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Nurse plant effect of *Solanum lycocarpum* A. St.-Hil. in area of Brazilian Savanna undergoing a process of restoration

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Abstract The use of nurse plants in ecological restoration aims to reactivate succession processes to improve environmental quality and biodiversity. This study targets *Solanum lycocarpum* as a nurse species to promote different plant species beneath its crown by microenvironmental changes in a disturbed area in Brazilian Savanna undergoing a process of restoration. The hypothesis is that *S. lycocarpum* modifies the microenvironment beneath its crown and influence in order to facilitate the density and richness of different plant species. Biotic parameter as density and species-rich biota, dispersal syndromes and habit were sampled. Additionally abiotic parameters were evaluated: litter thickness, light interception, penetration resistance, moisture, soil bulk density, saturated hydraulic conductivity of soil, nutrient content, acidity and soil structure. These parameters were evaluated in ten sampling units beneath *S. lycocarpum*, called the area of direct influence, ten around the nurse species crown, in the area of indirect influence and ten in open fields nearby without the influence of other trees, in the control area. For the biotic factors, density and species richness were higher beneath the crown of *S. lycocarpum* than in other treatments, mainly due to more litter accumulation, light interception, higher nutrient content (potassium, calcium and magnesium), more moisture and lower penetration resistance. Results showed the importance of *S. lycocarpum* as a nurse species in a Brazilian Savanna area, because of their role in local microenvironmental changes to facilitate other plant species and promote succession processes.

Keywords Density and species richness · Environmental conservation · Facilitation · Nucleation · Microenvironmental changes

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Introduction

The Brazilian Savanna, called locally the "Cerrado", encompasses more than 204 million hectares and still shows enormous vegetation richness. However, the past three decades (Klink and Moreira 2002; Klink and Machado 2005), Brazilian Savanna landscape has been extensively changed to farmland (Ratter et al. 1997; Sano et al. 2008), mainly by using alien species; fire and mining are some examples of aggression to "Cerrado" areas as well as few protected areas existence (Klink and Machado 2005).

In these conditions, ecological restoration can be an essential strategy to mitigate or reverse some effects from disturbed sites. The central idea is to reactivate the ecological successional dynamics (Connell and Slatyer 1977; Palmer et al. 1997; Rodrigues and Gandolfi 2000) and assemble ecological communities (Verdú and Valiente-Banuet 2008) to avoid soil erosion (Rodrigues and Gandolfi 2000), habitat fragmentation (Lord and Norton 1990), disruption of gene flow between populations (Metzger 2003) and loss of biodiversity (Pivello 2005).

Facilitation can be defined as a positive interaction that can contribute to reactive the succession dynamics (Connell and Slatyer 1977; Verdú and Valiente-Banuet 2008) and preserve global biodiversity (Verdú and Valiente-Banuet 2008). Nucleation is described by the spatial dynamic of a species to provide a significant improvement in the micro-environment favoring the establishment of different species (Yarranton and Morrison 1976). These principles can be strategies of restoration ecology and refer to the process by which species colonize, interact with other species and allows for different path-dependent outcome (Young 2000). This way, restoration needs not only to emphasize a pre-determinated or fixed way to a final product of succession, but it can be a trigger to succession and induce a success process in a multiple stable communities (Young et al. 2001).

Nowadays, restoration principles are based in biofunctionality and systemic restoration to redirect disturbed sites towards its integration with the surrounding natural landscape by stochastic process and resilience capacity (Reis et al. 2003; García and Zamora 2003; Castro et al. 2004; Gómez-Aparicio et al. 2004; Metzger 2006; Reis and Tres 2007). These restorations principles can be used with nurse species as an example of facilitation and nucleation, since these nurse species induce positive interaction by improving conditions for the germination, establishment and growth of other plant species, as well as becoming local points for greater recruitment of plants (McDonnell and Stiles 1983; Guevara et al. 1986, 1992; McClanahan and Wolfe 1993; Zaluar and Scarano 2000).

