

Volume 3 | Issue 1 | June, 2012 | 39-44



Research Article

Status and distribution of phosphorus fractions in red and lateritic soil profile of different agroclimatic zones of Karnataka

K.S. NIRANJANA, GANAPATHI, H.M. CHIDANANDAPPA, CHANDRUPATIL AND M.S. BHADRINATH

Abstract : The vertical distribution and speciation of phosphorus was studied in nine red and lateritic soil profiles of different agro climatic zones of Karnataka. The relative abundance of different fractions was in the order of Fe-P (131.64 ppm) > A1 – P (98.00 ppm) > Red-P (93.01 ppm>Ca-P(79.66 ppm) >Occl-P(51.84 ppm) >saloid-P (23.18 ppm). Organic P constituted 47.09 per cent of the total P. On an average, total P content varied from 353.28 ppm to 1522.28ppm. Soil CEC, iron oxide, pH, silt and clay content play an important role in distribution of phosphorus fractions in soil.

Key Words : Phosphorus fractions, Vertical distribution, Soil physic-chemical properties, Red and lateritic soils

How to cite this Article : Niranjana, K.S., Ganapathi, Chidanandappa, H.M., Chandrupatil and Bhadrinath, M.S. (2012). Status and distribution of phosphorus fractions in red and lateritic soil profile of different agroclimatic zones of Karnataka, *Internat. J. Forestry & Crop Improv.*, **3** (1) : 39-44.

Article Chronical : Received : 27.04.2012; Revised : 18.06.2012; Accepted : 21.06.2012

INTRODUCTION

Phosphorus (P) is the second major nutrient required by all the crops. The knowledge of P status and various fractions of soil phosphorus and their distribution play a significant role in soil fertility and productivity (Jayasree Sankar, 1991). The different forms of P vary greatly in solubility and availability to the plants. Since the soil solid phase phosphates control the phosphate concentration in soil solution and also reflect the reserve supply of nutrient, knowledge concerning the forms and amounts of P is important. Many scientists have tried to

- MEMBERS OF RESEARCH FORUM -

Author of the Correspondence :

GANPATHI, Organic Farm Research Center, Zonal Agricultural Research Center, Navile, SHIMOGA (KARNATAKA) INDIA Email : ganapathiguddekoppa@yahoomail.com

Address of the Coopted Authors :

K.S. NIRANJANA, CHANDRUPATIL AND M.S. BHADRINATH, Deparment of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, G.K.V.K., BENGALURU (KARNATAKA) INDIA

H.M. CHIDANANDAPPA, Deparment of Soil Science and Agricultural Chemistry, University of Agricultural Sciences, Navile, SHIMOGA (KARNATAKA) INDIA study the distribution of P in the soil, but the profile studies on the distribution of P with depth have been made only in few cases. Such studies would enable in refining the genetic characteristics of soils. Karnataka experiences a varied agroclimatic and diverse type of soil. Hence, the present study was under taken to study the distribution of different forms of P in red and lateritic soil profiles of different agro-climatic zones of Karnataka.

EXPERIMENTAL METHODS

Soil profiles samples, horizon wise were collected from North Eastern Transition Zone – Bidar (Rhodic Paleustalfs), Central dry zone – Arasikere (Rhodic Paleustalfs), Eastern Dry zone – Bangalore (Kandic Paleustalfs), Southren Dry zone – Mandya (Typic Rhodoustalfs), Southern Transition zone – Shimoga (Ultic Haplustalfs), Hilly zone – Chethalli (Ustic Palehumults), Mudigere (Paleustults), Sakaleshpur (Ultic Paleustalfs) and Coastal zone – Brahmavar (Typic Kandiustults). The collected soil samples were processed and analyzed for various physic-chemical properties by standard methods (Piper, 1950; Jackson, 1973). Total P was digested using diacid mixture of HNO_3 , and HC104 and estimated by Vanadomolybdo phosphoric yellow colour method (Hesse, 1971). Organic P was determined as suggested by Mehta *et al*, (1954). The method outlined by Peterson and Corey (1968) was followed to fractionate soil inorganic phosphorus.

EXPERIMENTAL RESULTS AND ANALYSIS

The data on physico-chemical properties and different fractions of phosphorus of different soil profiles are given in Table 1 and Table 2, respectively. The various fractions of P are discussed below.

Saloid P:

The data (Table 2) indicated that saloid P content generally decreased with depth. Its content varied from 10.73 to 32.42 ppm with an overall average of 23.18 ppm. It was the least dominant fraction in all the soil profiles. The higher content of saloid P at the surface layers might be due to the mixing of P from fertilizers and manures and high content of organic carbon, in the surface soil. Similar trend was also reported by Kothandaraman and Krishnamoorthy (1977).

A1-P:

A1-P content ranged from 20.17 to 161.34 ppm with an overall mean of 98.00 ppm. It was the second dominant fraction which can be related to the high A1 oxide content of the soils. It was the dominant fraction in Chethalli and Sakaleshpur soils. The distribution of A1-P did not follow any definite pattern with depth. Its distribution might be related to its relation with sesqui oxides, pH and CEC of the soils. The Fe and A1 containing soil minerals including clay minerals are the sources of A1 and Fe when soluble phosphates are added to soil. The sesqui oxides present in free or hydrated state are the main causes to fix water soluble P as A1-P (Kanwar and Grewal, 1990).

Fe-P:

Fe-P was the dominant fraction (Fig.1) with its content varying from 18.09 to 345.59 ppm, on an average its content was 131.64 ppm and constituted 14.51 per cent of total P (Fig.2). a very high temperature and rainfall resulted in accelerated weathering accompanied by higher amount of sesqui oxides might have contributed to the formation of appreciable amounts of Fe-P and A1-P (Kanwar *et al.*, 1983). The high content of Fe-P at the surface layers indicate that the mineral weathering and soil development are intensive in the upper part of the solum.

Ca-P:

This fraction of P varied widely in the soils, ranging from 29.51 to 188.54 ppm with a mean value of 79.66 ppm. This fraction constituted 8.78 per cent of total P. The amount of Ca-P was





relatively high in lower horizons of Bidar, Arasikere and Mandya where the pH of the soil increased with increase in depth. It might be due to the finer fractions of the soil with high CEC and exchangeable cations that would favor the information of Ca-P (Khanna and Datta, 1968). Though most of the soil profiles were acidic, a major portion of inorganic P was found to be Ca-P which was extracted by 0.5 N H2SO4. It might be due to high organic carbon content of soil profiles where acid labile fractions of organic P such as ribose-3-phosphate, adenosine-3phosphate, guanosine-3-phosphate and inositol phosphate were hydrolysed by acid and were estimated with Ca-P.

