International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(5): 826-830

Received: 20-07-2019
Accepted: 24-08-2019

Effect of enriched compost on soil organic carbon dynamics under soybean on Vertisols

Abhisek Pal, PW Deshmukh, SM Bhoyar, PR Chaure and DP Deshmukh

Abhisek Pal
Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

PW Deshmukh
Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

SM Bhoyar
Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

PR Chaure
Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

DP Deshmukh
Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Correspondence
Abhisek Pal
Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India

Abstract
An investigation was conducted to examine the effect of Enriched Compost on soil organic carbon dynamics under Soybean on Vertisols at Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India. The experiment was laid out in Randomised block design with eight treatments replicated thrice. The treatments were framed with two composts i.e. Phospho-compost and Nitro-Phospho-Sulpho compost with combination of chemical fertilizers. Application of enriched compost boosts soil fertility and upgrades soil productivity. The results obtained revealed that the status of soil biological properties and carbon fractions were found significantly highest with the application of 100% P through NPS followed by 100% P through PC as compared to other treatments.

Keywords: Soil organic carbon, Phospho-compost, Nitro-Sulpho-compost, SOM, Soybean & Vertisols

Introduction

Fruitful soil is the soul for healthy plants, organisms and animals, simultaneously soil organic matter and soil organic carbon are the foundation for healthy and productive soils. Soil organic carbon (SOC) content is one of the most important indicators of soil condition. Soil organic matter is a reservoir for plant nutrients having high CEC, provides water-holding capacity, stabilizes soil structure, and thus determines soil productivity. Enriched compost is prepared by phosphate rock, pyrite, biosolids and microorganisms like Aspergillus awamori and Bacillus megaterium. Composts materials have a stable organic base with low N content. Application of organic manures had increased the microbial activity in soil by both activating the microbial action and by aiding the multiplication of microbial population and improved soil health (Khursheed *et al*., 2012; Arora *et al*., 2016) [4]. The decomposition of SOM further releases mineral nutrients, thereby making them available for plant growth (Van der Wal and de Boer, 2017) [8], while better plant growth and higher productivity contribute to ensure food security. It is a positive asset to higher crop production. Soil organic carbon is the basis of soil fertility. Increasing soil organic carbon has two benefits which are assisting to mitigate climate change, and to improve soil health and fertility. Management practices that increase soil organic carbon also improve crop and pasture yields. SOC also plays an important role in ensuring food security, this is achieved by enhancing soil productivity and maintaining consistently high yields, particularly by increasing water and nutrient holding capacity and improved soil structure, thus improving plant growth conditions (Zdruli *et al*., 2017) [10]. Many studies have quantified the contributions of SOC in terms of food production, (De Moraes Sa *et al*., 2017) [2] reported that adoption of SOC conserving agriculture practices can increase food production by 17.6 Mt/year. Soil organic carbon is considered an important indicator of soil quality and agricultural sustainability because it improves soil aggregate stability and water retention and provides a reservoir of soil nutrients (Lieu *et al*., 2006) [5]. The amount and quality of SOM & SOC determines the number and activity of soil biota that interact with plant roots. Therefore, the soil microbial community structure is influenced largely by quality and quantity of SOC and to a lesser extent by plant diversity (Thiele-Brunh *et al*., 2012) [7]. Integrated Nutrient Management maintains soil fertility to an optimum level to obtain the maximum benefit from all possible sources of plant nutrients, organic as well as inorganic, in an integrated manner (Aulakh and Grant, 2008) [1]. Vertisols are vastly fertile with more than 30% high clay content, thick tropical black colour soils possessing slickensides and swell-shrink properties with gilgai micro-relief.

