

EFFECT OF ORGANIC MANURING ON SOME PHYSICAL PROPERTIES AND WATER RETENTION OF COASTAL SAND

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ABSTRACT

Effects of applying coir dust, coconut sheddings, forest leaves and cattle manure as organic fertilizer on some physical properties of littoral sand were investigated in this study. The incorporation of organic sources blended with inorganic nutrients continuously for 10 years was found to increase the water holding capacity and decrease the bulk density of the soil as compared to the application of inorganics alone. The saturated hydraulic conductivity was higher in soil samples from the basins of palms treated with organic manure. An improvement in water retention characteristics and available water capacity on account of coupling of organic sources with inorganic fertilization was also observed. The available water capacity of 0.78 percent by weight for plots treated with NPK alone increased to 1.94, 0.87, 1.39 and 1.13 percent when coir dust, coconut sheddings, forest leaves, and cattle manure, respectively, were incorporated along with NPK.

INTRODUCTION

Improvement of soil fertility and soil physical properties through long term organic manuring is well documented. The cumulative effect of organic manures in the improvement of soil structure, porosity, hydraulic conductivity, and water retention and decreasing bulk density in alluvial, black, red, and laterite soils has been reported by Biswas and Khosla (1971). Similar improvement of the physical parameters of highly permeable red sandy loam soils (Palaniswamy, 1975) and red and black soils (Shanmugham and Ravikumar, 1979; Ravikumar and Krishnamoorthy, 1979) has also been reported. Favorable effects of increased organic matter content on water retention and availability have been observed for many tropical soils (Lal and Kang, 1982).

In this study an attempt has been made to evaluate the effect of long term application of organic materials on some physical properties and water retention of littoral sand, where difficulty in establishing coconut groves was experienced. Reduction of coconut seedling mortality and improvement of growth by the application of organics have been reported earlier (Nambiar et al., 1983).

MATERIALS AND METHODS

Experimental Design

An experiment started in 1971 investigating the

effect of applying different organic materials as fertilizer on the establishment and growth of coconut palms on sand was extended to also evaluate the effect of these materials on some soil properties. Plots used in the experiment comprise a beach block of the Central Plantation Crops Research Institute in Kasaragod, Kerala, India. The original experiment was laid out following a randomized complete block design with five treatments replicated five times. The five treatments include NPK alone, NPK + coir dust, NPK + coconut sheddings, NPK + forest leaves, and NPK + cattle manure. Organic sources were applied at the rate of 10 kg (oven dry basis) per palm per year during the initial two years followed by 20 kg per palm per year from the third year onwards. Each experimental palm received recommended levels of the major plant nutrients, i.e., 500 g N, 320 g P₂O₅ and 1200 g K₂O per year in two split doses, one-third during April-May and two thirds during September-October, after compensation of manurial value of organic sources.

Pre-treatment Soil Description

The experiment was conducted on sandy soil (Quartzipsamments) with a composition of 98 percent sand, 0.2 percent silt, and 0.7 percent clay. The pre-treatment analysis indicated low available nitrogen (38-46 ppm), medium available phosphorus (18-21 ppm), and low available potassium (5.7-9.0 ppm). The pH of the soil was between 6.3 and 6.7.

Soil Sampling and Analysis

Twenty-five disturbed soil samples representing

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five treatments and five replications were collected from the upper 50 cm of the soil profile in 1980 for the estimation of organic carbon (Walkley and Black's method as described by Jackson, 1964), water holding capacity (WHC), and bulk density (BD) (Piper, 1966). Other disturbed soil samples collected from the basins of treated palms (0-50 cm and 50-100 cm depths) were utilized to derive moisture-tension curves using a pressure plate apparatus. The moisture retained at 0.1, 0.3, 1.0, 5.0, and 15 bars was worked out employing duplicate samples. Core samples were collected in 1981 for permeability tests in the laboratory by the constant head method (Black, 1965) and for working out WHC and BD of the soil.

