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Soil organic carbon pools under different land use and management practices in swell-shrik soils

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Abstract

The present investigation was carried out to assess the soil organic carbon pools under different land use management systems in swell-shrink soils. The objective was to study soil organic carbon pools, physical and chemical properties under different land use and management practices in swell-shrink soils. Seven different land use and management systems were selected on the research farm of the Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The results revealed that the physical properties like bulk density were improved under the long term use of FYM integrated with fertilizers. Sorghum-wheat cropping system recorded highest amount of available nutrients including nitrogen, phosphorus, potassium and sulphur and micro nutrients in addition to highest amount of organic carbon. This was largely due to higher biomass addition to the soil under these systems. The highest soil organic carbon stock was recorded under long term fertilizer experiment (22.80 Mg ha-1) followed by cotton based cropping system (18.46 Mg ha-1). The continuous integrated use of organics and crop residues with fertilizers recorded increase in soil carbon stocks also with the soil attributes indicating more carbon sequestration for soil health sustenance. The total soil organic carbon (TOC) content varied from 4.32 to 8.64 g kg-1 and the soils under sorghum-wheat cropping system recorded highest TOC (6.84 g kg-1). The very labile carbon (fraction 1:CVL) varied from 0.73 to 1.28 g kg-1 under different land use and management systems which constitute 14.81 to 19.45 percent of total organic carbon. The non-labile carbon (fraction 4: CNL) varied from 2.81 to 5.85 g kg-1 which constitute 61.87 to 67.70 percent forms the largest contribution in the total soil organic carbon. The labile carbon (fraction 2: CL) ranged from 0.51 to 1.04 g kg-1 under different land use and management systems and contributed 10.63 to 14.16 percent of the total organic carbon. The active pool (CVL+CL) ranged between 26.84 to 31.66 percent and the passive pool (CLL+CNL) between 68.32 to 73.13 percent of total organic carbon under various land use systems. It can thus be concluded that the soil organic carbon pools were significantly influenced under various land use and management practices and active pool contributed 29.16%, while the passive carbon pool (70.76%) contributed significantly higher proportion. The abundance of four soil organic carbon fractions was in order non-labile carbon (64.41) > very labile carbon (16.91%) > labile carbon (12.30%) > less labile carbon (6.35%).

Keywords: carbon pools, different land, management practices

Introduction

Soil organic carbon (SOC) is dynamic, however, and anthropogenic impacts on soil can turn it into either a net sink or a net source of greenhouse gases (GHGs). Soil organic carbon is the main component of soil organic matter (SOM). As an indicator for soil health, soil organic carbon is important for its contributions to food production, mitigation and adaptation to climate change, and the achievement of the Sustainable Development Goals (SDGs). Soil organic carbon is important as it determines ecosystem and agro-ecosystem functions influencing various soil properties.

Soil organic carbon is thus an extremely valuable natural resource. The process of photosynthesis by which growing plants fix carbon dioxide into biomass is mainly responsible for its removal from the atmosphere. As photosynthesis is a primary source of carbon dioxide, 100 billion metric tons of carbon is estimated to be sequestered in coming 50 years by plant at global scale. The worldwide amount of carbon dioxide emission due to agricultural and deforestation activities is calculated approximately 1.6 billion tons of carbon per year. An increasing awareness about environmental pollution by carbon dioxide emissions has led to recognition of need to enhance soil carbon sequestration through sustainable agricultural management practices for minimizing greenhouse effects and improving soil quality (Lal *et al.*, 2003) [5].

World soils are important reservoirs of carbon. As such, soil can either be a source or sink for atmospheric CO_2 depending on land use and the management of soil vegetation (Lal, 2005) [4]. Soil represents a main sink of carbon cycle. The estimates are about 1100 to 1600 billion tons of carbon is sequestered in world soils annually which is almost double than amount of carbon in living vegetation and in the troposphere together.

