International Journal of Chemical Studies

Kumar Chiranjeeb
Department of Soil Science, Dr.
Rajendra Prasad Central
Agricultural University, Pusa,
Samastipur, Bihar, India

Dr. SS Prasad
Department of Soil Science, Dr.
Rajendra Prasad Central
Agricultural University, Pusa,
Samastipur, Bihar, India

Dr. SP Singh
Department of Soil Science, Dr.
Rajendra Prasad Central
Agricultural University, Pusa,
Samastipur, Bihar, India

Dr. Vikram Bharati
Department of Agronomy,
Tirhut College of Agriculture,
Dholi, Pusa, Samastipur, Bihar,
India

Vivek Kumar
Department of Soil Science, Dr.
Rajendra Prasad Central
Agricultural University, Pusa,
Samastipur, Bihar, India

Effect of household waste based vermicompost and fertilizer on carbon pools and nutrient status in an incubation experiment

Kumar Chiranjeeb, Dr. SS Prasad, Dr. SP Singh, Dr. Vikram Bharati and Vivek Kumar

DOI: https://doi.org/10.22271/chemi.2020.v8.i2c.9740

Abstract
An incubation experiment consisting of three levels of fertilizer (0%, 100%, 50%) as well as four levels of vermicompost (0 t ha^{-1}, 1.25 t ha^{-1}, 2.5 t ha^{-1}, 3.7 t ha^{-1}) along with calcareous sandy loam soil conducted over a period of one year during *kharif,*2018 at Dr. RPCAU, Pusa. The effect of incubation on water soluble carbon (WSC), hot-water soluble carbon (HWSC) and available-N increased from 0th DAI to 115th DAI, whereas TOC, OC, KMnO4-C increased from 0th DAI to 65th DAI and then decreased up to 115th DAI.

Keywords: Incubation, vermicompost, carbon pools, nutrients status

Introduction
Vermicomposting is proven to be the ultimate solution for waste management as well as environment pollution as it totally excludes chemical usages for decomposition rather it take the help of earthworms. Vermicasts are rich in different enzymes such as lipase, protease, cellulose, amylase as well as very fine texture, good water holding capacity, good soil conditioners and thus helpful in organic matter decomposition and act as a pool of nutrient resource. (Kumar *et al*. 2020).

The SOC fractions like water-soluble organic C (WSC), microbial biomass C (MBC), labile C and mineralizable C are considered as more sensitive indicators of management induced changes than total SOC (Saviozzi *et al,* 2001; Yang *et al*. 2005) [13, 16]. These pools have potential to provide an early indication of the changes or impacts of management or environmental stress on soil quality. However, changes in labile pools of SOC due to different soil management practices have been studied mainly in cooler and temperate regions of the world (Liang *et al.* 1998; Sherrod *et al*. 2005) [7, 14], but such studies in tropical and subtropical regions are very few. Application of organic fertilizers and especially manure, either alone or in combination with inorganic fertilizers, increases SOC concentration and increase in carbon pools in soil. Labile C fractions i.e. hot-water extractable C (HWC) and permanganate oxidizable C (KMnO$_4$ -C) respond more quickly to changes in management practices than SOC, and are thus used as early and sensitive indicators of SOC changes (Ghani *et al*. 2003) [5]. On the other hand application of organic materials enhances the microbial activity in soil so much so there is a positive correlation between microbial activity and transformation of Nutrients.

Materials and Methods
An Incubational experiment was conducted at Dr. RPCAU, Pusa, and Samastipur during *kharfi,* 2018. In the experiment four levels of vermicompost (0 t ha^{-1}, 1.25 t ha^{-1}, 2.5 t ha^{-1}, 3.7 t ha^{-1}) and three levels of fertilizer (0%, 100%, 50%) were mixed with 200 gram soil in the incubation boxes and proper lab temperature and moisture content were maintained. The Incubation experiment started from 0thDAI(Days After Incubation) to 115th DAI as well as the design of experiment was Factorial Completely Randomized with three levels of factors (vermicompost-level, fertilizer-levels and incubation days)along with twelve treatments and three replications.

Corresponding Author:
Kumar Chiranjeeb
Department of Soil Science, Dr.
Rajendra Prasad Central
Agricultural University, Pusa,
Samastipur, Bihar, India

Total Organic Carbon (TOC)

0.25 g of processed soil sample is weighed out into a 25 ml volumetric flask, 20 ml of 0.4 N chromic acid solution is added to the soil samples and similar quantity is taken for the blank(without soil). The mixture is heated in H_3PO_4 bath and heated on hot plate at such a rate that a temperature of 155^0C is reached in 20 to 25 minutes. The temperature is held at 155^0C to 160^0C for an additional 5 minutes. The chromic acid solution, cooled to room temperature, is diluted with distilled water to 200 ml, and then 1g NaF and 2-4 drops di-phenyl ammine indicator added. The solution is back titrated with the 0.2 N ferrous ammonium sulphate until the solutions colour turns from violet to light green (Jackson, 1973) [56].

$$TOC (\%) = 10.67 \times (B - S)/B$$

Where, B= Blank Titration (ml), S= Sample titration (ml)

Available N

The available nitrogen in soil was determined by alkaline potassium permanganate method as described by Subbiah and Asija (1965).

Available P

Soil available phosphorus was determined by using 0.5M NaHCO3 (pH 8.5) solution (Olsen extractant) as suggested by Olsen *et al.* (1965).

Active Organic Carbon

Organic carbon was determined by wet digestion method of Walkley and Black (1934) as described in Black (1965). Fifty mg of vermicompost sample and one gram of soil samples were taken for analysis considering same amount of chemicals and method.

$$Organic\ carbon\ (\%) = \frac{10(B-S)\ x\ 0.003\ x\ 100}{B\ x\ weight\ of\ sample\ (g)}$$

Where,
B = titration value of blank
S = titration value of sample

Water soluble carbon (hot and cold water extractions)

Ten gram of moist soil was taken in a centrifuge tube and 20ml deionised water was added. It was sealed with para film at 105° C in heating block for 45-60 mins and centrifuged at 3500 rpm for 30-40 mins. Then it was filtered through 0.2μm filter and washed 3-4 times and final 50ml volume was made with water. 10 ml of filtrate was taken in 500ml flask and 0.4N $K_2Cr_2O_7$(2ml),10 ml Conc.H_2SO_4, 5ml orthophosphoric acid, 70mg HgO was added and heated on hot plate at 105^oC for 60mins in reflux condition. Then it was cooled, 250ml water was added and titrated against 0.035N FAS using ferroin indicator and brick-red end point was observed. The calculation was done according to McGill *et al.* (1986). The other method of Ghani *et al.* (2003) [5] can also be used.

