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# Quantification of litter fall and assessment of nutrient composition in bamboo (*Bambusa vulgaris* var. *Vulgaris*) plantation

C.N. HARI PRASATH, A. SUDARSHAN AND PRAVEEN T. GOROJI

**ABSTRACT :** To quantify the leaf litter bamboo *(Bambusa vulgaris var. Vulgaris*) plantation/year and assessing nutrient in litter an experiment was conducted in farmer's field at Kottur, Tanjore district during 2014 with three different type of spacing *viz.*, 5 x 5m, 6 x 4m and 7 x 4m. The litter fall study was initiated during November 2013 and biometric parameters *viz.*, tree height, DBH and number of culms were recorded. For litter fall quantification, green shade net was tied around the trees at different spacing and litter fall was quantified at 3 months intervals. Litter samples were collected and analysed for nutrient contents. Soil samples were collected, processed and analysed for changes in nutrient status. The result revealed that the growth of bamboo differed from tree spacing and it was observed that 7 x 4m spacing recorded maximum tree height (8.3m), number of culms (39.3) and DBH (4.4cm).The maximum quantity of litter fall observed in 6 x 4m of about 7000 kg $ha^{-1}$ $yr^{-1}$.The analytical result showed that the nitrogen content in bamboo was varied between 2.042 to 2.099 per cent, total phosphorus between 0.265 to 0.275 and total potassium between 1.061 to 1.072 per cent. With regard to changes in soil properties, soil pH was found to be slightly alkaline (7.48) in nature at the time of establishment of the plantation but over period of five years it decreased to acidic (6.26) and soil EC was decreased from 0.156 to 0.125 dS $m^{-1}$. There was considerable improvement in available nitrogen, available phosphorus, available potassium and organic carbon status from the initial status 260.3 kg $ha^{-1}$, 25.63 kg $ha^{-1}$, 140.63 kg $ha^{-1}$ and 0.652 per cent to 314.82 kg $ha^{-1}$, 34.27 kg $ha^{-1}$, 206.50 kg $ha^{-1}$ and 0.681 per cent, respectively.

**KEY WORDS :** Litter fall, Quantification, Soil, Nutrient, Spacing, Bamboo

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## INTRODUCTION

*Bambusa vulgaris* var. *vulgaris* is one of the most important thornless bamboo species found throughout India, belongs to the sub-family Bambusoideae of the family Poaceae. *Bambusa vulgaris* is naturally distributed in North East India and in the natural forest of central India. It is distributed from tropical mixed deciduous forest to wet evergreen forests in the different forest types in India. It is a moderate sized bamboo with bright green, glossy, erect culm, which can grow upto 8 - 20m, usually covered with brown hairs with internodes upto 15 cm long.

Bamboo is grown in the home gardens which is one of the agroforestry systems. It is also grown in pure or mixed with other vegetation. Farmers in the rural landscape maintain high density of bamboo culms. Bamboos in home garden are

**MEMBERS OF RESEARCH FORUM**

**Address of the Correspondence** :
**C.N. HARI PRASATH,** Department of Silviculture, Forest College and Research Institute, METTUPALAYAM (T.N.) INDIA
Email: prasathforestry@gmail.com

**Address of the Coopted Authors :**
**A. SUDARSHAN,** Department of Silviculture and Agroforestry, College of Forestry, Kerala Agricultural University, THRISSUR (KERALA) INDIA

**PRAVEEN T. GOROJI,** Krishi Vigyan Kendra, Sirsi, UTTARA KANNADA (KARNATAKA) INDIA

principally managed for household purposes and in bamboo grove for commercial purposes (Nath *et al.*, 2008).

Depending upon the species, bamboo was grown on areas from sea level to as high as 2800-3200m. They thrive best on well-drained sandy loam to clay loam derived from river alluvium or from underlying rocks having a pH of about 5.0-6.5. An increase in the number of culms per clump and a corresponding enlargement in the height and diameter of the clumps were noted in the closer spacing treatment as compared to medium and wider spacing treatments at 207, 388 and 572 DAP.

