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COMPARATIVE STUDY ON LITTER DECOMPOSITION, CHEMICAL AND PHYSICAL PARAMETERS OF DIFFERENT TREE CANOPY SOIL

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ABSTRACT

Leaf litter is an important factor that to estimate the quality of fertility of soil. The soils under different tree canopy have different fertility. Leaves, twigs and pieces of bark that have fallen to the ground make up leaf litter. Leaf litter is an important component of healthy soil. Decomposing leaf litter releases nutrients in to the soil and also keeps it moist. Total litter fall is composed of leaf litter and non leaf litter. Litter plays an important role in nutrient turn over and transfer of energy between plants and soil. The most suitable method for analysing the fertility of soil is the physical and chemical parameters. The present study deals with the decomposition of litter of different tree canopies of ten sample soils. The sample of *Dillenia indica* tree canopy soil shows the highest growth rate for *Solanum melongena* and other chemical parameters like nitrite and phosphate content. The P^H of the soil samples were almost same, and shows neutral and slightly acidic values. The moisture content was highest for *Terminalia paniculata*. The colour of the samples are dark and medium. *Swietienia macrophylla* sample shows the least growth for the plat *Solanum melongena.*

KEYWORDS: plant litter, decomposition,chemical parameters, physical parameters.

INTRODUCTION

Soil is a mixture of organic matter, minerals, gases, liquids and organisms that together support life. Earth's body of the soil is the pedosphere, which has four important functions; Soil is the medium for plant growth, water storage, modifier of earth's atmosphere and habitat for organisms; all of which in turn modify the soil. Soil is a product of influence of climate, relief, organisms and its parent materials interacting overtime. It continually undergoes development by way of numerous physical chemical and biological processes, which include weathering with associated erosion. Soil is a major component of the Earth's ecosystem. In terms of soil texture, silt type usually refers to the different types of mineral particles in a particular sample. Soil is made up in part of finely ground rock. Hard surface of base is called hard strata soil particles, grouped according to size as sand and silt. In addition to clay, organic material such as decomposed plant matter. Each component and its size play an important role. For example large particle, sand, determine the aeration and drainage characteristics. While the tiniest, sub microscopic clay particles, are chemically active binding with water and plant nutrients. The ratio of these sizes determines soil types: clay, loam, clay-loam, silt-loam and so on.

In addition to the mineral composition of soil, humus which is an organic material also plays an important role in soil characteristics and fertility for plant life. Soil may be mixed with larger aggregate such as pebbles or gravel. Not all types of soils are permeable, such as pure clay. Plant nutrient availability is affected by soil pH, which is a measure of the hydrogen ion activity in the soil solution. Soil pH is a function of many soil forming factors, and is generally lower (more acid) where weathering is more advanced. Leaf litter is an important factor that to estimate the quality of fertility of soil. The soils under different tree canopy have different fertility. The non living litter over the forest soil is one of the most important layers. It consist of un decayed to mostly decayed matter usually leaves, which are broken down into soil by decomposers such as microorganisms, insects, earthworms, and exposure to light, wind and rain.

The importance of forest floor components to site productivity is well known. The decomposition of forest litter is the foremost pathway for providing organic and inorganic elements for the nutrient cycling processes and maintenance of soil nutrient pool. Litter production and decomposition is a key process in biogeochemical process of forest ecosystem and varies with climate, season, substrate quality, and type of biota. Chemical composition, amount of lignin, nitrogen, hemicelluloses and secondary compounds are the variable for affecting decomposition. Total litter fall is composed of leaf litter and non leaf litter. The decay rate of leaf litter and non leaf litter also varies. In general, non leaf litter decays slowly but it also provides habitats for fungi, bacteria, arthropods, and invertebrates (Vinod *et al.*, 2014). The quantity of nutrients released in a unit area or in particular ecosystem is known to be dependent on the quality of biomass accumulated. Decomposition of litter is a sequential process whereby complicated organic compounds are continuously degraded into simpler substances, releasing nutrients as by-product of their breakdown. To comprehend its dynamics, it is important to start with the chemical composition of plant litter as litter chemistry is the main determinant of litter decomposition within a given climatic region followed by rate of decomposition and nutrient release to soil organic pool. However, little is known regarding litter production, rate of decomposition, and releases of these main nutrients to soil organic matter pool through various types of leaf litter forms (Vinod *et al.*, 2014).

