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Investigation of physico – chemical, physical properties and moisture content studies of soil using organic amendment

Jeyaseeli, P.[1*], Jeyamangalam, F.[1], Selvaraj, S.[2] and Vella Durai, S. C.[3,4]

[1]Department of Physics, Sarah Tucker College (Autonomous), Tirunelveli-627007, India; [2]PG and Research Department of Physics, The M.D.T. Hindu College, Tirunelveli-627004, India; [3]Department of Physics, JP College of Arts & Science, Agarakattu, Tenkasi-627852, India; [4]Manonmaniam Sundaranar University, Tirunelveli-627012, India.

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Abstract The organic farming custom of crop revolution keeps safety and well-bring attribution of soils. The behavior of soil Physico-chemical properties, physical properties, and moisture content during the organic farming regularity were investigated. The treated soils were analyzed in a soil testing chemistry laboratory. The soil fertility is replenished by improving the physical properties such as bulk and particle densities, water holding capacity, saturated moisture, hydraulic conductivity, pore space, and permeability for suitable organic amendment. Physico-chemical properties of electrical conductivity and pH levels reduced more than the control plot, then the available nitrogen, phosphorus, and potassium are increased. For the amended plot with less pH values, it indicated that the soil was good for farming practices. Organic farming would increase the small nutrients such as nitrogen, phosphorus and potassium within the sandy loam soil for crop production.The observed physical properties such as bulk density, particle density decreased more than the control plot, so that the plants in cultivated soil would better root growth and high crop yields. The water holding capacity, pore space, saturated moisture content, hydraulic conductivity, permeability, and porosity increased more than the control plot. The soil before and after harvest, the physical properties such as the field capacity, wilting point and the moisture content increased more than the control plot.

Keywords: Organic amendment, Soil capacity, Organic farming, Soil physic

Introduction

Organic farming keeps the soil to reuse the energy resources in production and ensure a safe environment. It also protects us from global warming. Organic farming derived from living matter without the use of chemical fertilizers. Organic farming study amends the soil physical properties (Stone and Ekwe, 1995) and supplies the needful things for plant nutrients with high yield (Meek and Husnjak, 1978). Soil structure was decided by the

[*] **Corresponding Author**: Jeyaseeli, P. ;**Email:** jeyaseeli.rkr@gmail.com

physical arrangement of soil samples and pore space between them using the core sampler (John, 2017). The soil physical properties like bulk density dependent on the denser mineral fraction of the soil (Powers, 2015). Bulk density is the mass of dry soil per unit of bulk volume in the air space (Fitzpatrick and Stott, 2013). The particle density of the soil particles is always greater than the bulk density. The sol physical properties can be changed after repeated organic fertile such as organic matter, pH and biological acticities (Yan *et al*., 2013). The maximum organic matter in solis would contain air drainage, water holding capacity to balance the neutral pH, and adapting for high productivity of crop (Inderpal *et al*., 2017). Adding organic amendments increased the high absorption capacity for phosphorus (P) in energy storage and transfer (Xiaoyan *et al*., 2018). Electrical conductivity explains the presence of ions in solution which proportional to soil capacity, and gives the soluble salts in the soil (Rakesh, 2018). Excess amount of salts affect the germination of all crops resulting in much-reduced yield (Bini, 2014). Soil pH slightly increases with soil depth due to accumulation of basic cat ion in cultivated lands (Kizikaya and Dengiz, 2010). The pH of the soil due to Organic manure promising for high crop productivity as reported by Okwuagwu *et al*. (2003). The N, P, K ratio is an important indicator in crops production that identifies balanced and unbalanced fertilization. Nitrogen influences the quality of plants fruit with fruit protein content (Ku and Sangita, 2015). Physico-chemical parameters pH, EC, N, P, K values suggest no pollution effect. The physico-chemical properties of soil reveal the presence of nourishment in the soil; knowing the N, P, K parameters the farmer make use of organic fertilizers in the soil for to increase the percentage yield of crops (Kiran and Chaudhari, 2013). The objective was investigated the soil physical properties responding for the transition from conventional to organic farming. The application of organic amendment was investigated to contribute high yield in to corn crop. The physical properties was also determined the variation of field across the landscape.

Materials and methods

The experiment was carried out at Karisalpatti, Cheranmahadevi Taluk, Tirunelveli district, Tamilnadu, South India in 2018. The experiment was performed in Randomized Complete Block Design (RCBD) with 3 replications. A plot has each like of 5 x 8 metres where chosen in 13 parts. One controlled

plot was taken, without using organic manure. GM was applied at 7.5, 12.5, 17.5 t ha^{-1} in next three plots respectively. The equal combination of GM+FYM(3), GM+VC(3) and GM+FYM+VC(3) was added in selected continue plots. The experiments were laid out in arrangement and corn was planted. The effect of Goat Manure(GM)) with Farm Yard Manure(FYM) and Vermicompost(VC) in different combinations and concentration on soil physical properties were analysed. For the treated soil, the electrical conductivity and pH value were calculated with (1:2.5 - soil water) potentiometry technique given by Jackson (1973). The experiment was preformed in RCBD with 3 replications. Physical properties of soils e.g. water holding capacity, pore space, bulk density etc, are determined using KR box (Keen and Raczkowski, 1921).

