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Effect of Press Mud Application on Physical, Chemical and Biological Characteristics of Some Common Soils

1. Laboratory Studies

M. INDIRARAJA[1] and D. RAJ[2]

Laboratory studies were carriedcut with five soils amended with press mud at 0, 5 and 10 tons per hectare and incubated for a period of 60 days. The analysis of the incubated soils showed that press mud at 10 tons/ha improved the stability index and aggregate stability of the black (wetland) and acid soils significantly. Press mud application resulted in progressive increase in available nitrogen, available phosphorus and organic carbon contents of all the soils studied. Press mud at 10 tons/ha increased the cation exchange capacity of all the soils, while it increased the exchangeable calcium in the red, acid and black (gardenland) soils. The biological activity of soil as indicated by the CO_2 evolution recorded a significant increase with press mud application in the red, alkali and acid soils. Press mud application resulted in increase in bacterial population of red soil and fungal population of black (wetland) soil.

Press mud whose composition varies depending on many factcrs like the maturity of cane, milling percentage and method of clarification employed is rich in organic matter, calcium and phosphorus and it also contains some organic nitrogen and trace elements. It has been used as soil ameliorant, soil conditioner and source of nutrients for crop growth. Azzam (1965) reported that filter press cake was useful in improving the texture and moisture retention capacity of soils. According to Alexander (1972) filter cake might assist in soil aeration and drainage in heavy soils whereas, in sandy soils it helped in improving the retention of moisture and plant nutrients. In an experiment conducted to study the effect of filter-press mud on the macro-and micro-nutrient availability of soils, Prasad (1974) found substantial increases in availability of phosphorus in clayey and sandy soils, and a tendency of increased potassium availablity of calcium, magnesium and zinc also increased as a result of filterpress mud application.

This paper gives an account of a laboratory investigation carried out to determine the effect of press mud application on the properties of some common soils.

MATERIAL AND METHODS

In order to study the effect of press mud on properties of different soils, five soils of varying properties were collected viz., (i) red soil from

1 - 2 Department of Bio-chemistry, Tamil Nadu Agricultural University, Coimbatore-641 003.

Dharapuram (Coimbatore district) (ii) black soil from wetlands Coimbatore, (iii) black soil from gardenland, Coimbatore, (iv) alluvial non-saline alkali soil from Modakkurichi (Coimbatore) and (v) acid soil from Kanyakumari. The soils were analysed for physical, chemical and biological properties. Press mud obtained from M/s. Sakthi Sugars, Appakudal, Erode was analysed for chemical composition. The soils were treated with press mud at 0, 5 and 10 tons per ha with three replications and incubated at field capacity for a period of 60 days. After the incubation, the soils were examined for pH, EC, available nitrogen, phosphorus, potassium, calcium, magnesium and cation exchange capacity. The structural indices like aggregate stability and stability index and physical constants, maximum water holding capacity, porespace, volume expansion on wetting, apparent density and absolute specific gravity were determined. The biological activity of soil as indicated by carbon dioxide evolution was determined by the method given by Chesters *et al* (1957). The soils were examined for population of bacteria, fungi and actinomycetes.

RESULTS AND DISCUSSION

The results of initial analysis of the soils are given in Table I. The soils showed a wide range of properties. The texture of the soils varied from sandy clay loam, to clay with the clay percentage ranging from 18 per cent to 42 per cent black (wetland) soil. The pH of the soil varied from 5·8 for acid soil to 10·2 for the alkali soil. The available phosphorus, calcium and potassium contents were the highest in the alkali soil.

The composition of the press mud used in the study is given in Table II

The results of analysis for physical properties of the incubated soils are presented in Table III. In general, the aggregate stability increased significantly with press mud application at 10 tons/ha as compared to control. In the black (wetland) soil which registered the higest aggregate stability among the five soils, significant improvement in this property was absarved by application or press mud at 5 and 10 tons/ha. while the alkali soil registered improvement only for the lower level (5 tons/ha) press mud, the acid soil registered improvement only with the higher level (10 tons/ha) treatment. Lugo Lopez *et al* (1953) observed better retention of available moisture in soils due to filter cake application at 16 and 32 tons and Azzam (1963) reported the effectiveness of filter cake in improving the texture and moisture retention property of soil used for tomato cultivation.

