ISSN 2236 - 4420

Influence of the different substrates in the production of seedlings of mutamba (*Guazuma ulmifolia* Lam. Malvaceae)

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Abstract: In the propagation of plant species, depth and substrate are conditions needed for seed germination and seedling development. Therefore, this study evaluated the effects of the influence of different depths on germination of *Guazuma ulmifolia* Lam seeds as well as the seedling production, using different substrates. For analysis of depth and substrate, it was used the design in randomized blocks (DBC); in both analyzes were used 5 treatments, 4 replicates and 25 seeds per plot. In the test, the seeds were sown at different depths (cm): P1 - Witness (seeds exposed at the surface); P2 - 0.5; P3 - 1.0; P4 - P5 and 2,0 - 3,0. In the analysis of substrate, the treatments were: 80% of soil and 20% of wood shavings (S1 - Witness); 80% of soil and 20% of washed sand (S2); 80%of soil and 20% of cattle manure (S3); 100% of soil (S4); 80% of soil and 20% of sawdust (S5). The variables analyzed were: Emergency Speed Rate (ESR), height (cm), number of leaves, lap diameter (mm), root length (cm), fresh and dry weight of shoot, fresh and dry weight of root (g). It was found that the depth of 0.5 to 1.0 cm presented a faster speed of emerging seedlings. The treatment with 80% of soil and 20% of cattle manure showed better development for plants.

Keywords: Propagation, Germination, Overcoming dormancy.

Influência de diferentes substratos na produção de mudas de mutamba (*Guazuma ulmifolia* Lam. Malvaceae)

Resumo: Na propagação de espécies vegetais a profundidade e o substrato são condicionantes necessários à germinação das sementes e ao desenvolvimento das plântulas. Diante disto, esse trabalho avaliou os efeitos da influência de diferentes profundidades na germinação das sementes de *Guanzuma ulmifolia* Lam., bem como a produção de mudas utilizando diferentes substratos. O experimento foi conduzido na casa de vegetação do Departamento de Ciências Humanas da Universidade do Estado da Bahia (UNEB), *Campus* IX / Barreiras. Para análise de profundidade e de substrato utilizou-se o delineamento em blocos ao acaso (DBC) em ambas as análises foram utilizados 5 tratamentos, 4 repetições e 25 sementes por parcela. No ensaio as sementes foram semeadas em diferentes profundidades: P1 - Testemunha (sementes expostas à superfície); P2 - 0,5; P3 - 1,0; P4 - 2,0 e P5 - 3,0. Já na análise de substrato os tratamentos foram: 80% de solo e 20% de maravalha (S1 - Testemunha); 80% de solo e 20% areia lavada (S2); 80% de solo e 20% de esterco bovino (S3); 100% de solo (S4); 80% solo e 20% de pó de serragem (S5). As variáveis analisadas foram: IVE, altura, número de folhas, diâmetro do coleto, comprimento da raiz, massa fresca e seca da parte aérea, massa fresca e seca da raiz. Verificou-se que a profundidade de 0,5 e 1,0 cm foi a que apresentou maior velocidade de plântulas emergidas. Já o tratamento com 80% de solo e 20% de esterco bovino foi o que melhor exibiu desenvolvimento para as plantas.

Palavras chave: Propagação, Germinação, Superação da dormência.

Introduction

The Cerrado is one of Brazilian ecosystems which in recent years have achieved high levels of exploitation for the agribusiness supply, endangering its conservation and biodiversity. Due to this degradation process, it is of great importance the replacement of native vegetation in this ecosystem. This replacement depends on basic knowledge on the development and adaptation of species that are occurring (Oliveira et al., 2005).

The replacement of the original vegetation of cerrado by monocultures and grasslands entails large losses in biodiversity, where exotic species with high competitive ability dominate the native species that became extinct (Pivello, 2006). In an attempt to restore native vegetation some factors should be observed for the production of seedlings, seed storage, temperature, moisture, soil type, and for the emergence another factor becomes important: the depth. There are few studies covering the sowing depth, however, the irregularity of the arrangement of seeds in the soil in the direction of depth, can cause significant yield losses.

The success of the initial growth in reforestation, among other factors, also depends on the quality of the substrate (Barros et al., 2007). According Zietemann and Roberto (2007), the substrate is intended to sustain the plants during the rooting and to serve them as a source of nutrients.

