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The effect of continuous use of animal manure with rock phosphate on plant nutrient status of a Typic Hapludalf

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Abstract

In a field experiment with wheat (*Triticum aestivum* L. emend. Fiori & Paol) and soybean (*Glycine max*. L. Merr.) rotation, effect of Udaipur rock phosphate alone and in combination with organic amendments was compared with superphosphate. Effect of rock phosphate on available phosphorus was inferior to superphosphate whereas Ca and Mg were comparable with superphosphate. Addition of organic amendments such as farmyard manure, biogas slurry and poultry manure along with URP increased the effect of rock phosphate on all the three nutrient elements.

Additional Keywords: Udaipur rock phosphate, superphosphate, farmyard manure, biogas slurry, poultry manure, content and uptake of P, Ca and Mg.

Introduction

An application of rock phosphate in powder form, has been found as effective as superphosphate in acid soil (Misra 1992). However, due to its sparingly soluble nature the initial response is recorded inferior to that of superphosphate, but when it is applied alongwith organic amendments, an improved response was recorded. The present study was therefore, undertaken to evaluate the effect of animal manures with Udaipur rock phosphate on some plant nutrient status of an acid soil (Typic Hapludalf).

Materials and methods

Field experiment with wheat (*Triticum aestivum*) (Sonalika variety) and soybean (*Glycine* max. L. Merr.) (Bragg variety) as test crops was conducted at research farm of Krishi Viswavidyalaya, Palampur during *rabi* 1987-88 to *kharif* 1989. The experimental soil has clay loam texture (23.7, 41.7 and 33.0 percent sand, silt and clay) with organic carbon 1.0 per cent, and pH 5.7 (1:2.5 soil:water). Alkaline $KMnO_4$-N, was 140 ppm; Olsen's P, was 7 ppm and NH_4OAc-K was 127 ppm. The exchangeable Ca and Mg were 4.1 and 2.1 cmol(+) kg^{-1}, respectively.

Ten treatments were replicated four times in randomised block design. The treatments consisted of single superphosphate, Udaipur rock phosphate, FYM, biogas slurry and poultry manures in different combinations (Table 1).

Phosphorus was applied to wheat at the rate of 39 kg P ha^{-1} in the form of single superphosphate (SSP) and 39 and 78 kg P ha^{-1} in the form of Udaipur rock phosphate (URP). Similarly it was applied to soybean @ 26 kg P ha^{-1} in the form of SSP, and 26 and 52 kg ha^{-1} in the form of URP. Farmyard manure (FYM), biogas slurry (BGS) and poultry manure (PTM) were applied @ 10 t ha^{-1} on fresh weight basis to both the crops. Total P, Ca and Mg content in FYM was 0.066, 0.38 and 0.23 per cent, in BGS was 0.33, 0.42 and 0.27 per cent and that in PTM was 0.98, 2.04 and 1.12 per cent, respectively. A basal dose of 120 kg N and 25 kg K ha^{-1} to wheat, and 20 kg N and 33 kg K ha^{-1} to soybean was applied through urea and muriate of potash, respectively.

Rock phosphate (100 mesh) contained 30.5 per cent Ca, 5.3 per cent Mg, 6.9 per cent P and 0.45 per cent citrate soluble P. The plot size was 20 m^2. Soil samples were collected before sowing and after harvest of each crop and were analysed for 0.5 M $NaHCO_3$ (pH 8.5) extractable P (Olsen *et al.* 1954) and neutral NH_4 OAc extractable Ca and Mg. The total nutrient uptake was calculated as under:

Table 1. Olsen's P (ppm) as affected by Udaipur rock phosphate application

Treatment	Rabi		Kharif	
	1987-88	1988-89	1988	1989
T1 (control)	6.8	8.3	7.9	6.5
T2 (SSP:39W,26S)	10.0	21.5	10.5	10.0
T3 (URP:39W,26S)	7.8	7.3	8.1	6.6
T4 (URP:78W,52S)	7.0	7.5	8.0	7.0
T5 (URP:39W,26S+FYM)	7.6	11.0	8.5	8.1
T6 (URP:78W,52S+FYM)	9.0	11.0	10.1	9.3
T7 (URP:39W,26S+BGS)	7.8	12.8	9.0	9.5
T8 (URP:78W,52S+BGS)	10.5	15.5	9.5	10.5
T9 (URP:39W,26S+PTM)	9.5	23.8	14.3	15.4
T10 (URP:78W,52S+PTM)	10.0	26.3	15.9	17.5
Control Vs others				
Control	6.8	8.3	7.9	6.5
Others	8.8	15.2	10.4	10.4
Between organic manures				
FYM	6.8	11.0	9.3	8.7
BGS	9.1	14.1	9.3	10.0
PTM	9.8	25.0	15.1	16.4
URP doses				
Single	8.3	15.8	10.6	11.0
Double	9.8	17.6	11.8	12.4
C.D. at 5%				
Different treatments	2.0	4.1	3.3	3.2
Control Vs others	1.5	3.1	2.5	2.4
Between organic manures	NS	2.9	2.4	2.3
Between URP Doses	1.1	NS	NS	NS

$$\text{Total nutrient uptake} = \frac{\text{Grain yield kg ha}^{-1} \times \text{\% nutrient in grain}}{100} + \frac{\text{Straw yield kg ha}^{-1} \times \text{\% nutrient in straw}}{100}$$

