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Influence of Soil Amendments on the Physical Properties of Black Soil and Yield of Ragi

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Studies to evaluate the efficacy of organic and inorganic amendments in black soil revealed that organic amendments viz., poultry manure, maize straw and farm yard manure were superior to inorganic industrial wastes and mineral amendments in improving the physical properties of soil and yield of ragi (Co. 10). Industrial wastes like lime sludge and furnace slag and mineral amendments like gypsum were found next best respectively in improving the aggregate stability, hydraulic conductivity available water status of soil and yield.

Application of soil amendments are reported to rectify the adverse soil physical and chemical conditions met with in saline and alkali soils, acid soils, poorly aggregated soils, soils with impeded or excessive drainage conditions and in soil and water conservation practices. Different types of crops and animal residues, organic and inorganic industrial wastes and minerals like gypsum and dolomite are used as amendments to improve soil properties. Adequate information on the utilisation of industrial wastes as amendments and their relative efficacy compared to organic and mineral amendments is not available. Hence the present study was undertaken to evaluate the influence of application of organic amendments, inorganic industrial wastes and mineral amendmends in improvement of physical properties of black soil and yield of ragi (*Eleusine coracana* Gaertn.) var Co. 10.

MATERIAL AND METHODS

A field experiment was conducted in black soil of Perianaickenpalayam series (Coimbatore District) with poor permeability and aggregation status. Randomised block design was adopted with 11 treatments and three replications. The treatments included organic amendments viz., farm yard manure (T_1) poultry manure (T_2), maize straw (T_3) and cotton waste compost (T_4); inorganic amendments viz., gypsum (T_5), magnesite (T_6), and tank silt (T_7) and industrial wastes viz. furnace slag from iron industry (T_8), smoke chamber dust from cement industry (T_9) and lime sludge from paper industry (T_{10}) and control (no amendment (T_{11}). The amendments were mixed well with the soil and allowed to react for four weeks prior to planting *ragi* (Co. 10). The organic amendments and tank silt were applied at 25 t/ha and the inorganic amend-

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ments at 10 t/ha. A uniform fertilizer dose of 90 kg of N, 45 kg P_2O_5 and 22.5 kg K_2O/ha was applied to all the treatments in the form of amonium sulphate, super phosphate and muriate of potash respectively. The phosphatic and potassic fertilizers were applied as basal dressing while the nitrogenous fertilizer was applied in two split doses viz., half at planting and half at flowering. The nutrient content of amendments was not considered while applying the fertilizers since the former is too small and not available during the short growth period of *ragi*. Initial and post-harvest soil samples were collected at 0-20 cm depth and analysed for the various physical properties. Correlations were worked out between the physical properties of soil and yield.

Undisturbed core soil samples were collected and the physical analysis of soil was done in triplicate and mean values reported. The bulk density of soil was estimated as ratio between the weight of soil to its volume under field condition (Dakshinamurti and Gupta, 1968). Cone type of penetrometer was used for assessing the soil strength. Hydraulic conductivity was estimated with constand head permeameter and calculated as per Darcy's equation. Yoder's (1936) wet sieving technique was adopted for aggregate analysis and the aggregate stability, stability index and mean weight diameter of aggregate were calculated (Dakshinamurti and Gupta, 1968). International pipette method was used for mechanical analysis of soil (Piper, 1966). The available soil moisture was estimated as difference between the 1/3 bar and 15 bar moisture tensions and were estimated in pressure plate and pressure membrane apparatus respectively (Dastane, 1972).

RESULTS AND DISCUSSION

The mechanical analysis of initial soil sample showed it to be of silty clay loam texture. The hydraulic conductivity, aggregate stabilty and stability index of the soil were low initially (Table I).

TABLE I Physical properties of initial soil sample (0-20 cm depth)

Properties:	
Coarse sand %	12.35
Fine sand %	29.96
Silt %	26.05
Clay %	30.20
Bulk density (g/cc)	1.30
Soil Strength (Kg/cm)	28.01
Aggregate stability %	25.20
Stability Index	18.12
Structural Coefficient	0.25
Aggregate Index	0.15
Mean weight diameter (mm)	0.20
1/3 bar moisture %	27.79
15 bar moisture %	17.02
Available water %	10.77
Hydraulic conductivity (cm/hr)	0.35

Application of organic amendments like maize straw, farm yard manure, poultry manure and cotton waste compost significantly reduced the bulk density of post-harvest soils compared to the inorganic amendments viz. cement dust, furnace slag and magnesite (Table II). Maize straw, farm yard manure, cotton waste compost and poultry manure treatments recorded loss soil strength than inorganic amendments. The increase in hydraulic conductivity of soil was significantly improved by the addition of organic amendments like poultry manure, maize straw, farm yard manure and industrial wastes viz., lime sludge and furnace slag. Gypsum and furnace slag treatments were as effective as poultry manure in improving the mean weight diameter of aggregates. The 1/3

TABLE II Physical properties of Post-harvest soils

Treatments	Bulk density (g/cc)	Soil Strength (Kg/cm²)	Hyd. conductivity (cm/hr)	Agg. Stability (%)	Stability Index	Mean wt. diameter (mm)
T_1	1.06	23.10	0.77	42.76	28.68	0.46
T_2	1.04	18.15	1.06	44.15	34.53	0.44
T_3	1.10	23.65	0.97	44.61	35.43	0.56
T_4	1.11	23.38	0.47	42.31	27.63	0.41
T_5	1.12	24.20	0.44	38.84	25.99	0.40
T_6	1.14	26.22	0.76	40.15	26.68	0.50
T_7	1.17	27.04	0.44	38.48	25.99	0.43
T_8	1.17	27.48	0.74	43.18	31.48	0.56
T_9	1.24	27.58	0.55	42.78	30.29	0.41
T_{10}	1.13	25.55	0.63	43.64	32.96	0.46
T_{11}	1.30	28.01	0.38	29.69	22.51	0.38
S.E.	0.01	00.56	0.09	0.49	0.43	0.003
C.D.	0.04	1.66	0.27	1.44	1.27	0.009

