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LONG TERM EFFECT OF GRADED DOSES OF FERTILIZERS AND MANURES ON SOIL PHYSICAL CONDITIONS.

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Long term application of graded doses of NPK fertilizers did not have significant influence on bulk density and porespace, but significantly influenced the hydraulic conductivity and to some extent the soil aggregate parameters. The combined application of inorganic fertilizers with organic manures viz., FYM improved the physical condition of soil by increasing the hydraulic conductivity, porosity and aggregation and reducing the bulkdensity of soils. The improvement in Physical condition of soil due to the combined application of inorganic fertilizers and organic manures was reflected in the highest yield of grain and straw.

Continuous application of graded doses of fertilizers and manures brings many beneficial and harmful effects in physical, chemical and biological properties of soil The crop performance under long term fertilization was studied extensively through the field experiments. The changes in soil physical properties due to long term application of fertilizers and manures were reported from few investigation. Therefore the present investigation was initiated to study the changes in soil physical properties due to long term effect of graded doses of fertilizers with and without combination of organic manures.

MATERIAL AND METHODS

The long term fertilizer experiment (LTFE) (started during (1972) and new permanent manurial expreiment (NPME) (started during 1925) which are under progress in the Department of soil science and agricultural chemistry, TNAU Coimbatore were utilized for this study.

The LTFE consists of ten treatments replicated four times in a randomised block design and the treatment details are as follows:

T_1 — 50% optimum NPK + herbicide + plant protection chemicals (PPc)
T_2 — 100% " " " "
T_3 — 150% " " " "

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T_4 — 100% optimum NPK + handweeding + PPc.
T_5 — 100% optimum NPK + herbicides + $ZnSo_4$ (25kg/ha) + PPc
T_6 — 100% optimum NP + herbicide + PPc.
T_7 — 100% Optimum N + „ „
T_8 — 100% Optimum NPK + herbicides + PPC + FYM (10t/ha)
T_9 — 100% Optimum NPK + weeding + PPC (S. free).
T_{10} — Unmanured control.

Dose of NPK : 135 : 67.5 : 35kg N,P_2O_5 and K_2O/ha (maize)

The experimental soil is grouped under peelamedu series of typic vertisol according to the USDA soil taxonomic classification.

The NPME comprises of ten treatments replicated four times in a randomised block design and the details of the treatments are as follows.

T_1 — Control
T_2 — N alone
T_3 — N + K
T_4 — N + P
T_5 — N + P + K
T_6 — P + K
T_7 — K alone
T_8 — P alone
T_9 — Cattle manure residue
T_{10} — Cattlemanure (10t/ha)

Dose of NPK : 90 : 45 : 22.5 Kg NI,P_2O_5 and k_2o/ha (Sorghum)

After the harvest of 27th crop of maize (var co 11) under LTFE and 96th crop of sorghum (Var. TNS 27) from NPME, surface core soil samples (undisturbed) were collected as per the standardised procedure. The soil samples were analysed for bulk density, hydraulic conductivity, porespaces and aggregate parameters as per the procedure given by Dakshinamoorthy and Gupta (1980).

RESULTS AND DISCUSSION:

(*i*) *Long term fertilizer experiment*:

The results of the statistical analyses showed that continuous application of different levels of fertilizers did not have significant influence on the bulk density of soil, althouh in some of the treatments there was a reduction in bulk-density when compared to control (Table 1). The plots receiving 10 of FYM/ha recorded the B.D of 1.32g/cc which was found to be reduced when compared to control (1.35) As the levels of NPK fertilizers increased from 50 percent to 150 per cent, there was a tendency to increase in B.D (from 1.30 to 1.33 g/cc) which might be due to deterioration of structure of the soil by nitrogenous fertilizer (Biswas *et al* 1971. and Prasad *et al*, 1983). Similar results were also observed by Prasad and Singh (1980). Due to the incorporation and subsequent decomposition of organic matter in the soil, the FYM applied plot recorded lower B.D than control (Manickam and Venkataraman 1972).

There was a significant increase in hydraulic conductivity due to cotinuous application of inorganic fertilizers and manures. The combination of 100 per cent optimum NPK and 10 tonnes of farm yard manure recorded the highest value of hydraulic conductivity (2.90 cm/hr) that might be due to incorporation of organic matter and subsequent

Table : 1 Physical properties of soil after 27th crop of Maize (Var. CoH1) under Longterm fertilizer experiment.