Results and discussion

Phosphorus status as affected by wheat

The uptake of P by wheat was significantly higher under T9 and T10 (URP + PTM) treatments as compared to other treatments (Table 2). Application of single dose of rock phosphate alone (T3) reduced the uptake as low as the control treatment. The effect of the application of URP with FYM or BGS (T5 to T8) was slightly superior to control but inferior to application of SSP (T2). The lowest value recorded with T3 treatment indicated the possibility of low amount of P availability from URP. The application of double dose of URP with or without organic manures did not differ significantly over single dose of URP in terms of P uptake by wheat crop. This probably reflects the slow availability of P from rock phosphate even under acidic soil conditions.

The (Olsen's) phosphorus level after the harvest of wheat crop 1988-89 was higher in case of SSP as compared to treatments T3 to T8 (Table 1). The addition of poultry manure along with single or double dose of URP (T9 to T10) raised the level further attaining the highest value. This could be attributed to the high content of P in poultry manure. This indicated that the addition of poultry manure, maintained the soil P level and thereby may have increased its uptake by wheat crop.

Table 2. Total P-uptake (kg ha^{-1}) as affected by application of different source of phosphate

Treatment	Rabi (wheat)		Kharif (soybean)	
	1987-88	1988-89	1988	1989
T1	6.65	7.44	10.24	12.73
T2	10.98	10.39	15.56	19.74
T3	6.64	7.07	10.90	12.77
T4	9.15	8.00	11.07	13.46
T5	10.71	8.63	11.38	16.34
T6	12.68	9.57	13.14	18.34
T7	11.33	9.53	11.92	16.02
T8	11.13	10.20	12.90	18.23
T9	13.13	13.97	13.00	21.43
T10	14.37	14.46	16.64	24.71
Control Vs others				
Control	6.65	7.74	10.24	12.73
Others	11.12	10.20	12.94	17.89
Between organic manures				
FYM	11.69	9.10	12.26	17.34
BGS	11.23	9.86	12.41	17.12
PTM	13.75	14.21	14.82	23.07
URP doses				
Single	11.72	10.71	12.10	17.93
Double	12.73	11.41	14.23	20.43
C.D. at 5%				
Different treatments	3.06	1.44	3.63	3.60
Control Vs others	2.28	1.08	2.70	2.68
Between organic manures	NS	1.02	NS	2.55
Between URP Doses	NS	NS	2.09	2.08

The trends in the previous *rabi* season were also similar but were less clearly defined in terms of uptake of P.

The addition of FYM @10 t ha^{-1} as well as BGS @10 t ha^{-1} although improved P availability significantly over control as well as that of application of rock phosphate alone in single or double dose, the increase in uptake was only marginal because of lower yield response. The higher uptake of P with PTM treatment is because of higher levels of P addition through it as compared to SSP probably due to improvement in overall growth as

poultry manure is rich in several other nutrients besides P. The addition of organic manures with rock phosphate would be more beneficial to assess the long term effect to maintain soil P level.

Phosphorus status as affected by soybean

The trends in P uptake as affected by different manures and fertilizers in soybean was similar to that of wheat. The data indicated that the effect due to the application of SSP and PTM was superior to other treatments. The treatment consisting of FYM and BGS combined with rock phosphate (T5 to T8) affect the change in uptake of P by soybean (Table 2) marginally.

After harvest of soybean, the soil P status varied from a minimum of 7.9 ppm in control (T1) to a maximum of 15.9 ppm in T10 (52 kg P through URP + 10t PTM). Application of URP with PTM (T9 & T10) were significantly superior to all other treatments.

Uptake of Ca by wheat and exchangeable Ca in soil

Application of SSP (T2) recorded higher Ca uptake than URP applied @ 39 kg ha^{-1} (T3) (Table 3). Treatments T4 to T10 did not differ among themselves, however, they were superior to control (T1) and SSP (T2) in respect of Ca-uptake by wheat. It means that double dose of URP alone and single or double dose of URP with manures were alike. Almost similar trends of Ca uptake were observed during *rabi* 88-89. Application of SSP and URP with or without manures enriched the soil exchangeable Ca after wheat harvest, the difference, however, were significant only after *rabi* 88-89. T10 was significantly superior to all other treatments except T6 and T9. Similar trends of exchangeable Ca were observed after the harvest of wheat 1987-88. Both FYM and BGS were equally effective but PTM was superior to both of them in respect of exchangeable Ca (Table 3).