KMnO₄ Carbon

Three gram of air dried soil was taken in 50ml centrifuge tube and 30ml of 20Mm permanganate solution was added. Container was shaken for 15mins the centrifuged for 5mins at 2000 rpm. 2 ml filtrate was taken in 50ml volumetric flask and volume was made the reading was taken at 560nm. (Blair *et al.* 1995).

$$POSC\ (mg\ kg^{-1}) = \frac{(B-S)\ x50x30x1000x9}{2x1000x3}$$

Where,
B= conc. Of $KMnO_4$ in blank (milimoles)
S= conc. Of $KMnO_4$ in sample (milimoles)
50/2 = dilution factor
9 = mg of carbon oxidized by 1 mM of $KMnO_4$

Results and Discussions

A. Water Soluble Carbon (mg g⁻¹)

The water soluble carbon content (fig. no.)1 in the soil during the incubation period showed the effects towards the application of vermicompost and fertilizer on water soluble carbon.

The water soluble carbon increased significantly with increasing levels of vermicompost and fertilizers irrespective of different incubation periods. Irrespective of all incubation periods, the increasing levels or doses of vermicompost increased the mean water soluble carbon from 0.053 to 0.097 mg g⁻¹soil and along with increasing fertilizers levels increased the from 0.059 to 0.077 mg g⁻¹soil. With highest vermicompost doses the mean water soluble carbon increased from 0.033 to 0.055 mg g⁻¹, 0.048 to 0.071 mg g⁻¹**,** 0.060 to 0.084 mg g⁻¹**,** and0.071 to 0.099 mg g⁻¹s along with high fertilizers doses increased water soluble carbon from 0.038 to 0. mg g⁻¹,0.054 to 0.072 mg g⁻¹, 0.066 to 0.084 mg g⁻¹and 0.079 to 0.097 mg g⁻¹at 0th, 30th, 65th and 115th DAI, respectively.

However during the incubation period the water soluble carbon increased at a gradually in all incubation periods from 0th DAI to 115 DAI at a increasing rate. The highest dose of vermicompost (3.75 t ha⁻¹) along with highest dose of fertilizer (100% RDF) showed significant increase in the water soluble carbon, which was superior than other vermicompost + NPK treatments but significantly superior than sole doses of vermicompost, NPK and control. All the interactions of incubation stages, vermicompost and fertilizer doses were found significant. Similar results were reported by Banger *et al*. (2009).

B. Hot-Water Soluble Carbon (mg g⁻¹)

The Hot-water soluble carbon content in the soil during the incubation period has been depicted in fig. no. 2.

The Hot-water soluble carbon increased significantly with increasing levels of vermicompost and fertilizers irrespective of different incubation periods. Irrespective of all incubation periods, the increasing levels or doses of vermicompost increased the mean hot-water soluble carbon from 0.088 to 0.102 mg g⁻¹and and along with increasing fertilizers levels increased the from 0.090 to 0.102 mg g⁻¹. Irrespective of fertilizers levels with highest vermicompost doses the mean hot-water soluble carbon increased from 0.082 to 0.097 mg g⁻¹, 0.087 to 0.101 mg g⁻¹, 0.089 to 0. mg g⁻¹ and 0.093 to 0.107 mg g⁻¹and with high fertilizers doses increased hot-water soluble carbon from 0.085 to 0.095 mg g⁻¹,0.089 to 0.101 mg g⁻¹, 0.091 to 0.103 mg g⁻¹and 0.095 to 0.107 mg g⁻¹at 0th, 30th, 65th and 115th DAI, respectively.

However during the incubation period the Hot-water soluble carbon increased at a gradual rate in all incubation periods from 0th DAI to 115th DAI. The highest dose of vermicompost (3.75 t ha⁻¹) along with highest dose of fertilizer (100% RDF) showed significant increase in the hot-water soluble carbon, which was superior than other vermicompost +NPK

treatments but significantly superior than sole doses of vermicompost, NPK and control. All the interactions of incubation stages, vermicompost and fertilizer doses were found non-significant.

C. Total Organic Carbon (%)
The fig. no. 3 shows the effect of vermicompost and fertilizer on status of total organic carbon content in the soil during the incubation period.

The Total organic carbon increased significantly with increasing levels of vermicompost and fertilizers irrespective of different incubation periods. Irrespective of all incubation periods, the increasing levels or doses of vermicompost increased the mean total organic carbon from 1.04 to 1.35% and along with increasing fertilizers levels increased the TOC from 1.14 to 1.28%. Irrespective of fertilizers levels with highest vermicompost doses the mean total organic carbon increased from 1.04 to 1.32%, 1.06 to 1.45%, 1.07 to 1.49% and 0.98 to 1.14% at 0th DAI, 30th DAI, 65th DAI and 115th DAI, respectively. Irrespective of vermicompost doses the increasing fertilizer level ranged the TOC 1.11 to 1.27%, 1.21 to 1.34% and 1.24 to 1.37% and 1.01 to 1.12% at 0th DAI, 30th DAI, 65th DAI and 115th DAI, respectively.

However during the incubation period the Total organic carbon increased at a faster rate in all incubation periods from 0th DAI to 65 DAI and then decreased up to 115th DAI. The highest dose of vermicompost (3.75 t ha⁻¹) along with highest dose of fertilizer (100% RDF) showed significant increase in the Total organic carbon, which was superior than other vermicompost +NPK treatments but significantly superior than sole doses of vermicompost, NPK and control. The increase in TOC up to 65 days and then decrease up to 115 days might be attributed to the decomposition of organic matter and release of CO_2 which might have resulted into increase in organic carbon content of soil. The treatments which consists of no manure and no fertilizer i.e. control, recorded lowest of TOC. Addition of organic manures significantly augmented the organic carbon and thereby the organic matter contents of soil. Similar results were found by Manna *et al.* (2013). All the interactions of incubation stages, vermicompost and fertilizer doses were found non-significant.

D. KMnO₄-Carbon (g kg⁻¹)
The KMnO₄-carbon increased significantly due to the combined application of different levels of vermicompost (0 t ha⁻¹, 1.25 t ha⁻¹, 2.5 t ha⁻¹, 3.7 t ha⁻¹), and fertilizers (no fertilizer, 100% NPK, 50% NPK) either alone or together than the control (no compost + no fertilizer) is shown in the table-30 and depicted in fig. no. 4. The combined application of vermicompost and fertilizer sources increased KMnO₄-carbon at increasing rate up to 65-90 days and then decreased up to 120 DAI, similar results were found by Purakayastha *et al.* (2008), where he found that soils amended with 100% NPK and FYM significantly increased KMnO₄-carbon content than control soil. Irrespective of all incubation stages the mean KMnO₄-carbon increased from 1.13 to 1.36 g Kg⁻¹ with the increasing vermicompost levels as well as the fertilizer level increased KMnO₄-carbon from 1.20 to 1.34 g kg⁻¹. The KMnO₄-carbon mean increased from 0.44 to 0.67g Kg⁻¹ with vermicompost levels and 0.52 to 0.67 g kg⁻¹ at 0th DAI.
The mean KMnO₄-carbon varied from 0.44 to 0.67 g kg⁻¹, 0.42 to 0.62 g kg⁻¹, 2.08 to 2.39 g kg⁻¹ and 1.61 to 1.76 g kg⁻¹

with increasing levels of vermicompost and from 0.52 to 0.67 g kg⁻¹, 0.46 to 0.59 g kg⁻¹, 2.16 to 2.38 g kg⁻¹ and 1.66 to 1.76 g kg⁻¹ with increasing levels of fertilizers at 30 DAI, 65 DAI, 115 DAI, respectively. All the treatments consisting of 100%NPK with all highest doses of vermicompost (3.75 t ha⁻¹) increased the KMnO₄-carbon than vermicompost and fertilizers sole doses and over control, might be due to balanced nutrition enhanced the enzymatic activity. However the overall interactions among the incubation stages, vermicompost and fertilizers showed significant results.

