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# Effect of long term application of fertilizer and manure on passive pool of organic carbon under maize-wheat sequence in *Heplustepts*

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**Abstract**
A field study entitled "Effect of long term application of fertilizer and manure on passive pool of organic carbon under maize-wheat sequence in *Heplustepts*" was conducted during *Kharif* 2013-14 and 2014-15 in the Long Term Fertilizer Experiments initiated in *Kharif*, 1997 at the Instructional Farm of the Rajasthan College of Agriculture, Udaipur. The soil of the experimental site was sandy clay loam in texture, slightly alkaline in reaction, medium in available nitrogen and phosphorus, while high in potassium and zinc. The objective of study was to assess the effect of continuous application of plant nutrients through organic and inorganic sources and its combination on passive fractions of soil organic carbon. Twelve treatments i.e. control, 100 % N, 100 % NP, 100 % NPK, 100 % NPK + Zn, 100 % NPK + S, 100 % NPK + Zn + S, 100 % NPK + *Azotobacter*, 100 % NPK + FYM 10 t $ha^{-1}$, FYM 10 t $ha^{-1}$ + 100 % NPK (-NPK of FYM), 150 % NPK and FYM 20 t $ha^{-1}$ were evaluated under randomized block design (RBD) with four replications. The results of the present investigation revealed that the highest Humin, Humic and Fulvic acid were obtained under the application of FYM 20 t $ha^{-1}$.

**Keywords:** organic manure, bio-fertilizer (*Azotobacter*), Humin, Humic acid, Fulvic acid

## Introduction

The amount of SOM in soils of India is relatively low (0.1 to 1.0%) and typically less than 0.5%. The maintains of organic carbon in tropical soils up to a desirable level of 0.5- 1.0 per cent is extremely important for sustainable crop production (Swarup and Wanjari, 2000) [24, 25]. In the tropics, SOM determines the fertility and productivity of soils, especially when these are highly weathered, with small or no reserves of nutrients and are managed without any external inputs of organic or inorganic fertilizer.

The SOM is composed of series of fractions from very active and passive pools. These fractions act as highly sensitive indicators of soil fertility and productivity. In the sequence of humification process, first the decomposition products of the original plant residues are active fractions. The active fractions include soil microbial biomass, water soluble carbohydrates and it rarely comprise more than 10 to 20 per cent of total SOM (Smith and Paul 1990) [22]. It provides most of the readily accessible food for the soil organisms. Microbial biomass represents a significant part of the active SOM pool (Schnurer *et al.*, 1985) [18]. The subsequent decomposition/synthesis products of humification process are passive fraction of SOM. It includes humus physically protected in clay- humus complexes viz., humin and humic acids. The passive fractions contribute to the colloidal properties of soil, CEC and WHC (Smith and Paul 1990) [22].

Sustainable agriculture involves successful management of resources for increase agricultural production to satisfy changing human needs, while maintaining or enhancing the environment and natural resources (FAO, 1989) [5]. The amount of SOM in soils of India is relatively low (0.1 to 1.0%) and typically less than 0.5%. The maintenance of organic carbon in tropical soils up to a desirable level of 0.5- 1.0 per cent is extremely important for sustainable crop production (Swarup and Wanjari, 2000) [24, 25]. In the tropics, SOM determines the fertility and productivity of soils, especially when these are highly weathered, with small or no reserves of nutrients and are managed without any external inputs of organic or inorganic fertilizer. Long-term experiments initiated during 1930's and 1940's in India revealed that for sustained crop production adequate P and K fertilization was necessary along with nitrogen (Nambiar and Abrol, 1989) [14].

The major constraint affecting the soil fertility is the adequate availability of suitable fertilizer and organic manures. Under the normal soil condition of the Udaipur region choosing of suitable Bio-fertilizer and fertilizer is a necessity for soil fertility sustainability.

Concomitantly, adoption of appropriate integrated nutrient management operations may result in acceptable phenotypical characteristics of soil, *viz*., Humin, humic acid, and fulvic acid ultimate enhancement of on organic carbon frication. One of the feasible solutions for addressing the imbalanced nutrient and related constrains, is the applied of Bio-fertilizer, which promote soil fertility and organic carbon in soil.

The soil fertility of Udaipur region is decreasing day by day due to low use of farmyard manure and consequently increase in use of chemical fertilizers, our aim is to study the trend of change in different organic carbon fractions of soil as influenced by continuous application of fertilizer and manure. The organic matter is decreasing in our soil. Therefore such study will generate useful information on managing soil health. Organic matter fractions from the soil of long-term field experiment will provide a platform for predicting the organic matter status of these soils.

