 b	15.50 b	14.00 b
V_2F_1	3.16 c	6.90 a	15.00 a	13.43 a	15.63 a	14.23 a
V_2F_2	3.00 d	5.10 b	12.96 c	10.46 d	14.20 c	13.23 c
S_x	0.032	0.040	0.045	0.052	0.047	0.056
LS	*	**	**	**	**	**
Variety (2016-2017)						
BRRI dhan50	2.72	5.51	13.71	15.60 a	15.12	15.06 b
BRRI dhan63	2.70	4.82	13.80	16.2 8 b	15.84	15.54 a
LS	NS	NS	NS	**	NS	*
Fertilizer (2016-2017)						
$N_{138}P_{22.4}K_{63.5}S_{13.5}Zn_{1.3}$	3.06 a	5.32	15.16 a	18.75 a	18.36 a	20.06 a
$N_{69}P_{11.2}K_{31.7}S_{6.7}Zn_{0.65}$	2.42 b	5.01	12.44 b	13.14 b	12.74 b	13.04 b
LS	**	NS	*	**	**	**
Variety × Fertilizer (2016-2017)						
V_1F_1	2.95	6.05	16.04	17.12	17.52 b	18.11
V_1F_2	2.56	4.96	11.45	12.45	12.45 d	12.06
V_2F_1	3.04	4.74	14.16	18.66	18.64 a	21.02
V_2F_2	2.37	5.05	13.52	13.97	13.92 c	15.54
S_x	-	-	-	-	0.349	-
LS	NS	NS	NS	NS	**	NS

In a column, figure(s) having common letter(s) do not differ significantly but having different letter(s) indicate significantly different, ** = Significant at 1 % level of probability; NS = Not Significant, LS = Level of significance, V_1 = BRRI dhan50, V_2 = BRRI dhan63, F_1 = NPKSZn (recom.), F_2 = NPKSZn (50% of recom.)

Variation of tillers hill^{-1} under different varieties during 2016-17 were significant (Table 3). The higher number of tillers hill^{-1} (15.5) at harvest was produced by BRRI dhan63. Tillers hill^{-1} varied significantly due to application of different fertilizer doses (Table 3). The higher number of tillers hill^{-1} (20.0) was produced due to NPKSZn (recom.). The highest number tillers hill^{-1} (18.87) produced due to interaction of different varieties and application of different fertilizer doses (Table 3).

Number of effective tillers hill^{-1} varied significantly between the varieties BRRI dhan50 and BRRI dhan63 (Table 4). The higher number of effective tillers hill^{-1} (12.73) was produced by BRRI dhan63. Number of grains panicle^{-1} in BRRI dhan63 was higher than BRRI dhan50. Number of sterile spikelets panicle^{-1} varied significantly due to different varieties. The higher number of sterile spikelets panicle^{-1} (12.28) was produced by BRRI dhan50 over BRRI dhan63. The longer panicle (17.56 cm) was produced by BRRI dhan63. The higher weight (21.06 g) of 1000 grains was obtained by BRRI dhan63. Grain and straw yield varied significantly between varieties. The higher grain yield of 39.20 g pot^{-1} and straw yield of 66.86 g pot^{-1} was produced by BRRI dhan63.

Table 4. Yield and yield contributing characters of boro fine rice as affected by variety, fertilizer and their interaction in acid soil during 2015-2016 and 2016-17

Treatments	Effective tillers hill^{-1}(no.)	Grains panicle^{-1} (no.)	Sterile spikelets panicle^{-1} (no.)	Panicle length (cm)	1000 grains weight (g)	Grain yield (g pot^{-1})	Straw yield (g pot^{-1})
Variety (2015-2016)							
BRRI dhan50	11.33 b	55.25 b	12.26 a	16.46 b	19.70 b	38.78 b	66.16 b
BRRI dhan63	12.73 a	63.88 a	10.11 b	17.56 a	21.06 a	39.20 a	66.86 a
LS	**	**	**	**	**	**	**
Fertilizer (2015-2016)							
$N_{138}P_{22.4}K_{63.5}S_{13.5}Zn_{1.3}$	10.26 a	96.45 a	10.10	20.10 a	21.32	48.02 a	93.64 a
$N_{69}P_{11.2}K_{31.7}S_{6.7}Zn_{0.65}$	9.74 b	91.70 b	10.33	19.82 b	21.24	41.58 b	82.80 b
LS	**	**	NS	*	NS	**	**
Variety × Fertilizer (2015-2016)							
V_1F_1	9.70 d	62.06 c	10.06 d	16.10 d	19.86 c	28.90 d	51.66 d
V_1F_2	12.96 b	48.43 d	10.16 c	16.83 c	20.16 b	43.50 b	75.20 b
V_2F_1	13.00 a	64.23 a	14.10 a	18.00 a	21.96 a	49.50 a	82.06 a
V_2F_2	12.46 c	63.53 b	10.43 b	17.13 b	19.53 d	34.06 c	57.13 c
S_x	0.047	0.138	0.076	0.050	0.078	0.123	0.116
LS	**	**	**	**	**	**	**
Variety (2016-2017)							
BRRI dhan50	13.62 b	91.05 b	33.44	18.27	19.54 b	64.46 b	87.15 b
BRRI dhan63	15.05 a	99.25 a	32.02	16.66	21.46 a	78.21a	95.18a
LS	**	**	NS	NS	**	**	*
Fertilizer (2016-2017)							
$N_{138}P_{22.4}K_{63.5}S_{13.5}Zn_{1.3}$	18.25 a	99.85 a	31.84	17.65 a	21.05 a	86.00 a	107.78 a
$N_{69}P_{11.2}K_{31.7}S_{6.7}Zn_{0.65}$	11.72 b	90.74 b	33.62	17.21 b	20.04 b	56.68 b	74.55 b
LS	**	**	NS	**	**	**	**
Variety × Fertilizer (2016-2017)							
V_1F_1	17.83 a	105.71 a	32.27 b	16.83 b	20.07 c	81.53 b	108.13
V_1F_2	9.36 c	92.72 ab	34.53 a	19.60 a	19.10 d	65.96 c	82.23
V_2F_1	18.57 a	94.06 ab	31.37 b	18.40 b	21.97 a	90.46 a	107.43
V_2F_2	14.05 b	88.75 b	32.80 b	14.93 b	21.00 b	47.40 d	66.86
S_x	0.265	4.791	0.461	0.497	0.127	3.082	3.213
LS	**	**	**	*	**	**	*