Significant positive correlations were observed among the physical

TABLE I Initial Analysis of soil samples used for Laboratory incubation studies

Particulars of analysis	Red soil	Black wet-land soil	Black garden-land soil	Alkali soil	Acid soil
A Physical Properties					
1 Mechanical composition					
Clay %	26.2	42.2	24.3	18.1	27.8
Silt %	3.5	11.1	16.8	5.6	2.2
Fine sand %	36.1	29.8	28.4	26.5	46.8
Course sand %	34.4	11.5	23.8	40.3	22.1
Acid solubles % (by difference)	—	5.4	6.7	9.4	1.1
Texture	sandy clay loam	Clay	Sandy clay loam	Sandy clay loam	Sandy clay loam
2 Physical constants					
Maximum waterholding capacity %	36.3	77.5	51.5	65.6	35.1
Pore space %	49.7	67.6	71.2	50.2	52.8
Volume expansion on wetting %	13.1	50.5	12.9	33.8	5.6
Apparent density	1.59	1.40	1.31	1.35	1.60
Absolute specific gravity	2.76	2.74	3.32	2.36	3.16
3 Structural indices					
Aggregate stability %	8.8	58.4	23.0	5.9	22.6
Stability index	5.1	45.7	15.5	3.0	15.3
B Chemical Properties					
Moisture %	2.2	5.5	4.5	2.1	1.2
Organic Carbon %	0.17	0.69	0.32	0.26	0.14
Available nitrogen (N) %	0.0087	0.0127	0.0073	0.0049	0.0091
Available phosphorus (P)%	0.00015	0.00053	0.00016	0.00112	0.00015
Available potassium (K) %	0.0028	0.0114	0.0118	0.0444	0.0028
Available calcium (me Ca/100 g)	6.8	22.0	24 0	5.2	6.0
Cation exchange capacity (me/100 g)	12.8	33.5	22.1	14.2	10.4
pH	6.1	7.9	8.2	10.2	5.8
Electrical conductivity (mmhos/cm)	0.075	0.6	0.16	3.1	0.35
C Biological properties					
Carbon dioxide evolution mg/100 g soil/day	1.60	1.88	1.68	2.04	1.84
Microbial population per g soil					
Bacteria	18×10^4	63×10^4	84×10^4	51×10^4	20×10^4
Fungi	7.4×10^3	1.1×10^3	4.2×10^3	—	1.0×10^3
Actinomycetes	6.1×10^3	9.5×10^3	15.7×10^3	4.1×10^3	1.5×10^3

TABLE II Composition of press and Results expressed as percentage on moisture free basis

Moisture	12.7	Lime (CaO)	13.5
Ash	39.9	Magnesia (Mgo)	2.5
Loss on ignition	60.1	Sodium (Na_2 O)	0.2
Acid insolubles	10.1	(Fe_2 O_3 + Al_2 O_3)	18.5
Nitrogen (N)	3.2	Organic carbon	17.1
Phosphoric acid (P_2 O_5)	8.4	Sulphate (SO_3)	2.9
Potash (K_2 O)	0.9	C/N ratio	5.4
		pH	7.3

properties even after press mud treatment showing that these strong interrelationships were not altered on account of press mud application. The water holding capacity was correlated with pore space ($r=0.992^{***}$), volume expansion on wetting ($r=0.956^{***}$) and aggregate stability ($r=0.759^{***}$).

The available nutrient status of the soils is given in Table IV. Press mud application resulted in progressive increase in available nitrogen of soils. Similarly the available phosphorus status of soils also increased progressively with increasing level of press mud application and the soils did not differ in this regard. The increase in available nitrogen on account of press mud application indicated that the nitrogen present in press mud was immediately available for crop nutrition. This is in agreement with the view expressed by Pandalai *et al* (1953) that since the C/N ratio of the material was narrow, the nitrogen present would be immediately available for plant use. The increase in available phosphorus content of soil with press mud application was evidently due to the high phosphorus content of the material and also probably due to solubilisation of insolvable forms of phosphate by organic acids produced during the decomposition of organic matter present in press mud. Prasad (1974) reported substantial increases in soil available phosphorus as a result of filter-press mud application in an incubation experiment.