Bamboo has versatile uses as building material, paper pulp, scaffolding, food, agriculture implements, fishing rods, weaving material and substitute for manufacturing rattan, plywood and particle board. The major user of bamboo in India is paper industry, which consumes sizeable proportion of the total annual production in bamboo. Leaf senescence and fall is a major component of litter and the organic compounds of the litter are physically and chemically broken down by detritivore and decomposers into inorganic nutrients that plants are able to take. This organic layer is then decomposed and released as inorganic soil nutrients. The study of plant litter has received much attention from ecologists because it is an integral factor in ecosystem dynamics, indicative of productivity and influences nutrient cycling and soil fertility. Litter decomposition and nutrient mineralization may provide up to 70 - 90 per cent of the total nutrient requirements of trees in forests (Waring and Schlesinger, 1985) and is the main pathway for the return of nutrients from plants to the soil.

Bamboo leaf-litter fall occurs over the whole year, but has two annual peaks - in spring (April or May) and late autumn (November). The annual quantity of leaf-litter is greatly affected by both the biological properties of bamboo and the environmental conditions, an attack of pests or disease significantly increases the amount of litter.

The amount of annual litter production in India accounts to be 13.5 t $ha^{-1}$ and 13.2 t $ha^{-1}$, respectively in the tropical dry evergreen and deciduous forest in India. However, leaf litter production in tropical semi- evergreen forest is 9.0-9.6 t $ha^{-1}$ $yr^{-1}$ and moist deciduous forest is 11.6 t $ha^{-1}$ $yr^{-1}$ of India (Pragasan and Parthasarathy, 2005). During decomposition of leaf litter, the nutrient elements go through three stages of leaching, accumulation and release. In the present study, it was observed that the concentrations of N, P and K were initially low for a short period but increased gradually; that of Ca and Mg reduced rapidly in the initial ten week period of incubation following which the loss was slower. Temperature and precipitation significantly affect the decomposition of bamboo leaf litter, for they influence the level of the microbial population.

## EXPERIMENTAL METHODS

The present study was carried out at farmer's field at Kottur, Tanjore district, during 2014.

**Study area :**

The bamboo plantation is situated in Tanjore district with 10.81° N latitude and 79.24° E longitude. These locations receive an annual average rainfall of 1000 - 1500 mm and mean annual temperature of 30.2°C (Minimum of 24.6°C and Maximum of 39 °C). The area was fully cultivated with the paddy, so the soil was found to be muddy soil, whereas the clay content was more.

To assess the growth rate of trees in plantation at the afforestation site, the following biometric observations were recorded at 3 months interval.

*Plant height* (*m*) :

The total height of each tree was initially measured from the ground level to the leading terminal tip using the standard scale and is expressed in metre.

*Diameter at breast height* (*cm*) :

The basal diameter was measured at ground level using digital calipers and is expressed in cm.

*Number of culms* :

The total number of culms of each plant in the spacing was measured in nos.

**Litter collection :**

The shade net was made for the litter collection of bamboo leaf litter from different spacing was obtained by making net in the shape covering the total canopy cover of the plant. The net was made in the range of 5m length x 5m breadth for 5x5 spacing, the 6m length x 4m breadth for 6x4 spacing and 7m length x 4m breadth for 7x4 spacing. After making the net the litters were collected and weighed from inside the net for two intervals.

**Soil collection :**

The soil samples collected from each spacing from the net at different spacing under plantation were subjected for analysis of both physio – chemical properties such and chemical properties. The greatest challenge in soil sampling is obtaining a sample that reflects the true fertility of the field. A composite soil sample gives a mean analytical value representative of the soil sampling volume from which the composite sample is taken.

