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Study on Soil Phosphatase Activity in Reference to Deforestation in the Shiwalik Hills of Jammu Division of Jammu and Kashmir

Rohit Kumar Arora, Sarabdeep Kaur, Lalit Upadhyay* and Vikas Sharma
Division of Soil Science, K. V. K. Reasi,
Sher-e-Kashmir University of Agricultural Sciences & Technology – Jammu (J&K), India.

(Corresponding author: Lalit Upadhyay)*
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ABSTRACT: Deforestation is a major problem in the hilly regions, which effect the soil quality and activity. To assess the effect of deforestation, a study was conducted in Batote, Bhaderwah, Bani, Basholi, Poonch and Samba (Shiwalik hills) areas of Jammu division of Jammu and Kashmir (India) and sites of deforestation and adjacent forest area were identified. Composite surface soil samples from all the six locations were collected. Deforested sites were selected along with adjacent forest sites. Ten soil samples from each area at four depths were taken. Phosphatase activity was determined by Tabatabai and Bremner (1969) method. It is based on colorimetric determination of the p-nitro phenol released by phosphatase activity when the incubation of soil is done with p-nitro phenyl phosphate disodium salt. Results of the study showed that there was significant difference in the amount of Acid phosphatase and alkaline phosphatase in the forest and deforested areas. With moving from hills to plain area, the acid phosphatase content was reduced in soil but it was higher under trees in plain area also. This study find that the acid phosphatase and alkaline phosphatase was reduced in the soil of deforested areas, which indicates the importance of forests for our environment.

Keywords: Acid phosphatase, Alkaline phosphatase, Deforestation, Shiwalik hills.

INTRODUCTION

Among several factors responsible for climate change, land-use change is one of the major factors of global biodiversity loss, climate change and ecological degradation (Kooch *et al*., 2018). Land use conversions and deforestation are major ecological problems in all the countries. The conversion of natural forest into plantations and agricultural land significantly alter the soil processes and properties, and thereafter the functioning of soil (Celik 2005; Dawson and Smith 2007). Land use change (LUC) is considered as the main causes of environmental degradation, greatly contributing to increase of global atmospheric CO_2 concentration, climate change, and loss of ecosystem services and functions (Turner *et al.*, 2007; Hosonuma *et al.*, 2012). Phosphorus (P) is essential for life as an essential element for energy transport, cellular structures, and nucleic acids. The two main phosphorus sources for ecosystems growing are weathering of parental material (Walker and Syers 1976) and the input from dust deposition of the atmosphere (Chadwick *et al*., 2003). The availabilities of P are nevertheless low in most terrestrial ecosystems due to regular sorption and leaching which leads to gradual P-blockage in secondary minerals. Magid *et al*., (1996) described that in different inorganic and organic forms the distribution of P reflects the function, history, and present structure of an ecosystem.

Smeck (1985) observed that the chemical nature and concentrations of soil organic phosphorus (SOP) are mainly dictated by a combination of the major soil-forming factors: organisms, climate, time, parent material and topography, in natural ecosystems. Various studies have reported that land use would affect the physico-chemical, biological properties, and soil organic matter (SOM) dynamics. This change subsequently alters the soil quality and fertility of the land (Zhao *et al.*, 2013). Phosphatase activity plays a fundamental role in the transformation of Phosphorus (P) from soil organic matter into available forms, as organisms can assimilate phosphorus only in form of dissolved phosphate (Caldwell, 2005). The production of Phosphatase depends on a combination of P demand from plants and microbes, P limitation of the soil and available organic P substrate. Phosphatase enzymes are produced by plant roots, fungi and bacteria, and serve to split a phosphate group from its substrates to create transforming complex and sometime unavailable forms of organic P into assimilable phosphate. A widely used potential indicator for determining the effect of land use conversions and management practices on soil health is, measurement of soil enzyme activities in key nutrient cycling (C, N, and P) and oxidation–reduction processes (Acosta-Martínez *et al.*, 2007; Pandey *et al.*, 2014; de Medeiros *et al.*, 2015). Soil contains large quantities of intracellular and extracellular phosphatases. Phosphatases can moreover be stabilized in the soil on surface-reactive particles.

Trasar-Cepeda *et al.*, (2008) found the most important factors were soil's physical and chemical characteristics, vegetation and management practice that affect the activity of extracellular enzymes in soils, independently from their producers and ecosystem processes.

