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EFFECT OF ORGANIC AMENDMENTS AND INORGANIC FERTILIZERS ON THE PROPERTIES OF THERI SOIL

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ABSTRACT

A pot culture experiment was conducted at Agricultural College and Research Institute, Killikulam, during December 2016 – April 2017 to evaluate the effect of organic amendments on the physico-chemical properties of theri soil. The experiment was conducted with eleven treatments comprising of three amendments at three levels along with recommended dose of fertilizers in completely randomized design replicated thrice using Brinjal as test crop. Among the different treatments, application of press mud @17.5 t ha^{-1} along with recommended dose of fertilizers is recommended (T_{11}) resulted in improvement in the physico-chemical characteristics of theri soil and it was found to be comparable with the application of press mud @12.5 t ha^{-1} along with recommended dose of fertilizers (T_{10}) and it could be considered as a better option for improving the physico-chemical characteristics like pH, EC and Cation Exchange Capacity of theri soil.

(Key words: Theri soil, Brinjal, Physico-chemical properties, Press mud)

INTRODUCTION

In Tamil Nadu the red sandy dunal soils called theri soils occupy about 20,000 ha. Thoothukudi district has the largest area of 11,200 ha (Jawahar, 1996). Theri soils are located along the coastal areas of Thoothukudi and Tirunelveli districts of Tamil Nadu. Theri soils can be defined as soil formed in isomegathermic and ustic regimes from geogenic sand deposits under a climate with mean annual temperature of 28 to 32^0 C and 700 mm of mean annual rainfall. The soil colour is red to yellowish red through reddish brown. The theri soils are poor in nutrient status, water holding capacity and organic carbon content. Theri soils are also susceptible to wind erosion (Jawahar *et al.,* 1999). The available nutrients in this soil are very low as the soil contains very low amount of clay. The organic matter content of the soil is also very low.

The organic amendments are the vital sources to sustain the microbial activity and to improve the physical constituents of the soil while they can partly substitute requirement of N, P and K fertilizers. Soil physical properties are important for favorable conditions of crop growth and to maintain soil quality. The soil structure is improved by the incorporation of organic matter. The addition of organic amendments like FYM, composted coir pith, tank silt and press mud resulted in a significant increase in soil organic carbon, available nitrogen, available phosphorus and exchangeable potassium (Binitha, 2006). The use of organics will also improve many physical, chemical and biological properties of soil.

MATERIALS AND METHODS

A pot culture experiment was conducted at Agricultural College and Research Institute, Killikulam, during December 2016 – April 2017 to evaluate the effect of organic amendments on the physico-chemical properties of theri soil. The climate of the experimental site is semi-arid tropical type**.** The mean annual rainfall is 786.6 mm in 40 rainy days. The mean maximum and minimum temperature of the location are 33.4 ÚC and 23.6 ÚC respectively. The relative humidity ranges from 60 to 80 per cent. The soil required for this pot culture experiment was collected from Sathankulam village of Thoothukudi district. Soil sample collected was analysed in the laboratory for its various physical, chemical and physico-chemical properties. The soils of the experimental site were deep, sandy in texture, neutral in soil reaction (pH 6.91), poor in organic carbon (0. 81 g kg^{-1}) and low in available NPK status. The experiment was laid out in a completely randomized design with following eleven treatments;

T_1 – Control, T_2 - Recommended dose of fertilizers, T_3 - T_2 + Composted coir pith @ 7.5 t ha^{-1}, T_4 - T_2 + Composted coir pith @ 12.5 t ha^{-1}, T_5 - T_2 + Composted coir pith @ 17.5 t ha^{-1}, T_6 - T_2 + Tank silt @ 7.5 t ha^{-1}, T_7 - T_2 + Tank silt @ 12.5 t ha^{-1}, T_8 - T_2 + Tank silt @ 17.5 t ha^{-1}, T_9 - T_2 + Press mud @ 7.5 t ha^{-1}, T_{10} - T_2 + Press mud @ 12.5 t ha^{-1}, T_{11} - T2 + Press mud @ 17.5 t ha^{-1}.

