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# Assessment of Leaf Litter Production in Tropical Trees

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***Abstract:*** ***Litter is the layer of detached dead plant material present on the surface of the soil. It plays an imperative part in the nutrient budgeting in agroforestry system. The quantum of litter produced varies with species and also seasons. Generally the litter production will be more during summer and less during monsoon times. Further the nature of the tree species like evergreen and deciduous will also influence litter production. In the present study, 10 tree species commonly found in farm lands were identified and selected from the experimental plot, which was located in Southern agro-climatic zone of Tamil Nadu and the soil type is alfisol with a pH of 6.0. The age of the trees was 10 years. The litter collection was done throughout the year on monthly basis and quantities produced were recorded. The data recorded were subjected to statistical analysis. The results revealed the following. Acacia auriculiformis produced a maximum leaf litter of 10.0 t/ha/year followed by Senna siamea. Summer season had more litter (3.55 kg/tree) followed by winter (1.54 kg/ha). A maximum mean monthly litter of 2.54 kg/tree was recorded in Tamarindus indica followed by Acacia mangium (0.76 kg/tree). Senna siamea and Gliricidia produced leaf litter throughout the year. Tamarind produced a maximum annual litter of 30.42 kg/tree followed by Acacia mangium (9.07 kg/tree).***
***Keywords: tropical trees, leaf litter, seasons, decomposition***

## I. INTRODUCTION

Under agroforestry systems, leaf litter production and decomposition is a major biological process that aids in soil fertility building and other soil chemical processes and predominantly various traditional multipurpose tree species have been grown in association with crops in farm lands. These trees could be categorized by their products, litter fall patterns, nitrogen fixing ability and habitat. Although there have been several studies on litter dynamics in tropical forest ecosystems in India [5,16,15], information on litter production and decomposition of common trees grown on farm lands and agroforestry systems is limited. Evaluating the litter production by different tree species is an important aspect and, [7]observed that in tropics soil organic pool is accomplished through the litter fall and its decomposition. Litter is the layer of detached dead plant material present on the surface of the soil. It plays an imperative part in the nutrient budgeting in agroforestry system (Swaminathan, 2004). The quantum of litter produced varies with species and also seasons. Generally the litter production will be more during summer and less during monsoon times. Further the nature of the tree species like evergreen and deciduous will also influence litter production. Litter decomposition proceeds through plentiful mechanisms including heterotrophic consumption of organics, rainwater leaching, activities of small insects and microbes, thereby nitrogen (N), phosphorus (P) and calcium (Ca) released from plant litter through decomposition are added to the soil and later accessible for uptake by crops and soil microorganisms[13]. The present study was therefore undertaken to estimate the quantum of leaf litter produced annually and its variation in relation to seasonal climate in multi-functional tree species. Farmers and local people value *Tectona grandis* as the best quality timber species, *Albizia lebbek, Gliricidia sepium, Senna siamea* as the best quality green leaf manure tree species, and *Acacia auriculiformis, Acacia mangium, Casuarina equisetifolia* as a medium quality timber and fuel wood species. *Artocarpus heterophyllus* and *Tamarindus indica* as fruit species and *Eucalyptus tereticornis* as a pulpwood species. These tree species are either grown in farm lands or found naturally.

## II. MATERIALS AND METHODS

In the present study, 10 tree species commonly found in farm lands were identified and selected from the experimental plot, which was located in Southern agro-climatic zone of Tamil Nadu and the soil type is *alfisol* with a pH of 6.0. The age of the trees was 10 years. Ten trees were selected in each species except for Tamarind and *Acacia mangium*, where only 6 trees were selected. It was decided to collect the falling leaf litter by HDPE sheets of different sizes as per the canopy spread of the tree species. The sheets were spread under each tree and the sheet boundaries were clipped upwards and stacked with wooden sticks in such a way that due to wind blow the litter had not been taken out of the collection sheet. The treatment details were the no. of tree species- 10 and no. of trees per species-10 except for Tamarind and *Acacia mangium*, 6 nos) and hence total no. of samples for the study was 92. (table 1)

The litter collection was done throughout the year. Every month, the quantum of litter accumulating on the sheet floor under each species was gathered, dried and weighed in an electronic balance. It was done so as to get monthly, seasonal and annual litter production data for each tree species. The quantum of litter production by individual trees was also recorded. The details about number of trees and plot area are presented below:

