Original Research Article

EFFECT OF TRIPLE SUPER PHOSPHATE ON THE GROWTH AND YIELD OF BORO RICE IN HAOR AREAS OFSUNAMGANJ DISTRICT IN BANGLADESH

ABSTRACT

A field experiment was conducted at Bilpar village of Sunamganj district during November 2016 to May 2017 to find out the effects of TSP fertilizer on the growth and yield of boro rice in*haor* areas. Two factors viz. varieties (BRRI dhan29 and BRRI dhan58) and six TSP fertilizer levels [F_1- 85 kgTSP ha^{-1} (Farmers' practice), F_2- 142 kgTSP ha^{-1}, F_3- 127 kgTSP ha^{-1}, F_4- 112 kgTSP ha^{-1} (BARC recommended dose), F_5- 97 kgTSP ha^{-1}, F_6- 82kgTSP ha^{-1}] were included in the experiment.The experiment was conducted in the farmers' field and laid out in a RCBD with three replications. Data were taken on plant height and tillers hill^{-1} at 15 days intervals. The yield and yield contributing parameters were also taken at harvest. Plant height, number of total tillers, effective tillers hill^{-1}, panicle length, sterile spikelets, 1000 grain weight, grain and straw yield varied significantly due to variety. BRRI dhan58 produced higher number of effective tillers (10.60) and grains panicle^{-1} (136.9) over BRRI dhan28. BRRI dhan58 produced higher grain yield (8.92 t ha^{-1}) compared to BRRI dhan28 (7.27 t ha^{-1}). All the studied parameters differed significantly with the application of TSP fertilizer except non-effective tillers hill^{-1}. Application of 112 kg TSP ha^{-1} produced the highest number of effective tillers hill^{-1} (12.00) and the lowest in farmers practice (7.20). Fertilizer Recommendation Guide based TSP fertilizer (112 kg ha^{-1}) produced the highest grain yield (8.80 t ha^{-1}) of boro rice and the lowest grain yield (7.40 t ha^{-1}) in farmers' practice.Results of the study elucidated that TSP application @ 112 kg ha^{-1}was effective to improve the rice productivity.

Key words: Rice, TSP fertilizer, Growth & Yield.

1. INTRODUCTION

Agriculture is a large sub-sector of economy since it comprises about 14.23% of the country's GDP [1].Major share is responsible for rice production. Sufficient rice production is the key to ensure food security in Bangladesh. In fact, 'Rice security' is synonymous to 'Food security' in Bangladesh as in many other rice growing countries [2]. Since *Haor*goes under flooding (5-10 m) from late May to October, so only winter rice (boro rice) covered 80% of total area as mono crop. It is worthy to mention that Haor areas contribute with 18% to the national rice production [3]. Majority of *haor* farmers practiced BRRI dhan29, but its long cropduration (165 days) invites crop yields subject to flash flood. Considering natural calamities BRRI dhan58 (150-155 days)has some positive effects. It can be harvest 7-10 days earlier than BRRI dhan29 with same yield potential and avert early flash flood.It has been observed that crop yield reductions are strongly related with soil quality degradation, particularly nutrient depletions [4], which can be attributed to either insufficient orimbalanced fertilizer use [5]. The rate and types of fertilizers used depend on a farmer's financial ability, and the farmer's choice is often made without considering indigenous supply capacities of soils under variables agro in ecological zone of Bangladesh. Besides, being cheaper and prompt visible response of N than P and K fertilizers, farmers apply more N (in single fertilizer form) for rice production [6] and thus create nutrients imbalance in many cases. The imbalanced fertilizer use in Bangladesh agriculture is speeding up in nutrients depletion [7,8], which becomes a major problem in rice production. The rice yield in the P-deficit soil was less than 50% of that obtained from soils containing even moderate levels of P [9]. Using inadequate P for intensive cropping systems and with the inclusion of modern cultivars rice, most of the soils of Bangladesh become P deficit [10]. Haor soil is usually deficient in phosphorus. As a reason P limits growth and yield of rice [11]. Due to low P^H of soil in the haor area P availability is lower. Thus the application of phosphate fertilizer is essential for better crop production.From the views above, two modern varieties were tested to identify the adequate dose of phosphorus to achieve the higher yield.