Solanum lycocarpum A. St.-Hil can be a possible species in the process of natural colonization of open and disturbed areas (Oliveira et al. 2004) and be tested as a nurse species. Although this species can be initially described as allelopathic mainly by extraction from leaf (Oliveira et al. 2004; Aires et al. 2005; Leite and Oliveira 2007) and fruit (Aires et al. 2005), this result was tested only in the laboratory and with exotic plants (Leite and Oliveira 2007; Aires et al. 2005; Oliveira et al. 2004), never in natural environment. This species is an arboreal species from Solanaceae family (Silva-Junior 2005) with rare occurrence in native vegetation (Felfili et al. 1992), but widely distributed in disturbed environments of Brazilian Savanna (Oliveira Filho and Oliveira 1988; Lombardi and Motta Junior 1993). It grows in unfavorable soil conditions (Oliveira-Júnior et al. 2003), resists to arid and prolonged drought weather (Campos 1994; Vidal et al. 1999; Chaves Filho and Stacciarini-Seraphin 2001) and constant fire system (Campos 1994). It is also used as perch for birds (Santos et al. 2002) and the seeds are dispersed by common agents from open and disturbed areas (Oliveira et al. 2004), as the Maned Wolf (*Chrysocyon brachyurus* Illiger) (Lombardi and Motta Junior 1993) and bats (Kissman 1997).

Based on these informations, this study aimed to evaluate a native species from the Brazilian Savanna (Cerrado sensu stricto), *S. lycocarpum* A. St.-Hil, as a nurser-grown species. Aspects evaluated were the density and richness species beneath its individuals, as well as microenvironmental changes related to their presence, in an area of Brazilian Savanna undergoing a process of restoration. The hypothesis is that *S. lycocarpum* modifies the microenvironment beneath its influence thus facilitating the density and richness of different plant species.

Materials and methods

Characterization of the study area

The study was performed in a disturbed area near a preserved area of natural Brazilian Savanna at the National Institute of Meteorology (INMET) (15°46′56.5″S and 47°55′38.6″W) in Brasília-DF, Brazil (Fig. 1). INMET covers a circular area of 78.5 ha with a radius of 500 m. It is located in an urban area within Brasilia, the capital of Brazil, characterized by its typical seasonal climate with a pronounced regime of drought in winter and rain in summer and annual precipitation between 750 and 2,000 mm (Silva et al. 2008). Local soils are typically nutrient-poor and acidic, with high sand and clay content (Reatto et al. 2008).

This study is a continuum project of land recovery where 19 native species (46 individuals species^{-1}) were planted to recover one ha of disturbed area adjacent to a fragment of Brazilian Savanna within INMET (Fig. 1) at the project 'Demonstration Units of Recovery' in partnership with the University of Brasilia (UnB), the Brazilian Agricultural Research Corporation (Embrapa) and Environment Ministry (MMA). The installation of these units complies with the need to preserve the richness of the Brazilian Savanna with gradual recovery processes, ecological functions, environmental services and also bring opportunities for financial return. *S. lycocarpum* A. St.-Hil (Solanaceae) was one of the 19 species planted and it was chosen in this research because it had the highest survival rate (100 %) and exceptional initial growth in height and stem diameter per year (Oliveira 2006).

Sampling method and evaluated parameters

From the 46 individuals planted from seeds in 2004, 10 adult individuals of *S. lycocarpum* (stem diameter >5 cm at 30 cm from ground level and average crown radius of 2 m)

