Performance of Rock Phosphate and Triple Super Phosphate on Nutrient Dynamics and Yield of Rice (BRRI Dhan 39) in Transplanted Aman season in a Piedmont soil of Bangladesh

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Abstract

A field experiment was done in the Old Himalyan Piedmont Plan Soil of Bangladesh at Wheat Research sub-center, Dinajpur-5200 to study the effect of application of rock phosphate (PR) in comparison with TSP as a source of P on the growth and yield of BRRI Dhan 39 rice during transplanted aman season. The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replications of each treatment. The treatments were T_1: control (0kg P ha^{-1}), T_2: PR (35kg Pha^{-1}), T_3: TSP (35kg P ha^{-1}), and T_4: PR (210kg P ha^{-1}). Basal application was made with N, K, S and Zn. The results indicated that there was no statistical difference in dry matter yield at maximum tillering stage, but at panicle initiation stage the differences became evident over control treatment. Among the yield and yield contributing characters, the effective tillers hill^{-1}, filled grains panicle^{-1} grain yield and straw yield were significantly varied with P treatments. The highest grain yield was recorded in T_4 treatment and the lowest yield and the lowest yield in control treatment. The yields due to different treatments ranked in the order of $T_4 > T_3 > T_2 > T_1$. The N, P, K and S contents as well as uptake by rice plant were also increased due to application of different treatment. The maximum N, P, K and S content as well as uptake in rice plant, grain and straw were recorded in T_4 treatment. The economic results showed that the highest net benefit of Tk. 21207 ha^{-1} was obtained in T_4 Treatment followed by Tk. 20930 ha^{-1}, Tk. 17918 ha^{-1} and Tk. 16084 ha^{-1} in T_3, T_2 and control treatments, respectively. The highest net benefit was obtained in T_4 treatment with higher rate of P but TSP (T_3 treatment) has better performance over rock phosphate (T_2 treatment) having the same rate of phosphorus (35kg P ha^{-1}).

Key words: Rock phosphate, Triple super phosphate, Rice yield, Economic benefit

Introduction

Phosphorus is the second most important nutrient needed in adequate quantity in available source for the growth, reproduction, yield and quantity of any crop. It is indispensable for all forms of life because of its genetic role in RNA and function in energy transfers via TP (Ozanne, 1980). It is associated with several vital functions and is responsible for typical characteristics of plant growth involved in biochemical functions such as utilization of sugar, starch polysaccharides, nucleic acid formation, cell organization and the transfer of hereditary characters. The phosphorus content of Bangladesh soils is relatively low due to the low phosphorus content of the parent materials, the age of the soils and depletion of phosphorus day by day due to crop removal particularly in intensive crop

production culture. Application of phosphatic fertilizer is recommended for all soils and crops in Bangladesh to obtain better yield (BARC, 1997). Unfortunately, the farmers of this country do not always follow the fertilizer recommendation guide or do not make rational use of phosphatic fertilizers. The amount of phosphatic fertilizer used is often too small and the efficiency of use is also low. Thus, the phosphorus balance in agro-ecosystem is usually negative. Triple super phosphate (TSP) and Single super phosphate (SSP) containing water soluble phosphate has been commonly used as the phosphatic fertilizer by the farmers throughout Bangladesh. Rock phosphate (PR) is the cheapest and economic source per unit of phosphorus (Hoffland, 1991) which is not directly being used in the crop field of this country. Soils and climatic conditions are also favorable for direct application of PR. It is considered as a promising source for crop use in acidic soil, especially red one. So, the present research programme has been taken with the following objectives: **i)** to assess the comparative performances of PR (Rock Phosphate) and TSP as source phosphorus on growth and yield of rice, and **ii)** to assess the soil fertility condition and to determine the economic benefits of PR as a source of phosphorus compared to TSP.

Materials and Methods

The experiment was carried out in the farm of wheat Research sub-center, Rajbari at Dinajpur district during T-Aman season. The farm belongs to Agro-Ecological Zone 1, highland, well drained soil under Gangachara Soil Series. The land was above flood level and sufficient sunshine was available during the experimental period. The climate of the experimental area is in sub-tropical accompanied by moderate high rainfall associated with relatively high temperature during T. aman season.

