ISSN: 2377-6196
The American Journal of
SCIENCE AND MEDICAL RESEARCH, 1(2), 44-52
Research Article Open Access

Comparison of biological activities and soil parameters associated with leaf litter decomposition under natural forest conditions

Venu N[1]*, Srinivas Reddy V[2] and Vikram Reddy M[3]

[1,2] *Department of Zoology, Kakatiya University, Warangal-506 009. Telangana State, India*
[3] *Department of Ecology and Environmental sciences, Pondicherry University, Pondicherry 605 014, India*

E-mail: venunaganulu@gmail.com

Abstract

The present study was conducted to compare the biological activities and soil parameters associated with leaf litter decomposition under natural forest conditions. Emphasis was given on the impact of decomposition of four leaf litter types of Cassia siamea, Shorea robusta, Acacia auriculiformis, and Dalbergia sissoo trees in enhancing nutrient enrichment and major physicochemical characteristics in afforested laterite wastelands. Comparison of nutrient status of forest soil in Cassia, Shorea, Acacia, and Dalbergia tree stands during winter, summer and rainy seasons indicated that the organic carbon content was high in Dalbergia and Cassia but low in Shorea and Acacia. Similarly, nitrate nitrogen content of soil was also more in Cassia closely followed by Dalbergia and very low in the soil of Acacia and Shorea stands. Available phosphorus content of soil was also high in the soil of Dalbergia and Cassia forests. Shorea stand had the lowest organic carbon content whereas Acacia stand had low concentrations of nitrate nitrogen and available phosphorus. C/N ratio and P/N ratio was highest in Acacia followed by Shorea, low values in the soil of Cassia and Dalbergia stands indicated fast rates of carbon utilization and nutrient release. A general comparison showed that the soil was acidic in nature in all the stands with pH ranging from 5.18 in Acacia to 6.83 in Dalbergia. Similarly, the electrical conductivity of soil was highest in Dalbergia followed by Cassia, and Acacia to reach lowest in Shorea. Electrical conductivity was recorded low during winter and high during summer season in all the tree sites.

Keywords: Leaf litter decomposition, *Dalbergia, Shorea, Acacia, Cassia* and Soil parameters.

INTRODUCTION

Plant litter decomposition is an important process in nutrient cycling in natural ecosystems. A proper scientific understanding of the soil ecological functions requires thorough knowledge on the underlying biological and biochemical processes. Such knowledge is essential to formulate strategies and approaches for land resource management and policy decisions to promote long- term ecosystem sustainability. There are several biological properties that can serve as early indicators of ecosystem stress, these may function as “sensors” whose perturbation may sensitively indicate the extend of soil degradation as compared to other classical and slowly changing soil properties, such as organic matter (Dick, 1994). Many studies have been conducted on litter decomposition and the dynamics of nutrient release to analyze the effect of environment, litter quality as well as of soil organisms.

In recent years, attention has turned to the degrading capacity of microorganisms by evaluating their biological activities as potential indices. In this chapter an attempt has been made to compile the recent information available on soil enzyme activities with particular reference to leaf litter decomposition in forest ecosystems. Microbial species and communities release enzymes into the environment in order to degrade macromolecular and insoluble organic matter prior to cell uptake and metabolism (Burns, 1982). This important property may allow decomposition rates to be related to the enzymes that directly mediate the degradation of the

How to Cite this Article:

Venu N, Srinivas Reddy V and Vikram Reddy, M (2015). Comparison of biological activities and soil parameters associated with leaf litter decomposition under natural forest conditions. *The American Journal of Science and Medical Research,* 2015,1(2):44-52. doi:10.17812/ajsmr2015112

Received 4 March 2015; Accepted 18 April, 2015; Published online 20th April, 2015

major structural components of plant material and can provide functional information on specific aspects of the microbial community and succession (Sinsabaugh et al., 1991).

Assessment of soil quality has been a major topic of research in soil science during the past decades. Among several contemporary definitions available that describe soil quality, the most appropriate and widely accepted one is by. Karlen et al. (1997), “soil quality is the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation”. With respect to the selection of parameters for use as indicators, Doran and Parkin (1996) have recommended several characteristics for use in soil quality evaluation, which includes physical (texture, rooting depth, infiltration rate, bulk density, water retention capacity), chemical (pH, total C, electrical conductivity, nutrient level) and biological (microbial biomass, potentially mineralizable N, soil respiration) properties. The nitrogen mineralization capacity refers to the transformation of organic nitrogen compounds into ammonium / nitrate under optimum moisture and temperature conditions of soil over a given period of time. This determination has been used to assess the impact of soil management on soil quality. Significant seasonal variations limit its value as a soil quality indicator (Tscherko and Kandeler, 1999). It increases with light grazing (Banerjee et al., 2000) and with conventional ploughing (Kandeler et al., 1999), although in the later case the increase was explained by the mixing of the organic residues with the surface soil. Pankhurst et al. (1995) criticized the use of nitrogen mineralization capacity as a soil quality indicator because it is only scarcely affected by soil management, being only modified by additions of massive quantities of cattle slurry to the soil.