(Mean of 4 replications)

Treatments / Properties	Bulk density (g/cc)	Hydraulic conductivity (cm/hr)	Total porosity(%)	Capillary porosity (%)	Non capillary Porosity (%)
T_1 50% Opt. NPK+W+PPC	1.30	0.51	48.94	42.41	6.53
T_2 100% Opt. NPK+W+PPC	1.31	0.65	48.71	43.12	5.59
T_3 150% Opt. NPK+W+PPC	1.33	0.63	49.77	42.09	7.68
T_4 100% Opt. NPK+W+PPC	1.38	0.83	50.39	42.82	7.58
T_5 100% Opt. NPK+HW+PPC	1.40	0.74	48.28	43.37	4.91
T_6 100% Opt. NPK+W+PPC +MN	1.26	0.59	49.75	44.11	5.64
T_7 100% Opt. NPK+W+PPC	1.33	0.72	46.32	41.36	4.98
T_8 100% Opt. NPK+W+PPC+FYM	1.32	2.90	51.63	43.29	8.24
T_9 100% Opt. NPK+W+PPC+ (S. free)	1.39	0.25	50.10	42.70	7.40
T_{10} Unmanured control	1.35	0.17	44.68	40.15	6.25
SED :	NS	0.389	NS	NS	NS
CD (at 5%) :		0.799			

increase in porosity of soil. This result was in confirmity with the findings of Biswas *et. al.*, (1970) and Prasad and Singh (1980).

Various fertilizer treatments had no significant influence on porespace of soil: but again the plots applied with 100 per cent optimum NPK plus FYM (10t/ha) had registered numerically higher values of total porosity (51.5%) and non - capillary porosity (8.24%) due to the addition of organic matter. Similar result was reported by Sinha *et. al.*, (1980). But it was contradicted to the findings of Prasad and Singh (1980) who obtained significant effect on porespaces by long term fertilization. Over the years the continuous application of fertilizer and manure had not changed the total porosity considerebly but their influence was observed on noncapillary and capillary porespace as it was observed that the non capillary porespace decreased and the capillary porosity increased.

The structural indices viz. stability index, mean weight diameter and strucural coefficient were significantly influenced by the different doses of fertilizer (Table 2) as a result of improvement in soil aggregation. Though the aggregate stability was not changed considerably, it was observed that FYM application had increased the stability of aggregate due to incorporation and subsequent decomposition of organic matter (Prasad and Singh 1980, and Bhatia and Shukla, 1982). There was not much fluctuation in structural parameters due to continuous application of fertilizers over the years in all the treatments except farm yard manure applied plot.

Table : 2 Structural indices after 27th crop of Maize under LTFE

Mean of 4 replication

Treatments	Stability Index	Aggregate Stability (%)	Mean Weight Diameter (mm)	Structural coefficient	Grain yield (kg/ha)	Straw yield (kg/ha)
T_1 — 50% Opt. NPK+W+PPC	47.36	53.16	0.687	0.475	4175.0	11106
T_2 — 100% Opt. NPK+W+PPC	45.41	60.37	0.810	0.454	4900.0	12156
T_3 — 150% Opt. NPK+W+PPC	43.85	59.14	0.584	0.440	4600.0	13300
T_4 — 100% Opt. NPK+HW+PPC	52.76	67.00	0.693	0.529	4575.0	12000
T_5 — 100% Opt. NPK+W+PPC+MN	53.03	60.10	0.820	0.534	5000.0	12688
T_6 — 100% Opt. NPK+W+PPC	55.41	62.02	0.596	0.556	4475.0	11556
T_7 — 100% Opt. N+W+PPC	48.92	63.34	0.685	0.489	1488.0	8113
T_8 — 100% Opt. + NPK+W+PPC + FYM	52.65	69.92	0.611	0.530	5300.0	13075
T_9 — 100% Opt. NPK+W+PPC+ (S. free)	50.74	65.97	0.505	0.508	4888.0	12450
T_{10} — Unmanured control	40.35	51.86	0.531	0.571	1100.0	3694
SED	3.52	NS	0.591	0.050	326.1	662.9
CD (at 5%) :	7.23		0.121	0.103	668.5	1359.1

Table : 3 Physical properties of soil after the harvest of 96th crop of Sorghum under New permanent manurial experiment

(a) Bulk density (g/cc)

(b) Hydraulic conductivity (cm/hr)

