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Comparative Study of Soil Reclamation Using Vermicomposting and Tank Silt Amended Theri Soil in Tuticorin District

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Abstract
A special type of Red sandy dunal soil [Theri-soil] of Tamil Nadu is called Theri-soils. Theri-soils. (Theri-soil) are located in Tuticorin, Tirunelveli and Kanyakumari districts of Tamil Nadu. The Merits of Theri lands are deep sand zone, good permeability and quality ground water. The Demerits of Their lands are UN suitable for agriculture, the surface of the soil is not plane, higher level of soil erosion, sand dunes, from the top to the bottom only sand, low nutrients and minerals and Low water holding capacity. Tank silt and Vermicomposting are the materials used for the amendment of the *Theri* soils selected for the study to improve the fertility constraints of the soil. Measurements were made on the physio chemical and physical properties such as pH, EC, Particle density, Bulk density, Porosity, Water holding capacity, Organic carbon content, and Hydraulic conductivity. To convert this soil into a cultivable land, attempts were made to improve the soil moisture characteristics of the soil using soil amendment.

Keywords: Theri soils, Vermicompost, Tank silt, Organic amendments, Water holding capacity

Introduction
Theri-soil occupies about 20,000 hectares in Tuticorin, Tirunelveli and Kanyakumari districts. Tuticorin district has the highest area 11,200 ha. Theri (mettu) lands are deep land zones**.** About 20,000 hectares of Theri-lands are left unused in the aforesaid three districts. These are considered to be unsuitable for continuous irrigation. The mean annual rainfall of the area is between 610 to700mm. (Jawahar et al.,1999 a).

Fertility capability classification indicated that these are not suitable for agriculture but can easily be brought to use through appropriate soil management technologies and conservation. (Janakiraman et al., 1997)

The organic wastes and residues offer the best possible means of restoring the productivity of severely eroded agricultural soils or of reclaiming marginal soils. The proper use of organic amendments is utmost important in maintaining the soil moisture level and hence the fertility and the productivity of the soils and in minimizing the wind and water erosion. The desired increase of water holding capacity will improve the ability to supply nutrients to the soil. Nowadays, the cultivable lands are gradually becoming the sites for constructing houses and industries. Due to the emergence of population, we need more cultivable lands. Bringing Theri soils to cultivation will add to the development of the economy of the country. Reclamation of soils without environmental pollution is the urgent need of the hour.

Materials and methods
This study was undertaken in parts of Tuticorin district located in Tamilnadu which lies between 73º 1'and 73º 4'E longitude and 8º33'and 8º28'N latitude. The study area has semi-arid tropical climate. The average annual rainfall is 630mm. The material used is theri-soil collected from an area of the village called Sawyerpuram that is 26 Km in the west from Tiruchendur in Tuticorin district of Tamil Nadu. The soil samples were taken from the top surface of the soil to a depth of 15 cm. Tank silt and Vermicomposting were the amendments used in the study. For amendments, tank silts of nearby tanks were collected, dried and

powdered and used. Before using them, all the powdered tank silt particles were passed through 2mm sieve for ensuring uniformity in size

Vermicomposting was prepared according to the advice given by the Agriculture department. Let T be *theri*-soil. Ten different combinations viz : T+ 5% of Amendment, T+ 10% of Amendment, T+ 15% of Amendment, T+ 20% of Amendment, T+ 25% of Amendment, T+ 30% of Amendment, T+ 35% of Amendment, T+ 40% of Amendment, T+ 45% of Amendment, T+ 50% of Amendment on volume basis were made. The different combinations were thoroughly ameliorated mechanically before use. For example, in T+10% of amendment, 400 cc of amendment was mixed with 4000 cc of T. The volume of the soil is fixed. The different combinations of amendments were thoroughly mixed mechanically before use. Each treatment (combination) was replicated five times in pots to minimize error. The mixtures were subjected to sustainable wetting with water and allowed to settle for a period of 60 days without allowing them to get dried. After this incubation period, the mixtures were removed from the pots and once again dried and powdered. For each replication, measurements were made on the physio chemical and physical properties such as pH, EC (dSm^{-1}), Particle density (g/cm^3), Bulk density (g/cm^3), Porosity (%), Water holding capacity (%), Organic carbon content (%), and Hydraulic conductivity (mm/hr).(Piper,1966)

