International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2017; 5(6): 2019-2022

Received: 05-09-2017
Accepted: 06-10-2017

Avinash Singh Tomar
Department of Soil Science and Agricultural Chemistry, College of Agriculture (RVSKVV), Gwalior, Madhya Pradesh, India

Correspondence
Avinash Singh Tomar
Department of Soil Science and Agricultural Chemistry, College of Agriculture (RVSKVV), Gwalior, Madhya Pradesh, India

Study the effect of integrated nutrient management on carbon pools (Organic & microbial biomass carbon) in pearl millet- wheat cropping system

Avinash Singh Tomar

Abstract
The present study has been carried out at R.B.S. College, Agricultural Research Farm, Bichpuri, Agra during Kharif and Rabi seasons. It is situated at latitude of 2702' North, longitude of 7709' East and above of 168 m from mean sea level. Conjoint application of inorganic fertilizers along with *Azotobacter chroococcum* and farmyard manure play a significant role in sustaining crop productivity and restoring soil fertility. Because of their easy availability and capacity to supply major as well as micronutrients the farmyard manure can supplement the nutritional requirement of the crop. Keeping this in view, field experiments were conducted for two years using Pearl millet and wheat as test crops to study the influence of combined application of FYM, *Azotobacter chroococcum* and fertilizers on crop productivity and soil fertility. A significant effect of integrated nutrient supply of FYM and fertilizers on organic carbon and microbial biomass carbon content was observed in both crop seasons. Application of FYM alone also improved the buildup of organic carbon and microbial biomass carbon in soil. Similarly, NPK fertilizers also improved the status of organic carbon in soil. The data on the status of organic carbon and microbial biomass carbon in the soil after the harvest of Pearl millet crop in previous year indicate that all the treatments from T_2 to T_{12} increased over the treatment T_1 (control). The similar results were also obtained after the harvest of Pearl millet crop in 2nd year.

Keywords: OC, MBC, INM, carbon pools, soil organic matter, CEC

Introduction

Pearl millet--Wheat sequence is predominant in the north-Western plain zone and central zone of India. Even with the application of recommended dose of fertilizers, yield potential of this sequence (cereal-cereal) has reached to a plateau because of deterioration in soil health. In sustainable crop production, organic manuring plays an important role. The results of a large number of experiments on manures and fertilizers conducted in the country and abroad reveal that neither the chemical fertilizer alone nor the organic source exclusively can achieve the production sustainability of soils as well as crops under highly intensive cropping system. Therefore, it becomes necessary to know the suitable combination of chemical fertilizers with organic manures for profitable crop production in cereal based cropping systems. Soil organic matter (SOM) is a committal component of the terrestrial ecosystem because SOM as involved in the global bio-geo chemistry cycle of element and contributes to the chemical and physical fertility of soil. The ability of SOM to its fullest function depends on its quantity and on its turnover rates. The location of SOM in the soil structure appears to be the key factor that governs SOM stocks and dynamics. Tillage breaks soil aggregates and thereby expose SOM, which was previously protected within the aggregate structure on the other hand, SOM is known to be a major agent responsible for stabilizing aggregates. Several studies concluded that decrease in SOM content, through cultivation or tillage intensification, are often related to deterioration of soil structure e.g. loss of aggregate stability and enhancement in soil erosion.

The concept of soil quality is centered on the ability of the soil to perform specific functions like sustaining biological activity, regulating water flow, buffering, storing and cycling of nutrients etc. The information on the long term effect of manure and fertilizer on crop residue production and its subsequent effects on soil organic carbon (SOC) storage and soil quality is limited in sub-humid and semi-arid tropical cropping system. In India, indeed, quantification of SOC in relation to various crop management practices is of prime importance in identifying sustainable system for SOC in relation to various crop management practices and SOC dynamics in soil. There is lack of research knowledge of carbon quantification through below ground crop residues under cultivated land management system. This is extremely important to understand the effects of nutrient management on SOC storage which could influence yield sustainability and soil quality.