Estimation of electrical conductivity

The dry soil samples of 10 grams were collected in in a 50 ml beaker and added 25 ml of distilled water. Those soil suspensions were stirred at regular intervals for 20-30 minutes by magnetic stirrer. The soil suspension was used for estimating by electrical conductivity meter, and standing for sedimentation in 1 hour.

Estimation of pH

The air dried soil of 10 grams was collected in a 50 ml beaker and added 25 ml of distilled water. The sample of soil suspension was stirred for 20 - 30 minutes by magnetic stirrer. pH value was measured by Blackman's glass electrode pH meter after standing for sedimentation in 1 hour..

Estimation of nitrogen

The dry soil samples ofv 10 grams was mixed with 25 ml extraction buffer together with adding 80 mg of $Ca(OH)_2$, 200 mg $MgCO_3$ and activated charcoal. The sample was filtered by whatman filert parer No.1. 10 ml of The filtrate of 10 ml was dried on a hot plate.3 ml of phenol-disulphonic acid was added after cooling to the residue, and kept for 10 minutes before adding 15 ml distilled water. The ice-cold ammonium hydroxide solution of 120 ml was gradually added to defvelop yellow color. The final volume of 100 ml was added distilled water and the optical density was measured at 420 nm using spectrophotometer. The different concentrations of KNO_3 were used for standard curve preparation.

Estimation of phosphorus

The dried soil sample of 2 grams was mixed with 20 ml extraction solution. The mixture sample was shaken for 5 minutes and filtered, then 2 ml filtrate was mixed with 3 ml of 0.8 (M) boric acid, 2 ml distilled water, 2 ml ammonium molybdate solution. The mixture sample was then added 1 ml of freshly prepared stannous chloride solution and used was measure spectrophotometrically at 680 nm. Potassium dihydrogen phosphate (KH_2PO_4) was used for standard curve preparation.

Estimation of potassium

The soil solution contained available K measured by normal ammonium acetate solution in a soil solution at a ratio of 1:5. The extracted available K is estimated by flame photometer.

Results

Electrical conductivity and pH studies

In this present study for GM+FYM+VC amended plot at 12.5 t ha^{-1} the pH was lowest as 6.3 ds m^{-1} which has 10 % less than control plot as shown in the Figure 1 (a). pH value was as high as 7 ds m^{-1} in the control plot. The electrical conductivity value was obtained (Figure 1b) to be minimum in GM+FYM+VC at 7.5 t ha^{-1} and 12.5 t ha^{-1}, GM+FYM at 17.5 as 0.12 which was 47.8 % less than the control plot. The controlled plot had the maximum value of pH as 0.23.

Nitrogen, phosphorus and potassium analysis

The nitrogen values were found to be high in GM plot at 17.5 t ha^{-1} with a value was 265 Kg ha^{-1}, which was 44.3 % higher than the control plot (Figure 1c). For the control plot, the value of nitrogen content was minimum as 147.5 Kg ha^{-1}. The values of phosphorus content were maximum (Figure 1d) at GM+FYM+VC amended plot at 17.5 t ha^{-1} as 32.5 Kg ha^{-1} which was 84.6 % higher than the control plot. The level of potassium was high as 360 Kg ha^{-1} in GM+FYM at 7.5 t ha^{-1} and low as 215 Kg ha^{-1} which was 52.2 % more than the control plot.

