LUMEN ET VIRTUS

Natural regeneration of Miconia albicans (SW.), Triana and Dalbergia miscolobium Benth in the interior of stands of Pinus caribaea Morelet: A contribution

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ABSTRACT

The present study was carried out at the Floresta do Lobo Farm, in the municipality of Uberlândia, MG. This production farm has been working for decades with the forestry of Pinus caribaea Morelet and Eucalyptus spp., as well as agricultural crops such as corn, sorghum and pastures for livestock. For the present study, 3 areas were used in the interior of Pinus caribaea Morelet plantations, where 10 plots of 100m² and 10 plots of 4m² were randomly distributed along transects equidistant 100m from each other. In the 100 m² plots, individuals between 1 m in height and 5 cm in diameter (pre-reproductive) were sampled, and in the 4m² samples, individuals between 15 cm and 1 m in height (seedlings and juveniles) in each stand. For M. albicans, the density of individuals ranged from 0 to 30 per plot and for D. miscolobium between 0 and 4 individuals. Significant differences in plant density were observed in the three areas using ANOVA for the two species studied. Regarding the frequency in the plots, D. miscolobium ranged from 50% to 90% of the sampled plots, while M. albicans ranged from 80% to 90%. The higher environmental plasticity in M. albicans together with apomixis may be determining elements in the remarkable regeneration potential of the species.

Keywords: Plant Ecology, Silviculture, Facilitation.

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INTRODUCTION

With less than half a century of intensive occupation, the Cerrado biome has emerged as a prominent agricultural region both in Brazil and globally. Currently, vast tracts of cultivated pastures, annual and perennial crops, as well as forest areas, can be found in this biome. The area legally protected by Conservation Units (indirect and sustainable use) in the Cerrado varies from 1.7% to 51%, according to the region (Sano et al. 2019).

The anthropic action of agriculture and livestock, favored mainly by its plateau relief, triggered a great loss of the original territorial extension of the Cerrado. By 2013, about 54.4% of the original cover remained, with the area supported by Conservation Units corresponding to just over 10% of the natural vegetation (SANTOS, 2018). Wooded savannas and those without gallery forests were the most affected, with approximately 50,000 km² deforested in this period. Forest formations, which occupied more than 175,000 km² in 2002, lost about 20,000 km² (10.6%). Semideciduous and alluvial seasonal forests were the most impacted, with a combined loss of more than 16,000 km² (MMA, 2014). Subsequently, about 10 years later, in 2023, 7,852 km² of native vegetation lost in the Cerrado were detected, denoting an increase of 44% compared to 2022, which is the largest deforested area since 2018 (WWF, 2024).

In addition to the impacts on biodiversity and the distribution of species, the fragmentation of habitats and the advance of monocultures also have a socioeconomic impact, since many communities depend on the natural resources of the Cerrado for their livelihoods. These communities include indigenous ethnic groups, quilombolas, geraizeiros, ribeirinhos, babaçueiras and vazanteiros, all of whom are part of Brazil's rich historical and cultural heritage. These communities hold a deep traditional knowledge about the biodiversity present in the Cerrado biome (MMA, 2019).

Plantations with exotic species (genera Pinus spp. and Eucalyptus spp.) are one of the important extractive activities practiced in the Triângulo Mineiro region, whether for the production of wood, cellulose or resin. However, the Pinus caribaea Morelet species has been documented as an invasive species, with an impact on areas of cerrado sensu stricto and also on wetlands, which play an important role in the provision of ecosystem services (SOARES et al. 2022). Thus, invasive species represent the second largest cause of species extinction in the world. Other factors that contribute to extinction include the overexploitation of plants and animals, the use of hybrids and monocultures in agriculture and reforestation, the contamination of soil, water and atmosphere by pollutants, as well as climate change (BECHARA, 2003).

A number of practices that can improve natural regeneration are already known, but the understanding of their success in different contexts is currently lagging, limiting the expansion of natural regeneration as a restoration practice (Lohbeck et al. 2021). In this way, the understanding of the regeneration of potential species and communities in different environments and limiting factors

can contribute to a greater knowledge of this practice for the management and conservation of ecosystems and landscape.

This work aims to investigate the natural regeneration of Miconia albicans and Dalbergia miscolobium, within stands of Pinus caribaea Morelet., using density and frequency estimates, and also to discuss ecological aspects of this process.

