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Assessment of soil biological 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 biological properties under different land uses in Barog-Dhillon watershed in Solan district of Himachal Pradesh" was carried out with a view to ascertain the biological 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 Bacterial count (310.56 and 155.56 cfu g^{-1}), fungal count (3.57 and 1.78 cfu g^{-1}), and actinomycetes count (15.81 and 8.43 cfu g^{-1}) recorded higher in surface and subsurface soils under forest land and lowest under scrub land soils, respectively. Whereas, in case of conditions, bacterial count (271.62 and 136.01 cfu g^{-1}), fungal count (3.73 and 1.86 cfu g^{-1}) and actinomycetes count (12.52 and 6.73cfu g^{-1}) recorded higher in surface and subsurface soils under watershed project area compared to non-project area of watershed. It was concluded that biological properties assessed for different land uses were found higher in case of watershed project area as compared to non- watershed project area.

Keywords: Land Uses, Soil Biological Properties, Watershed

1. Introduction

Watershed is an area draining the rain water into a stream through single outlet. It is a small catchment from which all precipitation, rainfall as well as snowfall flows into a single stream. Watersheds are commonly classified by physiography (headwater, steep land, lowland, etc.), environmental condition (pristine, degraded, etc.), or their principal use or land cover (forest, urban, agricultural, municipal water supply, etc.).

Soil and water are essential components of watershed and very important for all land based activities like production of food, fuel, fodder and fiber to meet the challenges of mankind. The success in soil management to maintain soil quality depends upon the understanding that how soils respond to agricultural practices over a period of time.

Larson and Pierce (1991) [5] considered soil quality as capacity of soil to function within ecosystem boundaries to sustain biological productivity maintain environment quality and promote plant and animal health. Changes in the capacity of soil to function are reflected in soil properties that changes in response to management or climate. Different land use plays an important role in improving soil quality through leaf litter, binding of soil through root system, checking runoff, soil and nutrient losses, etc. In view of variable influence of different land uses on soil quality, various biological measures have become an integral component of watershed management programmes in India.

Soil is basic and unique; it control plant productivity of terrestrial ecosystems and it maintains biogeochemical cycles since microorganisms in the soil degrade almost all organic compounds. The living population inhabiting soil includes macrofauna, mesofauna, microfauna and microflora. 80–90% of the processes in soil are mediated by microbes (Nannipieri and Badalucco, 2003) [7]. Numerous ecological factors, for example carbon and energy sources, mineral nutrients, growth factors, ionic composition, available water, temperature, pressure, air composition, pH, oxidation–reduction potential and interaction between microorganisms can able to affect the ecology, activity and population dynamics of microorganisms in soil. These environmental factors can vary distinctly, and so microhabitats in soil are dynamic systems.

Land use as system such as forest land, grass land, agriculture land and scrub land etc., provide stability and sustainability to the farming system. Therefore, the maintenance and improvement of soil quality in continuous cropping system are very important to sustain agricultural productivity for future. These systems are not only helpful to the farming community in providing assured income but also protect the land from its degradation and enhances soil quality. In Himalayan region, the agriculture production has linkage with surrounding natural ecosystem. Therefore, the present study entitled "Assessment of soil biological 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 biological properties under different land uses in Barog-Dhillon watershed in Solan district of Himachal Pradesh" was carried out during the year 2014-2015.

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. 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 biological properties (total microbial count, etc).

Biological properties of soil

Important biological properties of soil were determined in the laboratory by using following methods:

Total microbial count (bacteria, fungi and actinomycetes count in soil)

The serial dilution and plating techniques suggested by Rao (1999) [7] was employed for isolation and identification of viable bacteria, actinomycetes and fungi count. Media were prepared for desired micro flora. The autoclaved and cooled (45 ^{0}C) medium was poured into sterile plates and allowed to solidify. One gram of sieved (2 mm) soil was added to 9 ml sterile water blank and shaked for 15-20 minutes. Serial dilutions of 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5}, 10^{-6} and 10^{-7} were prepared and 0.1 ml of aliquots of various dilutions were added, over cooled and solidified medium in petriplates. Pour plate method was employed. The plates were rotated for uniform distribution of bacterial cells and fungal spores in the aliquot under the media and allowed to solidify. After the media solidified the plates were inverted and incubated at 28^{0}C for 3-4 days. The appearances of colonies on the surface of medium in the plates were observed. Population count of bacteria, fungi and actinomycetes were noted using dilution plate technique by employing nutrient agar (NA), potato dextrose agar medium (PDA) and kenknight's agar media, respectively. (Table 1)

