Characterization of different population structures of *Blepharocalyx salicifolius* (kunth) O. Berg (Myrtaceae) submitted to different disturbance scenarios

Caracterização de diferentes estruturas populacionais de Blepharocalyx salicifolius (Kunth) O. Berg (Myrtaceae) submetidas a diferentes cenários de perturbação

Caracterización de las diferentes estructuras poblacionales de Blepharocalyx salicifolius (Kunth) O. Berg (Myrtaceae) sometidas a diferentes escenarios de perturbación

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Abstract

The ordinary models of agriculture economic development and land occupation pressures natural Brazilian savannas landscapes, especially over the last few decades. Those pressures result in the intensification of disturbance factors like fire, exotic species and fragmentation. Understanding how native species are structured under disturbance in Cerrado may contribute to mitigate anthropic pressure. In this study we have compared the structure of a native Myrtaceae species under different scenarios of fire disturbance by comparing population subsets attributes in an area of cerrado sensu stricto in Brazil. We have found the classical physiognomic responses to fire and vegetation cover to stem diameter, the number of branches and height. However, here well descripted to a Cerrado native species, usually poorly reported by science. Mean stem diameter was a sensitive parameter to disturbance. The number of bifurcations was higher where fire is intensified. This Cerrado's Myrtaceae species is competitive in height as similarly reported to Australian eucalypts and corroborates evolutive abilities to avoid fire topkill.

Keywords: *Cerrado. Disturbance. Ecology.*

Resumo

Os modelos ordinários de desenvolvimento econômico agrícola e de ocupação da terra pressionam as paisagens naturais das savanas brasileiras, especialmente durante as últimas décadas. Essas pressões resultam na intensificação de fatores de perturbação como fogo, espécies exóticas e fragmentação. A compreensão de como as espécies nativas estão estruturadas sob perturbação no Cerrado pode contribuir para mitigar a pressão antrópica. Neste estudo, comparamos a estrutura de uma espécie nativa de Myrtaceae sob diferentes cenários de perturbação do fogo, comparando atributos de subconjuntos populacionais em uma área de cerrado sensu stricto no Brasil. Encontramos as respostas fisionômicas clássicas ao fogo e cobertura vegetal para diâmetro do caule, número de ramos e à altura. No entanto, aqui bem descritas para uma espécie nativa do Cerrado, geralmente pouco relatado pela ciência. O diâmetro médio do caule foi um parâmetro sensível a distúrbios. O número de bifurcações foi maior onde o fogo é intensivo. A espécie Myrtaceae do Cerrado é competitiva em altura, tal como os eucaliptos australianos, e corrobora habilidades evolutivas para evitar a linha de mortalidade do fogo (topkill).

Palavras-chave: *Cerrado. Distúrbio. Ecologia.*

Resumen

Los modelos ordinarios de desarrollo económico agrícola y de ocupación de la tierra presionan los paisajes naturales de las sabanas brasileñas, especialmente en los últimos decenios. Esas presiones dan lugar a la intensificación de factores de perturbación como el fuego, las especies exóticas y la fragmentación. Comprender cómo se estructuran las especies nativas bajo perturbación en la sabana puede contribuir a mitigar la presión antrópica. En este estudio, hemos comparado la estructura de una especie nativa de Myrtaceae bajo diferentes escenarios de perturbación por incendio, comparando los atributos de los subconjuntos de la población en un área de cerrado sensu stricto en Brasil. Hemos encontrado las respuestas fisonómicas clásicas al fuego y la cubierta vegetal al diámetro del tallo, el número de ramas y la altura. Sin embargo, aquí se describe bien a una especie nativa del Cerrado, usualmente mal reportada por la ciencia. El diámetro medio del tallo era un parámetro sensible a la

perturbación. El número de bifurcaciones fue mayor cuando el fuego se intensifica. Esa especie de Myrtaceae de Cerrado es competitiva en altura como se ha reportado de manera similar a los eucaliptos australianos y corrobora las habilidades evolutivas para evitar el fuego.

Palabras clave: *Cerrado. Perturbación. Ecología.*

Introduction

Factors influencing Neotropical tree populations processes may vary in space at different scales and, consequently, the population structures vary in space (SWAINE; LIEBERMAN; PUTZ, 1987), in physiognomy heterogeneity and seasonally (ALENCAR *et al.*, 2020). Considering the Brazilian actual environmental scenario, disturbance and sensitivity to disturbance is a factor that can limit the spatial distribution and population structure of native species in fragmented and disturbed environments (GARDNER, 2006), an increasingly frequent reality in natural environments from Cerrado of Brazil, a Neotropical savanna (KLINK; MOREIRA, 2002). Especially in large-scale studies of the Brazilian Cerrado, through remote sensing technologies, the high structural heterogeneity of plant communities and seasonality, makes the detection of changes (natural vs. anthropogenic) a challenging task (ALENCAR *et al.*, 2020) that demands field studies and remote imaging.

