**Annals of Plant and Soil Research 18(4): 366-369 (2016)**

# CHANGES IN STATUS OF ORGANIC CARBON, AVAILABLE NITROGEN AND BACTERIAL POPULATION IN SOILS WITH ORGANIC MANURES

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Received: July, 2016; Revised accepted: October, 2016

## ABSTRACT

*A laboratory incubation study was conducted during 2015 at Indore (M.P.) to assess the changes in status of organic carbon, available nitrogen and bacterial population in Alfisol and Vertisol with organic manures. The treatments comprised organics (FYM and Vermicompost) and two soils (Alfisol and Vertisol) were incubated at 15, 30 45 and 60 days. Vertisol had higher amount of organic carbon as compared to Alfisol at all incubation period. Similarly increased levels of organics increased the organic carbon content in soils. The results revealed that Vertisol + 5 t VC ha$^{-1}$ showed significantly higher organic carbon content (7.6 g kg$^{-1}$) at 15 days of incubation as compared to Alfisol at the same period of incubation. Vermicompost (5 t ha$^{-1}$) showed significantly higher values of available N i.e. 181, 187, 192 and 198 kg ha$^{-1}$ at 15, 30, 45 and 60 days after incubation, respectively over other treatments. The interaction effect of Vertisol + 5 t VC ha$^{-1}$ showed maximum available nitrogen content i.e. 186, 191, 195 and 200 kg ha$^{-1}$ at 15, 30, 45 and 60 days after incubation. Alfisol showed significantly lower C:N ratio (12.33 -14.81) as compared to Vertisol (12.63-15.05) at all incubation period. A decreasing trend of C:N ratio was noticed in soils during successive incubation period. The bacterial counts were found significantly higher in Vertisol as compared to Alfisol at all incubation period. The highest bacterial count (66.0, 79.0, 82.1 and 88.0 x 10$^6$ g$^{-1}$ at 15, 30, 45 and 60 days of incubation) was recorded with 5 t VC ha$^{-1}$ application.*

***Key words*:** Organics, Alfisol, Vertisol, Vermicompost, FYM and C:N ratio

## INTRODUCTION

Soil organic carbon content plays an important role for maintaining physico-chemical and biological properties of cultivated land and soil health. Due to shifting of natural to managed ecosystem in the modern agriculture leads to soil degradation processes and depletion of soil organic carbon resulting in imbalance of C:N ratio (Rattan Lal, 2015). So, there is a need to improve carbon content in soil. An application of organic sources in soil has immense impact on mineralization pattern of carbon and nitrogen in soil. Many studies have evaluated the relationships between carbon and nitrogen availability with chemical composition and other parameters for various organic sources, the knowledge of carbon and nitrogen mineralization dynamics in soil amended with value added organic manures is of prime importance. In general, mineralization is always accompanied by immobilization. Limited information is available on changes of organic carbon, available nitrogen and bacterial population in soils with organic manures at different incubation periods under changing agro-ecosystem in modern agriculture in arid and semi arid climatic conditions. Recently Thind *et al.,* (2016) reported that addition of FYM @ 15 t ha$^{-1}$ significantly improved the soil organic carbon, available nitrogen, phosphorus and potassium as well as microbial population. Similarly, nitrogen supplying capacity of organics in soil depend on both the initially available inorganic N present in it and the long term rate of mineralization of N in soil. The C/N ratio is commonly used to assess whether plant residues will release or immobilize inorganic N. However, it is sometimes inadequate for predicting mineralization kinetics. To optimize the use of compost or vermicompost and supplement N needed during the plant growth period, the rate of net mineralization of C and N in compost in the soil must first be determined. Looking to the above facts, a laboratory study was conducted to know the changes in status of organic carbon, available nitrogen and bacterial population in Vertisol and Alfisol with organics including FYM and vermicompost under various incubation periods.

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## MATERIALS AND METHODS

The Vertisol (Indore, M.P.) and Alfisol (Bengaluru, Karnataka) soil samples were collected and analysed for their physical, chemical and biogical properties (Table 1). Total ten treatments comprising of two organics (FYM 5, and 10 t $ha^{-1}$ and Vermicompost 2.5 and 5 t $ha^{-1}$ and absolute control i.e. no FYM/VC) with Alfisol and Vertisol were replicated three times in a CRD. An incubation study was conducted in these soils in the laboratory till 15, 30, 45 and 60 days at field capacity at 25°C temperature in polythene bottles of 100 ml capacity. The chemical composition of organics used in the present investigation was as (FYM: OC - 221 g $kg^{-1}$, total N – 0.62%, total P – 0.28%, total K – 0.60%, C:N ratio – 35.6 and total bacterial count – 81 $x10^6$ $g^{-1}$ and VC: OC - 324 g $kg^{-1}$, total N – 1.36%, total P – 0.81%, total K – 1.12%, C:N ratio – 23.8 and total bacterial count – 95 $x10^6$ $g^{-1}$). The uniform moisture content was maintained by adding distilled water in each bottle during incubation. The polythene bottles opened every day once to facilitate proper aeration. Soil samples were collected at 15, 30, 45 and 60 days of incubation and subjected to chemical analysis (Jackson 1973) as well as microbial counts as per standard procedures (Martin, 1950; Allen, 1957; Kuznetsov and Arjunrao, 1972).