Cosgrove (1967) described the activities of soil phosphomonoesterases and recorded those phospholipids and nucleic acids, whose degradation is catalyzed by phosphodiesterases, are the major sources of fresh organic P inputs to soil. Meena & Rao (2021) in their study recorded that enzyme activities and soil microbial parameters (SMBC, SSIR, SMBC/SC, SBR, qCO_2) are key indicators of fertility and soil health. Soil organic matter (SOM) content and soil microbial functions is altered by the land use. To prevent the soil carbon flux as CO_2 and maintaining the SC stock the management strategies focusing on the conservation of natural forest and minimizing the land disturbances will be highly effective.

MATERIALS AND METHODS

For present study a survey was conducted in Batote, Bhaderwah, Bani, Basholi, Poonch and Samba (Shiwalik hills) areas of Jammu division of Jammu and Kashmir (India) and sites of deforestation and adjacent forest area were identified. Composite surface soil samples from all the six locations were collected. Deforested sites were selected along with adjacent forest sites. Samples were collected depth-wise from both deforested sites and adjacent deforest sites. A profile was dug, and samples were taken from 0-15, 15-30, 30-60 and 60-90 cm. depth. Ten soil samples from each area at four depths were taken. Soil samples were brought to the laboratory and processed prior to analysis. Soil samples were dried in lab and sieved with a 2mm sieve for physico-chemical analysis. A portion of the sample was stored at 4^oC for biological analysis. Proper moisture correction was carried out for biological properties where fresh samples were used.

Phosphatase activity was determined by the method based on colorimetric determination of the p-nitro phenol released by phosphatase activity. It takes place when soil is incubated with p-nitro phenyl phosphate disodium salt (Tabatabai and Bremner 1969).

RESULT AND DISCUSSION

Results of the study clearly showed that deforestation severely affected the phosphatase enzyme in the soil. Results are discussed below in detail:

Acid Phosphatase. In the present study, it was observed that forest soil contains higher mean value of Acid phosphatase content at all locations. Higher values were obtained under forest lands in comparison to deforested lands. The mean value of acid phosphatase (µg of p-nitrophenol released/g of soil) recorded in forest areas at 0-15 cm soil depth was 65.40 in Bhaderwah; 64.31 in Basholi; 64.29 in Batote; 63.45 in Poonch; 65.25 in Bani; 60.90 in Samba whereas mean value of acid phosphatase (µg of p-nitrophenol released/g of soil) recorded in deforested areas at 0-15 cm soil depth was 35.93 in Bhaderwah; 35.33 in Basholi; 35.31 in Batote; 34.85 in Poonch; 35.84 in Bani; 33.45 in Samba.

The study results were like the studies conducted by Hendriksen *et al.*, (2016); Maharajan *et al.*, (2017); Moghimian *et al.* (2017), in which they confirmed that the acid phosphatase activity is influenced by soil pH, nutrients, SP, SOM quality, SC, SN and quantity, microbial community structure, SM, and soil temperature. Similar to this study, Silva *et al.*, (2019) recorded no correlation between acid phosphatase and soil phosphorus.

Alkaline phosphatase. Alkaline phosphatase content also followed the similar trend of Acid phosphatase and from the perusal of data, highest alkaline phosphatase content was recorded under forest soils than deforested soils. Amongst locations highest alkaline phosphatase content was obtained at Bhaderwah in forest as well as deforested soils. The mean value of alkaline phosphatase (µg of p-nitrophenol released/g of soil) recorded in forest areas at 0-15 cm soil depth was 58.40 in Bhaderwah; 56.60 in Basholi; 55.80 in Batote; 56.90 in Poonch; 56.40 in Bani; 53.30 in Samba whereas mean value of alkaline phosphatase (µg of p-nitrophenol released/g of soil) recorded in deforested areas at 0-15 cm soil depth was 32.06 in Bhaderwah; 31.05 in Basholi; 30.64 in Batote; 31.22 in Poonch; 30.97 in Bani; 29.27 in Samba.

Table 1: Effect of deforestation on acid phosphatase (µg of p-nitrophenol released/g of soil).

Locations	Forest				Deforested			
	Mean	SE	SD	CV(%)	Mean	SE	SD	CV(%)
Bhaderwah	65.40	0.57	2.58	3.94	35.93	0.41	1.87	5.21
Basholi	64.31	0.57	2.57	4.00	35.33	0.41	1.87	5.31
Batote	64.29	0.58	2.61	4.06	35.31	0.42	1.91	5.42
Poonch	63.45	0.57	2.59	4.08	34.85	0.42	1.90	5.45
Bani	65.25	0.56	2.50	3.84	35.84	0.40	1.80	5.03
Samba	60.90	0.66	2.97	4.87	33.45	0.51	2.29	6.84

Table 2: Effect of deforestation on alkaline phosphatase (µg of p-nitrophenol released/g of soil).