Decomposition is mediated by microorganisms and extracellular enzymes that are constrained by the interaction between climatic conditions and biochemical phenomena (e.g., soil temperature × plant productivity) That influence and are influenced by the supply of accessible nutrients such as nitrogen and phosphorous (Sinsabaugh, 1994). Numerous results from field and laboratory experiments confirm that soil decomposition processes increase with physical changes in temperature and aeration (Peterjohn et al., 1994; Katterer et al., 1998). The microbial response to seasonal soil temperature variation may be limited by other chemical and biological factors. The activity of microbially derived extracellular hydrolytic and oxidative enzymes that are responsible for the conversion of organic matter from high to low molecular weight compounds is principally regulated by temperature, hydrology, nutrient availability and vegetation type (Insam, 1990). In particular, the interaction between physicochemical factors such as temperature, changing pH, redox potential, inhibitors (e.g. trace metal ions, phenolics) and activators (e.g. ,) have been proven to be important (Eivazi and Tabatabai, 1990; Freeman et al., 1996, 2001).

This ecologically oriented study comprising field and laboratory experiments under tropical edaphic and climatic conditions is intended to enrich the existing knowledge on Effect of the tree Plantations on the diversity and densities of soil arthropods and on their role in litter decomposition with respect to the decomposition of leaf litter of four different deciduous forest tree species and to identify potential parameters for the evaluation of edaphic characteristics in afforested tropical wastelands. There are several isolated studies on the major groups of soil biota and their relation with physicochemical parameters of soil in different natural and degraded ecosystems of India. However, Very little information is available on their functional role and relationships with other biological characteristics like soil enzyme activity and soil microarthropod fauna with respect to leaf litter decomposition under tropical conditions. The present study has been designed as an interdisciplinary approach on the functional significance of biological activity in soil with special reference to soil enzyme activity and detritivore microarthropod population as influenced by type of leaf litter and rate of decomposition in afforested ecosystems. This ecologically oriented research has applied importance for evaluating the suitability of leaf litter types/tree species for enhancing soil fertility/soil conservation practices. Biological parameters namely population and community composition of soil microarthropod groups, microbial count, soil respiration, microbial biomass carbon, nutrient status, and activity of important soil enzymes were earmarked as potential indicators for the evaluation of edaphic characteristics and success of afforestation programmes in laterite wastelands. Therefore, the main objectives of present study is to Compare biological activities and soil parameters associated with leaf Litter decomposition under natural forest conditions.

MATERIAL & METHODS

Site Description

The site of present investigation is a deciduous tropical forest known as the Srisailam reserve forest, situated in between 23029' to 23045' south latitude and 87035' to 87045' East longitude. It is a part of Mahabubnagar district under the province of Andhra Pradesh in the Southern region of India. Historical evidences show that this area was once a thick forest but widespread forest denudation by human settlements form early nineteenth century had converted the entire area barren up to the line of horizon. These vast eroded wastelands bear an undulating and barren desert like landscape.

However, large scale afforestation programmers undertaken in this area during the past 50 years by the Forest Department, Local Government Bodies, and Institutions and Organizations using several native and exotic tree species could bring about some notable improvements in the soil and floral characteristics. In general, the soil of eroded laterite wastelands is yellowish red to brick red in colour, sandy loam in texture, has poor water holding capacity and low electrical conductivity, acidic pH and very poor organic carbon and phosphate status, below average nitrogen content and rich amount of oxides of aluminum and iron (Bhattacharya, 1979). Joy (1983) has noticed that the nature of soil is influenced greatly by the afforestation and agricultural practices with the pH varying between 5.38 and 7.51 and organic carbon content ranging from 0.14% to 0.61% in different local ecosystems. Ray (1986) recorded notable improvements in the soil characteristics (pH 7.5, organic carbon 1.38%) in the local Acacia auriculiformis forest area. A recently conducted comparative study of soil in different natural forests of Mahabubnagar district has recorded slightly acidic to alkaline pH condition (6.11 – 7.75), moderate electrical conductivity (0.43 – 0.68 mmoh), high organic carbon (1.2 – 1.4%), and nitrate nitrogen (47.7 – 69.1 ppm) contents. Bhattacharya (1974) designated the local climate as "dry sub-humid mega-thermal" following the climatic nomenclature of Thornthwaite (1948). However, with the advancement of forest cover and human activities during the past few decades the local climatic conditions have undergone notable improvement.

The present climatic record of the local meteorological station shows average monthly temperature of 26.10C in 2010 (range 10.90C in January to 38.40 C in May), 26.40C in 2011 (range 12.40C in January to 37.70C in June), total annual rainfall of 1516.7 mm in 2010 and 1381.5 mm in 2011, and mean monthly relative humidity 78.1% in 2010 and 77.8% in 2011. This climatic improvement could result in higher moisture content of the soil and enhanced litter breakdown under forest conditions and canopy base of trees. The Srisailam reserve forest has very rich in floral diversity with a dense vegetation of trees as well as well-developed under story consisting of shrubs, herbs, grasses and ferns. Afforestation started in this area during 1960's with monoculture stands of trees like Cassia siamea, Shorea robusta, Eucalyptus citriodora, Acacia auriculiformis, Anacardium occidentale, Dalbergia sissoo, etc, and a portion of the forest is now earmarked as a deer sanctuary. However, the ecological suitability of even the most commonly used tree species in restoring the lost properties and in enhancing nutrient status and biodiversity of soil remains underestimated. This background knowledge has led to the formulation of specific objectives of the present study to undertake an ecologically oriented evaluation. Emphasis has been given on the restoration of nutrient status, biological activity and biodiversity in the soil of different afforested monoculture stands, which are potential indices for evaluation of the success of ecofriendly activities such as afforestation for the conservation of ecological equilibrium and functional diversity of soil sub-system.