Reduced-P:

This fraction of ranged from 42.15 to 190.18 ppm and constituted 10.25 per cent of total P. This fraction is relatively high in lateritic soils than red soils. The high amount of Red-P in red and lateritic soils might be due to tropical climate with high temperature and high rainfall resulting in accelerated weathering and high amount of sesqui oxides present in these soils (Kanwar *et al.*, 1983).

DISTRIBUTION OF PHOSPHOROUS FRACTIONS IN RED & LATERITIC SOIL PROFILE OF DIFFERENT AGROCLIMATIC ZONES OF KARNATAKA

$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Table 1 : Physico-chemical properties of the soil profiles of different agro-climatic zones of Karnataka												
$ \begin{array}{ c c c c c c } \hline Horizon (cm) & und & und & (1) &$		·	Depth	Coarse	Fine	Silt	Clay	pН	EC	OC (%)	CEC Cmol	Fe ₂ O ₃	Al ₂ O ₃
Data (Rhodic Paleustalis) [North eastern transitions period Data (Rhodic Paleustalis) [North eastern transitions period North eastern transitions period North eastern transitions period Bidar (Rhodic Paleustalis) [Control days and period 0.10 7.20 27.00 8.07 0.14 0.65 10.22 10.43 7.90 Bit 35.30 59.50 11.50 37.0 25.50 8.00 0.15 0.42 12.24 10.73 6.94 Bit 30.57 53.20 12.60 9.20 25.00 8.08 0.14 0.40 12.50 12.01 6.32 Bit 15.40 44.84 31.16 31.44 20.86 7.65 0.11 0.01 0.43 3.82 3.85 Bit 13.40 51.85 7.45 18.05 7.61 0.08 0.06 14.37 2.70 2.97 Banglaber (Kondic Paleustalis) [Cleatern dry zone] - - - - - - - - - - - - - -	Location	Horizon	(cm)	sand	sand)		(1:25)	(dSm^{-1})		(p+) kg-1	(0	7_)
Balar Control event series Control event series <thcontro event="" series<="" th=""> <thcontrol event="" series<="" th=""></thcontrol></thcontro>													
A 0-10 0	Diuai (Kiiu		0 15	55 70		7.20	27.00	8.07	0.14	0.65	10.22	10.43	7.00
Bri 13-50 53-20 13-30 2.1.50 8.0.0 6.0.0 6.0.4 6.2.4 12.44 10.20 6.3.2 Bri 57.140 53.20 10.00 8.70 42.90 9.75 0.18 0.20 2.046 7.64 6.32 Arasikere (Rhodic Paleusu-I): [Certur Urv urv Urv Verv Verv Verv Verv Verv Bri 15-40 8.44 3.16 7.45 18.05 7.71 0.11 0.35 10.38 3.82 3.85 Bri 15-216 40.57 30.40 2.25 2.76 8.71 0.11 0.43 0.26 4.50 Bri 12-216 13.8 3.82 4.33 4.50 8.23 4.50 8.51 0.61 0.04 0.44 0.43 2.02 2.046 12.30 12.30 Bri 11-35 3.72 2.78 5.31 0.04 0.46 12.25 6.40 12.00 Bri 6.7140		Dt	15 20	50.50	11.20	2 70	27.00	8.07	0.14	0.05	12.54	10.45	6.04
Bit 57-40 3.2.0 1.2.00 8.2.0 2.3.00 8.3.8 0.1.4 0.4.0 0.2.0 1.2.01 0.2.01 6.0.2 Arasikere (Rhodic Palesustation Variance (Rhodic Palesustation Variance Variance (Rhodic Palesustation Variance Varia Variance Varia Variance Varia Varia Variance Variance Varia Vari			15-50	59.50	12.00	5.70	25.50	8.00	0.13	0.42	12.34	10.75	0.94
Bis 57-140 57-140 6.20 4.20 9.75 0.16 0.20 0.20 0.40 0.40 0.40 0.40 Araiskere (Rhodi: Patessut-II) Centruit dry zong App 0.15 57.65 1.8.05 7.71 0.11 0.35 10.38 3.82 3.85 Bit 15-40 44.84 31.16 3.14 2.08 7.65 0.11 0.20 0.93 2.66 4.01 Bit 15-40 44.84 31.16 3.14 2.08 8.16 0.08 0.09 8.24 2.57 3.10 Bit 15-60 15.8 30.85 2.48 15.09 8.16 0.08 0.09 8.24 2.57 3.10 Bit 11-35 37.22 29.78 3.26 29.74 5.31 0.08 0.46 10.22 5.49 6.67 Bit 11-35 37.22 29.78 5.170 6.21 0.04 0.32 2.046 11.44 9.33 <t< td=""><td></td><td></td><td>50-57</td><td>55.20 29.20</td><td>12.60</td><td>9.20</td><td>25.00</td><td>8.08</td><td>0.14</td><td>0.40</td><td>12.50</td><td>12.01</td><td>6.32</td></t<>			50-57	55.20 29.20	12.60	9.20	25.00	8.08	0.14	0.40	12.50	12.01	6.32
Araskee (Rhole Palewills) [central view view Ap 0.15 57.65 16.85 7.71 0.11 0.20 9.93 2.66 4.01 Bt 15.40 44.84 31.16 3.14 20.86 7.65 0.11 0.10 10.48 2.50 4.50 Bt 12-16 18.9 28.95 18.31 15.0 8.44 0.33 0.66 14.37 2.70 2.97 Bargalore (Kandic Palewills) [Exsterm view view <td< td=""><td colspan="11">$Bt_3 \qquad 57{\text{-}}140 \qquad 38.30 \qquad 10.00 \qquad 8.70 \qquad 42.90 \qquad 9.75 \qquad 0.18 \qquad 0.20 \qquad 20.46$</td><td>/.64</td><td>6.02</td></td<>	$Bt_3 \qquad 57{\text{-}}140 \qquad 38.30 \qquad 10.00 \qquad 8.70 \qquad 42.90 \qquad 9.75 \qquad 0.18 \qquad 0.20 \qquad 20.46$											/.64	6.02
