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EFFECT OF LONGTERM FERTILIZATION ON PHYSICAL PROPERTIES OF SOILS

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ABSTRACT

Analysis of soil from the permanent manurial plots of Tamil Nadu Agricultural Unviersity farm at Coimbatore revealed that the clay content had a positive influence on water holding capacity and total pore space of soil and a negative influence with respect to hydraulic conductivity. Continuous application of cattle manure for 84 years recorded higher values for all the physical properties evaluated.

KEY WORDS : Longterm fertilization, organic, inorganic manures, water holding capacity, total pore space, hydraulic conductivity

Fertilizer application is an indispensable and integral part of modern crop production. Continuous application of manures and fertilizers is bound to influence the soil physical and chemical proeprties. Hence, the present study was undertaken in longterm experiments to evaluate the effect of longterm fertilization on soil physical proeprties and the results are presented in this paper.

MATERIALS AND METHODS

Soil samples were collected from the new and old permanent manurial plots at the Tamil Nadu Agricultural University farm, Coimbatore to study the effect of longterm fertiliztion on some physical properties of soils. The Old Permanent Manurial experiment (OPM) was started in the year 1909 and it is under rainfed condition. The New Permanent Manuarial experiment (NPM) started in the year 1985 is under irrigated condition. Each experiment has 10 treatments. The treatments being tried in both the experiments are (1) control (2) N, (3) NK, (4) NP, (5) NPK, (6) PK, (7) K, (8) P, (9) cattle manure and (10) cattle manure residue. Treatments 9 and 10 will receive cattle manure in alternative seasons *i.e.* CM plot will be the CMR plot in the succeeding season and *vice versa*. N, P, K are being

Table 1. Fertilizer doses

	N	P_2O_5	K_2O	FYM
	---------- kg ha^{-1} ----------			t ha^{-1}
Cotton	60.00	20.00	10.00	10.00
Sorghum	90.00	33.75	22.25	10.00
Cowpea	25.00	50.00	10.00	10.00

Table 2. Effect of treatments on clay (%) content

Treatments	OPM Depth (cm)			NPM Eastern Series Depth (cm)			NPM Western Series Depth (cm)		
	0-15	15-30	30-45	0-15	15-30	30-45	0-15	15-30	30-45
Control	21.83	25.85	28.45	33.75	32.50	26.00	30.50	37.5	43.25
Nitrogen	22.90	25.05	30.85	33.52	30.14	29.25	32.60	37.8	38.0
Nitrogen & Potassium	21.55	27.85	30.23	31.15	29.45	24.00	33.45	30.84	30.77
Nitrogen & Phosphorus	22.64	24.25	24.34	29.80	29.20	23.8	33.55	30.75	36.20
Nitrogen, Phosphorus & Potassium	20.93	23.17	25.66	29.34	29.85	22.74	33.80	20.87	41.50
Phosphorus & Potassium	24.36	28.09	26.77	29.25	26.23	21.87	31.75	23.45	35.65
Potassium	24.0	29.37	30.04	28.64	25.37	20.34	32.50	26.48	36.99
Phosphorus	20.76	26.52	21.46	28.54	28.10	20.15	34.75	19.75	22.34
Cattle manure	22.74	32.23	33.75	28.30	31.25	19.85	35.5	18.45	23.81
Cattle manure residue	22.68	28.75	31.35	27.56	32.45	20.95	35.7	19.34	25.22

Table 3. Effect of treatments on water holiding capacity % (OPM & NPM)

Treatments	OPM Depth (cm)			NPM Eastern Series Depth (cm)			NPM Western Series Depth (cm)		
	0-15	15-30	30-45	0-15	15-30	30-45	0-15	15-30	30-45
Control	42.8	50.9	58.3	64.3	62.0	56.0	60.0	64.4	65.5
Nitrogen	46.5	53.5	59.7	62.9	61.8	59.7	62.9	65.3	65.2
Nitrogen & Potassium	45.8	49.8	51.3	60.8	59.5	54.0	63.0	60.3	60.3
Nitrogen, Potassium & Phosphorus	53.5	53.3	54.3	59.3	59.9	52.1	64.0	46.3	66.2
Phosphorus & Potassium	50.2	57.4	58.4	58.6	56.4	49.9	57.0	48.9	60.8
Potassium	51.1	55.4	58.4	58.2	54.3	47.5	59.8	56.5	61.9
Phosphorus	45.5	54.9	59.6	56.5	57.5	46.9	63.6	45.9	47.5
Cattle manure	52.4	53.8	54.9	59.0	62.0	44.4	63.7	41.8	49.3
Cattle manure residue	59.7	62.5	60.6	58.5	62.3	45.0	64.0	44.9	55.5
		S.Ed		CD	S.Ed	CD	S.Ed	CD	
Depth (D)		0.129		0.236	0.126	0.265	0.116	0.243	
Treatment (T)		0.272		0.236	0.230	0.484	0.211	0.444	
D X T		0.409		0.859	0.399	0.830	0.366	0.769	

applied through urea, SSP and MOP respectively. In the NPM, the treatments are repeated in two series namely eastern and western series. A basal dose of FYM at 2000 kg ha^{-1} is applied to all but CMR plot in the western series as the initial soil fertility was lower in this than that of the eastern series.

The rate of fertilizers and manrues being applied is furnished in Table 1. Cotton followed by sorghum is the cropping sequence in OPM while in NPM cotton - cowpea is the rotation followed.