Result and discussion

Biological properties of soil under different land uses

2. Bacterial count

Data present in table 2 revealed that bacterial count was significantly affected by different land use system and conditions, however, their interaction effects were significant. The highest bacterial count of surface and sub-surface soils was found in forest land use with mean value of (310.56 and 155.56 cfu g^{-1}) in watershed project area and non-watershed project area, respectively. While, the lowest was found in scrubland use (120.32 and 60.58 cfu g^{-1}) in surface and sub-surface soils of watershed project area and non-watershed project area, respectively. Soil microbial respiration is indicated microorganisms activity. There is more organic material in forest and grassland with good vegetation cover is reason increased microbial activity. More activity microorganisms in grassland and forest are due to plant roots, plant residues and more organic matter Yousefifard *et al.* (2007) [12]. Higher bacterial in forest land may be due to the higher pore space and organic material added to the soil through leaf litter which serves as a source of energy for microbial population. Similar results were also observed by Joshi and Yadav (2005) [4]. In the interaction effect, bacterial count of soil of different land uses ranged between (106.93-369.27 and 54.08-184.99 cfu g^{-1}) in surface and sub-surface soils of watershed project and non-watershed project area, respectively. The highest bacterial count was recorded in forest land soil (369.27 and 184.99 cfu g^{-1}) under watershed project area and lowest in scrub land (106.93 and 54.08 cfu g^{-1}) which under non project area watershed of surface and sub-surface soils respectively. The higher bacterial count in forest land soils under watershed project area may be due to combined effect of leaf litter and watershed project activities. The soil of watershed project area was also significant in respect to bacterial count (271.62 and 136.01 cfu g^{-1}) as compared to non-project area of watershed (195.75 and 98.31 cfu g^{-1}) of surface and sub-surface soils, respectively. Higher value of bacterial count under watershed project area may be due to watershed project activities, resulted to decrease in soil erosion and nutrient loss through runoff, which enhance the bacterial count. Mathan and Mahendran (1994) [6] also observed watershed project activities control the runoff, check soil erosion and enhance the ground water recharge.

3. Fungal count

Fungal count was significantly affected by different land use system, conditions, however, their interaction effects were non-significant (Table 3). The highest fungal count of surface and sub-surface soils was found in forest land use with mean value of (3.57 and 1.78 cfu g^{-1}) in watershed project area and non-watershed project area, respectively. While, the lowest was found in scrubland use (2.61 and 1.36 cfu g^{-1}) in surface and sub-surface soils of watershed project area and non-watershed project area, respectively. Higher fungal count in the forest land soils may be due to low pH and higher organic matter content, accumulation possibly due to root biomass incorporation and huge amount of leaf litter. These results are in accordance with the findings of Jalali *et al.* (1989) [3] and Qin *et al.* (2006) [8]. In the interaction effect, bacterial count of soil of different land uses ranged between (1.79-4.35 and 1.02-2.17 cfu g^{-1}) in surface and sub-surface soils of watershed project and non-watershed project area, respectively. The highest fungal count was recorded in forest land soil (4.35 and 2.17 cfu g^{-1}) under watershed project area and lowest in scrub land (1.79 and 1.02 cfu g^{-1}) which under non project area watershed of surface and sub-surface soils respectively. The soil of watershed project area was also significant in respect to fungal count (3.73 and 1.86 cfu g^{-1}) as compared to non-project area of watershed (2.33 and 1.20 cfu g^{-1}) of surface and sub-surface soils, respectively. Higher value of fungal content under watershed project area may be due to watershed project activities, resulted to decrease in soil erosion and nutrient loss through runoff, which enhance the fungal count. Mathan and Mahendran (1994) [6] also observed watershed project activities control the runoff, check soil erosion and enhance the ground water recharge.

