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Impacts of Different Management Practices on Physico-Chemical Properties of Soil in Mid-Hill, Sub-Humid Zone-II of Himachal Pradesh

TANVI KAPOOR[1]*, RAMESH C CHAUHAN[2] and HUKAM CHAND[1]

[1]Department of Environmental Science,
Dr Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (HP)-173230, India.
[2]Department of Biology and Environmental Science,
College of Basic Sciences, CSK HPKV, Palampur (HP), India.

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ABSTRACT

A study was conducted at Hill Agricultural Research and Extension centre Bajaura of CSK HP Krishi Vishvavidayalaya, Palampur, Himachal Pradesh to investigate the Impacts of different management practices on physical as well as chemical properties of the soil. Sample analysis of three management practices i.e. organic, inorganic and integrated revealed that, water holding capacity was found to be highest in organic treatment (50.8%), followed by integrated (44.9%) and least in inorganic (40.2%) whereas field capacity of the three farming systems followed an order as integrated > organic> inorganic treatment. The bulk density of the soil was in the range of 1.36-1.58 Mg cm-2 in the three farming systems and the value was highest in inorganic treatment and lowest in organic treatment. The organic carbon content of soil was highest (1.8 Kg g-1) in organic treatment followed by integrated and lowest (0.75 Kg g-1) in inorganic treatment. The available nitrogen was found to be lowest in integrated treatment followed by organic and inorganic. Cation exchange capacity was found to be highest (16.58 c mol (+) kg 1) in organic and lowest (10.82 c mol(+) kg 1) in inorganic practice. Hence organic agriculture practice is best for the restoration of agricultural lands and an environmentally sound and inexpensive way to sustainably intensify crop production on marginal land as well as improving the ecology of the soil environment.

Key words: Organic, Inorganic, Integrated, Physico-chemical.

INTRODUCTION

The importance of combating environmental degradation in diverse human socio-economic activities has lead to increased calls for a shift to organic farming practices so as to improve the health of soils, ecosystems as well as people. The main idea behind organic farming is ‘zero impact’ on the environment. Increasing consciousness about conservation of environment as well as health hazards are the major factors that led to the growing interest in organic farming in the world. The organic agriculture practice increases decomposition and build up nutrient status of soil, whereas long time intensive agriculture practice reduced the fertility of soil and loss of diversity of crops. One of the methods of farming introduced by green revolution is inorganic farming which is used widely throughout the world promote the use of synthesized chemicals in the production of crops. Excessive use of chemicals fertilizers and pesticides deteriorated soil health and ultimately made it completely infertile[1]. The integrated farming was introduced to minimize and control the detrimental effects of chemical farming and involves the use of low chemical inputs along with organic inputs to fields so as to enhance the crop productivity and protect soil from harmful chemicals. Thus integrated farming is an agricultural system conceived so as to have the least impact on the environment. The soil fertility in organic farming system is managed through crop rotation and green manuring practices. Any changes in organic matter input may affect soil properties, mineral nutrient supply as well as crop yields in different farming systems. Most research suggests that organic practices have improved the soil functions like nutrient cycling. This suggests that recognized beneficial management practices have a bigger impact on the soil fertility as that of land-use system itself. Therefore, in present investigation impact of three farming system on the various properties of soil has been studied and aimed at identifying the best management practice in the region.

MATERIALS AND METHODS

Study was conducted in the mid-hills sub-humid zone II situated at 31° 51' 0" North, 77° 9' 0" East and at an altitude of 1090 m a.m.s.l. on the farm of Hill Agricultural Research and Extension Centre of CSKHP Krishi Vishvavidayalaya at Bajaura, Kullu H.P. Cropping sequences selected for the study were, French bean- French bean- Cauliflower, Tomato-Cauliflower- Pea and Cauliflower- Cauliflower-Pea. The area receives mild annual precipitation of 1500 mm. The soil is neutral to acidic in reaction; sandy loam and clay loam. The field experiment comprised of three treatments, 100 % organic (50% NPK was substituted by vermicomposting + 50% FYM), 100% inorganic (NPK-20:40:60) and integrated (50% inorganic + 50% FYM). The number of replications were three and the statistical design used was randomized block design (RBD) 2 factorial. Total nine plots of size 4.5 X 4.0 m^2 were laid down. Three cropping sequences were taken, Tomato- Cauliflower-Pea (A1), French bean- French bean-Cauliflower (A2) and Cauliflower-Cauliflower-Pea (A3). The recommended dose source of chemical fertilizer NPK for Tomato- 100:75:55, Cauliflower- 125:75:65, Pea- 25:65:65 and French bean- 45:100:30. Surface (0-15cm) and subsurface (15-30cm) soil samples were collected before sowing the crop and after the harvest of crop and analyzed for physical properties such as particle size distribution, bulk density[2], field capacity[3], water holding capacity[2], wilting point[3] as well as for chemical properties like pH[4], organic carbon[4], cation exchange capacity[8] and available Nitrogen[5], Phosphorus[6] and Potassium[7].

