INFLUENCE OF FARM YARD AND POULTRY MANURE AS ORGANIC AMENDMENT ON PHYSICO PHYSICAL PROPERTIES OF THERISOIL

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***Abstract*: A pot culture study was conducted during 2014(Oct) to2015(Jan) in Theri soil. Theri lands are located along the coastal areas of Tuticorin district of Tamilnadu, South India. Proper management of the land is difficult because of its poor quality structure, low nutrition, meagre moisture holding capacity, low value of organic content, and high value of hydraulic conductivity. The permeability of water in theri soil is high and is not suitable for agriculture which is presently considered as a wasteland.The objective is to nurse the soil back to health and reclaim the soil, Farm Yard and Poultry Manures amended with theri soil to reduce the fertility constraints of the soil. The effect of soil physical properties were investigated by ameliorating the soil with Farm Yard and Poultry Manures laid out in a pot culture with ten treatments replicated thrice. In order to reduce soil Physical constraints and to make the soils fit for sustained water availability and large agricultural applications. different proportions of Farmyard and Poultry Manures were tried on soil and the Physical and Physico -chemical parameters which brings the soil cultivable were studied and their inter relationships were determined.**

***Keywords*: Amendment, Theri soil. Farmyard, Poultry Manure,Water holding capacity.**

INTRODUCTION

Theri soils are situated in Tuticorin and Tirunelveli districts ofTamilnadu with an extend of 20,171 hectares (Jawahar 1996).Research field is in Punnai nagar (Kachanavilai), Tuticorindistrict, Tamil Nadu, India. This place lies between Long:78°11E , Lat:8 °30° N . Soil samples (TH) were collected atthis location at 19 km west from Tiruchendur 5km fromNazerath. These soils are also prone to soil and wind erosion.Theri soils had excessive drainage, poor moisture holdingcapacity, poor nutrient status etc. Differentinterpretive systems indicated that these are not suitable foragriculture (Janakiraman *et al*., 1997). The unfavourabletopography of the soil causes a lot of problems for intensivecultivation. The intensive agriculture, which ushered in an era of green revolution is nowbecoming the cause of severe degradation of soil quality,questioning the sustainability of the production system.Hence Biological techniques are to be adopted for the controlof soil erosion by wind and water and rehabilitation of sand dunes. The organic amendment not only supplements thechemical fertilizers but also reduces the environmentalpollution. A substantial increase in production can be obtainedby use of fertilizers. However, due to high cost of fertilizers,only a few farmers can afford to apply chemical fertilizers asper recommended doses. Organic matter increases biologicalactivity, Therefore to improve the overall biological, chemicaland Physical conditions of the dry land soils, regular additionof Organic material would be beneficial (Barzegar*et al*., 2002). At present Farmyard and Poultry Manures which is an organic source helps inincreasing the yield as well as increasing soil Physical,Physico-chemical and Chemical properties of Theri soil. It helps in maintaining environment health by reducing the level of pollution. FYM was used to replace 50% requirements ofthe chemical fertilizers (Bagla *et al*2008). Keeping in view of above points the detailed micro level study was conducted toassess the physical, physico-chemical characteristics and available nutrients status of theri soil

2. MATERIALS AND METHODS

Soil samples (Theri soil) were collected at Punnainagar (Kachanavilai) that is located at 19 kmwest from Tiruchendur in Tuticorin district ofTamil Nadu. A soil sample was collected in theexperimental site at adepth of 15 cm from the surface. It was dried and passthrough 2 mm sieve for unformity in size and analyzed for theirphysico-chemical and physical properties. A potexperiment was conducted during Rabi seasonduring 2014- 2015. The experiment was laid out in a pot culture withten treatments replicated thrice. The pots werearranged under the screen house according tosteel and Torrie [6]. In the screen house study,1 litre (1000 c.c) of theri soil thoroughly mixedwith different percentage of farm yard and poultrymanure mixture in a clay pot. (2 mm sievepowder). Ten different combinations, namelytheri soil (Th)+10% of FP (Farmyard + Poultry manure);Th+20% of FP; Th+30% of FP; Th+40% of FP;Th+50% of FP; Th+60% of FP; Th+70% of FP;Th+80% of FP; Th+90% of FP; Th+100% of FP.These different combinations were thoroughly ameliorated mechanically before use. Forexample Th+10% of FP mean 100 cc ofFarmyard+poultry manure was mixed with 1000 cc ofTheri soil. The volume of the soil is fixed. These mixtures were allowed to settle for aperiod of 90 days by wetting with water regularlyand without allowing them to get dried. After 90days measurements were made on the physicaland physico-chemical properties, such as pH,EC, NPK, particle density, bulk density, porosity,water holding capacity, volume expansion,organic carbon content and hydraulic conductivity