Fire is an important ecological component of Cerrado vegetation and fire or its impacts on natural ecosystems is essential for the development of management strategies (GOMES *et al.*, 2020). Fire is considered to be an important determinant of Cerrado evolution, and the origin of this vegetation may have coincided with the rise of C4 grasses, that are more susceptible to fire, between 10 and 4 Mya (SIMON *et al.*, 2009). However, anthropic activities have had a large impact on fire regimes of tropical savannas and it is expected that moist savannas of Australia, Africa, Asia, and South America commonly burn at intervals of 1–3 yr (COUTINHO, 1990; EITEN; GOODLAND, 1979; LACEY *et al.*, 1982; MENAUT *et al.*, 1991; RUSSELL-SMITH; RYNA; DURIEU, 1997; TROLLOPE, 1984) and this interval of burning is considered to decrease woody community density and diversity (MEDEIROS; MIRANDA, 2005; MOREIRA, 2000).

Variability in fire sensitivity in plants may the determined by morphological adaptations (CRISP *et al.*, 2009) and population strategy (HOFFMANN, 1999; MOREIRA, 2000), and comparing population structure analysis from populations submitted to different histories of disturbance can be an assessment to investigate aspects of disturbance strategies on natural plant populations (MOREIRA, 2000; WERNER, 2012). Understanding the woody plant population structure strategies may contribute to understand species adaptations in the presence of fire disturbance and may reveal intraspecific patterns that can be extended to the community level (HOFFMANN; SOLBRIG, 2003; HOFFMANN; MOREIRA, 2002).

Several fire adaptations are present in the endemic flora of Cerrado (MOREIRA, 2000), including the occurrence of xylopodium, lignified tubes, thick suber, trees with often tortuous architecture, thick buds and blooms often confined to these shoots, accented occurrence of perennial herbs, flowers and specialized fruits (EITEN, 1972; RATTER; RIBEIRO; BRIDGEWATER, 1997). However, the interpretation of phylogenies and the expected ecological interactions related to the species of the Cerrado plants show many of the lineages of this have congeneric relatives in large groups in ecotones rainforest, seasonally dry forest, subtropical grasslands and wetland (SIMON *et al.*, 2009). There is a close relationship between fire-dependent biomes in Australia and evolution of Myrtaceae tolerance of fire (CRISP *et al.*, 2011). Myrtaceae dominates fire-dependent woodlands and forest in Australia (CRISP *et al.*, 2011; WERNER, 2012) and is one of the most important family in the rainforest and Cerrado biomes in South America (OLIVEIRA FILHO; FONTES, 2000). *Blepharocalyx salicifolius* (Kunth) O. Berg (Myrtaceae), may be the closest Neotropical species of the Myrtaceae Australasian group (LUCAS *et al.*, 2007).

This study aimed to analyze the spatial distribution and population structure of native a Cerrado species of putative forest origin - *Blepharocalyx salicifolius* , comparing population subsets attributes in an area of *cerrado sensu stricto* under different scenarios of fire disturbance caused by human interference.

Material and Methods

The species of study

Blepharocalyx salicifolius (Kunth) O. Berg is a tree or shrub (LANDRUM, 1986) pollinated by bees' generalists, self-incompatible (PROENÇA; GIBBS, 1994) and ornithocoric (LENZA; KLINK, 2006), and occurs in tropical and subtropical forests of South America and the Cerrado (CARVALHO, 2013). In the latter, it occurs in forestlands (cerradão and gallery forest), shrublands (*cerrado sensu stricto*) and grasslands (campo sujo and campo rupestre) (MENDONÇA *et al.*, 2008; SILVA JÚNIOR, 2005). Despite its wide latitudinal distribution, considering the phytogeographic provinces for the Cerrado (BRIDGEWATER; JAMES; RIBEIRO, 2004), this species occurred only in the central and southeast portions, connecting regions with coastal biomes and the southern portion of Brazil.

Background

We have acceded field work data conducted in 2012 at a remaining *cerrado sensu stricto* (RIBEIRO; WALTER, 2008), a woodland savanna, with 4–6 m height, woody density ranging from 628 to 1990 ind.ha^{-1} and basal area from 6 to 18 m^2.ha^{-1} at the Olimpic Center of the Universidade de Brasília, at the environmental protection area of Paranoá (APA Paranoá), Brasília – DF (15° 46' S and 47° 50' W). The site is one of the few remnants of natural vegetation within the urban perimeter of Brasília (ASSUNÇÃO; FELFILI, 2004; FANK DE CARVALHO *et al.*, 2009) (Figure 1).

The climate of the region corresponds to Cwa of Köppen – tropical savanna. The rainfall index ranges from 1.400 to 1.450 mm/year with the concentration of rainfall in the summer. The slope is between 2 and 5% and the altitude between 1.000 and 1.050 m. The vegetation of the study area is a *cerrado sensu stricto* on dark red Latosol (ASSUNÇÃO; FELFILI, 2004).

