FOREST SCIENCES (CIÊNCIAS FLORESTAIS)

Rescue strategies for *Xylopia sericea* A.St.-Hil. plants from natural regeneration

Gleica Cândido Santos[1], Luana Cristielle Araújo Silva[1], Paula Alves Oliveira[1], Estela Rosana Durães Vieira[2], Israel Marinho Pereira[1], Márcio Leles Romarco de Oliveira[1], Miranda Titon[1], Múcio Magno de Melo Farnezi[1]

[1] Universidade Federal dos Vales do Jequitinhonha e Mucuri, Diamantina-MG, Brasil. E-mail: gleicacandidosantos@gmail.com; luana.araujoflorestal@gmail.com; oliveiraalvespaula@gmail.com; imarinhopereira@gmail.com; marcioromarco@gmail.com; mirandatiton@gmail.com; muciomagno@yahoo.com.br
[2] Instituto Federal de Educação, Ciência e Tecnologia do Amazonas, Manaus-AM, Brasil, E-mail: estela.duraes@gmail.com

ABSTRACT: The objective of this study was to test different rescue strategies of *Xylopia sericea* plants from natural regeneration. Two experiments were conducted in a completely randomized design, in split-plots, with the first one consisting of four levels of shading (0 or full sun, 30, 50 and 70% of shading) and four substrates; and the second consisting of four levels of shading and three leaf reduction intensities (0, 50 and 100%). After 150 days from the rescue, the survival and increments in height and diameter were obtained. The general mean survival was 26.1% in the first experiment and 26.7% in the second one. In both experiments the plants in full sun resulted in 100% mortality, while the 70% shading showed to be more effective concerning the survival and in the growth resumption. It is recommended to use substrates whose mixture has at least 50% subsoil as one of its components. Overall, the results obtained by leaf reduction were not sufficient to justify and recommend this procedure, taking into account the increase of the process total costs.

Key words: forest restoration; germplasm rescue; leaf reduction; seedling production

Estratégias para resgate de plantas de Xylopia sericea A.St.-Hil. provenientes da regeneração natural

RESUMO: Este estudo teve como objetivo testar diferentes estratégias de resgate de plantas de *Xylopia sericea* provenientes da regeneração natural. Foram conduzidos dois experimentos em delineamento inteiramente casualizado, em parcelas subdivididas, o primeiro composto por quatro níveis de sombreamento (0 ou pleno sol, 30, 50 e 70% de sombreamento) e quatro substratos; e o segundo experimento foi constituído por quatro níveis de sombreamento e três intensidades de redução da lâmina foliar (0, 50 e 100%). Após 150 dias do resgate obteve-se a sobrevivência e incrementos em altura e diâmetro. A sobrevivência média geral foi de 26,1% no primeiro experimento e de 26,7% no segundo. Em ambos experimentos, o acondicionamento das plantas a pleno sol acarretou 100% de mortalidade, enquanto o sombreamento de 70% foi mais adequado tanto em relação à sobrevivência quanto na retomada do crescimento. Recomenda-se a utilização dos substratos cuja mistura possui pelo menos 50% de terra de subsolo como um dos componentes. De maneira geral, os ganhos obtidos pela execução da redução foliar não foram suficientes para justificar e recomendar a sua realização, levando em consideração o aumento dos custos totais do processo.

Palavras-chave: restauração florestal; salvamento de germoplasma; redução foliar; produção de mudas

Introduction

Xylopia sericea A.St.-Hil. (Annonaceae) is a species that belongs to the late secondary ecological group (Meira Junior et al., 2015) and has a wide occurrence distribution in the Brazilian territory, covering more than 15 states (Maas et al., 2015). It is also adapted to dry and low fertility areas, as well as a fruit producer quite appreciated by the fauna, which corroborates its indication and use in plantations in degraded areas (Lorenzi, 2000). Although it is a very abundant species in its areas of occurrence, when under nursery conditions the seed germination usually does not occur or is very low (Santos et al., 1994). Therefore, obtaining seedlings via rescuing plants from natural regeneration may be a promising alternative to overcome this difficulty, increase the diversity of native seedlings produced in the nurseries and, mainly, avoid the loss of genetic material in places that will be subjected to vegetation suppression (Viani & Rodrigues, 2007).

