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Research Article

EVALUATION OF ORGANIC AMENDMENTS USING POULTRY AND GOAT MANURE FOR THE IMPROVEMENT OF PHYSICAL AND PHYSICO-CHEMICAL PROPERTIES OF THERI SOIL

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A B S T R A C T

The coastal red sandy dunal soils of Tamil Nadu are called Theri soils. The entire Theri area is covered by thorny bushes, palm trees, spiky Trees, shrubs etc. Soil survey and Land use Organisation, New Delhi (1987) reported that the soils occurring in Theri lands suffered by surface crusting and surface droughtiness, poor moisture retention and rapid drying are the major problems that are associated with theri soils because of the low organic matter content, low exchangeable bases and the sandy Soil erosion, water logging, salinity and alkalinity, sand dunes, floods and other manmade factors bring about degradation of land resources. Now it is not suitable for agriculture and it is considered as a waste land because of its sandy texture and unfavourable topography. The present investigation is undertaken to study the effect of organic manures like Poultry Manure and Goat Manure on developing the fertility status of Theri soil to improve the agriculture production. This study tests for the changes of physical properties through the addition of organic manures and aims in describing relationship among the soil physical properties such as bulk density(BD), Particle density (PD), Water holding density(WHC), Pore space (PS), Hydraulic conductivity (HC), Thermal Conductivity(TC), Volume Expansion(VE) of the soil through various methods. Physico-Chemical properties like Electrical conductivity (EC), Potential of Hydrogen (pH) and Chemical properties namely NPK, Organic Carbon(OC) are also studied.

INTRODUCTION

India is facing one of the largest challenges of this century to continue to increase annual food production to about 125 Mt by 2020 to ensure food security with shrinking cropland and limited resources, while maintaining or improving soil fertility, and protecting the environment. Theri Soils occur in the Tuticorin and Tirunelveli districts of Tamilnadu with an extend of 20,171 hectares (Jawahar 1996). Rich experiments in integrated and efficient utilization of different strategies of crop rotation, intercropping, and all possible nutrient resources accumulated by Indian farmers in traditional farming systems have been gradually abandoned and nutrient management shifted to over-reliance on synthetic fertilizers. There is little doubt that current nutrient management practices are not sustainable. Soil survey and Land use Organization, New Delhi (1987) reported that the soils occurring in Theri lands suffered by surface crusting and surface doughtiness, poor moisture retention and rapid drying are the major problems that are associated with theri soils because of the low organic matter content, low exchangeable bases and the sandy texture.

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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. On account of continuous world energy crisis with increasing prices of chemical fertilizer the use of organic manures as renewable sources of plant nutrients is gaining importance.

MATERIALS AND METHODS

This study was undertaken in parts of Tuticorin district located in Tamilnadu which lies between 73° 1'and 73° 4'E longitude and 8°33'and 8°28'N latitude. The study area has semi-arid tropical climate. The average annual rainfall is 630mm. The material used is *their*-soil collected from an area of the village called Punnainagar that is 19 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. Poultry and Goat Manure were the materials used. Poultry and Goat Manure were prepared according to the advice given by the Agriculture department. The two manures were in equal proportions. Let T be *theri*-soil. Ten different combinations viz : T+ 10% of Amendment, , T+ 20% of Amendment, T+ 30% of Amendment, , T+ 40% of Amendment, T+ 50% of Amendment, T+ 60% of Amendment, T+ 70% of Amendment,

T+ 80% of Amendment, T+ 90% of Amendment, and T+ 100% 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 physico chemical and physical properties such as bulk density(BD),Particle density(PD),Water holding density(WHC), Pore space (PS),Hydraulic conductivity(HC),Thermal Conductivity(TC), Volume Expansion(VE) of the soil through various methods. Physico-Chemical properties like Electrical conductivity (EC), Potential of Hydrogen(pH) and Chemical properties namely NPK, Organic Carbon(OC) were studied. 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 Poultry and Goat Manure amended theri soil can be best represented by the linear model,

Y= a+ b x.

DISCUSSION

Bulk density

Bulk density has positive association with pH (0.939), particle density (0.988), porosity (0.988), hydraulic conductivity (0.973) and negative association with EC (0.954), water holding capacity (0.986), volume expansion (0.984), organic carbon (0.963), thermal conductivity(0.970), N (0.980), P (0.973) and K (0.985).

