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Direct and residual effects of rock phosphate on mustard (cv. BARIsharisa 11) in two different sites under high Ganges river floodplain

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Abstract: Two experiments were conducted on High Ganges River Flood Plain AEZ 11 -1 at BRRI Sub-station, Rajshahi and the other at Pulse Research Centre, Ishurdi, Pabna to study the direct and residual effects of rock phosphate (RP) on growth and yield of mustard (cv. BARI Sharisa-11) during Rabi season 2004-05. The experiment consists of 4 treatments and laid out in a Randomized Complete Block Design (RCBD) with 4 replications. The treatments were T_1: Control (no P), T_2: RP (26 kg P ha^{-1}), T_3: TSP (26 kg P ha^{-1}) and T_4: Residual RP (210 kg P ha^{-1}) applied in previous crop. Recommended rates of N, K and S were used as usual in all the treatments. Yield and yield contributing characters of mustard were significantly influenced by different treatments. The highest seed and stover yield were obtained in T_3 treatment at both the sites amounting 1.46 and 3.64 t ha^{-1}, at site-I and 1.50 and 3.24 t ha^{-1} at site-II. The economic analysis showed that the highest net benefits were also obtained in T_3 treatment at both the sites as Tk. 16,996 (site-I) and Tk. 17,989 (site-II) per hectare. TSP has better performance over rock phosphate having the same rate of P (26 kg P ha^{-1}) followed by T_4 and T_2 treatments. The overall findings of the study indicate that the residual and directly applied RP were less effective than the applied TSP.
Key words: Rock phosphate, Mustard, Ganges river floodplain

Introduction

Mustard (*Brassica juncea*) is an important oil seed crop of the world after soybean and palm and it supplies about 13.2% of the world annual edible oil (FAO, 2005). It is also a major oil seed crop in Bangladesh and contributes a significant part of domestic edible oil production. Mustard seeds contain 40-45% oil and 20-25% RPotein (FAO, 2005). In Bangladesh about ten oil seed crops are grown. Among them the Brassica is the most important group of the species that supplies major edible oil in Bangladesh (BBS, 2007). It covers about 72% of the total oil seed acreage and about 68% of the total oil seed production (BBS, 2007). Bangladesh requires 0.29 million tons of oil which covers only 30% of the domestic need (BBS, 2007). More than 70% of requirement of oil has to be imported every year by spending huge amount foreign currency (BBS, 2007). Therefore, any means of increase in oil seed production can contribute to the national economy.

Judicious application of fertilizer is very important along with modern cultural practices and high yielding varieties to increase per unit area yield. Out of the three major elements of plant nutrients uptaken from the soils, phosphorus (P) plays a major role in crop production. Deficiencies in P is becoming widespread and acute in any soil of Bangladesh (Islam, 2000). Thus, the application of phosphate fertilizer is essential for balanced fertilization and also for better yield and quality of the crop. Application of P significantly increased the yield parameters, seed and stover yields, protein and oil content and net return of mustard (Patel and Shelke, 1999). Application of P also significantly increased number of siliqua $plant^{-1}$, seeds $silique^{-1}$, length of silique of mustard (Balder *et al*., 1999).

The main constraint of P fertilization is its fixation with soil constituents within short period of application rendering more than two-thirds unavailable (Mandal and Khan, 1972). Therefore, the application of rock phosphate (RP) could be a potential alternative of the traditionally used P fertilizers (TSP and SSP) to avoid P fixation as P released very slowly from RP. It is documented in literature that the application of RP can minimize P fixation in acidic soil having high contents of Fe and Al (Panda and Mathur, 1979). Moreover, RP is agronomically effective as well as less costly and highly profitable than TSP and SSP fertilizer (Goh and Chew, 1995) and bring socioeconomic benefit to the farmers. However, only very few literature is available regarding the efficiency of RP in alkaline soils. Therefore, this piece of research was undertaken to study the efficiency and economic feasibility of directly applied and residual effect of RP in compare to TSP on growth, yield and P content as well as uptake by mustard.

