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Effect of Long Term Application of Fertilizers and Manures on Organic Matter Fractions at different Depths Under Soybean-wheat Sequence in Vertisol

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ABSTRACT: The study was aimed to enquire the effect of long term application of fertilizers and manures on soil organic matter fractions at different depths under soybean-wheat sequence in vertisol. The experiment was conducted during the year of 2016-17 at Research Farm of Department of Soil Science and Agricultural Chemistry, JNKVV, Jabalpur. Effect on varying doses of N, NP, NPK, NPK with FYM, Zn on organic matter fractions viz., Humic acid, Fulvic acid and Humin after 46 year of soybean-wheat crop sequence was studied. The study includes ten different treatments i.e. 50% NPK, 100% NPK, 150% NPK, 100% NPK+HW, 100% NPK+ Zn, 100% NP, 100% N, 100% NPK+FYM, 100% NPK-S and control. The result obtained from the study revealed that application of 100 % NPK + FYM @ 15t ha^{-1} to soybean and wheat significantly increased the organic matter fractions in the soil. Combined use of 100% NPK and FYM was significantly superior over all the treatments. It was also observed that the soil organic matter fractions decreased significantly with the soil depth from 0-15cm to 30-45cm among various treatments.

Keywords: Long term fertilizer experiment, Humic acid, Fulvic acid, Humin, Vertisol

INTRODUCTION

Soil organic matter (SOM) act as a source of nutrients in soil and it has a wide range of effect on the physical, chemical, and biological properties of soils. Soil organic matter has charge properties which play as a site for ion exchange. Soil microorganisms used it as a source of energy and it influences the different biological processes in the soil. The SOM pool comprises active, intermediate/slow, and passive pools, which act as sensitive indicators of soil quality (Manna *et al.*, 2013). These active and passive organic pools of the SOM, act as highly sensitive indicators of soil fertility and productivity. The active pools (water-soluble carbon and water-soluble carbohydrate (WS-CHO)) generally contribute about 10–20% toward total SOM, whereas the stable or passive pools (humic acid (HA) and fulvic acid (FA)) have 80–90% contribution toward total SOM (Brady and Weil 2002). The buildup in these pools of SOM is a slow process and may take even more than three decades for any significant change as a result of different management practices (Baldock and Skjemstad 1999).

The quantity and quality of organic matter are greatly influenced by vegetation, climate, soil reaction, and biological conditions. Humified organic matter will have a strong impact on soil fertility and may need to be taken into consideration in development of fertilizer recommendations. Several workers reported that SOM levels increased markedly in plots receiving farmyard manure (FYM) and long-term continued use of inorganic fertilizers containing nitrogen (N), phosphorus (P), and potassium (K) (Sharma and Subehia 2014; Verma *et al.*, 2012). Long-term fertilizer experiments (LTFE) gives credential information on the effect of continuous application of different levels of fertilizer nutrients and organic manures under intensive cropping on soil fertility and crop productivity. Long-term experiments are the primary source of information to determine the effect of cropping systems on soil quality attributes (Lakaria *et al.*, 2017). Soil quality attributes may include humin, humic acid, fulvic acid content that are most sensitive to management inputs and to ascertain the impact of long-term use of integrated nutrient on soil health (Kharche *et al.*, 2013). These advanced information of soil organic matter is used to improve integrated nutrient management system to maintain the soil health and soil quality.

As information is lacking on the long-term effect of fertilization and manuring on changes in the soil organic matter fractions in a Vertisol under soybean-wheat cropping system at different soil depths, this study has been conducted. The hypothesis of the investigation was that the long-term fertilization and manuring under intensive cropping system may influence the soil organic matter fractions and ultimately the crop productivity. Therefore, the objective of the study is to understand the changes in the soil organic matter fractions at different depths under soybean-wheat sequence in vertisol.

MATERIALS AND METHODS

Present study was conducted during kharif and Rabi seasons of 2016-17 at the LTFE research field college of agriculture, JNKVV Jabalpur. Long fertilizer experiment in JNKVV, Jabalpur was started in the year 1972, to study the effect of continuous application of inorganic fertilizer (NP &K) and manure in a soybean-wheat crop sequence. This experiment revealed that the application of various amount of major nutrient fertilizers which change the soils major nutrient status soil organic carbon fractions. The characteristics feature of Jabalpur region is semiarid and subtropical in climate with dry summer and cold winter. The location of the experiment is situated at $23^{o}10''$N latitude and $79^{o}57''$E longitude and at 393 meters above the mean sea level.