Soil microbial biomass acts as an agent for transformation of all substance entering in to the soil and represents a relatively liable pool of C, N, P and S. The buildup and turners of microbial biomass N and P greatly influence the availability of nutrient to the plant. Therefore, the measurement of the soil microbial biomass is of great importance. It is of practical interest to know the distribution of contents of N, P, K, and microbial biomass in soil profile.

Materials and methods

Chemical Analysis of the Experimental Soil

Sample of experimental soil (0-30 cm. depth) was used for the chemical analysis of the soil before the sowing of Pearl millet crop. The results of this chemical analysis are presented in Table 1. The results reveal that the soil was alkaline in reaction and had a moderate cation exchange capacity. Again it was low in organic carbon and nitrogen, medium in phosphorus (P_2O_5) and high in potash (K_2O) contents.

Table 1: Chemical Analysis of the Experimental Soil

S. N.	Characteristics	Values Obtained	Method of Determination
1.	Organic Carbon (g/kg)	4.5	Walkley and Black Method (Piper,1966)
2.	Microbial Biomass Carbon (ppm)	123.5	Chloroform Fumigation Extraction Method (Brooke's *et al.*, 1985)
3.	Soil pH (Soil-Water Suspension, 1: 2.5)	7.8	Method No, 20, USDA Hand Book No. 60 (Richards, 1954)
4.	Electrical Conductivity (dSm-1 at 250 Celsius)	1.71	Method No. 4, USDA Hand Book No. 60 (Richards, 1954)

Technical Programme:-

(i) Treatments:
   T1: Control
   T2: 10 t FYM ha-1
   T3: 10 t FYM ha-1+Azotobacter
   T4: NPK (50% recommended dose)
   T5: NPK (50%)+10 t FYM ha-1
   T6: NPK (50%)+ Azotobacter
   T7: NPK (50%) + 10 t FYM ha-1 + Azotobacter
   T8: NPK (75% recommended dose)
   T9: NPK (75%)+10 t FYM ha-1
   T10: NPK (75%)+ Azotobacter
   T11: NPK (75%) + 10 t FYM ha-1 + Azotobacter
   T12: NPK (100% recommended dose)
(ii) No. of Treatments : 12
(iii) Replications : 3
(iv) Experimental Design : Randomized Block Design
(v) Total No. of Plots : 12 x 3 = 36
(vi) Size of each plot : Gross Size-5m x 3m Net Size - 4.4m x 2.4m

Result & discussion

Pearl Millet: Table-2 & Appendix 1 exhibit that after the harvest of Pearl millet crop in previous year the status of organic carbon (g/kg) and microbial biomass carbon (ppm) in the soil was statistically superior under the treatments T2, T3, T4, T5, T6, T7, T8, T9, T10, T11 and T12 over the treatment T1 (control). Similarly after the harvest of Pearl millet crop in 2nd year the status of organic carbon (g/kg) and microbial biomass carbon (ppm) in the soil was also found statistically superior under the treatments T2, T3, T4, T5, T6, T7, T8, T9, T10, T11 and T12 over the treatment T1 (control).

Moreover, the application of FYM significantly improved the status of organic carbon and microbial biomass carbon in soil which may be ascribed to the supply of organic carbon through organic matter addition to the soil. These results are in close conformity with the findings of Sud *et al.* (1990) and Brae *et al.* (1995).

Inoculation of seeds treated with Azotobacter chroococcum coupled with farmyard manure slightly increased the status of organic carbon and microbial biomass carbon in soil over FYM alone. The increase in organic carbon and microbial biomass carbon in soil with FYM and biofertilizer inoculation has also been reported by Brae *et al.* (1995).

Organic carbon and microbial biomass carbon status of the soil was also improved over control with all three levels of NPK (50 and 75% NPK, 75 and 100%) fertilizers. Similar results were also reported by Acharya *et al.* (1988) [1] and Thomas and Nair (1997) [4].