Replication	Eastern Series		Western series		Mean	Eastern series		Western series		Mean
Treatment	Old dose	New dose	Old dose	New dose		Old dose	New dose	Old dose	New dose	
T_1 Control	1.39	1.36	1.29	1.35	1.35	0.78	1.68	1.52	1.57	1.39
T_2 — N	1.27	1.35	1.21	1.29	1.28	1.88	2.12	2.24	4.31	2.64
T_3 — NK	1.28	1.30	1.24	1.23	1.26	1.05	3.13	1.20	2.43	1.95
T_4 — NP	1.29	1.32	1.30	1.34	1.31	4.92	2.06	3.08	2.78	3.21
T_5 — NPK	1.23	1.22	1.25	1.27	1.24	3.61	1.80	4.20	1.47	2.77
T_6 — PK	1.29	1.28	1.31	1.27	1.29	2.31	1.90	2.06	1.09	1.84
T_7 — K	1.31	1.26	1.32	1.26	1.29	1.45	2.69	1.39	3.70	2.31
T_8 — P	1.30	1.32	1.34	1.23	1.29	4.64	1.97	3.20	2.95	3.19
T_9 — CMF	1.24	1.17	1.14	1.15	1.17	4.31	3.75	6.43	6.12	5.15
T_{10} — CM	1.21	1.18	1.14	1.22	1.19	4.47	7.09	5.05	5.72	5.58
SED		NS						0.788		
CD		NS						1.615		

Table : 4 Percent poréspaces of soil after 96th crop

Replication / Treatment	Total porosity (%)					Capillary Porosity (%)					Non Capillary Porosity (%)				
	Eastern series		Western series		Mean	Eastern series		Western series		Mean	Eastern series		Western series		Mean
	Old dose	New dose	Old dose	New dose		Old dose	New dose	Old dose	New dose		Old dose	New dose	Old dose	New dose	
T_1 — Control	48.62	47.24	49.36	51.01	49.06	31.86	34.71	44.19	31.95	35.68	16.76	12.53	5.17	19.06	13.38
T_2 — N	50.09	50.55	49.26	50.46	50.09	35.73	27.07	44 66	32.14	24.90	14.36	23.48	4.60	18.32	15.19
T_3 — NK	46.87	47.24	53,87	50.09	49.52	31.56	25.05	46.39	36.05	34.82	15.29	22.19	7.28	14.04	14.70
T_4 — NP	48.16	49.08	49.91	49.45	49.15	31.95	30.76	45.86	32.32	35.22	16.21	18.32	4.05	17.13	13.93
T_5 — NPK	50.55	46.41	50.55	53.04	50.14	31.03	27.26	46.87	38 86	36.01	19.52	19.15	3.68	14.8	14.13
T_6 — PK	46.96	47.69	53.68	51.93	50.07	27.07	38.03	46.32	37.20	37.16	19.89	9.66	7.36	14.73	12.91
T_7 — K	44.94	46.50	54.33	51.93	49.43	32.04	37.66	46.87	37.57	38.54	12.90	8.84	7.46	14.36	10,89
T_8 — P	45.95	47.24	53.84	47.33	48.39	31.03	38.77	42.54	36.83	37.29	14.92	8.47	10.50	10.50	11.09
T_9 — CMR	50.83	49.58	52.58	52.29	51.49	31.03	38.03	44.48	38.67	38.05	19.80	11.55	8.10	14.28	13.43
T_{10} — CM	50.46	46.04	53.78	55.89	51.54	29.93	34.99	46.69	43.28	38.73	20.53	11.05	7.09	12.61	12.82
SED															
CD			NS					NS					NS		