TABLE III Available water content of soil

Treatments	1/3 bar moisture (%)	15 bar moisture (%)	Available water (%)
T 1	31.77	17.34	14.43
T 2	31.48	17.52	13.97
T 3	34.88	17.84	16.59
T 4	30.24	17.92	12.33
T 5	29.72	18.74	10.98
T 6	31.47	18.22	13.25
T 7	30.45	18.34	12.11
T 8	33.65	17.76	15.90
T 9	29.97	17.13	12.85
T 10	31.31	17.39	13.92
T 11	27.40	17.02	10.38
S. E.	0.22	0.20	0.79
C. D.	0.66	0.59	2.97

bar moisture (Table III) showed significant improvement in poultry manure and furnace slag treatments over others. The 15 bar moisture showed a decreasing trend in poultry manure, furnace slag and farm yard manure treatments resulting in increased available wate content of soil in these treatments.

The yield data of *ragi* (Table V) revealed that poultry manure, lime sludge and farm yard manure treatments improved the grain yield significantly compared to other treatments. The straw yield data revealed that poultry manure treatment was superior to farm yard manure, lime sludge and maize straw which were on par.

The decrease in bulk density of soil by the application ot amendments may be attributed to the organic matter content of soil which, in turn, would have influenced the aggregation of soil particles. Morachan *et al.* (1972) reported similar decrease in bulk density of soil by the application of organic amendments. Bulk density of soil (Table IV) was negatively correlated with the available water (r = — 0.296*), grain yield (r = — 0.369*) and straw yield (r = — 0.423*). Bulk density of soil was positively correlated with soil strength (r = 0.552*) which is in agreement with the findings of Kumar *et al.* (1971). Aggregate stability was positively correlated with grain (r = 0.590 **) and straw yields (r = 0.438 *). Stability index was positively correlated with the mean weight diameter (r = 0.685 **), available water (r = 0.879 **) and grain yield (r = 0.590 **). The above relationships may be attributed to tha favourable influence of amendments in improving the structural properties of the soil. Hydraulic conductivity was negatively correlated with the findings of Ramamohan Rao *et al.* (1973). Salter and Williams (1965) observed that increase in water retention characteristics at lower tension of 1/3 bar was due to

TABLE IV Physical properties of soil - Correlation coefficients and Regression equation (N = 33)

Variables X	Y	Correlation Coefficient r	Regression equation
Bulk density	Available water	(—) 0.296 *	Y = 4.202 — 0.0076X
Bulk density	Grain yield	(—) 0.369 *	Y = 0.1032 — 0.0249X
Bulk density	Straw yield	(—) 0.423 *	Y = 0.3301 — 0.0250X
Bulk density	Soil strength	0.552 **	Y = - 8.952 + 0.0088X
Aggregate. stability	Grain yield	0.589 **	Y = 30.3938 + 6.2587X
Aggregate. stab.	Straw yield	0.438 *	Y = 34.7885 + 4.0705X
Stability index	Mean Wt. Diameter	0.685 **	Y = 29.2086 + 41.8345X
Stability index	Available water	0.879 **	Y = 3.5706 + 1.9283X
Stability index	Grain yield	0.590 **	Y = 28.0592 + 3.4197X
Hydraulic conductivity	Bulk density	(—) 0.511 **	Y = 1.458 + 1.949X
1/3 bar moisture	Aggregate stability	0.804 **	Y = 37.0337 + 6.1837X
Available water	Stability index	0.879 **	Y = 23.9016 + 1.9283X

TABLE V. Yield of Ragi (Co. 10)

Treatments	Grain yield (Kg/ha)	Straw yield (Kg/ha)
T_1	2491	3032
T_2	2166	2874
T_3	2882	3524
T_4	2141	2524
T_5	2199	2666
T_6	2249	2741
T_7	2058	2674
T_8	2316	2599
T_9	2141	2574
T_{10}	2574	2999
T_{11}	1716	1966
S.E.	0.097	0.112
C.D.	0.274	0.318

improved aggregation and favourable pore geometry of soil. The 1/3 bar moisture was significantly correlated with the aggregate stability ($r = 0.804^{**}$) in the present investigation. As reported by Biswas and Khosla (1971), the treatment differences in this investigation were wider for moisture retention at 1/3 bar as compared to that of 15 bar tension. The available water was positively correlated with stability index ($r = 0.879^{**}$) which is in conformity with the findings of Biswas and Ali (1967).

Application of amendments, apart from improving the physical properties of soil, improved the yield of *ragi*. The efficacy of amendments tried, based on their improvement of physical properties of soil and yield of crop may be graded as follows: Organic amendments > industrial wastes > mineral amendments. Within the above broad groups, the order of efficacy of the amendments in each group at the dose tried were as follows:

Organics:

Poultry manure, farm yard manure, maize straw, cotton waste compost.

Industrial wastes:

Lime sludge, furnace slag, cement dust.

Mineral amendments:

Gypsum, tank silt, magnesite.

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