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Assessment of soil biological properties under different land uses in north eastern zone of Kashmir valley

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Abstract
The present investigation entitled "Assessment of soil biological properties under different land uses in north eastern zone of Jammu & Kashmir" was carried out with a view to ascertain the biological properties of soils under different land uses viz. Forest, pasture, apple, vegetable, maize and paddy. On the basis of detailed survey and random sampling, representative soil samples from two depths i.e. 0-20 cm and 20-40 cm were collected. The highest mean content (µg g^{-1}soil) of microbial biomass carbon (252.07), nitrogen (36.00) and phosphorus (5.98) was found in forest followed by pasture > apple > vegetable > maize and lowest was found in paddy. The highest bacterial count (cfu $\times 10^6$ g^{-1} soil) was found in forestry with a mean value of (76.20) while, lowest (63.60) was found in maize. The highest (30.00 cfu $\times 10^5$ g^{-1} soil) fungal count was found in forest and lowest value was recorded in paddy in surface and sub-surface soils, respectively. It was concluded that biological properties assessed for different land uses were found higher in forest soils as compared to cultivated soils and decreased with increase in depth.

Keywords: Land uses, soil biological properties, forest, bandipora

Introduction
Soil quality, antonym for soil degradation, has deteriorated due to natural and anthropogenic activities particularly with the advent of the intensive management practices. Karlen *et al*. (1997) [12] defined soil quality as the capacity of a specific kind of soil to function within natural or managed ecosystem boundaries to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation. Different land uses plays an important role in improving soil quality through leaf litter, binding of soil through root system, checking runoff, soil and nutrient losses, etc. Study by Wakene and Heluf (2003) [20] have examined the impacts of different land uses on soil quality and their study indicated that land use systems, soil types, topography and climatic conditions have a great impact on rate of soil quality degradation. Maintaining or improving soil quality can provide economic benefits in the form of increased productivity. To estimate soil quality a wide range of soil indicators have been identified. The use of indicators made the soil quality a complex functional concept which cannot be measured directly in the field or laboratory (Stocking, 2003) [18] but can only be measured from soil characteristics (Diack and Stott, 2001) [9]. Soil quality is more focused on dynamic soil properties which can be strongly influenced by management and are mainly monitored in the top 20-30 cm of the soil. Soils are characterized by a high degree of variability due to the interaction of physical, chemical, biological and human activities that operate with different intensities and at different rates (Goovaerts, 1998) [10]. The dynamic nature of soil describes the condition of a specific soil due to land use and management practices and it is measured by using physical, chemical and biological indicators (Karlen, 2003) [13]. Assessing soil quality involves measuring soil physical, chemical and biological properties.
The decline in soil quality has often been associated with conversion of grasslands and forests into arable agricultural land. Cultivation of agricultural lands and adoption of mono cultures have further resulted in physical loss of soil organic matter associated with increased release of carbon dioxide to the atmosphere. Decreased organic matter content along with use of tillage and harvesting equipment's have resulted in deteriorated soil structure, tilth, water holding capacity, water infiltration and increased penetration resistance (Oldeman, 1994) [17]. Intensive production in cropping systems, overgrazing in grassland systems, and deforestation of fresh ecosystem resulted not only in accelerated loss of top soil but also wind and water erosion.

Therefore, the present study entitled "Assessment of soil biological properties under different land uses in district Bandipora of North eastern zone of Kashmir" has been carried out.

Materials and Method

The present investigation entitled "Assessment of soil biological properties under different land uses in North eastern zone of kashmir" was carried out during the year 2018-2019.

Location and Climate

The site from where samples had been taken is located at an Elevation range of 1578-1581 meters. District Bandipora, which is spread mostly to north-east direction of Jammu and Kashmir with a total area of 345 km^2. It is located at 34.42^o N and 74.65^o E surrounded by Kupwara district in the west, Baramulla district in south and Kargil, Srinagar and Ganderbal districts in the east. The district is constituted into three tehsils (Bandipora, Sumbal-Sonawari & Gurez). It covers a total area of 1068 thousand hectares, out of which 20.347 thousand hacteres are under cultivation, 0.330 thousand hectares are under forest, 3.482 thousand hectares are under non-agricultural use and 1.663 thousand hectare are fallow. It comes under North Western Himalayan region having cold arid humid agro-climatic zone with annual rainfall of 1476.2 mm with 86 normal rainy days.

