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Shading of seedlings of pau-rainha and the use of fertilized substrate

Sombreamento de mudas de pau-rainha e uso de substrato fertilizado

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Content

1. Introduction
2. Material and methods
3. Results
4. Discussion
5. Considerações finais
Acknowledgements
Referências bibliográficas

ABSTRACT:

The work was conducted with the purpose of checking the effect of shading screens on the early growth of seedlings of pau-rainha on fertilized substrate. The treatments in completely randomized experimental design in factorial scheme 6x2, with five replications. The factors under study were A factor: T1-control (no inoculation and no nutrient solution); T2 addition of ERR 326 strain *(Bradyrhizobium* sp.) grown per 120 hours; T3 idem T2 (96 hours), T4 addition of nutrient solution + addition of inoculum with rhizobia grown for 96 hours; T5-addition of nutrient solution + addition of inoculum with grown for 120 hours; T6 - addition of nutrient solution; concerning second factor two shading environments: seedlings with single cover and with double cover. Shoot height and its diameter 0.5 cm from ground level were evaluated over 210 days and dry masses of the root, of the shoot and total were evaluated at 210 days. The Dickson index was determined. Use of the shading screen is efficient in the growth of seedlings of Centrolobium paraense under climatic conditions of Boa Vista - Roraima. The double layer of shading screen provides improvements in the

RESUMO:

O trabalho foi realizado com objetivo de verificar o efeito de telas de sombreamento no crescimento inicial de mudas de pau-rainha em substrato fertilizado. Foram testados os tratamentos em delineamento experimental inteiramente casualizado, em esquema fatorial 6x2, com cinco repetições. Os fatores em estudo foram fator A: T1- testemunha (sem inoculação e sem solução nutritiva); T2- adição da estirpe ERR 326 (*Bradyrhizobium* sp.) crescida por 120 horas; T3- adição da estirpe ERR 326 crescida por 96 horas; T4- adição de solução nutritiva e da estirpe ERR 326, crescida por 96 horas; T5- adição de solução nutritiva e da estirpe ERR 326, crescida por 120 horas; T6- adição de solução nutritiva, no segundo fator dois ambientes de sombreamento: mudas com cobertura simples e com dupla cobertura. Foi avaliado, a altura da parte aérea, diâmetro do coleto, ao longo de 210 dias e a massa seca radicular, da parte aérea e total aos 210 dias. Determinou-se o índice de Dickson. O uso de tela de sombreamento é eficiente no crescimento de mudas de C. paraense nas condições de Boa Vista - Roraima. A camada dupla de tela de sombreamento proporciona

growth and quality of the seedlings of pau-rainha obtained at 210 days after transplanting. The addition of nutrient solution and of strain favors the growth in height, stem diameter at ground level and results into greater Dickson quality indices, dry matter of the shoot, of the root system and total dry matter, consequently being indicated to the growth of seedlings of Centrolobium paraense.
Keywords: *Centrolobium paraense*; Luminosity; Dickson Index; Plant nutrition.

melhorias no crescimento e na qualidade das mudas de pau-rainha obtidas aos 210 dias após transplantio. A adição de solução nutritiva e da estirpe favorece o crescimento em altura, diâmetro do coleto e resulta em maiores índices de qualidade de Dickson, massa seca da parte aérea, do sistema radicular e massa seca total, sendo indicada para crescimento de mudas de C. paraense.
Palavras-chave: *Centrolobium paraense*; Luminosidade; Índice de Dickson; Nutrição de plantas.

1. Introduction

The demand for wood in Brazil has been increasing each year and with it the pressure against the deforestation of the native forests. That fact causes the need for commercial reforestation of timber species to increase (CIRIELLO et al., 2014). Among the native species which have been being utilized for commercial purposes stood out pau-rainha(*Centrolobium paraense* Tul.), a species with a wide tropical distribution which has been planted commercially in several countries of Latin America (BARAÚNA et al., 2014; PEDREIRA et al., 2010; PIRIE et al., 2009).

One of the outstanding characteristics of this species, in addition to its potential for reforestation in a number of landscapes of Lavrado, is the capacity of numerous species of generous *Centrolobium* to form nodes and perform symbiosis with diazotrophic bacteria of the group of rhizobia (BARAÚNA et al., 2014). At present, in the majority of cases, the afforestation and reforestation projects make use of seedlings produced in forestall nurseries, since the edaphoclimatic conditions of a great part of the sites to be planted does not allow making use of no-tillage in field (DUARTE et al., 2015).

In this context, the production of new technologies in seedling production has recognized importance; above all, for the reasons presented, effective measures should be deployed on a short term. For the forest species, in particular the native ones, the information concerning their nutrient requirements during their early growth are still incipient (SMIDERLE and SOUZA, 2016; SOUZA et al., 2011; CECONI et al., 2006).

Due to the wide genetic diversity and different nutrient demands, there is no way to define a fertilization pattern which fulfill the requirements of all species, standing out the need for specific programs for this purpose (SMIDERLE et al., 2016; REIS et al., 2012). For this reason, additional research is necessary to better understand the several technical and physiological aspects brought about by the use of shading and mineral fertilizers, in order to optimize their application in the production of seedlings of *C. paraense*.