Table 1: Chemical, mechanical and microbial composition of soils

| Characteristics | Vertisol | Alfisol |
|---|---|---|
| pH | 7.8 | 6.5 |
| EC ($dSm^{-1}$) | 0.35 | 0.62 |
| OC (g $kg^{-1}$) | 6.0 | 4.5 |
| $CaCO_3$ (g $kg^{-1}$) | 62.0 | 17.0 |
| Texture | clay | sandy loam |
| Available N (kg $ha^{-1}$) | 170 | 160 |
| Available P (kg $ha^{-1}$) | 9.5 | 27.5 |
| Available K (kg $ha^{-1}$) | 596 | 315 |
| Bacteria ($x10^6$ $g^{-1}$) | 20 | 18 |
| Fungi ($x10^3$ $g^{-1}$) | 24 | 14 |
| Actinomycetes ($x10^4$ $g^{-1}$) | 10 | 0 |
| C:N ratio | 13.2:1 | 12.8:1 |

## RESULTS AND DISCUSSION

The Vertisol and Alfisol behaved differently in respect of organic carbon content with advancement of incubation period from 15 to 60 days (Table 2). The alfisol contained lower

Table 2: Effect of soils, organics and their interactions on organic carbon content and available nitrogen of soil at different incubation periods

| Treatments | Organic carbon (g $kg^{-1}$) | | | | Available nitrogen (kg $ha^{-1}$) | | | |
|---|---|---|---|---|---|---|---|---|
| | Incubation period (days) | | | | Incubation period (days) | | | |
| | 15 | 30 | 45 | 60 | 15 | 30 | 45 | 60 |
| Soils | | | | | | | | |
| Vertisol | 7.0 | 6.8 | 6.6 | 6.3 | 177 | 180 | 183 | 184 |
| Alfisol | 5.4 | 5.3 | 5.1 | 4.9 | 168 | 173 | 177 | 180 |
| CD (P=0.05) | 0.1 | 0.1 | 0.1 | 0.1 | 2 | 2 | 2 | 2 |
| Organics | | | | | | | | |
| Control | 5.2 | 5.0 | 4.8 | 4.6 | 163 | 160 | 154 | 143 |
| 5 t FYM $ha^{-1}$ | 6.2 | 6.1 | 5.9 | 5.8 | 170 | 175 | 181 | 186 |
| 10 t FYM $ha^{-1}$ | 6.5 | 6.2 | 6.1 | 5.9 | 175 | 180 | 186 | 192 |
| 2.5 t VC $ha^{-1}$ | 6.4 | 6.2 | 6.0 | 5.8 | 176 | 182 | 187 | 193 |
| 5.0 t VC $ha^{-1}$ | 6.8 | 6.5 | 6.1 | 5.7 | 181 | 187 | 192 | 198 |
| CD (P=0.05) | 0.2 | 0.2 | 0.2 | 0.2 | 3 | 3 | 3 | 3 |
| Interaction | | | | | | | | |
| Vertisol + Control | 5.9 | 5.6 | 5.4 | 5.1 | 168 | 165 | 159 | 148 |
| Vertisol + 5 t FYM $ha^{-1}$ | 7.0 | 6.8 | 6.7 | 6.6 | 175 | 179 | 184 | 188 |
| Vertisol + 10 t FYM $ha^{-1}$ | 7.4 | 7.1 | 6.9 | 6.7 | 179 | 183 | 188 | 193 |
| Vertisol + 2.5 t VC $ha^{-1}$ | 7.2 | 7.0 | 6.8 | 6.5 | 181 | 186 | 190 | 195 |
| Vertisol + 5.0 t VC $ha^{-1}$ | 7.6 | 7.3 | 7.0 | 6.4 | 186 | 191 | 195 | 200 |
| Alfisol + Control | 4.4 | 4.4 | 4.2 | 4.1 | 158 | 155 | 149 | 139 |
| Alfisol + 5 t FYM $ha^{-1}$ | 5.5 | 5.3 | 5.2 | 5.1 | 165 | 172 | 178 | 184 |
| Alfisol + 10 t FYM $ha^{-1}$ | 5.5 | 5.4 | 5.4 | 5.2 | 171 | 177 | 184 | 191 |
| Alfisol + 2.5 t VC $ha^{-1}$ | 5.7 | 5.5 | 5.3 | 5.2 | 172 | 178 | 185 | 192 |
| Alfisol + 5.0 t VC $ha^{-1}$ | 6.0 | 5.8 | 5.2 | 4.9 | 176 | 183 | 189 | 196 |
| CD (P=0.05) | 0.3 | 0.3 | 0.3 | 0.3 | 5 | 5 | 5 | 6 |