The available potassium content of soil did not show significant difference due to treatments. This might have been due to the low potassium content of press mud. The available (exchangeable + water soluble) calcium content of soil was significantly higher for the treatments press mud at 5 and 10 tons/ha as compared to control. The soils however, differed in this regard. The increase in available calcium content of soil observed was evidently due to the high calcium content of press mud and it is in agreement with the findings of Prasad (1974), Golden (1975) and Prasad (1976) who reported increased availability of calcium in soils due to filter-press mud application.

TABLE III Physical Properties of soils incubated with Press mud (Mean values of 3 replications)

Properties	Treat-ment	Red soil	Black (wetland soil)	Black (garden land soil)	Alkali soil	Acid soil
Maximum waterholding capacity%	T_1	32.5	69.5	62.8	39.3	36.8
	T_2	31.7	71.1	61.6	41.5	35.7
	T_3	34.4	70.7	63.3	39.4	37.6
Porespace%	T_1	49.9	71.7	67.8	55.3	52.3
	T_2	49.6	71.2	66.7	56.6	50.9
	T_3	50.7	71.1	67.2	55.5	52.2
Volume expansion on wetting%	T_1	10.4	42.5	36.3	6.2	5.8
	T_2	9.4	44.7	36.6	4.0	5.3
	T_3	12.2	45.6	39.8	3.8	6.4
Apparent density	T_1	1.57	1.31	1.35	1.41	1.46
	T_2	1.56	1.31	1.36	1.34	1.48
	T_3	1.54	1.33	1.38	1.37	1.46
Aggregate stability%	T_1	13.5	46.3	38.8	5.8	24.0
	T_2	11.9	56.9	25.7	16.6	26.1
	T_3	21.2	59.4	39.4	5.9	42.4
Stability Index	T_1	7.3	37.5	24.2	3.3	14.5
	T_2	6.4	44.0	15.9	7.8	16.8
	T_3	12.0	45.7	24.8	3.3	26.8

The available magnesium content of soil did not increase with press mud application. This might be on account of the low magnesium content of press mud.

The cation exchange capacity of soils differed significantly for soils as well as the treatments, press mud application at 10 tons/ha having resulted in a significant increase in this soil characteristic. This might have been due to the contribution of organic matter to cation exchange capacity of soil as stated by Ghonsikar and Musande (1977).

The organic carbon increased progressively with press mud application in all the soils. This was evidently due to the organic carbon content of press mud. Highly significant positive correlations were observed between organic carbon and log available nitrogen ($r = 0{\cdot}511$ ***), log carbon dioxide evolution, ($=0{\cdot}868$***), log aggregate stability ($r=0{\cdot}640$***) and cation exchange capacity ($r = 0{\cdot}971$ ***). These relationships stress the improvement role organic matter in favourably influencing soil properties Sankaranarayana and Mehta (1967) reported a significantly high correlation of soil aggregation with soil organic carbon. Velayutham and Raj

TABLE IV Chemical Properties of soils incubated with Press mud (Mean of 3 replications)