Table 1. Tree species and plot area of selected tree species.

| S.No | Tree species | Plot area ($m^2$) | No. of trees |
|---|---|---|---|
| 1. | *Acacia auriculiformis* | 20x18 | 40 |
| 2. | *Albizia lebbek* | 21x12 | 45 |
| 3. | *Acacia mangium* | 12x5 | 06 |
| 4. | *Artocarpus heterophyllus* | 21x9 | 12 |
| 5. | *Casuarina equisetifolia* | 12x21 | 48 |
| 6. | *Senna Siamea* | 12x12 | 30 |
| 7. | *Eucalyptus tereticornis* | 12x10 | 25 |
| 8. | *Gliricidia sepium* | 15x30 | 48 |
| 9. | *Tamarindus indica* | 18x27 | 06 |
| 10. | *Tectona grandis* | 24x15 | 40 |

For seasonal litter analysis, the monthly litter data were pooled according to the four seasons *viz.*, winter (January-February, Summer (March-May), and 2 monsoon seasons i.e. South West (June-September) and North East (October-December) and presented. The data recorded were subjected to statistical analysis, the ANOVA prepared and the values tested for significance using F values for their significance[8].

## III. RESULTS AND DISCUSSION

The information and data generated on forest floor litter production by the ten forest tree species are presented in table 2 and Fig.1. The major input into the soil is from plants, in the form of aboveground litter, or belowground material which involves both abiotic and biotic processes of decomposition. The rate of decomposition is dependent on litter quality and environmental conditions. Litter quality factors important to decomposition and mineralization include: nutrient content (e.g., C/N ratio), composition of organic matter, especially lignin concentrations (lignin/nitrogen ratio), and concentrations of polyphenols (including tannins). Litter with higher concentrations of nutrients and lower concentrations of lignin and polyphenols will decompose more rapidly and net mineralization begins earlier. Availability of nutrients from other soil pools also enhances decomposition rates if nutrient concentrations are low in litter[6].

### *A. Monthly Litter Production.*

Table 2. Monthly litter production (kg/tree) of each tree species

| | Species | Jan. | Feb. | Mar. | Apr. | May. | Jun. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *A. auriculiformis* | 1.18 | 1.69 | 0.86 | 1.02 | 0.88 | 0.25 | 0.50 | 0.18 | 0.03 | 0.62 | 0.65 | 0.72 | 8.58 |
| 2 | *Albizia lebbeck* | 0.39 | 0.35 | 0.33 | 0.21 | 0.11 | 0.14 | 0.08 | 0.00 | 0.05 | 0.12 | 0.35 | 0.37 | 2.50 |
| 3 | *Acacia mangium* | 1.20 | 1.40 | 0.90 | 1.00 | 0.20 | 0.50 | 0.70 | 0.00 | 0.22 | 0.55 | 1.20 | 1.20 | 9.07 |
| 4 | *A.heterophyllus* | 0.30 | 0.75 | 0.60 | 0.35 | 0.15 | 0.35 | 0.20 | 0.40 | 0.20 | 0.08 | 0.35 | 0.10 | 3.83 |
| 5 | *C. equisetifolia* | 0.44 | 0.67 | 0.58 | 0.47 | 0.22 | 0.14 | 0.03 | 0.13 | 0.06 | 0.12 | 0.45 | 0.33 | 3.64 |
| 6 | *Senna Siamea* | 0.40 | 0.687 | 1.18 | 0.23 | 0.27 | 0.07 | 0.25 | 0.07 | 0.27 | 0.18 | 0.35 | 0.15 | 4.11 |
| 7 | *E.tereticornis* | 0.32 | 0.24 | 0.58 | 0.38 | 0.22 | 0.32 | 0.10 | 0.08 | 0.16 | 0.50 | 0.43 | 0.56 | 3.89 |
| 8 | *Gliricidia sepium* | 0.08 | 0.10 | 0.10 | 0.11 | 0.08 | 0.05 | 0.08 | 0.13 | 0.1 | 0.13 | 0.29 | 0.25 | 1.50 |
| 9 | *Tamarindus indica* | 2.00 | 2.42 | 17.5 | 4.67 | 1.75 | 1.58 | 0.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 30.42 |
| 10 | *Tectona grandis* | 0.27 | 0.55 | 0.46 | 0.07 | 0.00 | 0.02 | 0.00 | 0.00 | 0.03 | 0.13 | 0.08 | 0.17 | 1.78 |
| | Total | 6.58 | 8.857 | 23.09 | 8.51 | 3.88 | 3.42 | 2.44 | 0.99 | 1.12 | 2.43 | 4.15 | 3.85 | |
| | Mean | 0.66 | 0.89 | 2.31 | 0.85 | 0.39 | 0.34 | 0.24 | 0.09 | 0.01 | 0.24 | 0.42 | 0.39 | |
| SEm | | Trees - 2.732 | | | | | | Months – 0.176 | | | | | | |
| SD | | Trees – 8.641 | | | | | | Months – 0.618 | | | | | | |

