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Effects of Long Term Organic and Conventional Farming on Physical and Chemical Properties of Soil

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ABSTRACT

Field experiment was conducted to compare the soil status of organic and conventional farming system under rice and wheat cropping system. Laboratory analysis was made on the soil samples collected from a long-term organic farm (SOF) at Department of Soil Science, Khalsa College, Amritsar and compared with the soil samples collected from different conventional fields (SCF) after the harvest of rice crop to investigate the effect of organic sources and chemical fertilizers. The results of the study revealed that soil physical properties *viz.,* bulk density, particle density and porosity varied from 1.26 g/cm^3 to 1.31g/cm^3 (SO) and 1.35 g/cm^3 to 1.44 g/cm^3 (SC), 2.62 g/cm^3 to 2.67 g/cm^3 (SO) and 2.62 g/cm^3 to 2.68 g/cm^3 (SC) and 50.19 to 52.80 per cent (SO) and 45.48 to 48.49 per cent (SC), respectively. Soil pH showed slightly acidic to alkaline (6.75 to 7.34) range in organic soil samples while conventional soil samples showed alkaline range (7.98 to 8.28). The electrical conductivity (EC) of conventional farming system was significantly higher than organic farming system. The highest value (0.421dS/m) of EC was observed in conventional farming system field while lowest (0.391 dS/m) in organic field. Soil organic carbon (OC) content in surface soil ranged between 0.74 to 0.85 per cent and 0.26 to 0.35 per cent in organic and conventional farming systems, respectively. Similar trends were observed in soil status of available N, P and K under organic and conventional farming systems.

Key Words: Bulk density, Conventional, Cropping system, Farming, pH.

INTRODUCTION

Rice-wheat cropping system on most of the fertile lands has resulted in the decline of soil fertility and soil organic carbon (SOC) content (Sultana *et al*, 2015). The widely practiced rice-wheat system in Punjab is one such instance, where sustainability is under threat. Because of nutrient mining in soils, the soil health has deteriorated, especially in intensively cropped areas. Conventional farming systems are reported to be associated with a decline in soil structure and soil aggregation, increase in soil bulk density and soil salinity. Conventional farming is a more input intensive system with higher use of fertilizers, pesticides for high outputs in terms of yield (Hathaway *et al,* 2010). Conventional farming systems (Kumar *et al,* 2013) have brought the serious concern with soil quality and have led to the development and promotion of organic farming system as an alternative.

Organic farming has gained worldwide acceptance due to environmental, economic and social concerns (Araujo *et al,* 2008). Various organic amendments such as farmyard manure, poultry manure, vermi-compost, green manure, wheat straw etc, are used in organic farming. These organic amendments have assumed a great importance and have vital significance for the maintenance of soil properties (Tiwari *et al,* 2017) Organic farming practices have been associated with improved soil properties through a number of considerations including the addition of soil organic matter, increased earthworm population, microbial biodiversity and soil fertility. Hence, there is greater potential for soil structure improvement in organically managed soils than conventionally managed (Dhaliwal and Walia, 2013). These changes will affect the mineral availability to crops either directly by contributing to nutrient pools

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or indirectly by influencing the soil environment. Studies comparing conventional and organic farming systems have shown an increase in soil organic matter and mineral contents in organically managed soils (Herencia *et al,* 2008). In contrast, organic farming attempts to mimic or follow natural processes that tend to improve soil and plant health while preserving soil and water resources. It is important to note that increases in soil organic matter and other favorable soil quality characteristics change slowly over time with organic management (Gomiero *et al,* 2011). The slow rates of change will affect accurate assessment of soil qualities under different management practices. Thus, need of an hour is to adopt for sustainable crop input management technology which is economically viable, socially acceptable and implementable. Keeping in view the above points, the study has been conducted to note down the effects of long-term organic and conventional farming on soil physical and chemical properties.

MATERIALS AND METHODS

Study area

Amritsar is situated at latitude 31.6340°N, longitude 74.87213°E and altitude is 234m above the mean sea level. Soil samples were collected during November 2016 after the harvest of rice crop from organic and conventional farms where organic and conventional farming were carried out more for more than 10 yr.