Materials and Methods

The experiments were conducted in representative high land rice growing soil one at BRRI sub-station, Rajshahi and another at the pulse research centre Ishurdi, Pabna during the rabi season of 2004-2005. Both the experimental sites belong to High Ganges River Flood Plain (AEZ-11) were under sub tropical climate (scantly rainfall and low temperature at rabi season). Soils of the both sites were silty loam in texture, well drained, calcareous brown floodplain under Sara series having pH 7.30-7.88 in site-I and pH 7.53-7.71 in site-II. Mustard variety BARI sharisa-11 developed by Bangladesh Agricultural Research Institute, Joydebpur, Gazipur was used as an experimental crop for this study. Four treatments used in the experiment were as T_1: control (no P), T_2: RP (26 kg P ha^{-1}), T_3: TSP (26 kg P ha^{-1}) and T_4: Residual RP (210 kg P ha^{-1}) applied in previous crop. The experiments were laid out in Randomized Complete Block Design (RCBD). According to the design and objectives of the experiments, half dose of N and full dose of P, K, S and B were applied before final ploughing of the plots. Second split of N was applied at 21 days after emergence of seedlings.

Seeds were sown in line maintaining a row to row distance of 30 cm. Plots were irrigated twice, at 21 and 50 days after emergence of seedlings. Weeding was done as and when necessary. Crops were harvested at maturity and subsequently threshed and data collected on plant height, number of primary branches $plant^{-1}$, pods $plant^{-1}$, seeds pod^{-1}, length of siliqua, 1000 seeds weight, seed and stover yield, and oil content. Phosphorus content of mustard seed and stover were analyzed following coloremetric method (Olsen and Sommers ,1982). The oil content of mustard seeds were determined by folch False method (Folch *et al*., 1957). The data were analysed by using statistical software MSTAC and the results were interpreted. The mean results in case of significant F values were adjudged by Duncan's Multiple Range Test (DMRT).

Results and Discussion

All the yield contributing characters of BRRI sharisa-11 except plant height and 1000 grain weight were significantly influenced by the treatments at both the sites (Table 1 and 2). The highest primary branches plant^{-1} (4.47 and 4.11 at site I and II, respectively), pods plant^{-1} (133.56 and 123.82 at site I and II, respectively), seeds pod^{-1} (24.47 and 11.55 at site I and II, respectively) and length of siliqua (4.94 and 4.75 at site I and II, respectively) were found in T_3 (TSP 26 kg P) treatment at both the sites. The highest plant height and 1000 grain weight were also recorded in T_3 though those two parameters were insignificant. The lowest values of those yield contributing characters were recorded in control treatment. This result is in line with Balder *et al.*(, 1999) who reported a significant increased in number of siliqua plant^{-1}, seeds silique^{-1}, length of silique of mustard with P application.

Table 1. Effects of residual and directly applied RP and TSP on yield contributing characters of mustard

Treatments	Plant height (cm)		primary branches plant^{-1}		Pods plant^{-1}		Seeds pod^{-1}		Length of siliqua (cm)	
	Site-I	Site-II	Site-I	Site-II	Site-I	Site-II	Site-I	Site-II	Site-I	Site-II
T_1 Control (P)	111.13	125.11	2.92c	3.04b	86.75b	98.41b	8.04c	7.23b	4.13d	4.05b
T_2 RP (26 kg P ha^{-1})	111.17	125.88	3.70b	4.01a	110.47a	129.05a	9.61b	11.24a	4.40c	4.65a
T_3 TSP (26 kg P ha^{-1})	112.04	125.93	4.11a	4.47a	123.82a	133.56a	11.55a	12.47a	4.75a	4.94a
T_4 Residual RP (210 kg P ha^{-1*})	113.14	125.40	3.90ab	4.32a	125.18a	129.38a	10.47ab	11.60a	4.57b	4.68a
SE (±)	NS	NS	0.054	0.134	3.420	1.435	0.289	0.318	0.036	0.070
CV (%)	0.75	0.56	3.00	6.75	6.13	2.34	5.83	5.97	1.64	3.03

*Applied in RPevious crop to cover the succeeding crops, SE (±) = Standard error of means, Figures in column having common letter(s) do not differ significantly at 5% level of significance

Table 2. Effect of residual and directly applied RP and TSP on seed and stover yield of mustard

Treatments	1000-seed weight (g)		Oil content (%)		Seed yield (t ha^{-1})		Stover yield (t ha^{-1})	
	Site-I	Site-II	Site-I	Site-II	Site-I	Site-II	Site-I	Site-II
T_1 Control (P)	3.50	3.54	41.12	41.21	1.13d	1.22c	2.77c	2.55c
T_2 RP (26 kg P ha^{-1})	3.51	3.46	41.36	41.62	1.22c	1.36b	2.88bc	2.84bc
T_3 TSP (26 kg P ha^{-1})	3.52	3.56	44.11	44.36	1.46a	1.50a	3.64a	3.24a
T_4 Residual RP (210 kg P ha^{-1*})	3.51	3.55	43.22	43.27	1.34b	1.38b	3.05b	3.06ab
SE (±)	NS	NS	NS	NS	0.013	0.228	0.038	0.0695
CV (%)	0.08	0.10	6.21	6.77	2.02	3.35	2.54	4.76