According to Martins (2007), the *Guazuma ulmifolia* Lam. stands out in phytosociological survey of Riparian Forests, and this, according to scientific reports, shows efficacy in recovery projects because of its rapid development and providing of fruits that contributes to fixation of the fauna. It is recommended for natural revegetation of gullies (Farias et al., 1993), but its seeds have a mechanical barrier preventing the integument (Araújo Neto & Aguiar, 2000). This is due to the mucilage that covers the seed, which should be eliminated for good germination (Santos, 1979).

The species *Guazuma ulmifolia* is popularly known as mutambo, mutamba, fruit-of-monkey, embira, embireira and true mutamba. It belongs to the Malvaceae family comprising 250 genera of pantropical distribution. Herbaceous, shrubby or arboreal with leaves arranged alternately, simple or compound with stipules. Its flowers are small or showy, diclamídeas, cyclical, hermaphrodite, pentamerous, in general, of radial symmetry. Dried fruit, berry, esquizocarpo, capsule, samara or drupe. Its seeds sometimes are oilseeds (Souza & Lorenzi, 2005). It is a heliophila, semideciduous, pioneer species, and characteristic of secondary formations occurring throughout Latin America (Barbosa & Macedo, 1993).

According Malheiros and Junior (2001), is a species adapted to soils with good fertility, more frequent in soils with pH greater than 5.5. In Brazil, the season of its flowering occurs in late September through early November, the fruits of this flowering mature in the next year in the months of August and September (Araújo & Aguiar, 1999).

Aiming to produce seedlings for restoration of degraded areas arise several alternative of substrates, which hardly presents all favorable characteristic to the growth of seedlings (Carneiro, 1995).

In this sense, there are mixtures of substrates with vermiculite, organic compounds, cattle manure, urban waste, worm humus, peat, charcoal ash, subsoil land, sawdust, cane bagasse and acicula of Pinus, among others, usually conditioned by their availability (Gonçalves & Poggiani, 1996). Therefore, the choice of the type of substrate should be made according to the requirements of the seed (Brasil, 2009).

Considering the great importance of this species for restoration of degraded areas, this work aimed to evaluate the seed germination of *G. ulmifolia* at different depths, as well as the production of seedlings, all using different substrates in a protected environment with 50% of brightness.

Material and methods

The experiment to evaluate the emergence of mutamba seeds at different depths was conducted in the nursery of native species of the Cerrado Biome in March 2014, located in the Department of Humanities at the State University of Bahia [UNEB], Campus IX / Barreiras, BA, at 12º 08’ 38” S e 44º 57’ 22” W; with an average altitude of 452 m. The climate, according to Köppen, is of type Aw, sub-humid and dry, with an annual average of 1,018 mm per year. The average annual temperature of 25.1 ° with a maximum of 32 ° and minimum of 18.1 ° and annual average relative humidity of 68% (climatological standard: 1961-1990), National Institute of Meteorology of Brazil [INMET] (2005).

The fruits were collected from 10 matrices in Barreiras, BA, located in the following geographical coordinates: 12 ° 08 '41.8 "latitude and 44 ° 57' 44.9" longitude, at an altitude of 502 m. In the Native Seed Laboratory of the Cerrado biome, was carried out a selection of fruits, choosing those who provided the size uniformity. Therefore, it was used 20 fruits of each matrix, and these showed no signs of attack of pests and diseases.

After processing of fruits, the seeds removed were stored in plastic bag in the refrigerator for four days until the day of planting. To overcoming dormancy, a heat shock was used, in which the seeds were submerged in water 80 ºC during for two minutes, and then placed in water for two hours (Lima et al., 2003). After these procedures, the seeds were transferred to paper towels so that all the mucilage covering the seeds was dried to be, in the following day, sown in Sand sterilized in an autoclave at 120 °C for two hours.

For the analysis of depth, we used a randomized block design (RBD) with 5 treatments, 4 replicates and 25 seeds per replicate in plastic trays with size 36.5 cm long, 24 cm wide and 7, 5 cm depth, where: P1 - witness (launched surface); P2 - seeds sown 0.5 cm; P3 - 1.0 cm; P4 - 2.0 cm; and P5 - 3.0 cm.

The experiment was monitored daily, and watered twice daily for fifteen minutes with through the irrigation system of the nursery. The number of emerged seedlings was counted until the last emerged one (25 days after sowing). It was considered the emerged seedlings with two pairs of full leaves. It was used the formula Maguire (1962) for calculating ESR according to the equation:

$$IVE = \frac{E_1}{T_1} + \frac{E_2}{T_2} + \dots \frac{E_i}{T_i}$$

In which:

Emergency Speed Rate (ESR);

E1 to Ei is the number of emergence occurring every day;

T1 to Ti is the time (days).