2. MATERIALS AND METHOD

The experiment was conducted at Bilpar village under the Saidergaonunion of Chatokupazila of Sunamganj district during Boro season (November 2016 to May 2017) to evaluate the effect of phosphate fertilizer on growth and yield of two modern boro rice varieties. The soil was silty clay loam in texture containing pH 4.50, organic matter content 2.69%, total N 0.14%, available P 1.17 ppm, exchangeable K 0.12 me 100 g^{-1} soil and available S 25.16 ppm as initial status. Two factors experiment was laid out in a Randomized Complete Block Design (RCBD) with two boro rice cultivars (BRRI dhan29 and BRRI dhan58) and six TSP fertilizer levels [F_1- 85 kgTSP ha^{-1} (Farmers' practice), F_2- 142 kgTSP ha^{-1}, F_3- 127 kgTSP ha^{-1}, F_4- 112 kgTSP ha^{-1} (BARC recommended dose), F_5- 97 kgTSP ha^{-1}, F_6- 82kgTSP ha^{-1}] replicated thrice. All the fertilizers except urea i.e. TSP, MoP, gypsum and zinc-sulphate were applied as basal doses in all the plots at final land preparation. Urea was applied in three equal splits. The size of plot was 4 m × 5 m. Thirty five days old seedlings were transplanted maintain spacing20 cm ×15 cm. The experimental field was prepared on 1-5 January, 2017. Immediately after final land preparation, the experimental layout was made on 5-6 January 2017 according to experimental treatments. Rice was transplanted on 6 January 2017. Standing water was maintained at 4-5 cm in the field throughout the growing period. Different intercultural operations such as irrigation, weeding, pest control etc. were done as and when required. BRRI dhan58 and BRRI dhan29 were harvested on 3rd and 11th May 2017, respectively. Growth data,at maturity 5 hills were randomly selected in each plot for recording the data. The grain and straw weights for each plot were recorded after proper sun drying and then converted into t ha^{-1}. The recorded data were compiled and tabulated for statistical analysis. Analysis of variance was done with the help of computer package, MSTAT-C. The mean differences among the treatments adjudged using Duncan's Multiple Range Test (DMRT).

3. RESULTS AND DISCUSSION

3.1 Plant height

Plant heights of tested varieties were recorded at 15, 30, 45, 60, 75 days after transplanting (DAT) and at harvest. Plant heights at 15, 30, 45, 60 DAT and at harvest differed significantly while difference at 75 DAT was statistically insignificant (Table1). BRRI dhan58 produced higher plant height (94.97 cm) than BRRI dhan29 (91.14 cm) at harvest.This result supported by [12]. [13] also found the similar result that plant height varied significantly at different DAT among 12 indigenous bororice varieties.Plant heights also varied significantly due to different levels of TSP fertilizer application. As per Table 2, phosphorus levels significantly influenced plant heights throughout crops growth and up to maturity, in which application of 112 kg TSP ha^{-1} produced the longest plant (94.40 cm) which was statistically similar with F_2 or 142 kg TSP ha^{-1} (94.03 cm). Plant grown under farmers' practice had produced the shortest plant (92.02 cm).An increased phosphorus application, increased plant height was evident due to better root increase and nutrient uptake by [14]. The effect of interaction of varieties and TSP levels did not vary the plant heights significantly.

Table 1. Effect of variety and TSP fertilizer rates on plant height of boro rice at different DAT in the *haor*areas

Treatment	Plant height (cm)					
	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	At harvest
Variety						
BRRI dhan29	26.65b	35.84b	49.50b	64.32b	83.13	91.14b
BRRI dhan58	28.28a	43.66a	56.95a	72.01a	84.28	94.97a
LS	**	**	**	**	NS	**
TSP fertilizer rate (kg ha^{-1})						
F_1 (85)	25.34b	38.38b	50.45c	64.31	76.05	92.02b
F_2 (142)	28.02a	39.62ab	55.36ab	69.64	85.45	94.03a
F_3 (127)	27.73a	39.89a	52.58abc	68.26	82.73	92.75b
F_4 (112)	28.19a	40.81a	56.35a	70.36	88.37	94.40a
F_5 (97)	27.81a	39.86a	52.95abc	68.31	83.91	92.75b
F_6 (82)	27.73a	39.95a	52.05bc	68.14	85.73	92.40b
$S\bar{x}$	0.29	0.32	1.23	-	-	0.27
LS	**	**	*	NS	NS	**

*In a column, the figure(s) having similar letter do not differ significantly whereas dissimilar letter differ significantly. ** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS= Not significant, LS= Level of significance.*

