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# Studies on Physico Chemical Properties of Soil in Tree Arboretum of UAS GKVK Bengaluru, Karnataka, India

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**A B S T R A C T**

The study entitled "Studies on physico chemical properties of soil in tree arboretum of UAS GKVK Bengaluru" was carried out in 30-year-old plantation at tree arboretum UAS GKVK Bengaluru with majorly found tree species such as *Ceiba pentandra, Artocarpus hirsutus, Grevillea robusta and Sterculia companulata.* The results revealed that at different depth (0-15 and 15-30cm) of soil among the different tree species maximum available Nitrogen (287.31kg/ha) (270.95 kg/ha), Potassium (109.3 kg/ha) (96.0 kg/ha) and soil moisture (12.02 %) (12.9 %) was found highest in *Ceiba pentandra* at depth of 0-15cm and 15-30cm respectively. *Artocarpus hirsutus* showed higher amount of Phosphorous (40.74 kg/ha) (24.1 kg /ha) content, Electrical conductivity (0.20 ds/m) (0.19 ds/m) and Organic carbon (2.38%) (2.25%) and *Sterculia companulata* has higher bulk density (1.14 g/cm3) (1.6 g/cm3) at depth of 0-15cm and 15-30cm respectively. Hence *Ceiba pentandra and Artocarpus hirsutus*are the tree species which improves the soil quality and maintains the soil in an sustainable way.

## Introduction

The Arboretum UAS GKVK (Bengaluru) was established in the year 1987 by the Department of Forestry with the main goal to establish a social forest and the best use of wasteland. Introduction of species involves adaptation, productivity and success in new types of environmental conditions but these there tree species are indigenous to India and they are more vigorous in adaptation in general, each plant species has specific requirements for the soil-ecological environment. If plants are to grow to their potential, they must be provided by a satisfactory soil environment. On the other hand, inappropriate conditions may limit or

even make it impossible to grow a given plant species. Tree growth requires adequate availability of water and oxygen from the soil as well as a sufficient supply of nutrients, light and heat (Wall and Heiskanen, 2009). Many works define mainly physical and chemical of soil properties affecting plants growth. The physical properties are considerably undervalued, even though excessively wet or dry, shallow or impermeable soils can severely limit or even interrupt the growth of plants (Huxley *et al.*, 1992). For the favourable course of biological processes as well as the life of soil organisms and plant roots, it is important to provide a sufficient supply of water and air into the soil. On the base of soil moisture monitoring, which is carried out it can be stated that in the recent years there were significant changes in the dynamics of soil moisture, available water supplies and soil moisture stratification. In contrast to laterite soils, poor moisture conditions are in the lowest forest zones, in the areas where the output of water significantly exceeds atmospheric precipitation, and the ability of soil to provide enough utilizable water usually covers only for some days. Unfavourable moisture is one of the main causes of deteriorating soil environment with a tendency of physiological weakening and even necrosis of trees (Tužinský, 2007). Soil moisture not only affects physical, chemical and biological soil properties, but it is also essential for plant growth. The amount of soil water used by plant varies depending on characteristics of soil e.g., texture and plant e.g., roots distribution, depth and transpiration coefficient (Hosseinia *et al.*, 2016). Since favourable rooting space, an abundance of nutrients, water and appropriate air exchange in the soil are important conditions for right tree life, the study aimed to find out which Physico-chemical properties of soil promote or limit the vitality among the four tree species introduced.

## Materials and Methods

A present study was conducted in tree arboretum UAS, GKVK. Bengaluru established in 1987, geographically, the place is located at $13^0$ 05" N latitude and $77^0$ 34" E longitude. The centre is at an altitude of 924 meters above mean sea level. The annual rainfall ranges from 528 mm to 1374.4 mm with the mean of 915.8 mm. Tree species identified are indigenousnamely *Ceiba pentandra*, *Artocarpus hirsutus*, *Grevillea robusta* and *Sterculia campanulata*. of thirty years of age and planted with 2 m× 2 mspacing.The soil samples were collected from the tree arboretum up to depth of 0-15 cm and 15 -30 cm layer of the top soil from each tree species for soil analysis. At each sampling point, 8 samples were collected (4 tree species × 3 replications). Thus a total 24 soil samples were collected and analysed for physico chemical properties such as soil moisture, Bulk density, soil pH, organic carbon, electrical conductivity, available nitrogen, available phosphorus, and exchangeable potassium using standard procedures like Soil moisture content was determined by weight loss after drying fresh soil at 100-110˚C for 24 hours using a formula.

$$\text{Soil moisture content (\%)} = \frac{\text{Wet soil (g)} - \text{Oven Dry soil (g)}}{\text{Oven Dry soil(g)}} \text{ Oven Dry soil (g)} \times 100$$

Bulk density of were done using a steel cylinder (Jackson, 1958). Bulk density was estimated by taking out a core of undisturbed soil by using steel cylinder. The soil was dried and weighed.

The volume of soil was calculated by measuring the volume of cylinder ($\pi r2h$). The bulk density was calculated by dividing the oven dry weight of samples (g) by volume of the soil.