*FYM - Farm yard manure, VC - Vermicompost*

amount of organic carbon content as compared to Vertisol. It was decreased with advancement of incubation period. All the levels of organic manures irrespective of source significantly increased, The organic carbon content at different incubation periods. An appreciable variation was obtained in the organic carbon content perhaps due to increased addition of organic matter through FYM and VC. The lower organic carbon content was noticed in control treatment where no FYM/VC was applied. The application of FYM and VC improved the organic carbon content significantly over control at all incubation period under study. The 10 t FYM $ha^{-1}$ and 5 t VC $ha^{-1}$ differed significantly in respect of organic carbon content at 15 and 30 days of incubation. These results confirm the findings of Bahadur *et al.,* (2012) who observed significant increase in soil organic carbon, available P and K content in sodic soil with the addition of FYM. Roy and Kashem (2014) also observed an increasing trend in organic carbon contents of manure treated soils reached its peak at 15 days of incubation and decreased thereafter with time regardless of the type of manures. At higher incubation period, the decreasing trend in organic carbon was noted due to the fact that after addition of organic matter, microbial population increases in soil which utilized organic carbon as a source of energy. The addition of 5 t VC $ha^{-1}$ in vertisol showed significantly higher organic carbon content (7.6 g $kg^{-1}$) at 15 days of incubation. Similarly, addition of 5 t VC $ha^{-1}$ in Alfisol showed similar trend in respect of organic carbon content.

The Vertisol showed significantly higher available nitrogen content i.e. 177, 180, 183 and 184 kg $ha^{-1}$ at 15, 30, 45 and 60 days after incubation, respectively as compared to Alfisols (Table 2). Application of 5 t VC $ha^{-1}$ showed highest available nitrogen content i.e. 181, 187, 192 and 198 kg $ha^{-1}$ at 15, 30, 45 and 60 days after incubation, respectively. This proved significantly superior in respect of available N over other treatments of organic manures. Application of 5 t VC $ha^{-1}$ in vertisol showed maximum available nitrogen content i.e. 186, 191, 195 and 200 kg $ha^{-1}$ at 15, 30, 45 and 60 days after incubation. It was significantly higher over other treatments. Jha and Rattan (2007) also obtained an improvement in available nitrogen with the addition of organics. With the advancement of incubation period (15 to 60 days) the C:N ratio tended to become narrower (Table 3). The behaviour of both the soils was similar in expressing the narrowing down the

Table 3: Effect of soils, organics and their interactions on C:N ratio and bacterial count at different incubation periods

