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PHOSPHORUS FERTILIZATION IN INBRED AND HYBRID RICE

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Abstract

Five phosphorus rates (0, 5, 10, 20 and 30 kg P/ha) were tested with four rice genotypes in Boro (BRRI dhan36, BRRI dhan45, EH_1 and EH_2) and T. Aman (BRRI dhan30, BRRI dhan49, EH_1 and EH_2) season. Phosphorus rates did not influence grain yield irrespective of varieties in T. Aman season while in Boro season P response was observed among the P rates. Application of P @ 10 kg/ha significantly increased the grain yield. But when P was applied @ 20 and 30 kg P/ha, the grain yield difference was not significant. The optimum and economic rate of P for T. Aman was 20 kg P/ha but in Boro rice the optimum and economic doses of P were 22 and 30 kg/ha, respectively. Hybrid entries (EH_1 and EH_2) used P more efficiently than inbred varieties. A negative P balance was observed up to 10 kg P/ha.

Introduction

Phosphorus deficiency in wetland rice has so far received limited attention. The imbalance nutrient management practices may impair productivity of the soils of Bangladesh, which contain a low level of organic matter. Yield declining has been reported in the Philippines.(1,2) In India, in spite of balanced fertilization of N, P and K, the yield was declining.(3) However, the omission of P and K fertilizer, the yield declined than that of balanced fertilization. The cultivation of modern rice varieties increased the removal of P, K, S and other plant nutrients and more rice soils are becoming P and K deficient than before.

Nevertheless, inappropriate P fertilizer management coupled with increasing cropping intensity with modern high yielding variety (HYV) led P deficiency in many alluvial soils of Bangladesh. Water logging increases soil P availability, but this increase in P deficient rice soil is minimum and temperature dependent.(4) Because of high price of chemical P fertilizers and less noticeable response of it to rice, farmers usually ignore P application to rice. Acute P deficiency in soil caused a yield reduction in lowland rice by 50% or more.(5) Optimum P fertilizer doses for modern rice varieties deserve special attention. Application of optimum amount of P fertilizer is very important to maximize rice production.

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Generally, rice plant can utilize 10 - 20% of the applied phosphorus (P). In rice fields P availability is higher in T. Aman season and low in Boro season may be due to seasonal temperature variation. For this reason, P deficiency is particularly severe in Boro season. Soil with low P status needs substantial P application until adequate soil P level reached for high crop yield. Considering these points in mind the experiment was initiated to determine the optimum and economic dose of P fertilizer for different BRRI MVs and hybrid entries in a rice - rice cropping pattern.

Materials and Methods

The experiment was conducted at the Bangladesh Rice Research Institute farm, Gazipur (AEZ-28, land type -High Land) on Chhiata clay loam soil (hyperthermic Vertic Endoaquept). The soil had pH 5.92, organic C 0.82%, total N 0.08%, available P 6 mg/kg[6], and exchangeable K 0.26 cmol(+)/kg. Five doses of P i.e. 0, 5, 10, 20 and 30 kg/ha were imposed as treatment. The design of the experiment was split-plot with fertilizer in the main plot and variety in the sub-plot. Each plot received a flat dose of 145 kg N, 50 kg K and 10 kg S/ha as STB in Boro season and 70 kg N, 50 kg K and 10 kg S/ha in T. Aman season, respectively. BRRI dhan30, BRRI dhan49 and two hybrid entries i.e. EH_1 and EH_2 were tested in T. Aman season but in Boro season BRRI dhan36, BRRI dhan45 and the same hybrid entries were tested in the experiment during 2007 - 08. Urea N was applied in three 3 equal splits i.e. 1/3 N at final land preparation, 1/3 N at active tillering stage and rest 1/3 N at 5 - 7 days before PI stage. Phosphorus, potassium and sulfur fertilizers were applied at final land preparation in the form of TSP, MoP and gypsum. The unit plot size was 6 m × 6.5 m. Forty-day-old seedlings were transplanted using 2 - 3 seedlings/hill. Plant protection measures were taken whenever required. At maturity, the crop was harvested 5 m^2 area at the centre of each plot and 16 hills were collected for straw yield. The grain yield was recorded at 14% moisture content and straw yield as oven dry basis. Plant P was determined by di-acid (HNO_3 + $HCLO_4$) digestion method.[7] The obtained data was statistically analyzed following[8] IRRISTAT version 4.1. Economic analyses were calculated following the method of.[9]

