IMPROVEMENT OF SOIL PHYSICAL PROPERTIES AND ENHANCEMENT OF YIELD WITH THE USE OF ORGANIC MANURES

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Abstract
An analysis of field study was undertaken at Keela kadayam village in Ambasamudram Taluk, Tenkasi district of Tamil Nadu, South India in 2020 and the yield of rice measurement was done for the sandy loam clay soil which is situated at 8.72o latitudes and 77.68o longitudes. The analysis was highly focused to evaluate the possibilities of composting different organic manures i.e. Farm Yard Manure (FYM), Goat Manure (GM) and Compost Manure (CM). FYM, GM and CM were applied with and without three different concentrations like 8.5 t ha-1, 12.5 t ha-1 and 16.5 t ha-1 in the field of the study and yield were measured. The result showed that the combination of FYM+GM+ CM in the concentration 16.5 t ha-1 recorded the highest yield of 7538 kg ha-1. The grain yield and yield components (plant height, no. of fertile tillers) of rice increased significantly with the application of organic material in the combination of F Y M +GM+ CM. After paddy harvesting, the available amount of all the major nutrients (N, P, and K) increased in the soil. The elements present in the samples before and after harvesting were identified by powder XRD studies were carried out for the samples. On the basis of experimental results, a recommendation for the farmers can be formulated that they should compost the crop residues and apply in their soils for the increased sustainable crop production. In this way, the soil fertility can be improved with a net improvement in land productivity and paddy yield.
Keywords: Farm yard manure, Goat manure, Compost manure, XRD, paddy yield.

1. Introduction

Sandy loam clay soil is common in Ambasamudram Taluk, Tenkasi district of Tamilnadu, South India. Sandy clay is a fine texture soil with 45%–65% sand, 35%–55% clay and 0% – 20% silt. When it is dry, it is very hard and it can be broken with extreme pressure. In moist condition, sandy loam clay is sticky and plastic and shows a good fingerprint. It is proposed to add varieties of manures to increase the soil fertility and to increase the paddy yield. The different types of manures considered in this work are FYM, GM and CM. FYM refers to the decomposed mixture of dung and urine of farm animals along with litter and left-over material from roughages or fodder fed to the cattle. Farm yard manure application to the crops is being practiced for a long time. Well decomposed FYM in addition to supplying plant nutrients act as binding material and improves the soil physical properties. The droppings of sheep and goats are called as goat manure

Journal of New Zealand Studies NS34 (2022), https://doi.org/ 10.5281/zenodo.7262666

and it contains higher nutrients than farmyard manure and compost manure. On an average, the manure contains 3 % N, 1% P2O5 and 2 % K2O. Compost Manure is an organic matter that has been broken down into simpler material in a process called composting. The addition of FYM is considered as the best source of nitrogen which being proved from the results of incubation study and most effective in increasing the plant height was reported by Sharma and Dayal (2005). The application of GM significantly increased soil pH, organic matter content, total N, available P, exchangeable K, Ca, Mg and the cation exchange capacity (CEC) status of the soil. Growth and yield parameters such as plant height, number of leaves, number and weight of grains and total grain yield were significantly increased by GM. The aim of the paper is to study the distribution of different fractions of NPK in sandy loam clay soils, the effect of organic materials on yield of paddy and to study the effect of addition of different amounts and types of organic materials on yield of paddy. The present experiment was undertaken to study the effect of organic manures (FYM, GYM and CM) and the optimum proportion of the manures on the basis of yield.

2. Materials and methods

2.1 Experimental site

Main field experiment was carried out at Keela Kadayam village, Ambasamudram Taluk of Tenkasi District of Tamilnadu. The farm coordinates are at latitude 8.728°, longitude 77.68° and elevation / altitude of the experiment site is 102 meters above sea level.

2.2 Weather and climate

The Keela Kadayam village has a tropical climate. The summers have a good deal of rainfall, while the winters have very little. The average annual temperature is 27.8 °C | 82.0 °F. Precipitation here is about 1086 mm | 42.8 inch per year. The maximum temperature is 29.40C and the minimum temperature is 22.2 oC. The average rainfall received during the year is 100 mm.

