Int.J.Curr.Microbiol.App.Sci (2017) *6*(10): 216-224

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 10 (2017) pp. 216-224**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2017.610.027

Influence of Different Levels of Phosphorus and PSB Seed Treatment on P Fraction in Soil at Different Growth Stages of Groundnut (*Arachis hypogaea* L.)

M.C. Anjali[*] and B.C. Dhananjaya

Department of Soil Science and Agricultural Chemistry, Krishi Vigyan Kendra, College of Agriculture, UAHS, Shimoga-577204, Karnataka, India
**Corresponding author*

A B S T R A C T

Keywords

Al-P, Fe-P, Groundnut, Occl-P, Organic-P, Phosphate solubilizing bacteria (PSB), Phosphorus, Red-P, Total P.

Article Info

Accepted:
04 September 2017
Available Online:
10 October 2017

In order to know the effect of PSB seed treatment and P levels on P-fractions in different growth stages of groundnut a field experiment was conducted on a sandy loam soil at KVK, UAHS, Shimoga during *kharif* of 2013 The levels of phosphorus @ 0, 25, 37.5 and 50 kg P_2O_5 as DAP per ha^{-1} with or without PSB seed treatment were tried in a randomized complete block design with three replications and eight treatments. The result indicated in all the growth stages higher values of saloid – P and Ca – P fractions status in soil were recorded in treatment 50 kg P_2O_5 ha^{-1} as DAP with PSB seed treatment at similarly higher values of Al - P, Fe – P, red – P, occl – P, organic – P and total - P fractions were recorded in treatments involving P levels without PSB seed treatment compared to application of P levels with PSB seed treatment. The treatment which receives 50 kg P_2O_5 ha^{-1} as DAP recorded higher Al-P, Fe – P, red – P, occl – P, organic – P and total - P values in all the growth stages of groundnut.

Introduction

Despite its wide distribution in nature, P is a limited resource for plant growth and its low availability is a major constraint to crop production in most arable soils (Redel *et al.*, 2011). About 25 - 50 kg of phosphorus (P_2O_5) ha^{-1} has been recommended for different groundnut-growing regions in India. Complete dosage of phosphorus should (P_2O_5) be applied at the time of sowing as the demand for phosphorus is high during the early stages of crop growth. The phosphate applied to soils enter into complex reactions (transformation) with the various constituents such as Fe, Al, Mg, Ca clay minerals and get quickly converted to less soluble or insoluble forms. Twenty to twenty five percent of the applied phosphatic fertilizer is utilized by the crop and the remaining is converted into insoluble forms of phosphorus and fixed in the soil. Crops cannot absorb insoluble forms of phosphorous and has to be converted into soluble forms by phosphatase enzyme such as acidic and alkaline phosphatase. Several soil microorganisms particularly phosphate solubilizing bacteria (phosphobacteria), possess the ability to solubilize insoluble inorganic phosphate and make it available to plants. The solubilization effect is generally due to the production of organic acids by these organisms, has an indirect but definite effect on the nodulation and yield of legume crops like groundnut through increased phosphate solubilization. In view of the above facts, a field experiment entitled Influence of different levels of Phosphorus and PSB seed treatment on P fraction in soil at different growth stages of Groundnut (*Arachis hypogaea* L.)

Materials and Methods

Field experiment was conducted on a sandy loam soil (*Typic Haplustalf*) at Krishi Vignana Kendra (KVK), UAHS campus, Shimoga, during *kharif*, 2013. The different levels of phosphorus @ 0, 25, 37.5 and 50 kg P_2O_5 as DAP per ha^{-1} with or without PSB seed treatment with 8 treatment combinations along with recommended dose of FYM, N and K fertilizers and gypsum used in a RCBD with three replications.

Soil samples were collected from Ap horizon (0-15 depth) at different growth stages of crop growth like 30, 60, 90 days after sowing and at harvest of the crop. The soil samples are air dried at room temperature. Total phosphorus in the soils was estimated by digesting one gram of finely powdered soil with perchloric acid as outlined by Jackson (1967). Inorganic phosphate fractions *viz.*, Saloid – P, Al – P, Fe –P, Red – P, Occl –P and Ca – P by the fractionation procedure of Peterson and Corey (1966). Organic phosphorus content in soil was calculated as the difference between the total P content and the total mineral P content of soil.