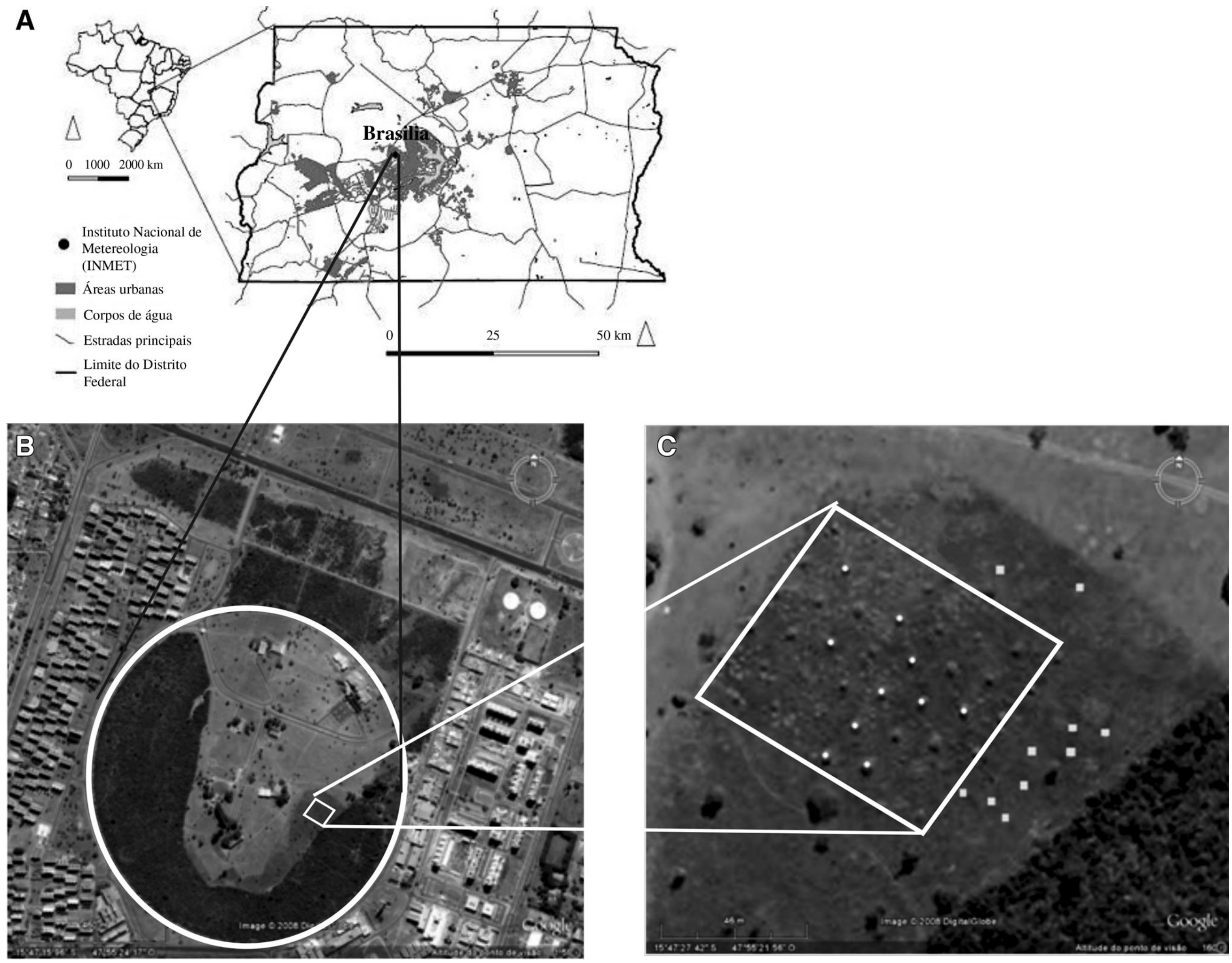

Fig. 1 **a** Location of the National Institute of Meteorology (INMET) in Brasilia, Distrito Federal—DF, Brazil. **b** Boundaries of the National Institute of Meteorology (INMET) (*larger circle*), Distrito Federal—DF, Brazil and location of study area (*small square*). **c** Nurse plants distribution (*ball*) and control area (*square*) in INMET. Images taken from GoogleEarth, June 2008

were chosen randomly. Among these individuals, the area of direct influence (ADI) was delimited as the crown projection of *S. lycocarpum* and as well as the area of indirect influence (AII), equivalent to the area immediately surrounding the ADI in 2008 in the rainy season (Fig. 2).

