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Short Communication

SPECTROSCOPIC INVESTIGATION OF SOIL TREATED WITH AND WITHOUT ORGANIC MANURES

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ABSTRACT

FTIR analytical study has been carried out to investigate the mineralogical composition of the soil. A field experiment was carried out at Servaikaranmadam of Thoothukudi district, Tamil Nadu during Kharif season in 2018 on sandy clay loam soil to access the effect of organic manures in the soil and to determine the chemical compositions of soil samples. The experiment was laid out in Randomized Block Design (RBD) with three replications. The experiment comprised of thirteen treatment combinations. The results of the present study revealed that soils have various mineral compositions namely Quartz, Kaolinite, Montmorillonite, Feldspar and Illite etc. The application of organic manures like Goat manure (G), Vermicompost (V) and Swine manure (S) in triple manure concentration at 17 t ha^{-1} reveals the presence of Organic Carbon along with the minerals, before and after harvest. This ensures a better yield of black gram (*Vigna Mungo* L.).

Keywords: Mineralogical Analysis, Organic Carbon, Kaolinite, Organic manures.

1. INTRODUCTION

Soils are complex mixtures of minerals, water, air, organic matter and countless organisms that are the decaying remains of once living things. It is considered as the "Skin of the Earth". It is the unconsolidated mineral or organic matter on the surface of the earth which is available as a natural medium for the growth of land plants. The quality of the soil refers to the soil's ability to endure production [1]. The techniques such as Infrared spectroscopic analysis, Ultra-Violet absorption studies and X-ray diffraction studies are used for mineral analysis [2].

X-ray diffraction method is the best characterization tool for identifying crystalline minerals present in soil. Fourier Transform Infrared (FTIR) absorption spectra of soil segments hold more information concerning minerals [3]. With the aspect of mineralogical application, pathologists used this FTIR technique. It is used to differentiate the various types of clay minerals present in the soil. The most widely occurring clay minerals in soil are kaolinite which is the simplest of all the clay minerals [4]. Fertilizers add nutrients like nitrogen, phosphorus, potassium and micro-nutrients but not organic matter. Organic amendments add nutrients as well as organic matter, offering many more opportunities for improvement of soil physical, chemical and biological properties. This can accelerate initial reclamation and lead to self-sustaining net crop production [5]. Organic amendments occur in many forms from manure to bio solids, pulp and paper mill sludge [6].

Goat manure (G) which is rich in nutrients like nitrogen, phosphorus and potassium rather than obtaining from farm yard manure is expected to add nutrients to soil and it also makes a change in the physical properties of the soil. Vermicompost (V) is the end-product of organic matter by earthworms. It contains microsite rich in available carbon and nitrogen. Since Vermicompost improves the microbial activity of soil thereby it also increases the capability of solvability of the nutrients. Swine manure (S) is a good source of nutrients, mainly for vegetable.

The main objective of this study is to analyse the mineralogical composition of soil sample with and without organic manures using FTIR spectral analysis.

2. MATERIAL AND METHODS

2.1. Experimental site

The experiment was conducted at Servaikaranmadam of Thoothukudi district which lies in 8.6970 °N latitude, 78.0502 °E longitude during September to December 2018. Black gram (*Vigna Mungo* L.), variety of Vamban BG (4) was chosen for cultivation with duration of 90 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 for the studies.

Fig. 1: Randomized Block Design with organic manure applied plots

2.3. Treatments, experimental design and plot size

Thirteen soil treatments were used: No manure/ Control (CO), Goat manure (G), Swine manure (S), and Vermicompost (V) were applied in single manure concentration and also in triple manure concentration which is applied @ 8, 12.5 and 17 t ha^{-1}. Treatment combinations were organized in RBD with three replications. Thirteen plots each of 40 m^2 were chosen. Plants were grown at a spacing of 10 cm and 30 cm within rows as shown in fig. 2.