Ap 0-15 0-168 7.45 18.08 7.71 0.11 0.20 9.03 2.66 4.01 B1: 172-12 40.57 30.43 7.25 21.76 8.02 0.11 0.14 10.48 2.50 4.50 B1: 172-126 51.58 30.85 2.48 15.09 8.16 0.08 0.09 8.24 2.57 3.10 B1: 172-126 51.58 38.52 4.93 22.10 5.41 0.08 0.64 10.22 5.49 6.67 B1: 13-55 37.70 8.52 4.93 52.10 0.41 0.64 12.24 6.64 10.23 B1: 13-35 37.22 29.78 3.64 0.52 0.04 0.32 20.46 11.44 9.83 B1: 13-38 45.85 13.00 9.85 51.70 6.21 0.04 0.32 20.46 11.44 9.83 Mardya (Typic Rhodowsti/s) [Swetter tracked sits 3.01	Arasikere (Rhodic Pale	ustalfs) [Centr	al dry zone]		10.05	1	0.11	0.25	10.00		2.05
Bi 15-40 4.84 3.10 3.14 20.80 7.65 0.11 0.20 9.93 2.60 4.01 Bi 40.72 40.57 30.43 7.25 2.76 8.02 0.11 0.44 0.48 2.50 3.10 Bi 126-100 18.29 28.95 18.23 34.56 8.40 0.33 0.06 1.43 2.70 2.97 Bangalore (Kande Paleusutis) [Easurer 72-126 23.95 23.82 4.93 2.10 5.41 0.08 0.64 10.22 5.49 6.67 Bi 11-35 37.22 29.78 3.26 29.74 5.31 0.04 0.46 12.34 6.64 10.02 Bi 11-35 37.22 29.78 3.26 5.67 0.09 0.44 1.33 7.13 3.87 Madya (Typic Rhod-ustifs) [Souter Visit Visit 2.54 2.65 7.01 0.13 0.26 1.72 2.74 4.37		Ap	0-15	57.65	16.85	7.45	18.05	7.71	0.11	0.35	10.38	3.82	3.85
Bis 40-72 40.77 30.43 7.25 21.76 8.02 0.11 0.14 10.48 2.20 4.30 Bit< 17.22 51.58 0.80 28.48 15.09 8.16 0.08 0.09 8.24 2.27 3.10 Bangalore (Kandic Paleusatts) Usatts ty zows vizatts vizatts <thvizatts< th=""> viz</thvizatts<>		Bt_1	15-40	44.84	31.16	3.14	20.86	7.65	0.11	0.20	9.93	2.66	4.01
Bit 72-12b 51.88 30.88 2.48 1.50 8.16 0.08 0.09 8.24 2.70 2.70 Bargalore (Kandic Paleusztis) (Eastern try town): Usern		Bt ₂	40-72	40.57	30.43	7.25	21.76	8.02	0.11	0.14	10.48	2.50	4.50
B4 12-6100 18.29 28.29 18.23 9.8.46 0.8.84 0.0.33 0.00 14.37 2.7.0 2.97 Bangalore (Kandic Paleustris) (Esuttrus veg vous <		Bt_3	72-126	51.58	30.85	2.48	15.09	8.16	0.08	0.09	8.24	2.57	3.10
Bangalore (Kandie PaleustalF) (Eastern dry zowali Ap 0-11 34.45 38.52 4.93 22.0 5.31 0.08 0.64 12.24 6.64 Bit 11-35 37.22 29.78 3.26 29.74 5.31 0.04 0.46 12.54 6.64 10.20 Bit 67.10 24.65 13.80 9.85 31.70 6.52 0.08 0.35 12.50 12.30 12.33 Madya (Typic Rhodoustaris) Votata 3.71 3.81 6.72 0.77 0.72 10.42 3.76 2.74 Ap 0-9 41.34 3.11 4.62 29.93 6.72 0.17 0.72 10.42 3.76 2.74 Ap 0-9 41.34 3.11 6.72 2.74 0.12 2.74 3.73 3.87 Bwn 13.45 45.85 14.6 7.23 2.875 7.40 0.89 0.20 12.23 1.33 3.1 Bwn		Bt_4	126-160	18.29	28.95	18.23	34.56	8.84	0.33	0.06	14.37	2.70	2.97
Ap0-1134.4538.524.9322.105.410.080.6410.225.496.67Bt,11-3537.2229.783.2629.745.310.040.4612.546.6410.00Bt,67-72.353.709.853.405.620.080.3512.5012.3012.33Bt,67-14024.6513.809.8551.706.210.040.3220.4611.449.83Mandya (TypicRhodoustall's[Southern transitority transition tran	Bangalore	(Kandic Pale	ustalfs) [Eastr	ern dry zo	ne]								
Bit 11-35 37.22 29.78 3.26 29.74 5.31 0.04 0.46 12.54 6.64 10.00 Bit 36-70 23.95 31.70 9.85 31.50 5.62 0.08 0.35 12.50 12.30 12.33 Mandya (Typic Rhodoustalls) Souta variable variable variable variable variable variable variable variable 0.32 20.46 11.44 9.83 Mandya (Typic Rhodoustalls) Isouta 45.86 25.43 5.08 27.67 6.75 0.09 0.84 12.66 2.59 2.91 Bwa 13.46 45.55 19.46 7.25 2.8.7 7.40 0.89 0.20 19.20 5.48 4.02 Shimoga (Ultic haplustalls) Isoutherr variable variable variable variable variable variable ja.84 4.02 Shimoga (Ultic haplustalls) Isoutherr 15.50 16.71 5.30		Ap	0-11	34.45	38.52	4.93	22.10	5.41	0.08	0.64	10.22	5.49	6.67