Seventy days after transplanting, the plants were evaluated and the variables studied were: number of leaves; root size and plant height, both measured with a millimeter ruler. The first, after the removal of the entire substrate and the second by the distance between the lap and the apical bud of the plant; stem diameter - with the digital caliper was obtained the stem diameter in the lap region of the plant; fresh weight of shoot (FWS) and root system (FWR) - the seedlings were sectioned in the lap region of the plant, separating the plant shoots from the roots and then were weighed on an analytical balance and placed in kraft paper bags ; and dry weight of shoot (DWS) and root (DWR) - after weighing, the mass of fresh material was dried in a greenhouse with forced air circulation regulated at 65 ° C for 24 hours.

In the assay for analysis of the substrate, DBC was used, which consisted of five treatments and four replications. After sown in trays, seedlings were transplanted into black plastic bag with size of 25.5 cm long and 14.7 cm wide. The treatments were: 80% of soil and 20% of wood shavings (S1); 80% of soil and 20% of washed sand (S2); 80% of soil and 20% of cattle manure (S3); 100% of soil (S4); 80% of soil and 20% of sawdust (S5). Chemical and analysis of the substrates, according to the adopted methodologies for Cerrado soils (Embrapa, 1997), was performed.

Data were subjected to analysis of variance by F test ($p < 0.05$) and the means were compared by Tukey test at 5% of probability, using the software ASSISTAT version 7.6 Beta, (Silva, 2011).

Results and discussion

The emergence of the seedlings of the *Guazuma ulmifolia* species occurred after seven days of sowing, in which the emergency speed rates (ESR) were observed for each treatment used. The treatments P3 and P2 were the most efficient treatments, presenting a rate of 4,595 and 3,545, respectively (Table 1).

The results found by Motta et al. (2006) evaluating the longevity of mutamba seeds showed that these, when placed on the soil surface and buried at 2 cm deep, have a higher rate of seedling emergence in the field that the buried seeds at greater depths. This is in agreement with the present work, because the seeds buried at 1 cm (P3) depth proved to be superior compared with those buried at greater depths. The inferiority of emergence of seeds placed on the surface (P1), according to Baskin and Baskin (1998) is justified because it is more exposed to environmental conditions.

Table 1- The means of treatments related to the ESR at different depths. Barreiras, 2014.

Treatments	The means in respect depth
P1	1,040 d
P2	3,545 b
P3	4,595 a
P4	2,335 c
P5	0,162 e
C.V	12,15

The Means followed by the same letter do not differ statistically by Tukey test at 5% of probability.

According to Wendlinng et al. (2007), for the production of seedlings with quality, one of the most important factors is the quality of the substrate that sustains them therefore some aspects such as acidity, aeration, humidity and fertility are closely linked to the substrate. The results of the leaf number evaluation, according to Table 2, show that for this variable there was a significant difference between treatments, in which S3 presented the highest number of leaves. The diameter of the collector of the S3 treatment was superior to the other treatments, because the substrates interfered in its thickness. These results were possible due to the fact that S3 presented higher fertility of essential nutrients in relation to the other treatments.

Table 2 - The means of the results of variables evaluated on different substrates: number of leaves, lap diameter, height and root length. Barreiras, 2014.

Treatments	Number of leaves	Diameter of the lap (mm)	Height (cm)	Root length (cm)
S1	6,550 d	1,394 c	5,905 c	19,84 b
S2	10,65 b	2,645 b	16,265 b	27,75 a
S3	12,15 a	4,402 a	31,69 a	27,40 a
S4	8,650 c	1,843 bc	6,025c	19,72 b
S5	7, 600 cd	2, 008 bc	4,657c	23,27 ab
C.V	7,28	15,64	16,44	10,74

The means followed by the same letter do not differ statistically by Tukey test at 5% of probability.

These data confer with those of Coelho et al. (2008) who worked with *Heteropteris aphrodisiaca* O. Mach (nó de cachorro) seedlings on different substrates, and a better development in stem diameter was for substrate seedlings containing manure in their composition. Souza et al. (2006) also worked with different forest species and obtained the best results for stem diameter in the plants submitted to the same treatment.

The best performance of the species in the S3 treatment can be justified by the chemical analysis of the substrate (Table 3), where the amount of phosphorus (P) of the treatment is within the normal range while the other treatments showed deficiency of this element. According to Naiff (2007) and Lima (2009), this deficiency reduces the respiration and the photosynthesis, as well as decreases the plant height, causes delay in emergence of leaves and reduction in sprouting, in the development of secondary roots and in dry matter and seeds production.