In a column, figure(s) having common letter(s) do not differ significantly but having different letter(s) indicate significantly different, ** = Significant at 1 % level of probability, NS = Not Significant, LS = Level of significance, V_1 = BRRI dhan50, V_2 = BRRI dhan63, F_1 = NPKSZn (recom.), F_2 = NPKSZn (50% of recom.)

Number of effective tillers hill^{-1}, number of grains panicle^{-1} and panicle length were varied significantly due to application of different fertilizer doses during 2015-16 (Table 4). The higher number of effective tillers hill^{-1} (10.26) was produced due to application of NPKSZn (recom.). Significant variations were observed in number of grains panicle^{-1} due to application of different fertilizer doses. The higher number of grains panicle^{-1} (96.45) was produced due to application of NPKSZn (recom.). Panicle length varied significantly due to application of different fertilizer. The higher panicle length of 20.10 cm was produced due to application of NPKSZn (recom.). Grain and straw yield showed significant variation due to application of different fertilizer doses. The higher grain yield of 48.02 g pot^{-1} and straw yield of 93.64 g pot^{-1} was produced due to application of NPKSZn (recom.).

Number of effective tillers hill^{-1}, number of grains panicle^{-1} and panicle length were showed significant variation due to interaction of varieties and fertilizer doses. The highest number of effective tillers hill^{-1} (13.00) was produced due to interaction of BRRI dhan63 with application of NPKSZn (recom.). Number of grains panicle^{-1}, number of sterile spikelets panicle^{-1}, panicle length, 1000 grains weight, grain yield and straw yield differed significantly due to interaction of different varieties and application of different fertilizer doses. The highest grain yield of 82.06 g pot^{-1} was produced by the interaction effect of BRRI dhan63 and application of NPKSZn (recom.).

During 2016-17 number of effective tillers hill^{-1} varied significantly between the varieties (Table 4). The higher number of effective tillers hill^{-1} (15.0) was produced by BRRI dhan63. Number of grains panicle^{-1} varied significantly due to different varieties. The higher number of grains panicle^{-1} (99.2) was produced by BRRI dhan63. Number of sterile spikelets panicle^{-1} and panicle length did not vary significantly due to different varieties. The higher 1000 grains weight (21.4 g) was produced by BRRI dhan63. The higher grain yield of 78.21 g pot^{-1} and straw yield of 95.18 g pot^{-1} was produced by BRRI dhan63.

Again at 2016-17, number of effective tillers hill^{-1} varied significantly due to application of different fertilizer doses (Table 4). The higher number of effective tillers hill^{-1} (18.2) was produced due to application of NPKSZn (recom.). Number of grains panicle^{-1} varied significantly due to application of different fertilizer doses. The higher number of grains panicle^{-1} (99.8) was produced due to application of NPKSZn (recom.). Panicle length varied significantly due to application of different fertilizers. The longer panicle of 17.6 cm was produced due to application of NPKSZn (recom.). Grain and straw yield varied significantly due to application of different fertilizer doses. The higher grain yield of 86.00 g pot^{-1} and straw yield of 107.78 g pot^{-1} was produced due to application of NPKSZn (recom.).

Number of effective tillers hill^{-1} significantly differed due to interaction of different varieties and application of different fertilizer doses (Table 4). The highest number of effective tillers hill^{-1} (18.5) was produced due to interaction of BRRI dhan63 and application of NPKSZn (Recom.). Number of grains panicle^{-1}, number of sterile spikelets panicle^{-1}, panicle length, 1000 grains weight, grain yield and straw yield differed significantly due to interaction of different varieties and application of different fertilizer doses. The highest grain yield of 90.46 g pot^{-1} and straw yield of 108.13 g pot^{-1} was produced by the interaction of BRRI dhan50 and application of NPKSZn (recom.).

Conclusion

The result of the experiment revealed that the highest grain yield of 49.50 g pot^{-1} in 2015-16 and 90.46 g pot^{-1} in 2016-17 were obtained by BRRI dhan63 due to application of recommended dose of NPKSZn.

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