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PHYSICO-CHEMICAL PARAMETERS OF ORGANIC MANURE, SOIL AND IMPACT OF ORGANIC MANURE AND NPK FERTILIZER ON SEED GERMINATION OF SOYBEAN AND WHEAT

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Abstract:

In order to investigate the comparative analysis of physico-chemical parameters of experimental soil (black cotton soil), vermicompost, farmyard manure and their impact on seed germination, the study was conducted by using Randomized block design (RBD) with three replications at the Department of Botany Govt. Madhav Science P.G. College Ujjain, M.P. The various physico-chemical parameters (pH, electric conductivity, organic carbon, nitrogen, phosphorus, potassium, zinc, copper, iron, and manganese) and seed germination of soybean and wheat were studied in the experiment. The results revealed that pH (7.14), electric conductivity (1.84 ds/m), organic carbon (198.53 g/kg), nitrogen (246.57 kg/ha), phosphorus (55.24 kg/ha), potassium (438.52 kg/ha), zinc (320.13 ppm), copper (289.34 ppm), iron (239.34 ppm) and manganese (248.37 ppm) were found more efficient in vermicompost followed by farmyard manure and soil. The results also revealed that seed germination percentage of soybean was found highest (91%) by using 20% vermicompost followed by 20% farmyard manure (86%), 200 gm NPK (73%) treatment, control (69%) and seed germination in wheat was maximum (93%) in 20% vermicompost treatment followed by 20% farmyard manure (87%), 200 gm NPK (74%) and minimum (70%) in control. The study concluded that vermicompost is nutrient rich and most efficient organic manure than farmyard manure and NPK fertilizer for the better growth and sustainable agriculture of soybean.

Keywords: *Organic manure; NPK; Vermicompost; Farmyard manure; Seed germination.*

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1. Introduction

Soil is a complex mixture of minerals, water, air, organic matter, and a number of organisms that are the decaying remains of once-living things. It forms at the surface of land and is known as the "skin of the earth." It is a dynamic, living matrix that is an essential part of the terrestrial ecosystem. It is a critical resource not only for agricultural production and food security but also towards maintenance of most life processes. Soil is considered a storehouse of microbial biodiversity and activity which plays an important role in soil processes that determine plant productivity.

The understanding of physico-chemical properties of soil or organic manure (vermicompost, farmyard manure) is important because of their effect on nutrient availability to the plants. Many plants need all the essential nutrients for normal growth and completion of their life cycle. Fifteen of the essential nutrients for plants are supplied by the soil system. Of these, nitrogen (N), phosphorus (P) and potassium (K) are referred to as primary or macronutrients. This is because they are required by the plant in large amounts relative to other nutrients and they are the nutrients most likely to be found limiting plant growth and development in soil systems. Calcium (Ca), magnesium (Mg) and sulphur (S) are termed as secondary nutrients because they are less likely to be growth-limiting factors in soil systems. Zinc (Zn), chlorine (Cl), boron (B), molybdenum (Mo), copper (Cu), iron (Fe), manganese (Mn), cobalt (Co) and nickel (Ni) are termed micronutrients because they are found in only very small amounts relative to other nutrients in the plant and they are least likely to be limiting plant growth and development in many soil systems.

"Black Cotton Soil" is popularly known so because of its dark brown colour and suitability for growing cotton. These soils are deficient in nitrogen, phosphoric acid and organic matter but rich in calcium, potash and magnesium.

Fertilizers are organic or inorganic materials of natural or synthetic origin that are added to soil to supply one or more nutrients essential for the growth of plants. Organic manure or organic fertilizers are fertilizers derived from animal or plant matter (e.g. compost, manure etc). Manure is any organic substance that is added to the soil to increase its fertility and for enhancing plant growth (Boller and Hani, 2004). The word manure came from Middle English "manuren" meaning "to cultivate land". Organic farming (organic agriculture) is an oldest farming practice and has gained importance early in the 20th century in order to reduce the use of chemical fertilizers because of their toxic effects.