Fig. 2: Black gram crop grown in field

2.4. Sample collection

From each plot, sample was collected at a depth of 0-30 cm. All the samples including control plot soil were collected and dried at room temperature in open air for two days, and then it was stored in polythene bags and grounded well into a fine powder by using mortar and pestle. FTIR spectra are recorded using KBr pellet technique in the region of 4000-400 cm^{-1} using spectrometer for the control plot (T5) , and the plot which gives the best yield, T4 of concentration B (Before and After Harvest).

3. RESULTS AND DISCUSSION

3.1. Before organic amendment treatment

The amendments chosen for the field work and their corresponding doses are given in table 1. 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 control plot soil is shown in fig. 3.

Spectra of soil samples represent the compositions of Kaolinite, Quartz, Montmorillonite, Illite and Feld spar. The absorption band around 3620-3625 cm^{-1} in the spectrum of samples suggests that there is possibility of water hydration in the absorbent. A strong absorption peaks are observed at 3699 cm^{-1} and 3623 cm^{-1} indicates the presence of Kaolinite [7]. It indicates the possibility of the hydroxyl group (-OH) that is attributed to the stretching vibration of inner surface -OHs and -OH respectively can be seen around in absorption peaks of 3600-3700 cm^{-1}.

Bands at 913.97 cm^{-1} correspond to the Al-OH bending vibrations whereas doublet at 780-798 cm^{-1} refers to Si-

O-Si inter tetrahedral bridging bonds. Si-O stretching vibrations seen at 1878.63 cm^{-1}, 796.56 cm^{-1}, 779.36 cm^{-1} and 694.20 cm^{-1} show the presence of quartz in the soil. The broad absorption band is observed at 1035.59 cm^{-1} and 1008.60 cm^{-1} represents the Si-O stretching of kaolinite [8]. Vibration observed at 537.66 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 [9].

3.2. After organic amendment treatment

Soil samples taken from the organically amended plots like T4-B (Before and After Harvest) were used for the FTIR study. The spectrum indicates the composition of quartz, kaolinite, montmorillonite in appropriate level. A medium absorption band is observed at 2925 cm^{-1}, 2853 cm^{-1} indicates the presence of organic carbon content. Fig. 4 and 5 represents the FTIR spectrum of T4-B before Harvest and after Harvest.

The peaks of resultant spectrum are compared with the published literature [10-18]. The observed frequency at 2853 cm^{-1} can be explained by $-CH_2$ symmetric stretching. Additionally absorption peak of 1384 cm^{-1} is seen in the samples of T4-B both before and after harvest, which belongs to $-CH_3$ symmetric stretching.

Table 1: Amendments taken for study along with different concentrations/doses

S. No	Manure	Plots	Dose
1	G	T1	A
2	G	T1	B
3	G	T1	C
4	S	T2	A
5	S	T2	B
6	S	T2	C
7	V	T3	A
8	V	T3	B
9	V	T3	C
10	G+S+V	T4	A
11	G+S+V	T4	B
12	G+S+V	T4	C
13	CO	T5	-

G- Goat Manure S - Swine Manure V- Vermicompost CO - Control
A - 8 t ha^{-1} B - 12.5 t ha^{-1} C - 17 t ha^{-1}

