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Technical Note

Brightness and recipient in the emergence and development of cedar plants[1]

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Abstract

Cedar is a species of great economic value and intensive exploitation by timber industries. The conventional production presents problems of standardization and research that would require the propagation and development. This work aimed to evaluate the emergence and development of cedar plants (*Cedrela odorata*) through the use of morphological parameters, produced in different environments and recipients. The experimental design was completely randomized, arranged in a factorial arrangement 2 x 2 (two sizes of recipients and two light intensities in Plantmax® with five replications of 10 plants. The evaluations were performed daily after sowing until the 63th day, environment in full sun and shading of 50% in tubes with volumes of 50 and 110 cc. These characteristics were the emergency number of seedlings, the index of germination speed, the diameter of the collar, the length of root length shoot, the dry weight of root and dry weight of shoots. Based on the results of the small container (50 cm³) may be used. The environment with 50% shade enhanced growth of seedlings of cedar until the day 63th.

Keywords: Tree seeds, Meliaceae, Forest nurseries, *Cedrela odorata.*

Introduction

Cedar (*Cedrela odorata*), which belong to the family Melicacea and is popularly known as Spanish cedar, Mexican cedar, Cigar-box cedar, Cedro-cheiroso in natural stage, and it is a species partially umbrófila in the young stage and heliophyle in the adult stage, which occurs both in the primary forest, mainly in the forest borders or clearings, as in the secondary forest, however never in pure formations (AMARAL, 2006).

For the conventional production in initial stage of cedar in basic studies the knowledge of the Best environment and ideal size of container are of main importance. SILVA et al. (2007), observed that the efficiency in the plant growth may be related to the ability of adaptation of seedlings to the light conditions of the environment.

According to PEREIRA et al. (2002), the productivity of forest species, mainly the natives, is determined by the capacity of capture of the sun radiation of each species, of the transformation and form of distribution of photoassimilates from leaves to the rest of the plant.

The use of shading screed for the evaluation of the seedling vigor, in order to simulate natural conditions of shading, has been frequently tested due to great difficulties of reproducing the natural environment. The use of protected environment (shaded) helps in the control of the temperature, in the intensity of the sun radiation and, in great part, improves the environmental conditions for the production (FONSECA et al., 2002).

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When evaluating potential of Forest species for restoration of changed areas, ALMEIDA et al. (2005) produced seedlings of *Jacaranda puberula* in plant nursery with different levels of shading. The seedlings at full sun presented high index of mortality when compared to those produced at 50% of shading.

The quality of the seedlings depends on the recipient to be used, and must consider biological, physical, technique and economical nature, as good root formation and permeability, good humidity retention, easiness of management and transport and, if possible, enable the mechanized planting and satisfactory costs (CARNEIRO, 1995).

For some species, depending on their size, tubes may restrict the growth of the root system. This restriction is applied for seedlings of *Jacaranda* sp may harm the growth of the species in the plant nursery (REIS et al., 1991). However, GOMES et al. (1985), when researching the use of rigid plastic tubes of 50 cm^3 of volume, and verified that they provided to *Eucalyptus grandis* the development of a more structured root system.

SANTOS (2000) found significant differences in the growth of seedlings of *Cryptomeria japônica* between tubes of different dimensions (50 cm^3, 56 cm^3, 120 cm^3 and 240 cm^3), verifying better development for seedlings produced in the reciepes with higher volumes.

LISBOA (2006) produced seedlings of Spanish cedar in tubes with dimensions of 56 cm^3, 115 cm^3, 180 cm^3 and 280 cm^3 and, after the morphologic evaluations, concluded that tubes of 280 cm^3 are the most indicated to this species.

In the choice of the package, it still must be considered the cost of acquisition, the height of the seedling to be commercialized, the seed size, the area of the plant bed and the management to be adopted (HAHN et al., 2006).

In this sense, the objective of the work was to evaluate the emergence the seedling vigor in cedar plants in different environments and recipients trough morphological parameters and their inter relations.

Material and Methods

The experiment was conducted in the *Viveiro da Floresta*, located in the municipality of Rio Branco, Acre, in the period from January to May 2011. It is geographically located at 9° 58' 29" South and 67° 48' 36" West, in an altitude of 153 meters above the sea level, and it is part of the zone of confluence of the Andean mountains and Amazonian lowlands.

For the development of the experiment it was used seeds of the forest species cedar (*Cedrela odorata*), acquired in the bank of germplasm of the Fundação de Tecnologia do Acre – FUNTAC (Acre Technology Foundation) collected in Nov 24th 2010 and stored in the foundation until the seedling in January and March in chamber with controlled temperature and humidity.