Properties	Treatment	Red soil	Black (wetland soil)	Black (Garden-land) soil	Alkali soil	Acid soil
Available nitrogen (N) ppm	T_1	69.3	01.3	84.3	39.7	86.7
	T_2	89.3	05.0	80.0	50.3	89.7
	T_3	98.0	12.3	87.0	56.3	91.3
Available phosphorus (P) ppm	T_1	5.1	4.3	1.8	19.1	2.9
	T_2	2.1	9.4	2.5	26.3	5.5
	T_3	7.7	16.0	22.6	40.9	5.1
Available potassium (K) ppm	T_1	39.3	32.3	146.3	397.7	36.0
	T_2	39.3	31.7	143.7	378.7	31.0
	T_3	42.7	32.7	143.0	397.0	36.0
Available (watersoluble +	T_1	6.6	21.3	20.8	5.1	5.7
changeable) calcium (Ca) me/100 g	T_2	7.3	20.3	22.0	5.7	6.4
	T_3	7.5	21.4	21.7	5.3	6.6
vailable (water soluble+exchangeable)	T_1	2.5	11.6	11.9	2.0	1.9
magnesium (Mg) me/100 g	T_2	2.6	13.7	10.5	1.9	1.5
	T_3	2.9	12.2	10.3	2.2	1.4
Cation exchange capacity me/100 g	T_1	13.9	33.6	22.7	14.5	10.1
	T_2	14.4	34.8	22.4	12.3	10.5
	T_3	16.2	35.3	23.5	14.4	12.0
Organic carbon%	T_1	0.21	0.76	0.43	0.22	0.18
	T_2	0.28	0.82	0.45	0.29	0.21
	T_3	0.32	0.88	0.47	0.33	0.26
pH	T_1	6.63	7.83	7.83	9.30	6.07
	T_2	6.70	7.80	7.87	9.30	6.37
	T_3	6.70	7.87	7.90	9.20	6.60
Electrical conductivity mm hos/cm	T_1	0.08	0.69	0.15	3.57	0.14
	T_2	0.14	0.61	0.21	3.51	0.23
	T_3	0.20	0.53	0.24	3.59	0.29

(1971) also reported a high correlation between water holding capacity and organic carbon in four soil groups of Tamil Nadu.

The pH values showed a significant reduction in the case of alkali soil at the higher level of press mud (10 tons/ha) although the decrease was not considerable, thereby showing that higher doses are required for effective reduction. The pH of acid soil showed a significant progressive increase with increasing level of press mud. Prasad (1974) also reported a slight increase in pH of acid soils due to filter press mud application.

The electrical conductivity of soils was not significantly influenced by press mud treatement.

The biological properties of the soils are presented in Table V

The differences in carbon-dioxide evolution of soils as an index of biological activity of soils were significant for treatments, soils and their interaction. When all the soils were pooled together the values for Co_2 evolution progressively increased with increasing levels of press mud application. A significant positive correlation was obtained between organic carbon and log Co_2 evolution. ($r = 0{\cdot}748^{***}$). Ramaswami and Raj (1973) in a study of five soil groups of Tamil Nadu found that the change in Co_2 evolution was the highest in soils treated with green manure as compared to those treated with inorganic fertilizers.

TABLE V Biological Properties of soils incubated with Press mud
(Mean values of 3 replications)

Particulars	Treatment	Red Soil	Black (wetland) Soil	Black (Garden-land) Soil	Alkali Soil	Acid Soil
Carbon-dixide	T_1	1.20	2.49	1.80	1.06	1.03
evolution (mg/100 g	T_2	2.05	2.54	2.24	1.51	1.53
soil per day)	T_3	2.01	2.94	2.48	2.01	2.82
Bacteria (10^4 / g)	T_1	21.3	110.0	306.7	15.7	34.7
	T_2	46.0	126.7	373.3	8.0	36.3
	T_3	47.0	173.3	303.3	12.3	42.3
Fungi (10^2 / g)	T_1	60	30	100	0.2	183
	T_2	50	73	57	0.1	160
	T_3	60	77	33	0.3	247
Actinomycetes (10^3 / g)	T_1	11.7	7.0	9.0	nil	6.8
	T_2	19.0	6.2	6.3	nil	6.5
	T_3	9 3	15.3	5.3	nil	18.3

The bacterial population of soil showed a significant increase due to press mud application in the case of red soil, while the fungal population showed an increase in the case of black (wetland) soil. These increases may be due to the organic matter and other nutrients of press mud serving as energy source for these microorganisms, as also influenced by other conditions prevailing in these soils. The actinomycetes population did not vary significantly with treatments. Oblisami (1973) reported a large increase in bacterial population, a substantial increase in actinomycetes and a decrease in fungal flora of an acid soil consequent to liming. Ramamoorthy and Agarwal (1966) stated that organic matter stimulated microbial activity and caused lowering of pH in alkali soils by producing organic acids.

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