Industrial Microbiology
Explore – Journal of Research for UG and PG Students
ISSN 2278 – 0297 **(Print)**
ISSN 2278 – 6414 **(Online)**

http://www.patnawomenscollege.in/journal

Comparative study of soil supplemented with chemical fertilizer and compost in terms of its physico-chemical properties and Microbial biomass carbon

Aisha Rakshinda • Ravita Kumari • Sulekha Pandey • S. Bedi

Received : December 2010
Accepted : February 2011
Corresponding Author : S. Bedi

Abstract : *The soil microbial biomass carbon is a sensitive indicator of change resulting from agronomic practices and it is directly related to the amount and quality of carbon and other nutrients available in the soil. A study was conducted to estimate the impact of organic and inorganic fertilizer on the microbial biomass carbon and physico-chemical properties of the soil. The organic fertilizer included farmyard manure and vermicompost while the inorganic fertilizer was the mixture of urea and diammonium phosphate. Replicates were maintained for each treatment. A control was also set up without the addition of any fertilizer. The study was carried on for a period of two months. The results showed that microbial biomass carbon, organic carbon and available potassium were higher in organically amended soils as compared to chemical fertilizer and control. Inorganically treated soil showed highest content of available nitrogen and available phosphorous followed by organically treated soils and least in control. This could be explained by the ratio of fertilizer being applied. The application of both organic and inorganic fertilizers increased the organic carbon content of the soil, thereby increasing the microbial biomass carbon. This may be attributed to better nutrient status of the soil.*

Key words: *Microbial biomass carbon, organic and inorganic fertilizer.*

Aisha Rakshinda
B.Sc. III year, Industrial Microbiology (Hons.),
Session: 2008-2011, Patna Women's College,
Patna University, Patna, Bihar, India

Ravita Kumari
B.Sc. III year, Industrial Microbiology (Hons.),
Session: 2008-2011, Patna Women's College,
Patna University, Patna, Bihar, India

Sulekha Pandey
B.Sc. III year, Industrial Microbiology (Hons.),
Session: 2008-2011, Patna Women's College,
Patna University, Patna, Bihar, India

S. Bedi
Associate Professor, Dept. of Industrial Microbiology,
Patna Women's College, Bailey Road, Patna – 800 001,
Bihar, India

Introduction :

Soil is a complex system made up of mineral matter, organic matter, soil water and soil air. It is habitat of a diverse array of organism which includes both micro flora and fauna. The most important factor which is responsible for the fertility & nutrient cycle in the soil is the microbial community which is greatly influenced by the supplements that are given during cropping system and it may be chemical fertilizers or organic fertilizers. The application of chemical fertilizer generally improves crop production; however, concerns have been raised not only about the severe environmental problems posed by such practices but also about the long term sustainability of such system (Fliebach & Madar, 2000). Organic applications increased nutrients status, microbial activity and productive potential of soil (Kang et al, 2005). In comparision with conventional farming, organic farming has potential benefits in promoting soil structure formation ,enhancing soil biodiversity and improving food quality and safety. The role of soil organic matter, in relation to soil fertility and physical conditions, are widely recognized. The organic matter is the source of plant nutrients which are released in assimilable forms during microbial degradation. A major proportion of N (95-99% of the total), P (33-67% of the total) and S (75% of the total) in soil occurs in organic combination, which mineralize to release the nutrients in inorganic forms to be used by plants. Therefore, for accessing the quality and impact of inorganic fertilizer or organic fertilizer, soil microbial biomass carbon and other physico-chemical properties including available nitrogen, available phosphorus, available potassium ,organic carbon, pH and electrical conductivity act as an important tool. However, the mineralization in most cases is too slow to meet the full requirement of a high-yielding variety/crop. Nevertheless, it serves as a reservoir of plant nutrients, in promoting water storage, and in regulating microbial activity.

