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COMPARISON OF NUTRIENT DISTRIBUTION IN MONOCULTURE AND POLYCULTURE LAND USE SYSTEM OF SUB-TEMPERATE MIDHILLS OF HIMACHAL PRADESH

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Abstract

The present investigation is aimed at analyzing nutrient status in monoculture and polyculture land use systems in Solan (HP). Organic C, N, P and K distribution in pine forest (monoculture) and broad leaf forest (polyculture) were studied at soil depths of 0-15, 15-30 and 30-60 cm. It was observed that organic carbon, nitrogen and potassium decreased with an increase in soil depth but reverse trend was observed for phosphorus content. Soil organic carbon was 0.78 %, 0.59 % and 0.36 % in monoculture and 1.27 %, 1.00 % and 0.77 % in polyculture. Similarly nitrogen content 267.85, 212.64 and 194.32 kg ha^{-1} in pine forest and 247.77, 237.88 and 218.89 kg ha^{-1} in broad leaf forest was observed. Soil potassium decreased depth wise. Soil phosphorus increased with soil depth in both the types of forest studied. It is pertinent to mention that the nutrient status was better in polyculture compared for monoculture land use system.

Key Words: *Nutrient accumulation, Nutrient management, Monoculture, Polyculture; Land use system.*

1. Introduction

The mountainous state Himachal Pradesh, located in western Himalayan range, present a wide range of land use systems owing to the diverse physiographic and demographic mosaic. It extends over a geographical area of 55673 km^2 which is 1.69 percent of country's area and 10.5 percent of the Himalayan landmass (Forest Survey Report, 2011). The predominant land use system comprises of forest and agriculture. Forest comprises of 38.3 percent of the total landmass (HFR, 2013). The forests of Himachal Pradesh are rich in vascular flora, which forms the conspicuous vegetation cover. Champion and Seth (1968) broadly classified forests into coniferous forests and broad-leaved forests. In between these two extremes, distinct vegetational zones of mixed deciduous forests of Bamboo, Chir, Oaks, Deodar, Kail, Fir and Spruce, are found. Nutrient distribution in the vegetation and soil compartments provides useful information on nutrient budgeting of the ecosystem (Das and Ramakrishnan, 1987; Bargali *et al*., 1992; Shanmughavel *et al*., 2001).The understanding of nutrient accumulation and storage processes help in evolving suitable strategies of nutrient management for maximizing biomass production. The management of organic C and nutrient pools in soil is crucial as it not only affects the plants survival and its growth but also influences. In a given climate, the carbon accretion depends on the soil organic matter and availability of nutrients, which in turn depends on the pattern and role of their cycling (Rawat and Singh, 1988). Nutrient concentration within tree system usually depends upon the pattern and role of their cycling. Carbon sequestration depends upon biomass production capacity, which in turn depends upon interaction between edaphic, climatic and topographic factors of an area. Hence results obtained at one place may not be applicable to another. Therefore, region-based potential of different land uses needs to be worked out and in the present paper attempt in that direction has been made.

2. Material and Methods

The present investigation on nutrient distribution in pine forest (monoculture) and broad leaf forest (polyculture) land use systems of sub-temperate midhills of Himachal Pradesh was conducted in the year 2010. The study was carried out in the Solan district of Himachal Pradesh, which lies between 30^0 50'30"-30^0 52'0" N latitudes and 77^0 8'30"-$77^0$11'30" E longitude (Survey of India Top sheet No. 53F/1). It is classified in Zone-II, sub-temperate and sub-humid, mid hills category. Two land use sites within the vicinity of Shoolini University were selected. Site-1 comprises of (village Bajhol) Chir forest i.e. monoculture and the Site -2 (village Manjholi) has broad leaf forest. The forests in Solan district has pure and mixed stands of Chir pine and mostly confirm to Champion and Seth's Forest type 9 C_1- Lower or Shiwalik Chir pine forest. They lie between 900-1200 m a.s.l

2.1 Study Sites

Site-1 Monoculture Forestry System

Site-1 is monoculture forest of Chir- pine (*Pinus roxburghii* Sarg.) of approximately 15 years old, located in Bajhol village of Solan. Shrubs present in the study area are *Carrisa carandus, Rubus ellipticus, Woodfordia floribunda* and *Myrsine africana*. Grasses present are *Chrysopogon montanus, Chrysopogon gryllus* and *Panicum maximum*.