2.1 Methods Used for Analysis

The soil samples were characterized forimportant physico-chemical properties usingstandard procedures. Bulk density, Particledensity, Water holding capacity, Porosity,Volume expansion by KeenRaczkowski(KR) Boxmodel [7], Soil pH and EC

was determined in1:2.5 soil water suspensions with help of glasselectrode pH meter with a digital display and witha null balance conductivity metercorrespondingly [8], Organic Carbon determinedChromic acid wet oxidation method [9]. Available"N" alkaline permanganate method [10]. Theavailable "P" was estimated by Flamephotometer [11] and available "K" determined byAmmonium acetate method [12]. Finally soilsamples were collected from pots and air driedin shade processed and screened through a2mm sieve. After sieving all the samples werepacked in polythene bags for analysis

3. DISCUSSION

3.1 Bulk density

Bulk density has positive association with particle density (0.975), pH (0.937),porosity(0.975), and hydraulic conductivity (0.973), and negative association with EC(0.965), N (0.986), P(0.986),K(0.986) water holding capacity (0.934), volume expansion (0.940),
organic carbon (0.980), thermal conductivity (0.963).
In this, the fitted best equation is
$y = 1.9754 - 0.0079x$; $R^2 = 0.9437$**
where y is the bulk density and x is the levels of amendment. Here R-square is0.9437, which is significant at one percent level of probability indicating that 94.37 percentof 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 FP brings down the bulk density. That is a unit increase in the value of the amendment level would produce a decrease of 0.0079 units in the bulk density.

3.2Particle density:

Particle density is positively related to bulk density (0.975), porosity (0.977), pH (0.955) and hydraulic conductivity (0.972) and negatively associated with water holding capacity (0.968), EC (0.973), N (0.975), P(0.988),K (0.965), thermal conductivity (0.959),
volume expansion (0.954) and organic carbon (0.987).
The fitted equation is
$y = 3.1788 - 0.0143x$; $R^2 = 0.9652$**
The negative coefficient of x in the equations confirms that the increase in the amendment rates brings only decrease in the particle density . That is FP brings a reduction in the particle density. The initial particle density of the original soil is nearly 3.17 units. The
highly significant R- Square value expresses the fact that about 96.52 percent of the variations in the behavior of particle density is being explained by the different amendment levels of FP used in the experiment.

3.3 Porosity

The porosity of the soil has got positive association with bulk density (0.975), particledensity (0.977), hydraulic conductivity(0.986) and pH(0.967) and negative association withEC(0.972), N(0.970), P(0.981), K (0.966),volume expansion (0.953),water holding capacity(0.983), thermal conductivity(0.961) and organic carbon (0.985).The best equation fitted in this case is
$Y = 38.194 - 0.0667x$; $R^2 = 0.9744$**
The sign of the x term ascertains the fact that increase in the amendment levels willdecrease the porosity level of the soil. The initial porosity of the soil seems to be high andequal to 38.194 units. This high value might be the cause of high depletion of water in *Theri* soils . Moreover, the high value of R- Square ascertains that 97 percent of the variations inporosity is being explained by the amendments through FP. Further, a unit increase in theamendment level brings down the porosity by 0.0667 units.

3.4 Water holding capacity

Water holding capacity has positive relation with volume expansion (0.932), EC(0.958), thermal conductivity (0.939), organic carbon (0.971), N (0.943), P(0.962)and
K(0.932) and negative relation with bulk density (0.934), particle density (0.968), porosity (0.983) and pH (0.966).The best equation fitted is
$Y = 21.491 + 0.1866x$; $R^2 = 0.952$**
The positive value of the coefficient of x agrees with the correlation results .The R-Square is equal to 0.96, which is significant at 0.01 level of probability indicating that the 96.03 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 21.491units. Again a unit further increase in the amendment could increase the water holdingcapacity of the soil by0.1866 units.

