ROLE OF SOIL PHYSICAL PROPERTIES AND CHARACTERISATION OF FTIR SPECTRUM USING FARM YARD MANURE

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Abstract

To accomplish organic nourishment for the quickly growing population in India can hold creating purposeful events at fostering the wise use of organic manure in crop productivity, Tenkasi in 2018. This study signifies the endowment of soil characteristics by availing the organic amendment proper organic manure is used to predict the soil productivity at different composition. A field experiment was conducted at Keela Kadayam village, Ambai block, Tenkasi district of Tamil Nadu, South India in 2019 to evaluate the tendency of Farm Yard Manure as organic amendment for the sandy loam clay soil. The experiment was laid out in randomized block design. The aim of the study is to determine the physico-chemical properties and Fourier Transform Infrared (FTIR) spectroscopy of the soil by adding Farm Yard Manure (FYM), Goat Manure (GM) and Compost Manure (CM) at different concentrations and combinations such as 8.5 t ha^{-1}, 12.5 t ha^{-1} and 17.5 t ha^{-1}. The result shows that due to the addition of organic manure there is a strong OH bond absorption and it also confirms presence of mineral and organic components of soil samples.

Keywords: Physical, FITR and organic amendment.

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1 Introduction

Organic farming will increase the small nutrients within the sandy loam clay soil for crop production. The quality of the soil refers to the soils ability to endure production [1]. The techniques such as Infrared Spectroscopic analysis Ultraviolet absorption studies and X-ray diffraction studies are used for mineral analysis [2]. Fourier Transformation Infrared (FTIR) absorption spectra of soil segments hold more information concerning minerals [3]. FTIR Techniques is used to differentiate the various types of clay minerals[4] in soil are kaolinite which is the simplest of all the clay minerals Goat Manure (GM) which is rich nutrients like Nitrogen (N), Phosphorus (P) and Potassium (K) rather than obtaining from Farm Yard Manure (FYM). The Farm yard manure is expected to add nutrients to soil and it also makes a change in the physical properties of the soil. Organic manures enhanced the nutrients uptake, which led to the increase in plant biomass and relative growth rate as compared to the control Hossain etal., (2017)[5].

The main objective of this study is to analyze the mineralogical composition of soil sample with and without organic

manures using FTIR spectral analysis.

2 Materials and Methods

2.1 Experimental Site

The experiment was conducted at Keelakadayam of Tenkasi district which lies in 8.72° latitude and 77.68° longitude during August to November 2019. Rice variety of Ambai-16 (ASD-16) was chosen for cultivation with duration of 110 days.

2.2 Field Area Preparation

The ground was prepared by proper ploughing three times into a fine tilth and manuring before the one month of cultivation. Experiment was laid out in Randomized Block Design (RBD) which is shown in fig 1. Soil samples were collected from the corresponding plots from the depth of 0-30 cm and it was used to study the soil properties.

Fig 1: Randomized block design with organic manure applied plots

2.3 Treatments experimental design and plot size

Thirteen soil treatments were used: A block without organic manure. Farm Yard Manure (FYM), Goat Manure (GM), and Compost Manure (CM) were applied in single manure concentration and also in triple manure concentration which applied @ 8, 12.5 and 16.5 t ha^{-1}. Treatment combinations were organized in RBD Thirteen plots each of 40 m^2 was chosen plants were grown at spacing of 10 cm and 30 cm within rows.

2.4 Sample Collection

From each plot, sample was collected at a depth of 0-30 cm. All the soil samples including control plot were collected and dried at room temperature in open air for two days. Soil samples were stored in polythene bags after grinding well into a fine powder by using mortar and pestle. FTIR spectra was recorded using kBr pellet technique in the region of 4000-500 cm^{-1} using spectrometer for the control plot (T5) and the plot which gave the best yield.ie., T4 of concentration C (Before and after harvest).

2.5 Soil Analysis

The soil samples were collected using V shaped cut at the depth of 15cm, air-dried, ground, mixed passed through 2 mm sieve and analyzed for their physical properties at the soil testing laboratory, Tirunelveli before and after planting

3 Physical Properties - Research Findings and Analysis

3.1 Bulk Density: (BD)

Bulk density is defined as the weight of dry soil per unit volume typically expressed in gm cm^{-3}. Weight of dry soil per unit volume of more compacted soil with less pore space has a higher bulk density. Generally, in sandy loam clay soil's bulk density ranges from 1.55-1.75 gm cm^{-3}.

The bulk density decreased with increased organic manure added at different combinations and concentrations. Bulk density of the soil amended with FYM resulted in low value

when compared to the control plot. In this study the maximum value of B.D was 1.645 gm cm^{-3} found in the control plot. After adding the organic manure the B.D was decreased till 1.502 gm cm^{-3} with the combination of FYM @ 16.5 t ha^{-1} which was 8.69 % less than the control plot. This is similar to Shirani et.al. (2002)[6] Who revealed the effect of Farm Yard Manure application on bulk density of the soil surface (0-15 cm) was significant.