Lighting is the basic factor concerning the growth of seedlings, depending on the capacity of capturing and utilizing light; the plants present different responses and determinants to their survival and adaptation to different environments (ALMEIDA et al., 2016; SARAIVA et al., 2014). In this sense, the effect of shading screens upon the early growth of seedlings of pau-rainha in fertilized substrate under nursery conditions in Boa Vista – Roraima the objective of this study.

2. Material and methods

The study was conducted at Embrapa Roraima, during the period of May to November of 2014, in the facilities of the seedling nursery, situated on BR 174, Km 8, Industrial District, under the geographical reference coordinates 02º45’28”N and 60º43’54”W and 90 m above sea level. Boa Vista lies in the Tropical Climate Zone. The climate in the region is, according to Köppen, type Aw: (rainy, tropical with a consistent dry period) with annual average rainfall between 1700-2000 mm (ARAÚJO et al., 2001). The rainy period occurs with highest frequency from April to August with a monthly total higher than 100 mm. From September on occurs sharp reduction, with a characteristic dry period occurring more frequently from November to March (TONINI, 2011). The average annual temperature is 25.5 oC (OLIVEIRA et al., 2016).

The species utilized was *Centrolobium paraense* the seeds of which utilized for obtainment of seedlings were originated from two distinct sites, one in the Água Boa region (N 02°43'39.5" and W 06°51'35.4". *Datum*: WGS84) and the other in Vila do Taiano (N 03°06'46.7" and W 060°49'38.6". *Datum:* WGS84), both in the state of Roraima. The seeds were distributed in seedbed and irrigated daily with water. At 45 days after sowing, the seedlings five centimeters tall, on average, were transferred to polyethylene bags 17 cm high and 2 mm in diameter, containing two liters of substrate soil + sand (2:1).

The distribution of the seedlings in each treatment was at the spacing of 15 cm apart, both at the row and in the interrow. At beginning of the experiment de seedlings, the total height (cm) and the stem diameter 0.5 cm for ground level (mm) were measured, as an early characterization, from which it was possible to evaluate the increase of the variables in time. Over the study, the irrigations were by sprinkling scheduled at every four hours during the day, each irrigation lasting five minutes. After the transplanting of the seedlings, inoculation with strain ERR 326 (*Bradyrhizobium* sp.) efficient in biological fixation of nitrogen in pau-rainha was performed to some treatments (BARAÚNA et al., 2014). For this purpose, 1 mL seedling-1 of the culture medium 79 was pipetted (Fred and Waksman, 1928) containing the strain grown for 96 or 120 hours, applied singly to de seedling at the base of the stem (ground level). In treatments T3 and T4 with strain ERR 326 grown for 96 hours and in T2 and T5 with "120 hours of growth". In seedlings of treatments T4, T5 and T6 was added singly, with the aid of a becker, two weekly applications of 20 mL of the nutrient solution proposed by Souza et al. (2011), after the last daily irrigation, to reduce the leaching of the nutrients applied along 210 days.

The experimental design utilized was the completely randomized in factorial scheme 6 x 2, with five replications and five seedlings (one in each container) per plot. The factors under study were, factor A: T1– control (no inoculation and no nutrient solution); T2- addition of the strain grown for 120 hours; T3- addition of the strain grown for 96 hours; T4- addition of nutrient solution and of the strain grown for 96 hours; T5- addition of the nutrient solution and of the strain grown for 120 hours; T6- addition of nutrient solution; Factor B: shading environments: seedlings with single cover (a shading screen 50%), seedlings with double cover (two shading screens 50% overlaying).

The shading screens were placed over the seedlings at 2.70 meters from ground level. With the aid of a digital lux meter, the incident light flow in the area of the seedlings' (close to the apical meristem) was measured for determination of the illuminance provided by the different covers. That procedure was in the form of sampling, with measurement of illuminance during the five first days of each month. The measurement was done 12 times during the day (07h00min; 8h00min, 9h00min, 10h00min; 11h00min, 12h00min, 13h00min; 14h00min, 15h00min, 16h00min; 17h00min, 18h00min). To characterize the transparency provided by the different covers, the mean of the evaluations at the end of the study was utilized.

Every 30 days, the measurements concerning height and diameter of the seedlings of *C. paraense* were conducted. The values of height of the seedlings were obtained by measuring with a printable millimeter ruler from ground level to the apical meristem while for the diameter, the measures were taken with a digital pachymeter at 0.5 cm from the substrate level.

At the end of the experiment (210 days after transplanting - DAT), besides the height of the seedlings (H) and stem diameter 0.5 cm from grown level (SD), the dry mater of the root (DMR) and of the shoot (DMS) were measured. The root system was submitted to washing in running water to get rid off adhered substrate. For drying, the roots and shoot of the seedlings were packed in paper bags and kept in forced air circulation oven at 65 ºC, till they reached constant mass. To measure the quality of the seedlings and their later survival in the field, Dickson quality index (DQI) was utilized, which was determined dividing the total dry matter (TDM), by the addition of the ratio between shoot height (H) and stem diameter 0.5 cm from the grownd (SD), and the ratio between dry matter shoot (DMS) and of the dry matter root (DMR) by means of the formula found in Dickson et al. (1960).