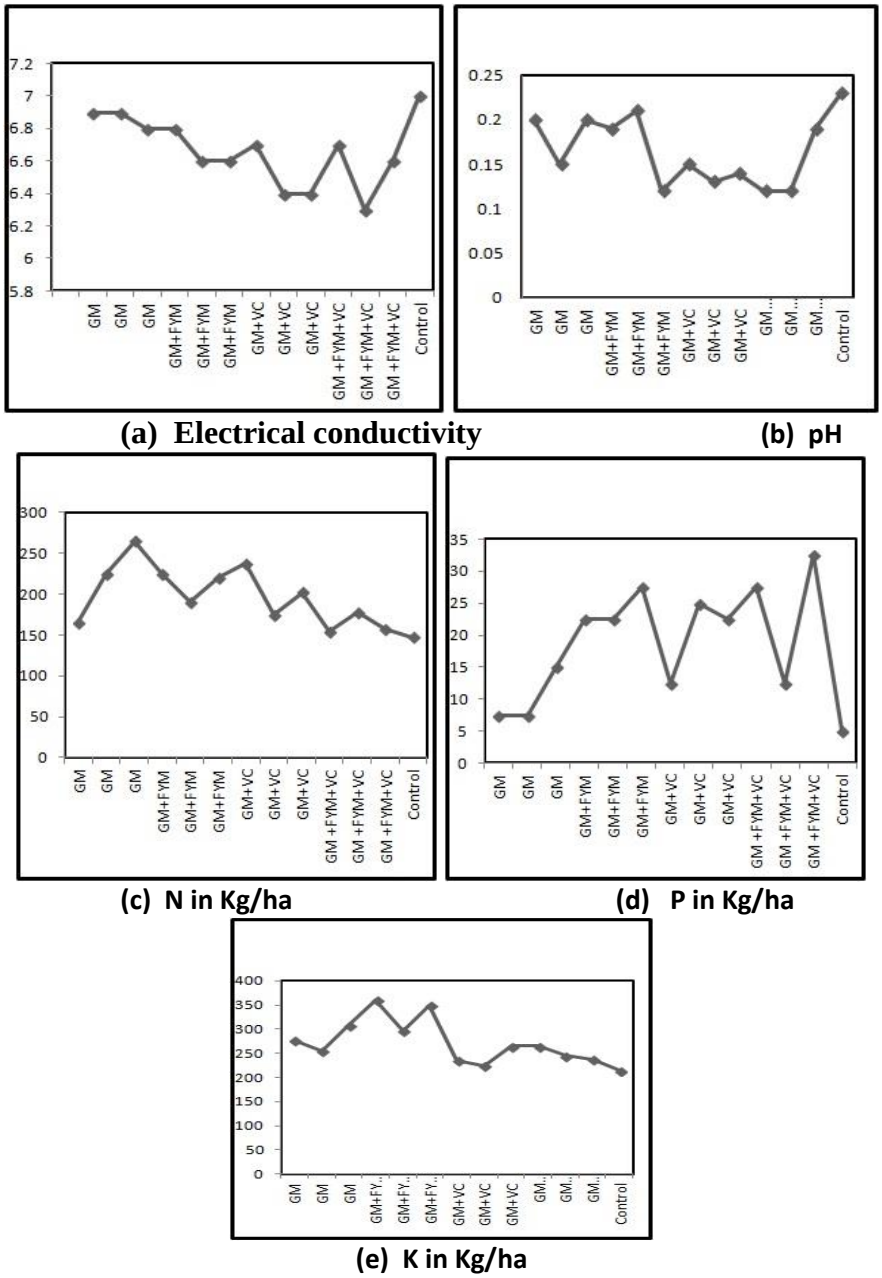


Figure 1. Graphical representation of Physico - Chemical Properties (Before Harvest)

Electrical conductivity and pH studies

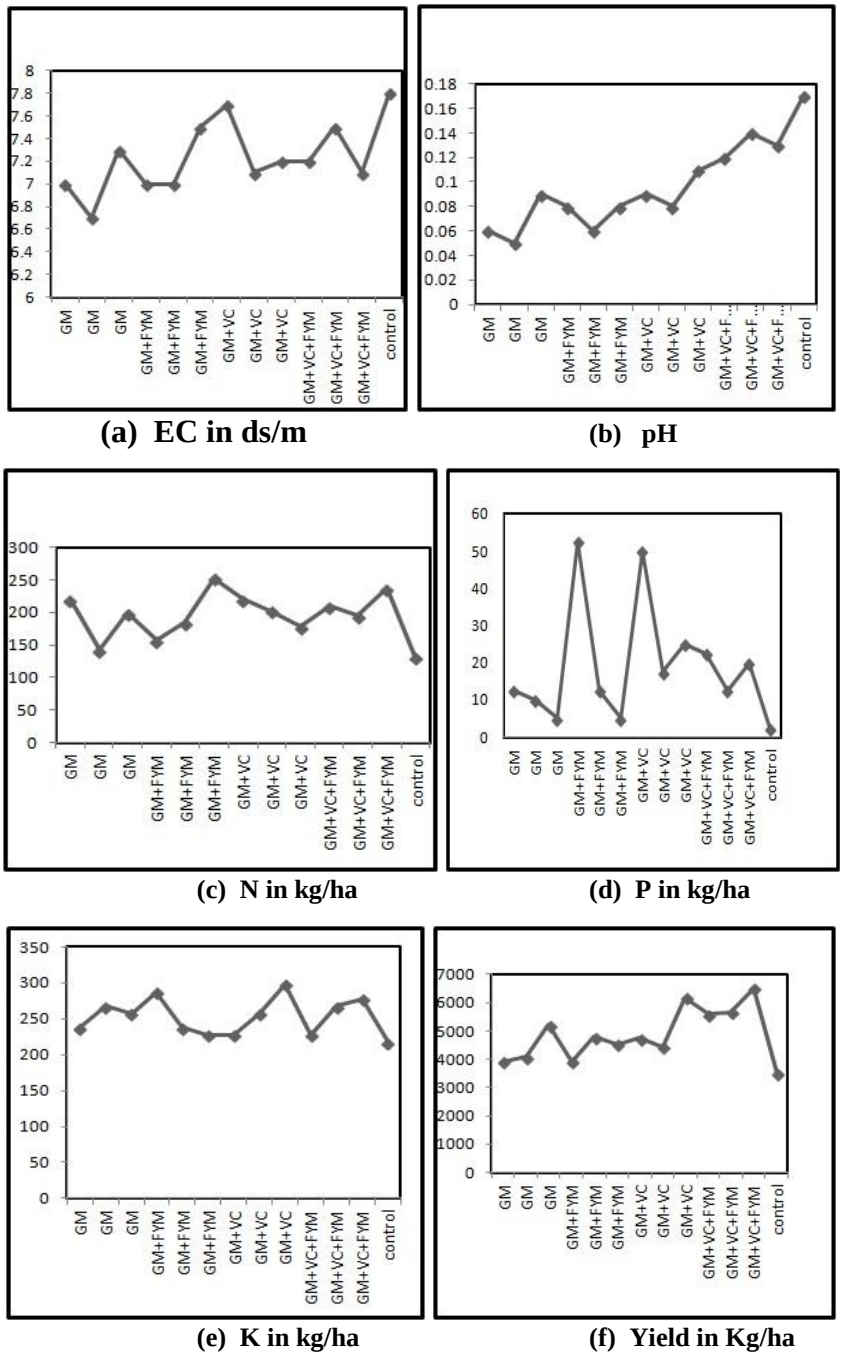
In this study for GM edited plot at 12.5 t ha^{-1} pH showed the lowest 6.7 ds m^{-1} which 14.1 % less than the control plot as shown in Figure 2(a). pH values were maximum as 7.8 ds m^{-1} in the control plot. The electrical conductivity values have obtained to be minimum (Figure 2 b) in GM plot at 12.5 t ha^{-1} as 0.05 ds m^{-1} which was 70.6 % less than the control plot. The electrical conductivity was 0.17 ds m^{-1} at maximum in control plots. The statistical data for the organic treated soil significant resulted in pH studies as the dosage of concentration increased.

