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Studies on the Role of Essential Nutrient Dynamics under Different Stands of *Shorea robusta* in Tropical Forest Ecosystem in Bilaspur (C.G.)

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Abstract: ***Changes in the soil nutrient changes the productivity of the forest. The nutrient status of soil is very important for the maintaining the productivity of the forest and also the forest management practices. Therefore, a study was conducted to estimate the nutrient status of soil under Sal forest in Bilaspur forest division Chhattisgarh, India. The mean values of organic carbon, moisture content and other nutrient content in soil including soil fertility status were recorded relatively higher in undisturbed stands of Sal as compared to disturbed areas. The result showed that all the soil properties in undisturbed and disturbed stands of Sal were significantly different.***

Keywords: soil properties, nutrient status, Shorea robusta, undisturbed and disturbed forest stand

1. Introduction

Sal is one of the most important species of economic value and is very extensive in its distribution in tropical forest area. Sal therefore occurs under the exceptionally wide range of climatic geological and soil condition. Chhattisgarh state is naturally gifted with good floristic composition of the Sal forest. Nutrient and energy in a forest ecosystem is conveyed through the biological components into the soil which is closely related to initiate the nutrient dynamics (Ahmed et. al., 2015). Further, the important soil nutrient factors in tropical forests are highly influenced by nitrogen; phosphorus, potassium, and soil pH. Plant litter is the main source of soil organic matter which brings the changes in physical, chemical, biological characteristics and the balance of the nutrient resources in the soils (Bhattari and Mandal, 2012). The Physiochemical characteristics of soils in the forest ecosystem vary with space and time due to variations in topography, climate, weathering processes, vegetation cover, microbial activities and several other biotic and abiotic factors (Acharya and Shrestha, 2012). The nutrient distribution in a floristic composition and soil compartments provides useful information on budgeting of nutrient in an ecosystem (Kaur et al., 2013). Nutrient concentration in the tree ecosystem depends on the role of nutrient cycling and their pattern (Kaur et al., 2013). The disturbance in forest influences the availability of resources such as light, water, and nutrients, which are essential for establishment and growth (Muscolo et. al., 2006).

Thus in the present investigation, it has been designed to study the role of nutrient dynamics with respect to soil organic carbon, nitrogen, phosphorus, potassium, and soil pH in undisturbed and disturbed forest stands.

2. Material and Methods

The Achanakmar Amarkantak Biosphere Reserve is situated in Bilaspur district of central India of Chhattisgarh. This Biosphere Reserve is recognized as the biodiversity hotspot and has been declared as the tiger reserve under the project tiger in 2009. The Biosphere Reserve lies between the parallels of latitude 21^{O} 15'- 22^{O} 58'N and 81^{O} 25' to 82^{O} 5' E longitude. The study was conducted in the natural Sal forest area situated in Achanakmar Tiger Reserve which is the part of Bilaspur Forest Division in northwest Chhattisgarh. December and January are considered as the coldest months whereas May month is considered as the hottest month. The mean temperature is between 21ºC to 33ºC and the area experiences pre-monsoon showers at the end of May and monsoon from July to August. The average annual rainfall is about 1,900 mm and is received largely from South-West monsoon (Singh et. al., 2010). The floristic composition mainly comprises of *Shorea robusta* and its associates like *Terminalia tementosa*, *Pterocarpus marsupium*, *Adina cordifolia*, *Anogisus latifolia*, *Bahunia lanzan*, *Aegle marmelos*, *Casearia graveolens*, *Bahunia variegate*, *Diospyros melanoxylon* are the important part of the of the study area. The soil samples were collected randomly at 0-10cm, 10-20cm and 20-30cm depths from the two sites. The composite soil samples were made y collecting the soil from five sites of each soil depth at a given sites of the study area and was investigated for the nutrient and soil parameters. The soil samples were further air dried, ground with mortar and pestles and sieved with 2mm mesh before the analysis of it. The soil samples at different depths were analyzed for soil pH, Ec, soil organic carbon (Walkley and Black, 1965), nitrogen (Kjeldahl technique), phosphorus (Jackson, 1958), potassium (Jackson, 1958), and soil moisture percentage.

