



Physical properties and fertility status of the rice soils of Thanjavu district

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Abstract: Survey on rice soils of Thanjavur district was undertaken for identifying physical and fertility constraints limiting crop production. Profile studies were conducted at 23 locations covering 8 predominant soil series under vertisol, alfisol, entisol and inceptisol. Among the soils, Alangudi and Kalathur series showed poor infiltration and impeded drainage conditions. In Madukur and Pattukottai series moisture retention was poor. Regarding fertility, soils were mostly deficient in available N. Available P was high in Kalathur, Madukkur and Padugai series. While available K was high in Alankudi, Kalathur and Melkadu series.

Key words : Physical constraints, Moisture retention, Fertility.

Introduction

For increasing production levels of agricultural lands, besides nutrient management practices aim to sustain productivity of the soil and hence require identification of physical problems associated within the profile of cropped lands. High permeability and low water retentivity, slow permeability and poor aeration, high mechanical impedance in sub-surface soil, shallow soil etc., are the major causes physically limiting crop production. In order to draw information on these lines, physical properties and fertility status of important soil series of Thanjavur district were studied and detailed in this paper.

Materials and Methods

Thanjavur district, the rice bowl of Tamil Nadu occupying a total geographical area of 3.6 lakh hectares, covers eight major soil series (Soil Survey, 1990) under four soil orders viz. vertisol, alfisol, entisol and inceptisol (Table 1). Nearly three-fourth area is occupied by Kalathur, Adanur, Madukkur, Patukottai and Padugai series.

For the study, to represent entire district, profiles were opened during 1997 at 23 locations. However, the present description is limited to 8 locations covering the major eight soil series (Table 1). Undisturbed soil cores of size 7.0 cm diameter x 7 cm height were collected horizon-wise and physical parameters were estimated in the laboratory following standard method of analysis. Using double ring infiltrometer in situ infiltration rate was carried out (Gupta

and Dakshinamoorthy, 1981). Using bulk so sample collected from horizons available 1 ($\text{KMnO}_4\text{-N}$), P ($\text{NaHCO}_3\text{-P}$), K ($\text{NH}_4\text{OAc-K}$) and cation exchange capacity (CEC) were estimated to assess soil fertility as per standard procedure.

Results and Discussion

The preliminary objective of the study was covered by examining the major morphological features of each series and relating the physical properties (Table 2), and fertility and moisture retention characteristics (Table 3). From the investigation, following information on soil physical conditions and constraints is brought out for each series.

Alangudi series (Entic Chromustert)

The soils are dark, greyish brown to dark, yellowish brown, and clay in texture with 26 mm surface thickness. The immediate sub-surface horizon was nearly 50 cm thick, dominant in clay and relative to the horizon above it had high bulk density. Further it was sticky and plastic when wet and very hard when dry. Infiltration rate was low, but hydraulic conductivity was very high in such horizon. With depth, hydraulic conductivity decreased which may be possibly due to increase in bulk density as reported by Ghildayal and Gupta (1991). Available nutrients were low for N, medium for P and high for K. Soil had high CEC throughout the profile and alkalinity increased with depth. The moisture retention capacity of the profile was very high.

Table 1. Per cent distribution and locations of the study area

Order	Soil series	Sub group	per cent distribution	Location of the study area
Vertisol	Alangudi	Entic Chromustert	17.14	Perungudi
Vertisol	Kalathur	Udothentic Pellustert	4.46	Thittai
Alfisol	Madukkur	Udic Haplustalf	30.89	Pulavankadu
Alfisol	Pattukkottai	Ultic Haplustalf	11.43	Senniavidithi
Entisol	Melkadu	Aquic Udifluent	1.40	Parakkalakottai
Entisol	Padugai	Typic Ustifluent	10.72	Kadiramangalam
Inceptisol	Adanur	Vertic Ustropept	8.92	Adanur
Inceptisol	Peravurani	Typic Ustropept	1.85	Korattur Ukkadai

Kalathur series (Udothentic Pellustert)

The soils are light brownish gray to very grayish brown. Surface horizon was within 5 cm and the sub surface horizon was double the thick of surface horizon. Both horizons were dominant in clay of montmorillonite type (40%) and forms cracks when dry. Down the profile alkalinity increased, a common characteristic of Vertisol (Walia and Rao, 1996). In case of CEC, hydraulic conductivity, capillary porosity and bulk density, a decrease was observed with depth. In the surface horizon available N was low, P and K were high. Infiltration rate was poor, but the profile showed very high capacity to retain moisture.

