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EFFECTS OF DIFFERENT LAND USE SYSTEMS ON SELECTED PHYSICO-CHEMICAL PROPERTIES OF SOILS IN INDUSTRIAL AREA OF SELAQUI, DEHRADUN, INDIA

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ABSTRACT

A study conducted in the Selaqui area of Dehradun, Uttarakhand, India was to assess and compare the changes in the physical and chemical properties of soils under different land-use viz. natural forest soil, agricultural (cultivated) soil, abandoned soil, and industrial soil. Soil samples collected randomly from the four sites with three replications for each land-use system, at two varied depth levels (0-15 cm and 15-30 cm). Results of this study indicated that the forest land recorded the highest moisture content, electrical conductivity, total nitrogen, organic carbon, available phosphorous and available potassium while the higher pH and calcium content were observed in an abandoned land and industrial land use respectively. However, the lowest moisture content, electrical conductivity, total nitrogen, and calcium content were recorded from abandoned land use; the pH from industrial land use and the available phosphorous and available potassium from agriculture (cultivated) land use.

Keywords: Land-use, Physic-chemical properties, Total Nitrogen, Organic Carbon.

1. Introduction

Land use is defined as the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it (Ufot *et al.*, 2016). Land, when used in accordance with its strength and position, the risks of soil degradation will be considerably reduced so that if steep lands are covered with forest or natural grasslands, the soil degradation process will be decreased and it stabilizes the soil in different ways. On the contrary, making any mistake in land-use change exacerbates soil degradation and causes irreparable damage. There is a closed correlation between land use and soil degradation and if the land used unreasonably, degradation will be highly increased. It seems that sustainable land management is the possible solution to the problem of natural resource degradation by preventing the degradation of soil and land and cause of stabilization and ensuring sustainable production for future generations (Gholami, 2010). Soil resource has also provided a great contribution in the production of food and fiber, in the maintenance of local, regional, and worldwide environmental quality (Bore and Bedadi, 2015).

With the ever-increasing demand for agriculture production, land-management dependence is crucial at regional, national, and regional levels. The management of agro-ecosystems at these scales ultimately expected to meet various objectives to ensure the socio-economic viability of rural areas, including sustainable water management, biodiversity conservation, landscape integrity, and economic attractiveness (Nainggolan *et al.,* 2008). Soil resources are finite, non-renewable, and prone to degradation through misuse and mismanagement (Lal, 2000). In addition, intensive agriculture, combined with dynamic population and long-term exploitative farm practices, has led to the continuous depletion of the natural vegetation cover and over-utilization of land resources. Furthermore, due to increasing demand for firewood, timber, pasture, food, and residential dwelling, the hardwood forests are being continuously degraded or converted to cropland at an alarming rate in the study area. Under such situations, soil degradation is inevitable (Ronggui, 2001). Keeping the above different land use and effects in view, the current study was undertaken with the objective to study effects of different land use systems on selected physico-chemical properties of soils in industrial area of Selaqui, Dehradun

2. Materials and Methods

2.1 Description of the study area

The present study was conducted in the Selaqui area, which is located in the Dehradun district of Uttarkhand.

Selaqui is situated at about 25 km approx. distance from the main city of Dehradun. Geographically, the location of Selaqui is 30° 22' 41.08'' N, 77°50' 08.89''E and situated at an altitude of 682.584 meters (2240 ft) above sea level. The climate of the area is humid subtropical. It varies greatly from tropical to severe cold depending upon the altitude of the area. The soils are mainly developed on the deep alluvial deposits with the parent material derived from the Doon alluvium.