To study the cause and effect of the various parameters measured, simple regression equations were tried. Simple regression analysis shows that the variations in the properties of Vermicomposting amended theri soil can be best represented by the linear model,

$$Y= a+ b x$$

pH

It is observed from the correlation table that pH of vermicomposting amended Theri soil has positive association with Bulk density (0.9879), EC (0.9776), Hydraulic conductivity (0.9790), Particle density (0.9902) and, Porosity (0.9810) and negative association with Organic carbon (0.9586) and Water holding capacity (0.9642) and The equation selected is

$Y = 7.8840 - 0.0173^{**}x$; $R^2 = 0.992^{**}$

**- Significant at one percent level of probability

Addition of Vermicomposting to the Theri soil reduce the value of pH

It is observed from the correlation table that pH of Tank silt amended Theri soil has positive association with Electrical Conductivity (0.9627), Organic Carbon (0.9873), Particle density (0.9926) and Water holding capacity (0.9940) and negative association with Bulk density (0.9947), Hydraulic Conductivity (0.9949) and Porosity (0.9481) and The best equation selected is

$Y = 7.3640 + 0.0057^{**}x$; $R^2 = 0.990^{**}$

Addition of Tank silt to the Theri soil increases the value of pH

Electrical conductivity (EC)

The correlation table reveals that the EC of Vermicomposting amended Theri soil has positive association with bulk density (0.9615), Hydraulic conductivity (0.9567), Particle density (0.9670), pH (0.9776) and Porosity (0.9653) and negative association with organic carbon (0.9485), and water holding capacity (0.9360).

The equations in the case of EC is

$Y = 0.3380 - 0.0026^{**}x$; $R^2 = 0.953^{**}$

Addition of Vermicomposting to the Theri soil reduce the value of EC

The correlation table reveals that the Electrical conductivity of Tank silt amended Theri soil has positive association with organic carbon (0.9749), Particle density (0.9697), pH (0.9627), water holding capacity (0.9696) and negative association with bulk density (0.9597), Hydraulic conductivity (0.9596) and Porosity (0.9726).

The best equation in the case of Electrical conductivity is

$Y = 0.1780 + 0.0037^{**}x$; $R^2 = 0.949^{**}$

Addition of Tank silt to the Theri soil increases the value of EC

Particle density

The correlation table reveals that the particle density of Vermicomposting amended Theri soil is positively related to bulk density (0.9985), EC (0.9670), Hydraulic conductivity (0.9781), pH (0.9902) and Porosity (0.9731) and negatively associated with organic carbon (0.9507) and water holding capacity (0.9571). The fitted equation is

$Y = 2.7973 - 0.0198^{**}x$; $R^2 = 0.992^{**}$

Addition of Vermicomposting to the Theri soil reduce the value of Particle density

Te correlation table reveals that the particle density of Tank silt amended Theri soil is positively related to Electrical conductivity (0.9697), organic carbon (0.9973), pH (0.9926) and water holding capacity (0.9950) and negatively associated with bulk density (0.9972), Hydraulic conductivity (0.9977) and Porosity (0.9548). The fitted equation is

$Y = 2.0327 + 0.0115^{**}x$; $R^2 = 0.996^{**}$

Addition of Tank silt to the Theri soil reduces the value of Particle density.

Bulk density

From the correlation table, we observe that the bulk density of Vermicomposting amended Theri soil is positively related to Electrical Conductivity (0.9615), Hydraulic conductivity (0.9771), Particle density (0.9985), pH (0.9879) and Porosity (0.9750) and negatively related to Organic Carbon (0.9535), and Water holding capacity (0.9629).

The fitted equation is

$Y = 1.9527 - 0.0132^{**}x$; $R^2 = 0.991^{**}$

Addition of Vermicomposting to the Theri soil reduce the value of Bulk density

From the correlation table, we observe that the bulk density of Tank silt amended Theri soil is positively related to Hydraulic conductivity (0.9963) and Porosity (0.9395) and negatively related to Electrical Conductivity (0.9597), Organic Carbon (0.9937), Particle density (0.9972), pH (0.9947) and Water holding capacity (0.9948). The fitted equation is

$Y = 1.7213 - 0.0047^{**}x$; $R^2 = 0.994^{**}$

Addition of Tank silt to the Theri soil reduces the value of Bulk density.