MATERIAL AND METHODS

FIELD OF STUDY

Historically, not only the Minas Gerais triangle, but the entire state of Minas Gerais had agribusiness as its main economic activity, in addition to mineral extractivism. The Floresta do Lobo Farm is located at the coordinates UTM 796000 – 802500 mE and 7885000 – 7893000 mN and for decades has been working with the silviculture of Pinus spp. and Eucalyptus spp. (Figure 2) and agricultural crops such as corn, sorghum and pastures for cattle. The farm has undergone changes in land use in recent years with the replacement of silvicultural plantation areas with agricultural crops and pastures.

The region of the central plateau of Brazil where the city of Uberlândia-MG is located, has an Aw climate according to the Köppen classification, as well as other biomes in Brazil, the location and extent of the Cerrado are determined by the tropical climate, with average annual rainfall of 750 to 2,000 mm, although most states receive 1,100 to 1,600 mm of rain per year (ALVARES et al. 2013). Two climatic seasons in a year stand out, a dry season (March to October) and the rest of the year (November to February) is the rainy season (EITEN, 1994).

The relief of the site is predominantly of a plateau located on the Paraná Sedimentary Basin at an altitude of 950 meters above sea level and presents gentle undulations on sedimentary formations On the farm, soils of the Yellow Latosol and Red Yellow Latosol predominate, with a little steep slope (LEFEBVRE & NASCIMENTO, 2016).

The place has areas with plantations of Pinus caribaea Morelet. at the end of rotation (Figure 1), Eucalyptus spp. and agricultural crops (sorghum, maize p.x.) and pastures. The farm also has preserved areas with the phytophysiognomy of the Cerrado biome in the Legal Reserve areas and in the Permanent Preservation Areas. In these places, there are fragments of cerrado sensu stricto, veredas and, to a lesser extent, semideciduous seasonal forest.

Figure 1. Aspect of natural regeneration within Pinus caribaea Morelet plantations showing variation in native woody cover, Uberlândia, MG. In the image on the right, you can see the thinning of the pine trees and the removal of natural regeneration.



Source: Birth Photos, A.R.T.

