Madras Agric. J., 81(10): 542-545 October, 1994 https://doi.org/10.29321/MAJ.10.A01577

INVESTIGATION ON SOME PHYSICAL PROPERTIES OF ALFISOL AND ENTISOLS OF KAMARAJAR DISTRICT

K.K.MATHAN and P.P.MAHENDRAN
Department of Soil Science, Agricultural College, Madurai.

ABSTRACT

Three major soil subgroups namely, Udic Haplustalf, Typic Haplustalf and Typic Ustorthent to represent the Alfisols and Entisols of Kamarajar district of Tamil Nadu were taken up to evaluate the interrelationships of certain physical properties. The results revealed that clay content negatively influenced saturated hydraulic conductivity, bulk density, effective porosity and aggregate stability. It revealed also the active role played by organic matter in controlling the bulk density. Increasing sand fractions in the soils increased noncapillary pores resulting in higher Ks. Bulk density of soils was found to be independent of clay content in decreasing Ks. Total porosity did not show any relationship with Ks, but noncapillary porosity and effective porosity were positively correlated with Ks.

Many of the physical properties of soils are observed to be interrelated to each other. McNeal (1968) reported that hydraulic conductivity decreased markedly with increasing clay content. It was reported that hydraulic conductivity decreased with increasing clay content and that light soils with single grain structure recorded higher hydraulic conductivity than light soils with angular blocky structure. Bouma and Hole (1971) concluded that hydraulic conductivity was negatively correlated with bulk density and positively correlated with porosity and organic matter content in the soil horizons. Bhatia and Srivastava (1982) observed highly significant and positive correlation of aggregate stability, mean weight diameter and organic carbon with hydraulic conductivity. In the present investigation, the interrelationships between certain soil physical properties in three different major soil subgroups were studied.

MATERIALS AND METHODS

Horizonwise undisturbed soil cores (7.5cm diameter and 7.5cm length) were collected from nine profiles representing three major soil subgroups in Kamarajar district of Tamil Nadu (India). Textural analysis was carried out as per the International Pipette Method (Piper, 1966). Porosity parameters aggregate stability, bulk density and saturated hydraulic conductivity were determined in the cores of following the method described by Dakshinamoorthy and Gupta (1968). The apparent saturated hydraulic conductivity over the entire profile (Ksa) was calculated from the formula,

$$Ksa = \frac{D}{\sum_{i=1}^{n} \frac{di}{ki}}$$

Where,

D = Total depth of the profile

di = Depths of individual profile i

Ki = Saturated hydraulic conductivity of horizons i,

n = Number of horizons

Organic carbon was estimated by the wet digestion method. Correlations between the relevant parameters of soil (subgroupwise) were worked out as per the method of Fisher (1936).

RESULTS AND DISCUSSION

The results of analytical data are presented in Tables 1 and 2. The clay content ranged from 24.2 to 42.4, 28.8 to 56.1 and 3.9 to 27.6 per cent in the subgroups Udic Haplustalf (Uhsf), Typic Haplustalf (Thsf) and Typic Ustorthents (Tuot) respectively. The soils of the subgroups are classified under the following groups based on clay content according to Ekstrom (1927).

Textural group	Subgroup	Apparent saturated hydraulic conductivity
Medium to heavy clay soil	Typic Haplustalf	0.31 - 0.41
Medium clay soil -	Udic Haplustalf	0.53 - 0.67
Low clay soil	Typic Ustorthents	20.00-22.00