Brinjal seeds were treated with pseudomonas fluorescence @ 10 g kg^{-1} and azospirillum @ 40 g 400 g^{-1} of seeds and kept for half an hour. The treated seeds were

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sown in portray. The treatments were replicated thrice and calculated quantities of different organics were applied to respective pots. Half the recommended dose of N and full dose of P& K (100:50:30 kg of N, P_2O_5 and K_2O) was applied to all pots except control through urea, single super phosphate and muriate of potash as basal. The 35 days old fully grown healthy seedlings were transplanted in the pots. The remaining half of the N was applied as top dressing on 30 days after planting.

Soil samples were collected before sowing as well as after harvesting of brinjal and analysed for its bulk density, water holding capacity, pH, EC, organic carbon and available macronutrient status. The initial soil properties of the experimental field are given in table 1. The pH (Potentiometry; Jackson, 1973), EC (Conductometry; Jackson, 1973), CEC (Neutral Normal Ammonium Acetate extract; Schollenberger and Dreibelbis, 1930), soil organic carbon (Chromic acid wet oxidation; Walkley and Black, 1934). Available nitrogen (Alkaline permanganate method; Subbiah and Asija, 1956), phosphorus (0.5M $NaHCO_3$ extraction; Olsen *et al.,* 1954) and potassium (1N NH_4OAc extraction; Stanford and English, 1949), exchangeable calcium and magnesium (Complexometry; Jackson, 1973) were determined by adopting standard scientific procedure. The observed data were statistically scrutinized in AGRESS software to find out different treatmental influence.

Table 1. Initial soil characteristics

Soil parameters	Value
Textural class	Sandy
Bulk density (Mg m^{-3})	1.54
Particle density (Mg m^{-3})	2.44
Pore space (per cent)	14.55
Water holding capacity (per cent)	26.21
pH	6.91
EC (dS m^{-1})	0.126
CEC (cmol (p^+) kg^{-1})	4.08
Organic carbon (g kg^{-1})	0.81
Available Nitrogen (kg ha^{-1})	89.6
Available Phosphorous (kg ha^{-1})	7.36
Available Potassium (kg ha^{-1})	102.4

RESULTS AND DISCUSSION

The results obtained from the pot culture experiment are presented under the following heads.

Physico-chemical properties

The soil reaction (pH) of 6.72 was recorded in the treatment that received PM @ 17.5 t ha^{-1} + RDF. It was slightly reduced over the control (6.92). The reduction in soil pH might be attributed to the production of CO_2 and inorganic acids due to incorporation of organics. Application of press mud increased the microbial population which results in increased CO_2 from the respiration of microorganisms. Yaduvanshi (2001) also observed a decrease in soil pH after the use of organic amendments.

The EC value of 0.14 dSm^{-1} was recorded in the treatment that received PM @ 17.5 t ha^{-1} + RDF. There is no significant variation in the soil electrical conductivity among the different treatments. The lowest EC value was observed in control (0.10 dSm^{-1}). The increase in the electrical conductivity was observed in the treatment that received higher quantities of press mud. This may be attributed to decomposition processes of organic matter which might have favour the accumulation of CO_2 and release of large amount of salts in solution (Kalaivannan and Omar Hattab, 2008).

The higher cation exchange capacity of 8.45 C mol (p^+) kg^{-1} was recorded in the treatment that received PM @ 17.5 t ha^{-1} + RDF which was statistically on par with the treatment PM @ 12.5 t ha^{-1} + RDF (Table 2). It may be attributed to enhanced adsorbing power of the soils up to 90 per cent with release of cations such as Ca^{2+}, Mg^{2+} and K^+ during decomposition (Sunil Kumar *et al.,* 2017).