However, there are many gaps between the legal aspect of plant rescuing and the compatibility of a large-scale enforcement (Santos, 2018). Several species respond positively to rescue, which facilitates their collection and handling (Viani & Rodrigues, 2007; Calegari et al., 2011; Silva et al., 2017; Zimmermann et al., 2017). Still, this is not a rule, as rescued species generally exhibit distinct behaviors when analyzed in isolation, with large variations in the survival and growth rates being noted (Viani & Rodrigues, 2007; Silva et al., 2015). Thus, the lack of knowledge about adequate methodological procedures for execution and conduction of the activity, as well as the lack of specific responses to the range of native species after the rescue, often result in failed attempts. Eliminating bottlenecks such as this is critical to increase the success assurance of the practice, directing the reduction of genetic material loss, enriching restoration programs and reducing total costs of the process.

Among the essential factors for seedling survival and quality, the ambient light conditions and the used substrate stand out. Light is a factor of fundamental importance, since it is able to interfere in the physiological processes of plants (Dutra et al., 2012) and, consequently, their growth and development (Sabino et al., 2016; Silva et al., 2018). Plants adaptation to this factor depends on the adjustment of their photosynthetic apparatus, so that the ambient light is used as efficiently as possible (Silva et al., 2007). Incident light acclimatization is based on maximizing total carbon gain; however, such response may vary considerably between species, in accordance to the degree of plasticity and dependence on the light quantity or quality (Pacheco & Paulilo, 2009).

On the other hand, choosing a quality substrate with low cost and easy acquisition, as well as being effective in surviving and resuming the growth of rescued seedlings, can be substantial in the total project costs reduction. Therefore, several authors recommend mixing materials for obtaining a substrate with appropriate conditions, both physical and chemical, as these conditions may vary for different native

forest species (Gervasio et al., 2016; Sousa et al., 2016; Cabreira et al. al., 2017).

Another factor that can contribute to the better establishment of rescued plants is the cutting of the leaf blades. Generally speaking, it is recommended to partially cut the leaves of individuals transplanted to nursery (Viani & Rodrigues, 2007), preventing excessive transpiration. However, studies are needed to prove the efficiency and, especially, the necessity to use these recommendations (Viani et al., 2012) for most native species.

Given the above, this study aimed to evaluate the effect of different substrates, leaf reduction intensities and shading levels in relation to growth and survival of rescued *Xylopia sericea* seedlings obtained from natural regeneration, favoring a better use of the seedlings bank for seedling production and their subsequent use in ecological restoration.

Materials and Methods

The rescue of the individuals was during the rainy season, in February, in a fragment of Semideciduous Seasonal Forest located on the margins of the MG-010 highway (coordinates 18°51'30.27"S and 43°23'51.39"O), located in the municipality of Conceição do Mato Dentro, Minas Gerais, Brazil. The study area is part from the geomorphological domain of Serra do Espinhaço, having a Köppen Cwa climate: subtropical humid mesothermal (Sá Júnior et al., 2012), with mean annual temperature of 20.6 °C, mean annual precipitation of 1400 and 1500 mm (Amaral et al., 2017) and 704 m of altitude. The rescue technique was established by the environmental agency as a mitigation measure of the vegetation suppression for iron mining by the Anglo American Iron Ore Brazil Company, in this municipality.

In total, 420 young *Xylopia sericea* plants were rescued and removed from the soil together with the clod by using a gardening shovel, and then they had these clods manually broken until obtaining the bare root. Afterwards, they were placed in buckets containing water in order to avoid water stress and then transported to the municipality of Diamantina, Minas Gerais, approximately 140 km away from the rescue area.