Litter plays an important role in nutrient turn over and transfer of energy between plants and soil. The sources of the nutrient are being accumulated by the upper most layers of the soil (Singh, 1971). Plant litter decomposition is the biological disintegration of litter during which mineralization of complex organic compounds into simple inorganic forms occurs. It includes leaching, break up by soil fauna, transformation of the organic matter by microorganisms and transfer of organic and mineral compounds to the soil (Loranger *et al*., 2002). Leaf litter constitutes major part of the total litter fall, providing an important nutrient pool. Mechanisms of nutrient release from litter are only partially understood. Mechanical leaching often causes a rapid lose of sodium and potassium. It also mobilise considerable amounts of magnesium from forest litter. Other elements are largely mineralised by microbial or animal activity. Essential elements are retained by decomposer organism and a maximum carbon element ratio is often required for a net loss of certain elements to occur from the decomposer substrate system (Alexander, 1997). The breakdown of leaf litter is thus a key component in nutrient cycling in tropical forests and tree plantation ecosystems. The release of nutrients during litter decomposition is a key process governing the availability of nutrients in ecosystems (Moore *et al*., 2006). And important ecosystem function play crucial role in nutrient release in forest and tree plantation ecosystems. It is a comsplex process regulated by number of abiotic and biotic factors (Lavelle *et al*., 1993, Reddy, 1995). The soil organisms contribute to litter decomposition by playing the role of decomposers. The soil fauna through communiting mechanisms fragment the substrates, thereby increasing the surface area leading to the acceleration of microbial activity (Wise and Matthias, 1994; Reddy, 1995; Seastedt, 1995; Coleman and Crossley, 1996; Knoepp *et al*., 2000; Ekschmitt *et al*., 2005; Janzen, 2006).

The present study aims to focus on leaf litter breakdown and nutrient release in different tree plantation ecosystems, such as *Sapindus laurifolia*, *Hydnocarpus wightiana*, *Santalum album, Tectona grandis, Swietenia macrophylla, Dillenia indica, Magnolia champaca, Chrysophyllum cainito, Xylia xylocarpa* and *Terminalia paniculata*. The study particularly look on variations in the rates of leaf litter decomposition in terms of breakdown, release of nutrients, nitrate, nitrite, phosphate, ammonia, chlorine, fluoride, iron, pH, moisture content, colour and growth rates.

MATERIALS AND METHODS

Study Area

The present study was conducted in the area of Kerala Forest research institute Sub centre (KFRI sub centre) which is situated in the fringe area of the Nilgiri Biosphere Reserve and about 5 Km away from the Nilambur town of Malappuram district, Kerala, India. With a cmpus of around 43.30 ha, the KFRI sub centre is one of the important green institution in Malappuram, district with a rich floral and faunal diversity. The climate is tropical in Nilambur. Nilambur has significant rain fall most months, with a short dry seasons. The average annual temperature in Nilambur is 27.7^0 C. About 2666mm of precipitation fall annually.

The soil was collected from the tree canopy *Sapindus laurifolia*, *Hydnocarpus wightiana*, *Santalum album*, *Tectona grandis*, *Swietenia macrophylla*, *Dillenia indica*, *Manglolia champaca*, *Chrysophyllum cainito*, *Xylia xylocarpa* and *Terminalia paniculata.* The soil samples collected from all the tree plantations was sandy, mostly acidic and neutral in nature.

CHEMICAL PARAMETERS

Chemical parameters are tested mainly using soil testing kit.

1. Determination of nitrate content in the soil

Using the 1 ml syringe take 1 ml of the soil solution in the 10 ml glass bottle. Using the measuring cylinder add 9 ml distilled water to this glass bottle. Using a mini spatula add a small pinch of metal powder. Add 3 drops of N2 and 2 drops of N3 liquids. Shake continuously and vigorously for 1 minute. After waiting for 5 minutes and immediately compare the colour developed with the nitrate colour chart. If there is no nitrate the colour will not change. If the nitrate is present, the soil sample will change into pink.

2. Determination of the nitrite content in the soil

Using the measuring cylinder, taken 10 ml of soil solution in the 10 ml of glass bottle. Add 2 drops of N2 and 2 drops of N3 liquids. Gently shake the bottle. If there is no nitrate, the colour will not change. If nitrate is present the colour of water will change into pink.

3. Determination of phosphate content in the soil

Using measuring cylinder, take 10 ml of soil solution in the 10 ml of glass bottle. Add 5 drops of P1 liquid. Gently shaken the bottle. Then add 1 drop of P2 liquid. Again gently shake. If there is no phosphate colour will not change. If the phosphate is present, the colour of the water will change into blue.

4. Determination of ammonia content in the soil

Using the measuring cylinder, take 10 ml of soil sample in the 10 ml glass bottle. Add 5 drops of AM liquid. Gently shake the bottle. If there is no ammonia, the colour will not present. If the ammonia is present, colour of the solution turns yellow.

