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EFFECTS OF DIFFERENT SOURCES OF PHOSPHORUS ON THE GROWTH AND YIELD OF BRRI DHAN29

Robbani MG[1], Hoque MA[1], Huda A[2], Bir MSH[3], Haque MM[4] and Uddin MJ[5]

[1]*Dept Soil Science, Bangladesh Agril University, Mymensingh*

[2]*Dept of Soil Science, Sylhet Agril University, Sylhet*

[3&4]*Scientific Officer, Bangladesh Institute of Nuclear Agriculture, Mymensingh*

[5]*Executive Officer, Janata Bank Limited, Gouripur, Mymensingh*

ABSTRACT

An experiment was carried out at Mymensingh during the period from February to June 2011 to study the effects of different sources of phosphorus on the growth and yield of BRRI dhan29. The experiment was designed with six treatments and laid out in a Randomized Complete Block Design (RCBD) with three replications. The treatment combinations were T_O: control (No P), T_1: 100% P from Triple super phosphate (TSP), T_2: 100% P from Di-ammonium phosphate (DAP), T_3: 100% P from compost, T_4: 50% P from TSP + 50% P from compost T_5: 50% P from DAP + 50% P from compost. All the plots received P from different sources @ 25 kg ha^{-1} except control. Application of different sources of P resulted in a significant increase in yield contributing characters of BRRI dhan29. The effect of DAP was more pronounced than that of TSP or compost. Application of P also significantly increased the grain and straw yields of rice. The highest grain (5.19 ha^{-1}) and straw (7.11 t ha^{-1}) yields were observed by the addition of P from DAP while the lowest grain (3.95 t ha^{-1}) and straw (4.20 t ha^{-1}) yields were observed in control treatment where no P fertilizers were added. Results also indicate that application of DAP caused a remarkable increase in grain and straw yields of rice. Application of P from different sources led to an increase in NPKS contents and uptake by rice. In most cases, DAP resulted in a higher nutrient uptake by rice crop. DAP can be used as a better source of P fertilizer compared to TSP or compost for rice cultivation in Bangladesh.

Keyword: *Phosphorus, BRRI dhan29, growth and yield*

INTRODUCTION

Rice is the most extensively cultivated cereal in Bangladesh. It plays an absolutely dominant role over all other crops in respect of economic and social significance. Rice also plays an important role in the national economy of our country. Bangladesh is the densely populated agro-based country having its current population of about 140.60 million (BBS, 2011). The rapid increase in population exerts tremendous pressure on increasing food production. Increased rice production in Bangladesh is essential to meet the food demand of the growing population.

In Bangladesh, the annual use of nutrients is 102 kg ha^{-1} that includes N, P, K, S and Zn against a total removal of 200 kg nutrients ha $^{-1}$ from soils (Islam *et al.,* 2007). Intensive cropping with high yielding varieties, low use of organic matter and improper soil and crop management practices have caused a marked depletion of soil fertility in Bangladesh (Ali *et al.,* 1997). Phosphorous is the second key nutrient element and plays a critical role in the life cycle of plants. It is needed greatly by young fast growing tissue of plants and performs a number of functions related to growth, development, photosynthesis and utilization of carbohydrates, whereas insufficient nutrient P seriously limits growth and yield of rice (Yampracha *et al.,* 2005). Phosphorus has a marked beneficial impact on seedling establishment, root biomass production, flowering and maturity of the crop and decreased floret sterility (Ortega and Rojas, 1999).

