Int.J.Curr.Microbiol.App.Sci (2017) *6*(9): 3398-3404

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 9 (2017) pp. 3398-3404**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2017.609.418

Effect of Phosphorus Levels through Integrated Nutrient Management (INM) Packages on Phosphorus Availability and Phosphorus Fractions in Soil under Groundnut Crop

B. Amruth[1*], G.N. Thippeshappa[1], K.T. Gurumurthy[1], H.M. Chidanandappa[1] and B. Chandra Sheker[2]

[1]Department of Soil Science and Agricultural Chemistry, University of Agricultural and Horticultural Sciences, Shivamogga (Karnataka)-577225, India
[2]Department of Soil Science and Agricultural Chemistry, College of Agriculture, University of Agricultural Sciences, Dharwad (Karnataka) – 580005, India
**Corresponding author*

Keywords

Phosphorus, INM, Groundnut.

Article Info

Accepted:
10 July 2017
Available Online:
10 September 2017

A B S T R A C T

The field experiment was conducted at College of Agriculture, Shivamogga during *kharif* 2015-2016. The total quantity of P and plant-available P often differ greatly fraction in acidic soils. Assessing available P is fundamental aspect to managing P in many of these soils. The objectives of this study were to effect of phosphorus levels through integrated nutrient management (INM) packages on status of phosphorus in soil under groundnut crop. The results revealed that significantly higher availability of phosphorus was recorded in treatment (T_9) whereas, lower phosphorus availability was found in treatment (T_1) at different stages of the crop growth stages. Significantly higher amount of all inorganic and organic forms of P in soil were recorded in application of higher dose of P i.e.50 kg ha^{-1} (T_6). The percent contribution of different phosphorus fractions *viz.*, Saloid-P Al-P, Fe-P, Reductant Soluble-P, Occluded-P, Ca-P, Organic-P to Total-P, the lowest contribution to total-P from Occl-P (3.20 %), Ca-P (3.46 %), followed by Saloid-P (6.16 %), Red-P (9.83 %). The contribution from org-P (51.96 %) to total-P found to be highest, but Al-P (13.73 %) and Fe-P (13.16 %) was observed to be similar per cent contribution to total-P.

Introduction

In soils, applied phosphate fertilizer enter into complex reactions with the various constituents of soils such as Fe, Al, Ca, Mg and get quickly converted to less soluble or insoluble forms as a result 20-25 per cent of applied phosphatic fertilizer is utilized by the crop in a season indicating low phosphorus use efficiency and buildup of P in soil is very common in the soils. The fixation of P is a pH dependent chemical reaction that makes it unavailable to crops.

Phosphorus availability in acid soils is low because of its fixation by iron and aluminium oxides which often limit the plant growth.

Further, phosphorus occurs in soils in both inorganic and organic forms. The inorganic phosphorus forms are largely associated with aluminium, iron and calcium compounds which act as major forms phosphorus in soils. On the contrary, the occluded and reductant soluble forms of phosphorus are interrelated and contribute to the pool of plant available phosphorus in soils.

Integrated use of phosphorus fertilizers with FYM and bio-fertilizers like P solubilising bacteria for instance *Pseudomonas striatus*, enhancing the more P solubility and availability in soils. The INM practices increases available nutrients, facilitates slow release of nutrients and thus reduces nutrient losses. As such, P status is not poor in soils but its availability to plants from soil is meager as it is present mostly in unavailable or fixed forms. Therefore, efforts need to be made to solubilize unavailable P forms to plant available forms.

Keeping these views and facts in mind, a field experiment was conducted at College of Agriculture, Navile, Shivamogga during 2015-2016 on sandy loam soil to study the effect of phosphorus levels through integrated nutrient management (INM) packages on status of phosphorus in soil under groundnut crop.

Materials and Methods

A field experiment was conducted to investigate the effect of phosphorus levels through integrated nutrient management (INM) packages on status of phosphorus in soil under groundnut crop during the *kharif* 2015-16 under rainfed condition at College of Agriculture and ZAHRS, Shivamogga, comes under University of Agricultural and Horticultural Sciences, Shivamogga and belongs to Southern Transition Agro-climatic Zone of Karnataka (Zone No. 7). The experimental site is situated at $14^o0'$ to $14^o1'$ North latitude and 75^o 40' to 75^o 42' East longitude with an altitude of 650 meters above the mean sea level. Groundnut crop variety (G2-52) was selected as a test crop. The experiment comprised nine treatment combinations with three phosphorus levels *viz.*, 20, 30 and 50 kg P_2O_5 ha^{-1} applied through inorganic P fertilizer (75 %) and FYM (25 %) along with PSB bio fertilizer which are laid out in Randomized Completely Block Design (RCBD) with three replications. The treatment details are given below.