Table 2. Effect of organic amendments on physico-chemical properties of theri soil

Treatments	pH	EC(dSm^{-1})	CEC(C mol (p^+) kg^{-1})
T_1 - Control	6.92	0.10	4.56
T_2 - Recommended dose of fertilizers	6.81	0.11	5.96
T_3 - T_2 + Composted coir pith @ 7.5 t ha^{-1}	6.80	0.11	6.94
T_4 - T_2 + Composted coir pith @ 12.5 t ha^{-1}	6.79	0.12	7.82
T_5 - T_2 + Composted coir pith @ 17.5 t ha^{-1}	6.78	0.12	7.96
T_6 - T_2 + Tank silt @ 7.5 t ha^{-1}	6.81	0.11	6.74
T_7 - T_2 + Tank silt @ 12.5 t ha^{-1}	6.80	0.12	7.42
T_8 - T_2 + Tank silt @ 17.5 t ha^{-1}	6.79	0.12	7.53
T_9 - T_2 + Press mud @ 7.5 t ha^{-1}	6.80	0.11	7.01
T_{10} - T_2 + Press mud @ 12.5 t ha^{-1}	6.75	0.13	8.32
T_{11} - T_2 + Press mud @ 17.5 t ha^{-1}	6.72	0.14	8.45
S Ed	0.14	0.002	0.13
CD (0.05 %)	-	-	0.27

Chemical properties

Organic carbon

The organic carbon content of the experimental soil varied from 0.85 to 0.99 g kg^{-1}. Significantly higher organic carbon content of 0.99 g kg^{-1} was recorded in the treatment that received press mud @ 17.5 t ha^{-1} along with recommended dose of fertilizers. However, it was found to be on par with the treatment that received press mud @ 12.5 t ha^{-1} along with recommended dose of fertilizers (0.96 g kg^{-1}). This may be attributed to the high organic nature of the press mud (Angelova *et al.,* 2013).

Available nitrogen

Soil available nitrogen status was significantly influenced by the treatment that received different organic amendments along with recommended dose of fertilizers. At post harvest stage, the maximum soil available nitrogen status of 88.7 kg ha^{-1} was recorded in the treatment that received press mud @ 17.5 t ha^{-1} along with recommended dose of fertilizers (T_{11}). However, it was found to be on par with the treatment that received press mud @ 12.5 t ha^{-1} along with recommended dose of fertilizers (87.2 kg ha^{-1}). The lowest soil available nitrogen status of 62.3 kg ha^{-1} was recorded in control (T_1). This might be due to the congenial environment for soil organisms involved in nitrogen transformation (Sridhar *et al.,* 2014).

Table 3. Effect of organic amendments on chemical properties of theri soil

Treatments	OC (g kg^{-1})	Available N (kg ha^{-1})	Available P P (kg ha^{-1})	Available K (kg ha^{-1})
T_1 - Control	0.85	62.3	6.36	76.3
T_2 - Recommended dose of fertilizers	0.86	72.3	7.38	85.0
T_3 - T_2 + Composted coir pith @ 7.5 t ha^{-1}	0.87	76.3	7.76	87.3
T_4 - T_2 + Composted coir pith @ 12.5 t ha^{-1}	0.89	78.3	8.19	94.9
T_5 - T_2 + Composted coir pith @ 17.5 t ha^{-1}	0.95	78.6	8.32	99.6
T_6 - T_2 + Tank silt @ 7.5 t ha^{-1}	0.87	73.3	7.53	85.3
T_7 - T_2 + Tank silt @ 12.5 t ha^{-1}	0.88	79.0	8.06	89.6
T_8 - T_2 + Tank silt @ 17.5 t ha^{-1}	0.88	74.6	8.21	91.5
T_9 - T_2 + Press mud @ 7.5 t ha^{-1}	0.87	75.0	7.96	90.2
T_{10} - T_2 + Press mud @ 12.5 t ha^{-1}	0.96	87.2	8.32	100.9
T_{11} - T_2 + Press mud @ 17.5 t ha^{-1}	0.99	88.7	8.83	106.0
S Ed	0.02	1.60	1.60	1.68
CD (0.05 %)	0.04	3.20	3.20	3.48

Available phosphorus

At post harvest stage the maximum soil available phosphorus status of 8.83 kg ha^{-1} was recorded in the treatment that received press mud @ 17.5 t ha^{-1} along with recommended dose of fertilizers (T_{11}). However, it was found to be on par with the treatments that received either press mud @ 12.5 t ha^{-1} or composted coir pith @ 17.5 t ha^{-1} along with recommended dose of fertilizers (8.32 kg ha^{-1}). The lowest soil available phosphorus status of 6.36 kg ha^{-1} was recorded in control (T_1). This might be attributed to during the decomposition of organic residues, a range of organic acids are produced, which mobilize the P from fixed sites and are easily available to the plants (Dotaniya *et al.,* 2013).