Collection and preparation of soil samples

Seven fields were selected for rice-wheat cropping system under organic and conventional farming each and one composite sample was collected from each field. In order to collect soil samples grasses, mosses, litter and other plant residues were removed from soil surface. Collection of soil samples was done by using an auger. In each case, V-shaped cut was made with the help of the auger (0-15 cm depth). Soils were collected in sampling bags, which were sealed and labeled properly. Soil samples were brought to the laboratory for analysis. Before analysis, the collected samples first dried in shade then oven dried at 105ºC for 24 hr. The dried samples were crushed with pestle mortar and passed through 2 mm sieve and stored in cloth bags until further analysis.

Soil Analysis

After the harvest of the crop the composite soil surface (0-15 cm) samples from each plot of the experimental field were analyzed for different physical and chemical properties.

Physical Analysis

Bulk density was determined using core sampling method (Prihar and Hundal, 1971). Particle density (PAU Moisture Gauge Method) (Prihar and Sandhu, 1965) and Porosity was also analyzed by adopting standard procedures.

Chemical Analysis

Soil chemical properties like pH and EC (Jackson, 1954), OC (Walkley and Black, 1934), Available N (Subbiah & Asija, 1956), P (Olsen *et al,* 1954) and K (Jackson, 1967) was measured by

Table 1. Locations under study with their geographical coordinates and codes of Amritsar district, Punjab.

Sr. No.	Sampling location	Farming system	Co-ordinates	Code
1.	Bhagat Pooran Singh Natural Agriculture Farm, Dherekot	Organic	31.5939˚N 75.0095˚E	SOF
2.	Farmer's fields (Dherekot)	Conventional	31.5972˚N 75.0087˚E	SCF

SOF: Soil Organic Farm, SCF: Soil Conventional Farm standardized procedures.

Statistical analysis

The comparisons between organic and conventional farms' for soil characteristics, with normally distributed data were tested using Student's t tests with the help of SPSS software at $p \leq 0.01$ level of significance.

RESULTS AND DISCUSSION

Physical Properties

The bulk density values (Table 2) recorded in organic farming fields were significantly lower than conventional fields which promote the total porosity of the soil as the microbial decomposition products of organic manures such as polysaccharides and bacterial gums are known as soil binding agents. These binding agents increase the porosity and decrease the bulk density of soil by improving the aggregation (Rasool *et al,* 2007).

A significant decrease in bulk density with an associated increase in total porosity of soil related to greater amount of organic matter deposition and loosening of soil by root action was also reported by Saha *et al* (2010). The recorded values of particle density under organic and conventional farming system ranged from 2.62 to 2.67 g/cm^3 and 2.62 to 2.68 g/cm^3, respectively. The particle density was observed to be almost same owing to both management practices. The values of soil porosity under organic and conventional farming system were 51.40 and 47.21per cent, respectively. High soil porosity under organic farming system might be due to addition of more organic-matter content on weight basis, better aggregation, and changing pore-size distribution of the soil (Saha *et al,* 2010).

Chemical Properties

The soil chemical properties *viz,* pH, EC, OC was significantly varied from organic to conventional farming system during the time of experimentation (Table 3). The highest pH and EC was recorded in conventional farming with continuous use of chemical fertilizers and lowest in fields received nutrients through organic sources. The decrease in the pH may be attributed to the production of organic acids and release of CO_2 due to microbial actions (Kumar and Singh, 2010; Singh *et al,* 2008). An increase in electrical conductivity in conventionally managed soils could be attributed to the higher input of salts in the form of chemical fertilizers (Karishma

Table 2. Effects of long-term organic and conventional farming on physical properties of soil.

