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Paricá recoverability after simulated defoliation

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Abstract - *Schizolobium parahyba* var. *amazonicum* (paricá) is a native tree species, widely used in reforestation. However, the damages caused by insects to the species reduce the photosynthetically active area, interfering with final growth. Therefore, the objective of this work was to evaluate the recoverability of paricá in early ages after a simulated defoliation. The experiment was designed in randomized blocks divided in four experiments with four replications, separated into two distinct periods (30 and 60 days after emergence) and the percentage of leaves and folioles. After 30 and 60 days of plants emergence, defoliation was carried out. After 30 days in both phases plants height, stem diameter and leaf recovery were evaluated. Data of all defoliation percentages were submitted to variance and regression analyses. Under artificial defoliation, paricá had low reduction in growth and good capacity for damage recovery and it was therefore considered tolerant to different damage percentages tested.

Capacidade de recuperação do paricá após simulação de desfolha

Resumo - O paricá, *Schizolobium parahyba* var. *amazonicum* (Huber ex Ducke) Barneby, é uma espécie florestal largamente utilizada em reflorestamentos. Entretanto, os danos causados por insetos podem reduzir a área fotossintética, interferindo no crescimento. Portanto, o objetivo deste trabalho foi avaliar a capacidade de recuperação de paricá em idades precoces, pela simulação de desfolha. Foi utilizado o delineamento experimental em blocos casualizados, divididos em quatro experimentos, com quatro repetições, separados em dois períodos (30 e 60 dias após emergência) e pela porcentagem de folhas e folíolos. Ao completar 30 e 60 dias após emergência foram realizadas as desfolhas e após mais 30 dias, nas duas fases, avaliou-se altura da planta, diâmetro do caule e recuperação foliar. Os dados foram submetidos à análise de variância e regressão para os percentuais de desfolha. Sob desfolha artificial, o paricá apresentou baixa redução de crescimento e boa capacidade de recuperação de danos, sendo assim considerado tolerante às diferentes porcentagens de danos testadas.

Introduction

Brazil is a major exporter of pulp, wood panels and paper, mainly to Europe, China and Latin America countries. As a reference, only the pulp imported by China was estimate in US$ 177 million (Cenário Ibá, 2016). To sustain this production, it is important to diversify the species used, as they should combine fast growth and high timber potential. However, today 70% of planted forests in Brazil are eucalyptus (Anuário…, 2013).

A species with high potential is *Schizolobium parahyba* var. *amazonicum* (Huber ex Ducke) Barneby, popularly known as paricá. It is a native tree species in Amazon region. It has being planted by reforestation companies in Pará State (Rosa, 2006). Parica can be used in homogeneous or mixed plantation, presenting annual average productivity ranging from 20 to 30 m^3 ha^1 $year^{-1}$, similar growth registered for pine species (25 a 30 m^3 $ha^{-1}year^{-1}$), and higher than teak (15 to 20 m^3 $ha^{-1}year^1$) (Iwakiri et al., 2010).

It presents soft lightweight wood with smooth surface and density of about 0.40 g cm^{-3} that is a good choice for manufacturing liners, toothpicks, paper, veneer and plywood, as it offers at the end of lamination process a product with great finishing (Albino & Zanetti, 2006; Iwakiri et al., 2010). According to Almeida et al. (2013), this wood has small defect rate and number of knots, straight grain, and also little warping, which is related to resistance to parallel compression to fibers and wood apparent density. Moreover parica wood presents superior or equal quotient than other species used in construction, like *Pinus* genus.

Currently, the greatest obstacles to increase paricá productivity are the biotechnological (cloning and genetic breeding) and phytosanitary aspects, which still require applied research, since expansion of parica planted areas was not followed by phytosanitary actions, such as systematic monitoring of insects and the understanding of damages due to wood-degrading organisms (Tremacoldi et al., 2009) and insects, like *Pantophthalmus kerteszianus* and *P. chuni* (Lunz et al., 2010b) or *Syssphinx molina* (Batista et al., 2013).