The average values were submitted to the analysis of variance through F test with the statistic program Sisvar (FERREIRA, 2011), performing the regression analysis for the factor time (height and diameter) and the Tukey test at 5% of probability for the comparisons among the means of the other variables.

3. Results

In Figure 1, the reduction of the average values of the luminous flux with the addition of the layers of the shading screen is verified. Between the no-protection screen treatment (full sunshine-110.0 klx m^{-2}) and one simples layer (52.0 klx m^{-2}), there was reduction of 58.0 klx m^{-2} (43.7%) between the times of 11h00min and 13h00min. But with the use of the double layer, the lowest value of illuminance was found, with 40.0 klx m^{-2} at 14h00 min, with a reduction of 70.0 klx m^{-2} (64.0%) compared with the no-protection screen treatment. Concerning the treatment of double layer with the single layer, there was reduction of 12.0 klx m^{-2} in the periods of greatest incidence of luminous flux (Figure 1).

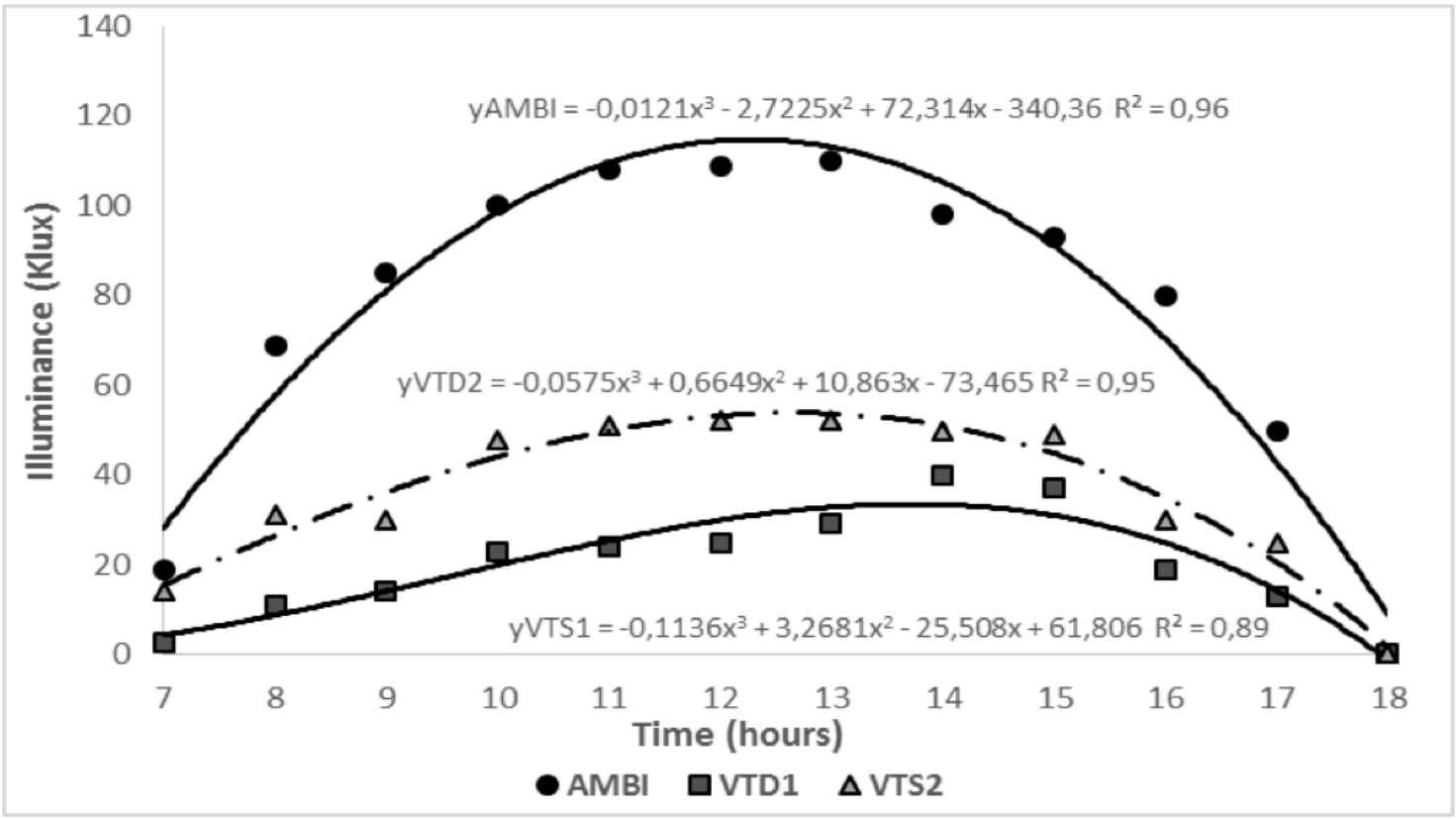

Figure 1- Illuminance flux obtained from 07h00min to 18h00min hours under different layers of shading screen. Boa Vista, Roraima 2014. (VTD1= double protection screen; VTS2= single protection screen; AMBI= external environment).

The factors studied singly, addition of nutrient solution with or without the addition of strain ERR 326 of *Bradyrhizobium* sp. and the monitoring (days) presented significant effect as well as the interaction fertilization x protection screen (single and double layer) for the two variables (height and stem diameter). Reduced growth in the seedlings of *C. paraense* in treatments T1, T2 e T3 was found, the highest values both for height and diameter were obtained with T4 and T5 for both the shading screens (Figures 2A, 2B, 3A and 3 B).