E. Organic Carbon (g kg⁻¹)
The Organic carbon content in the soil during the incubation period has been given in the table-31 and depicted in fig. no. 5.

The Organic carbon increased significantly with increasing levels of vermicompost and fertilizers irrespective of different incubation periods. Irrespective of all incubation periods, the increasing levels or doses of vermicompost (no mature, 1.25 t ha⁻¹, 2.5 t ha⁻¹, 3.7 t ha⁻¹) increased the mean organic carbon from 6.38 to 7.71 g kg⁻¹ soil and along with increasing fertilizers levels (no fertilizer, 100% NPK, 50% NPK) increased the from 6.57 to 7.62 g kg⁻¹ soil. Irrespective of fertilizers levels with highest vermicompost doses the organic carbon increased from 6.10 to 7.43 g kg⁻¹ soil, 6.27 to 7.60 g kg⁻¹ soil, and 6.62 to 7.95 g kg⁻¹ soil, 6.51 to 7.84 g kg⁻¹ soil and excluding vermicompost levels with high fertilizers dose organic carbon from 6.30 to 7.34 g kg⁻¹ soil, 6.47 to 7.51 g kg⁻¹ soil, 6.81 to 7.86 g kg⁻¹ soil and 6.70 to 7.75 g kg⁻¹ soil at 0th, 30th, 65th and 115th DAI, respectively.

However during the incubation period the organic carbon increased at a gradual rate in incubation periods from 0th DAI to 65th DAI and the decreased from 65th DAI to 115th DAI. The highest dose of vermicompost (3.75 t ha⁻¹) along with highest dose of fertilizer (100% RDF) showed significant increase in the organic carbon, which was superior than other vermicompost +NPK treatments but significantly superior than sole doses of vermicompost, NPK and control. Similar results were found by Reddy *et al.* (2017). All the interactions of incubation stages, vermicompost and fertilizer doses were found non-significant.

F. Available-N (kg ha⁻¹)
The available-N content in the soil during the incubation period has been depicted in fig. no. 6.

The available-N increased significantly with increasing levels of vermicompost and fertilizers irrespective of different incubation periods. Irrespective of all incubation periods, the increasing levels or doses of vermicompost increased the mean available-N from 214.12 to 215.91 kg ha⁻¹and along with increasing fertilizers levels increased the from 218.48 to 216.03 kg ha⁻¹.Irrespective of fertilizers levels with highest vermicompost doses the mean available-N increased from 208.90 to 210.81 kg ha⁻¹, 211.52 to 213.40 kg ha⁻¹, 217.52 to 219.50 kg ha⁻¹ and 218.55 to 219.92 kg ha⁻¹ and excluding vermicompost levels with high fertilizers doses increased available-N from 209.28 to 210.89 kg ha⁻¹, 211.79 to 213.44 kg ha⁻¹, 217.93 to 219.36 kg ha⁻¹ and 218.93 to 220.42 kg ha⁻¹ at 0th, 30th, 65th and 115th DAI, respectively.

However during the incubation period the Available-N increased at a faster rate in all incubation periods from 0th DAI to 115th DAI. The highest dose of vermicompost (3.75 t

ha^{-1}) along with highest dose of fertilizer (100% RDF) showed significant increase in the Available-N, which was superior than other vermicompost + NPK treatments but significantly superior than sole doses of vermicompost, NPK and control. Similar results were found by Meena *et al.* (2013). All the interactions of incubation stages, vermicompost and fertilizer doses were found significant. The Available-N content increased in all incubation stages from 0 DAI to 115 DAI and might be due to the increased mineralization throughout the experiment.

G. Available- P$_2$O$_5$ (kg ha^{-1})
The graph in fig. no. 7 shows the effect of vermicompost and fertilizer on available- P$_2$O$_5$ content in the soil during the incubation period.

The Available-P$_2$O$_5$ increased significantly with increasing levels of vermicompost and fertilizers irrespective of different incubation periods. Irrespective of all incubation periods, the increasing levels or doses of vermicompost increased the mean Available- P$_2$O$_5$ from 13.62 to 15.91 kg ha^{-1} and along with increasing fertilizers levels increased the from 9.27 to 10.85 kg ha^{-1}. Irrespective of fertilizers levels with highest vermicompost doses the mean available-P$_2$O$_5$increased from 4.81 to 7.54 kg ha^{-1}, 14.51 to 17.08 kg ha^{-1}, 24.00 to 29.05 Kg ha^{-1} and 9.68 to 10.41Kg ha^{-1} and excluding vermicompost levels with high fertilizers doses increased available- P$_2$O$_5$ from 5.61 to 7.02 Kg ha^{-1}, 14.12 to 16.91 kg ha^{-1}, 25.49 to 29.44 kg ha^{-1}, 9.27 to 10.85 kg ha^{-1} at 0th, 30th, 65th and 115th DAI, respectively.

However during the incubation period the available- P$_2$O$_5$ increased at a faster rate in all incubation periods from 0th DAI to 65th DAI and then decreased sharply up to 115th DAI. The highest dose of vermicompost (3.75 t ha^{-1}) along with highest dose of fertilizer (100% RDF) showed significant increase in the available-P$_2$O$_5$, which was superior than other vermicompost + NPK treatments but significantly superior than sole doses of vermicompost, NPK and control. Similar results were found by Maitra *et al.* (2008). All the interactions of incubation stages, vermicompost and fertilizer doses were found significant. The Available-P$_2$O$_5$ content increased in all incubation stages from DAI to 65 DAI and then decreased up to 115 DAI might be due to the initial secretion of organic acids released fixed phosphorus but in later stages highest microbial activity utilized more amount of available phosphorus.

