The study on chemical parameter of the litter collected from the selected tree canopy in plotted land, Bengaluru, Karnataka

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Abstract

The key pathway of essential nutrients returns to the soil is through the litter. Good soil promotes, good vegetative growth such as increase in size and height of trees, numbers of stem, leaves, roots. The reclamation of degraded land will be redeemed by planting woody perennial selective trees. For the present study, five different tree of different genera's litter samples (fresh and dry leaves, wood logs, flowers, fruits) were collected from the project land to find out the chemical properties of macronutrient and micronutrient, such as Nitrogen, Potassium, Phosphorus, Magnesium, Calcium, Chloride and iron. The result shows *Acacia auriculiformis* A. Cunn.ex Benth., has better nutrient availability followed by *Thespesia populena* (L) Sol.ex Correa., *Fillicium decipens* (Wight&Arn.) Thwaites., the remaining trees such as *Markhamia lutea* (Benth.) K. Schum. *and Tabebuia rosea*(Bertol.) Dc comparatively very less nutrients present. Thereby, the present study assists to understand the nutrient level of litter in plotted area and also known through this, the selection of the trees is important to improve the soil quality in the urban environment.

Introduction

Soil is the important valuable and natural resource encompasses with flora, fauna and soil biota. Unplanned soil practices, population and erratic rainfall leads to degraded soil. Another important factor for soil degradation is by human activities involved in deforestation, conversion of land due to urbanization, soil contamination, compaction, salinization, loss of soil nutrients due to industrial growth. Moreover, among these factors, soil fertility is greatly affected by soil erosion and water erosion, which leads to low water infiltration, leaching of Calcium (Ca), Magnesium (Mg) due to low pH, less availability of phosphorus (P), removal of rich top fertile layer. These frequent soil contamination, leads to affects socio economy and human health. A Soil quality consists of four constituents: water, air, biological and climatic conditions (Andrews *et al*., 2002) therefore, for the tree growth requires an adapted set of indicators for a soil quality assessment. By improving soil quality, we can promote human health, sustainable biological productivity, flora & fauna health, maintain environmental quality (Doran and Parkin, 1994).

A fertile soil, is well structured with physical and chemical properties like, good storage of soil organic matter, decomposition rate, water holding capacity. Moreover, good soil promotes vegetative growth such as increase in size and height of trees, numbers of stem, leaves, roots. The reclamation of degraded land will be redeemed by planting woody perennial trees. But, trees have response to its environment and its genetic nature. Environmental factors can inhibit physiological processes which directly affects trees growth. Some of the trees has specific genotypes which can adapt to grow in any conditions. In addition to that, the composition of the tree species can influence ecosystem, nutrient cycling, plant nutrient up take and use, rhizosphere interactions and changes in decomposition ratio (Hobbie,1992). Hence, the selection and maintenance of trees are important to enhance properties of trees (Young,2002) as well soil fertility.

Robertson and paul, (1999) reported that, the key pathway for essential nutrients return to the soil is through the litter. Particularly, 70% of leaf tissues falls above the ground level and the remaining consist of stems, reproductive parts and small twigs. Increasing soil fertility is associated with leaf litter quality, nutrient concentrations in live leaf tissue, decomposition rate and nitrogen mineralization (Edwards 1982, Vitousek 1988, Aerts and Chapin, 2000). The physical and chemical properties of litters play important role on nutrient cycling and soil organic matter for further fixation on the soil. However, the quality of litter may act vary with species and physical properties (Perez-Harguindeguy *et al*., 2000). For example, long life span such as, conifer trees have less leaf area and nutrient concentration. But, accumulation of secondary metabolites (lignin and tannins) generally increase when life span increases. Prescott, (2002) reported that the characteristics of canopy have greatly influence on decomposition and nutrient cycling due to physical parameter such as soil moisture, temperature conditions and changes in the chemical composition of precipitation. The aim of the study is to find out chemical properties of litter quality, and thereby enhance the soil quality.

