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Influence of Different Protected Environments and Reflector Material on Cultivated Oiti (*Licania tomentosa* [Benth.] Fritsch) Seedlings

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Abstract. Background: Oiti (*Licania tomentosa* [Benth.] Fritsch) is an option for urban forestation and rural environments that require shading by plants, so studying the plant environment to obtain quality seedlings is essential. The present study aimed to evaluate oiti seedlings in different protected environments with or without reflective material on a cultivation bench. Methods: The following protected environments were evaluated: an agricultural greenhouse covered with a low-density polyethylene film and a thermo-reflective screen with 42%/50% shading under the film; an agricultural screenhouse with an aluminized screen with 35% shading; an agricultural screenhouse with a black screen with 30% shading; and an agricultural screenhouse with a black screen with 18% shading. Production systems with and without photosynthetically active radiation-reflecting material (aluminized screen, Aluminet®) on the cultivation bench were assessed in each protected environment. Results: There was no interaction between the environmental factors; however, the environments influenced height, stem diameter, root dry matter, and total biometric relationships and growth rates. The reflective material did not improve the quality of oiti seedlings. The ratio of shoot and root dry matter was, on average, 71% for the shoots and 29% for the roots. The photosynthetically active radiation received by oiti seedlings ranged from 600 to 1,100 µmol m^{-2} s^{-1}. Conclusions: The greenhouse with 42%/50% shading screen under the film and the black screen with 30% shading were the best environments for the formation of *Licania tomentosa* seedlings. The reflective material on the cultivation bench did not result in better quality oiti seedlings.

Keywords. Chrysobalanaceae; Greenhouse; Luminosity; Screenhouse.

INTRODUCTION

The species *Licania tomentosa* (Benth.) Fritsch, also known by the common name oiti or oitizeiro, is widely used in the ornamentation or afforestation of Brazilian cities (Alves et al. 2018; Lafetá et al. 2020) as well as in air quality monitoring (Maioli et al. 2008), wood production, and recovery of degraded areas.

It is necessary to obtain high-quality seedlings for the various uses of this species. Studies on the seeds, emergence, and seedlings of this species are scarce in the literature. A few studies have been conducted on the use of compost and vermicompost from urban waste in substrates (Alves and Passoni 1997), the emergence of seedlings and the storage of endocarps (da Silva et al. 2018), and the morphological characterization of fruits, seeds, and post-seminal development (Monteiro et al. 2012).

In the production of seedlings of forest species, for the most part, structures covered with plastic films and/or screens are used that provide some protection against solar radiation, rain, intense winds, and interference from biotic factors such as pathogens and predators. These structures are called greenhouses, screenhouses, nurseries, or protected environments; they aim to improve the growing environment in order to produce plants with satisfactory biometric traits that will ensure adequate survival of the seedlings once they have been transplanted to the final place of cultivation (de Paula et al. 2017; Costa et al. 2020b; da Silva et al. 2021a).

For many forest species, the influence of levels of shading or types of protected environments on the formation of seedlings has already been researched; however, in the literature, there are few studies on how plant environment affects the formation of oiti seedlings (*Licania tomentosa*) and other species of the same family (Chrysobalanaceae).

Some forest species have been assessed on cultivation benches containing reflective material and obtained promising results regarding the use of supplementary radiation provided by the reflection of photosynthetically active radiation (PAR). For jambolana (*Syzygium cumini*), reflective material on the cultivation bench inside a 30% shading screen promoted the best seedlings (Salles et al. 2017). There was a positive effect on the quality of paricá (*Schizolobium amazonicum*) seedlings with a reflective material (aluminum foil) on cultivation benches inside an agricultural greenhouse with a 42%/50% shading screen under film (Mortate et al. 2019). The use of mirrors as reflective material on benches in cultivation provided better seedlings of baru (*Dipteryx alata* Vog.)(Costa et al. 2020a); however, the use of aluminized screen (Aluminet®) did not increase their quality (da Costa et al. 2020). Seedlings of rubber tree rootstock (*Hevea brasiliensis*), clone GT1, showed a robust root system and better-quality seedlings on benches with Aluminet® reflective material (Costa et al. 2021).

The present study aims to evaluate the formation of oiti seedlings in different protected environments with or without reflective material on a cultivation bench.

MATERIALS AND METHODS

The experiments were conducted from December 2019 to March 2020 at the State University of Mato Grosso do Sul (UEMS) in Cassilândia-MS, Brazil, at 19°07′21″S, 51°43′15″W and an altitude of 516 m (Cassilandia-A742 automatic station). The climate of the region is Aw-type, rainy in summer and dry in winter.

