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The Influence of Organic Fertilizer on the Seedling Growth of an Oleaginous Species from the Amazon: Andiroba (*Carapa Procera* Aubl.)

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***Abstract*—** *Andiroba (Carapa Procera Aubl) belongs to the Meliaceae family and is a plant of great importance for the traditional medicine in the Amazon. Also, the oil obtained from its seeds is widely used in the cosmetics industry. The following study was carried out at the Tropical Silviculture Experimental Station of the National Institute of Amazon Research (EEST/INPA), where the growth of andiroba seedlings was evaluated using three types of substrates which received daily irrigation, according to the following treatments: T1 = sand/clay; T2 = clay/organic fertilizer and T3 = forest topsoil. The following data were collected monthly: height, neck diameter, and number of leaves. The results showed a non-significant difference with a t-test at a p-value of 0.05 for seedling height. For neck diameter, there was a significant difference, especially in T2 and T3, which presented higher average values, indicating that the use of both commercial organic fertilizer and forest soil which particularly has a high concentration of decomposing organic matter, are beneficial to seedling growth. However, the usage of forest topsoil as a substrate must be taken carefully due to the large amount needed that may harm local ecosystem. Therefore, seedling production with organic substrates is a viable alternative for local producers disposed to produce better quality seedlings.*

***Keywords*— andiroba, oil, seedlings, seedling nursery, substrates.**

I. INTRODUCTION

Andiroba (*Carapa Procera* Aubl.) stands out among the oilseeds tree species due to its productive and economic potential It is a multiple-use species of great economic, ecological and social importance for the Amazon region [1]. This tree is of great import

ance in the pharmacopeia of the Amazonas State. Amazon traditional people use its products – made with the oil extracted from seeds, for medicinal purposes such as healing ointment, insect repellent, external anti-inflammatory, febrifuge as well as anthelmintic. The cosmetics industry uses it to make shampoos, moisturizers, and soaps [2]. Andiroba seeds contain 56% of a clear, liquid and light-yellow oil that, when subjected to temperatures below 25 ° C, it solidifies to a similar consistency of petroleum jelly. Also, andiroba timber is used in construction, furniture, veneer and plywood [3].

Studies with andiroba have shown that it has the potential to adapt to anthropized environments [4]. That makes it a promising species for restoration and enrichment of degraded areas [2]. Despite all existing forms of use and their importance to traditional populations, many trees have been cut down, often illegally in order to support the woodworking sector, leading to the reduction of natural populations and the loss in production of tons of seeds, which could have been produced throughout the lifecycle of an Andiroba tree.

In the Amazon around two hundred thousand families profit from the use of non-timber forest products (NTFP) of various species [5] as a source of income. Andiroba seed oil provides additional profit for the Amazon traditional people but seedling production of this species is irregular and highly predated by the *Hypsipyla ferrealis* Hampson and *Hypsipyla grandella* Zeller, which are insects that decrease the germination percentage [6], besides high cost

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added due to the need for chemical fertilization. Rural producers find it difficult to produce seedlings on farms via germination. Given this fact there is a need to try alternatives to reduce the costs in the phase of seedling production and provide technical support to the traditional populations of the Amazon.

The aim of this paper is to evaluate the nursery growth of Andiroba seedlings, submitted by different substrate types, including the use of organic fertilization.

II. METHODS

2.1 Description

2.1.1 Genus

The genus *Carapa* is widely distributed in Africa, South America and Central America. There are two genetic varieties: *Carapa guianensis* and *Carapa procera*. Due to its use as a NTFP, the extractivist exploitation of the species is increasing, leading to the need of conservation strategies of natural resources, such as projects to develop its adequate management [2].

2.1.2 Species

The species is commonly known as *Andiroba, Andirobeira, Andirobinha, Igapó andiroba, Carape, Andiroba, Penaiba,* among others. The synonyms *Carapa guianensis* and *Carapa procera* are known by the same common names and are also commercialized as the same species [7]. *Carapa guianensis* is found throughout the Amazon basin mainly in *várzeas* (floodplain areas in the Amazon basin) whereas the *Carapa procera* species is more restricted to the Amazon, but also found in Africa [2]. It is a leafy tree that can reach up to 55 m in height. The species *C. procera* is smaller and can reach up to 30 m in height. Its stems are cylindrical and erect, and might present buttresses. Its barks are gray, thick and bitter. Its leaves are dark green and elongated and display small, cream-colored flowers.

Its fruits are globe-like and may contain from 4 to 16 seeds, which are released when it gets in contact to the ground. Its seeds float and can be dispersed through the watercourse stream, but on forests in *terra-firme* (upland areas in the Amazon basin), most fruits and seeds are found under the parent trees. During the dispersal period, seeds are sought out by rodents, armadillos, wild pigs, lowland pacas, deer, cotias, etc.

2.1.3 Usage

The species presents a wide range of usage. Its wood can be easily handled, due to physical-mechanical qualities and is sought after for building houses and manufacturing furniture. The bark is used by the traditional population to treat fever, worms and bacteria. Its seeds are used for oil production, used in the region as local medicine to treat tumors, rheumatism, worms, muscle strain, healing as well as insect repellent. The cosmetics industry also uses the oil to make shampoo, body oils and soaps. The seed residue is used for candle making as a mosquito repellent against *Aedes aegypti* which is responsible for transmitting the dengue fever. The candle is not toxic and does not produce smoke while burning [9].

In the cosmetics market, there are three noteworthy companies that profit from Andiroba oils: Cognis do Brasil, CRODA and BERACA, which provide the raw material for large cosmetics companies both intern and foreign market [9].