Materials and Methods

The current research entitled "Effect of enriched compost on soil organic carbon dynamics under soybean on Vertisols" was assessed at Research Farm of Department of Soil Science and Agricultural Chemistry, Dr. PDKV, Akola during Kharif season of 2018-19. The treatment constitutes of the following amalgamations T_1 - Control, T_2 - 100% RDF, T_3 - 50% P through PC + Remaining dose through chemical Fertilizers, T_4 - 25% P through PC + Remaining dose through chemical Fertilizers, T_5 - 50% P through NPS + Remaining dose through chemical Fertilizers, T_6 - 25% P through NPS + Remaining dose through chemical Fertilizer, T_7 - 100% P through PC, T_8 - 100% P through NPS. Whereas PC indicates Phospho-compost and NPS indicates Nitro-phospho-Sulpho compost. The experimental soil was developed on basaltic plateau on plain land and classified under Vertisols. The morphological characteristics of soil is medium deep, clayey in texture.

For the biological properties of soil, soil sample from rhizosphere were collected at 50% flowering and pod formation stage of the crop and stored carefully at 4^0C for biological study and air dried in shade and processed for further analysis by following standard procedure. Subsequently for analysing the soil carbon fractions samples were collected after harvest of the crop.

Results and Discussion

Effect of enriched compost on soil biological properties at flowering stage

A. Effect on SMBC

Soil Microbial Biomass carbon is a measure of carbon present in the living component of soil organic matter which acts as a superior indicator of soil health. SMBC as influenced by various treatments is presented in table 1 and all the biological parameters in FIG 1. The study declared that with application of T_8 i.e.100 % P through NPS, the activity was highest (208.42 mg kg^{-1} soil), followed by T_7 i.e. 100 % P through PC (208.18 mg kg^{-1} soil). Both of these treatments were found statistically at par with each other. The increase in soil SMBC in organic treatments is higher owing to supply of organic sources resulting in upscale microbial activity and subsequently higher biomass.

The integrated nutrient management plot where application of 50% P through NPS + Remaining dose of P through chemical fertilizer was done also showed better response which recorded soil microbial biomass carbon of 206.23 mg kg^{-1} soil which was at par with 100% compost application. The significantly lowest Soil Microbial Biomass carbon was noticed in control plot (174.20 mg kg^{-1} soil) without application of any source of nutrients. The results are in confirmatory with the studies of Yadav *et al.,* (2017) [9] with the lowest soil biomass carbon in control plot where no fertilizer and nutrient source was applied.

B. Effect on CO_2 Evolution

CO_2 evolution as affected by various treatments is presented in table 2 where the activity ranged from 29.3 to 43.6 (mg CO_2 per 100 gm soil). It is evident from the data that application of T_8 i.e. 100 % P through NPS evolved maximum amount of CO_2 i.e. 43.6 mg CO_2 per 100 gm soil, followed by **T_7 i.e.**100 % P through PC recording 41.4 mg CO_2 per 100 gm soil. Both of these treatments were found statistically at par with each other. The higher CO_2 evolution might in the wake of 100% supply of well decomposed material of enriched compost.

The significantly lowest CO_2 evolution was noticed in control plot (29.3 mg CO_2 per 100 gm) without application of any source of nutrients. The present findings are in line with those of Yadav *et al.* (2017) [9].

C. Effect on dehydrogenase activity

Dehydrogenase activity is a respiratory enzyme for micro-organisms and one of the important indicators of soil microbial activity. DHA as influenced by various treatments is presented in table 3 where the activity ranged from 27.80 to 44.75 µg TPF g^{-1} 24 hr^{-1}. The study observed that with application of T_8 i.e.100 % P through NPS the activity was highest (44.75 µg TPF g^{-1} 24 hr^{-1}), followed by **T_7 i.e.** 100 % P through PC. Both of these treatments were found statistically at par with each other. The increase in dehydrogenase activity might be due to addition of organic matter in the form of compost which resulted in elevated microbial activity.

The treatment T_5 plot where application of 50% P through NPS + Remaining dose of P through chemical fertilizer was done also highlighted good response i.e. (43.85 µg TPF g^{-1} 24 hr^{-1}) which was found statistically at par with sole application of both 100% PC & NPS. The significantly lowest Dehydrogenase activity was noticed in control plot. (27.80 µg TPF g^{-1} 24 hr^{-1}) where there was no application of any nutrient sources. This opinion was supported by (Dsouza *et al.,* 2017) [3].