The long-term fertilizer experiment includes 10 treatments and each treatment had four replicates were arranged in a simple randomized block design in both soybean and wheat. The 10 treatments under the study: T1- 50 % NPK, T2- 100 % N P K, T3 -150 % N P K, T4 - 100 % N P K + HW, T5 - N P K + Zn, T6 - 100 % N P, T7 - 100 % N, T8 - 50 % N P K + FYM, T9 - 100 % N P K- S, T10 – Control. Soil samples for the present study were collected with using tube auger and from each treatment. The sample soils were collected from three depths of 0-15, 15-30 and 30-45cm of surface and sub-surface soil after the harvest of soybean and wheat. Soil organic matter fractions viz. humic acid, fulvic acid and humin were analyzed by Stevenson (1965) method.

RESULT AND DISCUSSION

A. Humic Acid

Data obtained from the experiment on humic acid reveals that the application of nutrients changes in humic acid content in soil. The values of humic acid varies from 0.33, nutrients changes humic acid content in soil. The values of humic acid varies from 0.33, 0.30 & .26 g kg^{-1} in control (lowest) to 1.23, 1.18 & 1.10 g kg^{-1} in the treatment received 100%NPK+FYM after the harvest of soybean. The increase in HA content in 100% NPK + FYM-treated plots over control might be attributed to lesser depolymerization of small-chain carbon compounds at moderate soil pH (Yagi *et al.,* 2003). Gathala *et al.* (2007); Srilatha *et al.* (2013) reported that HA contents increased due to application of organic amendments to the soil.

Data further indicates that application of NPK and increase in quantity of NPK from 50 to 100 % and to 150% NPK results concomitant increase in the humic acid content and these values were 0.53, 0.87 & 1.10 g kg^{-1} at 0-15cm depth, 0.49, 0.83 & 1.05 g kg^{-1} at 15-30cm and 0.44, 0.76 & .96 g kg^{-1} at 30-45cm depth of soil respectively. The values of humic acid content in 150% NPK and NPK+ FYM were significantly superior over rest of the treatments. The results also showed that the distribution of humic acid content with soil depths varied from for 0-15 to 15-30, 30-45cm over the various treatments of experiment. It was found that humic acid content in the soil decreases significantly with depth i.e. maximum value in 0-15cm and minimum in 30-45cm soil depth. The manurial treatments were produced variations in humic acid (HA) content. The higher clay content in the soil causes the humic acid under FYM at high level as it contributes for humification (Lavti and Paliwal, 1981; Zhang *et al*., 1988).

B. Fulvic acid

Fulvic acid (FA) is a part of the organic matter soluble in alkali and it remains in solution when the humic acid is precipitated with acid. The data obtained from the experiment revealed that treatment NPK + FYM (1.14, 1.13 & 0.90 g kg^{-1}) shows the increased status of fulvic acid significantly and followed by 150% NPK, 100% NPK, and 50% NPK. The values these treatments varied from (0.39, 0.52 & 1.01 g kg^{-1}) at 0-15cm, (0.37, 0.50 & 1 g kg^{-1}) at 15-30cm and (0.35, 0.46 & 0.85 g kg^{-1}) at 30-45cm depth of soil. Fulvic acid content in the soil significantly increased with the application of major nutrient fertilizer and manure. Similar positive influence of FYM on FA content has also been reported by Srilatha *et al.* (2013); Song *et al*. (2014). Similarly, Gathala *et al.*, (2007) showed that contents of fulvic acid in the soil significantly increased with the application of fertilizer and farm yard manure. The values of fulvic acid in soil among different treatments varied from control (Lowest) to 100% NPK + FYM (Highest) i.e. 0.23 to 1.14 g kg^{-1} in surface layer of 0-15cm, 0.2 to 1.13 (15-30cm) and 0.20 to 0.90 (30-45cm) in subsurface layers of soil. 100% NPK + FYM was significantly superior over rest of the treatments. This result was also confirmed by Kumari *et al.* (2011) who reported that continuous application of organic manure alone or in combination with inorganic fertilizer significantly influenced the fulvic acid fraction in soil. Fulvic acid constituents bind soil particles into structural units called soil aggregates, which helps in the mobilization and transport of sesquioxides in soil by Tripura *et al*. (2020). The data obtained from the experiment revealed that fulvic acid content in soil at 0-15cm depth was significantly higher than those in 15-30cm and 30-45cm soil depth.