Correlation Coefficients

Table 1: Pearson coefficient 0th Dai

	TOC	WSC	HWSC	KMnO$_4$-C	OC	N	P
TOC	1.000						
WSC	0.755**	1.000					
HWSC	-0.087^{NS}	-0.338^{NS}	1.000				
KMnO$_4$-C	0.677*	0.934**	-0.395^{NS}	1.000			
OC	0.774**	0.958**	-0.346^{NS}	0.858**	1.000		
N	0.677*	0.978**	-0.335^{NS}	0.906**	0.959**	1.000	
P	0.779**	0.950**	-0.363^{NS}	0.893**	0.885**	0.881**	1.000

(** Significant at P= 0.01 level, *Significant at P = 0.05 level)

The correlation coefficient showed positive and highly significant between water soluble carbon and available nitrogen. Both positive and negative correlations are shown in Table-1.

Table 2: Pearson Coefficient 30th Dai

	TOC	WSC	HWSC	KMnO$_4$-C	OC	N	P
TOC	1.000						
WSC	0.904**	1.000					
HWSC	0.901**	0.971**	1.000				
KMnO$_4$-C	0.878**	0.915**	0.887**	1.000			
OC	0.888**	0.955**	0.977**	0.886**	1.000		
N	0.881**	0.989**	0.984**	0.922**	0.975**	1.000	
P	0.654*	0.756**	0.691*	0.714**	0.694*	0.756**	1.000

(** Significant at P= 0.01 level, *Significant at P = 0.05 level)

The correlation coefficient showed positive among all parameters and highly significant between hot water soluble carbon and available nitrogen. Both positive and negative correlations are shown in Table-2

Table 3: Pearson Coefficient 65th DAI

	TOC	WSC	HWSC	KMnO$_4$-C	OC	N	P
TOC	1.000						
WSC	0.916**	1.000					
HWSC	0.894**	0.984**	1.000				
KMnO$_4$-C	0.869**	0.874**	0.905**	1.000			
OC	0.870**	0.956**	0.973**	0.849**	1.000		
N	0.920**	0.984**	0.984**	0.899**	0.976**	1.000	
P	0.174^{NS}	0.153^{NS}	0.271^{NS}	0.224^{NS}	0.359^{NS}	0.258^{NS}	1.000

(** Significant at P= 0.01 level, *Significant at P = 0.05 level)

The correlation coefficient showed positive and highly significant between water soluble carbon hot water soluble carbon and available nitrogen (Table-3). Available-P found non-significant with other parameters.

Table 4: Pearson coefficient 115th DAI

	TOC	WSC	HWSC	KMnO$_4$-C	OC	N	P
TOC	1.000						
WSC	0.984**	1.000					
HWSC	0.981**	0.960**	1.000				
KMnO$_4$-C	0.968**	0.983**	0.941**	1.000			
OC	0.967**	0.969**	0.984**	0.940**	1.000		
N	-0.061^{NS}	0.088^{NS}	-0.083^{NS}	0.010^{NS}	0.028^{NS}	1.000	
P	-0.155^{NS}	-0.139^{NS}	-0.218^{NS}	-0.102^{NS}	-0.263^{NS}	0.190^{NS}	1.000

(** Significant at P= 0.01 level, *Significant at P = 0.05 level)

The correlation coefficient showed positive and highly significant between hot water soluble carbon and organic carbon. Both available-P and N found NS with other parameters (Table-4).

Conclusions
The study revealed that application of vermicompost and fertilizer together increased the availability of nutrients like nitrogen and phosphorus along with elevated the levels of water soluble carbon, hot-water soluble carbon, total organic carbon, active organic carbon and KMnO$_4$-Carbon. The combined application of vermicompost and fertilizer might have increased microbial population thus leading to nutrient solubilization and post availability in soil. The combined application of vermicompost and fertilizer improved the soil health and soil ecological environments.
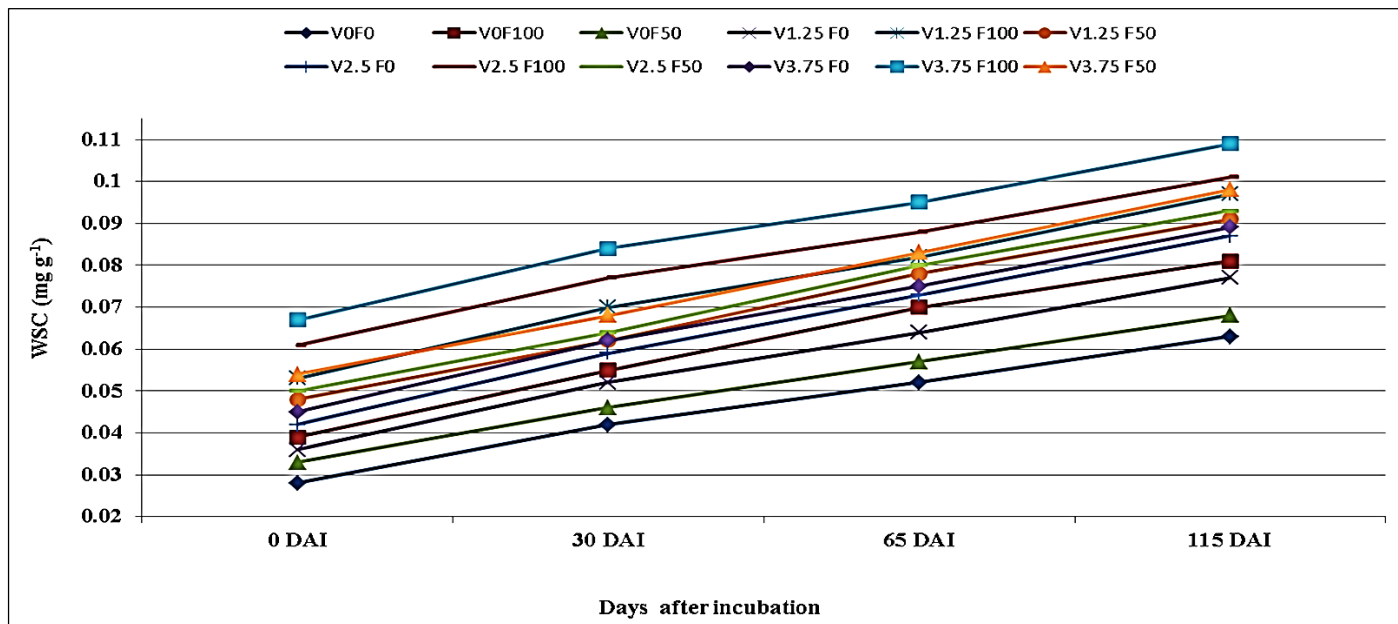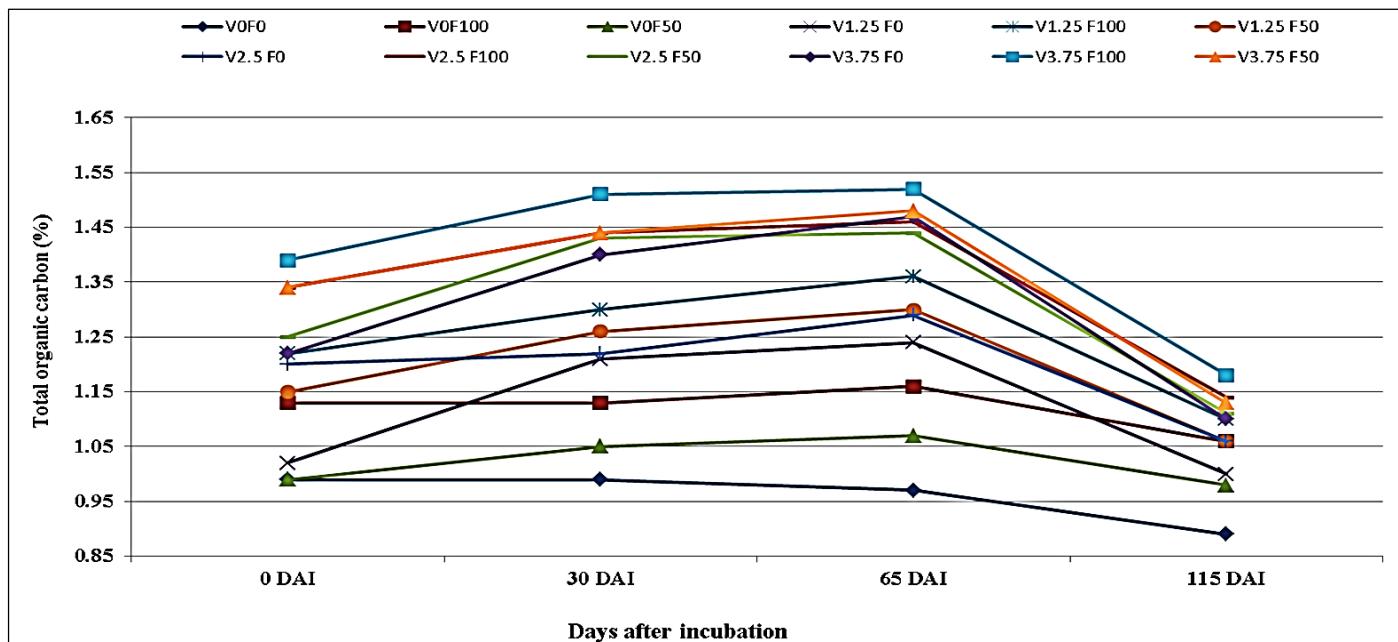
V_o= Vermicompost (0 t ha^{-1}), $V_{1.25}$= Vermicompost (1.25 t ha^{-1}), V2.5= Vermicompost (2.5 t ha^{-1}), $V_{3.75}$ = Vermicompost (3.75 t ha^{-1}), F_0= Fertilizer (no fertilizer), F_{100}= Fertilizer (100 % RDF), F_{50}= Fertilizer (50 % RDF) and V_0F_0 = control (0 t ha^{-1} vermicompost +no fertilizer).