In Brazil, forest companies are investing financial and scientific resources to minimize damages to reforestation caused by insects (Buratto et al., 2012). Studies show that leaf-cutting ants can reduce productivity by 13.4 to 39.2 m^3 ha^{-1} (Souza et al., 2011), and Lunz et al. (2010a) have reported that *Quesada gigas* attack may cause losses that currently reach 20% of planted area.

Photosynthetically active area reduction by defoliation promotes physiological instability in trees and interferes with photosynthate allocation for sprouting of new leaves reducing growth (Freitas & Berti Filho, 1994). When defoliation level is extreme, such as total defoliation, reduction in volume increase may be high, since growth is primarily dependent on existing photosynthesis (Kozlowski, 1963). In addition, damage caused extends beyond reduced productivity, also affecting plants resistance, making them more susceptible to other insects attack and diseases (Ferreira, 1989).

Artificial defoliation can be a valuable tool, making possible to measure defoliation intensity caused by insects and to compare growth reduction with damage-free trees (controls), cultivated under the same conditions (Kulman, 1971). Studies related to artificial defoliation produce basic information and safe techniques that provide quantitative knowledge regarding crops capacity to tolerate foliar area reduction (Fazolin & Estrela, 2004).

Thus, the objective of this study was to assess *Schizolobium parahyba* var. *amazonicum* recoverability through simulated defoliation, in early ages, through different levels of artificial defoliation.

Material and methods

The experiment was conducted at Universidade Estadual de Goiás, Ipameri, GO at coordinates 17º43'20"S and 48º09'35"W and altitude 773 m. According to Köppen classification, climate is Aw, humid tropical, with two distinct seasons: dry season, corresponding to fall and winter from May to September, and a rainy one corresponding to spring and summer.

The experiment was conducted between June and October, using the randomized blocks design, divided in two experiments, separated in two distinct periods of plant growth, 30 and 60 days after emergence (DAE), and one experiment with 0, 50 and 100% of leaves removal and the other with 0, 25, 50, 75, and 100% of leaves removal, with four replications. Defoliation was carried out manually using scissors, removing the entire leaf from the sheath. Defoliation of folioles was from the petiole removing youngest leaves.

Soil samples, were collected in at 0-20 cm, screened and limed according to chemical soil analysis (Table 1), stored for about 30 days and irrigated every two days. It was classified as red-yellow dystrophic oxissol. Subsequently, crop fertilization was mixed thoroughly into the soil accomplished with 3 g kg^{-1} soil of urea, 2.5 g of triple superphosphate and 2.2 g of potassium chloride before filling polypropylene bags with 3.5 kg of soil.

Seeds obtained from the Laboratory of Seedlings and Seeds of Amazon Forest Tree Species (Aimex) were submitted to dormancy breaking in sulfuric acid, following recommendation of Cruz et al. (2007). Sowing was carried out using three seeds per bag, to ensure the desired number of plants, and maintained until thinning, when only one plant remained for assessment, and the bags were placed on benches under full sun.

Table 1. Soil chemical properties (0-20-cm depth) without application of fertilizer or lime. Ipameri, GO, 2015.

Characteristics	pH	OM	P_{resin}	H+Al	K	Ca	Mg	SB	ECC	V%
	$CaCl_2$	dm^{-3}	mg dm^{-3}	———— $mmol_c$ dm^{-3} ————						
Soil	4.9	24	9	30	2.1	18	7	27	57	47

pH – active acidity, OM – organic matter, P –available phosphorus, H + Al – potential acidity, K – available potassium, Ca – exchangeable calcium Mg – exchangeable magnesium, ECEC – effective cation exchange capacity, V% – base saturation.

At 30 and 60 days after plant emergence, defoliation was carried out according to treatments. Plants recovery were assessed after 30 days, measuring plant height (PH) measured with graduated scale considering plant neck-to-apex; stem diameter (SD), measured with calipers at plant stem base; and leaf recovery (LR) determined by counting all plant leaves.

Data were submitted to variance analysis and when F test result was significant, regression analyzes were carried out according to defoliation percentages at 5% probability, using the statistical software SISVAR (Ferreira, 2011).

