COMPARATIVE STUDY OF SOIL RECLAMATION USING TANK SILT AND NEEM COMPOST AMENDED THERI SOIL

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Abstract

A special type of Red sandy dunal soil [*Theri-soil*] of Tamil Nadu is called *Theri-soils. Theri-soils*are located inTuticorin, Tirunelveli and Kanyakumari districts of Tamil Nadu. The Merits ofTheri 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 Neem Compost 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 physico 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.The observations were taken for both the Tank silt added Theri soil and the Neem compost added Theri soil. Comparing the above eight properties of the amended Theri soil, the best amendment among the two was found out.

Key words: *Therisoil, Tank silt, Neem Compost, Amendments, Water holding capacity*

1. Introduction

. (*Theri-soil*) occupy 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.

2. Materials and methods

This study was undertaken in parts of Tuticorindistrict located in Tamilnaduwhich lies between 73^o 1'and 73^o 4'E longitude and 8^o33'and 8^o28'N latitude. The study area has semi-arid tropical climate. The average annual rainfall is 630mm. The material used is T*heri*-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 the Neem Compost were the amendments used in the study .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.Neem Compost was prepared according to the advice given by the Agriculture department. Let T be T*heri*-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% ofAmendment, T+ 35% of Amendment, T+ 40% of Amendment, T+ 45% of Amendment, T+ 50% of Amendment on volume basis were made for Tank silt and the above said combinations were made for Neem Compost separately. Thetwo 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 physico 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 Tank silt amendedTheri soil and Neem compost amended Therisoil can be best represented by the linear model,

$$Y = a + b\,x$$

3. DISCUSSION

3.1 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

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

The sign of x in the equation confirm the behavior with the results obtained through simple correlation analysis. That is increase in amendment increase the pH level .The R- Square value indicates that about 99.4 percent of the variations in pH is being determined by the amendment levels used in the equation.

It is observed from the correlation table that pH value of Neem Compost amended Therisoil has positive association with Electrical conductivity (0.9950), Organic carbon (0.9901). Porosity (0.9931) and Water holding capacity (0.9991) and negative association with Bulk density (0.9900) and Particle density (0.9983), Hydraulic conductivity(0.9949).

The best equation selected is

$Y = 8.4413 + 0.0130^{**}x$; $R^2 = 0.997^{**}$

The sign of x in the equation confirm the behavior with the results obtained through simple correlation analysis. That is increase in amendment increases the pH level .The R- Square value indicates that about 99.8 percent of the variations in pH is being determined by the amendment levels used in the equation. The pH without any amendment is nearly 8.44 units.

3.2 Electrical conductivity (EC)

The correlation table reveals that the Electrical conductivityof 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 conductivityis

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

Where y is the Electrical conductivityand x is the level of amendments. Here R-Square is 0.978, which is significant at one percent level of probability indicating the fact that 97.8 percent of the variations in the EC level is being explained by the different levels of amendments added to the soil. This gives the EC level of the original *Theri* soil. The coefficient of x in the linear equation indicates that a unit increase in the level of amendment will increase the Electrical conductivity level of the soil by 0.0037 units. That is amendments help in decreasing the level of Electrical conductivity in the original soil.

The correlation table reveals that the Electrical conductivity value of Neem Compost amended Theri soil has positive association with organic carbon (0.9972), PH (0.9950), Porosity (0.9810) and water holding capacity (0.9948) , negative association with bulk density (0.9877) and particle density (0.9951) and Hydraulic conductivity (0.9940)

The best equation in the case of EC is

$Y = 0.8440 + 0.0155^{**}x$; $R^2 = 0.990^{**}$

Where y is the Electrical conductivity and x is the level of amendments. .The coefficient of x in the linear equation indicate that a unit increase in the level of amendment will increase the Electrical conductivity level of the soil by 0.0155 units. That is amendments help in increasing the level of Electrical conductivity in the original soil.

3.3 Particle density

The correlation table reveals that the particle densityof 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

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

The negative coefficient of x in the equation confirm the behavior expressed in simple correlation .That is increase in the amendment rate brings only increase in the particle density. That is added amendment brings an addition in the particle density. The initial particle density of the original soil is nearly 2.0 units. The highly significant R- Square value expresses the fact that about 99.8 percent of the variations in the behavior of particle density is explained by different amendment levels.

The correlation table reveals that the particle density of Neem compost added Therisoil is positively related to bulk density (0.9951), Hydraulic conductivity (0.9944), and negatively associated with Electrical conductivity (0.9951), organic carbon (0.9416), pH(0.9983), porosity (0.9920) and water holding capacity (0.9950). Hence its behavior must be similar to that of Electrical conductivity and Organic carbon.