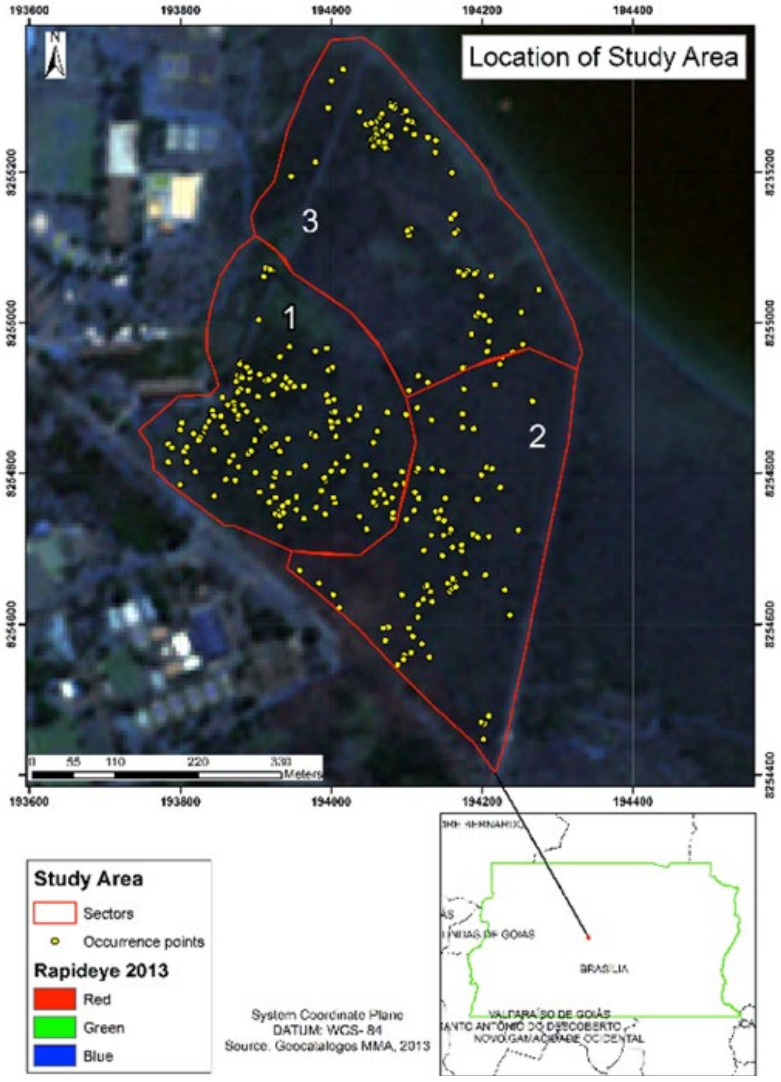

Figure 1 – Satellite image (Rapideye 2013) of a *cerrado sensu stricto* area in Brasilia, Brazil, and *Blepharocalyx salicifolius* distribution in 33.01 ha (latitude and longitude values in UTM, 23L Zone) with different disturbance scenarios (sectors: 1 – close canopy and low impact, 2 – open grass-shrub and medium impact, 3 – open area with exotic grass and high impact).

Fonte: Autores (2020).

Currently, the area is in a state of neglect and has suffered various degrading actions, such as illegal dumping of garbage and rubble and constant fires (ASSUNÇÃO; FELFILI, 2004; FANK DE CARVALHO *et al.*,

2009). It is a natural area of experimentation, as they are observed annual burning and invasive grass proliferation (mainly *Melinis minutiflora* Beauv and *Urochloa decumbens* (Stapf) R.D. Webster) (ASSUNÇÃO; FELFILI, 2004; FANK DE CARVALHO *et al.*, 2009).

Experimental design and plots

Based on field observation of canopy distribution sites, areas with exotic grasses invasion, fire occurrence signals and estimated Normalized Difference Vegetation Index (NDVI) values, we set up three sectors with as closest as possible area size summing 33.01 ha. These sectors were arbitrarily classified in terms of disturbance defined as low impact (sector 1, 8.05 ha) - tree species forming canopy, few exotic grasses and fire signals only in the base of trees; medium impact (sector 2, 14.15 ha) and validated by NDVI values – no canopy formation with sparse trees with usually burnt up to the chest height, exotic grasses colonizing some areas (FANK DE CARVALHO *et al.*, 2009); high impact (sector 3, 10.81 ha) – open area with fewer trees, high frequency of exotic grasses (reaching clumps with more than 2 meters tall), intense fire signs with some shrubs and few trees totally burned and burn marks above chest height (Figure 1). We believe that the design of these experimental plots represents a natural laboratory for the study of the effect of anthropogenic characteristics under native areas quite typical in Cerrado remnants, especially in regions where urban frontier expansion occurs.

In order to validate the experimental plots by disturbance and the process of changing the plant components, we generate vegetation indices (NDVI) using the RapidEye images, which have 5 meters spatial resolution and five spectral bands in the visible to infrared ranges. The images available on the MMA (Ministry of Environment – Brazil) geo catalogs System are the years 2012 and 2013. In order to extract the NDVI values of RapidEye images, they were converted to apparent reflectance values and then we performed the calculation of the NDVI using bands 3 and 5, which correspond to the spectral bands of red and near infrared.