Statistical analysis

The data generated from the study was statistically analyzed through the procedure as outlined by Gomez and Gomez [9]. The design used for the study was randomized block design 2 factorials.

RESULTS AND DISCUSSIONS

Physical properties

Soil texture

The soil was silty-clay loam in the study area. The silt, clay and sand content of the soil were observed as 21.7, 52.4 and 25.9 per cent respectively (Table 1).

Bulk density

Bulk Density of soil was found to be maximum (1.58 Mg cm^{-3}) in the inorganic treatment and the minimum (1.36 Mg cm^{-3}) in organic treatment (Figure 1) which might be due to that organic matter is much lighter than the corresponding mineral matter. The bulk density was found increased in the soil after crop harvesting because the cultivation reduces the organic matter thereby increasing the bulk density. Its value in the surface soil was higher 1.56 per cent than sub surface soil i.e.1.58 per cent.

Field capacity

The field capacity in the three practices varied in the range of 26.0 to 32.7 percent (Figure 2). It was observed maximum in integrated treatment (32.7%) followed by organic (30.1%) and inorganic (28.0 %) respectively. This may be due to the reason that the integrated use of nutrients improve the soil aggregates allowing the free movement of water within the soil thus increasing water content of soil at field capacity.

The value of field capacity increased with depth and also in the after harvesting samples. The results were in line with the findings of Walia *et al.* [10].

Water holding capacity

The highest (50.8%) water holding capacity of soil was observed in the organic and lowest (40.2%) in inorganic treatment in after harvesting and before sowing samples (Figure 3). This may be ascribed to organic matter which has an important role for the changes in the capillary water in soil.

Table 1: Particle size distribution

Soil textural class	Silt	Clay	Loam
Silty clay loam soil	21.7	52.4	25.9

Permanent wilting point

The permanent wilting point varied in the three treatments as maximum (20.69%) in integrated treatment followed by inorganic and the least (14.84 %) in organic treatment (Figure. 4). The higher water holding capacity and organic matter content of soil in integrated treatment can be the reason for higher wilting point. Similarly Walia *et al.* [10] studied the long term effect of integrated use of organic and inorganic sources of nutrients on permanent wilting point and also reported that there is significant improvement in permanent wilting point by applying recommended dose of fertilizers along with FYM. The value of

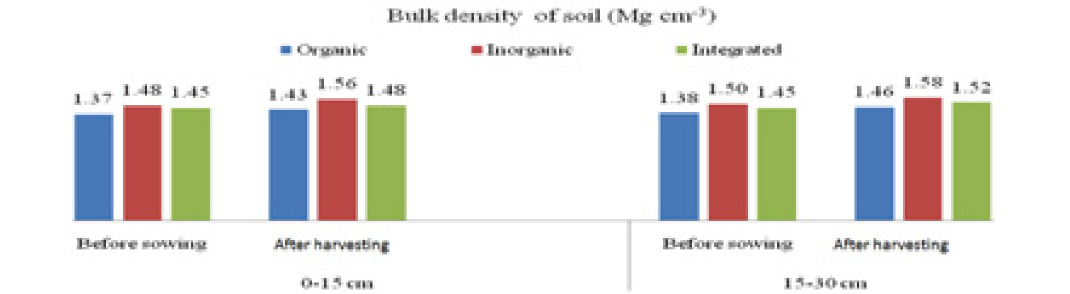

Fig. 1: Effect of management practices on bulk density of soil (Mg cm^{-3})