The methodology fallowed for soil analysis

| Particulars | Methodology adopted | Reference |
|---|---|---|
| **pH** | 1:2.5 soil water suspension with the help of digital pH meter | **Jackson (1973)** |
| **EC (ds/m)** | 1:2.5 soil water suspension using conductivity bridge | **Jackson (1973)** |
| **Organic Carbon (%)** | Walkley and Black rapid titration method | **Walkley and Black (1934)** |
| **Available N (kg ha$^{-1}$)** | Alkaline potassium permanganate method | **Subbiah and Asija (1956)** |
| **Available $P_2O_5$ (kg ha$^{-1}$)** | Spectrophotometric (Olsen Extraction method with 0.5 M NaHCO3) | **Jackson (1973)** |
| **Available $K_2O$ (kg ha$^{-1}$)** | **Flame photometric (Extraction with N $NH_4OAc$ of pH 7)** | **Jackson (1973)** |

## Results and Discussion

### Soil moisture and Bulk density

Soil moisture is an important component and key mediator between land surface and atmospheric interactions and the observations can be seen that, soil moisture in the deeper layer having high moisture.

The higher soil moisture content was noticed in *Ceiba pentandra* (12.02%) and (12.9%) at the depth of 0-15 cm and 15-30 cm respectively followed by *A. hirsutus* (8.04%) and (9.86%), *Grevillea robusta* (7.20) and (8.90) and lowest moisture content in *Sterculia companulata* (7.06) and (8.80).The bulk density of soil calculated from the undisturbed soil cores collected from the field under different tree species revealed that bulk density shows a direct relationship with increase in depth of soil and maximum bulk density observed in *Sterculia companulata* (1.14g/cm$^3$) and (1.6g/cm3) with depths 0-15 cm and 15-30 cm respectively followed by *Grevillea robusta* (1.07g/cm$^3$) and (1.35g/cm$^3$), *Artocarpus hirsutus* (1.07g/cm$^3$) and (1.21g/cm$^3$) and the minimum in *Ceiba pentandra* (1.06 g/cm$^3$) and (1.1g/cm$^3$) which is ideal for better plant growth.

### Soil pH, Electrical conductivity and Organic Carbon

The maximum pH observed in *Ceiba pentandra* (6.45) and (6.2) followed by *Artocarpus hirsutus* (6.03) and (5.9), *Sterculia campanulata* (5.78) and (5.70) and the minimum in *Grevillea robusta* (5.60) and (5.45) with the depth 10-15 cm and 15 -30 cm respectively,but Electrical conductivity was found significantly higher in *Artocarpus hirsutus*(0.20 ds/m) and (0.19 ds/m) than the remaining tree species i.e., followed by *Grevillea robusta*(0.19 ds/m) and (0.19 ds/m), *Ceiba pentandra* (0.18 ds/m) and (0.17 ds/m) a *Sterculia companulata* (0.17 ds/m)) and (0.16 ds/m) with respect to depth 0-15 cm and 15-30 cm.The decrease in soil pH and EC under tree cover and increase in soil nutrient and organic carbon content was also observed. Soil organic carbon content was found significantly higher in *Artocarpus hirsutus* (2.38%) and (2.25%) followed by

*Ceiba pentandra* (1.59%) and (1.36%), *Grevillea robusta* (1.65%) and (1.52%) and *Sterculia companulata* (1.33%) and (1.20%) with respect to depth 0-15 cm and 15-30 cm. The SOC content in all the depth, varied significantly and it followed an inverse relation with increase in depth.

## NPK status

available nitrogen at 0-15 cm and 15-30 cm depth under four different tree species likein *Ceiba pentandra*(287.31 kg/ha) and (270.95 kg/ha) was significantly higher than the remaining trees followed by *A.hirsutus* (252.78 kg/ha) and (240.95 kg/ha), *Sterculia companulata* (270.95 kg/ha) and (270.95 kg/ha) and lowest value observed in *Grevillea robusta* (194.01 kg/ha) and (180.63 kg/ha) and the similar pattern was observed in a exchangeable potassium except the *Sterculia componata* is replaced by *Grevillea robusta.* When coming to available phosphorous *Artocarpus hirsutus* (40.74 kg/ha) and (24.1 kg/ha) was significantly higher followed by *Ceiba pentandra* (25.95 kg/ha) and (21.0 kg/ha), *Sterculia companulata* (20.83 kg/ha) and (15.04 kg/ha) and *Grevillea robusta* (16.01 kg/ha) and (12.36 kg/ha) with respect to depth 0-15cm and 15-30 cm wer e noticed. The tree arboretum established in 1987 has changed the physico chemical nature of soil and the land which was converted in to productive and become a rich in soil nutrients, specifically the tree species *Ceiba pentandra*and *Artocarpus hirsutus* were the game changer in all respect of soil physico-chemical alteration in a positive manner.