RESULTS AND DISCUSSION

Effect on Organic Carbon Content

The pre-treatment soil samples revealed a variation of organic carbon content between 0.078 and 0.090 percent. After 10 years of continuous application of organics, the organic carbon level was found to vary between 0.146 and 0.220 percent. This represented a two to three fold increase. The estimated rate of increase of 0.015 percent per year in the case of coir dust was the maximum followed by cattle manure (0.0112 percent/year), forest leaves (0.009 percent/year), and coconut sheddings (0.0062 percent/year). The yearly increase in organic carbon content due to the application of different organic materials was rather low. There is therefore a need to apply higher doses of organic matter than the present level (20 kg/palm/year). The study also indicated that for building up the organic carbon status of littoral sands, a continued application of organic sources in the basins of palms is required. Kanwar and Prihar (1962), Poonia and Pal (1979), and Singh et al. (1980) have also indicated the necessity for continued

application of organic matter for building up organic carbon status of tropical soils. The present investigation revealed that the change in organic carbon content is dependent on the nature of organic sources being incorporated. Coir dust, being a more lignicious material and hence resisting decomposition, has been observed to increase the organic carbon content most. The NPK alone showed no change in organic carbon status of sand over nine years. Computed correlation coefficients between organic carbon content and WHC, BD and available water capacity (Table 1) indicate that the increase in organic carbon content may have been instrumental in improving various physical parameters of the coastal sand evaluated.

Effect on Water Holding Capacity, Bulk Density, and Saturated Hydraulic Conductivity

At the start of the experiment in 1971 the WHC of the treatment plots varied between 18.9 and 20.6 percent by weight. In 1980 the WHC values increased and these fell within the range of 25.9 to 27.5 percent. The magnitude of increase per year varied between 0.61 and 0.79 percent in plots blended with organic materials. Even the plots treated with NPK alone showed increased WHC values varying from 20.6 to 23.6 percent. This was probably caused by enhanced root activity resulting in *in situ* organic matter addition. The increase in WHC of the disturbed samples was also associated with the decrease in BD of sands in treated plots as compared to pre-treatment samples. The BD of the soil originally varying from 1.77 to 1.81 gm/cc decreased to 1.59 to 1.64 gm/cc by continuous application of organic sources over nine years.

Hydraulic conductivity tests on the 1981 core samplings showed that the application of organics significantly increased the water transmitting power of

Table 1. Correlation coefficients between organic carbon content and water holding capacity, bulk density, and available water capacity.

SAMPLING DEPTH (cm)	NO. OF SAMPLES	WATER HOLDING CAPACITY (%)	BULK DENSITY (g/cc)	AVAILABLE WATER CAPACITY (bars)	
				0.3-15	0.1-15
Surface (0-50)	25	0.74**	-0.64**	0.64**	0.46*
Sub-surface (50-100)	25	0.62**	-0.60**	0.11	0.43*

*Significant at 5 percent

**Significant at 1 percent

the soil as compared to applying NPK alone (Table 2).

Increase in organic matter content and consequent improvement in aggregate stability and physical parameters has been demonstrated in previous studies (Biswas et al., 1964 and Lal et al., 1980). Since this study was conducted on sand with a single-grain structure, it is difficult to explain the exact mechanism of improvement in the soil matrix and associated physical

parameters. The favorable changes observed in both the growth of palms and soil fertility (Nambiar et al., 1983) are however indications of some changes in the matrix of the soil at least at the micro level.

Effect on Moisture-Tension Relationships

The soil moisture retained at different tensions are presented in Table 3. It was observed that the

Table 2. Cumulative effect of application of different organic sources along with inorganic sources on some physical properties

TREATMENT	ORGANIC CARBON (%)			DISTURBED SOIL SAMPLES						CORE SAMPLES		
	1971	1980	Average increase per year	Water Holding Capacity (%)			Bulk Density (g/cc)			Water Holding Capacity (% by wt)	Bulk density (g/cc)	Saturated hydraulic conductivity (cm/hr)
				1971	1980	Average increase per year	1971	1980	Average increase per year			
Coir Dust	0.088	0.221	0.0147	20.6	27.5	0.766	1.81	1.59	0.026	33.8	1.37	181.2
Coconut Sheddings	0.090	0.146	0.0062	20.4	25.9	0.611	1.81	1.64	0.018	27.1	1.48	194.8
Forest Leaves	0.088	0.169	0.0090	18.9	26.0	0.788	1.77	1.61	0.017	27.2	1.50	175.8
Cattle Manure	0.084	0.185	0.0112	19.9	26.3	0.711	1.81	1.60	0.023	26.5	1.57	150.7
Control (NPK alone)	0.078	0.080		20.6	23.6	0.333	1.85	1.70	0.016	23.42	1.60	133.3

Table 3. Cumulative effect of application of different organic sources along with inorganic fertilizers on soil moisture retention characters of coastal sandy soil.