The test crop was a rice variety (cv. BRRI Dhan 39). The experimental design was Randomized Complete Block Design (RCBD) with Treatment: 4, Replication: 4, Total number of plots: 16.

There were four treatments consisting of TSP and two rates of rock phosphate and a control. Treatments were T_1 = Control (0 kg p ha^{-1}), T_2 = Phosphate rock (PR) @ 35 kg P ha^{-1}), T_3 = Triple Super phosphate @ 35 kg P ha^{-1}), T_3 = Phosphate rock (PR) @ 210 kg P ha^{-1}).

The data of the agronomic characters of the crop were calculated as Plant height (cm), Number of tillers per hill, Panicle length (cm), Unfilled and filled grains per panicle, 1000-grain weight, Grain and straw yields (kg/plot). The soil properties studied included pH, organic matter, total N, available P and exchangeable K. Soil sample analysis and plant nutrient content analysis was done in Regional Laboratory, Faridpur of Soil Resource Development Institute and Dept. of Soil Science in Bangladesh Agriculture University, Mymensingh.

The statistical analysis for different characters including the nutrient content and uptake were done following the ANOVA technique and the mean results in case of significant F-values were adjusted by the Duncan's Multiple Range Test (DMRT).

Results and Discussion

The presentation and discussion of the results obtained due to direct application of Rock Phosphate (PR) on growth and yield components of T. aman rice (cv. BRRI Dhan 39). The result of studied such as dry matter yield, nutrient content and uptake by rice plant at maximum tillering (MT) and panicle initiation (Pl) stage as well as yield attributes, grain and straw yields and chemical characteristics of the soil at post harvest are discussed in this part. Growth and development of rice plant: There were no significant differences in different treatments on dry matter yield of rice plants at MT stage which ranged from 909.53 to 935.02 kg ha^{-1} (Table 3.1). Maximum dry matter yield was recorded in T_4 treatment (935.2.02 kg ha^{-1}) and the minimum dry matter yield was recorded in control treatment (909.53 kg ha^{-1}). All the treatment differed significantly over control in dry matter development at PI

stage of growth of rice plants. Maximum dry matter yield was obtained in PR (210kg P ha^{-1}) treatment, which was 17.65% over control, 13.93% over T_2 treatment (35 kg ha^{-1}) and 10.54% over TSP (35 kg P ha^{-1}) treatment (Table 3.1). The maximum plant height (112.45 cm) was attained in control treatment. The minimum height of rice plants (107.40cm) was obtained in T_3 treatment. T_4 treatment appeared to have produced maximum number of effective fillers (12.10 $hill^{-1}$) which was statistically significant over T_2 and control treatments, although it is statistically similar to T_3 treatment. TSP treatment produced better result over PR having same P rate (35 kg P ha^{-1}). Panicle length was not influenced significantly, although there were some apparent increases in fertilizer treatment over control (Table 1.1) and the maximum panicle length (24.50 cm) was attained in T_4 treatment and minimum panicle length (23.70 cm) was found in control. Maximum number of filled grain $panicle^{-1}$(119.35) of rice plant was recorded in T_4 treatment which was statistically significant over all other treatments (Table 1.2). Maximum grain yield (5.96 t ha^{-1}) of rice was obtained in T_4 treatment (Table 3.3). There was no significant grain difference between PR and TSP treatments having the same P rate. The minimum rice yield (4.55 t ha^{-1}) was obtained in the control. Chowdhury (1978) reported that the grain yield of rice increased with increasing levels of P from either TSP or PR. Straw yield was maximum (7.55 t ha^{-1}) under T_4 treatment over rest treatment and the lowest straw yield (5.57 t ha^{-1}) was found in control.

Table 1.1 Effects of different treatments on dry matter yield at Maximum Tillering (MT) stage and Panical Initiation (PI) stage of rice (BRRI Dhan 39)

Treatments	Maximum Tillering (MT) stage				Panical Initiation (PI) stage			
	Dry matter yield (kg ha^{-1})	Increase over control (%)	Increase over T_2 (%)	Increase over T_3 (%)	Dry matter yield (kg ha^{-1})	Increase over control (%)	Increase over T_2 (%)	Increase over T_3 (%)
T_1 Control (0 kg P ha^{-1})	909.53	-	-	-	4900 b	-	-	-
T_2 PR (35 kg P ha^{-1})	912.90	0.37	-	-	5060 b	3.26	-	-
T_3 TSP (35 kg P ha^{-1})	928.85	2.12	1.74	-	5215 b	6.42	3.06	-
T_4 PR (210kgP ha^{-1})	935.02	2.80	2.42	0.66	5765 a	17.65	13.93	10.54
SE(±)	9.52	-	-	-	20.00	-	-	-
CV(%)	2.02	-	-	-	3.85	-	-	-

