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Cumulative Effect of Manures and Fertilizers on the Mechanical Fractions of Soils

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The different size fractions of the experimental plots of the Old Permanent Manurial Experiments at Coimbatore were determined during 1922, 1929 and 1976. The data revealed that during 55 years of experimentation, the coarse sand fraction significantly reduced and clay fractions increased. Of the major nutrients N, P and K, nitrogen application increased the clay content whereas others did not. The influence of nitrogen might be mainly due to its content in the organic residues added to the soil. Coarse fraction was not influenced by the different treatments. Cattle manure application (5 tons/acre) was as good as NPK fertilization in maintaining the proportion of mechanical fractions.

Literature on the cumulative effect of continuous application of fertilizers, manures and cropping on the physical properties and biological changes are available in plenty. But references to the changes in the separates are not to be found in general.

MATERIALS AND METHODS

The Old Permanent Manurial Experiments at Coimbatore was started in 1909 and so for 108 crops were raised. Each crop received the nutrients either alone or in combination in the following treatments. (1) No manure (control), (2) N, (3) NK, (4) NP, (5) NPK, (6) PK, (7) K, (8) P, (9) Cattle manure at 5 tons/ac and (10) cattle manure residues. Nitrogen, phosphorus and potassium were applied to the soil in the form of ammonium sulphate, superphosphate and potassium sulphate respectively. N, P_2O_5 and K_2O were supplied at the rate of 22.5, 60.5 and 54.0 lb per acre respectively. The soil samples were analysed for the mechanical fractions (during 1922, 1929 and 1976) and the results were compared. In the case of 1922 and 1929, however, the system of representing mechanical composition data was different from what it was in 1976. In the former case the British system was followed, and in the latter case (1976) the International system has been followed. As the size intervals for these two systems are considerably different for fine sand and silt, these were not strictly comparable. But in the case of coarse sand and clay the size intervals were similar in both the systems namely, between 2.0 and 0.2 mm and 0.002 mm respectively and hence were compared.

RESULTS AND DISCUSSION

Changes due to time and cropping : During the course of first seven

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TABLE I. Coarse sand fractions

	Coarse sand fraction						
	1922	1929	1976	Reduction from 1922 to 1927	Reduction from 1929 to 1976	Reduction from 1922 till 1976	% reduction
O	64.2	57.3	27.7	6.9	29.6	36.5	56.85
N	61.0	57.0	32.4	4.0	24.6	28.6	46.89
NK	55.6	59.3	31.6	3.7	27.7	24.0	43.16
NP	61.0	57.7	26.4	3.3	31.3	34.6	51.31
NPK	60.0	59.9	29.5	0.1	30.4	30.5	50.83
KP	45.4	55.4	26.6	10.1	28.8	18.8	41.41
K	57.6	52.6	29.7	5.0	22.9	27.9	48.44
P	63.0	56.4	33.1	6.6	23.3	29.9	47.66
DM	65.6	62.4	16.1	3.2	46.3	49.5	75.46
DMR	65.9	62.0	33.9	3.9	28.1	32.0	48.56

TABLE II. Clay fractions

	Clay fractions						
	1922	1929	1976	Increase from 1922 to 1929	Iecrease from 1929 to 1976	Increase from 1922 to 1976	% reduction increase
O	4.5	10.7	23.0	6.2	12.3	18.5	411.11
N	4.8	9.3	29.7	4.5	20.4	24.9	518.75
NK	7.1	8.9	21.5	1.8	12.6	14.4	202.82
NP	4.9	9.3	24.7	4.4	15.4	19.8	404.08
NPK	7.5	9.9	24.7	2.4	14.8	17.2	229.33
KP	8.8	10.4	24.7	1.6	14.3	15.9	180.68
K	7.2	12.1	25.1	4.9	13.0	17.9	248.68
P	6.6	9.1	20.5	2.5	11.4	13.9	210.61
DM	5.9	7.7	20.0	1.8	12.3	14.1	238.88
CMR	6.2	6.4	19.8	0.2	13.4	13.6	219.35