Site- 2 Polyculture Forestry System

Site-2 is a mixed forest of *Quercus leucotrichophora* Smith. (Oak), *Pyrus pashia* Buch-ham. (Kainth), *Bauhinia variegata* Linn. (Kachnar), *Celtis australis* Linn. (Khirak), *Pinus roxburghii* Sarg. (Chir) and *Toona ciliata* Roxb. (Toon).

Shrubs present in the study area are *Berberis lycium, Rubus ellipticus* and *Murraya koengii.* Grasses present are *Chrysopogon montanus, Panicum maximum* and *Themada anathera.* Ferns like *Pteris vittata* and *Selaginella bryopteris* are also present.

The study area of the two land use systems was divided equally into five replications of 10x10 m and in each replication all trees were selected and enumerated. A total of 42 trees in Pine forest (Site-1) and 41 trees in Broad leaf forest (Site-2) were selected. The selected trees were 15-18 years old.

2.2 Soil Nutrient Analysis

Soil samples were collected randomly from all the three sites at 0-15 cm, 15-30 cm and 30-60 cm depths. Samples in five replications of each soil depth at a given site were analyzed for the distribution of nutrient elements and other parameters. Collected soil samples were dried, ground with mortar and pestles and sieved through 2 mm mesh before analysis. Soil at different depths of selected sites was analyzed for organic carbon, available N, P and K. Organic carbon was analysed following the Walkley-Black Method (1965). Nitrogen was estimated by Micro-Kjheldhal method given by Chapmann and Pratt (1961). Potassium and Phosphorus were analysed by Flame Photometer following method of Jackson (1967) and spectrophotometrically by Watambe and Olsen (1965) method, respectively.

3. Results and Discussion

The physico-chemical properties of soil in monoculture land use system reveals that at 0-15, 15-30 and 30-60 cm depths of soil, soil organic carbon, nitrogen and potassium showed a decrease whereas reverse trend was observed in phosphorus (Table 3.1). Organic carbon, nitrogen and potassium showed significant variation while phosphorus showed non-significant variation.

Table 3.1: Comparison of soil physico-chemical properties at different soil layers in Pine forest (monoculture)

soil-chemical properties of Pine forest for the year 2010				
Depth in cm	**% Organic carbon**	**Nitrogen kg/ha**	**Phosphorus kg/ha**	**Potassium kg/ha**
0-15	0.78±0.22	267.85±61.32	0.18±0.06	215.86±62.73
15-30	0.59±0.26	212.64±22.49	0.24±0.03	166.43±70.07
30-60	0.36±0.12	194.32±16.67	0.30±0.02	128.10±59.81
p-value	0.027*	0.03*	0.13	0.003*

***p≤0.05**
± Standard error

However the physico-chemical properties in polyculture land use system revealed that at different depths of soil, percent organic carbon, nitrogen and potassium showed a decrease whereas increase was observed in phosphorus content. Organic carbon showed significant variation while nitrogen, phosphorus and potassium showed non-significant variation.

Table 3.2: Comparison of soil physico-chemical properties at different soil layers in broad leaf forest (polyculture)

Soil physico-chemical properties of Broad leaf forest for the year 2010				
Depth in cm	**% Organic carbon**	**Nitrogen kg/ha**	**Phosphorus kg/ha**	**Potassium kg/ha**
0-15	1.27±0.04	247.77±29.33	0.60±0.54	241.53±29.36
15-30	1.00±0.22	237.88±31.57	0.64±0.56	213.22±60.83
30-60	0.77±0.34	218.89±14.92	0.73±0.52	174.81±66.84
p-value	0.02*	0.25	0.19	0.07

***p≤0.05**
± Standard error

Soil organic carbon (%), nitrogen and potassium declined from top to bottom soil layers in both the systems (monoculture and polyculture). Phosphorus showed depth wise increase as it is evident from Figs. 1-4.

