Soil properties as influenced by different land uses systems on under subtropical region of Jammu

Abstract

This work was ~~T~~to study the effect ~~-~~of different land use~~s~~ systems on physical and chemical changes in soil. Soil samples ~~will be~~were collected from five different land use systems, ~~such as~~including agriculture, horticulture, forest, agroforestry and grasslands. Soil bulk density, mean weight diameter, maximum water holding capacity, pH, nitrogen, phosphorous, potassium, cation exchange capacity and organic carbon were analysed. The forest land use registered least bulk density and pH in surface and sub-surface soil layers compared to all other land uses, but higher mean weight diameter, maximum water holding capacity, nitrogen, potassium, found in surface and sub-surface soil layers of forest land use than all other land uses. H~~But h~~ighest available phosphorous was found in agriculture land use. The forest land use is best for soil bulk density, mean weight diameter, water holding capacity, pH, nitrogen, phosphorous over all other land uses.

INTRODUCTION

Ecologically incompatible human land-use and management practices implemented locally such as deforestation, and soil fertility depletion have led cumulatively to an alteration in the global biogeochemical cycles. Land-use changes affect many natural resources and ecological processes such as surface runoff and erosion and changes soil resilience to environmental impacts (Fu *et al.*, 2000;~~,~~ Hacisalihoglu, 2007). The increasing intensity of land-use may cause erosion and soil compaction through changes in soil physical and chemical properties (Celik, 2005). Soil quality index (SQI) is a tool which integrates many kinds of collected data, to arrive a single number that can be used to compare one soil to another to be better understand and evaluate the process that improves or degrade soils. It is a comprehensive way to ascertain environmental quality, agronomic sustainability and socioeconomic viability of a region (Bhardwaj *et al.*, 2011). This tool helps in ascertaining whether soil quality is improving, stable or declining under different land use systems (Masto *et al.*, 2008).

Material and Methods

Soil samples were collected from different land uses of subtropical region of Jammu and analysis was done in the Division of Soil Science and Agriculture Chemistry, Faculty of Agriculture, SKUAST, JAMMU. A total of 180-200 soil samples ~~will be~~were collected from five different land use systems such as agriculture, horticulture, forest, agroforestry and grasslands. ~~At~~ ~~E~~Each location samples were taken from two soil depths i.e. 0-15~~cm~~ and 15-30 cm.

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The core method (Blake and Hartge, 1986) was used for determination of soil bulk density. Fresh undisturbed soil cores of 5 cm diameter and 5 cm length were collected in triplicate from each replicated plot from 0-15 ~~cm~~ and 15-30 cm soil depth ~~soil layers~~ after the wheat harvest. These samples were oven-dried at 105^0C, weighed and the dry weights were divided by the core volume to obtain the soil BD for the respective layer. Maximum water holding capacity, it was determined by Keen Roezkowski box method (Chopra and Kanwar, 1991) The mean weight diameter (MWD) of aggregates were calculated as (Kemper and Rosenau, 1986):

$$MWD\ (mm) = \frac{\sum_{i=1}^{n} x_i w_i}{\sum_{i=1}^{n} w_i}$$

Where, Wi is the aggregates retained over the sieve (g) and Xi the mean diameter of the size class (mm). –A soil suspension was prepared with distilled water keeping 1:2 soil to water ratio and the concentration of hydrogen ions in soil (pH) of suspension was measured by potentiometric method (Jackson, 1973). The pH of the solution being directly proportional to the potential developed on the glass membrane was measured in conjunction with saturated calomel electrode as reference electrode. Available nitrogen was determined by alkaline $KMnO_4$ method (Subbaiah and Asija, 1956), which is based on the extraction of inorganic and readily oxidizable N from organic compounds. The N was extracted with 0.32% ~~per cent~~ $KMnO_4$ and distilled by 2.5 ~~per cent~~% NaOH. The distillation process was carried out by nitrogen analyzer and manual titration was done. The liberated ammonia was absorbed in 2% ~~per cent~~ boric acid, containing bromocresol green and methyl red mixed indicator. The amount of ammonia absorbed was determined titrimetrically using standard H_2SO_4 (0.02 *N*) till the colour flashed from green to pink. Available phosphorous was determined by Olsen's method as described by Watanabe and Olsen using 0.5 *M* sodium bicarbonate pH (8.5) as an extractant. Darco-G-60 was used to absorb the dispersed organic matter and make the filtrate colorless for further colorimetric analysis (Nelson and Sommer 1982). Available potassium and CEC were determined by the flame photometer using neutral N ammonium acetate (pH 7.0) as an extractant as described by Piper (1996).