Organic manure (vermicompost, farmyard manure) is becoming an important component of environmentally sound agriculture. Recently, the use of organic materials as fertilizers for crop production has received attention for sustainable crop productivity (Arif et al., 2014). Organic manure act not only as a source of nutrients and organic matter, but also increase size, biodiversity and activity of the microbial population in soil, influence structure, nutrients get turnover and many other changes related to physical, chemical and biological parameters of the soil (Albiach et al., 2000). Nutrients contained in organic manure are released slowly and are stored for a longer time in the soil, thereby ensuring a longer residual effect and persistence of nutrient availability. Residual nature of organic sources makes them more value based for the whole system compared to individual crops (Arora and Maini., 2011). The judicious applications of organic manures not only improve the productivity but also make cultivation of crops more sustainable (Tiwari et al., 2002).

One of the fastest and effective ways to recycle the organic materials is vermicomposting, which is an eco-biotechnological process that transforms energy rich and complex organic substances into stabilized humus like end product (vermicompost) by the joint action of earthworms and microorganisms. In vermicomposting, the capacity of feeding and excretion of earthworms is exploited to degrade organic materials and convert it into high grade manure i.e. vermicompost. Vermicompost is rich source of macro- and micro-nutrients, vitamins, enzymes, antibodies, growth hormones and immobilized microflora (Bhawalker, 1991). Carbon present in soil is in the form of organic matter. Organic matter concentrations have been proved to enhance the yield and yield components of crops as well as soil aeration, soil density and maximizing water holding capacity of soil for seed germination and plant root development (Zia et.al., 1998).

Soybean (Glycine max L.) and wheat (Triticum aestivum L.) are the two very important crops grown in the state of Madhya Pradesh. Soybean is known as "Golden bean" or "Miracle crop" of 20th century as it is the richest source of protein and oil. The approximate biochemical composition of Soybean is 40% to 45 % of proteins, 18% to 20 % of edible oils, 24% to 26% of carbohydrates and good amount of vitamins (Kaul and Das, 1986). Wheat is the most important cereal crop and is highest in production of all the crops grown on more land area than any other commercial food crop in the world. The approximate biochemical composition of the crop is 66-71.6% carbohydrates, 13-16.7% proteins, 2.5-3.1% fats, 2.5-3% crude fibre (Khan, 1984).

The study of physico-chemical properties is very essential because the quality (fertility) of soil or organic manure (vermicompost, farmyard manure) can be determined by studying these properties of that substance. All agricultural productions depend upon the physico-chemical parameters of the soil used for it. So taking the above facts under consideration the study was done to investigate the physico-chemical parameters of soil, vermicompost, farmyard manure and to see their comparative impact on the seed germination of soybean and wheat.

2. Material and Methods

The research work was carried out under field conditions at the "Botanical Garden" of Govt. Madhav Science P.G. College, Ujjain (M.P.).

Selection of Soil: The type of soil used in the present study was black cotton soil.

Selection of Organic Manure: The organic manure used was Vermicompost (VC)- cowdung Vermicompost and Farmyard manure (FYM).

2.1. Physico-Chemical Parameters

The various physico-chemical parameters studied in the present investigation are;
pH: It was performed according to the method proposed by Jackson (1967).
Electric conductivity (EC): (According to Jackson, 1967)
Organic carbon (OC): (According to Walkley and Black, 1934)
Nitrogen (N): (According to Saxena, 1989)

Phosphorus (P), Potassium (K), Zinc (Zn), Copper (Cu), Iron (Fe) and Manganese (Mn): These were performed according to the method proposed by APHA, AWWA, WPCA (1998) and Saxena (1989).

2.2. Seed Germination

It was performed under laboratory conditions and by using petriplates. Moreover the germination percentage was calculated by dividing the total number of seeds sown to the total number of seeds germinated multiplied by hundred (100).

Treatments of organic manure and NPK fertilizer used for the seed germination of Soybean and Wheat;
20% Vermicompost (VC) = 80% Soil + 20% VC
20% Farmyard manure (FYM) = 80% Soil + 20% FYM
200 gm NPK added in 1 m2 of soil.

3. Results and Discussion

3.1. Physico-Chemical Parameters of Soil, Vermicompost (VC) and Farmyard Manure (FYM);

The results related with physico-chemical parameters are given in table 1 and graphically shown in figure 1.