Soil microbial biomass is considered to act both as the agent of biochemical changes in soil and a repository of plant nutrients such as nitrogen(N) and Phosphorous (P) in agriculture ecosystems (Jankinson and Ladd, 1981).The changes in soil organic carbon contents are directly associated with change in soil biomass carbon and biological activity in the soil. Microbial biomass contains labile fraction of organic C and N, which are mineralized rapidly after the death of microbial cells. Another important parameter influencing reactions in a soil is pH . Soil fertility is directly influenced by pH through the solubility of many nutrients. At a pH lower than 5.5, many nutrients become very soluble and are readily leached from the soil profile. At high pH, nutrients become insoluble and plants cannot readily extract them. The purpose of this study was to investigate the effect of organic and inorganic fertilizer on the physico-chemical properties of soil and thus their importance in long term application.

Materials and Method :

The study was carried out in the ICAR Research Complex for Eastern Region, Patna for a period of two months.

Experimental procedure: The experiment consisted of organic and inorganic fertilizer treatments. Accordingly each of the experimental pots were designated as T_1(control), T_2 (chemical fertilizer), T_3(vermicompost) and T_4(farmyard manure). Each pot contained 5 Kg of soil.

The soil samples were randomly collected from the depth of 0-15 cm from a fallow field. The previous crop was mustard. All the samples were mixed thoroughly to get a homogenous mixture. Some amount of the soil was stored in refrigerator for carrying out the initial tests. The remaining soil was air dried and sieved for the experiment.

The study was conducted under three phases of incubation,at 15 days interval. All the parameters namely pH, electrical conductivity (EC), organic carbon (OC), available nitrogen, available phosphorus, available potassium and microbial biomass carbon (MBC) were measured to standard protocol (Chopra & Kanwar 1991). Replicates were maintained for each treatment. The organically treated pots were amended with farmyard manure (25g) and vermicompost (12.5g) while the inorganically treated pot was amended with a mixture of urea (31.5g) and diammonium phosphate (300mg). a control was also set up without the additon of any fertilizer. Watering was done at regular interval to avoid drying of soil.

Physico-chemical analysis: The soil samples were arrayed for available nitrogen, available phosphorus, available potassium, organic carbon, soil pH and electrical conductivity values .The content of available nitrogen in the soil was analysed by auto nitrogen analyser using the alkaline hydrolysable diffusion method (Hu Cheng & Zhibing, 2007). In this method 5g of soil and 10ml of distilled water was taken in a cylindrical beaker and placed in auto-nitrogen analyzer, titration was carried out with standard acid (0.01N HCl). The potassium content was measured with the ammonium acetate flame photometry method,standardization of the instruement (Flame photometer burner unit 121) was done with KCl solution of different strength (40ppm, 30ppm, 20ppm, 10ppm, 5ppm), For measurement, 5g of soil and 25 ml of neutral N NH_40Ac (ammonium acetate extractant)was taken, shaken on mechanical shaker for 5 minutes ,filtered and reading was taken in flame photometer. Available P content was measured colorimetricaly at 840 nm. Organic carbon content was measured with Walklay and Black titration method(Deluca and Keeney,1994) .In this method 1g of soil ,10 ml $K_2Cr_2O_7$ and 20 ml Conc. H_2SO_4 was taken and incubated for half an hour. After incubation 200 ml distilled water, 10 ml orthophosphoric acid and 1ml of diphenylamine indicator was added. Blue colour developed, titrated against 0.5 N $Fe(NH_4)_2(SO_4)_2$ [Ferrous ammonium sulfate (FAS)], end point was greenish yellow. pH and EC were measured with pH meter (Digital pH meter R.S. 17) and electrical conductivity meter (Vario Cond Set, Bestell Nr,) respectively.