Results and Discussion

The results reveal that application of different P levels with and without PSB seed treatment in ground nut crop significantly increased the values of saloid – P fraction in soil at different crop growth stages (Table 1).

Higher values of saloid – P fractions were recorded in treatments involving P levels with PSB seed treatment compared to application of only P levels. Treatment T_8 (50 kg P_2O_5 ha^{-1} as DAP with PSB seed treatment) recorded significantly higher saloid - P fraction in soil (22.92, 29.90, 35.96 and 39.11 mg kg^{-1}, at 30, 60, 90 DAS and at harvest, respectively) followed by treatment T_7 (50 kg P_2O_5 ha^{-1} as DAP) and T_6 (37.5 kg P_2O_5 ha^{-1} as DAP with PSB seed treatment) compared to other treatments at all stages of crop growth. These results are agreement with the findings of Singaram and Kothandaraman (1993) who reported that application of P irrespective of the sources tended to increase the content of saloid – P. Singaram and Kothandaraman (1992) reported that higher amount of saloid - P in soil was observed with water soluble P source. Incorporation of PSB with DAP and rock phosphate (RP) marginally increased saloid - P value compared to RP and DAP alone. They attributed it to complexing of P fixing metallic cations with organic acids released from P solubilizing micro-organisms and preventing P to be adsorbed on soil particles. Thus, it helped in extraction of loosely bonded NH_4Cl extractable fraction of P.

Results on changes in Al – P fractions in soil at different growth stages of groundnut (Table 1) reveal that application of P levels with or without PSB seed treatment significantly increased the Al – P fractions in soil at different growth stages of crop growth. Higher values of Al – P fractions were recorded in treatments involving only P levels without PSB seed treatment compared to application of P levels with PSB seed treatment. Application of 50 kg P_2O_5 ha^{-1} as DAP (T_7) recorded higher Al - P values

(69.20, 75.49, 78.44 and 79.84 mg kg^{-1}, at 30, 60, 90 DAS and at harvest, respectively) followed by application of 50 kg P_2O_5 ha^{-1} as DAP with and without PSB seed treatment (T_8) compared to other treatments. This may be due to application of P fertilizers which increased the Al-P content over control. This suggests that portion of added P was transformed into Al - P. Treatments comprising application of water soluble P sources like DAP, favoured greater formation and accumulation of Al - P content of soil. This may be attributed to dissolution of aluminium of the clay in the acid produced as a result of hydrolysis of DAP in soil. It corroborates with the findings of Rao *et al.*, (1972) and Sheela (2006).

Increases in Fe – P fractions in soil at different growth stages of crop growth due to P levels with and without PSB seed treatment as presented in table 2. Higher values of Fe – P fractions were recorded in treatments involving only P levels without PSB seed treatment compared to application of only P levels with PSB seed treatment. Application of 50 kg P ha^{-1} as DAP (T_7) recorded higher Fe - P values (85.63, 96.80, 102.96 and 116.70 mg kg^{-1}, at 30, 60, 90 DAS and at harvest, respectively) followed by Application of 50 kg P ha^{-1} as DAP with PSB seed treatment (T_8) compared to other treatments. There is no significant variation in the values of Fe - P fraction at different stages of crop growth. Application of DAP resulted in the formation of more Fe - P during different period of incubation in the soil as the soluble monocalcium phosphate of DAP would have been converted to Fe - P and Al - P (Singh and Singh, 1976). Chang and Jackson (1957) and Yuan *et al.*, (1960) observed that application of phosphatic fertilizers to acid soils increases the fixation and transformation of added phosphate into Fe - P. The reduction of Fe - P with P - solubilizers compared to phosphate fertilizers alone is ascribed to dissolution of iron oxide coatings with organic acids produced by P solubilizers causing reduction in Fe - P. These results corroborate with the findings of Sheela (2006).

The results revealed that different levels of P with and without PSB seed treatment significantly increased the red soluble - P fractions in soil at different crop growth stages (Table 2). Higher values of red soluble - P fractions were recorded in treatments involving application of only P levels compared to P levels with PSB seed treatment. Application of 50 kg P_2O_5 ha^{-1} as DAP (T_7)(78.97, 84.62, 86.79 and 91.03 mg kg^{-1}, at 30, 60, 90 DAS and at harvest, respectively) recorded higher red soluble - P values followed by application of 50 kg P_2O_5 ha^{-1} as DAP with PSB seed treatment (T_8) compared to other treatments.