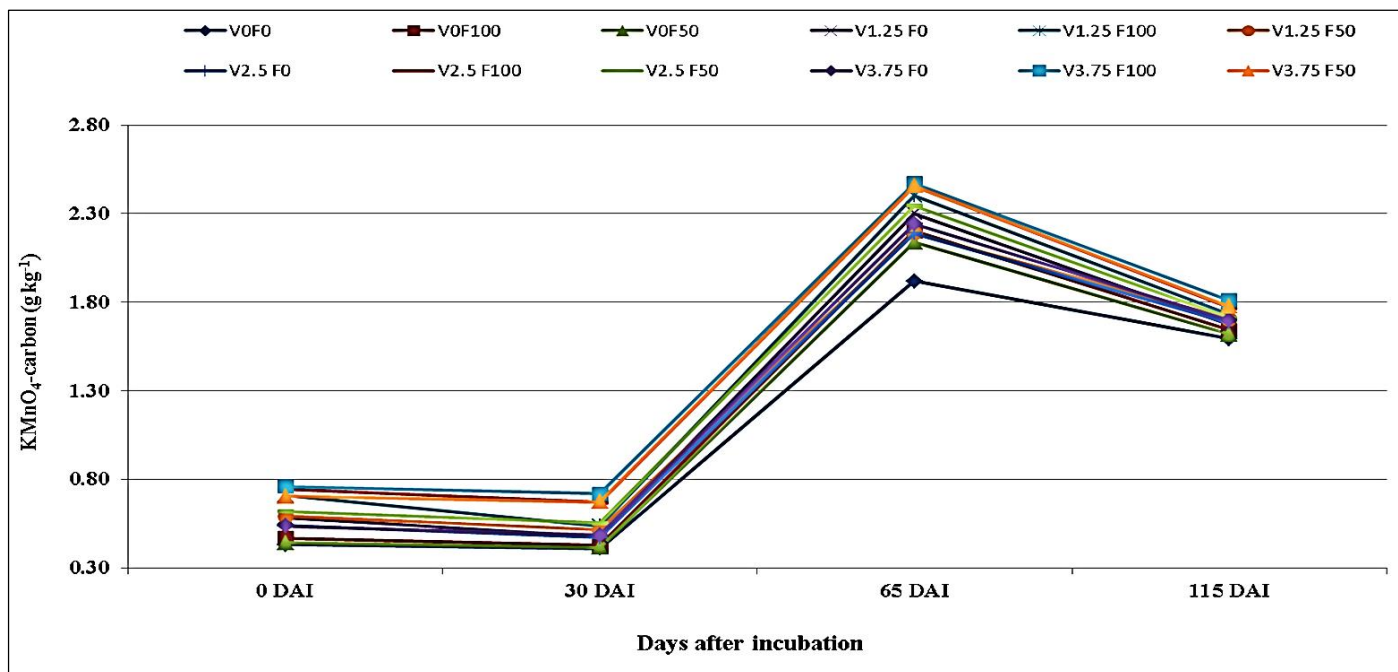**Fig 1:** Effect of vermicompost and fertilizer on water soluble carbon -WSC (mg