Using a soil probe, soil auger, or spade can collect surface soil samples; however, for collecting subsoil samples, a spade is not very satisfactory. A post-hole digger can be used for collecting deep samples, but its use requires some special techniques. The soil probe or tube is the most desirable tool for collecting soil samples. It will give a continuous core with

**Table A : Standard procedures for litter analysis**

| Sr.No. | Estimation | Author | Method / No. extractant |
|---|---|---|---|
| 1. | Total nitrogen | Jackson (1973) | Di-acid extract- micro Kjeldahl method |
| 2. | Total phosphorus | Jackson (1973) | Triple acid extract- colorimetric method |
| 3. | Total potassium | Jackson (1973) | Triple acid extract- flame photometric method |

**Table B : Methodology for analysing soil parameters**

| Sr.No. | Parameter | Method | References |
|---|---|---|---|
| 1. | Soil water suspension 1:2.5 ratio | Potentiometry | Jackson , 1973 |
| 2. | Soil water suspension 1:2.5 ratio | Conductometry | Jackson , 1973 |
| 3. | Soil organic carbon | Wet chromic acid digestion | Walkley and Black, 1938 |
| 4. | Available nitrogen | Alkaline permanganate method | Subbaiah and Asija, 1956 |
| 5. | Available phosphorus | Olsen's method | Olsen *et al.*, 1954 |
| 6. | Available potassium | Neutral normal $NH_4OAC$, Flame photometry | Stanford and English, 1949 |

minimal disturbance of the soil. The cores can be divided for the various depths. The collected soil was weighed and processed for further nutrient analysis to assess how the soil macro nutrients varied due to the addition of litter.

**Digestion method :**

A main consideration in the selection of digestion methods was the possibility for simultaneous determination of the most important macro- and micronutrients in the soils and plants by a single digestion procedure. Our preliminary studies showed that the most appropriate digestion methods are ISO 14869-1 (2001) (decomposition by acid mixture of $HF + HNO_3 + HC1O_4$) for soil samples and EPA method 3051(decomposition by acid mixture of $HNO_3 + H_2O_2 + HF$) and dry ashing at 500°C for plant materials (Table A).

**Nutrient analysis in soil :**

Soil samples collected during Nov.'13 and Feb.'14 in 3 different spacing *viz.*, 5x5, 6x4, 7x4 were analyzed for changes in soil nutrient status by following the standard procedures (Table B). The soil samples were air-dried and sieved through 2 mm sieve and were analyzed for various soil parameters by adopting standard procedures.

The data generated were statistically analysed.

## EXPERIMENTAL RESULTS AND ANALYSIS

The results obtained from the present study have been discussed in detail under following heads :

**Biometric parameters of bamboo plantation :**

Biometric parameters of bamboo plantation were studied with different spacing *viz.*, 5 x 5m, 6 x 4m, 7 x 4m during Nov.'13 and Feb.'14. Among three different spacing the maximum height of 7.5m was observed in 7 x 4m spacing followed by 6.4m (6 x 4m) and lowest height of about 5.7m was recorded in 5 x 5m spacing during Nov'13. Likewise the same trend was followed in Feb.'14 with order of 7 x 4m (8.3m) > 6 x 4 (6.8m) > 5 x 5 (6.4m).

In Nov.'2013 the maximum DBH was registered in 6 x 4m spacing with the value of 3.7cm and lowest of 3.2cm was observed in 5 x 5m spacing. In contrary with Nov.'13, the DBH of Feb.'14 was registered maximum spacing at 7 x 4m (4.4cm) spacing followed by 6 x 4m (4.2cm) and lowest in 5 x 5m (3.7cm). A similar trend was followed in no of culms in both periods of year *viz.*, Nov.'13 and Feb.14, respectively (Table 1).

**Leaf litter quantification in bamboo plantation under different spacing :**

The present study conveyed that the leaf litter was quantified with the weight of 5833 kg $ha^{-1}$ $yr^{-1}$ and 7000 kg $ha^{-1}$ $yr^{-1}$ during Nov.'13 and Feb.'14 (Table 1). On supporting the present study, Bala *et al.* (2010) showed that highest litter production in *E.camaldulensis* was 6087 kg $ha^{-1}$ $yr^{-1}$, 5240 kg $ha^{-1}$ $yr^{-1}$, 2422 kg $ha^{-1}$ $yr^{-1}$ and 2042 kg $ha^{-1}yr^{-1}$ for the 12, 17, 8, 4 years old plantations in canal command area at Indian desert. Manivasakan (2007) reported that the total litterfall was