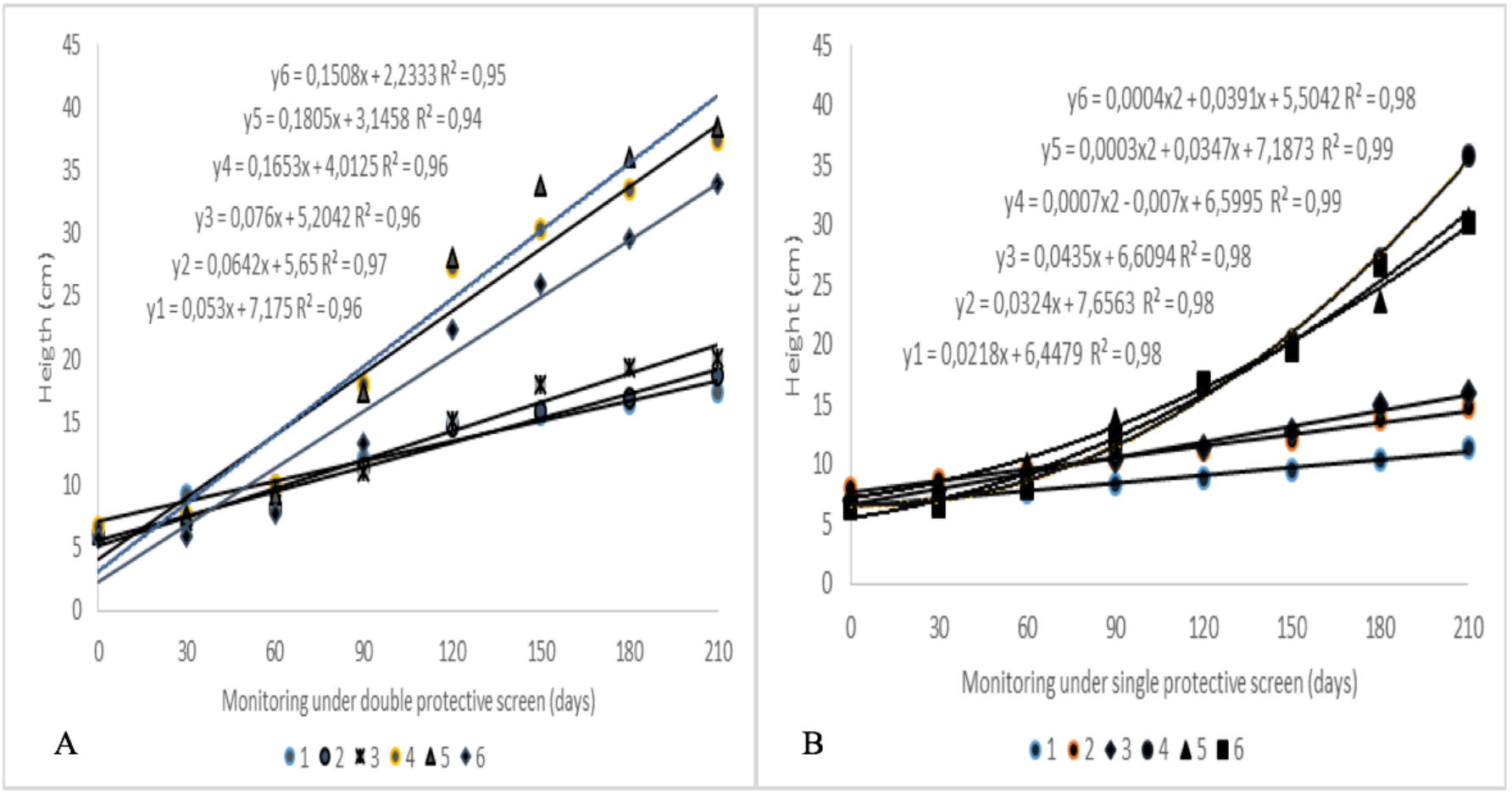

Figure 2- Growth in height of the seedling under double protection screen (A) and under single protection screen (B) of C. paraense cultivated with six treatments: T1– control (no strain and no nutrient solution); T2- addition of strain E326, grown for 120 hours; T3- addition of strain E326, grown for 96 hours; T4- addition of nutrient solution and of strain E326, grown for 96 hours; T5- addition of nutrient solution and of strain E326, grown for 120 hours; T6- addition of nutrient solution, for 210 DAT.

At the end of the evaluation period (210 DAT) treatments T4 and T5 and the use of double protection layer presented greatest increase in diameter (8.36 mm) and height (38.5 cm), not differing significantly from the treatment with use of single layer of shading screen (Figures 2A, 2B, 3A e 3 B).