3.5 Volume expansion

Volume expansion has positive relation with water holding capacity (0.932), thermalconductivity (0.979), EC (0.975), organic carbon (0.975),N (0.953), P(0.970) and K(0.933)and negative relation with porosity (0.953), bulk density (0.940), hydraulic conductivity(0.982), particle density (0.954) and pH(0.950).
The best regression equation fitted through least squares in this case is
$y = 6.0562 + 0.0837x$; $R^2 = 0.9596$**
The coefficient of x in the equation is positive . This fact is in agreement withthe correlation results. That is increase in amendment increases the volume expansion of thesoil. The R- Square is very high indicating the fact that 96 percent of the variations in thevolume expansion is being determined by the amendments included in the experiment. Theregression constant is

nearly 6.0562 which indicates the initial volume expansion of the *theri*soil. Moreover, a unit increase in the amendment increases the volume expansion by 0.0837units.

3.6 Hydraulic conductivity

Correlation table shows that the hydraulic conductivity has positive association with porosity (0.986), pH (0.978), particle density (0.972) and bulk density (0.973) and negative association with EC (0.975), water holding capacity (0.961), volume expansion (0.982), organic carbon (0.989),thermal conductivity (0.982), N(0.964), P (0.985) and K (0.953).The best fitted equation is

$Y = 157.43 - 0.6938x$; $R^2 = 0.9867$**

The relationship expressed in the simple correlation coefficient is being reflected by the negative values of the x term. The initial hydraulic conductivity level of the soil is nearly 157.43 .The R - Square is 0.987expressing the fact that 98.7 percent of the variations in thehydraulic conductivity of the soil is being decided by the amendment levels considered in the experiment .The coefficient of x2 is low negative which expresses the lower responsiveness due to the changes in the amendment levels. Again a unit increase in the amendment level will decrease the hydraulic conductivity by 0.6938 units. That is in the case of hydraulic conductivity, rapid changes occur due to amendments.

3.7Thermal conductivity

The correlation table reveals that thermal conductivity of the soil is directly related toEC (0.980), water holding capacity (0.939), volume expansion (0.979), organic carbon(0.988) and N (0.967), P (0.988) and K (0.948) and indirectly related to pH (0.969), porosity(0.961), bulk density (0.963), particle density (0.959) and hydraulic conductivity (0.982).In the case of, thermal conductivity the regression equation selected is

$y = 0.2991 + 0.0012x$; $R^2 = 0.9772$**

The R- Square is uniformly 0.98 which is significant at the highest level indicating the amount of fitness. That is to say that changes in the levels of amendments could decide the changes in thermal conductivity at 98 percent level. The initial thermal conductivity level is around 0.2991 units and the response in changes is higher than that for EC. Moreover additional levels of amendments could increase the thermal conductivity and a unit increase in the amendment could increase the level of thermal conductivity by 0.0012 units.

3.8 pH

pH has positive association with particle density (0.955), hydraulic conductivity (0.978) and bulk density (0.937), porosity (0.967) and negative association with water

holding capacity (0.966), EC (0.955), thermal conductivity (0.969), N (0.926), P (0.968), volume expansion (0.950), K (0.906) and organic carbon (0.975).The best equation selected is

$y = 7.1547 - 0.0021x$; $R^2 = 0.9681$**

The sign of x in the equation confirms the behaviour with the results obtained through simple correlation analysis that amendment reduces the pH level .The R- Square value indicates that about 96.8 percent of the variations in pH is being determined by the amendment levels used in the equation. The pH without any amendment is nearly 7.15 units.