The fitted equation is

$y = 2.4093 - 0.0224^{**}x$; $R^2 = 1.000^{**}$

The negative coefficient of x in the equation confirm the behavior expressed in simple correlation .That is increase in the amendment rate brings only decrease in the particle density . That is added neem compost brings a reduction in the particle density. The initial particle density of the original soil is nearly 2.4 units. The highly significant R- Square value expresses the fact that about 100 percent of the variations in the behavior of particle density is explained by different amendment levels.

3.4 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).

In the case of Bulk density, the fitted equation is

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

Where y is the bulk density and x is the level of amendment. Here, R- Square is almost near to one for the cubic equation. This shows that 99.9 percent of the variations in the bulk density in the soil is being explained by the levels of amendments made .The value of the constant term in the equation is almost equal to 1.7 indicating the initial bulk density of the soil .The very low value of the coefficient of the second degree term indicates the slow response of the bulk density value with respect to the changes made in the amendment. That is the addition of amendment reduces the bulk density.

That is the amendment needed to get any desired level of bulk density can be obtained by substituting the desired bulk density level for y in the above equation. Thus the amendment help in fixing any desired level of bulk density in the soil.

From the correlation table, we observe that the bulk density of Neem compost added Theri soil is positively related to particle density (0.9951), Hydraulic Conductivity (0.9850) and negatively related to Electrical Conductivity (0.9877),, Organic Carbon (0.9787), pH (0.9900), Porosity (0.9866), Water holding capacity (0.9924).

In the case of Bulk density, the fitted equation along with the R-Square values and the significance of the coefficients is

$Y = 1.7573 - 0.0208^{**}x$; $R^2 = 0.987^{**}$

Where y is the bulk density and x is the level of amendment. Here, R- Square is almost near to one for the cubic equation. This shows that 99.4 percent of the variations in the bulk density in the soil is being explained by the levels of amendments made .The value of the constant term is equal to 1.7 indicating the initial bulk density of the soil . That is the addition of neem compost reduces the bulk density. That is a unit increase in the value of the amendment level would produce a decrease of 0.0208 units in the bulk density.

3.5 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

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

The porosity of Neem compost added theri soil has got positive association Electrical conductivity (0.9810), Organic carbon (0.9736) pH (0.9931) and Water holding capacity (0.9923) and negative association with Bulk density (0.9866) and Particle density (0.9920), Hydraulic conductivity(0.9893).

The best equation fitted in this case is

$y = 29.4133 + 0.0501^{**}x$; $R^2 = 0.985^{**}$

The addition of Neem compost increases the value of Porosity.

3.6 Water holding capacity

The correlation table reveals that the water holding capacity of Tank silt amended Therisoil 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

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

The positive value of the coefficient of x agrees with the correlation results .The R-Square is 0.996 expressing the fact that 100 percent of the variations in the water holding capacity is being explained by the amendment levels.

The correlation table reveals that the water holding capacity of Neem compost amended Theri soil has positive association with Electrical conductivity (0.9948), Organic carbon (0.9884), pH (0.9991) and Porosity (0.9923) and negative association with Bulk density (0.9924) and Particle density (0.9995), Hydraulic conductivity (0.9956)

The best equation fitted in this case is

$y = 26.7467 + 0.3005^{**}x$; $R^2 = 1.000^{**}$

The positive value of the coefficient of x agrees with the correlation results .The R-Square is 1.000 expressing the fact that 100 percent of the variations in the water holding capacity is being explained by the amendment levels.

3.7 Organic carbon

The organic carbon of Tank silt amended Therisoil 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

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

The R-Square is 0.996 which is significant at the highest level of probability indicating the fact that the amendments chosen could explain 99.6 percent of the variations in the organic carbon .The positive coefficient for x gives the confirmation of the fact derived from simple correlations. That is increase in the levels of amendments bring additional organic carbon content. The intercept term is almost consistent in the quadratic and cubic equations indicating the fact that the level of organic carbon present in the non- amended soil is nearly 0.1 units.

The organic carbon of Neem compost amended Theri soil has positive correlation of 0.9972, 0.9901, 0.9736 and 0.9884 respectively with available Electrical conductivity, pH, porosity and water holding capacity and negative association of 0.9787, 0.9416,0.9881 respectively with bulk density , particle density and Hydraulic conductivity.

The best equation fitted is

$y = 0.1007 + 0.0144^{**}x$; $R^2 = 0.978^{**}$

The R-Square is 0.992 which is significant at the highest level of probability indicating the fact that the amendment chosen could explain 99.2 percent of the variations in the organic carbon .The positive coefficient for x gives the confirmation of the fact derived from simple correlations. That is increase in the levels of amendment bring additional organic carbon content.