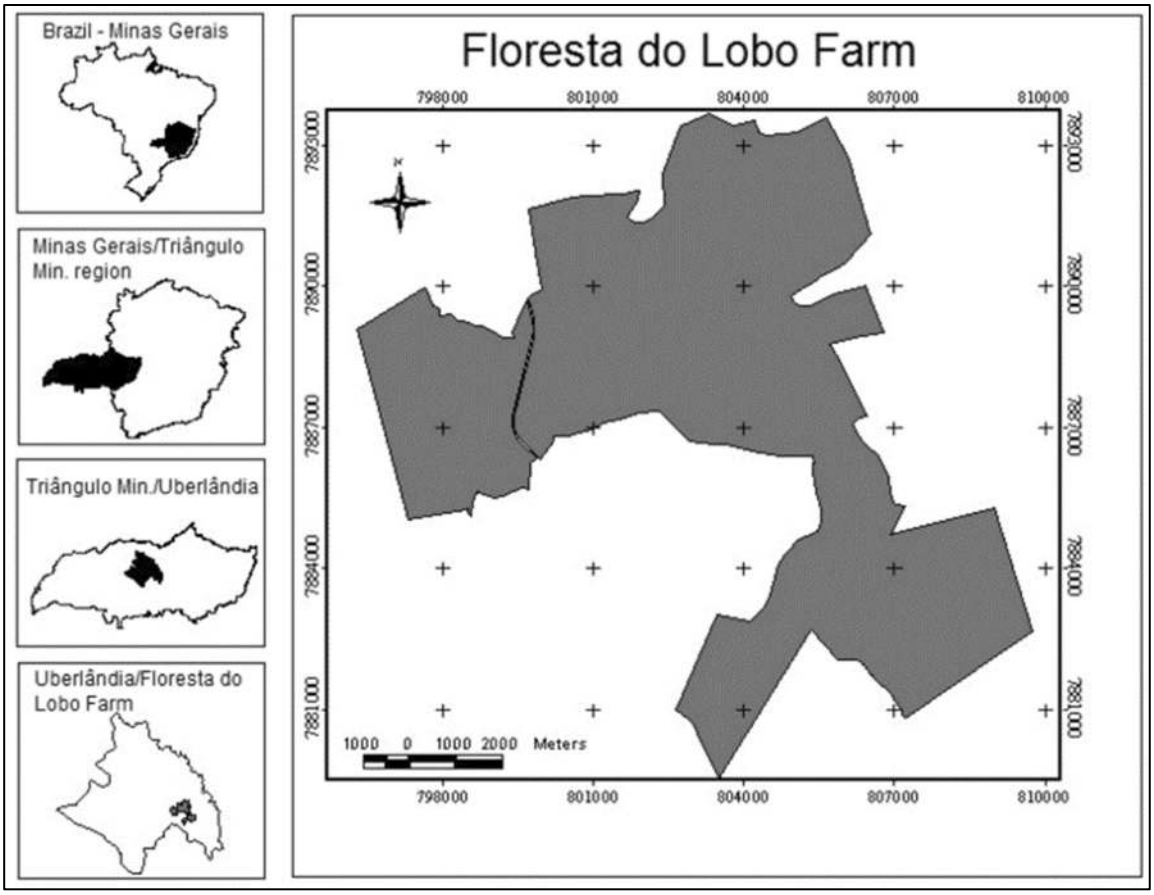
DATA COLLECTION AND ANALYSIS

For this work, 20 plots of 2 sizes were used in each stand (along equidistant lines of 100m). Of this total, 10 plots of 10 m x 10 m (100m²) and 10 plots of 2mx2m (4m²) were randomly drawn in each stand. In the 100 m² plots, individuals between 1 m in height and 5 cm in diameter (pre-reproductive) were sampled, and in the 4m² samples, individuals between 15 cm and 1 m in height (seedlings and juveniles) of Miconia albicans (Sw.), Triana and Dalbergia miscolobium Benth, were sampled. For more details of the sampling, see Pinho Jr et al. (2015).

From the 20 plots, the density and frequency estimates for the two species in each stand were calculated using mean and standard error. The density data were presented using Box and wiskey plots, where the column represents the mean in each stand and the vertical line the standard error of the estimates.

In order to compare the density estimates of the two species in the stands, ANOVA was used following the assumptions for this type of analysis (Zar, 1996). All procedures were performed using the STATISTICA version 8.0 software (StatSoft, 2007).

Figure 2. Map of the location of the study area in Uberlândia, in the Triângulo Mineiro region, in the state of Minas Gerais, Brazil.



Source: HENRIQUES (2010) used in LEFEBVRE AND NASCIMENTO (2016)

These two woody species were chosen because they have an expressive population size on the farm (Pinho Jr et al, 2015), and are common species in surveys of the cerrado sensu stricto in the Triângulo Mineiro region.

CHARACTERIZATION OF THE SPECIES ANALYZED

Dalbergia miscolobium Benth., popularly known as jacaranda-caviúna, is a tree native to Brazil belonging to the Fabaceae family. It is a species of tree with a tortuous and short trunk, reaching a maximum of 6 meters in length, the largest found individuals are about 16 meters (CARVALHO, 2014).

It has dichotomous branching and a crown with brown terminal branches and buds. The shell is thick, with continuous fissures and ridges, in small plates. Its leaves are compound, measuring from 15 cm to 22 cm in length, with 4 to 8 subchoriaceous and glabrous leaflets. The flowers are aromatic, ranging from light purple to dark purple, with a calyx of equal teeth (CARVALHO, 2014).

The fruit is a flat samaroid legume with 1 to 2 seeds. The seeds are flat and riniform, located in the center of the fruit. Its dispersion is aerochoric with flowering occurring between January and February in the state of Minas Gerais (HERINGER, 1947). On the other hand, Dalbergia miscolobium is also a pioneer species that tolerates altered environments (MONTEIRO et. al, 2003).

The most striking characteristic of this species is its excellent quality wood, valued for its resistance, durability and attractive color pattern, which varies from reddish-brown to dark yellow, with distinctive veins and textures. Because of these characteristics, rosewood-caviúna is widely used in the furniture industry, in the manufacture of fine furniture, musical instruments, floors and coatings (CARVALHO, 2014).

Miconia albicans is a species of plant belonging to the Melastomataceae family, it is a shrubby species or small tree, its stem has arachnoid trichomes on the young branches, while its leaves have an oval to oblong shape, acuminate apex and a corded, rounded or cuneate base. The leaf margin is entire and non-ciliate, with a basal vein composed of three pairs of longitudinal veins and two inconspicuous intramarginal veins (GOLDENBERG, 2015).