Oiti seedlings were developed under protected environments with and without reflective material on the cultivation bench. The protected environments used, with a galvanized steel structure, were: (A1) agricultural greenhouse covered with low-density polyethylene (plastic screen) film (LDPE) with a screen of 42%/50% shading under the film; (A2) agricultural screenhouse with an aluminized screen of 35% shading; (A3) agricultural screenhouse with a black screen of 30% shading; and (A4) agricultural screenhouse with a black screen of 18% shading. All environments had dimensions of 8 m wide × 18 m long. The A1 environment had a zenith opening, side and front closures at 90°, a black screen with 30% shading, and a ceiling height of 3.5 m. The screened environments A2, A3, and A4 had a ceiling height of 4.0 m, and the side and front screens closed at 45°. Inside the protected environments, production systems were tested with (RM) and without reflective material (WRM) on the cultivation benches using aluminized thermo-reflective screen (Aluminet®).

The seeds were collected from the fruits of parent plants on the university campus in Cassilândia-MS. Sowing took place on 2019 December 10 in polyethylene bags (15 × 25 cm) with a capacity of 1.8 L using Carolina Soil® substrate (Carolina Biological Supply Company, Burlington, North Carolina, USA). Two seeds per bag were sown. Emergence was verified 14 days after sowing (DAS). After emergence stabilization, thinning was performed, leaving one seedling per container. Irrigation was performed daily according to the needs of the crop without soaking the substrate using a suspended micro-sprinkler system with Netafim SpinNet™ emitters (Netafim, Fresno, California, USA).

At 40, 55, and 70 DAS, the stem diameter (SD, mm) was measured with a digital caliper (SD1 = stem diameter at 40 DAS; SD2 = stem diameter at 55 DAS; SD3 = stem diameter at 70 DAS); the seedling height (SH, cm) was assessed with a millimeter ruler, measuring the distance from the soil surface to the apex of the apical meristem of the stem (SH1 = seedling height at 40 DAS; SH2 = seedling height at 55 DAS; SH3 = seedling height at 70 DAS); and the number of leaves (NL) was counted (NL1 = number of leaves at 40 DAS; NL2 = number of leaves at 55 DAS; NL3 = number of leaves at 70 DAS). Also, the relationship between seedling height and stem diameter (H:D1 = ratio between seedling height and stem diameter at 40 DAS; H:D2 = ratio between seedling height and stem diameter at 55 DAS; H:D3 = ratio between seedling height and stem diameter at 70 DAS) and absolute growth rates between the collection intervals of seedling height data (AGR, cm day^{-1}) were determined (Equations 1, 2, 3).

$$\mathrm{AGR12} = \frac{(\mathrm{SH2} - \mathrm{SH1})}{(55\ \mathrm{DAS} - 40\ \mathrm{DAS})} \quad \text{(Equation 1)}$$

$$AGR23 = \frac{(SH3-SH2)}{(70\ DAS-55\ DAS)} \quad \text{(Equation 2)}$$

$$AGR13 = \frac{(SH3-SH1)}{(70\ DAS-40\ DAS)} \quad \text{(Equation 3)}$$

At 70 DAS, the shoot (SDM, g) and root (RDM, g) dry matter was measured on an analytical balance after drying in a forced-air circulation oven at 65 °C for 72 hours. Also, the total dry matter (TDM, g) determined by the sum of SDM and RDM, the Dickson quality index (DQI = TDM/[SH/SD + SDM/RDM])(Dickson et al. 1960), and the relationship between seedling height and shoot dry matter (H:S) were assessed.

Photosynthetically active radiation (PAR) was measured in µmol m^{-2} s^{-1} with a portable digital pyranometer (Apogee Instruments, Logan, Utah, USA) at 10:00 AM on sunny days and with a slight cloudiness, inside and outside the environments. PAR data were compared in a randomized block design with 4 replications (each replicate was composed of one month of data collection).

Except for PAR, other data were thus analyzed: as there were no repetitions of the protected environments, each environment was considered an experiment. In each environment, the experimental design used was completely randomized, with 4 replications and 3 plants per plot. Initially, the data were submitted for the analysis of individual variances of the benches, then the evaluation of the mean squares of the residues and the joint analysis of the experiments (Banzatto and Kronka 2013) in a 4 × 2 factorial (4 protected environments × 2 types of the cultivation bench with and without reflective material). The statistical software Sisvar 5.3 (Ferreira 2011) was used, and the data were submitted to the *F*-test. The means were compared by the Tukey test for the environments and the *F*-test for the cultivation benches, both at 5% probability.