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

Frequency (cm^{-1})			Tentative Assignment	Mineral Name	Reference Frequency (cm^{-1})
T5	T4-B (BH)	T4-B (AH)			
3699.12	3699.21	3699.36	In Plane degenerated vibration of the water molecule	Kaolinite	3692
3623.22	3623.28	3623.36	-OH Stretching vibration of inner hydroxyl group	Kaolinite	3625
3433.83	3434.90	3433.61	H-O-H Stretching of water molecule	Montmorillonite	3445
2925.391	2925.23	2925.27	- CH Symmetric Stretching vibration	Organic Carbon	2926
-	-	2853.69	- CH Symmetric Stretching vibration	Organic Carbon	2856
-	-	2237.96	- CH Symmetric Stretching vibration	Organic Carbon	2230
1878.63	1878.62	1879.26	C-O band	Organic Carbon	1730
1008.60	1008.55	1007.74	Si-O Stretching vibration	Kaolinite	1005
1035.59	1035.34	1035.77	Si-O Stretching of clay mineral	Kaolinite	1035
913.97	913.5	913.71	Al-OH Stretching Vibration	Ilite	916
779.36	779.94	779.99	Si-O Stretching	Quartz	775
694.20	694.57	694.44	Si-O Stretching	Quartz	695
537.66	537.97	538.60	Si-O-Si Asymmetric bending	Orthoclase/Feldspar	535-540
469.26	468.93	469.56	Si-O-Si Asymmetric bending	Feldspar	465-469
432.18	432.87	431.25	Si-O of Microcline	Microcline/Feldspar	432-428