3.2 Particle Density: (PD)

The weight of an individual soil particle per unit volume is called Particle density. Itis usually expressed in units of gm cm^{-3}. Particle densities of the sample of surface soil containing humus in fair quantities are commonly between 2.5 and 2.6 gm cm^{-3}.

The particle density analysis was found to be minimum in the manure combination of FYM + GM+CM @ 12.5 t ha^{-1} with a value of 2.063 gm cm^{-3} which was 19.97 % less than

The control plot which had the maximum value of 2.578 gm cm^{-3}. Similar results were revealed by the studies of Melis (2008) [7] using composted tobacco waste and Farm Yard Manure.

3.3 Water Holding Capacity: (WHC)

Simply defined soil water holding capacity is the amount of water given to the soil which can hold it for crop use. Larger the surface area, it is easier for the soil to hold water so that it has a higher water holding capacity.

The WHC of the soil amended with FYM results had increased values when compared to the control plot. WHC value was increased as 62.41% for the manure combination of FYM+CM @ 12.5 t ha^{-1} which was 86.92% greater than the control plot. This was similar to the result of Jeyamangalam et.al, (2012) [8].

3.4 Pore Space: (P S)

Pore space is defined by the porosity of a material possessing free space between the mineral grains, expressed as percentage (Suganya and Sivasamy et.al., 1996)[9] and depends on size and sorting of the particles as cubic or hexagonic package.

The physical properties like BD, PD, WHC and PS were analyzed by Keen Raczkeowski (KR) box given by Keen et al., (1921).

The pore space was increased as 56.28% and 49.36% in FYM+GM amended plot @ 12.5 t ha^{-1} and 16.5 t ha^{-1} respectively. PS was the maximum as 58.53% in FYM @ 16.5 tha^{-1} which was higher than the control plot with 28.76%. According to Jeyamangalam (2015)[10] the increase of pore space to 14.89% than control plot was noticed in the manure combination of FYM+GM+CM @12.5 t ha^{-1}.

3.5 Yield:

The yield was maximum as 7538 kg ha^{-1} in the most superior treatment with equal combination of FYM+GM+CM @ 16.5 t ha^{-1}. The control plot yield was 800 kg ha^{-1}. It is an unusually hardy food crop, and consequently there is a progressive increase in the use of these grains as a major food staple, especially among subsistence farmers and the rural favorably influenced the soil physical and physico-chemical properties of the soil which in turn paved way for better crop yield and quality. Thus the application of organic amendments in the proper combination may be a good strategy to reclaim the soils and to improve its health[11].

Table 1 : Soil Physical Properties for FYM along with GM and CM(One month after applying manure)

S.No	Manure	Sample	BD gm cm^{-3}	PD gm cm^{-3}	WHC %	PS %	Yield Kg ha^{-1}
1	FYM	T1-A	1.604	2.014	40.62	46.56	5250
2	FYM	T1-B	1.512	2.463	46.46	52.37	4338

3	FYM	T1-C	1.502	2.325	44.57	54.53	3788
4	FYM+GM	T2-A	1.433	1.976	53.58	50.62	2813
5	FYM+GM	T2-B	1.356	2.295	60.15	56.28	3875
6	FYM+GM	T2-C	1.632	2.463	55.02	49.36	4325
7	FYM+CM	T3-A	1.538	2.070	48.43	47.67	3763
8	FYM+CM	T3-B	1.605	2.821	62.47	50.09	5825
9	FYM+CM	T3-C	1.556	2.395	46.57	51.32	6663
10	FYM+GM+CM	T4-A	1.056	2.442	59.25	46.53	4550
11	FYM+GM+CM	T4-B	1.545	2.063	60.41	47.86	3025
12	FYM+GM+CM	T4-C	1.627	2.321	58.26	49.43	7538
13	Control Plot	T5	1.645	2.578	33.42	28.76	800

FYM – Farm Yard Manure, GM – Goat Manure, CM – Compost Manure A - 8.5 t ha^{-1}, B- 12.5 t ha^{-1}, C- 16.5 t ha^{-1} 5298

4 Fourier Transform Infra Red (FTIR) Analysis

Spectroscopy deals with the production measurement and interpretation of spectra using the interaction of electromagnetic radiation with soil matter. Most soil will have a combination of minerals and organic matter so features of both will appear in their spectral studies. Sandy soils appear darker when wet than when dry. This results from decreased reflectance of incident radiation with an increase in moisture content in the visible region of the spectrum. FTIR spectroscopy has been widely used for the characterization of complex organic molecules. Table 2 shows that hydroxyl OH stretching occurs at 3750-3600 cm^{-1}, O-H stretch is highly sensitive to oxide types properties like iron oxides presents in the soil indicates weathering and soil colouring [12]. FTIR spectroscopy measures absorbance of infrared light at frequencies specific to organic matter bond type and excitation upon absorption. Figure 1 shows that FTIR spectrum confirms the presence of basic nutrients N P K in sandy loam soil. Jeyamangalam et al., (2016) [13] reported that the soil nutrient such as N P K increases due to the addition of organic amendments.

