



APPLICATION OF FOLIAR FERTILIZER AND DIFFERENT SUBSTRATES ON THE GROWTH OF *Mouriri guianensis* Aubl. SEEDLINGS FOR USE IN THE ECOLOGICAL RESTORATION OF THE MATO GROSSO PANTANAL

Elisangela Francisca Da Silva¹
Josué Ribeiro Da Silva Nunes²
José Ricardo Castrillon Fernandez³
Fernando Ferreira De Moraes⁴
Ellen Cristina Magalhães Nacanishi⁵
Solange Kimie Ikeda Castrillon⁶

ABSTRACT

Objective: To evaluate the effect of different substrates and the use of foliar fertilizer on the growth of *M. guianensis* seedlings in nursery conditions in order to indicate the ideal one for their development.

Method: Three types of substrate were used: 100% black soil (TP); 100% soil from the area where the species occurs (TO); 100% Vivatto® commercial substrate (CS). A 2x3 factorial experimental design was adopted. Finally, the parameters used to assess the growth of the seedlings were: height of the aerial part (H), diameter of the neck (DC) and number of leaves of each seedling (NF).

Results and conclusion: The results obtained showed significant differences in the characteristics of height and number of leaves in *Mouriri guianensis* seedlings, with the 100% Vivatto® commercial substrate treatment. There were no significant differences in the use of foliar fertilizer.

Implications of the research: The *Mouriri guianensis* species is extremely important as it provides food for fish and birds, has medicinal uses and is recommended for recovering degraded areas. It is therefore important to obtain information on its production, as well as to assess the quality of the seedlings in alternative substrates.

Originality/value: describe the study's contribution to the advancement of science in the field and/or socio-environmental management practices in organizations, in line with the scope of the RGSA.

Keywords: Seedling Production, Species Native, Quality of seedling, Degraded Areas e Alternative Substrate.

APLICAÇÃO DE FERTILIZANTE FOLIAR E SUBSTRATOS DIFERENTES NO CRESCIMENTO DE PLÂNTULAS DE *Mouriri guianensis* Aubl. PARA USO NA RESTAURAÇÃO ECOLÓGICA DO PANTANAL MATO-GROSSENSE

RESUMO

Objetivo: Avaliar o efeito de diferentes substratos e uso de fertilizante foliar no crescimento de mudas de *M. guianensis* em condições de viveiro a fim de indicar o ideal para seu desenvolvimento.

¹ Universidade do Estado de Mato Grosso (UNEMAT), Cáceres, Mato Grosso, Brasil.

E-mail: elisangela.francisca@unemat.br Orcid: <https://orcid.org/0000-0001-5556-0644>

² Universidade do Estado de Mato Grosso (UNEMAT), Cáceres, Mato Grosso, Brasil. E-mail: josue@unemat.br
Orcid: <https://orcid.org/0000-0003-3927-5063>

³ Instituto Federal de Mato Grosso (IFMT), Cáceres, Mato Grosso, Brasil. E-mail: jrcastrillon@gmail.com
Orcid: <https://orcid.org/0000-0002-3011-1997>

⁴ Universidade Federal da Paraíba (UFPB), João Pessoa, Paraíba, Brasil. E-mail: fernandobotanica@gmail.com
Orcid: <https://orcid.org/0000-0001-7111-2833>

⁵ Universidade do Estado de Mato Grosso (UNEMAT), Cáceres, Mato Grosso, Brasil.
E-mail: ellen.nacanishi@unemat.br Orcid: <https://orcid.org/0000-0001-6977-5750>

⁶ Universidade do Estado de Mato Grosso (UNEMAT), Cáceres, Mato Grosso, Brasil.
E-mail: solangeikeda@unemat.br Orcid: <https://orcid.org/0000-0003-1862-4615>



Método: Foram utilizados três tipos de substratos: 100% terra preta (TP); 100% terra da área de ocorrência da espécie (TO); 100% substrato comercial Vivatto® (CS). Foi adotado o delineamento experimental em esquema fatorial 2x3, por fim, os parâmetros utilizados para avaliação do crescimento das mudas foram: altura da parte aérea (H), diâmetro do colo (DC) e número de folhas de cada muda (NF).

Resultados e conclusão: Através dos resultados obtidos foi possível observar diferenças significativas para as características de altura e número de folhas nas plântulas de *Mouriri guianensis*, com o tratamento 100% substrato comercial Vivatto®. Em relação ao uso de fertilizante foliar não houve diferença significativa.

