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RESEARCH PAPER

Effect of organic manures and various levels of rock phosphate with PSB on soil physico-chemical properties, available NPK nutrients in soil and their uptake by chickpea (*Cicer arietinum* L.) grown in vertisol

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Abstract **:** A field experiment was conducted on vertisols at Agriculture Research Station, Annigeri, UAS, Dharwad during *Rabi* season of 2009-2010 and 2010-2011,to study the effect of organic manures and various levels of rock phosphate with PSB on soil physico-chemical properties, available NPK nutrients in soil and their uptake by chickpea (*Cicer arietinum* L.). The soil application of organic manures with varied levels of rock phosphate with PSB had significant influence on the soil physico-chemical properties, available NPK nutrients in soil and their uptake by chickpea crop. Among various treatment combination, compost 5t per ha with rock phosphate 200kg per ha recorded significantly higher soil organic carbon content(0.56%), higher available NPK in soil(233kg N, 22.75kgP_2O_5, 349.5kg K_2O / ha), higher NPK uptake by chickpea (119.51kg N, 15.79kg P_2O_5, 71.81kg K_2O / ha), higher grain yield(2130kg / ha), haulm yield (3300kg / ha), number of pods per plant (67.76), 100 seed weight(20.71g) and higher BC ratio(3.36) compared to other treatment combinations.

Key Words **:** Rock phosphate, Organic manures, PSB, Soil physico-chemical properties

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INTRODUCTION

Indian soils are poor in available phosphorus status, while pulses need greater phosphorus than most of the nutrients. Application of organic manures and rock phosphate with PSB secretes various organic and inorganic acids which help in increasing crop productivity by way of increasing in solubility of insoluble P, stimulating plant growth by providing hormones, vitamins and other growth factors. Several authors reported that, inoculation of PSB improves the physico-chemical, bio-chemical and biological properties of rock phosphate amended soil. It has been reported that the higher available phosphorus and aggregate stability levels, higher soil carbon levels and enzyme activities and lower soil pH were also reported due to inoculation of these PSB along with rock phosphate (Iman, 2008).

Chickpea is an important pulse crop extensively grown in India during *Rabi* season. Being leguminous crop, it utilizes atmospheric nitrogen fixation to meet its partial nitrogen requirement, and thus, occupies an important place in crop rotation in different region of the country. The results of large number of experiments on manures, fertilizers conducted across the country revealed that neither chemical fertilizers nor organic sources alone can sustain the soil productivity under high intensive cropping systems (Singh and Yadav, 1992). Therefore, under rainfed situation and less intensive

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cropping system, use of organic manures, bio-fertilizers, rockphosphate with PSB and biological sources have potential to improve soil fertility on sustainable basis since it supplies almost all the nutrients besides increasing nutrient use efficiency and improving physico-chemical properties of soil. Hence, there is a need to study the effect of various organics on soil physico- chemical properties, nutrient uptake and yield of chickpea grown in vertisol.

MATERIALS AND METHODS

A field experiment was conducted during *Rabi* seasons of 2009-2010 and 2010-2011 at Agricultural Research Station, Annigeri, UAS, Dharwad, Karnataka. The soil was clayey in texture with bulk density of 1.27 g per cc, pH of 7.90 with organic carbon content of 0.51 per cent. The soils were low in available N (202 kg/ha) and available P (18.90 kg/ha), and medium in available K (347 kg/ha). The treatments consisted of two organic manures, FYM (5 t/ha) and compost (5 t/ha) with four levels of rock phosphate with PSB (50, 100, 150 and 200 kg/ha) and one absolute control. The experiment was laid out in a factorial RCBD with three replications. The seeds were treated with *Rhizobium* in all the treatments. The chickpea crop (var. JG-11) was sown on 10-10-2009 and 13-10-2010, respectively with spacing of 30 cm x 10 cm. The required quantity of organic manures and rock phosphate with PSB was incubated for 30 days as per treatment before sowing of crop under shade by covering gunny bags with regular watering and were applied at the time of sowing as per treatment. Soil samples were collected from 0-30 cm depth just after harvest of crop from each treatment of the experimental plot and analyzed for available nitrogen, phosphorus and potassium contents using alkaline permanganate method (Subbiah and Asija, 1956), Olsen's method (Jackson, 1967) and flame photometer method (Muhr *et al.*, 1965), respectively. The soil organic carbon content was determined by Walkley and Blacks wet oxidation method as described by Jackson (1973). Soil pH measurement was made in soil and water solution of 1:2.5 ratio using pH meter as described by Piper (1966). Total porosity was calculated using formula of Black (1965).