3.9 Electrical conductivity (EC)

The EC has positive relation with water holding capacity (0.958), volume expansion (0.975), organic carbon (0.993), thermal conductivity (0.980), N (0.988) , P(0.988) and K(0.975) and negative relation with porosity (0.972), pH (0.955), bulk density (0.965) andparticle density (0.973) and hydraulic conductivity (0.975).The best equation in the case of EC is

$Y = 1.06 + 0.0016x$; $R^2 = 0.9773$**

Where y is the EC and x is the level of amendments. Here R-square is 0.99, which is significant at one percent level of probability indicating the fact that 99 percent of thevariations in the EC level is being explained by the different levels of FP added to the soil.Thecoefficient of x in the linear equation indicates that a unit increase in the level of amendmentwill increase the EC level of the soil by 0.0016 units. That is amendments help in increasingthe level of EC in the original soil.Solving the linear equation, the needed amendment level to get a desired EC level is0.0016

3.10 Organic carbon

The organic carbon has positive correlation of 0.971, 0.975, 0.988, 0.993, 0.986,0.998 and 0.973 respectively with water holding capacity, volume expansion, thermalconductivity, N, P and K and negative correlation of 0.980, 0.987, 0.985, 0.989 and 0.975 with bulk density, particle density, porosity, hydraulic conductivity and pH .The best least square equation fitted in this case is

$Y = 0.25 + 0.0032x$; $R^2 = 0.9957$**

The R-Square is 0.999 which is significant at the highest level of probability indicating the fact that the amendments so chosen could explain 99.5 percent of the variations in the organic carbon .The coefficient of x gives the confirmation of the fact derived from simple correlations. That is increase in the levels of amendments bring additional organic carbons. The equation for obtaining the level of amendment in order to get the desired organic carbon level is 0.0032.

3.11 Nitrogen(N)

The correlation table reveals that nitrogen level of the soil is directly related to water holding capacity (0.943), volume expansion (0.953), thermal conductivity (0.967), EC(0.988), organic carbon (0.986), P(0.988), K(0.997) and indirectly related to

pH (0.926), bulk density (0.986), particle density (0.975) and hydraulic conductivity (0.964), porosity (0.970).In the case of nitrogen level, the regression equation selected is

$Y = 82.867 + 0.3261x$; $R^2 = 0.9497$**

The R- Square is 0.94 which is significant at the highest level indicating the amount of fitness. That is to say that changes in the levels of amendments could decide the changes in nitrogen at 99 percent level. The initial nitrogen level is around 82.867 units and the response in changes is higher than that for EC. Moreover additional levels of amendments could increase the nitrogen level and a unit increase in the amendment could increase thelevel of nitrogen by 0.3261 units.

3.12 Phosphorus

Phosphorus has positive relation with water holding capacity (0.962), volume expansion (0.970), EC (0.988), thermal conductivity (0.988), organic carbon(0.998),N(0.988) and K (0.976)and negative relation with bulk density (0.986), porosity (0.981), hydraulic conductivity (0.985), particle density (0.988)and pH(0.968).The best regression equation fitted through least squares in this case is

$y = 37.14 + 0.3798x$; $R^2 = 0.9884$**

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 Phosphorus level of the soil. The R- Square is very high indicating the fact that 98.8 percent of the variations in the phosphorus level is being determined by the amendments included in the experiment. The regression constant is nearly 37.14 which indicates the initial Phosphorus level of the *Theri* soil. Moreover, a unit increase in the amendment increases the phosphorus level by 0.3798 units.

3.13 Potassium

It is positively associated with Phosphorus has positive relation with water holding capacity (0.932), volume expansion (0.933), EC (0.975), thermal conductivity (0.948),organic carbon(0.973),N (0.997) and P (0.976)and negative relation with bulk density(0.986), porosity (0.966), hydraulic conductivity (0.953), particle density (0.965) and pH(0.906). The available moisture was taken as the dependent variable (y) and the amendments (x) were taken as the independent variable .The best equation selected is

$Y = 429.93 + 0.7448x$; $R^2 = 0.9215$**

Here R- Square value is nearly 0.9924 which is significant at 0.01 level of probability indicating the fact that more than 92 percent of the variations in the available moisture level is being explained by the levels of FP added to the soil. It also asserts that the likelyprobability of this statement to go wrong is one out of hundred cases. Irrespective of the type of function fitted, the regression constant has value around 429.93 which is the initial available Potassium level of the soil without the addition of the FP. Moreover as per the value of the

Coefficient of x in the linear trend equation a unit increase in the amendment level will bring an increase of 0.7448 units in the levels of the potassium level.