The ADI was defined by the axis from the center of the tree trunk of *S. lycocarpum* individuals in the direction of the four cardinal points (North, South, East and West) and the boundaries delimited directly below the crown cover projection. The definition of AII boundaries was based on the size of the ADI axis, making the AII three times the size of the ADI (3:1). The internal area for each individual was calculated by assuming ADIs and AIIs to be in the shape of an ellipse [$A = \pi \cdot a \cdot b$, in which (a) and (b) are respectively the major and minor axis of the ellipse]. Besides, 10 control areas (CA) were plotted in an open field, to be considered free of the influence of trees. These CA plots were calculated based on the average of the areas (ADI and AII) of the 10 individuals of *S. lycocarpum* selected. Ten replications of each treatment were plotted, producing 30 sampling units.

Biotic and abiotic parameters were evaluated beneath the crown projection and in the other treatments. In the biotic parameters, density and richness species for woody (Ratter et al. 2003) and herbaceous plants (excluding grasslike species) were collected in all sampling units. Species were also classified according to the functional dispersion group: anemocoric, autocoric or zoocoric (Van der Pijl 1982) and habit: tree, shrub or herbs (Mendonça et al. 2008).

Abiotic parameters were measured as follows:

(1) Litter thickness. This was quantified by the M-H collector-measurer of layer litter, an instrument for measurement and collection of quantitative samples

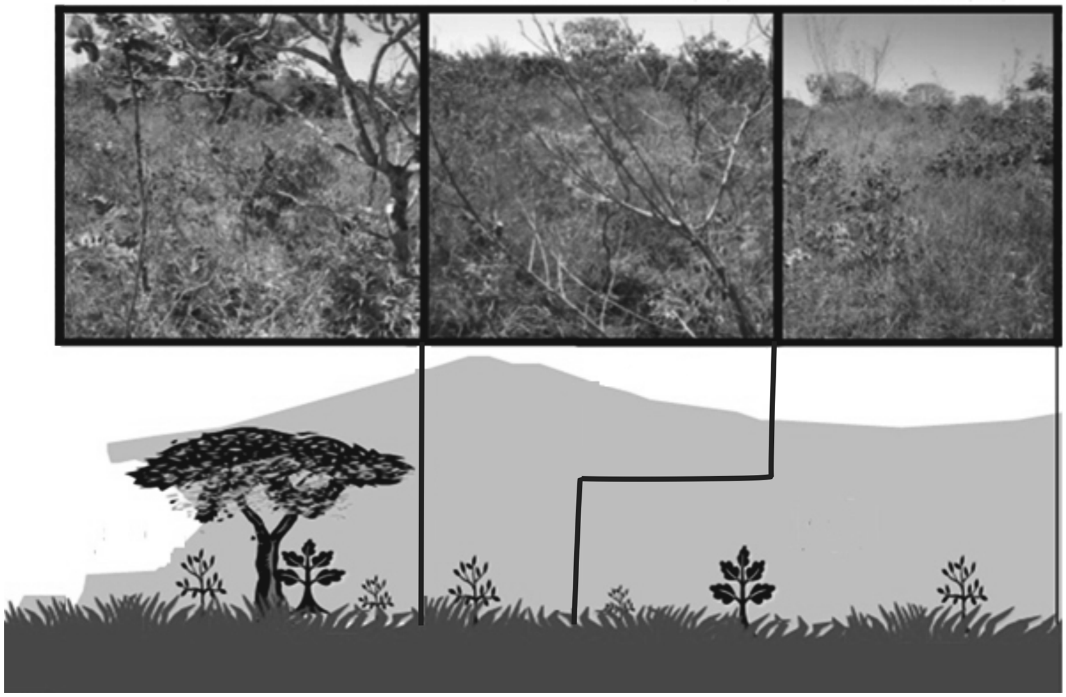

Fig. 2 Schematic pictures of the area of direct influence (ADI), area of indirect influence (AII) and control area (CA) at the National Institute of Meteorology (INMET)

of the litter layer in forests (INPM Patent No. PI-0505830-9) (Marimon Júnior and Hay 2008). The crown cover was measured at four points in the ADI in each quarter of each *S. lycocarpum* individual crown cover and at eight points both in AII and in CA.

