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# Physical Attributes of Soil in Different Forest Cover in South of Tocantins

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

Eucalyptus planting represents 72.7% of the total area of planted trees in Brazil, and is constantly growing in the Cerrado biome. Thus, the present study aimed to evaluate the physical qualities of soil under *Eucalyptus* sp. and a fragment of cerrado sensu stricto. The study was conducted at the experimental farm of the Federal University of Tocantins, campus Gurupi, TO, on the coordinates 11º 46' 25'' latitude S and 49º 02' 54'' longitude W, in soil classified as Plinthosol petric. The collections were performed in the layer with a depth of 0–20 cm, with eleven repetitions for each area. The attributes evaluated were: soil texture, density (DS), particle density (PD) and total

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porosity (TP). The soil granulometric composition in the two studied areas was predominant of the sandy fraction. The values of DS, PD and TP did not show significant differences by Tukey test (5%), which assumes that the change of cover from cerrado sensu stricto to forest planted with *Eucalyptus* sp. does not favor physical problems for the soil under study.

*Keywords: Soil density; soil porosity; sandy soils; physical qualities of soil.*

## 1. INTRODUCTION

The total area of planted trees in Brazil reaches almost 8 million hectares, growth due exclusively to the increase of areas with Eucalyptus that occupies 72.7% of the total area of planted trees in the country [1]. Eucalyptus forestry is constantly growing in the Cerrado domain, mainly driven by the presence of forest-industrial companies. This underscores the importance of the effects of planted forest cover on soil attributes [2].

Forest cover acts as a natural barrier to weather such as wind and rain reducing the impact of droplets on the soil, which decreases runoff and the process of soil erosion [3]. In addition, mulching also promotes a better quality of soil physical characteristics, with the contribution of organic matter, which helps in reducing soil compaction, increases porosity and provides greater aggregate stability [4]. Raindrops when they fall directly into the soil cause greater impact and consequently greater soil compaction, causing pore shrinkage, which reduces aeration, water percolation and hindering plant root development [5].

Physical soil quality is conceptualized as the ability to perform sustainable functions in relation to organic production, environmental quality and to provide healthy conditions for plants, animals and man [6]. Among the main physical indicators used in the evaluation of soil quality, the density and total porosity of the soil have often been used. These indicators are related to the organization of the particles and the porous space of the soil, thus reflecting growth limitations, root growth, seedling emergence, water infiltration and percolation in the terrestrial profile [7].

Considering the importance of vegetable cover in maintaining physical properties for quality soil, this study aims to evaluate the influence of *Eucalyptus* sp. on changes in soil physical attributes compared to a cerrado sensu stricto fragment in southern Tocantins.

## 2. MATERIALS AND METHODS

### 2.1 Characterization of Areas

The study was developed at the experimental farm of the Federal University of Tocantins, Gurupi campus, Tocantins, under the geographic coordinates 11º 46’ 25’’ south latitude and 49º 02’ 54’’ west longitude. The characteristic climate of the region according to Thornthwaite is of type C2wA“a”, sub-humid climate with moderate water deficiency, having two well defined seasons, with about six months of drought comprising the winter period and six months of rain that correspond to summer. The average annual temperature ranges from 25 to 29ºC, the average annual precipitation of 1,650 mm and the average altitude of 287 m [8].

The region's soil is classified as a petric plinthossol, with a plinthic or concretions diagnostic B horizon, formed by mineral, acidic soils, which have as their characteristics high water table or at least have temporary restriction on water percolation, favoring the development of Plinthic horizon, by allowing the terrain to remain saturated with water for at least part of the year, the soils have variable coloration, with a predominance of pale colors [9].

The studied areas were a fragment of cerrado sensu stricto and a stand of *Eucalyptus* sp. Each area has the following characteristics:

The stand of *Eucalyptus* sp. it is approximately 11 years old, with a total area of 0.65 ha and located at the coordinates 11º 46’ 28’’ south and 49º 03’ 08” west. The opening of the area was performed with the aid of a crawler tractor with front-blade, with subsequent soil preparation. The seedlings was produced by the nursery AM Florestal de Brasilândia - SP, with 25 cm tall at planting time. Were planted in pits with dimensions of 0.4 X 0.4 X 0.4 m with the aid of diggers, and spacing of 3 X 2 m between the seedlings [10].