RESULTS

The incidence of PAR in the cultivation environments was lower than the external environment. The PAR in the screenhouse with the black screen of 18% shading (1,120 µmol m^{-2} s^{-1}), which did not significantly differ from the black screen of 30% shading (936 µmol m^{-2} s^{-1}), was higher than the PAR observed in the greenhouse covered with low-density polyethylene film and 42%/50% shading screen under the film (604 µmol m^{-2} s^{-1}) and the 35% shading aluminized screen (713 µmol m^{-2} s^{-1})(Figure 1).

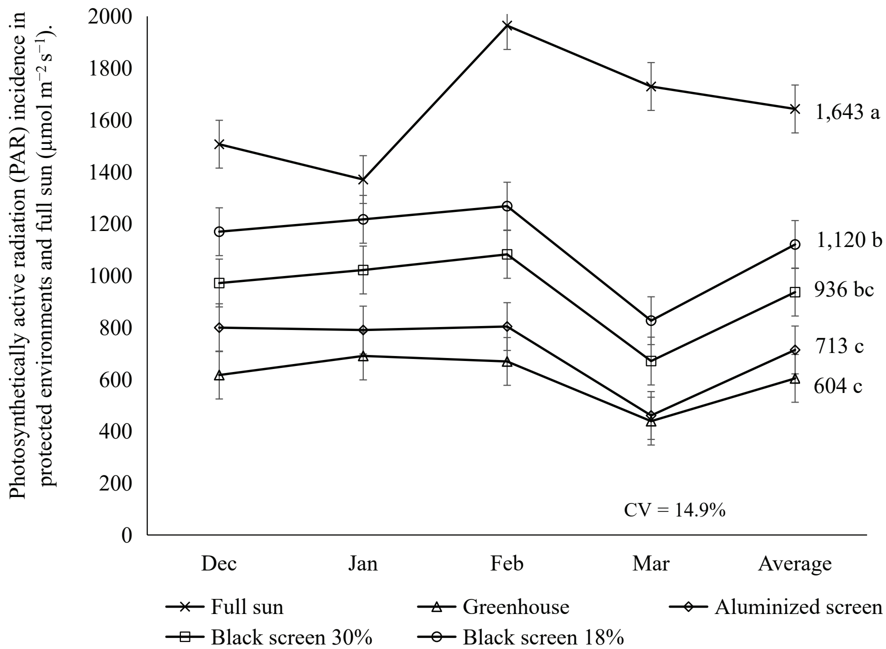

Figure 1. Photosynthetically active radiation (PAR) incidence in protected environments and full sun. Averages followed by equal lowercase letters do not differ from each other by the Tukey test at 5% probability. CV = coefficient of variation. Vertical bars correspond to standard error.

The PAR incidence in full sun was 1,643 µmol m^{-2} s^{-1}. On average during the period studied, 37% of this total reached the interior of the greenhouse (A1), 43% passed the aluminized screen (A2), 57% passed the black screen of 30% shading (A3), and 68% passed the black screen of 18% shading (A4)(Figure 1).

For the variables SH2, SH3, SD1, S:R, and H:S, it was found that the ratio between the largest and smallest mean square error (RMSE) was greater than 7.0, and therefore, for the variables mentioned above, it was not possible to perform the joint analysis of experiments (Banzato and Kronka 2013) and compare the protected environments. For these variables mentioned above, the production systems with and without reflective material on the bench in each experiment (environment) were evaluated separately. For the other variables, the RMSE was lower than 7.0 (Table 1), and therefore they were assessed in a 4 × 2 factorial scheme (4 environments × 2 production systems).

In the variables that presented RMSE lower than 7.0 (Table 1), the analysis of variance revealed that there was no interaction between the cultivation environments and reflective material (A × B), and there was no significance for the cultivation benches. For the cultivation environment factor, the variables seedling height at 40 DAS (SH1), stem diameter at 55 DAS (SD2), root dry mass (RDM), total dry mass (TDM), ratio between seedling height and stem

Table 1. Mean square error (MSE) and ratio between the largest and smallest mean square error (RMSE) for the variables of seedling height (SH), number of leaves (NL), and stem diameter (SD) at 40, 55, and 70 days after sowing (1, 2, and 3, respectively), shoot dry matter (SDM), root dry matter (RDM), ratio between SDM and RDM (S:R), total dry mass (TDM), ratio between SH and SD (H:D) at 40, 55, and 70 days after sowing (1, 2, and 3, respectively), ratio between SH and SDM (H:S), Dickson quality index (DQI), absolute growth rate between SH1 and SH2 (AGR12), absolute growth rate between SH2 and SH3 (AGR23), and absolute growth rate between SH1 and SH3 (AGR13) of oiti seedlings.