NDVI = (NIR-RED) / (NIR + RED)

Based on these images it was possible to validate differences in vegetation indices from the three sectors based on average values of NDVI. The sector 1 (low impact) had the highest NDVI values in 2012 and 2013, 0.24 and 0.22 respectively. In sector 2 (medium impact), the average NDVI values were 0.23 and 0.14, respectively for the same period. But the sector 3 (high impact) had the lowest values of NDVI, 0.19 and 0.17, respectively for the same period.

Trees of *Blepharocalyx salicifolius* were sampled by census method. All woody plants with diameter of the base (Db) not less than 5 cm were sampled and permanent marked with metallic stickers. The repetition of marked trees in the field indicated that the areas were well collected. For each individual the diameter of the base (Db) - considered the 30 cm of the soil; the total height (H) - considered from the base of the trunk to the highest branch or foliage; number of bifurcation at the base (Bb); number of bifurcation at breast height (Bp); and geographical coordinates using a GPS in UTM (Universal Transverse Mercator) - metric system that enables the practical application of two-dimensional projection on the Cartesian coordinate system, using a portable GPS (5 meters of precision).

Trees with bifurcations were included when at least one of the trunks had the minimal inclusion diameter. In such cases, the bifurcations were measured separately and then calculated the quadratic mean diameter converting many bifurcations in a single value for the diameter (SCOLFORO, 1994).

Data analyses

We used the interpretation of the frequency distribution of the base diameter (Db) to infer whether the population was self-regenerative or not (FELFILI; SILVA JÚNIOR, 1988; SILVA JÚNIOR; SILVA, 1988). We have tested the hypothesis of intra-population differentiation between the established sectors by comparing the average values of population parameters (Db and H) using analysis of variance (ANOVA). Homogeneity of variances tests (Levene test for $p = 0.05$) were carried out to avoid

error type I (to avoid rejecting a true null hypothesis of no difference between population sets). When the variances were not homogeneous, we conducted equitability testing with the average using the Welch test and Brown-Forsythe (the significant level $\alpha = 0.05$). To infer previous background history of the area, we explored the relationship between the number of bifurcations on the base (Bb) and the number of bifurcations on the breast height (Bp) comparing the relative frequencies from each sector. Therefore, we assume that the number of branches bifurcation of this species could be a result of the impact area (mainly fire), so that more impacted areas would present trees with more branches as reported in other studies (HOFFMANN, 1998).

Results

From the disturbed population of *Blepharocalyx salicifolius* we have sampled 330 trees (Figure 1). In the low impact sector, we have found 139 trees, 105 in the intermediate impact sector, and 86 in the high impact sector. The density of the population estimated was 10.0 ind.ha^{-1} and the densities from the sectors were 17.26 ind.ha^{-1}, 7.42 ind.ha^{-1} and 7.95 ind.ha^{-1}. The average values (± SD) to the diameter of the base (Db) was 18.6 cm (± 0.63), 15.66 cm (± 0.57) to diameter at breast height (Dp) and 4.62 m (± 0.09) to height (H).

The analysis of diameter frequency distribution of the total population showed an "inverted J" curve aspect, and failures in this distribution corroborate the presence of disturbances in the area (Figure 2). However, the refinement of the analysis from the sectors, as expected, showed a differentiation in the diameter distribution of trees from different sectors. Those sectors are structurally different from each other and the analysis of variance (ANOVA) to the base diameter (Db) between those sectors showed a significant difference between them ($p \leq 0.05$) (Figure 3). The intermediate impact sector (2) had the highest average for Db, 22.02 cm (± 1.10), followed by the low impact sector (1) with 18.60 cm (± 1.03), and the high impact sector (3) had the lowest average Db, 14.42 cm (± 0.95).

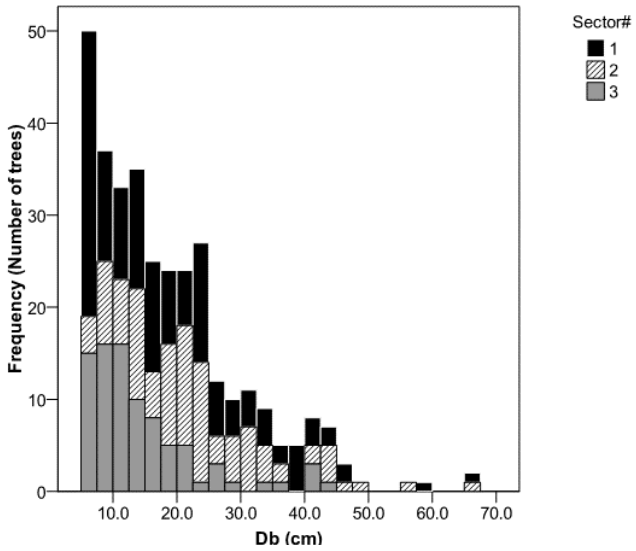

Figure 2 – Diameter of the base (Db) distribution of a *Blepharocalyx salicifolius* population in a disturbed *cerrado sensu stricto* in central Brazil submitted to distinct history of impact (sectors: 1 – close canopy and low impact, 2 – open grass-shrub and medium impact, 3 – open area with exotic grass and high impact).