3.2. pH

The pH is a numeric scale which is used to identify the acidity or basicity of a particular medium. It can be defined as the negative log to the base 10 of the H+ ion concentration. The pH of the field soil samples was recorded as 7.60 while in case of farmyard manure pH was 7.43. However in the vermicompost it was observed as 7.14.

The results revealed that there was no significant difference in pH value between soil, VC and FYM. The decrease of pH towards neutral is an important factor to be considered influencing retention of nitrogen (Haimi and Huhta, 1987). Ramalingam (1997) reported that the earthworm casts are found to be more neutral than the soil in which the earthworms live.

Moreover the occurrence of neutral pH in the organic manure (vermicompost, farmyard manure) might have been because of the production of CO2 and organic acids by the microbial activity during the process of bioconversion of the different substrates in the beds (Haimi and Huhta, 1987).

The study revealed that in case of vermicompost pH was more towards neutral than recorded in farmyard manure and soil. Furthermore pH governs the distribution of minerals (nitrogen) in the soil.

3.3. Electric Conductivity

Electric conductivity (EC) is the measurement of total amount of soluble salts present in the sample. It was found 1.84 ds/m in the vermicompost while it was observed 1.63 ds/m in farmyard manure. However in case of soil it was recorded 0.42 ds/m.

Electrical conductivity is a very important indicator of concentrations of soluble salts. The results revealed that organic manures (vermicompost, FYM) contain more soluble salts (EC) than soil. The more electric conductivity in the vermicompost as compared to farmyard manure and soil (control) might be due to the presence of more exchangeable calcium, magnesium and potassium in worm casts than the soil (Bhatnagar and Palta, 1996). Moreover the results are in agreement with the findings of Balamurugan et al., (1999), Bhatnagar and Palta (1996) and Balamurugan (2002) who reported that high concentration of dissolved salts in the vermicompost than the soil and farmyard manure. Moreover the well rotten farmyard manure acts as a nutrient reservoir and produces organic acids, thereby absorbed ions are released slowly during entire crop growth period.

3.4. Organic Carbon

It was recorded maximum (198.53 g/kg) in the vermicompost followed by 196.46 g/kg in farmyard manure and was found least (5.63 g/kg) in the soil samples.

Microorganisms present in the organic manure (vermicompost, farmyard manure) have the capability of utilizing carbon as their energy source and nitrogen for growth during the process of decomposition of organic materials in which carbon gets released as CO2. According to Bhatnagar and Palta (1996) during the process of respiration in earthworms the process of combustion of carbon into CO2 brings down the amount of carbon in the organic material. The respiration of earthworms and growth of microorganisms in the vermicompost may be the reason for the reduction of organic carbon from its initial value in the organic material. The earthworm casts has considerably more organic carbon than the parental soil and the casts are significantly richer in polysaccharides than the soil (Bhandari et al., 1967). Hence it could be concluded that the organic carbon present in the organic manure (vermicompost, farmyard manure) is the main source of energy for the microorganisms, plants and soil aggregates.

3.5. Macro-Nutrient Analysis

3.5.1. Nitrogen (N)

It was observed maximum (246.57 kg/ha) in case of vermicompost followed by 233.46 kg/ha in farmyard manure and was least (95.62 kg/ha) found in the soil.

The presence of higher nitrogen content in the vermicompost than the other organic materials (manures, composts or soil) is in agreement with the findings of Dash and Patra (1979), Curry et al. (1992), Ramalingam (1997) and Balamurugan (2002) who explored that there is considerable increase in the nitrogen content in the vermibeds during different stages of vermicomposting. Edwards and Lofty (1977) reported that out of the total nitrogen excreted by earthworms, about another half is secreted as mucoproteins by gland cells found in the epidermis, and half in the form of ammonia, urea and possibly uric acid in a fluid excreted from the nephridiopores. Moreover the casts of earthworms are reported to contain more nitrogen than the surrounding soil (Graff, 1971; Dash and Patra 1977). The increase of nitrogen content in the vermicompost is reported to be due to the addition of muco-proteins secreted from the body wall of the earthworms (Lee, 1985). Furthermore, Blair et al., (1997) revealed that increase in the nitrogen content by the earthworm might be due to the reduction in the microbial immobilization. Farmyard manure contains excess amount of nutrients, such as nitrogen, that are trapped by bacteria in the soil.