3. Result and Discussion

In the present study, the soil properties were grouped into two locations of undisturbed and disturbed forest stand depending on the *Shorea robusta* density and difference in anthropogenic or biotic pressure. The area having such disturbances is selected as disturbed area and other having least such disturbances is selected as the undisturbed area from the study sites. The selected physicochemical properties which can be used as the indicator of the soil fertility status for undisturbed and disturbed forest sites are presented in table no. 1. In the study area, it was found that

there was the difference in the total nutrient contents in the soil may be due to the disturbance in the forest stands of natural Sal. The soil was laterite, red to brownish in color with loamy-clayey texture in both undisturbed and disturbed forest stand. Analysis of variance for soil physio-chemical properties was found significant for all parameters ($P<0.05$) for disturbed and undisturbed forest sites. However, they showed the non-significant relationship between soil depths. The soil pH measure is an important parameter which helps in identification of chemical nature of soil (Shalini et .al., 2003). The pH of soil sample of the study area ranged from 5.7 to 6.4 indicating the soil existence is acidic in nature. The soil erosion was also noticed in the disturbed forest stand due to various anthropogenic disturbances which may be the cause of lower fertility of the soil. The soil accounting for nutrient dynamics in different forests stands varies greatly. The pH of the soil of the study area was 5.9 for (0-10 cm) surface soil layer, 5.8 for (10-20cm) subsurface soil sample and 5.8 for (20-30 cm) lower subsurface soil layers. The Ec was found higher (0.20 dsm-1) in lower subsurface soil sample than the surface (0.19 dsm-1) and subsurface soil layer (0.19 dsm-1). The moisture percent of surface layer soil was 37.20% for surface soil, 36.90% subsurface and 32.40 for the lower subsurface layer of soil under undisturbed forest stand. The organic carbon content in soil was 1.2% higher in surface soil layer of soil than 1.0% in subsurface layer and 0.7% in lower subsurface soil layer in the undisturbed forest stand. The soil nitrogen was found higher 203 Kgha-1 for the surface soil than 180 Kgha-1 for subsurface soil and 120 Kgha-1 for lower subsurface soil layer. The phosphorous was estimated 29 Kgha-1 for surface soil, 22 Kgha-1 for subsurface soil and 19.5 Kgha-1 for the lower subsurface soil sample. The potassium content in soil sample studied was 354.5, 350 and 332 Kgha-1 for the surface, subsurface and lower subsurface soil layers respectively in the undisturbed forest area.

The soil texture of disturbed forest stand was loamy. The soil pH was found higher 6.4 in (0-10 cm) surface layer in and 6.2 and 6.1 for (10-20 cm) sub-surface and (20-30 cm) lower surface soil. The Ec was higher 18 dsm-1 in surface soil than 0.17 dsm-1 subsurface and 0.17 dsm-1 lower surface soil sample. The moisture content in soil was 32.40%, 32.0%, 30.25% for surface soil, subsurface soil, and lower subsurface soil respectively. The organic carbon content was 0.75%, 0.6% and 0.59% for depth wise of surface soil, subsurface soil, and lower subsurface soil respectively. The nitrogen content in the soil was 197.5 Kgh-1, 172 Kgh-1 and 111.2 Kgh-1 for the surface, subsurface and lower surface soil. The phosphorus content in soil was 12.87 Kgh-1 for surface soil layer, 8.75 Kgh-1 for subsurface soil and 7.25 Kgh-1 in the lower subsurface soil layer. The value for potassium was 245 Kgh-1, 222 Kgh-1 and 220 Kgh-1 surface soil, subsurface soil, and lower subsurface soil respectively in the disturbed forest area.