Fonte: Autores (2020).

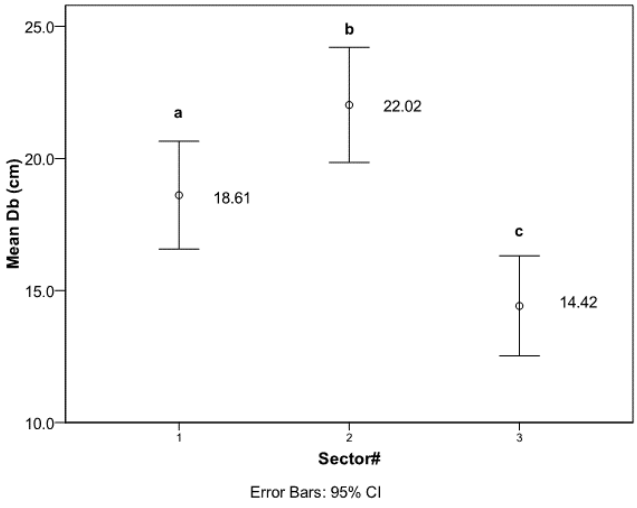

Figure 3 – Mean diameter of the base (Db) of a *Blepharocalyx salicifolius* population in a disturbed *cerrado sensu stricto* in central Brazil submitted to distinct history of impact (sectors: 1 – close canopy and low impact, 2 – open grass-shrub and medium impact, 3 – open area with exotic grass and high impact). Different letters are groups statistically different (Tukey HSD tests, LSD, Bonferroni and Gabriel; p = 0.05).

Fonte: Autores (2020).

The mean height of the *B. salicifolius* population was 4.6 m (Figure 4). When comparing the trees height from the sectors, the analysis of variance (ANOVA) showed a significant difference between the low impact sector and the others ($p \leq 0.05$) (Figure 5). The low impact sector showed highest average height 5.23 m average (± 0.14), 4.28 m (± 0.13) and 4.05 m (± 0.16) at the intermediate impact and high impact sector, respectively.

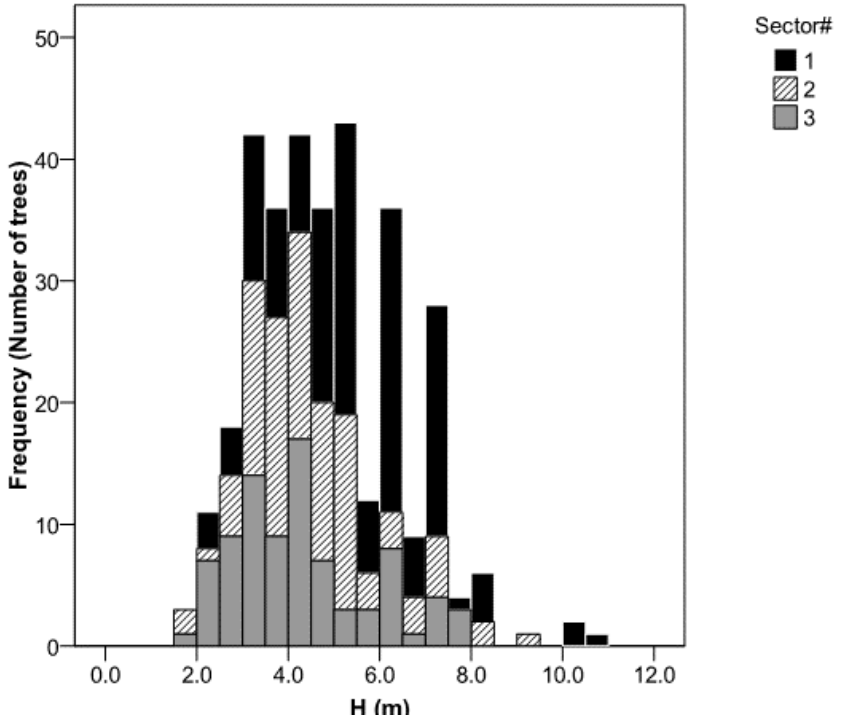

Figure 4 – Height (H) distribution of a *Blepharocalyx salicifolius* population in a disturbed *cerrado sensu stricto* in central Brazil submitted to distinct history of impact (sectors: 1 – close canopy and low impact, 2 – open grass-shrub and medium impact, 3 – open area with exotic grass and high impact).

Fonte: Autores (2020).