| Treatments | C:N ratio | | | | Bacterial count ($x10^6$ $g^{-1}$) | | | |
|---|---|---|---|---|---|---|---|---|
| | Incubation period (days) | | | | Incubation period (days) | | | |
| | 15 | 30 | 45 | 60 | 15 | 30 | 45 | 60 |
| Soils | | | | | | | | |
| Vertisol | 15.05 | 14.34 | 13.35 | 12.63 | 48.4 | 59.8 | 66.0 | 72.0 |
| Alfisol | 14.81 | 14.11 | 12.81 | 12.33 | 38.4 | 47.8 | 56.2 | 58.0 |
| CD (P=0.05) | 0.08 | 0.06 | 0.07 | 0.06 | 2.8 | 2.5 | 2.7 | 3.2 |
| Organics | | | | | | | | |
| Control | 12.84 | 12.63 | 12.59 | 12.33 | 24.0 | 33.0 | 41.3 | 37.5 |
| 5 t FYM $ha^{-1}$ | 15.18 | 14.51 | 13.31 | 13.02 | 27.5 | 44.0 | 49.0 | 52.5 |
| 10 t FYM $ha^{-1}$ | 15.48 | 14.72 | 13.31 | 12.66 | 53.5 | 58.5 | 66.0 | 73.0 |
| 2.5 t VC $ha^{-1}$ | 15.26 | 14.44 | 13.25 | 12.55 | 46.0 | 54.5 | 67.0 | 74.0 |
| 5.0 t VC $ha^{-1}$ | 15.89 | 14.80 | 12.95 | 11.83 | 66.0 | 79.0 | 82.1 | 88.0 |
| CD (P=0.05) | 0.12 | 0.12 | 0.13 | 0.12 | 4.4 | 4.0 | 4.3 | 5.0 |
| Interaction | | | | | | | | |
| Vertisol x Control | 13.11 | 12.58 | 12.55 | 12.11 | 28.1 | 35.3 | 42.2 | 43.5 |
| Vertisol x 5 t FYM $ha^{-1}$ | 15.12 | 14.61 | 13.62 | 13.24 | 35.3 | 55.1 | 56.3 | 63.2 |
| Vertisol x 10 t FYM $ha^{-1}$ | 15.90 | 15.15 | 13.50 | 12.93 | 60.2 | 70.7 | 82.5 | 85.6 |
| Vertisol x 2.5 t VC $ha^{-1}$ | 15.23 | 14.51 | 13.67 | 12.80 | 43.2 | 59.4 | 67.3 | 78.2 |
| Vertisol x 5.0 t VC $ha^{-1}$ | 15.91 | 14.84 | 13.41 | 12.07 | 76.1 | 80.1 | 83.2 | 91.1 |
| Alfisol x Control | 12.57 | 12.68 | 12.63 | 12.56 | 20.4 | 31.3 | 41.3 | 32.6 |
| Alfisol x 5 t FYM $ha^{-1}$ | 15.24 | 14.42 | 13.00 | 12.80 | 30.2 | 33.1 | 42.1 | 42.2 |
| Alfisol x 10 t FYM $ha^{-1}$ | 15.06 | 14.30 | 13.12 | 12.40 | 47.6 | 47.4 | 50.4 | 61.1 |
| Alfisol x 2.5 t VC $ha^{-1}$ | 15.30 | 14.38 | 12.83 | 12.30 | 49.3 | 50.6 | 67.4 | 70.3 |
| Alfisol x 5.0 t VC $ha^{-1}$ | 15.88 | 14.76 | 12.50 | 11.60 | 56.4 | 78.1 | 81.6 | 85.2 |
| CD (P=0.05) | 0.17 | 0.14 | 0.17 | 0.13 | 6.2 | 5.7 | 6.1 | 7.1 |

C:N ratio.However, the magnitude of C:N ratio was higher in Vertisol as compared to Alfisol. Addition of organics showed significantly wider C:N ratio over control. Application of higher dose of organics i.e. 10 t FYM $ha^{-1}$ and 5 t VC $ha^{-1}$ showed similar impact on C:N ratio in both the soils at all the incubation periods. The narrowest C:N ratio (11.60) was recorded in Alfisol with 5 t VC $ha^{-1}$ at 60 days after incubation, similarly at 15 day in alfisol without organics (12.57), at 30 days in Vertisol without organics (12.58) and at 45 days in Alfisol with 5 t VC $ha^{-1}$ (12.50). These findings are in close agreement with the observations of Sitaramalakshmi *et al.,* (2013) who also reported a decreasing trend in C:N ratio due to application of organic matter. The organics and their interactions with soils had significant effect on bacterial counts at all the incubation periods (Table 3). Bacterial counts were found significantly higher in Vertisol as compared to Alfisol. The bacterial counts recorded in Vertisol were $48.4x10^6$, $59.8x10^6$, $66.0x10^6$ and $72.0x10^6$ $g^{-1}$ at 15, 30, 45 and 60 days after incubation.

The application of FYM and VC showed a significant increase in bacterial population over control. The highest bacterial counts were observed in 5 t VC $ha^{-1}$ i.e. $66.0x10^6$, $79.0x10^6$, $82.1x10^6$ and $88.0x10^6$ $g^{-1}$ at 15, 30, 45 and 60 days incubation, respectively which were significantly higher over other treatments of organics. The addition of 5 t VC $ha^{-1}$ in vertisol showed highest ($7.16x10^6$ $g^{-1}$) bacterial counts at 15 days of incubation. The addition of organic matter in the form of organics served as a source of nutrients and also as a substance for decomposition and mineralization of nutrients, thereby creating a favourable condition for proliferation of microbes in the soil. Jadhav *et al.,* (2016) also obtained higher bacterial counts in soil with the addition of organics in the form of VC, FYM and neem cake in banana cultivation.

From the results, it may be concluded that vermicompost proved its superiority over FYM in both the soils in improving the organic carbon, available nitrogen in soil as well as the bacterial counts.

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