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Assessment of soil chemical Properties under different land uses in Barog-Dhillon watershed in Solan district of Himachal Pradesh

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Abstract
The present investigation entitled "Assessment of soil chemical properties under different land uses in Barog-Dhillon watershed in Solan district of Himachal Pradesh" was carried out with a view to ascertain the chemical properties of soils under different land uses viz. agriculture land, forest land, grassland and scrub land under project area and non-project area of Barog-Dhillon watershed. On the basis of detailed survey and random sampling, representative soil samples from two depths i.e. 0-15cm and 15-30cm were collected. The highest soil pH (6.84) was recorded under scrub land where as lowest under forest land (6.37). The electrical conductivity was found highest under scrub land (0.32 d Sm-1) and lowest (0.18 d Sm-1) in grassland soils. The soil organic carbon content of different land uses was recorded highest under grassland soils (17.05 g kg-1) and lowest under scrub land (6.71 g kg-1). The cation exchange capacity in soils of different land uses was highest under forest land soils (15.84 cmol (p+) kg-1) whereas lowest under scrub land (7.97 cmol (p+) kg-1). Available N was higher in grassland soils (316.38 kg ha-1) and lowest under scrub land soils (168.75 kg ha-1). Highest available phosphorus contents were recorded in the soils under agricultural land (60.56 kg ha-1). Highest available potassium contents were recorded in the soils under grassland soils (252.76 kg ha-1) whereas lowest under scrub land (177.98 kg ha-1). The study showed that chemical properties of soil assessed for different land uses were found better in case of watershed project area as compared to non-watershed project area.

Keywords: Soil Chemical Properties, Land Uses, Watershed

1. Introduction

The management of natural resources on micro-watershed has emerged as one of the potential and holistic approach in rainfed areas for higher and sustainable agriculture production system. The sustainable development of a region is not only the protection and reclaimation of natural resources, but also a scientific basis for the resource management in harmony with environment. These resources should be managed in a sustainable manner so that the changes proposed to meet the needs of development are brought out without diminishing the potential for their future use (Kanwar, 1994) [9]. Understanding the effects of landuse and land cover changes on soil properties has implications for devising land management strategies for sustainable use. Generally, a sound understanding of landuse effects on soil properties provides an opportunity to evaluate sustainability of landuse systems (Bewket and Stroosnijder, 2003) [2]. Land use and soil management practices influence the soil nutrients and related soil processes, such as erosion, oxidation, mineralization, and leaching, etc (Celik, 2005; Liu *et al*., 2010) [4, 12]. As a result, it can modify the processes of transport and re-distribution of nutrients.

The supply of nutrients to the plants in an appropriate quantity at the correct time is essential for sustainable yield. Soil organic matter, crop residues and manure plays a vital role in supplying N, P, K and S to plants and transformation between the various organic and inorganic forms often control availability both for plant uptake and loss to the environment. The nutrient dynamics forms the basis for fertilizer application to get regular and optimum yield without losing the soil health. An appropriate land use system plays an important role in improving soil quality through the addition of leaf litter, binding of soil through root system, checking runoff, soil and nutrient losses, etc. Therefore, the effects of different land uses on soil quality have become an integral component of watershed management practices. Maintaining soil quality is a key issue in ensuring sustainable agricultural production for food and fiber security. A systematic characterization of soil is of prime importance for evolving suitable agronomic practices and predicting their ability in relation to the different land use systems.

Therefore, the present study entitled "Assessment of soil chemical properties under different land uses in Barog-Dhillon watershed in Solan district of Himachal Pradesh" has been carried out.

Material and Methods

The present investigation entitled "Assessment of soil chemical properties under different land uses in Barog-Dhillon watershed in Solan district of Himachal Pradesh" was carried out during the year 2014-2015. The total area of selected micro- watershed was approximately 556 ha with an outlay of Rs 3.0 lakh.

Location and Climate

The site from where samples had been taken is located at an elevation of 1500-1950m above mean sea level in the mid-Himalayan zone (Fig.1). It lies between 30^0 50' 533" N latitudes and 75^0 5'947" E longitudes. The areas falls in the mid- hill zones of Himachal Pradesh.The terrain is undulating, hilly and marked with elevation and depressions and has a gentle slope towards the south- eastern aspect.

Climatically, the site lies in the sub- tropical belt but is slightly skewed towards the temperate climate. The area experiences a wide range of temperature with a minimum of 1 °C in winter to a maximum of 37 °C during hot summer and mean annual temperature being 19.8 °C with May and June as the hottest months whereas December and January as the coldest months. Winters are accompanied by a fair amount of frost which kills large amount of regeneration in the area but snowfall is witnessed rarely. The area receives an annual rainfall of 1150mm, most of which is concentrated during the month of June to September (monsoon period).