C. Humin

Humin is the insoluble component of soil organic matter. Application of varying levels of major nutrients NPK and organic manures significantly influence the humin content in soil. It varied from 3.73, 3.18 and 2.99 g kg^{-1} (Lowest) in control to 6.23, 5.68 and 4.64 g kg^{-1} (highest) in NPK+FYM treated plot at 0-15, 15-30 and 30-45cm depths of soil. Data further illustrates that

increase in dose of nutrient from 50 to 100 per cent and to 150 per cent result increases in humin content and the respective values were 5.10 to 5.98 g kg^{-1} at 0-15 cm, 4.56 to 5.35 g kg^{-1} at 15-30 cm and 4.3 to 5.09 g kg^{-1} soil. The various treatments of organic manure and inorganic fertilizer were statistically superior over control. Meena *et al.* (2017) also reported that among the twelve different treatments the highest huminfraction were obtained under the application of FYM 20 t ha^{-1} than other treatment. The results indicate that Humin fraction decreased significantly with the soil depth from 0-15cm to 30-45cm across various treatments in the soil. The humin fraction was increase in the concentration of mineralization owing to the higher temperature of surface soil in tropical regions (Santhy *et al.*, 2001). Critical observation of data revealed that decline in humin content with imbalance application of nutrient (N alone) and unfertilized continuously for long period (control). It is interesting that incorporation of FYM and application of NPK fertilizer increases the Humin content. However, a reverse trend was found in humin content on application of fertilizer, due to decline in organic carbon. Tripura *et al.* (2020) reported that continuous addition of organic and inorganic treatments noticed increased content of humin status in soil over control. The reason might be due to better and improved soil physical parameters and conductive environment for its fraction.

Table 1: Effect of long-term application of fertilizer and manure on HA, FA & Humin at various depths.

Treatment	Humic acid			Fulvic acid			Humin		
	0-15cm	15-30cm	30-45cm	0-15cm	15-30cm	30-45cm	0-15cm	15-30cm	30-45cm
50%NPK	0.53	0.49	0.44	0.39	0.37	0.35	5.10	4.56	4.30
100%NPK	0.87	0.83	0.76	0.52	0.50	0.46	5.98	5.35	5.09
150%NPK	1.10	1.05	0.96	1.01	1.00	0.85	6.46	5.94	5.69
100%NPK+HW	0.86	0.82	0.75	0.54	0.53	0.48	6.04	5.37	5.13
100% NPK+ Zn	0.85	0.81	0.74	0.52	0.51	0.47	6.12	5.46	5.21
100%NP	0.69	0.66	0.61	0.49	0.48	0.43	5.76	5.21	4.92
100%N	0.41	0.37	0.33	0.30	0.28	0.28	4.59	4.00	3.79
100%NPK+FYM	1.23	1.18	1.10	1.14	1.13	0.90	6.64	5.98	5.69
100% NPK-S	0.67	0.63	0.59	0.44	0.42	0.39	6.07	5.36	5.14
Control	0.33	0.30	0.26	0.21	0.18	0.21	3.73	3.18	2.99
SEm+	0.008	0.010	0.019	0.005	0.065	0.018	0.031	0.062	0.063
CD (p=0.05)	0.022	0.029	0.055	0.013	0.188	0.052	0.090	0.180	0.183

CONCLUSION

Long-term fertilizer experiments of more than four decades have shown a build-up in soil organic matter fractions as a result of combined application of organic manures and inorganic fertilizers under soybean–wheat cropping system. Integrated use of farmyard manure and fertilizers maintained and improved soil organic carbon. The results showed that the treatment 100 % NPK + FYM in soybean-wheat sequence registered significantly higher value of humic acid, fulvic acid & humin content in soil over control during the year 2016 after the harvest of wheat. The continuous addition of organic and inorganic treatments noticed increased organic matter fractions in soil. It is due to better and improved soil physical parameters and conductive environment for its fraction. Thus, NPK + FYM were the best option for increasing organic matter status in soil. Thus the balanced application of NPK fertilizers with FYM was the best option for nutrient management in intensive cropping system to improve the soil fertility and productivity of soils in soybean-wheat cropping system.

FUTURE SCOPE

Continuous cropping with fixed treatment of fertilizer and manure has stabilized the experiment therefore the data generated over the years may serve as valuable parameter for the development of models for carbon sequestration and prediction of other soil nutrient status in soil.

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Conflict of Interests. None.

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