Soil microbial biomass carbon: The fumigation-extraction method described by Vance *et al.,*(1987) was used to measure soil microbial biomass carbon. 10.0g was fumigated with ethanol free chloroform in a vacuum desiccator. Fumigated and unfumigated soil samples were extracted separately with 25ml of 0.5 M K_2SO_4 by shaking for 30 minutes. Each suspension was filtered using a whateman No.1 filter paper. Organic carbon in the extracts was determined using digestion titration method. 10ml of the extract was transferred to 500ml flask, 2ml of 0.2N $K_2Cr_2O_7$, 10 ml of conc H_2SO_4 and 5 ml of orthophosphoric acid were then added. The samples were placed on hot plate (100^{O}C), cooled and titrated against 0.005N ferrous ammonium sulphate with standard chemical procedure.

Results and Discussion :

Physico-chemical properties : The values of soil organic matter, available nitrogen, available phosphorus, available potassium, soil pH and electrical conductivity had significantly varied due to the supplementation of chemical fertilizer and compost. The pH of the soil amended with different fertilizers decreased while electrical conductivity increased with incubation time. The decrease in the pH of the soil in different treatments followed the order $T_1>T_2>T_4>T_3$ and increase in electrical conductivity followed the order $T_2>T_3>T_4>T_{1.}$

Although all the treatments and control showed increase in organic carbon content, it was relatively higher in organically treated soils. The microbial biomass carbon was highest in the soil amended with vermicompost as compared to other treatments.

Soil is the unconsolidated mineral matter that has been subjected to, and influenced by environmental factors. Environmental factors mainly include parent character of the soil, climatic condition, level and type of organisms or microorganisms as well as topography, all acting over a period of time. One of the most important chemical properties influencing reactions in a soil is pH. Soil fertility is directly influenced by pH through the solubility of many nutrients. pH of vermicompost treated soil (T_3) was found to be the lowest after 45 days (Fig-1) ,this may be due to more solubilisation of nutrients. EC of fertilizer treated soil (T_2) showed highest values, this may be due to more availability of free ions due to the decomposition of chemical fertilizer (Fig-2).