2.1.4 Seedling production

The seeds used for seedling production should be obtained by collecting the previously selected parent trees, not containing pests or diseases, presenting a well-developed crown and good growth in height and diameter.

Seed extraction should take place as soon as possible by manually opening the fruits and placing for germination shortly after harvesting, covered with a layer of rich organic matter substrate and should be irrigated twice a day in a semi-shaded environment [10]. In order to obtain good quality seedlings, it is necessary to evaluate the type of substrate and the size of the recipient that will be used. It must also provide root development and nutrition during the seedling nursery period.

2.1.5 Forest seeding market

Forest establishment for industrial purposes has expanded, making it a challenge to produce good quality seedlings at a lower cost on a commercial scale [11].

One of the biggest problems for the practice of environmental restoration in the Amazonas State is the scarcity of native forest species seedlings produced in seedling nurseries accredited by Environmental Agencies. The lack of knowledge in seedling production techniques means that the population does not possess a viable alternative to develop a potential economic activity.

III. STUDY DELIMITATION

In order to develop better quality Andiroba seedlings at a lower cost, the study was developed by using different types of substrates. The results obtained could be used by farmers and nurseries in the region to enhance production performance. The study was conducted in the seedling nursery of the Tropical Silviculture Experimental Station of the National Institute of Amazon Research (EEST/INPA), located at BR-174, km 42.

Due to the fact that the 2006 seed production failed to present the expected production at the time. It was not possible to use seeds for seedling production. However, in

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order to carry this study, seedlings were obtained from natural regeneration.

3.1. Natural Regeneration

Seedlings were collected under primary forest parents trees at BR – 174, km 42. The seedlings were approximately ± 10cm tall and were left in the nursery for 30 days. After this rustification period, the seedlings were placed in 20cm x 32cm recipients containing the three different substrate types.

3.2 Organic Fertilization

It was added 150g of commercial organic fertilizer per seedling, and the same amount continued being added every 2 months. All seedlings were distributed in seedbeds under 50% shading. The treatment were the following ones: T1 = sand/clay, T2 = clay/organic fertilizer and T3 = forest topsoil, which were daily irrigated.

3.3 Data Gathering

Growth data were collected monthly. The seedlings remained in the nursery for 212 days including the entire experimental period, and the following variables were monitored: overall height, seedling neck diameter and number of leaves.

All seedlings containing greenish-colored stems, regardless of the presence of leaves, were considered alive.

3.4 Experimental Design

The experimental design chosen was the DBC with 6 replications of 7 samples each per treatment, coming to a total of 126 seedlings that were submitted to t-test at a p-value of 0.05 and the analyzes were obtained by the Sisvar statistical program.

IV. RESULTS AND DISCUSSION

According to the results achieved, after 180 days, the analysis of variance of height growth of Andiroba seedlings did not show significant interaction (p-value < 0.05) among the tested substrates. The forest soil substrate presented higher average values during the months of observation.

For the seedling neck diameter, the data showed a significant difference, especially for treatment T2 which obtained higher average values when compared with different treatments. When it comes to the T3 data, it can be seen that the high concentration of decomposing organic matter contained in the forest soil was beneficial to the diameter growth of the seedlings. However, the removal of large amounts of forest soil superficial layers can impair the ecosystem dynamics.

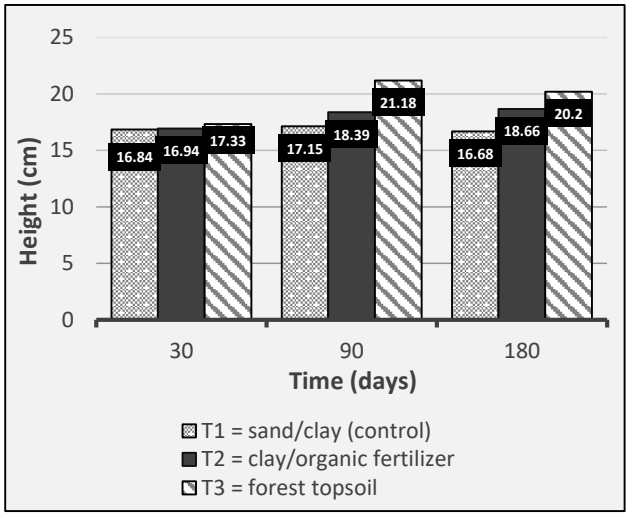

Fig. 1: Growth in height of Andiroba (Carapa procera Aubl.*) seedlings submitted to different substrates (T1, T2 and T3).*

Table 1. Means of variables: Height and neck diameter as a function of different substrates and organic fertilization of Andiroba (Carapa procera Aubl. seedling after 180 days).

Treatment	Composition	Height*	Diameter*
1	sand/clay *(control)*	17,04 A	4,08 B
2	clay/organic fertilizer	**18,90 A**	**4.67 A**
3	forest topsoil	18,51 A	4,56 AB
CV(%)		5,51	4,24

* Averages followed by the same letter do not differ significantly by the t-test (p-value < 0.05).

V. CONCLUSION

The production of seedlings using forest soil as substrates presented the best results. However, this soil has a seed bank and nutrients for plant development. Large-scale use may affect the forest successional stages.

The given results presented above show that the treatment using clay and organic fertilizer is viable for local producers disposed to produce better quality seedlings. This fertilizer can be produced by the farmers themselves or purchased in local trade market. The use of this substrate is indicated as a source of nutrients and at a low cost besides not affecting the environment.

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