2.2 Sampling and Soil Analysis

The composite soil samples were collected randomly from four sites with three replications under different land use *i.e.* Natural forest soil, Agricultural (cultivated) soil, Abandoned soil, and Industrial soil and were brought to Central Soil and Water Conservation Research Training and Institute (CSWCRTI) laboratory for further analysis. From the samples collected from each site, the representative two composite soil samples from each site were used based on the specific depth of 0-15 cm and 15-30 cm. Soil samples were air-dried, graded, sieved, and stored in polythene bags until further physical and chemical analysis. During the collection of soil samples, gravel materials, dead plants, old manures, areas near trees and compost pits were excluded. This is to minimize the differences variation, which may arise because of the dilution of soil OM due to mixing through cultivation and other factors. The analysis was carried out using the following methods: available Nitrogen (kg/ha) (Alkaline $KMnO_4$ method - Subbiah and Asija, 1956), Available Phosphorus (kg P /ha) (Olsen's method - Olsen *et al.,* 1954), Available Potassium (kg K /ha) (Flame emission spectrophotometry method (Jackson 1973), Organic Carbon (%) (Walkley and Black method 1934 and Jackson, 1967); pH (1:2) (Glass electrode ph meter - Jackson, 1967) and EC (dS m^{-1}) (Electrical Conductivity Meter - Bower and Wilcox, 1965. The percentage of soil colloids (sand, silt, and clay) were calculated using International Pipette Method (Kilmer and Alexander, 1949), and Soil texture was observed using Bouyocos hydrometer Method (Black, 1965).

2.3 Statistical Analysis

Data recorded from the study were subjected to analysis of variance technique using Complete Randomized Block Design for laboratory (Panse and Sukhatme, 1967). Significance of treatment means was tested by F-test and the critical difference at 5 percent as well as 1 percent level of significance to know if there was a significant difference between two treatment means.

3. Results and Discussion

3.1 Physico-chemical characteristics of soil

3.1.1 Moisture percent

Moisture content percent was found significantly higher (11.69 % and 12.66 %) in forest land at both 0-15 cm and 15-30 cm depths respectively than all other land use. While, the lowest (3.64 % and 4.04 %) moisture was observed under abandoned land which was non-significant than the rest of the land uses (Table 3.1.1). Similar results were also obtained by Selassie and Ayanna (2013) and Ayoubi *et al.,* (2011) who found out that forest land (natural forest) soil has more moisture content than agriculture (cultivated) land (agriculture) soils.

Table 3.1.1: Soil moisture content (%) under different land use.

Land Use	Depths	
	0-15 cm	15-30 cm
Agriculture (cultivated) land	9.51	8.89
Industrial land	8.48	10.53
Forest Land	11.69	12.66
Abandoned land	3.64	4.04

3.1.2 pH

The pH of abandoned land was significantly higher (7.10 and 6.57) at both the depths *i.e.* 0-15 cm and 15-30 cm from the rest of the land uses but was statistically at par with agriculture (cultivated) land for 15-30 cm. Whereas, the smallest (5.50 and 5.31) pH was observed under industrial land which was significantly lower than all other land uses except forest land for 0-15 cm (Table 3.1.2). Similar results were obtained by Lichaikul *et. al.,* (2004) who found forest soils more acidic as compared to agricultural soils. The same result was also observed by Ayoubi *et al.,* (2011) who found forest land (natural forest) soils more acidic than agriculture (cultivated) land (agricultural) soils. Similarly, Selassie and Ayanna (2013) also reported the same result who found forest land (natural forest) soils more acidic than agriculture (cultivated) land (agriculture) soils. Negassa and Gebrekidan (2004) also reported similar results who found that agriculture (cultivated) land (agricultural) soils more acidic than abandoned land (abandoned) soils.

Table 3.1.2: pH of different land use at different depths.

Land Use	Depths	
	0-15 cm	15-30 cm
Agriculture (cultivated) land	6.50	6.47
Industrial land	5.50	5.31
Forest Land	5.60	5.60
Abandoned land	7.10	6.57

3.1.3 Electrical Conductivity

The electrical conductivity of forest land was recorded significantly maximum (0.144 and 0.172) than other treatments at both depths, 0-15 cm and 15-30 cm respectively. While minimum EC was found in abandoned land (0.068) and industrial land (0.058) at depths 0-15 cm and 15-30 cm respectively; this was statistically lower than the rest of the land uses (Table 3.1.3). Similar results were reported by Kizilkaya and Dengiz (2010) who found out that forest land (natural forest) has more electrical conductivity as compared to agriculture (cultivated) land (agricultural) soils. Ayoubi *et al.* (2011) also obtained similar results natural forest has more electrical conductivity than agriculture (cultivated) land (agricultural) soils. Gholami (2013) also observed similar results where the electrical conductivity of agriculture (cultivated) land (agricultural) soils was more as compared to abandoned land (abandoned) soils.

