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STABILITY INDICES OF PERMANENT MANURIAL EXPERIMENTS UNDER IRRIGATED AND DRYLAND AGRICULTURE

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ABSTRACT

To study the stability indices of permanent manurial experiments under irrigated and dryland agriculture of Tamil Nadu Agricultural University farm at Coimbatore, the post harvest soil amples at three depths were collected after the harvest of cotton and cowpea at OPM and NPM respectively. Analysis of soil from both the experiments showed the improvement in the aggregate stability in the 30-45 cm depth of OPM, 15-30 cm layer and 30-45 cm layer of eastern and western series of NPM due to higher clay content in these layers and organic matter content of the soil. As the clay and organic matter are the prerequisites for the structure formation and stability of structure hence it was reflected in terms of per cent aggregate stability. Similar effects were seen for mean weight diameter and distribution of water stable aggregates.

KEY WORDS: Permanent manurial plots, Aggregate Stability, Organic matter

The impact of intensive land use in association with continuous use of high dose of chemical fertilisers and organic manures require careful and detailed investigation on the soil characteristics because such heavier doses of fertiliser application at frequent intervals in the absence of judicious combinations of organic and inorganics is bound to critically tell upon the soil properties especially soil fertility. The long term field studies are a primary source of scientific knowledge about the changes during long periods of farming that are taking place in soil physical and chemical properties. Hence the present study was undertaken and the results are presented in this paper.

MATERIALS AND METHODS

Soil samples for the present study were collected from the New and Old permanent Manurial experimental plots of Tamil Nadu Agricultural University farm, Coimbatore in the year 1993 after the harvest of cotton (MCU-10) and fodder cowpea (C04) in OPM and NPM respectively. The Old Permanent Manurial experiment (OPM) was started in the year 1909 under rainfed condition and the New Permanent Manurial experiment (NPM) started in 1925 is under irrigated cropping. The treatments are 1) Control, 2) nitrogen, 3) nitrogen & potassium, 4) nitrogen & phosphorus, 5) nitrogen, phosphorus & potassium, 6) phosphorus & potassium, 7) potassium, 8) phosphorus, 9) cattle manure, 10) cattle manure residue. Treatments 9 and 10 received cattle manure in alternate seasons i.e., CM plot will be the CMR plot in succeeding season and vice versa. Treatments are the smae in NPM excepting that the treatments are repeated in two series *viz.*, 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 series than that of the eastern series. Cotton followed by sorghum (Co 26) was the cropping sequence in OPM while in NPM cotton-cowpea is the rotation followed. The recommended dose of N.P.K was applied in the form of urea, single super phosphate and potassium sulphate (Table 1).

The soil of the experimental plot is calcareous red loam with the organic carbon content varying

Table 1. Fertiliser dose to crops

	N (kg/ha)	P (kg/ha)	K (kg/ha)	FYM (t/ha)
Cotton	60.00	20.00	10.00	10
Sorghum	90.00	32.25	20.25	10
Cowpea	25.00	50.00	10.00	10

from 0.25-0.59 per cent and 0.22-0.72 per cent in the OPM and NPM plots respectively. The fertility status of the soil is high, low and medium high in available N, P and K respectively for both OPM & NPM.

Post harvest soil samples were collected at the rate of three samples per treatment from 3 depths *viz.*, 0-15, 15-30, and 30-45 cm. The modified Yoder's (1936) method of wet sieving (Dakshinamurthi and Gupta, 1967) was employed to estimate the structural indices. A set of screen with sieves of 5, 2, 1, 0.5, 0.25 and 0.1 mm sizes were used and the following were calculated using the formulae

1) Mean weight diameter = X_{iwi}

X_i - Mean weight diameter of the fraction

I - 0.175, 0.375, 0.75, 1.5, 3.5 mm

W_i - the proportion of the total sample weight occurring in the fraction.

2) Per cent aggregate stability =

$$\frac{\text{Weight of soil particles} > 0.25 \text{ mm} - \text{weight of sand} > 0.25 \text{ mm} \times 100}{\text{Oven dry weight of soil} - \text{weight of sand} > 0.25 \text{ mm}}$$

3) Percentage water stable aggregates in each size group =

$$\frac{\text{Weight of aggregate in each size group} \times 100}{\text{Total weight of soil}}$$

RESULTS AND DISCUSSION

Per cent aggregate stability (Table 2)

In the case of OPM soils, the per cent aggregate stability varied from 32.1 to 56.1. In the case of NPM, it varied from 53.0 to 75.3 and 53.2 - 73.9 in Eastern series and Western series respectively. The improvement in the per cent aggregate stability as observed in the 30-45 cm depth in OPM, 15-30 cm layer of eastern and western series was due to higher clay content in these layers (Table 2) upto 33.75, 33.5, 430.25) and

Table 2. Effect of treatments on per cent aggregate stability

Treatments	OPM			NPM - Eastern series			NPM - Western series		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Control	33.3	38.3	42.4	67.8	66.0	64.5	65.8	65.5	62.5
Nitrogen	40.4	32.1	43.4	54.5	53.0	63.5	60.2	66.6	63.0
Nitrogen & Potassium	35.3	37.3	47.7	56.7	59.1	65.8	68.2	66.8	53.2
Nitrogen & Phosporus	49.2	36.9	51.3	66.6	65.0	60.4	67.0	61.4	68.4
Nitrogen, Phosporus & Potassium	55.7	48.0	53.7	67.2	65.2	63.4	69.3	64.5	63.2
Phosporus & Potassium	42.5	40.5	44.5	58.5	65.6	58.5	60.5	59.7	62.0
Potassium	41.7	39.6	47.0	64.6	62.4	56.0	66.3	58.0	62.5
Phosphorus	33.8	40.8	50.9	72.5	58.6	57.8	70.9	59.0	67.0
Cattle manure	52.1	51.0	46.7	75.3	65.9	59.8	73.9	61.2	66.9
Cattle manure residue	56.1	48.5	46.5	72.0	69.0	61.5	73.0	65.3	68.9
	SEd	CD	SEd	CD	SEd	CD			
Depth	0.165	0.346	0.152	0.320	0.412	0.866			
Treatments	0.301	0.632	0.278	0.585	0.753	1.58			
D X T	0.521	1.095	0.482	1.013	1.30	2.74			