D. Effect on alkaline phosphatase activity

Alkaline Phosphatase as affected by various treatments is presented in table 4 where the activity ranged from 146.23 to 175.62 (µg p-nitro phenol released g^{-1} 24 hr^{-1}). The study revealed that with application of T_8 i.e.100 % P through NPS the activity was highest (175.62 µ g p-nitro phenol released g^{-1} 24 hr^{-1}), followed by **T_7 i.e.**100 % P through PC. The higher activities of alkaline phosphatase in organically treated soils may be owing to enhanced microbial activity and diversity of phosphatase solubilising bacteria (Mandal *et al*., 2007).

The increase in Alkaline Phosphatase activity were also noticed in the treatments where the conjunctive use of compost and fertilizer were applied. Significantly lowest Alkaline Phosphatase activity was noticed in control plot i.e. (146.23 µg p-nitro phenol released g^{-1} 24 hr^{-1}) where the plot was skipped from nutrient application. The results confirmed the findings of (Dsouza *et al.,* 2017) [3] who also reported the same.

Effect of enriched compost on soil carbon fractions after harvest of crop

E. Effect on Oxidizable Carbon

The oxidizable carbon content in soil is reported in table 5 and carbon fractions is presented graphically in FIG 2 which pronounced that its content after harvest of crop ranged from 4.72 to 6.86 g kg^{-1}. The significantly highest soil oxidizable carbon content of 6.86 g kg^{-1} was recorded in treatment T_8 i.e. 100% P through Nitro-phospho-Sulpho compost followed by application of 100% P through Phospho-compost i.e. 6.82 g kg^{-1}. The oxidizable carbon content in the treatment where 50% P through NPS and 25% P through PC in combination with chemical fertilizers were applied was found at par with sole application of compost.

The treatment T_5 where both organic and chemical fertilizer were applied in combination i.e. 50% P through NPS + Remaining dose of P through chemical fertilizer also reported higher oxidizable carbon content of 6.59 g kg^{-1}. Significantly lowest soil oxidizable carbon content of 4.72 g kg^{-1} was reported by control treatment. The boost in oxidizable carbon content might be attributed to addition of organic matter through composts in both the treatments. Similar trend of oxidizable carbon content was reported by (Dsouza *et al*., 2017) [3].

F. Effect on potential mineralizable carbon

The Potential mineralizable carbon content in soil is reported in table 6 which states its content after harvest of crop ranged from 195 to 298 mg kg^{-1}. The significantly highest potential mineralizable carbon content of 298 mg kg^{-1} was recorded in treatment T_8 i.e. 100% P through Nitro-phospho-Sulpho compost followed by 289 mg kg^{-1} from T_7 i.e.100% P through Phospho-compost.

The integrated application of both organic and inorganic i.e. 50% P through NPS + Remaining dose of P through chemical fertilizer indicated more potential mineralizable carbon of 278 mg kg^{-1}. Significantly lowest soil organic carbon content of 195 mg kg $^{-1}$ was reported by control treatment. However, T_7 and T_8 were found at par with each other. Similar results were reported by (S. Swati *et al*., 2018) [6].

G. Effect on water soluble carbon

The water-soluble carbon content in soil is reported in table 7 which highlighted that its content at post-harvest ranged from 122 to 241 mg kg^{-1}. The significantly highest water-soluble carbon content of 241 mg kg^{-1} was recorded in treatment T_8 i.e. 100% P through Nitro-phospho-Sulpho compost followed by 226 mg kg^{-1} from T_7 i.e. 100 % P through PC.

The combined application of both organic and inorganic i.e. 50% P through NPS + Remaining dose of P through chemical fertilizer recorded better water-soluble carbon content of 219 mg kg^{-1}. Significantly lowest content of 122 mg kg^{-1} was reported by T_1 i.e. control treatment. The higher amount of water-soluble carbon content might be due to addition of organic sources through composts or in combination with both fertilizer and manure. Similar finding were received and supported by (S. Swati *et al*., 2018) [6].