Experimental design:

The study site was located in Srisailam reserve forest, Mahabubnagar District as described earlier. Experiments were conducted using the random soil samples collected from monoculture forest stands of the following tree species namely Cassia siamea., Shorea robusta, Acacia auriculiformis, and Dalbergia sissoo. Experiments were conducted in 2011 and soil samples were collected at regular intervals, during three consecutive seasons – winter, summer, rainy.

S.No	Common Name	Scientific Name	Family
1	Cassia	*Cassiasiamea (Lamk.)*	Caesalpiniaceae
2	Shal	*Shorea robusta (Gaertn)*	Dipterocarpaceae
3	Acacia	*Acacia auriculiformes*	Mimosaceae
4	Rosewood	Dalbergia sissoo (Roxb.)	Fabaceae

Soil Sampling

After careful removal of the dry litter layer from the top, random soil samples of the size (10 × 10 × 10 cm) were collected from the (0 – 10 cm) layer with a sterilized steel auger (5 cm diameter), at least from three different stands of each tree species. The soil samples were then pooled, and sieved (2 mm mesh) to remove coarse stones and root fragments. Then it was divided into two portions. One portion was air-dried for 72 hrs at room temperature and ground to pass through 80-mesh sieve (180 µm) and then used for chemical analyses, the other portion of soil sample was immediately stored at 400C for soil enzyme analysis.

Physicochemical Analysis of Soil

Measurement of soil temperature and moisture:

During each sampling the temperature of soil was recorded by inserting a 'soil thermometer' to a depth of 5 cm. The prevailing moisture content of soil was measured immediately using an 'infrared torsion balance moisture meter' at 105 0C. The moisture percentage of the sample soil (m) was directly read from the apparatus and then converted into dry weight percentage (md) using the formula

Soil pH:

10 gram of air-dried soil sample was taken in a 50 ml beaker and 25 ml of distilled water was added to it. The suspension was stirred for 20 to 30 minutes using magnetic stirrer. Then a digital pH meter was used to measure the pH of solution (µpHsystem 361 - Systronics) after 1 h of standing for sedimentation.

Electrical conductivity:

10 gram of air-dried soil sample was taken in a 50 ml beaker and 25 ml of distilled water was added to it. The suspension was stirred at regular intervals for 20 to 30 minutes using magnetic stirrer. Then the soil suspension was used for estimation of E.C. by a digital conductivity meter after 1 h of standing for sedimentation (Direct Reading Conductivity Meter 304 – Systronics).

Organic carbon content:

Five gram powdered soil sample was taken in a 500 ml conical flask. Two ml of distilled water was added to m4oisten the sample. Then 20 ml potassium dichromate followed by 20 ml H_2SO_4 - Ag_2SO_4 mixture. The sample was incubated for 30 minutes at room temperature and then diluted with 200 ml tap water. 5 ml metaphosphoric acid was added. The solution was now tritrated against ferrous ammonium sulphate solution after adding 1 ml DPA indicator until the blue colour changed to dull green. Each sample was estimated at least in 3 replications. A blank estimation was made and normality of FAS was adjusted regularly.

Calculation:
The organic carbon is calculated in percentage as follows –
1 ml (N) $K_2Cr_2O_7$ = 0.003g of carbon % of organic carbon =
Where, V1 = Volume of standard $K_2Cr_2O_7$
V2 = Volume of standard $Fe(NH_4)_2SO_4, 6H_2O$
W = Weight of soil sample

Nitrate Nitrogen Content:

10 gm dry soil sample was mixed with 25 ml extraction buffer. During mixing of the contents 80 mg of $Ca(OH)_2$ followed by 200 mg $MgCO_3$ and a pinch of activated charcoal were added. It was then filtered by Whatman No 1 filter paper. 10 ml of filtrate was evaporated to dryness on a hot plate. After cooling, 3 ml of phenol-di-sulphonic acid was added to the residue, kept for 10 minutes and then 15 ml distilled water was added. 10 ml of ice-cold ammonium hydroxide solution was slowly added for the development of yellow colour. Final volume was then made up to 100 ml by adding dist water and the optical density was measured at 420 nm using spectrophotometer. A standard curve was prepared using different concentration of KNO_3.

Calculation:
Result of the experiment was expressed as ppm N (nitrate form)
Nitrate nitrogen (mg/g dry soil) = A X X
Where, A = X 0.02
Volume of extraction solution = 25
Volume of filtrate used = 10 ml
Final colour volume = 100 ml

Available Phosphorus Content:

Available phosphorus content was determined following 'ammonium molybdate blue colour' method (Jackson, 1962). 2 gm dry soil was mixed with 20 ml extraction solution. The mixture was shaken for 5 minutes and then filtered. 2 ml filtrate was mixed with 3 ml 0.8 (M) boric acid, 2 ml distilled water, 2 ml ammonium molybdate solution. Finally 1 ml of freshly prepared stannous chloride solution was added and was measured spectrophotometrically at 680 nm. The standard curve was prepared using potassium dihydrogen phosphate (KH_2PO_4).

Calculation:
The value of available phosphorus was expressed as g g^{-1} dry soil.
µg available phosphorus g^{-1} dry soil =
Where, A =
Volume of extraction solution = 20 ml
Volume of filtrate used = 2 ml, Weight of soil = 2 gm

RESULTS

Field experiments in monoculture forest stands:

Experiments were conducted in afforested monoculture stands of Cassia siamea, Shorea robusta, Acacia auriculiformis, and Dalbergia sissoo trees in the Srisailam Reserve Forest during 2011. Soil samples were collected at random from several stands of each tree species during winter (January), summer (May) and rainy (September) seasons. These were processed and analyzed to compare the biological activities and soil parameters associated with leaf litter decomposition.