Keywords

Soil degradation, Physical parameter of litter, Soil quality, Tree canopy,

Materials and methods

Study area (plate 1&2)

Bengaluru is located south eastern part of Karnataka, surrounding area of 741km^2. Bengaluru encompasses lush green cover with parks, gardens, institutions, defense campus, plots and apartments. It comes under tropical savanna region. The average lowest temperature is 15^{o}C and highest 35^{o}C. Champion and seth, (1968) reported Bengaluru was classified dry deciduous forest type of vegetation, which had 979 species in 542 genera and 133 families. Ramaswamy and Razi, (1973)) reported that, there are 142 species introduced in Bengaluru over the period of last 150 years for gardening and floriculture in urban area. These species have been adapted to Bengaluru's environment and become heritage trees. All these have enhanced beauty to the landscape and the quality of life. Hence, it is called garden city of India.

Plate 1: Location Map

Plate 2: Study Area

Shriram Malhaar, a 30 acre plotted gated community land located in Sarjapura, south-east Bengaluru. Before the layout formation the land was having only 19 trees (10 coconut trees, 5 fruit trees and 4 decorative trees while layout making 821 trees (60 fruit trees, 180 flowering trees and 580 decorative trees) are planted and covered with grass and weeds. Ground water is the source of water for the layout and its just 200 meters away from the Sarjapura lake. The layout is built with all amenities like parks, playgrounds, amphitheater, tar roads, underground electricity and drainage system. In order to conserve the scarce availability of water in and around Bengaluru, the layout has been provided with a state-of-the-art rain water harvesting system. A well designed storm water system has been laid along both sides of the road to collect the rain water and use it for recharging the recharge pits located all over the site. This will recharge the first aquifer and will strengthen the underground water source. The human occupancy of the layout is zero as of now and its home for birds and fauna.

Collection of tree litter sample

For the present study five different trees (Plate 3,4,5,6 &7) of different genera such as *Thespesia populena* (L) Sol.ex Correa., *Fillicium decipens* (Wight&Arn.) Thwaites., *Acacia auriculiformis A. Cunn.ex* Benth., *Markhamia lutea* (*Benth.*) K.Schum. *and Tabebuia rosea* (Bertol.) Dc., were selected from the project land to find out the chemical parameter of litter (Nitrogen, Potassium, Phosphorus, Magnesium, Calcium, Chloride and iron). The tree canopy litter was collected during the year 2019. Litter samples of fallen fresh and dry leaves, wood logs, flowers, fruits were air dried and powdered, kept in airtight container and chemical parameter were analyzed.

Sample 1: Plate 3
Thespesia populena (L) Sol.ex Correa

Sample 2: Plate 4
Fillicium decipens (Wight&Arn.)Thwaites

Sample 3: Plate 5
Acacia auriculiformis A. Cunn.ex Benth

Sample 4: Plate 6
Markhamia lutea (Benth.)K.Schum

Sample 5: Plate 7
Tabebuia rosea(Bertol.)Dc

Results and discussions

The tree litter quality is measured by the chemical composition of essential nutrients like primary, secondary and trace elements. Nitrogen, Potassium, Phosphorus are the important necessary nutrients for tree growth. Gaudinski et al.,2000, observed that the litter quality particularly reduces throughout decomposition. Because, the loss of easily obtainable carbon and the accumulation of recalcitrant compounds.