Table 3.1.3: Electrical conductivity (dS m^{-1}) of different land use at different depths.

Land Use	Depths	
	0-15 cm	15-30 cm
Agriculture (cultivated) land	0.123	0.081
Industrial land	0.075	0.058
Forest Land	0.144	0.172
Abandoned land	0.068	0.079

3.1.4 Organic Carbon percent

The organic carbon percent of forest land was obtained highest (1.037 % and 0.551 %) in both *i.e.* 0-15 cm and 15-30 cm depths respectively which were significantly higher than agriculture (cultivated) land, industrial land, and abandoned land. However, statistically, the lowest organic carbon percent was obtained under industrial land (0.059 %) at 0-15 cm depth and abandoned land (0.237 %) at 15-30 cm depth (Table 3.1.4). Similar results were obtained by Abera and Belachew (2011) who found that forest soil has more percent of organic carbon than agriculture (cultivated) land (agriculture) soils. Also, Selassie and Ayanna (2013) found similar results of more percent of organic carbon in forest Land (natural forest) than agriculture (cultivated) land (agriculture) soils. Kara and Bolat (2008) also obtained similar results who found that Forest Land (forest) soils have more percent of organic carbon than agriculture (cultivated) land (agriculture) soils. Negassa and Gebrekidan (2000) found that agriculture (cultivated) land (agriculture) soils have more organic carbon percent than abandoned land (abandoned) soils.

Table 3.1.4: Organic carbon (%) under different land use.

Land Use	Depths	
	0-15 cm	15-30 cm
Agriculture (cultivated) land	0.860	0.404
Industrial land	0.059	0.287
Forest Land	1.037	0.551
Abandoned land	0.309	0.235

3.1.5 Total Nitrogen

The total nitrogen percent was observed highest in industrial land (0.102 %) at 0-15 cm depth and in agriculture (cultivated) land (0.062 %) at 15-30 cm depth which was significantly higher than other treatments. Whereas, the lowest total nitrogen percent was recorded under abandoned land at both the depths i.e. 0-15 cm and 15-30 cm respectively (Table 3.1.5). Forest land (forest) soil was found to have more total nitrogen than agriculture (cultivated) land (agricultural) soil. Similar results were obtained by Abera and Belachew (2011); Ayoubi *et al.* (2011), and Kara and Bolat (2008). Negassa and Gebrekidan (2000) found that agriculture (cultivated) land (cultivated) soils have more total nitrogen percent than abandoned land (abandoned) soil.

Table 3.1.5: Nitrogen (%) under different land use.

Land Use	Depths	
	DI	DII
Agriculture (cultivated) land	0.085	0.049
Industrial land	0.102	0.050
Forest Land	0.090	0.062
Abandoned land	0.062	0.046

3.1.6 Available phosphorus

The available phosphorus of forest land was recorded statistically highest (10.00 and 14.00 ppm) at both 0-15 cm and 15-30 cm depths respectively. Similarly, the lowest (5.57 and 4.5 ppm) available phosphorus was observed under agriculture (cultivated) land at both 0-15 cm and 15-30 cm depths (Table 3.1.6). Similar results were obtained by Selassie and Ayanna (2013) who found that forest land (forest) soils have more available phosphorus than agriculture (cultivated) land (agriculture) soils. Kizilkaya and Dengiz (2010) also found that forest land (natural forest) soils have more available phosphorus than agriculture (cultivated) land (agriculture) soils. Similar results were also obtained by Oguike and Mbagwu (2009) who found that available phosphorus of industrial land (natural forest) soils are more than agriculture (cultivated) land (agriculture) soils.

Table 3.1.6: Phosphorus content (ppm) under different land use.