**Table 1 : Biometric parameters and litter fall quantification of the bamboo plantation**

| Sr. No. | Spacing (m) | Height of the tree (m) | | Number of culms per tree | | DBH (cm) | |
|---|---|---|---|---|---|---|---|
| | | Nov'13 | Feb'14 | Nov'13 | Feb'14 | Nov'13 | Feb'14 |
| 1. | 5 x 5 | 5.7 | 6.4 | 35 | 35 | 3.2 | 3.7 |
| 2. | 6 x 4 | 6.4 | 6.8 | 38.6 | 38.6 | 3.7 | 4.2 |
| 3. | 7 x 4 | 7.5 | 8.3 | 40.3 | 40.3 | 3.5 | 4.4 |

observed in teak plantation in forest College and Research Institute, Mettupalayam was very spectacular and it ranged from low of 93 kg ha$^{-1}$ during October to 1703 kg ha$^{-1}$ during February.

The bamboo plantation had recorded a maximum litter production with more than 7000 kg ha$^{-1}$yr$^{-1}$ and it varies with different spacing (Fig. 1). This study helps in viewing the support to present study, where in 30 years old teak plantation, Rajagopal *et al*. (2001) reported that the litter production amounted to 9.9 t ha$^{-1}$ of which the leaf litter alone contributed 91.48 per cent. Nisharaj *et al*. (2003) reported that litter production was higher in *Bambusa bambos* forests (7415 kg ha$^{-1}$) followed by *Terminalia paniculata* forests (6661 kg ha$^{-1}$), *Dalbergia latifolia* forests (6410 kg ha$^{-1}$) and *Tectona grandis* forests (4492 kg ha$^{-1}$).

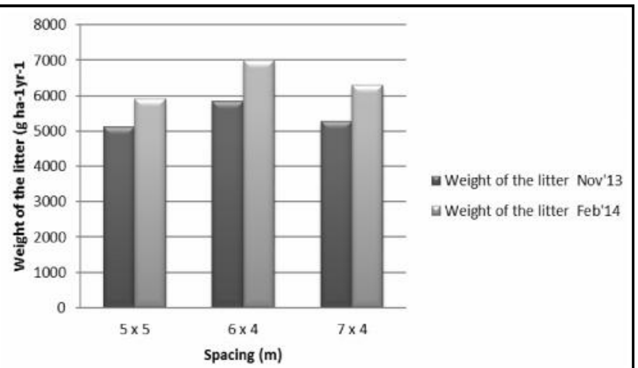


**Fig. 1 : Weight (kg ha$^{-1}$ yr$^{-1}$) of the bamboo litter collected in plantation at different spacing in two intervals**

*Nutrient analysis of bamboo litter* :

The nutrient analysis of bamboo litter was analysed in three different spacing at 2 different intervals during Nov.'13 and Feb.'14. The result showed that the total nitrogen content of the bamboo litter in Nov.'13 was between 2.042 to 2.091 per cent. Whereas, in Feb.'14 it shows only slight variation between 2.053 to 2.099 per cent. Among two intervals 7 x 4m spacing registered maximum nitrogen content of 2.091 and 2.099 per cent during Nov.'13 and Feb.'14, respectively (Table 2 and Fig. 2). Nitrogen is an integral component of many essential plant compounds. It is the major part of all amino acids, which are the building blocks of all proteins including enzymes, which control virtually all biological processes. Nitrogen is also essential for the use of carbohydrates within plants. A good supply of nitrogen stimulates root growth and development as well as the uptake of other nutrients. The present result showed that the total nitrogen content of the bamboo litter was observed between 2.042 to 2.091 per cent. On supporting it litter foliage generally contains 2.5 to 4.0 per cent nitrogen, depending on the age of the leaves and whether the plant is a legume (Brady, 1990). In contrary, Rawat *et al.* (1995) reported a highly negative correlation between nitrogen concentration and per cent weight remaining during decomposition (Fig. 2).