	MSE							
Environment	**SH1**	**SH2**	**SH3**	**NL1**	**NL2**	**NL3**	**SD1**	**SD2**
Greenhouse 42%/50%	15.281	11.750	8.020	0.813	0.983	0.386	0.053	0.030
Aluminized screen 35%	16.948	23.786	10.553	0.247	0.820	2.599	0.008	0.066
Screenhouse 30%	22.115	7.460	6.058	0.509	0.628	0.573	0.100	0.090
Screenhouse 18%	60.417	1.973	1.430	0.531	1.053	1.803	0.143	0.131
RMSE	3.95	12.06	7.38	3.29	1.68	6.73	18.00	4.44
Environment	**SD3**	**SDM**	**RDM**	**S:R**	**TDM**	**H:D1**	**H:D2**	**H:D3**
Greenhouse 42%/50%	0.013	0.743	0.209	0.087	1.487	0.847	0.465	0.388
Aluminized screen 35%	0.061	0.435	0.042	0.122	0.517	0.941	0.458	0.347
Screenhouse 30%	0.085	0.259	0.147	0.041	0.750	1.025	0.068	0.194
Screenhouse 18%	0.030	0.661	0.129	0.367	0.976	3.859	0.470	0.113
RMSE	6.56	2.86	4.95	9.01	2.88	4.56	6.94	3.45
Environment	**H:S**	**DQI**	**AGR12**	**AGR23**	**AGR13**			
Greenhouse 42%/50%	2.44	0.015	0.045	0.017	0.013			
Aluminized screen 35%	1.25	0.005	0.076	0.024	0.012			
Screenhouse 30%	0.29	0.007	0.103	0.027	0.044			
Screenhouse 18%	2.16	0.009	0.312	0.010	0.075			
RMSE	7.50	2.96	6.96	2.64	6.29			

diameter at 55 and 70 DAS (H:D2 and H:D3, respectively), Dickson quality index (DQI), and the absolute growth rate (AGR) showed significance (Table 2).

For the biometric variables influenced by the cultivation environments, it was observed that the plants produced in the screenhouse with 18% shading had the highest number of variables with the lowest averages. The plants produced in the greenhouse with 42%/50% shading and those produced in the screenhouse with 30% shading had the highest means for biometric data (Table 3).

For variables with RMSE greater than 7, only the cultivation benches within each cultivation environment were compared. Only for seedling height at 70 DAS (SH3), in the screenhouse with the black screen of 18% shading, plants were larger on the bench without reflective material than on the bench with reflective material (Table 4), showing that the reflected radiation did not influence seedling growth.

It is observed that the distribution of shoot and root dry matter in oiti seedlings follows a proportion, on average, of 71% for the shoot and 29% for roots, regardless of the cultivation environment and the use or not of reflective material on the bench (Figure 2).

DISCUSSION

These results show that the shading value does not correspond to the percentage of PAR inside the environment, since the black screen of 30% shading let through only 57% PAR and the aluminized screen of 35% let through 43% PAR. The 30% shading, with 57% of the external PAR, allowed for adequate growth and the obtaining of quality seedlings of *Licania tomentosa*, since for *Hirtella triandra*, of the same botanical family (Chrysobalanaceae), the minimum necessary PAR for the development of suitable initial growth is 249.42 µmol m^{-2} s^{-1} (Kitajima et al. 2013).

The PAR percentage results corroborate those obtained in rubber tree (*Hevea brasiliensis*) seedlings by Costa et al. (2021), who verified PAR incidence inside an aluminized screenhouse of 46.3% shading and a black screenhouse of 30% shading as 59% of the external PAR. Moreira et al. (2021) observed an internal PAR of 63% of the external PAR in a black screenhouse with 30% shading in the cultivation of biquinho pepper (*Capsicum chinense*), higher than that observed in the present study.

The reflective material did not influence an increase in the quality of oiti seedlings, similar to what was observed by da Silva et al. (2021b) for achachairu (*Garcinia humilis*) seedlings. However, other studies have shown an increase in the quality of seedlings with the use of reflective material on the cultivation benches, such as baru (*Dipteryx alata*)(Costa et al. 2020b), jambolan (*Syzygium cumini*)(Salles et al. 2017), paricá (*Schizolobium amazonicum*)(Mortate et al. 2019), and rubber tree rootstock seedlings (*Hevea brasiliensis*)(Costa et al. 2021).