Various management practices has become an increasingly popular tool that grower have embraced as part of their production strategies. The soil organic carbon content is crucial parameter which determines many soil properties important for crop production. The prevailing environment in semiarid regions characterized by higher temperature is depleting. Soil orgaic carbon, leading to overall soil health decline day by day. This largely necessitates conservation of soil organic carbon by adoption of appropriate management options. The various crops and cropping systems have profound influence on soil organic carbon status which needs to be systematicaaly moitored in order to identify proper soil management practices. The soil organic carbon has large influence on the soil physical and chemical properties which determine soil quality. It is necessary to study impact of different cropping systems on the soil organic carboin status and in turn soil health. Crop residues play a major role in supplying nutrients to soil and become available to the subsequent crops on decomposition. The crop residues influence agricultural sustainability by enhancing productivity.

Material and Methods

For the present study the existing field experiments conducted at various Research Farm of, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during kharif season 2017-18. Akola is situated in the subtropical region at $22^0$42' North latitude and $77^0$02' East longitude and at an altitude of 307.42 m (Agromet observatory) above mean sea level. Experimental fields are situated at the latitude of $22^0$42' 19.2" North and longitude of 77^0 03' 43.2" East at the altitude of 307.42 (m) above mean sea level (MSL).

The soils of the experimental area were medium deep black, clay loam texture in general with, high water holding capacity. In order to study the physical chemical properties of soil, the treatment wise soil samples at each site were taken from 0-20 cm depth at harvesting of crop at each site.

S. No	Land use and management system	Treatment under study	History of Each site		
			Year of start	Cropping pattern	Tillage operation
1.	Long Term Fertilizer Experiment	100% NPK + 5t FYM ha^{-1} to sorghum and 100% NPK wheat	1988-1989 (30 years)	Sorghum-wheat cropping	Conventional Tillage (Once in 3 years)
2.	Nagpur Mandarian Orchard	1200:400:400 NPK /plant + 30kg FYM/plant	2010-2011 (8 years)	Mandarian sole cropping	Conservation Tillage (Green manuring + crop residue incorporation)
3.	Cotton Based Cropping System (Long term Project)	50% N(Inorganic) + 50%N FYM +100% P2O5 ha^{-1} (Inorganic)	1987-1988 (31 years)	Cotton+ greengram	Coventional Tillage (Once in 3 years)
4.	Soybean Based Cropping System	75%N (Inorganic)+100% P +15kg K (Inorganic)+15kg K through glyricidia	2015-2016 (3 years)	Soybean sole cropping	Coventional Tillage (Once in 3 years)
5.	Oilseed Research Unit	100% recommended NPK + 5t FYM ha^{-1} crop residue incorporation with T. viride	2013-2014 (5 years)	Soybean sole cropping	Conservation Tillage (crop residue incorporation)
6.	Pulses Research Unit	25 kg N+ 50kg P_2O_5 + 5t FYM ha^{-1}	2008-2009 (10 years)	Pigeonpea Sole Cropping	Conventional Tillage (Once in 3 years)
7.	Integrated Farming System	40 kg FYM + 200 g N+ 100 g P_2O_5 + 100 g K_2O/Plant	2009-2010 (9 years)	Custrad Apple-Pigeonpea-Agasto-Drumstick	Conservation Tillage (Crop residue recycling)

Results and Discussion

The data on various soil organic carbon pools under various land use and management systems under study is given in Table.

Very Labile Carbon

The highest very labile carbon (1.28 g kg-1) was recorded under the long term fertilizer experiment where the integrated nutrient management was followed as shown in table 2. This may be due to long term application of FYM since last 30 years, which has resulted into significant increase in the very labile carbon pool. Similarly, it was reported by Das *et al.* (2016) [3] that NPK+FYM treatment encouraged the accumulation of very labile carbon pool.

The lower values of very labile carbon under integrated farming system (0.73g kg-1) may be due to comparatively lower addition of biomass under perennial orchard of custard apple. However, the intercropping of pigeonpea has been observed to contribute to pools of organic carbon.

It has been observed that the magnitude of very labile carbon is varying significantly on different sites having variation in land use i.e cropping pattern and management practices. The continuous growing of intercropping system since last 31 years (T3) has also recorded higher values of very labile carbon (1.19 g kg-1). The green manuring and crop residue incorporation in the mandarin orchard has also been observed to record very labile carbon to the tune of 1.08 g kg-1. However, the conventional tillage followed under the land use systems which are comparatively recently initiated have recorded lower values of very labile carbon. Although conservation tillage is practiced the values of very labile carbon were low which indicates that long term application of conservation practices will only be useful for built up of carbon in the soil.