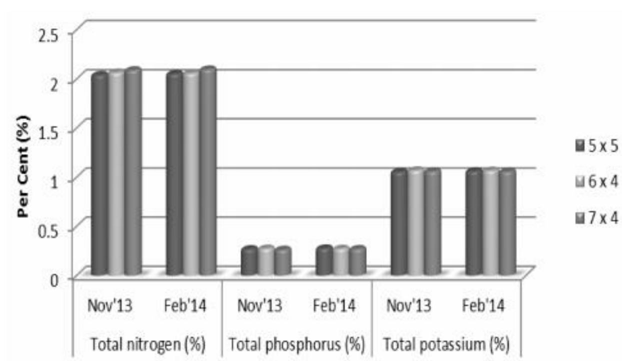


**Fig. 2 : Nutrient analysis of bamboo litter at different intervals**

Following total nitrogen, the total phosphorus showed maximum in 6 x 4m spacing of about 0.276 per cent during Nov.'13 and minimum total phosphorus of 0.265 per cent was recorded in 7 x 4m spacing. But during Feb.'14, the maximum total phosphorus was observed in 5 x 5 spacing with the value of 0.278 per cent followed by 6 x 4m (0.275 %) at lowest was observed in 7x 4m spacing with total phosphorus value of 0.272 per cent. Lal *et al.* (2000) was also stated that total phosphorus content increased significantly due to incorporation of various organic materials. Addition of organic matter produced organic acids during decomposition which increased availability of P in soil as well as in the leaf composition. Gosz *et al.* (1973) studies indicated that P levels can influence the mineralization or immobilization of other important nutrients. P and Mg were rapidly released from the litter by leaching.

Lastly, the total potassium was observed maximum in 6 x 4m spacing of about 1.072 per cent followed by 7 x 4m spacing with 1.061 per cent and lowest percentage of 1.056 per cent

**Table 2 : Nutrient analysis of bamboo litter at different intervals**

| Sr.No. | Spacing (m) | Total nitrogen (%) | | Total phosphorus (%) | | Total potassium (%) | |
|---|---|---|---|---|---|---|---|
| | | Nov'13 | Feb'14 | Nov'13 | Feb'14 | Nov'13 | Feb'14 |
| 1. | 5 x 5 | 2.042 | 2.053 | 0.271 | 0.278 | 1.056 | 1.063 |
| 2. | 6 x 4 | 2.067 | 2.059 | 0.276 | 0.275 | 1.072 | 1.069 |
| 3. | 7 x 4 | 2.091 | 2.099 | 0.265 | 0.272 | 1.061 | 1.059 |

was recorded in 5 x 5m spacing during Nov.'13. Likewise in Feb.'14, the maximum total potassium in litter was observed in 6 x 4 spacing with 1.069 per cent followed by 5 x 5m spacing (1.063 %) and lowest total potassium was registered in 7 x 4m spacing with potassium value of 1.059 per cent. The total potassium was observed between 1.072 per cent between 1.056 per cent in the fifth year of plantation. Likewise, Salmanca *et al.* (1998) conducted a study on nutrient dynamics in *Quercus serrata* leaf litter in Japan and observed that mobility of elements during the course of study was in the order of K > P > Ca > Mg > C > Lodhiyal *et al.* (2002) studied litter and nutrient dynamics, nutrient return of popular plantations in moist, plain areas of central Himalayas. They observed that the total amount of potassium return through litter was 46.61 kg $ha^{-1}$ $yr^{-1}$ which was increased with increase in plantation age because of higher amount of litter.

**Soil physico - chemical properties of bamboo plantation :**

*Soil pH and electrical conductivity* :

During the intial stage of the plantation, the soil was found to be slightly alkaline in nature but after the establishment of the plantation soil pH was slightly changed into acidic with pH ranges between 6.26 to 6.32 (Table 3).

But in soil EC the status was entirely reverse where the soil EC during intial stage of plantation was 0.156 $dSm^{-1}$ but after the five years of the establishment, the soil EC was ranged between 0.119 $dSm^{-1}$ to 0.125 $dSm^{-1}$. Good organic management practices do not increase soil salinity (Clark *et al.*, 1998).