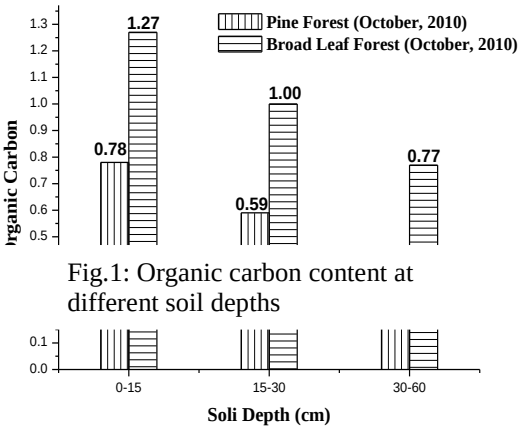

Fig.1: Organic carbon content at different soil depths

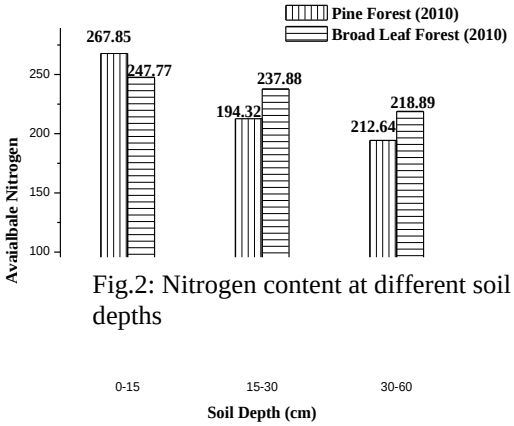

Fig.2: Nitrogen content at different soil depths

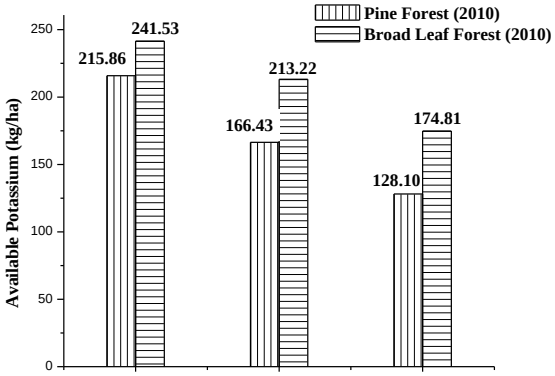

Fig.3: Potassium content at different soil depths

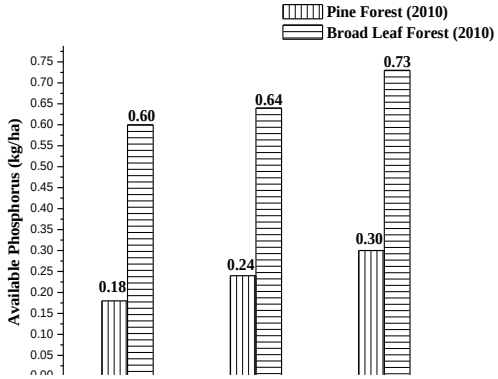

Fig.4: Phosphorus content at different soil depths

The productivity (biomass) of trees is influenced by availability of nutrients which in turn depends on the pattern and role of their cycling. Understanding of nutrient accumulation and storage processes helps in evolving strategies of nutrient management for maximizing biomass production. In present study it has been postulated that the land use practices such as forest, plantation and agroforestry are followed in Himachal Pradesh that have different impacts, especially in terms of nutrient distribution. It is pertinent to mention that the nutrient status was better in polyculture (broad leaf forest) as compared to monoculture (pine forest) land use system. Earlier Swamy *et al*. (2003) have studied the growth, biomass, carbon storage and nutrients (N, P and K) variations in 1 to 6 years-old chronosequence plantations of *Gmelia arborea*. Soil organic carbon increased from 8.46 to 14.02 Mg ha^{-1} within 6 years. At soil depths 0-20 cm, 21-40 cm and 41-60 cm, available N enhanced by 14.85 percent, 11.98 percent and 11.25 percent, K by 10 percent, 9.13 percent and 10.63 percent, whereas P declined by 26 percent, 23 percent and 20 percent respectively. Similarly, Negi *et al*. (2010) reported the soil organic carbon storage under different land use systems in Giri catchment of Himachal Pradesh and found that maximum organic carbon (93.47 t ha^{-1}) was in the soils where Kail+Silver fir forest, Kail+Oak forests followed by Deodar forests (82.14 t ha^{-1}) had minimum carbon compared to polyculture land use system. The results conclude that a change in vegetation type and use of land had a profound impact on the built up of nutrients. Polyculture land use system are recommended for the built up of nutrient status in any land use system.

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