



## FORMS OF PHOSPHORUS OF REPRESENTATIVE SOIL SERIES OF SUB-MONTANE ZONE OF MAHARASHTRA

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**Abstract:** The representative soil samples of order Entisol, Inceptisol and Vertisol were collected from Agriculture College, Kolhapur and different research stations of Sub-Montane Zone of Maharashtra were assessed for different forms of Phosphorus and its distribution. The average mean value of saloid-P, Al-P, Fe-P, Red-P, Occl-P and Ca-P (3.74, 31.03, 19.29, 38.17, 13.24 and 148.63 mgkg<sup>-1</sup>) were recorded in Entisol, Inceptisol and Vartisol, respectively. The saloid -P contributed very lowest form than the rest of forms of phosphorus (0.96 %) of total P. Higher value of saloid -P was observed in surface layer and decreased with increase in depth.

Al-P ranged from (17.50 to 46.78mg kg<sup>-1</sup>) in Vertisol and Entisol in ARS, Karad. The higher values of Red-P, Fe-P, and Occl-P were noticed in Entisol and Inceptisol respectively. Whereas higher values of Ca-P was noticed in Vertisols. Ca-P content was increase with increase in depth in Entisol, Inceptisol and Vertisol could be due to increasing CaCO<sub>3</sub> content.

**Key words:** Phosphorus, Soil order, Sub-montane zone of Maharashtra.

### Introduction:

Phosphorus is key element in all living things. It is essential for plant growth and metabolism. In plant, it is essential for photosynthesis, respiration, cellular function, gene transfer, and root growth. It performs the main function in energy transformation, metabolic processes and structure of plants that cannot be performed by any other element. In soil, phosphorus exists in organic as well as inorganic forms and distribution varies with climate, vegetation and parent material. 20-85% of total phosphorus is in organic form, but plants can only utilized this after it is mineralized.

The plants mainly depend on inorganic phosphorus forms, their phosphorus requirements. They take up phosphorus in soluble inorganic phosphate (Bileski and Ferguson, 1983). The proportion of forms of phosphorus such as Ca-P, Al-P, Fe-P, Occluded-P and Organic-P governs the response to applied phosphorus (Singh *et al.* 2003). id-P, Al-P and Ca-P fractions are main source of

phosphorus supply to the plants. At present the information on forms of phosphorous and phosphorous supplying capacity of different soil series of sub-montane zone of Maharashtra is limited, hence the present experiment is planned

### Material and Methods:

Horizon wise twelve profile and surface samples from representative soil series of order viz., Entisols, Inceptisols and Vertisols from Agriculture College Farm, Kolhapur and different Research Stations of Sub-montane Zone of Maharashtra were collected. The collected soil samples were analysed for different forms of phosphorus, Saloid-P, Al-P, Fe-P, Red-P, Occl-P and Ca-P using (Peterson and Corey, 1966). Total phosphorus determined by (Jackson, 1973). Organic-P was determined by subtracting inorganic from total -P in soil. Available -P in soil was determined by using 0.5 N Na HCO<sub>3</sub> (Watanbe & Olsen, 1965) and 0.03N NH<sub>4</sub> by (Brays and Kurtz, 1945).

### Results and Discussion:

The horizon wise distribution of different forms of phosphorus in different soil series of Entisol, Inceptisol and Vertisols were presented in Table No. 1, 2 and 3. The average mean values of Saloid-P in Entisol, Inceptisol and Vertisols are 3.70, 3.90 and 3.68 mgkg<sup>-1</sup>, respectively. Sihag et al (2005) reported that saloid -P ranged from 6.4 to 8.9 mgkg<sup>-1</sup>.

Higher value of saloid-P observed in Ahmedpur series (Entisol) of ARS, Karad (5.43mgkg<sup>-1</sup>) followed by Sathesai series Entisol of NARP, Shenda park, Kolhapur (4.92 mgkg<sup>-1</sup>) and Kankauli series Inceptisol of ARS, Radhnagari. (4.70 mgkg<sup>-1</sup>). In all series higher of saloid -P observed in surface layer and decreases with depth Similar results were reported by Kulkarni (1994) and Gajbhiye (2001). It is observed from the data Al-P content in different soil series varied from 17.50 mgkg<sup>-1</sup> in Koregaon series (Vertisol) of ARS, Karad to 46.78 mgkg<sup>-1</sup> in Ahmedpur series (Entisol) of ARS, Karad. The higher mean value of Al-P observed in Ahmedpur series (Entisol) of ARS, Karad (46.78 mgkg<sup>-1</sup>) followed by Kankauli series (Inceptisol) of ARS, Radhnagri (38.01 mgkg<sup>-1</sup>) and Vertisol (36.99 mgkg<sup>-1</sup>) of RSJRS, Kolhapur. Gajbhiye (2001) reported that Al-P varied from 3.2 to 69.48 mgkg<sup>-1</sup> and Trivedi et al. (2010) reported that, Al-P ferom (15.5 to 76.3 mgkg<sup>-1</sup>) in Alfisol and Inceptisol, respectively of Madhya Pradesh.