Locations	Forest soils				Deforested soils			
	Mean	SE	SD	CV(%)	Mean	SE	SD	CV(%)
Bhaderwah	58.4	0.82	3.69	13.62	32.06	0.67	3.00	9.03
Basholi	56.6	0.72	3.25	10.61	31.05	0.58	2.60	6.79
Batote	55.8	0.70	3.14	9.89	30.64	0.56	2.50	6.27
Poonch	56.9	0.72	3.25	10.62	31.22	0.58	2.60	6.78
Bani	56.4	0.70	3.14	9.90	30.97	0.55	2.50	6.25
Samba	53.3	0.74	3.32	11.08	29.27	0.60	2.70	7.31

Soil microflora and fungi effects the process of phosphorus release, through their possession of phosphatases that split various types of organophosphates. This study hypothesizes that as sensitive indicators of soil health we can use soil enzyme as its attributes vary across different land use. The purpose of the study was to evaluate the effect of deforestation on the acid phosphatase and alkaline phosphatase enzymes in the Himalayan region of Jammu and Kashmir. The acid and alkaline phosphatase were high under forest soils in all the locations irrespective of altitude. It depicts that the organic carbon and available nutrients under trees influence the activity of enzymes. With moving from hills to plain area, the acid phosphatase content was reduced in soil, but it was higher under trees in plain area also. Study conducted by Kandeler *et al.*, (1996) also supported the study who also found that soil enzyme activity is influenced by the soil characteristics related to soil microbial activity, nutrient availability, and land use management processes that modified the potential soil enzyme-mediated substrate catalysis. Raiesi and Beheshti (2020) reported a reduction in soil enzyme activities after the conversion of natural forests into cultivated lands, which was similar to the study conducted.

CONCLUSION

From the present study it may be concluded that land use changes and management practices in the forest areas influence the soil microbial parameters and enzyme activities in semiarid regions. Deforestation reduces the SOM, which limits the soil microbial activity thereby reducing SMBP, acid and alkaline phosphatase content. An increased amount of substratum quantity and quality in the forest land enhances the SOM content which increases high microbial activities. The microbial activity further affected by variation in plant species composition, SM content, and litter quality within the land use. Similar results were recorded by Singh *et al.* (2018), Tiwari *et al.* (2019) and Singha *et al.* (2020) in their study regarding the effect of land use change on soil.

FUTURE SCOPE

This study will help to understand the scenario of soil after deforestation and will help to understand the relationship between soil microbes and enzymes under different types of land use.

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Conflict of Interest. None.

REFERENCES

Acosta-Martínez V., Mikha, M. M. and Vigil, M. F. (2007). Microbial communities and enzyme activities in soils under alternative crop rotations compared to wheat-fallow for the Central Great Plains. *Appl. Soil Ecol., 37*(1-2): 41–52.

Caldwell, B. A. (2005). Enzyme activities as a component of soil biodiversity: A review. *Pedobiologia (Jena),* 49: 637–644.

Celik, I. (2005). Land-use effects on organic matter and physical properties of soil in a southern Mediterranean highland of Turkey. *Soil Tillage Res., 83*(2): 270–277.

Chadwick, O. A. (2003). The impact of climate on the biogeochemical functioning of volcanic soils. *Chem. Geol., 202*: 195–223.

Cosgrove, D. J. (1967). Metabolism of organic phosphates in soil. In: McLaren AD, Peterson GH (*eds*) *Soil biochemistry*, vol. 1. Marcel Dekker, New York, pp 216–228.

Dawson, J. J. C. and Smith, P. (2007). Carbon losses from soil and its consequences for land use management. *Sci. Total Environ., 382*(2-3): 165–190.

de Medeiros E.V., Notaro, K. A. de Barros, J. A. Moraes, W. S. Silva A. O. and Moreira, K. A. (2015). Absolute and specific enzymatic activities of sandy entisol from tropical dry forest, monoculture and intercropping areas. *Soil Tillage Res., 145*: 208–215.

Hendriksen, N., Creamer, R., Stone, D. and Winding, A. (2016). Soil exo-enzyme activities across Europe - the influence of climate, land-use and soil properties. *Appl. Soil Ecol., 97*: 44–48.