The native vegetation area of cerrado sensu stricto is 22.82 ha, over 50 years old and located at the coordinates 11º 46' 13'' south and 49º 03' 25'' west. The vegetation was characterized by five species with the highest value importance *Myrcia splendens* (Sw.) DC. (13.04%), *Qualea multiflora* Mart. (9.87%), *Protium heptaphyllum* (Aubl.) Marchand (7.53%), *Magonia pubescens* A.St.-Hil. (5.35%), and *Qualea grandiflora* Mart. (5.02%) [11].

## 2.2 Soil Sampling

Samples were collected from May to June 2019, undeformed samples were used to determine soil density and deformed samples used to determine particle density, samples were taken from the 0-20 cm surface layer, with eleven repetitions for each area.

The deformed samples were dried at room temperature and passed through a 2 mm sieve for physical analysis. Undeformed samples were collected with the volumetric ring (measuring 3 x 8 cm, diameter and height, respectively), after collected they were wrapped with PVC paper and placed in foamed boxes for transport.

## 2.3 Physical Soil Analysis

Soil density was determined by the volumetric ring method (Kopecky) [12] and particle density was determined by the volumetric balloon method [13].

From the density and particle density results, the total soil porosity was obtained by the indirect method [14].

The particle size analysis was determined by the pipette method [15]. Subsequently, the triangular diagram developed by Lemos and Santos [16] was used to determine texture classification from laboratory analyzes and to determine sand, silt and clay values (Fig. 1).

## 2.4 Statistical Analysis

Estimates of soil density and particle density of the areas under study were subjected to analysis of variance and the comparison of averages were performed by Tukey test at 5% significance using the SISVAR statistical software [17].

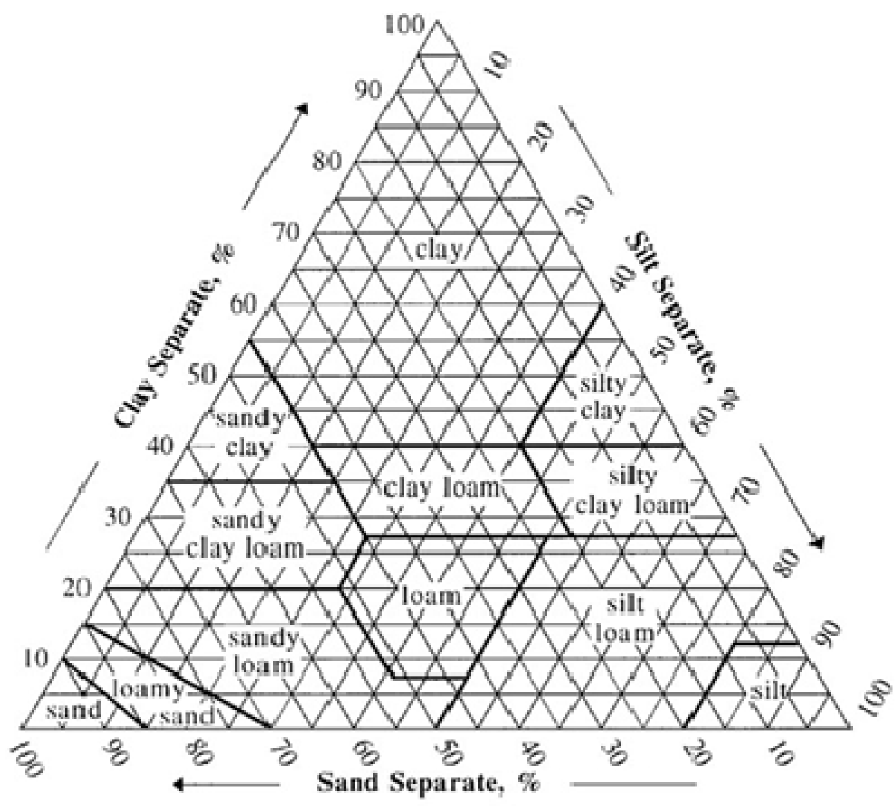


**Fig. 1. Triangular diagram used for soil textural classification**
*Source: [16]*

## 3. RESULTS AND DISCUSSION

The soil granulometric composition in the two studied areas was predominant of the sandy fraction, which is related to the nature of the source material. The soil of the cerrado sensu stricto area presented a Sandy-clay-loam texture and in the planting area of Eucalyptus sp. Sandy-clay (Table 1). The predominance of sand in both soils may indicate low nutrient uptake capacity due to the size of their relatively large aggregates, which makes them poorly capable of holding water and not adhering to each other. The presence of frank texture may indicate that the percentage of clay contained in the soil, although reduced, can induce its clay properties in the soil [18].