Table 2. Analysis of variance for seedling height at 40 (SH1) days after sowing (DAS), number of leaves at 40 (NL1), 55 (NL2), and 70 (NL3) DAS, stem diameter at 55 (SD2) and 70 (SD3) DAS, shoot dry matter (SDM), root dry matter (RDM), total dry matter (TDM), ratio between seedling height and stem diameter at 40 (H:D1), 55 (H:D2), and 70 (H:D3) DAS, Dickson quality index (DQI), absolute growth rate between seedling height at 40 DAS and 55 DAS (AGR12), absolute growth rate between seedling height at 55 and 70 DAS (AGR23), and absolute growth rate between seedling height at 40 and 70 DAS (AGR13) of oiti seedlings. A = environment; B = cultivation bench; A × B = interaction between environment and cultivation bench; ns = not significant; * = significant at 5%; ** = significant at 1%; CV = coefficient of variation.

	SH1	NL1	NL2	NL3	SD2	SD3	SDM	RDM
A	*	ns	ns	ns	*	ns	ns	**
B	ns	ns	ns	ns	ns	ns	ns	ns
A × B	ns	ns	ns	ns	ns	ns	ns	ns
CV (%)	35.6	53.9	11.2	11.3	6.2	4.4	13.9	16.6
	TDM	**H:D1**	**H:D2**	**H:D3**	**DQI**	**AGR12**	**AGR23**	**AGR13**
A	*	ns	**	**	*	**	**	**
B	ns	ns	ns	ns	ns	ns	ns	ns
A × B	ns	ns	ns	ns	ns	ns	ns	ns
CV (%)	13.1	35.0	7.7	5.9	14.4	26.7	27.9	20.23

Table 3. Seedling height at 40 days after sowing (SH1), number of leaves at 40, 55, and 70 days after sowing (NL1, NL2, and NL3, respectively), stem diameter at 55 and 70 days after sowing (SD2 and SD3, respectively), shoot dry matter (SDM), root dry matter (RDM), total dry matter (TDM), ratio between seedling height and stem diameter at 40, 55, and 70 days after sowing (H:D1, H:D2, and H:D3, respectively), Dickson quality index (DQI), absolute growth rate between SH1 and SH2 (AGR12), absolute growth rate between SH2 and SH3 (AGR23), and absolute growth rate between SH1 and SH3 (AGR13) of oiti seedlings. CV = coefficient of variation.

Environment	**SH1 (cm)**	**NL1**	**NL2**	**NL3**	**SD2 (mm)**	**SD3 (mm)**
Greenhouse 42%/50%	14.1 ab	1.38 a	8.70 a	10.51 a	4.56 ab	4.93 a
Aluminized screen 35%	18.7 a	1.60 a	8.30 a	9.88 a	4.64 a	4.93 a
Screenhouse 30%	17.2 ab	1.60 a	8.46 a	9.63 a	4.61 ab	5.09 a
Screenhouse 18%	10.3 b	0.81 a	7.83 a	10.99 a	4.24 b	4.86 a
Cultivation bench						
Without reflective material	15.7 a	1.39 a	8.27 a	10.23 a	4.57 a	4.95 a
With reflective material	14.4 a	1.30 a	8.38 a	10.26 a	4.46 a	4.95 a
CV (%)	35.6	53.9	11.2	11.3	6.2	4.4
Environment	**SDM (g)**	**RDM (g)**	**TDM (g)**	**H:D1**	**H:D2**	**H:D3**
Greenhouse 42%/50%	5.46 a	2.53 a	8.00 a	3.36 a	8.43 a	9.58 a
Aluminized screen 35%	4.97 a	2.00 bc	6.97 ab	4.47 a	7.02 b	8.38 b
Screenhouse 30%	5.55 a	2.44 ab	7.99 a	4.19 a	8.29 a	8.46 b
Screenhouse 18%	4.85 a	1.678 c	6.62 b	2.77 a	7.82 ab	8.49 b
Cultivation bench						
Without reflective material	5.18 a	2.18 a	7.35 a	3.90 a	7.93 a	8.75 a
With reflective material	5.24 a	2.19 a	7.43 a	3.49 a	7.85 a	8.71 a
CV (%)	13.9	16.6	13.1	35.0	7.7	5.9
Environment	**DQI**	**AGR12 (cm day^{-1})**	**AGR23 (cm day^{-1})**	**AGR13 (cm day^{-1})**		
Greenhouse 42%/50%	0.68 ab	1.63 a	0.58 a	1.10 a		
Aluminized screen 35%	0.64 ab	0.94 b	0.57 a	0.75 b		
Screenhouse 30%	0.74 a	1.40 ab	0.33 b	0.86 ab		
Screenhouse 18%	0.59 b	1.51 a	0.55 a	1.03 a		
Cultivation bench						
Without reflective material	0.66 a	1.37 a	0.47 a	0.92 a		
With reflective material	0.67 a	1.38 a	0.54 a	0.96 a		
CV (%)	14.4	26.7	27.9	20.23		

Equal lowercase letters in the column for each variable do not differ by Tukey test at 5% probability for cultivation environments and *F*-test for cultivation benches.