Labile Carbon

In the present study in order to study the influence of different cropping systems and management practices on different fractions and pools of SOC, seven sites under different land use and management practices have been studied. The data shows the lowest value of labile carbon under oilseed (0.51 g kg-1) which may be due to low inputs of organic materials into the soil and also due to the recent start of experiment since 5 years. However, the addition of 5t FYM ha-1 with crop residue incorporation and with treatment of Tricoderma viride may contribute to pools of organic carbon.

The highest labile carbon (1.28 g kg-1) was recorded under the long term fertilizer experiment where the integrated nutrient management was followed. This may be due to long term application of FYM since last 30 years, which has resulted into significant increase in the very labile carbon pool. Similarly, it was reported by Awanish Kumar *et al*. (2018) [1] and Das *et al*. (2016) [3] that NPK+FYM treatment was significant under long term fertilization.

It has been observed that the magnitude of very labile carbon is varying significantly on different sites having variation in land use i.e cropping pattern and management practices. The continuous growing of intercropping system since last 31 years (T3) has also recorded higher values of labile carbon (0.89 g kg-1). The organic and inorganic use of fertilizers in cotton based cropping system indicated the labile pool of carbon to the tune of (0.89 g kg-1). However, the conventional tillage followed under the land use systems which are recently initiated have recorded lower values of labile carbon.

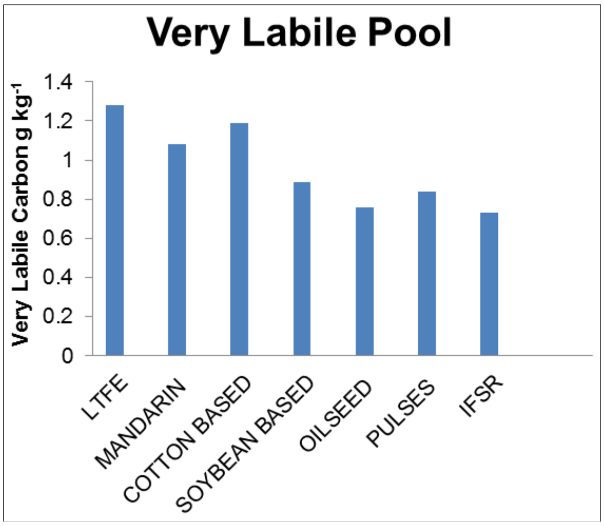

Fig 1: Very labile pool under various land use and management practices

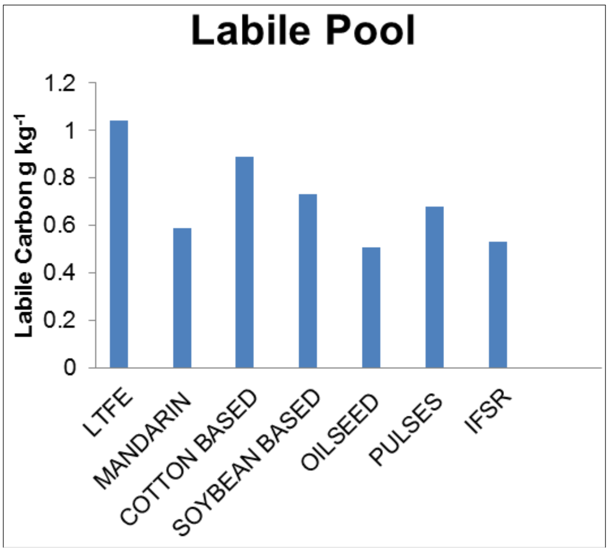

Fig 2: Labile pool under various land use and management practice

Less-Labile Carbon

The data in respect of less labile carbon under different land use and management practices have been compiled and placed in table 2, the highest less labile carbon (0.47g kg-1) was recorded under the long term fertilizer experiment where the integrated nutrient management was followed. This may be due to long term application of FYM since last 30 years, which has resulted into significant increase in the less labile carbon pool. Similarly, it was reported by Moharana *et al*. (2017) [2] and Das *et al*. (2016) [3] that NPK+FYM treatment under long term fertilization with FYM was significant.

