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SPECTROSCOPIC CHARACTERISATION STUDY ON ORGANICALLY AMENDED SOIL

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ABSTRACT

A spectroscopic analytical study has been carried out to investigate the mineralogical composition of the soil by amending the organic manure application. For this, a field experiment was carried out with the TKM 9 rice variety planted on sandy clay loam texture soil at Alwanneri village, Tirunelveli district, Tamil Nadu, during the Kharif season in 2020 to ascertain the effect of organic manures on the soil and to determine the chemical compositions of soil samples. The experiment was laid out in a Randomized Block Design (RBD) with three replications and thirteen treatments with three combinations of organic manure. This present work discusses the soil's mineral compositions (i.e. Quartz, Kaolinite, Feldspar, Illite, etc.) and physical properties by varying the applications of organic manures like Farmyard manure (FYM), Vermicompost (VC) and Vegetable Waste Compost (VWC) with manure concentration at 11.5 t ha^{-1} and 17.5 t ha^{-1} to ensure an improved production of TKM 9 crop.

Keywords: Sandy clay loam, mineral composition, TKM 9 –rice variety.

1. INTRODUCTION:

The term "soil" originates from L. solum and has countless definitions. Soil is defined as the product of the weathering of rocks, and it is composed of mineral and organic particles that bear varying sizes and compositions that are relevant to a plant's growth. According to the National Bureau of Soil Survey and Land Use Planning, roughly 30% of the soil in India is of a degraded reserve covering 146.8 million hectares, around 29% of seashore areas, 61% is transferred from one place to another, and 10% is deposited in reservoirs. Soil degradation is caused by natural processes, water scarcity, deforestation and excess usage of chemical fertilizers are the major causes of soil infertility. Traditional organic compost manure has a reasonable amount of macro and micronutrients, capable of reversing the soil fertility. The soil fertility can be preserved using organic manure, followed by crop rotation methods by planting cover crops for several durations. Pest diseases and weeds are managed via physical and biological control systems. Organic livestock is reared without the application of antibiotics and growth hormones. They are also given routine immunization, vitamins and minerals supplementation T.K.Das et.al, [1]. Also, Monawara et.al, [2], reported that the organic amendments treated soil gave better results than the control soil and organic amendments can be used to mitigate the problem of soil salinity. Transitioning from synthetic fertilizers to organic options would further contribute to environmental preservation, Kamaleshwaran and Elayaraja et. al, [3].

India is an agronomical country, where rice is the staple food consumed by a huge number of people. To increase the productivity of the rice crop, it's important to feed the soil with organic amendments without compromising soil fertility and losing land to soil degradation. Currently, organic agriculture is receiving an increase in attention for its potential to enhance production quality also minimizing detrimental impacts on both soil and the environment. To improve this, there are many kinds of manures available, in which each category of organic fertilizers possesses distinct properties among those varieties, vermicompost and farmyard manure being the most prevalent resources that provide essential nutrients for plant growth. Farmyard manure comprises a decomposed amalgamation of cattle faeces, urine, and bedding materials such as straw and litter, along with some residual feed intended for livestock. Dung and urine-soaked waste from the cattle shed are collected daily and dumped into each trench 6-7 metres long, 1 metre deep, 1.5 to 2 metres broad. At an elevation of around 0.5 m above ground level. The heap's top must be shaped like a dome and earth slurry-plastered with cow manure. After three to four months, it is ready for use. This method can produce 7 to 8.5 cubic metres of manure per cow per year Negagrover et.al, [4]. Vermicompost is commonly used in organic farming, since it is rich in nitrogen content it helps to keep the soil healthy. Vermicompost is not harmful to the soil and helps to increase its nutrient content in soil Aman et.al, [5]. This research paper elucidates the synergetic effect of organic manure on soil physical properties and crop yield.

2. MATERIAL AND METHODS

2.1 Characterisation of Soil:

This study uses top soils (0–30 cm) from the field experiment conducted on farmer's agricultural lands in Alwanneri village, Nanguneri Taluk, Tirunelveli district. The field soil is the sandy clay loam which is non–calcerous in nature, where each plot is designed under a randomised block design. The experimental field coordinates coincide at latitude 8.608°, longitude 77.755° and 141 metres height above the sea level. The chosen land was uncultivated for a minimum of 15 years, the field was prepared by proper ploughing into a fine tilth and manure before 30 days of cultivation. The organic compost manure combination with different concentration weightage @ 11.5 t ha^{-1}, 17.5 t ha$^{-1,}$ like farm yard manure, vermicompost and vegetable waste composts, are admixed evenly according to the appropriate combination in each plot except the control plot kept with no manure. The crop used for plantation during the kharif season 2020 in the field is TKM-9, whose growth period is 110 days. The soil samples of before and after harvest are collected randomly from the entire plot area and are preserved in separate polybags, which are used for analysing physical properties like bulk density, particle density, pore space and moisture content.