Lowest value of red soluble - P fraction in soil was recorded in only PSB applied T_2 treatment. Addition of P fertilizers significantly increased the fixation and transformation of added P in the soil.

Application of DAP resulted in higher buildup of red soluble – P values compared to other treatments. Since, DAP is water soluble, readily reacts with ferric hydroxides, leading to conversion of water soluble form to insoluble form (Singaram and Kothandaraman, 1991). The reduction of red soluble - P with P - solubilizers compared to P fertilizers alone is attributed to dissolution of iron oxide coatings with organic acids produced by P solubilizers. These results are in agreement with the findings of Sheela (2006).

Significant increases in occl– P fractions in soil at different growth stages of crop growth were observed due to different levels of P with and without PSB seed treatment (Table 3). Higher values of occl – P fractions were recorded in treatments involving only P levels compared to application of P levels with PSB seed treatment. Application of 50 kg P_2O_5 ha^{-1} as DAP (T_7) recorded higher occl - P values (17.57, 18.82, 19.87 and 20.96 mg kg^{-1}, at 30, 60, 90 DAS and at harvest, respectively) followed by application of 50 kg P_2O_5 ha^{-1} as DAP with PSB seed treatment (T_8) compared to other treatments. Lowest value of occluded - P fraction in soil was recorded only PSB applied T_2 treatment. The fixation and transformation of native and added P to occl – P is generally low (Ranjit, 2005). Treatments involving application of P solubilizers recorded lower occl - P values. This might be due to dissolution of Al - P and Fe - P present in the form of oxides of Fe and Al by the action of organic acids released by P solubilizers. These results are in accordance with the findings of Goroji (2000).

The results on changes in Ca - P fraction in soil at different growth stages of groundnut (Table 3) reveal significant increase in Ca - P fractions in soil at different growth stages of crop growth were recorded with application of P levels with and without PSB seed treatment. Higher values of Ca - P fractions were recorded in treatments involving application of P levels with PSB seed treatment compared to application of only P levels. The values of Ca - P in only PSB applied T_2 and no P applied T_1 treatment decreased with crop growth stages and the values of Ca – P in other treatments increased with crop growth. Treatment T_8 (50 kg P_2O_5 ha^{-1} as DAP with PSB seed treatment) recorded higher Ca - P (19.98, 22.01, 22.92 and 24.88 mg kg^{-1}, at 30, 60, 90 DAS and at harvest, respectively) followed by treatment T_7 (50 kg P_2O_5 ha^{-1} as DAP) compared to other treatments. The buildup of Ca-P compared to control in the P applied soils as P fertilizer alone or with P solubilizers was also observed by Mathan and Joseph (1998).

Table.1 Effect of P levels with or without PSB seed treatment on Saloid bound P and Aluminium bound P fractions in soil at different growth stages of groundnut

