P: ISSN No. 0976-8602 RNI No.UPENG/2012/42622 VOL.-7, ISSUE-1, January-2018

E: ISSN No. 2349-9443 Asian Resonance

Influence of Individual Tree Species of Aravallis on Floor Dynamics

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Abstract

The foothill of Central Aravallis is stabilized with indigineous and exotic tree species. Tree species such as *Acacia leucophloea*, *Acacia tortilis*, *Maytenus emarginata*, *Anogeissus pendula*, *Acacia senegal*, *Grewia tenax* are dominants in Central Aravallis of Ajmer. These tree species were found to be suitable for plantation on different soil substrata. From ecological point of view it is necessary to find out the impact of these tree species on floor vegetation, soil and transfer of nutrient dynamics because many plant species show difference in chemical constituency which may lead to illuminate many beneficial local flora. In the present investigation, it has been observed that individual tree species affect the soil and litter properties and phytosociological parameters of many herbaceous plant species, such changes are either negative or positive from economic utilization point of view. It was estimated that differential rate of litter production in different seasons and chemical constituency of individual plant lead to differences in above ground biomass (AGB) and below ground biomass (BGB) of herbaceous species. Therefore, individual tree species should be scrutinized before plantation at specific sites of Aravalli hill ranges. Micro level variations in nutrient cycling may thus result in the differences in tree floor characteristics.

Keywords: Vegetation, Nutrient Dynamics, Litter, Canopy.

Introduction

Tree is a large woody perennial plant having a single well defined stem and more or less a definite crown. Human life is directly or indirectly influenced by trees. Trees alter input to the soil system by increasing capture of wet fall and dry fall by adding nutrients to the soil. They affect the morphology and chemical conditions of the soil as a result of the above ground and below ground litter inputs. The under story is a critical feature of forest ecosystem which affects energy flow and nutrient cycling, biodiversity and regeneration capacity (Gilliam 2007). Understory plants have heterogeneous composition, structure and distribution patterns which depend on the individual tree species, forest structure, microenvironment and stand condition (Marialigeti et al. 2016; Tinya and Odor 2016). The chemical and physical nature of leaf, bark, branches and roots alter decomposition and nutrient availability via control on soil water and soil fauna involved in litter breakdown.

In general, several tree species represent the indicator of site condition, sites for the accumulation of nutrient within a landscape and effect of climate change (Gracia et al. 2007; Chavez and Macdonald 2012). From an ecological perspective the soil patches found beneath tree canopies are important local and regional nutrient reserve that influence community structure, ecosystem function and conservation status (Dale et al. 2002; Lencinas et al. 2008a; Chavez and Macdonald 2012). Different vegetation on the development of soil horizon is mainly due to the redistribution of nutrients and through the synthesis and input of various substances to the litter and upper mineral soil. Individual tree also influence the substrate upon which they grow, mainly affected by their crown and roots. The objective of the present study was to determine the influence of *Acacia leucophloea* and *Eucalyptus camaldulensis* on herb layer, soil and litter properties under individual tree species.

Aim of the Study

Linkage between forest dynamics and ecosystem processes are poorly understood and this limits our ability to adequately estimate future changes in forest ecosystem due to human- induced global changes. In particular at the single tree level, our understanding of changes in soil and litter chemical properties and aboveground and belowground biomass during forest succession is limited. Thus the objective of present study is to find out the availability of nutrient through soil and litter decomposition under individual tree, enhance the biomass production. Difference in the properties of soil under tree crowns are attributed with the influence of occupying vegetation along with the impact of individual trees.

Review of Literature

Tree plantation at sandy sites influence the herbaceous species which have been naturally acclimatised as initial colonisers during stabilization. Reports on different soil profile formed under individual tree canopies, because of difference among characteristics of above and below ground leachates and exuadetes (Lakshmanan 1962, Challinor 1968 and Sohet et al. 1988). Shankar et al. (1976) reported that biomass production of the ground cover under *Prosopis chilensis* is normally low due to presence of growth inhibitor in leaf litter. Whitmore (1988) observed that plant species which can grow and established in open light can easily germinate and persist below individual tree canopy.