The P content in majority soils of Bangladesh is low (Islam, 2000). Thus application of phosphate fertilizer is essential for better crop production. Farmers commonly use Triple Super Phosphate (TSP), Single Super Phosphate (SSP), or Di-ammonium Phosphate (DAP) as the source of P to meet the demand of P. Application of DAP has a positive effect on rice production in Bangladesh as a fertilizer for P source over TSP and compost (Sharma *et al.,* 2006). Although DAP has high price but it reduces the requirement of nitrogen in rice field. It could be an added factor for easy acceptance of P fertilizer compared to other phosphatic fertilizers and its socioeconomic impact on farmer's acceptability. Addition of compost is useful in maintaining or increasing organic substances in soil which are decomposed slowly. The greatest benefit from cycling and recycling of compost in soil is the overall improvement of soil health. The use of compost may reduce requirement of chemical fertilizers, thus allowing the small farmer to save in part the cost of production. Every year Bangladesh has to import huge amount of TSP or its raw materials to meet up the phosphorus requirement of the crops. But the main problem concerning phosphatic fertilizers is its rapid fixation in soil within a very short period of application rendering more than two-thirds unavailable to plants (Saharawat *et al.,* 2001). Application of phosphorus in proper amount is crucial for profitable rice cultivation in Bangladesh. Considering the above facts, the present study was undertaken to investigate the effects of different sources of phosphorus on the growth and yield of BRRI dhan29 and to observe the effects of different sources of P on nutrient content and uptake by BRRI dhan29.

MATERIALS AND METHODS

The experiment was carried out at the Soil Science Field Laboratory, Bangladesh Agricultural University (BAU), Mymensingh during the boro season (February to June) of 2011 to investigate the effects of different sources of phosphorus on the growth and yield of BRRI dhan29. The soil belongs to the Sonatola soil series under the AEZ of Old Brahmaputra Floodplain. Characteristically, the soil was silt loam in texture having organic matter 1.523%, total nitrogen 0.164%, available phosphorus 10.10 ppm, available sulphur 11.98 ppm, exchangeable potassium (me/100g soil) 0.089 and CEC (me/100g soil) 13.54. There were six treatments consisting of different rates and sources of P including control treatment as follows: To = Control (No P), T_1= 100% P from TSP, T_2 = 100% P from DAP, T_3 = 100% P from Compost, T_4 = 50% P from TSP + 50% P from Compost, T_5 = 50% P from DAP + 50% P from Compost. The experiment was laid out in a randomized complete block design (RCBD) with three replications. A basal application of fertilizer was made with nitrogen, potassium, sulphur, and zinc at the rate of 125, 65, 15 and 3 kg ha^{-1} respectively. Phosphorus was added as per treatment from three sources as TSP, DAP and compost. All fertilizers except urea were incorporated to soil during final land preparation. Urea was applied in three equal splits; first one-after 10 days of transplanting (seedling establishment stage), second split after 35 days of transplanting (tillering stage) and the third split after 60 days of transplanting (panicle initiation stage). Forty days old rice seedlings were transplanted in the experimental plots. Intercultural operations like thinning, weeding, irrigation and pest control were done as and when necessary as per treatment. The crop was harvested at full maturity and the data on plant height, panicle length, effective tillers $hill^{-1}$, filled grains $panicle^{-1}$, 1000-grain weight, grain yield and straw yield were recorded. The grain and straw yields were adjusted with 14% moisture. The grain and straw samples were analyzed for N, P, K and S content and uptake. The collected data were analyzed statistically by F-test to examine the treatment effects and the mean differences were examined by Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Yield contributing characters

Plant height of BRRI dhan29 was significantly influenced due to application of different sources of phosphorus (Table 1). The tallest plant (78.53cm) was found in T_2 treatment where 25 kg P fertilizers were applied from DAP which was statistically similar with TSP (T_1 treatment). The shortest plant (72.85cm) was obtained in the control treatment where no P fertilizers were applied. Similar observation was also reported by Haque and Khan (1981). Application of full dose of P from DAP (T_2 treatment) contributed to the maximum effective tillers $hill^{-1}$. The lowest number of effective tiller $hill^{-1}$ (8.133) was found in the control treatment. Samorir and Blair (1983) also found that N, P and K nutrition increased the number of effective tillers $hill^{-1}$. A positive correlation between grain yield and effective tiller (0.164) was recorded. The maximum panicle length (25.87 cm) was recorded in T_2 treatment while the minimum value (22.10cm) was noted in control treatment. Aprosto (1989) observed that application of organic and inorganic fertilizers increase the panicle length of rice. A positive correlation between grain yield and panicle length (r=0.251) was observed (Fig. 2). Application of P from DAP (T_2 treatment) contributed to the maximum filled grains. The lowest number of filled grains $panicle^{-1}$ (76.73) was found in the control treatment. The filled grains $panicle^{-1}$ was significantly correlated (r=0.396) with grain yield (Fig. 1). Mondal *et al.* (1990) observed that the percentage of filled grains of rice was increased with the increasing NPK rates. The highest number of unfilled grains $panicle^{-1}$ was (15.40) recorded in the control plots and the lowest number of filled grains $panicle^{-1}$ (9.86) was found in T_2 treatment. The maximum 1000-grain weight (22.95g) was observed in response to P from DAP. On the other hand, the lowest value (20.20g) was obtained in the control plots.