Results and Discussion

Application of P rates did not influence growth (tiller/m^2, panicle m^2) and yield irrespective of varieties in soils having 6 mg P/kg soil during T. Aman season (Table 1) indicating P fertilizer had no effect on growth and yield of both inbred and hybrid entries. Similar results were also reported.[10]

But in the same field during Boro season P response was observed among the P rates on both growth and yield (Table 2) because the mineralization of soil P was low due low temperature (< 15^0C) . It may be said that phosphorus rates had no effect on tiller/m^2 and panicle/ m^2 but it differs significantly among the varieties. It may be due to varietals

differences. The highest number of tiller/m^2 and panicle/m^2 was found in hybrid entries EH_2 resulting highest grain and straw yields. Application of P @ 10 kg/ha significantly increased the grain yield. But when P was applied @ 20 and 30 kg P/ha, the grain yield difference was not statistically significant. However, the increasing trend up to 20 kg P/ha was found very remarkable**.** Similarly, the straw yield increased with increasing P application but it was statistically insignificant (Table 2). Similar results were observed.[10]

Table 1. Effect of P fertilizer rates on the growth and yield of T. Aman rice.

P rate (kg/ha)	Tiller/ m^2	Panicle/ m^2	Yield (t/ha)	
			Grain	Straw
P_0	202	189	3.78	4.42
P_5	232	213	4.18	5.20
P_{10}	236	208	4.48	5.50
P_{20}	234	218	4.45	5.15
P_{30}	228	207	4.41	5.12
$LSD_{0.05}$	NS	NS	NS	NS
Variety				
BRRI dhan30	213	198	4.43	5.44
BRRI dhan49	217	201	4.31	5.68
EH_1	211	203	4.22	5.38
EH_2	223	194	4.50	5.17
$LSD_{0.05}$	NS	NS	NS	NS

Table 2. Effect of P fertilizer rates on the growth and yield of Boro rice.

P rate (kg/ha)	Tiller/ m^2	Panicle/ m^2	Yield (t/ha)		P uptake (kg/ha)
			Grain	Straw	
P_0	289	264	1.51	2.62	3.0
P_5	306	294	4.57	4.63	10.0
P_{10}	342	327	5.48	5.42	13.0
P_{20}	340	326	5.81	5.56	16.0
P_{30}	318	307	6.11	5.94	16.0
$LSD_{0.05}$	NS	NS	0.71	0.41	2.0
Variety					
BRRI dhan36	253	238	4.23	4.48	11.0
BRRI dhan45	250	237	4.34	4.67	11.0
EH_1	331	310	4.95	5.04	12.0
EH_2	343	330	5.24	5.14	13.0
$LSD_{0.05}$	33	31	0.44	0.51	NS

Regression analysis in T. Aman and Boro rice show that the estimated function between P rates and grain yield (mean of 4 varieties) was quadratic in nature. The value of R^2 (Coefficient of determination) was significant (Figs. 1 and 2).

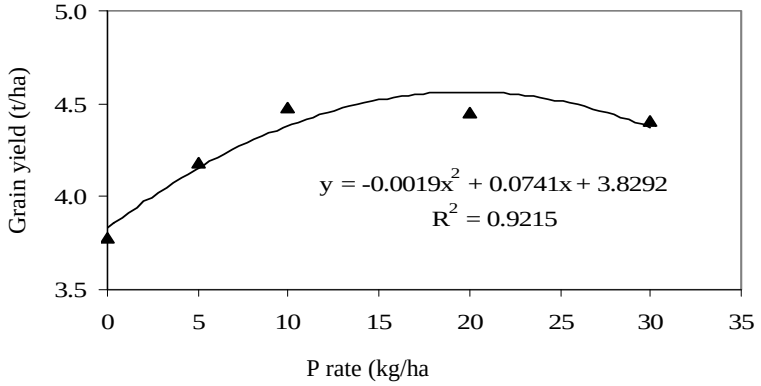

Fig. 1. Relationship between P rates and grain yield of T. Aman

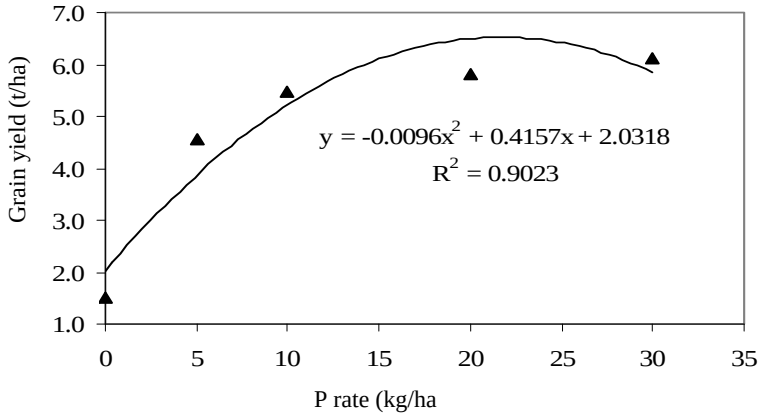

Fig. 2. Relationship between P rates and grain yield of Boro rice.