Inoculation of seed treated with Azotobacter chroococcum along with NPK (50 and 75%) fertilizers also slightly improved the organic carbon and microbial biomass carbon over T_4 and T_8 treatments respectively in both years of experimentation. Integrated use of organics, inorganic and biofertilizer enhanced the organic and microbial biomass carbon status of soil. The maximum values of organic and microbial biomass carbon were recorded under treatment T_{11} indicating the beneficial effect of combined use of FYM, Azotobacter chroococcum and NPK fertilizers.

Wheat crop

The data on the status of organic carbon and microbial biomass carbon after harvest of wheat crop have been presented in Table-3, Appendix ii. The table exhibits that after the harvest of wheat crops in previous year, the status of organic carbon (g/kg) and microbial biomass carbon (ppm) in soil was statistically superior under all the treatments from T_2 to T_{12} over the treatments T_1 (control). Similarly after the harvest of wheat crop in 2nd year, the status of organic carbon and microbial biomass carbon was again found statistically superior under all the treatments from T_2 to T_{12} over the treatment T_1 (control).

Furthermore there was a significant increase in the status of organic carbon and microbial biomass carbon in soil with 10 t FYM ha^{-1} addition. The improvement in organic carbon and microbial biomass carbon status may be ascribed to the supply of organic carbon and microbial biomass carbon through organic matter application to the soil. Sud *et al.* (1990) and Brar *et al.* (1995) [2] also reported similar results. The inoculation of seeds treated with Azotobacter chroococcum along with 10 t FYM ha^{-1} further enhanced the status of organic carbon and microbial biomass carbon in soil over 10 t FYM ha^{-1} alone. These results are in close conformity with the findings of Brar *et al.* (1995) [2]. The content of organic carbon and microbial biomass carbon increased significantly over T1 treatment with the application of NPK (50, 75 100%) levels in both the crop seasons. The addition of 10 t FYM ha-1 coupled with both levels of NPK

(50 and 75%) further increased the status of organic carbon and microbial biomass carbon which may be attributed to the addition of organic matter through FYM. The increase in organic carbon and microbial biomass carbon status with FYM and NPK fertilizers has also been reported by Acharya *et al.* (1988) [1] and Thomas and Nair (1997) [4]. Both the levels of NPK (50 and 75%) together with Azotobacter chroococcum also improved the status of organic carbon and microbial biomass carbon over T_4 (50% NPK) and T_8 (75% NPK) treatments, respectively but the beneficial effect was greater with farmyard manure. Integrated use of nutrients (50% NPK + 10 t FYM ha-^{1} + Azotobacter) increased the status of organic carbon and microbial biomass carbon synergistically. The maximum and minimum values of organic carbon and microbial biomass carbon content were obtained under T_{11} and T_1 treatment, respectively.

Table 2: Effect of various treatments on organic carbon, microbial biomass carbon in soil after harvest of Pearl millet crop.

Treatments	Previous year		2nd year	
	Organic carbon (g/kg	Microbial biomass carbon (ppm)	Organic carbon (g/kg)	Microbial biomass carbon (ppm)
T_1	3.8	103.74	4.1	112.38
T_2	4.7	128.44	4.9	133.38
T_3	4.9	133.38	5.1	139.55
T_4	4.3	118.56	4.6	125.97
T_5	5.1	139.55	5.4	148.2
T_6	4.6	125.97	4.8	130.91
T_7	5.2	142.02	5.6	153.14
T_8	4.4	119.79	4.7	128.44
T_9	5.3	144.49	5.7	155.61
T_{10}	4.7	128.44	4.9	133.38
T_{11}	5.6	153.14	5.8	158.08
T_{12}	4.5	124.2	4.9	134.18
SEm±	0.11	1.16	0.12	1.04
CD at 5%	0.32	3.40	0.35	3.04

Table 3: Effect of various treatments 0n organic carbon (OC), microbial biomass carbon (MBC), in soil after harvest of wheat crop.