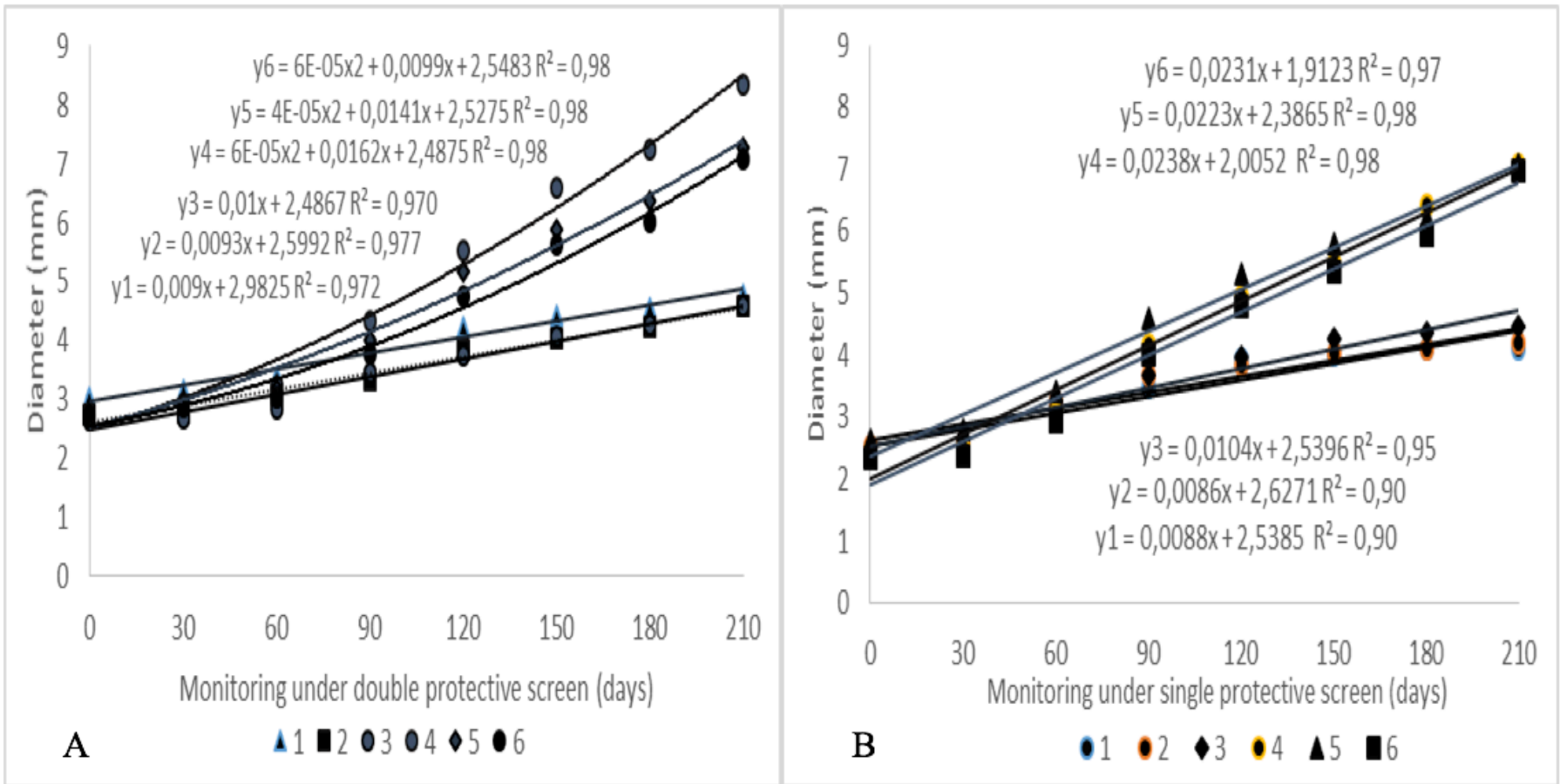

Figure 3- Diameter of the seedling under double protection screen (A) and under single protection screen (B) of *C. paraense* cultivated with six treatments: T1–control (no strain and no nutrient solution); T2- addition of strain E326, grown for 120 hours; T3- addition of strain E326, grown for 96 hours; T4- addition of nutrient solution and of strain E326, grown for 96 hours; T5- addition of nutrient solution and of strain E326, grown for 120 hours; T6- addition of nutrient solution, for 210 DAT.

The analysis of variance indicated that the different layers of shading screens exert influence on the studied variables as well as the addition of nutrient solution at the end of the 210 days of conduction of the experiment (Table 1).

Table 1- Average values for seedling Height (H, cm), Stem Diameter (SD, mm), Root Dry Matter (RDM, g), shoot dry matter (SDM, g), ratio root dry matter/shoot dry matter (RD/SD), Total dry matter (TDM, g) and Dickson quality index (DQI) in the layers of shading screen: double (CD) and single (CS), obtained at 210 days after transplanting