Available potassium

At post harvest stage the maximum soil available potassium status of 106.0 kg ha^{-1} was recorded in the treatment that received press mud @ 17.5 t ha^{-1} along with recommended dose of fertilizers (T_{11}). The lowest soil available potassium status of 76.3 kg ha^{-1} was recorded in control (T_1) (Table 3). The higher values of available K might be due to the additional availability of K applied through organic amendments. Soil microorganism through release of organically bound K affects the availability and release of K from organics by decomposition as well as solubilization of insoluble forms present in soil and minerals (Ravi Shankar Nag, 2003).

Exchangeable calcium

The various treatments that received different organic amendments significantly influenced the soil exchangeable calcium status. Among the treatments, significantly higher soil exchangeable calcium status of 2.68 C mol (p$^+$) kg^{-1} was recorded in the treatment that received press mud @ 17.5 t ha^{-1} along with recommended dose of fertilizers. However, it was found to be on par with the treatment that received press mud @ 12.5 t ha^{-1} along with recommended dose of fertilizers (T_{10}) has recorded an exchangeable calcium status of 2.66 C mol (p$^+$) kg^{-1}. The lowest soil exchangeable calcium status of 2.03 C mol (p$^+$) kg^{-1} was recorded in the control. The increase in exchangeable calcium in soil treated with organic amendments may be due to the solubilizing effect of organic acids released during bio degradation of press mud on calcium and related compounds in the soil (Sharma *et al.,* 2000).

Table 4. Effect of organic amendments on exchangeable calcium and magnesium (C mol (p$^+$) kg^{-1})

Treatments		Exchangeable calcium	Exchangeable magnesium
T_1 - Control		2.03	0.91
T_2 - Recommended dose of fertilizers		2.18	0.99
T_3 - T_2 + Composted coir pith @ 7.5 t ha^{-1}		2.28	1.09
T_4 - T_2 + Composted coir pith @ 12.5 t ha^{-1}		2.50	`1.18
T_5 - T_2 + Composted coir pith @ 17.5 t ha^{-1}		2.52	1.14
T_6 - T_2 + Tank silt @ 7.5 t ha^{-1}		2.25	1.07
T_7 - T_2 + Tank silt @ 12.5 t ha^{-1}		2.45	1.14
T_8 - T_2 + Tank silt @ 17.5 t ha^{-1}		2.47	1.16
T_9 - T_2 + Press mud @ 7.5 t ha^{-1}		2.30	1.08
T_{10} - T_2 + Press mud @ 12.5 t ha^{-1}		2.66	1.25
T_{11} - T_2 + Press mud @ 17.5 t ha^{-1}		2.68	1.27
S Ed		0.05	0.05
CD (0.05 %)	-	0.11	0.09

Exchangeable magnesium

Significant variation among the treatments was observed in soil exchangeable magnesium status. Among the treatments, significantly higher soil exchangeable magnesium status of 1.27 C mol (p$^+$) kg^{-1} was recorded in the treatment that received press mud @17.5 t ha^{-1} along with recommended dose of fertilizers. However, it was found to be on par with the treatment that received press mud @ 12.5 t ha^{-1} along with recommended dose of fertilizers which has recorded soil exchangeable magnesium status of 1.25 C mol (p$^+$) kg^{-1}. The lowest soil exchangeable magnesium status of 0.91 C mol (p$^+$) kg^{-1} was recorded in the control (Table 4). This might be due to the solubilizing effect of organic acids released during bio degradation of press mud on calcium and related compounds in the soil (Sharma *et al.,* 2000).

Application of press mud is considered as the cost-effective technology for the improvement of theri land. Considering brinjal on theri soil, application of 12.5 t ha^{-1} of press mud + recommended dose of 100:50:30 kg of N,P_2O_5 & K_2O is recommended to get profitably higher yield simultaneously improving the quality of brinjal and physico-chemical characteristics of theri soil. Over all, from the pot culture experimental results, it could be enlightened that application of press mud @ 12.5 t ha^{-1} along with recommended dose of fertilizers could be considered as a better option to improve the properties of theri soil.

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