Table 1.2 Effect of different treatments on yield contributing characters of BIRRI Dhan 39 at harvest stage

Treatments	Plant height (cm)	Effective tiller $hill^{-1}$ (No.)	Panical length (cm)	Unfilled grain $penical^{-1}$ (No.)	% Unfilled grain	Filled grains $penical^{-1}$	% Filled grains	1000-grain weight
T_1 Control (0 kg P ha^{-1})	112.45	9.75 c	23.70	15.50 a	14.56	90.89 d	85.46	24.62
T_2 PR (35 kg P ha^{-1})	108.90	10.50 bc	23.90	16.00 a	14.04	97.90 c	85.96	24.90
T_3 TSP (35 kg P ha^{-1})	107.40	11.35 ab	24.10	16.65 a	13.19	109.50 b	86.81	25.35
T_4PR (210 kgP ha^{-1})	108.90	12.10 a	24.50	13.80 b	10.36	119.35 a	89.64	25.95
SE(±)	2.42	0.655	NS	0.850	-	2.247	-	NS
CV(%)	2.66	7.60	10.25	9.75	-	2.78	-	2.45

Table 1.3 Effects of different treatments on grain and straw yields of BRRI Dhan 39

Treatments	Grain				Straw			
	Grain yield T ha^{-1}	Increase over control (%)	Increase over T_2 (%)	Increase over T_3 (%)	Straw yield T ha^{-1}	Increase over control (%)	Increase over T_2 (%)	Increase over T_3 (%)
T_1 Control (0 kg P ha^{-1})	4.55 c	-	-	-	5.57 c	-	-	-
T_2 PR (35 kg P ha^{-1})	4.90 bc	7.69	-	-	5.96 c	7.00	-	-
T_3 TSP (35 kg P ha^{-1})	5.34 b	17.36	8.97	-	6.88 b	23.51	15.43	-
T_4PR (210kgP ha^{-1})	5.96 a	30.98	21.63	11.61	7.55 a	35.54	26.67	9.73
SE(±)	0.118	-	-	-	0.103	-	-	-
CV (%)	6.78	-	-	-	3.19	-	-	-

