Agropedology, 2000, **10**, 40-43

Changes in available phosphorus and grain yield of black gram (*Vigna mung*) under integrated nutrient management in Inceptisol

S. Thiyageshwari and Rani Perumal

Department of Soil Science and Agricultural Chemistry, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu 641 003

Abstract

A pot experiment with a Vertic Ustropept was conducted to test the changes in soil phosphorus forms, uptake and grain yield due to integrated nutrient management of blackgram through conjuctive use of imported tunisia rock phosphate, vermicompost and phosphobacteria. Growth of blackgram and P uptake was slow in vegetative phase but rapid during reproductive phase. Vermicompost application significantly enhanced grain yield followed by phosphobacteria over 100 per cent P as tunisia rock phosphate. P uptake by blackgram was higher in the combined application of rock phosphate with vermicompost and phosphobacteria. Available phosphorus was higher in the vegetative stage and later decreased at harvest due to P utilisation by blackgram.

Additional keywords : Vermicompost, phosphobacteria, tunisia rock phosphate.

Introduction

Sustainable productivity of blackgram is possible only when best nutrient management practices are adopted. Judicious application of inorganic along with organic sources of nitrogen to crops especially pulses is one of the best management practices. Organic sources like farmyard manure, biogas slurry, poultry manure, coir compost are commonly used. The vermicompost (V), a rich source of nutrients has gained momentum as a constituent of integrated nutrient management.

Rock phosphates are generally used in acid soils. Their use in alkaline calcareous soil can be enhanced when applied along with organics and biofertilizer. Phosphobacteria (PB) is a very good P solubiliser. The contribution of vermicompost with phosphobacteria in conjunction with inorganic fertilizers in a calcareous black soil was critically evaluated.

Materials and methods

Calcareous black soil of alkaline pH (Vertic Ustropept) at Tamil Nadu Agricultural University, Coimbatore was collected and filled up in 8 kg capacity earthern pots. The soil selected for the experiment belonged to the order Inceptisol of sandy clay loam texture with a pH of 8.4 and electrical conductivity of 0.27 dS m^{-1}. The initial analysis indicated the soil to contain 0.58 per cent organic carbon, 118.78, 10.81 and 592.82 kg ha^{-1} of available nitrogen, available phosphorus and available potassium, respectively. Vermicompost (v), prepared in the laboratory by composting farm wastes with earthworms, having a nutrient content of *N* 1.75, phosphorus 0.30, potassium 2.63 and organic carbon 29.76 per cent was used as an organic source @ 2 kg ha^{-1}. Phosphobacteria namely Bacillus megaterium var. phosphaticum was used as a biofertiliser. The organic and bio fertilizer source was mixed with imported tunisia rock phosphate (TRP) (28% P_2O_5) and single super phosphate (SSP)

(16% P_2O_5) as per the treatments. The treatments involved were combinations of SSP and TRP (75 and 100%) of the recommended dose of 40 kg P_2O_5 ha^{-1} and phosphobacteria (PB) @ 2 kg ac^{-1}, besides control. All together there were 9 treatments replicated thrice. Nitrogen and potassium were applied basally @ 80 and 40 kg ha^{-1}, respectively. The experiment was laid out in a randomised block design (RBD) with CO5 blackgram as test crop. Samples were collected at vegetative, flowering and post harvest stages to estimate dry matter production, P uptake, soil available P (Olsen's *et al.* 1954) and grain yield.

Results and discussion

Dry matter : The dry matter production (Table 1) increased with increase in P levels upto 100 per cent TRP indicating the stimulatory effect of P on dry matter production. The effect of PB with V and TRP maintained a pronounced effect indicating the positive effect of PB in solubilising P from TRP which contributes towards increased dry matter yield. Dry matter yield increased with crop growth and the highest dry matter yield was recorded at harvest. Santhi (1985) observed that phosphobacteria increased dry matter by solubilisation in green gram. The positive effect of organics (vermicompost) on dry matter production was in line with the results of Reddy *et al.* (1990). The dry matter accumulation was maximum with TRP (100%) in combination with vermicompost and PB followed by TRP (75%) with vermicompost and PB at vegetative stage. The sole application of TRP was inferior to the direct source of P viz., SSP and the combined application of TRP with vermicompost and PB significantly increased the dry matter production over SSP irrespective of the levels. Similar trend of results was observed at all stages.

Table 1. Comparative effect of sources of phosphorus on dry matter and grain yield of black gram

Sl.No.	Treatments	Grain yield (g $plant^{-1}$)	Dry matter (g $plant^{-1}$)		
			VS	FS	PHS
1.	T1 Control	5.10	0.98	2.06	3.22
2.	T2 75% P_2O_5 as SSP	7.62	1.30	2.43	3.54
3.	T3 75% P_2O_5 as TRP	6.80	1.18	2.31	3.42
4.	T4 100% P_2O_5 as SSP	7.80	1.48	2.61	3.74
5.	T5 100% P_2O_5 as TRP	7.02	1.28	2.42	3.53
6.	T6 75% P_2O_5 as SSP + V + PB	8.37	1.31	2.44	3.57
7.	T7 75% P_2O_5 as TRP + V + PB	8.67	1.58	2.69	3.82
8.	T8 100% P_2O_5 as SSP + V + PB	8.63	1.51	2.67	3.80
9.	T9 100% P_2O_5 as TRP + V + PB	8.74	1.69	3.02	3.93
	Mean	7.64	1.36	2.52	3.62
	CD (P=0.05)	2.99	0.14	0.05	0.02