Two experiments were set up in an area of CIPEF (Integrated Forest Species Propagation Center) of UFVJM (Federal University of Valles do Jequitinhonha e Mucuri), located in the municipality of Diamantina, at an altitude of 1400 m, and coordinates of 18°12'.07"S and 43°34'20"O. The region climate regime is typically tropical, Cwb in the Köppen classification (Sá Júnior et al., 2012), with mean annual precipitation ranging from 1250 to 1550 mm. During the experiments conduction period, the monthly mean relative humidity, minimum and maximum temperature were 74%, 14 and 24 °C, respectively.

Experiments were conducted in a completely randomized design, in a split-plot scheme. In Experiment 1, the plots were constituted by the shading levels and the subplots by the substrates (Table 1). In Experiment 2, the shading levels

Table 1. Description of the tested factors in experiments 1 and 2.

Experiment 1		Experiment 2	
Plots	Subplots	Plots	Subplots
Shading	Substrate	Shading	Leaf Reduction
0%	S1=70% vermiculite and 30% carbonized rice husk	0%	0%
30%	S2=50% subsoil, 30% carbonized rice husk and 20% manure	30%	50%
50%	S3=60% subsoil, 20% coconut fiber and 20% manure	50%	100%
70%	S4=40% vermiculite, 30% rice husk and 30% coconut fiber	70%	-

composed the plots and the leaf reduction intensities the subplots (Table 1).

Experiments were implanted about 15 h after the rescue, using 280 cm³ tubes. The substrate used in Experiment 2 consisted of sifted subsoil (Red-Yellow Oxisol), carbonized rice husk and tanned manure, in a 5:3:2 ratio (Substrate 2 of Experiment 1). Both experiments received initial fertilization of 5 g.L^{-1} of single superphosphate and 3 g.L^{-1} of Osmocote ® (14-14-14).

After transplanting, the first height measurement was held, considering the point between the collar until the insertion of the last bud (cm) and the diameter of the root collar (mm) of the seedlings. Height was obtained by using a measuring tape and the diameter through digital caliper. Initially, the plants from experiments 1 and 2 had, on average, 19 and 24 cm in height and 2.3 and 3.2 mm in diameter, respectively.

At 150 days after the experiments were set up, the survival percentage was determined, and the subjects were re-measured in order to obtain the height and diameter increments in relation to the initial measurement. Only the increment data were subjected to the analysis of variance. In case of significant difference between treatments, the means were compared by Tukey test at 5% significance. All analyzes were performed using the R software (R Core Team, 2018).

Results and Discussion

Survival

Shading was found to be essential in the survival of rescued *Xylopia sericea* plants, since in both experiments there was 100% mortality rate of the individuals placed under full sun. Exposure to direct sunlight probably caused increased transpiration, and since the root apparatus was already sensitive due to the rescue procedure, it was unable to meet the water increased demand (Corvello, 1983). Due to this high mortality, the full sun environment was disregarded when presenting the results in this study.

The general survival obtained in Experiment 1 (Shading x Substrate) was of 26.1%, in other words, from the 180 evaluated seedlings, only 47 survived. And the 30, 50 and 70% shadings showed survival of 30, 16.7 and 31.7%, respectively. Substrates 1, 2, 3 and 4 obtained 26.7; 33.3; 24.4 and 20% survival, respectively (Figure 1).

In the second experiment (Shading x Leaf Reduction) the general survival obtained was of 26.7%, that is, from the 135 seedlings obtained from natural regeneration only 40 survived. Shadings of 30, 50 and 70% had general survival means of 35.6; 22.2 and 31.1%, respectively. Leaf reductions of 0, 50 and 100% had 28.9; 22.2 and 37.8% of general survival, respectively (Figure 2).

The low survival observed in both experiments may be related to the fact that the studied species belongs to the ecological group of late secondary species. Although there is variation in the light regime caused by the seasonal fall of tree leaves, the understory naturally has milder lighting and temperature conditions, as well as higher air humidity (Corvello, 1983). Therefore, the impact suffered by these plants is greater when they are removed from their environment and transferred to a nursery in full sun or even under shading, generally showing inferior survival when compared to pioneer species (Viani & Rodrigues, 2007).