Results and discussion

No difference (P > 0.05) was observed for stem diameter when defoliation was carried out 30 days after emergence (DAE) and also for plant height with defoliation at 60 DAE (Table 2), demonstrating paricá ability to recover from defoliation damage. These results are similar to that found by Reis Filho et al. (2011), who simulated ant attack through different levels of artificial defoliation in *Pinus taeda* and *Eucalyptus grandis* and observed no influence of defoliation in *P. taeda* height .

For the other characteristics assessed, defoliation did influence the development of parica seedlings, especially in plants in which leaflet defoliation was carried out, since they presented significant difference in all the characteristics in both growth stages assessed.

Plants with 50% of leaves removal after 30 and 60 DAE (Figure 1) showed decrease of leaf growth by around 40%, which consequently caused a decrease in height growth due to smaller photosynthetic tissue. Plants height reduction was of about 5 cm with 50%-removal treatment and approximately 8 cm in plants that all leaves were removed. A similar result was found by Reis Filho et al. (2011), who observed a reduction in height with leaves removal of 50%, being more severe in cases of all leaves removal when plants are in advanced growth stages (6 to 12 months), with a possible decrease of 20 cm.

Paricá seedlings presented similar behavior with defoliation at 30 and 60 DAE (Figure 2), decreasing as leaves were removed. Plants height (7 cm) were more affected than stem diameterdiameter (no more than 2 cm).

This result is different of that presented by Matrangolo et al. (2010) with total removal of eucalyptus tree leaves in early stages, because it resulted in losses of 18.9% in diameter growth and 12.0% in height, with significant losses in total volume (37.9%) that could even reach 79.7%. However productivity rate of *Pinus taeda* seedlings decreased by 34.4 and 28.7% in year 0 and year 1, respectively, when attacked by leaf-cutting ants (Cantarelli et al., 2008).

When plants were subjected to different leaflet defoliation percentages at 30 DAE, it can be seen that leaf recovery (LR) presented positive quadratic trend, as well as at 60 DAE (Figure 3 A). This means that when decreasing percentages of defoliation there is an increase of number of leaves. However, results of defoliation treatments at 30 DAE and 60 DAE were different, as with 50% defoliation there was a decrease of about 40% in the number of leaves from the first to the second treatment, showing that at this growth stage damage is greater, delaying growth recovery. These results are unlikely to be significant for timber volume reduction since according to Mattson & Addy (1975) forest production may not be affected by herbivores when defoliation is lower than 40% of tree canopy, as there may be compensatory growth when defoliation rates are low.

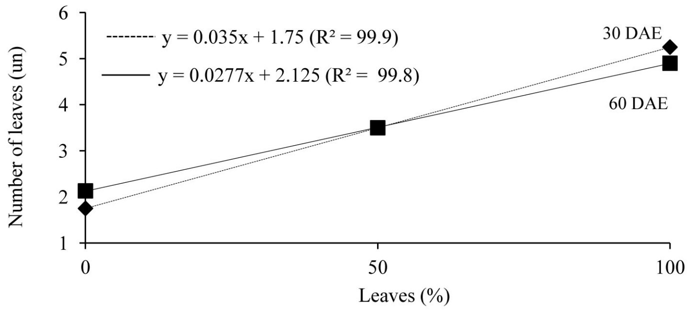

Figure 1. Leaves recovery at 30 and 60 days after emergence of *Schizolobium parahyba* var. *amazonicum*, under different percentages of artificial defoliation of leaves. Ipameri, GO, 2015.

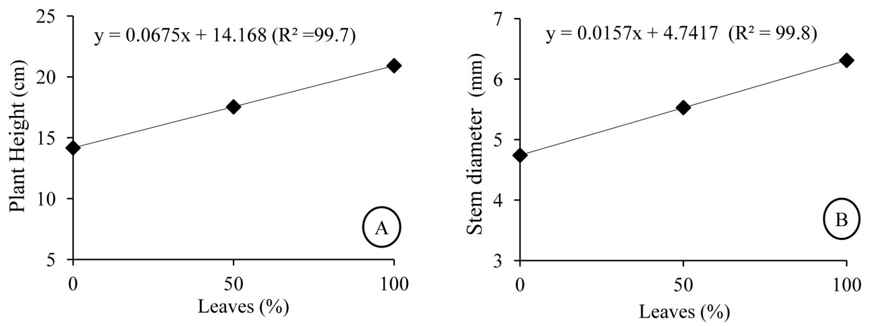

Figure 2. Height (A) at 30 days after emergence and stem diameter (B) at 60 days after emergence of *Schizolobium parahyba* var. *amazonicum* under different percentages of artificial defoliation of leaves. Ipameri, GO, 2015.