Climatic parameters of study site

The climatic data for the year 2011 was obtained from the local meteorological station at Sunnipenta, only about 7 km away from the study site. The total annual precipitation was 1381.5 mm. The rainfall was highest in July (340.2mm) and the driest month was November with no rainfall. The average monthly temperature in 2011 was 26.350C and monthly relative humidity was 77.83%.

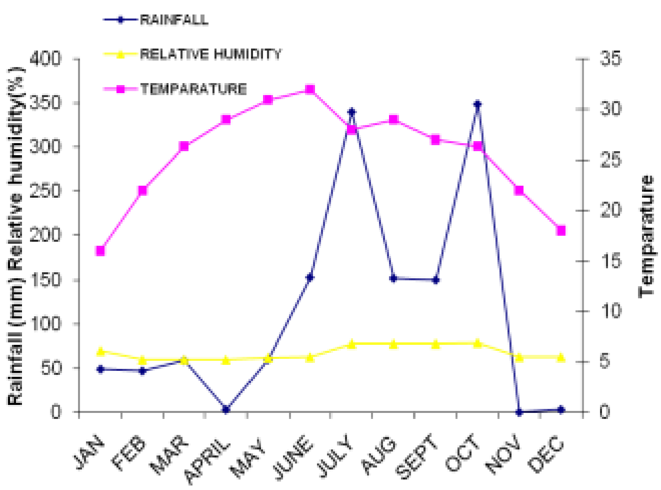

Figure-I. Monthly fluctuations in temperature, rainfall and relative humidity of the area of investigation in the year 2011.

The highest and lowest humidity occurred in July and April respectively. The highest temperature measured during the month of June was 37.70C and lowest value of 12.40C in January (Figure-I).

Physicochemical Analysis of Soil:

Measurement of soil temperature and moisture and Soil pH:

Seasonal changes in some important physico-chemical parameters of soil in Cassia siamea, Shorea robusta, Acacia auriculiformis, and Dalbergia sissoo tree stands are given in figure-2. An overall comparison shows that the soil was acids in nature in all stands with pH ranging from 5.177 in Acacia to 6.83 in Dalbergia. The soil of Acacia site was most acidic in all the seasons with lowest value of 4.9 in winter, whereas in Dalbergia stands notable improvement towards neutral level of 7.15 could be recorded in summer seasons.

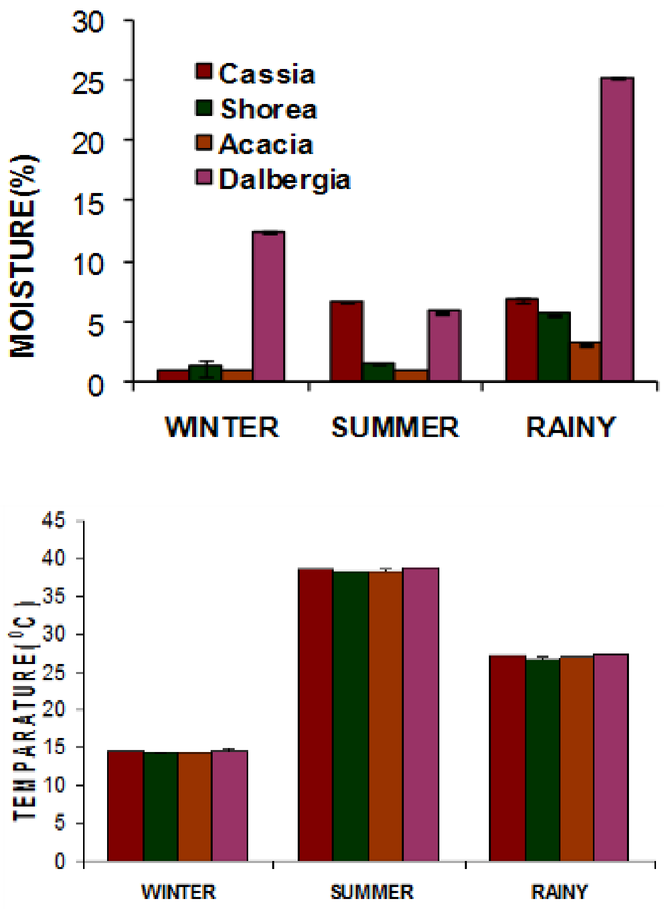

Figure-2. **Seasonal changes of moisture and temperature of soil in different forests**

Electrical conductivity:

Similarly, the electrical conductivity of soil was highest in Dalbergia (0.217 mho/cm) followed by Cassia, and Acacia to reach lowest in Shorea (0.0843 mho/cm). Electrical conductivity of soil, which measures the soluble salt content, indicates nutrient availability for plants. It recorded low during winter and high during summer season in all the tree sites. Turning to the moisture content of soil at each sampling interval, the value was highest in the afforested site of Dalbergia trees but very low in Acacia stand. The moisture content of soil recorded high during rainy season when compared to other seasons but there were large variations among the sites. On the contrary, the soil temperature depicted least variation among the sites (range 26.5-26.94^{0}C). This property was consistent for all the seasonal intervals. Summer was the hottest with soil temperature above 380C while in winter the soil temperature was just below 15^{0}C.