RESULTS AND DISCUSSION

Among the major nutrients, phosphorus is an important for root growth and development for a pulse crop like chickpea. Different sources of phosphorus are used to meet P requirement of the crop. Rock phosphate is one of the cheaper sources of phosphorus. Hence, in this study, rock phosphate was used as a source of P with varied levels and amending with organic manures along with P solubilizing bacteria for its efficient use.

The data on organic carbon, soil pH, bulk density and porosity in soil after harvest of chickpea pooled data of 2009-10 and 2010- 11 are presented in Table 1.

In the present investigation, the soil organic carbon content was significantly higher with compost 5t per ha (0.54%) over FYM 5t per ha. Likewise higher levels of rock phosphate application 150 and 200kg per ha recorded significantly higher soil organic carbon content (0.54% and 0.55%, respectively) over other treatments. Interaction of organic manures and varied levels of rock phosphate with the treatment combination of OM_1RP_4 (0.56%) recorded significantly higher organic carbon content in soil over other treatment combinations except OM_1RP_3, OM_1RP_2 and OM_2RP_4. This is possibly due to higher root and microbial activity which resulted in better growth of the crop and addition of higher organic matter to the soil.

Table 1 : Organic carbon, soil pH, bulk density and porosity in soil after harvest of chickpea as influenced by organic manures and levels of rock phosphate (Pooled data of 2009-10 and 2010-11)

Treatments	Organic carbon (%)	Soil pH	Bulk density (g/cc)	Porosity (%)
Organic manures (OM)				
OM_1: Compost 5 t/ha	0.54	7.82	1.28	50.73
OM_2: FYM 5 t/ha	0.52	7.86	1.28	50.60
S.E.±	0.00	0.03	0.01	0.30
C.D. (P=0.05)	0.01	NS	NS	NS
Levels of rock phosphate (RP) with PSB				
RP_1: 50 kg rock phosphate/ha	0.50	7.88	1.29	50.58
RP_2: 100 kg rock phosphate/ha	0.53	7.86	1.27	50.92
RP_3: 150 kg rock phosphate/ha	0.54	7.79	1.27	50.76
RP_4: 200 kg rock phosphate/ha	0.55	7.82	1.29	50.41
S.E.±	0.00	0.04	0.01	0.43
C.D. (P=0.05)	0.01	NS	NS	NS
Interaction				
OM_1RP_1	0.50	7.81	1.28	50.53
OM_1RP_2	0.54	7.88	1.27	50.92
OM_1RP_3	0.55	7.78	1.27	50.84
OM_1RP_4	0.56	7.81	1.28	50.63
OM_2RP_1	0.50	7.95	1.29	50.63
OM_2RP_2	0.51	7.85	1.27	50.92
OM_2RP_3	0.53	7.81	1.28	50.67
OM_2RP_4	0.54	7.82	1.29	50.19
Absolute control	0.52	8.01	1.35	48.69
S.E.±	0.01	0.06	0.01	0.60
C.D. (P=0.05)	0.02	NS	0.04	NS

FYM – Farm yard manure RP – Rock phosphate with PSB
DAS – Days after sowing NS – Non-significant

The application of organic manures, various levels of rock phosphate and their combination did not show any significant influence on soil pH and porosity after harvest of chickpea crop. Whereas, organic manures applied with various levels of rock phosphate had significant influence on reducing the bulk density of the soil after harvest of the chickpea crop. All the treatment combination significantly reduced the bulk density over absolute control. This was mainly due to increase in porosity as a result of increased organic carbon content in soil due to the addition of organic manures with rock phosphate and better growth of the crop, specially through increased root growth and activity as compared to absolute control. These results are in line with the findings of Shivakumar *et al*. (2004) and Shakawat *et al*. (2006).

The data on available N, P_2O_5 and K_2O in soil after harvest of chickpea pooled data of 2009-2010 and 2010-2011 are presented in Table 2. The application of rock phosphate 200kg per ha (RP_4) recorded significantly higher available nitrogen (232.25kg/ha) in soil over other treatments except RP_3. In treatment combinations, OM_1RP_4 (233kg N/ha) and OM_2RP_4 (231.50kg N/ha) both recorded significantly higher available N in soil over other treatments except OM_1RP_3 and OM_2RP_3, while lowest available N in soil was recorded with absolute control. Whereas, the organic manure application of compost 5t per ha (OM_1) recorded significantly higher available phosphorus (20.14kg P_2O_5/ ha) in soil than application FYM 5t per ha (OM_2). The higher levels of rock phosphate application of 200kg per ha recorded significantly higher available phosphorus (22.33kg P_2O_5/ ha) in soil than other lower levels of rock phosphate application. Among treatment