Bic 35.67 23.95 31.70 9.85 54.50 6.62 0.08 0.35 12.50 12.30 12.33 Mandya (Typic Rhod=ustalls) Q2.65 13.80 9.85 51.70 6.21 0.08 0.32 20.46 11.44 9.83 Mandya (Typic Rhod=ustalls) Q-9 41.34 30.11 4.62 29.93 6.72 0.17 0.72 10.42 3.76 2.74 A1 9.13 45.86 25.43 5.08 23.63 6.57 0.09 0.84 12.66 2.59 2.91 Bw1 13.68 45.55 19.46 7.32 27.67 6.75 0.24 0.32 14.33 7.13 3.87 Bw2 69.97 41.15 31.26 2.54 25.05 7.40 0.20 12.23 1.92 3.58 A1 7.24 60.62 15.55 5.86 17.97 5.88 0.06 0.20 12.23 1.92 3.58		Bt_1	11-35	37.22	29.78	3.26	29.74	5.31	0.04	0.46	12.54	6.64	10.00
Bf3 67-140 24.65 13.80 9.85 51.70 6.21 0.04 0.32 20.46 11.44 9.83 Mandya (Typic Rhoeus=tris) [Soutterne try zeroterne vierone vierone <t< td=""><td></td><td>Bt_2</td><td>35-67</td><td>23.95</td><td>31.70</td><td>9.85</td><td>34.50</td><td>5.62</td><td>0.08</td><td>0.35</td><td>12.50</td><td>12.30</td><td>12.33</td></t<>		Bt_2	35-67	23.95	31.70	9.85	34.50	5.62	0.08	0.35	12.50	12.30	12.33
Mandya (Typic Rbodous Rot 9 41.34 30.11 4.62 29.93 6.72 0.17 0.72 10.42 3.76 2.74 A2 9-13 45.86 25.33 5.08 23.63 6.57 0.09 0.84 12.66 2.59 2.51 Bw1 13.68 45.55 19.46 7.32 27.67 6.75 0.24 0.32 17.33 3.87 Bw2 69.97 41.15 31.26 2.54 25.05 7.40 0.89 0.20 19.20 5.48 4.02 Bw3 97.140 48.52 15.48 7.25 28.75 7.40 0.89 0.20 19.20 5.48 4.02 Shimoga (Ultic haplustation for haming the structure transcore		\mathbf{Bt}_3	67-140	24.65	13.80	9.85	51.70	6.21	0.04	0.32	20.46	11.44	9.83
Ap0-941.3430.114.6229.936.720.170.7210.423.762.74A29-1345.8625.435.0823.636.570.090.8412.662.592.91Bw113-6845.5519.467.3227.676.750.240.3214.337.133.87Bw269-9741.1531.262.542.5057.010.130.2617.263.414.09Shimoga (Ultic haplust=//submetric trustic tru	Mandya (T	ypic Rhodo	ustalfs) [South	nern dry zo	ne]								
A_2 9-1345.8625.435.0823.636.570.090.8412.662.592.91 Bw_1 13-6845.5519.467.3227.676.750.240.3214.337.133.87 Bw_2 69-9741.1531.2625.057.010.130.2617.263.414.09 Bw_3 97.14048.5215.487.2528.757.010.130.2617.263.414.09Shimoga (Ultic haplus=I): Souther transition contrastVirtual Action and transition contrast0.0712.231.923.58 A_2 17.2460.1222.962.5514.776.320.050.177.660.641.86 A_3 24.4055.7818.168.1217.945.050.120.179.240.962.54 Ac_1 40-9066.261.515.5016.735.430.110.1411.520.573.93 Ac_2 90-14057.803.003.709.106.340.053.2012.2713.5515.00 E 10-3732.2310.758.1238.906.640.092.0019.0414.4210.50 E 10-3732.2310.758.1238.906.640.092.0019.0414.4210.50 E 10-3732.2310.758.1238.906.640.092.0019.0414.4210.50		Ap	0-9	41.34	30.11	4.62	29.93	6.72	0.17	0.72	10.42	3.76	2.74
Bw113-6845.5519.467.3227.676.750.240.3214.337.133.87Bw269-9741.1531.262.5425.057.010.130.2617.263.414.09Bw397-14048.5215.487.2528.757.400.890.2019.205.484.02Shimoga (Ulic haplustalis) [Southerree restrictor construction of the planes][Southerree restrictor construction of the planes]1.525.8617.975.880.600.2012.231.923.58A217-7460.122.962.5514.776.320.050.177.660.641.86A324-4055.7818.168.1217.945.050.120.179.240.962.54Ac140-9066.2611.515.5016.735.430.110.1411.520.573.93Ac290-14054.3318.157.5419.786.560.120.098.090.612.89Chettalli (Ultic Pateherree)VilliVilliVilli3.2318.157.5419.786.560.120.098.090.612.89Chettalli (Ultic Pateherree)VilliVilliVilli3.2318.157.5419.786.560.120.0919.0414.42D00503.003.003.008.700.533.0212.5713.551		A_2	9-13	45.86	25.43	5.08	23.63	6.57	0.09	0.84	12.66	2.59	2.91
Bw269-9741.1531.262.5425.057.010.130.2617.263.414.09Bw397-14048.5215.487.2528.757.400.890.2019.205.484.02Shimoga (Ultic haplustal/5)JSoutherri interviewvertail </td <td></td> <td>$\mathbf{B}\mathbf{w}_1$</td> <td>13-68</td> <td>45.55</td> <td>19.46</td> <td>7.32</td> <td>27.67</td> <td>6.75</td> <td>0.24</td> <td>0.32</td> <td>14.33</td> <td>7.13</td> <td>3.87</td>		$\mathbf{B}\mathbf{w}_1$	13-68	45.55	19.46	7.32	27.67	6.75	0.24	0.32	14.33	7.13	3.87