Treatment details

T_1: RDNK + 20 kg P_2O_5 ha^{-1}, T_2: RDNK + 75 % of 20 kg P_2O_5 ha^{-1} through chemical fertilizers (CF) + 25 % through FYM, T_3: T_2 + PSB, T_4: RDNK + 30 kg P_2O_5 ha^{-1}, T_5: RDNK + 75 % of 30 kg P_2O_5 ha^{-1} through chemical fertilizers (CF) + 25 % through FYM, T_6: T_5 + PSB, T_7: RDNK + 50 kg P_2O_5 ha^{-1}, T_8: RDNK + 75 % of 50 kg P_2O_5 ha^{-1} through chemical fertilizers (CF) + 25 % through FYM and T_9: T_8 + PSB

The initial properties of experimental site were determined by following standard procedures. The experimental site was Sandy loam (72.54 % sand, 10.25% silt, 17.21% clay). The soil was acidic in reaction pH : 5.47, EC: 0.078 dS m^{-1}, OC : 4.82 g kg-1, CEC: 9.3 c mol (p+) kg^{-1} and the status of available N, P and K were 207.43, 142.48 and 191.06 kg ha^{-1}, respectively. Exchangeable Ca and Mg were2.70 and 1.50, respectively and available sulphur were 8.40 mg kg^{-1}. The initial values of soil P fractions (mg kg^{-1}) were as Saloid -P: 8.21, Al-P: 57.65, Fe-P: 50.98, Reductant Soluble-P: 48.95, Occluded –P: 6.52, Ca-P: 8.41and organic P: 237.55 and total –P: 418.27. Analysis of inorganic phosphorus fraction was carried out standard procedure outlined by (Peterson and Corey, 1966). The analysis of variance to factorial randomized block design to test difference among treatments was carried out as per the procedure described by Panse and Sukhatme (1985).

Results and Discussion

Data pertaining to available of phosphorus status in soil at different crop growth stages of groundnut as influenced by different levels of P with and without FYM and PSB treatment is given in table 1.

The data on available phosphorus in soil recorded at 30, 60, 90 DAS and at harvest of the crop showed significant variations among the treatments due to influence of phosphorus levels through integrated nutrient management (INM) packages. The available P status of soil decreased as the crop growth stages advanced and at harvest the status of available P was found to be low. The treatment supplied with higher dose of P i.e., 75 % of 50 kg P_2O_5 ha^{-1} through CF + 25 % through FYM + PSB recorded higher phosphorus availability in soil to the tune of 147.67, 138.32, 131.58 and 129.92 kg ha^{-1} at 30, 60, 90 DAS and at harvest stage, respectively. But, it was statistically on par with treatment supplied with 75 % of 30 kg P_2O_5 ha^{-1} through CF + 25 % through FYM + PSB which recorded to extent of 136.92, 133.11, 124.92 and 118.60 kg ha^{-1} at 30, 60, 90 DAS and harvest stage respectively. Significantly lower P status was recorded due to application of lower dose of P i.e., 20 kg P_2O_5 ha^{-1} in T_1 treatment (112.09, 109.01, 108.31 and 106.57 kg ha^{-1}at 30, 60, 90 DAS and harvest stage, respectively).

Application higher dose P along with FYM and PSB resulted in the solubilisation and mobilization by ligand exchange reaction of negative charged organic acids with phosphate ions on aluminium and iron phosphate minerals and finally releases the phosphate ions into solution. The treatment T_6 with 30 kg ha^{-1} P applied along with FYM and PSB showed less availability compared to higher dose of P applied. This may be due to more uptake of phosphorus which reduces the concentration of P in soil solution. Application of PSB helps in realising P from native P as well as protecting fixation of added P and rendering more available P. The results are in accordance with the findings of Ramesh Chander *et al.,* (2011). Significantly lower P status was recorded due to application of lower dose of P i.e., 20 kg P_2O_5 ha^{-1} in T_1 (106.57 kg ha^{-1}at harvest stage). It might be attributed to less availability of P and their less utilization by the crop. Applied P, might have enter in to fixation and adsorption on soil colloids; this mechanisms are relevant to P losses (Vogeler, *et al.*, 2009).