Nitrogen, phosphorus and potassium analysis

The nitrogen values were obtained to be maximum (Figure 2(c)) in GM +FYM plot at 17.5 t ha^{-1} with a value of 252.5 Kg ha^{-1}, which was 47.5 % higher than the control plot. As the dosage of concentration increased as 7.5, 12.5 & 17.5 t ha^{-1} in the GM+FYM plots the nitrogen values increased as 157.5, 185 and 252.5 Kg ha^{-1}. For the controlled plot the values of nitrogen content was minimum as 132.5 Kg ha^{-1}. The values of phosphorus content was the maximum (Figure 2 d) at GM+FYM plot at 7.5 t ha^{-1} as 52.5 Kg ha^{-1} which was 95.2 % higher than the control plot. For the controlled plot the values of phosphorus content have a minimum as 2.5 Kg ha^{-1}. The levels of potassium showed as high as 277.5 Kg ha^{-1} in GM+ FYM+VC plot at 17.5 t ha^{-1} which was 39.6 % more than the control plot. For the controlled plot the values of potassium content was minimum as 167.5 Kg ha^{-1}.

Yield studies

The yield was high in the FYM+GM+VC plot at17.5 t ha^{-1} as 6493.5 Kg ha^{-1}, which was 46.2 % more than the control plot. For the control plot, the value of yield was low as 3494.5 Kg ha^{-1}. The yield produced by the soil is shown in Figure 2f. The collected data were statistically analyzed using SPSS software. 'F' test was found significant in organic amended plots as BD (1.241), PD(4.698), WHC(1.062), PS(3.553), SM(1.322), HC(2.729), yield(3.687). The statistical data for the yield was significantly highest in the organic treated soil.



(a) EC in ds/m **(b) pH**

(c) N in kg/ha **(d) P in kg/ha**

(e) K in kg/ha **(f) Yield in Kg/ha**

Figure 2. Graphical representation of Physico - Chemical Properties (After Harvest**)**

Determination of field capacity, wilting point and moisture content using pressure plate apparatus

Pressure plate apparatus is used for measuring soil water retention. Field capacity is the size of soil pore decides the moisture retained in the soil. When saturated soil is subjected to pressure differences across its length, water from the soil drains off until the pores having a diameter corresponding to applied pressure differences and greater, and lose their water moisture contents are measured by heating by an electric oven at105^0C to 110^0C for 8 hours. The loss in weight is reported to be the moisture content of the sample. The field capacity, wilting point and the moisture content increased when compared to the control plot. (ie., without organic manure). The soil before harvest, the physical properties such as the moisture content, wilting point and field capacity values were 9.189%, 3.218% and 5.219% for GM+FYM+VC at 17.5 t ha^{-1} but for the control plot the values were as low as 7.145%, 3.161% and 3.984% . After harvest, the moisture content, wilting point and field capacity values were 8.100%, 3.092% and 5.008% for GM+FYM+VC at 17.5 t ha^{-1}. For the control plot was low value as 6.710%, 3.004% and 3.706 which revealed that the moisture content of soil increased due to the organic amendments.