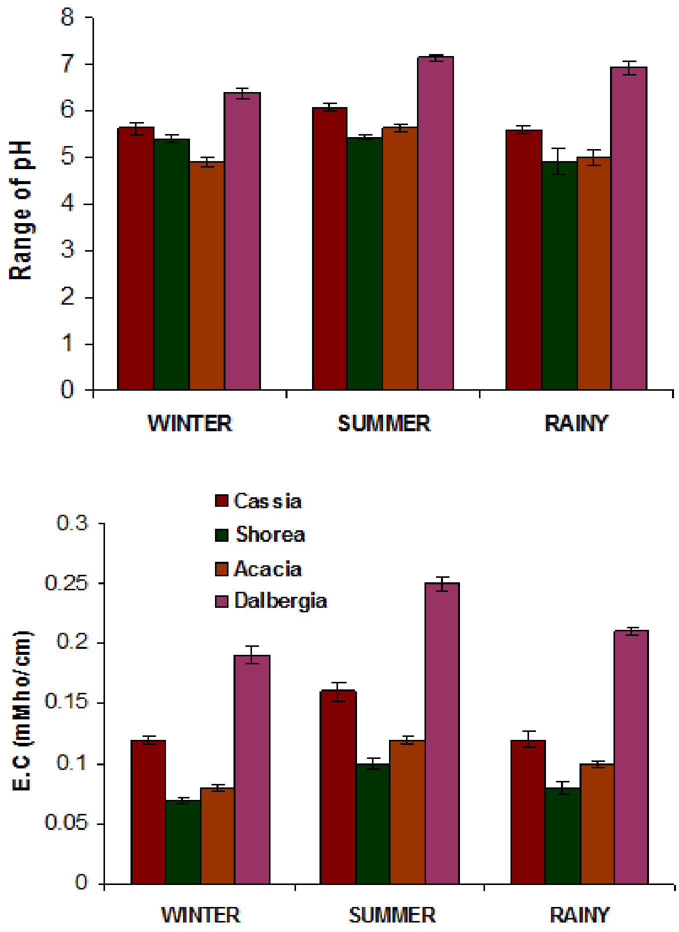

Figure-3. Seasonal changes of pH and Electrical conductivity of soil

Nutrient status of soil:

Important soil nutrient parameters namely organic carbon, nitrate nitrogen and available phosphorus contents were quantitatively estimated in the samples collected at seasonal intervals from the afforested stands of *Cassia siamea, Shorea robusta, Acacia auriculiformis,* and *Dalbergia sissoo* trees.

Table–1 incorporates a comparison of nutrient status of forest soil in *Cassia, Shorea, Acacia*, and *Dalbergia* tree stands during winter, summer and rainy seasons. Organic carbon content was high in *Dalbergia* and

Table-1. Seasonal variations in nutrient status of forest soil at four different tree stands

Nutrients	Seasons	Types of forest stands			
		Cassia	*Shorea*	*Acacia*	*Dalbergia*
Organic Carbon%	winter	1.057 ± 0.004	0.513 ± 0.025	0.483 ± 0.002	1.845 ± 0.002
	summer	0.992 ± 0.006	0.312 ± 0.002	0.423 ± 0.005	0.795 ± 0.005
	Rainy	1.17 ± 0.018	0.434 ± 0.005	0.56 ± 0.552	1.077 ± 0.009
	Average	**1.0731**	**0.4195**	**0.4885**	**1.2388**
Nitrate nitrogen (mg /g dry soil)	Winter	7.083 ± 0.102	0.644 ± 0.049	0.017 ± 0.008	7.487 ± 0.048
	summer	15.04 ± 0.197	0.598 ± 0.015	0.05 ± 0.009	6.433 ± 0.203
	Rainy	5.13 ± 10.23	1.217 ± 0.037	1.444 ± 0.034	5.023 ± 0.048
	Average	**9.0855**	**0.8195**	**0.5036**	**6.314**
Available Phosphorus (µg/g dry soil)	Winter	20.17 ± 0.47	6.04 ± 0.12	4.03 ± 0.12	20.28 ± 0.15
	Summer	29.38 ± 0.79	5.96 ± 0.18	4.35 ± 0.31	30.52 ± 0.13
	Rainy	29.16 ± 0.77	6.33 ± 0.22	2.51 ± 0.17	49.54 ± 0.35
	Average	**26.24**	**6.11**	**3.63**	**33.45**
C/N ratio		**0.118**	**0.512**	**0.97**	**0.196**
P/N ratio		**2.89**	**7.46**	**7.21**	**5.30**

Cassia but low in *Shorea* and *Acacia*. Nitrate nitrogen content of soil was also more in Cassia closely followed by Dalbergia. On the contrary, soil of Acacia and Shorea stand contained very low amount of nitrate nitrogen. Available phosphorus content of soil was also high in the soil of Dalbergia and Cassia forests. Shorea stand had the lowest organic carbon content whereas *Acacia* stand had lowest concentrations of nitrate nitrogen and available phosphorus. A clear distinction of the afforested sites could be seen with Cassia and Dalbergia representing nutrient-rich habitats while Shorea and Acacia were nutrient-poor sites. Calculation of C/N ratio and P/N ratio in different sites also revealed low values in Cassia and Dalbergia when compared to high values in the soil of Shorea and Acacia stands. This indicated that in the soil of Cassia and Dalbergia the carbon utilization and nutrient release occur at fast rates.

Findings of the above experiment were statistically analyzed to determine the validity of observed differences between the amounts of soil nutrients with respect to seasonal intervals of estimation in different tree stands. Here the graphical representations of the seasonal variations in nutrient parameters namely organic carbon, nitrate nitrogen and available phosphorus are presented along with the summary of the analysis of 2-Way ANOVA for a clear cut comparative idea of nutrient status of the soil of Cassia, Shorea, Acacia and Dalbergia forest stands.