(2) Percentage of intercepted light. It was measured by a Ceptometer (Accupar LP-80 Ceptometer, Decagon Devices, USA), which evaluated Photosynthetically Active Radiation (PAR) both above the crown (one reading) and at ground level (eight readings). Light interception percentage was calculated as: [(the average of eight measures of PAR at ground level) $\cdot 100] \cdot (\text{PAR above the crown})^{-1}$. Readings were taken during the dry season (July) on days with no cloud cover, because the quantum that composes the instrument sensors is most indicative under direct light and between 10 am and 3 pm, when the sun is highest.

(3) Hydraulic conductivity. Saturated hydraulic conductivity (average Ks) and bulk density of soil were collected using an Uhland-type sample holder and metal cylinders (height = 5.1 cm, diameter = 5.0 cm, volume = 100 cm^3) from the first 5 cm of the soil surface to quantify the speed that water moves through the soil. Four samples were collected at each sampling unit. Samples were analyzed according to Embrapa protocol for physical analysis of soils (Embrapa 1997).

(4) Soil chemistry and texture. Ten samples for each treatment were collected by an Auger for deformed samples. Analysis was carried out for chemical content of: Al, P, K, Ca, Mg, H + Al, pH and the percentage of organic matter in the soil, as well as soil texture (Embrapa 1997).

(5) Penetration resistance (Mpa). This was collected using portable dynamometer penetrometers (Kiya Seisakusho ltd, Yamanaka) to evaluate the ability of the root to penetrate the soil. Values were randomly collected from eight points in each sampling unit. Soil moisture was also measured (graviometric water content) in each experimental unit. Samples were wet weighed (WW) and stored in an oven at 70 °C for 48 h for dry weight (DW). The percentage of the gravimetric water content was calculated by the equation: $[(\text{WW–DW}) \cdot \text{DW}^{-1}] \cdot 100$ (Embrapa 1997).

Statistical analysis

The biotic parameters were tested by analysis of variance (ANOVA) followed by Tukey's test-Q paired and to abiotic parameters were tested by paired *t* test. All statistical tests were analyzed in the PAST program (PAlaeontological STatistics, ver. 1.72) (Hammer et al. 2001) with significance level of 0.05.

Table 1 Biotic and abiotic parameters examined in area of direct influence (ADI), area of indirect influence (AII) and control area (CA)

