

INFILTRATION AND HYDRAULIC CONDUCTIVITY OF TEN MAJOR SOIL SERIES OF TAMIL NADU

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ABSTRACT

A study conducted to characterise the major soil series of Tamil Nadu for infiltration rate (IR) and hydraulic conductivity (HC) indicated that the soils coming under the Vertisol order possessed lowest IR followed by Alfisol, Inceptisol and Entisol. The hydraulic conductivity of the soils had shown the presence of hardpan in the sub surface of the soils coming under Alfisols. Among the soil physical properties, there was a positive and significant correlation between the sand content and HC and negative correlation with the silt and clay content. Peelamedu, Perianaickenpalayam, Palathurai, Madukkur and Pattukkottai soil series have moderate IR with moderate to rapid HC. Tulkanur, Palladam and Vyalogam soil series have moderately rapid IR with rapid to very rapid HC. Irugur soil series showed rapid IR with moderately rapid HC, while Kalathur soil series recorded moderately poor IR and moderate HC.

KEY WORDS: Infiltration rate ; Hydraulic conductivity, Major soil series of Tamil Nadu.

INTRODUCTION

Infiltration is one of the important factors controlling agricultural production. It controls supply of water to the root zone and prevents erosion due to high runoff over the surface. Soil surface crusting is a common problem in semi arid and arid soils. Due to clay dispersion, clogging of soil pores or swelling of mono valent cations, the infiltration rate is drastically reduced (Helalia *et al.*, 1988). Structural disturbance of rain drops impact and sorting action of water flowing over the soil surface reduces hydraulic conductivity of such soils to large extent. Structural stability, a measure of permeability and hydraulic conductivity is also affected by texture. The 2:1 type of clays with high amounts of exchangeable sodium is very sensitive to the change in the valence of adsorbed cations and the electrolyte concentration of the soil solution and under arid conditions becomes infiltrable (Chiang *et al.*, 1987). The entrapped air also contributes to the hydraulic conductivity of the soil. Suarez *et al.*, (1984) observed that the increase in saturated hydraulic conductivity was due to gradual escape of entrapped air from soil pores. High silt content weakens soil structure and creates a high density crust causing reduction in infiltrability and hydraulic conductivity (Evans and Buol, 1968). Frankel *et al.*, (1978) reported that clay

type and content affected the hydraulic conductivity.

It is seen, thus, various soil factors influenced the infiltration rate and hydraulic conductivity of the soils. Therefore in the present investigation the infiltration rate and hydraulic conductivity were characterised in some important soil series.

MATERIALS AND METHODS

Bench mark profiles from 10 major soil series of Tamil Nadu were dug opened. The details of the soil series, location and the sub group are furnished in Table 1. The profile represented Vertisols, Alfisols, Inceptisols and Entisols. In addition to recording the morphological characteristics of the profiles, undisturbed soil core samples from each horizon of the profiles were collected and analysed for saturated hydraulic conductivity and bulk density and *in situ* infiltration rate by the standard methods (Gupta and Dakshinamurti, 1981). The pH, electrical conductivity and particle size fractions were analysed following the methods described by Jackson (1973). The results are discussed in this paper.

RESULTS AND DISCUSSION

Irugur soil series (Typic Ustorthents)

The soil texture ranged from loamy sand to caly loam. These were dark brown (2.5 YR 4/6) to dark gray (2.5 YR 3/4) soils of recent alluvial origin with saturated hydraulic conductivity ranging from 11.2 to 11.6 cm h⁻¹. The steady state infiltration rate was 15.2 cm h⁻¹. Thus Irugur soil series showed rapid infiltration rate due to higher sand fractions constituting about 81.4 per cent in the particle distribution. This also caused moderately rapid HC.

Palladam soil series (Typic Ustochrepts)

These were medium textured dark brownish gray (5 YR 4/4) calcareous soils. The steady state infiltration rate was 8.6 cm h⁻¹ which is rated as moderately rapid. The hydraulic conductivity was also rated as rapid (12.8 cm h⁻¹). This may be due to gravelly loamy sand texture. The positive and significant correlation between the sand content and hydraulic conductivity ($r= 0.566^{**}$) and negative correlation with the silt and clay content ($r= -0.519^{**}$ and 0.879^{**} respectively) supports the above conclusion.