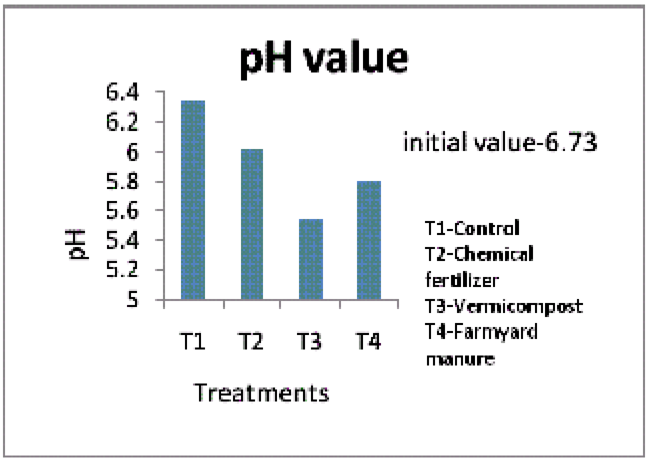

Fig -1 : Bar diagram showing pH of the soil samples after 45 days

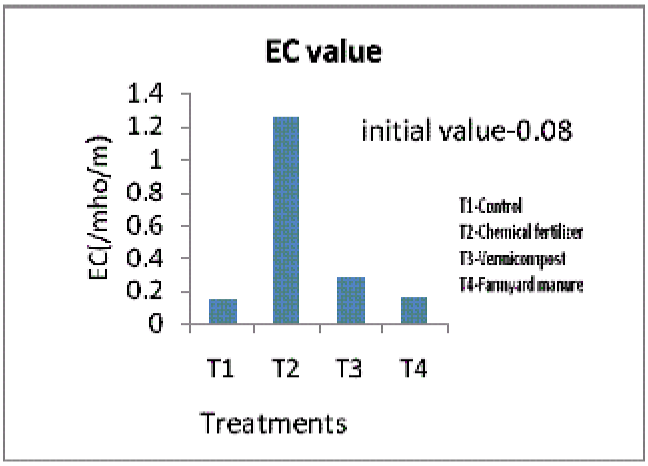

Fig - 2 : Bar diagram showing EC of the soil samples after 45 days

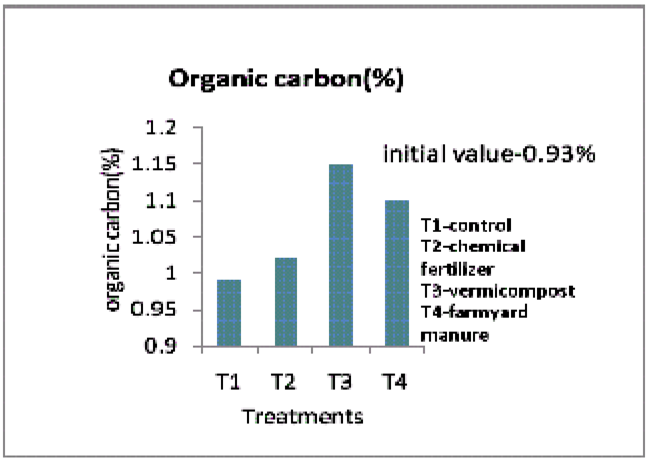

Fig -3 : Bar diagram showing organic carbon content after 45 days

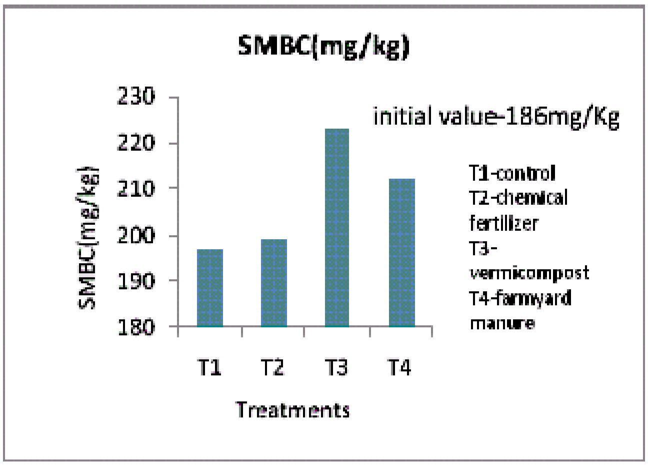

Fig - 4 : Bar diagram showing SMBC content after 45 days

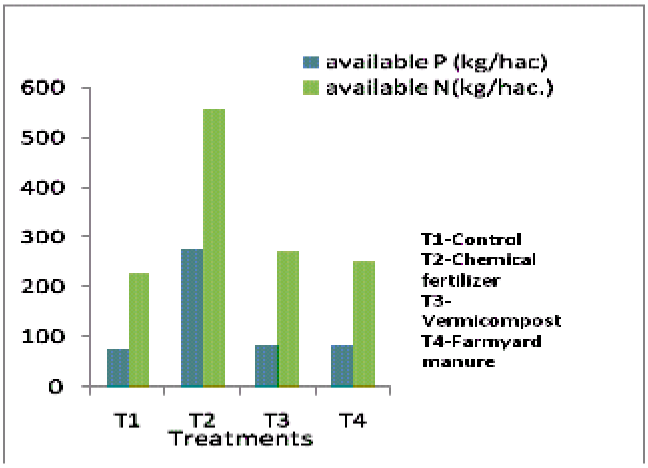

Fig - 5 : Bar diagram showing available N and P content after 45 days

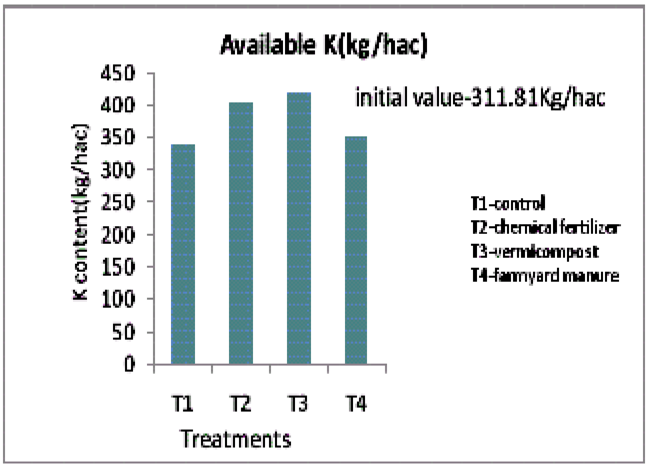

Fig - 6 : Bar diagram showing available K content after 45 days

The application of both organic and inorganic fertilizers increased the organic carbon content of the soil in all the treatments. However , the increase in vermicompost treated soil was relatively more i.e. from 0.93% to 1.15%, which indicated the enhanced microbial activity. The result is in accordance with the findings of Kumar et al.,(2000), who found that the organic materials applied alone or in combination with inorganic fertilizers gave greater residual soil fertility in terms of increase in organic carbon content from 0.36% to as high as 0.61%. Kang *et al* .,(2005) reported the increase in bacterial number in response to chemical fertilizer which may be attributed to better nutrient status of the soil . In the case of available potassium, value obtained was higher in the vermicompost treated soil as compared to the fertilizer treated soil. During supplementation urea and diammonium phosphate (DAP) were used, which were the source of nitrogen and phosphorus; this may be attributed as the reason of lowering of the potassium content in fertilizer treated soil This also indicates that the potassium content in the soil is not very much affected by the amendments as compared to other nutrients (Nakhro & Dkhar, 2010).

With regards to available nitrogen and available phosphorus (Fig-5), highest concentration was observed in T_2 as compared to other three treatments. This might be due to the addition of urea and DAP. Urea has the highest content of nitrogen and diammonium phosphate is also a good source of phosphorus. Also result is in accordance with the study done by Parham *et al*(2002), where manure treated soil was compared with chemical fertilizer treated soil in which fertilizer treated soil showed higher nitrogen content. Higher phosphorus was observed with soil that received phosphorus fertilizer.

