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RELATIVE RESPONSE OF KHARIF CROPS TO PHOSPHORUS IN ALLUVIAL SOILS

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ABSTRACT

In a field experiment on an alluvial soil, the relative response of pearl millet, paddy and clusterbean to phosphorus was studied at Bichpuri, Agra during Kharif season of 2006 and 2007. Application of phosphorus up to 90 kg P_2O_5 ha^{-1} significantly increased the grain and stover yields of kharif crops whereas at higher P level (120 kg P_2O_5 ha^{-1}) the yields tended to decrease. The magnitude of response differed from crop to crop and arranged in descending order as: pearl millet (30.7%) > clusterbean (23.9)> paddy (20.7%). Phosphorus application progressively increased its uptake in grain and stover of kharif crops. The maximum P removal was recorded in paddy grain and minimum in clusterbean stover. Phosphorus application also improved the content of protein in grain and stover of the crops. P levels influenced the apparent recovery of P with maximum at 90 kg P_2O_5 ha^{-1} except paddy where maximum (11.50) apparent recovery was noted at 30 kg P_2O_5 ha^{-1}. The P use efficiency increased with its increasing levels and maximum use efficiency was recorded at 60 kg P_2O_5 ha^{-1} application except clusterbean where maximum (3.81 kg produce /kg P) P use efficiency was noted at 90 kg P_2O_5 ha^{-1}.

Keywords: Response, kharif crops, phosphorus

INTRODUCTION

Phosphorus, as a plant nutrient is one of the important crop yield limiting factors in intensive crop production system. Its deficiency in soils is widespread and crop grown under deficient situation show significant responses to fertilizer P. Response of crops to fertilizers vary with their species as well as varieties. Thus, there is a need to avoid blanket fertilizer schedules for different crops, more so with phospatic fertilizers. The information regarding the differential behaviour of kharif crops to phosphorus application under identical soil and weather conditions was considered to be of interest. The present investigation was, therefore, undertaken to study the variability in the response of kharif crops to phosphorus application in alluvial soil of Agra.

MATERIALS AND METHODS

A field experiment was initiated during the kharif season of 2006 and 2007 on a sandy loam soil at Raja Balwant Singh College Research farm, Bichpuri, Agra in Uttar Pradesh. The pH, EC, organic carbon and available phosphorus of the soil at the initial stage (before sowing) were 7.9, 0.2 dSm^{-1}, 4.2 g kg^{-1} and 8.9 kg ha^{-1}, respectively. The soil was low in available N (178.7 kg ha^{-1}) and medium in K (142.5 kg ha^{-1}). Phosphorus was applied to soil at the rate of 0, 30, 60, 90 and 120 kg ha^{-1} through triple superphosphate in three kharif crops namely pearl millet (86 M32) clusterbean (Pusa sadabahar) and paddy (Pant 4). These crops were sown/trans planted on July 5, 2006 and July 15, 2007. Randomized block design was followed with four replications. A basal application of 120 kg N and 60 kg K_2O ha^{-1} was given to pearl millet, 20 and 60 for clusterbean and 150 and 60 for paddy through urea and muriate of potash, respectively. The kharif crops were harvested at maturity and yields recorded. Grain and straw samples were digested in di acid mixture and P concentration was determined by vanadomolybdate yellow colour method (Jackson, 1973).

RESULTS AND DISCUSSION

The results (Table 1) distinctly indicated that all the test crops responded markedly to P application. In general, each additional dose up to 90 kg P_2O_5 ha^{-1} increased significantly the grain yields and thereafter a decreasing trend was observed. Thus, a level of 90 kg P_2O_5 ha^{-1} appeared to be the optimum dose under the experimental conditions. The significant response

to P may be due to ready availability of applied P in low P fixing light textured soils of the experimental fields. Responses of pearl millet, clusterbean and paddy to phosphorus application were also reported by Chaudhary et al. (2003), Kumar and Kushwaha (2006) and Pathan et al. (2005).

Table 1: Effect of P levels on yield (q ha^{-1}) and protein content (%) in grain and stover of kharif crops

Kharif crops	Phosphorus levels (kg ha^{-1})						
	0	30	60	90	120	SEm±	CD (P=0.05)
Yield							
Pearl millet	24.01 (60.16)	26.03 (65.21)	29.12 (71.28)	31.39 (78.42)	30.79 (77.3)	0.52 (1.09)	1.14 (2.38)
Clusterbean	15.57 (36.17)	16.51 (38.98)	17.54 (41.09)	19.0 (43.77)	19.33 (44.51)	0.33 (0.50)	0.71 (1.31)
Paddy	54.62 (101.26)	58.61 (108.55)	62.94 (118.06)	65.96 (126.64)	65.15 (123.76)	1.31 (2.12)	2.86 (4.61)
Protein content							
Pearl millet	10.37 (4.09)	10.52 (4.18)	10.68 (4.28)	10.78 (4.34)	10.90 (4.31)	0.09 (0.06)	0.16 (0.14)
Clusterbean	19.03 (4.78)	19.28 (5.09)	19.56 (5.28)	19.78 (5.37)	19.93 (5.56)	0.19 (0.12)	0.41 (0.27)
Paddy	12.62 (3.18)	12.90 (3.31)	13.15 (3.43)	13.34 (3.46)	13.44 (3.50)	0.09 (0.04)	0.21 (0.10)

Data in parenthesis indicate mean yield and protein content of stover

The crops also differ widely in their yield capability as evidenced by mean grain and straw yield variation from 17.59 to 61.33 and 40.90 to 115.65 q ha^{-1}, respectively. The percent grain yield response at 90 kg P_2O_5 ha^{-1} level was calculated as follows: Increase in yield due to P application yield in control x100, which varied from 20.7 to 30.7 percent among the crops. The differences in crop response to P may be due to variation of root system. Slow growing deep-rooted crops respond less to P while the shallow rooted quick growing cereals require higher dose of P. Differential responses of kharif crops to added phosphorus have also been reported by Singh et al. (1979). On the basis of percent grain yield response due to applied P, the crops may be arranged as: pearl millet (30.7%) > clusterbean (23.9%)> paddy (20.7%).