Chemical parameter of the litter collected from the selected tree canopy Table 1.

s.no	Parameter	*Thespesia populena*	*Fillicium decipens*	*Acacia auriculiformis*	*Markhamia lutea*	*Tabebuia rosea*
1	**Nitrogen**	3.24%	3.12%	**3.64%**	3.08%	3.02%
2	**Potassium**	268.0mg	208.0mg	**288.0mg**	186.20mg	168.0mg
3	**Phosphorus**	48.0mg	**60.0mg**	46.32mg	32.0mg	30.08mg
4	**Calcium**	**2650.0mg**	1264.14mg	1485.0mg	982.0mg	926.22mg
5	**Magnesium**	324.0mg	322.0mg	**364.0mg**	312.0mg	296.0mg
6	**Chloride**	428.0mg	**653.0mg**	589.24mg	566.0mg	414.0mg
7	**Iron**	**22.13mg**	19.18mg	20.88mg	16.56mg	16.02mg

Nitrogen content of the litter

Nitrogen is crucial important nutrient for tree growth. it is the major constituent of all proteins, chlorophyll and nucleic acids. The deficiency of nitrogen reflects, stunted growth and yellowish leaves. Basically litter quality is measured on the basis of chemical composition of N, P, K and cell wall component that influence the litter decomposition and release nutrients. (Swift et al. 1979). The percentage of nitrogen content was found to be high in *Acacia auriculiformis A.* Cunn.ex Benth., (3.64%) and lowest recorded in *Tabebuia rosea* (Bertol.) Dc., (3. 02%).Comparatively not much variation showed between the species (Table 1 & chart 1). Basically, the concentration of the nutrients varies from species to species. Gustafson (1943); Berg and McClaugherty (2003) reported that, leaf litter of the nitrogen has great concentration in alder species (above 3%) but, in contrast nitrogen concentration is poor in pine litter (under 0. 4%).Therefore, tree species has a feature of defining the litter value. Reich and Oleksyn (2004); Yuan and Chen (2009) reported that temperature is one of the reason for the variation of N. Leaf litters N compound increases with increasing temperature. Singh *et al*., (2011) reported that less percentage of the soil N storage due to less litter input, which cause denitrification thereby loss of N. Therefore, High and low concentration of N is determined by physical parameter, availability of the cell wall component and quality of the litter and soil.

Potassium content of the litter

Potassium plays important role, from protein synthesis to maintenance of water balance of tree growth (Sumithra et al.,2013). Among five tree species, *Acacia auriculiformis* A. Cunn.ex Benth., shows highest (288.0 mg) and the lowest in *Tabebuia rosea* (Bertol.) Dc., (168 mg) (Table 1 & chart 2). Motsara,(2002) reported that excess of calcium present in the soils, slow down the uptake of Potassium. Potassium content significantly decreased in leaves, stem, tap roots, and lateral root tissues in response to increase soil salinity. Less availability of Potassium present in leaf litter results in increasing soil salinity (taiz,2006). Potassium are essential nutrients for trees, because it limits microbial actions. Moreover it is quickly removed from decaying litter.

Phosphorus content of the litter

Phosphorus is an essential macro component for plant growth and metabolic activity which is acting as an energy storage and helps to transfer it in various parts of the trees (Jain et al.,2014). The present study shows highest in *Fillicium decipens (*Wight&Arn.) Thwaites., (60.0%) and lowest in *Tabebuia rosea* (Bertol.) Dc., (30.08%) respectively (Table 1 & chart 3). The reason for increasing available phosphorus in the soil due to production and releasing of organic acid during decomposition. (lal *et al*.,2000). Moreover, the process of releasing happens very slowly from insoluble phosphate. So limited quantities of Phosphorus available to plants from the soil (Norman, 2010).

Calcium

Calcium is one of the secondary nutrients present in the leaves with lower concentrations in seeds, fruits and roots. Its major function is as a constituents of cell walls. Calcium is also used in activating certain enzymes and to send signals that coordinate certain cellular activities. The result shows highest among the five species is *Thespesia populena* (L) Sol.ex Correa., (2650.0 mg) and lower is *Tabebuia rosea* (Bertol.) Dc., (926.22 mg) (Table 1 & chart 4). Calcium, in the form of calcium pectate, is responsible for holding together the cell walls of plants. When calcium is deficient, new tissue such as root tips, young leaves, and shoot tips often exhibit distorted growth from improper cell wall formation. The reason for high soil pH, is accumulation of the calcium in the soil. Calcium content from the leaf litter is adsorbed by soil particles and helps in stabilizing and prevents damage to soil structure.