As regards the mean monthly litter production, March had more litter (2.31 kg/tree) followed by February (0.89 kg/ha) and April (0.85 kg/ha). In the month of August and September litter production was minimum as it coincides with rainfall period. The common green leaf manure trees like *Gliricidia* and *Senna siamea* had litter through thee year indicating the availability of green manure round the year. However the other green leaf manure tree *Albizia lebbek* had no litter during August and less litter during September.

### *B. Seasonal Litter Production*

The data recorded on seasonal litter production were presented in table 3 and Fig.2. There are four major seasons viz., winter, Summer and two monsoon seasons i.e. South West and North East.

Table 3. Seasonality of Litter Production (kg/tree)

| S.No | Species | Winter | Summer | SWM | NEM | Total |
|---|---|---|---|---|---|---|
| 1 | *A. auriculiformis* | 2.87 | 2.76 | 0.96 | 1.99 | 8.58 |
| 2 | *Albizia lebbeck* | 0.74 | 0.65 | 0.27 | 0.84 | 2.50 |
| 3 | *Acacia mangium* | 2.6 | 2.1 | 1.42 | 2.95 | 9.07 |
| 4 | *A.heterophyllus* | 1.05 | 1.1 | 1.15 | 0.53 | 3.83 |
| 5 | *C. equisetifolia* | 1.11 | 1.27 | 0.36 | 0.9 | 3.64 |
| 6 | *Senna Siamea* | 1.087 | 1.68 | 0.66 | 0.68 | 4.11 |
| 7 | *E.tereticornis* | 0.56 | 1.18 | 0.66 | 1.49 | 3.89 |
| 8 | *Gliricidia sepium* | 0.18 | 0.29 | 0.36 | 0.67 | 1.5 |
| 9 | *Tamarindus indica* | 4.42 | 23.92 | 2.08 | 0 | 30.42 |
| 10 | *Tectona grandis* | 0.82 | 0.53 | 0.05 | 0.38 | 1.78 |
| | Total | 15.437 | 35.48 | 7.97 | 10.43 | |
| | Mean | 1.54 | 3.58 | 0.79 | 1.04 | |
| | SD | | trees - 0.82 | | seasons - 0.737 | |

The mean seasonal litter production data revealed that maximum mean litter production was observed during summer season (3.58 kg / ha) followed by winter season (1.54 kg/ha.). Monsoon seasons produced less litter as it is the period for vegetative phase of tree species. As regards the trees tamarind produced maximum litter of 23.92 kg/tree during summer season and the least was observed in *Tectona grandis* with a value of 0.53 kg/tree in the same season.

### *C. Annual Litter Production per Hectare*

The individual litter of tree species may not be reflected in the litter production from 1.0 ha of land as the population of each species will vary due to their morphology, canopy spread and growth as well as phonological parameters. The data are presented in table 4.

Table 4. Annual litter production (kg/ha)

| | Species | Litter (kg/ha/year) |
|---|---|---|
| 1. | *Acacia auriculiformis* | 10086.1 |
| 2. | *Albizia lebbeck* | 4271.3 |
| 3. | *Acacia mangium* | 7624.6 |
| 4. | *Artocarpus heterophyllus* | 1931.9 |
| 5. | *Casuarina equisetifolia* | 6920.9 |
| 6. | *Senna Siamea* | 8563.9 |
| 7. | *Eucalyptus tereticornis* | 8103.1 |
| 8. | *Gliricidia sepium* | 1592.7 |
| 9. | *Tamarindus indica* | 3754.8 |
| 10. | *Tectona grandis* | 1916.3 |
| S.Em | | **995.099** |
| SD | | **3146.772** |

Hence, it is incorrect to infer that the species which had the highest litter viz., *Tamarindus indica* which produced 30.42 kg/tree falls below in quantum of litter production in a unit area of 1.0 ha. The maximum annual litter production in 1.0 ha of land was recorded by *Acacia auriculiformis* (10086.1 kg/ha) followed by *Senna siamea* (8563.9 kg/ha). The minimum litter was produced by *Tectona grandis* (1916.3 kg/ha) and *Atrocarpus heterophyllus* (1931.9 kg/ha). The common green leaf manure tree, *Gliricidia* produced only 1592.4 kg/ha of litter.