g^{-1}) in soil during incubation study
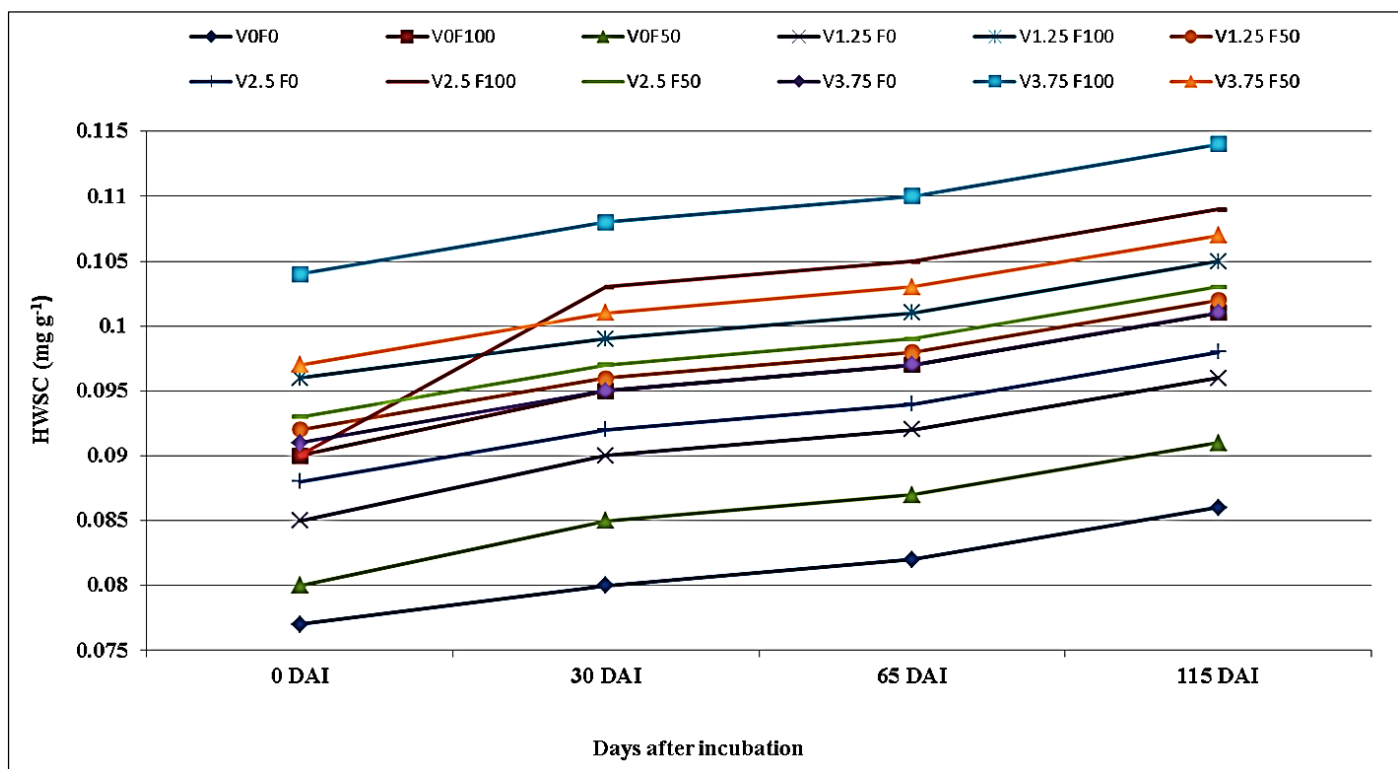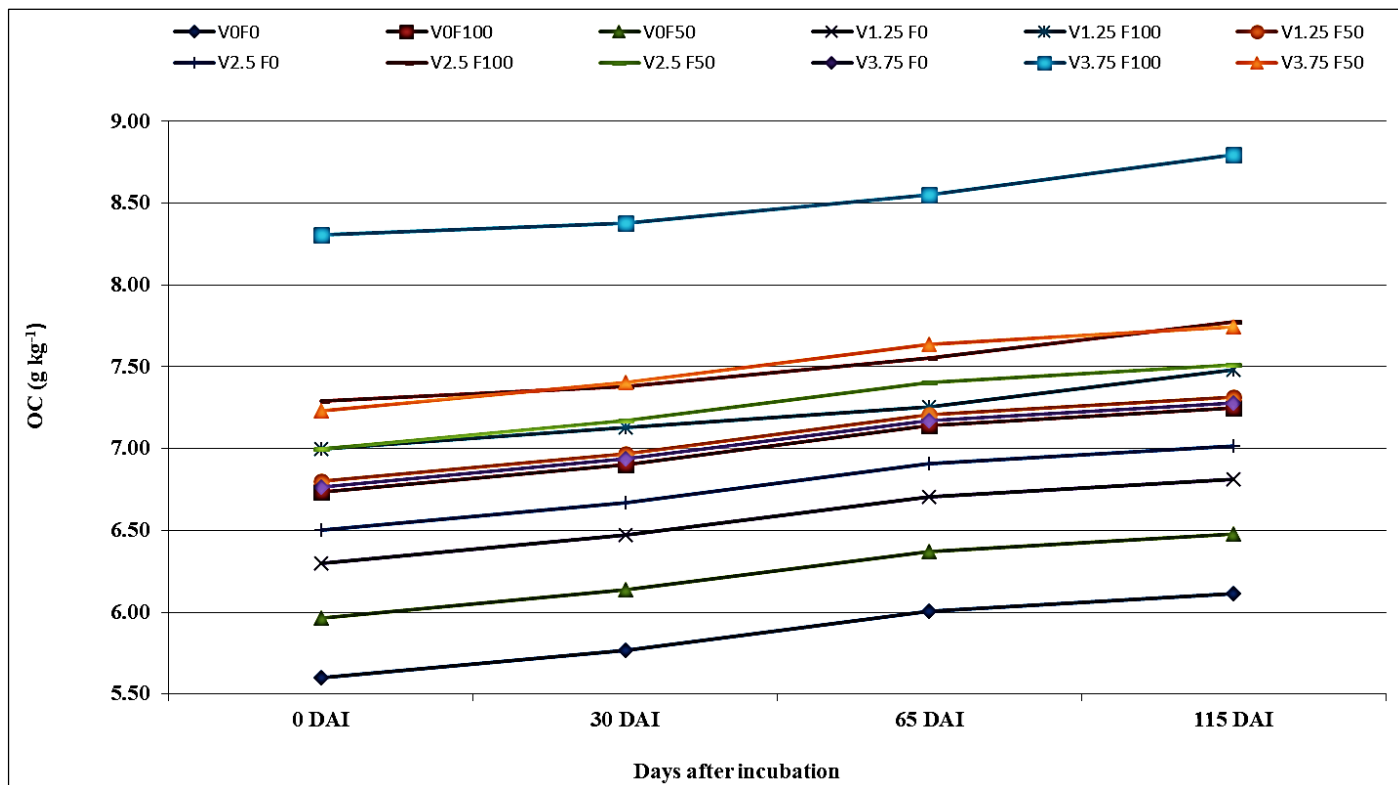