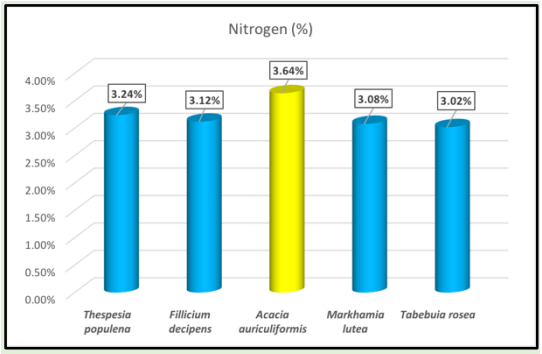

Chart 1: Nitrogen

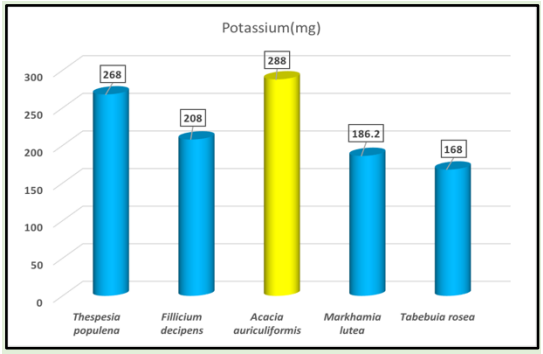

Chart 2: Potassium

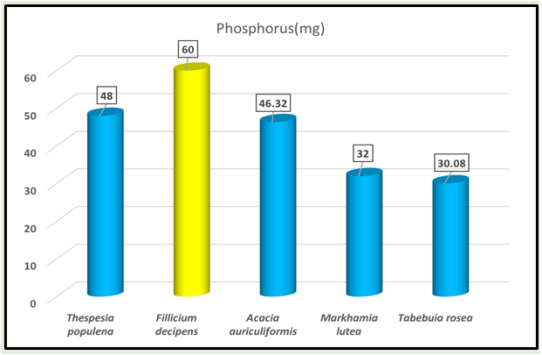

Chart 3: Phosphorus

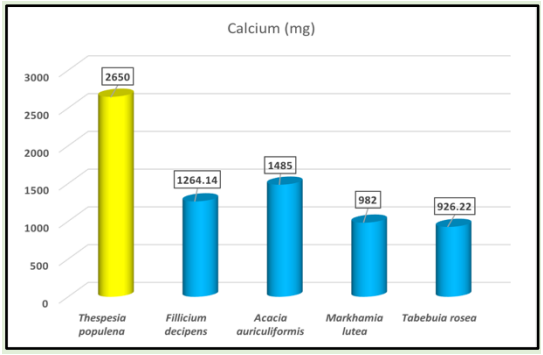

Chart 4: Calcium

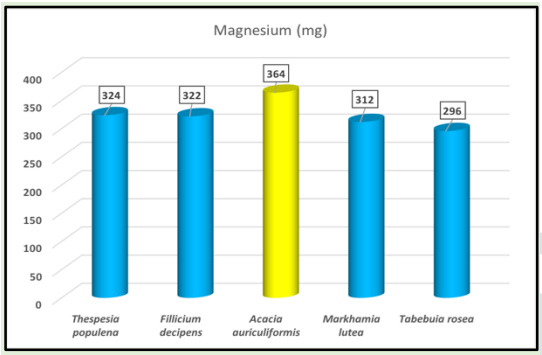

Chart 5: Magnesium

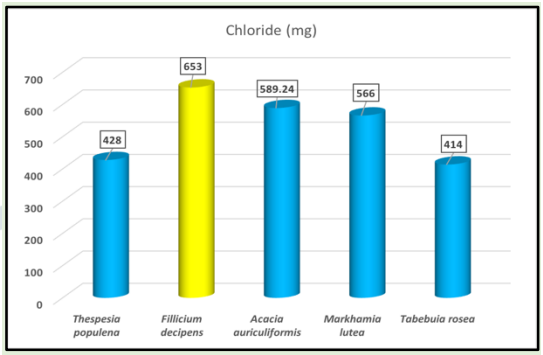

Chart 6: Chloride

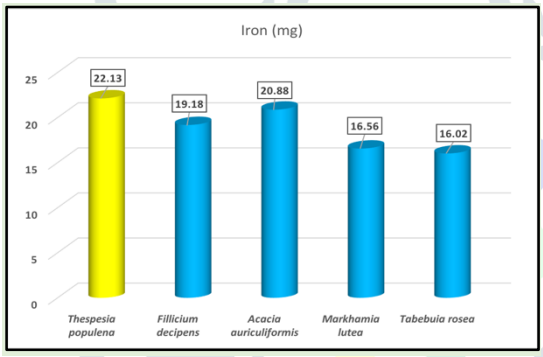

Chart 7: Iron

Magnesium

Magnesium is an essential for photosynthesis, activator for many enzymes and stabilize the nucleic acid. Marschner,1995 reported that, deficiency of magnesium shows stress responses, due to the presence of Mg^{2+} ion in the chlorophyll molecule. *Acacia auriculiformis*, *A.* Cunn.ex Benth., has highest litter content (364.0 mg) and lowest in *Tabebuia rosea* (Bertol.) Dc., **(**296.0mg) (Table 1 & chart 5). Potassium and Magnesium are important nutrients for tree. But it limits the microbial actions and are easily removed from decomposing litter (Anderson and Ingram 1983). Moreover, the chlorophyll development is much reduced when Magnesium uptake is restricted, because it is an integral part of the pigment. It maintains the dark green color of leaves and regulates the uptake of other materials particularly Nitrogen and Phosphorus (Motsara, 2002).

Chloride

Chloride is an essential micronutrient and required in small quantities. The requirement of the chloride differs from species to species because it is often related with salinity damage and toxicity. The result shows highest chloride present in *Fillicium decipens* (Wight&Arn.) Thwaites., (653.0mg) and lowest is *Tabebuia rosea* (Bertol.) Dc., (414.0mg) (Table 1 & chart 6). High concentration of chloride can accumulate in the leaves and cause toxicity problem.

Iron