Table 2 : Available N, P_2O_5 and K_2O in soil after harvest of chickpea as influenced by organic manures and levels of rock phosphate (Pooled data of 2009-10 and 2010-11)

Treatments	Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)
Organic manures (OM)			
OM_1: Compost 5 t/ha	222	20.14	343
OM_2: FYM 5 t/ha	220	19.33	338
S.E.±	2	0.19	3
C.D. (P=0.05)	NS	0.55	NS
Levels of rock phosphate (RP) with PSB			
RP_1: 50 kg rock phosphate/ha	210	16.42	333
RP_2: 100 kg rock phosphate/ha	216	19.03	339
RP_3: 150 kg rock phosphate/ha	225	21.17	343
RP_4: 200 kg rock phosphate/ha	232	22.33	347
S.E.±	3	0.27	4
C.D. (P=0.05)	9	0.77	NS
Interaction			
OM_1RP_1	212	16.92	336
OM_1RP_2	219	19.40	340
OM_1RP_3	226	21.50	345
OM_1RP_4	233	22.75	350
OM_2RP_1	209	15.92	331
OM_2RP_2	214	18.67	338
OM_2RP_3	225	20.83	341
OM_2RP_4	232	21.92	344
Absolute control	180	13.13	322
S.E.±	4	0.41	5
C.D. (P=0.05)	12	1.17	15

FYM – Farm yard manure RP – Rock phosphate with PSB
DAS – Days after sowing NS – Non-significant

Table 3 : Nutrient uptake at harvest of chickpea as influenced by organic manures and levels of rock phosphate (Pooled data of 2009-10 and 2010-11)

Treatments	Nitrogen uptake (kg/ha)	Phosphorus uptake (kg/ha)	Potassium uptake (kg/ha)
Organic manures (OM)			
OM_1: Compost 5 t/ha	109.89	13.49	67.00
OM_2: FYM 5 t/ha	104.60	12.63	64.52
S.E.±	0.99	0.13	0.49
C.D. (P=0.05)	2.87	0.37	1.42
Levels of rock phosphate (RP) with PSB			
RP_1: 50 kg rock phosphate/ha	93.29	9.96	58.91
RP_2: 100 kg rock phosphate/ha	102.80	11.90	63.43
RP_3: 150 kg rock phosphate/ha	116.14	15.12	69.98
RP_4: 200 kg rock phosphate/ha	116.76	15.24	70.74
S.E.±	1.41	0.18	0.70
C.D. (P=0.05)	4.06	0.53	2.02
Interaction			
OM_1RP_1	96.45	10.12	60.31
OM_1RP_2	104.19	12.36	64.63
OM_1RP_3	119.41	15.69	71.25
OM_1RP_4	119.51	15.79	71.81
OM_2RP_1	90.13	9.81	57.50
OM_2RP_2	101.42	11.44	62.22
OM_2RP_3	112.87	14.56	68.70
OM_2RP_4	114.00	14.70	69.67
Absolute control	67.30	7.48	46.69
S.E.±	2.09	0.26	0.99
C.D. (P=0.05)	6.00	0.73	2.84

FYM – Farm yard manure RP – Rock phosphate with PSB
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combinations OM_1RP_4 recorded significantly higher available phosphorus (22.75kg P_2O_5/ ha) in soil than other treatment combination except OM_2RP_4. Similarly, the available potassium in soil after harvest of chickpea crop was significantly influenced by the treatment combination of OM_1RP_4 (349.50kg K_2O/ha) in soil over OM_2RP_1 and absolute control, while rest of the treatments were at par with each other.

Higher soil available N, P_2O_5 and K_2O may be due to higher soil microbial and root activity in the rhizoshpere and improved soil physical and chemical properties. Similar results were observed by Joseph (1994); Alagawadi and Gaur (1988); Waigwa *et al.* (2003) and Prasad (2009).

The results indicated that, the nitrogen, phosphorus and potassium uptake was significantly higher (Table 3) with the application of compost (109.89, 13.49 and 67.00 N, P and K kg /ha) over FYM (104.60, 12.63 and 64.50 N, P and K kg/ ha). Similarly, application of RP at higher level resulted in higher uptake of nitrogen (116.76 kg /ha), phosphorus (15.24 kg /ha) and potassium (70.74 kg ha^{-1}) when compared to application of RP at lower levels. Further, the combination of higher levels of RP with compost resulted in significantly higher uptake of NPK. The treatment combination of OM_1RP_4 recorded significantly higher NPK uptake by chickpea crop (119.51, 15.79 and 71.81 NPK kg/ ha) over other treatments except OM_1RP_3 and OM_2RP_4. Higher uptake of NPK in these treatments was as a result of better mineralization of phosphorus and greater availability of phosphorus at higher level of RP, which resulted in higher uptake of phosphorus by chickpea. These results are in accordance with the findings of