			CD												
TT	**H**		**SD**		**RDM**		**SDM**		**RD/SD**		**TDM**		**DQI**		
T1	17.4	b*	4.78	c	10.77	b	5.22	c	2.36	a	15.99	c	3.95	b	
T2	18.8	b	4.59	c	12.64	b	4.62	c	2.71	a	17.26	c	3.92	b	
T3	20.1	b	4.58	c	11.12	b	5.33	c	2.15	ab	16.46	c	3.43	b	
T4	37.5	a	8.36	a	28.71	a	21.27	a	1.41	b	49.98	a	8.76	a	
T5	38.5	a	7.29	b	23.94	a	18.17	ab	1.33	b	42.11	ab	7.26	a	
T6	34.0	a	7.08	b	23.19	a	15.51	b	1.50	b	38.70	b	7.24	a	
			CS												
T1	11.37	b	4.11	b	3.563	c	2.049	b	1.99	a	5.61	b	1.84	b	
T2	14.75	b	4.20	b	4.400	c	2.399	b	1.84	a	6.80	b	1.67	b	
T3	16.00	b	4.48	b	7.738	bc	3.932	b	1.99	a	11.67	b	2.88	b	
T4	35.75	a	7.07	a	18.138	a	15.130	a	1.21	ab	33.27	a	5.30	a	
T5	30.50	a	7.08	a	13.938	a	14.786	a	0.96	b	28.72	a	5.34	a	
T6	30.25	a	6.99	a	12.975	ab	16.576	a	0.80	b	29.55	a	5.40	a	
CV.%	21.22		8.51		20.93		23.17		26.73		17.55		19		
CD	27.72	A	6.11	A	18.39	A	11.69	A	1.91	A	30.08	A	5.77	A	
CS	23.10	B	5.66	B	10.12	B	9.15	B	1.46	B	19.27	B	3.74	B	

In the column, means followed by the same letter do not differ statistically from one another by the Tukey test at 5% of probability. T1–control (no strain and no nutrient solution); T2- addition of strain E326, grown for 120 hours; T3- addition of strain E326, grown for 96 hours; T4- addition of nutrient solution and of strain E326, grown for 96 hours; T5- addition of nutrient solution and of strain E326, grown for 120 hours; T6- addition of nutrient solution.

4. Discussion

The variations on reduction of the luminous flux with the addition of layers of shading screen showed in the present work was also recorded by Marco et al. (2014) in studies with red cedar (*Toona ciliata* M. Roem var. *australis*), in which reduction of 46.46 klx.m^{-2} (63.7%) between the no protection screen treatment (full sunshine) and a single layer was found, differing significantly from the treatment with a double layer (10.70 klx.m^{-2}). No apparent differences between the plants developed in the two evaluation environments were found, differing from Da Matta (2004).

Campos and Uchida (2002), testing the levels of 0, 30%, 50% and 70% of shading, found no significant difference among the treatments with jacaranda (*Jacaranda copaia* (Aubl.) D. Don.). However, in a shading study with pau-de-balsa (*Ochroma lagopus* Swartz), increased growth in stem diameter was found when level of 30% of shade was utilized (SCALON et al., 2003). According to Mazzini-Guedes and Pivetta (2014), different light levels can cause morphophysiological changes in the plant, its being able to be different among the plant species, considering the characteristics of each species. Also, depending on the capacity of capturing and utilizing light, plants respond in a different way (ALMEIDA et al., 2016).

Among the surveyed variables, it was found that in the cover with shading screens, double layer, presented greater stem diameter (SD) and height (H) when compared with the single layer. However, Marco et al. (2014) obtained greater diameters of the trunk and height of red cedar (*Toona ciliata* M. Roem var. *australis*) when utilizing single layer shading. Likely, the reduction of luminosity in the treatment with a double layer of shading screen (on average 40.0 klx.m^{-2}), can have increased the relative proportion of diffuse light in the environment and altered the quality of light (PÉREZ et al., 2006), can also have increased the photosynthetic rate of the plants of pau-rainha, bringing about greater increase in H when compared with the treatment with single layer (52.0 klx.m^{-2} of luminosity) proving, thus, little adaptation to the high luminosity in this developmental phase.

For the variables RDM, SDM and TDM (Table 1), the greatest means were obtained when utilizing double layer of shading, in which nutrient solution was added and applied strain ERR 326 (T4), which reinforces the importance of the substrate fertilization with addition of nutrient solution + the strain for the species at issue, when cultivated under the conditions of the present study.

The results of the ratio SDM/RDM are also indicative of the greatest probability of survival of seedlings in the field. Schumacher et al. (2004) obtained equilibrium value of this ratio while growing seedlings of *Acacia mangium*, an estimated value of 0.45. In the present study, however, values higher than that estimate were found, likely in part can be ascribed to the fact that the plants of pau-rainha shed the older leaves, which reduced the shoot dry mass at 210 DAT.

As to the DQI, the best index was reached when utilizing double protection layer (Table 1). According to Fonseca et al. (2002), the DQI is one of the best quality indicators of the seedlings, for in its calculation are considered robustness and the balance of the plant mass distribution. As to that index, Souza et al. (2015) states that the greater its value the best is the quality of the seedlings, so, one can infer that the treatments T4, T5 and T6 exert direct interference and positively in obtaining seedlings of best quality and, therefore, with greater probability of survival in field, according to the statement of Smiderle and Souza (2016).

The results of DQI obtained in the present study with T2, in area with single layer, were the lowest and the average value of DQI presented lower index, but not enough to classify it as poor quality seedlings, since that this result is in the ideal range recommended by Gomes and Paiva (2006). Also, confirmed when compared with results of the experiment conducted by Gomes et al. (2013), with seedlings of *Tectona grandis*, which presented a maximum value of the DQI of 1.98, reached at 120 days after the experiment mounting.