Table 4. Seedling height at 55 and 70 days after sowing (SH2 and SH3, respectively), stem diameter at 40 days after sowing (SD1), ratio between shoot and root dry matter (S:R), and ratio between seedling height and shoot dry matter (H:S) of oiti seedlings on benches with (RM) and without (WRM) reflective material (Aluminet®) in different cultivation environments. CV = coefficient of variation.

	SH2 (cm)	SH3 (cm)	SD1 (mm)	S:R	H:S
	Agricultural greenhouse with 42%/50% shading screen under the film				
WRM	38.22 a	47.02 a	4.30 a	2.20 a	9.30 a
RM	38.75 a	47.35 a	4.10 a	2.16 a	8.35 a
CV (%)	8.91	6.00	5.50	13.52	17.71
	Aluminized screen with 35% shading				
WRM	34.57 a	41.17 a	4.17 a	2.40 a	8.0 a
RM	31.07 a	41.42 a	4.20 a	2.63 a	9.0 a
CV (%)	14.86	7.87	2.12	13.88	13.26
	Black screen with 30% shading				
WRM	37.55 a	42.60 a	3.90 a	2.30 a	8.27 a
RM	38.77 a	43.47 a	4.30 a	2.28 a	7.35 a
CV (%)	7.16	5.72	7.71	8.79	6.7
	Black screen with 18% shading				
WRM	34.07 a	42.25 a	3.67 a	2.72 a	8.48 a
RM	37.87 a	40.07 b	3.62 a	2.87 a	8.91 a
CV (%)	7.16	2.90	10.34	21.66	16.91

Equal lowercase letters in the column for each variable do not differ from each other by the *F*-test at 5% probability.

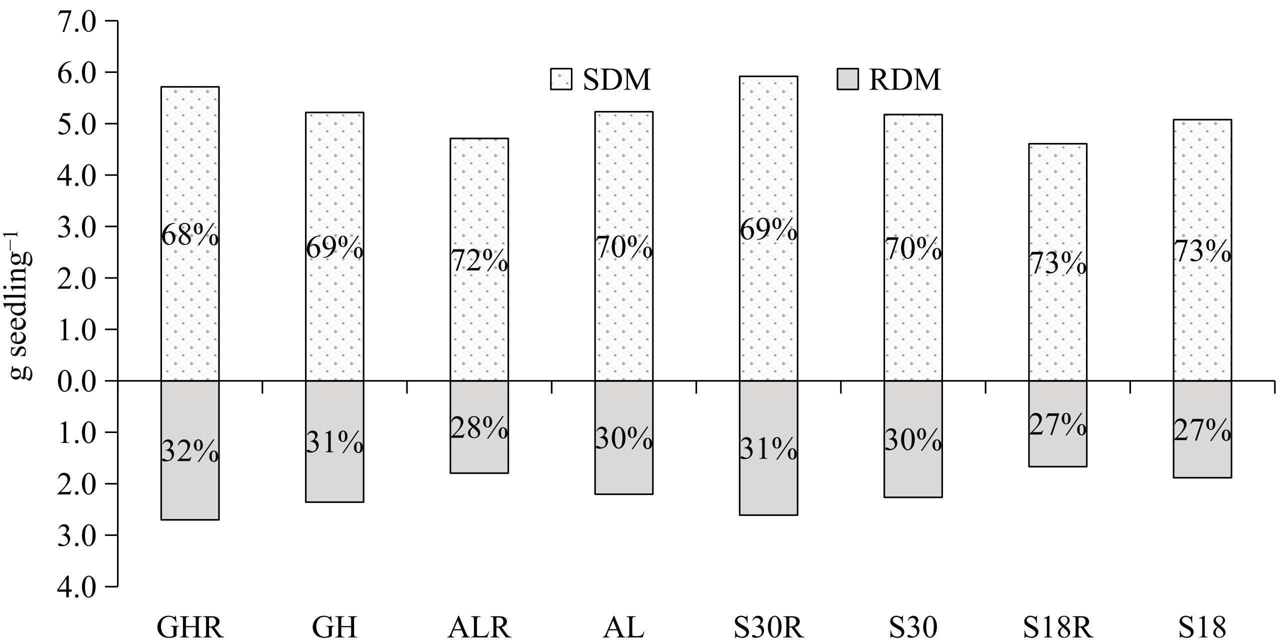

Figure 2. Distribution of shoot (SDM) and root (RDM) dry matter in the greenhouse on a bench with reflective material (GHR) and without reflective material (GH); in the environment with aluminized screen on a bench with reflective material (ALR) and without reflective material (AL); in the screenhouse with a black screen of 30% shading on a bench with reflective material (S30R) and without reflective material (S30); and in the screen house with a black screen of 18% shading on a bench with reflective material (S18R) and without reflective material (S18).