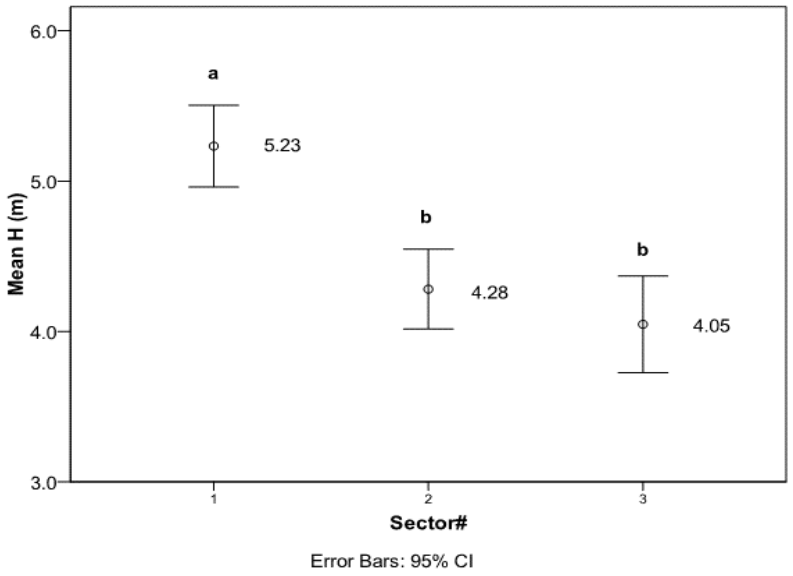

Figure 5 – Mean height (H) of a *Blepharocalyx salicifolius* population in a disturbed *cerrado sensu stricto* in central Brazil submitted to distinct history of impact (sectors: 1 – close canopy and low impact, 2 – open grass-shrub and medium impact, 3 – open area with exotic grass and high impact). Different letters are groups statistically different (Tukey HSD tests, LSD, Bonferroni and Gabriel; $p = 0.05$).

Fonte: Autores (2020).

We observed that most of the trees in all sectors had no bifurcation at the base (Bb), above 60% (Figure 6). Therefore, the level of impact didn't seem to contribute significantly to bifurcation at the base. However, more than 80% of the trees from the low impact sector have no bifurcations at base and relative frequencies of trees with one or more bifurcation at the base increase gradually from the low impact sector for high impact sector. Only the high impact sector showed trees with 3 and 4 bifurcations (Figure 6). When considering the number of bifurcations at breast height (Bp) trees have more bifurcations, however at least 40% of trees didn't have bifurcations (Figure 7). Similarly to the number of bifurcations at the base, most of the population are trees with one or two branches. The low impact sector showed 66% of trees with no bifurcations and the number of bifurcations increases gradually from the intermediate to high impact sectors (Figure 7).

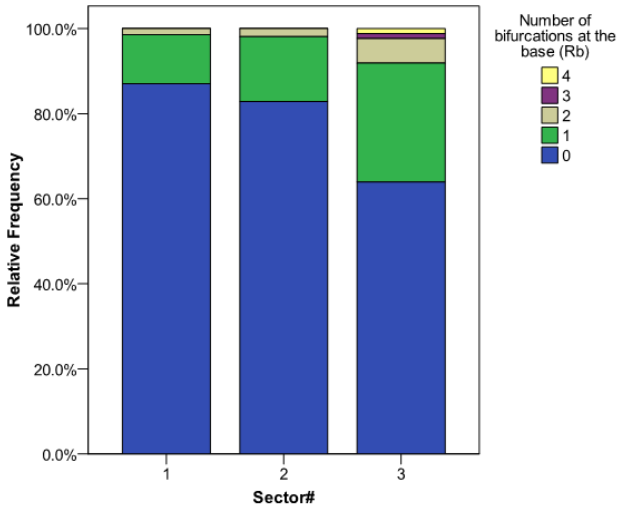

Figure 6 – Relative frequencies of the number of bifurcation at the base (Bb) of a *Blepharocalyx salicifolius* population in a disturbed cerrado *sensu stricto* in central Brazil submitted to distinct history of impact (sectors: 1 – close canopy and low impact, 2 – open grass-shrub and medium impact, 3 – open area with exotic grass and high impact).

Fonte: Autores (2020).

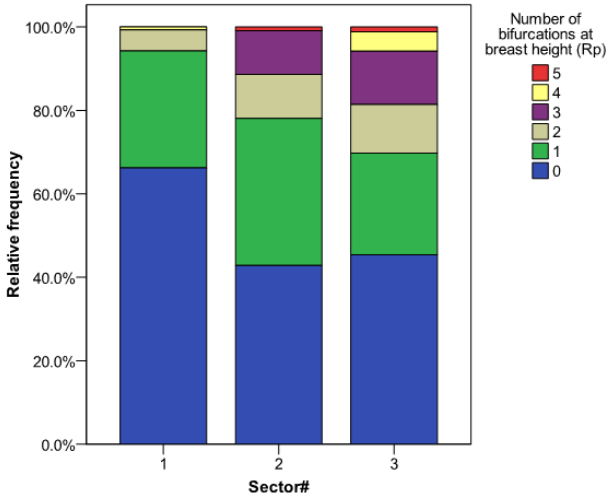

Figure 7 – Relative frequencies of the number of bifurcation at the breast height (Bp) of a *Blepharocalyx salicifolius* population in a disturbed cerrado *sensu stricto* in central Brazil submitted to distinct history of impact (sectors: 1 – close canopy and low impact, 2 – open grass-shrub and medium impact, 3 – open area with exotic grass and high impact).