Bw3 97-140 48.52 15.48 7.25 28.75 7.40 0.89 0.20 19.20 5.48 4.02 Shimoga (Ultic haplustation transmistor transmistor) Variability 60.17 60.92 15.25 5.86 17.97 5.88 0.06 0.20 12.23 1.92 3.58 A2 17-24 60.12 22.96 2.55 14.77 6.32 0.05 0.17 7.66 0.64 1.86 A2 24.40 55.78 18.16 8.12 17.94 5.05 0.12 0.17 9.24 0.96 2.57 3.93 Ac2 90-140 54.33 18.15 7.54 19.78 6.31 0.11 0.14 11.52 0.57 3.93 Ac2 90-140 57.80 30.00 3.70 9.10 6.34 0.05 3.20 12.57 13.55 15.00 E 10-37 32.23 10.75 8.12 38.90 6.04 0.09 2.00 19		$\mathbf{B}\mathbf{w}_2$	69-97	41.15	31.26	2.54	25.05	7.01	0.13	0.26	17.26	3.41	4.09
Shimoga (Ultic haplustJ) South and the probability of the probabi		$\mathbf{B}\mathbf{w}_3$	97-140	48.52	15.48	7.25	28.75	7.40	0.89	0.20	19.20	5.48	4.02
Ap0-1760.9215.255.8617.975.880.060.2012.231.923.58A217-2460.1222.962.5514.776.320.050.177.660.641.86A324-4055.7818.168.1217.945.050.120.179.240.962.54Ac140-9066.2611.515.5016.735.430.110.1411.520.573.93Ac290-14054.3318.157.5419.786.560.120.098.090.612.89Chettalli (Ultic Palehumuts)//HIIJVVV8.003.709.106.340.053.2012.5713.5515.00E10-3732.2310.758.1238.906.040.092.0019.0414.4210.50E37.6232.2420.828.7538.795.820.011.2217.0213.7415.00E10-3732.2310.758.1236.044.600.092.0019.0414.4210.50E13.7421.2436.044.600.011.2217.0213.7415.00B62-14037.1513.7512.9436.044.600.011.2217.0213.7415.89Mudigere (Palehumuts)///Livauuuts//Livauuuts//Livauuuts//Livauuuts//Livauuuts//Livauuuts//Livauuuts//Livauuuts//Livauuuts//Livauuuts//Livauuuts//Livauuuts//Livauuuts//L	Shimoga (I	Ultic haplusta	alfs) [Southerr	n transition	zone]								
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		Ap	0-17	60.92	15.25	5.86	17.97	5.88	0.06	0.20	12.23	1.92	3.58
A_3 24-4055.7818.168.1217.945.050.120.179.240.962.54 Ac_1 40-9066.2611.515.5016.735.430.110.1411.520.573.93 Ac_2 90-14054.3318.157.5419.786.560.120.098.090.612.89Chettalli (Ultic Palehumuris) (Hilly zone: O 0.1057.8030.003.709.106.340.053.2012.5713.5515.00 E 10-3732.2310.758.1238.906.040.092.0019.0414.4210.50 EB 37-6232.2420.828.7538.795.820.011.2217.0213.7415.50 B 62-14037.1513.8712.9436.044.860.050.3724.1313.0416.00Mudigere (Palehumults)(Hilly zone)13.8712.9436.044.860.050.3724.1313.0416.00Mudigere (Palehumults)(Hilly zone)13.8712.9436.044.860.050.3724.1313.0416.00Mudigere (Palehumults)(Hilly zone)13.8712.9436.044.860.050.3724.1316.3418.90Mudigere (Palehumults)(Hilly zone)15.8716.970.040.7012.8317.9816.32 <td></td> <td>A_2</td> <td>17-24</td> <td>60.12</td> <td>22.96</td> <td>2.55</td> <td>14.77</td> <td>6.32</td> <td>0.05</td> <td>0.17</td> <td>7.66</td> <td>0.64</td> <td>1.86</td>		A_2	17-24	60.12	22.96	2.55	14.77	6.32	0.05	0.17	7.66	0.64	1.86
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		A_3	24-40	55.78	18.16	8.12	17.94	5.05	0.12	0.17	9.24	0.96	2.54
Ac290-14054.3318.157.5419.786.560.120.098.090.612.89Chettalli (Ultic Palehumuts) [Hilly zurot00-1057.8030.003.709.106.340.053.2012.5713.5515.00E10-3732.2310.758.1238.906.040.092.0019.0414.4210.50EB37-6232.2420.828.7538.795.820.011.2217.0213.7415.50B62-14037.1513.8712.9436.044.860.050.3724.1313.0416.00Mudigere (Palehumuts)[Hilly zone]Mudigere (Palehumuts)[Hilly zone]Ap0-2630.5339.7720.599.795.830.382.8017.1915.8916.32Ag0-2630.5339.7720.599.795.830.382.8017.1915.8916.32Bi134.9627.9345.1216.1510.805.200.040.7012.8317.9818.80Bi296-14833.8612.238.1045.814.910.040.4614.9116.5020.89Sakaleshpur(ultic Paleuts):[Hilly zone]Ap0.1537.7629.2714.1418.816.000.112.0613.7512.507.05Bi415.7045.1622.8613.1818.805.62 <t< td=""><td></td><td>Ac_1</td><td>40-90</td><td>66.26</td><td>11.51</td><td>5.50</td><td>16.73</td><td>5.43</td><td>0.11</td><td>0.14</td><td>11.52</td><td>0.57</td><td>3.93</td></t<>		Ac_1	40-90	66.26	11.51	5.50	16.73	5.43	0.11	0.14	11.52	0.57	3.93
Chettalli (Ultic Palehumuts) [Hilly zone] O 0-10 57.80 30.00 3.70 9.10 6.34 0.05 3.20 12.57 13.55 15.00 E 10-37 32.23 10.75 8.12 38.90 6.04 0.09 2.00 19.04 14.42 10.50 EB 37-62 32.24 20.82 8.75 38.79 5.82 0.01 1.22 17.02 13.74 15.50 B 62-140 37.15 13.87 12.94 36.04 4.86 0.05 0.37 24.13 13.04 16.00 Mudigere (Palehumuts)/Hilly zone] 9.79 5.83 0.38 2.80 17.19 15.89 16.32 Ap 0-26 30.53 39.77 20.59 9.79 5.83 0.38 2.80 17.19 15.89 16.32 Ap 0-26 30.53 39.07 20.59 9.79 5.83 0.38 2.80 17.19 15.89 16.32 Ap 0-26 37.56 35.00 24.86		Ac_2	90-140	54.33	18.15	7.54	19.78	6.56	0.12	0.09	8.09	0.61	2.89