Table 1: Phyaixal properties of soils

P.No.	Horizon	Depth (cm)	Texture (%)				Ks cm/hr	BD g/cc	TP %	NCP %	CS %	Ag.St. %	Oe	%
			Clay	Silt	Fine sand	Ciarse Sand								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
I. Subgroup: Udic Haplustalf														
Pedon 1	Manamkathan													
1	Ap	0 - 15	26.5	13.2	32.1	28.2	0.84	1.68	49.5	15.2	34.3	43.4	8.5	0.48
2	A12	15 - 60	32.7	15.3	24.7	27.4	0.79	1.77	45.8	6.8	39.0	39.4	7.4	0.32
3	A21	16 - 100	40.3	12.3	22.2	25.1	0.25	192	33.0	10.6	22.4	27.7	4.5	0.23
4	B22b	100 - 130	42.4	11.5	22.8	23.2	0.19	1.92	40.6	4.4	36.3	19.9	1.2	0.19
Pedon 2	Kilpudupatti													
5	Ap	0. - 13	25.0	16.3	22.9	29.9	0.75	1.65	37.5	12.1	25.4	56.7	7.3	0.40
6	B21	13 - 65	35.7	11.2	25.3	27.8	0.72	1.78	27.9	5.5	22.3	48.0	6.8	0.42
7	B22E	65 - 110	42.1	10.0	24.2	23.7	0.31	1.69	32.2	7.5	24.8	32.1	5.8	0.15
Pedon 3	Kundukulam													
8	Ap	0 - 16	24.2	15.2	34.1	26.4	0.83	1.61	32.2	10.4	21.8	35.8	8.3	0.55
9	B21	16 - 68	31.4	16.2	26.1	26.3	0.79	1.43	33.1	8.8	24.4	52.0	7.6	0.41
10	B22t	68 - 120+	42.2	16.2	16.0	25.6	0.38	1.72	42.2	9.4	32.9	28.2	5.6	0.24
II. Subgroup: Typic Haplustalf														
Pedon 4	Nedungulam													
11	Ap	0 - 18	32.8	13.7	35.2	18.2	0.93	1.65	36.7	15.4	21.3	60.8	27.4	0.48
12	A12	18 - 40	34.6	20.6	26.4	18.5	0.61	1.69	34.5	12.2	22.4	57.2	8.2	0.29
13	B21	40 - 85	40.3	27.3	16.5	16.0	0.13	1.72	33.2	10.0	23.2	29.9	11.9	0.20
14	B22t	85 - 150	56.1	25.7	5.2	12.9	0.10	1.78	38.8	5.4	33.5	32.1	5.5	0.11
Pedon 5	Thambipatti													
15	Ap	0 - 15	12.9	10.7	39.1	21.4	0.85	1.66	42.8	14.3	28.5	60.1	18.2	0.56
16	B21	15 - 35	30.7	18.4	30.8	20.1	0.48	1.69	40.0	10.7	29.3	65.4	8.4	0.28
17	B22t	35 - 90	35.5	18.3	29.4	16.8	0.17	1.70	30.0	10.8	29.3	60.0	3.7	0.19
18	B23	90 - 145	51.3	24.6	9.5	14.6	0.01	1.69	44.3	7.4	37.1	50.2	9.2	0.12
Pedon 6	Pudupatti													
19	Ap	0 - 16	30.6	12.2	37.9	19.4	0.87	1.59	44.3	16.5	27.8	70.7	16.7	0.60
20	B21	16 - 48	34.0	14.3	31.3	20.5	0.25	1.57	41.0	12.4	28.6	50.6	12.4	0.31
21	B22t	48 - 80	39.7	21.4	21.5	16.9	0.12	1.65	40.2	10.2	30.1	50.0	4.4	0.19
22	B23	80 - 150	53.3	21.4	13.2	12.1	0.01	1.60	46.2	8.4	37.8	42.7	3.5	0.13
III. Subgroup: Typic Ustorthent														
Pedon 7	Athipatti													
23	Ap	0 - 14	3.9	6.4	50.3	35.5	34.00	1.73	32.5	29.0	3.6	9.3	12.8	0.10
24	A12	14 - 45	19.3	7.4	42.7	20.5	20.00	1.70	30.3	9.4	20.9	31.1	1.1	0.38
25	A13	50 - 110	27.3	10.5	37.0	25.2	12.00	1.81	30.1	7.3	20.8	26.4	1.6	0.12
Pedon 8	O.Mettupatti													
26	Ap	0 - 16	5.9	7.6	49.9	36.6	38.00	1.67	31.7	17.5	14.3	10.3	12.2	0.11
27	A12	16 - 50	19.8	8.9	41.1	30.2	18.00	1.87	36.9	7.5	29.4	37.3	4.9	0.20
28	A13	50 - 110	27.6	12.5	35.3	24.6	10.00	1.85	33.5	11.1	22.4	13.0	1.5	0.12
Pedon 9	Tiruchuli													
29	Ap	0 - 20	8.3	9.2	42.4	40.2	29.00	1.68	33.6	20.1	13.5	18.1	11.2	0.15
30	A12	20 - 40	11.0	8.5	41.3	39.3	25.00	1.85	40.5	5.4	35.2	48.0	12.6	0.25
31	A13	40 - 120	23.6	12.9	37.3	25.8	8.00	1.86	33.8	5.5	28.3	28.9	1.1	0.14