3.5.2. Phosphorus (P)

The phosphorus content was found more i.e.55.24 kg/ha in the vermicompost than the farmyard manure where it was found 50.16 kg/ha. However it was recorded minimum (7.63 kg/ha) in the soil.

The uptake of bacteria, fungi and other microorganisms by the earthworms, excretion and decomposition by the earthworms and microorganisms might be the reason of releasing and increasing the content of phosphorus compounds in the vermicompost (Coleman et al., 1983). The phosphorus content is reported to be present more in the worm castings than the field soil (Lunt and Jacobson, 1944; Graff, 1971). Almost 15-30% extra phosphorus is made available to plants by worm activity (Bhatnagar and Palta 1996). Jambhekar (1992) reported that the vermicompost prepared from the cow dung contained higher level of phosphorus compared to the farmyard manure and soil.

3.5.3. Potassium (K)

It was recorded maximum (636 kg/ha) in vermicompost followed by farmyard manure where it was found 596 kg/ha. The least potassium content i.e. 145 kg/ha was recorded in the soil. The presence of higher content of potassium in the organic manure (vermicompost, farmyard manure) than the soil is reported in several studies. Gunjal and Nikam (1992) reported that water-soluble potash of grapevine increased more than 8.4 times in vermicompost over control. There is considerable increase in the available potassium than during the decomposition of different organic material (cow-dung, animal residues and agricultural wastes) than the field soil (Jambhekar, 1992). Similar findings were also reported by Graff (1971), Nijhawan and Kanwar (1952), Watanabe (1975), Buchanan et al., (1988) and Ramalingam (1997).

3.6. Micro-Nutrient Analysis

3.6.1. Zinc (Zn)

In vermicompost zinc content was found maximum (320.13 ppm/ha) followed by farmyard manure where it was found 291.52 ppm/ha. It was observed least (39.47 ppm/ha) in the soil.

3.6.2. Copper (Cu)

Maximum copper content i.e. 289.34 ppm/ha was recorded in vermicompost followed by 273.53 ppm/ha in farmyard manure. However copper content was found least (96.24 ppm/ha) in the soil.

3.6.3. Iron (Fe)

In vermicompost iron content was found 239.24 ppm/ha and was recorded more than the farmyard manure where it was observed 212.34 ppm/ha. It was found minimum (29.26 ppm/ha) in the soil.

3.6.4. Manganese (Mn)

It was found maximum (249.37 ppm/ha) in vermicompost followed by farmyard manure where it was observed 214.15 ppm/ha. Manganese content was recorded minimum (68.31 ppm/ha) in the soil.

The presence of more amount of micronutrients in the vermicompost than the farmyard manure and soil might be due to the release of the excess amount of micronutrients and heavy metals from the earthworm body into the environment through the calciferous glands. Ireland (1975) suggested that the chemical changes that occur in the alimentary tract of earthworms might facilitate various minerals (Zn, Cu, Fe, Mn, Ca, Pb, etc) more readily available to plants and mineralization of dead earthworms would release accumulated heavy metals into the environment. The earthworm cast contains excess amount of various micro-nutrients as compared to the other organic materials (termite mould, gallery, cow-dung etc) (Reddy and Dutta, 1984). Bouche (1983) reported that the presence of ionic regulatory mechanism in the earthworms is responsible for the uptake of Fe, Mn and other metals from ingesta and its excretion through the calciferous glands. Similar observations were also reported by Ash and Lee (1980), Mba (1983). Anderson and Laursen (1982) observed the excretion of Zn, Mn, Cu and Fe through the calciferous glands of the earthworms. Same findings were also reported by Ramalingam (1997) and Balamurugan (2002).