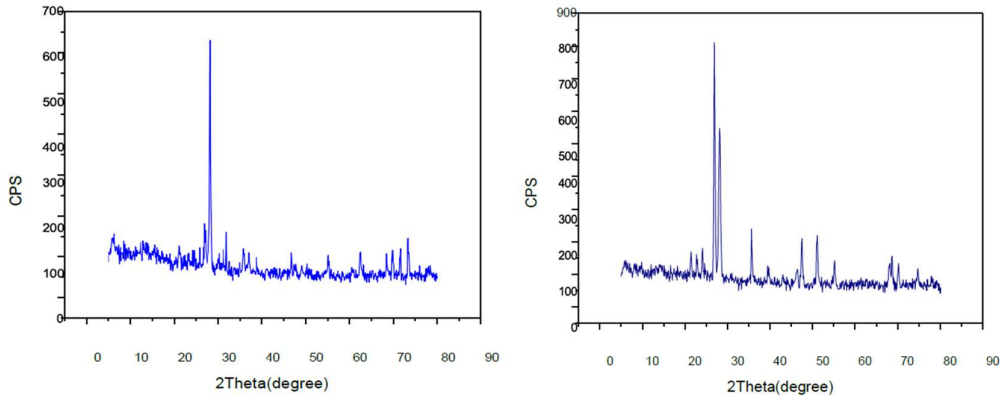
2.3 Samples

Different organic manures i.e. FYM, GM and CM in various concentrations and combinations were added into the soil of experimental site and paddy was cultivated. Best three yield and control plot soil samples were collected before harvesting and after harvesting of the paddy from the experimental site. The manure concentrations and manure combinations considered for the XRD studies were FYM + GM + CM and FYM at 16.5 t ha-1, FYM + GM + CM at 12.5 t ha-1 and Control plot soil (without manure). After harvesting, paddy yield was measured. The soil samples were subjected to XRD studies for analyzing the soil properties. The yield produced by the soil also increases due to the addition of organic manure similar results were obtained.

3. Results and discussion Powder XRD studies

When fast moving electrons hit on a metal target, X-rays are emitted. The characteristic and monochromatic X-rays are used in the method of X-ray diffraction (XRD). When X-rays fall on sample, diffracted X-rays will be emitted from the sample if Bragg's condition is satisfied and this is known as XRD. X-ray diffraction is a common technique for the study of crystal structures and atomic spacing. For a given set of lattice planes with an interplanar distance of d, the condition for a diffraction to occur can be simply written as $2 d \sin \theta = n \lambda$ In this equation, λ is

the wavelength of the X-rays, θ is the scattering angle and n an integer representing the order of the diffraction. X-ray diffractometers are based on this principle of X-ray diffraction. A diffractometer is a measuring instrument for analyzing the structure of a material from the scattering pattern produced when a beam of X-ray radiation interacts with it. A typical diffractometer consists of a source of radiation, a monochromator to choose the wavelength, slits to adjust the shape of the beam, a sample and a detector. Powder XRD method is the technique which is readily applicable to powder crystalline materials like soil samples. A powder X-ray diffractometer is used to record the XRD patterns of the soil samples before and after harvest.
Fig.1 shows the powder XRD patterns of the Sample 1 FYM + GM + CM at 16.5 t ha-1 before and after harvest.

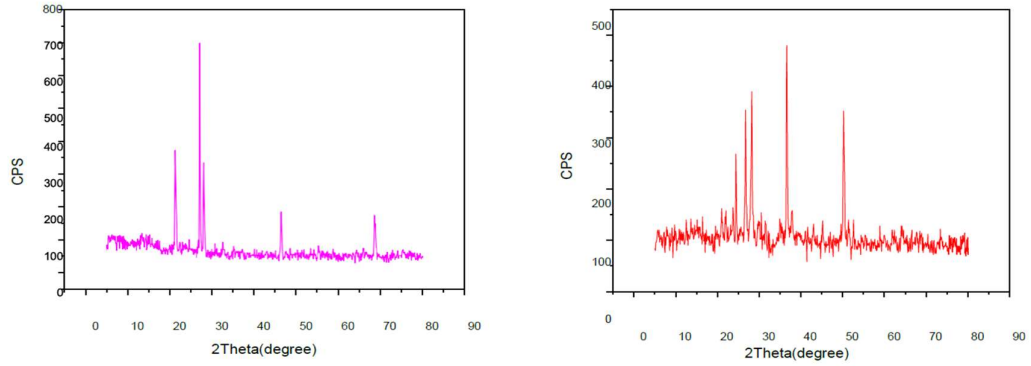


(i) Before Harvest (ii) After Harvest

Fig.1: Powder XRD patterns of the Sample 1 FYM + GM + CM at 16.5 t ha-1

The XRD pattern of the Sample 1 before harvest contains the prominent diffraction peaks at 27.67o, 32.58o, 47.48o, 62.94o and 72.57o. The XRD pattern of the Sample 1 after harvest contains more number of diffraction peaks and also the intensity of the peaks is more compared to that of the Sample 1 before harvest.