The collected soil samples are used for FT-IR analysis. The FT-IR methodology is employed to differentiate clay minerals Ojenijl et.al, [6] and to extract data regarding their structural alterations, chemical composition, and identification of functional groups within the molecular structure, whereby such groups oscillate through various modes of stretching and bending.

3. RESULT AND DISCUSSION:

3.1 Bulk density

Soil bulk density is a measure of how tightly packed or dense the soil is and is measured by the mass of dry soil in a unit of volume (g/ml or g/cm^3). To maintain crop productivity of sandy soils, the use of inorganic and organic fertilizers and irrigation are required Kraft et.al, [7]. The mass of soil per unit volume including pore space is known as bulk density.

The results showed that the highest bulk density was recorded in the control at 1.53 g cm^{-3}, which remained the same during the growth period. Then, a gradual decrease was observed in those plots that were amended with organic manures as compared to the control. The minimum bulk density of 1.17 g cm^{-3} and 1.25 g cm^{-3} was recorded in triple and double dosage of organic manure viz, FYM+VC+VWC, FYM+VWC @ 11.5 t ha^{-1} and FYM+VC@ 17.5 t ha^{-1} than the control plot and these are agreeable with Shrirani et.al, [8]. These changes in soil properties result from the influence of manure application, which notably reduces bulk density and amplifies the soil porosity.

3.2 Particle Density

Particle density, also termed as true density, mentions the weight per unit volume of the solid portion of soil and is expressed in g cm^{-3}. The particle density at control plot was 1.84 g cm^{-3} and with the incorporation of organic manure FYM+VC+VWC @ 11.5 t ha^{-1} had a maximum value of 2.70 g cm^{-3}observed at FYM+VC+VWC @ 11.5 t ha^{-1} and 2.67 g cm^{-3} was noted for FYM+VWC @11.5 t ha^{-1} and

2.52 g cm^{-3} was noted in FYM+VWC@17.5 t ha^{-1} with comparison to the control plot. The results are slightly increased compared to Melis et.al, and agreeable with Sasi Punitha et.al, [9, 10].

3.3 Pore Space

Pore space (also called voids) in soil consists of the portion of the soil volume not occupied by solids, either minerals or organic matter. The pore space under normal conditions is occupied at times by air and water. Pore space directly controls the amount of water and air in the soil and indirectly influences plant growth and crop production.

The minimum porosity of 17% was recorded in the control followed by the maximum porosities of 53%, 57% and 47% were recorded for FYM+VWC and FYM+VC+VWC@ 11.5 t ha^{-1} and FYM+VWC @17.5 t ha^{-1} shown in Table-1. The interaction of FYM exerted a positive effect on the accumulation of soil organic matter. This makes a notable increase in soil organic matter, porosity and reduced bulk density. The soil moisture was 16% found low in the control plot whereas the manured plot showed slight increase in soil moisture. This result leans with the findings of Jeyamangalam et.al, [11], in which the addition of organic amendment showed a decrease in particle density in FYM combined plots.

Dosage	Combination	Bulk Density g cm^{-3}	Particle density g cm^{-3}	% Pore Space	% Soil Moisture
11.5 t ha^{-1}	**FYM**	1.42	1.89	25	29
	VC	1.32	1.86	29	29
	VWC	1.40	2.27	38	22
	FYM+VC	1.42	2.33	39	37
	FYM+VWC	1.25	2.67	53	28
	FYM+VC+VWC	1.17	2.70	57	28
17.5 t ha^{-1}	**FYM**	1.46	2.08	30	39
	VC	1.30	2.10	38	39
	VWC	1.38	2.18	37	30
	FYM+VC	1.25	1.86	33	24
	FYM+VWC	1.33	2.52	47	37
	FYM+VC+VWC	1.25	1.83	32	36
Control plot	**No manure**	1.53	1.84	17	16

FYM-Farm Yard Manure VC- Vermicompost VWC- Vegetable Waste Compost
Table- 1: Physical properties of the soil with and without manure condition (after harvest)

3.4 FT-IR analysis of the soil

The soil samples are dried at room temperature, sieved and ground well into a fine powder by using a mortar and pestle. After being well powdered it is used to analyse Fourier infrared spectra for the samples and the spectra are recorded using the KBr pellet technique in the region 4000–400 cm^{-1}. Graphs were plotted by Origin 8.5 software for the control plot and the plot that gives the best yield at before and after Harvest. The FT-IR spectrum of the control, before and after harvest of FYM+VWC @11.5 t ha^{-1} and 17.5 t ha^{-1} were depicted in the Figures [1-5].