H. Effect on water soluble carbohydrate

The water-soluble carbohydrate content in soil is reported in table 8 which highlighted that its content post-harvest of crop ranged from 57 to 146 mg kg^{-1}. The significantly highest water-soluble carbohydrate content of 146 mg kg^{-1} was recorded in treatment T_8 i.e. 100% P through Nitro-phospho-Sulpho compost followed by 129 mg kg^{-1} from T_7 i.e. 50 % P through NPS + Remaining P through chemical fertilizer.

The integrated application of both organic and chemical fertilizer in treatment T_5 also noted good amount water-soluble carbohydrate content of 116 mg kg^{-1}. Significantly lowest content of 57 mg kg^{-1} was reported by T_1 i.e. control treatment. The higher amount of water-soluble carbohydrate content might be because of fresh organic sources application through composts or in combination with both fertilizer and manure. The results resembled with the findings of (S. Swati *et al*., 2018) [6] in Vertisols of Marathwada region in long-time fertilizer experiment.

Table 1: Soil Microbial Biomass carbon as Influenced by various treatments at flowering stage.

	Treatments	SMBC (mg kg^{-1} soil)
T_1	Control	174.20
T_2	100% RDF	193.25
T_3	50% P through PC + Remaining through chemical fertilizers	204.16
T_4	25% P through PC + Remaining through chemical fertilizer	194.20
T_5	50% P through NPS + Remaining through chemical fertilizer	206.23
T_6	25% P through NPS + Remaining through chemical fertilizer	199.24
T_7	100 % P through PC	208.18
T_8	100 % P through NPS	208.42
	SE(m)±	1.16
	CD at 5 %	3.52

Table 2: CO_2 evolution from soil as Influenced by various treatments at flowering stage

	Treatments	CO_2 Evolution (mg CO_2 per 100 gm soil)
T_1	Control	29.3
T_2	100% RDF	31.1
T_3	50% P through PC + Remaining through chemical fertilizers	34.1
T_4	25% P through PC + Remaining through chemical fertilizer	38.7
T_5	50% P through NPS + Remaining through chemical fertilizer	39.2
T_6	25% P through NPS + Remaining through chemical fertilizer	37.5
T_7	100 % P through PC	41.4
T_8	100 % P through NPS	43.6
	SE(m)±	0.88
	CD at 5 %	2.66

Table 3: Dehydrogenase activity of soil as Influenced by various treatments at flowering stage

	Treatments	Dehydrogenase activity (µg TPF g^{-1} 24 hr^{-1})
T_1	Control	27.80
T_2	100% RDF	32.16
T_3	50% P through PC + Remaining through chemical fertilizers	34.26
T_4	25% P through PC + Remaining through chemical fertilizer	32.18
T_5	50% P through NPS + Remaining through chemical fertilizer	43.85
T_6	25% P through NPS + Remaining through chemical fertilizer	34.36
T_7	100 % P through PC	44.18
T_8	100 % P through NPS	44.75

	SE(m)±	0.80
	CD at 5 %	2.43

Table 4: Soil Alkaline Phosphatase activity as Influenced by various treatments at flowering stage

	Treatments	Alk-P activity (μ g p-nitro phenol released g^{-1} 24 hr^{-1})
T_1	Control	146.23
T_2	100% RDF	149.65
T_3	50% P through PC + Remaining through chemical fertilizers	157.17
T_4	25% P through PC + Remaining through chemical fertilizer	153.75
T_5	50% P through NPS + Remaining through chemical fertilizer	159.93
T_6	25% P through NPS + Remaining through chemical fertilizer	157.17
T_7	100 % P through PC	168.78
T_8	100 % P through NPS	175.62
	SE(m)±	1.60
	CD at 5 %	4.84

Table 5: Soil oxidizable carbon as Influenced by various treatments after harvest