4.Results and Conclusion

Addition of the amendment with Theri Soil decreases the bulk density, particle density, pH, ,Porosity and hydraulic conductivity but increases water holding capacity, Volume Expansion, Thermal conductivity, EC,N,P,K 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+50%, T + 40% and T + 60% amendments. The total porosity varies in the neighborhood of 50% (Baver, 1959) Here all the treatments range 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 values 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 exceeds 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 50 % cent and the hydraulic conductivity reduced to the minimum value of 113 mm / hr. T + 50%, T + 60% and T + 40% combinations were better than the other combinations for the purpose of cultivation. Increase of organic Carbon improves the growth condition of the crops. Here NPK values also increased to more than 50%. Giving more importance to the major soil physical constraint namely the water retention and the permeability T + 50% amendment treatment could be predicted as the best among all the treatments.

table:1
Change of Physical and chemical properties of Theri soil amended with Farmyard and Poultry Manure

%	B.D	P.D	Porosity	W.H.C	V.E	H.C	T.C	pH	EC	OC	N	P	K
10	1.904	3.077	38.095	21.16	7.15	149	0.319	7.12	1.07	0.28	84	41.2	430
20	1.818	2.857	38.363	27.098	7.30	143	0.319	7.11	1.08	0.31	88	44.2	442
30	1.777	2.817	36.08	28.214	8.48	138	0.329	7.09	1.11	0.34	92	47.2	452
40	1.7	2.6	35.417	29.472	9.6	129	0.341	7.07	1.13	0.38	96	51.2	460
50	1.6	2.424	35.294	30.61	10.62	127	0.365	7.07	1.15	0.42	102	57.6	472
60	1.4	2.4	33.898	31.124	11.08	113	0.378	7.04	1.16	0.45	106	61.2	486
70	1.333	2	33.333	34.035	12.12	108	0.378	7.02	1.17	0.48	108	65.2	489
80	1.31	2	32.787	37.473	12.18	101	0.392	6.98	1.18	0.51	109	68.2	491
90	1.29	1.9	32.258	38.851	12.71	99	0.406	6.95	1.2	0.54	111	71.2	493
100	1.269	1.86	31.746	39.51	15.35	85	0.422	6.94	1.21	0.56	112	73.1	494

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

References

1. Farouki OT. Thermal properties of soilscold regions research and engineering Laboratory Report 82-8, U.S. Army Corps of Engineers, Hanover, New Jersey; 1981.
2. . Keen BA, Raczkowski H. Relation between the clay content and certain physical properties of soil. Journal of Agricultural Science. 1921;11:441-449.
3. Walkley A, Black JA. An examination of the Degt Jareft method for determination of soil organic matter and proposed modification of chromic acid titration method. Sci. Soil 1934;37:29-38.
4. Subbaiah BV, Asija GC. A rapid procedure for the determination of available nitrogen in soils. Current Science. 1956;25:259-262.
5. Hanway JJ, Heidel. Soil analysis methods as used in lowa state college of soil testing laboratory. Iowa Agric. 1952;57:1-31.
6. Warner SL, Fonteno WC. Changes in physical and chemical properties of loamy sandy soil when amended with composted poultry manure. J. Environ. Hort. 1993; 11(4):186-190.
7.Chandrashekara CP, Harlapur SI, Muralikrishna S, Girijesh GK. Karnataka J.Agri. Sci. 2000;13(1):144-146
8. . Rees HW, Chow TL, Zebarth BJ, Xing Z, Toner P, Lavoie J, Daigle JL. Effects of supplement a poultry manure applications on soil erosion and runoff water quality from a loam soil under potato production in Northwestern New Brunswick, Canadian. Journal of Soil Science. 2011;91:595-613.
9. Motavalli PP, Anderson SH, Pengthamkeerati P. Surface compaction and poultry litter effects on corn growth, nitrogen availability, and physical properties of a clay pan soil. Field Crops
Research. 2003;84(3):303-18.
10. . Rangaraj T, Somasundaram E, Mohamed M, Amanullah V, Thirumurugan V, Ramesh S, Ravi S. J. Agric. and Bio. Sci. 2007;3(3): 153-156.
11.. Appavu K, Saravanan A, Mathan KK. Effect of organics and irrigation levels on soil physical properties and yield of crops under sorghum-soybean cropping system.Madras Agric. J. 2000;87(1-3):50-53.