Porosity

The porosity of Vermicomposting amended Theri soil has got positive association Bulk density (0.9750), Electrical conductivity (0.9653), Hydraulic conductivity (0.9894),

Particle density (0.9731) and pH (0.9810) and negative association with Organic carbon (0.9211) and Hydraulic conductivity (0.9781).

The equation fitted in this case is

$Y = 43.6640 - 0.2076^{**}x ; R^2 = 0.973^{**}$

Addition of Vermicomposting to the Theri soil reduce the value of Porosity.

The porosity of Tank silt amended Theri soil has got positive association with Bulk density (0.9395), Hydraulic conductivity (0.9451) and negative association with Electrical conductivity (0.9726), Organic carbon (0.9579), Particle density (0.9548), pH (0.9481) and Water holding capacity (0.9653).

The best equation fitted in this case is

$Y = 33.6553 - 0.0644^{**}x ; R^2 = 0.926^{**}$

Addition of Tank silt to the Theri soil reduces the value of Porosity.

Water holding capacity

The correlation table reveals that the water holding capacity of Vermicomposting amended Theri soil has positive association with Organic carbon (0.9061) and negative association with Bulk density (0.9629), Electrical conductivity (0.9360), Hydraulic conductivity (0.9535), Particle density (0.9571), pH (0.9642) and Porosity (0.9781)

The equation fitted in this case is

$Y = 25.1867 + 0.2239^{**}x; R^2 = 0.942^{**}$

Addition of Vermicomposting to the Theri soil increases the value of Water holding capacity.

The correlation table reveals that the water holding capacity of Tank silt amended Theri soil has positive association with Electrical conductivity (0.9696), Organic carbon (0.9927), Particle density (0.9950) and pH (0.9940) negative association with Bulk density (0.9948), Hydraulic conductivity (0.9932) and Porosity (0.9653)

The best equation fitted in this case is

$Y = 31.2767 + 0.1370^{**}x; R^2 = 0.996^{**}$

Addition of Tank silt to the Theri soil increase the value of Water holding capacity.

Organic carbon

The organic carbon of Vermicomposting amended Theri soil has positive correlation of 0.9061 respectively with water holding capacity and negative association of 0.9535, 0.9485, 0.9082, 0.9507, 0.9586 and 0.9211 respectively with bulk density, Electrical Conductivity, Hydraulic conductivity, particle density, pH and Porosity.

The equation fitted is

$Y = 0.4167 + 0.0137^{**}x; R^2 = 0.920^{**}$

Addition of Vermicomposting to the Theri soil increases the value of Organic carbon.

The organic carbon of Tank silt amended Theri soil has positive correlation of 0.9749, 0.9973, 0.9873 and 0.9927 respectively with Electrical Conductivity, particle density, pH and water holding capacity and negative association of 0.9937, 0.9918, and 0.9579 respectively with bulk density, Hydraulic conductivity, and Porosity.

The best equation fitted is

$Y = 0.1320 + 0.0276^{**}x; R^2 = 0.995^{**}$

Addition of Tank silt to the Theri soil increases the value of Organic carbon.

Hydraulic conductivity

Hydraulic conductivity of Vermicomposting amended Theri soil has negative association with Organic carbon (0.9082) and Water holding capacity (0.9629) and positive association with bulk density (0.9771), EC (0.9567), particle density (0.9781) pH (0.9790), and Porosity (0.9894)

The equation is

$Y = 164.467 - 2.0388^{**}x; R^2 = 0.966^{**}$

Addition of Vermicomposting to the Theri soil reduces the value of Hydraulic conductivity.

Hydraulic conductivity is another important factor deciding plant growth in soil. Tank silt amended Theri soil has negative association with Electrical conductivity (0.9596), Organic carbon (0.9918), particle density (0.9977), pH (0.9949) and Water holding capacity (0.9932) and positive association with bulk density (0.9963) and Porosity (0.9451). The best fitted equation is

$Y = 130.267 – 0.9006^{**}x; R^2 = 0.991^{**}$

Addition of Tank silt to the Theri soil reduces the value of Hydraulic conductivity.