Fonte: Autores (2020).

Discussion

The density calculated for *Blepharocalyx salicifolius* population (10.0 ind.ha^{-1}) was close to that found by another study in the same area (8 ind.ha^{-1}) using the same inclusion limit (ASSUNÇÃO; FELFILI, 2004). This corroborates the classification of the species as too little abundant, occurring with density ≤ 35 ind.ha^{-1} (NUNES *et al.*, 2002). When considering the analyzed sectors, the density of population is broadly associated with the NDVI mean values of the community. The low impact sector had 0.24-0.23 mean NDVI (2012-2013) and 17.26 ind.ha^{-1}, intermediate and high impact sector and 0.23-0.14 (2012-2013), 7.42 ind.ha^{-1} and 0.19-0.17 (2012-2013), 7.95 ind.ha-1, respectively. The density of *B. salicifolius* from each the sector seems to influence the height structure of the population once differences in the density corresponded to statistically different mean height (Figure 5). The disturbance, in turn, seems to influence the diameter structure *B. salicifolius* population (Figure 3).

The low impact sector trees showed the highest values of height (mean H above 5 m) and intermediate mean values of diameter of base (Db) (Figures 3 and 5). This is probably due to competition for space and light, which may be limiting the investment in diameter, balanced with a greater investment in height. When density is lower (in the intermediate and high impact sectors with similar densities), we observed statistically equal heights but two different diameter structure, higher values of diameter in intermediate disturbance scenario and low diameters where the disturbance is higher (Figure 3).

This ability observed in the sector with higher values of vegetation (higher NDVI) and higher densities within species trees corroborates other studies of *B. salicifolius* that reported its diameter increment is influenced by the canopy, and sub canopy trees have much lower increase (about 0.38 mm per year) in relation to the trees of canopy (about 9.07 mm per year) (KANIESKI *et al.*, 2013; LONGHI *et al.*, 2006). This species has different growth strategies: while the adults prioritize diameter increment after reaching the canopy, the young trees investing in height until reaching the photic zone as reported in other study (KANIESKI *et al.*, 2012).

There are other physiological responses on diameter growth like temperature, observed to influence the increment in diameter in alluvial forests (KANIESKI *et al.*, 2012). The temperature was noted to influence the increase in diameter of *B. salicifolius* (KANIESKI *et al.*, 2013). However, fire shaped global biome evolution and distribution, maintaining the structure and function of fire-prone communities globally as a significant consumer analogous to herbivory (BOND; KEELEY, 2005). In our findings, the approach of disturbance as a consequence of fire intensity, NDVI values and population structure correspond to different population strategies of *B. salicifolius*.

Woody plants of the Cerrado usually reproductive respond to burning and studies indicate that vegetative reproduction is much more successful than sexual reproduction under higher frequency of fire (HOFFMANN, 1998) because of resource limitation to sexuality due to plant investment to replace burned vegetative parts (GAWRYSZEWSKI; SATO; MIRANDA, 2020). Many woody species of the Cerrado are known to reproduce asexually via underground shoots or rhizomes (RAW; HAY, 1985; RIZZINI; HERINGER, 1962). It doesn't seem to be the case of *Blepharocalyx salicifolius* (MATOS, 1994). Moreover, we have found that under high disturbance, diameters are smaller, the frequency of trees from the smaller diameter classes is lower and this scenario is expected to have a negative impact on sexual reproduction of *B. salicifolius* as reported for other neotropical species from Brazilian Cerrado (GAWRYSZEWSKI; SATO; MIRANDA, 2020; HOFFMANN, 1998). *B. salicifolius* doesn't have much choice but to grow taller as soon as possible.

And so, she did. *Blepharocalyx salicifolius* plasticity operates differently on population strategies in diameter and height variation. Our findings showed this species may invest highly in height, and this adaptation helps recruits to overcome the limit of higher mortality caused by fire. Higher seedling and trees are expected to have smaller mortality rates (FRANCO; SOUZA; NARDOTO, 1996; FROST; ROBERTSON, 1987; MIRANDA *et al.*, 1993). Fire may be more aggressive to plants measuring between 1 and 2 m in height and 2 and 3 cm in diameter (MEDEIROS; MIRANDA, 2005). Even common fire-tolerant

savanna trees, when under frequent fire (annual and biannual fire), will face a large negative effect on crown architecture and on flowerand fruit production (GAWRYSZEWSKI; SATO; MIRANDA, 2020).