The results on Saloid-P, Al-P, Fe-P and Red-P content of soil as influenced by different P levels application through INM packages are presented in tables 2 and 3. At harvest stage, among the imposed treatments, treatment T_7 (50 kg P_2O_5 ha^{-1}) recorded significantly higher Saloid-P (34.69 mg kg^{-1}) content in soil. But it was statistically on par with T_9 treatment supplied with 75 % through CF of 50 kg P_2O_5 ha^{-1} + 25 % through FYM + PSB (32.52 mg kg^{-1}). Saloid-P fraction in soil found significantly lower content in T_1 treatment (17.14 mg kg^{-1}) supplied with 20 kg P_2O_5 ha^{-1} alone. Additions of P fertilizers increased Saloid-P it might be due to physically adsorbed on soil particles Singaram and Kothandaraman (1993). These results are in agreement with findings of Patel *et al.,* (1992) and Singh and Gupta (1995) who reported that the irrespective application of P fertilizers sources tended to increase the content of Saloid-P.

At harvest stage of groundnut, among the levels of P applied, the treatment T_7 (50 kg P_2O_5 ha^{-1}) was recorded significantly higher content of Al-P, Fe-P, Reductant Soluble-P, Occluded-P fraction (90.63 mg kg^{-1}, 86.95 g kg^{-1}, 64.80 mg kg^{-1}, 21.09 mg kg^{-1}, respectively). The significantly lower value of Al-P fraction was recorded in T_3 (51.77 mg kg^{-1}, 63.64 mg kg^{-1}, 63.81 mg kg^{-1}, 3.56 mg kg^{-1}, respectively) supplied with 75 % of 20 kg P_2O_5 ha^{-1} through CF + 25 % through FYM + PSB.

Table.1 Effect of phosphorus levels through INM packages on available P_2O_5 status of soil at different growth stages of groundnut

Treatments	Available P_2O_5 (kg ha^{-1})			
	30 DAS	60 DAS	90 DAS	Harvest
T_1: 20 kg P_2O_5 ha^{-1}	112.09	109.01	108.31	106.57
T_2: 75 % of 20 kg P_2O_5 ha^{-1} through CF + 25 % through FYM	115.16	113.30	112.26	109.09
T_3: T_2 + PSB	118.63	116.57	114.33	111.57
T_4: 30 kg P_2O_5 ha^{-1}	122.82	119.40	116.68	113.59
T_5: 75 % of 30 kg P_2O_5 ha^{-1} through CF + 25 through FYM	124.00	123.41	118.74	115.56
T_6: T_5 + PSB	136.92	133.11	124.92	118.60
T_7: 50 kg P_2O_5 ha^{-1}	140.09	128.57	125.62	123.70
T_8: 75 % of 50 kg P_2O_5 ha^{-1} through CF + 25 % through FYM	144.95	132.21	128.77	125.88
T_9: T_8 + PSB	147.67	138.32	131.58	129.92
S Em $\pm$	2.40	1.76	1.07	1.31
CD (P=0.05)	7.20	5.30	3.20	3.93

CF: Chemical Fertilizers, PSB: Phosphorus Solubilising Bacteria, DAS: Days After Sowing
RDNK and FYM @ 10 t ha^{-1} common to all treatments

Table.2 Effect of phosphorus levels through INM packages on distribution of P fractions in soil at harvest stage of groundnut

Treatments	P Fractions (mg kg^{-1})			
	Saloid- P	Al – P	Fe- P	Red- P
Initial status	8.21	57.65	50.98	48.95
T_1: 20 kg P_2O_5 ha^{-1}	17.14 (3.53)	59.48 (12.29)	70.65 (14.59)	59.28 (12.23)
T_2: 75 % of 20 kg P_2O_5 ha^{-1} through CF + 25 % through FYM	21.42 (4.50)	54.68 (11.46)	66.38 (13.93)	57.92 (12.15)
T_3: T_2 + PSB	23.68 (4.27)	51.77 (9.33)	63.64 (11.49)	55.68 (10.04)
T_4: 30 kg P_2O_5 ha^{-1}	26.44 (4.53)	78.40 (13.40)	79.51 (13.58)	63.81 (10.91)
T_5: 75 % of 30 kg P_2O_5 ha^{-1} through CF + 25 % through FYM	28.25 (4.70)	75.79 (12.59)	76.14 (12.65)	56.41 (9.36)
T_6: T_5 + PSB	30.63 (4.65)	71.56 (12.70)	72.99 (12.94)	53.79 (9.57)
T_7: 50 kg P_2O_5 ha^{-1} through CF	34.69 (6.16)	90.63 (13.73)	86.95 (13.16)	64.80 (9.83)
T_8: 75 % of 50 kg P_2O_5 ha^{-1} through CF + 25 % through FYM	31.77 (5.02)	84.37 (13.31)	83.07 (13.12)	62.48 (9.89)
T_9: T_8 + PSB	32.52 (5.22)	82.21 (13.21)	81.81 (13.14)	61.03 (9.81)
S Em $\pm$	0.92	2.12	1.75	1.72
CD (P=0.05)	2.97	6.36	5.24	5.17