**Table.1**. Soil moisture and Bulk density (g/cm3**)** of soil under four different tree species of 30-years tree arboretum at UAS GKVK

| | | Soil Moisture | | Bulk Density | |
|---|---|---|---|---|---|
| **Sl. No.** | **Tree species** | **0-15 cm** | **15-30 cm** | **0-15 cm** | **15-30 cm** |
| **1** | *Ceiba pentandra* | 12.02a | 12.9a | 1.06c | **1.10c** |
| **2** | *Artocarpus hirsutus* | 8.04b | 9.86b | 1.07b | **1.21c** |
| **3** | *Grevillea robusta* | 7.20c | 8.90c | 1.07b | **1.35b** |
| **4** | *Sterculia companulata* | 7.06c | 8.80c | 1.14a | **1.60a** |
| | F significance | * | * | * | ***** |
| | Tree species (SEm) | 0.8 | 0.8 | 0.03 | **0.03** |
| | Depth (SEm) | 0.4 | 0.4 | 0.01 | **0.01** |
| | CD | 0.21 | 0.21 | 0.03 | **0.05** |
| | **CV** | **2.3** | **2.3** | **4.1** | **4.1** |

*Significance at 5%
Values in the parenthesis are standard deviation of the mean.
Values followed by same superscript in a column do not differ significantly (LSD, P, 0.05)

**Table.2** Soil pH and Electrical conductivity (ds/m)of soil under four different tree species of 30-years tree arboretum at UAS GKVK

| | | soil pH | | Electrical conductivity (ds/m) | |
|---|---|---|---|---|---|
| **Sl.No.** | **Tree species** | **0-15 cm** | **15-30 cm** | **0-15 cm** | **15-30 cm** |
| **1** | *Ceiba pentandra* | 6.45$^{a}$ | 6.20$^{a}$ | 0.18$^{bc}$ | **0.17$^{ab}$** |
| **2** | *Artocarpus hirsutus* | 6.03$^{b}$ | 5.90$^{b}$ | 0.20$^{a}$ | **0.19$^{a}$** |
| **3** | *Grevillea robusta* | 5.60$^{c}$ | 5.45$^{c}$ | 0.19$^{ab}$ | **0.19$^{a}$** |
| **4** | *Sterculia companulata* | 5.78$^{c}$ | 5.70$^{b}$ | 0.17$^{c}$ | **0.16 $^{bc}$** |
| | F significance | | * | * | * |
| | Tree species(SEm) | 0.16 | 0.16 | 0.07 | **0.07** |
| | Depth (SEm) | 0.32 | 0.32 | 0.15 | **0.15** |
| | CD | 0.30 | 0.21 | 0.01 | **0.01** |
| | **CV** | **4.1** | **4.1** | **15.98** | **15.98** |

*Significance at 5%
Values in the parenthesis are standard deviation of the mean.
Values followed by same superscript in a column do not differ significantly (LSD, P, 0.05)

**Table.3**: NPK status at different depths of soil under different major tree species in tree arboretum.

| | | Organic Carbon % | | Available Nitrogen (kg ha-1) | | Available phosphorous (kg $ha^{-1}$) | | Exchangeable potassium (kg $ha^{-1}$) | |
|---|---|---|---|---|---|---|---|---|---|
| **Sl. No.** | Tree species | 0-15 cm | 15-30 cm | 0-15 cm | 15-30 cm | 0-15 cm | 15-30 cm | 0-15 cm | **15-30 cm** |
| **1** | *Ceiba pentandra* | 1.59b | 1.36c | 287.31a | $270.95^{a}$ | 25.95b | $21.0^{b}$ | $109.30^{a}$ | **$96.00^{a}$** |
| **2** | *Artocarpus hirsutus* | 2.38a | 2.25a | 266.78bc | $240.95^{b}$ | 40.74a | $24.1^{a}$ | $87.63^{b}$ | **$79.20^{b}$** |
| **3** | *Grevillea robusta* | 1.65b | 1.52b | 194.01c | $180.63^{c}$ | 16.01d | $12.36^{d}$ | $54.93^{c}$ | **$51.32^{c}$** |
| **4** | *Sterculia companulata* | 1.33c | 1.20c | 270.95b | $252.78^{b}$ | 20.83c | $15.04^{c}$ | $34.28^{d}$ | **$28.40^{d}$** |
| | F significance | * | * | * | * | * | * | * | * |
| | Tree species (SEm) | 0.05 | 0.05 | 0.28 | 0.28 | 0.18 | 0.16 | 0.17 | **0.17** |
| | Depth (SEm) | 0.02 | 0.02 | 0.14 | 0.14 | 0.09 | 0.32 | 0.08 | **0.08** |
| | CD | 0.12 | 0.09 | 3.50 | 2.48 | 1.44 | 1.02 | 1.42 | **0.35** |
| | **CV** | **15.23** | **15.23** | **1.14** | **1.14** | **4.5** | **4.5** | **1.62** | **1.62** |

*Significance at 5%
Values in the parenthesis are standard deviation of the mean.
Values followed by same superscript in a column do not differ significantly (LSD, P, 0.05)

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