Land Use	Depths	
	0-15 cm	15-30 cm
Agriculture (cultivated) land	5.57	4.5
Industrial land	7.75	6.0
Forest Land	10.00	14.0
Abandoned land	6.25	7.5

3.1.6 Available Potassium

The available potassium of Forest Land was found highest (171.50 and 183.47 ppm) with a significant difference from other land uses at both 0-15 cm and 15-30 cm depths respectively. However, statistically the lowest (47.00 and 40.30 ppm) available potassium was observed under agriculture (cultivated) land at both 0-15 cm and 15-30 cm depths respectively (Table 3.1.7). Similar results were obtained by Negassa and Gebrekidan (2000) who found out those Forest Land (abandoned) soils have more available phosphorus than agriculture (cultivated) land (agriculture) soils. Oguike and Mbagwu (2009) also obtained similar results who found that Forest Land (natural forest) soils have more available potassium than agriculture (cultivated) land (agriculture) soils.

Table 3.1.7: Potassium (ppm) content under different land use.

Land Use	Depths	
	0-15 cm	15-30 cm
Agriculture (cultivated) land	47.00	40.30
Industrial land	85.47	59.50
Forest Land	171.50	183.47
Abandoned land	63.00	68.30

3.1.7 Calcium content

At Depth 0-15 cm, the calcium content (0.060 mg) of industrial land was significantly higher than agriculture (cultivated) land and abandoned land and was at par with forest land Whereas, the lowest (0.038 mg) calcium content was found at abandoned land. Likewise, the calcium content (0.057 mg) of industrial land was found statistically higher at depth 15-30 cm than the rest of the treatments. While both agriculture (cultivated) land and abandoned land recovered low (0.040 mg) calcium content which was significantly lower than agriculture (cultivated) land and was at par with Forest Land (Table 3.1.8). Similar results were obtained by Negassa and Gebrekidan (2000) who found out that agriculture (cultivated) land (agriculture) soils have more calcium than abandoned land (abandoned) soils.

Table 3.1.8: Calcium content (mg) of different land use at different depths.

Land Use	Depths	
	0-15 cm	15-30 cm
Agriculture (cultivated) land	0.048	0.040
Industrial land	0.060	0.057
Forest Land	0.054	0.046
Abandoned land	0.038	0.040

3.1 Mechanical characteristics

The relative proportions of sand, silt, and clay in the soil under different land use are given in table 3.2 below. The silt percentage was found to be higher in the soil of the study area at all the land use. The sand percentage was found to be the highest in agriculture (cultivated) land at depth 0-15 cm (14%) and at par with forest land at depth 15-30 cm (13.61%). While the sand percentage of industrial land was found to be significantly low at both depths 0-15 cm and 15-30 cm (2.33% and 2.1%). The silt percentage of industrial land was found to be highest at both depths 0-15 cm and 15-30 cm (40.85% and 52%) respectively and the lowest was observed in forest land at depths 0-15 cm (20.8%). Similarly, the clay percentage of industrial land was also found to be highest at both the depths 0-15 cm and 15-30 cm (47.91 and 36.05%) and the lowest was found in agriculture (cultivated) land and forest land at depth 0-15 cm and 15-30 cm (10% and 10.41%). Generally, the clay content was higher in the subsurface layer of cultivated land as compared to the adjacent industrial, forest and abandoned lands. The reason might be due to the preferential removal of clay particles and its downward movement into the subsurface soil layer through the process of clay migration. Similarly, Chemada *et al.* (2017) stated that the clay content of cultivated land was increased from the surface to subsurface soil layer due to the long period of cultivation.

Table 3.2: Mechanical characteristics of the soils at different land use and depths.

Land use	Depth	Sand (%)	Silt (%)	Clay (%)
Agriculture (cultivated) land	0-15 cm	14	26	10
	15-30 cm	13.23	29.25	19.50
Industrial land	0-15 cm	2.33	40.85	47.91
	15-30 cm	2.1	52	36.05
Forest Land	0-15 cm	10.2	20.8	14.1
	15-30 cm	13.61	34.04	10.41
Abandoned land	0-15 cm	10.24	24.31	17.1
	15-30 cm	9.13	26.68	15.03

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