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Study on Soil Enzyme Activities in Reference to Deforestation in the Shiwalik Hills of Jammu and Kashmir

ROHIT KUMAR ARORA, LALIT UPADHYAY*, KULDEEP JOSHI and ARVINDER KUMAR*

Sher-E-Kashmir University of Agricultural Sciences & Technology – Jammu (J&K), India.

Abstract

A study was conducted in the forest area of Bani, Batote, Basholi, Bhaderwah, Poonch and Samba (Shivalik region) of Jammu division of Jammu and Kashmir. 10 samples of soil at four depths from each area were taken. A portion of the sample was stored at 4°C for biological analysis. *Sulphatase* was estimated by Tabatabai and Bremner method (1972). The p-nitrophenol released by soil arylsulfataseenzymes was calculated by a standard calibration curve developed using 10-50 micro gram p-nitrophenol. The mean value of *sulphatase* (µg of p-nitrophenol released/g of soil) inforest areas recorded at 0-15 cm soil depth was 76.95 in Bhaderwah; 76.45 in Basholi; 75.85 in Batote; 74.95 in Poonch; 76.45 in Bani; 62.01 in Samba. Whereas in deforested areas mean value of *sulphatase* recorded at 0-15cm soil depth was 42.26 in Bhaderwah; 41.98 in Basholi; 41.65 in Batote; 41.16 inPoonch; 41.98 in Bani; 34.05 in Samba. Results showed that the *sulphatase* in soil decreased due to deforestation.

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Keywords

Deforestation;
Shivalik hills;
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Introduction

Forests have been involved in land maintenance by improving soil health through the action of root system and addition of organic matter. Due to the decomposition processes of the plant litter forest soils are enriched with enormous nutrients. On the other hand, deforestation in the naturally delicate ecosystem with unstable geology, steep slopes and heavy rains have expedite the degradation process of fertile soil in the Himalayan region. Soil is a complex system in which different taxonomic groups belonging to living soil organisms interact at different levels within the community and plays a significant role in maintenance of soil properties.[1,2]

Soil microorganisms are important components of terrestrial ecosystems, as they affect soil enzymatic activities which are closely related to microbial activity in soil as they catalyse biochemical reactions and nutrient cycling. They act as a source and sink for nutrients. Soil microorganisms are involved in decomposition of wood, litter and organic matter, generating organic carbon, nitrogen and energy from these organic substrates.[3,4]

CONTACT Lalit Upadhyay lupadhyay@gmail.com Sher-E-Kashmir University of Agricultural Sciences & Technology – Jammu (J&K), India.

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Deforested area is deprived of root exudates and no fresh soil organic carbon is available for microbial metabolism and transformation of nutrients is hampered while enzyme activity starts gradually declining and finally affecting the soil health. There are reports that afforestation of deforested area becomes difficult due to absence of indigenous microbes. These indigenous microbes forms rhizosphere, which is the narrow region of substrate directly influenced by root secretions complimentary and helps in establishment of plants. The changes that occurred after deforestation included decrease in microbial activity.[5] The microbial community influence the transformation of Carbon (C), Nitrogen (N) and Phosphorus (P) of the soil and plays a key role in the nutrient dynamics of different ecosystems. Soil enzymes activity can indicate mineralization rates of soil organic matter and decomposition processes in long terms. Soil enzymes activities have been reported to be well correlated with soil properties like soil temperature, moisture contents, nutrient status, organic matter content and soil pH. Soil temperature may employ direct or an indirect effect on the soil enzymatic properties. Neal[6] showed when the soil temperature decrease, the soil enzymatic activities decreased significantly.

Very few studies regarding enzyme activities have been done in Jammu region so far, so keeping this in mind the current study was carried out in six different forests of Jammu division J&K India to assess the impact of deforestation on soil enzyme activities.

Material and Methods

Study Area

The present study was conducted in the forest area of Bani, Batote, Basholi, Bhaderwah, Poonch and Samba (Shivalik hills) region of Jammu division of J&K.

Batote is situated at an elevation of 1555 m above the sea level; average rainfall is 1560 mm per annum. Being a temperate zone, soils are loam to clay in texture and have fine granular well developed angular blocky structure. These soils are slightly acidic in reaction and belong to the groups Hapludalfs, *Hapludolls, Eutrochreptsand Haplumbrepts.* Major forest cover of Batote forest division is Deodar (*Cedrusdeodara*), Firs (*Abiespindrow*), Chir (*Pinusroxburghii*).

Bhaderwah is situated at an elevation of 1613 msl, average rainfall is 1262 mm per annum with temperate climate. Soils are loamy to clay texture with fine granular well-developed angular blocky structure belonging to the groups *Hapludalfs, Hapludolls, Eutrochrepts and Haplumbrepts.*

Bani is also temperate region; rainfall is 1560 mm per annum. Soils are fine granular sub angular blocky structure and silty loam to clay texture. They belong to the group of *Haplustalfs, Ochraualfs, Eustrochrepts, hapludolls, Udorthrents, Cryothrents and Udifluvents.*

Basholi soils are silty loam to clay texture with fine granular sub angular blockystructure. It is in the intermediate zone falling between temperate in the north and subtropicalin the south. The soils belong to the group of *Haplustalfs, Ochraualfs,Eustrochrepts, Hapludolls, Udorthrents, Cryothrents and Udifluvents.* Basohli tehsil has Deodar trees, Kail, Khair and other broad-leaved species forest. The grass areas were mostly void inside the Deodar and other forests which were usually used as grazing grounds by the villagers. The samples were collected from closed canopy forest.