The observed absorption peaks along with the assignments and minerals are shown in from all spectra are measured in table 2. The FTIR spectrum of the best yield FYM+GM+CM @ 16.5 t ha^{-1} before and after harvest control plot soil is shown in fig: 2, 3 and 4.

FTIR Spectrum for best yield and control plot

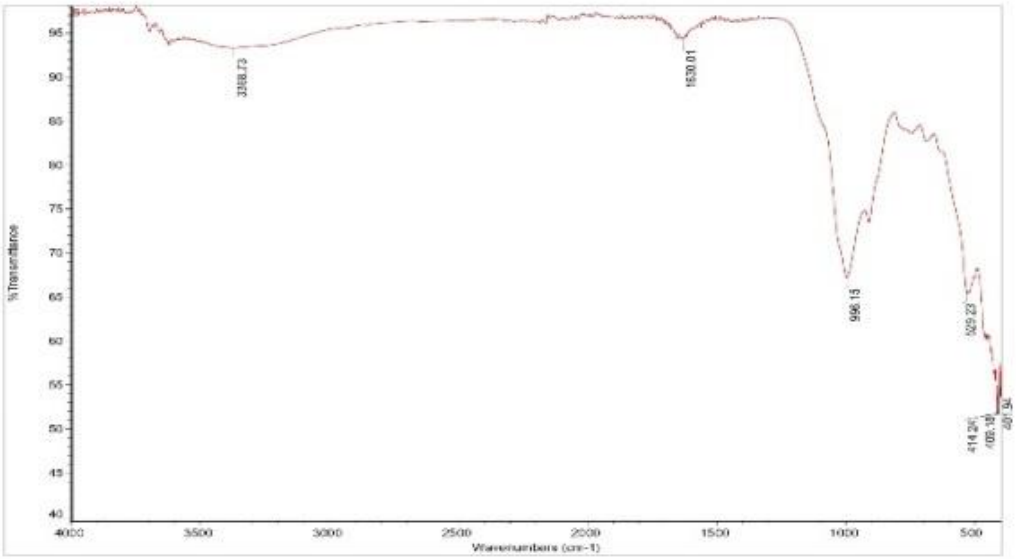

Figure 2: FTIR Spectrum for FYM+GM+CM @ 16.5 t ha^{-1} Before Harvest

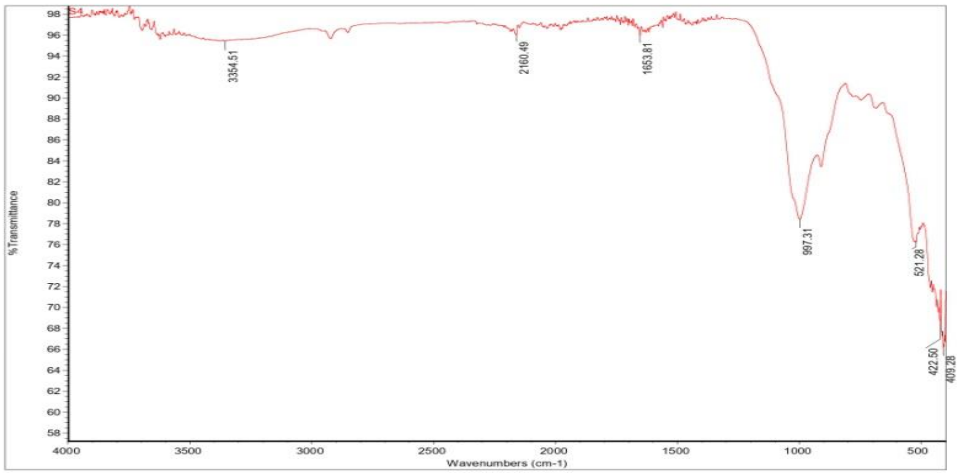

Figure 3: FTIR Spectrum for FYM+GM+CM @ 16.5 t ha^{-1} After Harvest

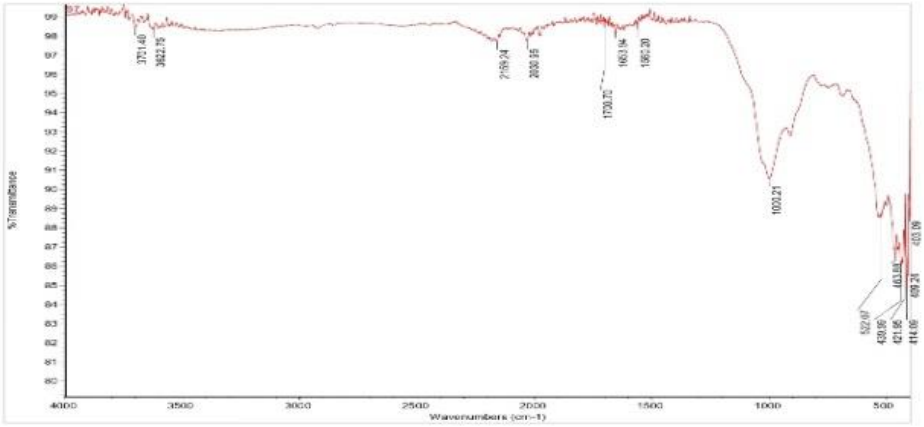

Figure 4: FTIR Spectrum for Control Plot

Table 2: Observed absorption peeks along with the assignments and minerals

Frequency cm^{-1}			Tentative Assignment	Mineral Name	Reference Frequency cm^{-1}
Before Harvest	After Harvest	Control Plot			
3368.73	3354.57	3701.20	OH Stretching vibration of inner hydroxyl group	Kaolinite	3500
1630.01	1653.81	1653.94	C=N Stretching vibration	Organic Carbon	1730
996.15	997.31	1000.21	Si-O Stretching of clay mineral	Kaolinite	1005
529.23	521.28	522.07	Si-O-Si Asymmetric Binding	Feldspar	535
414.24	422.50	421.95	Si-O Microcline	Feldspar	428

4.1 Before organic amendment treatment:

Spectra of soil sample represent the compositions of kaolinite, organic carbon and Feldspar. The strong absorption band peaks are observed at 3368 cm^{-1} indicates the presence of kaolinite [14]. It indicates the possibility of the hydroxyl group (-OH) that is attributed to the stretching vibration in inner surface –OH s and –OH respectively can seen around in absorption peaks of around 3400-3300 cm^{-1}.

Bands at 16.30 cm^{-1} correspond to the C=N stretching vibrations where as 996 cm^{-1} corresponds to the Si-O stretching. The broad absorption band is observed at 996 cm^{-1} represents the Si-O stretching of kaloinite [15]. Vibration observed at 529 cm^{-1} indicates the possibility of the presence of Feldspar and the peak is due to Si-O asymmetric bending vibration. The frequency around 3400 cm^{-1} is due to H-O-H stretching of water molecules present in the interlayer region on Montmorillonite. It is a hydrophilic one, which swells with the absorption of water which greatly increases its volume [16].

4.2 After Organic Amendment Treatment