TREATMENT	SURFACE-SOIL MOISTURE RETENTION TENSION (bars)					AVAILABLE WATER CAPACITY		SUB-SOIL MOISTURE RETENTION TENSION (bars)					AVAILABLE WATER CAPACITY	
	0.1	0.3	1.0	5.0	15	a	b	0.1	0.3	1.0	5.0	15	a	b
Coir Dust	3.95	2.94	1.67	1.58	1.00	2.95	1.94	2.38	1.65	0.98	1.10	0.70	1.68	0.95
Coconut Sheddings	2.41	1.76	1.08	0.98	0.89	1.52	0.87	2.40	1.53	0.89	0.76	0.70	1.70	0.83
Forest Leaves	2.79	2.03	1.39	1.11	0.64	2.15	1.39	2.37	1.65	0.91	0.78	0.67	1.70	0.98
Cattle Manure	2.90	1.90	1.13	0.96	0.77	2.13	1.13	2.55	1.72	1.04	0.86	0.58	1.97	1.14
Control (NPK alone)	1.17	1.22	0.80	0.63	0.44	0.73	0.78	1.43	0.92	0.63	0.73	0.30	1.13	0.62

Note: 'a' and 'b' denote the differences between 0.1 bar and 15 bars and 0.3 bar and 15 bars respectively.

blending of organic sources with inorganic nutrients was effective in increasing the moisture retained by the soil from full saturation to wilting point (up to 15 bars) in surface as well as subsoil samples. The increase in water holding capacity was more pronounced in the surface soil. The moisture-tension curves of surface samples (Fig. 1) reveal a maximum increase in water retention in coir dust treated samples followed by other organic sources over NPK application alone. Obviously this behavior has been altered favorably by the blending of organics with inorganics. This behavior of soil with respect to water retention at various tensions on one hand and the increase in saturated hydraulic conductivity on the other clearly supports the consensus that organic manuring helps in strengthening the bonds that stabilize the structural units and maintains favorable balance between retention and transmission pores. The available water capacity when considered as moisture retained between 0.3 and 15 bars and 0.1 and 15 bars was increased most in sand treated with coir dust. Sand treated respectively with forest leaves, cattle manure, coconut sheddings, and NPK alone showed decreasing increases in water holding capacity in the surface layer. In the case of the subsoil, treatment with cattle manure and forest leaves increased available water capacity more than treatment with coir dust and coconut sheddings. This may be attributed to the nature of sources being used. The organic sources were placed at a depth of 30-50 cm. Forest leaves and cattle manure decompose relatively faster than lignicious materials like coir dust and coconut sheddings hence there may have been movement of decomposition products to lower layers. A similar observation of increase in water retention with increase in organic matter content was also made by

Russel and Shearer (1964) in long term fertility experiments with some south Australian soils.

In conclusion, the better establishment of seedlings, vigorous growth, and earlier flowering of palms as reported by Nambiar et al. (1983) could be attributed to the improved physical environment around root zone as a result of addition of organic sources.

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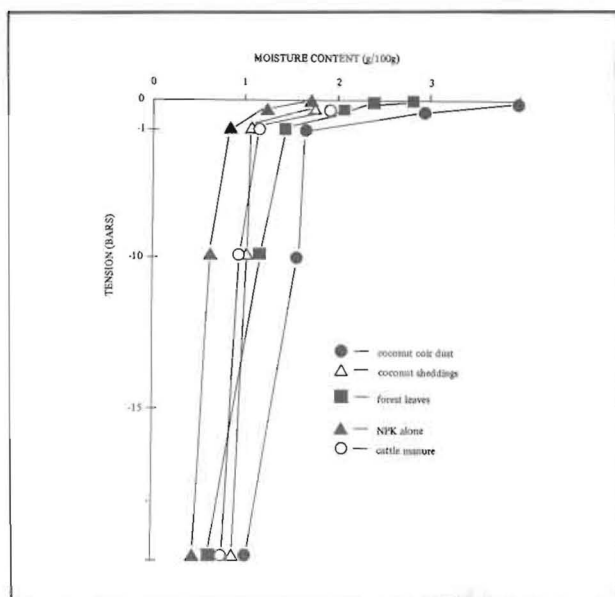


Fig. 1. Tension - Moisture Relationships for Quartzsammments under Variable Treatments

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