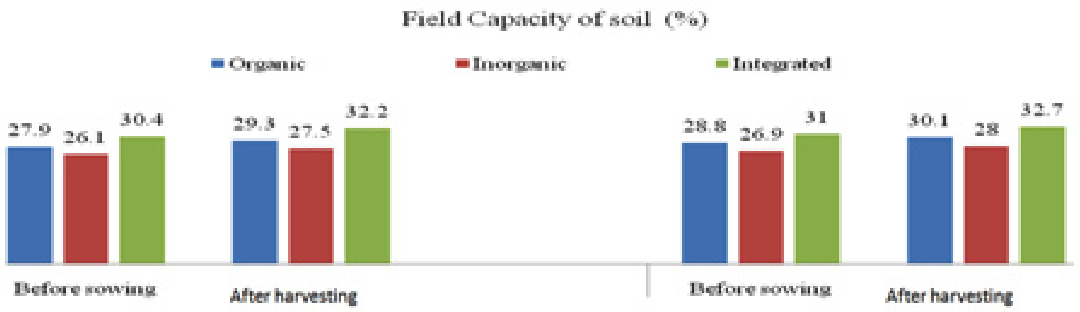

Fig. 2: Effect of management practices on Field Capacity of soil (%)

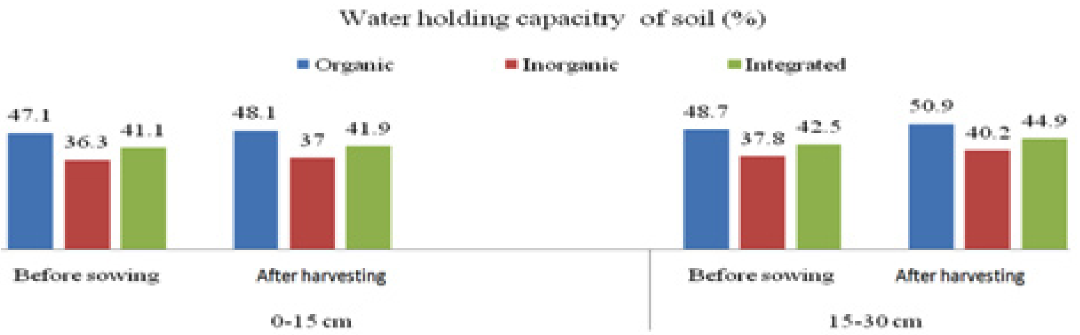

Fig. 3: Effect of management practices on Water holding capacity of soil (%)

Table 2: Effect of organic, inorganic and integrated treatments on organic carbon content (g kg^{-1})

Farming System	Before Sowing								After Harvesting							
	0-15 cm				15-30 cm				0-15 cm				15-30cm			
	A1	A2	A3	MEAN	A1	A2	A3	MEAN	A1	A2	A3	MEAN	A1	A2	A3	MEAN
Organic	1.3	2.0	1.7	1.7	1.3	1.8	1.5	1.5	.82	1.2	1.5	1.1	0.71	1.1	1.4	1.1
Inorganic	1.2	1.6	1.3	1.3	1.1	1.3	1.1	1.2	0.50	.82	1.2	.90	0.4	0.8	1.0	0.8
Integrated	1.3	1.8	1.5	1.5	1.2	1.6	1.4	1.4	0.70	1.2	1.4	1.1	0.7	1.1	1.3	1.0
MEAN	1.3	1.8	1.5		1.9	1.6	1.3		0.70	1.1	1.3		0.6	1.0	1.2	
CD($p \leq 0.05$)	0.03				0.02				0.02				0.03			

·A1, A2 and A3 represents cropping sequences given in material & methods section
·0-15cm and 15-30 cm are the depths of soil samples