The analysis of soil the soil of the study area showed the nature of the soil. However, the soil pH was more acidic in undisturbed forest stand than in disturbed forest stand. The finding of present study was in accordance to these, Marasini, 2003(4.5 to 5.5 pH range in Churia forest of Rupandehi), Bashyal, 2005 (5.3 (mean) in tropical Sal forest Palpa), and Acharya and Shrestha, 2012 (4.2 to 6.2 pH range from in mixed Sal forest of Rupandehi). The acidic nature of the soil in the study area may be due to characteristics of high rainfall which may be adequate for removing the basic cation from the surface soil. The availability of many plant nutrients in the soil changes as a result of reactions in the soil, which are largely controlled by soil pH. The soil organic matter was also found higher in undisturbed forest soil than disturbed forest soils. Accumulation of litter from plant leaves might have caused the addition of organic matter into the soil in the undisturbed forest stand. It lies with the result of Gomes (2005) who have found that organic matter content of surface soil i.e. 0-15cm depth of Sal forest varies from 0.7% to 2.11%. Loss of this surface soil through human or natural disturbances would be determined the functioning of these ecosystems (Adeboge et. al., 2011). The values of nitrogen content varied significantly in both forest types. Nitrogen is mostly present in the form of nitrates in the soil, which is very mobile and can get moved freely with moisture (Gupta and Sharma, 2008). Phosphorus is one of the nutrients which can limit the tree growth especially for the tropical forest (Zas and Serrada, 2003; Lee et. al., 2015). The similar result for phosphorus was found by ranged 6.43 to 30.0 Kg/ha in Churiya forest of Rupendehi (Marasini, 2003), higher than 6.8 to15.75 Kg/ha in tropical Sal forest Palpa (Bashyal, 2005), and lower than 37.0 to 184 Kg/ha in Sal forest of Barandahar (Shrestha, 2003). The potassium content was found higher than (197.0- 267.0 Kg/ha) in Churiya forest of Rupendehi (Marasini, 2003), (234.0 Kg/ha) tropical Sal forest of eastern Nepal (Paudel and Sah, 2003).

The low to the medium fertility of the soil was found in both the study area and similar result was also found by Acharya and Shrestha (2012). This might be the common attribute of Sal dominant areas (Bhatnagar, 1965; and Acharya and Shrestha 2012). The present investigation and assessment of nutrient dynamics in Sal forest may help in its forest management.

Table 1: Physico-chemical properties (± 1 SE) of soil in undisturbed and disturbed forest site of Achanakmar

parameter	UN- disturbed Forest			Disturbed Forest		
	0-10 (cm)	10-20 (cm)	20-30 (cm)	0-10 (cm)	10-20 (cm)	20-30 (cm)
Soil pH	5.9 ± 0.19	5.8 ± 0.16	5.8 ± 0.14	6.4 ± 0.25	6.2 ± 0. 21	6.1 ± 0.19
Ec (ds /m)	0.19 ± 0.05	0.19 ± 0.04	0.20 ± 0.05	0.18 ± 0.03	0.17± 0.04	0.17 ± 0.03
SOC (%)	1.2 ± 0.13	1.0 ± 0.06	0.7 ± 0.05	0.75 ± 0.05	0.6 ± 0.3	0.59 ± 0.03
N (Kg/ha)	203 ± 2.75	180 ± 1.33	120 ± 1.07	197.5 ± 1.71	172 ± 1.23	111.2 ± 1.05
P (Kg/ha)	29 ± 1.13	22 ± 0.35	19.5 ± 0.12	12.75 ±0.97	8.75 ± 0.05	7.25 ± 0.03
K(Kg/ha)	354.5 ± 2.50	350 ± 2.16	332 ± 1.90	245 ± 1.81	222 ± 1.17	220 ± 1.05
Moisture (%)	37.20 ± 1.35	36.90 ± 0.85	32.40 ± 0.65	32.40 ± 1.15	32.0 ± 0.45	30.25 ± 1.05

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