Adanur series (Vertic Ustropept)

The soils under this series were dark brown to very dark yellowish brown with sandy clay loam in texture and a sand belt was noticed at the bottom most horizon. All the horizons were near neutral in pH, bulk density and capillary porosity were more or less uniform and normal. Moisture retention capacity was very high. Available nutrients decreased with depth. In surface available N was low, whereas available P and K were medium.

This series is an allied series of Kalathur series but there will be a sand belt below 15 cm (approximately).

Madukkur series (Udic Haplustalf)

The horizons varied from very dark grayish brown in surface to yellowish brown in subsurface.

The soil was neutral with low CEC, because the kaolinite clay forms the dominating clay in this series. Infiltration rate was high. The horizons within 75 cm were sandy clay loam in texture with medium porosity and moderate hydraulic conductivity. However, with depth hydraulic conductivity decreased which may be attributed to relative increase in clay content. Similar finding was reported by Mahendran and Mathan (1995). In surface soil available N was low, but P and K were high. Remarkably, subsurface horizons were poor in all nutrients. In addition, moisture retention capacity of the profile was also low.

Pattukkottai series (Ultic Haplustalf)

The soil showed dark grayish brown, strong brown and yellowish brown variations with depth. Within 90 cm depth, the soil was sandy clay loam in texture, neutral in pH with low CEC, and showed moderate hydraulic conductivity. Further the moisture retention of soil was high. Surface soil had low available N and medium levels of P and K.

The two soil series namely Pattukkottai and Madukkur are allied series and occur in close association and mostly the crop management practices will decide the existence of these series. If the soil is maintained under upland condition, the Pattukkottai series will exist and the same soil is maintained under submerged conditions continuously will become Madukkur series and hence these two series are considered as the man made series.

Table 2. Physical properties of major soils of Thanjavur district

Soil series	Profile depth (cm)	Clay (%)	Texture*	Bulk density (Mg/m ³)	Capillary porosity (%)	Hydraulic conductivity (cm hr ⁻¹)	Infiltration rate (cm hr ⁻¹)
Alangudi	0-26	40.0	c	1.18	47.7	2.03	1.36
	26-77	38.4	c	1.34	41.3	2.07	
	77-118	44.7	c	1.51	46.5	1.92	
	118-189	38.1	scl	1.65	40.6	1.86	
Kalathur	0-24	48.4	c	1.16	45.0	1.58	0.80
	24-70	49.5	c	1.38	42.5	1.61	
	70-110	50.9	c	1.48	42.0	1.22	
	110-143	32.4	scl	1.42	37.9	1.48	
	143-200	37.3	scl	1.76	40.7	1.16	
Madukkur	0-18	18.0	scl	1.68	39.0	3.11	3.00
	18-34	21.4	scl	1.85	38.7	2.22	
	34-74	27.5	scl	1.56	37.6	2.17	
	74-127	35.8	sc	1.61	33.5	1.83	
	127-172	28.7	scl	1.59	34.0	2.76	
Pattukottai	0-17	20.6	scl	1.62	43.2	3.71	3.24
	17-47	26.8	scl	1.58	37.5	2.85	
	47-92	29.2	scl	1.47	39.2	2.43	
	92-126	37.4	sc	1.52	48.4	1.24	
	126-196	36.5	sc	1.44	43.6	1.24	
Melkadu	0-13	18.9	sl	1.72	24.1	6.40	3.20
	13-45	21.2	scl	1.83	34.6	3.52	
	45-65	31.9	scl	1.89	37.4	2.73	
	65-118	22.7	scl	1.47	35.7	2.15	
	118-160	38.7	scl	1.40	21.8	5.20	
Padugai	0-29	43.8	c	1.36	35.3	3.42	4.63
	29-59	27.7	scl	1.47	39.1	3.04	
	59-94	27.3	scl	1.60	30.4	2.68	
	94-114	2.5	s	1.73	24.4	14.98	
	114-170	1.3	s	1.47	21.4	17.22	
Adanur	0-15	34.6	scl	1.37	40.7	2.22	2.79
	15-55	35.0	scl	1.36	39.9	2.22	
	55-83	32.9	scl	1.33	38.9	2.01	
	83-151	29.5	scl	1.42	40.2	2.06	
	151-190	16.7	ls	1.45	21.8	7.01	
Peravurani	0-11	19.0	scl	1.67	41.9	2.42	4.80
	11-42	23.4	scl	1.75	36.3	1.55	
	42-74	27.6	scl	1.84	35.8	2.02	
	74-115	24.3	scl	1.79	35.1	1.83	
	115-179	15.8	sl	1.88	26.1	4.07	

* c: clay; scl: sandy clay loam; sc: sandy clay; sl: sandy loam; s: sand; ls: loamy sand