*Soil organic carbon* :

In the present study, higher soil organic carbon content was observed in different spacing during five years of the plantation. During the initial stage of the plantation the soil organic carbon was found to be low but after the establishment of the plantation the soil organic carbon was increased with the consistent due to the leaf litter decomposition in the soil. The significant increase in soil organic carbon content in plantation after litter fall could be due to the addition from decomposition of leaf litter. Soil organic carbon was more in 7 x 4m spacing than other two spacing of 6 x 4m and 5 x 5m (Fig. 3).

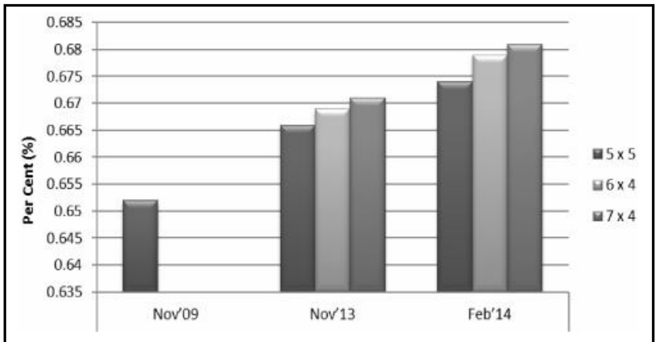


**Fig. 3 : Effect of organic carbon (%) due to addition of bamboo litter in plantation at different spacing in two intervals**

The results showed that application of different leaf litter increased per cent organic matter in soil where the highest organic matter (2.53 %) was obtained from teak leaf litter treated soil whereas organic matter content of 2.08 per cent, 2.40 per cent and 2.03 per cent obtained from acacia, eucalyptus and sal leaf litters treated soil, respectively as compared to control treatment (1.22 %) and chemical fertilizer treated soils (1.28 %) (Sarkar and Saha, 2010). Organic carbon (OC) values of soils under decomposing Albizia, Eucalyptus and teak litters during different periods of observation are provided. The organic carbon status of soils ranged between 1.53 to 1.83 per cent for Albizia, 1.55 to 1.82 per cent for eucalyptus and 2.3 to 2.6 per cent (Mary and Sankaran, 1991).

*Soil available nitrogen* :

The soil available nitrogen status was recorded a considerable change from the initial plantation (Nov.'09) and after 5 years (Nov.'13 and Feb.'14) with 3 different spacing.

**Table 3 : Physico - chemical properties of the soil in bamboo plantation**

| Sr. No. | Spacing (m) | Soil pH | | | Soil EC (dS $m^{-1}$) | | |
|---|---|---|---|---|---|---|---|
| | | Nov'09 | Nov'13 | Feb'14 | Nov'09 | Nov'13 | Feb'14 |
| 1. | 5 x 5 | | 6.32 | 6.3 | | 0.121 | 0.121 |
| 2. | 6 x 4 | 7.48 | 6.29 | 6.26 | 0.156 | 0.125 | 0.121 |
| 3. | 7 x 4 | | 6.31 | 6.29 | | 0.12 | 0.119 |

**Table 4 : Chemical properties of the soil at different intervals in bamboo plantation**

| Sr. No. | Spacing (m) | Available nitrogen (kg $ha^{-1}$) | | | Available phosphorus (kg $ha^{-1}$) | | | Available potassium (kg $ha^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Nov'09 | Nov'13 | Feb'14 | Nov'09 | Nov'13 | Feb'14 | Nov'09 | Nov'13 | Feb'14 |
| 1. | 5 x 5 | 260.3 | 312.36 | 312.91 | 25.63 | 33.51 | 33.94 | 140.63 | 204.61 | 205.89 |
| 2. | 6 x 4 | | 313.08 | 314.42 | | 33.78 | 34.10 | | 205.09 | 206.01 |
| 3. | 7 x 4 | | 313.90 | 314.82 | | 34.06 | 34.27 | | 205.40 | 206.50 |

The soil available nitrogen status during planting was 260.3 kg ha$^{-1}$. After 5 years, the nitrogen content was increased up to 313.00 kg ha$^{-1}$ due to the litter nutrient release to the nitrogen. Among the three different spacing, the maximum soil available nitrogen was observed in 7 x 4m spacing with the value of 313.90 kg ha$^{-1}$ (Table 4).