The core cutter soi samples were collected from the experimental plots at the rate of 3 samples per treatment from 3 depths *viz.*, 0-15, 15-30 and 30-45 cm during 1993. Waterholding capacity, total pore space and hydraulic conductivity were determined as per the routine methods.

RESULTS AND DISCUSSION

In the OPM plots, higher water holding capacity was observed in the 15-30 and 30-45 cm layers as compared to the surface soils. This was

Table 4. Effect of treatments on Total Porocity % (OPM & NPM)

Treatments	OPM Depth (cm)			NPM Eastern Series Depth (cm)			NPM Western Series Depth (cm)		
	0-15	15-30	30-45	0-15	15-30	30-45	0-15	15-30	30-45
Control	56.8	60.0	62.5	59.0	58.3	55.3	52.0	62.9	64.8
Nitrogen	58.9	59.9	63.8	57.0	56.2	55.0	54.7	63.8	62.8
Nitrogen & Potassium	56.7	62.0	63.4	56.5	55.9	52.9	56.2	57.9	59.0
Nitrogen & Phosphorus	57.5	55.1	58.9	55.9	54.2	52.5	55.6	56.4	59.9
Nitrogen, Phosphorus & Potassium	56.9	57.4	59.0	55.8	55.0	51.6	56.9	50.1	63.7
Phosphorus & Potassium	60.3	62.3	59.6	55.2	53.9	50.8	53.4	53.7	60.8
Potassium	59.1	62.9	62.9	54.9	52.8	49.0	54.5	59.3	61.9
Phosphorus	56.9	60.8	56.6	54.0	54.9	48.7	60.1	46.7	53.3
Cattle manure	57.2	63.8	64.2	53.7	57.5	44.9	61.3	47.0	54.2
Cattle manure residue	58.6	62.3	60.8	50.0	57.1	49.7	62.4	50.3	55.2
	S.Ed	CD	S.Ed	CD	S.Ed	CD			
Depth (D)	0.116	0.247	0.124	0.261	0.404	0.848			
Treatment (T)	0.215	0.452	0.261	0.226	0.737	0.1550			

Table 5. Effect of treatments on hydraulic conductivity (cm hr^{-1})

Treatments	OPM Depth (cm)			NPM Eastern Series Depth (cm)			NPM Western Series Depth (cm)		
	0-15	15-30	30-45	0-15	15-30	30-45	0-15	15-30	30-45
Control	10.5	7.9	6.6	5.5	6.8	11.9	9.3	4.8	3.7
Nitrogen	9.9	8.2	5.5	6.2	7.2	10.4	8.9	3.9	4.7
Nitrogen & Potassium	10.9	6.5	5.5	7.3	8.4	15.6	8.3	9.2	9.1
Nitrogen & Phosphorus	10.1	12.6	8.98	9.5	10.8	16.5	7.9	9.5	6.2
Nitrogen, Phosphorus & Potassium	12.5	9.9	9.5	9.4	11.0	17.9	7.1	21.9	3.7
Phosphorus & Potassium	7.9	6.7	8.1	10.9	11.5	18.9	9.1	19.2	6.4
Potassium	8.4	5.9	5.1	11.3	14.9	19.5	8.8	12.5	5.8
Phosphorus	18.0	8.8	10.8	12.9	12.3	23.0	6.7	23.9	17.8
Cattle manure	9.8	4.3	4.1	10.3	7.4	24.2	6.1	24.5	16.4
Cattle manure residue	10.2	6.6	4.8	11.3	6.4	23.0	5.9	23.6	14.2
	S.Ed	CD	S.Ed	CD	S.Ed	CD			
Depth (D)	0.129	0.272	0.126	0.265	0.116	0.243			
Treatment (T)	0.236	0.496	0.230	0.484	0.211	0.444			
D X T	0.409	0.859	0.399	0.839	0.366	0.769			

due to the increase in clay content (Table 2) with depth. Besides, the organic carbon content, also exhibited an increasing trend with depth and this could be another reason for increased value in the subsurface layers as reported by several workers (Prasad *et al.*, 1983 ; Parameswar *et al.*, 1989 ; Suresh Lal and Mathur, 1989). The total porosity of soils exhibited a similar trend. (Tables 3 and 4).

A higher water holding capacity and total porosity of soils in the 30-45 cm layer of the western and 15-30 cm layer of the western series was observed due to higher clay content than in the surface layer. (Table 2). Among the treatmens, cattle manure plots recorded higher values in both CPM and western series of NPM whereas lower values in the case of eastern series due to lower clay content (Table 2).

Hydraulic Conductivity

The hydraulic conductivity was lower in both NPM and OPM plots wherever the clay content was higher (Table 5). For instance, in the case of OPM, the clay content increased with depth and hence, a decrease in the hydraulic conductivity with depth. It was further strengthened by the fact in NPM the clay content was higher in the cattle manure treatment (35.75%) of western series and the control plot of eastern series (33.75%) and due to this reason, the hydraulic conductivity was lower in these treatments.

In both the experiments continuous application of phosphorus recorded higher hydraulic conductivity. This could be due to the fact that phosphorus improves soil structure (Muthuvel. 1973) by better granulation which would naturally improve the hydraulic conductivity of the soil. However, in the western series of NPM such effect was absent under the P treatment. This was because of the relatively higher clay content in this treatment which recorded a 4 per cent (Muthuvel, 1973) increase in clay content as compared to control.

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