	Treatments	Oxidizable carbon (g kg^{-1})
T_1	Control	4.72
T_2	100% RDF	6.35
T_3	50% P through PC + Remaining through chemical fertilizer	6.45
T_4	25% P through PC + Remaining through chemical fertilizer	6.48
T_5	50% P through NPS + Remaining through chemical fertilizer	6.59
T_6	25% P through NPS + Remaining through chemical fertilizer	6.55
T_7	100 % P through PC	6.82
T_8	100 % P through NPS	6.86
	SE(m)±	0.11
	CD at 5 %	0.35

Table 6: Potential mineralizable carbon as Influenced by various treatments after harvest.

	Treatments	Potential mineralizable carbon (mg kg^{-1})
T_1	Control	195
T_2	100% RDF	226
T_3	50% P through PC + Remaining through chemical fertilizer	267
T_4	25% P through PC + Remaining through chemical fertilizer	251
T_5	50% P through NPS + Remaining through chemical fertilizer	278
T_6	25% P through NPS + Remaining through chemical fertilizer	271
T_7	100 % P through PC	289
T_8	100 % P through NPS	298
	SE(m)±	3.01
	CD at 5 %	9.10

Table 7: Water soluble carbon as Influenced by various treatments after harvest

	Treatments	WS-C (mg kg^{-1})
T_1	Control	122
T_2	100% RDF	169
T_3	50% P through PC + Remaining through chemical fertilizer	213
T_4	25 % P through PC + Remaining through chemical fertilizer	178
T_5	50 % P through NPS + Remaining through chemical fertilizer	219
T_6	25 % P through NPS + Remaining through chemical fertilizer	186
T_7	100 % P through PC	226
T_8	100 % P through NPS	241
	SE(m)±	2.46
	CD at 5 %	7.43

Table 8: Water soluble carbohydrate as Influenced by various treatments after harvest

	Treatments	WS-CHO (mg kg^{-1})
T_1	Control	57
T_2	100% RDF	78
T_3	50% P through PC + Remaining through chemical fertilizer	95
T_4	25 % P through PC + Remaining through chemical fertilizer	91
T_5	50 % P through NPS + Remaining through chemical fertilizer	116
T_6	25 % P through NPS + Remaining through chemical fertilizer	109
T_7	100 % P through PC	129
T_8	100 % P through NPS	146
	SE(m)±	2.41
	CD at 5 %	7.29

Conclusion

The impact of enriched compost has highlighted indispensable importance in boosting the organic carbon dynamics of soil with properties related to soil health i.e. physical, chemical and biological generally improved. Results from the present study concluded that with the sole application of 100 % P through NPS the biological parameters like SMBC, CO_2 evolution, enzymic activities and subsequently carbon fractions were increased which was followed by application of 100 % P through PC.