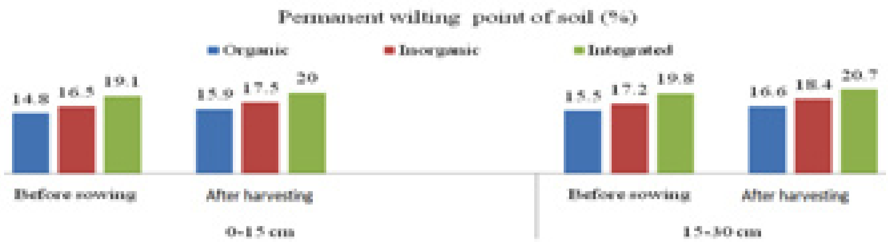

Fig. 4: Effect of management practices on Permanent Wilting Point of soil (%)

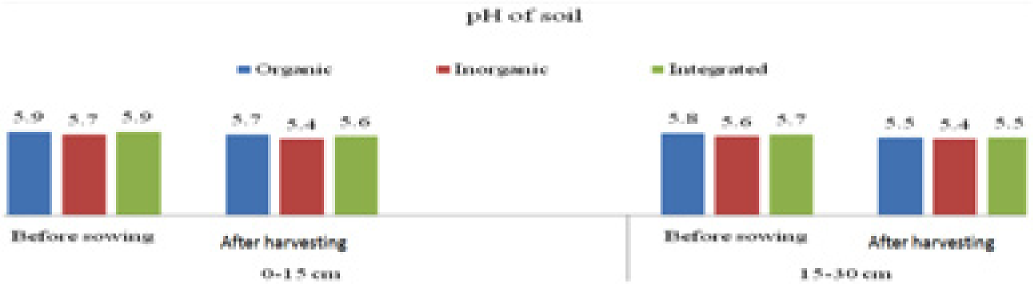

Fig. 5: Effect of management practices on pH of soil

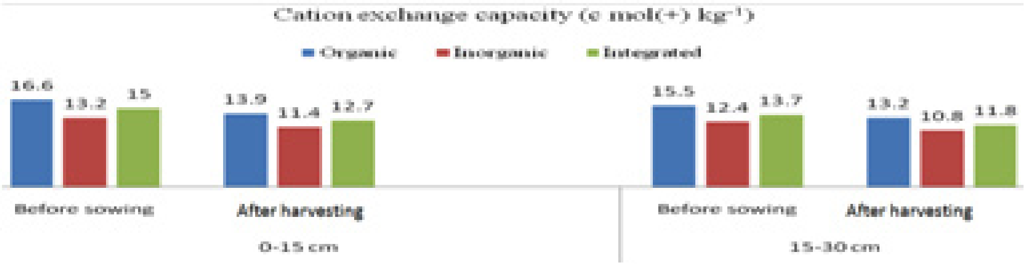

Fig. 6: Effect of management practices on Cation exchange capacity of soil (c mol(+) kg^{-1})

permanent wilting point was found increased in the after harvesting samples.

Chemical properties

Soil pH

The soil pH (Figure 5) values ranged from 5.4 to 5.9 in the surface soil and 5.4- 5.8 in the sub-surface soil in all the three farming systems. Results revealed almost no significant change in the pH values in different farming systems except organic farming system where it was recorded slightly higher.

Cat-ion exchange capacity

Cat-ion exchange capacity was found to be maximum (16.58 c mol (+) kg^{-1}) in organic treatment and minimum (10.82 c mol (+) kg^{-1}) in inorganic practice (Figure 6). It is because of the reason that more amount of organic matter accounts for a larger value of CEC.

Organic carbon

The value of organic carbon in the surface and sub surface soil in before sowing samples were 1.7g/kg and 1.5g/kg respectively and that in after harvesting samples were 1.2 g/kg and 1.1 g/kg respectively (Table 2). It was observed maximum (1.8 g kg^{-1}) in case of organic treatment followed by integrated and minimum (0.75 g kg^{-1}) inorganic treatment, which may be attributed to the FYM optimum C: N ratio for the release of nutrients to the growing plant..The value decreased in the subsurface soil because of the accumulation of organic matter in the surface layers. The results were in line with the findings of Bodruzzaman *et al.*[11].

Available nitrogen

The available nitrogen content in the soil before sowing the crop was found highest 485.5 kg/ha in integrated treatment followed by organic (440.4 kg /ha) and it was lowest (393.0 kg/ha) in inorganic treatment (Table 3). The cropping sequence one gave the maximum value of available nitrogen. In another study Gill and Meelu[12], also found that when FYM and inorganic fertilizers are combined it results in an appreciable build up of available nitrogen content of the soil. The amount of available nitrogen decreased in the after harvesting samples as the plant take up some amount of nitrogen from the soil.