Land use classes

The major field crops cultivated are paddy, maize, pulses, fodder, oil seed and millets. Among horticultural crops (fruits) apple, walnut, peach, pear and cherry are cultivated. In addition to above mentioned crops medicinal and aromatic crops are also put under cultivation. The natural vegetation of the area consists of trees like *Salix alba*, *Salix Wallachian*, *Populus alba*, *Plantarinum orientalis*, *Juglans regia and Roubinea pseudoacacia*. The high hill ranges are covered with forests and dominant species are *Pinus sylvestris*, *Pinus walichiana*, *Cedrus deodar*.

Collection and preparation of soil samples

Six different land uses were selected in three different locations viz; Bandipora, Sumbal- sonawari and Gurez of district Bandipora. Composite soil samples were collected at five sites from each land use from two depths (0-20 and 20-40 cm) with the help of core sampler. Random sampling method was followed for the collection of samples. A sum total of sixty composite soil samples were collected from different land uses. The properly stored soil samples were taken to the soil testing laboratory of Division of Soil Science and Agricultural Chemistry, Faculty of Agriculture Wadura for further processing and analysis.

Biological properties of soil

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

1. **Soil microbial carbon (µg g^{-1}soil):** Soil microbial carbon estimation was done by Chloroform fumigation and incubation method given by Jenkinson *et al*. 1979 [11].
2. **Soil microbial nitrogen (µg g $^{-1}$soil)**: Estimation of soil microbial nitrogen was done by Direct incubation method as given by Keeney and Nelson, 1982.
3. **Soil microbial phosphorus (µg g $^{-1}$soil):** Microbial phosphorus estimation in soil was done by Fumigation-extraction method as given by Brookes *et al*. 1982.
4. **Viable Bacterial and fungal count (cfu g^{-1} soil)**: Both viable bacterial and fungal count estimation was done by Serial dilution and pour plate technique given by Anija, 2001.

Result and Discussion

Biological properties of soil under different land uses

Microbial biomass carbon, nitrogen and phosphorus

The examination of data showed that microbial biomass carbon, nitrogen and phosphorus (µg g^{-1}soil) under different land uses varied from (54.17-268.54), (7.73-38.36) and (1.28-6.39), respectively.

The highest mean content (µg g^{-1}soil) of microbial biomass carbon (Table 1), was found in forest 252.07 followed by pasture > apple > vegetable > maize and lowest was found in paddy with a mean values of 75.25.

The maximum value of soil microbial nitrogen (Table 2) under the examined land uses was found in forest soils having the mean value of (36.00 µg g^{-1}soil) and the minimum mean was found in paddy (10.74 µg g^{-1}soil). After forest soils pasture recorded the highest microbial biomass nitrogen.

The microbial biomass phosphorus (Table 3) follows the order forest> pasture>

Table 1: Microbial biomass carbon under different land uses

Sites	Forest	Pasture	Apple	Vegetable	Maize	Paddy
Badiyor	245.54	246.24	180.08	154.21	111.45	54.17
Turekpora	240.48	228.59	220.56	150.28	126.43	76.48
Ajas	255.65	235.69	190.43	169.00	116.21	86.21
Dawar	250.12	240.15	173.34	140.15	135.20	65.07
Tulail	268.54	223.19	186.34	147.45	120.05	94.32
Mean±SE	252.07±4.82	234.77±4.08	190.15±8.10	152.22±4.80	121.87±4.10	75.25±7.19
95% CI	238.68-265.5	223.4-246.11	167.57-212.70	138.94-165.50	110.38-133.36	55.29-95.21

Table 2: Microbial biomass nitrogen under different land uses

Sites	Forest	Pasture	Apple	Vegetable	Maize	Paddy
Badiyor	35.07	35.17	25.72	22.03	16.35	7.73
Turekpora	34.35	32.65	31.50	21.40	18.06	10.92
Ajas	38.36	33.67	27.20	24.10	16.60	12.31
Dawar	35.73	34.30	24.76	20.02	19.31	9.29
Tulail	36.52	31.88	26.62	21.06	17.15	13.47
Mean±SE	36.00± 0.68	33.53± 0.58	27.16±1.16	21.72±0.68	17.49±0.54	10.74±1.03
95% CI	34.09-37.92	31.92-35.15	23.94-30.38	19.84-23.60	15.99- 18.99	7.89- 13.6