		ADI	AII	CA
Biotic parameters	Species density (individual ha^{-1})	**6.40[a] ± 1.35**	**3.54[b] ± 1.07**	**3.14[b] ± 1.33**
	Herbaceous density (individual ha^{-1})	0.81[a] ± 0.23	0.34[a] ± 0.23	0.24[a] ± 0.18
	Shrub density (individual ha^{-1})	**4.61[a] ± 1.04**	**2.52[b] ± 0.83**	**2.25[b] ± 1.20**
	Tree density (individual ha^{-1})	0.98[a] ± 0.40	0.68[a] ± 0.21	0.65[a] ± 0.27
	Anemocoric density (individual ha^{-1})	**2.16[a] ± 0.79**	**1.30[b] ± 0.46**	**1.05[b] ± 0.40**
	Autocoric density (individual ha^{-1})	**2.41[a] ± 0.95**	**1.23[b] ± 0.5**	**1.24[b] ± 0.69**
	Zoocoric density (individual ha^{-1})	**1.82[a] ± 0.15**	**1.0[b] ± 0.36**	**0.84[b] ± 0.40**
	Species richness (species ha^{-1})	**2.04[a] ± 0.34**	**0.94[b] ± 0.22**	**0.76[b] ± 0.13**
	Herbaceous richness (species ha^{-1})	**1.88[a] ± 0.68**	**0.10[b] ± 0.05**	**0.08[b] ± 0.03**
	Shrub richness (species ha^{-1})	0.58[a] ± 0.30	0.54[a] ± 0.14	0.44[a] ± 0.07
	Tree richness (species ha^{-1})	0.21[a] ± 0.07	0.30[a] ± 0.08	0.23[a] ± 0.08
	Anemocoric richness (species ha^{-1})	**0.64[a] ± 0.18**	**0.27[b] ± 0.07**	**0.24[b] ± 0.06**
	Autocoric richness (species ha^{-1})	**0.72[a] ± 0.17**	**0.31[b] ± 0.08**	**0.24[b] ± 0.07**
	Zoocoric richness (species ha^{-1})	**0.68[a] ± 0.13**	**0.35[b] ± 0.12**	**0.26[b] ± 0.06**
Abiotic parameters	Thickness of litter (cm)	**2.19[a] ± 0.71**	**0.44[b] ± 0.23**	**0.36[b] ± 0.18**
	Light interception (%)	**75.3[a] ± 4.3**	**67[b] ± 5.98**	**66[b] ± 0.1**
	Saturated hydraulic conductivity of soil (average ks) (cm seg^{-1})	0.018[a] ± 0.004	0.019[a] ± 0.003	0.020[a] ± 0.004
	Bulk density (g cm^{-3})	1.20[a] ± 0.04	1.20[a] ± 0.03	1.21[a] ± 0.02
	pH	4.99[a] ± 0.23	4.8[a] ± 0.12	4.86[a] ± 0.13
	Potassium (K) (mg l^{-1})	**54.4[a] ± 12.36**	**29.8[b] ± 4.76**	**26[b] ± 4.52**
	Calcium (Ca) (me 100 cc^{-1})	**0.99[a] ± 0.52**	**0.46[b] ± 0.19**	**0.26[c] ± 0.12**
	Magnesium (Mg) (me 100 cc^{-1})	**0.37[a] ± 0.12**	**0.2[b] ± 0.06**	**0.17[b] ± 0.05**
	Phosphorus (P) (mg l^{-1})	0.81[a] ± 0.13	0.76[a] ± 0.09	0.73[a] ± 0.27
	Aluminum (Al) (me 100 cc^{-1})	0.3[b] ± 0.12	0.46[b] ± 0.1	0.44[b] ± 0.22
	H + Al (me 100 cc^{-1})	4.45[b] ± 0.38	5.1[b] ± 0.57	5.99[c] ± 1.56
	Organic matter (%)	2.3[a] ± 0.59	1.93[a] ± 0.62	2.47[a] ± 0.51
	Clay (%)	26.5[a] ± 8.24	28.6[a] ± 11.06	36.20[a] ± 13.73
	Silt (%)	1.9[a] ± 1.52	2.50[a] ± 1.90	4.00[a] ± 4.99
	Sand (%)	31.6[a] ± 7.79	32.7[a] ± 7.06	27.20[a] ± 9.45
	Silt/Clay (%)	0.08[a] ± 0.06	0.09[a] ± 0.07	0.09[a] ± 0.06
	Penetration resistance (Mpa)	**0.59[a] ± 0.21**	**0.85[b] ± 0.16**	**1[b] ± 0.2**
	Moisture (g g^{-1})	**0.08[a] ± 0.03**	**0.04[b] ± 0.01**	**0.04[b] ± 0.01**

Means and standard deviation are given. Significant higher values are indicated by different letters and bold ($P \leq 0.05$)

Results

Biotic parameters—*S. lycocarpum* values for density and species richness beneath its crown (ADI—area of direct influence), as expected, were greater than in area immediately surrounding the crown (AII—area of indirect influence) and in area free of the influence of trees (CA—control area). The significant difference in density was $Q = 7.201$, $P = 0.000185$ to AII and $Q = 8.198$, $P = 0.000134$ to CA. Regarding Species richness, the significant difference was $Q = 14.06$, $P = 0.000127$ to AII and $Q = 16.38$, $P = 0.000127$ to CA. For functional dispersion group, shrub species were more common and had higher density in ADI, while herbaceous species showed greater richness. As for dispersal syndrome groups, there was significant difference both in density and richness only when ADI was compared with the other treatments (Table 1).