Walkley and Black carbon (SOC), rapid titration method (wet digestion method) was used for organic carbon determination (Walkley and Black, 1934). In this determination 2 gm of dried soil was treated with 10 ml of 1 *N* $K_2Cr_2O_7$ solution in a 250 ml conical flask. 20 ml of concentrated H_2SO_4 was slowly added to the flask. After 30 minutes, about 0.5 gm of NaF, 100 ml of distilled water and 10 drops of diphenylamine indicator were added to the flask. These contents were titrated against 0.5 *N* ferrous amonium sulphate (FAS) solution. The change from violent to bright green through blue colour was the end point. The value of FAS used for titration was adopted for calculating organic carbon and was expressed as percentage. 10 ml of 1N $K_2Cr_2O_7$ solution in another flask was titrated without soil against 0.5 *N* FAS solution to determine blank. The organic carbon in the soil was calculated as:

Organic carbon (%) = [(X-Y) * 0.003 * 100 * N]/W

Where X = volume of 0.5 *N* FAS used for blank titration

Y = volume of 0.5 *N* FAS used for soil sample

N = Normality of FAS used

Statistical analysis

The data were analyzed by using analysis of variance by single factor ~~anova~~ANOVA, least significant difference (LSD) was used to compare the treatment effects.

Results and Discussion

The forest land use registered least bulk density (1.39 and 1.44 Mg m^{-3}) in surface and sub-surface soil layers which was followed by grassland, horticulture, agroforestry and agriculture. This result might be attributed by the addition of fallen litters, which loosened the soil (Chandel et al., ~~(~~2017). These results are in agreement with the findings of Sharma et al. (2014) studied that the mean bulk density was greatest under agriculture followed by degraded land in all three soil depths. Forest and horticulture soils had lower bulk density than that in other land uses. Soil bulk density in all the land use systems increased with soil depth. Chandel *et al.* (2017) also reported that the lower bulk density in the forest, horticulture, and grasses than that in agriculture and bare land uses. The higher MWHC was observed in forest land use (38.74 and 37.19 %) in both the soil depths followed by horticulture, agroforestry, grassland, and least in agriculture land use (Table 1). Similar findings were reported by Chandel et al. (2017), the maximum WHC was observed in the land use forest which was significantly at par with the horticulture followed by grasses and cultivated land use, lowest WHC was in bare land use. Saha et al. (2014) they reported that the bulk density values are higher in eroded soils in both the surface and sub-surface soil over the other land-uses. Same trend also observed in the study of Goyal (2009) maximum water holding capacity found in forest, grasslands and agriculture land use. The highest values of maximum water holding capacity in forest soil could be attributed to high soil organic matter and finer clay content in these soils. The decreasing trend of WHC with depth may be due to less organic carbon and clay content of soil under different land use systems. In surface (0-15 cm) and subsurface (15-30 cm) soil layers, the MWD presents in ~~table~~ Table 1 was highest in forest land (3.18 and 2.64 mm) followed by grassland, agroforestry, horticulture and least in agriculture (Table. 1). The lower MWD agriculture land use might be due to lower inputs of organic matter from the vegetation and loss of SOC by water erosion. On the contrary, the higher fibrous root biomass in forest followed by grassland agroforestry and horticulture soils could have contributed a higher SOC and leads to a higher MWD in these soils, these results are in line with Kukal et al. (2007) reported that the stability of soil aggregates was higher under grasslands as compared to other land use systems. Sushil et al. (2002) found that the forest soils had higher MWD than that in cultivated land. The higher the MWD of soil sample the better the stability of the soil to break down caused by erosion agents and degradation. Lower MWD in the agriculture land use could be due to lack of vegetative cover, impact of raindrops and low SOC content in degraded soils. Franzluebbers *et al.* (1999) reported that the mechanical disturbance