Treatments	***Saloid bound – P (mg kg^{-1})***				***Aluminium bound – P (mg kg^{-1})***			
	30 DAS	***60 DAS***	***90 DAS***	***Harvest***	***30 DAS***	***60 DAS***	***90 DAS***	***Harvest***
T_1: Recommended NK	11.33 (2.14)	13.18 (3.59)	16.59 (3.37)	18.16 (3.70)	61.49 (11.63)	59.66 (11.72)	58.65 (11.91)	56.74 (11.56)
T_2: T_1 + PSB	13.41 (2.60)	15.55 (3.08)	20.48 (4.34)	22.73 (4.75)	58.37 (11.32)	57.71 (11.43)	56.52 (11.98)	55.52 (11.60)
T_3: T_1 + 25 kg P_2O_5 ha^{-1} as DAP	14.46 (2.61)	16.53 (2.95)	22.18 (3.95)	24.26 (4.15)	65.25 (11.78)	71.15 (12.68)	70.84 (12.63)	72.77 (12.45)
T_4: T_3 + PSB seed treatment	16.54 (3.03)	19.55 (3.57)	24.38 (4.46)	27.50 (4.88)	62.99 (11.54)	65.37 (11.95)	68.06 (12.44)	70.20 (12.45)
T_5: T_1 + 37.5 kg P_2O_5 ha^{-1} as DAP	17.08 (2.93)	20.92 (3.54)	26.56 (4.50)	28.25 (4.58)	69.54 (11.94)	71.40 (12.10)	74.72 (12.66)	76.50 (12.40)
T_6: T_5 + PSB seed treatment	19.85 (3.45)	24.24 (4.16)	31.10 (5.34)	33.51 (5.63)	67.63 (11.74)	68.59 (11.77)	72.29 (12.41)	70.37 (11.83)
T_7: T_1 + 50 kg P_2O_5 ha^{-1} as DAP	20.40 (3.38)	27.94 (4.49)	33.71 (5.35)	34.20 (5.19)	69.20 (11.45)	75.49 (12.12)	78.44 (12.46)	79.84 (12.10)
T_8: T_7 + PSB seed treatment	22.92 (3.87)	29.40 (4.82)	35.96 (5.88)	39.11 (6.10)	67.78 (11.44)	72.70 (11.92)	75.28 (12.31)	77.04 (12.01)
S. Em ±	0.58	0.64	0.96	0.99	2.27	1.96	2.15	2.32
C.D at 5%	1.76	1.95	2.91	3.00	6.90	5.94	6.52	7.02

* DAS = Days after sowing
* Figures in the parenthesis indicate the per cent contribution to the total P pool

Table.2 Effect of P levels with or without PSB seed treatment on iron P and reductant soluble P fractions in soil at different growth stages of groundnut

Treatments	Iron – P (mg kg^{-1})				Reductant soluble – P (mg kg^{-1})			
	30 DAS	60 DAS	90 DAS	Harvest	30 DAS	60 DAS	90 DAS	Harvest
T_1: Recommended NK	72.54 (13.72)	70.85 (13.91)	69.85 (14.18)	68.23 (13.90)	59.62 (11.28)	57.77 (11.35)	56.51 (11.47)	55.60 (11.33)
T_2: T_1 + PSB	67.75 (13.14)	65.67 (13.00)	64.83 (13.74)	64.77 (13.54)	56.77 (11.01)	61.52 (12.18)	53.51 (11.34)	52.77 (11.03)
T_3: T_1 + 25 kg P_2O_5 ha^{-1} as DAP	77.03 (13.91)	81.74 (14.57)	84.97 (15.15)	88.54 (15.15)	66.64 (12.03)	72.86 (12.99)	75.64 (13.48)	79.88 (13.67)
T_4: T_3 + PSB seed treatment	73.54 (13.47)	76.65 (14.01)	80.71 (14.75)	84.32 (14.96)	62.42 (11.44)	68.02 (12.43)	70.43 (12.87)	75.82 (13.45)
T_5: T_1 + 37.5 kg P_2O_5 ha^{-1} as DAP	82.57 (14.17)	90.05 (15.26)	92.96 (15.75)	96.89 (15.70)	72.89 (12.51)	77.73 (13.17)	80.77 (13.68)	84.92 (13.76)
T_6: T_5 + PSB seed treatment	79.45 (13.79)	86.77 (14.89)	88.57 (15.20)	92.79 (15.60)	68.64 (11.92)	74.90 (12.85)	77.29 (13.26)	79.91 (13.44)
T_7: T_1 + 50 kg P_2O_5 ha^{-1} as DAP	85.63 (14.17)	96.80 (15.54)	102.96 (16.35)	116.70 (17.69)	78.97 (13.07)	84.62 (13.58)	86.79 (13.79)	91.03 (13.80)
T_8: T_7 + PSB seed treatment	80.51 (13.59)	88.73 (14.55)	96.76 (15.85)	110.85 (17.28)	74.80 (12.62)	80.15 (13.14)	83.65 (13.68)	86.88 (13.54)
S. Em ±	2.26	2.56	2.58	2.73	2.01	2.49	2.23	2.36
C.D at 5%	6.85	7.77	7.81	8.27	6.08	7.55	6.75	7.15

* DAS = Days after sowing

* Figures in the parenthesis indicate the per cent contribution to the total P pool

