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Effect of soil Amendments on the Chemical Properties of Vertisol and Yield of Finger Millet* (*Eleusine coracana* Gaertn.)

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A field experiment conducted to evaluate the effect of soil amendments on the chemical properties of vertisol revealed that application of organics *viz.*, poultry manure, farm yard manure and inorganics like furance slag and lime sludge improved the organic carbon, available nitrogen and phosphorus status. The total cation exchange capacity of soil was positively correlated with organic carbon content. The exchangeable calcium and magnesium status were improved by lime sludge and magnesite treatments, respectively. Application of poultry manure, farm yard manure and lime sludge significantly improved the yield of finger millet (CO 10). Organic amendments were superior to inorganics in improving the chemical properties of soil and yield of finger millet.

Application of amendments to soil, apart from improving the physical properties, improve the availability of nutrients, organic carbon and cation exchange capacity of soil, provide an optimum soil environment and increase the yield of crops. The present study was undertaken to evaluate the efficacy of organic and inorganic amendments in improving the chemical properties of soil and yield of finger millet in vertisol which was tending to become alkali.

MATERIAL AND METHODS

A field experiment was conducted in Perianaickenpalayam series of vertisol in Coimbatore district adopting split plot design with eleven treatments and three replications. The treatments were organic amendments *viz.*, farm yard manure (T_1), maize straw (T_2), poultry manure (T_3), cotton waste compost (T_4) and tank silt (T_5) at 25 t/ha, mineral amendments *viz.*, gypsum (T_6) and magnesite (T_7) and industrial wastes like furnace slag from iron industry (T_8), smoke chamber dust from cement industry (T_9) and lime sludge from paper industry (T_{10}) at 10 t/ha with a control (T_{11}). The amendments were mixed well with the soil and allowed to react for four weeks prior to transplanting of the test crop of finger millet (CO 10.). A fertiliser dose of 90 kg. N, 45 kg P_2O_5 and 22.5 kg K_2O/ha in the form of ammonium sulphate, superphosphate and muriate of potash, rerpectively were applied. Nitrogen was applied in two split doses, half at planting and half at flowering. The phosphorus and potassic fertilisers were applied as basal dressing. The initial and post-harvest soil samples were collected at 0-20 cm depth and analysed for the various

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chemical properties. Soil pH and EC were estimated in 1:2 soil water suspension. Organic carbon was estimated by chromic acid wet digestion method (Walkley and Black, 1934). Total N was determined by Kjeldahl digestion method (Piper, 1966), available N by alkaline permanganate method (Subbiah and Asija, 1956), available P by Olsen's method (Olsen *et. al.*, 1959) and available K with flame photometer. The cation exchange capacity of soil was determined using neutral normal ammonium acetate (Schollenberger and Dreibelbis, 1930), exchangeable Ca and Mg by versenate titration (Jackson, 1973) and exchangeable Na and K with flame photometer. Correlations were worked out between the chemical properties of soil and yield of finger millet. The amendments used were analysed for their macro, secondary and micronutrient contents.

RESULTS AND DISCUSSION

The analysis of initial soil sample (Table I) revealed that the pH was slightly alkaline (8.3) and EC was within safe limits (1.3 m.mhos/cm). The exchangeable Na percentage indicated that the soil is tending to become alkali (ESP 14). The organic carbon (0.36), total N (0.020), available N (102 ppm) and available P status (4.5 ppm) were low, while available K (302 ppm) was high. Exchangeable Ca predominated the exchange complex and exchangeable Na (3.8 me/100 gm) was higher than exchangeable K (1.2 me/100 gm).

The analysis of amendments used (Table II) showed that poultry manure contained higher percentages of N (1.5), P (1.10), Ca (1.11), Mg (0.96), zinc (16 ppm) and iron (5000 ppm) than the other organic amendments. The industrial wastes and mineral amendments used contained low amounts of macronutrients and higher amounts of secondary and micronutrients than the organics. The Ca percentage of lime sludge (30.6), gypsum (27.69) and smoke chamber dust (26.57) were high while the Mg. percentage was high in magnesite (27.5) compared to other amendments. Furnace slag was rich in iron (31,250ppm) and manganese (110 ppm) than other amendments.