Abiotic parameters—litter thickness across the area was five to six times higher in ADI than AII ($t = 9.105$, $P = 0.00001$) and CA ($t = 8.277$, $P = 0.0001$). ADI also had greater light interception than AII ($t = 5.321$, $P < 0.001$) and CA ($t = 4.61$, $P < 0.001$). In relation to soil properties, potassium ($t = 5.734$, $P = 0.0003$) and magnesium levels ($t = 4.955$, $P = 0.001$) in ADI were twice that of AII and CA, while calcium ($t = 3.736$, $P = 0.005$) was two to four times higher in ADI. About soil moisture, it also presented greater values in ADI than AII ($t = 5.065$, $P = 0.001$) and CA ($t = 3.862$, $P = 0.004$). The penetration resistance (Mpa) in ADI tended to be lower than AII ($t = -4.444$, $P = 0.002$) and CA ($t = -4.303$, $P = 0.002$).

Discussion

Although this species has been mentioned initially as allelopathic at least in the laboratory (Oliveira et al. 2004; Aires et al. 2005; Leite and Oliveira 2007), our research showed that individuals of *S. lycocarpum* seem to facilitate establishment and occurrence of other species in its microenvironment site and it should be therefore strategic in the restoration of disturbed environments in the Brazilian Savanna. An important factor is the increase in density and species richness beneath its crown (ADI—area of direct influence), as predicted by Yarranton and Morrison (1974) for nurse species. Such an increment may be promoted by changes due to *S. lycocarpum*'s presence, such as greater shade and litter deposit, as well as less soil penetration resistance, greater soil moisture and in the levels of K, Ca and Mg in the surface layer in ADI.

This means that, according to the successional models, the first step after the arrival of the early species is the modification of the environmental conditions, which will stimulate the arrival of new species on the site (Connell and Slatyer 1977; Ren et al. 2008). The factors that could prevent the species from colonizing the site are, among others, soil compaction, drought and the shortage of organic matter and nutrients. However, early plant species modifies the microenvironment and provides suitable sites for establishing new species, so it can create good conditions for the germination and establishment of new propagules, as seems to be occurring here. Continuously, changes in the micro-environment provided by early nurse plants, such as *S. lycocarpum*, may be judged by the greater number of species and individuals established in ADI, due to its crown cover, than around its crown (AII—area of indirect influence) and in control area (CA).

In addition, some studies suggest that solar incidence reduction is the main factor that facilitates the establishment of species and individuals beneath the crown of nurse species, especially in environments with the most severe conditions, such as semi-arid climate (Callaway 1995), sandbanks (Scarano 2002), and degraded areas (Carnevale and Montagnini 2002), because it prevents the drying of seeds and seedlings (Vieira and Scariot 2006) and photoinhibition (Lemos Filho 2000). But, according to Holmgren et al. (1997), in dry environments, facilitation by shading can only occur when the benefit of decreasing water stress exceeds the effects of reducing photosynthetic rate. Other studies report this situation as a barrier to the germination and establishment of some herbaceous plants that, in general, prefer sunny conditions (Carmona et al. 1998; Zaidan and Carreira 2008). Conversely, factors such as positive photoblastism (Zaidan and Carreira 2008), dispersal by birds, vegetative propagation, alien species behavior and colonization strategies that offer fruits for longer and different maturation periods (Albuquerque et al. 2013), may have favored greater shrub density in the sites, mostly in ADI in this study.

However, there is experimental evidence that many plants from the Brazilian Savanna are indifferent to light during the germination process (Felippe and Silva 1984; Hoffmann 1996; Zaidan and Carreira 2008). Salomão et al. (2003) reviewed germination and growth of 18 woody species of the Brazilian Savanna and identified 11 positive photoblastic species, six species indifferent to light during germination and only one that needed darkness to germinate. Even so, these analyses support the proposal that the presence of nurse species, such as *S. lycocarpum*, enhances environmental heterogeneity. Partial shading may stimulate the occurrence of species with different light requirements, inducing higher species diversity and succession.