It was sowed five replications of 10 seeds, at 3 cm of depth, in two tubes sizes with capacity of 50cm^3 and 110cm^3, in a total of 50 seeds, directly in tubes filled with the commercial substrate Plantmax®, using one seed per recipient. On the seed it was placed a thin layer of the same substrate used for the tuber filling, approximately one and a half times its lower diameter, with the major aim at protecting the seeds. Soon after the seeding it was made the irrigation, which was conducted in an automatic way, with continuous and uniform irrigation each hour, with no cultural treats and thinning during the experiment.

Tubes were placed in plain trays of polypropylene hanging at 80 cm from the soil and maintained in two levels of light intensity. The different conditions of luminosity were obtained keeping trays with two sizes of tubes both at full sun (open skies) as in screened plant nursery with shading, woven with microfilament of High Density Polyethylene – HDPE, with additives to resist to the UV radiation and antioxidants, promoting 50% of shading.

Seedling emergence (SE) – it occurred from the 1st to the 63rd day evaluating normal seedlings, i.e., those whose epicotyl was above the substrate surface (BRASIL, 2009). The calculation of the percentage of emergence followed the model proposed by LABORIAU and VALADARES (1976):

Equation 01. Seedling emergence:

$$\textbf{SE (\%)} = n \div A \times 100$$

In which N: number of emerged seedlings; A: total number of seeds placed to germinate.

Emergence Speed Index (ESI) – evaluated together with the test of seedling emergence it was determined by adding the seedlings emerged each day, divided by the respective number of days passed from the sowing (NAKAGAWA, 1999). The calculation of the emergence speed followed the model proposed by Maguire (1962):

Equation 02. Emergence Speed Index:

$$ESI = (n1 \div D1 + N2 \div D2 + N3 \div D3 + ... + Nn) \div Dn$$

In which: ESI = Emergence Speed Index; N1:n = number of seedlings emerged in the day1, 2, 3, … n; and D = days for the seedlings to emerge.

At the end of each treatment, five seedlings from each replication were randomly selected for the determination of biometric parameters.

Collar diameter (CD): measured with aid of digital caliper measured in millimeters, it was considered the measure of the insertion of stem with the root.

Root length (RL): The seedling root system was separated and measured with the metric ruler, and the results were expressed in centimeters. It was considered as root the part between the mesocotyl and the terminal portion of the main root.

Aerial part length (APL): The aerial part of the seedlings was separated and measured with metric ruler, and the results were expressed in centimeters. It was considered aerial part as the portion comprehended between the mesocotyl and the point of insertion of the last pair of leaves.

Root Dry Matter (RDM): After the determination of the length, the root system of the seedlings of each treatment and replication was washed in running water and conditioned, separately, in Kraft paper bags and placed in oven with forced air circulation and a constant temperature of 70ºC and it was maintained there for 48 hours. In the end of this period, it was determined the weight in analytic weight (accuracy 0.0001 g), and the results expressed in grams.

Arial Part Dry Matter (APDM): After the determination of the length, the aerial part of the seedlings of each treatment and replication was conditioned, separately, in Kraft paper bags and placed in oven with forced air circulation and a constant temperature of 70ºC and it was maintained there for 48 hours. In the end of this period, it was determined the weight in analytic weight (accuracy 0.0001 g), and the results expressed in grams.

For the experimental design the data were analyzed using the statistic program ASSISTAT considering the completely randomized design, in the factorial scheme 2 x 2 (two recipient sized and two light intensities), being 5 replications of 10 plants. It was made the comparison of the means of the variables, trough the Tukey test at 5% of probability. The data of seedling emergence was transformed in arc sin $(x/100)^{0,5}$.

Results and discussion

In Table 1, it can be seen the data of the analysis of variance of seedling emergence (SE), Emergence Speed Index (ESI), Collar diameter (CD), Root length (RL), Aerial part length (APL), Root Dry Matter (RDM) and Arial Part Dry Matter (APDM) studied under different types of recipient and shading. It is observed in this table that there was significant interaction in the level of 5% of probability only for the morphological parameter root length (RL)

The variables SE, ESI, CD, APL, APDM and RDM did not present significant interaction. For these parameters, the different types of recipients and luminosity acted in an independent way.

Independent parameters showed that future work may be applied using data of interest, as for instance the relation of root growth isolated in function of shading and recipient.