In the case of bulk density, the best fitted equation along with the R-Square value and the significance of the coefficients is
$y = 1.9713 - 0.0064x$; $R^2 = 0.9546$**

Where y is the bulk density and x is the level of amendment. Here, R- Square takes the value 95.46 percent of the variations in the bulk density in the soil is being explained by the levels of amendments made. Here, the coefficient of x is negative, indicating the decreasing value of the bulk density with respect to increase in the values in the amendments. That is addition of the amendment brings down the bulk density. That is a unit increase in the value of the amendment level would produce a decrease of 0.0064 units in the bulk density.

Particle density

Particle density is positively related to pH (0.951), bulk density (0.988), porosity(0.988) and hydraulic conductivity (0.989) and negatively associated with thermal conductivity (0.986), EC (0.958),water holding capacity(0.995), volume expansion (0.986), organic carbon(0.971),N (0.990), P(0.986), K(0.992). The fitted equation is

$y = 3.5821 - 0.0161x$; $R^2 = 0.9707$**

That is addition of the amendment brings a reduction in the particle density.

Porosity

The porosity of the soil has got positive association with bulk density (0.988), pH(0.939), hydraulic conductivity(0.972), and particle density (0.988) and negative association with thermal conductivity (0.983),N (0.975), volume expansion(0.975), water holding capacity (0.976),organic carbon(0.958),EC (0.949), P(0.972) and K(0.986). The best equation fitted in this case is
$y = 45.919 - 0.1153x$; $R^2 = 0.9484$**

The sign of the x term ascertain the fact expressed through simple correlations. That is increase in the amendment levels will bring down the porosity level of the soil. The initial porosity of the soil seems to be high and equal to 45.9 units. The high value of R- Square ascertains that 98.7 percent of the variation in porosity is being explained by the amendments. Further, a unit increase in the amendment level brings down the porosity by 0.1153 units.

Water holding capacity

Water holding capacity has positive association with volume expansion (0.990), thermal conductivity (0.981), EC (0.961) ,N (0.987), P(0.982), organic carbon (0.967) and K(0.988) and negative association with bulk density (0.986), hydraulic conductivity (0.984), particle density(0.995),pH(0.946), and porosity(0.976). The best equation fitted is
$y = 21.601 + 0.1667x$; $R^2 = 0.9616$**

The positive value of the coefficient of x agrees with the correlation results .The R-Squares is almost equal to 1, which is significant at 0.01 level of probability indicating that the 99 percent of variations in the water holding capacity is being explained by the amendment levels. Also the initial level of water holding capacity of the soil is around 21.601 units. Again a unit further increase in the amendment could increase the water holding capacity of the soil by 0.1667 units.

Volume expansion

Volume expansion has positive relation with water holding capacity (0.990), thermal conductivity (0.981), EC (0.958), N (0.985), P(0.984), organic carbon (0.973) and K(0.992) and negative association with bulk density (0.984), hydraulic conductivity (0.981), particle density (0.986), pH (0.953), and porosity (0.975).

The best regression equation fitted through least squares in this case is

$y = 4.6278 + 0.0943x$; $R^2 = 0.9658$**

The coefficient of x in the equation is positive. This fact is in agreement with the correlation results. That is increase in amendment increases the volume expansion of the soil. The R-Square is very high indicating the fact that 98.68 percent of the variations in the volume expansion is being determined by the amendments included in the experiment. The regression constant is nearly 4.6 which indicates the initial volume expansion of the their soil. Moreover, a unit increase in the amendment increases the volume expansion by 0.0943 units.

Hydraulic conductivity

Hydraulic conductivity has positive association with bulk density (0.973),pH (0.978), particle density (0.989), porosity (0.972), and negative association with water holding capacity (0.984), volume expansion (0.981), EC(0.981), organic

carbon(0.992), thermal conductivity (0.986), N (0.998), P(0.999) and K (0.994).

The best fitted equation is
$y = 200.74 - 0.5973x$; $R^2 = 0.9962$**

The initial hydraulic conductivity level of the soil is nearly 200.74 .The R - Square is 0.9971 expressing the fact that 99.7 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 by 0.5973 units.