Implicações da pesquisa: A espécie *Mouriri guianensis*, é de suma importância, pois seve de alimento para peixes e aves, possui uso medicinal e é recomendada para recuperação de áreas degradadas, e devido a este fato é importante obter informações sobre sua produção, bem como avaliar a qualidade das mudas em substratos alternativos.

Originalidade/valor: O conhecimento adquirido nesta pesquisa oferece informações importantes sobre o melhor substrato a ser utilizando no desenvolvimento de *Mouriri guianensis*, para obter mudas de qualidades.

Palavras-chave: Produção de Mudas, Espécie Nativa, Qualidade de Muda, Áreas Degradadas e Substrato Alternativo.

APLICACIÓN DE FERTILIZANTE FOLIAR Y DIFERENTES SUSTRATOS EN EL CRECIMIENTO DE *Mouriri guianensis* Aubl. PLÁNTULAS PARA LA RESTAURACIÓN ECOLÓGICA DEL PANTANAL DE MATO GROSSO

RESUMEN

Objetivo: Evaluar el efecto de diferentes sustratos y el uso de fertilizante foliar sobre el crecimiento de plántulas de *M. guianensis* en condiciones de vivero, con el fin de indicar cuál es el ideal para su desarrollo.

Método: Se utilizaron tres tipos de sustrato: 100% tierra negra (TP); 100% de suelo de la zona donde se encuentra la especie (TO); Sustrato comercial (CS) 100% Vivatto®. Se adoptó un diseño experimental factorial 2x3. Finalmente, los parámetros utilizados para evaluar el crecimiento de las plántulas fueron: altura de la parte aérea (H), diámetro del cuello (DC) y número de hojas de cada plántula (NF).

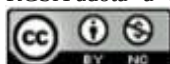
Resultados y conclusión: Los resultados obtenidos mostraron diferencias significativas en las características de altura y número de hojas en plántulas de *Mouriri guianensis*, con el tratamiento de sustrato comercial Vivatto® 100%. No hubo diferencias significativas en el uso de fertilizante foliar.

Implicaciones de la investigación: La especie *Mouriri guianensis* es extremadamente importante ya que proporciona alimento para peces y aves, tiene usos medicinales y se recomienda para recuperar áreas degradadas. Por lo tanto, es importante obtener información sobre su producción, así como evaluar la calidad de las plántulas en sustratos alternativos.

Originalidad/valor: describir la contribución del estudio al avance de la ciencia en el campo y/o las prácticas de gestión socio-ambiental en las organizaciones, en línea con el alcance de la RGSA.

Palabras clave: Producción de plántulas, Especies nativas, Calidad de las plántulas, Áreas degradadas y Sustrato Alternativo

RGSA adota a Licença de Atribuição CC BY do Creative Commons (<https://creativecommons.org/licenses/by/4.0/>).





1 INTRODUCTION

The Melastomataceae family is important. The species in this family have life strategies and adaptations such as high seed production, efficient propagule dispersal, high germination rates and rapid growth that can enable the activation of ecological processes involved in the natural regeneration of disturbed habitats. Among the species that make up the Suparacidae family, *Mouriri guianensis* Aubl, is a medium-sized tree species, 4-7 m tall, Floral phenology between September and February and its fruits ripen from December to April. It is widely distributed in South America and extends to Central America. Popularly known in the Pantanal as roncadour and in other Brazilian regions as: gurguri, murriri, ururi, goiabarana. Its fruit is edible and has twice the vitamin C of orange and lemon, serves as food for fish and birds, and is used medicinally for skin problems, ulcers and postpartum baths. (Pott and Pott 1994; Mors, Rizzini and Pereira, 2000; Lorenzi, 2009; Cruz and Kaplan; 2004).

This species is recommended for the recovery of degraded areas, as it is part of the native vegetation potentially suitable for Agroforestry Systems (AFS), mainly as an alternative source of income, through the production of fruits, wood, medicinal products, bee pasture and recovery of riparian forests (Pott and Pott, 2014). Here we observe that ecosystem restoration is the act of restoring ecological processes that have been destroyed or degraded, responsible for rebuilding a functional community that presents high diversity (Ser, 2004; Engst, 2014). *et al*, 2016; Pimentel and Rempel, 2022). Reis *et al*. (2014), highlights that the restoration of degraded areas is essential, mainly, in the sense of increasing connectivity between natural remnants, a vital action to maintain the quality of life on planet Earth.