V_o= Vermicompost (0 t ha^{-1}), $V_{1.25}$= Vermicompost (1.25 t ha^{-1}), V2.5= Vermicompost (2.5 t ha^{-1}), $V_{3.75}$ = Vermicompost (3.75 t ha^{-1}), F_0= Fertilizer (no fertilizer), F_{100}= Fertilizer (100 % RDF), F_{50}= Fertilizer (50 % RDF) and V_0F_0 = control (0 t ha^{-1} vermicompost +no fertilizer).

Fig 2: Effect of vermicompost and fertilizer on hot-water soluble carbon -HWSC (mg g^{-1}) in soil during incubation study

V_0= Vermicompost (0 t ha^{-1}), $V_{1.25}$= Vermicompost (1.25 t ha^{-1}), V2.5= Vermicompost (2.5 t ha^{-1}), $V_{3.75}$ = Vermicompost (3.75 t ha^{-1}), F0= Fertilizer (no fertilizer), F_{100}= Fertilizer (100 % RDF), F_{50}= Fertilizer (50 % RDF) and V_0F_0 = control (0 t ha^{-1} vermicompost +no fertilizer).

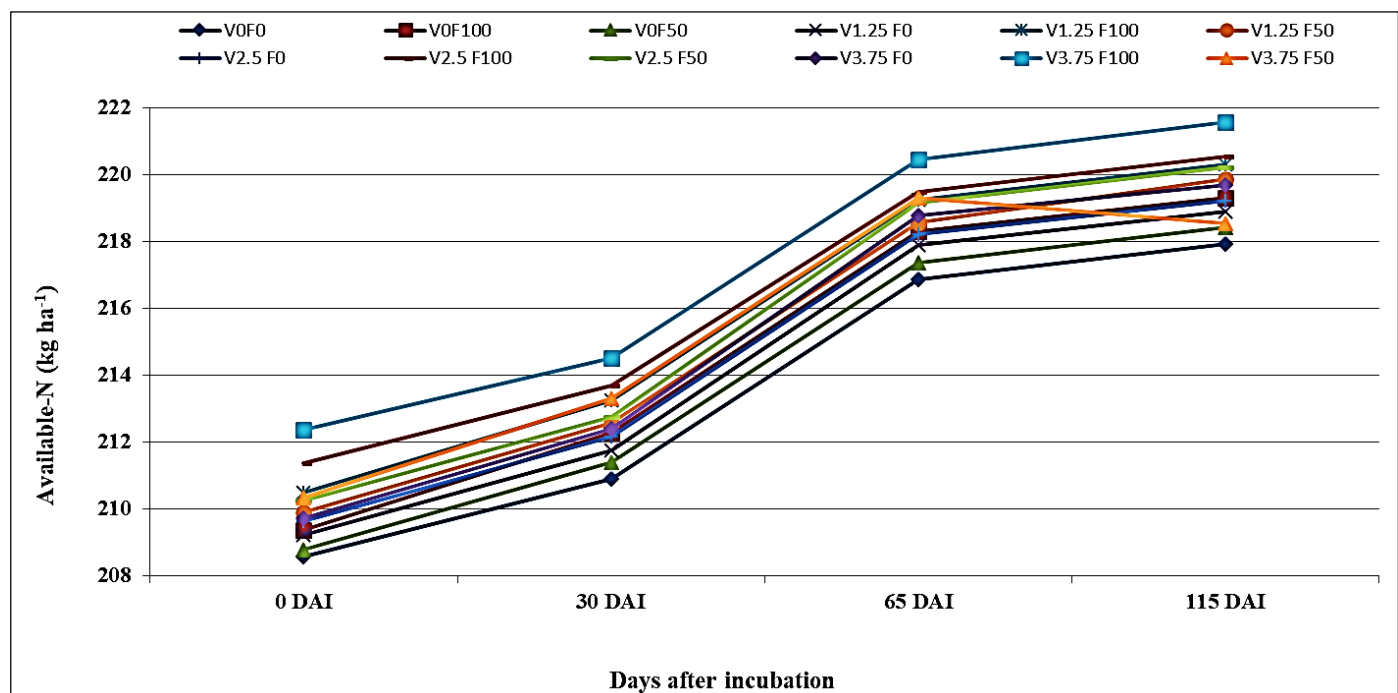**Fig 3:** Effect of vermicompost and fertilizer on total organic carbon-TOC (%) in soil during incubation study

V_0= Vermicompost (0 t ha^{-1}), $V_{1.25}$= Vermicompost (1.25 t ha^{-1}), V2.5= Vermicompost (2.5 t ha^{-1}), $V_{3.75}$ = Vermicompost (3.75 t ha^{-1}), F0= Fertilizer (no fertilizer), F_{100}= Fertilizer (100 % RDF) F_{50}= Fertilizer (50 % RDF) and V_0F_0 = control (0 t ha^{-1} vermicompost +no fertilizer).

Fig 4: Effect of vermicompost and fertilizer on permanganate carbon–KMnO$_4$-carbon (g kg^{-1}) in soil during incubation study
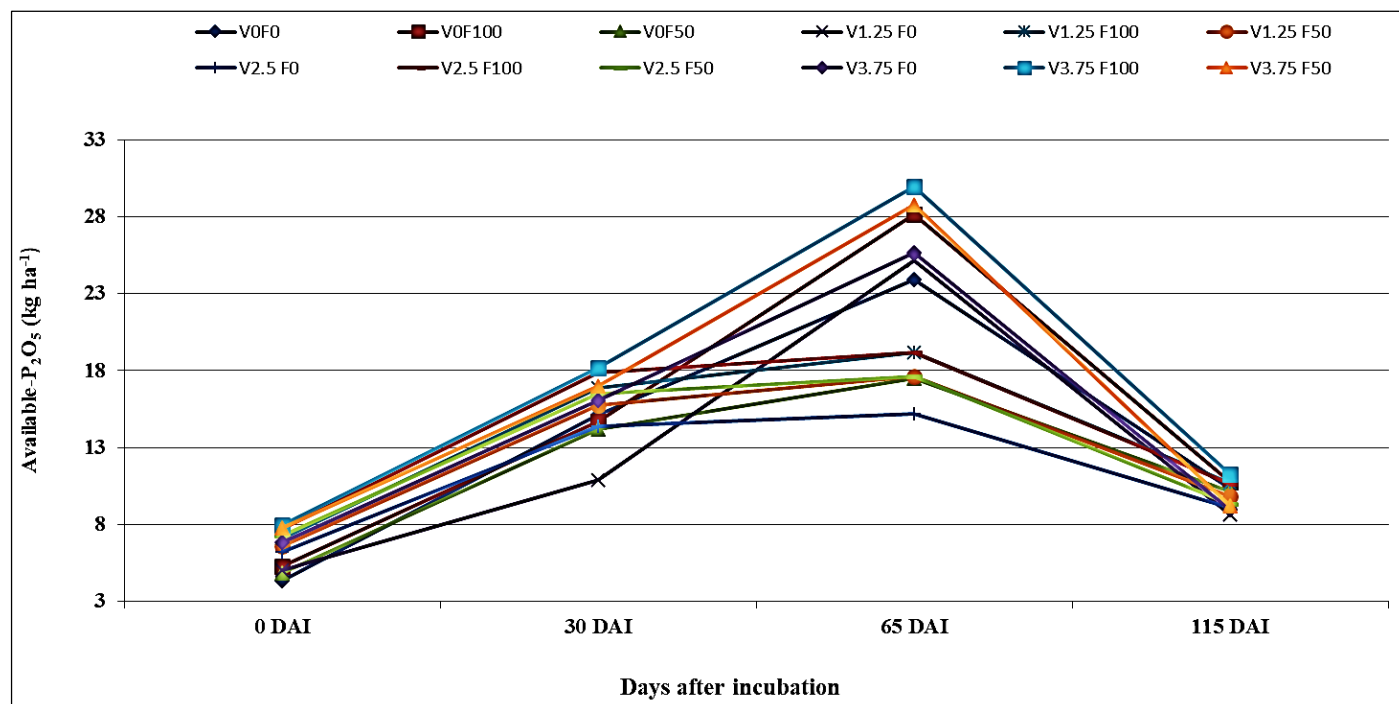
V_o= Vermicompost (0 t ha^{-1}), $V_{1.25}$= Vermicompost (1.25 t ha^{-1}), V2.5= Vermicompost (2.5 t ha^{-1}), $V_{3.75}$ = Vermicompost (3.75 t ha^{-1}), F_0= Fertilizer (no fertilizer), F_{100}= Fertilizer (100 % RDF), F_{50}= Fertilizer (50 % RDF) and V_0F_0 = control (0 t ha^{-1} vermicompost +no fertilizer).