4. Conclusion

The present study concludes that organic manure (vermicompost, farmyard manure) is rich in organic carbon and contains more supply of both macro and micro nutrients than the soil. Vermicompost is nutrient rich organic fertilizer than farmyard manure that contains sufficient amount of dissolved salts (minerals) and optimum pH for the better seed germination, plant growth and best fertility and quality of soil.

Table 1: Physico-chemical parameters of Soil, Farmyard manure (FYM) and Vermicompost (VC)

Type of Material	pH	EC (ds/m)	OC (g/kg)	N (Kg/ha)	P (kg/ha)	K (kg/ha)	Zn (ppm)	Cu (ppm)	Fe (ppm)	Mn (ppm)
Soil	7.60 ±0.19	0.42 ±0.02	5.63 ±0.34	95.62 ±1.67	7.63 ±0.94	146.53 ±2.45	0.59 ±0.06	3.88 ±0.21	2.87 ±0.13	2.46 ±0.16
Farmyard manure (FYM)	7.43 ±0.16	1.63 ±0.04	196.46 ±1.13	233.46 ±1.16	50.16 ±1.10	396.37 ±2.64	291.52 ±1.47	273.52 ±1.52	212.34 ±1.44	214.15 ±1.62
Vermicompost (VC)	7.14 ±0.12	1.84 ±0.02	198.53 ±0.92	246.57 ±0.85	55.24 ±0.91	438.52 ±2.04	320.13 ±1.16	289.34 ±1.41	239.24 ±1.51	248.37 ±1.24

EC = Electric conductivity, OC = Organic carbon. Value given in each cell of the table is mean value; ± sign denotes standard deviation (SD)

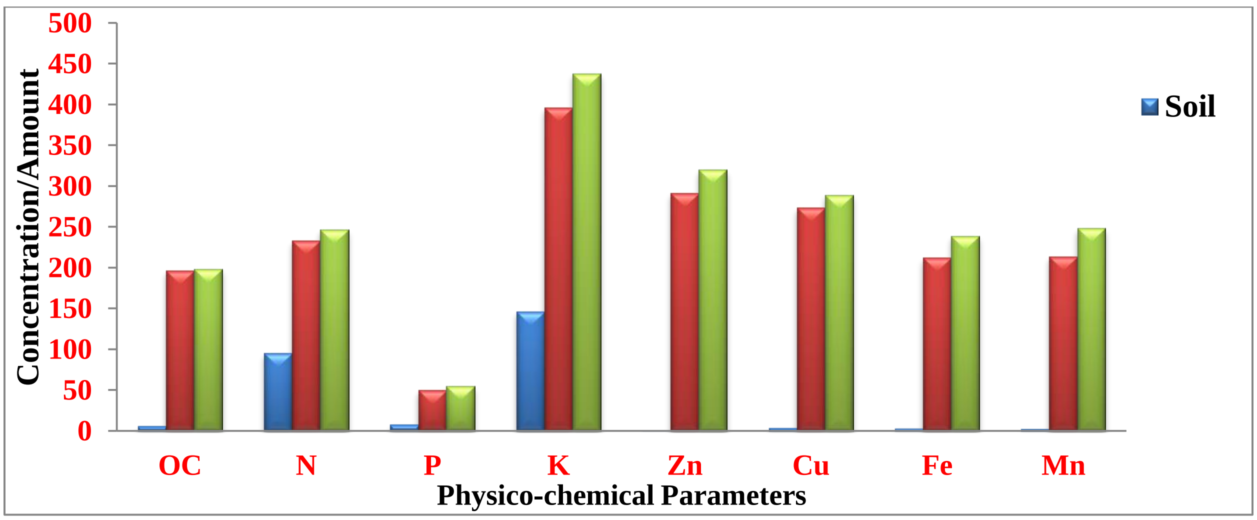

Figure 1: Physico-chemical parameters of Soil, Farmyard manure (FYM) and Vermicompost (VC)

5. Effect of Vermicompost (VC), Farmyard Manure (FYM) and NPK Fertilizer on the Seed Germination of Soybean and Wheat

The results related with seed germination are given in table 2 and graphically represented in figure 2.

5.1. Soybean

The results revealed that seed germination percentage was maximum (91%) found in 20% VC followed by 20% FYM (86%), 200 gm NPK (73%) and minimum (69%) recorded in control.