According to Rosa et al. [19] DS and TP are less influenced by the type of management when it presents soils with clay content within the values found in this study. This may explain the equality in the soil density and total porosity results in both forest cover, as the clay content found, 36.64% for eucalyptus soils and 34.58% for cerrado sensu stricto was within the proposed range.

Soils under different uses differ in their physical attributes in relation to native vegetation, and these differences are more evident in the topsoil [20]. Among the two forest coverings, the area of Eucalyptus presented higher values for DS and TP however; the numbers did not present significant difference. The average soil density at 0–20 cm depth was 1.66 g $cm^{-3}$ for Eucalyptus and 1.63 g $cm^{-3}$ for the cerrado sensu stricto area (Table 2), data within the range considered normal for sandy soils according to Ren et al. [21]. The results found in this study can be justified due to their similar particle size that both had a direct influence on the density, since the studied area does not present traffic of vehicles or animals that justify the high density values found. However, the density data presented may indicate the occurrence of soil degradation, which indicates probable soil compaction and / or densification [5]. The higher DS value for the soil under Eucalyptus planting compared to the cerrado sensu stricto shows that the soil of the area is still in regeneration process, due to the land preparation, fertilization and planting process. However, it is worth highlighting the values close of DS and PD presented by the soil of both areas.

Brizi et al. [22] and Almeida et al. [23] found similar numbers to those exposed in this study, where the density found in areas that did not presented alteration (native vegetation) was lower compared to planted forests. Zhang et al. [24] confirms in the results presented in their study that the lowest values of DS are found in areas under native forest.

The PD presented similar results in the soils of both areas, 2.59 g $cm^{-3}$ for eucalyptus and 2.58 g $cm^{-3}$ for cerrado sensu stricto (Table 2). There were no significant effects on treatments and the results are very close to the values found for most mineral soils, where the PD varies between 2.60 and 2.75 g $cm^{-3}$ [25]. These numbers are probably due to the presence of minerals such as quartz, feldspar, mica and silicate colloids in the soil, since soils with these characteristics have particle density values close to this range [22].

The soils of both cover analyzed present predominance of coarse sand and fine sand which justifies its high density. Sandy soils have a higher density than fine textured soils (considerable clay contents), as they have a low amount of organic matter and solid particles less

**Table 1. Granulometry and texture of soil in cerrado sensu stricto and *Eucalyptus* sp.**

| Forest Coverage | Coarse Sand | Fine Sand | Silt | Clay | Texture |
|---|---|---|---|---|---|
| Cerrado *sensu stricto* | 45.08 ±2.96 | 12.73 ±1.64 | 7.61 ±0.55 | 34.58 ±2.45 | Sandy-clay-loam |
| *Eucalyptus* sp. | 46.38 ±2.27 | 10.39 ±2.69 | 6.59 ±1.42 | 36.64 ±2.02 | Sandy-clay |

**Table 2. Average values of density (DS), particle density (PD) and total porosity (TP) of soil in cerrado sensu stricto and *Eucalyptus* sp**

| Forest Coverage | Depth (cm) | DS (g $cm^{-3}$) | PD (g $cm^{-3}$) | TP (%) |
|---|---|---|---|---|
| Cerrado sensu stricto | 0 – 20 | 1.63a* | 2.58a | 35.77a |
| *Eucalyptus* sp. | 0 – 20 | 1.66ª | 2.59a | 36.93a |

** Averages followed by the same letter do not differ statistically from each other at 5% significance by the Tukey test (P = 0.05)* predisposed to form aggregates. Sandy and clay soils have similar pore quantities, with the difference that sandy soils have fewer pores within their aggregates which justify a lower total porosity [7].

Thus, the TP numbers found are in agreement with what was exposed by Brady and Weil [25], since the studied soil presents predominance of sand and probably low organic matter content, which justifies the total pore percentage for the soils under the planting of Eucalyptus 36.93% and for the cerrado sensu stricto 35.77% (Table 2).

The proximity of the found values of DS, PD and TP in soils under Eucalyptus and the cerrado sensu stricto shows that forest management such as Eucalyptus sp. contribute to the maintenance of the physical attributes of the soil, most likely due to the absence plowing practices and the greater disposal of organic matter in the soil, considering this within the limitation of sandy soils.

## 4. CONCLUSION

In view of the results obtained, it can be concluded that due to Eucalyptus planting and Cerrado sensu stricto not present significant differences in the soil physical attributes evaluated in the 0-20 cm depth, it can be stated that Eucalyptus planting contributes to the maintenance of physical attributes of the soil.

The soil density in both analyzed areas is mainly due to the high sand contents present in the granulometry.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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