Grain and straw yields

Grain and straw yields increased over control for all treatments due to the effects of P fertilizers (Table 2). The maximum grain yield (5.19 t ha^{-1}) was noted in the plots where 25 kg P fertilizers were applied from DAP which was statistically similar to T_1 treatment (TSP). The lowest grain yield (3.95 t ha^{-1}) was obtained in the control treatment where no P fertilizers were applied. Results indicate that DAP increases the grain yield because it contains 18% percentage of nitrogen. Application of different sources of P markedly influenced straw yield of BRRI dhan29. Application of P from DAP produced the maximum straw yield (7.11 t ha^{-1}). The lowest straw yield (4.10 t ha^{-1}) was recorded in the control plots.

Phosphorus use efficiency (PUE)

Phosphorus use efficiency represents the response of rice plant in terms of grain yield to P fertilizer (Fig. 3). The highest value of PUE was (49.6 kg ha^{-1}) recorded in T_2 treatment and the lowest value (25.2 kg ha^{-1}) was found in T_3 treatment.

Table1. Effects of different sources of phosphorus on yield contributing characters of BRRI dhan29

Treatments	Plant height (cm)	Effective tillers hill^{-1}	Panicle length (cm)	Filled grains panicle^{-1}	Unfilled grains panicle^{-1}	1000-grain weight (g)
T_0	72.85b	8.13b	22.10c	76.73d	15.40a	20.20b
T_1	75.79ab	8.20b	23.67b	102.4c	12.93b	22.40a
T_2	78.53a	11.33a	25.87a	118.2a	9.86c	22.95a
T_3	74.93b	9.80ab	25.23a	107.1bc	12.73b	21.80ab
T_4	73.60b	8.13b	24.67ab	103.7c	13.33b	22.60a
T_5	73.83b	9.53ab	25.41a	111.1b	12.53b	22.07a
SE(±)	**0.837**	**0.526**	**0.569**	**5.79**	**0.724**	**0.396**
Level of signif.	**	**	**	**	**	*
CV%	2.27	10.60	3.30	3.70	6.26	4.14

*** = Significant at 1% level of probability; * = Significant at 5% level of probability; SE = Standard Error; CV =Coefficient of Variation*

T_o = Control (no P); T_1 = 100% P from TSP; T_2 = 100% P from DAP; T_3 = 100% P from Compost; T_4 = 50% P from TSP + 50% P from Compost; T_5 = 50% P from DAP + 50% P from Compost