It is worth mentioning that the fact that the rescue was performed during February, on a sunny day, may have contributed to the low survival, increasing the trauma and stress caused by the procedure, even though the individuals were kept hydrated until the transplantation moment. However, for both experiments, close survival values were observed (26.1% and 26.7% for experiments 1 and
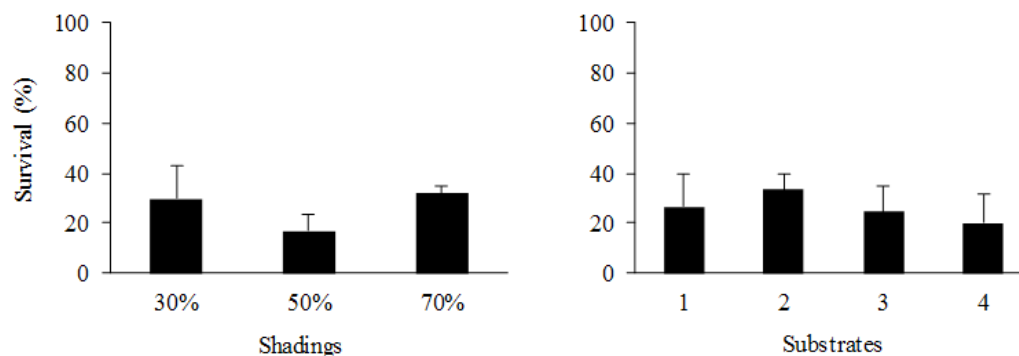
Figure 1. Survival of Experiment 1, at 150 days after its set up, for the respective shadings and substrate tested.
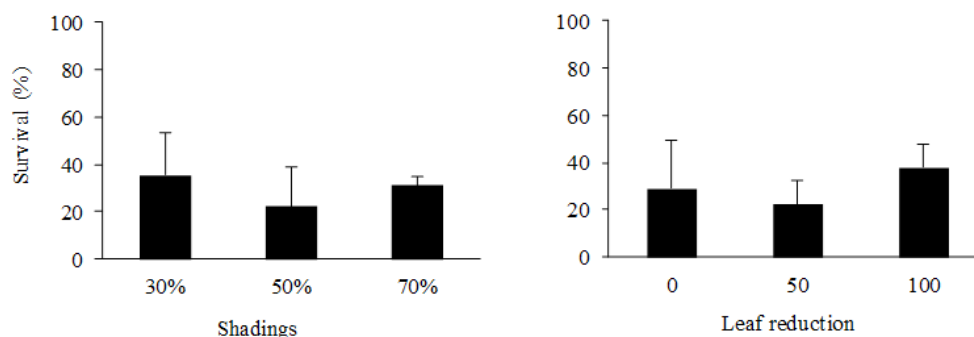
Figure 2. Survival of Experiment 2, at 150 days after its set up, for the respective shadings and leaf reductions tested.

2, respectively), indicating that the high mortality seen is possibly linked to intrinsic characteristics of *X. sericea* species. *Xylopia brasiliensis* Spreng., for example, belonging to the late secondary ecological group (Meira Junior et al., 2015), was considered by Bechara (2006) as a species with high rescue sensitivity, since the author obtained only 4% of survival in a similar study.

On the other hand, the species *Cordia trichotoma* (Vell.) Arráb. ex Steud. was classified by Zimmermann et al. (2017) as being highly adaptive to the stress caused by the method, since at 150 days after rescue, these authors obtained 100% survival for all tested treatments (30, 50 and 70% shading and 0, 50 and 100% leaf reduction). Corroborating to the idea that distinct species have different response capacities to the rescue procedure (Viani et al., 2012).

In Experiment 1, the substrate 2, composed of subsoil soil, carbonized rice husk and tanned manure, in a 5:3:2 ratio, provided a numerically greater survival. Thus, it was expected that in the leaf reduction experiment (Experiment 2) survival would be enhanced, since all seedlings received the abovementioned substrate (substrate 2). However, this was not the observed, demonstrating that the reduction technique did not effectively collaborate in increasing the survival of individuals.