Content and uptake of nutrients by rice plant

The N content due to different treatments ranged from 1.81 to 2.07% at maximum tillering stage. The maximum N content was obtained in T_4 treatment and the minimum value was obtained in control treatment. The N uptake by rice plant was found statistically significant due to different treatment (Table 1.4). The highest N uptake (19.37 kg ha^{-1}) was obtained in T_4 treatment and the lowest value was noted in control treatment. The treatments T_2 and T_3 were statistically identical. The content of P in rice plant in different treatments at MT stage varied from 0.208 to 0.265% (Table 1.4) and the maximum value was noted in T_4 treatment and the minimum value was obtained in control. P uptake by BRRI Dhan 39 also varied significantly (Table 1.4) with the maximum P uptake (2.48 kg ha^{-1}) was noted in T_4 treatment which was statistically identical to T_3 treatment and the minimum P uptake (1.86 kg ha^{-1}) was found in control treatment which was statistically similar to the treatment T_2. K content in rice plant at MT stage was significant due to different treatments (Table 1.4). The highest K content (1.427%) was recorded in T_4 treatment and the minimum K content (1.302%) was noted in control and the K content due to different treatments ranked in the order of T_4> T_3> T_2> T_1>. The highest K uptake (13.34 kg ha^{-1}) was recorded in T_4 treatment and the lowest K uptake (11.64 kg ha^{-1}) was recorded in control. The treatments T_2 and T_3 were statistically similar. The highest value (0.174%) of S content was obtained in T_3 treatment and the minimum value (0.123%) was noted in T_4 treatment (Table 1.4). The treatments T_1 and T_2 were statistically identical. The highest value (1.61 kg ha^{-1}) of S content was found in T_3 treatment and the lowest value (1.14 kg ha^{-1}) was noted in T_4 treatment. The treatment T_1 and T_2 were statistically similar. The maximum N content (2.12%) was obtained in the T_4 treatment and the lowest value (1.05%) was found in control treatment. The treatments T_2 and T_3 were statistically similar (Table 1.5). The highest N uptake (64.71 kg ha^{-1}) was obtained in T_4 treatment and the lowest value (51.82 kg ha^{-1}) was noted in control. The treatments T_2 and T_3 were statistically identical. The P content ranged from 0.176 to 0.231% (Table 1.5). The maximum P content was observed in T_4 treatment and the minimum P content was noted in control. A significant increase in P uptake by rice plant was also recorded due different treatments (Table 1.5). The treatment T_4 showed the maximum uptake (13.32 kg ha^{-1}) and control treatment showed the lowest P uptake (8.61 kg ha^{-1}). The K content due to different treatments ranged from 1.24 to 1.41% (Table 1.5). The highest value was obtained in treatment T_4 and control treatment showed the minimum K content. The K uptake ranged from 61.12 to 81.83 kg ha^{-1}. The highest K uptake (81.83 kg ha^{-1}) was noted in T_4 treatment and the lowest value (61.12 kg ha^{-1}) was found in control. S content at panicle initiation stage did not increase significantly due to different treatments (Table 3.5). S content in rice plant ranged from 0.159 to 0.172%. The maximum value was found in the treatment T_4 where as the control treatment produced minimum S content. The highest value was noted in T_4 treatment and the lowest value was found in control. The S content range varied from 7.76 to 9.83 kg

ha^{-1} (Table 1.5). The maximum N content was recorded in T_4 treatment. The lowest N content was observed in control. The treatments T_2 and T_3 were statistically identical (Table 1.6). On the other hand, the lowest N content was found in control. Treatment T_3 (0.56%) was shown a slight improvement then the treatment T_2 (0.52%).The maximum N uptake was recorded in T_4 treatment and the lowest value was obtained in control. The treatment T_3 was significantly superior to T_2 treatment. In case of straw, N uptake ranged from 27.52 to 47.94 kg ha-1 (Table 1.6). Similar observations of increase in N content in cereals with the application of P were reported by many investigators BRRI, 1978 and Munson, 1986. Munson (1986) descried that P enhanced N content as well as uptake of grain because of improved metabolism and utilization of other elements. The maximum N uptake (47.94 kg ha^{-1}) was noted in T_4 treatment and the lowest N uptake (27.52 kg ha^{-1}) was obtained in control. The maximum total N uptake was found in T_4 treatment and the lowest value was noted in control. The treatment T_3 was significantly superior to T_2 treatment (Table 1.6). The maximum P content (0.318%) was attained in T_4 treatment followed by T_3 (0.313%) and T_2 (0.302%). The minimum P content (0.297%) was attained in control (Table 3.7). Significant increase in P content as well as uptake with the application of P fertilizer was in corroboration with the findings of Agarwal, 1976, BRRI, 1978 and Hammond et al., 1986. The highest P content in straw was also attained in T_4 treatment followed by T_3 (0.125%) and T_2 (0.122%) and the minimum content was observed in control treatment. However, in both cases (grain & straw) TSP had shown better effect over PR having the same rate of P. Like P content, P uptake by grain and straw, was influenced significantly due to different treatments. The maximum P uptake was recorded in T_4 treatment with higher P rate from PR source and minimum was in control. TSP had shown better effect over PR having same rate of P. Similar trends was also noticed in case of total P uptake and the range (total uptake) varied from 18.92 to 19.15 kg ha^{-1} (Table 1.7). The K content in grain ranged from 0.224 to 0.245% (Table 1.8) and the maximum K content were recorded in T_4 treatment and the control treatment and control treatment showed the minimum K content, which was statistically similar to T_2 treatment. In case of straw, K content varied from 1.463 to 1.715% and all the treatments increased the K content significantly over control. The maximum K content (1.715%) was noted in T_4 treatment and the minimum K content (1.463%) was obtained in control. All the treatments increase the K uptake significantly over control. The highest K uptake was found in T_4 treatment and the control treatment showed the minimum K uptake (Table 1.8). The intake in straw ranged from 80.45 to 129.54 kg ha^{-1} (Table 1.8). The highest K uptake was obtained in T_4 treatment and the lowest K uptake was noted in control. K uptake varied significantly due to different treatments and uptake ranged from 90.65 to 144.09 kg ha^{-1}. The maximum K uptake was found in T_4 treatment and the lowest K uptake was noted in control (Table 1.8). Similar observations of increase in K content and uptake with the application of phosphatic fertilizers were reported by investigator Agarwal, 1976. The content ranged from 0.113 to 0.123% (Table 1.9). The highest S content was found in T_4 treatment and the minimum S content was noted in control treatment which was statistically similar to T_2 treatment. In case of straw, S content varied from 0.103 to 0.112%. The highest S content was noted in T_4 treatment which was statistically similar to T_3 treatment. The lowest S content was recorded in control treatment which was statistically similar to T_2 treatment. The ranges of S uptake were observed in grain at 5.15 to 7.34 kg ha^{-1}. All the treatments are statistically significant over in T_4 treatment and the minimum S uptake was noted in control (Table 1.9). In case of straw, the maximum S uptake was recorded in T_4 treatment which was statistically identical to T_3 treatment and the minimum value was noted in control treatment which was statistically similar to T_2 treatment and the range varied from 5.65 to 7.64 kg ha^{-1} (Table 1.9). Application of PR and TSP had significant effect on total S uptake. The highest total S uptake (14.98 kg ha^{-1}) was obtained in T_4 treatment which was statistically similar to T_3 treatment and the lowest total S uptake (10.80 kg ha^{-1}) was noted in control (Tale 1.9) which was statistically identical to T_2 treatment. Earlier investigations also revealed that P fertilization increases S content and uptake in rice grain as found by Joshy (1975) and Ahmed (1993).