Fe-P content in different soil series ranged from (12.15 mgkg<sup>-1</sup>) in Vertisols of Agriculture, Farm Kolhapur to (25.46 mgkg<sup>-1</sup>) in Entisol of ARS, Karad with mean value 19.29 mgkg<sup>-1</sup>. Fe-P contributed average mean value in different series 4.91 per cent of the total -P. Dongale (1993) reported it ranged from 31.00 to 175.00 ppm in Lateritic soil. It is observed that Red-P varied from (26 48 to 53. 75 mg kg<sup>-1</sup>) in Vertisol of Gadhinglaj and Entisol of ARS, Karad respectively with mean value (38. 17 mg kg<sup>-1</sup>). It contributed mean value of all series are 9.82 per cent of total -P. Trivedi *et. al.* (2010) reported Red-P

from 26. 70 mgkg<sup>-1</sup> in Inceptisol to 117.8 mg kg<sup>-1</sup> in Alfisol of Madhya Pradesh.

Occl-P ranged from 8.36 mg kg<sup>-1</sup> in Vertisol of ARS, Karad to 17.33 mgkg<sup>-1</sup> in Inceptisol of Agril. Farm, Kolhapur with mean value 13.24 mgkg<sup>-1</sup>. The higher value in Inceptisol of Agril. Farm, Kolhapur (17.33 mgkg<sup>-1</sup>) followed by Entisol of ARS, Karad (16.36 mgkg<sup>-1</sup>). According to Walkar and Syres (1976) Occl-P increases due to highly weathered acid solis are rich in Occl-P.

The fraction of Ca-P ranged from (76.39 to 263.07 mgkg<sup>-1</sup>) in Entisol and Vertisol of ARS, Karad respectively. The mean value of Ca-P was maximum in Vertisol 263. 07 mgkg<sup>-1</sup> in followed by 220.67 mgkg<sup>-1</sup> in vertisol of Agril. Farm Kolhapur. Lower value of Ca-P noticed in Entisol and Inceptisol (76. 39 and 94.17 mgkg<sup>-1</sup>) of Vadgaon Maval. Shrinivastava and Pathale (1970) reported similar results.

Inorganic - P content in different soil series, the mean value of Entisol, Inceptisol and Vertisol are (241.32, 232.97 and 285.97 mgkg<sup>-1</sup>), respectively. Inorganic - P contributed (40.74 to 94.96) per cent of total -P. Dongale (1993) reported (52.2 to 99.40 %) of total in lateritic soils of coastal region. Organic-P content in different soil order, the average mean value of Entisol, Inceptisol and Vertisol are (120.39, 196.72 and 98. 62 mgkg<sup>-1</sup>) respectively. Highest organic -P observed in Inceptisol (218.12 mgkg<sup>-1</sup>) in ARS, Radhangari followed by Inceptisol (194.85 mgkg<sup>-1</sup>) of Agril. Farm, Kolhapur. Total -P content in different soil order, the average mean value of Entisol, Inceptisol and Vertisol are (361.71, 429.69 and 384.56 mgkg<sup>-1</sup>) respectively.

### Conclusion:

The present study revealed that considerable variation in the distribution of different forms of P in the horizon of different soil samples collected from different representative soil series of Sub-montane Zone of Maharashtra, The higher values of Saloid-P, Al-P, Red-P, Fe-P and Occl-P were noticed in Entisol, Inceptisol and Vertisols soil series.

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**Table 1: Forms of Phosphorus of soil series of Entisols (mg kg-1)**