Table 5. Aggregate Parameters of soil after the harvest of 96 th crop of sorghum

Replication / Treatments	Eastern series				Western series				Mean Grain yield (kg/ha)	Mean Straw yield (kg/ha)
	Stability Index	Aggregate Stability (%)	Mean Weight diameter (mm)	Structural co-efficient	Stability Index	Aggregate stability(%)	Mean Weight diameter (mm)	Structural co-efficient		
T_1 — Control	39.9	65.4	0.761	0.399	47.1	65.2	0.616	0.471	1735.0	3375.0
T_2 — N	45.7	69 0	0.693	0.457	48.5	65.4	0.604	0.485	2135.0	4250.0
T_3 — NK	49.4	71 7	0.579	0.494	50.1	71.4	0.988	0.501	2430.0	4150.0
T_4 — NP	48.2	71.2	0.698	0.482	49.9	67.9	0.715	0.499	2520.0	4600.0
T_5 — NPK	52.5	77.3	0.915	0.525	52.7	72.3	0.789	0.527	2890.0	5550.0
T_6 — PK	41.4	63.5	0.831	0.414	53.1	67.6	0.721	0.531	2342.5	4025.0
T_7 — K	45.5	61.8	0.777	0.455	51.3	71.2	0.743	0.513	1790.0	3675 0
T_8 — P	46.9	72.0	0.922	0.469	50.9	67.9	0.569	0.509	1980.0	4250.0
T_9 — Cattle Manure Residue	58.3	80.9	0.712	0.583	64.3	82.6	0.586	0.643	2745.0	6025.0
T_{10} — Cattle Manure	58.0	76 9	0.862	0.582	53.0	67.2	0.643	0.530	2815 0	6475.0
	3.26	3.77	NS	NS					209.1	175.8
(CD at (5%)	6.64	7.73							428.6	360.4

(ii) Newpermanent manurial experiment:

Under NPME, the results revealed that the different treatments significantly influenced the hydraulic conductivity, but their influence on bulk density was found to be not significant (Table 3a &b) The highest values of hydraulic conducti. vity (5.58 cm/hr) and the lowest values of bulk density (1.19g/cc) were observed in the plots receiving cattle manure and cattle manure residue due to the decomposition of cattle manures in the soil.

With regard to porespaces, though there was difference between treatments, the treatment effect on porespace was not statistically significant. The addition of cattlemanures and cattle manure residues registered the highest percentage of porespaces. Comparing two series, the western series which received a common basal dose of 2 tonnes of FYM per hectare recorded higher porosities than Eastern series due to the incorporation and decomposition of organic matter in the soil. (Khanna *et al* 1975).

The stability index and aggregate stability were significantly influenced due to continuous application of fertilizers and manures : Whereas the mean weight diameter and structural coefficient were not affected significantly (Table 5). The application of cattle manures and cattlemanure residue improved the soil aggregation as it could be seen from the significant increase in stability index and stability of aggregates. Similar result was reported by Prasad *et al* (1983) The grain and straw yield of sorghum showed that the organic manure alone applied plot recorded the yield which was on par with the yield obtained by the application of NPK fertilizers, due to increase in hydraulic conductivity, porespace, reduction in bulk density and further improvement n soil aggregation.

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REFERENCES

BISWAS, T. D , M. R. ROY and B. N SAHU 1970. "Effect of different sources of organic manures on the Physical properties. of soil growing rice " J. Indian Soc. Soil Sci. 18 (3) : 233-242.

BISWAS, T. D., B. L. JAIN and S. C. MANDAL 1971 "Cumulative effect of different levels of manures on the Physical properties of Soil." J. Indian Soc. Soil Sci 19 (1) : 31-37

BHATIA, K. S., and K. K. SHUKLA. 1982. 'Effect of continuous application of fertilizers and manures on some physical properties of eroded alluvial soil. "J Indian Soc. Soil Sci. 30 (1) : 33-36.

DAKSHINAMOORTHY, C and R. P. GUPTA 1980. Practicals in soil Physics." IARI. New Delhi.

KHANNA, P. K., JAGANNATH, S. N. TANEJA and V. P. GOYAL 1975. "Effect of organic manuring on some soil physical properties of sandy loam soils of Hissar. J. Indian Soc. soil sci 23 (3) : 380-383.

MANICKAM. T. S. and C. R. VENKATARAMAN. 1972. Effect of continuous application of manures on some of the physical properties of soil under dry condition". Madras agric J. 59 : 309-314.

PRASAD, B and A. P. SINGH. 1980. Changes in soil properties with longterm use of fertilizers, lime and FYM. J. Indian soc. soil sci. 28(4) 465-468.

PRASAD B., R. P. SINGH., H. K. ROY and H. SINHA. 1983. Effect of fertilizers, lime and manure on some physical and chemical properties of a Redloam soil under multiple cropping". J. Indian Soc. soil sci. 31(4) 601-603.

SINHA N. P., B. PRASAD and A. B. GHOSH 1980 "Soil physical properties as influenced by long term use of Chemical fertilizers under intensive cropping" J. Indian soc. soil. Sci. 28(4) : 516-518.