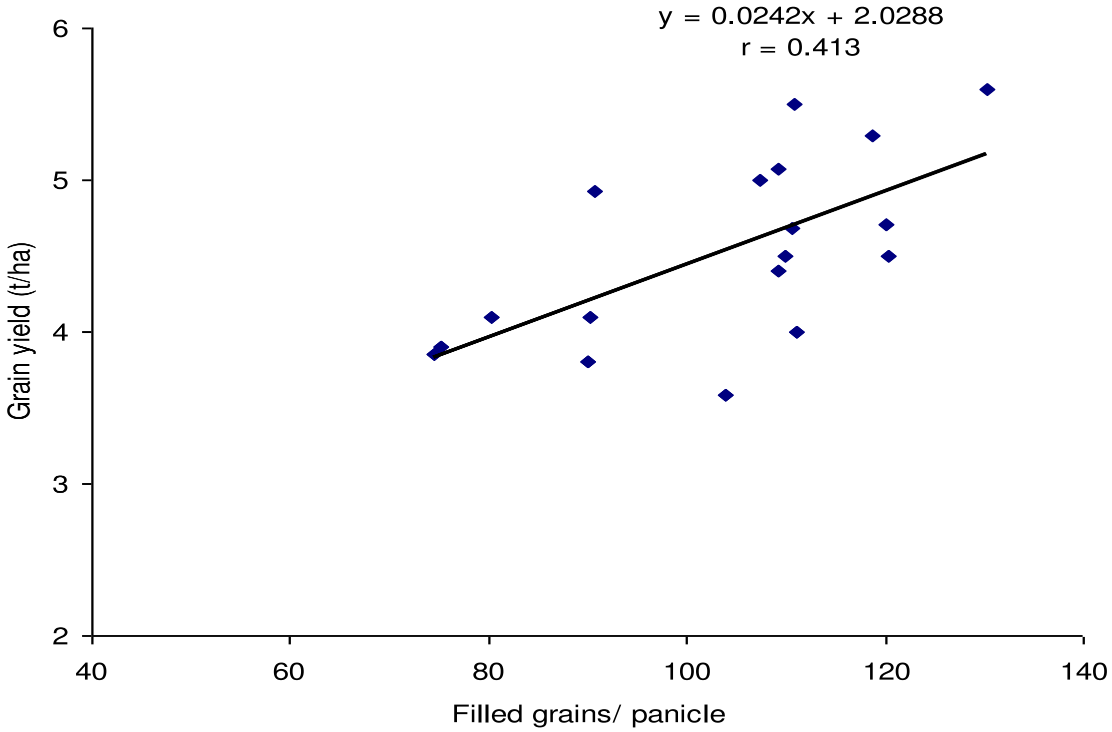

Figure 1: Relationship between grain yield and filled grain of BRRI dhan29

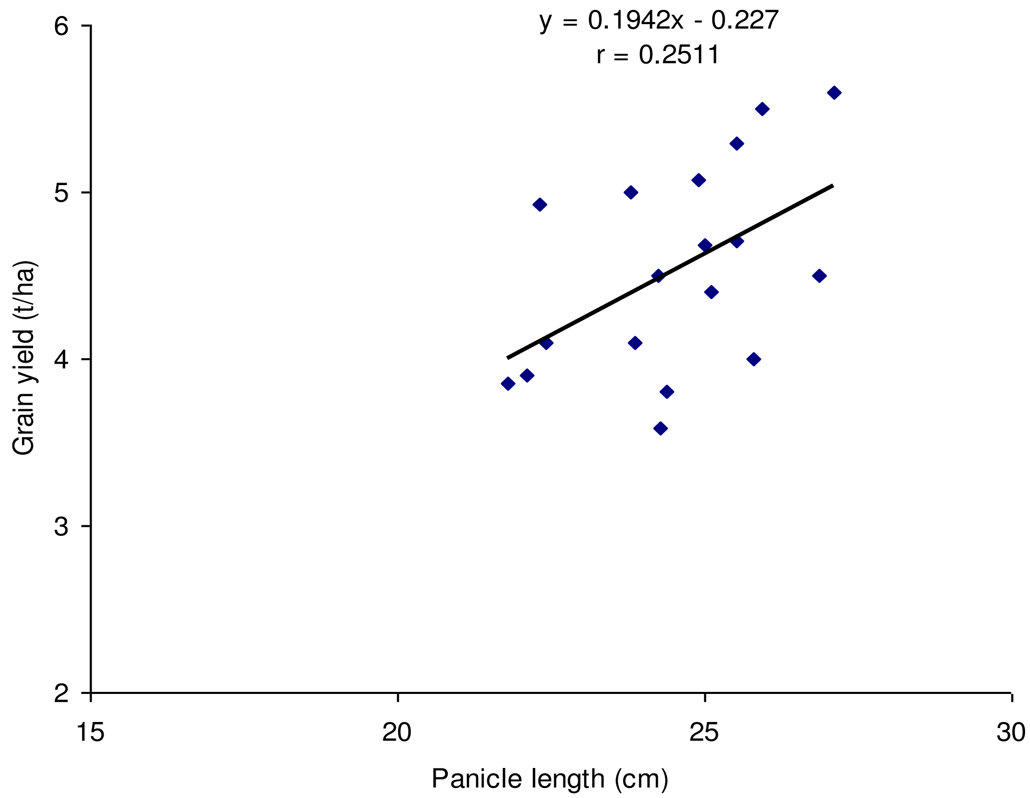

Figure 2: Relationship between grain yield and panicle length of BRRI dhan29

Table 2. Effect of different sources of phosphorus on grain and straw yields of BRRI dhan29

Treatments	Grain yield (t ha^{-1})	% increase over control	Straw yield (t ha^{-1})	% increase over control
T_o (No P)	3.95c	-	4.20d	-
T_1 (100% P from TSP)	5.00ab	26.58	5.60b	33.34