Preservation of the clod during the rescue and transplantation procedure may be a plausible alternative to enhance the survival of *Xylopia sericea* plants. Viana et al. (2015), when rescuing *Xylopia frutescens* Aubl seedlings and conditioning them under 70% shading obtained 7.5% survival for rescued plants with bare root. In contrast, 100% of the seedlings taken from the preserved clod survived. This

suggests that, for species of the *Xylopia* genus, maintaining the clod may mitigate the trauma of the procedure and reduce the sensitivity to rescue. While preserving the clod reduces the operating efficiency of the rescue technique, it can also provide high survival (Oliveira et al., 2017), which is advantageous when considering the total cost of the project.

Height and diameter

In the first experiment, for the height increment variable, a significant interaction between shading factors and substrates was verified. In a manner that, for substrates 1, 2 and 4, the height increase was similar regardless of the used shading. For substrate 3, the largest increase was observed under 70% shading (Table 2). For the 30% and 50% shading there was no difference between the tested substrates. For the 70% shading, the highest mean was found for substrate 3, while the other substrates did not differ from each other (Table 2).

Regarding the increment in diameter, the factors shading and substrate and their respective interactions were considered statistically similar (Table 2).

In relation to the second experiment, for the increment in height, there was no interaction record between shading and leaf reduction, as well as significant difference for the treatments in isolated manner. For the increment in diameter, there was interaction between treatments (shading x leaf reduction). Unfolding the shading levels within the leaf reduction intensities, only in the 50% reduction there was a distinction regarding the shading, so that the 70% one provided a larger mean diameter. Analyzing each leaf reduction intensity within the shading levels, it was observed that the 70% shading resulted in the largest increase in diameter for

Table 2. Increment in height and diameter of *Xylopia sericea* plants rescued from natural regeneration, transplanted to 4 substrates (S1= 70% vermiculite and 30% carbonized rice husk; S2= 50% subsoil, 30% carbonized rice husk and 20% manure; S3= 60% subsoil, 20% coconut fiber and 20% manure; S4= 40% vermiculite, 30% rice husk and 30% coconut fiber) kept under 3 distinct shadings (30, 50 and 70%) and conducted in nursery for 150 days (Experiment 1).

Shading	Height (cm)				Diameter (mm)			
	Substrate				Shading		Substrate	
	S1	S2	S3	S4				
30%	2.28 aA	1.85 aA	1.33 bA	0.30 aA	30%	0.53 ^{ns}	S1	0.43 ^{ns}
50%	1.25 aA	1.20 aA	0.00 bA	4.00 aA	50%	0.78 ^{ns}	S2	0.56 ^{ns}
70%	0.25 aB	0.46 aB	7.60 aA	0.08 aB	70%	0.64 ^{ns}	S3	0.80 ^{ns}
					-	-	S4	0.80 ^{ns}

Means followed by the same letter, lowercase in the column and uppercase in the row, are considered equal by the Tukey test, 5% significance. Means followed by ^{ns} do not differ from each other by the F test at 5% significance.

Table 3. Height and diameter increment of *Xylopia sericea* plants rescued from natural regeneration, submitted to 3 levels of leaf blade reduction (0, 50 and 100%), kept under 3 different shadings (30, 50 and 70%) and conducted in a nursery for a period of 150 days (Experiment 2).

Height (cm)				Diameter (mm)			
Shadings		Leaf Reduction		Shading	Leaf Reduction		
					0%	50%	100%
30%	2.45 ns	0%	3.07 ns	30%	0.63 aA	0.36 bA	0.35 aA
50%	2.75 ns	50%	4.43 ns	50%	0.42 aA	0.74 bA	0.45 aA
70%	3.42 ns	100%	1.90 ns	70%	0.63 aB	1.74 aA	0.48 aB

Means followed by the same letter, lowercase in the column and uppercase in the row, are considered equal by the Tukey test, 5% significance. Means followed by ns do not differ from each other by the F test at 5% of significance.

the 50% reduction of the leaf blade. The others did not differ from each other (Table 3).