The FT-IR spectra of the sample before harvest represent the presence of Kaolinite, Quartz, Illite and Feldspar. The band around 3700 cm^{-1} suggest the possibility of the presence of water of hydration. The peaks around 3709 cm^{-1} and 3689 cm^{-1} were due to the plane degenerated vibration of the associated water molecules. The peaks in the range of 3627 cm^{-1} were due to O-H stretching of inner hydroxyl groups. The new peaks generated around 2980 cm^{-1}, 2359 cm^{-1} and 2341cm^{-1} were due to the organic matter from the farmyard manure and vegetable waste compost which was not present in the control plot. The peaks around 1652 cm^{-1} were attributed to H-O-H stretching frequency of illite. The peaks around 1000 cm^{-1} were due to Si-O Stretching vibration of kaolinite. The peaks around 668 cm^{-1} were due to Fe-O out-of-plane bending frequency of Fe_2OH. The peaks at 526 cm^{-1} and 458 cm^{-1} were due to Fe-O stretching and Al-O deformation of feldspar. The peak around 423 cm^{-1} was due to the Si-O-M stretching frequency from feldspar.

The FT-IR spectra of the sample after harvest represent the presence of Kaolinite, Quartz, Illite and Feldspar. The band around 3700 cm^{-1} suggest the possibility of the presence of water of hydration. The peaks around 3709 cm^{-1} and 3689 cm^{-1} were due to the plane degenerated vibration of the associated water molecules. The peaks in the range of 3629 cm^{-1} were due to O-H stretching of inner hydroxyl groups. The new peaks generated around 2980 cm^{-1}, 2359 cm^{-1} and 2341 cm^{-1} were due to the organic matter from the farmyard manure and vegetable waste compost which was not present in the control plot. The peaks around 1653 cm^{-1} were attributed to H-O-H stretching frequency of Illite. The peaks around 998 cm^{-1} were due to Si-O Stretching vibration of kaolinite. The peaks around 668 cm^{-1} were due to Fe-O out-of-plane bending frequency of Fe_2OH. The peaks at 526 cm^{-1} and 446 cm^{-1} were due to Fe-O stretching and Al-O deformation of Feldspar. The peak around 425 cm^{-1} was due to the Si-O-M stretching frequency from feldspar. The peak of the resultant spectrum is compared with published literature [12-16].

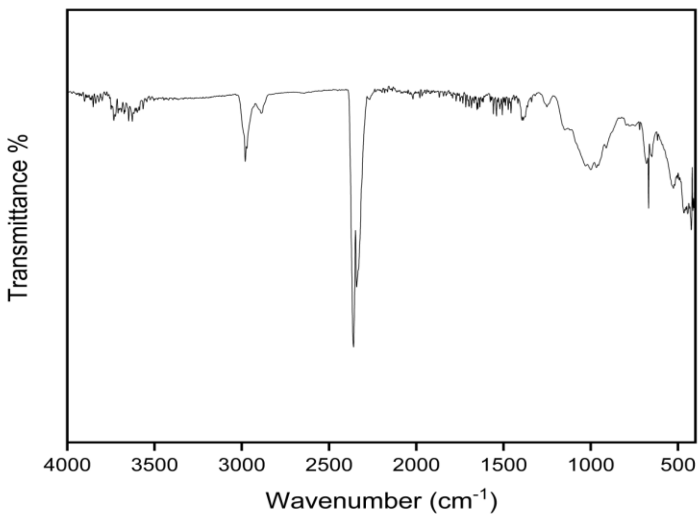

Figure -1: FYM +VWC @ 11.5 t ha^{-1}(before harvest)