The Pantanal is an extensive seasonally flooded plain, which makes it extremely productive in different habitats, where diverse and rare species occur (Alho, 2008; Alho, 2019). In recent years, the Biome has been suffering from fires, which in 2020 affected almost a third of the Pantanal territory, with more than four million hectares on fire (Libonati *et al*. 2020). In 2021, the Pantanal had 1,945,150 hectares (12.6% of the biome) consumed by flames, while in 2022 it was 218 thousand hectares. And in 2023, more than 1.2 million hectares of this area were devastated by fire. (SOS Pantanal, 2021; WWF-Brazil, 2023; Granchi, 2023). Thus, knowing the native species, as well as adaptations ecophysiological characteristics of the substrates and how these species grow and develop in their original habitat can provide us with important parameters for use in the ecological restoration of this Biome and, therefore, reduce the impacts of deforestation.



The type of substrate is one of the most important external factors in the development of seedlings in the nursery phase, influencing both seed germination and seedling growth, which contributes to production in a short period (Dutra *et al.* 2012). The composition of the substrate also aids in root development, influences the good quality and formation of seedlings, and the availability of physical and chemical characteristics, making them viable for being taken to the field in order to facilitate planting and obtain good post-planting performance (Marques *et al.* 2017; Fonseca *et al.* 2017). Therefore, it is necessary to identify the substrates that promote the best conditions for the development of seedlings of the species presented here.

In forest species, especially native ones, there is still insufficient information regarding their nutritional requirements during their initial growth (CECONI *et al.*, 2006). However, studies may show different results with the use of foliar mineral supplementation in the development of seedlings, due to genetic diversity and their different nutritional demands (Reis *et al.*, 2012). Given this reality, it is important to conduct studies using different substrates and applying foliar fertilizer to evaluate the growth and development of native species. A good substrate for seedling production can be the appropriate medium for their support and retention of sufficient and necessary amounts of water, oxygen and nutrients, in addition to offering compatible pH, absence of chemical elements at toxic levels and adequate electrical conductivity (Caldeira, *et al.* ; 2008; Oliveira *et al.* 2016).

Furthermore, the substrate plays an essential role in providing nutrients for seedling growth and in root aggregation so that when the seedling is removed from the container, before planting, it can protect it from impacts (Silva *et al.* 2019; Costa *et al.* 2020; Rodrigues *et al.* 2021). Fertilizers are the compound with the nutrients that the plants will absorb during their growth (Takane *et al.* 2013). Thus, in addition to the substrate, the use of foliar fertilizers helps to increase the nutrients absorbed by the plants.

Given the above, the economic and ecological importance of this species, the objective of this study was to produce *Mouriri seedlings. guianensis* Aubl . under different types of substrates, in order to indicate the ideal one for their initial development considering that seedlings depend on different nutrients for their growth and development. The hypothesis developed that the type of substrate associated with the spraying of foliar fertilizer on the seedlings can contribute to the growth of seedlings of this species for use in ecological restoration . Considering the urgent demands for restoring degraded areas in the Pantanal due to fires in recent years .



