



Research Article

DEPTH WISE SULPHUR STATUS OF REPRESENTATIVE BENCH MARK SOIL SERIES OF WESTERN MAHARASHTRA REGION

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Abstract- The present soil survey was made on "Depth wise sulphur status of representative bench mark soil series of western Maharashtra region" was conducted during the year 2011-2012. For the present investigation total 9 representative soil series like, Thejoda, Kolyachiwadi, Masala, Sonawadi, Ranjani, Jaipur, Valwa, Manjra and Bodla were selected for depth-wise soil sample collection in 9 district of Western Maharashtra region like, Nashik, Ahmednagar, Solapur, Satara, Pune, Jalgaon, Sangli, Kolhapur and Dhule district, respectively, were studied at the original sites where the soil series were first studied as per technical bulletin of soil series of Maharashtra published by National Bureau of Soil Survey and Land Use Planning. All depth-wise collected soil from nine soil profiles samples were analyzed for physical properties viz., bulk density, hydraulic conductivity soil texture and chemical properties viz., pH, EC, organic carbon, calcium carbonate. These soil samples were also analyzed for available nitrogen, phosphorus, potassium and different forms of sulphur viz., total sulphur, organic sulphur, water soluble (1% NaCl extractable) sulphur, sulphate sulphur (0.15% CaCl₂ extractable) and non-sulphate sulphur by using standard method. All physical and chemical parameters of soil profiles are decreased with the depth in all the soil profiles under study except bulk density, clay, pH, EC, calcium carbonate and water-soluble sulphur.

Keywords- Sulphur, Forms of sulphur, Bulk density, hydraulic conductivity and available NPK.

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Introduction

Sulphur is an element that occurs naturally in the environment and it is the sixteen most abundant in the earth crust, averaging 0.06 to 0.10%. Sulphur deficiency has become a major constraint in crop production in coarse textured soils. Introduction of higher yielding crop varieties, intensive and the decreased use of farmyard manures seem to have led to a wild occurrence of sulphur deficiency and diverted the attention of the researchers towards this hitherto neglected element. Sulphur is gaining importance in Indian agriculture in enhancing the crop productivity, not only in oil seeds, pulses, legumes and forages but also in cereals, plantation crops and forest vegetation. Sulphur is present as sulphide, sulphate and in organic combination with carbon and nitrogen. There are different forms of sulphur or sulphur fractions as total sulphur, organic sulphur, sulphate sulphur, adsorbed sulphur, non-sulphate sulphur, water soluble sulphur, heat soluble sulphur. The content of total sulphur in soils of Maharashtra ranged from 95 to 513 ppm [1]. Sulphur deficiencies in India are widespread [2]. Intensification of agriculture with high yielding varieties and multiple cropping coupled with the use of high analysis sulphur free fertilizers along with the restricted or no use of organic manures have accrued in depletion of the soil sulphur reserve. Soils, which are deficient in sulphur, cannot on their own provide adequate sulphur to meet crop demand resulting in sulphur deficient crops and sub-optimal yields. The knowledge of sulphur status throughout root zone is essential for improving sulphur nutrition of crops. Several soil factors influence the availability of sulphur and hence the status of different forms of sulphur in soils varies widely with soil type [3]. Therefore, an attempt was made to "Depth wise sulphur status of representative bench mark soil series of western Maharashtra region (M.S.).

Materials and Methods

Total 9 representative soil series like, Thejoda, Kolyachiwadi, Masala, Sonawadi, Ranjani, Jaipur, Valwa, Manjra and Bodla were selected for depth wise soil sample collection in 9 district of Western Maharashtra region like, Nashik, Ahmednagar, Solapur, Satara, Pune, Jalgaon, Sangli, Kolhapur and Dhule district, respectively, were studied at the original sites where the soil series were first studied as per technical bulletin of soil series of Maharashtra published by National Bureau of Soil Survey and Land Use Planning (Challa et al., 1999) were analyzed for physical properties viz., bulk density, hydraulic conductivity and soil texture by using clod coating method, constant head method, and international pipet method, respectively and chemical properties viz., pH by using Potentiometric method, EC determined by conductometric method, organic carbon determined by wet oxidation method, and calcium carbonate determined by rapid titration method. These soil samples were also analyzed for available nitrogen by using alkaline permanganate method, phosphorus by using Olsen's method, potassium by using neutral normal ammonium acetate method and different forms of sulphur viz., total sulphur by using digesting solution (HNO₃ + KNO₃) method [4], organic sulphur by using turbidimetric method [5], water soluble and sulphate sulphur by using turbidimetric method [6] and non-sulphate sulphur by using standard formulae of subtracting sulphate sulphur plus organic sulphur from total sulphur.