Table 3: Microbial biomass phosphorus under different land uses

Sites	Forest	Pasture	Apple	Vegetable	Maize	Paddy
Badiyor	5.84	5.86	4.28	3.67	2.72	1.82
Turekpora	5.72	5.44	5.25	3.50	3.01	1.28
Ajas	6.39	5.61	4.53	4.02	2.76	2.05
Dawar	5.90	5.71	4.12	3.33	3.21	1.54
Tulail	6.08	5.31	4.43	3.40	2.86	2.24
Mean±SE	5.98±0.12	5.59±0.09	4.52±0.19	3.58±0.12	2.91±0.09	1.78±0.17
95% CI	5.66-6.31	5.32-5.86	3.98-5.06	3.24-3.93	2.66-3.16	1.31-2.26

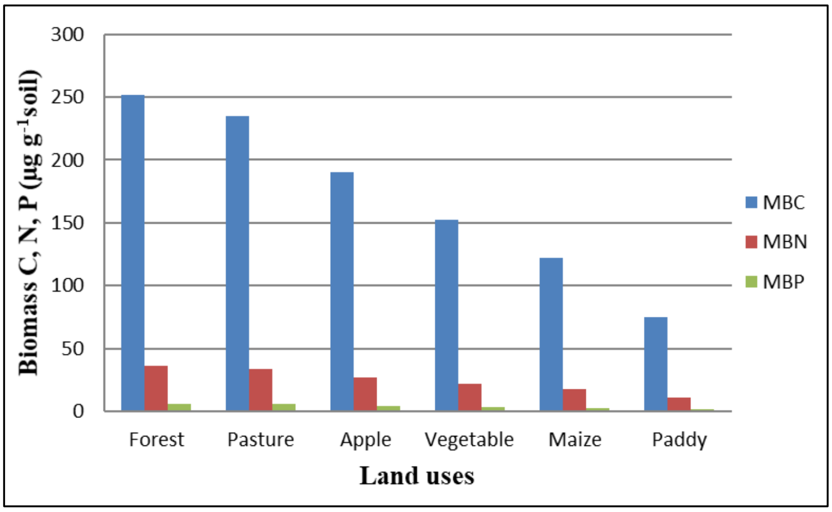

Fig 1: Microbial Biomass carbon, nitrogen and phosphorus of surface soils under different land uses

Table 4: Viable Bacterial count under different land uses

Sites	Forest	Pasture	Apple	Vegetable	Maize	Paddy
Badiyor	70.00	75.00	68.00	74.00	52.00	53.00
Turekpora	66.00	63.00	75.00	68.00	70.00	68.00
Ajas	80.00	66.00	71.00	77.00	55.00	71.00
Dawar	76.00	75.00	55.00	59.00	75.00	62.00
Tulail	89.00	60.00	67.00	67.00	66.00	73.00
Mean±SE	76.20±4.00	67.80±3.09	67.20±3.35	69.00±3.11	63.60±4.39	65.40±3.61
95% CI	65.08-87.32	59.22-76.38	57.89-76.51	60.35-77.65	51.42- 75.78	55.37-75.43

Table 5: Viable fungal count under different land uses

Sites	Forest	Pasture	Apple	Vegetable	Maize	Paddy
Badiyor	27.00	36.00	18.00	30.00	9.00	7.00
Turekpora	22.00	23.00	31.00	25.00	24.00	12.00
Ajas	34.00	27.00	24.00	34.00	13.00	15.00
Dawar	29.00	34.00	10.00	13.00	28.00	10.00
Tulail	38.00	20.00	22.00	18.00	17.00	19.00
Mean±SE	30.00±2.77	28.00±3.08	21.00±4.46	24.00±3.83	18.20±3.48	12.60±2.06
95% CI	22.30-37.70	19.44-36.56	11.38-30.62	13.35-34.65	8.53 -27.87	6.87-18.33