Table 4 : Influence on organic manures and various levels of rock phosphate with PSB on yield and yield attributes of chickpea (Pooled data of 2009-10 and 2010-11)

Treatments	No. of pods per plant	100-seed weight (g)	Grain yield (kg/ha)	Haulm yield (kg/ha)
Organic manures (OM)				
OM_1: Compost 5 t/ha	63.86	19.98	1991	3163
OM_2: FYM 5 t/ha	60.65	19.61	1923	3079
S.E.±	1.37	0.17	42.21	73.39
C.D. (P=0.05)	NS	NS	NS	NS
Levels of rock phosphate (RP) with PSB				
RP_1: 50 kg rock phosphate/ha	57.72	19.05	1775	2930
RP_2: 100 kg rock phosphate/ha	61.29	19.27	1880	3047
RP_3: 150 kg rock phosphate/ha	63.77	20.39	2069	3254
RP_4: 200 kg rock phosphate/ha	66.22	20.48	2104	3255
S.E.±	1.94	0.24	59.69	103.79
C.D. (P=0.05)	5.59	0.70	172.40	NS
Interaction				
OM_1RP_1	58.95	19.21	1803	2969
OM_1RP_2	63.00	19.42	1911	3091
OM_1RP_3	65.71	20.60	2120	3292
OM_1RP_4	67.76	20.71	2130	3300
OM_2RP_1	56.49	18.89	1747	2890
OM_2RP_2	59.58	19.12	1849	3003
OM_2RP_3	61.83	20.18	2017	3215
OM_2RP_4	64.68	20.25	2079	3210
Absolute control	48.97	18.92	1450	2597
S.E.±	2.62	0.32	79.65	138.36
C.D. (P=0.05)	7.52	0.93	228.90	397.66

FYM – Farm yard manure RP – Rock phosphate with PSB
DAS – Days after sowing NS – Non-significant

Table 5 : Gross returns, net returns and B:C ratio of chickpea as influenced by organic manures and levels of rock phosphate (Pooled data of 2009-10 and 2010-11)

Treatments	Gross returns (Rs./ha)	Net returns (Rs./ha)	B:C ratio
Organic manures (OM)			
OM_1: Compost 5 t/ha	55544	38108	3.18
OM_2: FYM 5 t/ha	53678	36242	3.08
S.E.±	1084.48	1084.48	0.06
C.D. (P=0.05)	NS	NS	NS
Levels of rock phosphate (RP) with PSB			
RP_1: 50 kg rock phosphate/ha	49673	32425	2.88
RP_2: 100 kg rock phosphate/ha	52531	35158	3.02
RP_3: 150 kg rock phosphate/ha	57671	40173	3.30
RP_4: 200 kg rock phosphate/ha	58568	40945	3.32
S.E.±	1533.68	1533.68	0.09
C.D. (P=0.05)	4429.60	4429.60	0.25
Interaction			
OM_1RP_1	50454	33206	2.93
OM_1RP_2	53395	36022	3.07
OM_1RP_3	59030	41532	3.37
OM_1RP_4	59297	41674	3.36
OM_2RP_1	48892	31644	2.83
OM_2RP_2	51666	34293	2.97
OM_2RP_3	56313	38815	3.22
OM_2RP_4	57839	40216	3.28
Absolute control	40880	26257	2.80
S.E.±	2047.14	2047.14	0.12
C.D. (P=0.05)	5883.55	5883.55	0.34

FYM – Farm yard manure RP – Rock phosphate with PSB
DAS – Days after sowing NS – Non-significant

Kumar *et al.* (1994); Alagawadi and Gaur (1988) and Waigwa *et al.* (2003).

It was evident that application of varied levels of rock phosphate with PSB and their interaction with organic manures had significant influence on number of pods per plant, 100-seed weight, grain yield and haulm yield (Table 4).

Among various levels of rock phosphate, significantly higher number of pods per plant (66.22), 100-seed weight (20.48 g) and grain yield (2104 kg/ha) were recorded at higher levels of rock phosphate (200 kg/ha) over all other levels except with 150 kg rock phosphate which was at par.

Interaction of rock phosphate @ 200 kg per ha with compost @ 5 t per ha resulted in significantly higher number of pods (67.76), 100-seed weight (20.71 g), grain yield (2130 kg/ha) and haulm yield (3300 kg/ha) over application of rock phosphate at lower levels with organic manures and absolute control, but it was at par with OM1RP3, OM_2RP_3 and OM_2RP_4.