3.2 Total tillers hill^{-1}

Effect of two varieties on number of tillers hill^{-1} at 75 DAT and at harvest differed significantly. BRRI dhan58 gave higher total tillers hill^{-1} (14.10) compared to BRRI dhan29 (11.90) (Table 2).[15] observed the variations in number of total tillers hill^{-1}under different varieties.Number of total tillers hill^{-1} varied significantly due to different rates of TSP fertilizers application at 15, 30, 45, 75, 90 days after transplanting (DAT) and at harvest (Table 2).The highest total tillers hill^{-1}(14.70) was found due to application of 112 kg TSP ha^{-1} which was statistically superior to other TSP levels and farmers' practice (85 kg TSP ha^{-1}) gave the lowest number of total tillers hill^{-1} (10.90).The statement of [16] revealed that phosphorus application on rice plants increased production of tillers.[17] stated that tillers number reduction after 75 DAT, it could be happened due to tiller mortality of rice plants after reproductive stage. Combined effects of varieties and TSP levels on tiller production were not significant.

Table 2. Effect of variety and TSP fertilizer rates on number of total tillers hill^{-1} of boro rice at different DAT in the *haor* areas

Treatment	Total tillers hill^{-1} (no.)					
	15 DAT	30 DAT	45 DAT	60 DAT	75 DAT	At harvest
Variety						
BRRI dhan29	3.00	6.80	13.70	18.30	21.20b	11.90b
BRRI dhan58	3.20	6.90	14.00	18.90	21.80a	14.10a
LS	NS	NS	NS	NS	**	**
TSP fertilizer rate (kg ha^{-1})						
F_1 (85)	2.40b	5.80c	13.10c	17.80	20.60d	10.90d
F_2 (142)	3.20ab	7.00ab	14.40ab	19.30	21.90ab	13.40b
F_3 (127)	3.80a	7.20ab	13.90abc	18.60	21.60bc	13.30b
F_4 (112)	3.90a	7.80a	14.80a	19.80	22.60a	14.70a
F_5 (97)	2.60b	6.70b	13.50bc	18.20	21.30bcd	13.30b
F_6 (82)	2.60b	6.30bc	13.40bc	17.90	20.90cd	12.20c
$S\bar{x}$	0.34	0.21	0.25	-	0.21	0.23
LS	*	**	**	NS	**	**

*In a column, the figure(s) having similar letter do not differ significantly whereas dissimilar letter differ significantly. ** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS= Not significant, LS= Level of significance.*

3.3 Effective tillers hill^{-1}

Higher number of effective tillers hill^{-1} (10.60) was observed in BRRI dhan58 in comparison to BRRI dhan29(Table 3). Effective tillers hill^{-1} in modern boro rice was also varied significantly due to different levels of TSP fertilizer application.Application of 112 kg TSPha^{-1} produced the highest number of effective tillers hill^{-1} (12.00) which was statistically different to other levels. Plants grown under farmers' practice F_1(85 kg TSP ha^{-1}) produced the lowest effective tillers hill^{-1} (7.20). [18] also reported that it is necessary to apply much P fertilizers to help rice plants to accelerate the phosphate absorption for increased tillering. [19]reported that the 75 kg P_2O_5 ha^{-1} produced higher effective tillers hill^{-1}. Combined effects of varieties and TSP levels on effective tillers hill^{-1} were not significant.

3.4 Number of non-effective tillers hill^{-1}

Varieties showed non-significant effect on non-effective tillers hill^{-1}(Table 3). Numerically, higher number of non-effective tillers hill^{-1} (3.50) was observed in BRRI dhan58 in comparison to BRRI dhan29 (3.30). The effect of TSP fertilizer application on non-effective tillers hill^{-1}also non-significant (Table 3). Numerically the highest non-effective tillers hill^{-1} (3.80) was observed under farmers' practice and the lowest (3.00) due to application of 112 kg TSPha^{-1}. Combined effects of varieties and TSP levels on non-effective tillers hill^{-1} were not significant.

3.5Grains panicle^{-1}

Variety exerted non-significant influence on grains panicle^{-1} while significantly affected by different TSP fertilizer levels (Table 3). The highest number of grains panicle^{-1} (147.50) was observed due to application of 112 kg TSP ha^{-1}, which was statistically similar to those recorded in F_2 and $F_3$with values 136.00 and 135.40, respectively.Farmers' practicei.e application of 85 kg TSP ha^{-1} produced the lowest grains panicle^{-1} (123.90). Perhaps, the more sufficient the number of grains panicle^{-1} produced, the better capacity the crop has to bring forth sufficient yields. [20] reported that 50 kg P_2O_5 ha^{-1} gave the highest total grains panicle^{-1}. Combined effects of varieties and TSP levels on grains panicle^{-1} were not significant.