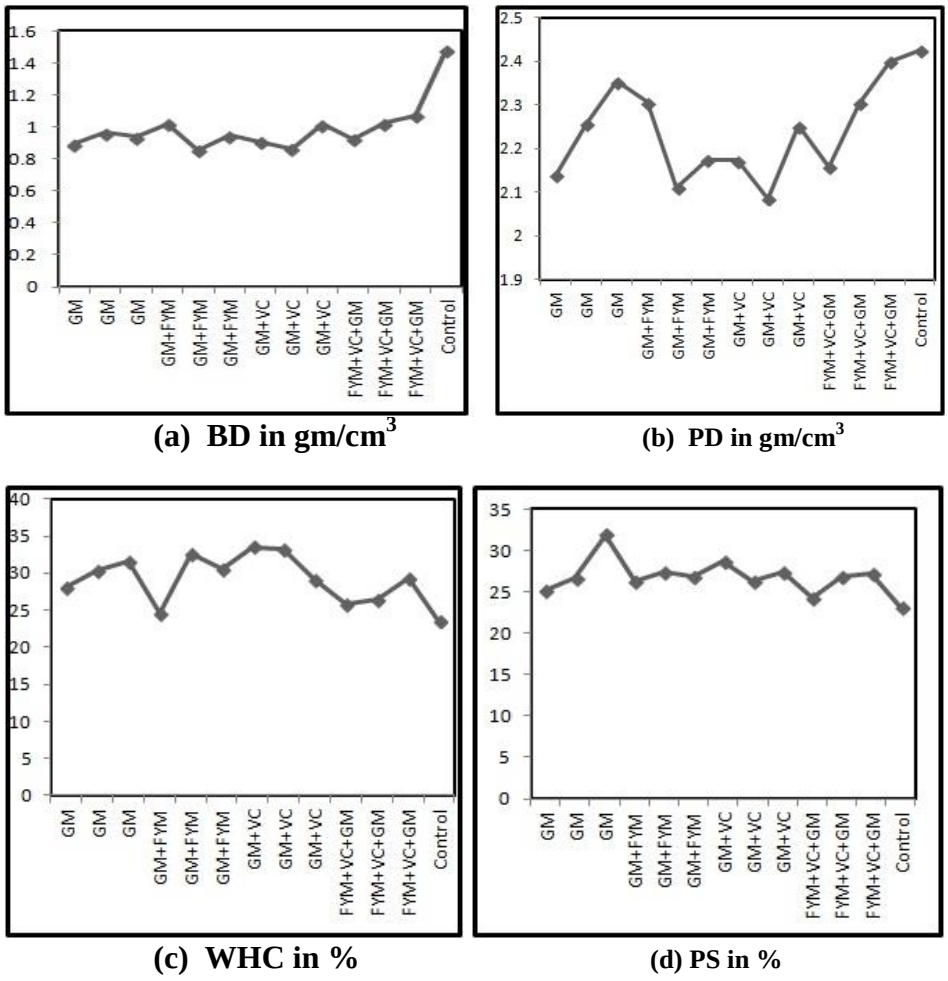
Bulk density (BD), particle density (PD), water holding capacity (WHC) and pore space (PS) analysis

The bulk density of the soil amended with GM result in low values compared to the control plots. In this study for GM+FYM at 17.5 t ha^{-1} as 1.1852 gm/cm^3 has the lowest value, which was 22.94% less than the control plot (Figure 3 a) . The particle density of the soil amended with GM at 7.5 t ha^{-1} as 1.7922 gm/cm^3 was the lowest value of 22.25% which less than the control plot shown in Figure 3b. In this study for GM+FYM+VC at 17.5 t ha^{-1} as 34.7635% showed the highest value (Figure 3 c) of water holding capacity, which was 33.77 % higher than the control plot. The pore space of the soil amended with GM at 17.5 t ha^{-1} as 40.9633% had the highest value which was 12.39% more than the control plot shown in (Figure 3d).

Saturated moisture (SM), hydraulic conductivity (HC), permeability (PE) and porosity (PO) analysis

The saturated moisture of the soil for GM at 7.5 t ha^{-1} was high (Figure 4 a) value as 31.1125%, which was 38.15% more than the control plot. The highest value for hydraulic conductivity obtained at GM+FYM at 7.5 t ha^{-1} and

GM+VC at 12.5 t ha^{-1} as 2.1116 mm/hr which was 13.3% higher than the control plot shown in (Figure 4 b). The highest value for permeability (Figure 4 c) obtained at GM+FYM at 7.5 t ha^{-1} and GM+VC at 12.5 t ha^{-1} as 0.1923 mm/hr, which was 13.04% higher than the control plot. The porosity of the soil amended with GM+FYM at 7.5 t ha^{-1} and GM+VC at 17.5 t ha^{-1} had the high value as 5.1812 cm/hr, which was 7.67% higher than (Figure 4 d) the control plot. The control plot had low value as 4.7845 cm hr^{-1}.



(a) BD in gm/cm^3 **(b) PD in gm/cm^3**

(c) WHC in % **(d) PS in %**

Figure 3. Graphical representation of Bulk Density, Particle Density, Water Holding Capacity and Pore Space (Before harvest)