Although the behavior of height and diameter for non-pioneer plants is difficult to predict or explain, due to their slow growth rate, in this study, it was evidenced that the use of 70% shading favored the plant growth resumption, similarly to what was reported by Viana et al. (2015).

Hence, it is advisable to use 70% shading in the acclimatization of *Xylopia sericea* seedlings in the post-rescue period, since it exhibited higher responses in height and diameter, giving more vigorous-looking seedlings. In addition to that, it provided acceptable survival results in both experiments.

As for the substrate, it was evidenced that those whose mixture used the subsoil component were more adequate to obtain longer survival (S2= 50% of subsoil soil; 30% of carbonized rice husk, 20% of manure) and greater increase in height (S3= 60% underground soil; 20% coconut fiber, 20% manure).

The solid phase of a substrate should consist of a mixture of mineral and organic particles in appropriate percentages. The qualitative and quantitative arrangement of the employed minerals and organic materials influence the supply of nutrients, available water and oxygen, having direct effects on plants (Queiroz et al., 2012). In this sense, the soil contributed to the drainage process, good aggregation and water retention, while the presence of organic substances contributed to both the aggregation process and the increase of water retention capacity, besides increasing the cation exchange capacity (Queiroz et al., 2012).

Viani et al. (2012), after performing 50% leaf reductions in rescued seedlings of *Esenbeckia leiocarpa* Engl. (Rutaceae), *Eugenia ligustrina* (Sw.) Willd (Myrtaceae) and *Maytenus salicifolia* Reissek (Celastraceae), realized that leaf cutting did not affect the survival over time and after eight months of evaluation. Hence, the authors showed that such procedures are unnecessary for these species, as a way of reducing mortality.

In the present study, the execution of the 50% leaf cutting provided greater response in diameter, but on the other hand, the survival was numerically lower for this treatment, so that it was not found evident need to perform the leaf reduction. Considering that it increases the operational cost of the project, especially when the technique is applied on a large scale, it is not advised performing reduction cuts of the leaf blade for the studied species.

Conclusions

Nursery shading is essential for survival and growth resumption of rescued individuals from *Xylopia sericea*.

It is advisable to use 70% shading to provide greater survival, increased height and diameter.

Substrates with subsoil use were more adequate to obtain longer survival (50% subsoil; 30% carbonized rice husk, 20% manure) and greater increase in height (60% subsoil; 20% coconut fiber, 20% manure).

There was not enough evidence to justify the leaf reduction, and it is not necessary in the rescue practice for this species.

Acknowlodgements

Literature Cited

Amaral, L.A.; Pereira, I.M.; Silva, M.A.P.; Oliveira, M.L.R.; Machado, E.L.M.; Laia, M.L. Use of topsoil for restoration of degraded pasture area. Pesquisa Agropecuária Brasileira, v.52, n.11, p.1080-1090, 2017. https://doi.org/10.1590/s0100-204x2017001100014.

Bechara, F.C. Unidades demonstrativas de restauração ecológica através de técnicas nucleadoras: floresta estacional semidecidual, cerrado e restinga. Piracicaba: Universidade de São Paulo, 2006. 248p. Tese Doutorado. https://doi.org/10.11606/T.11.2006.tde-22082006-14573.

Cabreira, G.V.; Leles, P.S.S.; Alonso, J.M.; Abreu, A.H.M.; Lopes, N.F.; Santos, G.R. Biossólido como componente de substrato para produção de mudas florestais. Floresta, v.47, n.2, p.165-176, 2017. https://doi.org/10.5380/rf.v47i1.44291.

Calegari, L; Martins, S.V.; Busato, L.C.; Silva, E.; Junior, R.C.; Gleriani, J.M. Produção de mudas de espécies arbóreas nativas em viveiro via resgate de plantas jovens. Revista Árvore, v.35, n.1, p.41-50, 2011. https://doi.org/10.1590/S0100-67622011000100005.