Table 2. Correlation between certain physical parameters for the subgroups put together

	r	Regression equation
Clay Vs Saturated hydraulic conductivity	-0.781**	Y = 26.59 - 0.659*
Fine sand Vs "	+0.739**	Y = 15.46 - 0.74x
Coarse sand Vs "	+0.774**	Y = -22.44 + 1.19x
Bulk density "	+0.184 NS	-
Non capillary porosity Vs Saturated hydraulic conductivity	+0.482*	Y = -4.88 + 1.05x

** Significant at 1% level; * Significant at 5% level

As the texture varied from heavy clay to low clay. the saturated hydraulic conductivity (Ks) increased from a very low level of 0.31 - 0.41 to as high as 20.0 - 22.0 cm/hr. A significant negative correlation of clay with Ks was recorded in subgroups viz., Uhsf (r = -0.761**), Thsf (r = -0.683**) and Tuot (r = -0.958**). Aggregate stability percentage (AS), organic carbon (OC) in the subgroups Uhsf and Thsf, non-capillary porosity in the Thas subgroup and coarse and fine sand in Tuot subgroup were significantly and negatively correlated with clay.

The silt content ranged from 10.0 to 16.3, 10.7 to 27.3 and 6.4 to 12.9 per cent in the profiles of subgroups Uhsf, Thsf and Tuot respectively. silt content was significantly and negatively correlated with coarse sand, fine sand and Ks in the subgroups Thsf and Tuot only. It was positively and significantly correlated with clay in the subgroups, Thsf (r = 0.757**) and Tuot (r = 0.775**).

Coarse and fine sand fractions varied from 23.2 to 29.9 and 16.0 to 34.1 in Uhsf; 12.9 to 21.4 and 5.2 to 39.1 in Thsf; and from 26.6 to 40.2 and 35.3 to 54.3 per cent in Tuot. Saturated hydraulic conductivity (Ks) maintained highly significant and positive correlation with coarse sand fraction (r = 0.809** in Uhsf; r = 0.722** in Thsf; and r = 0.858** in Tuot). The increasing sand content increased the non-capillary pores in the soils that facilitated the higher conductivities. Significant positive correlation with AS in Uhsf and Tuot subgroups and with non- capillary porosity (NCP) in the subgroup Thsf was observed. Find sand fraction also registered highly significant positive correlation with Ks in all the subgroups (r = 0.704** in Uhsf; r = 0.825 in Thsf and r = 0.889** in Tuot).

Bulk density of the pedons ranged from 1.43 to 1.82, 1.55 to 1.78 and 1.67 to 1.87 Mg m^{-3} in Uhsf, Thsf and Tuot subgroups respectively. Bulk density of soils registered significant negative correlation with Ks in the subgroups Uhsf (r = -0.548*) and Tuot (r = -0.740*). The influence of BD on Ks was observed to be independent of clay content even though clay content was significantly correlated with BD. This fact brings forth perhaps, that clay aone is not the only contributing factor for bulk density, but other parameters like organic carbon, cation content and their ratios also contributed. In this investigation, there was significant negative correlation between OC and BD (r = -0.616**). Bhatia and Srivastava (1982) reported that increasing BD would result in decreased total porosity of the soil, resulting in reduced Ks. It was significantly and negatively correlated with non-capillary porosity in the subgroups Thsf (r = -0.642) and Tuot (r = -0.676**).

The range of values of porosity parameters are presented in Table 1. Total porosity did not show any relationship with Ks in all the subgroups. The non-capillary porosity maintained highly significant positive correlations with Ks in the subgroups Thsf (r = 0.879**) and Tuot (r = 0.799*) only. The Ks tended to decrease with increasing capillary porosity (CP) as evidenced by a significant negative correlations between these parameters in the subgroup Thsf (r = -0/637*) and Tuot (r = 0.606*). this might be due to the fact that capillary pores do not form a continuous pore system and in fact increasing CP reduced the conductivity of water through soil, leading to reduced Ks.

The effective porosity (0_e) (calculated as the difference between the per cent moisture content at the soil saturation and the per cent moisture at 33 KPa tension) which ranged from 1.3 to 8.5, 0.2 to 27.4 and 1.1 to 12.8 per cent respectively showed highly significant and positive correlation with Ks in all the subgroups viz., Uhsf (r = 0.894**), Thsf (r = 0.845**) and Tuot (r = 0.894**). Aggregate stability (AS) percentage ranged from 19.9 to 56.7, 59.9 to 70.7 and 9.3 to 48.0 respectively in the soil subgroups, Uhsf, Thsf and Tuot respectively. The

AS recorded highly significant positive correlations with Ks and OC in the subgroups Uhsf and Thsf only.