Table 1.4 Effects of different treatments on nutrient content and uptake by BRRI Dhan 39 at maximum tillering (MT) stage

Treatments	Nutrient content (%)				Nutrient uptake (%)			
	N	P	K	S	N	P	K	S
T_1 Control (0 kg P ha^{-1})	1.81 c	0.208 d	1.302 d	0.162 b	16.23 c	1.86 c	11.64 c	1.45 b
T_2 PR (35 kg P ha^{-1})	1.87 bc	0.222 c	1.380 c	0.164 b	17.09 b	2.02 b	12.59 b	1.51 b
T_3 TSP (35 kg P ha^{-1})	1.91 b	0.251 b	1.392 b	0.174 a	17.44 b	2.35 a	12.72 b	1.61 a
T_4PR (210 kg P ha^{-1})	2.07 a	0.265 a	1.427 a	0.123 c	19.37 a	2.48 a	13.34 a	1.14 c
*SE(±)	0.0243	0.0032	0.0085	0.0013	0.2365	0.0471	0.0804	0.0288
*CV (%)	2.53	2.74	1.24	1.67	2.70	4.32	1.28	4.03

Table 1.5 Effects of different treatments on nutrient content and uptake by BRRI Dhan 39 at panicle initiation (PI) stage

Treatments	Nutrient content (%)				Nutrient uptake (%)			
	N	P	K	S	N	P	K	S
T_1 Control (0 kg P ha^{-1})	1.05 b	0.16 d	1.24 d	0.159	51.82 c	8.61 d	61.12 d	7.76 c
T_2 PR (35 kg P ha^{-1})	1.10 ab	0.200 c	1.28 c	0.162	55.74 b	10.20 c	65.10 c	8.20 bc
T_3 TSP (35 kg P ha^{-1})	1.09 ab	0.215 b	1.35 b	0.166	57.58 b	11.18 b	70.58 b	8.61 b
T_4PR (210 kg P ha^{-1})	1.12 a	0.231 a	1.41 a	0.172	64.71 a	13.32 a	81.83 a	9.83 a
SE(±)	0.0178	0.0044	0.0103	NS	1.0511	0.221	0.6458	0.039
CV (%)	3.24	4.33	1.55	1.00	3.66	4.09	1.85	1.00

Table 1.6 Effects of different treatments on N concentration and N uptake by BRRI Dhan 39 at harvest

