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Effect of different resource conservation practices on vertical distribution of organic and inorganic carbon under soybean

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Abstract
The present investigation entitled, "Effect of different resource conservation practices on vertical distribution of organic and inorganic carbon under soybean" was undertaken during 2014-15 at Research farm, Dr. PDKV, Akola. The experiment was laid out in Randomized Block Design with nine treatments replicated three times. The treatments comprised of unfertilized control, chemical fertilizers alone and their combinations with organics *viz.*, FYM and phosphocompost. The soil of experimental site was black belongs to Vertisols. The soil and plant samples were collected and analyzed for their different properties. The highest organic carbon (6.24 g kg^{-1}) was observed with RDF based on soil test through FYM + remaining P through phosphocompost in soybean. The content of organic carbon decreased with an increase in soil depth. However the inorganic carbon was marginally decreased with the application of organic sources.

Keywords: Conservation practices, organic, inorganic, FYM, compost

Introduction
Soybean (*Glycine max*) is known as 'Golden bean' of 20^{th} century. It is the second largest oilseed crop in India after groundnut. Among all agricultural crops soybean is most important crop for carbon sequestration because soybean forms mutualistic symbiosis with mycorrhizal fungi. Mycorrhizal fungi contributes in carbon sequestration as it has high constriction of fungal hyphae, the hyphal entanglement stabilizes soil aggregates which may stabilize organic matter against rapid decomposition.

Resource conservation technologies is gaining acceptance in many parts of the world as an alternative to both conventional agriculture and to organic agriculture. Although the practice of conservation agriculture on a large scale emerged out of Brazil and Argentina, similar developments were occurring in many other areas of the world, notably North America in zero tillage, and Africa and Asia with technologies such as agroforestry. Conservation agriculture is based on the principles of rebuilding soil, optimizes the crop production input, including labour, and optimizing the profit.

Soil organic matter is responsible for maintenance of not only the soil physical conditions of the soil but also supplies essential plant nutrients for successful crop production. Humus, most important and largest constituent of soil organic matter, is formed by the decomposition of plant and animal residues by microorganisms. It is a store house of various nutrients essential for plant growth. Besides, humus also exerts a pronounced influence on physical, chemical and biological properties of the soil. Therefore, present study was undertaken to evaluate the impact of continuous application of fertilizers, manure, and their combination on humus fractions and their contribution to soil properties.

Material Methods
The cotton-soybean experiment was carried out during 2014-15 on based of crop rotation at Research Farm, Department of Soil Science and Agriculture Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.

The field experiment comprised of nine treatments with three replications in the Randomized Block Design (RBD) was conducted on cotton-soybean rotation. The present experiment was superimposed on soybean during 2014-15.

The treatments comprised of RDF based on soil test (100% RDF through only chemical fertilizers), RDF based on soil test (25% N (through dhaincha lopping, composted cotton stalk, wheat, sorghum stubbles and neemcake), soil test based RDF through FYM + remaining P through phosphocompost (100% N through FYM with compensation of P through phosphocompost), soil test based RDF through FYM + remaining P through phosphocompost (50% N through FYM with compensation of N, P through phosphocompost and urea) and soil test based RDF through FYM + remaining P through phosphocompost (50 % N through leucaena loppings with compensation of N and P through phosphocompost and urea). The experimental soil was Vertisol, having montmorillonitic mineralogy, alkaline in reaction with low available N and P and high in K.

Collection and processing of soil samples for analysis

Soil samples were collected at 0-15 cm, 15-30 cm depth from nine treatment plots of all the three replications (27 nos.) before sowing in *kharif* and after harvest of soybean crop during 2014-15. Soil samples were air dried in shade and stored in polythene bags for further analysis. The air dried samples were carefully and gently ground with the wooden pestle to break soil lumps (clods) and were passed through 2 mm diameter sieve. The sieved samples were mixed thoroughly and stored in polythene bags, properly labeled and preserved for subsequent analysis. For mean weight diameter analysis, 8 mm size aggregates were retained on the sieve and used. Soil samples for biological parameter were collected at harvesting stage of crop and immediately analyzed. Walkley and Black method as described by Nelson and Sommers (1982) [5] was used to determine soil organic carbon content. The data on different parameters were tabulated and analyzed statistically by the methods described by Panse and Sukhatme (1971) [6].

Results and Discussion

Effect of different resource conservation practices on soil organic and inorganic carbon

Soil carbon (soil organic and inorganic carbon) is important as it determines ecosystem and agro- ecosystem functions, influencing soil fertility, water holding capacity and other soil parameters which ultimately influence crop productivity.

Data on organic carbon and inorganic carbon content in soil as influenced by various treatments under soybean is presented in Table 1.

Application of RDF based on soil test through FYM + phosphocompost (100 % N through FYM + compensation of P through phosphocompost to previous crop) (T_7) recorded higher organic carbon in 0-15 and 15-30 cm depth i.e. 6.24 and 5.60 g kg^{-1}, respectively followed by RDF based on soil test through phosphocompost (50% N through FYM + compensation of P through phosphocompost + N compensation through urea) (T_8), RDF based on soil test through phosphocompost (50% N through leucaena loppings and P compensation through PC + N compensation through urea to previous crop) (T_9). However these treatments were found at par with each other.