Results and Discussion

The data regarding physical, chemical properties and different forms of sulphur presented in [Table-1]. The Thejoda, Masala, Sonawadi, Jaipur and Valwa soil series were clayey in texture and gravely sandy clay loam in Kolyachiwadi, gravely

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sandy loam in Ranjani, sandy clay loam in Bodla and clay loam texture in Manjara soil series. Higher values of clay were found in Pedon 1, 3, and 4 which were in Jaipur (Vertisol), Masala (Inceptisol) and Sonawadi (Inceptisol) soil series in Jalgaon, Solapur, and Satara district, respectively. However, it was low in Pedon 8

and 9, which were in Manjra (Alfisol), and Bodla (Entisol) soil series in Kolhapur and Dhule districts, respectively. The clay content increased with the depth in all the soil profiles under study might be due to removal of fine materials from surface horizons to its subsequent horizons [7].

Table-1 Physical and Chemical properties of typifying pedon of representative soil series of Western Maharashtra region

Soil profile	Horizon depth (cm)	Horizon Name	B.D. (Mg m ⁻³)	H.C. (cm hr ⁻¹)	Particle size distribution (%)			Chemical properties				Available nutrient (Kg ha ⁻¹)			Forms of sulphur (mg kg ⁻¹)				
					Sand	Silt	Clay	pH	EC (d Sm ⁻¹)	O.C. (%)	CaCO ₃ (%)	N	P	K	TS	OS	WSS	AS	NSS
Pedon 1: Thejoda soil series : Nashik (Typic Haplustepts)																			
	0-18	Ap	1.24	1.17	18.2	30.4	51.4	8.28	0.25	0.39	10.8	202	13.31	426	435	278	24.29	22.90	134
	18-40	BK ₁	1.25	1.15	17.5	29.9	52.6	8.32	0.27	0.32	11.6	192	12.23	393	393	252	25.65	22.32	121
	40-60	BK ₂	1.27	1.14	17.1	29.6	53.3	8.41	0.29	0.24	13.7	164	11.10	345	368	239	26.04	21.25	112
	60-90	BK ₃	1.30	1.12	16.4	28.7	54.9	8.52	0.32	0.20	14.2	142	9.28	302	321	207	26.54	20.14	103
Pedon 2: Kolyachiwadi soil series : Ahmednagar (Fluventic Haplustepts)																			
	0-20	Ap	1.21	1.36	38.4	22.7	38.9	8.29	0.27	0.36	5.2	276	17.50	393	717	327	18.49	17.50	372
	20-36	B ₁	1.22	1.33	37.2	21.3	41.5	8.31	0.27	0.31	5.8	208	16.24	366	694	293	19.13	16.98	312
	36-70	B ₂	1.25	1.31	36.8	20.2	43.0	8.39	0.29	0.27	7.9	189	14.28	343	654	266	19.32	15.46	286
	70-105	B ₃	1.27	1.30	35.7	19.4	44.9	8.42	0.30	0.22	10.3	162	13.11	285	587	214	20.54	14.52	213
Pedon 3: Masala soil series : Solapur : (Vertic Haplustepts)																			
	0-12	Ap	1.28	0.84	16.7	33.1	50.2	8.72	0.19	0.43	10.2	164	12.47	325	618	239	18.23	17.80	361
	12-40	B ₁	1.30	0.81	15.2	32.7	52.1	8.82	0.21	0.39	12.1	142	11.33	296	542	197	19.24	16.84	326