Table 2: Effect of P levels on its uptake (kg ha^{-1}) by grain and stover of kharif crops

Kharif crops	Phosphorus levels (kg ha^{-1})						
	0	30	60	90	120	SEm±	CD (P=0.05)
Pearl millet	39.8 (39.3)	43.8 (43.6)	49.7 (48.8)	54.1 (54.5)	53.7 (53.3)	1.86 (1.79)	4.08 (3.93)
Clusterbean	47.3 (27.6)	50.9 (31.8)	54.9 (34.6)	60.1 (37.6)	61.6 (39.6)	1.46 (1.24)	3.21 (2.73)
Paddy	110.3 (51.6)	121.0 (57.5)	132.4 (64.9)	140.8 (70.1)	140.1 (69.3)	1.98 (1.41)	4.36 (3.10)

Data in parenthesis indicate mean P uptake by stover of kharif crops

Increasing levels of phosphorus significantly increased stover yield in pearl millet from 60.16 to 78.42, 36.17 to 44.51 paddy from 101.26 to 126.64 and clusterbean from 36.17 to 44.51 g ha^{-1} up to 90 and 120 kg P_2O_5 ha^{-1}, respectively. The average stover yields of kharif crops exhibited practically no difference at 90 or 120 kg P_2O_5 ha^{-1} level. Hence, 90 kg P_2O_5 ha^{-1} can be regarded as suitable dose. The stover yield of two kharif crops (pearl millet and paddy) tended to reduce at 120 kg P_2O_5 ha^{-1}. The variable magnitude of response to P_2O_5 application among different kharif crops has also been reported by Singh et al. (1979). Increasing levels of phosphorus increased the protein content in grain and stover of pearl millet, clusterbean and paddy from 10.37 to 10.90 and 4.09 to 4.34, 19.03 to 19.93 and 4.78 to 5.56 and 12.62 to 13.44 and 3.18 to 3.50 %, respectively with 120 kg P_2O_5 ha^{-1} application. Among these

crops, the minimum value of protein content was recorded in pearl millet grain and paddy stover. The increase in the protein content with phosphorus application has been reported in cereals (Chaudhary et al. 2003) and legume (Singh and Manohar, 1982).

Table 3: Effect of P levels on apparent recovery (%) and use efficiency (kg produce/kg P) of phosphorus of kharif crops

Kharif crops	Phosphorus levels (kg ha^{-1})			
	30	60	90	120
Pearl millet PAR	5.80	5.74	5.83	4.58
PUE	7.16	8.52	8.20	5.65
Clusterbean PAR	2.49	2.66	2.72	2.50
PUE	3.13	3.29	3.81	3.13
Paddy PAR	11.50	10.66	9.49	8.03
PUE	13.28	13.86	12.59	8.77

PAR = Phosphorus apparent recovery
PUE = Phosphorus use efficiency

The average P uptake increased from 39.8 to 54.1 and 39.3 to 54.5 kg ha^{-1} in grain and stover of pearl millet, 110.3 to 140.8 and 51.6 to 70.1 kg ha^{-1} in grain and stover of paddy at 90 kg P_2O_5 ha^{-1} and 47.3 to 61.6 and 27.6 to 39.6 kg ha^{-1} in grain and stover of clusterbean at 120 kg P_2O_5 ha^{-1}. This increase in P uptake may be attributed to increase in P content in kharif crops yield due to rising phosphorus levels. These results are in agreement with the findings of Pathan et al. (2005) and Nehra et al. (2006). Phosphorus uptake by different crops also differed widely. Under control, the differences of P uptake are under among the crops as compared to those under P applied condition. The maximum values of apparent recovery of phosphorus by pearl millet and clusterbean were 5.83 and 2.72 percent, respectively at 90 kg P_2O_5 ha^{-1} except paddy where maximum (11.50%) apparent recovery was noted at 30 kg P_2O_5 ha^{-1}. The minimum values of apparent recovery of phosphorus in all the kharif crops were noted at 120 kg P_2O_5 ha^{-1} level. Chaudhary and Totawat (1985) also reported similar results. Phosphorus utilization efficiency (kg produce /kg P_2O_5) an increase up to the level of 60 kg P_2O_5 ha^{-1} in all the crops except clusterbean where an increase in response in kg grain per kg P_2O_5 was noted at 90 kg P_2O_5 ha^{-1}. Further increase in the level of P_2O_5 (120 kg P_2O_5 ha^{-1}) tended to decrease the P use efficiency over 60 kg P_2O_5 ha^{-1}. Better phosphorus use efficiency was obtained with P_2O_5 addition up to 60 kg P_2O_5 ha^{-1} recording 8.52 kg grain in pearl millet 3.81 kg in clusterbean and 13.86 in paddy per kg P_2O_5 applied. Similar increase in PUE with increasing levels of P application was reported by Kumar and Kushwah (2006).

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