The economics doses of P during T. Aman (BRRI dhan30, BRRI dhan49, EH_1 and EH_2) and Boro (BRRI dhan36, BRRI dhan45, EH_1 and EH_2) seasons were calculated from Tables 3 and 4. Optimum doses of P for T. Aman and Boro rice were calculated from response curve (Figs. 1 and 2). The result showed that the optimum and economic dose for T. Aman was 20 kg/ha while in Boro rice the optimum and economic doses of P were 22 and 30 kg/ha, respectively.

Table 3. Economic analysis of P response during T.Aman season.

P rate (kg/ha)	Extra-production value (Tk./ha)	TVC	MBCR	Net additional income (Tk./ha)
P_0	-	-	-	-
P_5	8760	1435	6.1	7325
P_{10}	14760	2730	5.4	12030
P_{20}	24360	4438	5.5	19922
P_{30}	12740	6132	2.1	6608

Table 4. Economic analysis of P response during Boro season.

P rate (kg/ha)	Extra production value (Tk./ha)	TVC (Tk./ha)	MBCR	Net additional income (Tk./ha)
P_0	-	-	-	-
P_5	59100	5159	11.5	53941
P_{10}	77060	7308	10.5	69752
P_{20}	83280	9520	8.7	73760
P_{30}	89440	11690	7.7	77750

TSP = Tk. 35/kg, Labor wage rate = Tk. 140/day, ten additional man days/ha are required for per ton additional products including by products, rice grain = Tk. 18/kg, rice straw = Tk. 2/kg.

Table 5. Responsive and economic P rates of different rice varieties (inbred and hybrid) during T. Aman and Boro season.

T. Aman (BRRI dhan30, 49, EH_1 and EH_2)		Boro (BRRI dhan36, 45, EH_1 and EH_2)	
Optimum rate (kg/ha)	Economic rate (kg/ha)	Optimum rate (kg/ha)	Economic rate (kg/ha)
20	20	22	30

Phosphorus uptake was increased with increasing P rates up to 20 kg/ha (Table 2). The uptake was significant among the P rates except the rates of P_{20} and P_{30}. However, the P uptake was more in hybrid entries (EH_1 and EH_2) than those of inbred rice indicating hybrid entries were exploited P more efficiently than inbred varieties of Boro rice (Table 2). A negative apparent P balance was observed when P was applied @ up to 10 kg P/ha. But when P was applied @ 20 kg P/ha a little amount of P existed in soil (Fig. 3). In Boro season, a significant amount of P remained in soil when P was applied @ 30 kg/ha. It may be suggested that when P was applied @ 30 kg/ha in Boro season, no need to apply P fertilizer in T. Aman season.

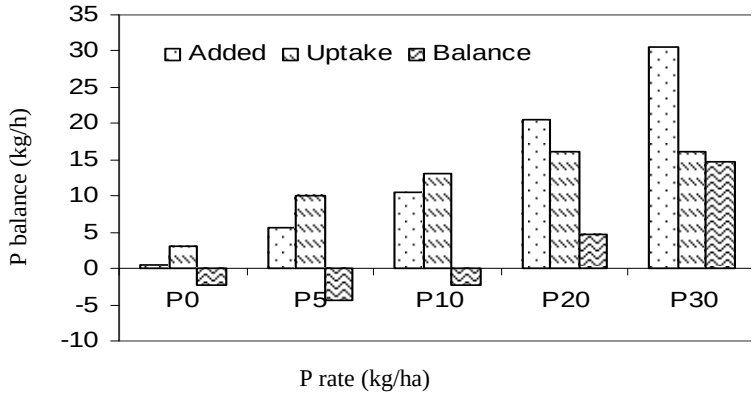

Fig. 3. Phosphorus uptake and balance after Boro.

Soils having available P around 6 mg/kg might be sufficient in T. Aman but in Boro season application of P @ 15 kg/ha appeared to be sufficient for produce optimum rice yield. The results also suggested that no need to apply P fertilizer in T. Aman season where P was applied @ 30 kg/ha in Boro season.

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