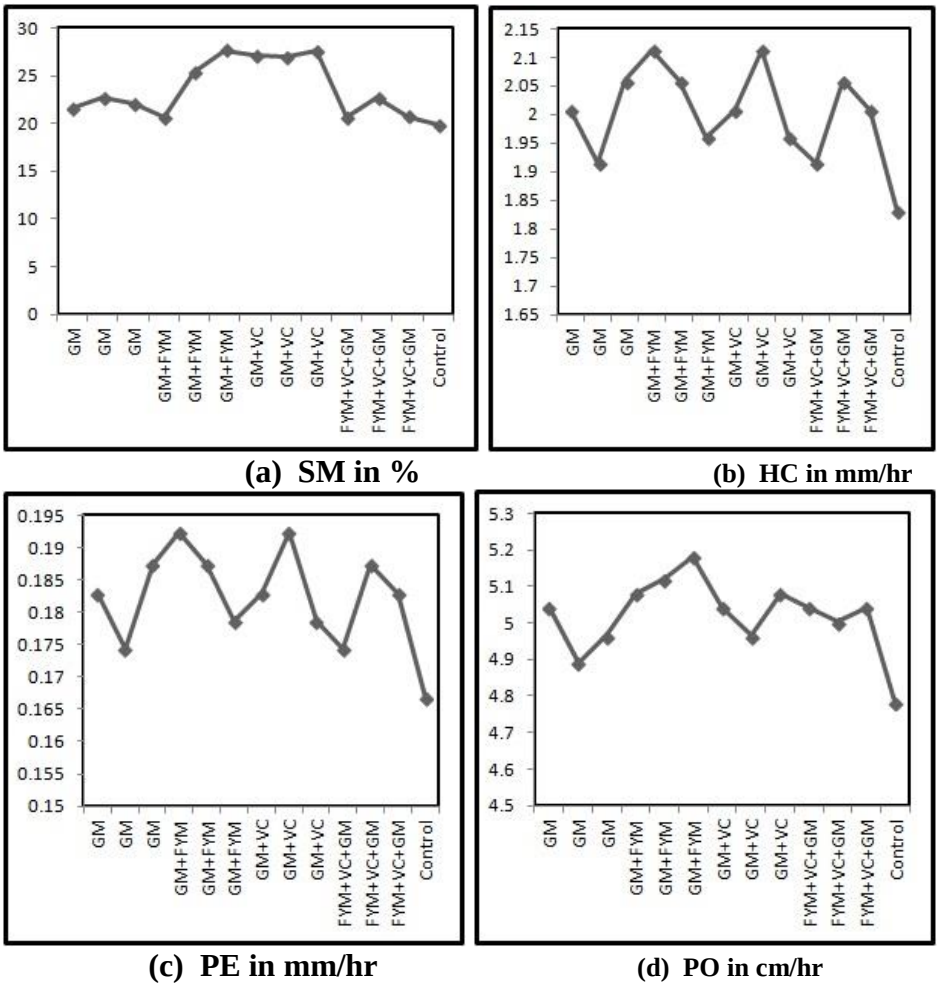
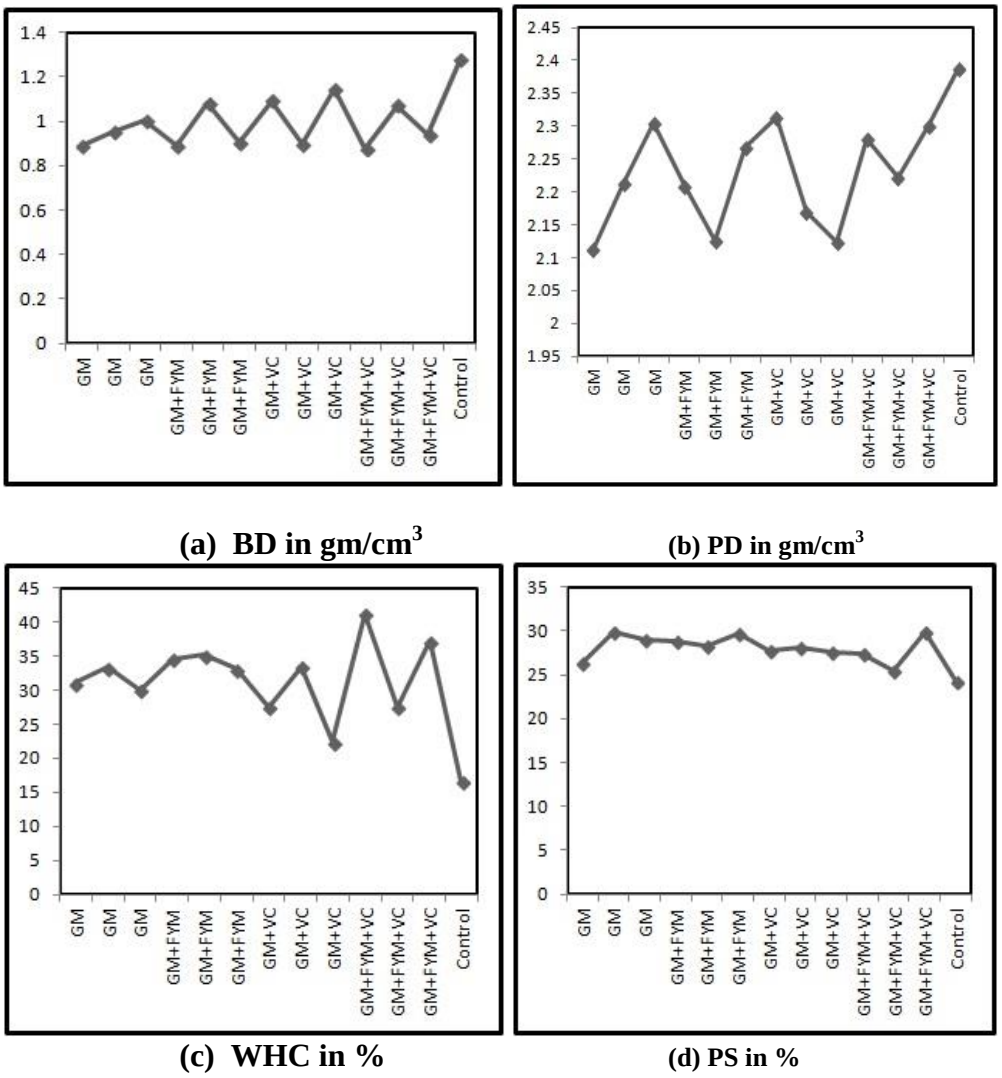