Treatments	Content (%)		Uptake($kgha^{-1}$)		Total uptake (kg ha^{-1})
	Grain	Straw	Grain	Straw	
T_1 Control (0 kg P ha^{-1})	1.058 c	0.50 c	48.20 d	27.52 c	75.71 d
T_2 PR (35 kg P ha^{-1})	1.118 b	0.52b c	44.69 c	31.42 c	76.81 c
T_3 TSP (35 kg P ha^{-1})	1.137 b	0.56 b	60.73 b	38.70 b	98.16 b
T_4PR (210 kg P ha^{-1})	1.213 a	0.63 a	72.26 a	47.94 a	120.21 a
SE(±)	0.0166	0.0131	1.755	1.248	2.601
CV (%)	2.93	4.71	5.95	6.86	5.46

Table 1.7 Effects of different treatments on P concentration and P uptake by BRRI Dhan 39 at harvest

Treatments	Content (%)		Uptake($kgha^{-1}$)		Total uptake ($kgha^{-1}$)
	Grain	Straw	Grain	Straw	
T_1 Control (0 kg P ha^{-1})	0.297 b	0.106 c	13.53 d	5.56 d	18.92 d
T_2 PR (35 kg P ha^{-1})	0.302 b	0.122 b	14.94 c	7.26 c	22.20 c
T_3 TSP (35 kg P ha^{-1})	0.313 a	0.125 b	16.70 b	8.56 b	25.01 b
T_4PR (210 kg P ha^{-1})	0.318 a	0.136 a	18.91 a	10.24 a	29.15 a
SE(±)	0.0011	0.0010	0.3673	0.1885	0.320
CV (%)	1.71	1.65	4.58	4.77	2.69

Table 1.8 Effects of different treatments on K concentration and K uptake by BRRI Dhan 39 at harvest

Treatments	Content (%)		Uptake (kg ha^{-1})		Total uptake (kgha^{-1})
	Grain	Straw	Grain	Straw	
T_1 Control (0 kg P ha^{-1})	0.224 c	1.463 d	10.20 d	80.45 d	90. 65 d
T_2 PR (35 kg P ha^{-1})	0.227 c	1.512 c	11.13 c	90.10 c	101.23 c
T_3 TSP (35 kg P ha^{-1})	0.236 b	1.593 b	12.58 b	109.54 b	122.12 b
T_4PR (210 kg P ha^{-1})	0.245 a	1.715 a	14.61 a	129.54 a	144.09 a
SE(±)	0.0008	0.0076	0.2698	1.962	2.031
CV (%)	1.00	1.00	4.45	3.83	3.55

Table 1.9 Effects of different treatments on S concentration and S uptake by BRRI Dhan 39 at harvest

Treatments	Content (%)		Uptake (kgha^{-1})		Total uptake (kg ha^{-1})
	Grain	Straw	Grain	Straw	
T_1 Control (0 kg P ha^{-1})	0.113 c	0.103 b	5.15 d	5.65 b	10.80 b
T_2 PR (35 kg P ha^{-1})	0.117 bc	0.105 b	5.70 c	6.25 b	11.95 b
T_3 TSP (35 kg P ha^{-1})	0.121 ab	0.111 a	6.53 b	7.65 a	14.18 a
T_4PR (210 kg P ha^{-1})	0.123 a	0.112 a	7.34 a	7.64 a	14.98 a
SE(±)	0.0014	0.0008	0.1717	0.2809	0.3718
CV (%)	2.36	1.55	5.55	8.26	5.73