Similar data was found by AZEVEDO (2003), with seedlings of cedar in different substrates and sizes of recipients. The author found independent variables for the aerial part length, collar diameter, aerial part and root dry matter, which may facilitate the choice of a recipient with a smaller size, reducing the costs with substrates.

Table 1. Summary of the analysis of variance for the variables of seedling emergence (SE), Emergence Speed Index (ESI), Collar diameter (CD), Root length (RL), Aerial part length (APL), Root Dry Matter (RDM) and Arial Part Dry Matter (APDM).

Conditions	Mean Squares						
	SE	ESI	CD	RL	APL	RDM	APDM
Shading	69.59 **	76.10 **	5.42 *	20.28 **	30.86 **	9.88 **	3.33 ns
Tubers	3.72 ns	9.32**	0.63 ns	5.10 *	2.94 ns	5.40 *	0.55 ns
Shad. x Tub.	0.019 ns	1.31ns	2.91 ns	7.81 *	0.0018ns	1.20ns	1.91 ns
CV(%)	21.26	26.37	30.46	10.45	9.63	47.61	39.53

**: significant at the level of 1% of probability ($p < 0.01$); *: significant at the level of 5% of probability ($0.01 \leq p < 0.05$); ns: not significant ($p \geq 0.05$).

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Independent parameters showed that future work may be applied using data of interest, as for instance the relation of root growth isolated in function of shading and recipient.

Similar data was found by AZEVEDO (2003), working with seedlings of Spanish cedar in different substrates and sizes of recipients. The same author found independent variables for the aerial part length, collar diameter, aerial part and root dry matter, which may facilitate the choice of a recipient with a smaller size, reducing the costs with substrates.

In Table 2 it is presented the mean values of seedling emergence (SE), Emergence Speed Index (ESI), Collar diameter (CD), Aerial part length (APL), Root Dry Matter (RDM) and Arial Part Dry Matter (APDM).

It is observed that there was no significant interaction at 5% of probability, for seedling emergence, evaluating shading and recipients, the seedling emergence in shading environments at 50% presented best average with 85% of emergence.

The percentage of emergence was statistically equal for the testes recipients 50cm³ and 110cm³.

Table 2. Average values of seedling emergence (SE), Emergence Speed Index (ESI), Collar diameter (CD), Aerial part length (APL), Root Dry Matter (RDM) and Arial Part Dry Matter (APDM) of cedar seedlings (*Cedrela odorata*) in function of shading and recipients.

Shading						
Conditions	**SE**	**ESI**	**CD**	**APL**	**RDM**	**APDM**
50%	85 a	0.47 a	0.14 a	7.2 a	0.3 a	0.5 a
0%	37 b	0.15 b	0.11 b	5.7 b	0.2 b	0.4 a
Tubes						
50 cm³	67 a	0.37 a	0.14 a	6.7 a	0.3 a	0.5 a
110 cm³	55 a	0.26 b	0.12 a	6.2 a	0.2 b	0.4 a
CV(%)	21.26	26.37	30.47	9.63	47.61	39.53

Averages followed by different letters, uppercase in column, differ by the Tukey Test ($0.01 \leq p < 0.05$).

Even though there was no statistic difference between tubes in shading and between shadings in tubes, the mean values of seedling emergence indicate that 50% of shading favored the development of the germination process of seeds and, consequently, the seedling emergence. In relation to tubes, it was not verified this difference, i.e., both present average results similar to this parameter.

CONHA et al. (2005) emphasized that larger recipients present better results, however, their use is only justified when the factors are superior, which is not the case of the present work, or when plants should remain a long time in the plant nursery.

In relation to shading, researchers conclude that levels of 50% to 70% are favorable to the forest species as cedar, mahogany, ipê and yellowheart (AMO, 1985; KOZLOWSKI, 1991; CHAVES and PAIVA, 2004).

This better germination performance in shading conditions may be explained by the fact that, even though cedar is an helophytic species in the adult stage, in the youth ir behaviors as partially umbrófila (AMARAL, 2006).

In the emergence speed index (ESI) there was no significant interaction between shading and tubes. However, trough the mean values it is possible to verify that the seedling emergence happened faster in shaded environment, its tolerance to shade in the initial phase, similar result to the one verified in the total emergence (Table 2). CAVALCANTE and RESENDE (2005) concluded that the speed of emergence of forest species in shaded environments is higher when compared to full sun.

For the speed of seedling emergence, small tubes were more favorable. Differently, GOMES et al. (1990) did not find significant differences between tubes with different sizes for this parameter in forest species with fast growth.