The H:D index, widely used in forest species (Carneiro 1995; Haase 2008; da Silva et al. 2020), is a tool that helps predict the robustness of seedlings in their final planting site, whether in the field or urban forest. For seedlings with the same height and different diameters, the smaller the diameter, the lower the quality; however, the quality of the change should not be evaluated only by this parameter.

The DQI is a vital parameter to assess seedling quality, being more important than variables such as height (Dickson et al. 1960; da Silva et al. 2020; Matos et al. 2020). Another variable of great importance to be considered is the RDM; it was observed that the seedlings from the 42%/50% greenhouse, as well as those from the 30% screenhouse, had roots with high weight, which means that there was an investment in producing denser roots, a characteristic of rustic plants that can adapt and survive in an environment more easily than plants with more fragile roots with less dry matter (Carneiro 1995), in addition to expanding the absorption of nutrients and promoting growth and superior performance.

When analyzing seedlings according to the quality indices, it was noted that the 30% screenhouse environment positively influenced the quality of the seedlings according to H:D3 and DQI, since the cultural practices of the setting are factors that directly influence the growth and development of the species, acting on the physiology of the plant and as a consequence on its morphological development (Grossnickle et al. 2020). The plants produced in the 42%/50% greenhouse and those produced in the 30% screenhouse had the highest means for biometric data.

The biomass distribution verified for *Licania tomentosa* evidenced that the seedlings were ready to be planted due to their quality and strong roots. With 29% root mass, *Licania tomentosa* seedlings have a great chance of survival and initial development in the field, allowing the roots to reach deeper layers of the soil where there is more water available, especially in times of drought. For *Hirtella triandra* of the same family (Chrysobalanaceae), seedlings with 22% root mass showed adequate development (Markesteijn and Poorter 2009). Additionally, a robust root mass enables increased nutrient absorption. This verified biomass distribution for *Licania tomentosa* is lower than that observed in rubber tree seedlings by Costa et al. (2021), who observed 60% for the shoot and 40% for the root system, regardless of the cultivation environment and the use or not of reflective material on the bench.

The high radiation did not favor the development of *Licania tomentosa* seedlings. This was probably due to increased transpiration rate, an abiotic stress that can cause plant dehydration, damage photosynthetic tissues, and decrease photosynthesis, resulting in plants with lower biomass, as seen in the 18% shading environment.

CONCLUSIONS

The greenhouse with 42%/50% shading screen under the film and the screenhouse with a black screen of 30% shading were the best environments for the formation of seedlings of *Licania tomentosa*. The reflective material on the cultivation bench did not provide better quality oiti seedlings.

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Résumé. Contexte: La lycanie tomenteuse (*Licania tomentosa* [Benth.] Fritsch) est une option pour la foresterie urbaine et les milieux ruraux qui nécessitent une couverture ombragée par les plantes, il est donc essentiel d'étudier l'environnement végétal pour obtenir des semis de qualité. La présente étude visait à évaluer les semis de lycanie selon différents milieux protégés avec ou sans matériau réfléchissant sur un banc de culture. Méthodes: Les milieux protégés suivants ont été évalués : une serre agricole recouverte d'un film de polyéthylène basse densité et d'un écran thermo-réfléchissant avec 42% à 50% d'ombrage sous le film; une serre agricole avec un écran aluminisé avec 35% d'ombrage; une serre agricole avec un écran noir avec 30% d'ombrage; et une serre agricole avec un écran noir avec 18% d'ombrage. Des systèmes de production avec et sans matériau réfléchissant le rayonnement photosynthétiquement actif (écran aluminisé, Aluminet®) sur le banc de culture ont été évalués dans chaque milieu protégé. Résultats: Il n'y a pas eu d'interaction entre les facteurs environnementaux; toutefois, les milieux ont influencé la hauteur, le diamètre des tiges, la matière sèche des racines, les relations biométriques totales et les taux de croissance. Le matériau réfléchissant n'a pas amélioré la qualité des plants de lycanie. Le ratio entre la matière sèche des pousses et des racines était en moyenne de 71% pour les pousses et de 29% pour les racines. Le rayonnement photosynthétiquement actif reçu par les semis de lycanie était compris entre 600 et 900 µmol m^{-2} s^{-1}. Conclusions: La serre avec un écran d'ombrage de 42% à 50% sous le film et l'écran noir avec un ombrage de 30% étaient les meilleurs milieux pour le développement des semis de *Licania tomentosa*. Le matériau réfléchissant sur le banc de culture n'a pas permis d'obtenir des plants de lycanie de meilleure qualité.