	40-70	B _w	1.35	0.79	13.8	30.6	55.6	8.84	0.23	0.34	14.9	123	9.36	264	465	168	20.39	15.62	254
Pedon 4: Sonawadi soil series : Satara : (Vertic Haplustepts)																			
	0-22	Ap	1.24	1.35	13.2	36.1	50.7	8.37	0.26	0.36	6.8	206	18.85	347	673	288	22.32	21.30	364
	22-48	Bw ₁	1.26	1.34	11.8	34.4	53.8	8.22	0.27	0.32	7.4	172	16.89	311	589	245	23.14	19.57	324
	48-110+	Bw ₂	1.29	1.31	9.7	33.2	57.1	8.43	0.30	0.27	9.6	128	15.47	286	456	206	24.44	18.95	289
Pedon 5: Ranjani soil series : Pune : (Lithic Ustorthents)																			
	0-20	Ap	1.26	1.31	48.2	10.8	41.0	8.10	0.17	0.27	5.8	142	16.91	325	588	264	10.24	9.10	316
	20-40	A ₁₂	1.28	1.28	46.4	9.7	43.9	8.26	0.21	0.23	7.4	118	15.21	297	476	207	12.02	8.42	275
Pedon 6: Jaipur soil series : Jalgaon: (Typic Haplustert)																			
	0-12	Ap	1.26	1.51	32.5	21.2	46.3	8.10	0.35	0.37	3.8	173	19.96	426	464	232	10.42	9.80	222
	12-36	B _w	1.28	1.42	19.2	30.8	50.0	8.23	0.37	0.36	4.2	153	18.20	398	442	225	11.35	8.21	217
	36-70	Bss ₁	1.31	0.94	12.4	31.7	55.9	8.32	0.39	0.32	5.6	134	17.00	369	376	194	12.75	7.56	167
	70-110	Bss ₂	1.33	0.88	10.3	32.4	57.3	8.46	0.42	0.29	7.3	117	15.28	302	357	176	12.54	7.24	154
	110-145+	Bss ₃	1.34	0.83	8.6	32.9	58.5	8.52	0.45	0.25	9.4	97	14.65	294	309	152	14.89	6.34	128
Pedon 7: Valwa soil series : Sangli: (Typic Haplustert)																			
	0-28	Ap	1.21	1.12	17.6	33.1	49.3	8.26	0.27	0.39	8.2	257	12.75	369	674	320	29.40	27.40	326
	28-40	B _w	1.23	1.08	16.4	31.3	52.3	8.29	0.28	0.36	9.6	214	11.24	322	587	289	29.46	25.75	285
	40-80	Bss	1.25	0.95	15.2	29.6	55.2	8.32	0.31	0.33	10.7	183	9.24	295	524	267	30.85	24.86	269
	80-120+	B ₂	1.26	0.87	14.1	28.1	57.8	8.40	0.35	0.28	12.8	146	8.62	283	463	237	32.78	22.95	215
Pedon 8: Manjra soil series : Kolhapur: (Typic Haplustalf)																			
	0-12	Ap	1.13	2.30	32.2	36.4	31.4	6.52	0.20	0.94	0.25	270	20.77	258	185	73	14.37	13.70	90
	12-40	Bt	1.20	2.10	30.5	35.2	34.3	6.72	0.23	0.84	1.3	213	18.56	213	126	57	16.19	10.14	74
Pedon 9: Bodla soil series : Dhule: (Typic Ustorthents)																			
	0-10	Ap	1.33	1.82	48.3	17.9	33.8	7.02	0.21	0.71	3.7	248	19.68	302	340	139	14.20	12.30	189

Bulk density:

Higher value of bulk density was found in Pedon 3, 4, 5, and 6 which were in

Masala (Inceptisol), Sonawadi (Inceptisol), Ranjani (Entisol) and Jaipur (Vertisol) soil series in Solapur, Satara, Pune, and Jalgaon districts, respectively, it was low

in Pedon 8 Manjra soil series of Alfisols in Kolhapur district. The bulk density increased with the depth in all the soil profiles under study might be due to increased clay with depth reflecting soil compaction.