O 0-10 57.80 30.00 3.70 9.10 6.34 0.05 3.20 12.57 13.55 15.00 E 10-37 32.23 10.75 8.12 38.90 6.04 0.09 2.00 19.04 14.42 10.50 EB 37-62 32.24 20.82 8.75 38.79 5.82 0.01 1.22 17.02 13.74 15.50 B 62-140 37.15 13.87 12.94 36.04 4.86 0.05 0.37 24.13 13.04 16.00 Mudigere (Palehumults)[Hilly zone] U U U U U U U U Ap 0-26 30.53 39.77 20.59 9.79 5.83 0.38 2.80 17.19 15.89 16.32 A2 26-34 27.56 35.00 24.86 12.46 6.15 0.08 0.93 15.76 16.34 18.04 B1 34-96 27.93 45.12 <td>Chettalli (</td> <td>Ultic Palehui</td> <td>nults) [Hilly z</td> <td>one]</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	Chettalli (Ultic Palehui	nults) [Hilly z	one]									
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		0	0-10	57.80	30.00	3.70	9.10	6.34	0.05	3.20	12.57	13.55	15.00
$\begin{array}{c c c c c c c c c c c c c c c c c c c $		Е	10-37	32.23	10.75	8.12	38.90	6.04	0.09	2.00	19.04	14.42	10.50
B 62-140 37.15 13.87 12.94 36.04 4.86 0.05 0.37 24.13 13.04 16.00 Mudigere (Palehumults)[Hilly zone]		EB	37-62	32.24	20.82	8.75	38.79	5.82	0.01	1.22	17.02	13.74	15.50
Mudigere (Palehumults)[Hilly zone] Ap 0-26 30.53 39.77 20.59 9.79 5.83 0.38 2.80 17.19 15.89 16.32 A2 26-34 27.56 35.00 24.86 12.46 6.15 0.08 0.93 15.76 16.34 18.04 Bt1 34-96 27.93 45.12 16.15 10.80 5.20 0.04 0.70 12.83 17.98 18.80 Bt2 96-148 33.86 12.23 8.10 45.81 4.91 0.04 0.46 14.91 16.50 20.89 Sakaleshpur(ultic Paleustalfs) [Hilly zone] Image: Paleustalfs P		В	62-140	37.15	13.87	12.94	36.04	4.86	0.05	0.37	24.13	13.04	16.00
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	Mudigere (Palehumults)[Hilly zone]										
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		An	0-26	30.53	39.77	20.59	9.79	5.83	0.38	2.80	17.19	15.89	16.32
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		A	26-34	27.56	35.00	24.86	12.46	6.15	0.08	0.93	15.76	16.34	18.04
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		Rt.	34-96	27.93	45.12	16.15	10.80	5.20	0.04	0.70	12.83	17.98	18.80
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		Bta	96-148	33.86	12 23	8 10	15.81	4 91	0.04	0.76	14.91	16.50	20.89
Ap 0-15 37.76 29.27 14.14 18.81 6.00 0.11 2.06 13.75 12.50 7.00 Bt1 15-70 45.16 22.86 13.18 18.80 5.62 0.01 0.96 11.83 14.25 7.25 Bt2 70-140 35.14 8.90 5.56 49.60 5.40 0.02 0.58 16.00 15.50 7.50 Brahmavar (typic Kandiusults) [Coastal zone] Image: Coastal zone] Image: Coa	Sakalashni	ur(ultia Dalau	otolfo) [Hilly a	JJ.00	12.23	0.10	45.01	4.91	0.04	0.40	14.91	10.50	20.07
Ap 0-13 37.70 22.27 14.14 10.61 0.00 0.11 2.00 13.73 12.50 7.00 Bt1 15-70 45.16 22.86 13.18 18.80 5.62 0.01 0.96 11.83 14.25 7.25 Bt2 70-140 35.14 8.90 5.56 49.60 5.40 0.02 0.58 16.00 15.50 7.50 Brahmavar (typic Kandiusults) [Coastal zone] Ap 0-13 25.67 22.79 12.76 38.78 5.27 0.06 1.77 18.52 15.53 16.27	Sakaiesiipt		0_15	37.76	20 27	14 14	18.91	6.00	0.11	2.06	13 75	12 50	7.00
$\begin{array}{cccccccccccccccccccccccccccccccccccc$		ъ.	15 70	JT.10	27.21	12.10	10.01	5.60	0.11	2.00	11.02	14.05	7.00
Brahmavar (typic Kandiustults) [Coastal zone] Ap 0-13 25.67 22.79 12.76 38.78 5.27 0.06 1.77 18.52 15.53 16.27		Dli Dt	13-70	43.10	22.00	13.18	10.00	5.40	0.01	0.90	11.00	14.23	1.23
Ap 0-13 25.67 22.79 12.76 38.78 5.27 0.06 1.77 18.52 15.53 16.27	Darbar	Bl_2	/0-140	33.14	8.90	5.56	49.60	5.40	0.02	0.58	10.00	15.50	7.50
AD U-LO ZOD/ ZZ/Y LZ/O OKAK OZ/ DUD L// LKOZ 1627	$\int \frac{1}{2} \int $											16.07	
$D_{t} = 12 140 = 27.52 = 14.09 = 12.22 = 25.17 = 6.24 = 0.06 = 0.59 = 12.02 = 12.05 = 10.27$		Ap	12 140	23.07	14.09	12.70	25.17	6.24	0.00	0.59	10.32	12.20	10.27