Boetteher and Kalisz (1990) have indicated that single tree influence on soil properties is detectable even in mined forest. Paul and Steve (1996) observed that isolated tree also influence the growth and productivity of understory vegetation. Individual tree modify the spatial pattern of plant species in herbaceous layers and chemical condition of the soil generating special heterogeneity (Bertilde and Pablo 2003). Jack and Michael (2009) observed that litter pattern and its chemical nature are the important factors which decide the structure of ground vegetation and floor dynamics. Webner and Bardgett (2011) studied the influence of single tree on spatial and temporal pattern of belowground properties in pine forest. Lencinas et al. (2011) and Simonson et al. (2014) observed that understory vegetation respond fast to avoiding erosion and provide suitable microenvironment for other species development. Influence of canopy layer composition on understory plant diversity in southern forest was studied by Mestre et al. (2017). They observed that canopy patch type with mixed stand will be important for conserving the natural pattern of understory plant compositon.

Study Area

The study site is located in central Aravalli region at a distance of 12 km. North- West to Ajmer ($26^0$25’ and $26^0$29’ N latitude $74^0$37’ and $74^0$72’ E longitude). The site comprises stabilised sand dunes where tree plantations were made by the forest department. The area is represented by trees such as *Acacia leucoploea*, *Acacia senegal*, *Acacia tortilis, Eucalyptus cameldulensis*, *Maytenus emarginata* alongwith shrubs like *Acacia jacquemontii* and *Zizypus nummularia*. The soil is sandy (80% Sand + 20% Clay) with low water holding capacity. Climatic data of Ajmer show that annual rainfall was 1641.2 mm out of which 784.4 was recorded for the month of September. Mean monthly temperature was maximum in June (31.7^{0}C) and minimum in month of January (15.9^{0}C). Humidity was maximum (80%) in month of July and minimum (27%) in month of April.

Methods

Field

Ten trees of each *Acacia leucophloea* and *Eucalyptus camaldulensis* were selected at the site of study. Estimation of biomass under individual tree was done by harvest method (Milner and Huges, 1968) at monthly interval. Under each tree a circle of three meter was plotted taking the main trunk as centre. Quadrate of 50 X 50 cm. under individual trees were sampled and separated into green and standing dead. Live shoot were separated species-wise. The below ground parts were removed from the soil by washing through the running water. The values of biomass were expressed on the dry weight basis. Litter was also collected by excavating 25 X 25 cm. to a depth of 30 cm. under individual trees and categorized into stem, leaves, seeds and miscellaneous. The sample of live shoot, standing dead and litter were dried in oven at 80^{0}C for 24 hours and weighed separately. Soil samples of upper surface and lower depths were collected beneath the crowns of individual trees and soil chemical properties were examined to detect the differences that could be attributed to vegetation.

Laboratory

Litter samples were dried in oven at 80^{0}C and then ignite at 450^{0}C to determine ash content. The analysis of Ca, Mg, P and Total N was done by standard procedure as described by Trivedy et al. (1987). Nutrient concentration of litter was expressed in oven dry weight basis. Soil sample were air- dried and sieved to remove coarse fragments. Soil analyses were performed for fine fraction of surface and lower depth soil samples. pH, alkalinity, chloride, Ca, Mg, P and total N were determined by the standard method as described by Saxena (1987) and Trivedy et al. (1987).

Result and Discussion

The values of above ground biomass (AGB), standing dead (SD), litter (L) and below ground biomass (BGB) under *Acacia leucophloea* and *Eucalyptus camaldulensis* are shown in Fig.1. AGB and litter were observed to be comparatively higher under *E.camaldulensis* as compared to *A.leucophloea* while the BGB were higher under *A.leucophloea* as compared to *E.camaldulensis* was observed. Peak value of AGB under both the tree was recorded for the month of October and further it declines gradually. Naik and Mishra (1974) have also observed peak AGB in October for humid grasslands. In the transfer dynamics system, it was observed that above ground net production (ANP) and litter disappearance were comparatively higher under *E.camaldulensis* while below ground net production (BNP) and root disappearance were significantly higher under *A. leucophloea* than *E.camaldulensis* (Tripathi et al. 1991). A similar pattern of biomass and transfer dynamics has been explained on the basis of grazing factor (Kumar and Joshi 1972; Singh and Yadav 1974; Pandeya et al. 1977). The canopy layer composition influences the understory structures and composition (Mestre et al. 2017).