T_2 (100% P from DAP)	5.19a	31.39	7.11a	50.30
T_3 (100% P from compost)	4.58c	15.56	5.04c	20.00
T_4 (50% P from TSP+ 50% P from compost)	4.70b	18.98	4.80c	14.28
T_5 (50% P from DAP + 50% P from compost)	4.60c	16.45	4.90c	16.67
SE(±)	0.21		0.41	
Level of significance	**		**	
CV%	3.68		3.07	

In a column the figures having similar letter(s) do not differ significantly as per DMRT at 5% level of significance.

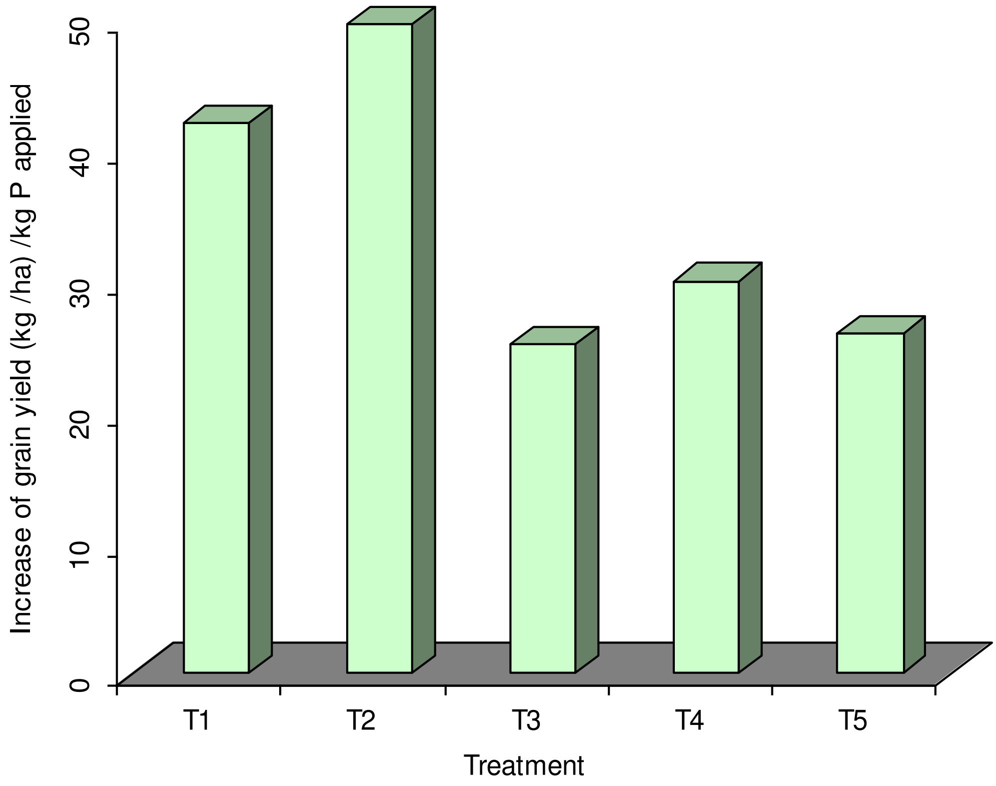

Figure 3: Phosphorus fertilizer use efficiency (agronomic efficiency)