Land use classes

The area encompasses many land uses and dominant land uses were agriculture lands, forest lands, grasslands and scrub lands. Four land uses viz., agriculture lands, forest lands, grasslands and scrub lands have been taken into consideration in the present study.

Collection and Preparation of Soil Samples

Based on the detailed survey and area under different land use classes, random sampling technique was followed for the selection of sampling sites. Accordingly, four representative soil samples from the surface (0-15cm) and subsurface layer (15-30cm) were collected in the month of September 2014 from watershed project area having four dominant land uses agriculture land, forest land, grassland and scrub land. In addition four soil samples were also collected from the surface (0-15cm) and subsurface layer (15-30cm) depths from non project area of watershed from some representative land uses. Each sample was air dried and divided into two equal parts. One part was processed i.e. properly grind in pestle and mortar and passed through 2 mm sieve and used for the analysis of soil chemical properties (pH, EC, OC, CEC, available N, P, K).

Chemical Properties of Soil

Important chemical properties were determined in the laboratory by using standard methods (Table 1).

Table 1: Soil chemical properties and methods

Sr. No.	Parameters	Method	Reference(s)
i)	Soil pH (1:2)	Potentiometric	Jackson (1973)
ii)	Electrical conductivity (dSm^{-1})	Wheat stone bridge circuit method	Jackson (1973)
iii)	Organic carbon (OC) (g kg^{-1})	Rapid titration method	Walkley and Black (1934)
iv)	Cation exchange capacity (CEC) (cmol(p^+)kg^{-1})	Centrifuge method	Bower *et al.* (1952)
v)	Available N (kg ha^{-1})	Alkaline potassium permanganate method	Subbiah and Asija (1956)
vi)	Available P (kg ha^{-1})	Olsen's method	Olsen *et al*.,(1954)
vii)	Available K (kg ha^{-1})	Flame photometric method (1N NH_4OAC extractable)	Merwin and Peech (1951)

Results and Discussion

The highest soil pH (6.84) was recorded under scrub land followed by the agriculture (6.42), grassland (6.50) and forest land (6.37) being lowest, respectively (Table. 2). Srikanth *et al.*, 2000 and Jeyabaskaran *et al.*, 2001 [7], also reported a decline in pH with the addition of organic manures. The electrical conductivity was found very well safe and normal in the range of (0.18-0.32 d Sm-1). It was highest under scrub land (0.32 d Sm-1) and lowest (0.18 d Sm-1) in grassland soils (Table. 2). Sitanggag *et al.*, 2006 also observed the similar results. The soil organic carbon content different land uses was highest under grassland soils (17.05 g kg-1) and scrub land (6.71 g kg-1) being lowest (Table. 3). The significantly higher OC value in grassland soils is probably because of a more rapid turnover and recycling of organic matter of the natural vegetation, less erosion and slower oxidation of the new organic material (Mandal *et al*., 2010) [13].

Table. 4 showed the cation exchange capacity in soils of different land uses ranged from 7.97– 15.84 cmol(p+) kg-1, highest under forest land soils (15.84 cmol(p+)kg-1) whereas lowest under scrub land (7.97 cmol(p+) kg-1). This may be due to comparatively higher organic carbon contents coupled with higher clay in forest soils. The results are in agreement with the finding of Billet *et al.* (1990) and Swaranam *et al.*, 2004.

Available N was higher in grassland soils (316.38 kg ha-1) and lowest under scrub land soils (168.75 kg ha-1) (Table. 5). Higher organic matter in grassland soils may be ascribed to the higher available N in grassland, since organic matter is the sole source of available N in the soils. These results are in agreement with the findings of Singh and Dutta (1988).

Highest available phosphorus contents were recorded in the soils under agricultural land (60.56 kg ha-1) because of frequent application of phosphatic fertilizers under intensive cropping system (Table 6). These results are in accordance with the findings of Dadhwal *et al.*, 2011) [5].

Highest available potassium contents were recorded in the soils under grassland soils (252.76 kg ha-1) followed by forest land (248.37 kg ha-1), agriculture land (207.19 kg ha-1) and scrub land (177.98 kg ha-1) being lowest (Table 7). Lowest value of available potassium in agriculture and scrub land soils, may be due to its depletion partly by vegetation removal and by leaching as the soils in these lands are coarser in texture. These results are also in consonance with those of Kumar (2005) [11] and Khongjee (2012) [10].