Application of recommended dose of fertilizer to both the crop (T_1) resulted substantial decline organic carbon in 0-15 cm (5.83 g kg^{-1}) and 15-30 cm (4.93 g kg^{-1}) depth. The significantly higher organic carbon was noted where plant residue, FYM, phosphocompost and cotton stalk was applied. Proportionally higher carbon content or carbon sequestration was identified in treatment receiving organic addition to both the crops which might be due to slower breakdown or constant mineralization of added organic residue. The similar findings are noted by Tyagi and Bharadwaj (1994), Babhulkar *et al*. (2000) [1] and Singh *et al*. (2004) [9].

Singh and Wanjari (2007) [8] studied the long term fertilizer experiments at various location and revealed that the organic carbon was increased from 4.6 to 6.8 g kg^{-1} (Akola), 5.7 to 9.4 g kg^{-1}(Jabalpur) and 6.2 to 6.4 g kg^{-1} (Raipur). The slower development of organic carbon is might be due to prevailing semi-arid climate. However, in Mollisol at Pantnagar, considerable increase in organic carbon from 14.8 to 16.1 g kg^{-1} was noted. Because of preservation of organic carbon under relatively cooler climate. In spite of regular application of organics in the Vertisols of semi-arid areas, the increase in organic carbon was gradual. This has a great challenge for sustenance of soil quality.

Effect of different resource conservation practices on soil inorganic carbon

The data pertaining to inorganic carbon in soil at the harvest of soybean crop is presented in Table 1.

The results revealed that the effect of various resource conservation practices on inorganic carbon of soil was non-significant in both soil depth. However, numerically higher inorganic carbon (6.98 and 7.64 g kg^{-1} in 0-15 and 15-30 cm depth respectively) was observed with the application of RDF based on soil test through FYM + phosphocompost (100 % N through FYM + P compensation through phosphocompost to previous cotton) i.e.T_7.

It is further to note that the content of inorganic carbon was gradually decreased with increase in depth. The higher amount of inorganic carbon (7.64 g kg^{-1}) was noticed at 15-30 cm depth as compared to 0-15 cm depth. This might be due to organic acids released during the decomposition of organic materials which might have reacted with $CaCO_3$ to release CO_2 thereby reducing $CaCO_3$ content of the soil. The results are in conformity with the findings of Bellakki *et al*. (1998), Sahrawat *et al*. (2005) [2], Kumar *et al*. (2012) [4] and Khambalkar *et al*. (2013) [3].

Table 1: Effect of different resource conservation practices on vertical distribution of organic and inorganic carbon in soil under soybean

Tr.	Rotation		Organic carbon (gkg^{-1})		Inorganic carbon (g kg^{-1})	
	Cotton	Soybean*	0-15 cm	15-30 cm	0-15 cm	15-30 cm
	Treatment details					
T_1	RDF	RDF	5.83	4.93	6.32	6.68
T_2	25 % N (Dhaincha loppings) + RDF compensation	RDF	6.00	5.12	6.43	6.78
T_3	25 % N (Cotton stalk) composted + RDF compensation	RDF	5.87	5.20	6.48	6.85
T_4	25 % N (Wheat straw) + RDF compensation	RDF	5.92	5.30	6.54	6.94
T_5	25 % N (Bio mulch)+ RDF compensation	RDF	5.94	5.42	6.61	7.00
T_6	25 % N (Neemcake) + RDF compensation	RDF	5.97	5.45	6.72	7.20
T_7	100 % N (FYM) + compensation of P (phosphocompost)	RDF+PC	6.24	5.60	6.98	7.64

T_8	50 % N (FYM) + P compensation (phosphocompost) + N compensation (Urea)	RDF+PC	6.14	5.53	6.92	7.49
T_9	50% N (Leucaena loppings) + P compensation (phosphocompost) + N compensation (Urea)	RDF+PC	6.10	5.50	6.86	7.43
	SE (m) ±		0.08	0.09	0.15	0.22
	CD at 5%		0.23	0.28	NS	NS

* T_1-T_6: RDF based on soil test
T_7-T_9: RDF based on soil test through FYM + remaining P through phosphocompost.

Summary and Conclusion

Organic Carbon

Relatively higher organic carbon content was recorded in the upper layer of soil (0-15 cm) with conjoint use of chemical fertilizers, FYM and phosphocompost under soybean crop. Amalgamation of chemical fertilizers with organics like FYM and phosphocompost were found beneficial for maintaining organic carbon content compared to the sole use of inorganic fertilizers. The highest organic carbon (6.24 g kg^{-1}) was observed with RDF based on soil test through FYM + remaining P through phosphocompost in soybean. The content of organic carbon decreased with an increase in soil depth.

Soil Inorganic Carbon

Inorganic carbon was gradually increased with increase in the depth, this might be due to the leaching of calcium carbonate through irrigation rain water. However the inorganic carbon was marginally decreased with the application of organic sources. Application of organics along with chemical fertilizers help to solubilize $CaCO_3$ and enhances Ca^{2+} in soil solution.

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