Hydraulic conductivity

Higher value of hydraulic conductivity (2.3 cm hr⁻¹) was found in Pedon 8 Manjra soil series of Alfisols in Kolhapur district. However, it was low (0.79 cm hr⁻¹) in Pedon 3 Masala soil series of Inceptisol in Solapur district. Profile study revealed that the hydraulic conductivity decreased with depth of soil profile having clayey textural class. The higher values in surface horizons are due to their porous nature as a result of regular tillage operations and relatively less clay content. The soils generally have a tendency to show higher BD values in subsurface horizons due to compaction. Hence, the hydraulic conductivity decreased in the subsurface horizons.

Soil reaction

Higher value (strongly alkaline) of pH (8.72 to 8.84) was found in Pedon 3 Masala soil series of Inceptisol in Solapur district. It was slightly acidic (6.52 to 6.72) in Pedon 8 Manjra soil series of Alfisols in Kolhapur district. The increase in soil pH was observed in the lower most horizons of all soils might be due to decrease in organic carbon with depth and bicarbonate precipitated as calcium carbonate due to high evaporative demand under semi-arid conditions. It is also reported by [8] in black soil collected from Western Maharashtra region. Higher value of EC was found in Pedon 6 and 7 which were in Jaipur and soil series of Vertisol in Jalgaon and Sangli district, respectively. However, it was low EC in Pedon 5 and 8, which were in Ranjani (Entisol) and Manjra (Alfisol) soil series of Pune and Kolhapur district, respectively. The EC of soil increased with the depth in all the soil profile under study might be due to basin topography of characterized area where the water table was high and also due to seepage of water along with soluble salts and carbonates of Ca and Mg might have increased electrical conductivity. The similar results were also reviewed by [9] in swell-shrink soils of Vidharbha region.

Organic carbon

Higher value of organic carbon was found in Pedon 8, which was in Manjra soil series of Alfisol in Kolhapur district, it was low in Pedon 5 which was in Ranjani soil series of Entisol of Pune district. The organic carbon of soil decreased with the depth in all the soil profile under study might be due to high temperature prevailing during the summer under the semi and arid climate and subsequent decomposition. Clayey soils had higher organic carbon content as compared to silty loam soils. The similar results were reported by [10] in Central Research Farm of MPKV, Rahuri.

Calcium Carbonate

Higher value of calcium carbonate was found in Pedon 1 and 3, which were in Thejoda and Masala soil series of Inceptisol in Nashik and Solapur district, respectively. However, it was trace in Pedon 8 which was in Manjra soil series of Alfisol in Kolhapur district. The calcium carbonate increased with the depth in all the soil profile under study might be due to arid and semi arid climate and precipitation of carbonates and bicarbonates. The similar trend of CaCO₃ in Block C, Central Campus MPKV, Rahuri was reported by [11].

Available NPK

Higher value of available nitrogen was found in Pedon 8 and 9, which were in Masala (Inceptisol), and Bodla (Entisol) soil series of Kolhapur and Dhule districts, respectively. However, it was low in Pedon 5, which was in Ranjani soil series of Entisol in Pune district. The available nitrogen decreased with the depth in all the soil profiles under study might be due to the higher pH, which declined the organic matter status by faster degradation, which reflected low status of available nitrogen. The similar results were recorded by [12] from Shevgaon Tehsil of Ahmednagar District. Available phosphorus was found higher in Pedon 4, 6, 8 and 9 which were in Sonawadi (Inceptisol), Jaipur (Vertisol), Manjra (Alfisol) and Bodla (Entisol) soil series of Satara, Jalgaon, Kolhapur and Dhule district, respectively. However, it was low in Pedon 3, which was in Masala soil series of Inceptisol in

Solapur district. The available phosphorus decreased with the depth in all the soil profile under study might be due alkaline in reaction and high content of CaCO₃ in the soil. Higher status of available potassium (426 kg ha⁻¹) was found in Pedon 6 and 1, which were in Jaipur (Vertisol), and Thejoda (Inceptisol) soil series of Jalgaon and Nashik district, respectively. However, it was low (313 kg ha⁻¹) in Pedon 8 which were in Manjra soil series of Alfisol in Kolhapur districts. The available potassium decreased with the depth in all the soil profile under study might be due to dissolution and diffusion of K from internal crystal lattice of silicate clay minerals and high clay content and montmorillonitic clay minerals present. The similar trends were also reported by [13].