3.6Panicle length

Longer panicle (23.80 cm) was observed in BRRI dhan58 in comparison to BRRI dhan29 (22.30 cm) (Table 3). The longest panicle length (24.77 cm) was found due to application of 112 kg TSPha^{-1}which was statistically similar with 142 kg TSPha^{-1}. The shortest panicle length (18.57 cm) was found under farmers' practice (85 kg TSP ha^{-1}).Similar result was reported for low land rice by [21]. [22] observed that due to the application of 60 kg P_2O_5 ha^{-1} increased the panicle length.Interaction effects of varieties and TSP levels on panicle length were not significant.

3.7Total spikeletspanicle^{-1}

Number of total spikelets panicle^{-1} was not responded significantly to varieties, while varied significantly due to application of TSP fertilizer levels (Table 3).The highest total spikelets panicle^{-1} (178.10) was observed due to application of 112 kg TSP ha^{-1}. Farmers' practicei.eapplication of 85 kg TSP ha^{-1} produced the lowest total spikelets panicle^{-1} (151.70). Combined effects of varieties and TSP levels on total spikelets panicle^{-1}were not significant.

Table 3. Effect of varieties and TSP fertilizer rates on yield and yield contributing characters of boro rice in the *haor* areas

Treatment	Effective tillers hill^{-1} (no.)	Non-effective tillers hill^{-1} (no.)	Grains panicle^{-1} (no.)	Panicle length(cm)	Total spikelets panicle^{-1} (no.)
Variety					
BRRIdhan29	8.50b	3.30	130.2	22.30b	162.2
BRRIdhan58	10.60a	3.50	136.9	23.80a	162.7

LS	**	NS	NS	**	NS
TSP fertilizer rate (kg ha^{-1})					
F_1 (85)	7.20c	3.80	123.9b	18.57c	151.7b
F_2 (142)	9.90b	3.40	136.0ab	23.43ab	166.5ab
F_3 (127)	9.80b	3.40	135.4ab	22.50b	166.0ab
F_4 (112)	12.00a	3.00	147.5a	24.77a	178.1a
F_5 (97)	9.70b	3.50	133.5b	22.23b	161.7ab
F_6 (82)	8.70b	3.50	125.0b	21.27b	157.8ab
$S_{\bar{x}}$	0.37	-	4.37	1.35	3.50
LS	**	NS	*	*	**

*In a column, the figure(s) having similar letter do not differ significantly whereas dissimilar letter differ significantly. ** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS= Not significant, LS= Level of significance.*

3.8Sterile spikelets panicle^{-1}

Higher number of sterile spikelets panicle^{-1} was recorded in BRRI dhan29 (32.60) than BRRI dhan58 (25.30). However, spikelet sterility also affected by genetic potential and response of the varieties to stress conditions. Similar spikelet sterility percentage differences across the varieties have been reported by [23]. Application of different TSP fertilizer levels had significant effect on sterile spikelets panicle^{-1}of bororice (Table 4). Among the P levels, the highest sterile spikelets panicle^{-1} (32.90) was produced due to Farmers' practice (85 kg TSP ha^{-1}) and this might be due to more number of unfilled grains in the panicles, while the lowest (23.00) was obtained due to application of 112 kg TSP ha^{-1}. This result was supported by [24]. Combined effects of varieties and TSP levels on sterile spikelets panicle^{-1} were not significant.

3.91000-grain weight

The effect of variety on 1000-grain weight did not vary significantly while application of different TSP fertilizer levels increased the 1000-grain weight significant (Table 4). The 1000-grain weight ranged from 21 to 23.40 g. All other P levels showed increased 1000-grain weight overFarmers' practice**.** The highest 1000-grain weight (23.40 g) was found due to application of 112 kgTSP ha^{-1}, which was statistically similar to F_2, F_3, F_5, F_6. The lowest 1000-grain weight (21.00 g) was observed due to the farmers' practice i.e. application of 85 kgTSP ha^{-1}. [25] reported application of 30 kg ha^{-1} P gave the highest 1000-grain weight. [26] found that application of 72 kg P_2O_5 ha^{-1} gave the highest 1000 grain weight. Combined effects of varieties and TSP levels on 1000-grain weight were not significant.