*Applied in previous crop to cover the succeeding crops, SE (±) = Standard error of means, Figures in column having common letter(s) do not differ significantly at 5% level of significance

Seed and Stover yields were significantly influenced by different P treatments. The highest seed yields (1.46 and 1.50 t ha^{-1} in site I and II) were recorded in T_3 treatment followed by T_4, T_2 and the lowest in control on both the sites (1.13 and 2.22 t ha^{-1} in site I and II). The percent increased in seed yields over control were 29, 19 and 7% at site-I and 12, 23 and 13% at site-II in T2, T3 and T4 treatments, respectively. The stover yield also followed the same trends at both the sites. These highest seed and stover yield in TSP treated plot reflects that more P became available to mustard plants from the TSP compare to residual and directly applied RP. It is also observed that a considerable percent of yield increased were observed in residual RP treated plots. This result is in agreement with Jena et al. (2004) who found a higher seed and stover yields of mustard due to the effect of residual RP applied in previous maize crop.

As with the seed and stover yield of mustard, oil content (%) in mustard seeds showed the similar trends however the variation in oil content among the treatments was insignificant (Table 2). This result slightly contradict with previous findings by Patel and Shelke (1999) who found a significant variation in oil content due to the application of different rates of P fertilizer.

Table 3. Effects of residual and directly applied RP and TSP on phosphorus content and uptake by seed and stover of mustard

Treatment	P content (%)				P uptake (kg ha^{-1})				Total P uptake	
	Seed		Stover		Seed		Stover			
	Site-I	Site-II	Site-I	Site-II	Site-I	Site-II	Site-I	Site-II	Site-I	Site-II
T_1 Control (P)	0.37b	0.35c	0.05c	0.05b	4.10c	4.46c	1.24d	1.32d	5.34d	5.78d
T_2 RP (26 kg P ha^{-1})	0.40ab	0.41b	0.08b	0.06b	6.05b	5.61b	1.69c	1.72c	7.74c	7.33c
T_3 TSP (26 kg P ha^{-1})	0.52a	0.50a	0.10a	0.09a	7.65a	7.56a	3.01a	3.01a	10.66a	10.57a
T_4 Residual RP (210 kg P ha^{-1*})	0.50a	0.47a	0.09a	0.08a	6.65b	6.51b	2.60b	2.47b	9.25b	8.98b
SE (±)	0.038	0.0152	0.003	0.0041	0.164	0.3021	0.113	0.1037	0.184	0.3310
CV (%)	9.35	6.97	10.38	7.50	5.37	10.01	10.61	9.74	5.83	8.07

*Applied in previous crop to cover the succeeding crops, SE (±) = Standard error of means, Figures in column having common letter(s) do not differ significantly at 5% level of significance

Table 4. Cost benefit analysis of mustard (cv. BRRI Sharisa-11) as influenced by different treatments

Treatments	Gross field income (Tk ha^{-1})						Total production cost (Tk ha^{-1})		Net income (Tk ha^{-1})	
	Seed		Stover		Total					
	Site-I	Site-II	Site-I	Site-II	Site-I	Site-II	Site-I	Site-II	Site-I	Site-II
T_1 Control (P)	31640	34160	3463	3184	35103	37344	25610	25610	9493	11734
T_2 RP (26 kg P ha^{-1})	34160	38080	3603	3544	37763	41624	26980	26980	10783	14644
T_3 TSP (26 kg P ha^{-1})	40880	42000	4181	4054	45061	46054	28065	28065	16996	17989
T_4 Residual RP (210 kg P ha^{-1*})	37520	38640	3816	3816	41336	42456	27904	27904	13432	14552

* Applied in RPevious crop to cover the succeeding crops, ** RPoduction cost other than fertilizer and RP remain same in all treatments, *** Grain and straw as per current market RPice Output: Seed @ Tk 28 kg ha^{-1},Stover @ Tk 1.25 kg ha^{-1} ; Input cost: Mustard seed: Tk. 34 kg^{-1},RP @ Tk 6 kg^{-1}, TSP @ Tk. 16 kg^{-1}, Urea @ Tk 6 kg^{-1}, MOP @ Tk 16 kg^{-1}, Gypsum @ Tk 5 kg^{-1}, Boric acid: Tk. 120 kg^{-1}; Irrigation: Tk. 2400, Pesticides: Tk. 1500,Labour cost: Tk. 14500, Plouging: Tk. 1850