T5 - Control BH- Before Harvest
T4-B - G+S+V AH- After Harvest

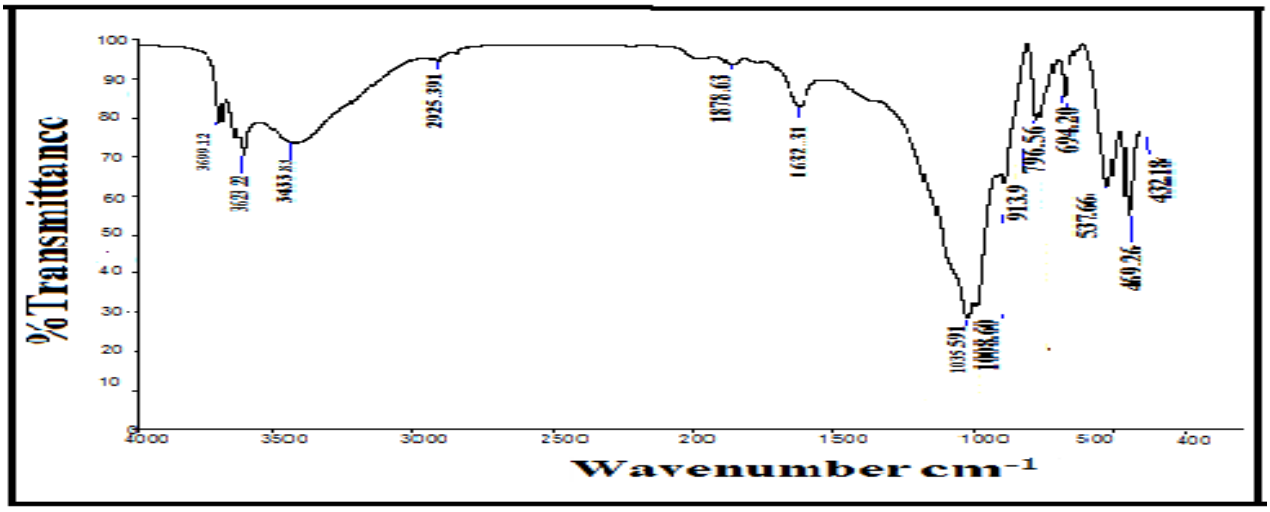

Fig. 3: FTIR Spectrum of the control plot

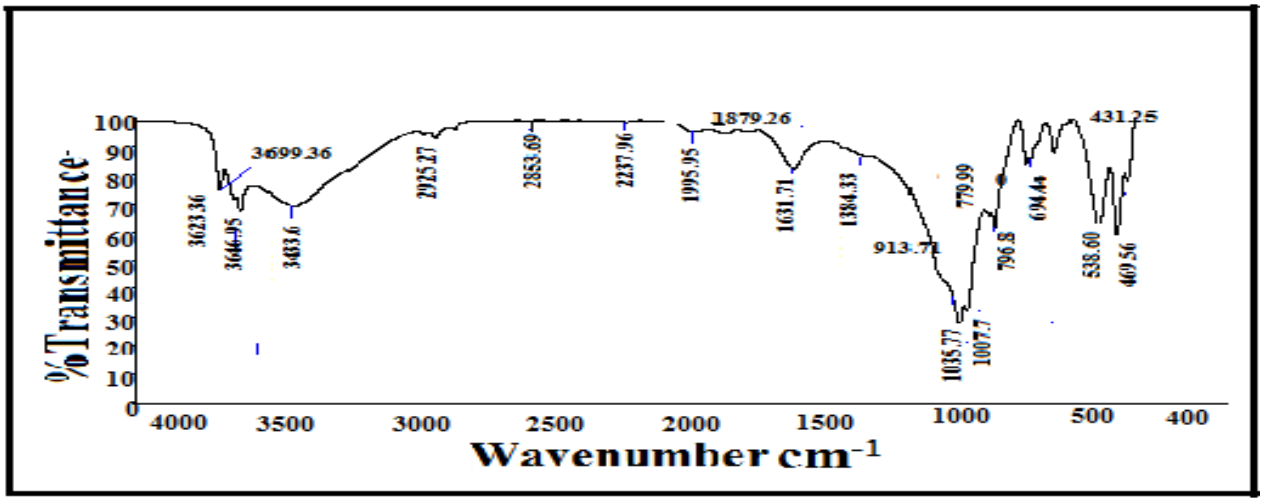

Fig. 4: FTIR spectrum of T4-B before Harvest

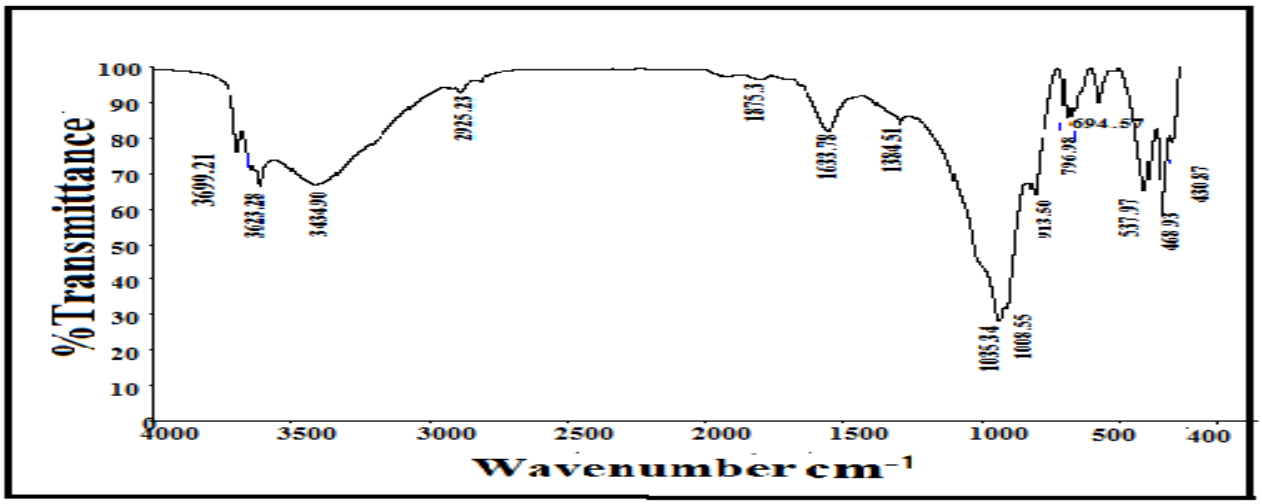

Fig. 5: FTIR spectrum of T4-B after Harvest

4. CONCLUSION

Spectroscopic tool provides details on mineralogical characterization of soil samples. The results indicate that samples of control plot have minerals like Quartz, Kaolinite, and Montmorillonite. Soil with organically amended samples improves the organic carbon content along with the minerals present in control plot. 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 fertilizers for agriculture 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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