For collar diameter (Table 2), there was no difference between the tuber size, but the shading at 50% presented better plant development. Similar results were obtained by ALMEIDA et al. (2005), when comparing the development in *caroba* plant nursery which presented highest averages of collar diameter in environment in controlled condition with 30% of shading.

The collar diameter is a parameter used to evaluate the seedling development and quality in different environments and it is directly related with plant growth in height and increase in leaf area (REGO and POSSAMAI, 2006). SALGADO et al. (2001), when evaluating the growth and distribution of biomass in seedlings of *Copaifera langsdorffii* Desf. submitted to different levels of shading in plant nursery, found that when the development of the collar in diameter was lower in seedlings growing in conditions which simulated a closed canopy (90% of shading).

On the other size, FERREIRA et al. (1977) observed that the collar diameter of *Schizolobium parayba* (guapuruvu) and *Hymenea stigonocarpa* (jatobá-do-cerrado) was higher in plain sun. In the same way, seedlings of the pioneer species *Muntingia calabura* L. present collar with higher diameter when conducted with 100% of active photosynthetic radiation, when compared to those grown with 67% and 48% (CASTRO et al., 1996).

Individually the average of the collar diameter was higher for shaded environments with 50% of light incidence and it was not different for the tubes size.

The aerial part length also did not have difference for the tuber size, however in conditions of 50% of shading and the aerial part developed more. Similar results were found by COSTA et al. (2009) studying different types of environments for the production of passion fruit plantlets; these authors was concluded that for the growth in plantlet height in the first 30 days the shaded environment provides better results.

When analyzing the relation shading x recipients for root dry matter it is observed that there was no significant interaction between factors. The best results of averages were observed for small recipients and shaded environments at 50%. Still, the aerial part of the dry matter had no difference for shading and recipients, possibly due to the small time of evaluation which was 63 days.

The cedar seedlings evaluated in different conditions of luminosity and tubes presented in their development significant interaction at the level of 5% of probability for the root length, according the data presented in the Table 3.

Table 3. Mean values of root length of cedar seedlings in function of shading and tubes.

Shading	Tubes	
	50 cm^3	**110 cm^3**
50%	11.1 a A	11.4 a A
0%	10.3 a A	7.9 b B

CV% General =10.45%. Averages followed by distinct letters, lowercase in column and uppercase in line differ by Tukey test ($0.01 \leq p < 0.05$).

When analyzing the interaction, the small tubes in shaded environment presented results statistically similar for the root length, in environments at full Sun and the smaller recipients (50 cm^3) provided better results.

The RL differed statistically when compared to the interaction shaded environment (50%) and at full sun (0%) in small tubes, for big tubes (110 cm^3) the RL presented better results in shaded environment, possibly in function of the diameter of the recipient which provided more secondary roots and small growth.

AZEVEDO (2003), studying different sizes of recipients with the forest species cedar and *ipê* observed that the root development occurred in recipients of medium size (110 cm^3), i.e., the largest ones (200 e 280 cm^3) did not present positive effect for this parameter.

Different results were found by MESQUITA et al. (2009), who studied the effect of the recipient in the initial growth of *jenipapo* plantlets, evaluated two sizes, which were 100 cm^3 and 180 cm^3, and concluded that the development was statistically superior in the larger recipients. In the same way, VIANA et al. (2008) characterizing different recipient sizes for the species orchid tree observed that the studied variables responded positively for the recipient sizes, i.e., the largest the recipient volume, the best the result for all the variables studied.

GOMES (2001) reports that, once the recipient size is different and their growth values are favored or equated to higher recipients, it is advised the use of smaller recipients, since larger tubes cause increase in the costs of production and transport. CUNHA et al. (2005) added that recipients with larger volumes offer better conditions for the plantlet development, however they should only be used for species which present slow development, and need to remain in the plant nursery for long periods, or when they desire well development seedlings, for sowing in public roads, for instance.

Cedar plants normally present good development in shaded environments, mainly in initial stage of production, possibly due to their characteristic of umbrófila plant in this stage, confirming thus the good development of plants in shaded environments with small recipients which guarantees economy of substrates and mobility of work.

Conclusões

1 – The combinations of different luminosities (0 and 50% of shading) and recipients (tubes of 50 and 110 cm^3) do not present interaction in the germination (SE and ESI) and in the development of cedar seedlings at 63 days, with exception of the root length (RL);

2 – The RL in 50% of shading did not differ between tubes of 50 and 110 cm^3, at full sun the length was favored by the smaller tubes;

3 – For the production of cedar seedlings in initial stage of plant nursery it may be used recipients with 50cm^3 and environments with 50% of shading.

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