Table1: Variation of the Characteristics of Theri soil with Vermicomposting

Percentage	pH	EC dsm^{-1}	Particle Density g/cm^3	Bulk Density g/cm^3	Porosity (%)	Water holding capacity (%)	Organic Carbon (%)	Hydraulic conductivity (mm/hr)
5	7.8	0.32	2.70	1.90	42.70	24.89	0.52	152
10	7.69	0.31	2.58	1.80	41.90	26.90	0.58	143
15	7.66	0.30	2.50	1.75	40.70	29.20	0.62	138
20	7.50	0.29	2.40	1.70	39.90	30.20	0.67	130
25	7.48	0.28	2.30	1.60	38.32	31.78	0.78	118
30	7.35	0.26	2.27	1.59	36.22	33.00	0.8	96
35	7.27	0.23	2.10	1.50	36.00	33.38	0.82	88
40	7.20	0.25	1.97	1.40	35.50	33.90	0.90	75
45	7.12	0.22	1.89	1.35	34.30	34.50	1.00	73
50	7.00	0.20	1.82	1.30	34.00	35.70	1.24	71

Table2: Variation of the Characteristics of Theri soil with Tank silt

Percentage	pH	EC dsm^{-1}	Particle Density g/cm^3	Bulk Density g/cm^3	Porosity (%)	Water holding capacity (%)	Organic Carbon (%)	Hydraulic conductivity (mm/hr)
5	7.38	0.20	2.10	1.70	33.20	32.00	0.30	125
10	7.43	0.23	2.15	1.68	32.80	32.50	0.40	121

15	7.45	0.24	2.19	1.65	32.60	33.50	0.52	119
20	7.48	0.25	2.25	1.63	32.50	34.01	0.70	113
25	7.50	0.26	2.33	1.60	32.30	34.50	0.85	108
30	7.55	0.27	2.37	1.58	31.78	35.50	0.90	102
35	7.57	0.29	2.45	1.55	31.60	36.20	1.10	97
40	7.60	0.34	2.50	1.53	31.25	36.78	1.22	93
45	7.62	0.35	2.55	1.51	31.00	37.25	1.41	90
50	7.64	0.38	2.60	1.50	29.80	38.20	1.52	87

Table3: Regression Coefficients (b Values) for all the eight parameters

PROPERTIES	Amendment	
	Tank Silt	Vermicomposting
pH	+0.0057	-0.0173
Particle Density	+0.0115	-0.0198
Bulk Density	-0.0047	-0.0132
Porosity	-0.0644	-0.2076
Water Holding Capacity	+0.137	+0.2239
Organic Carbon	+0.0276	+0.0137
Electrical Conductivity	+0.0037	-0.0026
Hydraulic conductivity	-0.9006	-2.0388

Results and discussion

Addition of the Vermicomposting amendment with Theri soil decreases the bulk density, particle density, pH, EC and hydraulic conductivity but increases porosity, water holding capacity and organic carbon. It is generally agreed that the bulk density of 1.5 – 1.6 g/cm^3 is critical for root growth of most of the plants. (Ayres et al. 1973). In this study the convenient root growth condition for the plants is achieved for T+25%, T + 30% and T + 35% amendments. The total porosity varies in the neighborhood of 50% (Baver 1959). Here in all the treatments porosity ranges from 34% to 43%. The pH value beyond 9 is undesirable on account of alkali hazards. Neither is the pH value below 4.5 good as availability of nutrients of plants becomes a limiting factor. The value of pH for all the amendments are favorable for cultivation purpose. Crop yields generally do not significantly decrease until the salt concentration in the soil solution exceed the threshold level which can differ for different crops and their varieties. The major soil physical constraints identified are low water retention and high permeability. The desired increase of water holding capacity will improve the ability to supply the nutrients to soil. The hydraulic conductivity is considerably controlled from very rapid stage to moderately rapid stage. This is because the applications of organic manures and pond sediments decrease the bigger pores and increase the smaller pores (Anonymous, 2002). Here in all the treatments water holding capacity increased and attained the maximum value of 36 % cent and the hydraulic conductivity reduced to the minimum value of 71 mm/hr. T + 25%, T + 30% and T + 35% combinations were better than the other combinations for the purpose of cultivation. Increase of organic carbon improves the growth condition of the crops. Giving more importance to the major soil physical constraint namely the water retention and the permeability T + 35% amendment treatment could be predicted as the best among all the treatments.