3.10Grain yield

BRRI dhan58 produced higher grain yield of 8.92 t ha^{-1} in comparison to BRRI dhan29 (7.27 t ha^{-1}). The results are in conformity with the observation of [23] in hybrid rice and [27]in T. aman rice.The grain yield varied significantly from 7.40 t ha^{-1} to8.80 t ha^{-1}and increased linearly with the increment of the TSP fertilizer doses up to 112 kg ha^{-1} and thereafter decreased (Table 4). The highest grain yield (8.80 t ha^{-1}) was obtained due to application of 112 kgTSP ha^{-1}, which was statistically identical to F_2 and F_3 levels but significant over F_1, F_5 andF_6 levels.The lowest grain yield (7.40 t ha^{-1}) was recorded due to Farmers' practice F_1 (85 kgTSP ha^{-1}) in respect of other levels of P fertilizer application.The yield advantage was mainly due to more filled grains $panicle^{-1}$ and the largest grains.[25] reported similar response of P on grain yield. [28] showed application of 50 kg P_2O_5 ha^{-1} is sufficient for rice cultivation. [29]reported that highest grain yield with the application of 80 kg P_2O_5 ha^{-1}. Combined effects of varieties and TSP levels on grain yield were not significant.

3.11Straw yield

BRRI dhan58 produced higher straw yield (11.80 t ha^{-1}) followed by BRRI dhan29 (10.02 t ha^{-1}).[30] reported that biomass production varied with variety which rendering different straw yield. The highest straw yield (11.90 t ha^{-1}) was produced due to application of 112 kg TSP ha^{-1}, which was significantly similar to F_2 and F_3 levels but significant overfarmers' practice (Table 4). The lowest straw yield (10.03 t ha^{-1}) was observed due to farmers' practice85 kg TSP ha^{-1}.[31] also reported similar effect of phosphorus..[26] also found that application of 48 kg P_2O_5 ha^{-1} and 72 kg P_2O_5 ha^{-1} gave higher straw yield. Combined effects of varieties and TSP levels on straw yield were not significant.

Table 2. Effect of varieties and TSP fertilizer rates on yield and yield contributing characters of boro rice in the *haor* areas

Treatment	Sterile spikelets $panicle^{-1}$ (no.)	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Variety				
BRRI dhan29	32.60a	22.20	7.27b	10.02b
BRRI dhan58	25.30b	22.60	8.92a	11.80a
LS	**	NS	**	**
TSP fertilizer rate (kg ha^{-1})				
F_1 (85)	32.90a	21.00b	7.40c	10.30b
F_2 (142)	25.70bc	23.04a	8.30ab	11.20ab
F_3 (127)	27.60abc	22.30ab	8.30ab	11.10ab
F_4 (112)	23.90c	23.40a	8.80a	11.90a
F_5 (97)	30.80ab	22.80ab	7.90bc	10.60b
F_6 (82)	32.90a	21.90ab	7.80bc	10.60b
$S_{\bar{x}}$	2.14	0.43	0.17	0.27
LS	*	**	**	**

*In a column, the figure(s) having similar letter(s) do not differ significantly whereas dissimilar letter(s) differ significantly. ** = Significant at 1% level of probability, * = Significant at 1% level of probability, NS= Not significant, LS= Level of significance.*

4. CONCLUSION

Variety BRRI dhan58 produced higher grain yield in comparison to BRRI dhan29 in the haor areas. It was also observed that application of TSP fertilizer following BARC recommendation guide (112 kg ha^{-1}) gave the highest grain yield. BRRI dhan58 with 112 kg TSP ha^{-1} may be disseminated among the farmers of the *haor* area for higher yield.

5. ACKNOWLEDGEMENT

The authors express thankful acknowledgement for the financial support rendered by Bangladesh Agricultural Research Council (BARC) under the project of "Yield gap minimization of boro rice in the *haor*areas through agronomic management with special reference to fertilization" and the Ministry of Science and Technology support first author through "NST" fellowship.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

AUTHORS' CONTRIBUTIONS

Author GOSWAMI BK and Author KASHEM MA designed the study. Author GOSWAMI BK wrote the protocol, wrote the first draft, reviewed and re-write the manuscripts. Author KASHEM MAand Author AZIZ MA managed the analyses of the study. Author AZIZ MA managed the literature searches. Author SAHA TK performed the statistical analysis. All authors read and approved the final manuscript.

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