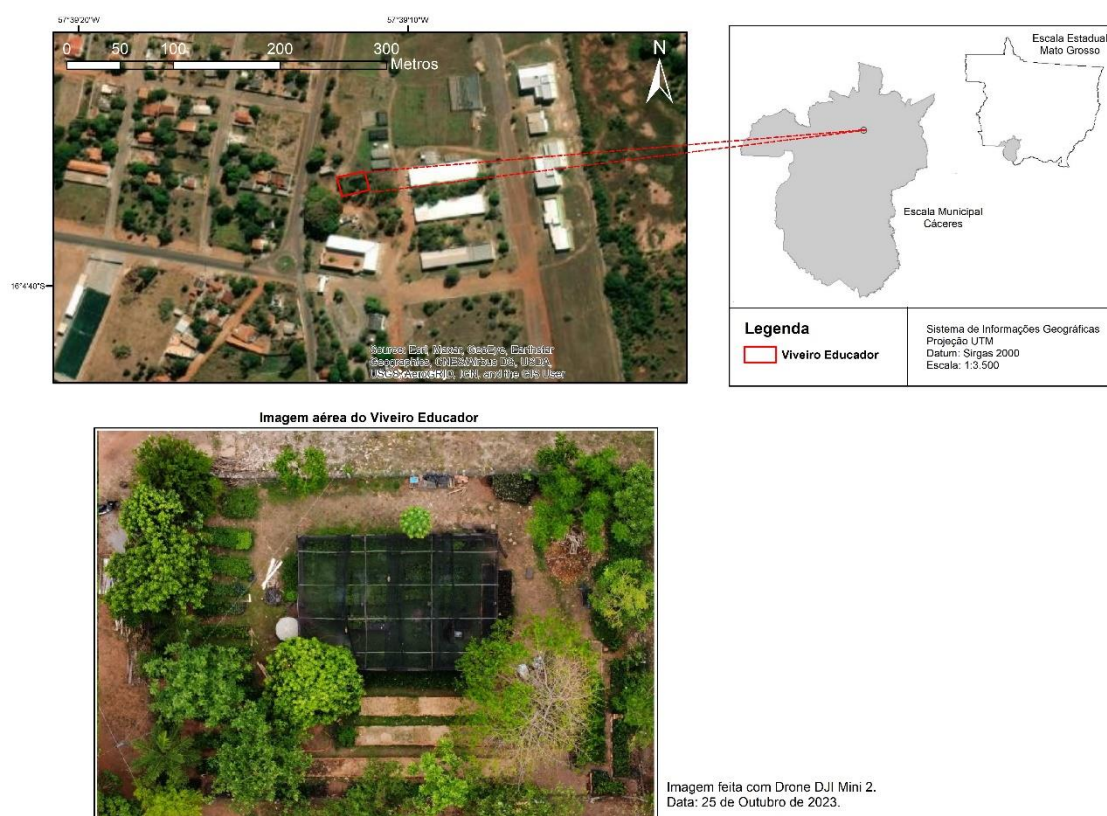
2 MATERIAL AND METHODS

2.1 STUDY AREA

The experiments were conducted in the Educator nursery of the Education, Ecological Restoration and Agroecology Laboratory - EDUCARE of the State University of Mato Grosso - UNEMAT in Cidade Universitária (Figure 1), in the municipality of Cáceres-MT, Pantanal Mato-gorssense , in the year 2023 In a shade house covered with “ sombrite ”, allowing 50% light to pass through the environment, with *M. guianensis* seedlings . Aubl .

Figure 1

Location where experiments with the Mouriri species were carried out guianensis Aubl .



Source: Datum SIRGAS (2000), adapted from Nacanishi (2024).

To analyze the influence of the type of substrate on the development of *M. guianensis* seedlings regarding height , collar diameter and number of leaves, an experimental design in a 2x3 factorial scheme was adopted. And to evaluate the influence of foliar fertilizer supplementation on the development of seedlings in relation to height, collar diameter and number of leaves of *M. guianensis* , two treatments were carried out: 1) the first without



introduction of foliar fertilizer and, 2) introduction of foliar fertilizer Base - Fertilizantes®, of NPK composition (10-10-10 + micronutrients), where three types of substrates were evaluated in each repetition, and the experimental units consisted of 7 repetitions with 6 seedlings, with 42 seedlings per treatment, totaling 252 seedlings. The substrates used in the experiment were : 100% black soil (TP); 100% soil from the area of occurrence of the species (TO); 100% commercial substrate Vivatto ® (CS).

Figure 2

Substrates organized according to the experimental design, before (A) and after (B and C) transplanting of M. guianensis seedlings Aubl .



Source: Prepared by the author.

For this purpose, tubes with a volumetric capacity of 280 cm³ were used, filled with the different substrates, arranged on suspended benches and from 30 days after transplanting, the foliar fertilizer was applied in the treatments to be evaluated the effect of fertilization.

To prepare the solution, 3 ml of the product Base - Fertilizantes®, composed of NPK (10-10-10 + micronutrients), was used . It was diluted in 2 liters of water and applied with a sprayer, after evaluating the variables of each month. Since then, these seedlings were evaluated for a period of 90 days and every thirty days.

The parameters used to evaluate seedling growth were: height of the aerial part (H), diameter of the collar (DC) and number of leaves of each seedling (NF). The height and diameter of the collar were measured every thirty days with the aid of a millimeter ruler, expressed in centimeters (cm) , from the level of the substrate to the height of the apical bud, and with a digital caliper with an accuracy of 0.01 mm, respectively, while the number of leaves was counted by counting the number of leaves per plant.



The data were subjected to analysis of variance and Tukey 's test at 5% probability, to compare the means, using the statistical *program* software BioEstat 5.3.

3 RESULTS AND DISCUSSION

In the results obtained from experiments with different substrates, it was possible to observe significant differences for the parameters height and number of leaves in *M. guianensis* seedlings , with the 100% commercial substrate Vivatto ® (SC) treatment when compared to the others. Silva *et al.* (2017) observed that *Eucalyptus* seedlings *grandis* showed significantly ($p \leq 0.05$) greater development in height, collar diameter and dry mass of the aerial part in the 100% commercial substrate treatment, for *Pinus elliottii* seedlings , those submitted to the use of 100% commercial substrate (Plantmax ®) showed higher averages of height and collar diameter.