On the abaxial face of the leaves, there is a dense indumentum and arachnoid trichomes. Its inflorescences are composed of secondary flowers, and the flowers have hypanate in a bell shape, persistent calyxes and well-defined lobes. Each flower has five petals, white anthers with a single small-width pore, and glabrous ovaries (GOLDENBERG, 2015).

M. albicans is also widely used in traditional medicine for the relief of arthritis pain, improved digestion and inflammation. Due to the presence of phenolic compounds, this species can be used as an antioxidant, the presence of ursolic acid and oleanolic acid also guarantees anti-inflammatory action, so it is a plant with great pharmacological potential (ALMEIDA, 2016).

RESULTS AND DISCUSSION

ESTIMATES OF THE NATURAL REGENERATION OF THE TWO SPECIES

The data show that for M. albicans the number of individuals ranged from 0 to 30 per plot and for D. miscolobium between 0 and 4 individuals (Chart 1). Significant differences in plant density (Figures 3 and 4) were observed in the three areas for M. albicans (F=9.30; p=0.0077) and for D. miscolobium (F=13.78; p=0.0025).

Table 1: Density estimates of individuals of each species for the analysis of the regeneration of the two woody species in the three stands (A1, A2 and A3), Floresta do Lobo, Uberlândia, MG. N = 20 plots in each stand.

	Areas	Media (E.P.)	Amplitude	N Total
Miconia albicans	A1	Media (E.P.)	Amplitude	N Total
	A2	6.90±2.77	0-30	69
	A3	4.10±1.57	0-17	41
Dalbergia miscolobium	A1	2.30±0.68	0-7	23
	A2	1.2 ±0.46	0-4	12
	A3	1.0± 0.31	0-2	10

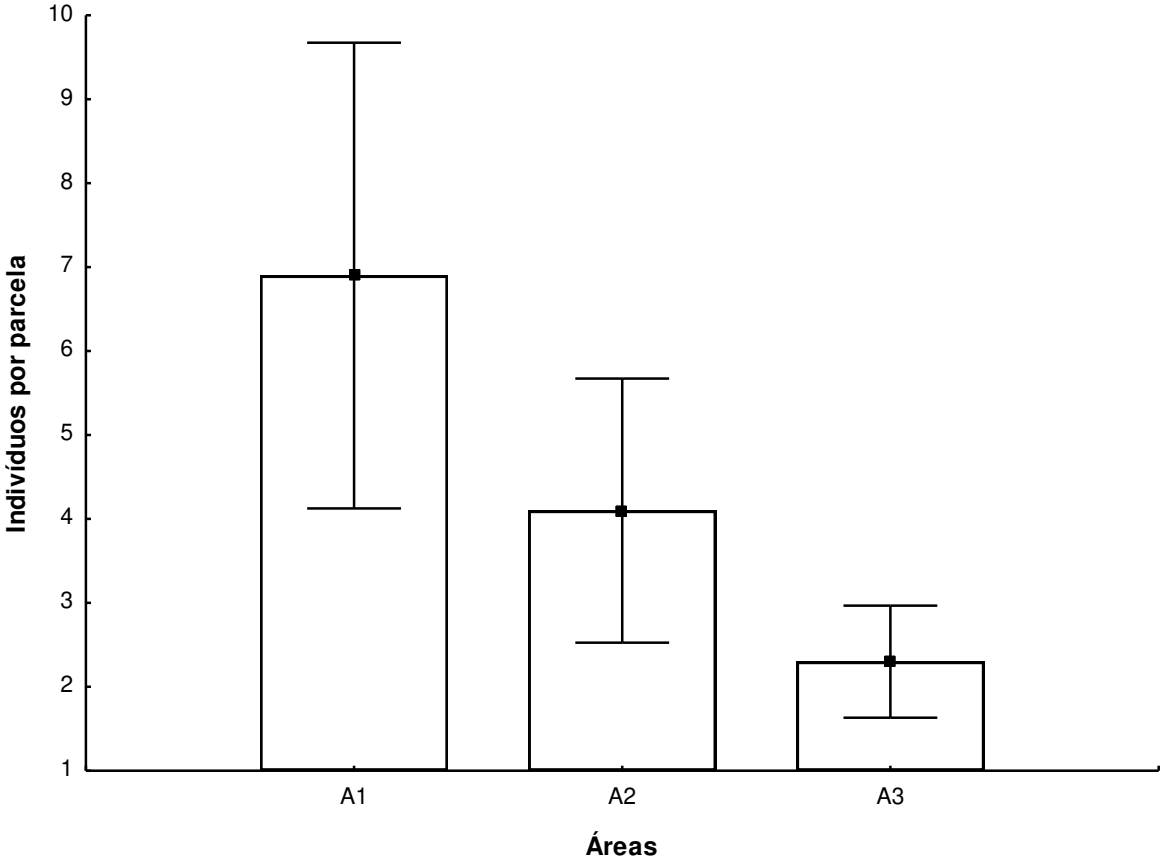
Source: Prepared by the authors.