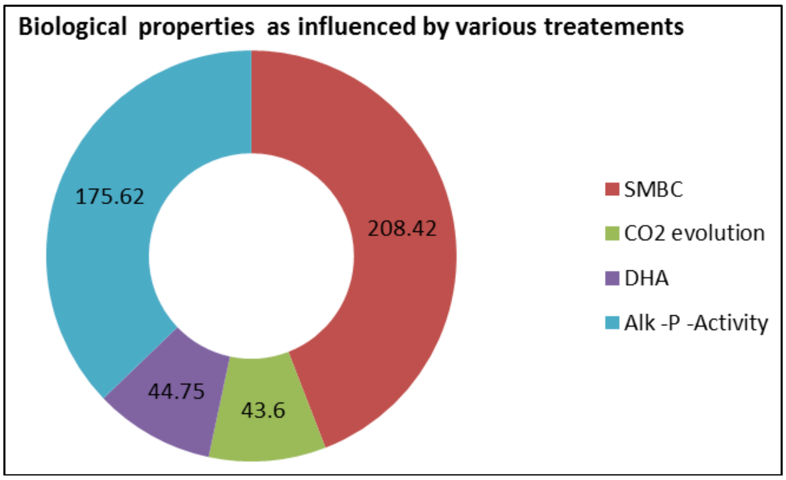

Fig 1: Biological Properties as Influenced by Various Treatments

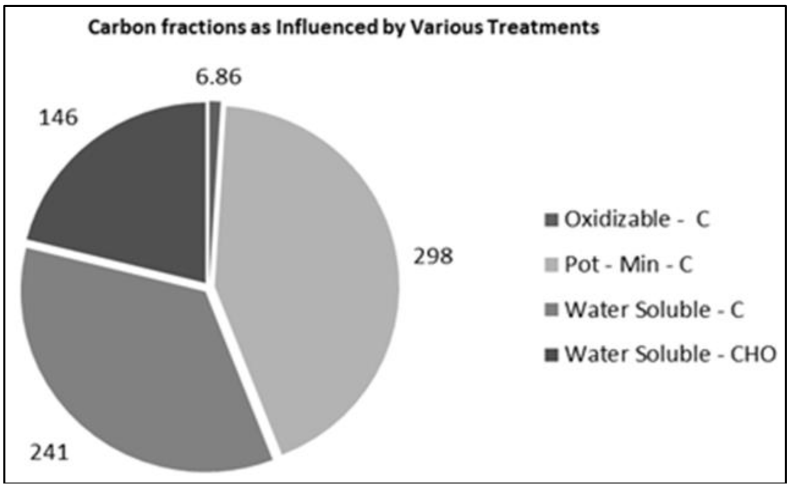

Fig 2: Carbon Fractions as Influenced by Various Treatments

References

1. Aulakh MS, Grant CA. Integrated nutrient management for sustainable crop production. The Haworth Press, Taylor and Francis Group: New York, 2008.
2. De Moraes Sa JC, Lal R, Cerri CC, Lorenz K, Hundria M, Casar P *et al*. Low-carbon agriculture in South America to mitigate global climate change and advance food security. Environment International. 2017; 98:102-112.
3. DSouza, Ashay PW, Deshmukh, Bhoyar SM. Effect of Enriched Composts on Rhizosphere Soil Enzymatic Activity of Soybean in Vertisols. Int. J Curr. Microbio. App. Sci. 2017; 6(10):105-111.
4. Khursheed S, Arora, Sanjay, Ali T. Effect of different organic sources on biochemical properties in Typical Inceptisols of Jammu. Progressive Agriculture. 2012; 12(2):348-353.
5. Liu X, Herbert SJ, Hashemi AM, Zhang X, Ding G. Effects of agriculture management on soil organic matter and carbon transformation- a review. Plant Soil Environ. 2006; 52:531-543.
6. Swati S, Dhawan AS, Syed Ismail. Long term effect of organic manure and fertilizers on soil organic carbon pools under soybean safflower cropping system in Vertisol. Int J. of Agric. Sci. 2018; 10(10):6137-6140.
7. Thiele-Brunh S, Bloem J, De Vries FT, Kalbitz K, Wagg C. Linking soil biodiversity and agricultural soil management. Environmental Sustainability. 2012; 4:523-528.
8. Van der Wal A, De Boer W. Dinner in the Dark: Illuminating drivers of soil organic matter decomposition. Soil Biology and Biochemistry. 2017; 105:45-48.
9. Yadav Pushpa, Nitin Konde, Shiv Singh Meena. Organic carbon fractions and vertical distribution of carbon under integrated nutrient management system in soybean-chickpea cropping sequence in Vidarbha region of Maharashtra. Int. J Curr. Microbiol. App. Sci. 2017; 6(6):390-397.
10. Zdruli P, Lal R, Cherlet M, Kapur S. New World Atlas of Desertification and Issues of Carbon Sequestration, Organic Carbon Stocks, Nutrient Depletion and Implications for food security. In: Carbon Management, Technologies, and Trends in Mediterranean Ecosystems. Springer International Publishing, 2017, 13-25.