The chemical analysis of litter and soil under both the tree species are shown in Table 1 and 2 respectively. Data indicate that Ca, Mg, and N concentrations were higher under *A. leucophloea* as compared with *E. camaldulensis*, while P concentration in litter as well as in soil is more or less similar under both the tree plantations. At the site of study, pH ranges from 7.5 to 8.5. Other chemical characteristics of soil like alkalinity and chlorides are quite similar under both the tree plantation. In case of *E. camaldulensis* the concentration of Ca and Mg in soil and litter resulted in decreased floor biomass. Amount of litter which was significantly higher under *E. camaldulensis* indicate that it has little effect on the above ground biomass. Earlier study highlight the importance of Canopy species leaf litter as a key factor influencing soil acidity and thereby nutrient rocks, whereas the upper 10 cm of soil are most significantly influenced by individual tree (Norden 1994; Finzi et al. 1998; Augusto et al. 2002, 2003). Soil homogenization and litter redistribution reduce the distinctness of single tree influence. Below ground biomass under *E. camaldulensis* may be reduced reasonably due to higher production of leaf litter which influence the soil property adversely, possibly due to releasing some organic compound from living or decomposing leaves and roots which has also been reported in earlier studies (Yang and Wang 1978; Simons 1988). Differences in the properties of litter and soil reported in the present study are due to influence of occupying vegetation under different tree species. This conclusion is based on the uniformity of parent material throughout the study area and climatic and topographic factors affecting soil development are reasonably uniform. The herb layer under both trees observed that it might serves as a temporary reservoir retaining nutrients in the upper mineral soil.

The study has shown that the influence of individual tree species can be detected in floor biomass. The magnitude of differences observed under different tree plantations may be attributed to the nature of forest stand and understory vegetation. Understanding species-specific differences in tree-soil interaction has important and immediate interest to farmers and agro foresters concerned with maintaining or increasing site productivity. The present investigation indicates that litter and soil chemical characteristics have a major influence on the structure, diversity and richness of understory vegetation. The rate and flux of nutrients mainly depend upon the litter production and the factor related to decomposition of organic matter in the soil.

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Table: 1. Litter chemical characteristics under *Acacia leucophloea* (AL) and *Eucalyptus Camaldulensis* (EC) tree species

Tree Species	Litter Category	Ca%	Mg%	N%	P%
AL	Stem	5.13	5.36	2.6	0.59
	Leaves	4.80	3.31	3.0	0.68
	Seeds	2.40	3.50	3.6	0.55
	Miscellaneous	4.00	4.28	1.8	1.76
EC	Stem	3.36	3.89	1.8	0.77
	Leaves	3.84	3.13	2.0	0.72
	Seeds	2.08	3.02	2.4	1.32
	Miscellaneous	3.68	3.50	1.2	0.81

Table 2: Soil chemical characteristics under *Acacia leucophloea* (AL) and *Eucalyptus Camaldunesis* (EC) tree species

Tree Species	Depth (cm)	pH	Alkalinity (meq/100 gm)	Chloride %	Ca %	Mg %	N %	P %
AL	Upper 0-5	7.5	2.9	0.177	0.416	0.202	0.298	0.005
	Lower	7.8	3.6	0.071	0.400	0.360	0.238	0.006

	10-20							
EC	Upper 0-5	8.4	2.8	0.014	0.245	0.126	0.083	0.006
	Lower 10-20	8.5	4.2	0.006	0.288	0.112	0.131	0.008

Fig. 1: Variation in AGB, BGB, SD and L under EC and AL trees