Phosphorus content and uptake by seed and stover of mustard at harvest

Phosphorus content and uptake in seed and stover were significantly influenced by different treatments in both the sites (Table 3). The highest seed and stover P content was found in T_3 treatment at both the sites. However, the seed and stover P content of T_3 treatment was statistically identical with T_4 treatment. The lowest seed and stover P content were always found in T_1 treatment. The highest seed, stover and total P uptake were also observed in T_3 treatment at both the sites and the lowest in T_1 treatment. Phosphorus uptake in seed recorded from residual (T_4) and directly applied RP (T_2) was statistically identical and higher and lower than the control (T_1) and TSP treated plots (T_3), respectively. However, in case of stover and total uptake (seed + stover) both the treatments differed significantly and the T_4 treatment was always higher than the T_2 treatment.

Economic analysis

The economic analysis was done with a view to determine the most profitable treatment based, on cost benefits of various treatments. Net benefit was calculated by subtracting the total production cost from the field gross income. Production cost included the cost for buying fertilizers, RP and pesticides and also for the cost commenced for irrigation and labour. Gross field income was calculated as the total market value of grain and straw of mustard. The highest net benefit was found in T_3 treatment (TSP 26 kg P) at both the sites and it was 79 and 53% higher than the control at site I and II, respectively. Next to the T_3 treatment, T_4 treatment (residual RP) gave the highest benefit at both the sites (Table 4). These results is in line with Roy et al. (1999) who reported that super phosphate gave the highest net profit compared with RP and green manuring. Considering yield and economic aspects, it could be concluded that TSP is the best source of P for the production of mustard in slightly alkaline soils. However, application of RP with higher dose for the residual effect is also economically profitable.

Thus it may conclude here that RP will entirely be a new source of P fertilizer to be used in the country. Present work in two different sites with mustard as the second crop (first crop was T-aman rice) in the trial with RP. In general, it was observed that TSP has the best performance over RP having same rate of P (26 kg P ha^{-1}). However, treatment T_4 with higher rate of P (RP 210 kg P ha^{-1} applied test crop) which treated as residual effect of RP showed comparatively better performance than T_2 (RP 26 kg P ha^{-1} applied directly) treatment. All yield contributing characters, seed as well as stover yield showed better performance with TSP compared to RP. The experiment needs to be repeated again in the same site to find out the next residual effect of RP due to its low solubility. Although RP bears some toxic substances in soil but its low price and residual effect and subsequent cropping system could be an added factor to easy acceptance of P fertilizer compared to other phosphate fertilizer and its socio-economic impact on farmers' acceptability.

References

Baldev, R., Rareek, R.G. and Ram, B. 1999. Effect of phosphorus, sulphur and PSB on growth and yield of mustard. Agril. Sci. Digest Karnal. 19(3): 203-206.

BBS (Bangladesh Bureau of Statistics). 2007. Statistical Yearbook of Bangladesh. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Govt. Peoples Republic of Bangladesh, Dhaka.

Berry, P.M. and Spink, J.H. 2006. A physiological analysis of oil seed rape yields: past and future. J. Agric. Sci., 144(5): 381-392.

FAO (Food and Agriculture Organization). 1996. Production Yearbook. Food and Agriculture Organization. Rome. 50: 122.

FAO (Food and Agriculture Organization). 2005. FAO Production Yearbook. Vol. 55, Rome.

Folch, J.M., Less and Sloane Stanley, G.H. 1957. A simple method for isolation and purification of total lipids from animal tissue. J. Biolog. Chem. 26: 497.

Goh, K.J. and Chew, P.S. 1995. Direct application of rock phosphates of plantation tree crops in Malaysia. In: Int. Workshop on Direct application of Rock phosphates and Appropriate Technology Fertilizers in Asia: What Hinders Acceptance Growth. Int. Fert. Dev. Center, Muscle Shoals, Alabama and Inst. of Fundm. Studies, Kandy, Srilanka.

Mongia, A.D., Singh, N.T. and Mandal, L.N. and Guha, A. 1998. Effect of liming supper phosphate and rock phosphate application to rice on the yield and uptake of nutrients on acid sulphate soils. J. Indian Soc. Soil Sci., 46(1): 61-66.

Singh, K.N., Marup, A., Sharma, D.P. and Rab, K.V.G.K. 2008. Effects of phosphorus on mustard yield. J. Indian Soc.Soil Sci.il Salinity Res. Inst. 28: 135-142.