Thermal conductivity

The correlation table reveals that the thermal conductivity is positively associated with water holding capacity(0.981), volume expansion(0.981), EC(0.967), organic carbon (0.979), N (0.988), P(0.989), K(0.993) and is negatively associated with pH(0.951), porosity(0.983), particle density(0.986), hydraulic conductivity(0.986) and bulkdensity(0.970). The thermal conductivity was taken as the dependent variable (y) and the amendment (x) was taken as the independent variable. As discussed in the methodology, the best of equation in their mathematical form along with their R-Square value and the level of significance is $y = 0.4844 + 0.003x$; $R^2 = 0.9723$** Here the R- Square value is greater than 0.98 which is significant at 0.01 level of probability indicating the fact that more than 98 percent of the variations in the thermal conductivity is being explained by the levels of amendment added to the soil.

pH

pH has positive association with bulk density(0.939), particle density (0.951), porosity(0.939), hydraulic conductivity (0.978) and negative association with water holding capacity(0.946),volume expansion(0.953), EC(0.979), organic carbon(0.974),thermal conductivity (0.951), N (0.970) P (0.976)and K(0.970).

The best equation selected is
$y = 7.128 - 0.0009x$; $R^2 = 0.9578$**
The R- Square value indicates that about 97.4 percent of the variations in pH is being determined by the amendment levels used in the equation. The pH without any amendment is nearly 7.128 units.

Electrical conductivity (EC)

The EC of the soil has positive association with water holding capacity(0.961),volume expansion (0.958),organic carbon(0.984),thermal conductivity(0.967),N (0.982) P(0.980) and K(0.976).and negative association with pH(0.979),bulk density (0.954), particle density(0.958),porosity (0.949)and hydraulic conductivity (0.981) The best equation in the case of EC is
$y = 1.0667 + 0.0006x$; $R^2 = 0.9701$

There y is the EC and x is the level of amendments. Here R-square is 0.97, which is significant at one percent level of significance indicating the fact that 97 percent of the variations in the EC level is being explained by the different levels of amendment added to the soil. The coefficient of x in the linear equation indicate that a unit increase in the level of amendment will increase the EC level of the soil by 0.0006 units. That is amendments help in increasing the level of EC in the original soil.

Organic carbon

It is observed from the correlation table that the organic carbon has positive association with water holding capacity(0.967), EC (0.984), volume expansion(0.973), thermal conductivity(0.979),EC (0.984), N(0.994),P(0.995) and K (0.989)and negative association with pH (0.974), bulk density(0.963), particle density(0.971), porosity (0.958) and hydraulic conductivity(0.992).

The best equation fitted is
$y = 0.2507 + 0.0014x$; $R^2 = 0.9926$**
The R-Square is 0.995 which is significant at the highest level of probability indicating the fact that the amendments chosen could explain 99.5 percent of the variations in the organic carbon .The positive coefficient for x gives the confirmation of the fact that increase in the levels of amendments bring additional organic carbons

Nitrogen

It is observed from the correlation table that the Nitrogen has positive association with water holding capacity(0.987), EC(0.982), volume expansion (0.985), organic carbon (0.994), thermal conductivity(0.988), K(0.996) and P(0.998)and negative association with pH (0.970), bulk density (0.980),particle density(0.990),porosity (0.975)and hydraulic conductivity(0.998). In the case of nitrogen, the regression equation selected is
$y = 88.6 + 0.3236x$; $R^2 = 0.9974$**

The R- Square 0.998 which is significant at the highest level indicating the amount of fitness i.e. to say that changes in the levels of amendments could decide the changes in nitrogen at 99.8 percent level. The initial nitrogen level is around 88.6 units. Moreover additional levels of amendments could increase the nitrogen level and a unit increase in the amendment could increase the level of nitrogen by 0.3236 units.

Phosphorus

Phosphorus of the soil is directly related to water holding capacity(0.982), EC(0.980), volume expansion (0.984), organic carbon (0.995), thermal conductivity(0.989), K(0.995) and N(0.998) and inversely related to bulk density (0.973), hydraulic conductivity (0.999), particle density (0.986), pH (0.976), and porosity (0.972). The best equation in this case is
$y = 42.347 + 0.3173x$; $R^2 = 0.9979$**

The coefficient of x in the equation is positive. The initial value of the soil Phosphorus is nearly 42.347 units and a unit increase in the value of the amendment will induce an increase of 0.3173 units in the Phosphorus.

Potassium (K)

It is observed from the correlation table that Potassium has positive association with water holding capacity(0.988), EC(0.976), volume expansion (0.992), organic carbon (0.989), thermal conductivity(0.993), p(0.995) and N(0.996) and inversely related to bulk density (0.985), hydraulic conductivity (0.994), particle density (0.992), pH (0.970), and porosity (0.986). The best equation selected is
$y = 441.27 + 0.9297x$; $R^2 = 0.9909$**

The sign of x in the equation confirm the behaviour with the results obtained through simple correlation analysis that amendment with amendment increases the Potassium level .The R- Square value indicates that about 99.64 percent of the variations in Potassium is being determined by the amendment levels used in the equation. The Level of Potassium without any amendment is nearly 441.27 units.