Regarding the frequency in the plots, D. miscolobium ranged from 50% to 90% of the sampled plots, while M. albicans. ranged from 80% to 90%. The populations of M. albicans

(seedlings, juveniles and pre-reproductive) ranged from 23 to 69 individuals, with averages between 2.30 ± 0.68 to 6.90 ± 2.77, denoting larger populations within the stands.

The two species have different dispersal strategies: M. albicans is zoochoric (ornithochoric) and D. miscolobium is primarily dispersed by wind (Silva Jr, 2005). This is a factor that can influence the dispersal and, subsequently, regeneration of the species within the stands, with the stems and crowns of P. caribaea functioning as a physical barrier for seed dispersal.

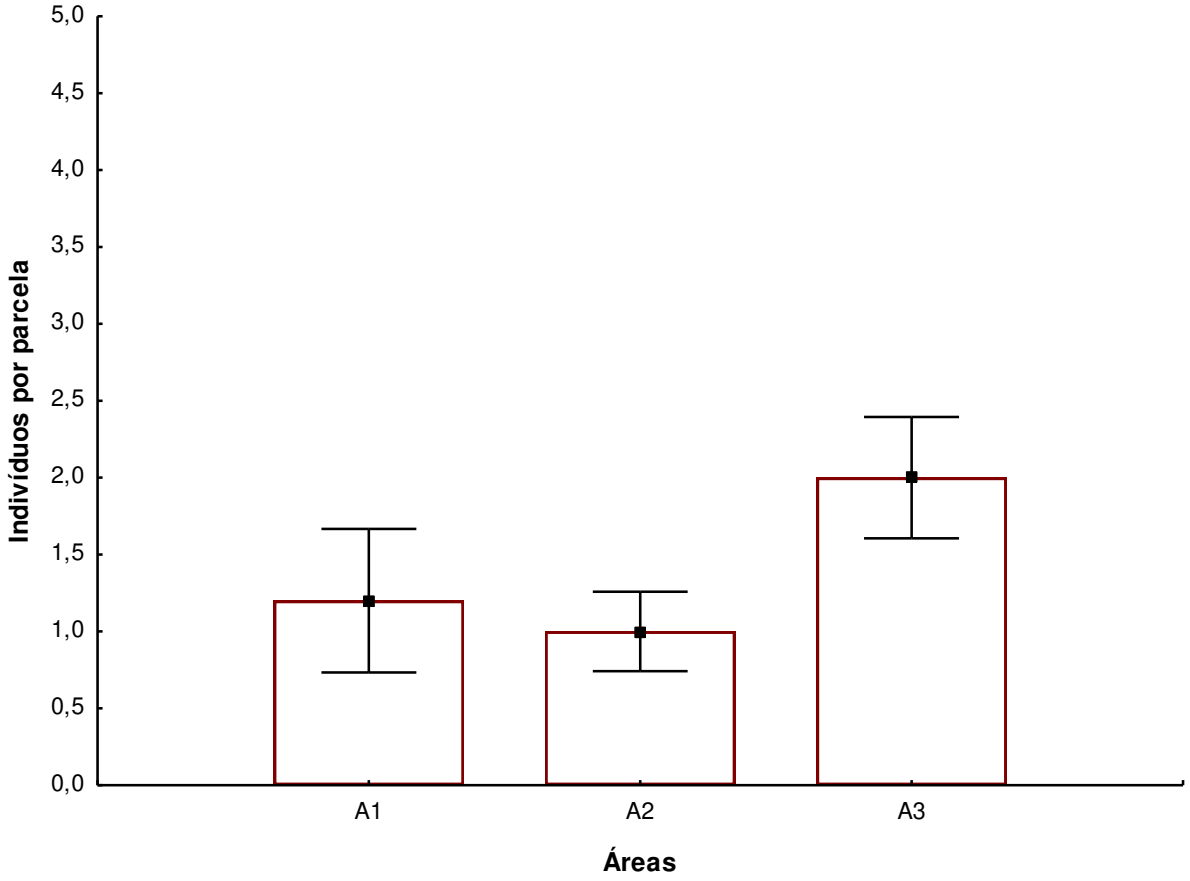
Figure 3. Density estimates by plot Miconia albicans (Sw.) Triana in the interior of 3 stands of Pinus caribaea Morelet (A1, A2 and A3), Floresta do Lobo, Uberlândia, MG. The columns represent the average and the vertical lines represent the standard error of the estimates. Significant differences were made by ANOVA (F=13.78; p=0.0025).