Figure 4. Graphical representation of Saturated Moisture, Hydraulic Conductivity, Permeability and Porosity (Before harvest)

Bulk density(BD), particle density(PD), water holding capacity(WHC) and pore space(PS) analysis

The bulk density of the soil amended with GM+FYM at 7.5 t ha^{-1} as 1.1026 gm/cm^3 had the lowest value (Figure 5 (a)), which was 25.04% less than the control plot. The particle density of the soil amended with GM at 17.5 t ha^{-1} as 1.6943 gm/cm^3 had the lowest value which was 26.04% less than the control plot shown in (Figure 5 b). In this study for GM+FYM+VC at 7.5 t ha^{-1} as 41.1705% had the highest value (Figure 5 (c)) of water holding capacity which was 31.58 % higher than the control plot. The pore space of the soil

amended with GM+FYM+VC at 17.5 t ha^{-1} as 52.6502% had the highest value which was 30.94% more than the control plot shown in (Figure 5d).



(a) BD in gm/cm^3 **(b) PD in gm/cm^3**

(c) WHC in % **(d) PS in %**

Figure 5. Graphical representation of Bulk Density, Particle Density, Water Holding Capacity and Pore Space (After harvest)

Saturated moisture(SM), hydraulic conductivity (HC), permeability (PE) and porosity (PO) analysis

The saturated moisture of the soil for GM+FYM+VC at 17.5 t ha^{-1} had high (Figure 6 (a)) value as 40.9563% which was 51.14% more than the control

plot. The highest value for hydraulic conductivity obtained at GM+FYM+VC at 7.5 t ha^{-1} as 2.1116 mm/hr which was 17.02% higher than the control plot shown in Figure 6 b. The highest value for permeability obtained (Figure 6 c) at M + FYM+VC at 7.5 t ha^{-1} as 0.1923 mm/hr which was 6.76% higher than the control plot. The porosity of the soil amended with GM+FYM at 7.5 t ha^{-1} and 17.5 t ha^{-1} had the high (Figure 6 (d)) value as 5.1209 cm/hr which was 7.91% high than the control plot.