*D. Species Wise Litter Production.*

The data are presented in table 5. This information clearly demonstrates the variations between species in terms of litter production. Species like *Tamarindus indica*, *Acacia mangium* and *Acacia auriculiformis* have the characteristics of shedding more litter during their growth period. Further, the weight of the litter may also influence this phenomenon. At the same time the leaves of leguminous trees viz., which are often used as green leaf manure in crop production shed very little quantity of litter because they leaves are often harvested from the trees and used for incorporation into soil before sowing of crops.

Table 5. Species wise litter production.

| | Species | Litter (kg/tree/year) |
|---|---|---|
| 1. | *Acacia auriculiformis* | 8.58 |
| 2. | *Albizia lebbek* | 2.5 |
| 3. | *Acacia mangium* | 9.07 |
| 4. | *Artocarpus heterophyllus* | 3.83 |
| 5. | *Casuarina equisetifolia* | 3.64 |
| 6. | *Senna Siamea* | 4.107 |
| 7. | *Eucalyptus tereticornis* | 3.89 |
| 8. | *Gliricidia sepium* | 1.5 |
| 9. | *Tamarindus indica* | 30.42 |
| 10. | *Tectona grandis* | 1.78 |
| S.Em | | 2.693 |
| SD | | 8.510 |

The amount of nutrient addition through litter decomposition varies from species to species. The amount of nutrient addition to a particular ecosystem was found to vary with the species and other climatic conditions. Appropriate tree species selection based on nutrient cycling is a vital issue in agroforestry practice. The factors leading to reduction in soil organic matter in an open cycle system is due to management practices that alter the living and nutrient conditions of soil organisms, such as repetitive tillage or burning of vegetation, result in a degradation of their microenvironments. In turn, this results in a reduction of soil biota, both in biomass and diversity[12].

Many factors influence litter production such as the ecosystem viz., temperate forest ecosystems[1]; tropical forest ecosystems[5] and vegetation density, basal area, age structure[11] (Stohlgren, 1988); altitude [9]; latitude[1]; species composition and soil-water retention [3,12] and season are factors that strongly influence litter fall dynamics.

The rate of decomposition depends on the structural and chemical properties of litter. For e.g., the litter of bryophytes are decomposed at a slower rate due to the presence of lignin like complex chemicals [6]. Among the ten tree species evaluated, it has been inferred that the litter production varies with the tree species seasons and also the population density of the species, which has been very well documented above. They[2] also stressed that litter on the forest floor functions as a nutrient input-output system. Nevertheless, the rate at which litter falls and subsequent decay and decomposition regulate nutrient cycling [17] ; nutrient budgeting[10].

Nutrient acquisition by crop plants under agroforestry is influenced by the litter accumulated in the farm lands. It is triggered by the addition of litter as it decides the soil carbon and organic matter contents and also nutrient cycling. Leaf litter, main and fastest source of organic matter, improves soil quality. The nutrients in litter were added to the soil through microbial decomposition and physical leaching of soluble components followed by microbial oxidation of refractory components.

## IV. CONCLUSIONS

A few related observations are litter free months during a calendar year of tree growth were observed in teak, tamarind, *Albizia lebbek* and *Acacia mangium.* Tamarind is capable of accumulating more than 78% of its litter during summer. During summer months the forest floor litter also had flowers and pods in *Albizia lebbek*, pods in *Acacia auriculiformis*, flowers in *Gliricidia sepium* flowers and cones in Eucalyptus and *casuarina.*

Acacia *auriculiformis* produced a maximum leaf litter of 10.0 t/ha/year followed by *Senna siamea*. Summer season had more litter (3.55 kg/tree) followed by winter (1.54 kg/ha). A maximum mean monthly litter of 2.54 kg/tree was recorded in *Tamarindus indica* followed by *Acacia mangium* (0.76 kg/tree). *Senna siamea* and *Gliricidia* produced leaf litter throughout the year. Tamarind produced a maximum annual litter of 30.42 kg/tree followed by *Acacia mangium* (9.07 kg/tree).