Treatments		Previous year		2nd year
	Organic carbon (g/kg)	Microbial biomass carbon (ppm)	Organic carbon (g/kg)	Microbial biomass carbon (ppm)
T_1	3.9	107.02	4.2	115.26
T_2	4.6	126.20	4.8	131.73
T_3	4.8	131.70	5.0	137.22
T_4	4.2	115.26	4.6	123.7
T_5	5.0	137.22	5.1	139.92
T_6	4.3	118.01	4.7	128.98
T_7	5.3	145.45	5.4	148.20
T_8	4.5	123.8	4.7	128.92
T_9	5.4	148.20	5.7	153.03
T_{10}	4.8	131.73	5.1	139.96
T_{11}	5.7	156.43	5.9	161.92
T_{12}	4.6	126.24	4.9	134.47
SEm±	0.12	1.17	0.11	1.05
CD at 5%	0.35	3.43	0.32	3.07

Appendix -I: Analysis of variance for Organic carbon, Microbial biomass carbon in soil after the harvest of Pearl millet crop.

Source of variation	d.f.	Organic carbon (g/kg)				Microbial biomass carbon (ppm)				F tab
		Previous year		2nd year		Previous year		2nd year		
		MSS	F cal	MSS	F cal	MSS	F cal	MSS	F cal	
Replication	2	.0416	1.14	.0513	1.18	393.72	97.69*	541.14	167.01*	F.05 (2,22) = 3.44
Treatment	11	.0838	2.30*	.0989	2.29*	481.32	119.43*	621.23	191.73*	F.05 (11,22) = 2.26
Error	22	0.363		.0432		4.03		3.24		

* Significant at 5% level of significance

Appendix II: Analysis of variance for Organic carbon, Microbial biomass carbon in soil after the Harvest of Wheat crop.

Source of variation	d.f.	Organic carbon (g/kg)				Microbial biomass carbon (ppm)				F tab
		Previous year		2nd year		Previous year		2nd year		
		MSS	F cal	MSS	F cal	MSS	F cal	MSS	F cal	
Replication	2	.0349	.8078	.0431	1.18	400.55	97.69*	552.83	167.01*	F.05 (2,22) = 3.44
Treatment	11	.0984	2.28*	.0838	2.31*	489.68	119.43*	634.65	191.73*	F.05 (11,22) = 2.26
Error	22	.0432		.0363		4.10		3.31		

* Significant at 5% level of significance

References

1. Acharya CL, Bishnoi SK, Yaduvanshi HS. Effect of long term application fertilizers and organic and inorganic amendments under continuous cropping on soil physical and chemical properties in alfisol. Indian J. agric. Sci. 1988; 58(7):509-516.
2. Brar BS, Dhilion NS, Chand M. Effect of farmyard manure application on grain yield and uptake and availability of nutrients in rice Oryza sativa - wheat Triticum aestivum rotation J Indian Agric. J. Indian Soc. Soil. Sci. 1995; 65(5):350-353.
3. Panse VG, Sukhatne PR. Statistical methods for agricultural workers. ICAR: New Delhi, 1967.
4. Thomas M, Nair SS. Physical and chemical properties of rice soils as influenced by organic and inorganic of nutrients. J. Indian agric. Res. 1997; 31(4):257-261.
5. Wang FE, Chen YX, Tian GM, Kumar S, He YF. Microbial biomass carbon, nitrogen and phosphorus in the soil profile of different vegetation covers established for soil rehabilitation in a red soil region of southeastern china. Nutrient cycling in agroecosystem. 2004; 68(2):181-189.
6. Banu NA, Balwant Singh, Copeland L. Soil microbial biomass and microbial biodiversity in some soils from New South Wales, Australia. Austr. J. Soil Res. 2004; 42(7):777-782.