**Materials and Methods**

At the inception of the experiment, the composite soil samples were drawn from 0-15 cm depth prior to treatment application in order to as certain initial fertility status and physico-chemical properties of the experimental soil. The soil having pH 8.20, EC 0.48 $dSm^{-1}$, Organic carbon 6.80 g $kg^{-1}$, available Nitrogen 360 kg $ha^{-1}$, available phosphorus 22.4 kg $ha^{-1}$, available potassium 671 kg $ha^{-1}$, available Zn 3.76 mg $kg^{-1}$, available Fe 2.52 mg $kg^{-1}$. The experiment was carried out at the Instructional Farm of the Rajasthan College of Agriculture, Udaipur, in randomized block design (RBD) with four replications. The treatments control, 100 % N, 100 % NP, 100 % NPK, 100 % NPK + Zn, 100 % NPK + S, 100 % NPK + Zn + S, 150 % NPK, 100 % NPK + *Azotobacter*, FYM 10 t $ha^{-1}$ + 100 % NPK (-NPK of FYM), 100 % NPK + FYM 10 t $ha^{-1}$ and FYM 20 t $ha^{-1}$. The active pool of soil organic carbon were estimated with method of Stevenson, 1965. Statistical analysis was done as outlined by Panse and Sukhatme (1985) [16]. The data so generated during the course of present investigation were subjected to simple correlations, regression analysis.

**Result and Discussion**

Among the different passive pools Humin was maximum followed by Humic acid and Fulvic acid (Table-1) regardless the treatments. Contents of Humin, Humic acid and Fulvic acid increased in soil significantly with the application of fertilizer and farm yard manure. The highest Humin, Humic acid and Fulvic acid 0.565, 0.318 and 0.198 per cent was recorded under FYM @ 20 t $ha^{-1}$ followed by 0.553, 0.310 and 0.195 per cent, respectively under 100% NPK + FYM @ 10 t $ha^{-1}$, which should be have to improved soil organic matter and a conducive environment for the fraction of humic acid (Sharma and Gupta, 1998, Santhy *et al.*, 2001) [19, 20, 17].

Among the treatments receiving chemical fertilizer alone, passive fraction of organic carbon were highest under 150% NPK. The addition of root residue consequent to higher biomass might have produced more amount of humus fraction.

Amount of humic acid was higher than the fulvic acid regardless of treatments. Fulvic acid although primarily considered to be humic acid precursor, may be humic acid degradation as well. It is probable that fulvic acid can be adsorbed onto clay, but the size of their molecules suggest that the force of attraction would be less than those for larger humic acid constituents (Anderson, 1979) [2]. Humic acid/ Fulvic acid ratio was recorded less with the application of farm yard manure alone or along with inorganic fertilizer due to the positive association between fulvic acid and total organic matter (Blaszozy, 1991; aleshin *et al.,* 1994) [4, 1]. The increase in the magnitude of organic matter fractions might have been due to faster rate of decomposition and mineralization owing to the higher temperature of the surface soil in tropical regions (Sharma *et al.,* 1988; Santhy *et al.,* 2001) [19, 20, 17].

There was progressive increase in humin and humic acid significantly higher values (humin at 2013-14 (0.562%), at 2014-15 (0.569%), pooled (0.565) and humic % at 2013-14 (0.317), at 2014-15 (0.320), pooled (0.318) respectively) observed in treatment $T_{12}$ (FYM 20 t $ha^{-1}$). However humin and humic % treatment $T_9$ (100% NPK + FYM 10 t $ha^{-1}$) was found to be statistically at par with $T_{12}$ (FYM 20 t $ha^{-1}$). However at 2013-14, 2014-15 and pooled humin % highest (0.562, 0.569 and 0.565 respectively) were observed in treatment $T_{12}$ (FYM 20 t $ha^{-1}$), which was 55.67, 54.62 and 55.22% higher than lowest value (0.361, 0.368 and 0.364 respectively) in treatment $T_1$ Control. However at 2013-14, 2014-15 and pooled humic % highest (0.317, 0.320 and 0.318 respectively) were observed in treatment $T_{12}$ (FYM 20 t $ha^{-1}$), which was 38.42, 38.52 and 38.26% higher than lowest value (0.229, 0.231 and 0.230 respectively) in treatment $T_1$ Control.

There was progressive increase fulvic % significantly higher values (at 2013-14 (0.194), at 2014-15 (0.202) and pooled (0.198) respectively) observed in treatment$T_{12}$ (FYM 20 t $ha^{-1}$). However fulvic % treatment$T_9$ (100% NPK + FYM 10 t $ha^{-1}$) and treatment $T_{10}$ (FYM 10 t $ha^{-1}$ + 100% NPK (-NPK of FYM) was found to be statistically at par with$T_{12}$ (FYM 20 t $ha^{-1}$). However at 2013-14, 2014-15 and pooled fulvic % highest (0.194, 0.202 and 0.198 respectively) were observed in treatment $T_{12}$ (FYM 20 t $ha^{-1}$), which was 113.18, 110.41 and 112.90% higher than lowest value (0.091, 0.096 and 0.093 respectively) in treatment $T_1$ Control.