The post-harvest soil showed significant reduction in pH from 8.2 (control) to 7.5 in organic amendment treatments poultry manure, farm yard manure and maize straw (Table III). Among the inorganics, the reduction in pH was higher in gypsum (7.6) than with other treatments. EC showed a greater reduction in poultry manure and furnace slag (0.59 m.mhos/cm) than other treatments. The organic carbon significantly improved in all the treatments than control and the treatments, poultry manure, farm yard manure, furnace slag and cotton waste compost were equally effective and superior to other treatments. Poultry manure was significantly superior to other treatments in improving the total N (0.093%), available N (191.3 ppm) and available K (410 ppm). The available P showed significant improvement in poultry manure, farm yard manure, gypsum and furnace slag treatments (9.5 ppm). The total cation exchange capacity of soil was significantly improved by poultry manure and furnace slag treatments. Lime sludge was superior to other treatments in improving the exchangeable Ca (22.6 me./100 g soil) while magnesite enhanced the exchangeable Mg (9.7 me./100 g soil) over other treatments. The exchangeable Na showed higher reduction in lime sludge (2 me./100 g. soil) and gypsum treatments (2.4 me. 100 g. soil) when compared to control (3 me./ 100 g. soil).

The grain yield (Table IV) was significantly increased by poultry manure, farm yard manure, lime sludge and gypsum application which were on par and superior to other treatments. The straw yield recorded significant improvement in farm yard manure, maize straw, poultry manure, lime sludge and gypsum treatments which were equally effective and superior to other treatments. Somani and Saxena (1975) observed higher increase in yield of wheat (Kalyan sona) in farm yard manure and poultry manure treatments than in wheat straw and paddy husk treatments and attributed it to the increase in organic matter, availability of plant nutrient- and to the presence of growth regulating factors like hormones and enzymes in these oranic amendments. The increase in yield of finger millet in the present investigation in poultry and farm yard manure treatments could also be attributed to the above factors.

The organic carbon content of soil in the present investigation (Table V) showed positive correlation with available N ($r=0.823^{**}$) and grain yield ($r=0.561^{**}$). Obviously, the decomposition products of organic matter could have increased the availability of N and thereby increased the yield. The organic carbon revealed highly significant correlation with available P ($r=0.751^{**}$) indicating that organic matter might have influenced the release of native P and the production of CO_2 during its decompositions could have played a role in improving the available P status of soil as suggested by Ambika Singh and Banarsi Lal (1976). The organic carbon content showed correlation with the total cation exchange capacity ($r=0.741^{**}$) which indicates that the functional groups in organic matter might have contributed substantially to the cation exchange capacity. The total N content showed a positive correlation with available N ($r=0.846^{**}$) and organic carbon ($r=0.855^{**}$) which is in agreement with the finding of Mandal and Jain (1965). The available N content showed a positive correlation with the yield of grain ($r=0.516^{**}$) and straw ($r=0.309^{**}$). Inorganic amendments like lime sludge and magnesite which are rich in calcium and magnesium, respectively, showed improvement in the exchangeable Ca and Mg status which is in conformity with the finding of Kanwar (1976).

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TABLE I· CHEMICAL ANALYSIS OF INITIAL SOIL SAMPLE

PH	8.3
Electrical conductivity (m.mhos/cm) ct 25° c	1.3
Organic carbon (per cent)	0.36
Total nitrogen (per cent)	0.020
Available nitrgoen (ppm)	102
Available phosphorus (ppm)	4.5
Available potassium (ppm)	302
Total cation exchange capacity (m.e/100 g soil)	27.2
Exchangeable calcium (m.e/100 g soil)	19.2
Exchangeable magnesium (m.e/100 g soil)	2.8
Exchangeable sodium (m.e/100 g soil)	3.8
Exchangeable potassium (m e/100 g soil)	1.2
Exchangeable sodium percentage (ESP)	14.0