Defoliation at 30 DAE in the same growth stage resulted in decrease of around 3 leaves in the treatment with 0% of folioles compared to the treatment with 100% of folioles. However at 60 DAE, the reduction was less than two leaves.

The total removal of folioles yielded smaller plant diameter than in seedlings where all the folioles were kept (Figure 3B), with 4 cm at 60 DAE and 5 cm at 30 DAE, respectively, showing negative effect of damage caused by defoliation. Stem diameter is an important variable to be considered as seedlings quality. According to Araújo et al. (2000) it expresses the conditions of root system more precisely than height.

Diameters with defoliation at 30 DAE, in percentages from 0 to 50%, were slightly reduced and they did not reach 1 cm. However when 100% of folioles were kept plants growth were approximately 24% higher than the other treatments. At 60 DAE diameters increment were smaller in 0-leaflet percentage, since the difference did not reach 1 cm.

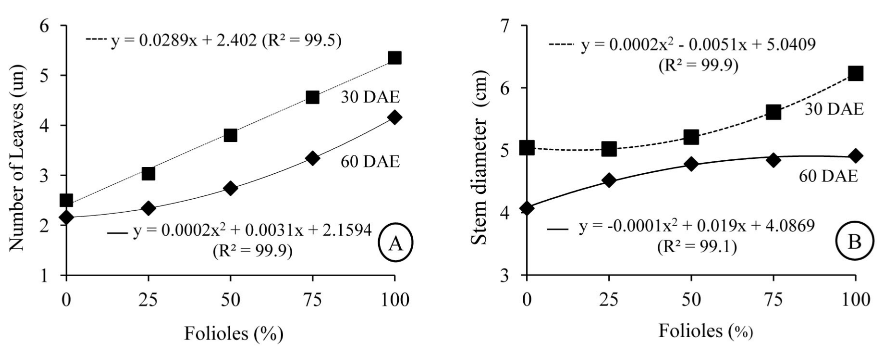

Figure 4. Height at 30 and 60 days after emergence of *Schizolobium parahyba* var. *amazonicum*, under different percentages of artificial defoliation and removal of folioles. Ipameri, GO, 2015.

Plant height in the two defoliation periods (Figure 4) suffered the greatest impact on those from which all folioles had been removed, being reduced by about 10 cm. A similar result was found by Nadai et al. (2012), who observed a reduction in height of eucalyptus of about 6.29% when exposed to *Lampetis nigerrima* attack. In initial growth stage, defoliation affects growth of trees interfering with rates and balance of internal physiological processes, especially metabolism of nutrients, hormones and water (Kozlowski, 1969).

Defoliation accelerates a sequence of metabolic disorders, which are much more than a simple change in physiological processes like photosynthesis. This explains the close relationship between damages caused by insects and plant growth in all treatments.

These results show that despite of growth reduced caused by defoliation there was no seedling mortality, meaning that at this stage paricá was damage-tolerant. This was also observed in eucalyptus by Reis Filho et al. (2011), who assessed the effect of different degrees of defoliation on pine and eucalyptus and concluded that only severe and repetitive defoliation causes significant growth reduction.

Defoliated trees tend to present lower yields, and the losses found may be even greater, resulting in a decrease in wood production. However, this behavior depends on the plant development. This could also be observed in paricá, when defoliated seedlings at 30 DAE had better growth than those defoliated at 60 DAE, indicating that in early stages, plants manage to recover and achieve better growth. However, the study should be extended to longer periods of observation, thus it would be possible to measure and compare the actual effect of initial defoliation on wood volume production of paricá.

Conclusion

Defoliation at 30 and 60 days after emergence of *Schizolobium parahyba* var. *amazonicum* seedlings has little effect on growth in diameter and height. It is suggested that the species may be tolerant to damages caused by pests if defoliation is not continuous.

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