Soil microbial biomass carbon: Increased soil microbial biomass carbon content was recorded in vermicompost and farmyard manure treated soils, while fertilizer treated soil showed no increase, proving that chemical fertilizer had not supported positively in increasing the microbial biomass carbon content. Fraser *et.al.,(*1994) reported a 10-26% increase in microbial biomass carbon under organic management .microbial biomass carbon differed among soils amended with different treatments. The rise in the MBC content of the two treatments might be due to the incorporation of organic matter which has increased the soil microbial activities. Another possible reason for this rise may be attributed to the fact that manure promotes biological and microbial activities, which accelerates the breakdown of organic substances in the supplemented manure. As suggested by Jankinson and Ladd (1981), microbial biomass not only contains a labile pool of nutrients but also drives the cycling of organic matter and nutrients in the soil. Leita *et al.,* (1999) indicated that soils treated with FYM and composts showed a significant increased in total organic carbon and biomass carbon in response to the increasing amount of organic carbon added. A positive effect of organic fertilizer on the microbial biomass carbon and nitrogen content in the soil was also observed and reported by Cerny *et al.,* (2008).

Since vermicompost is an advanced form of compost rich in nitrogen, potassium and phosphorus favouring microbial activity, thereby adding more biomass carbon to the soil. Since the soil in treatment T_2 was directly amended with urea and diammonium phosphate, it had shown abnormally high amount of available nitrogen and available phosphorus. In the case of farmyard manure treated soil T_4, increase in all the nutrient content was noted but at a very slow rate.

Conclusion :

In conclusion considering all the amendments, vermicompost has proved better then chemical fertilizer. Although chemical fertilizers provides quick nutrients to the soil but causes severe environmental problem. Since vermicompost favours the decomposition process as well as microbial activity but at a slower rate, nevertheless it serves as a reservoir of plant nutrients, help in promoting water storage and regulating microbial activity.