Sr. No.	Hori zon	Depth (cm)	Saloid-P	Al-P	Fe-P	Red-P	Occl-P	Ca-P	Inorganic-P	Organic-P	Total P	Avail-P (kg ha-1)
<b>I) Ahmedpur- A.R.S., Karad</b>												
	Δp	0-21	6.37	56.56	36.68	62.50	22.37	145.87	330.35	106.95	437.30	29.47
	Δ+C	21-45	4.50	37.00	14.25	45.00	12.00	156.00	268.75	14.25	283.00	15.96
	Mean	5.43	46.78	25.46	53.75	17.18	150.93	299.55	60.60	360.15		22.71
<b>II) Kurkum- R.S. and J.R.S., Kolhapur</b>												
	Δp	0-22	4.62	54.43	35.18	62.50	23.25	101.93	281.91	172.13	454.04	22.37
	Δ12	22-50	3.50	45.75	25.25	55.00	11.25	90.50	231.25	168.75	400.00	27.02
	Δ13	50-80	2.50	37.00	21.00	45.00	15.00	112.50	233.00	183.50	416.50	21.06
	Δ14	80-107	1.50	31.25	15.00	35.50	11.25	136.75	231.25	168.75	400.00	18.51
	Δ15	>107	2.00	15.25	09.00	23.50	04.00	75.00	128.75	37.75	166.50	11.20
	Mean		2.82	36.74	21.08	44.30	12.95	103.34	221.23	146.17	367.40	20.03
<b>III) Sathesai- N.A.R.P.(S.Z.), Shendapark</b>												
	Δp	0-25	6.35	40.75	26.75	50.04	15.18	88.93	228.00	188.58	416.58	12.70
	Δ1	25-50	3.50	16.75	07.75	23.50	04.75	112.00	168.25	115.08	283.33	9.17
	Mean		4.92	28.75	17.25	36.77	09.96	100.47	198.12	151.83	349.95	10.93
<b>IV) Kurkum- Agriculture College, Kolhapur</b>												
	Δp	0-18	5.12	39.37	25.37	53.75	20.37	159.62	303.60	192.25	495.85	29.21
	Δ1	18-30	1.00	23.25	14.25	23.50	07.00	222.25	291.25	58.75	350.00	9.13
	Mean		3.06	31.31	19.81	38.62	13.68	190.94	297.42	125.50	422.92	19.17
<b>V) Kurkum- A.R.S., Vadgaon-Maval</b>												
	Δp	0-20	3.75	47.08	30.93	56.25	17.43	58.68	214.12	177.54	391.66	14.81
	Δ1	20-45	2.00	30.50	17.25	35.50	10.25	66.00	161.50	88.50	250.00	9.59
	Δ2	>45	1.00	32.75	18.50	23.50	15.00	104.50	195.25	87.50	282.75	11.91
	Mean		2.25	36.78	22.23	38.41	14.23	76.39	190.29	117.84	308.13	12.10
	<b>Av.Mean</b>		3.70	36.07	21.17	42.37	13.60	124.41	241.32	120.39	361.71	16.99
	<b>Range</b>		1.00	15.25	7.75	23.50	4.00	58.68	128.75	14.25	166.50	9.13
			-	-	-	-	-	-	-	-	-	-
			6.37	56.56	36.68	62.50	23.25	222.25	330.37	192.25	495.83	29.21

**Table 2: Forms of Phosphorus of soil series of Vertisols (mg kg-1)**

Sr. No.	Hori Zon	Depth (cm)	Saloid-P	Al-P	Fe-P	Red-P	Occl-P	Ca-P	Inorganic-P	Organic-P	Total-P	Avail-P (kg ha-1)
<b>I) Kankauli- A.R.S., Radhanagari</b>												
	Δp	0-20	6.5	57.81	37.31	77.50	29.87	91.56	300.55	437.06	737.61	17.51
	B21	20-45	4.5	47.25	28.25	70.00	24.50	105.75	280.25	269.75	550.00	16.31
	B22	45-75	7.0	37.00	22.75	45.00	13.25	84.00	209.00	191.00	400.00	15.36
	B23	75-90	3.5	32.75	13.25	35.50	06.00	54.75	145.75	137.58	283.33	17.27

B24	90-115	2.0	15.25	11.25	23.50	08.25	151.00	211.25	55.25	266.50	13.91
Mean		4.7	38.01	22.56	50.30	16.38	97.41	229.36	218.12	447.48	16.07
<b>II) Bamburdi- Agriculture College, Kolhapur</b>											
Ap	0-15	8.12	46.18	36.43	50.00	27.43	118.87	287.03	327.93	614.96	43.00
B21	15-30	3.5	57.50	41.50	70.50	32.50	137.00	342.50	190.83	533.33	45.34
B22	30-46	4.0	23.25	22.75	25.50	13.25	156.75	245.50	171.00	416.5	17.67
B23	46-64	1.0	13.75	11.25	16.25	06.50	173.50	222.25	177.75	400.00	8.15
B24	>64	1.5	15.75	06.25	23.50	07.00	222.25	276.25	106.75	383.00	16.61
Mean		3.62	31.29	23.64	37.15	17.33	161.67	274.70	194.85	469.55	26.15
<b>III) Bamburdi- A.R.S., Vadgaon-Maval</b>											
Ap	0-20	8.37	36.12	31.81	47.50	23.12	71.87	218.79	274.93	493.72	19.90
B21	20-45	4.5	29.00	24.50	35.50	10.75	91.25	195.50	187.83	383.33	22.72
B22	45-75	2.0	43.00	25.75	45.00	16.25	92.75	224.75	175.25	400.00	16.78
B23	75-90	1.0	21.75	12.50	25.50	11.25	98.00	170.00	146.50	316.50	14.32
B24	90-105	1.0	13.75	09.50	16.25	07.75	117.0	165.25	101.41	266.66	9.40
Mean		3.37	28.72	20.81	33.95	13.82	94.17	194.85	177.19	372.04	16.62
<b>Av.Mean</b>		3.9	32.67	22.34	40.47	15.84	117.75	232.97	196.72	429.69	19.61
<b>Range</b>		1.0	13.75	6.25	16.25	6.00	54.75	165.25	55.25	266.50	8.15
		-	-	-	-	-	-	-	-	-	-
		8.37	57.81	41.50	77.50	32.50	222.25	300.47	437.06	737.50	45.34