Table 3. Effect of different sources of P on the NPKS uptake by BRRI dhan29

Treatments	N uptake (kg ha^{-1})		P uptake (kg ha^{-1})		K uptake (kg ha^{-1})		S uptake (kg ha^{-1})	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_0	35.35e	13.63e	6.92e	2.26e	10.54c	23.11e	3.25d	3.60c
T_1	58.49b	23.21b	12.39b	4.70b	15.67a	37.56b	5.97b	6.30a
T_2	63.13a	33.34a	14.09a	5.35a	16.14a	48.11a	6.12b	6.70a
T_3	38.46e	16.63d	7.50e	2.40de	10.18c	22.47e	4.75c	4.04b
T_4	46.25d	18.33cd	10.04c	2.73d	12.29b	26.34d	5.85b	4.35b
T_5	54.56c	19.24c	9.24d	3.63c	12.29b	31.48c	7.23a	6.29a
SE(±)	4.56	2.83	1.14	0.523	1.03	4.05	0.558	0.55
Level of sig.	**	**	**	**	**	**	**	**
CV%	4.19	4.83	3.65	6.42	4.71	3.25	3.69	4.35

*** = Significant at 1% level of probability, SE= Standard Error of mean, CV=Coefficient of Variation*

NPKS uptake by BRRI dhan29

Nutrient uptake by grain and straw were significantly influenced by the different treatments (Table 3). The maximum N uptake (63.13 kg ha^{-1}) by grain was recorded in T_2 treatment and the minimum N uptake (35.35 kg ha^{-1}) was recorded in the control treatment. The maximum N uptake by straw (33.34 kg ha^{-1}) was observed in response to P as DAP (T_2) which was significantly different from all other treatments. The lowest N uptake (13.63 kg ha^{-1}) by straw was recorded when plots were not treated with P. Sharma (2003) also found that phosphatic fertilizer increases the NPK uptake.

Application of P from DAP alone resulted in a significant increase in P uptake by grain. This increase was significantly superior to all other treatments. The minimum uptake (6.92 kg ha^{-1}) was recorded when P fertilizer was not applied to the plots. The highest phosphorus uptake by straw (5.35 kg ha^{-1}) was recorded in plants treated with P fertilizer as DAP (T_2). No application of P caused the lowest uptake of

P by straw. Datta and Gupta (1984) stated that P uptake increased with the increasing levels of DAP application. Similar results were also reported by Subbian *et al*. (1989).

Application of P from DAP alone resulted in a significant contributed to the maximum K uptake by grain. This increase was significantly superior to all other treatments except T_1. The lowest uptake (10.54 kg ha^{-1}) by grain was obtained in control treatment when P fertilizers were not applied. The highest K uptake (41.11 kg ha^{-1}) by straw was observed in plants treated with fertilizers as DAP (T_2). No addition of P caused the lowest uptake of P by straw. Sharma (2003) found that NPK uptake was increased with the application of DAP.

Applications of P from DAP and compost resulted in a significant increase in S uptake by grain. This increase was significantly superior to all other treatments. The lowest S uptake (3.25 kg ha^{-1}) by grain was obtained when P fertilizers was not applied to the plots. The highest S uptake (6.70 kg ha^{-1}) by straw was observed in plants treated with P fertilizer from DAP (T_2). No addition of P fertilizer caused the lowest uptake of S by straw.

CONCLUSION

It may be concluded that application of DAP had a positive effect on rice production as a fertilizer for P source over TSP and compost. Although DAP has high price but it reduces the requirement of nitrogen in rice field. It could be an added factor for easy acceptance of P fertilizer compare to other phosphate fertilizers and its socioeconomic impact on farmer's acceptability.

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