5.2. Wheat

Seed germination was highest (93%) in 20% VC followed by 20% FYM (87%), 200 gm NPK (74%) and minimum (70%) in control.

The experimental results revealed that seed germination is increased on the application of fertilizers than the control ones. The applications of organic manure (VC, FYM) are more beneficial than chemical fertilizer (NPK) for the seed germination and seedling emergence of soybean and wheat. Among all the fertilizers vermicompost is most suitable for seed germination and seedling emergence of wheat and soybean. The present results are in accordance with the studies of Karemegam et al., (1999, in green gram), Arancon et al., (2008, in petunia), Atiyeh et al., (2000, in tomato), Lazcano et al., (2010, in pine trees) Zaller (2007, in tomato) and Buckerfield et al. (1998), who reported that there is significant increase in seed germination percentage by the application of vermicompost (VC).

Moreover by using vermicompost the seed germination in mung bean was recorded highest (93%) than observed in control (84%) (Nagavallema et al., 2004). Joshi and Vig (2010) explored that the germination percentage in tomato (Lycopersicum aesculentum) was found highest (86%) in the soil treated with 15% of vermicompost than the control where germination was found 72%.

Chaudry et al., (2007) reported that application of chemical fertilizers significantly increased the seed germination in wheat. Mentler et al., (2002) explored that combined application of organic manure (farmyard manure) and chemical fertilizer resulted in the significant increase in the seed germination and growth of corn. The organic manure (VC, FYM) contains bioactive substances associated with humic acids. The presence of water soluble biologically active substances and plant growth regulators (hormones) present in the organic manure is the reason for enhancing the seed germination percentage (Cannelllas et al., 2002). Karemegam et al., (1999) reported that, seed germination percentage in green gram was found more (93.33%) by the application of VC as compared to 84.17% in the control.

Table 2: Seed germination (%) of Soybean and Wheat

Treatment (Material)	**Seed Germination (%)**	
	Soybean	**Wheat**
Soil (Control)	69 ±2.15	70 ±1.94
20% FYM	86 ± 1.92	87 ±1.86
20% VC	91 ±1.58	93 ±1.77
200 gm NPK	73 ±2.65	74 ±2.52

± sign denotes standard deviation (SD)

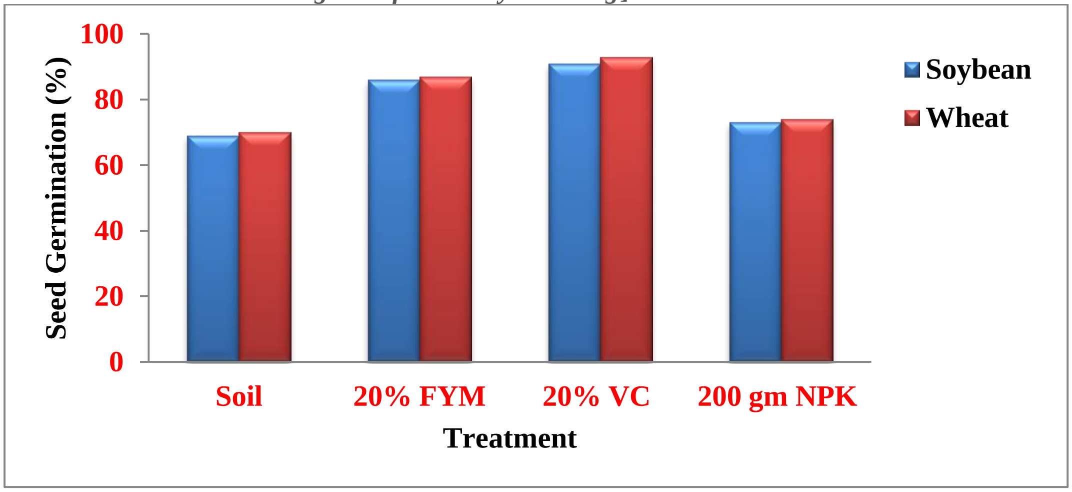

Figure 2: Seed Germination (%) of Soybean and Wheat

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