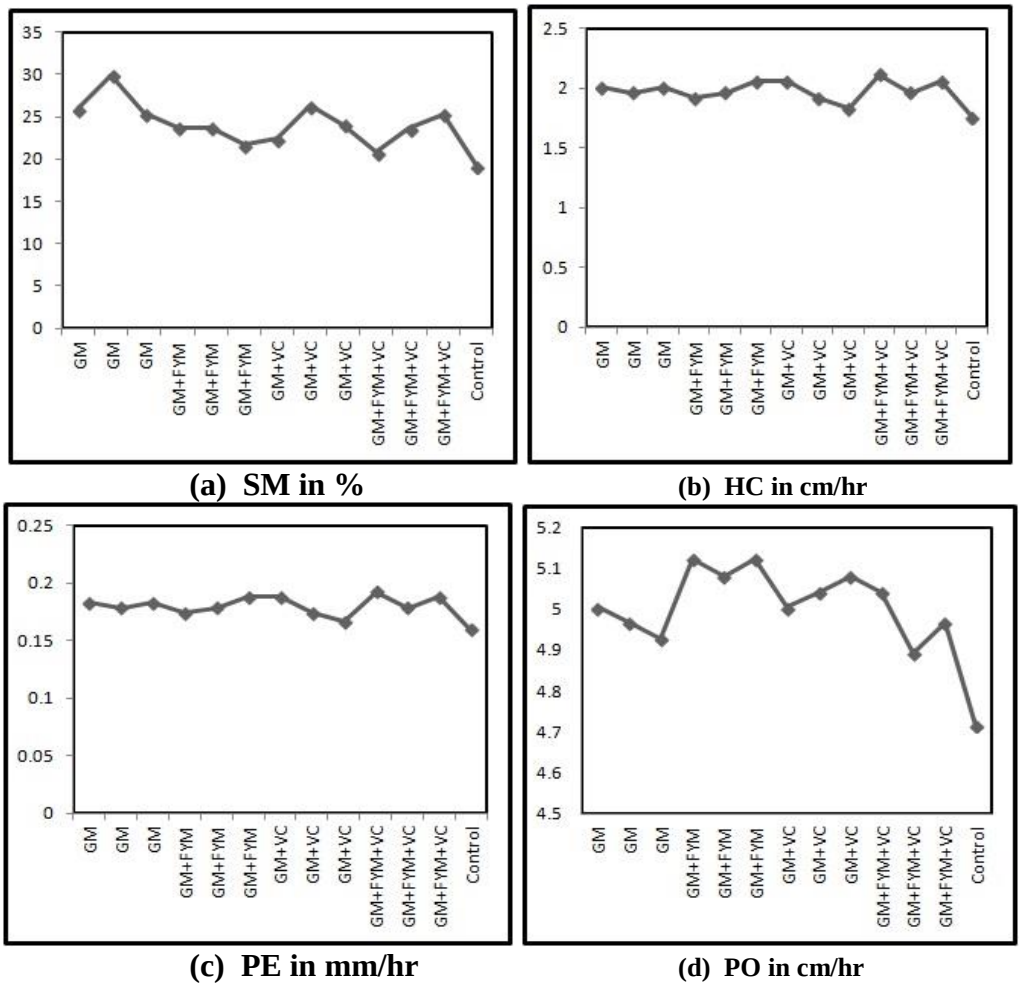


Figure 6. Graphical representation of Saturated Moisture, Hydraulic Conductivity, Permeability and Porosity (After harvest)

Discussion

Physico-chemical properties such as electrical conductivity (EC) and pH values decreased more than control plot and available Nitrogen, Phosphorus and Potassium values increased. Before harvest the pH value was as high as 7 ds m^{-1} in the control plot. The pH value of the organic manure treated sandy loam soil was reduced towards neutral as compared to control soil (Chaudhary *et al.,* 2004). The controlled plot had the maximum value of EC as 0.23 ds m^{-1}. Soils which have high value of EC causes to the instability of soil structure (Javad, 2014). The increase of nitrogen amount in the soil is essential for plant productivity (Saara *et al*., 2019). Sandy loam soil increased the ability to absorb phosphorus on the organic content (Kadhummakkinasir, 2018).

After harvest the pH values were maximum as 7.8 ds m^{-1} in the control plot. The EC values obtained to be minimum in GM plot at 12.5 t ha^{-1} as 0.05 ds m^{-1} which was 70.6 % less than the control plot. The EC has 0.17 ds m^{-1} at maximum in control plots. After harvest the increasing pH values of soil indicated that the high availableness of metals uptake by plant. (Ku and Sangita, 2015).As the dosage of concentration increased as 7.5, 12.5 & 17.5 t ha^{-1} in the GM+FYM plots the Nitrogen values increased as 157.5, 185 and 252.5 Kg ha^{-1}. Incorporation of vermicompost in soil increased the nitrogen availability (Chaudhary *et al*., 2004). The values of phosphorus content have the maximum at GM+FYM plot at 7.5 t ha^{-1} as 52.5 Kg ha^{-1} which was 95.2 % higher than the control plot. Similar results are recorded by Vinod *et al. (*2018). The levels of potassium were high as 277.5 Kg ha^{-1} in GM+ FYM+VC plot at 17.5 t ha^{-1} which was 39.6 % more than the control plot. For the controlled plot the values of potassium content was minimum as 167.5 Kg ha^{-1}. While the potassium per unit of dry matter accumulation increased because plants raised under stress situation grew better with reduced transpiration (Sekhon, 1999). The corn yield is very much higher for VC at 17.5t ha^{-1}as 6686.25 Kg ha^{-1}. Similar results are recorded by Jeyamangalam and Jeyalakshmi (2018).

The physical properties such as bulk density, particle density, water holding capacity, pore space, saturated moisture content, porosity, hydraulic conductivity, permeability are determined. Before harvest for GM+FYM at17.5 t ha^{-1} as 1.1852 gm/cm^3 had the lowest value, which was 22.94% less than the control plot. The particle density of the soil amended with GM at 7.5 t ha^{-1} as 1.7922 gm/cm^3 had the lowest value, which was 22.25% less than the control plot. In this study for GM+FYM+VC at 17.5 t ha^{-1} as 34.7635% had the highest value of water holding capacity, which was 33.77 % higher than the control plot. The pore space of the soil amended with GM at 17.5 t ha^{-1} as 40.9633%

had the highest value which was 12.39% more than the control plot. Similar results are recorded by Balasubramanian (2017).

After harvest the bulk density of the soil amended with GM+FYM at 7.5 t ha^{-1} as 1.1026 gm/cm^3 had the lowest value which was 25.04% less than the control plot. The particle density of the soil amended with GM at 17.5 t ha^{-1} as 1.6943 gm/cm^3 had the lowest value which was 26.04% less than the control plot. In this study for GM+FYM+VC at 7.5 t ha^{-1} as 41.1705% had the highest value of water holding capacity which was 31.58 % higher than the control plot. The pore space of the soil amended with GM+FYM+VC at 17.5 t ha^{-1} as 52.6502% had the highest value which was 30.94% more than the control plot. Similar variations are seen in other physical properties also, which showed that the soil was in good physical condition and it was statistically analyzed using SPSS software. The soil before and after harvest, the physico-chemical, the physical properties such as field capacity, wilting point and the moisture content varies due to the application of organic manure. The amount of water held in the equilibrium condition is a unique characteristic of soil and the response of soil physical properties showing the variation of field across the landscape. Thus, the application of organic amendment helps to increase yield in corn.

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