Perianaicken palayam and Peelamedu soil series (Typic Chromusterts)

The soils were dark brownish gray (10 YR 3/2) clay to clay loam that develop deep and wide cracks during the period of moisture deficiency. The clay mineralogy was dominantly montmorillonitic. The infiltration rate was moderate (2.6 cm h⁻¹) and the hydraulic conductivity was also moderate in Peelamedu series (2.9 cm h⁻¹). The soil reaction was on the alkaline range (8.1 to 8.9). The salt content also increased with depth, the EC being 0.3 to 2.2 dSm⁻¹. Correspondingly the bulk density also increased with depth. In Perianaickenpalayam series, the saturated hydraulic conductivity was moderate at the surface soil, while slow to very slow at the subsurface layers upto 102 cm indicating impeded drainage. The pH ranged from 7.5 to 8.0 indicating slight alkalinity although EC did not show any salinity problem.

Kalathur soil series (Udic Pellusterts)

These are dominantly dark gray (5 YR 3/2) cracking soils of montmorillonitic mineralogy. The steady state infiltration rate was 1.8 cm h⁻¹

Table 1. Particulars of the profiles representing major soil series of Tamil Nadu.

Sl.No.	Series	Location	District	Sub group
1.	Irugur	Thirumalainathampatty	Coimbatore	Typic Ustorthent
2.	Palladam	Palladam	Coimbatore	Typic Ustochrept
3.	Perianaickenpalayam	Perianaickenpalayam	Coimbatore	Typic Chromustert
4.	Peelamedu	Udumalpet	Coimbatore	Typic Chromustert
5.	Kalathur	Tanjore	Tanjore	Udic Pellustert
6.	Palathurai	Palakanathur	Madurai	Udic Haplustalf
7.	Marukkur	Thiruvudagam	Madurai	Typic Haplustalf
8.	Tulukkanur	Paramathy	Trichy	Typic Rhodustalf
9.	Vyalogam	Gundur	Trichy	Typic Rhodustalf
10.	Pattukkottai	Karapatti	Trichy	Ultic Haplustalf

Table 2. Analytical data of the major soil series of Tamil Nadu.

P.No.	Series	Depth (cm)	Clay (%)	Silt (%)	IR (cm h ⁻¹)	HC (cm h ⁻¹)	B.D. (Mg m ⁻³)	pH	EC (dSm ⁻¹)	Texture
1.	Irugur	0-28	7.2	5.4	15.2	11.6	1.69	7.6	0.2	ls
		28-60	23.2	2.6		11.2	1.74	7.7	0.3	scl
2.	Palladam	0-8	11.2	20.4	8.6	12.8	1.56	8.0	0.2	sl
		8-23	16.8	14.5		8.8	1.74	8.2	0.2	sl
3.	Perianaiken palayam	0-16	26.2	24.2	2.6	6.0	1.57	7.9	0.4	scl
		16-45	15.2	15.8		0.6	1.54	7.7	0.4	sl
		45-102	30.5	30.1		0.1	1.51	7.8	0.4	cl
		102-135	32.1	30.5		3.9	1.40	7.8	0.4	cl
4.	Peelamedu	0-17	51.5	6.6	2.6	2.9	1.28	8.1	0.3	c
		17-49	49.1	0.3		1.2	1.48	8.7	1.0	sc
		49-80	46.6	7.6		0.3	1.60	8.8	2.2	sc
		80-125	47.9	1.2		0.3	1.42	8.9	2.2	sc
5.	Kalathur	0-12	57.4	22.0	1.8	3.2	1.17	8.0	0.2	c
		12-33	46.3	11.0		1.8	1.63	8.5	0.2	c
		33-93	41.1	19.9		0.6	1.45	8.0	0.2	c
		93-175	41.7	11.8		0.1	1.56	7.9	0.2	c
6.	Palathurai	0-20	16.2	0.5	4.2	2.4	1.70	8.2	0.2	sl
		20-51	34.2	0.7		0.1	1.71	8.1	0.2	scl
		51-63	41.7	4.2		0.1	1.65	7.8	0.2	sc
		63-102	41.7	2.4		1.8	1.85	7.5	0.3	sc
7.	Tulukkanur	0-13	14.6	2.1	8.2	26.4	1.47	7.2	0.2	sl
		13-31	22.4	2.0		11.9	1.66	7.4	0.2	scl
		31-47	33.2	3.1		12.3	1.63	7.6	0.2	scl
8.	Vyalogam	0-10	8.2	5.2	11.4	23.3	1.64	6.9	0.2	s
		10-40	48.2	8.2		0.1	1.85	7.0	0.2	c
		40-110	51.2	5.4		0.1	2.00	7.0	0.1	c
9.	Madukkur	0-15	13.4	9.7	2.4	7.5	1.66	8.4	0.3	sl
		15-27	14.4	15.2		2.3	1.78	8.1	0.5	sl
		27-48	25.9	15.2		5.0	1.72	8.2	0.3	scl
		48-77	15.4	5.4		31.2	1.42	8.4	0.3	sl
		77-110	30.2	6.7		20.0	1.50	8.1	0.1	scl
10.	Pattukkottai	0-15	8.1	3.9	4.4	9.2	1.59	8.2	0.2	s
		15-59	32.0	6.4		1.8	1.64	7.1	0.2	scl
		59-120	23.4	9.3		1.0	1.92	7.2	0.2	scl