The experiment that was carried out can be termed as the short term duration (45 days) experiment. Since it was done in closed system in the soil without any plantation, therefore the changes that was observed in all cases from the initial reading to final reading were quite high. Any crop or plant absorbs nutrient from the soil and continuously exerts its outflow but here in this case all the nutrients have been increased which may be due to the continuous accumulation and negligible outflow. The initial readings of the samples were also quite high, since the sample was taken out from the field of ICAR-RCER, Patna; where various experiments were carried out on the cropping field with all kinds of amendments. Therefore the cropping field was initially rich in nutrients and thus, showed high initial value of each test.

Acknowledgement :

We would like to express our deep sense of gratitude to Dr.M.A.Khan, Director; Dr. K.M.Singh, Deputy head; Dr. Chunchun Kumar, Senior soil scientist, ICAR-RCER,Patna, for their support. We are extremely grateful to Dr. Sister Doris D'souza, Principal, Patna Women's College, Patna for financial support and guidance.

References :

Cerny, J., Balik J., Kulhanek M. and Needed, V. (2008). The changes in microbial biomass C and N in long-term field experiments. *Plant Soil Environ*., 54: 212-218.

Chopra S.L. and Kanwar J.S. (1991). *Analytical Agriculture Chemistry,* Published by Kalyani Publishers New Delhi.

Deluca T.H., Keeney D.R. (1994). Soluble carbon and nitrogen pools of cultivated soils: seasonal variation, *Soil Sci Soc Am Journal* 58:835-840.

Fliebach,A. and Madar P. (2000). Microbial biomass and size density fractions differ between soils of organic and conventional agricultural systems. *Soil Biol.Biochem*., 32: 757-768.

Fraser,P.M., Hayens and William, P.H. (1994). Effects of pasture improvement and intensive cultivation on microbial biomass, enzyme activities, and composition and size of earthworm population.*Biol.Fertil.Soils*, 17:185-190.

Hu Cheng and Cao Zhiping, (2007). Size and activity of the soil microbial biomass and soil enzyme activity in long term field experiments, *World Journal of Agri. Sciences,* 3 (1):63-70.

Jankinson D.S and Ladd J.N. (1981). Microbial Biomass in Soil: Measurement and Turnover. In: Soil Biochemistry,Paul, E.A. and J.N. Ladd (Eds.). Marcel Dekker, New York, USA., pp: 247.

Kang, G.S., Beri V., Rupela O.P. and Sidhu B.S. (2005). A new index to assess soil quality and sustainability of wheat based cropping system. *Biol. Fertil. Soils*, 41: 389-398.

Kumar, V., Ghosh B.C. and Bhat R. (2000). Complementary effect of crop wastes and inorganic fertilizers on yield, nutrient uptake and rediduial fertility in mustard(*Brassica juncea*);rice (*Oryza sativa*) cropping sequence. *Indian J. Agric. Sci.,* 70: 69-72.

Leita, L., Nobili M.D. and Mondini C. (1999). Influence of organic and inorganic fertilization on soil microbial biomass, metabolic quotient and heavy metal bioavailability. *Biol. Fet. Soils,* 28: 371-376.

Nakhro N. and. Dkhar M.S. (2010). Impact of organic and inorganic fertilizer on microbial populations and biomass carbon in paddy field soil. *Journal of agronomy* 9(3) :102-110.

Parham, J.A., Deng S.P., Da H.N., Sun H.Y. and Raun W.R. (2003). Long term cattle manure application in soil. II Effect on soil microbial population and community structure. *Biol.Fertil.Soils*, 38:209-215.

Vance, E.D, Brookes P.C., and Jankinson D.S. (1987). An extraction method for measuring soil microbial biomass carbon. *Soil Biol. Biochem.* 19:703-707.