Addition of the Tank silt amendment with Theri Soil decreases the bulk density, porosity and hydraulic conductivity but increases particle density, pH Electrical conductivity water holding capacity and organic carbon. It is generally agreed that the bulk density of 1.5 – 1.6 g/cm^3 is critical for root growth of most of the plants. (Ayres et al. 1973). In this study, the convenient root growth condition for the plants is achieved for T+25%, T + 30%, T + 35%, T+ 40%, T + 45%, T + 50%, amendments. The total porosity varies in the neighborhood of 50% (Baver 1959) Here in all the treatments range from 30% to 33%. The pH value beyond 9 is undesirable on account of alkali hazards. Neither is the pH value below 4.5 good as availability of nutrients of plants becomes a limiting factor. The value of pH for all the amendments is favorable for cultivation purpose. Crop yields generally do not significantly decrease until the salt concentration in the soil solution exceeds the threshold level which can differ for different crops and their varieties. The Electrical conductivity values are found to be optimum for several plants. The major soil physical constraints identified are low water retention and high permeability. The desired increase of water holding capacity will improve the ability to supply the nutrients to soil. The hydraulic conductivity is considerably controlled from very rapid stage to moderately rapid stage. This is because the applications of organic manures and pond sediments decrease the bigger pores and increase the smaller pores (Environmental soil physics, 1998). Here in all the treatments water holding capacity increased and attained the maximum value of 38 % cent. The hydraulic conductivity reduced to the minimum value of 87 mm / hr. For hydraulic conductivity T + 35%, T + 40%, T + 45% and T + 50% combinations are better than the other combinations for the purpose of cultivation. Increase of organic Carbon improves the growth condition of the crops. Giving more importance to the major soil physical constraints namely the root growth, the water retention and the permeability T + 50% amendment treatment could be predicted as the best among all the treatments.

From the analysis and discussion, we conclude that the desired parameter can be achieved by the proper choices of proportions of amendments used in this study for reclaiming Theri soils.

In the case of bulk density, already in the theri soils it is high and hence to make the soil cultivable a reduction is essential as per table 3 the two amendments help in the reduction of the bulk density. Here, the rate is highest for

amendment Vermicomposting, next comes the amendment Tank silt.

Regarding the Electrical Conductivity of the soil, increased levels might cause salinity problems and hence a reduction or slow increase can be considered as favorable. As per the value presented in table 3, amendment Vermicomposting has negative effect and the minimum positive effect with amendment Tank silt.

In the case of hydraulic conductivity, the soil needs a reduction and the two amendments are having reduction effect on this. Amendment Vermicomposting has the highest rate followed by amendment Tank silt.

Organic carbon content of the soil is very low and needs improvement. The two amendments are having positive effect on this variable of which the rate is highest for amendment Tank silt next comes amendment Vermicomposting.

Reduction in particle density improves the water holding capacity. The amendment Vermicomposting help in reducing the particle density of theri soil.

High level of pH might bring alkali hazards and a very low level below 4.5 makes the availability of nutrients as a limiting factor. As per table 3, the amendment Vermicomposting help in the reduction of pH.

Porosity and water holding capacity are inversely related and higher porosity is the problem of the theri soils and hence the amendment used should help in bringing down this. Accordingly, as per table 3, the two Amendments help in reduction of porosity. The highest rate is for amendment Vermicomposting and the amendment Tank silt in the second place.

When the soil has the high water holding capacity, the soil has the ability to supply the nutrients efficiently to the plants. The two amendments are capable of increasing the water holding capacity of the soil as per Table 3. In this, the rate is highest for amendment Vermicomposting followed by amendment Tank silt.

PH value beyond 8.5 is undesirable on account of alkali hazards. Neither is the pH below 4.5 good as availability of Nutrients to plants becomes a limiting factor. (Nanwal, 2001).Crop yields generally do not significantly decrease until the salt concentration in the soil solution exceed the threshold level which can differ for different crops and their varieties. The major soil physical constraints identified are low water retention and high permeability. The desired increase of water holding capacity will improve the ability to supply the nutrients to soil. The hydraulic conductivity is considerably controlled from very rapid stage to moderately rapid stage. This is because the applications of organic manures and pond sediments decrease the bigger pores and increase the smaller pores ((Indian Society of Soil Science, 2002).

Now, the above analysis shows that of the 8 characters considered apart from consistency in the performance of the two amendments, if rates of change are also taken into consideration, amendment Vermicomposting is first in 7 characters second for one character The Amendment Tank silt is first in one character and second in 7 characters. It stands best in achieving desired conversion of *theri* land into cultivable land, the amendment Vermicomposting has more dominating characters, and it comes first followed by the amendment Tank silt.

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