Internat. J. Forestry & Crop Improv.; 3(1) June, 2012: 39-44 HIND AGRICULTURAL RESEARCH AND TRAINING INSTITUTE

K.S. NIRANJANA, GANAPAT	HI, H.M. CHIDANANDAPPA	, CHANDRUPATIL AND M.S. BHADRINATI	ł

Table 2 : Distribution of forms of phosphorus in different soil profiles of agro climatic zones of Karnataka										
Location	Horizon	Depth	Saloid P	Al-P	Fe-P	Ca-P	Red-P	Occl-P	Total P	Organic P
Didai (Rii		0.15	26.60(1.79)	122 09/9 07)	245 50(22 14)	107 05(7 22)	104 97(7.02)	120 60(0 62)	1402 52	645 96(42 24)
	A	0-15	20.00(1.78)	133.96(6.97)	243.39(23.14)	107.95(7.25)	104.87(7.02)	(2.07(4.40))	1495.55	(20.77(42.07)
		15-50	20.00(1.83)	112.19(7.71)	320.47(22.44)	120.05(12.58)	105.09(7.27)	05.97(4.40)	1454.74	(20.1((42.54)
	Bt_2	30-57	18.50(1.28)	100.89(6.97)	297.06(20.52)	187.17(12.93)	126.8/(8.77)	86.76(5.99)	1447.41	630.16(43.54)
	Bt ₃	57-140	24.44(1.44)	126.63(7.48)	290.44(17.15)	188.54(11.13)	108.63(6.41)	136.03(8.03)	1693.43	818.72(48.35)
	Average		24.04(1.58)	118.42(7.78)	214.89(20.69)	150.93(9.92)	111.52(7.33)	103.87(6.82)	1522.28	683.63(44.91)
Arasikere	(Rhodic pa	leustalfs) [Central dry zo	ne]						
	Ap	0-15	32.42(6.69)	75.87(15.65)	188.24(38.82)	29.51(6.09)	51.77(10.68)	13.24(2.73)	484.91	93.86(19.36)
	Bt_1	15-40	28.33(8.76)	73.93(22.87)	22.79(7.05)	43.49(13.45)	56.01(17.33)	35.29(10.92)	323.28	63.44(19.62)
	Bt_2	40-72	25.37(7.94)	29.86(9.35)	89.71(28.09)	35.72(11.18)	69.45(21.74)	32.35(10.13)	319.40	38.35(12.01)
	Bt_3	72-126	21.17(5.61)	25.83(8.85)	27.21(7.21)	35.72(9.47)	68.04(18.04)	29.56(7.84)	377.16	169.63(44.98)
	Bt_4	126-160	13.27(5.07)	28.29(8.75)	18.09(6.91)	45.04(17.21)	42.15(16.11)	58.09(22.20)	261.63	56.70(21.67)
	Average		24.11(6.82)	46.76(13.24)	69.21(19.59)	37.90(10.73)	57.48(16.27)	33.71(9.54)	353.28	84.40(23.89)
Bangalore	(Kandic pa	leustalfs)	[Eastrern dry	zone]						
	Ap	0-11	29.38(3.41)	45.20(5.24)	179.41(20.81)	69.90(8.11)	58.85(6.83)	69.12(8.02)	862.07	420.21(47.58)
	\mathbf{Bt}_1	11-35	29.51(3.22)	89.86(9.81)	59.56(6.50)	90.09(9.84)	63.44(6.93)	32.35(3.53)	915.95	551.14(60.17)
	Bt_2	35-67	25.33(2.36)	89.37(8.34)	47.21(3.99)	61.35(5.72)	78.13(7.29)	26.62(2.48)	1070.66	762.65(71.17)
	Bt ₃	67-140	22.42(2.01)	89.37(8.00)	49.26(9.41)	82.32(7.37)	70.99(6.36)	31.47(2.82)	1116.45	770.62(69.02)
	Average		26.66(2.69)	78.45(7.91)	83.86(8.46)	75.92(7.66)	67.85(6.85)	39.89(4.02)	991.28	625.91(63.14)
Mandya (Typic Rhoo	loustalfs) [Southern dry	zone]						
	Ap	0-9	31.67(2.78)	75.06(6.59)	202.94(17.81)	83.88(7.36)	47.16(4.14)	58.82(5.16)	1139.22	639.69(56.15)
	A_2	9-13	23.43(3.62)	75.06(11.61)	213.97(33.09)	66.79(10.33)	62.03(9.59)	50.74(7.85)	646.55	154.53(23.90)
	$\mathbf{B}\mathbf{w}_1$	13-68	19.64(5.21)	25.02(6.63)	83.09(22.03)	84.65(22.44)	55.03(14.59)	41.76(11.07)	377.16	67.97(18.02)
	$\mathbf{B}\mathbf{w}_2$	69-97	14.52(4.02)	20.17(5.58)	25.00(6.91)	83.88(23.19)	46.96(12.99)	41.91(11.59)	361.64	76.99(21.29)
	Bw ₃	97-140	10.73(2.29)	25.02(5.33)	38.24(8.15)	82.32(17.54)	80.16(17.08)	94.12(20.05)	469.40	138.81(29.57)
	Average		20(3.34)	44.07(7.36)	112.65(18.81)	80.30(13.41)	58.27(9.73)	57.47(9.60)	598.79	215.60(36.01)
Shimoga (Ultic haplu	stalfs) [So	uthern transitio	on zone]						
	Ap	0-17	29.64(4.58)	71.97(11.13)	83.82(12.96)	44.56(6.89)	61.04(9.44)	33.82(5.23)	646.55	321.70(49.76)
	A_2	17-24	29.51(6.85)	94.71(21.97)	77.94(18.08)	51.74(12.00)	67.03(15.55)	41.18(9.55)	431.03	68.92(15.99)
	A_3	24-40	21.54(4.00)	80.67(14.97)	52.21(9.69)	65.24(12.11)	62.71(11.64)	27.21(5.05)	538.79	229.21(42.54)
	Ac_1	40-90	25.22(5.85)	73.09(16.96)	50.74(11.77)	55.92(12.97)	70.58(16.37)	22.94(5.32)	431.03	132.54(30.75
	Ac_2	90-140	19.77(4.14)	65.83(13.80)	149.26(31.28)	94.75(19.86)	77.78(16.30)	52.79(11.06)	477.16	16.98(3.56)
	Average		25.14(4.98)	77.25(15.30)	82.79(16.40)	62.44(12.37)	67.83(13.43)	35.59(7.05)	504.91	153.87(30.48)
Chettalli (Ultic palehumults) [Hilly zone]										
	0	0-10	26.41(2.64)	104.12(10.39)	88.24(8.80)	103.29(10.31)	131.69(13.14)	75.00(7.48)	1002.25	473.50(47.24)
	Е	10-37	24.44(3.06)	145.20(18.15)	84.56(10.57)	72.23(9.03)	112.11(14.02)	28.09(3.51)	799.91	333.28(41.66)
	EB	37-62	26.47(3.69)	135.51(18.86)	107.35(14.98)	37.28(5.20)	122.68(17.11)	23.24(3.24)	716.84	264.31(36.87)
	В	62-140	25.33(3.26)	127.44(16.41)	73.53(9.47)	78.44(10.10)	131.52(16.94)	45.59(5.87)	776.50	292.65(37.69)
	Average		25.66(3.12)	128.07(15.55)	88.42(10.73)	72.81(8.84)	124.40(15.11)	42.98(5.22)	823.88	340.94(41.38)

Table 2 contd....