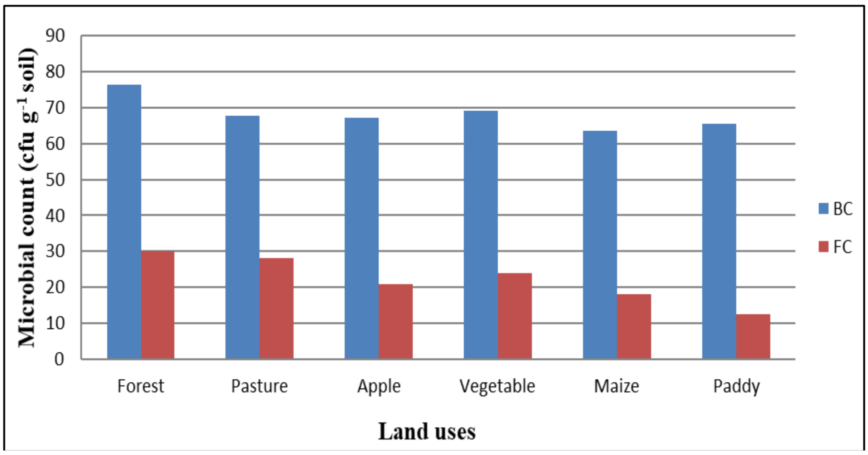

Fig 2: Viable bacterial and fungal count of surface soils under different land uses

apple> vegetable> maize and paddy. The highest mean value (5.98 µg g^{-1}soil) found in forest and lowest (1.78 µg g^{-1}soil) was found in paddy (Figure 1). The maximum value of all three fractions of microbial biomass was found in forest soils and may be attributed to high organic matter content in forest land use having high biological activity and microbial biomass carbon (Kirtika *et al*. (2018) [15]. Further, root biomass and above ground plant biomass are considered to be the main source of soil organic matter which is highly correlated with microbial biomass. Litter fall thus acts as a critical regulating component to enrich the microbial biomass carbon (Dutta and Agrawal, 2002) [7]. The influence is further supported by Chandel *et al*. (2018) [8].

Total viable Bacteria

The total viable bacterial count (Table 4) ranged from 52.00-89.00 cfu $\times10^6$ g^{-1} soil under different land uses. The highest bacterial count (cfu $\times10^6$ g^{-1} soil) was found in forestry with a mean value of (76.20) followed by pasture while, lowest (63.60) was found in maize, respectively. The highest bacterial count found in forest soils might be due to presence of larger carbon source in the form of organic matter, (Asadu *et al*. (2015) [2]. This carbon source needed for metabolism may have increased the growth and activities of bacteria in soils of these land uses. The slightly lower pH of the uncultivated land uses may also have encouraged the growth of bacteria which strive well in that level of pH (Kumar *et al*. (2017) [16] (Figure 2).

Total viable Fungi

The mean value of viable fungi in forest and pasture was higher than other studied land uses. The total viable fungal count (Table 5) ranged from 7.00-38.00 cfu $\times10^5$ g^{-1} soil under different land uses. The lowest value (12.60 cfu $\times10^5$ g^{-1} soil) was recorded in paddy and highest (30.00 cfu $\times10^5$ g^{-1} soil) in forest followed by pasture (28.00 cfu $\times10^5$ g^{-1} soil) (Figure 2). It might be due to low pH and higher organic matter in the forest soils. The presence of trees in forest land use may also have encouraged the presence of ectomycorrhizal fungi which colonize most tree species and prevent the reduced impact of heavy rainfall thus favoring abundant growth of fungi whereas intensive tillage operations common in cultivated land may have equally contributed to the reduced number of fungi in the cultivated land. This is because fungi are easily influenced by changes in soil and environmental conditions (Sui *et al*., 2012) [19]. Similar findings were also reported by Barrico *et al*. (2010) [3] and Bello *et al*. (2013) [4].

Conclusion

The highest mean content (µg g^{-1}soil) of microbial biomass carbon is 252.07, nitrogen is 36.00 and phosphorus is 5.98 was found in forest soils followed by pasture>apple>vegetable>maize and lowest was found in paddy with a mean value of 76.20, 10.74 and 1.78 respectively and a decreasing trend with depth was also recorded.

The highest bacterial count (µg g^{-1}soil) was found in forestry with a mean value of 76.20 while, lowest 63.60 was found in maize. The lowest mean value of fungal count was recorded in paddy and highest in forest soil followed by pasture.

A wide variation in biological properties with respect to studied land uses was observed. The undisturbed soil i.e. forest and pasture exhibited better properties than cultivated land uses, illustrating the adverse effect of prolonged cultivation on soil properties.

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