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Formatted: Font: (Default) Times New Roman, 12 pt reduced soil structural stability in different soil types. These low values of ~~mean weight diameter (~~MWD~~)~~ could lead to quick dispersion of the soil in any rainfall event leading to severe rill or inter-rill erosion. Hadda *et al.* (2020) reported that the larger mean weight diameter were observed under pear, grasses and fallow than that under rice-wheat. The least soil pH registered in f~~F~~orest land (6.6 and 6.7 in surface and sub-surface soil layers, respectively) which was followed by a~~A~~griculture (6.8 and 6.9~~-~~), h~~H~~orticulture (~~-~~6.9 and 7.0), a~~A~~groforestry (6.9 and 7.0) and ~~Grassland~~ grassland (7.0 and 7.1). The soils under study varied from slightly acidic to slightly alkaline in nature. Similar values had been seen ~~observed~~in kandi soils of Jammu observed by Sharma et al. (2009)~~, in kandi soils of Jammu~~. Forest soils showed lower pH values as compared to degraded lands, this could be because of their higher organic carbon content. The pH increased with depth in all land use systems, which is similar to the trend obtained by Gupta (1994). The increase in pH with depth could be due to leaching of calcium carbonate and exchangeable bases. The soil pH variability is usually attributed to organic materials in the soil which produce organic acids on their decomposition including carbonic acid which eventually lowers down the soil pH. Sarkar *et al*. (2001) also reported that the low pH value in surface soil is mainly due to leaching of bases and accumulation of basic cations from higher topography due to rainfall. Forest land use registered highest content available N ~~-~~presented in table 2 in surface and sub-surface soil layers ~~–~~(326.07 and 317.12 kg ha^{-1}) was followed by horticulture, grassland, agroforestry and lowest in agriculture. Mandal *et al.* 2018 studied the effect of three agricultural land-uses viz. cropland, horticultural land and uncultivated land on soil quality and fertility status. Available nitrogen content followed a trend horticulture > cropland > uncultivated land and also Panwar et al. (2013) studied the impact of land use on soil fertility, and reported that h~~H~~ighest N content was found under forest, followed by grassland, horticulture and agriculture and least in wasteland. Chandel *et al.* (2017) studied that the soil quality degradation is a major challenge in submontane Punjab and reported that the available N was lower under all land uses. The available N was maximum under the land use forest followed by cultivated, grasses which was significantly at par with the horticulture and bare. The available nitrogen was higher as expected in land use forest, because large amount of nitrogen was available through organic matter addition. The conversion of forest into the cropland reduced soil nitrogen in the long run (Runquan et al., 2002). Among all the land uses the available P was in the range of 19.45 to 21.49 kg ha^{-1} in surface and 17.87 to 19.94 kg ha^{-1} in subsurface soil depths. Agriculture land use registered highest content of available P in the surface and sub-surface soil layers, followed by grassland, forest, agroforestry and lowest in horticulture. The land use cultivated indicated higher available P by 40% compared to land use bare, which was significantly at par with the grasses followed by forest, horticulture and bare (Chandel *et al.*, 2017). Mandal et al. 2018 studied the effect of three agricultural land-uses viz. cropland, horticultural land and uncultivated land on soil quality and fertility status, found in case of phosphorus (P), it was follow the trend of cropland > horticultural land > uncultivated land. Forest land use registered highest content of available K in the surface and sub-surface soil depths (273.39 and 259.37) kg ha^{-1}) followed by horticulture, grassland, and agroforestry and lowest in agriculture. S.Pal.et al 2013 also studied that h~~H~~ighest N and K content were found under forest followed by grassland, horticulture and agriculture and least under wasteland. Nitrogen content decreased significantly with soil depth. Singh et al. (2013) reported that available K was higher in natural forest followed by grassland,

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plantation and lowest in cultivated. R. Singh et al. 2017 studied that available K was higher in forest compared to all other land uses.

Table 1: Effect of different land use systems on physical properties of soil

Land use	B~~.~~D (Mg m^{-3})		Maximum WHC (%)		MWD (MM)	
Depths→ (cm)	0-15 ~~cm~~	15-30~~cm~~	0-15 ~~cm~~	15-30~~cm~~	0-15 ~~cm~~	15-30~~cm~~
Agriculture	1.47	1.51	32.53	31.16	2.09	1.94
Horticulture	1.45	1.47	36.72	35.28	2.27	2.14
Forest	1.39	1.44	38.74	37.19	3.18	2.64
Agroforestry	1.46	1.48	35.66	34.01	2.88	2.56
Grassland	1.44	1.47	36.65	35.00	3.05	2.58
LSD@5%	0.046	0.043	1.55	1.56	0.17	0.17

Table 2: Effect of different land use systems on chemical properties of soil

Land use	Soil pH		Available N (kg /ha^{-1})		Available P (kg /ha-1~~kg/ha~~)		Available K (kg ha^{-1}~~kg/ha~~)	
Depths (cm)→	0-15 ~~cm~~	15-30~~cm~~	0-15 ~~cm~~	15-30~~cm~~	0-15 ~~cm~~	15-30~~cm~~	0-15 ~~cm~~	15-30~~cm~~
Agriculture	6.8	6.9	266.27	246.15	21.49	19.94	230.50	213.32
Horticulture	6.9	7.0	321.92	290.04	19.45	17.87	264.70	250.16
Forest	6.6	6.7	326.07	317.12	20.41	19.06	273.39	259.37
Agroforestry	6.9	7.0	293.78	276.64	19.90	18.62	246.35	240.21
Grassland	7.0	7.1	300.02	282.26	21.16	19.41	262.60	241.69
LSD@5%	0.38	0.39	41.87	46.83	1.08	1.05	31.87	33.84

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