Therefore, the use of substrates formulated with different mixtures of materials, such as the addition of the ERR 326 (*Bradyrhizobium* sp.) strain and nutrient solution, are sustainable

alternatives aiming to reduce costs and time for the production of high morphological quality seedlings.

5. Considerações finais

1. Use of shading screen is an efficient alternative for growth of seedlings of *C. paraense* when under the conditions of Boa Vista - Roraima.

2. The double layer of shading screen provides improvements in growth and quality of seedlings of *C. paraense* obtained at 210 days after transplanting.

3. The addition of nutrient solution and of the strain supports the growth in height, stem diameter and Dickson quality index, dry matter of the shoot, root system and total dry matter, being indicated for the growth of seedlings of *C. paraense*.

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Referências bibliográficas

ALMEIDA, E. I. B.; QUEIROZ, R. F.; CAJAZEIRA, J. P.; OLIVEIRA, I. M. S.; CORRÊA, M. C. M. (2016). Shading of stock plants and the use of auxin in red pitaya cuttings. *Semina*: *Ciências Agrárias*, v.37, n.5, p.2977-2988.

ARAUJO, W. F.; ANDRADE JUNIOR, A. S.; MEDEIROS, R. D.; SAMPAIO, R. A. (2001). Precipitação pluviométrica provável em Boa Vista, Estado de Roraima, Brasil. *Revista Brasileira de Engenharia Agrícola e Ambiental,* v.5, n.3, p.563-567.

BARAÚNA, A. C.; SILVA, K.; PEREIRA, G. M. D.; KAMINSKI, P. E.; PERIN, L.; ZILLI, J. E. (2014). Diversity and nitrogen fixation efficiency of rhizobia isolated from nodules of *Centrolobium paraense*. *Pesquisa Agropecuária Brasileira,* v.49, n.4, p.296-305.

BARAÚNA, A. C. *Diversidade e eficiência simbiótica de estirpes de rizóbios isolados de nódulos de pau-rainha* (*Centrolobium paraense* Tul.). Dissertação (mestrado em Agronomia) – Universidade Federal de Roraima, Boa Vista, 2013.

CAMPOS, M. A. A.; UCHIDA, T. (2002). Influência do sombreamento no crescimento de mudas de três espécies amazônicas*. Pesquisa Agropecuária Brasileira,* v.37, n.3, p.281-288.

CECONI, D. E.; POLETTO, I.; BRUN, E. J.; LOVATO, T. (2006). Crescimento de mudas de açoita-cavalo (*Luehea divaricata* Mart.) sob influência da adubação fosfatada. *Cerne,* v.12, n.3, p.292-299.

CIRIELLO, V.; GUERRINI, I. A.; BACKES, C. Doses de nitrogênio no crescimento inicial e nutrição de plantas de guanandi (2014). *Cerne,* v.20, n.4, p.653-660.

DA MATTA, F. M. (2004). Ecophysiological constraints on the production of shaded and unshaded coffee: a review. *Field Crops Research,* v.86, n.3, p.99-114.

DICKSON, A.; LEAD, A. L.; OSMER, J. F. (1960) Quality appraisal of white spruce and white pine seedling stock in nurseries. *Forestry chronicle,* v.36, n.1, p.10-13.

DUARTE, M. L.; PAIVA, H. N.; ALVES, M. O.; FREITAS, A.F.; MAIA, F.F.; GOULART, L. M. L. (2015). Crescimento e qualidade de mudas de vinhático (*Platymenia foliolosa* Benth.) em resposta à adubação com potássio e enxofre. *Ciência Florestal,* Santa Maria, v.25, n.1, p.221-229.

FRANCO, A. A.; CAPELLO, E. F.; SILVA, E. M. R.; FARIA, S. M. *Revegetação de solos degradados.* Seropédica: EMBRAPA-CNPAB, 1992. 8p. (EMBRAPA-CNPAB. Comunicado Técnico,

9).

FERREIRA, D. F. (2011). Sisvar: a computer statistical analysis system. *Ciência e Agrotecnologia,* Lavras, v.35, n.6, p.1039-1042.

FONSECA, E. P.; VALÉRI, S. V.; MIGLIORANZA, E.; FONSECA, N. A. N.; COUTO, L. (2002). Padrão de qualidade de mudas de *Trema micrantha* (L.) Blume, produzidas sob diferentes períodos de sombreamento. *Revista Árvore,* v.26, n.4, p.515-523.

FUNDAÇÃO DO MEIO AMBIENTE CIÊNCIA E TECNOLOGIA DO ESTADO DE RORAIMA*. O Brasil do hemisfério norte: diagnóstico científico e tecnológico para o desenvolvimento.* Boa Vista: Ambtec, 1993. 512 p.

GOMES, J. M.; PAIVA, H. N. *Viveiros florestais:* propagação sexuada. 3. ed. Viçosa, MG: UFV, 2006.

GOMES, D. R.; CALDEIRA, M. V. W.; DELARMELINA, W. M.; GONÇALVES, E. O.; TRAZZI, P. A. (2013). Lodo de esgoto como substrato para produção de mudas de *Tectona grandis* L. *Cerne,* v.19, n.1, p.123-131.