Regarding the interaction between substrates and foliar fertilization for the variables evaluated, there was no statistically significant difference between them. Other authors corroborate this result Freitas *et al.* (2017), Santos *et al.* (2022) regarding the interaction between substrates and foliar fertilization for the height variable, both did not have a significant interaction.

The treatment with commercial substrate Vivatto ® (SC), without the introduction of the foliar fertilizer Base - Fertilizandos® NPK (10-10-10 + micronutrients), and with the introduction of the fertilizer, showed no difference in the averages in relation to the height characteristic , during the 90-day period of experiment evaluation (Table 1). What differs from the result found by Matias *et al.* (2019) who evaluated the effect of supplemental foliar fertilization associated with different substrates on mastic seedlings (*Myracrodruon urundeuva* Allemão), where it achieved greater growth in substrates with supplemental foliar fertilization.

Table 1

Average height values (H) of *Mouriri* seedlings *guianensis* Aubl . In black soil (TP); soil in the species' area of occurrence (TO); commercial substrate (CS).

Substrates	Height (cm) – H					
	Days after transplantation					
	30		60		90	
	No fertilizer	With fertilizer	No fertilizer	With fertilizer	No fertilizer	With fertilizer
TP	8.8bA	8.5bA	9.9bA	9.7bA	11.3bA	10.9bA
TO	8.0bA	8.4bA	10.3bA	10.4bA	11.4bA	11.5bA
SC	10.7aA	9.5aA	11.7aA	11.3aA	13.0aA	13.0aA



CV (%)	15.1	6.9	8.9	7.7	8.0	9.2
--------	------	-----	-----	-----	-----	-----

Tukey test at 5% during each period evaluated.

When evaluating the neck diameter (DC) it was noted that there was no statistically significant difference between the means of the substrates tested for the *M. guianensis* seedlings, there was also no interaction between the substrates and foliar fertilization for the variables evaluated, they presented similar development, (Table 2). corroborating with Epiphanius *et al* . (2021) that in the data regarding height and diameter performed at 30 and 60 days, in all treatments there was no significant difference. Kratz *et al* . (2013) who used *Eucalyptus* seedlings *benthamii*, also observed that the diameter of the neck, both at 60 and 90 days, the substrate did not have a significant influence.

According to Souza *et al.* (2006), the evaluation of the seedling neck diameter is of fundamental importance in assessing the seedling's potential for survival and growth after planting. This characteristic is classified as the best morphological characteristic to predict future growth, because it is correlated with the seedling weight and the size of the root system (Duarte, *et al* . 2015; Grossnickle & MacDonald, 2018).

In the study carried out by Araujo *et al* . (2014) on the quality of seedlings of mangrove tree species grown in nurseries and different substrates, when evaluating the stem diameter (SC) there was no significant difference between the averages of the substrates tested for *Rhizophora* seedlings. *mangle* L., *Avicennia germinans* (L.) Stearn, *Laguncularia racemosa* (L.) Gaertn . f. , during the evaluation period.

Table 2

Average values of the neck diameter (CD) of *Mouriri* seedlings *guianensis* Aubl . In black soil (TP); soil in the species' area of occurrence (TO); commercial substrate (CS).

Neck diameter (mm) – DC						
Substrates	Days after transplantation					
	30		60		90	
	No fertilizer	With fertilizer	No fertilizer	With fertilizer	No fertilizer	With fertilizer
TP	1.6aA	1.5aA	1.9aA	1.7aA	2.0aA	1.9aA
TO	1.6aA	1.5aA	1.9aA	1.8aA	1.9aA	1.9aA
SC	1.6aA	1.5aA	1.8aA	1.8aA	2.0aA	2.0aA
CV (%)	0.0	0.0	3.1	3.3	2.9	3.0

Tukey test at 5% during each period evaluated.



The treatments with substrates of occurrence soil (TO) and commercial substrate Vivatto® (SC), without the introduction of the foliar fertilizer Base - Fertilizantes® NPK (10-10-10 + micronutrients), presented better averages in relation to the characteristic number of leaves, during the 60-day evaluation period of the experiment, (Table 3).

We can observe that there was a statistically significant difference between the substrates, especially the commercial substrate Vivatto® (SC), at 90 days of evaluation of the experiment in relation to the other substrates. In the work carried out by Silva *et al* (2020) they obtained similar results, where they used cupuaçu seedlings (*Theobroma grandiflorum*) produced in the Biomix® substrate showed the largest leaf areas.