Source: Prepared by the authors.

A factor that may contribute to the higher density of individuals of M. albicans (Figure 3) is the dispersion of its fruits by ants, which displace fruits both from the soil and directly from the trees, thus acting as primary and secondary dispersers, and this dispersion occurs both at the edge and inside fragments, thus influencing the dynamics of populations in the cerrado, these relationships can be even more complex in fragmented areas (LEITE, 2013). The fruiting time may be a factor that influences the greater number of individuals of M. albicans, being more notable in the dry season. The selective pressure on the plant in this season when the abundance of food becomes greater, makes it produce fruits with higher nutritional quality. In addition, they are pioneer plants, have reduced fruit size, a large number of seeds and a thin shell, so consumption and dispersal can be done by birds of varying sizes (AMÂNCIO & MELO, 2008).

Figure 4. Density estimates per plot of Dalbergia miscolobium Benth. in the interior of 3 stands of Pinus caribaea Morelet (A1, A2 and A3), Floresta do Lobo, Uberlândia, MG. The columns represent the average and the vertical lines represent the standard error of the estimates. Significant differences were made by ANOVA (F=9.30; p=0.0077).



Source: Prepared by the authors.

On the other hand, the staticness of the winds impairs the dispersal of D. miscolobium seeds (Figure 4). it would also justify the density of this species being lower than M. albicans. since they cannot disperse seeds over great distances, individuals that manage to survive germinate and grow close to the mother tree, subject to greater competition and predation (CAIN et al. 2011).

The survival rate and seedling formation in D. miscolobium are favored with attenuated solar insolation, in the same way that exposure to large amounts of water increases the mortality rate of seeds and seedlings, and the first year of life of this species is the most important for it to be able to establish itself in the environment (CARREIRA and ZIDAN, 2003).

In M. albicans, seeds and seedlings develop better in larger photoperiods, such as D. miscolobium., however, the mother plants of M. albicans are able to identify the longest period of humidity in the area and impose ways for their descendants to germinate using the available resources by changing the physiology of the seeds (REZENDE, 2021). Another factor is the existence of apomixis in Miconia albicans (Caetano, 2010), being a strategy that can increase the performance of plants, which can have aggregate distribution, and thus, larger populations and smaller differences between individuals. In the process of apomixis, plants reproduce asexually through seeds, and the offspring generated are genetically identical to the parent plant. In apomictic

plants, specialized differentiation of the ovaries, especially the ovules, occurs during the development of the female part of the flowers. This allows the production of seeds that preserve the genetic identity of the mother plant (GAUER & CAVALLI-MOLINA, 2000).

Regarding the seed dispersal of D. miscolobium. their reproductive success is linked to the amount of viable seeds that are dispensed out of the tree canopy (ALVES, 2003). Because it is a predominantly anemochoric species, the dynamics of the winds in the region can be influenced by the physical barrier of P. caribaea plantations, represented, in this case, by the crown and trunk of the individuals.

The highest environmental plasticity in M. albicans. Together with apomixis it may be a determining factor in the remarkable regeneration potential of the species. Associated with this, the high seed production and the interaction with the fauna allows the seeds to reach greater dispersal distances and, with this, reach viable sites for their establishment.

CONCLUSIONS

It can be inferred that M. albican showed a higher regeneration potential represented by the density and frequency estimates in the 3 areas. Thus, both the density per plot and the total absolute number of individuals of M. albicans were higher and showed greater variability (standard error) than D. miscolobium within the stands of Pinus caribaea Morelet.