The subsequent Decomposition/synthesis products of humification process are passive fraction of soil organic matter consisting of stable materials remaining in soil for hundreds or even thousands of years. This fraction includes humus physically protected in clay-humus complexes Viz. humin and humic acids. The passive fraction accounts for 60 to 80 per cent of the organic matter in moist soils and its quality is increased or diminished only slowly. The passive fraction contributes to the colloidal properties of soil cation exchange capacity and water holding capacity Similar findings was reported by (Smith and Paul, 1990) [22]. The important components that make up active fraction of organic matter are humic acid, fulvie acid and humin. Basically these three are similar but they differ in molecular weight, ultimate analysis and functional groups Similar findings was reported by.

The result showed a high buffering capacity of the humic substances and indicated that these substances behave as weak-acid polyelectrolytes, fulvic acid was found very different from humic acid and humin in composition and reactivity Similar findings was reported by Helal (2007) [11]

The quantity and quality of organic matter representative of humic and non humic substances were greatly influenced by vegetation Similar findings were reported by (Palaniappan. 1975: Budhilal and Rao, 1977) [15, 3], climate (Mukhuopadhyay *et al.*, 1982) [13], soil reaction (Shindo *et al.*, 1978; Ghosh and Schnitzer, 1980) [21, 9] and biological condition. Soil and crop management systems accentuate humification and increase the passive fraction of soil organic matter (Lal and Kimble, 1995) [12].

Application of organic manures such as Farmyard manure increases the availability of macro and micro nutrient, and promotes the activity of beneficial micro-organism. The long term effect on fertilization on fractionation of organic matter and found that OM, FA, HA content showed positive significant relationship with grain and fodder yield of maize. Similar findings was reported by Filon and Shelar (2002) [8] and Thakre and Ravankar (2004) [26].

The content of fulvic acid increased with increased levels of fertilizer application over control, respectively and higher content of humic acid and fulvic acid were recorded under 100% NPK+FYM. Similar findings was reported by

Humus Conservation in soils is favorably influenced by N fertilization through maintenance of equilibrium between humification and mineralization processes where organic-mineral fertilization of cultivated soils increases the fertility by accumulation of organic matter. Similar findings was reported by Tianu (1997) [27].

**Table 1:** Effect of Manure and Fertilizer on Humin, Humic and Fulvic Acid after harvest of wheat

| Treatment | HUMIN (%) | | | HUMIC (%) | | | FULVIC (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2013-14 | 2014-15 | Pooled | 2013-14 | 2014-15 | Pooled | 2013-14 | 2014-15 | Pooled |
| $T_1$ = Control | 0.361 | 0.368 | 0.364 | 0.229 | 0.231 | 0.230 | 0.091 | 0.096 | 0.093 |
| $T_2$ = 100% N | 0.383 | 0.388 | 0.385 | 0.242 | 0.244 | 0.243 | 0.099 | 0.103 | 0.101 |
| $T_3$ =100 NP | 0.445 | 0.452 | 0.448 | 0.252 | 0.256 | 0.254 | 0.113 | 0.117 | 0.115 |
| $T_4$ = 100% NPK | 0.451 | 0.454 | 0.453 | 0.272 | 0.277 | 0.274 | 0.119 | 0.121 | 0.120 |
| $T_5$ = 100% NPK + Zn | 0.448 | 0.453 | 0.451 | 0.264 | 0.266 | 0.265 | 0.125 | 0.128 | 0.127 |
| $T_6$ = 100% NPK+ S | 0.448 | 0.454 | 0.451 | 0.264 | 0.268 | 0.266 | 0.125 | 0.131 | 0.128 |
| $T_7$ = 100% NPK+ Zn + S | 0.459 | 0.463 | 0.461 | 0.266 | 0.269 | 0.267 | 0.124 | 0.131 | 0.128 |
| $T_8$ = 100% NPK + Seed treatment with Azotobactor | 0.472 | 0.476 | 0.474 | 0.285 | 0.289 | 0.287 | 0.161 | 0.169 | 0.165 |
| $T_9$ = 100% NPK + FYM 10 t $ha^{-1}$ | 0.548 | 0.557 | 0.553 | 0.309 | 0.311 | 0.310 | 0.191 | 0.199 | 0.195 |
| $T_{10}$ = FYM 10 t $ha^{-1}$ + 100% NPK (-NPK of FYM) | 0.505 | 0.511 | 0.508 | 0.297 | 0.299 | 0.298 | 0.189 | 0.197 | 0.193 |
| $T_{11}$ = 150% NPK | 0.501 | 0.507 | 0.504 | 0.293 | 0.298 | 0.296 | 0.165 | 0.152 | 0.158 |
| $T_{12}$ = FYM 20 t $ha^{-1}$ | 0.562 | 0.569 | 0.565 | 0.317 | 0.320 | 0.318 | 0.194 | 0.202 | 0.198 |
| S.Em.± | 0.007 | 0.007 | 0.005 | 0.003 | 0.003 | 0.002 | 0.002 | 0.003 | 0.002 |
| C.D. at 5 % | 0.020 | 0.020 | 0.014 | 0.009 | 0.010 | 0.007 | 0.007 | 0.010 | 0.006 |

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