The greater amount of leaf area contributes to a greater active photosynthetic surface, and consequently increases the production of energy and photoassimilates. Therefore, a plant that has a high capacity to accumulate leaf tissue may show a great competitive advantage, especially at the critical moment during its establishment phase. (Santos *et al* 2022).

Table 3

Average values of the number of leaves (NF) of Mouriri seedlings guianensis Aubl. In black soil (TP); soil in the species' area of occurrence (TO); commercial substrate (CS).

Substratos	Number of sheets -NF					
	Days after transplantation					
	30		60		90	
	Sem fertilizante	Com fertilizante	Sem fertilizante	Com fertilizante	Sem fertilizante	Com fertilizante
TP	10.7aA	10.6aA	10.5aA	8.8bA	11.2bA	9.8bA
TO	9.9aA	10.0aA	10.8aA	10.3aA	12.3bA	11.6bA
SC	10.5aA	10.0aA	11.6aA	11.0aA	13.6aA	13.6aA
CV (%)	4.0	3.4	5.2	11.2	9.7	16.3

Tukey test at 5% during each period evaluated.

It was observed, in the statistical analyses, that there was no significant difference in the evaluated variables of height (H), stem diameter (DC) and number of leaves (NF), in relation to the interaction of substrates with and without foliar fertilizer Base - Fertilizantes® NPK (10-10-10 + micronutrients). For Marques *et al*. (2017), the substrate, in addition to being essential, helps in root development, being responsible for the good formation of seedlings, making them viable for planting.



4 FINAL CONSIDERATIONS

Based on the parameters analyzed, the species *M. guianensis* develops better when using the commercial substrate Vivatto ® (SC), without foliar mineral supplementation, Base - Fertilizantes®, 10-10-10 + micronutrients.

Therefore, the commercial substrate Vivatto ® (SC) is indicated for the production of quality seedlings for the species *M. guianensis*, for use in restoration actions of degraded areas of disturbed environments in humid areas, such as the Pantanal Mato-Grossense.

ACKNOWLEDGMENTS

To the Brazilian Biodiversity Fund.

To the Terrestrial GEF - Conservation, Restoration and Management Strategies Project for the Biodiversity of the Caatinga, Pampa and Pantanal.

To the Biodiversity Restoration, Water Conservation and Fire Prevention Project in the Pantanal Wetlands - Taiaã Ecological Station.

The Coordination for the Improvement of Higher Education Personnel (CAPES) granted to the first author.

REFERENCES

- Alho, C. J. R. (2008). Biodiversity of the Pantanal: response to seasonal flooding regime and to environmental degradation. *Brazilian Journal of Biology*, 68(4) suppl, p. 957 – 966. Recuperado de <https://doi.org/10.1590/S1519-69842008000500005>
- Alho, C. J. R. (2019). O significado socioeconômico do turismo na natureza: o Pantanal diante das normas reguladoras do Estado. *Sociedade e Estado*, 34(03), 769–786. Recuperado de <https://doi.org/10.1590/s0102-6992-201934030006>.
- Araujo, E. C., Costa, R. S., Lopes, E. C., Daher, R. F., Fernandes, M. E. B. (2014). Qualidade das mudas de espécies arbóreas de mangue cultivadas em viveiro e diferentes substratos. *Acta Ambiental Catarinense*, 11(1/2), 21-32.
- Caldeira, M. V. W., Rosa, G. N., Fenilli, T. A. B., Harbs, R. M. P. (2008). Composto orgânico na produção de mudas de aroeira-vermelha. *Scientia Agraria*, 9(1), p. 27-33.
- Ceconi, D. E. *et al.* Crescimento de mudas de açoita-cavalo (*Luehea divaricata* Mart.) sob influência da adubação fosfatada. *Cerne*, Lavras, v.12, n. 3, p. 292-299, jul./set. 2006