Organic Carbon Analysis:

Figure–3 shows that organic carbon content of soil fluctuated slightly among different seasons in all the forest stands except Dalbergia, which registered notable increase during winter season. The amount declined during summer in all the tree sites followed by slow increase in rainy season and the decline was most prominent in Dalbergia. Seasonal comparison of organic carbon content revealed more or less steady level in all the sites. Dalbergia and Cassia litter could enhance the organic carbon content of soil whereas soil of Shorea and Acacia contained less amount of organic carbon in all the 3 seasons. In tropical deciduous forests the litter deposited during summer season undergoes decomposition at fast rates during the following rainy season and therefore the organic carbon content of soil would increase depending upon the type of litter. Organic carbon provides energy for soil biota and this parameter is an ecologically valid index of biological activity. As whole the observed variations in the organic carbon content of soil among Cassia, Shorea, Acacia, and Dalbergia forest sites and among winter, summer and rainy seasons were statistically highly significant. The summary of 2-Way ANOVA shows very high F value between forest types, an indication of the importance of litter types in enhancing the nutrient status of soil.

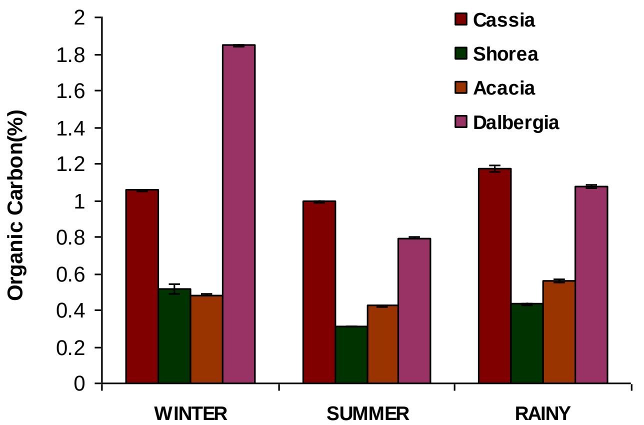

Figure-3. Seasonal changes of organic carbon content in soil of different forest sites

Nitrate Nitrogen Analysis:

Seasonal variation in the nitrate nitrogen content of soil in different forest tree stands is compared graphically in Figure-4. The overall amount was very high in Cassia followed by Dalbergia and very low in Shorea and Acacia. In Cassia stand the amount reached peak during summer and maintained more or less high level during winter and rainy seasons. On the other hand, in Dalbergia soil the nitrate nitrogen content was more in winter and gradually decreased to reach the low level in rainy season. The amount was very negligible in Acacia during winter and summer and increased slightly in rainy. Similarly, the nitrate nitrogen content of Shorea stand increased in rainy season. Highly significant statistical differences were established between nitrate nitrogen content of different litter types and between the seasons (analysis of 2 Way ANOVA). Here also the high F values among forests show the importance of litter types in enhancing soil fertility.

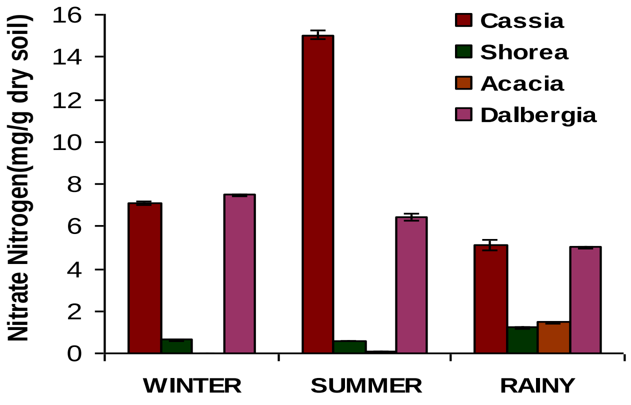

Figure-4. Seasonal changes of nitrate nitrogen content in soil of different forest sites

Available Phosphorus Analysis:

It is clear from Figure-5 that like the other soil nutrients, available phosphorus content of soil was also higher in Dalbergia and Cassia forests than in Shorea and Acacia stands. The seasonal aspect was very evident in Cassia and Dalbergia where the amount increased prominently from winter to rainy season. However, the level of available phosphorus remained more or less same throughout the study period in the soil of Acacia and Dalbergia. The summary of 2-Way ANOVA depicted statistically significant differences in available phosphorus content between tree species and between the seasons. As in previous parameters here also the high F value is suggestive of the benefit of certain litter types in improving the nutrient status of soil.

DISCUSSION

Changes in important physico-chemical parameters of soil in the afforested sites showed that the soil of Acacia was most acidic whereas in Dalbergia stand notable improvement towards neutral revel could be recorded. Similarly, the electrical conductivity of soil, which indicates the nutrient availability for plants, was highest in Dalbergia followed by Cassia, and Acacia to reach lowest value in Shorea. The moisture content of soil was highest in rainy season but recorded notable variation among sites during other seasons. On the other hand, the soil temperature showed wide fluctuations between the seasons but depicted least variation among the sites. Garay et al. (2004) observed that pH was slightly higher in the soil of Eucalyptus grandis plantation than from Acacia mangium. Fioretto et al. (2000) observed the changes in pH during litter decomposition of two species in a Mediterranean low shrub land: Cistusincanus a summer deciduous species, and Myrtuscommunis, an evergreen sclerophyll species. Although both litters had similar pH values at the start, they showed significantly different changes during decomposition. Freeman et al. (2001) proposed that temperature changes over the period were responsible for the 65% increase in dissolved organic carbon export. Soil temperature affects enzyme activities indirectly through influencing microbial proliferation and also directly by modifying enzyme kinetics (Freeman and Kang, 1999). Kang and Freeman (1998) found a limited response of extracellular enzyme activities to soil temperature. It was suggested that soil factors such as low pH, low ion concentrations, less oxygen content and low microbial proliferation may limit the enzyme activities.