The species D. miscolobium. it develops best in open formations (such as dirty fields) and savanna formations that receive more sunlight and its anemochory strategy would not be so compromised due to wind dynamics, the impediment of the canopy and trunk of P. caribaea Morelet trees. and the greater canopy cover, common within these stands.

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REFERENCES

Almeida, F. H. O. (2016). Revisão sistemática de Miconia albicans (Sw.) Triana: uso tradicional, atividade farmacológica e outras atividades (Undergraduate thesis, Universidade Federal de Sergipe).

Alvares, C. A., Stape, J. L., Pau Sentelhas, P. C., Gonçalves, J. L. M., & Sparovek, G. (2013). Köppen's climate classification map for Brazil. Meteorologische Zeitschrift, 22(6), 711-728.

Alves, D. L. (2003). Dispersão e germinação de sementes de espécies de Leguminosae do Cerrado: estudo de caso de Dalbergia miscolobium (Undergraduate thesis, Universidade Federal de Uberlândia).

Amâncio, S., & Melo, C. (2008). Frugivoria por aves em bordas de fragmentos florestais, Uberlândia, MG. Horizonte Científico, 1, 1-19.

Bechara, F. C. (2003). Restauração ecológica de restingas contaminadas por Pinus no Parque Florestal do Rio Vermelho, Florianópolis, SC (Master's thesis, Universidade Federal de Santa Catarina).

Brasil. (2019). O Bioma Cerrado. Ministério do Meio Ambiente (MMA). Available at: https://www.mma.gov.br/biomas/cerrado. Accessed on April 21, 2022.

Caetano, A. P. S. (2010). Apomixia e reprodução sexuada em espécies de Miconia Ruiz & Pavón, Melastomataceae (Unpublished D.Phil. thesis, Universidade Estadual de Campinas).

Cain, M. L., Bowman, W. D., & Hacker, S. D. (2011). Ecologia. Artmed.

Carneiro, C. E. (n.d.). Caryophyllaceae in Flora e Funga do Brasil. Jardim Botânico do Rio de Janeiro. Available at: http://servicos.jbrj.gov.br/flora/search/Miconia_albicans. Accessed on June 13, 2023.

Carvalho, P. E. R. (2014). Espécies arbóreas brasileiras. Embrapa Informação Tecnológica; Embrapa Florestas.

Carreira, R. C., & Zaidan, L. B. P. (2003). Estabelecimento e crescimento inicial de Miconia albicans (Sw.) Triana e Schizocentron elegans Meissn., sob fotoperíodos controlados. Hoehnea, 30, 155-161.

Da Silveira Lindoso, G., & Felfili, J. M. (2007). Características florísticas e estruturais de Cerrado sensu stricto em Neossolo Quartzarênico. Revista Brasileira de Biociências, 5(S2), 102-104.

De Pinho Júnior, G. V., Nascimento, A. R. T., Valverde, B. T., & Clemente, L. H. (2015). Brazilian savanna re-establishment in a monoculture forest: Diversity and environmental relations of native regenerating understory in Pinus caribaea Morelet. Journal of Forest Research, 26, 571–579.

Eiten, G. (1994). Vegetação do Cerrado. In M. N. Pinto (Ed.), Cerrado: caracterização, ocupação e perspectivas (2nd ed., pp. 17-73). Editora da UnB.

Gauer, L., & Cavalli-Molina, S. (2000). Apomixia: um método alternativo para a produção de sementes em plantas. Pesquisa Agropecuária Gaúcha, 6(1), 157-170.

Goldenberg, R., & Caddah, M. K. (2015). Miconia in Lista de Espécies da Flora do Brasil. Jardim Botânico do Rio de Janeiro. Available at: http://floradobrasil.jbrj.gov.br/jabot/floradobrasil/FB9668. Accessed in May 2024.

Henriques, T. R. (2010). Geoprocessamento aplicado nas mudanças de uso da terra e cobertura vegetal na Fazenda Floresta do Lobo, Uberlândia-MG. (Undergraduate thesis, Universidade Federal de Uberlândia).

Jardim Botânico do Rio de Janeiro. (2021). Miconia albicans (Sw.) Triana. Flora do Brasil 2020. Available at: http://floradobrasil.jbrj.gov.br/reflora/floradobrasil/FB109663. Accessed on April 28, 2023.