CF: Chemical Fertilizers, PSB: Phosphorus Solubilising Bacteria.
RDNK and FYM @ 10 t ha^{-1} common to all treatments
Values in parenthesis (): Percent contribute to Total -P

Table.3 Effect of phosphorus levels through INM packages on distribution of P fractions and Total-P in soil at harvest of groundnut

Treatments	**P Fractions (mg kg^{-1})**			
	Occl - P	**Ca – P**	**Org- P**	**Total - P**
Initial status	6.52	8.41	237.55	418.27
T_1: 20 kg P_2O_5 ha^{-1}	8.71 (1.80)	7.10 (1.47)	262.23 (54.10)	484.58
T_2: 75 % of 20 kg P_2O_5 ha^{-1} through CF + 25 % through FYM	5.33 (1.11)	5.34 (1.12)	265.90 (55.73)	476.97
T_3: T_2 + PSB	3.56 (0.64)	3.62 (0.66)	353.33 (63.57)	555.28
T_4: 30 kg P_2O_5 ha^{-1}	14.12 (2.41)	15.63 (2.68)	308.54 (52.50)	586.45
T_5: 75 % of 30 kg P_2O_5 ha^{-1} through CF + 25 % through FYM	11.46 (1.90)	13.00 (2.16)	341.20 (56.64)	602.25
T_6: T_5 + PSB	9.78 (1.73)	10.81 (1.92)	310.70 (54.97)	564.32
T_7: 50 kg P_2O_5 ha^{-1}	21.09 (3.20)	22.88 (3.46)	344.97 (51.96)	661.94
T_8: 75 % of 50 kg P_2O_5 ha^{-1} through CF + 25 % through FYM	18.56 (2.93)	18.56 (2.93)	335.58 (52.80)	634.40
T_9: T_8 + PSB	8.71 (2.51)	16.47 (2.64)	332.94 (53.47)	622.59
S Em $\pm$ RDNK and FYM @ 10 t ha^{-1} common to all treatments	0.84	0.72	13.79	14.37
CD (P=0.05)	2.51	2.18	41.33	43.10

Al-P fraction content in soil increased with increasing levels of P application. However, the Al-P content decreased with increasing levels of organic residue. The contribution of Al-P to Total –P over the percentage of Saloid -P might be ascribed to higher total aluminium content of soil. Relative increase of Al-P indicated the strong effect of fertilization on this form of phosphorus. Similar results were also reported by Singh and Gupta (1995), Bahl and Singh (1997) and Verma (2002). Application of DAP resulted in the formation of more Fe-P in the soil as the soluble MCP of DAP would have been converted to Fe -P and Al-P. The reduction of Fe-P with P solubilisers compared to phosphate fertilizers causing reduction in Fe-P Setia and Sharma (2007). This results are corroborates with the findings of Eresha *et al.*, (2015), The reduction of Red- P with FYM application which might be due to FYM ascribed to dissolution of iron oxide coating with organic acids released during decomposition of FYM causing reduction of Red – P in soil. These results are in line with Singaram and Kothandaraman (1991). The fixation and transformation of native and added P to Occl-P is generally low (Ranjit, 2007).

Application of different levels of phosphorus through INM packages significantly influenced on Calcium-P, Organic and Total-P fraction at harvest stage of groundnut. At harvest stage, treatment T_7 (50 kg P_2O_5 ha^{-1},) recorded significantly higher Ca- P (22.88 mg kg^{-1}, 353.33 mg kg^{-1}, 661.94 mg $kg^{-1}$$_{,)}$.

The content of Ca-P was lesser than Fe-P, Al-P and Occl-P. It can be inferred that the less content of Ca-P in the surface soil may be due to low soil pH Eresha *et al.*, (2015). Addition of organic residue increased food for microorganisms, during decomposition of organic residue release of low molecular weight organic acids in soil. Which convert non-labile P in to labile P and enhances soil solution P, there by decreases in Al- P and Ca-P while increase the availability of P in soil. Similar results were also reported by Eresha *et al.*, (2015) and Dotaniya *et al.*, (2014).