4. Actinomycetes count

Table 4 revealed that actinomycetes count was significantly affected by different land use system and conditions, however, their interaction effects were significant. The highest actinomycetes count of surface and sub-surface soils was found in forest land use with mean value of (15.81 and 8.43 cfu g^{-1}) in watershed project area and non-watershed project area, respectively. While, the lowest was found in scrubland use (3.28 and 2.01 cfu g^{-1}) in surface and sub-surface soils of watershed project area and non-watershed project area, respectively. This may be due to higher pore space and organic material added to the soil through leaf litter which serves as a source of energy for microbial population. Similar results were also observed by Seaker and Sopper 1988 [10] and Joshi and Yadav 2005 [4]. In the interaction effect, actinomycetes count of soil of different land uses ranged between (1.76-22.80 and 1.08-12.02 cfu g^{-1}) in surface and sub-surface soils of watershed project and non-watershed project area, respectively. The highest count was recorded in forest land soil (22.80 and 12.02 cfu g^{-1}) under watershed project area and lowest in scrub land (1.76 and 1.08 cfu g^{-1}) which under non project area watershed of surface and sub-surface soils respectively. The higher actinomycetes count in forest land soils under watershed project area may be due to combined effect of leaf litter and watershed project activities. The soil of watershed project area was also significant in respect to actinomycetes count (12.52 and 6.73cfu g^{-1}) as compared to non-project area of watershed (5.78 and 3.20 cfu g^{-1}) of surface and sub-surface soils, respectively. Higher value of actinomycetes count under watershed project area may be due to watershed project activities, resulted to decrease in soil erosion and nutrient loss through runoff, which enhance the actinomycetes count. Mathan and Mahendran (1994) [6] also observed watershed project activities control the runoff, check soil erosion and enhance the ground water recharge.

Table 1: The composition of these media was as below

Media	Composition	Quantity
Nutrient agar media (NA)	Beef extract	3g
	Peptone	5g
	NaCl	5g
	Agar-Agar	20g
	Distilled Water	1000ml
Potato dextrose agar media (PDA)	Potatoes	250g
	Dextrose	20g
	Agar-Agar	20g
	Distilled Water	1000ml
Kenknight media	K_2HPO_4	1g
	$NaNO_3$	0.1g
	KCl	0.1g
	$MgSO_4.7H_20$	0.1g
	Glucose	1.0g
	Agar-Agar	20g
	Distilled Water	1000ml

Table 2: Bacterial count of soils under different land uses

	Bacteria(CFU g^{-1})					
	Depth (cm)					
C \ L	0-15			15-30		
	WPA	NPA	Mean	WPA	NPA	Mean
Agriculture	281.74	197.49	239.62	141.07	98.99	120.03
Forest	369.27	251.86	310.56	184.99	126.43	155.56
Grassland	301.78	226.71	264.25	150.91	114.04	132.48
Scrub	133.70	106.93	120.32	67.08	54.08	60.58
Mean	271.62	195.75		136.01	98.31	
$CD_{0.05}$	L : 1.81 C : 1.28 L×C : 2.56			L : 1.41 C : 1.00 L×C: 1.99		

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

Table 3: Fungal count of soils under different land uses

	Fungi (cfu g^{-1})					
	Depth (cm)					
C \ L	0-15			15-30		
	WPA	NPA	Mean	WPA	NPA	Mean
Agriculture	3.53	2.33	2.93	1.76	1.16	1.46
Forest	4.35	2.79	3.57	2.17	1.39	1.78
Grassland	3.62	2.42	3.02	1.81	1.22	1.52
Scrub	3.42	1.79	2.61	1.71	1.02	1.36
Mean	3.73	2.33		1.86	1.20	
$CD_{0.05}$	L : 0.08 C : 0.06 L×C : NS			L : 0.08 C : 0.05 L×C : NS		

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

Table 4: Actinomycetes count of soils under different land uses

C \ L	Actinomycetes (cfu g^{-1})					
	Depth (cm)					
	0-15			15-30		
	WPA	NPA	Mean	WPA	NPA	Mean
Agriculture	9.51	5.78	7.65	4.96	2.94	3.95
Forest	22.80	8.81	15.81	12.02	4.84	8.43
Grassland	12.96	6.75	9.86	7.01	3.93	5.47
Scrub	4.79	1.76	3.28	2.95	1.08	2.01
Mean	12.52	5.78		6.73	3.20	
$CD_{0.05}$	L: 1.22 C : 0.86 L×C : 1.72			L : 1.14 C : 0.81 L×C : 1.61		

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

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