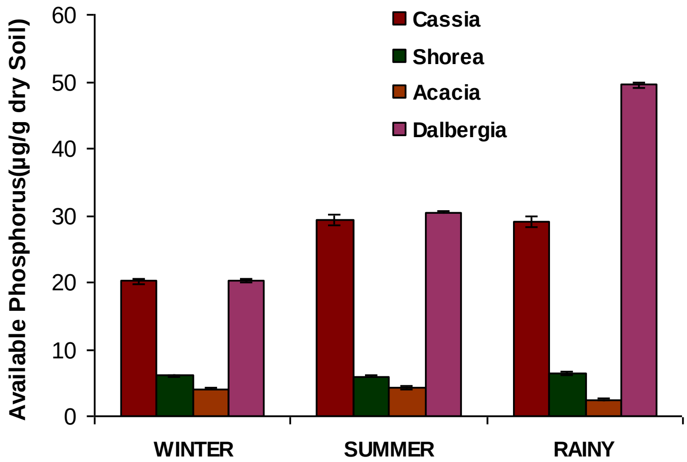

Figure-5. Seasonal changes of available phosphorus content in soil of different forests

Comparison of the nutrient status of soil registered a clear distinction of the afforested sites with Cassia and Dalbergia representing nutrient-rich habitats while Shorea and Acacia were nutrient-poor sites. The values of C/N ratio and P/N ratio were low in Cassia and Dalbergia but high in the soil of Shorea and Acacia stands indicating that carbon utilization and nutrient release occur at fast rates in the soil of Cassia and Dalbergia. Statistically significant variations suggested the benefit of certain litter types in improving the nutrient status of soil. Soil organic matter is a major determinant of carbon and nutrient cycling in the biosphere: it is the main nutrient source for plant growth through microbial decomposition and contributes to soil structure and resistance to erosion (Herrick and Wander, 1997). The accumulation of organic matter in soil results from the activity of the soil biota: plants ensure the supply of organic matter while soil fauna and microorganisms transform it. In soil the heterotrophic microorganisms that use organic carbon as nutrient and energy sources process most of the organic compounds.

Comparison of the organic carbon content of soil revealed more or less steady seasonal levels in all the sites. Dalbergia and Cassia litter could enhance the organic carbon content of soil whereas soil of Shorea and Acacia contained less amount of organic carbon in all the 3 seasons. In tropical deciduous forests the litter deposited during summer season undergoes decomposition at fast rates during the following rainy season and therefore the organic carbon content of soil would increase depending upon the type of litter. Organic carbon provides energy for soil biota and this parameter is an ecologically valid index of biological activity. Garcia et al. (2005) observed wide variations in total organic carbon content of soil under several plant systems Therhizosphere soil of slowest growing plants among those studied showed the lowest values of TOC. They suggested that the species with higher TOC values might be used for soil restoration under semiarid climate conditions. Soil organic matter did not vary significantly throughout the year and remained at about 90% of soil dry weight indicating that decomposition of SOM is constrained by soil anaerobiosis, limited oxygen availability, acidity and nutrient availability that suppress decomposition under warmer summer conditions (Bonnett et al. (2006). The nitrate nitrogen content of soil was very high in Cassia and Dalbergia but very low in Shorea and Acacia. More or less steady high level occurred in Casisa and Dalbergia during all the seasons but in Acacia and Shorea stands slight increase was noticed in rainy season only. It is well established that the avaiability of nitrogen has a regulatory effect on plant litter decomposition, and the formation and stabilization of soil organic matter (Fog, 1988). Increasing N availability influences the decomposition rates of plant litter and organic matter; the direction of impact depends on the stage of decomposition (Berg and Matzner, 1997).

n fresh litter, high external and internal concentrations of N stimulate degradation, while in later stages of decomposition and in lignified organic matter and humus, high N availability attenuates decomposition (Berg and Matzner, 1997; Fog, 1988). According to Garay et al. (2004) the N concentration in the L and F layers was about two times higher in Acacia mangium plantation while C/N ratio was higher in Eucalyptus grandis. Like the other soil nutrients, available phosphorus content of soil was also higher in Dalbergia and Cassia forests than in Shorea and Acacia stands. The seasonal aspect was very evident in Cassia and Dalbergia where the amount increased prominently from winter to rainy season. Garay et al. (2004) evaluated soil conditions in plantations in plantations of Eucalyptus grandis and Acacia mangium in Brazil. Organic matter was higher under A.mangium, with thicker L and F horizons in every season. Considering the fine fraction of the hemiorganic horizon, the contents of C, N, P and the exchangeable bases were higher under A.mangium. A large proportion of total phosphorus in forest soils is bound in organic forms (Zech et al., 1987).

Competing Interests Statement:

The authors declare that they have no competing financial interests.

REFERENCES

[1] Banerjee, M, R., Burton, D, L., McCaughey, W, P., Grant, C, A., 2000. Influence of pasture management on soil biological quality. Journal of Range Management, 53:127–133.