5. Determination of the iron content in the soil

Using the measuring cylinder, take 10 ml of the soil sample in the 10 ml of glass bottle. Add 5 drops of Fe1 liquid and 1 drop of Fe2 liquid, mix. Then add 5 drops of Fe3 liquid. Mix well. For colour less samples wait for 2 minutes. For turbid samples wait for 5-10 minutes till a persistent colour develops. If there is no iron, the colour will not change. If iron is present the colour of the solution will changed in red.

6. Determination of the fluoride content in the soil

The filtrate was follows these methods by using the materials glass bottle, ‘F’(fluoride) liquid. Take 5 ml of soil sample in 10 ml glass bottle using measuring cylinder. Add 5 drops of ‘F’ liquid. Mix, compare the colour with fluoride chart provided and record the fluoride value.

7. Determination of the chloride content the soil

Using the materials measuring jar, ‘C1’(chlorine) liquid, ‘C2’(chlorine) liquid. Using measuring cylinder 10 ml soil filtrate was taken in the glass bottle. Add 5 drops of ‘C1’ liquid. The soil samples turn yellowish in colour. Using 1 ml of syringe add ‘C2’ liquid in drops. If the colour remains the same there is no chloride content. If the colour of the solution changes to reddish colour, there is the presence of chloride content.

PHYSICAL PARAMETERS

1. Determination of the moisture content of the soil samples

To determine the moisture content of the soil samples following materials are used; Analytical balance, microwave oven, foil paper, weighing bottle. The soil samples are taken in the weighing bottle and were weighed using analytical balance. The weight of the weighing bottle is noted. Total weight of the soil is measured. Samples taken in a foil paper were kept overnight in microwave oven for drying. The weight of the dried soil was taken using analytical balance again. Moisture content was calculated using the equation.

MC (moisture content) = $\frac{\text{Fresh weight of soil} - \text{Dry weight of soil} \times 100}{\text{Dry weight}}$

2. Determination of the P^H of the selected soil sample

To determine the P^H of the collected soil samples are dissolved in the distilled water and it is filtered. The filtrate is treated with P^H paper. The values of the soil samples are noted.

3. Determination of the colour of the soil samples

To determine the colour of the soil samples the following materials are used, trowel, fork and watch glass. The soil samples were collected from the selected area using hand fork and trowel. The selected soil samples are kept in the watch glass and the colour of the soil is noted.

4. Determination of the growth rate of plants in the soil samples

To determine the growth rate plants in the selected soil samples was grown in pots. The pot mixture consists of 10 soil samples. The seeds are planted in those pots and the growth rate of the plant was noted.

RESULTS

Chemical parameters

The soil collected from different tree canopy soil samples of the trees *Sapindus laurifolia, Hydnocarpus wightiana*, *Santalum album*, *Tectona grandis*, *Swietienia macrophylla*, *Dillenia indica*, *Manglolia champaca*, *Chrysophyllum cainito*, *Xylia xylocarpa* and *Terminalia paniculata* and examined the chemical parameters of the soils such as nitrate, nitrite, phosphate, ammonia, iron, fluoride and chloride contents. In this table high nitrate content is present for both *Tectona grandis* (100mg/*l*) and *Terminalia paniculata* (100mg/*l*). And least nitrate content present in *Sapindus laurifolia* (20mg/*l*), *Hydnocarpus wightiana*(20mg/*l*)*and Xylia xylocarpa* (20mg/*l*).

The maximum nitrite content were present in *Dillenia indica* (1.0mg/*l*) and *Xylia xylocarpa* (1.0mg/*l*). *Hydnocarpus wightiana* (0.2mg/*l*), *Tectona grandis*(0.2mg/*l*) *Swietienia macrophylla* (0.2mg/*l*), *Chrysophyllum cainito*(0.2mg/*l*) are contain minimum nitrate content. *Sapindus laurifolia* (0.5mg/*l*), *Swietinia macrophylla* (0.5mg/*l*), *Dillenia indica* (0.5mg/*l*) and *Chrysophyllum cainito* (0.5mg/*l*) are having highest phosphate value. *Hydnocarpus wightiana* (0.1mg/*l*) and *Terminalia paniculata*(0.1mg/*l*) was having lowest phosphate content. Samples of *Sapindus laurifolia*(3.0mg/*l*) and *Swietienia macrophylla*(3.0mg/*l*) contain maximum ammonia content and *Mangnolia champaca* (0.5mg/*l*) is having the minimum ammonia content. Iron content maximum present in *Terminalia paniculata* (2.0mg/*l*) and the minimum iron content present is in the samples of *Sapindus laurifolia* (0.3mg/*l*), *Santalum album* (0.3mg/*l*) and *Dillenia indica* (0.3mg/l). *Swietienia macrophylla* (2.0mg/l), *Chrysophyllum cainito* (2.0mg/*l*) and *Terminalia paniculata* (2.0mg/*l*) is having the highest fluoride content and the samples of *Sapindus laurifolia* (0.5mg/*l*) and *Mangnolia champaca* (0.5mg/*l*) are having the least fluoride content. The maximum chloride content is present in the samples of *Tectona grandis* (0.5mg/*l*) and *Chrysophyllum cainito* (0.5mg/*l*). The samples of *Sapindus laurifolia* (0.2mg/*l*), *Santalum album* (0.2mg/*l*), *Dillenia indica* (0.2mg/*l*) and *Terminalia paniculata* (0.2mg/*l*) are having the minimum chloride content.