Another positive effect of species diversity provided by nurse species is litter production and accumulation under its crown cover. In the Savannas of Belize, Kellman (1979) noted an increase in the concentration of mineral nutrients beneath some species that are also native to the Brazilian Savanna. This author observed that *Miconia albicans* and *Byrsonima crassifolia* favored the establishment of woody plants by litter accumulation. Both Kellman (1979) and this study showed that litter thickness was five times higher beneath nurse species than in other treatments. This litter can be naturally transformed into nutrient supply, the lack of which might be limiting to plant growth and the regeneration of vegetation (Aide and Cavelier 1994). Apparently, in this study, soil nutrients have been enhanced by using the nurse species, as example *S. lycocarpum*, but despite this result, it is notable that other species can also favor microenvironmental changes (Yarranton and Morrison 1974; Kellman 1979; Vieira et al. 1994; Lambeck 1997; Castro et al. 2002; Holl 2002; Franks 2003; Corrêa Dias et al. 2005; Ren et al. 2008; Marimon et al. 2014).

Nevertheless, evergreen woody species have a lower concentration of nitrogen, phosphorus, calcium and magnesium than deciduous ones, a brevi-deciduous species has less concentration of nitrogen and phosphorus than a deciduous one and more nitrogen, phosphorus, calcium and magnesium than an evergreen species in the Brazilian Savanna (Araújo and Haridasan 2007). The litter thickness from evergreen nurse species, such as *S. lycocarpum* (Oliveira et al. 2004), seems to favor the increment the calcium level two to fourfold, doubling potassium and magnesium levels and nutrient cycling in ADI in comparison to AII and CA, probably for the constant leaf fall and replacement from these species (Oliveira et al. 2004).

This process can be beneficial and desirable when nurse species, as *S. lycocarpum*, are used in disturbed or undergoing restoration process fields, providing a gradual decomposition of leaf litter to increase nutrient content and organic matter in the soil. It also leads to a new abiotic environment and can help to accelerate vegetation restoration, because more fertile soils with higher humidity boost seed germination and provide floristic differences such as increased density and species richness. This may be favorable to native Brazilian Savanna species, because they can respond positively to liming and fertilization (Haridasan et al. 1997; Haridasan 2000), increasing productivity and nutrition concentration in the biomass (Haridasan et al. 1997).

Furthermore, nurse species apparently benefit soil structure, because the penetration resistance in ADI was diminished to almost half of the values found in the other treatments. The ability of the root to penetrate the soil does not depend only on the resistance offered by the substrate, but can also be on its moisture content and nutritional status. So, this condition may improve contact between seeds and soil, boosting root development and, consequently, establishing more individuals.

In contrast, phosphorus and organic matter did not show differential values in any of the treatments, but the increased litter beneath *S. lycocarpum* is expected to lead to an increase in these components in the future, since phosphorus is maintained in organic combinations, because it is one of the main limiting factors for plant growth (Brady 1989). Although pH levels did not show significant changes beneath species *S. lycocarpum*, as attested by Al and H + Al values, the levels of calcium increased to two for fourfold compared to other treatment and this can be indicative of an imminent change in soil acidity, because Ca^{2+} generally diminishes the aluminum levels and facilitates the absorption of essential nutrients by plants in local exchange (Motta et al. 2002).

In a 5-year period, all these parameters seem to contribute to establish different plant species under the crown of *S. lycocarpum*, thus emphasizing its ecological role as a good example of nurse species. Individuals of *S. lycocarpum* appear to collaborate in the succession process of local vegetation restoration, since results shown here promoted positive modifications in microenvironmental conditions, such as litter and shade, and these consequently promote increased moisture and nutrient content. Such parameters have been observed to increase density and richness species beneath the crown of nurse species.

Although this study tested only *S. lycocarpum* as species to aid in the recovery of savanna sites, it is probable that other species can also facilitate this succession process, as discussed before. This is especially likely if the nurse species presents rapid development in height and stem diameter, so as to favor initial colonization of the site, partly because they function as natural perches for animal dispersers, thus facilitating the arrival of seeds. Despite the fact that the phytophysiognomy of typical Brazilian Savanna species present a slow growth rate for restoration purposes, other very abundant species such as *Qualea grandifora* and *Q. parviflora*, with faster growth and crown cover development, should be considered in studies of nurse species in the Brazilian Savanna (Cerrado sensu stricto).

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