REFERENCES

BHATIA,K.S. and SRIVASTAVA,A.K. 1982. Hydraulic conductivity and related soil properties under different land use. **Annals of Arid Zone 21**: 195-198.

BOUMA,J. and HOLE,F.D. 1971. Soil structure and hydraulic conductivity of adjacent virgin and cultivated pedons at two sites. **Soil Sci.Soc.Am.Proc. 35**: 316-318.

DHAKSHINAMOORTHY,C and GUPTA,R.P. 1968. **Practicals in Soil Physics.** IARI, New Delhi.

EKSTROM,G. 1927. Klassifikation as svensk akerjordav Sv. Geol.Undersoku., ser.C., nv. 345. Quoted by Messing, I.1989. **Soil Sci.Soc.Am.J. 53**: 665-668.

FISHER,R.A. 1936. **Statistical Methods for Research Workers.** Oliver and Boyd, London.

MCNEALS, B.L. 1968. Factors influencing hydraulic conductivity of soils in the presence of mixed salt solutions. **Soil Sci. Soc.Am.Proc.32**: 187-190.

PIPER,C.S. 1966. **Soil and Plant Analysis.** Hans Publications, Bombay.

Madras Agric. J., 81(10): 545-547 October, 1994

DISTRIBUTION OF MICRONUTRIENTS IN LOWER BHAVANI PROJECT COMMAND AREA SOIL PROFILES

P.PARAMASIVAM and A.GOPALSWAMY
Dept. of Soil Science, TNAU, Coimbatore.

ABSTRACT

The study of distribution of micronutrients in major soils of Lower Bhavani Project Command Area revealed that total and available Zn,Fe and Cu decreased with depth in Lithic Haplustalf, Typic Ustochrept, Typic Haplustalf and Typic Chromustert, while total Mn decreased only in Lithic Haplustalf and Typic Ustochrept. But in Typic Ustifluvent, there is an irregular distribution of both total and available Zn,Fe,Cu and Mn. All the micronutrients are in sufficient level except Zn indicating the need for $ZnSO_4$ for sustainable crop production. All the micronutrients are closely related with organic carbon and clay.

The soils of Lower Bhavani Project Command area, which is intensively cultivated, occur in various types of Physiography. Importance of Micronutrients viz., Zn, Cu, Fe and Mn to agricultural crops well augmented and recognised in India. The deficiency of micronutrients has been observed in light textured and calcareous soils. Such deficiencies/sufficiencies of micronutrients in soils are likely to increase due to the introduction of High Yielding Varieties and intensive cropping system in Indian agriculture. The fertility status and fertilizer recommendations are essential to transfer the agrotechnology to other soils having comparable soil properties. Hence, the present investigation was carried out to assess the micronutrient status of soils occurring at different physiography.

MATERIALS AND METHODS

The soil samples were collected from five profiles representing soils of different physiographic units and processed for laboratory investigation. Organic carbon content and free calcium carbonate of soils were determined by usual procedures. The available micronutrients cation were extracted with solution consisting of 0.05M. DTPA, 0.01M $CaCl_2$ and 0.1M Triethanolamine (pH 7.3) as per the procedure outlined by Lindsay and Norvell (1978) and Fe, Cu, Mn and Zn were estimated in the extracts with Atomic Absorption Spectrophotometer. Total micronutrient cations were estimated by digesting the soil (0.5 mm sieved) in a mixture of HF and perchloric acid at 180-200° C.

RESULTS AND DISCUSSION

Soil characteristics are presented in the table 1. Upper terraced soil (Lithic Haplustalf) was low in pH (7.2 - 7.5), $CaCO_3$ (<%) and organic carbon (0.2%) than plain soil (Typic Chromustert) which was relatively high in pH (8.3 - 8.7), $CaCO_3$ (4.2-7.9%) and medium in organic carbon content (0.38 - 0.53%). The soil occurring in alluvial fan (Typic Ustifluvent) was low in $CaCO_3$ (0.12 - 0.24%) but having the highest organic carbon (0.6%) content among the pedons. There is no