[2] Berg, B. and Matzner, E., 1997. Effect of N deposition on decomposition of plant litter and soil organic matter in forest ecosystems. Environmental Reviews. 5: 1 –25.

[3] Bonnett, S, A, F., Ostle, N., Freeman, C., 2006. Seasonal variations in decomposition processes in a valley-bottom riparian peatland. Science of the total environment, 370: 561-573.

[4] Burns, R, G., 1982. Enzyme activity in soil: location and a possible role in microbial activity. Soil Biology and Biochemistry, 14 : 423-427.

[5] Dick, R, P., 1994. Soil enzyme activities as indicators of soil quality. In: Defining Soil Quality for a Sustainable Environment. (Ed. Doran, J.W.), SSSA Special Publication 35, Madison, WI : 107-124.

[6] Eivazi, F. and Tabatabai, M, A., 1990. Factors affecting glucosidases and galactodidases activities in soils. Soil biology and Biochemistry, 22 : 891-897.

[7] Fioretto, A., Papa, S., Curcio, E., Sorrentino, G., Fuggi, A., 2000. Enzyme dynamics on decomposing leaf litter of Cistus incanus and Myrtus communis in a Mediterranean ecosystem. Soil Biology and Biochemistry 32 : 1847-1855

[8] Fog, K., 1988. The effect of added nitrogen on the rate of decomposition of organic matter. Biological Reviews, 63 : 433-462.

[9] Freeman, C., Evans, C, D., Monteith, D, T., Reynolds, B., Fenner, N., 2001. Export of organic carbon from peat soils. Nature, 412: 785.

[10] Freeman, C., Liska, G., Ostle, N., Lock, M, A., Reynolds, B., Hudson J., 1996. Microbial activity and enzymic decomposition processes following peatland water table drawdown. Plant Soil, 180: 121-127.

[11] Garay, I., Pellens, R., Kindel, A., Barros, E., Franco, A, A., 2004. Evaluation of soil conditions in fast growing plantations of Eucalyptus grandis and Acacia magnum in Brazil : a contribution to the study of sustainable land use. Applied Soil Ecology, 27 : 177-187.

[12] Garcia. C., Roldan, A., Hernandez, T., 2005. Ability of different plants species to promote microbiological processes in semiarid soil. Geoderma, 124 : 193-202.

[13] Herrick, J, E. and Wander, M., 1997. Relationships between soil organic carbon and soil quality in cropped and rangeland soils : the importance of distribution, composition, and soil biological activity. In : Soil Processes and the Carbon Cycle, (Eds. Lal, R., Kimble, J.M., Follett, R.F., Stewart, B.A.) CRC Press, Boca Raton : 405-425.
[14] Insam, H., 1990. Are the soil microbial biomass and basal respiration governed by the climatic regime? Soil Biology and Biochemistry, 22 : 525-532.
[15] Kang, H. and Freeman, C., 1998. Measurement of cellulase and xylosidase activities in peat using a sensitive flurogenic assay. Soil Sci Plant Anal, 29 : 2769-2274.
[16] Karlen, D, L., Mausbach, M, J., Doran, J, W., Cline, R, G., Harris, R, F., Schuman, G, E., 1997. Soil quality: a concept, definition, and framework for evaluation. Soil Science Society of America Journal, 61 : 4-10.
[17] Karlen, D, L., Mausbach, M, J., Doran, J, W., Cline, R, G., Harris, R, F., Schuman, G, E., 1997. Soil quality: a concept, definition, and framework for evaluation. Soil Science Society of America Journal, 61: 4-10.
[18] Katterer, T., Reichstein, M., Andren, O., 1998. Temperature dependence of organic matter decomposition: a critical review using literature data analyzed with different models. Biology and Fertility of Soils, 27 : 258-262.
[19] M. N. Abubacker M. Visvanathan and S. Srinivasan. 2015. Impact of pesticides on amf spore population and diversity in Banana (Musa spp.) Plantation soils. Biolife, 2(4);1279-1286.
[20] Pankhurst, C, E., Hawke,B, G., McDonald, H, J., Kirby, C, A., Buuckerfield, J, C., Michelsen, P., O' Brien, K, A., Gupta, V, V, S, R., Doube, B, M., 1995. Evaluation of soil biological properties as potential bioindicators of soil health. Australin Journal of Experimental Agriculture, 35 : 1015-1028.
[21] Peterjohn, W, T., Melillo, J. M., Steudler, P, A., Newkirk K, M, Bowles, F, P., Aber J, D., 1994. Responses of trace gas fluxes and N availability to experimentally elevated soil temperatures. Ecol Appl, 4 : 617 - 625.
[22] Sinsabaugh, R, L., 1994. Enzymic analysis of microbial pattern and process. Biology and Fertility of Soils, 17 : 69-74. Sinsabaugh, R. and Findlay, S., 1995. Microbial production, enzyme activity, and carbon turnover in surface sediments of the Hudson River Estuary. Microbial Ecology, 30 : 127-141.
[23] Sinsabaugh, R, L., Antibus, R, K., Linkins, A, E., 1991. An enzymatic approach to the analysis of microbial activity during plant litter decomposition. Agriculture, Ecosystems and Environment, 34 : 43-54.
[24] Sonia Sethi and Saksham Gupta. 2015. Responses of soil enzymes to different heavy metals. Biolife. 3(1);147-153.
[25] Tscherko, D. and Kandeler, E., 1999. Classification and monitoring of soil microbial biomass, N-mineralization and enzyme activities to indicate environmental changes. Bodenkultur, 50 : 215-226.

*****