- Costa, E. G., Barreto, C. F., Farias, R. M., Martins, C. R. (2020). Propagação de amoreira-preta em diferentes substratos e estimuladores de enraizamento. *Brazilian Journal of Development*, 6(6), p. 36654-36662.
- Cruz, A. V. M; Kaplan, M. A. C. (2004). Uso medicinal de espécies das famílias Myrtaceae e Melastomataceae no Brasil. *Floresta e ambiente*, v. 11, p. 47-52.
- 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*, 25(1), p. 221-229.
- Dutra, T. R., Massad, M. D., Sarmiento, M. P. Q., Oliveira, J. C. (2012). Emergência e crescimento inicial da canafístula em diferentes substratos e métodos de superação de dormência. *Revista Caatinga*, 25(2), p. 65-71.
- Engst, K., Baasch, A., Erfmeier, A., Jandt, U., May, K., Schmiede, R., Bruelheide, H. (2016) Functional community ecology meets restoration ecology: Assessing the restoration success of alluvial floodplain meadows with functional traits. *Journal of Applied Ecology* 53:751–764. Recuperado de <https://doi.org/10.1111/1365-2664.12623>
- Epifanio, M., Gomes de Almeida Sous, H., Viana Souza, I., Aurélio Campos Aguiar, B., Braga Campos Duarte, V., Rayssa Antunes da Silva Oliveira, G., Vinicius de Melo Amorim, M., Freire Dias, C., Bezerra de Souza, F., Carneiro Fonseca, A. C., & Bezerra de Souza, P. (2021). Análise do crescimento de *Schizolobium parahyba* var *amazonicum* (Huber Ex Ducke) Barneby sob diferentes proporções de pó-de-rocha. *Pubvet*, 15(07). <https://doi.org/10.31533/pubvet.v15n07a851.1-6>
- Freitas, E. C. S. de., Paiva, H. N. de., Leite H. G., Oliveira Neto, S. N. de. (2017). Effect of phosphate fertilization and base saturation of substrate on the seedlings growth and quality of *Platymenia foliolosa* Benth. *Revista Árvore*. 41(1).
- Fonseca, E. F., Silva, G. O; Terra, D. L. C. V., & De Souza, P. B. (2017). Uso potencial da casca de arroz carbonizada na composição de substratos para produção de mudas de *Anadenanthera peregrina* (L) Speg. *DESAFIOS-Revista Interdisciplinar da Universidade Federal do Tocantins*, 4(4), 32-40.
- Grossnickle, S. C, & Macdonald, J. E (2018). Why seedlings grow: influence of plant attributes. *New Forests*, 49, 1–34. Recuperado de <https://doi.org/10.1007/s11056-017-96064>
- Granchi, G. (2023). Pantanal: por que chuvas não são suficientes para proteger bioma de fogo recorde. BBC News Brasil em Londres. Disponível em: <https://www.bbc.com/portuguese/articles/czq2z545dq1o>. Acesso em: 10 fev. 2024.
- Kratz, D., Wendling, I., Nogueira, A. C., & Souza, P. V. D. de. (2013). Substratos renováveis na produção de mudas de *Eucalyptus benthamii*. *Ciência Florestal*, 23(4), 607–621. <https://doi.org/10.5902/1980509812345>
- Libotani, R., Câmara, C. C., Peres, L. F., Carvalho, L. A. S & Garcia, L. C: Rescue Brazil's burning Pantanal wetlands. (2020). *Nature*. V. 588. p. 217 - 219 Recuperado de <https://doi.org/10.1038/d41586-020-03464-1>.