TABLE II Analysis of amendments

S. No.	Amendments	Nutrients (per cent)					Total nutrients (ppm)			
		N	P_2O_5	K_2O	CaO	MgO	Zn	Cu	Fe	Mn
1.	Farm yard manure	0.82	0.61	0.74	0.78	0.76	12	1.0	2400	12.0
2.	Maize straw	0.49	0.66	0.45	0.33	0.31	9	1.0	350	3.0
3.	Poultry manure	1.50	1.10	0.81	1.11	0.96	16	1.0	5000	7.0
4.	Cotton waste compost	1.12	0.73	1.59	...	...	12	0.5	950	3.5
5.	Tank silt	0.20	0.41	0.33	0.19	0.10	3	4.5	206	23.75
6.	Gypsum	...	0.01	0.14	27.69	3.40	12	1.0	6375	8.0
7.	Magnesite	...	0.18	0.19	3.49	27 50	7	...	4813	2.5
8.	Furnace slag	0.02	0.67	0·44	6.29	10.50	8	1.0	31250	100 0
9.	Smoke chamber dust	...	0.46	0.42	26.57	11.08	9	0.5	6375	12.5
10.	Lime sludge	0.12	0.07	0·61	30.06	11.00	16	0.5	3563	0.4

TABLE III. Chemical analysis of Post-Harvest soil

Treatments	pH	EC mmhos/ (%)	Organic carbon %	Total N (%)	Available nutrients (ppm)				Exch. Cation me/100 g soil			
					N	P	K	Total CEC/me/ 100g soil	Ca	Mg	Na	
T_1	7.5	0.65	0.73	0.082	149.3	9.5	340	32.5	19.7	8.3	2.8	0.75
T_2	7.5	0.66	0 68	0.086	165.6	6 3	375	32.5	19.6	8.5	2.7	0.73
T_3	7.5	0.59	0·74	0 093	191.3	9.5	410	34.3	21.6	8.5	2.6	0.76
T_4	7.7	0.72	0.71	0.084	147.6	8.7	330	33.7	22.4	8.1	2.7	0.65
T_5	7.7	0.66	0.51	0.058	130.6	5.6	343	30.8	18.9	7.6	2.9	0 51
T_6	7.6	0.67	0.63	0.073	144.8	9.5	361	33.6	21.9	8.5	2.4	0.46
T_7	7.7	0.67	0.54	0 078	137 6	7 2	334	33.7	20.7	9.7	2.7	0.58
T_8	7.7	0.59	0 74	0.086	173.8	9.5	353	34.2	20.9	9.2	2.6	0.63
T_9	7.7	0 62	0.55	0.057	123.1	7.5	329	32.3	21.0	8.4	2.3	0 48
T_{10}	7.8	0.73	0.58	0.076	150.0	9.1	351	33.6	22 6	7.6	2.0	0.68
T_{11}	8.2	1.36	0.40	0.043	99.8	4.5	320	25.3	18.1	3 0	3.0	0.83
S.E.	0 03	0 05	0.017	0 0026	1.92	0.07	2.84	0.16	0.20	0.04	0.08	0.04
C.D.	0.09*	0.15*	0.050**	0.0077**	5.65**	0.21**	8.54**	0.46**	0.59**	0.15*	0.25*	0.14*

TABLE IV. YIELD OF FINGER MILLET (Mean valus)

Treatments	Grain yield (kg/ha)	Straw yield (kg/ha)
T_1	3224	3682
T_2	2391	3540
T_3	3224	3190
T_4	2341	2774
T_5	2399	2774
T_6	2832	3265
T_7	2166	2166
T_8	2341	2357
T_9	2224	2940
T_{10}	3007	3332
T_{11}	1783	2149
S. E.	158	166
C D.	458	500

TABLE V. SIMPLE CORRELATION (M–33)

S. No.	Relation between X	Correlation coefficient
1.	Organic carbon Vs available nitrogen	0.828**
2.	Organic carbon Vs grain yield	0.561**
3.	Organic carbon Vs available phosphorus	0.751**
4.	Organic carbon Vs total cation exch. capacity	0.741**
5.	Total nitrogen Vs available nitrogen	0.846**
6.	Total nitrogen Vs organic carbon	0.855**
7.	Available nitrogen Vs grain yield	0.516**
8.	Available nitrogen Vs straw yield	0.309*

* Significant at 1% level
** Significant at 5% level