Lefebvre, I. D., & Nascimento, A. R. T. (2016). Densidade e aspectos populacionais de Dalbergia miscolobium Benth. em um fragmento de cerrado sensu stricto, Uberlândia, Minas Gerais. Iheringia, Série Botânica, 71(1), 85–92.

Leite, R. R., Araújo, S. S. C. de, & Oliveira, E. G. de. (2013). Remoção dos frutos de Miconia albicans (Sw.) Triana (Melastomataceae) por formigas na borda e no interior de um fragmento de Cerrado, Curvelo, MG. Revista Árvore, 37(3), 469–478.

Lorenzi, H. (2014). Árvores brasileiras: manual de identificação e cultivo de plantas arbóreas nativas do Brasil. Instituto Plantarum.

Lohbeck, M., Rother, D. C., & Jakovac, C. C. (2021). Enhancing natural regeneration to restore landscapes. Frontiers in Forest and Global Change, 4, 1-4.

Marques, R. V., & Ferreira, Q. I. X. (2019). Estratégias de dispersão e ornitocoria em Melastomataceae em três fragmentos do cerrado. Revista de Educação, Saúde e Meio Ambiente, 1, 94-109.

Meirelles, M. L., Guimarães, A. J. M., Oliveira, R. C., Araújo, G. M., & Ribeiro, J. F. (2004). Impactos sobre o estrato herbáceo de Áreas Úmidas do Cerrado. In L. M. S. Aguiar & A. J. A. Camargo (Eds.), Cerrado: ecologia e caracterização (pp. 41-68). Embrapa Informação Tecnológica.

PPCERRADO. (2014). Plano de Ação para prevenção e controle do desmatamento e das queimadas no Cerrado: 2ª fase (2014-2015). Ministério do Meio Ambiente.

Rezende, A. F. (2021). Germinação de sementes e respostas fotossintéticas de Miconia albicans (Sw.) Triana (Melastomataceae) e sua capacidade de estabelecimento em veredas alteradas (Master's thesis, Universidade Federal de Uberlândia).

Ribeiro, J. F., & Walter, M. T. (2008). As principais fitofisionomias do bioma Cerrado. In S. M. Sano, S. P. Almeida, & J. F. Ribeiro (Eds.), Cerrado: ecologia e flora (pp. 153-212). Embrapa Cerrados.

Santos, S. A. (2018). As unidades de conservação no Cerrado frente ao processo de conversão (Master's thesis, Universidade Federal de Goiás).

Sano, E. E., Rodrigues, A. A., Martins, E. S., Bettiol, G. M., Bustamante, M. M., Bezerra, A. S., & Bolfe, E. L. (2019). Cerrado ecoregions: A spatial framework to assess and prioritize Brazilian savanna environmental diversity for conservation. Journal of Environmental Management, 232, 818-828.

Sano, E. E., Rosa, R., Brito, J. L. S., & Ferreira, L. G. (2008). Mapeamento semidetalhado do uso da terra do Bioma Cerrado. Pesquisa Agropecuária Brasileira, 43, 153-156.

Silva Júnior, M. C. (2005). 100 árvores do Cerrado: guia de campo. Brasília: Rede de Sementes do Cerrado.

Soares, D. M., Nascimento, A. R. T., Oliveira, C. H. E., Silva, L. C., & Morais, I. L. (2022). Plant communities in veredas: Distribution of native tree/shrubby regeneration and of the invasive species Pinus caribaea Morelet. Feddes Repertorium, 133, 220-233.

Souza, V. C., Lorenzi, H., & Ferreira, E. (2012). Flora brasileira: Miconia albicans (Sw.) Triana (Melastomataceae). Plantas invasoras em ambientes naturais. Instituto Plantarum de Estudos da Flora.

Statsoft, Inc. (2007). STATISTICA (data analysis software system), version 8.0. Available at: www.statsoft.com.

WWF-Brasil. (2024, January 15). O Desmatamento migra da Amazônia para o Cerrado em 2023, indica Deter. Available at: https://www.wwf.org.br/?87680/Desmatamento-migra-da-Amazonia-para-o-Cerrado-em-2023-indica-Deter. Accessed on August 18, 2024.

Zar, J. H. (1999). Biostatistical analysis (4th ed.). Prentice-Hall.