Table 2: pH and EC of soils under different land uses

	pH (1:2)						EC (dS m^{-1})					
	Depth (cm)						Depth (cm)					
C	0-15			15-30			0-15			15-30		
L	WPA	NPA	Mean	WPA	NPA	Mean	WPA	NPA	Mean	WPA	NPA	Mean
Agriculture	6.45	6.40	6.42	6.37	6.30	6.34	0.26	0.29	0.28	0.20	0.26	0.23
Forest	6.50	6.23	6.37	6.41	6.13	6.27	0.18	0.21	0.19	0.13	0.20	0.16
Grassland	6.51	6.50	6.50	6.41	6.38	6.39	0.16	0.20	0.18	0.10	0.14	0.12
Scrub	6.95	6.72	6.84	6.87	6.64	6.75	0.29	0.35	0.32	0.24	0.27	0.25
Mean	6.61	6.46		6.52	6.36		0.22	0.26		0.17	0.22	
CD 5%	L : 0.13 C : 0.09 L×C : NS			L : 0.14 C : 0.10 L×C : NS			L : 0.02 C : 0.01 L×C : NS			: 0.02 C : 0.01 L×C : NS		

WPA: Watershed Project Area L = Land uses
NPA: Non Project Area of Watershed C = Conditions

Table 3: Organic carbon content of soils under different land uses

	OC (g kg^{-1})					
	Depth (cm)					
C	0-15			15-30		
L	WPA	NPA	Mean	WPA	NPA	Mean
Agriculture	9.30	8.17	8.74	7.89	7.12	7.50
Forest	11.72	11.63	11.68	8.85	7.62	8.23
Grassland	18.87	15.22	17.05	15.12	7.42	11.27
Scrub	7.62	5.80	6.71	6.77	5.17	5.97
Mean	11.88	10.21		9.66	6.83	
CD 5%	L : 1.19 C : 0.84 L×C : 1.69			L : 1.06 C : 0.72 L×C : 1.52		

WPA: Watershed Project Area L = Land uses
NPA: Non Project Area of Watershed C = Conditions

Table 4: Cation exchange capacity of soils under different land uses

	CEC (cmol(p$^+$)kg^{-1})					
	Depth (cm)					
C	0-15			15-30		
L	WPA	NPA	Mean	WPA	NPA	Mean
Agriculture	11.01	9.92	10.47	9.11	7.25	8.18
Forest	17.02	14.66	15.84	14.81	12.46	13.64
Grassland	9.39	7.26	8.33	7.25	6.92	7.08
Scrub	8.88	7.05	7.97	6.95	6.30	6.63
Mean	11.58	9.72		9.53	8.23	
CD 5%	L : 1.18 C : 0.84 L×C : NS			L : 1.10 C : 0.78 L×C : NS		

WPA: Watershed Project Area L=Land uses
NPA: Non Project Area of Watershed C=Conditions

Table 5: Nitrogen of soils under different land uses

	Nitrogen(kg ha^{-1})					
	Depth (cm)					
C	0-15			15-30		
L	WPA	NPA	Mean	WPA	NPA	Mean
Agriculture	272.83	203.28	238.06	243.83	179.25	211.54
Forest	310.47	210.58	260.52	282.24	180.65	231.44
Grassland	351.50	281.26	316.38	336.63	245.85	291.24
Scrub	184.24	153.26	168.75	176.58	148.54	162.56
Mean	279.76	212.10		259.07	188.57	
CD 5%	L : 17.19 C : 12.16 L×C : 24.32			L : 19.02 C : 13.45 L×C : 26.90		

WPA: Watershed Project Area L=Land uses
NPA: Non Project Area of Watershed C=Conditions

Table 6: Phosphorus of soils under different land uses

	Phosphorus (kg ha^{-1})					
	Depth (cm)					
C	0-15			15-30		
L	WPA	NPA	Mean	WPA	NPA	Mean
Agriculture	67.76	53.36	60.56	65.52	51.81	58.66
Forest	48.72	41.26	44.99	46.48	41.97	44.22
Grassland	47.04	41.49	44.27	44.80	39.83	42.31
Scrub	50.40	46.90	48.65	48.16	42.21	45.18
Mean	53.48	45.75		51.24	43.95	
CD 5%	L : 3.47 C : 2.46 L×C : 4.91			L : 3.36 C : 2.37 L×C : 4.75		

WPA: Watershed Project Area L=Land uses
NPA: Non Project Area of Watershed C=Conditions

Table 7: Potassium of soils under different land uses

	Potassium (kg ha^{-1})					
	Depth (cm)					
C	0-15			15-30		
L	WPA	NPA	Mean	WPA	NPA	Mean
Agriculture	246.32	168.06	207.19	205.31	110.13	157.72
Forest	285.47	211.26	248.37	225.88	150.96	188.42
Grassland	281.25	224.28	252.76	242.08	172.52	207.30
Scrub	207.81	148.14	177.98	172.44	115.24	143.84
Mean	255.21	187.93		211.43	137.21	
CD 5%	L : 4.97 C : 3.51 L×C : 7.03			L : 10.70 C : 7.56 L×C : 15.13		

WPA: Watershed Project Area L=Land uses
NPA: Non Project Area of Watershed C=Conditions

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