Table 3: Forms of Phosphorus of soil series of Vertisols (mg kg<sup>-1</sup>)

Sr. No.	Hori Zon	Depth (cm)	Saloid-P	Al-P	Fe-P	Red-P	Occl-P	Ca-P	Inorganic-P	Organic-P	Total-P	Avail-P (kg ha <sup>-1</sup> )
<b>I) Koregaon- A.R.S., Gadhinglaj</b>												
Ap		0-20	7.87	32.81	24.62	42.62	19.06	164.31	291.29	141.97	433.26	37.02
B21		20-55	4.5	23.25	22.75	23.50	11.25	173.50	258.75	57.75	316.50	36.17
B22		55-90	3.0	16.75	14.25	35.00	13.75	181.00	263.75	36.25	300.00	13.83
B23		90-105	6.5	10.00	13.75	16.25	07.00	195.25	248.75	34.25	283.00	24.04
C		>105	1.0	13.75	10.25	15.00	04.25	201.50	245.75	20.75	266.50	29.17
Mean			4.57	19.31	17.13	26.48	11.06	183.11	261.66	58.19	319.85	28.04
<b>II) Koregaon- A.R.S., Karad</b>												
Ap		0-23	4.62	30.31	18.75	50.00	14.06	240.87	358.61	322.62	681.23	46.81
B21		23-55	3.0	20.25	10.25	23.50	09.50	253.00	319.50	210.50	530.00	38.73
B22		55-85	3.5	26.75	25.25	35.50	12.00	260.00	363.00	37.00	400.00	17.87
B23		85-105	1.0	07.25	06.50	16.25	05.25	286.00	322.25	27.75	350.00	30.64
C		>105	0.5	02.92	01.75	11.50	01.00	275.50	293.18	22.88	316.06	42.98
Mean			2.52	17.50	12.50	27.35	08.36	263.07	331.30	124.15	455.45	35.40
<b>III) Shiware- R.S. and J.R.S., Kolhapur</b>												
Ap		0-24	3.62	51.18	30.18	58.75	21.92	118.25	283.90	228.40	512.30	22.34
B21		24-54	7.5	43.00	18.50	45.00	13.75	134.75	262.50	154.00	416.50	13.83
B22		54-85	5.0	31.25	11.25	35.50	15.00	148.25	246.25	103.75	350.00	13.46
B23		85-108	1.5	40.75	16.25	23.50	09.50	150.00	241.50	58.50	300.00	10.00
C		>108	1.0	18.75	08.25	11.50	06.50	156.00	202.00	48.00	250.00	19.36
Mean			3.72	36.99	16.89	34.85	13.33	141.45	247.23	118.53	365.76	15.79
<b>IV) Donoli- Agriculture college, Kolhapur</b>												
Ap		0-20	5.12	38.12	22.25	40.50	16.62	192.93	315.54	220.93	536.47	23.71
A12		20-55	4.5	21.75	16.25	55.00	16.25	222.25	336.00	97.00	433.00	25.17
Bss1		55-90	3.5	13.75	11.25	45.00	08.25	225.50	307.25	76.08	383.33	17.67
Bss2		90-105	5.0	16.75	07.00	23.50	09.00	229.00	290.25	59.75	350.00	8.15
AC		>105	1.5	10.75	04.00	16.25	03.00	233.50	269.00	14.34	283.34	16.61
Mean			3.92	20.22	12.15	36.05	10.62	220.64	303.60	93.62	397.22	18.26
<b>Av.Mean</b>			3.68	23.50	14.67	31.18	10.84	202.07	285.94	98.62	384.56	24.37
<b>Range</b>			0.5	2.92	1.75	11.50	1.00	118.25	202.00	14.33	250.00	8.15
			-	-	-	-	-	-	-	-	-	-
			7.87	51.18	30.18	58.75	21.93	286.00	363.00	322.62	681.25	46.81
<b>Overall series mean</b>			3.74	31.03	19.29	38.17	13.24	148.63	254.10	132.22	386.32	20.10
<b>Overall series range</b>			0.5	2.92	1.75	11.50	1.00	54.75	128.75	14.25	166.50	8.15
			-	-	-	-	-	-	-	-	-	-
			8.37	57.81	41.50	77.50	32.50	286.00	363.00	437.06	737.50	46.81