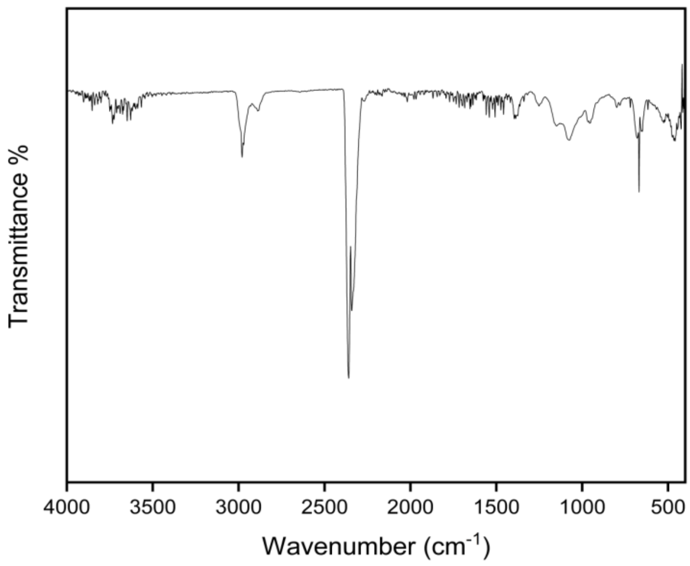

Figure -2: FYM +VWC @ 17.5 t ha^{-1}(before harvest)

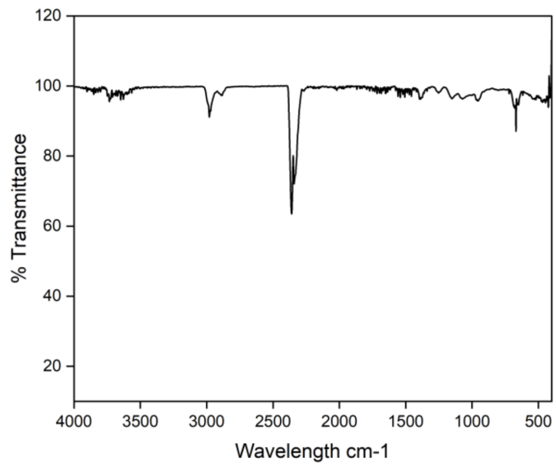

Figure -3: FYM +VWC @ 11.5 t ha^{-1}(after harvest)

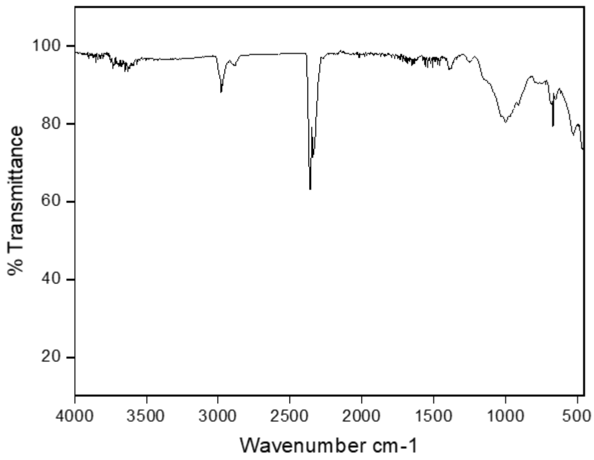

Figure -4: FYM +VWC @ 17.5 t ha^{-1} (after harvest)

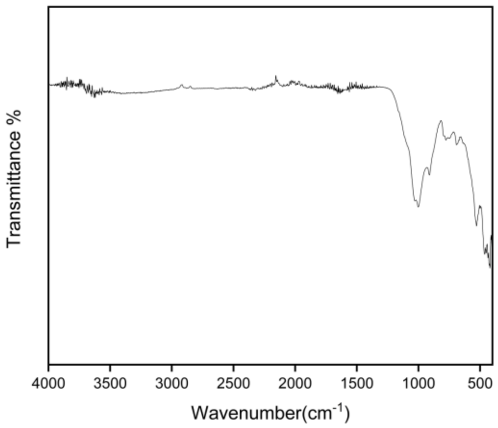

Figure -5: Control plot (without manure)

Figure [1-5]: The Graph represents the best yield plots before and after harvest of FYM+VWC @ 11.5 t ha^{-1}, 17.5 t ha^{-1} over control plot.

4. CONCLUSION:

This study features a positive impact of organic manures which boosts the soil's physical properties and improves particle density, porosity and reduces bulk density. These organic amendments facilitate better crop productivity and retain soil fertility for each cycle of yield. The FT-IR result indicates that the organically amended soil showed improvement in the absorption band with quartz, kaolinite, Illite, feldspar, carbon and minerals present. Compared to the control plot, organic amended soil improves soil structure, moisture retention and better aeration for roots. Therefore, this paper suggests farmers consider organic manure rather than using chemical fertilizers as it helps to preserve soil fertility and improves the harvest quality.

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