The litter additions provide a stable supply of carbon and energy to micro-organisms and cause an increase in the microbial biomass pool, thereby increasing soil respiration rate. This might help to enhance N availability in the soil (Surekha *et al*., 2004). But a significant decrease in available nitrogen was noticed with advancement of time. The initial increase in available nitrogen concentration of decomposing litter may be attributed to the conversion of carbon into $CO_2$ due to faster oxidation and leaching of soluble carbon compounds (Kumar and Deepu, 1992; Kumar *et al*., 2001).

*Soil available phosphorus* :

The initial available phosphorus content of the soil during starting of plantation (Nov.'09) was 25.63 kg ha$^{-1}$. During the initial stage of the plantation the soil available phosphorus was found to be low but after the establishment of the plantation the soil available phosphorus was increased with the consistent due to the leaf litter decomposition in the soil. At 3 months interval from Nov.'13 during Feb.'14, there was a slight modification in the soil available phosphorus value. This magnitude of return falls towards the higher range for N while lower range for P. This reveals that nitrogen return was more efficient than phosphorus in the plantation due to the conversion of phosphorus nutrient in soil is slow (Table 4).

The increase in available soil phosphorus content the species after litter fall could be attributed to the organic matter additions which produces organic acids during decomposition, there by increasing the availability of P in soils (Lal *et al*., 2000).

*Soil available potassium* :

The importance of potassium as an essential plant nutrient was first recognised by Home, 1962. The initial potassium content of the soil during Nov'09 was observed to be 140.63 kg ha$^{-1}$. After 5 years of the establishment of plantation, the soil potassium content was increased due to decomposition of leaf litter and release of nutrients to the soil (Table 4). Soil nutrient is moderately available to plants, depending on various soil parameters (Guilding and Talibuddin, 1979; Sparks and Huang, 1985) and largely determines the soil's ability to supply potassium over the long period of time.

**Conclusion :**

Litter decomposition and nutrient mineralization may provide up to 70-90 per cent of the total nutrient requirements of trees in forests and is the main pathway for the return of nutrients from plants to the soil. Plant litter is dead plant material, such as leaves and twigs that have fallen on the ground was lead to detritus or dead organic material and their nutrients are added to the top layer of soil. This organic layer is then decomposed and released as inorganic soil nutrients. The study of plant litter has received much attention from ecologists because it is an integral factor in ecosystem dynamics, is indicative of productivity and influences nutrient cycling and soil fertility. The leaf litter nutrients and soil nutrients had an increasing range from the initial level of plantation (Nov.'09) to five year of plantation (Nov.'13 and Feb.'14), due to leaf litter decomposition in soil and releasing of nutrients into soil.

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## REFERENCES

Bala, N., Kumar, Pramod, Bohra, N.K., Limba, N.K., Baloch, S.R. and Singh, G. (2010). Production and decomposition of litter in plantation forests of *Eucalyptus camaldulensis* along canal command area in Indian desert. *Indian Forester*, **178** (3): 164-172.

Brady, N.C. (1990). The nature and properties of soils. MacMillan Publishing Company, NEW YORK, U.S.A.

Clark, M.S., Ferris, H., Klonsky, K., Lanini, W.T., Bruggen, A.H.C. and Zalom, F.G. (1998). Agronomic, economic and environmental comparison of pest management in conventional and alternative tomato and corn systems in northern California. *Agric., Ecosyst. & Environ.,* **68**: 51–71.

Gosz, J.R, Likens, G.T. and Bormarm, F.H. (1973). Nutrient release from decomposing leaf and branch litter in the Hubbard Brook Forest, New Hampshire. *Ecol Monogr,* **43**:173-191.

Guilding, K.W.T and Talibuddin, O. (1979). Potassium reserve in a sandy clay soil from the saxmundhum experiments: Kinetics and equilibrium thermodynamics. *J.Soil Sci.,* **30**: 291-302.

Jackson, M.L. (1973). Soil chemical analysis. Prentice Hall, Inc. (1973 Ed.) Englewood cliffs, N.J.,

Kumar, B.M. and Deepu, J.K. (1992). Litter production and decomposition dynamics in moist deciduous forests of the Western Ghats in Peninsular India. *Forest Ecol. & Mgmt.*, **50**(3/4): 181-201.