The average diameter of the base values (Db) and height (H) found for *Blepharocalyx salicifolius* are high when comparing with six other common species in areas of cerrado *sensu stricto* in core portion of the biome (MIRANDA, 2012; RATTER; BRIDGEWATER; RIBEIRO, 2003) namely *Acosmium dasycarpum* (Vogel) Yakovlev (Fabaceae) (Db = 7.1 cm and H = 2.4 m); *Aspidosperma tomentosum* Mart. (Apocynaceae) (Db = 7.6 cm and H = 3.3 m); *Byrsonima coccolobifolia* Kunth (Malpighiaceae) (Db = 7.5 cm and H = 3.2 m); *Ouratea hexasperma* (A. St.-Hil.) Baill. (Ochnaceae) (Db = 7.9 cm and H = 1.8 m); *Pouteria ramiflora* (Mart.) Radlk. (Sapotaceae) (Db = 10.8 cm and H = 3.9 m); and *Qualea parviflora* Mart. (Vochysiaceae) (Db = 10.3 cm and H = 3.5 m).

The diameter of the base (Db) distribution curve is "inverted J" shaped and indicates that the mortality rate is less than the recruitment (FELFILI; SILVA JÚNIOR, 1988). Frequencies in diameter classes reflect the current situation of sizes in the community/population and make inferences about disturbances based on discontinuities in the sequence of classes, such as fires, deforestation, inefficiencies of biological processes such as pollination, dispersal, germination, attack of pests and diseases, among other factors (FELFILI; SILVA JÚNIOR, 1988; MIRANDA; SILVA JÚNIOR; SALLES., 2007; SILVA JÚNIOR; SILVA, 1988). Therefore, the discontinuities observed in the histogram reflect various disorders in the study area, and the characterization in sectors conducted in this study corroborates the results. The assessment of diameter distribution provided relevant information about the population structure and reflected the current situation of *B. salicifolius* organization. Steam diameter is considered to be one of the most important biometric measure in tropical ecology (HARPER, 1977).

The population of *B. salicifolius* seems to be competitive in height and the mean value found for this species (4.6 m) is characteristic of species that colonize areas of forestlands (RIBEIRO; WALTER, 2008). Myrtaceae are evolutionarily tolerant to fire and dispose different morphological strategies to colonize and establish in fire prone

environments (CRISP *et al.*, 2011). And considering the low number of bifurcations at the base it may corroborates the strategy of this species to be competitive in height and consequently avoid the topkill burning effect reported in may studies (HOFFMANN; SOLBRIG, 2003; MOREIRA, 2000; WERNER, 2012).

The relative higher number of bifurcations at breast height might be a result of the intensification of fire regimes in the area in the last years. Consequences of this disturbance is discussed in other studies on the area (ASSUNÇÃO; FELFILI, 2004; FANK DE CARVALHO *et al.*, 2009). Tallest trees tend to escape the direct effects of flame (MIRANDA; NASCIMENTO NETO; NEVES, 2010). The burning line usually occurs between 1.0 and 1.5 m (COUTINHO, 1990; SAN JOSE; FARINAS, 1983; SAN JOSE; FARINAS; ROSALES, 1991), so individuals with height above two meters can protect their buds and young branches increased post-survival fire.

Similar strategies are reported to eucalypts juvenile and sapling growth responses to fire and the probability of subadult trees reaching the canopy are related to fire–understory interactions (WERNER, 2012). It is suggested that the Myrtaceae (specially eucalypts and close relatives) mechanisms include morphological epicornic adaptations and carbohydrate storage dynamics which vary with tree size and life history stage (CRISP *et al.*, 2011; WERNER, 2012). Until now, those epicornic adaptations are not reported to *Blepharocalyx salicifolius*, however our study indicates this species has other adaptations in terms of population structure to maintain viable population under disturbance.

Conclusions

The selected variables were efficient to characterize different population structures of *Blepharocalyx salicifolius* submitted to different disturbance conditions. This species seems to respond in population level allowing to adapt differently in diameter and number of branches to different disturbance scenarios. This type of forest response is not new in the literature. However, it is poorly reported by science for

neotropical savanna whose ecosystem behavior is still unclear. Understanding the population adaptation strategies of the Cerrado flora can collaborate with environmental policies.

The height of trees seems to be influenced by density and NDVI values. The validation of the experimental plots using NDVI is a novelty of this study since few studies use this remote sensing tool to follow the structuring of native plant species. Considering native species of the Cerrado biome, these studies are practically non-existent. Considered to be with putative origin in forest ecosystems (seasonal forest, rain forest, etc.), this species may be a good competitor in height, and this can be a strategy to avoid topkill. The frequency and intensity of fire, due to the occurrence of invasive species may be one important disruptive agent in the natural woody populations in the Cerrado and results presented here corroborates this assumption.

Therefore, management actions in conservation areas should eliminate the invading grass, or at least monitor the dynamics of population structure of native species in order to better understand the effect of this disturbance in the management of botanical communities. Moreover, the recovery of the affected areas may be facilitated by the presence of smaller stable populations and understanding different population strategies can offer more economical conservation measures, acting more efficiently maintaining stable populations and eventually aiming natural recolonization.

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