The powder XRD patterns of the Sample 2 FYM at 16.5 t ha-1 are presented in the figure 2.



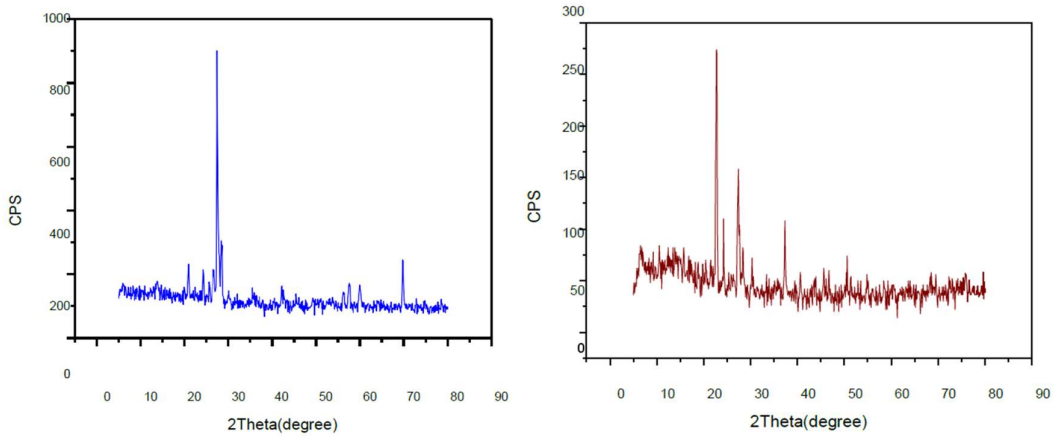
(i) Before Harvest (ii) After Harvest

Fig.2: Powder XRD patterns of the Sample 2 FYM at 16.5 t ha-1

Journal of New Zealand Studies NS34 (2022), https://doi.org/ 10.5281/zenodo.7262666

The diffraction peaks appeared in the pattern of the soil Sample 2 before harvest are 21.76o, 27.66o, 27.84o, 46.72o and 69.57o. But the prominent reflection peaks in the XRD pattern of Sample 2 after harvest is 24.73o, 26.36o, 27.44o, 32.84o and 49.51o. The changes in the diffraction patterns indicate that phases of the soil samples are different before harvest and after harvest.

The diffraction spectra of the Sample 3 FYM + GM + CM at 12.5 t ha-1 are shown in the figure 3.

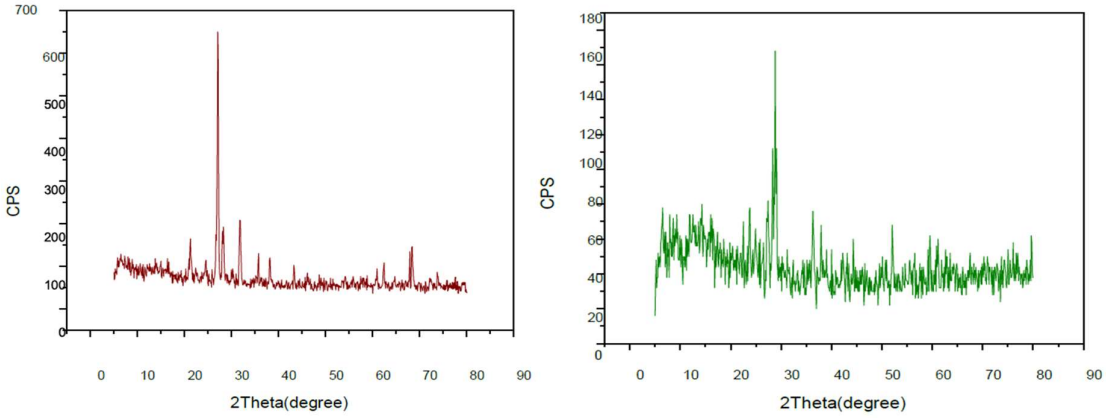


(i) Before Harvest (ii) After Harvest

Fig.3: Powder XRD patterns of the Sample 3 FYM + GM + CM at 12.5 t ha-1

The X-ray spectrum of the Sample 3 before harvest contains the diffraction peaks at 21.45o, 24.85o, 27.51o, 67.31o and 70.91o. But the diffraction peaks in the XRD pattern of Sample 3 after harvest is at 22.62o, 24.74o, 27.50o, 29.58o, 32.71o and 49.83o. Thus, changes of the diffraction peaks in the XRD patterns of the Sample 3 before and after harvest depicts that the soil composition are different.