Among all the soils lower value of very labile carbon were registered at oilseed research unit (0.24g kg-1) may be due to recent start of experiment since 5 years. However, the addition of 5t FYM ha-1 with crop residue incorporation of Tricoderma viride may contribute to pools of organic carbon.

It has been observed that the magnitude of less labile carbon is varying significantly on different sites having variation in land use i.e cropping pattern and management practices. The continuous growing of intercropping system since last 31 years (T3) has also recorded higher values of less labile carbon (0.45 g kg-1) at cotton based cropping system. The organic and inorganic use of fertilizers in the cotton based cropping system has been observed to record labile pool of carbon to tune of (0.45 g kg-1). However, the conventional tillage followed under the land use systems which are comparatively recently initiated have recorded lower values of less labile carbon.

Non -Labile Carbon

The findings on non-labile carbon in soils under land use and management practices is presented in table 2 and same is depicted in fig. 1. Based on the generated data, it was observed that the non-labile carbon was highest (5.85 g kg-1) under long term fertilizer experiment, where consistent use of inorganic and organic inputs were followed since last 30 years. Followed by (6.84 g kg-1) was registered under cotton based cropping system. This must be due to integration of organic and inorganic inputs and quantum of shaded biomass of cotton.

Similarly, it has been observed that the magnitude of non labile carbon is varying significantly on different sites having variation in land use i.ecropping pattern and management practices. The continuous growing of intercropping system since last 31 years (T3) has also recorded higher values of non labile carbon followed by under cotton based cropping system.

The lowest value of non-labile carbon was registered under oilseeds (2.81 g kg-1), which must be due to lower production of biomass and also the little supply of external production inputs.

The abundance of four soil organic carbon fractions was in the order non labile carbon (64.4%) >very labile carbon (16.91%) > labile carbon (12.30%) > less labile carbon (6.35%).

At each site the absolute control treatment existing in the field experiment of various land use and management systems were studied for carbon pools and various soil properties. The data on this is presented in Annexure from table no. 1 to table no. 7.