Application of FYM increased the organic carbon in soil which is positive relationships with Org.-P, thereby increase the Org.-P fraction in soil (Anil Kumar *et al.*, 2013) and (Manimaran, 2015).

The combined use of inorganic and organic P fertilizers like FYM along with phosphate solubilising bacteria like *Pseudomonas striatus* reduces the inorganic phosphorus forms. By adoption of INM packages increases the availability of phosphorus in soil by solubilization and mobilization of native build up P in soil and reduces the phosphorus fixation with iron, aluminium and calcium metal ions in soil.

References

Anil Kumar, Neeraj Kumar, Singhal, S. K., Vinay Singh and Sharma, V. K., 2013. Soil phosphorus fractions in a *Typic haplustept* as influenced by organic sources after soybean (*Glycine max*) and wheat (*Triticum aestivum*) cropping sequence in semi-arid condition. *Agric. Sci. Digest.*, 33(4): 304-308.

Bahl, G. S., and Singh, A., 1997. The inorganic soil phosphorus fractions and available P as influenced by green manuring, cropping and P fertilization. *J. Indian Soc. Soil Sci.*, 45(1): 19-23.

Dotaniya, M. L., Datta, S. C., Biswas, D. R. and Kuldeep Kumar, 2014. Effect of organic sources on phosphorus fractions and available phosphorus in *Typic Haplustept*. *J. Indian Soc. Soil Sci.*, 62(1): 80-83.

Eresha, Gowda, R. C., Sidharam Patil,

Srinivas, D. K. and Santosh, V. P., 2015. Effect of long term manure and fertilizer application on availability of phosphorus and its fraction in long term fertilizer experimental field under finger millet-maize cropping system in Karnataka. *Int. J. Farm Sci.*, 5(4): 17-23.

Jackson, M. L., 1973. *Soil Chemical Analysis*. Prentice Hall Pvt. Ltd., New Delhi.

Manimaran, M., 2015. Influence of different inorganic sources and organic manures on fractions of phosphorus in sodic soil. *J. Hormonized Res. Appl. Sci.*, 3(1): 21-26.

Page, A. L., Miller, R. H. and Keeney, D. R., 1982. Method of soil analysis, part-2, chemical and microbiological properties. *American. Soc. Agron. Soil Sci. Soc.*, Madison, Wisconsin, USA.

Panse, V. G., and Sukhatme, P. V., 1985. *Statistical methods for agricultural workers Indian Council of Agricultural Research (IARI)*, New Delhi. pp. 167-174.

Patel, M. S., Patil, R. G., Zalawadia, N. M. and Suteria, G. S., 1992. Effect of phosphorus, moisture and organic matter on phosphorus availability and its fractions in a calcareous clay soils at different incubation periods. *J. Indian Soc. Soil Sci.*, 40(4): 705-710.

Peterson, G. W., and Corey, R. B., 1966. A modified Chang and Jackson procedure for routine fraction of inorganic soil phosphates. *Soil Sci. Soc. American Proc.*, 30: 563-564.

Piper, C. S., 1966. Soil and Plant Analysis, University Adelaide, Australia.

Ranjit, R., Dasog, G. S. and Patil, P. L., 2007. Effect of lime and phosphorus levels on the pod, haulm and oil yield of two groundnut genotypes in acid soils of coastal agro-ecosystem of Karnataka. *Karnataka J. Agric. Sci.*, 20(3): 627-630.

Singaram, P., and Kothandaraman, G. V., 1991. Direct, residual and cumulative effects of phosphatic fertilizers as yield attribute on yield of finger millet, maize and black gram grown in cropping sequence. *Fert. News*, 36(8): 21-27.

Singh, M., and Gupta, M. L., 1995. Effect of sewage sludge on phosphorus transformation under wheat cultivation. In: *Abstracts of National seminar on "Developments in Soil Science". Indian Soc. Soil Sci.*, IARI, New Delhi, pp. 117.

Verma, S., 2002. Studies on long-term effects of chemical fertilizers and amendments on phosphorus dynamics and its budgeting in wet temperate zone soils of Western Himalayas. *M.Sc. Thesis*, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, India.

How to cite this article:

Amruth, B., G.N. Thippeshappa, K.T. Gurumurthy, H.M. Chidanandappa and Chandra Sheker, B. 2017. Effect of Phosphorus Levels through Integrated Nutrient Management (INM) Packages on Phosphorus Availability and Phosphorus Fractions in Soil under Groundnut Crop. *Int.J.Curr.Microbiol.App.Sci.* 6(9): 3398-3404. doi: https://doi.org/10.20546/ijcmas.2017.609.418