Uptake of Ca by soybean and exchangeable Ca in soil

The application of double the dose of rock phosphate along with 10 t ha^{-1} poultry manure (T10) resulted in highest Ca-uptake in SSP treatment (T2). Treatments T6, T8 and T9 were equally effective and were very close to T2 in respect of Ca-uptake by soybean. Almost similar trend of Ca-uptake was observed in *kharif* 89. The trends of exchangeable Ca after the harvest of soybean were almost similar to that found after the harvest of wheat crops. During *kharif* 88, exchangeable Ca varied from a minimum in control (T1) to a maximum by URP with poultry manure (T10). FYM and BGS were at par, whereas PTM was superior to both of them. The superiority of PTM to FYM and BGS may be explained on the basis of its higher Ca content.

It is evident that uptake of Ca is more prominent in soybean than in wheat because soybean being a leguminous crop resulted in better utilization of Ca present in rock phosphate. Marwaha and Kanwar (1981) also reported that legumes are better feeders of rock phosphate. Application of superphosphate also resulted in better Ca-uptake which may be due to higher yield in this treatment and Ca content in this fertilizer.

Uptake of Mg by wheat and exchangeable Mg in soil

Application of double dose of URP (T4) was also found as effective as SSP (T2) (Table 3). Application of URP in conjunction with organic manures (T5 to T10) differ

Table 3. Effect of different source of phosphorus on uptake and status of exchangeable Ca and Mg

Treat-ment	Ca-Uptake (kg ha^{-1})		Exchang. Ca c mol (+) kg^{-1}		Mg-Uptake (kg ha^{-1})		Exchang. Mg c mol (+) kg^{-1}	
	Rabi 87-88	Kharif 1988	Rabi 88-89	Kharif 1989	Rabi 87-88	Kharif 1988	Rabi 88-89	Kharif 1989
T1	6.3	19.9	3.4	4.3	5.4	16.8	1.9	1.6
T2	7.6	31.0	3.6	4.6	7.3	24.5	1.8	1.4
T3	6.1	26.6	3.6	4.7	5.4	20.2	2.1	1.8
T4	9.1	26.3	3.7	4.7	7.0	20.3	2.3	2.0
T5	10.0	26.9	3.7	4.4	8.5	19.5	2.2	1.9
T6	9.6	29.5	4.0	4.6	9.1	21.2	2.4	2.1
T7	10.0	26.9	3.6	4.6	8.7	20.1	2.2	1.9
T8	9.1	29.1	3.8	4.7	8.8	21.6	2.5	2.2
T9	10.3	29.2	4.0	4.8	9.5	21.7	2.5	2.3
T10	9.9	35.4	4.3	4.8	10.4	28.2	2.7	2.6
Control Vs others								
Control	6.3	19.9	3.4	4.3	5.4	16.8	1.9	1.6
Others	9.1	29.0	3.8	4.6	8.3	21.9	2.3	2.0
Between organic manures								
FYM	7.4	28.2	3.9	4.5	8.84	20.3	2.3	2.0
BGS	7.1	28.0	3.7	4.6	8.84	20.9	2.4	2.1
PTM	7.6	32.3	4.1	4.8	9.94	24.9	2.6	2.4
URP doses								
Single	7.6	27.7	3.8	4.6	8.94	20.4	2.3	2.0
Double	7.1	31.3	4.0	4.7	9.44	23.6	2.6	2.3
C.D. at 5%								
Diff. treat-ments	NS	3.7	0.4	NS	2.3	1.7	0.3	0.1
Control Vs others	NS	2.8	0.3	NS	1.7	1.3	0.3	0.1
Between organic manures	NS	2.6	0.3	NS	NS	1.2	0.2	0.1
Between URP Doses	NS	0.5	0.3	NS	NS	1.0	0.2	0.1

marginally among themselves. The application of double dose of rock phosphate with 10 t ha^{-1} poultry manure (T10) showed highest amoung of exchangeable Mg in soil after the harvest of wheat. It thus indicated that the application of poultry manure alongwith rock

phosphate proved significantly superior to other sources tried to enrich exchangeable Mg in these soils.

Uptake of Mg by soybean and exchangeable Mg in soil

Double dose of rock phosphate alongwith poultry manure (T10) was most effective followed by SSP treatment (T2) (Table 3). All the treatments were superior to control (T1). The pattern of exchangeable Mg after the harvest of soybean followed almost similar trends after the harvest of wheat crops and different treatments significantly affected exchangeable Mg in both the years. Application of double dose of URP in combination with 10 t ha^{-1} PTM (T10) resulted in significantly higher exchangeable Mg in soil. All other treatments where rock phosphate was applied alone or in conjunction with organic manure (T3 to T10) were better than T1 and T2. It may be due to Mg-addition through dolomite of rock phosphate.

From the foregoing discussion, it is evident that rock phosphate application has affected both the uptake and content of P, Ca and Mg which can be attributed to the presence of phosphate and dolomite in the rock phosphate. Superiority of poultry manure to FYM and BGS has been explained on the basis of its higher nutrient content that resulted in lower immobilization and more mineralization in comparison to FYM and BGS (Meelu and Singh, 1978).

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