Iron is necessary for photosynthesis and is present as an enzyme cofactor in plants. The result shows the maximum content was found in *Thespesia populena (L)* Sol.ex Correa., (22.13mg) and lowest in *Tabebuia rosea (*Bertol.) Dc., (16.02mg). Taiz (2006) identified that iron content in leaves, stems, tap roots and lateral roots significantly decreased in response to increase in soil salinity. There was a negative relationship between salt concentration in soil and Fe content in tissues. Motsara, (2002) reported that if iron is not taken up in adequate quantity, the growth of plants is less vigorous, and seed and fruit development suffer as a consequence of decreased photosynthetic activity in the leaves. Too much liming results in iron deficiency which results in chlorosis and leaves turn white and eventual leaf loss.

Conclusion

Over the recent decades, soil has been contaminated due to various urban activities. The only solution to overcome these problems is to plant many selective and quality trees to enhance the soil fertility. As per the present study, Nitrogen, Potassium and Magnesium nutrients are higher in *Acacia auriculiformis* A**.** Cunn.ex Benth**.,** Calcium and iron are higher in *Thespesia populena (L)* Sol.ex Correa., Phosphorus and chloride are higher in *Fillicium decipens* (Wight&Arn.) Thwaites., All these nutrients are lower in *Markhamia lutea* (Benth*.)* K.Schum*. and Tabebuia rosea* (Bertol.) Dc., compared to others. This observation shows that the fertility of the soil improved by quality of the litters. Therefore, the chemical components of litter are highly significant functioning in the ecosystems through recycling of high quality litter nutrients, especially, Nitrogen, Potassium, Phosphorus and other elements.

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