Fig 5: Effect of vermicompost and fertilizer on soil organic carbon -OC (g kg^{-1}) in soil during incubation study

V_o= Vermicompost (0 t ha^{-1}), $V_{1.25}$= Vermicompost (1.25 t ha^{-1}), V2.5= Vermicompost (2.5 t ha^{-1}), $V_{3.75}$ = Vermicompost (3.75 t ha^{-1}), F_0= Fertilizer (no fertilizer), F_{100}= Fertilizer (100 % RDF), F_{50}= Fertilizer (50 % RDF) and V_0F_0 = control (0 t ha^{-1} vermicompost +no fertilizer).

Fig 6: Effect of vermicompost and fertilizer on soil available-N (kg ha^{-1}) in soil during incubation study

V_o= Vermicompost (0 t ha^{-1}), $V_{1.25}$= Vermicompost (1.25 t ha^{-1}), V2.5= Vermicompost (2.5 t ha^{-1}), $V_{3.75}$ = Vermicompost (3.75 t ha^{-1}), F_0= Fertilizer (no fertilizer), F_{100}= Fertilizer (100 % RDF), F_{50}= Fertilizer (50 % RDF) and V_0F_0 = control (0 t ha^{-1} vermicompost +no fertilizer).

Fig 7: Effect of vermicompost and fertilizer on soil available-P_2O_5 (kg ha^{-1}) in soil during incubation study

Acknowledgment

References
1. Banger K, Kukal SS, Toor G, Sudhir K, Hanumanthraju TH. Impact of long-term additions of chemical fertilizers and farm yard manure on carbon and nitrogen sequestration under rice-cowpea cropping system in semi-arid tropics. Plant and Soil. 2009; 318(1):27-35.
2. Black CA. Methods of soil analysis Part I. *American Society of Agronomy Inc. Publications.* Madison Wiscons in USA, 1965.
3. Blair GJ, Lefroy RDB, Lise L. Soil carbon fractions based on their degree of oxidation, and the development of a carbon management index for agricultural systems. Australian Journal Agricultural Resources. 1995; 46(7):1459-1466.
4. Chiranjeeb K, Prasad SS, Singh SP, Bharati V, Jha S. Effect of Household Vermicompost and Fertilizer on Soil Microbial Biomass Carbon, Biomass Phosphorus and Biomass Nitrogen in Incubation Experiment. Int. J Curr. Microbiol. App. Sci. 2020; 9(02):1508-1516
5. Ghani A, Dexter M, Perrott KW. Hot-water extractable carbon in soils: sensitive measurement for determining impacts of fertilisation, grazing and culti-vation. Soil Biology and Biochemistry. 2003; 35(9):1231-1243.
6. Jackson ML. Soil Chemical Analysis. Practice Hall of Indian (Pvt.) Ltd., New Delhi, 1973.
7. Liang BC, MacKenzie AF, Schnitzer M, Monreat CM, Voroney PR, Beyaert RP. Management-induced changes in labile soil organic matter under continuous corn in eastern Canadian soils. Biology and Fertility of Soils. 1998; 26(2):88-94.
8. Maitra DN, Sarkar SK, Saha S, Tripathy MK, Majumdar B, Saha AR. Effect of phosphorus and farmyard manure applied to sunhemp (*Crotolaria juncea*) on yield and nutrient uptake in sunhemp-wheat (*Triticum aestivum*) cropping system. Indian Journal of Agricultural Science. 2008; 78(1):70-74.
9. Manna MC, Singh M, Wanjari R H, Mandal A, Patra AK. Soil Nutrient Management for Carbon Sequestration. In: Encyclopedia of Soil Science. 2015; III(3):1-6.
10. McGill WB, Cannon KR, Robertson JA, Cook FD. Dynamics of soil microbial biomass and water-soluble organic C in Breton L after 50 years of cropping to two rotations. Canadian Journal of Soil Science. 1986; 66(1):1-19.
11. Olsen SR, Cole CV, Watanabe FS, Dean LA. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. United States Department of Agriculture Circular, 1954, 939(19).
12. Reddy CV, Tiwari A, Tedia K, Verma A, Saxena RR. Effect Long term fertilizer experiments on Bulk Density, Crack Volume, Soil Organic Carbon stock and Carbon sequestration rate Rice crop. International Journal of Pure and Applied Bioscience. 2017; 5(4):1051-1057.
13. Saviozzi A, Levi-Minzi R, Cardelli R, Rivaldi R. A comparison of soil quality in adjacent cultivated, forest and native grassland soils. Plant and Soil. 2001; 233(2):251-259.
14. Sherrod LA, Peterson GA, Westfall DG, Ahuja LR. Soil organic carbon pools after 12 years in no-till dry land agroeco systems. Soil Science Society of America Journal. 2005; 67:1533-1543.
15. Subbiah BV, Asija GL. A rapid procedure for determination of available nitrogen in soils. Current Science. 1956; 25:259-260.
16. Yang CM, Yang LZ, Zhu OY. Organic carbon and its fractions in paddy soil as affected by different nutrient and water regimes. Geoderma. 2005; 124(1-2):133-142.
17. Walkly A, Black IA. An examination of the Degtjareff method for determining organic carbon in soil: Effect of variations in digestion conditions and of inorganic soil constituents. Soil Science.1934; 63:251-263.