Table 3. Fertility and available water capacity of soil series

Soil series	Profile depth (cm)	pH	CEC (C mol p(+) kg ⁻¹)	Available nutrients (kg ha ⁻¹)			Available moisture capacity (cm m ⁻¹)
				N	P	K	
Angudi	0-26	7.8	40.4	179	15.6	474	22.0
	26-77	9.1	37.6	175	8.6	341	
	77-118	9.2	40.6	168	6.1	266	
	118-189	9.1	39.8	137	4.6	215	
Alathur	0-24	8.4	33.4	255	26.9	1182	24.8
	24-70	8.7	30.3	158	9.9	768	
	70-110	8.7	19.8	93	8.5	394	
	110-143	8.9	17.2	66	7.0	259	
	143-200	8.8	11.2	64	5.6	84	
Aradukkur	0-18	8.1	8.1	161	25.7	421	8.4
	18-34	7.2	5.8	123	1.3	81	
	34-74	7.5	5.8	69	1.3	70	
	74-127	7.5	6.1	54	1.3	57	
	127-172	7.9	8.5	28	1.3	57	
Attukottai	0-17	6.7	8.3	171	16.2	267	17.5
	17-47	7.1	2.5	156	6.8	114	
	47-92	7.3	3.6	144	5.4	168	
	92-126	7.3	5.1	144	5.4	159	
	126-196	7.1	6.1	106	4.1	170	
Kelkadu	0-13	7.4	14.3	218	44.3	206	7.83
	13-45	7.9	14.3	81	12.9	151	
	45-65	8.1	18.2	62	7.6	144	
	65-118	9.2	15.7	47	5.5	116	
	118-160	7.5	22.4	47	2.8	83	
Kadugai	0-29	7.6	26.6	124	23.0	120	20.1
	29-59	7.6	11.9	104	17.9	81	
	59-94	7.4	8.9	95	10.9	57	
	94-114	7.6	3.1	25	2.7	34	
	114-170	7.2	5.7	16	1.3	34	
Kadanur	0-15	7.3	28.5	172	19.5	243	24.1
	15-55	7.7	27.4	153	15.3	154	
	55-83	7.6	31.1	157	16.6	116	
	83-151	7.8	27.5	122	8.1	108	
	151-190	8.3	5.4	47	2.7	34	
Peravurani	0-11	7.6	7.3	177	2.8	79	15.3
	11-42	8.5	7.9	103	1.3	92	
	42-74	9.1	11.2	61	1.3	92	
	74-115	9.1	13.0	52	1.3	104	
	115-179	9.1	13.1	23	1.3	93	

Melkadu series (Aquic Udifluent)

With increase in depth, soil varied from gray, brown and light yellowish brown in colour and from sandy clay loam and sandy clay in texture. Horizons constituting 0-65 cm were neutral with moderate CEC and medium porosity, moderately slow infiltration rate, and moderately rapid hydraulic conductivity. The horizons underlying were near alkaline associating with high clay and moderate hydraulic conductivity. The status of available N was low, available K was medium, but available P was noticeably high, especially in surface. Low moisture retention was observed.

Padugai series (Typic Ustifluent)

The soils are very dark brown to dark yellowish brown. The surface horizon was clay and subsurface horizons were sandy clay loam in texture. Soil was neutral in reaction throughout the profile. Surface horizon within 30 cm showed wide (1 cm) cracks due to the presence of expanding type of clay minerals. Hydraulic conductivity was moderate in surface and rapid in subsurface horizons, possibly due to drastic decrease in clay content with depth. This consequently resulted in an increase in sand and bulk density, a contrary situation to other series. However, moisture retention at the surface was very high when compared to Madukkur and Melkadu series. This could be because of higher clay content of horizons within a meter in Padugai than the above two series. Alike the situation reported earlier by Mathan *et al.* (1991) and Pagnis *et al.* (1996). Regarding fertility, surface soil showed low levels of available N and K, but available P was high.

Peravurani series (Typic Ustropept)

Soils were yellowish brown in surface and brown in subsurface. While surface was neutral, subsurface horizons were alkaline. Texture was sandy clay loam throughout the profile. Profile had moderate hydraulic conductivity and high moisture retention capacity. However, the

soil was poor in fertility with low levels of available N, P and K throughout the profile.

In abstract, Alankudi and Kalathur series indicated impeded drainage conditions due to the high bulk density, poor infiltration and sub-surface alkalinity causing dispersion. Whereas moderate hydraulic conductivity associated with sandy clay loam textures predisposed to poor moisture retention, particularly in Madukkur and Padugai series. In the case of Alankudi, Kalathur, Madukkur and Padugai series, available K was remarkably high. Physical conditions of Pattukottai, Adanur and Peravurani series were found to be normal.

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