Fig.4 represents the diffraction patterns of the control plot Sample 4.



(i) Before Harvest (ii) After Harvest

Fig.4: Powder XRD patterns of control plot soil (without manure)

The reflection peaks found in the XRD pattern of the Sample 4 before harvest are at 22.64o, 24.76o, 26.02o, 27.41o, 31.84o and reflection peaks in the pattern of the Sample 4 after harvest are at 26.52o, 32.69o, 33.51o, 44.20o, 52.73o, 59.31o, 79.42o. Thus, changes of the reflection's peaks of the soil samples without manure before harvest and after harvest of paddy indicate the alteration of soil composition.

The powder XRD pattern of the different samples shows that there is a significant difference on the soil composition.

Scherrer formula is used to find out the particle size of the soil before and after harvest.

The formula is,

$$D = K\lambda/\beta \cos\theta$$

The researcher used Microsoft excel to run the equation. The following table shows the particle size of the different samples.

Table 1: Particle size of the samples

Manure Combination	Particle Size	
	Before Harvest	After Harvest
FYM+GM+CM @16.5 t ha^{-1}	28.2733	33.410
FYM @ 16.5 t ha^{-1}	25.9766	28.0900
FYM+GM+CM @12.5 t ha^{-1}	23.9866	21.9400
Control Plot	18.9800	31.2000

Table 2: Descriptive statistics of the soil particle size

Descriptive Statistics						
	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Before Harvest	4	18.9800	28.2733	24.304125	3.9580573	15.666
After Harvest	4	21.9400	33.4100	28.660000	4.9832185	24.832

The mean value of the particle size before harvest is 23.304 and after harvest are 28.600.
There is a significant difference between before harvest and after harvest. The variance is 24.832 from the mean it is apparently high.

4. Measurement of N, P, K and paddy yield

The collected samples are analyzed on Tamilnadu government soil testing centre, Tirunelveli and the obtained data are given in the table 3.

Table 3: Values of N, P, K and yield of paddy per hectare

Concentration of Manure	Combination of manure	N kg ha^{-1}	P kg ha^{-1}	K kg ha^{-1}	Paddy yield kg ha^{-1}
16.5 t ha^{-1}	FYM+GM+CM FYM	84	28	31	7538
16.5 t ha^{-1}	FYM+GM+CM ---	80	41	16	6663
12.5 t ha^{-1}		74	39	28	5825
Without manure		76	20	36	800

From the study of different fractions of NPK in soil, it is observed that the amount of available nitrogen in soil is low and the available phosphorous is medium. Available potassium on soil is also low. Thus, sandy clay soil on the experimental site is low in fertility status. To improve the fertility, it is decided to add different combination of manure in various plots.

N:

The value of available Nitrogen (N) was found to be maximum in FYM +GM+CM plot @ 16.5 ha-1 with the value of 94 kg ha-1, which was higher than the control plot. For the control plot the value of N content was minimum as 76 kg ha-1. Nitrogen is an essential nutrient for plant growth.

P:

The value of available Phosphorus (P) content was maximum at FYM @ 16.5 ha-1 as 41 kg ha-1and the control plot has minimum value as 20 kg ha-1 which was higher than the control plot. Phosphorus is an essential macro element, required for plant nutrition.

K:

The value of available Potassium (K) increased as the concentration of the dosage increment. It shows that the combination of FYM+GM+CM and FYM @ 16.5 t ha-1 has the value of k content as 58 kg ha-1 and 46 kg ha-1 respectively. Similarly, the combination of FYM+GM+CM @ 12.5 t ha-1 has the value of K content as 38 kg ha-1 which was higher than the control plot value 36 kg ha-1.

Potassium (K) is the most abundant inorganic cation, and it is important for ensuring optimal plant growth.

Yield:

The data indicates that the combination FYM+GM+CM in the soil gives 7538 kg ha-1 of paddy. Similarly, FYM @ 16.5 t ha-1 gives the yield as 6663 kg ha-1 and FYM+GM+CM @ 12.5 t ha-1 combination of manure gives the yield as 5825 kg ha-1. The above yield of paddy was very high value when compared to the control plot (without manure) with the value of 800 kg ha-1. Thus, the experiment proves that FYM+GM+CM @ 16.5 t ha-1 is the optimum mix of manure and this combination produces the maximum paddy yield.