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Fig 1. Percent share of month wise litter production each tree species in a year

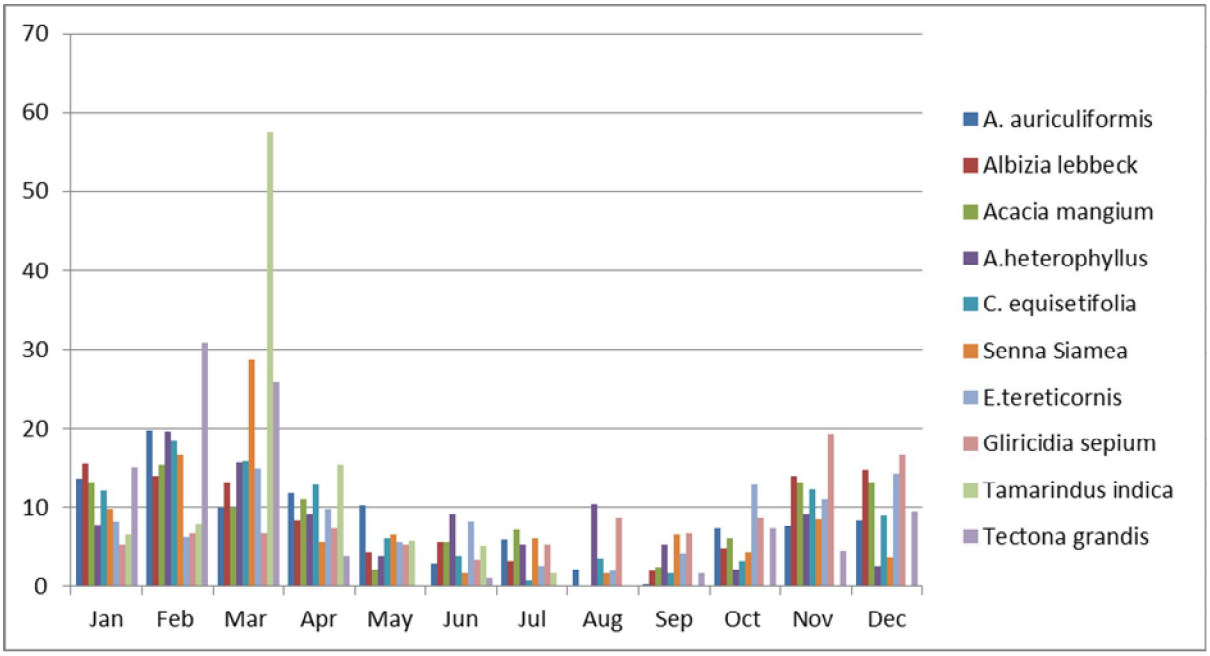