Zusammenfassung. Hintergrund: Oiti (*Licania tomentosa* [Benth.] Fritsch) ist eine Option für die städtische Aufforstung und ländliche Umgebungen, die eine Beschattung durch Pflanzen erfordern, so dass die Untersuchung der Pflanzenumgebung für die Gewinnung hochwertiger Setzlinge von wesentlicher Bedeutung ist. Ziel der vorliegenden Studie war es, Oiti-Setzlinge in verschiedenen geschützten Umgebungen mit oder ohne reflektierendem Material auf einer Anzuchtbank zu bewerten. Methoden: Die folgenden geschützten Umgebungen wurden bewertet: ein landwirtschaftliches Gewächshaus, das mit einer Polyethylenfolie niedriger Dichte und einem thermoreflektierenden Schirm mit 42% bis 50% Schattierung unter der Folie abgedeckt war; ein landwirtschaftliches Schirmhaus mit einem aluminisierten Schirm mit 35% Schattierung; ein landwirtschaftliches Schirmhaus mit einem schwarzen Schirm mit 30% Schattierung; und ein landwirtschaftliches Schirmhaus mit einem schwarzen Schirm mit 18% Schattierung. In jeder geschützten Umgebung wurden Produktionssysteme mit und ohne photosynthetisch aktives strahlungsreflektierendes Material (aluminisierter Schirm, Aluminet®) auf der Anbaubank bewertet. Ergebnisse: Es gab keine Wechselwirkung zwischen den Umweltfaktoren; die Umgebungen beeinflussten jedoch die Höhe, den Stammdurchmesser, die Wurzeltrockenmasse und die gesamten biometrischen Verhältnisse und Wachstumsraten. Das reflektierende Material verbesserte die Qualität der Oiti-Setzlinge nicht. Das Verhältnis von Spross- und Wurzeltrockenmasse betrug im Durchschnitt 71% bei den Sprossen und 29% bei den Wurzeln. Die photosynthetisch aktive Strahlung, die die Oiti-Sämlinge erhielten, lag zwischen 600 und 900 µmol m^{-2} s^{-1}. Schlussfolgerungen: Das Gewächshaus mit 42% bis 50% Schattierung unter der Folie und der schwarze Schirm mit 30 % Schattierung waren die beste Umgebung für die Bildung von *Licania tomentosa*-Setzlingen. Das reflektierende Material auf der Anbaubank führte nicht zu einer besseren Qualität der Oiti-Sämlinge.

Resumen. Antecedentes: Oiti (*Licania tomentosa* [Benth.] Fritsch) es una opción para la forestación urbana y los entornos rurales que requieren sombra por parte de las plantas, por lo que estudiar el entorno vegetal para obtener plántulas de calidad es esencial. El presente estudio tuvo como objetivo evaluar plántulas en diferentes ambientes protegidos con o sin material reflectante en un banco de cultivo. Métodos: Se evaluaron los siguientes entornos protegidos: un invernadero agrícola cubierto con una película de polietileno de baja densidad y una pantalla termorreflectante con 42% a 50% de sombreado debajo de la película; una casa de campo con una pantalla de aluminio con 35% de sombreado; una casa de campo con una pantalla negra con un 30% de sombreado; y una casa de campo con una pantalla negra con un 18% de sombreado. Los sistemas de producción con y sin material fotosintético activo, que reflejan la radiación (pantalla de aluminio, Aluminet®) en el banco de cultivo, se evaluaron en cada entorno protegido. Resultados: No hubo interacción entre los factores ambientales. Sin embargo, los ambientes influyeron en la altura, el diámetro del tallo, la materia seca de la raíz y las relaciones biométricas totales y las tasas de crecimiento. El material reflectante no mejoró la calidad de las plántulas de oiti. La proporción de materia seca de brotes y raíces fue, en promedio, del 71% para los brotes y del 29% para las raíces. La radiación fotosintéticamente activa recibida por las plántulas oiti varió de 600 a 900 µmol m^{-2} s^{-1}. Conclusiones: El invernadero con 42% a 50% de pantalla de sombreado debajo de la película y la pantalla negra con 30% de sombreado fueron los mejores ambientes para la formación de plántulas de *Licania tomentosa*. El material reflectante en el banco de cultivo no dio como resultado plántulas oiti de mejor calidad. La proporción de materia seca de brotes y raíces fue, en promedio, del 71% para los brotes y del 29% para las raíces.