0011101	able 2									
Mudigere (Palehumults)[Hilly zone]										
	Ap	0-26	23.56(1.90)	124.21(10.02)	154.41(12.46)	72.23(5.83)	74.85(6.04)	42.5(3.43)	1239.22	747.48(60.32)
	A_2	26-34	28.76(3.81)	122.60(16.25)	114.71(15.21)	61.35(8.13)	83.71(11.10)	34.50(4.57)	754.31	308.68(40.92)
	Bt_1	34-96	20.26(2.09)	117.76(12.14)	125.74(12.97)	69.90(7.21)	87.04(8.97)	65.44(6.75)	969.83	483.69(49.87)
	Bt_2	96-148	12.17(0.92)	125.02(9.44)	188.24(14.22)	68.34(5.16)	91.22(6.89)	51.47(3.89)	1324.14	787.68(59.49)
	Average		21.19(1.98)	122.40(11.42)	145.78(13.60)	67.96(6.34)	84.21(7.86)	48.48(4.52)	1071.88	581.88(54.29)
Sakaleshpur (ultic Paleustalfs) [Hilly zone]										
	Ap	0-15	30.39(2.23)	120.18(8.82)	76.47(5.61)	86.21(6.33)	71.44(5.24)	29.41(2.16)	1362.5	948.40(69.61)
	Bt_1	15-70	25.33(1.96)	118.56(9.17)	61.76(4.78)	62.91(4.87)	72.09(5.57)	25.00(1.93)	1293.10	927.45(71.72)
	Bt_2	70-140	11.73(1.21)	126.63(13.06)	69.12(7.13)	83.88(8.65)	89.71(9.25)	39.71(4.09)	969.83	549.05(56.61)
	Average		22.48(1.86)	121.79(10.08)	69.12(5.72)	72.75(6.02)	77.75(6.43)	31.31(2.60)	1208.48	808.30(66.89)
Brahmavar (typic Kandiustults) [Coastal zone]										
	Ap	0-13	23.43(1.98)	161.34(13.61)	208.09(17.56)	86.21(7.27)	185.23(15.63)	57.35(4.84)	1185.34	463.69(39.12)
	Bt	13-140	15.20(1.53)	128.25(12.92)	227.94(22.96)	105.62(10.64)	190.18(19.16)	88.97(8.96)	992.67	236.51(23.83)
	Average		19.32(1.77)	144.80(13.30)	218.02(20.02)	95.92(8.80)	187.71(17.24)	73.16(6.72)	1089.01	350.10(32.15)
Overall average		23.18(2.56)	98.00(10.80)	131.64(14.51)	79.66(8.78)	93.01(10.25)	51.84(5.71)	907.09	427.18(47.09)	

Occluded -P:

Contd Table 2

Ooccluded -P content of the soil profiles varied widely, ranging from 13.24 to 136.03 ppm with overall mean of 51.84 ppm (5.72 per cent of total P). Its content was appreciably high in some highly weathered soils. This is in conformity with the findings of Chang and Jackson (1958). Occl-P content was found to be high in the lower layers of most of the profiles and this can be attributed to the highly leached condition of the soil profiles (kothandaraman and Krshnamoorthy (1977).

Organic P:

Organic P ranged from 16.98 to 948.40 ppm. On an average, its content was 427.18 ppm and constituted 47.09 per cent of total P. This fraction did not show any definite pattern in distribution with depth. Its distribution closely followed the distribution of total P and clay.

Total P:

The total P status of the soils studied showed a wide variation, ranging from 261.63 to 1693.43 ppm with an overall mean of 907.09 ppm. The highest total P was recorded in Bt3 layer of Bidar soil profile and the lowest in Bt4 layer of Arasikere. Generally, it decreased from surface to subsurface layers and tends to increase in the bottom most layers. This might be related to the clay content and its distribution pattern. It might be also due to the leaching of H_2PO_4 ions from the upper part of the solum where the soil had high sand content and accumulation in the lower horizons of the soil had high clay content. This trend of distribution was also reported by Kanwar

et al. (1983). The higher amounts of total P in the surface layers can be attributed to the accumulation of organic matter and free iron oxides which are effective immobilizers of P (Chang and Chu, 1961). It might be also resulted from fertilizer and manure additions to the surface soil.

Conclusion:

From the foregoing results and discussion it can be concluded that the distribution of different fractions was in the order of Fe-P(131.64 ppm) > A1 – P(98.00 ppm) > Red-P (93.01 ppm>Ca-P(79.66 ppm) >Occl-P(51.84 ppm) >saloid-P (23.18 ppm). Organic P constituted 47.09 per cent of the total P. The distribution of P fractions varied greatly with clay, pH. organic carbon, CEC, sesqui oxides , management practices, degree of weathering and leaching

REFERENCES

- Chang, S.C. and Chu, W.K.(1961). The fate of soluble phosphate applied to soils. J. Soil Sci., **12**:181-189.
- Chang, S.C. and Jackson, M.L. (1958). Soil phosphate fractions in some representative soils. J. Soil Sci., 9(1):109-119.
- Hesse, P.R.(1971). *Text book of soil chemical analysis*. John Murray and Co., LONDON.
- Jackson, M.L.(1973). Soil chemical analysis. Prentice Hall Inc. India Pvt. Ltd., NEW DELHI (India).
- Jaysree Sankar, S. (1991).Investigation on NPK fractions under long terrm fertilization in irrigated inceptisol, Ph. D. Thesis, Tamil Nadu Agricultural University, COIMBATOR, T.N. (India).

- Kanwar, J.S. and Grewal, J.S.(1990). Phosphate fixation in Indian soils. ICAR Publication, NEW DELHI (India).
- Kanwar, B.B., Verma, J.S. and Tripathi, B.R.(1983). Phosphorus fractions in relation to soil properties and genesis in Alfisols and inceptisols of Himachal Pradesh. J. Indian Soc. Soil Sci., 31:65-72.
- Khanna, P.K. and Datta, N.P.(1968). Distribution of inorganic soil phosphorus in someIndian soils as affected by added phosphates. *Indian J. Agric. Sci.*, **38**:668-676.
- Kothandaraman, G.V. and Krishnamoorthy, K.K.(1977). Distribution of inorganic phosphorus fractions in Tamil Nadu soils. *Madras Agric. J.*, 64 (8): 516-521.

- Mehta, N.C., Legg, J.O., Goring, C.A.J. and Black, C.A.(1954). Determination of organic phosphorus in soils. *Soil Sci. Soc. Am. Proc.*, **18**:443-449.
- Peterson, G.W. and Corey, P.R. (1968). A modified Chang and Jackson procedure for routine fractionation of inorganic soil phosphorus. *Soil Sci. Soc. Am. Proc.*, **30** : 563-564.
- Piper, C.S. (1950). *Soil and plant analysis*. The University of Adelaide, Adelaide, AUSTRALIA.