Field	Bulk Density (g/cm^3)		Particle Density (g/cm^3)		Porosity (percent)	
	SOF	SCF	SOF	SCF	SOF	SCF
1	1.27	1.37	2.67	2.62	52.43	47.71
2	1.29	1.43	2.62	2.65	50.76	46.03
3	1.28	1.39	2.64	2.68	51.51	48.13
4	1.30	1.35	2.65	2.62	50.94	48.47
5	1.28	1.41	2.62	2.62	51.14	46.18
6	1.26	1.37	2.67	2.66	52.80	48.49
7	1.31	1.44	2.63	2.64	50.19	45.45
Mean	1.28	1.39	2.64	2.64	51.40	47.21
SE	0.01		0.01		0.60	
t value	7.71		0.20		6.99	
P value	0.00*		0.91^{NS}		0.00*	

NS= Not Significant ; *significant at 0.01 level and Prasad, 2015). Moreover, enhanced leaching losses and reduced accumulation of salts in the root zone under rice crop also contribute to decline in EC values (Singh *et al,* 2015). Whereas, OC content in soil was found higher and significantly differ within the organic and conventional farming system (Table 3). It was due to direct incorporation of these organic materials in the soil and results enhance organic carbon content of the soil. Increase in OC with the application of FYM, crop residues and vermi-compost has also been reported by Karishma and Prasad (2015).

Further, highest value of available macronutrients (NPK) was recorded under organic farming based fields (Table 4) which was statistically superior over conventional farming system. The organic farming soil was reported with higher urease activity than soil under conventional system (Singh *et al,* 2015). The process of ammonization, ammonification and mineralization brought about by microbial mediated enzymes systems are active in organic amendments, thus contributing more soluble N (Walia *et al,* 2010).

The higher P content was also observed under organic farming system which might be due to the permanent addition of organic matter promoted the increasing in the available P in soil. Similar results were found by Tiwari *et al* (2017). The increase in availability of potassium through addition of organic sources may also be due to decomposition of organic matter accompanied by release of appreciable quantities of CO_2, which when dissolved in water, forms carbonic acid, which is capable of decomposing primary minerals and release of nutrients (Chesti *et al,* 2015; Subehia and Sepehya 2012).

CONCLUSION

Based on the results, it was concluded that plots under organic farming system proved best for soil fertility and sustainability as compared to conventional farming under rice-wheat cropping cultivation. However, the farmers who relying on conventional farming should be advised to follow organic farming to maintain soil properties and sustainable agriculture.

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Table 3. Effects of long-term organic and conventional farming on pH, EC and OC of soil.

Field	pH		EC (dS/m^1)		OC (%)	
	SOF	SCF	SOF	SCF	SOF	SCF
1	6.82	7.98	0.39	0.41	0.74	0.31
2	6.75	8.16	0.39	0.41	0.79	0.29
3	7.16	8.24	0.39	0.42	0.83	0.32
4	6.92	8.28	0.38	0.41	0.81	0.35
5	7.34	8.19	0.38	0.42	0.85	0.26
6	7.26	7.98	0.38	0.42	0.79	0.28
7	6.94	8.24	0.38	0.41	0.75	0.34
Mean	7.03	8.15	0.38	0.41	0.79	0.31
SE	0.09		0.03		0.019	
t value	10.43		14.63		25.02	
P value	0.00*		0.00*		0.00*	

*significant at 0.01 level

Table 4. Effects of long-term organic and conventional farming on available N, P and K (kg/ha) content in soil.

Field	Available N		Available P		Available K	
	SOC	SCF	SOC	SCF	SOC	SCF
1	247.24	194.13	22.64	17.75	332.54	286.35
2	254.34	210.22	23.65	19.64	327.45	305.28
3	260.45	224.36	24.46	16.87	341.84	312.64
4	243.65	195.41	25.65	22.75	319.27	298.34
5	254.38	212.87	23.54	20.84	331.77	317.28
6	248.57	224.23	24.25	19.65	324.26	324.16
7	236.43	208.24	23.85	18.46	336.28	312.57
Mean	249.29	209.92	24.01	19.42	330.49	308.09
SE	5.47		0.83		5.54	
t value	7.17		5.55		4.02	
P value	0.00*		0.00*		0.00*	

*significant at 0.01 level

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