- Lorenzi, H. (2009). *Árvores brasileiras: manual de identificação e cultivo de plantas arbóreas nativas do Brasil*. Nova Odessa: Instituto Plantarum, v.3, p.385.
- Marques, L. O. D., Mello-Farias, P., de Lima, A. Y. B., Malgarim, M. B., & Santos, R. F. dos. (2017). Desempenho de diferentes substratos e influência do frio na germinação de sementes de araçá amarelo. *Revista da Jornada da Pós-graduação e Pesquisa*, 14(1), 1169-1180. Recuperado de <http://revista.urcamp.tche.br/index.php/rcjpgp/article/view/871/567>.
- Matias R. A. M., Venturoli F., Lima M. B. O., Martins T.O. (2019). Efeito da adubação suplementar foliar associada a diferentes substratos em mudas de *Myracrodruon urundeuva* Allemão. *Brazilian Journal of Development*, 5(11): 25617-25629
- Mors, W.B.; Rizzini, C.T., Pereira, N.A. (2000). *Medicinal Plants of Brazil*. 1ª ed. Michigan, USA: Reference Publications, 501 p.
- Oliveira, M. C., Ogata, R. S., Andrade, G. A., Santos, D. S., Souza, R. M., Guimarães, T. G., Manoel Júnior, C. S., Pereira, D. J. S., Ribeiro, J. F. (2016). Manual de viveiro e produção de mudas: espécies arbóreas nativas do Cerrado. Brasília: Rede de Sementes do Cerrado, 124.
- Pimentel, J. F., & Rempel, C. (2022). Plantio de mudas de espécies arbóreas nativas para a restauração das áreas de preservação permanente no sul da Amazônia. *Revista Ibero Americana de Ciências Ambientais*, 13(8), p.12-30, Recuperado de <http://doi.org/10.6008/CBPC2179-6858.2022.008.0002>
- pott, A & Pott, V. J. (1994). *Plantas do Pantanal*. Brasília: EMBRAPA-SPI, p.320, 1994.
- Pott, A., Pott, V. J. (2014). Plantas Nativas Potenciais para Sistemas Agroflorestais em Mato Grosso do Sul. *Eng. Agrôn., Embrapa Gado de Corte*, Campo Grande, MS.
- Reis, A.; Bechara, F. C.; Tres, D. R.; Trentin, B. E. (2014). Nucleação: concepção biocêntrica para a restauração ecológica. *Ciência Florestal*, 24(2), p. 509-519, abr-jun. Recuperado de <https://doi.org/10.5902/1980509814591>
- Reis, B. E. DOS.; Paiva, H. N.; Barros, T. C.; Ferreira, A. L.; Cardoso, W. C. 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. 389-396, 2012. Disponível em: <https://doi.org/10.5902/198050985746>
- Rodrigues, L. A.; Figueiredo, N. A.; Porto, V. G. V.; Barroso, D. G. Clod structure and the quality of moringa seedlings (*Moringa oleífera* Lam.) grown in commercial substrate and in organic composts. *Revista Árvore*, 45, e 4535, 2021. Recuperado de <https://doi.org/10.1590/1806-908820210000035>
- Santos, K. G. dos., Silva, L. D., & Gomes Rodrigues, G. (2022). Effect of foliar fertilization and soil conditioners on the rooting of a hybrid of *Pinus tecunumanii* vs. *Pinus caribaea* var. *honduransis*. *Advances in Forestry Science*, 9(3), 1823-1830. doi:10.34062/afs. V 9i3.13338



- SER - SOCIETY FOR ECOLOGICAL RESTORATION INTERNATIONAL E POLICY WORKING GROUP. (2004). The SER International Primer on Ecological Restoration. www.ser.org e Tucson: Society for Ecological Restoration International.
- Silva, R. F. D., Marco, R., Ros C. O., Almeida H. S. D., & Antonioli Z. I. (2017). Influência de diferentes concentrações de vermicomposto no desenvolvimento de mudas de eucalipto e pinus. *Floresta e Ambiente*, 24.
- Silva, L. S.; Leão, J. M.; Costa, F. S.; Brito, K. S. A.; Suassuna, J. F. (2020). Qualidade de mudas de cupuaçuzeiro (*Theobroma grandiflorum*) produzidas em substratos compostos por resíduos do agroextrativismo amazônico. *Brazilian Journal of Development*, 6(11), p.84526-84538.
- Silva, W. A. O., Silva, M. D. A., Melo, D. M. A., Reis, E. F., Viana, P. H. F., Araújo, A. E. (2019). Produção de mudas de pimenta-do-reino (*Piper nigrum* L.) em concentrações de composto orgânico e microrganismos eficientes. *Caderno Verde De Agroecologia e Desenvolvimento Sustentável*, 9(7), p.6947-p6947.
- Souza, C. A. M., Oliveira, R. B., Martins Filho, S., Lima, J. S. S. (2006). Crescimento em campo de espécies florestais em diferentes condições de adubações. *Ciência Florestal*, 16(3), p.243-249. Recuperado de <https://doi.org/10.5902/198050981905>
- SOS Pantanal. (2021). COMPARANDO OS INCÊNDIOS DE 2020 COM 2021 NO PANTANAL: O QUE MUDOU? Disponível em: <https://www.sospantanal.org.br/comparando-os-incendios-de-2020-com-2021-no-pantanal-o-que-mudou/> Acesso em: 12 jan. 2024.
- Takane, R. J., Yanagisawa, S. S., Gois, E. D. A. (2013). Técnicas em substratos para a floricultura. *Expressão Grafica e Editora, Fortaleza*, 1, 147p. BRA.
- Vieira, C. R., Weber, O. L. S. (2015). Avaliação de substratos na produção de mudas de mogno (*Swietenia macrophylla* king). *Revista Uniara*, 18(2).
- WWF-Brasil. (2023). Pantanal tem recorde de incêndios nos primeiros 20 dias de novembro. Seca extrema agravada pelo El Niño já produziu cerca de 4 mil focos no bioma neste mês. Disponível em: <https://www.wwf.org.br/?87280/Pantanal-tem-recorde-de-incendios-nos-primeiros-20-dias-de-novembro>. Acesso em: 12 fev. 2024.