a similar effect under NPK and organic manure treatments was due to the build up in the organic matter content of the soil. As the clay and organic matter are the prerequisites for structure formation and stability of structure, they reflected in terms of better per cent aggregate stability. Improvements in soil structural properties consequent to organic manuring was observed earlier by Muthuvel *et al.*, (1982) and Singh *et al.*, (1982). In both the series the surface layer recorded maximum values. Considering all the three depths together the cattle manure treated plot recorded the maximum

The mean weight diameter (Table 3)

The mean weight diameter of the surface soils of OPM varied, from 0.31 to 0.46 and in the case of NPM it ranged from 0.4 to 0.74 in eastern and western series respectively. There was a depth-wise increase in the mean weight diameter and the maximum values were recorded in the 30-45 cm layer (0.39 to 0.46) and in the case of eastern series the 15-30 cm layer (0.44-0.65) than 30-45 (0.40-0.62), whereas a reverse trend was noticed in the western series (0.37-0.56 and 0.44-0.72). The mean weight diameter which indicates the degree of aggregation was better in both OPM and NPM plots. Where ever there were increase in the clay and organic matter accumulation as in the case of aggregate stability aided by the binding action of the organic component. Similar results were obtained by Soung (1980) and Bhatia and Shukla (1982)

The percentage distribution of water stable aggregates > 0.25 mm. (Table 4)

In the case of OPM the per cent distribution of water stable aggregates > 0.25 mm ranged from 49.9 to 78.4 and in the case of NPM it ranged from 54.3 to 7.5 and 54.2 to 72.4 in eastern and western series respectively. The improvement in the per cent distribution of water stable aggregates > 0.25 mm in NPK and cattle manure treatments was due to higher organic matter content of the soil. Similar results was noticed in both the seires of NPM.

Table 3. Effect of treatments on mean weight diameter

Treatments	OPM			NPM - Eastern series			NPM - Western series		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Control	0.34	0.37	0.39	0.43	0.44	0.40	0.59	0.39	0.47
Nitrogen	0.41	0.31	0.42	0.48	0.50	0.47	0.61	0.47	0.57
Nitrogen & Potassium	0.35	0.36	0.44	0.55	0.54	0.49	0.64	0.56	0.44
Nitrogen & Phosporus	0.42	0.34	0.46	0.52	0.52	0.52	0.50	0.44	
Nitrogen, Phosporus & Potassium	0.43	0.40	0.46	0.62	0.55	0.56	0.54	0.46	0.56
Phosporus & Potassium	0.40	0.38	0.43	0.63	0.65	0.62	0.59	0.39	0.62
Potassium	0.38	0.37	0.44	0.56	0.58	0.55	0.59	0.37	0.59
Phosphorus	0.34	0.42	0.45	0.64	0.62	0.59	0.63	0.38	0.60
Cattle manure	0.46	0.44	0.43	0.53	0.54	0.51	0.74	0.54	0.72
Cattle manure residue	0.45	0.42	0.42	0.59	0.58	0.45	0.62	0.43	0.63
	SEd	CD	SEd	CD	SEd	CD			
Depth	0.132	0.028	0.002	0.005	0.003	0.006			
Treatments	0.024	NS	0.004	0.009	0.005	0.011			
D X T	0.041	NS	0.007	0.015	0.009	0.020			

Table 4. Effect of treatments on percentage distribution of water stable aggregates > 0.25 mm

Treatments	OPM			NPM - Eastern series			NPM - Western series		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Control	61.1	64.3	63.9	65.9	67.4	66.9	59.1	59.9	68.8
Nitrogen	63.2	49.9	64.1	50.6	54.6	62.8	54.2	62.7	69.6
Nitrogen & Potassium	54:2	61.1	67.3	56.7	72.9	67.7	62.2	58.2	74.0
Nitrogen & Phosporus	65.7	57.2	68.7	63.3	61.1	51.4	603	64.4	64.9
Nitrogen, Phosporus & Potassium	78.4	69.7	74.5	65.7	61.3	55.4	65.4	62.9	65.9
Phosporus & Potassium	65.7	68.1	64.4	62.1	53.4	55.3	58.7	60.0	64.0
Potassium	63.8	67.4	66.2	63	59.4	59.3	60.1	62.7	61.8
Phosphorus	52.6	69.1	68.2	66.7	54.3	53.9	66.4	65.7	62.7
Cattle manure	75.6	71.5	66.0	72.5	65.6	57.6	69.9	65.9	62.9
Cattle manure residue	69.9	69.6	66.3	66.5	57.0	60.1	68.2	72.4	68.0

	SEd	CD	SEd	CD	SEd	CD
Depth	0.149	NS	0.856	1.80	0.475	0.870
Treatments	0.272	0.571	1.563	3.28	0.998	1.820
D X T	0.471	0.989	2.710	5.69	1.500	3.160

This was supported by the finding of Suresh Lal and Mathur (1989). Moreover a positive relation was obtained between the summation per cent of water stable aggregates > 0.25 mm and per cent aggregate stability in the case of OPM (0.869**) and NPM (0.568**) eastern series.

In general, the application of organic manure registered maximum values of all stability indices.

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