Corvello, W.B.V. Utilização de mudas da regeneração natural em reflorestamentos com espécies nativas. Curitiba: Universidade Federal do Paraná, 1983. 105p. Dissertação Mestrado. http://hdl.handle.net/1884/25162. 09 Abr. 2019.

Rev. Bras. Cienc. Agrar., Recife, v.14, n.4, e7028, 2019

5/6

Dutra, T.R.; Massad, M.D.; Santana, R.C. Parâmetros fisiológicos de mudas de copaíba sob diferentes substratos e condições de sombreamento. Ciência Rural, v.42, n.7, p.1212-1218, 2012. https://doi.org/10.1590/S0103-84782012005000048.

Gervasio, C.R.; Silva, A.C.S.; Sarmento, M.B.; Netto, C.G.; Pinheiro, L.M.C.; Oliveira, C.J. Substratos na produção de mudas de espécies nativas do sul do Brasil. Magistra, v.28, n.2, p.268-272, 2016. https://magistraonline.ufrb.edu.br/index.php/magistra/article/view/428. 03 Abr. 2019.

Lorenzi, H. Árvores brasileiras: manual de identificação e cultivo de plantas arbóreas nativas do Brasil. Nossa Odessa: Plantarum, 2000. 640p.

Maas, P.; Lobão, A.; Rainer, H. *Annonaceae* in Lista de Espécies da Flora do Brasil. Rio de Janeiro: Jardim Botânico do Rio de Janeiro, 2015. http://floradobrasil.jbrj.gov.br/jabot/floradobrasil/FB110583. 08 Set. 2018.

Meira Junior, M.S.; Pereira, I.M.; Machado, E.L.M.; Mota, S.L.L.; Otoni, T.J.O. Espécies potenciais para recuperação de áreas de floresta estacional semidecidual com exploração de minério de ferro na serra do espinhaço. Bioscience Journal, v.31, n.1, p.283-295, 2015. https://doi.org/10.14393/BJ-v31n1a2015-23414.

Oliveira, P.A.; Carvalho, L.M.E.; Pereira, I.M.; Pinheiro, A.C.; Carvalho, A.C. Resgate e propagação de *Lagenocarpus rigidus* Nees. Enciclopédia Biosfera, v.14, n.26, p.629-640, 2017. https://doi.org/10.18677/EnciBio_2017B58.

Pacheco, P.; Paulilo, M.T.S. Efeito da intensidade de luz no crescimento inicial de plantas de *Cecropia glazioui* Snethlage (Cecropiaceae). Insula: Revista de Botânica, n.38, p.28-41, 2009. https://doi.org/10.5007/2178-4574.2009v38p28.

Queiroz et al., 2012

Queiroz, J.E.; Silva, G.H. da; Medeiros, J.X. de; Edimar Júnior, J.; A.M.F da N. Efeito de diferentes substratos no desenvolvimento inicial do cumaru (*Amburana cearensis* (Arr. Cam.) A.C. Smith). Revista Verde, Mossoró, v.7, n.1, p. 45-49, 2012. https://www.gvaa.com.br/revista/index.php/RVADS/article/view/1147. 03 Abr. 2019.

R Core Team. R: A language and environment for statistical computing. Vienna: R Foundation for Statistical Computing, 2018. URL https://www.R-project.org/.

Sá Júnior, A.; Carvalho, L.G. Application of the Köppen classification for climatic zoning in the state of Minas Gerais, Brazil. Theoretical and Applied Climatology, v.108, n.1-2, p.1-7, 2012. https://doi.org/10.1007/s00704-011-0507-8.

Sabino, M.; Korpan, C.; Ferneda, B.G.; Silva, A.C. Crescimento de mudas de ipês em diferentes telas de sombreamento. Nativa, v.4, n.2, p.61-65, 2016. https://doi.org/10.14583/2318-7670.v04n02a01.

Santos, A.C. Resgate de espécies endêmicas: estratégias para conservação da biodiversidade dos campos rupestres quartzíticos. Diamantina: Universidade Federal dos Vales do Jequitinhonha e Mucuri, 2018. 79p. Dissertação Mestrado. http://acervo.ufvjm.edu.br/jspui/handle/1/1899. 03 Abr. 2019.