Table.3 Effect of P levels with or without PSB seed treatment on occluded P and calcium bound P fractions in soil at different growth stages of groundnut

Treatments	***Occluded – P (mg kg^{-1})***				***Calcium bound- P (mg kg^{-1})***			
	30 DAS	***60 DAS***	***90 DAS***	***Harvest***	***30 DAS***	***60 DAS***	***90 DAS***	***Harvest***
$T_{1:}$ Recommended NK	9.21 (1.74)	8.67 (1.70)	7.18 (1.46)	6.93 (1.41)	8.29 (1.57)	7.85 (1.54)	6.79 (1.38)	6.12 (1.25)
$T_{2:}$ T_1 + PSB	8.71 (1.69)	7.54 (1.49)	6.26 (1.33)	5.83 (1.22)	10.38 (2.01)	9.44 (1.87)	8.81 (1.87)	8.79 (1.84)
$T_{3:}$ T_1 + 25 kg P_2O_5 ha^{-1} as DAP	11.81 (2.13)	12.81 (2.28)	13.91 (2.48)	15.00 (2.57)	10.34 (1.87)	12.58 (2.24)	14.79 (2.64)	16.99 (2.91)
$T_{4:}$ T_3 + PSB seed treatment	10.86 (1.99)	11.13 (2.03)	12.44 (2.27)	13.84 (2.45)	13.19 (2.42)	14.84 (2.71)	16.96 (3.10)	18.95 (3.36)
$T_{5:}$ T_1 + 37.5 kg P_2O_5 ha^{-1} as DAP	14.77 (2.54)	15.69 (2.66)	16.73 (2.83)	18.74 (3.04)	15.26 (2.62)	16.51 (2.80)	18.84 (3.19)	20.91 (3.39)
$T_{6:}$ T_5 + PSB seed treatment	13.34 (2.32)	14.18 (2.43)	15.76 (2.70)	17.22 (2.90)	17.39 (3.62)	19.36 (3.32)	21.67 (3.72)	22.94 (3.86)
$T_{7:}$ T_1 + 50 kg P_2O_5 ha^{-1} as DAP	17.57 (2.91)	18.82 (3.02)	19.87 (3.16)	20.96 (3.18)	18.96 (3.14)	20.93 (3.36)	22.16 (3.52)	23.93 (3.63)
$T_{8:}$ T_7 + PSB seed treatment	16.40 (2.77)	17.20 (2.82)	18.59 (3.04)	19.11 (2.98)	19.98 (3.17)	22.01 (3.61)	22.92 (3.75)	24.88 (3.88)
S. Em ±	0.46	0.44	0.51	0.48	0.43	0.54	0.61	0.63
C.D at 5%	1.39	1.33	1.56	1.45	1.30	1.64	1.86	1.90

* DAS = Days after sowing
* Figures in the parenthesis indicate the per cent contribution to the total P pool

Table.4 Effect of P levels with or without PSB seed treatment on organic P and total P fractions in soil at different growth stages of groundnut

Treatments	***Organic – P (mg kg^{-1})***				***Total – P (mg kg^{-1})***			
	30 DAS	***60 DAS***	***90 DAS***	***Harvest***	***30 DAS***	***60 DAS***	***90 DAS***	***Harvest***
$T_{1:}$ Recommended NK	306.06 (57.91)	291.24 (57.19)	276.98 (56.24)	279.10 (56.86)	528.54	509.21	492.54	490.88
$T_{2:}$ T_1 + PSB	303.71 (58.89)	287.67 (56.95)	276.53 (58.62)	301.34 (62.99)	515.76	505.10	471.76	478.43
$T_{3:}$ T_1 + 25 kg P_2O_5 ha^{-1} as DAP	308.42 (55.68)	293.29 (52.28)	278.61 (49.67)	286.85 (49.09)	553.95	560.95	560.95	584.28
$T_{4:}$ T_3 + PSB seed treatment	306.25 (56.11)	291.57 (53.29)	274.14 (50.11)	273.16 (48.45)	545.79	547.13	547.13	563.79
$T_{5:}$ T_1 + 37.5 kg P_2O_5 ha^{-1} as DAP	310.49 (53.29)	297.98 (50.48)	279.68 (47.38)	290.72 (47.12)	582.60	590.27	590.27	616.94
$T_{6:}$ T_5 + PSB seed treatment	309.77 (53.77)	294.68 (50.57)	276.03 (47.37)	277.98 (46.74)	576.05	582.72	582.72	594.72
$T_{7:}$ T_1 + 50 kg P_2O_5 ha^{-1} as DAP	314.18 (52.00)	298.32 (47.89)	285.66 (45.37)	292.93 (44.41)	604.24	622.91	629.58	659.58
$T_{8:}$ T_7 + PSB seed treatment	310.14 (52.34)	299.69 (49.14)	278.37 (45.52)	283.66 (44.22)	592.53	609.87	611.53	641.53
S. Em ±	1.96	2.27	1.99	3.26	15.64	14.69	20.65	20.44
C.D at 5%	5.93	6.88	6.04	9.89	47.43	44.57	62.65	62.01

