

Comprehensive Characterization of the Functional Groups from Humic Substances

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(Received : 22.05.2024 Accepted : 20.06.2024)

Abstract

An incubation study was conducted at the laboratory of Soil Science, central campus MPKV, Rahuri. The experiment was laid out in complete randomized block design (CRD) which comprised of organic manures viz; farm yard manure, vermicompost, poultry litter, press mud compost, urban compost and Inceptisol soil. Humic acids were extracted from different organic manures were characterized by chemical methods. The samples were collected for analysis at 0 and 120 days. The total acidity (TA) of different organic manures ranged between 0.53 me g^{-1} to 7.35 me g^{-1} and 0.54 me g^{-1} to 8.52 me g^{-1} , for 0 and 120 days, respectively. The carboxyl (COOH) group ranged from 0.11 me g^{-1} to 5.73 me g^{-1} and 0.12 me g^{-1} to 6.86 me g^{-1} , for 0 and 120 days, respectively. The phenolic-OH content ranged from 0.42 me g^{-1} to 2.99 me g^{-1} and 0.42 me g^{-1} to 3.25 me g^{-1} , at 0 and 120 days. The aim of this study is to investigate chemical characteristics during incubation period of humic substances present in different organic manures.

Key words : Total acidity, carboxylic, phenolic, humic substances.

Organic matter content strongly affects the soil fertility by increasing the availability of plant nutrients, by improving the soil structure and the water holding capacity, and by acting as an accumulation phase for toxic, heavy metals in the soil environment (Stevenson, 1985). As organic matter breaks down, it forms humus, a stable substance that enhances soil's ability to retain water, supports microbial activity, and improves soil texture. The primary measure of soil health and quality, soil organic matter (SOM), is heavily influenced by agricultural management practices.

Humic substances are often described as coiled, long chain molecules of two or three-dimensional cross-linked macromolecules which may vary in molecular weight depending on type of humic acid and method of measurement (Stevenson, 1994). Humic compounds have long been known to improve soil fertility through bettering physical conditions that lead to beneficial crop growth and making nutrients,

especially cationic nutrients, easier to move and more readily available. About 60% of organic matter is made up of humic compounds, which include humic acid, fulvic acid, and other similar chemicals.

The aim of this study is to investigate chemical characteristics during incubation period of humic substances present in different organic manures.

Study area : Geographically the central campus of MPKV, Rahuri is situated between $19^{\circ}34'$ N latitude and $74^{\circ}64'$ E longitude elevation of 513 meter above Mean Sea Level. Farmyard manure (FYM), vermicompost (VC), poultry litter (PL), press mud compost (PMC) and urban compost (UC) were used as different organic manures collected from Post graduate farm, MPKV, Rahuri. Dist Ahmednagar.

Material and Methods

The incubation study was carried out at

laboratory of Soil science, central campus MPKV, Rahuri. Five different organic manures analysed were used viz., farm yard manure (FYM), Vermicompost (VC), Poultry litter (PL), Press mud compost (PMC) and Urban compost (UC). The collected manures were weighed and filled into bottles separately for incubation at 300C. Moisture was maintained into every bottle. The periodical observations were taken from the samples collected for analysis at 0 days and 120 days. The extraction of Humic acid from various organic manures was performed according to Schnitzer (1982). Humic acid obtained after extraction were analysed for total acidity and carboxylic groups as per Martin et al., (1963). The difference between carboxyl groups and overall acidity was attributed to phenolic hydroxyl.

Result and discussion

The incubation study was conducted on different organic manures at central campus MPKV, Rahuri. The result of the investigation is described under following heading.

Characterization of Functional group :

Details of data regarding Functional group contents of Humic Acid are presented in Table 1 and Table 2.

Total acidity : The total acidity for different organic manures was recorded during the incubation period. The total acidity (TA) of humic acid of different organic manures ranged between 0.53 to 7.35 me g⁻¹ and 0.54 to 8.52 me g⁻¹, at initial (0) days and 120 days respectively. It was found that amongst all the organic manures press mud compost (PMC) consisted of highest total acidity content of 7.35 me g⁻¹ and 8.52 me g⁻¹, respectively. Significantly lowest value was recorded for inceptisol soil i.e., 0.53 and 0.61 me g⁻¹, respectively at 0 and 120 days. Functional groups obtained from humic acid are similar to those obtained by Sanyal, S. K. (2002), Srilatha

(2014) and Ramalakshmi *et al.* (2011). The research findings were in similar trend with Banik, G. C., and Sanyal, S. K. (2006). Srilatha (2001), Sujana Reddy and Rao (2000) observed that increase in total acidity with decreasing molecular weight was in consistence with increasing degree of oxidation of low molecular weight fractions.

COOH : The Periodical changes in different organic manures during decomposition period were recorded. It can be seen that, the carboxyl group content increased gradually up to the end of the incubation period. (Table 2)

The carboxyl group (COOH) of humic acid ranged between 0.11 me g⁻¹ to 5.73 me g⁻¹ and 0.12 me g⁻¹ to 6.86 me g⁻¹, respectively at the start to end period of incubation study. The highest value amongst different organic manures used was found to be in press mud compost i.e.,

Table 1. Functional group contents of Humic Acid at 0 Days

Material	Total acidity (me g ⁻¹)	COOH (me g ⁻¹)	Phenolic -OH (me g ⁻¹)
Farm yard manure (FYM)	3.46	2.11	1.35
Vermicompost (VC)	4.17	2.84	1.33
Poultry litter (PL)	7.28	5.14	2.14
Press mud compost (PMC)	7.35	5.73	1.62
Urban compost (UC)	6.15	3.16	2.99
SOIL	0.53	0.11	0.42

Table 2. Functional group contents of Humic Acid at 120 Days

Material	Total acidity (me g ⁻¹)	COOH (me g ⁻¹)	Phenolic -OH (me g ⁻¹)
Farm yard manure (FYM)	4.59	3.47	1.12
Vermicompost (VC)	5.25	3.76	1.49
Poultry litter (PL)	8.46	6.24	2.28
Press mud compost (PMC)	8.52	6.86	1.66
Urban compost (UC)	7.28	4.57	3.25
SOIL	0.54	0.12	0.42

5.73 and 6.86 me g⁻¹ at both 0 and 120 days, respectively. Carboxyl group imparts acidity to the humic fractions was observed. Similar findings were reported by Kar (2004)

Phenolic-OH : The results of phenolic-OH status are presented in Table 1 and 2. Here, at 0 and 120 days, urban compost records highest value in phenolic-OH group of 2.99 me g⁻¹, respectively. Higher content of carboxyl groups in humic acid than phenolic-OH groups suggest that the carbohydrates and phenolic compounds produced were easily degradable and thus readily converted to carboxyl groups on subsequent oxidation. These results are in accordance with the findings of Satisha and Devarajan (2011); Erdogan *et al.* (2007) and Banik and Sanyal (2006).

Conclusions

The incubation study conducted on different organic manures revealed significant changes in the chemical characteristics of humic acids over the 0-120 days of period. Total acidity, carboxyl groups, and phenolic-OH content showed a noticeable increase in all organic manure types during incubation. These findings highlight the dynamic nature of humic substances in organic manures, contributing to a better understanding of their role in soil health and fertility. The results provide valuable insights for improving organic amendments in sustainable agriculture practices.

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