Poonch is at 915 msl, average rainfall is 1560 mm per annum with subtropical climate in the southern and temperate on the northern part comprising hill tops. In higher regions, the climate remains cold throughout the year. Mainly two types of soils are present in the district with sub-mountainous soil toward southern parts and meadow soil over northern part. Localized wedges of alluvial soils are also present in the various valleys of the area. The vegetation in the area usually comprises of Chir pine (*Pinusroxburghii*) forests, broad leaved evergreen forest, broad leaves deciduous forests and scrub forests, intermixed with frequent patches of grassland and agricultural croplands.

Samba is situated at 384 msl average rainfall is 870 mm per annum. It consists of deep, poorly drained, very slowly permeable soil formed in old alluvium and pedi-sediments. Soils here are mostly coarse textured with low water holding capacity. Major forest tree species were Shisham, Neem (*Azadirachtaindica*), Babul (*Aaciaarabica*), Bohar (*Ficusbengalensis*) and Peepal (*Ficusreligiosa*) were other important trees which were commonly found throughout the Samba region. The samples were collected from closed canopy forest.

Collection and Preparation of Soil Samples

Soil samples of composite surface from the above areas were collected on deforested sites and along the adjacent forest sites at different depths 0-15, 15-30, 30-60 and 60-90 cm. 10 soil samples from each location at four depths were taken. Soil samples were brought to the laboratory and processed prior to analysis. Soil samples were dried and sieved with a 2 mm sieve for physico-chemical analysis. For biological analysis a portion of the sample was stored at 4°C.

Enzyme Activity

Sulphatase was estimated by Tabatabai and Bremner[7] method in which 1 g soil was pre-incubated for 1 hour at 20°C with 0.2 ml toluene to inhibit enzyme activity from microbial pro life ration and de novo enzyme synthesis. In next step, 4 ml 0.5 M NaO Ac buffer (pH 5.8)and 1 ml 0.05 M p-nitrophenyl sulphate were added. The mixture was allowed to be incubated for 1 hour at 37°C. The reaction was terminated by cooling the mixture to 0°C in an ice bath. For convenience and to prevent product losses, the samples were centrifuged at 11000 rpm for 10 minutes rather than through filtration to collect the supernatant. 3 ml of the supernatant liquid were combined with 2 ml 0.5 NaOH. The absorbance of the yellow product was measured by using a Beckman DU-70 spectro photometer at 400 nm. From each soil sample three replicates were examined, and controls were performed to account for the natural soil colour. The p-nitrophenol released by soil arylsulfataseenzymes was measured by referring to a standard calibration curve developed using 10-50 micro gram p-nitrophenol.

Result and Discussion

Enzymatic Studies

Sulphatase

Sulphatase content varied significantly between forest and deforested soil sand its highest value was recorded in Bhaderwah both under forest as well as deforested areas soils. The mean value of *sulphatase* (*µg* of p-nitrophenol released/g of soil) recorded inforest areas at 0-15 cm soil depth was 76.95 in Bhaderwah; 76.45 in Basholi; 75.85 in Batote; 74.95 in Poonch; 76.45 in Bani; 62.01 in Samba. The mean value of *sulphatase* observed in deforested areas at 0-15cm soil depth was 42.26 in Bhaderwah; 41.98 in Basholi; 41.65 in Batote; 41.16 in Poonch; 41.98 in Bani; 34.05 in Samba (Table 1). It was observed that *sulphatase* significantly decreased due to deforestation at all locations. highest value was recorded in Bhaderwah both under forest as well as deforested soils, the values were 76.95 and 42.26 µg of p-nitrophenol released/g of soil, respectively.

Table 1: Effect of deforestation on Sulphatase (µg of p-nitrophenol released/g of soil) at 0-15 cm soil depth

Locations	Forest soil				Deforested soil			
	Mean	SE	SD	CV	Mean (%)	SE	SD	CV (%)
Bhaderwah	76.95	0.85	3.91	5.08	42.26	0.70	3.14	7.44
Basholi	76.45	0.85	3.88	5.07	41.98	0.70	3.12	7.42
Batote	75.85	0.85	3.88	5.11	41.65	0.70	3.12	7.49
Poonch	74.95	0.81	3.69	4.92	41.16	0.66	2.95	7.15
Bani	76.45	0.83	3.79	4.95	41.98	0.68	3.02	7.20
Samba	62.01	0.80	3.67	5.92	34.05	0.68	3.04	8.94

Enzyme activities have key roles in the biochemical functioning of soils, including degradation and soil organic matter formation, nutrient cycling. Changes in soil quality due to land use management can be understand from the soil ecosystem functioning and knowledge of enzyme activities. Thus, in the areas under deforestation the enzymatic activities did not reach to the levels found in the forest areas, indicating the important role of forests in preserving the soil enzymatic properties.[8] Similar findings were also reported by Moorhead and Sinsabaugh,[9] Dick[10] and Kandeler.[11]

Conclusion

It can be concluded from the study that deforestation had a negative effect on soil health irrespective of forest types and climate zones. Removal of vegetation can significantly degrade soil health as is evident from decrease in enzymes activities. Absence of vegetation decreases soil biological activity as is evident from decreased biomass C, N and P as well as decreased enzymatic activity. Soil biological activity controls nutrient cycles and transformations. Absence of biomass in deforested soils decreases this activity and transformations are affected resulting in lower nutrient content. Further soil erosion is major issue in hills. Lack of vegetation exposes soils to water erosion resulting in loss of top fertile soil and consequently the ill effects on soil health.

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Conflict of Interest

The authors have no financial or personal conflict of interest.

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