* DAS = Days after sowing
* Figures in the parenthesis indicate the per cent contribution to the total P pool

The results on changes in organic - P fraction in soil at different growth stages of groundnut (Table 4) reveal that increased P levels with and without PSB seed treatment increased the organic - P fractions in soil at different growth stages of crop growth. Higher values of organic - P fractions were recorded in treatments involving application of only P levels compared to application of P levels with PSB seed treatment. The values of organic - P decreased up to 90 DAS and again increased at harvest of the crop in all treatments. This may be due to mineralization by micro-organism and crop uptake. It increases at harvest due to stimulated plant growth and accumulation of organic material in soil contributes to higher organic P in soil (Park *et al.,* 2004)

Application of 50 kg P_2O_5 ha^{-1} as DAP (T_7) recorded higher organic P (314.18, 298.32, 285.66 and 292.93 mg kg^{-1}, at 30, 60, 90 DAS and at harvest, respectively) compared to other treatments. Only PSB seed treatment in T_2 treatment recorded lowest organic - P value. An increase in organic P in the soil was observed with application of P fertilizers (Ranjit, 2005). This is due to excess P may be inhibited phosphorylase activity and consequently suppressed the mineralization processes and favored a buildup organic P. Soil microorganisms also play an important role in organic P transformations in soil through excretion of enzymes like phosphatase and dehydrogenase. Phosphatase catalyses the hydrolysis of esters and anhydrides of phosphoric acid and thus its activity indicates the mineralization potential of organic P in soils (Dick and Tabatabai, 1993).

The results on changes in total - P fraction in soil at different growth stages of groundnut (Table 4) reveal that increase in levels of P with and without PSB seed treatment significantly increased the total - P fractions in soil at different growth stages of crop growth. Higher values of total - P fractions were recorded in treatments involving application of only P levels compared to application of P levels with PSB seed treatment. Application of 50 kg P_2O_5 ha^{-1} as DAP (T_7) recorded higher total - P (604.24, 622.91, 629.58 and 659.58 mg kg^{-1}, at 30, 60, 90 DAS and at harvest, respectively) compared to other treatments. Lowest value of total - P fraction in soil at 90 DAS was recorded in T_2 treatment with only PSB seed treatment. The total - P in all the treatments increased with crop growth except in no P applied with or without PSB. There was significant increase in total – P in the soil with application of P fertilizers. These results corroborates with the findings of Sheela (2006) and Ranjit (2005).

The present study indicated that application of different levels of P with and without PSB seed treatment significantly increased the values of saloid – P, Ca – P fractions status in soil at different crop growth stages. Higher values of saloid – P and Ca – P fractions in soil were recorded in treatments involving P levels with PSB seed treatment compared to application of only P levels. Treatment T_8 (50 kg P_2O_5 ha^{-1} as DAP with PSB seed treatment) recorded significantly higher saloid – P and Ca – P fraction in soil followed by treatment T_7 (50 kg P_2O_5 ha^{-1} as DAP) and T_6 (37.5 kg P_2O_5 ha^{-1} as DAP with PSB seed treatment) compared to other treatments in all stages of groundnut.