Total sulphur

Higher value of total sulphur (587 to 717 mg kg⁻¹) was found in Pedon 2, which was in Kolyachiwadi soil series of Inceptisol in Ahmednagar district. However, it was low (126 to 185 mg kg⁻¹) in Pedon 8 which was in Manjra soil series of Alfisol in Kolhapur district. The total sulphur decreased with the depth in all the soil profile under study might be due to the most soil sulphur is primarily in the organic form. The organic matter content decreases regularly down the profiles and total sulphur also exhibits similar trend in all the soils. These findings are similar to those reported by [14].

Organic sulphur

Higher values of organic sulphur (214 to 327 mg kg⁻¹ and 237 to 320 mg kg⁻¹) were found in Pedon 2 and 7, which were in Kolyachiwadi (Inceptisol), and (Vertisol) soil series of Ahmednagar and Sangli district. However, it was low (57 to 73 mg kg⁻¹) in Pedon 8, which was in Manjra soil series of Alfisol in Kolhapur district. The organic sulphur decreased with the depth in all the soil profiles under study might be due to high content of organic matter in surface layer than subsurface and the organic matter content decreases regularly with increasing depth. Similar results were also reported by [15].

Available sulphur

Higher value of available sulphur (22.95 to 27.40 mg kg⁻¹ and 20.14 to 22.90 mg kg⁻¹) were found in Pedon 7 and 1, which were in (Vertisol) and Thejoda (Inceptisol) soil series of Sangli and Nashik district. However, it was low (6.34 to 9.80 mg kg⁻¹ and 12.30 mg kg⁻¹) in Pedon 6 and 8, which were in Jaipur (Vertisol), and Manjra (Alfisol) soil series of in Jalgaon and Kolhapur district, respectively. The available sulphur decreased with the depth in all the soil profiles under study might be due to greater plant and microbial activities and mineralization of organic matter in surface layer. Similar, results were also reported by [16].

Water Soluble sulphur

Higher values of water soluble sulphur (29.40 to 32.78 mg kg⁻¹ and 24.29 to 26.54 mg kg⁻¹) were found in Pedon 7 and 1 which were in Valwa (Vertisol) and Thejoda (Inceptisol) soil series of Sangli and Nashik district. However, it was low (10.42 to 14.89 mg kg⁻¹ and 12.19 to 14.37 mg kg⁻¹) in Pedon 6 and 8, which were in Jaipur (Vertisol) and Manjra (Alfisol) soil series of in Jalgaon and Kolhapur district, respectively. The water-soluble sulphur increased with the depth in all the soil profile under study might be due to water soluble sulphur depends on clay, soluble salt and calcium carbonate of soil, which also increased with depth.

Non-Sulphate sulphur

Higher values of non sulphate sulphur were found in Pedon 2, 3, 4, 5, and 7 which were in Kolyachiwadi (Inceptisol), Masala (Inceptisol), Sonawadi (Inceptisol), Ranjani (Entisol) and (Vertisol) soil series of Ahmednagar, Solapur, Satara, Pune and Sangli district, respectively. However, it was low in Pedon 8, which was in Manjra soil series of Alfisol in Kolhapur district. Profile study revealed that the non-sulphate sulphur decreased with the depth in all the soil profile under study might be due to the variation in sulphur compound in soil.

Conclusion

From this investigation concluded that all physical and chemical parameters of soil profiles are decreased with the depth in all the soil profile under study except bulk

density, clay, pH, EC, calcium carbonate and water-soluble sulphur in benchmark soil series of Western Maharashtra. The entire sulphur fraction was found lower in Manjra soil series of Kolhapur district.

Conflict of Interest: None declared

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