(Table 1). There is an inverse relationship between porosity and bulk density. Total pore space is typically increased by addition of organic matter. The Poultry & Goat manure in addition to its ameliorative effect being a store house of almost all the nutrients required for plant growth and improved soil environment via improvement in physio-chemical properties of soil.

Table 1 Change of Physical and chemical properties of Theri soil amended with Goat and Poultry Manure

%	B.D	P.D	Porosity	W.H.C	V.E	H.C	T.C	pH	EC	OC	N	P	K
10	1.86	3.333	44.186	24.573	6.388	195	0.525	7.12	1.07	0.26	92	46	454
20	1.818	3.2	43.18	25.94	6.637	189	0.559	7.12	1.08	0.278	96	48.5	461
30	1.777	3.076	42.22	26	7.422	182	0.559	7.1	1.08	0.29	98	51.7	468
40	1.739	3	41.3	26.955	7.6	178	0.596	7.09	1.09	0.31	101	54.6	478
50	1.702	2.9	40.42	28.563	8.72	172	0.639	7.08	1.1	0.32	104	58.2	485
60	1.63	2.75	40.8	30.609	9.88	166	0.639	7.08	1.1	0.34	108	61.5	492
70	1.538	2.5	38.46	33.558	11.85	159	0.686	7.06	1.11	0.35	111	64.3	508
80	1.509	2.22	36.956	35.56	12.05	150	0.740	7.06	1.11	0.36	115	68.7	516
90	1.333	2.0513	35	37.61	12.99	146	0.740	7.05	1.12	0.37	118	70.4	524
100	1.29	1.932	33.23	38.313	14.62	142	0.801	7.05	1.12	0.39	121	74.1	538

Abbreviations:

B.D – Bulk Density P.D – Particle Density W.H.C –Water Holding Capacity
V.E –Volume Expansion H.C –Hydraulic Conductivity T.C –Thermal Conductivity
N – Nitrogen P –Phosphorus K – Potassium
EC --Electrical Conductivity OC -Organic Carbon

RESULTS AND CONCLUSION

Application of Poultry and Goat manure with their soil at various proportions show a regular increase of all oxidizable organic carbon fractions. Application of Goat and poultry manure enhances the OC content of the soil. Increased OC values range from 0.26% to 0.39% with the mean value of 0.32% was observed. Addition of the amendments with theri soil decreases the pH, Bulk density, Particle density, Hydraulic conductivity, porosity but increases the EC, Water holding capacity, Volume expansion (Table1). The bulk density of soil ranges

from 1.29-1.86 g/cm3, generally bulk density of 1.5-1.6 g/cm3 is critical for root growth of the most of the plants [13]. But theri soil has bulk density of 1.73 g/cm3 which shows less convenience for root growth. The decrease in bulk density might be due to higher organic matter content of the soil with the application of Poultry and Goat manure. The nitrogen content increases as the dosage of the amendment increases. It ranges from 92 kg/ha-121 kg/ha. The reduction in soil pH was due to increased CO2 concentration in soil arising from the microbial decomposition of Poultry & Goat manure. The CO2 in contact with water forms Carbonic acid, which reacts with native CaCO3 of soil to bring Ca in soil solution, resulted in to lower value of soil pH. Poultry and Goat Manure treated theri soil shows a pH values ranges from 7.12-7.05. The pH value above 9 is undesirable and pH value below 4.5 is not good. Here in all treatments the porosity ranges from 44%-33% (Table 1). This range of porosity slightly hinders the growth of plants. The neutral pH value is obtained for all treatments. So this is most favourable for the cultivation purpose. The EC values vary from 1.07dsm-1 to 1.12dsm-1 higher than the control soil, but in all treatments EC do not exceed the threshold limit. The desired increase of water holding capacity ranged from 25% to 38% (Table1) will improve the ability to supply the nutrients to the soil. The hydraulic conductivity controlled from very rapid stage to moderate rapid stage ranges from195 mm/hr to 142 mm/hr enhances soil nutrients. In T + 80% treatment water holding capacity increases and attains the maximum value of 35% (Table1) and the hydraulic conductivity reduces to the minimum value of 142 mm/hr

Thus on addition of Poultry & Goat manure, increases the nutrient status due to mineralization of native as well as applied nutrients through organic fertilizers in addition to its own nutrient content. So the use of organic amendment helps to build up soil humus and beneficial microbes, besides improvement of soil physical properties.

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