Lowest values of saloid – P and Ca – P fractions in soil were recorded in no P applied T_1 treatment. Significant increases in Al - P, Fe – P, red – P, occl – P, organic – P and total - P fractions in soil at different growth stages of crop growth due to P levels with and without PSB seed treatment. Higher values of Al - P, Fe – P, red – P, occl – P, organic – P and total - P fractions were recorded in treatments involving P levels without PSB seed treatment compared to application of P levels with PSB seed treatment. Treatment, T_7 (50 kg P_2O_5 ha^{-1} as DAP) recorded higher Al-P, Fe - P red – P, occl – P, organic – P and total - P values followed by Application of 50 kg P_2O_5 ha^{-1} as DAP with PSB seed treatment (T_8) compared to other treatments. Lowest values of Al - P, Fe – P, red – P, occl – P, organic – P and total - P were recorded in only PSB seed treated T_2 treatment.

References

Chang, S.C., and Jackson, M.L., 1957. Fractionation of soil phosphorus. *Soil Sci. Soc. Am. J.*, 84: 133-144.

Chilean Ultisol. *Soil Use Manage*, 27: 221-228.

Dick, W.A., and Tabatabai, M.A., 1993. Significance and potential uses of soil enzymes. In: Metting FB (Ed.). Soil Microbial Ecology: Appl. Agric. Environ. Manage. Marcel Dekker, New York, pp. 95-127.

Goroji, P.T., 2000. Transformation of phosphorus in a Vertisol in sunflower - jowar cropping sequence. *Ph. D. Thesis*, Univ. of Agric. Sci., Dharwad.

Jackson, M.L., 1967. *Soil Chemical Analysis*. Prentice Hall Pvt. Ltd., New Delhi.

Kang, S.C., Hat, C.G., Lee, T.G. and Maheshwari, D.K., 2002. Solubilization of insoluble inorganic phosphates by a soil-inhabiting fungus *Fomitopsis sp.* PS 102. *Curr. Sci*., 82: 439 - 442.

Mathan, C.K., and Joseph, B., 1998. Influence of different fertilizer sources on phosphorus dynamics. *J. Indian Soc. Soil Sci.,* 46(4): 686 - 688.

Park, M., Singvilay, O., Shin, W., Kim, E., Chung, J. and Tongmin SA, 2004. Effects of long-term compost and fertilizer application on soil phosphorus status under paddy cropping system. *Comm. Soil Sci. Pl. Anal.,* 35(11-12): 1635-1644.

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

Ranjit, R., 2005. Response of groundnut genotypes to lime and phosphorus levels in coastal alluvial soil of north Karnataka. *M. Sc. Thesis* submitted to the Univ. Agric. Sci., Dharwad.

Rao, S., 1972. Fractionation of residual P compounds in black and red soils. *J. Indian Soc. Soil Sci.,* 20:323-326.

Redel, Y.D., Escudey, M., Alvear, M., Conrad, J. and Borie, F., 2011. Effects of tillage and crop rotation on chemical phosphorus forms and some related biological activities in a

Sheela, B.S., 2006. Dynamics of phosphorus in acid soils of North Karnataka. *M. Sc. (Agri.) Thesis*, Univ. Agric. Sci., Dharwad.

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.

Singaram, P., and Kothandaraman, G.V., 1992. Residual effect of different P fertilizers on available P of soil in the cropping sequence. *J. Indian Soc. Soil Sci.,* 40: 213-215.

Singaram, P., and Kothandaraman, G.V., 1993. Effect of P sources on phosphorus uptake by finger millet and changes in inorganic P fractions. *J. Indian Soc. Soil Sci.,* 41(3): 588 - 590.

Singh, S., and Singh, S.B., 1976. Effect of water logging and organic matter in inorganic P fractions of soils. *J. Indian Soc. Soil Sci.,* 24 (1): 88-90.

Yuan, T.L., Robertson, W.K. and Neller, J.R., 1960. Form of newly fixed phosphorus in three acid soils. *Soil Sci. Soc. Am. Proc.,* 24: 447 - 450.

How to cite this article:

Anjali, M.C. and Dhananjaya, B.C. 2017. Influence of Different Levels of Phosphorus and PSB Seed Treatment on P Fraction in Soil at Different Growth Stages of Groundnut (*Arachis hypogaea* L.). *Int.J.Curr.Microbiol.App.Sci.* 6(10): 216-224.
doi: https://doi.org/10.20546/ijcmas.2017.610.027