Characteristics of the post harvest soils

Characteristics of the post harvest soils as influenced due to different treatments showing a sharp variation of the pH, soil organic matter, N, P, K and S of the initial soil values. The pH values of the post harvest soil ranged from 5.12 to 5.92 (Table 1.10). The highest pH value was recorded by the treatment T_4 (5.92) followed by control (5.25) and T_2 (5.22). The lowest pH value (5.12) was noted in T_3 treatment. The organic matter content of the post harvest soils ranged from 1.41 to 1.51% (Table 3.10). The highest organic matter content was obtained in control treatment (1.51%) and the minimum organic matter content (1.41%) was obtained in T_3 treatment. The total N content of the post harvest soils influenced significantly due to different treatments. The maximum N content (0.132%) was recorded in T_4 treatment and the lowest N content (0.126%) was noted in T_2 treatment (Table 1.10). The treatments T_1 and T_3 were statistically similar. Available S content of post harvest soils influenced significantly due to different treatments. The maximum S content (14.62 ppm) was observed in T_3 treatment followed by T_2 (12.68ppm) and T_4 (11.70ppm) (Table 1.10). The lowest S content (11.18 ppm) was noted in control. Application of PR and TSP exerted significant effect on the P content in post harvest soils range varied from 11.26 to 16.48 ppm. The highest P content was recorded in the treatment T_4 and the lowest P content in the control treatment. The treatments T_2 and T_3 were statistically identical. The K content of post harvest soils ranged from 0.118 to 0.141 cmol kg^{-1} soil. The highest K content (0.141 meq/100 g soil) was found in control and the lowest K content (0.118 meq/100g soil) was noted in T_2 treatment (Table 1.10). The treatments T_3 and T_4 were statistically similar. Net benefit was calculated by subtracting the total input cost from the gross field income. Gross field income was calculated as the total market value of grain and straw of rice. The input cost was calculated as the total market value of fertilizers, and other materials and non-materials cost. The results of economic analysis of rice (cv. BRRI Dhan 39) showed that the highest net benefit of Tk. 21207.00 ha^{-1} was obtained in T_4 treatment followed by Tk. 20930.50 ha^{-1}, Tk. 17918.25 ha^{-1} and Tk.16084.50 ha^{-1} in T_3, T_2 and control treatments, respectively (1.11).

Table 1.10 Characteristics of the post harvest soil

Treatments	pH	Organic Matter (%)	Total nitrogen (%)	Available S (ppm)	Available P (ppm)	Exchangeable K (meq $100g^{-1}$ soil)
T_1 Control (0 kg P ha^{-1})	5.25	1.51	0.129 ab	11.18 c	11.26 c	0.141 a
T_2 PR (35 kg P ha^{-1})	5.22	1.42	0.126 b	12.68 b	13.32 b	0.118 c
T_3 TSP (35 kg P ha^{-1})	5.12	1.41	0.129 ab	14.62 a	13.31 b	0.124 b
T_4PR (210 kg P ha^{-1})	5.92	1.44	0.132 a	11.70bc	16.48 a	0.124 b
SE(±)	NS	NS	0.0006	0.3672	0.2812	0.0087
CV (%)	2.50	1.75	1.00	5.85	4.14	13.68
Initial soil	5.40	1.59	0.130	12.5	11.00	0.120

Table 1.11 Economics for fertilizer use in crop production under BRRI Dhan 39 during Kharif season

Treatments	Total input (kg ha^{-1})		Gross field Income (TK ha^{-1})			Total input cost (Tk ha^{-1})	Net benefit (Tk ha^{-1})	Net benefit due to addition of PR (35 kg P ha^{-1}) over control (Tkha^{-1})	Net benefit due to addition of TSP (35 kg P ha^{-1}) over T_2 (Tkha^{-1})	Net benefit due to addition of PR (210 kg P ha^{-1}) over T_3 (Tkha^{-1})
	Grain	Straw	Grain	Straw	Total					
T_1 Control (0 kg P ha^{-1})	4550	5570	36400	5570	41970	25885.50	16084.50	-	-	-
T_2 PR (35 kg P ha^{-1})	4900	5960	39200	5960	45160	27241.75	17918.25	1833.75	-	-
T_3 TSP (35 kg P ha^{-1})	5340	5880	42720	5880	49600	28669.50	20930.50	-	3012.25	-
T_4PR (210kgP ha^{-1})	5960	7550	47680	7550	55230	34023.00	21207.00	-		276.50

* Production cost other fertilizer remain same in all treatments.
*Current market price were used for rice grain, straw, fertilizers are listed value

Output cost	Input cost		
	a) Material cost		a) Non-material cost
Grain @8.00 kg^{-1} Straw @1.00 kg^{-1}	PR @ 5.00 per kg TSP @ 16.00 per kg Urea @ 6.00 per kg MOP @ 16.00 per kg	Zypsum @ 5.00 per kg ZnO @ 70.00 per kg Irrigation - 2000.00 Tk Pesticide-1760.00 Tk Seed-262.50 Tk	Labour cost-16718.00 Tk Ploughing – 1842.00 Tk

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