Physical parameters

The sample of *Terminalia paniculata*(11.23%) have the highest moisture content and the *Manglolia champaca* (1.82%) have the least moisture content. Most of the samples showed neutral P^H except *Santalum album*, *Dillenia indica* and *Chrysophyllum cainito* showed slightly acidic P^H range. *Hydnocarpus wightiana, Santalum album, Tectona grandis, Swietienia macrophylla* and *Manglolia champaca* showed a medium dark brown colour. And the others showed very dark brown colour soil. The sample of *Dillenia indica* tree canopy soil have the maximum growth rate and the *Swietienia macrophylla* tree canopy soil has showed the minimum growth within 8 days.

CONCLUSION

The soil samples are collected from KFRI sub centre Nilambur, Kerala. the trees are separated as different plots. The soil is collected from the canopy of 10 trees such as *Sapindus laurifolia, Hydnocarpus wightiana, Santalum album, Tectona grandis, Swietienia* *macrophylla*, *Dillenia indica*, *Manglolia champaca*, *Chrysophyllum cainito*, *Xylia xylocarpa* and *Terminalia paniculata.* The samples are subjected to analysing by chemical and physical parameters. The chemical parameters include Nitrate, Nitrite, Phosphate, Ammonia, Chlorine, Fluoride and iron. The physical parameters include P^H, Moisture content, Colour and Growth rate. The nitrate content was higher in *Tectona grandis* and *Terminalia paniculata* tree canopy soil. Samples of *Sapindus laurifolia*, *Hydnocarpus wightiana and Xylia xylocarpa* tree canopy soil contain lowest nitrate content. The *Dillenia indica* and *Xylia xylocarpa* tree canopy soil has the maximum nitrite content. *Hydnocarpus wightiana*, *Tectona grandis*, *Swietienia macrophylla* and *Chrysophyllum cainito* tree canopy soil having minimum nitrite content. Phosphate content was highest in the *Sapindus laurifolia*, *Swietienia macrophylla*, *Dillenia indica* and *Chrysophyllum cainito* tree canopy soil. *Hydnocarpus wightiana* and *Terminalia paniculata* tree canopy soil has lowest phosphate content. *Sapindus laurifolia* and *Swietienia macrophylla* tree canopy soil has the highest ammonia content. The lowest ammonia content is present in *Mangnolia champaca tree* canopy soil. The maximum iron content was present in *Terminalia paniculata* tree canopy soil. *Sapindus laurifolia*, *Santalum album* and *Dillenia indica* tree canopy soil has minimum iron content. The tree canopy soil of *Swietienia macrophylla*, *Chrysophyllum cainito* and *Terminalia paniculata* shows the highest fluoride content. The lowest fluoride content shows in *Sapindus laurifolia* and *Mangnolia champaca* tree canopy soil. The chloride content was highest in the *Tectona grandis* and *Chrysophyllum cainito* tree canopy soil. *Sapindus laurifolia*, *Santalum album*, *Dillenia indica* and *Terminalia paniculata* tree canopy soil has the least chloride content.

The sample of *Dillenia indica* tree canopy soil shows the highest growth rate for *Solanum melongena* and other chemical parameters like nitrite and phosphate content. The P^H of the soil samples were almost same, and shows neutral and slightly acidic values. The moisture content was highest for *Terminalia paniculata*. The colour of the samples are dark and medium. The soil can be used for cultivation purpose.

Interactive effect among litters from different tree species may be ecologically important. Seastedt(1984) proposed that litter of better quality should accelerate the decomposition of associated poor quality litter and conversely poor quality litter should retard decomposition of good quality litter. Plant species which produce good quality litter are disadvantaged by browsing, and that herbivory by browsing mammals therefore switches the competitive balance towards plants species with poor litter quality Pastor *et al.*, (1988).

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