S3 also showed an excellent amount of magnesium (Mg) which, according to Veiga (2006), helps phosphorus absorption, where it may acts increasing its absorption efficiency by the roots. After absorption, the phosphorus is accumulated in the cortical cells of the root and then transferred to the xylem through the simplasto, reaching the leaves or the growing regions (Malavolta, 2006).

Table 3 - Results of chemical analysis of substrates (S1, S2, S3, S4, S5) used to assess the development of *Guazuma ulmifolia*. Barreiras, 2014.

Trat.	**pH**	**M.O**	**P**	**K**	**H + Al**	**Ca**	**Mg**	**Ca +Mg**	**SB**	**CTC**
	(H_2O)	g/Kg	$mg\,dm^3$	$mg\,dm^3$	$mg\,dm^3$	cmol/ dm^3	Cmol/ dm^3	cmol/ dm^3	cmol/ dm^3	Cmol / dm^3
S1	6,11	2,40	7,90	93,00	1,70	2,0	0,60	2,60	62,54	4,54
S2	6,29	2,0	6,80	52,60	1,60	2,20	0,70	2,90	65,48	4,63
S3	6,79	2,20	22,60	368,80	1,20	2,80	1,10	3,90	80,15	6,05
S4	6,31	2,80	6,80	109,00	1,80	2,30	0,70	3,0	64,56	5,08
S5	6,29	3,10	10,90	110,00	2,0	2,0	0,60	2,60	59,03	4,88

Phosphorus (P) is one of the essential elements in the metabolism of plants, playing an important role in transfer of cell energy, acting in respiration and photosynthesis, and also as a structural component of nucleic acids, coenzymes, phosphoproteins and phospholipids that will promote the growth and development of plants structures mainly in the early stages. It is a mobile element and the absorption occurs largely by diffusion until the roots, being this form of absorption considered the most limiting factor, since this element is naturally available in low quantities in the soil and the absorption by the plants is proportional to the volume of the roots (Grant, 2001).

The other treatments present a large amount of magnesium within the standard, but much smaller. The treatment also showed a high value of potassium (K), which according to Bergmann (1992) plants can tolerate high concentrations of potassium without presenting disturbances, which may have directly influenced in the height of the plants that was relatively larger in this treatment.

The results for MFPA, MSPA, MFR and MSR (Table 4) indicated that substrate 3 composed of soil + bovine manure yielded superior results to the other substrates. Costa et al. (2005) obtained the best results and an adequate ratio of development between root and shoot (aerial part) with the combination of manure and black soil evaluating different substrates for the production of jenipapo seedlings (*genipa americana I.)*, which is also a native species of the “cerrado” biome. According to the author the presence of manure is necessary as a substrate component, improving the structure and especially nutritional issues, since the essential nutrient contents such as P, K, Mg and Ca were superior for the production of jenipapo seedlings with the presence of manure in the soil. The lower development of shoot and root mass of treatments S1, S2, S4 and S5 (Table 4) must have occurred because of the phosphorus deficiency presents in these treatments. Alves et al. (1996) reports that phosphorus deficiency interferes with the assimilation of nitrogen, which reduces respiration and photosynthesis, causing a decrease in plant height, delay in emergence of leaves and reduction in sprouting and development of secondary roots.

Table 4 - Means of the results of the variables: fresh weight of shoot, dry weight of shoot, fresh weight of root and dry weight of root in different substrates. Barreiras, 2014.

Treatments	Fresh weight of shoot – (g) FWS	Dry weight of shoot - (g) DWS	Fresh weight of root – (g) FWR	Dry weight of root - (g) DWR
S1	0,696 c	0,193 c	0,622 c	0,133 d
S2	3,477 b	0,894 b	4,259 b	4,250 b
S3	10,84 a	2,916 a	19,353 a	19,304 a
S4	1,121 c	0,280 c	0,749 c	0,724cd
S5	1,034 c	0,281 c	1,811 c	1,811 c
C.V	22,24	27,31	14,27	13,83

The means followed by the same letter do not differ statistically by Tukey test at 5% of probability.

Conclusion

It has been observed that in order to obtain a higher rate of emergence speed, the *Guazuma ulmifolia* seeds should be sown from 0.5 to 1.0 cm of deepness. The substrate that allows a better development of the plant is composed of 80% of soil and 20% of bovine manure.

Acknowledgments

To the Research Support Foundation [FAPESB] for granting the scholarship and to Mrs. Mariana de Jesus Lima for their support in this work.

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Recebido em: 13/04/2015
Aceito em: 18/04/2017