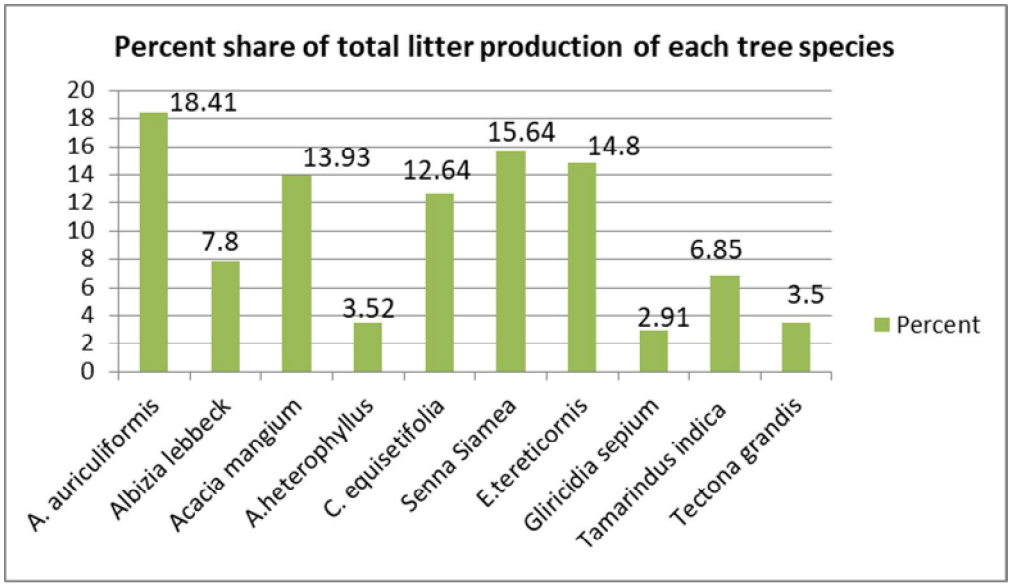
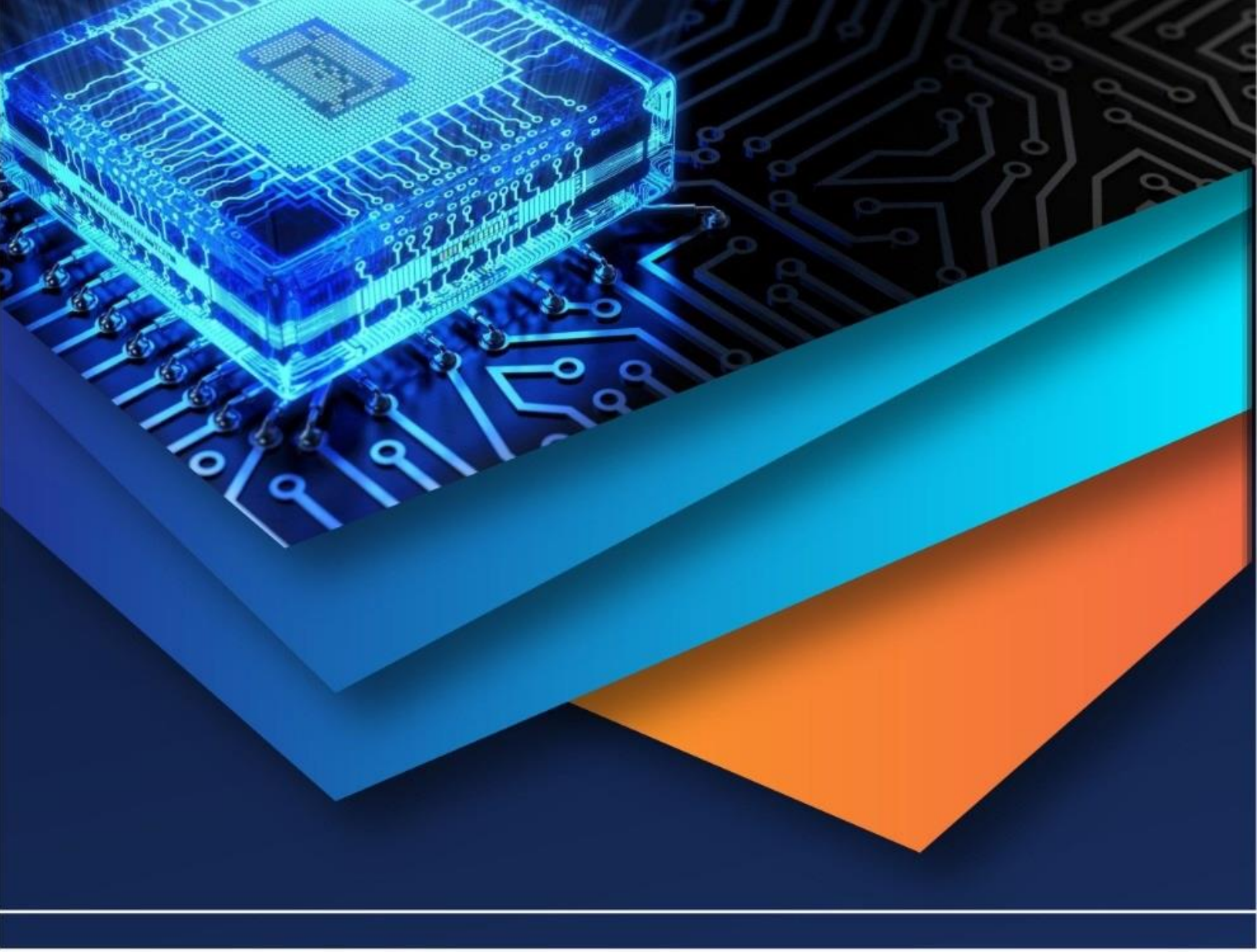



Fig 2. Percent share of total litter production of each tree species/year





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