JESUS, E. C.; MOREIRA, F. M. S.; FLORENTINO, L. A.; RODRIGUES, M. I. D.; OLIVEIRA, M. S. (2005). Diversidade de bactérias que *nodulam siratro* em três sistemas de uso da terra da Amazônia Ocidental. *Pesquisa Agropecuária Brasileira,* v.40, n.8, p.769-775.

MARCO, R.; CONTE, B.; PERRANDO, E. R.; FORTES, F. O.; SOMAVILLA, L.; BURGIN, M. B. (2014). Efeito de telas de sombreamento no crescimento e proteção de mudas de *Toona ciliata* sob baixas temperaturas. *Floresta,* v.44, n.4, p.607-616.

MAZZINI-GUEDES, R. B.; PIVETTA, K. F. L. (2014). Initial growth of *Bauhinia variegata* trees under different colored shade nets and light conditions. *Revista Árvore,* v.38, n.6, p.1133-1145.

MOREIRA, F. M. S.; SILVA, M. F. da; FARIA, S. M. (1992). Occurrence of nodulation in legume species in the Amazon region of Brazil*. New Phytologist,* v.121, p.563-570.

OLIVEIRA, D. L.; SMIDERLE, O. J.; PAULINO, P. S.; SOUZA, A. G. (2016). Water absorption and method improvement concerning electrical conductivity testing of *Acacia mangium* (Fabaceae) seeds. *Revista de Biologia Tropical,* v.64, n.4, p.1651-1660.

PEDREIRA, J. L.; HADA, A.; PINHO, R. C.; MILLER, R. P.; ALFAIA, S. S. 2010. Uso de rebrotas de pau-rainha (*Centrolobium paraense* Tul Fabaceae: Faboideae): uma via para a conservação local da espécie na Terra Indígena Araçá, Roraima. *Anais:* XXXI Congresso Nacional de Botânica, Manaus.

PÉREZ, M.; PLAZA, B. M.; JIMÉNEZ, S.; BARBEDO, J.; BOSCH, J. L. (2006). The radiation spectrum through ornamental net houses and its impact on the climate generated. *Acta Horticulturae,* v.719, n.4, p.631-636.

PIRIE, M. D.; KLITGAARD, B. B.; PENNINGTON, R. T. (2009). Revision and biogeography of *Centrolobium* (Leguminosae - Papilionoideae). *Systematic Botany,* v.34, p.345-359.

REIS, B. E.; PAIVA, H. N.; BARROS, T. C.; FERREIRA, A. L.; CARDOSO, W. C. (2012). Crescimento e qualidade de mudas de jacarandá-da-bahia (*dalbergia nigra* (vell.) Allemão ex benth.) em resposta à adubação com potássio e enxofre. *Ciência Florestal,* v.22, n.2, p.212-215.

SARAIVA, G. F. R.; SOUZA, G. M.; RODRIGUES, J. D. (2014). Aclimatação e fisiologia de mudas de guanandi cultivadas em telas de sombreamento foto-protetoras*. Colloquium Agrariae*, v.10, n.2, p.1-10.

SCALON, S. P. Q.; MUSSURY, R. M.; RIGONI, M. R.; SCALON FILHO, H. (2003). Crescimento inicial de mudas de *Bombacopsis glabra* (Pasq.) A. *Robyns* sob condições de sombreamento. *Revista Árvore,* v.27, n.6, p.753-758.

SCHUMACHER, M. V.; CECONI, D. E.; SANTANA, C. A. (2004). Influência de diferentes doses de fósforo no crescimento de mudas de angico-vermelho (*Paraptadenia rigida* (Benthan) Brenan).

Revista Árvore, v.28, n.1, p.149-155.

SILVA, B. M.; LIMA J.; DANTAS, V. A.; MORAES, W.; ZUMKELLER, D. S. (2007). Efeito da luz no crescimento de mudas de *Hymenaea parvifolia* Huber. *Revista Árvore,* Lavras, v.31, p.1019-1026.

SMIDERLE, O. J.; SOUZA, A. G. (2016). Production and quality of *Cinnamomum zeylanicum* Blume seedlings cultivated in nutrient solution. *Revista Brasileira de Ciências Agrárias,* v.11, n.3, p.104-110.

SMIDERLE, O. J.; SOUZA, A. G.; CHAGAS, E. A.; SOUZA, M. A.; FAGUNDES, P. R. O. (2016). Growth and nutritional status and quality of *Khaya senegalensis* seedlings.*Revista Ciências Agrárias,* v.59, n.2, p.47-53.

SOUZA, A. G.; CHALFUN, N. N. J.; FAQUIN, V.; SOUZA, A. A.; NETO, A. L. S. (2015). Massa seca e acúmulo de nutrientes em mudas enxertadas de pereira em sistema hidropônico. *Revista Brasileira de Fruticultura*, v.37, n.1, p.240-246.

SOUZA, A. G.; CHALFUN, N. N. J.; FAQUIN, V.; SOUZA, A. A.; NETO, A. L. S. (2011). Production of peach grafts under hydroponic conditions. *Ciência e Agrotecnologia*, n.2, v.35, p.322-326.

TONINI. H. (2011). Fenologia da castanheira-do-brasil (*Bertholletia excelsa* Humb. & Bonpl., Lecythidaceae) no sul do estado de Roraima. *Cerne*, v.17, n.1, p.123-131.

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