TABLE III. Percentage increase or decrease of size fractions of 1976 compared to 1922 values

Treatment	N_0	N_1	P_0	P_1	K_0	K_1
Coarse sand (Reduction %)	48.54	49.71	50.50	47.75	50.63	47.63
Clay (Increase %)	262.8	338.8	345.4	256.2	387.2	215.4

years, there was a definite shift in the proportion of the various size fractions. In the year 1922 the coarse sand and clay fractions in the control plot were 64.2 and 4.5 respectively (Tables I and II) and the proportion of the size fractions in the order changed to 57.3 and 10.7 during 1929 resulting in the reduction of coarse and in the increase of clay fractions. When the control plot samples were examined during 1976, and compared with the data of 1922, coarse sand fraction registered a reduction of 56.85 per cent and clay fraction increased by 421.11 per cent. The natural processes of soil formation would have brought about these changes. In addition, cultivation operations like ploughing, breaking clods, etc., were the other factors that would have contributed for the changes.

A similar trend of increase in the clay fractions was obtained in all the other treatments. The increase over the 1922 values ranged from 180.7 per cent to 518.8 per cent.

Clay fractions: The N_0 plots registered an average of 262.8 per cent increase of the clay fractions over the 1922 values, while application of N as ammonium sulphate has registered an increase of 338.8 per cent. Thus the process of increase of the clay fraction during these 50 years was accelerated by addition of nitrogen. This is quite understandable by the fact that nitrogen application induces the microbial population and enzymatic activities resulting in increase of organic residues in the soil, and the plant root exudates. These are responsible for accelerating the physical and chemical weathering processes. Above all, the organic residues as such contribute much to the clay fraction. The role of organic matter additions in increasing the clay fraction was observed by Barshad (1965). Bear (1965) stated that even if only a very small portion of the ash of the plants is converted to colloidal constituents upon their decay in the soil, these constituents would be an important contribution to clay formation atleast to several important constituents of the clay fractions. The results of the present investigation indicated that phosphorus and potassium did not have an additional influence in improving the rate of increase. The increase in clay fraction due to farm yard manure alone was not much different from that obtained by NPK fertilizers. The variability of the clay fraction is the mechanical composition among the plots in 1976 and is also significant with the standard deviation of 2.88 and standard error of 0.91. The amount of increase in the clay fraction from 1922-76 was

far higher than the variability among the plots. This observation indicated that the variability in the size frrctions might be due to weathering processes.

Coarses and fractions: A perusal of the coarse sand fractions showed that in N applied plots the reduction of coarse sand fraction was 49.71 per cent when compared to the 1922 values and in N_1 plots, it was 48.54 per cent (Table III). The values for P_0, P_1, K_0, K plots were 50.50, 47.75, 50.63 and 47.63 per cent respectively. The influence of the different treatments was very much in reducing the coarse sand fractions. The reduction due to cattle manure was the highest (75.46%). The variability of mechanical composition of different plots for coarse sand was significant with the standard deviation of 4.89 and the standard error of 1.54. The variability of this fraction between 1922 and 1976 far exceeds the variability in coarse sand fraction.

The foregoing observations revealed that the natural process of weathering has not been hindered by cropping or fertilization, and in fact, accelerated the process. In different plots, the factors of soil formation namely climate, relief, parent material and time factor being the same there was bound to be no change due to these factors. Different fertilization patterns were adopted for the past 50 years and this brought about an increased in the organic matter content of the soil (Sanyasi Raju, 1952) and consequent changes in the proportion of size fractions in the plots. In the present study, it was seen that application of nitrogen influenced the proportion of the different size fractions, whereas phosphorus and potassium did not influence as much as nitrogen. The influence was not observed in the coarse fraction. This suggested that organic residues and its bye products,organic acids and enzymes did not alter the rate of weathering or breaking down of the coarse sand fraction. The reduction in the percentage values was mainly due to the natural process.

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