Soil samples taken from the organic amended plots like T4 (Before and after harvest) were used for the FTIR study. In the after harvest sample, the spectrum indicates the composition of kaolinite organic carbon in appropriate level. A medium absorption band is observed at 3701 cm^{-1}, 1653 cm^{-1} and 522 cm^{-1} indicated the presence of organic carbon and feldspar.

The peaks of resultant spectrum are compared with the published literature [17]. The observed frequency at 1653 cm^{-1} can be explained by C=N stretching. Additionally absorption peak of 997 cm^{-1} is seen in the samples of T4-C both before and after harvest which belongs to Si-O stretching

4.3 Control Plot (Without Manure)

The result indicates the samples of control plot have minerals like kaolinite and organic carbon in the absorption band is observed at 3701 cm^{-1} and 1653 cm^{-1}.

5 Conclusions

FITR provides the molecular resolution of mineral and organic functional groups of soil. In al organically amended plots with FYM, GM and CM the pH electrical conductivity values decreases then control plot. Before and after harvest the electrical conductivity and pH value varies slightly which shows that the soil is in good physico-chemical condition. The yield produced by the soil is also large for the addition of organic manure spectroscopic results too provides details on mineralogical characterization of soil samples.

FITR spectroscopy strongly confirms the presence of organic matter in the sandy loam soil. The results indicate that the samples of control plot have minerals like kaolinite, organic carbon and feldspar. Soil with organically amended samples improves

the organic carbon content along with the minerals present in control plot. The transmittance of IR radiation is more for organic manure which shows that the sunlight easily penetrates into the soil. Additions of organic manure in the sandy loam clay soil increase the water holding capacity.

Therefore a significant variation is obtained in the manure treated soil after harvest. It herewith improves the soil structure and soil aeration. Instead of using chemical fertilizer for agricultural purpose farmers can choose organic manures for higher crop production and health of the soil. Thereby we can reduce the harmful effects of the soil and to the crop.

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