VS = Vegetative stage; FS = Flowering stage; PHS = Post Harvest stage

Phosphorus uptake : Phosphorus uptake at each growth stage presented in table 2 indicated that the uptake in control treatment was least and it was maximum when TRP was applied with V and PB. TRP at different levels when applied alone did not influence P uptake markedly when compared to SSP as in DMP. TRP (100%) with V and PB increased P uptake from 5.49 vegetative stage to 18.59 mg plantt^{-1} at post harvest stage and this was on par when TRP at 75 per cent levels were applied in combination with V and PB. The lower uptake in rock phosphate treatments may be due to relatively low P content. However, rock phosphate performed better when applied with PB, indicating the beneficial effect of PB. Application of inorganic P along with organic manures and their combinations increased P uptake over inorganic P alone. This is due to solubilisation of insoluble P from rock phosphate by the organic acids produced during decomposition of organic manures leading to the increased availability of P, higher P content of plant and higher dry matter and grain yield. A similar result was recorded by Subehia and Minhas (1993). The effective performance of PB in the presence of rock phosphate is distinctly observed.

Table 2. Comparative effect of sources of phosphorus on P uptake and soil available phosphorus of black gram

Treatment (T)	P Uptake (mg plant^{-1})			Olsen's P (kg ha^{-1})		
	VS	FS	PHS	VS	FS	PHS
T1	2.27	6.34	6.70	12.01	11.84	9.20
T2	3.56	9.55	12.28	16.19	14.05	10.41
T3	3.23	8.82	12.84	13.19	11.02	10.38
T4	4.50	11.58	14.30	18.38	15.24	10.61
T5	4.15	10.77	14.92	12.16	12.21	10.72
T6	3.89	11.42	13.97	15.79	14.62	12.98
T7	5.36	14.22	18.08	18.61	16.44	14.80
T8	4.88	12.98	15.66	16.33	14.16	12.52
T9	5.49	14.44	18.59	19.82	19.65	15.01
Mean	4.15	11.12	14.15	15.83	14.35	11.85
CD (P=0.05)	1.63	1.02	0.98	1.12	1.46	1.96

Available phosphorus : The soil available phosphorus was initially 10.81 kg ha^{-1}. An appreciable increase in Olsen's P was recorded with growth (Table 2). The increase was upto flowering stage and a decline in available P status at post harvest stage was recorded. The control treatments had a lower effect than other treatments at all stages. Maximum available P at all stages was recorded by the combination of TRP (100%) with V and PB (19.82, 19.65 and 15.01 kg ha^{-1} at vegetative, flowering and post harvest stages, respectively). Application of V and PB had an impressive effect on available P when compared to TRP alone, trio combination of SSP, V and PB and SSP alone. The low availability under TRP can be attributed to the soil reactions viz., alkaline nature of calcareous soil under study. Luthra *et al.* (1982) observed such phenomenon with rock phosphates.

Grain yield : Grain yield of blackgram increased with P application. Application of P through TRP (100%) in combination with V and PB increased significantly the grain yield of blackgram by 71 per cent over control (Table 1). This indicates that plants utilised more P from insoluble phosphate fertilizer in the presence of soil microorganisms. This was also reported by Gerretsen (1948). The significant results of phosphorus on yield is due to the stimulatory effect of phosphorus on growth, flowering and grain formation. The increase in grain yield due to P application is a consequence of increased number of pods/plant and 1000-grain weight by these treatments. Sole application of tunisia rock phosphate recorded significantly lower yield compared to SSP applied alone and with vermicompost and phosphobacteria.

The results suggest that integrated use of vermicompost @ 2 kg ha^{-1} and phosphobacteria @ 2 kg ac^{-1} along with imported tunisia rock phosphate at 100 per cent proved as an efficient source of P for blackgram in an alkaline calcareous soil. This study also indicated that TRP can be an alternative to single super phosphate without reduction in yield and uptake, when conjunctively applied with vermicompost and phosphobacteria for sustainable productivity and soil health.

References

Gerretsen, F.C. (1948). The influence of microorganisms on the phosphorus uptake by the plant. *Plant & Soil* **1**, 51-81.

Luthra, E.L., Saha, S.K., and Awasthi, P.K. (1982). Role of rock phosphate in present day agriculture. *Indian Journal of Agricultural Chemistry* **15**, 13-28.

Olsen, S.R., Cole, C.V., Watanabe, F.S., and Dean, A.L. (1954). Estimation of available phosphorus in soils by extraction with sodium carbonate. United States Department of Agriculture, Circular No. 939.

Reddy, S.N., Singh, B.G., and Rao, I.V.S. (1990). An analysis of dry matter production, growth, and yield in greengram and blackgram with phosphate fertilization. *Journal of Maharashtra Agricultural University* **15**, 189-191.

Santhy, P. (1985). The use of rock phosphate as a phosphatic fertilizers for rice (Oryza sativa L.) M.Sc. (Ag.) Thesis, Tamil Nadu Agricultural University, Coimbatore.

Subehia, S.K., and Minhas, R.S. (1993). Phosphorus availability from Udaipur rock phosphate as influenced by different organic amendments. *Journal of Indian Society of Soil Science* **41**, 96-99.

Received : March, 99 ; Accepted : March, 2000