3.8 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

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

The relationship expressed in the simple correlation coefficient is being reflected by the negative value of the x term. The R - Square is 0.998 expressing the fact that 99.8 percent of the variations in the hydraulic conductivity of the soil is being decided by the amendment levels considered in the experiment.

Hydraulic conductivity of Neem compost amended Theri soil has negative association with Electrical conductivity (0.9940), organic carbon (0.9881), pH(0.9949), porosity(0.9893) and water holding capacity (0.9956) and positive association with bulk density (0.9850), particle density (0.9944)

The best fitted equation is

$y = 193.2 – 2.4836^{**}x$; $R^2 = 0.999^{**}$

The relationship expressed in the simple correlation coefficient is being reflected by the positive value of the x term. The initial hydraulic conductivity level of the soil is nearly 193. The R - Square is 0.99 expressing the fact that 99 percent of the variations in the hydraulic conductivity of the soil is being decided by the amendment levels considered in the experiment. Again a unit increase in the amendment level will decrease the hydraulic conductivity by2.4836 units.

Table 1 : Variation of the properties with percentage of Tank salt amendment with Theri soil

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

Table 2 : Variation of the properties with percentage of Neemcompost amendment with Theri soil

Percentage	pH	EC(dS/m)	Partilce density (g/cm^3)	Bulk density (g/cm3)	Porosity (%)	Water holding capacity (%)	Organic Carbon (%)	Hydraulic conductivity (mm/hr)
5	8.5	0.9	2.3	1.63	29.7	28.2	0.14	191.00
10	8.57	0.96	2.18	1.54	30.0	29.8	0.20	180.00
15	8.64	1.10	2.08	1.46	30.2	31.2	0.35	151.00
20	8.7	1.18	1.96	1.35	30.3	32.8	0.4	144.00
25	8.77	1.25	1.85	1.28	30.5	34.3	0.51	133.00
30	8.84	1.32	1.74	1.17	31	35.8	0.55	115.00
35	8.9	1.4	1.62	0.98	31.1	37.3	0.6	104.00
40	8.97	1.47	1.5	0.88	31.5	38.7	0.7	90.00
45	9.0	1.53	1.4	0.79	31.6	40.1	0.73	72.00
50	9.1	1.59	1.3	0.76	32	41.9	0.78	54.00

Table 3: Regression Coefficients (b Values) for all the eight parameters

Amendment	Tank Silt	Neem Compost
pH	+0.0057	+0.0130
Particle Density	+0.0115	-0.0224
Bulk Density	-0.0047	-0.0208
Porosity	-0.0644	+0.0501
Water Holding Capacity	+0.1370	+0.3005
Organic Carbon	+0.0276	+0.0144
Electrical Conductivity	+0.0037	+0.0155
Hydraulic conductivity	-0.9006	-2.4836

4. Results and Conclusion

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, the two amendments help in the reduction of the bulk density. Here, the rate is highest for the amendment Neem compost, 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,amendments, both the amendments are

having positive effect. Here the increase in level is high in Neem. Therefore regarding the Electrical conductivity, Tank silt comes first, next comes the amendment Neem.

In the case of hydraulic conductivity the soil needs a reduction and the two amendments are having reduction effect on this. Amendment Neem compost 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 Tank silt , next comes amendment Neem compost.

Reduction in particle density improves the water holding capacity.The amendment Neem compost help in reducing the particle density whereas the amendment Tank silt increases the level of particle density of *theri* soil. The amendment Neem compost comes first, second comes the amendment Tank silt.

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 the amendment Vermicompost help in the reduction of pH. Since reduction beyond 4.5 is undesirable and the initial level is approximately 8.0, a slow rate of reduction is considered appreciable, accordingly amendment Tank silt, stands first, next the amendment Neem compost..

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 the table, amendment Tank silt can help in reduction of porosity.

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 soi. As per Table, the rate is highest for amendment Neem compost 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 Neem compost is first and Tank silt is the second place.

5. References

Ayres, K.W., et al. 1973. Soil Morphology and soil physical properties. II. Mechanical Impedance and moisture retention and movement. Can.J.Soil.Sci., 53: 9-19

Janakiraman,M., Arunachalam,G. and Jawahar,D.1997. Soil survey Interpretation for land use Planning in the Theri -soils of Tamil Nadu. J.Indian Soc. Soil Sci., 45.(No. 2):329-332.

Jawahar,D., Arunachalam G.And Janakiraman,M.1999a. Theries –Red Coastal Sand Dunes Of Tamil Nadu And Characteristics J.Indian Soc. Soil Sci. 47.(No.1):125-128.

Anonymous,Indian Society of Soil Science.2002.Fundamentals of soil science.Indian Agricultural Research Institute,New Delhi. Piper, C.S.1966. Soil and Plant analysis. Hans Publications

Baver, L.D. 1969. Soil physics, Chapman & Hall, Limited, London,