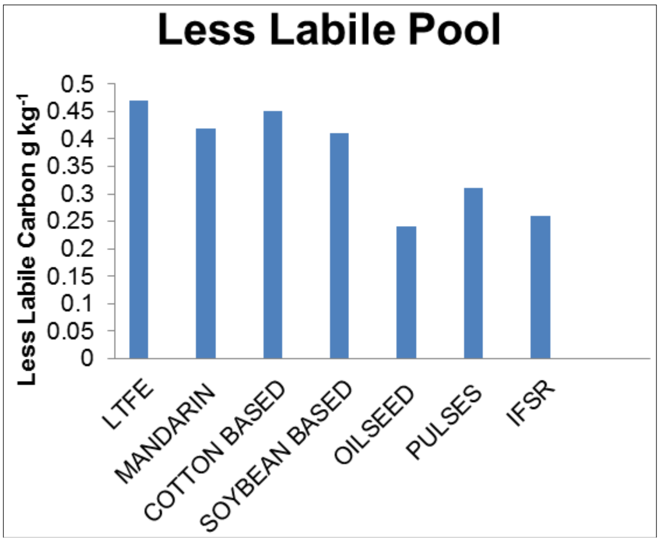

Fig 3: Less labile pool under various land use and management practices

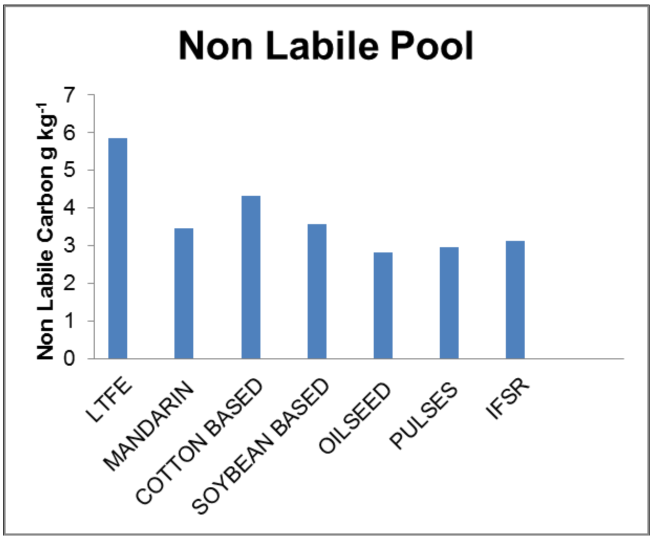

Fig 4: Non labile pool under various land use and management practices

Table 2: Soil organic carbon pools under different land use and management practices

Sr. No	**Land use and management system**	**Treatments**	**Very labile ($g\ kg^{-1}$)**	**Labile ($g\ kg^{-1}$)**	**Less Labile ($g\ kg^{-1}$)**	**Non Labile ($g\ kg^{-1}$)**	**Total SOC ($g\ kg^{-1}$)**
1.	Long Term Fertilizer Experiment	100% NPK + 5 t FYM ha^{-1} to sorghum and 100% NPK wheat	1.28	1.04	0.47	5.85	8.64
2.	Nagpur Mandarin Orchard	1200:400:400 g NPK /plant + 30kg FYM/plant	1.08	0.59	0.42	3.46	5.55
3.	Cotton Based Cropping System	50% N(Inorganic) + 50%N FYM +100% P_2O_5 ha^{-1} (Inorganic)	1.19	0.89	0.45	4.31	6.84
4.	Soybean Based Cropping System	75 % N (Inorganic)+100 % P +15 kg K (Inorganic)+15 kg K through gliricidia	0.89	0.73	0.41	3.56	5.59
5.	Oilseed Research Unit	100% recommended N P K + 5 t FYM ha^{-1} crop residue incorporation with T.viride	0.76	0.51	0.24	2.81	4.32
6.	Pulses Research Unit	25 kg N+ 50 kg P_2O_5+ 5 t FYM ha^{-1}	0.84	0.68	0.31	2.97	4.80
7.	Integrated Farming System	40 kg FYM + 200 N+ 100 g P_2O_5 + 100 g K_2O/plant	0.73	0.53	0.26	3.12	4.64
		SE(m)±	0.013	0.015	0.013	0.049	
		CD at 5%	0.040	0.047	0.041	0.153	

Conclusion

It can be concluded that the soil organic carbon pools were significantly influenced under various land use and management practices and active carbon pool contributed 29.16%, while the passive carbon pool contributed (70.76%) relatively higher proportion.

The bulk density was improved under long term use of FYM and crop residue recycling while it was comparatively higher under recently initiated land use systems. The soil available nutrients and soil organic carbon stock were higher under long term use of FYM and crop residue recycling.

The abundance of four soil organic carbon fractions was in the order Non-labile carbon (64.41%) >Very labile carbon (16.91%) >Labile carbon (12.30%) > Less labile carbon (6.35%).

References

1. Awanish Kumar, Anusuiya Panda. Short-Term of Conservatio Tillage on Carbon Pools under Rainfed Cropping Systems of Central India. International Journal of Current Microbiology and Applied Sciences, 2018.
2. Moharana PC, Naitam RK, Verma TP. Effect of long term cropping systems in soil organic carbon pools and soil quality in western plain of hot arid India, 2017.
3. Das D, Dwivedi BS, Singh VK, Datta SP. Long-term effects of fertilizers and organic cources on soil organic carbon fractions under rice-wheat syatem in the Indo-Gangetic Plaind of north-west India. CSIRO Publishing, 2016.
4. Lal R. World crop residues production and implication of its use as a biofuel. Environment International. 2005; 31:575-586.
5. Lal R. Global potential of soil C sequestration to mitigate the greenhouse effect. Critical Reviews in Plant Science. 2003; 22:151-184.
6. Franzluebbers AJ, Hones FM, Zuberer DA. Soil organic carbon, microbial biomass and mineralization carbon and nitrogen in sorghum. Soil Sci. Soc. American J. 1995; 59:460-466.