Kumar, G., Hegde, K.R. and Luckins, C.B. (2001). Decomposition and nutrient release pattern of leaf litters of mangium (*Acacia mangium* Wild). *Indian J. Agroforestry,* **3**(1): 11-22.

Lal, R., Kimble, J.M. and Follett, R.F. (2000). Methodological challenges toward balancing soil C pool and fluxes. In: R. Lal, J.M. Kimble, R.F. Follett and B.A. Stewart (Eds) Assessment Methods for Soil Carbon Pools. CRC/Lewis Publishers, Boca Raton, FL: 659-667pp.

Lodhiyal, L. S., Lodhiyal, N. and Singh, S.K. (2002). Litter dynamics and nutrient return of poplar plantations in moist plain areas if Central Himalaya. *Indian Forester,* 1183-1194.

Manivasakan, S. (2007). Studies on nutrient dynamics in teak (*Tectona grandis* Linn. f.) ecosystem. Ph.D. Thesis, Tamil Nadu Agricultural University, Coimbatore, T.N. (INDIA).

Mary, M.V and Sankaran, K.V. (1991). Ex-situ decomposition of leaf litters of *Tectona grandis*, *Eucalyptus tereticornis* and *Albizia falcataria*. KFRI Research Report, **71**: 41.

Nath, A.J., Das, G. and Das, A.K. (2009). Above ground standing biomass and carbon storage in village bamboos in North East India. *Biomass & Bioenergy,* **33**: 1188-1196.

Nisharaj, S., Paulsamy, S. and Sekaran, S. (2003). Litterfall and nutrient return in four tropical deciduous forests of western ghats. *My Forest,* **39**(1): 25-30.

Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L.A. (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate. USDA Circular 939.U.S. Government Printing Office, WASHINGTON D.C.

Pragasan, Arul L. and Parthasarathy, N. (2005). Litter production in tropical dry evergreen forests of south India in relation to season, plant life forms and physiognomic groups. *Curr. Sci.,* **88** (8): 12-25.

Rajagopal, K., George, M., Buvaneswaran, C. and Vijayan, C.V. (2001). Litter production and nutrient return in teak plantation. *Adv. Forestry Res. India,* **24**: 136-150.

Rawat, M.S., Uniyal, D.P. and Emmanuel, C.J.S.K. (1995). Use of coppice shoots in seed production areas of teak: A New Concept. *Indian Forester,* **121** (6): 469 – 471.

Salamanca, Eric F., Nobuhiro, Kaneko and Shigeo, Katagiri (1998). Effects of leaf litter mixtures on the decomposition of *Quercus serrata* and *Pinus densiflora* using field and laboratory microcosm methods. *Ecological Engg.,* **10** : 53–73.

Sarkar, U.K., Saha, B.K., Goswami, C. and Chowdhury, M.A.H. (2010). Leaf litter amendment in forest soil and their effect on the yield quality of red amaranth. *J. Bangladesh Agril. Univ.,* **8** (2) : 221-226.

Sparks, D.L. and Huang, P.M. (1995). Physical chemistry of soil potassium. In: Potassium in Agriculture (Ed. Munson, R.D.). ASA/CSSA/SSSA, Madisn, WI, USA.

Stanford, G. (1978). Evaluation of ammonium release by alkaline permanganate extraction as an index of soil nitrogen availability. *Soil Sci*., **126**:244-253.

Subbiah, B.V. and Asija, G.L. (1956). A rapid procedure for estimation of available N in soil, *Curr. Sci.,* **25** : 259-260.

Surekha, K., Reddy, M. Narayana, Rao, K.V. and Cruz, P.C. Sta (2004). Evaluation of crop residue management practices for improving yields, nutrient balance and soil health under intensive rice-rice system. *J. Indian Soc. Soil Sci.,* **52**(4): 448-453.

Walkley, A. and Black, I.A. (1938). An examination of Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Sci.,* **37**: 29-37.

Waring, R. H. and Schleslnger, W.H. (1985). Forest ecosystems: concepts and management. Academic Press, ORLANDO.

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