indicating slow entry of water with moderate hydraulic conductivity (3.2 cm h⁻¹) in the surface layer which decreased with depth to even traces at the lowest horizon. The pH of the soil was alkaline. The texture with silty clay to clay. This

may tend to run-off loss of water during rainy seasons.

Palathurai soil series (Udic Haplustalf)

These soils were deep, matured medium to heavy textured and reddish brown (5.0 YR 4/4) soils

with an argillic horizon. They do not have calcic horizon within 1.25 metres. The infiltration rate (4.2 cm h^{-1}) and the hydraulic conductivity was moderated (2.4 cm h^{-1}) in the surface horizon. It decreased sharply with the depth perhaps due to increased clay content with depth. This is supported by a negative and significant correlation between HC and clay content ($r = -0.879^{**}$). Similar observations were reported by Frankel *et al.*, (1978).

Madukkur soil series (Typic Haplustalf)

The morphological features of the soils were the same as Palathurai series except that it had calcic horizon within 1.25 metres. The infiltration rate was 2.4 cm h^{-1} which was moderate and the hydraulic conductivity was moderately rapid (7.5 cm h^{-1}) at the surface horizon which was reduced to 5.0 cm h^{-1} at 27 - 48 cm layer. Still at deeper horizons it increased substantially to 31.2 cm h^{-1} indicating textural variations in the horizons which influenced HC in the profile.

Tulukkanur soil series and Vyalogam soil series (Typic Rhodustalfs)

These soils were reddish brown (5.0 YR 4/4) to yellowish red (5 YR 4/6) with an argillic horizon. The infiltration rate was moderately rapid in both Tulukkanur soil series (8.2 cm h^{-1}) and Vyalogam soil series (11.4 cm h^{-1}). In Vyalogam soil series because of the presence of high amounts of clay and bulk density layers below 10 cm from the surface (1.85 to 2.00 Mg m^{-3}) the hydraulic conductivity was also reduced to mere traces at subsoil layers.

Pattukottai soil series (Ultic Haplustalf)

These soils are sandy loam to clay loam textured, reddish yellow (7.5 YR 6/6) to dark red (2.5 YR 3/6). The infiltration rate was 4.4 cm h^{-1} which was moderate. The bulk density increased

with depth and the very high bulk density at 59 - 120 cm layer (1.92 Mg m^{-3}) was due to the presence of high amount of iron concretions. Hydraulic conductivity decreased with depth from 9.1 cm h^{-1} to traces and with increasing bulk density. The low hydraulic conductivity in the 59 - 120 cm horizon was due to high amount of clay and compaction.

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