Hosonuma, N., Herold M., De Sy V., De Fries, R. S., Brockhaus, M., Verchot, L., Angelsen A. and Romijn, E. (2012). An assessment of deforestation and forest degradation drivers in developing countries. *Environ. Res. Lett., 7*: 44009.

Kandeler, E., Kampichler, C. and Horak, O. (1996). Influence of heavy metals on the functional diversity of soil microbial communities. *Biol. Fertil. Soils, 23:* 299–306.

Kooch, Y., Tavakoli, M. and Akbarinia, M. (2018). Tree species could have substantial consequences on topsoil fauna: a feedback of land degradation/restoration. *Eur. J. For. Res., 137*: 793–805.

Magid, J., Tiessen, H., and Condron, L. M. (1996). Dynamics of organic phosphorus in soils under natural and agricultural ecosystems. In: Piccolo A, editor. Humic substances in terrestrial ecosystems. Amsterdam: *Elsevier;* p. 429–466.

Maharajan, M., Sanaullah, M., Razavi, B. S., and Kuzyakov, Y. (2017). Effect of land use and management practices on microbial biomass and enzyme activities in subtropical top- and sub-soils. *Appl. Soil. Ecol., 113*: 22–28.

Meena, A. and Rao, K. S. (2021). Assessment of soil microbial and enzyme activity in the rhizosphere zone under different land use/cover of a semiarid region. *India, Ecological Processes, 10*: 16.

Moghimian, N., Hosseini, S. M., Kooch, Y. and Darki, B. Z. (2017). Impacts of changes in land use/cover on soil microbial and enzyme activity. *Catena, 157*: 407–414.

Pandey, D., Agrawal, M. and Bohra, J. S. (2014). Effects of conventional tillage and no tillage permutations on extracellular soil enzyme activities and microbial biomass under rice cultivation. *Soil Tillage Res., 136*: 51–60.

Raiesi, F. and Salek-Gilani, S. (2020). Development of a soil quality index for characterizing effects of land-use changes on degradation and ecological restoration of rangeland soils in a semi-arid ecosystem. *Land Degrad Dev, 31*(12): 1533–1544.

Silva, E. O., de Medeiros, E. V., Duda, G. P., Junior, M. A. L., Brossard, M., de Oliveira, J. B., dos Santos, U. J., Hammecker, C. (2019). Seasonal effect of land use type on soil absolute and specific enzyme activities in a Brazilian semi-arid region. *Catena, 172*: 397–407.

Singh, R., Bhardwaj, D. R., Pala, N. A., Kaushal, R. and Rajput, B. S. (2018). Soil microbial characteristics in sub-tropical agro-ecosystems of North Western Himalaya. *Curr. Sci., 115*(10): 1956–1959.

Singha, A. K., Xiao-Jin, J., Bin, Y., Wua, J., Rai, A., Chena, C., Ahirwal, J., Wanga, P., Liua, W., and Singh, N. (2020). Biological indicators affected by land use change, soil resource availability and seasonality in dry tropics. *Ecological Indicators, 115*: 106369.

Smeck, N. E. (1985). Phosphorus dynamics in soils and landscapes. *Geoderma, 36*: 185–199.

Tabatabai, M. A. and Bremner, J. M. (1969). Use of p-nitrophenyl phosphate for assay of soil phosphatise activity. *Soil Biol Biochem, 1*: 301–307

Tiwari, S., Singh, C., Boudh, S., Rai, P. K., Gupta, V. K. and Singh, J. S. (2019). Land use change: a key ecological disturbance declines soil microbial biomass in dry tropical uplands. *Aust. J. Environ. Manag., 242*: 1–10.

Trasar-Cepeda, C., Leirósb, M. C. and Gil-Sotres, F. (2008). Hydrolytic enzyme activities in agricultural and forest soils. Some implications for their use as indicators of soil quality. *Soil Biol. Biochem., 40*(9): 2146–2155.

Turner, B. L., Lambin, E. F. and Reenberg, A. (2007). The emergence of land change science for global environmental change and sustainability. *Proc. Natl. Acad. Sci. U. S. A., 104*: 20666–20671.

Walker, T. and Syers, J. (1976). The fate of phosphorous during pedogenesis. *Geoderma, 15*: 1–19

Zhao, D., Li F., Yang, Q., Wang, R., Song, Y. and Tao Y. (2013). The influence of different types of urban land use on soil microbial biomass and functional diversity in Beijing, China. *Soil Use Manag., 29*: 230–239.

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