Santos, G.P.; Andersen, V.U.; Zanuncio, J.C.; Zanuncio, T.V. Quebra de dormência e danos por *Coccotripes* sp. (Coleoptera: Scolytidae) em sementes de pimenteira *Xylopia sericea* (Annonaceae). Científica, v.22, n.1, p.111-116, 1994.

Silva, N.F.; Pereira, I.M.; Silva, M.A.P.; Titon, M.; Oliveira, M.L.R.; Araújo, L.C.; Carlos, L. Potential production of *Aspidosperma cylindrocarpon* seedlings viarescue seedlings. Ciência Rural, v.47, n.5, 6p., 2017. https://doi.org/10.1590/0103-8478cr20141019.

Silva, N.F.; Pereira, I.M.; Titon, M.; Oliveira, M.L.R.; Laia, M.L.; Araújo, L.C. Resgate de mudas de *Lychnophora pohlii* como alternativa para recuperação e conservação de campo rupestre. Floresta, v.45, n.3, p.645-654, 2015. https://doi.org/10.5380/rf.v45i3.31949.

Silva, R.R.; Anjos, A.B.; Freitas, G.A.; Nogueira, A.M.; Faria, A.J.G. Desenvolvimento inicial de mudas de *Plathymenia foliolosa* Benth. sob influência de sombreamento. Gaia Scientia, v.12, n.2, p.134-143, 2018. https://doi.org/10.22478/ufpb.1981-1268.2018v12n2.30813.

Silva, R.R.; Freitas, G.A.; Siebeneichler, S.C.; Mata, J.F.; Chagas, J.R. Desenvolvimento inicial de plântulas de *Theobroma grandiflorum* (Willd. ex Spreng.) Schum. sob influência de sombreamento. Acta Amazonica, v.37, n.3, p.365-370, 2007. https://doi.org/10.1590/S0044-59672007000300007.

Sousa, H.S.; Silva, H.S.; Gonçalves, D.S.; Souza, P.A.; Santos, A.F. Efeito de diferentes sistemas de produção de mudas e substratos no desenvolvimento de *Enterolobium Contortisiliquum*. Revista da Universidade Vale do Rio Verde, v.14, n.2, p.1093-1100, 2016. http://periodicos.unincor.br/index.php/revistaunincor/article/view/2940/pdf_598. 03 Abr. 2019.

Viana, B.L.; Farias, W.W.; Nascimento, L.M.; Paulo, F.V.L.; Coêlho, C.B.; Falcão, C.J.L.M.; Silva, W.R. Produção de mudas de *Xylopia frutescens* Aubl. a partir da técnica de repicagem de plântulas da regeneração natural. Arrudea, v.1, n.2, p.34-46, 2015. http://arrudea.recife.pe.gov.br/arrudea/index.php/Arrudea/article/view/9. 03 Abr. 2019.

Viani, R.A.G.; Brancalion, P.H.S.; Rodrigues, R.R. Corte foliar e tempo de transplantio para o uso de plântulas do sub-bosque na restauração florestal. Revista Árvore, v.36, n.2, p. 331-339, 2012. https://doi.org/10.1590/S0100-67622012000200014.

Viani, R.A.G.; Rodrigues, R.R. Sobrevivência em viveiro de mudas de espécies nativas retiradas da regeneração natural de remanescente florestal. Pesquisa Agropecuária Brasileira, v.42, n.8, p.1067-1075, 2007. https://doi.org/10.1590/S0100-204X2007000800002.

Zimmermann, A.P.L.; Tabaldi, L.A.; Fleig, F.D.; Michelon, I.J.; Marangon, G.P. Métodos de transplantio para utilização de mudas de regeneração natural de *Cordia trichotoma*. Revista Brasileira de Ciências Agrárias, v.12, n.1, p.74-78, 2017. https://doi.org/10.5039/agraria.v12i1a5416.