Table 3: Effect of organic, inorganic and integrated treatments on available Nitrogen (kg/ha)

Farming System	Before Sowing								After Harvesting					
	0-15 cm				15-30 cm				0-15 cm				15-30 cm	
	A1	A2	A3	MEAN	A1	A2	A3	MEAN	A1	A2	A3	MEAN	A1	A2
Organic	479.0	435.6	406.7	440.4	452.3	413.6	398.3	421.4	431.3	390.3	375.7	399.1	420.7	374.1
Inorganic	428.0	382.6	368.3	393.0	416.0	356.4	349.7	374.0	391.0	542.6	326.7	353.4	380.3	313.5
Integrated	521.0	494.3	441.3	485.5	499.7	406.5	433.0	446.4	457.3	453.4	350.7	420.5	445.3	406.5
MEAN	476.0	437.5	405.4		456.0	392.2	393.7		426.6	395.4	351.0		415.4	364.7
CD ($p \leq 0.05$)	1.6				2.8				3.8				2.4	

Table 4: Effect of organic, inorganic and integrated treatments on available Phosphorous (kg/ha)

Farming System	Before Sowing								After Harvesting							
	0-15 cm				15-30 cm				0-15 cm				15-30 cm			
	A1	A2	A3	MEAN	A1	A2	A3	MEAN	A1	A2	A3	MEAN	A1	A2	A3	MEAN
Organic	80.6	37.2	64.2	60.6	77.2	34.6	59.0	56.9	35.6	77.7	37.0	50.1	42.7	65.1	40.7	49.5
Inorganic	56.9	71.5	45.3	57.9	52.0	65.5	36.4	51.3	25.7	45.4	55.0	42.0	32.8	82.3	29.3	48.4
Integrated	72.8	76.1	56.9	68.6	67.1	71.3	48.6	62.3	44.9	80.2	46.3	57.1	28.2	78.1	49.0	51.6
MEAN	70.1	61.6	55.5		65.4	57.1	48.0		35.4	67.7	46.1		34.6	75.2	39.7	
CD ($P \leq 0.05$)	1.9				1.7				2.9				2.5			

Table 5: Effect of organic, inorganic and integrated treatments on available Potassium (kg/ha)

Farming system	Before Sowing								After Harvesting							
	0-15 cm				15-30 cm				0-15 cm				15-30 cm			
	A1	A2	A3	MEAN	A1	A2	A3	MEAN	A1	A2	A3	MEAN	A1	A2	A3	MEAN
Organic	206.0	320.9	242.3	272.1	251.0	229.3	234.7	238.3	231.0	245.7	234.3	237.0	217.0	236.7	223.3	225.8
Inorganic	272.7	280.5	312.7	288.6	266.1	273.6	279.0	272.9	253.2	287.4	293.7	282.7	263.0	249.3	253.0	255.1
Integrated	311.0	296.4	332.0	313.1	201.6	316.4	301.3	273.1	266.9	325.0	317.3	303.6	297.0	261.3	247.0	285.1
MEAN	242.0	311.1	284.4		239.7	273.1	271.7		271.6	274.2	293.0		259.0	249.1	241.1	
CD ($P \leq 0.05$)	38.4	3.3	8.4	6.5												

Available phosphorous

The organic, inorganic and integrated treatments gave different values for available phosphorous, which varied in a range of 50-70 kg/ha for available phosphorous (Table 4). The maximum amount was observed in integrated treatment followed by organic and the least amount was observed in inorganic. It may be due to the fact that the application of organics along with in-organics increased the organic form of nutrients in the soil and the combined application enhanced the activity of different microorganisms which played an active role in mineralisation and transformation of P. The results are in confirmation with the findings of Singh *et al.*[13].

Available potassium

The available potassium content of the soil was found to be highest (313.3kg/ha) in integrated treatment and lowest (288.6 kg/ha) in the inorganic treatment it was (Table 5). The value of available Potassium decreased with the after harvesting samples as the plant take up some amount of nutrients from the soil.

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