The increased yield attributing characters and yield in higher levels of rock phosphate with PSB and their interaction with organic manures were attributed to the increased availability of phosphorus which also favoured the symbiotic N_2 fixation and in terms of stimulated the growth of plants, thereby having positive effect on yield attributes (Kushwaha, 2007). These results are also in accordance with the findings of Alagawadi and Gaur (1988) and Thiyageshwari and Raniperumal (2002).

The data on gross returns, net returns and B:C ratio are provided in Table 5. The gross returns (Rs. 58568/ha) and net returns (Rs. 40945/ha) were significantly higher with application of 200 kg per ha (Table 3) over RP_1 and RP_2 except RP_3. The highest net returns had resulted in higher B:C ratio with which it was at par with application of 200 kg rock phosphate per ha (3.325) followed by 150 kg rock phosphate per ha (3.30). Among interactions of organic manures and levels of rock phosphate significantly higher B:C ratio was recorded OM_1RP_3 (3.37) followed by OM_1RP_4 (3.36). Higher B:C ratio was due to lower cost of cultivation.

REFERENCES

Alagawadi, A.R. and Gaur, A.C. (1988). Associative effect of Rhizobium and phosphate solubilizing bacteria on the yield and nutrient uptake of chickpea. *Plant Soil*, **105** : 241-246.

Biju, Joseph (1994). Studies on phosphorus in soybean-wheat crop sequence in Vertisols. M.Sc. (Ag.) Thesis, University of Agricultural Sciences, DHARWAD, KARNATAKA (India).

Black, C.A. (1965). Method of soil analysis Part-II, Chemical and microbial properties, American Society of Agronomy Incorporation, Madison, Wisconsin, United States of America No. 9, 569 pp.

Iman, M.E. (2008). Effect of phosphate solubilizing fungi on growth and nutrient uptake of soybean (*Glycine max* L.) plants. *J. Appl. Sci. Res.,* **4**(6) : 592-598.

Jackson, M.L. (1967). *Soil chemical analysis*, Prentice Hall of India Pvt. Ltd., New Delhi (India), 498 pp.

Jackson, M.L. (1973). *Soil chemical analysis*, Prentice Hall of India Private Limited, New Delhi, pp. 38-82.

Kumar, Anil, Verma, L.P. and Singh, Roop (1994). Evaluation of mussourie rock phosphate as a source of P for summer moong. *J. Indian Soc. Soil Sci.*, **42** : 463-484.

Kushwaha, H.S. (2007). Response of chickpea to biofertilizers, nitrogen and phosphorus fertilization under rainfed environment. *J. Food Legumes*, **20**(2): 179-181.

Muhr, G.R., Dutta, N.P., Shankaranbramoney, K., Lely, V.P. and Donahure, R.L. (1965). *Soil Testing in India,* USAID, New Delhi (India), pp. 39-41.

Piper, C.S. (1966). *Soil and plant analysis,* Academic Press, New York pp. 47-77.

Prasad, R. (2009). Efficient fertilizer use : The key to food security and better environment. *J. Trop. Agric.*, **47**(1-2) : 1-17.

Shakawat, M.S., Sharma, D.D. and Mehta, Y.K. (2006). Rock phosphate applied along with acidulants under soybean-mustard cropping system in alkaline soils. In : Phosphate rich organic manure : An alternate to phosphate fertilizers, Himanshu Publications.

Shivakumar, B.G., Ballari, S.S. and Saraf, C.S. (2004). Effect of sources and levels of phosphorus with and without seed inoculation on the performance of rainfed chickpea (*Cicer arietinum* L.). *Ann. Agric. Res. New Series,* **25**(2) : 320-326.

Singh, G.B. and Yadav, D.V. (1992). Integrated nutrient supply system in sugarcane and sugarcane based cropping system. *Fertizer News*, **37** : 15-22.

Subbiah, B.V. and Asija, G.L. (1956). A rapid procedure for the estimation of available nitrogen in soils. *Curr. Sci.*, **25**(8) : 259-260.

Thiyageshwari, S. and Raniperumal (2002). Integrated use of source of phosphorus with vermicompost and phosphobacteria in urdbean. *Indian J. Pulse Res.*, **15**(1) : 81-82.

Waigwa, M.W., Othieno, C.O. and Okalebo, J.R. (2003). Phosphorus availability as affected by the application of phosphate rock combined with organic materials to acid soils in Western Kenya. *Experimental Agric.,* **39**: 395-407.

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