5. Conclusion

The experiment was conducted on sandy clay soil which is low in fertility status. Initially, nitrogen (N) is low, phosphorous (P) is medium and potassium (K) is low in the sandy clay soil. 22 plots of soil were arranged and the experiment was performed in detail. Organic manures such as FYM, GYM and CM were used individually and also combination of these manures was used to improve soil fertility, to improve N, P, K and to improve the paddy yield. After adding the manures in the different plots, paddy was cultivated and yield of paddy was measured. The soil properties were analyzed by different studies like XRD studies. The result indicates that by adding the combination of FYM, GYM and CM is the optimum mix of manure and it gives the maximum yield of paddy. It is mentioned here that the manures such as FYM, GYM and CM are found to be an effective and cheaper organic source in supplying available nutrients for paddy and it enhances the fertility of the soil. The combination of FYM, GYM and CM in the proper combination and it may be a good strategy to reclaim the sandy clay soil. This study reveals that the addition of organic soil amendments has improved the soil physical and chemical properties.

Acknowledgement

The authors like to thank the local people who helped in many ways at the experimental site in Keela kadayam village in Ambasamudram Taluk, Tenkasi district of Tamilnadu. Also, the authors are thankful to the staff members of Tamilnadu Government Agricultural Department Soil Testing Centre, Tirunelveli for collecting the research data.

References

1. Piebiep, G . (2008). Evaluating the constraints and opportunities for sustainable rice production in Cameroon. Res. J. Agric. Biol. Sci. 6:734-744.
2. Awodun, M. A . (2007). Effect of Goat Manure and Urea Fertilizer on Soil, Growth and Yield of Okra (Abelmoschusesculentus (L.) Moench). Int. J. Agri. Res, 2: 632- 636.
3. Eyo, V. E. and Uwah, D. F. (2014). Effects of number and rate of goat manure application on soil properties, growth and yield of sweet maize (Zea mays L. saccharata Strut). Sus. Agri. Res, 3: 75-83.
4. Zea Mays L. Saccharata Strut, (2014), Sustainable Agriculture Research; ISSN 1927-050X E-ISSN 1927-0518 Published by Can. Cen. Sci. Edu, 3: 4
5. Sharma, V.K., and Dayal, B, (2005) Effect of organic and inorganic source of nitrogen on growth, yield and nutrient uptake under cowpea, linseed cropping system. Legume Res., 28(2):79-80.
6. Adegboyega, A. A. and Ojeniyi, S. O., (2003). Effect of combined use of urea and goat dung manure on celosia. Nig. Agric. J., 54: 87-90.
7. Gichangi, E. M., and Mnkeni, P. N. S. (2009). Effects of goat manures and lime addition on phosphate sorption by two soils from the Transkei region, South Africa. Commun. Soi Sci.PlantAnal, 40: 3335-3347.
8. Anwar-ul-Hasan and Iqbal Muhammad. (2008). Response of wheat growth and yield to various levels of compost and organic manure. Pakistan Journal of Botany. 40: 2135-2141.
9. Annadurai, B. Arunachalam, N. and Jeyamangalam, F., (2011). “Evaluation of organic amendments using FYM for the improvement of physical properties of their soil in Tamilnadu India”, Asian Sci., 6(1&2):88-92.

10. Kumar, R. and Patidar, A., (2019). A studies on the effect of different organic sources on onion (Allium cepa L.) productivity and soilhealth. J. Pharm. Phy., 8(3): 1069- 1072.
11. Aboul-Enein, H.Y., and Bunaciu, A.A., (2014) X-Ray Diffraction: Instrumentation and Applications. Crit. Rev. Anal. Chem., 45: 289–299.
12. Das, R.; Eaqub, A., and Hamid, A., (2014) Current applications of X-ray powder diffraction-A review. Rev. Adv. Mater. Sci., 38: 95–109.
13. Kumar, B. Prasad, J. Singh, S., and Singh, R. N., (2002). Effect of green manuring, fym and biofertilizer in relation to fertilizer nitrogen on yield and major nutrient uptake by upland rice. J. Ind. Soc. Soil Sci., 50(3):313-314.
14. Mohankumar, A.B. and Narase Gowda, N.C. (2010). Effect of different organic manures and inorganic fertilizers in available NPK, microbial density of the soil and nutrient uptake of brinjal (Solanum Melongena L.) Asian J. Soil Sci., 5(2):291- 294.
15. Narendra, S.. Reena, L. and Vinod, K. P. (2018). Effect of different levels of NPK and vermicompost on chemical properties of maize. Int. J. Chem. Stu., 6:8-11.