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Top pruning on seedlings rejuvenation: a tool for nurseries in Brazilian Atlantic Forest reforestation

Poda no rejuvenescimento de mudas: uma ferramenta para viveiros no reflorestamento da mata atlântica brasileira

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ABSTRACT
Plant nurseries produce many species simultaneously, which are often not used at the right time, remaining in the nurseries. These plants become aged and tall and, when planted in the field, often show poor performance, topple over, or die in degraded areas. This work aimed to evaluate the practice of drastic pruning in the rejuvenation of aged seedlings of native tree species for the restoration of the Atlantic Forest. Two tests (TA and TB) were conducted in southern Brazil, evaluating the relationship between pruning height × species and measuring regrowth and survival. In TA, 24 species (80%) had high survival (100%). Drastic pruning at 15-cm height generated greater regrowth heights compared to pruning at 30 cm for all species, but statistically only for 12 species. In TB, no differences were observed between pruning heights, but pruning at 15 cm and at collar level showed better values. It is recommended that seedlings be pruned for some species, to resume growth and to achieve a better height/diameter ratio in the nurseries and possibly to increase field survival, especially in degraded tropical areas, to be reforested.
Keywords: drastic pruning; severe pruning; seedlings quality; seedlings recuperation; ecological restoration.

RESUMO
Os viveiros produzem grande quantidade de espécies simultaneamente, as quais muitas vezes não são utilizadas no momento adequado, permanecendo nesses viveiros. Essas plantas tornam-se envelhecidas e altas e, quando plantadas a campo, frequentemente apresentam baixo desempenho, tombam ou morrem em áreas degradadas. Este trabalho objetivou avaliar a prática da poda drástica no rejuvenescimento de mudas envelhecidas de espécies arbóreas nativas para a restauração da mata atlântica. Dois testes (TA e TB) foram conduzidos no sul do Brasil, avaliando a relação entre altura de poda × espécie e medindo as rebrotas e a sobrevivência. No TA, 24 espécies (80%) tiveram alta sobrevivência (100%). A poda drástica a 15 cm de altura gerou maiores alturas de rebrota comparada à poda a 30 cm, para todas as espécies, mas estatisticamente só para 12 delas. No TB, não foram observadas diferenças entre as alturas de poda, mas a poda a 15 cm e a poda ao nível do colo apresentaram melhores valores. Recomenda-se a poda de mudas para algumas espécies, para a retomada do crescimento e para alcançar melhor relação altura/diâmetro nos viveiros e, possivelmente, aumentar a sobrevivência a campo, sobretudo em áreas tropicais degradadas, a serem reflorestadas.
Palavras-chave: poda drástica; poda severa; qualidade das mudas; recuperação de mudas; restauração ecológica.

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INTRODUCTION

Brazil is the country with the highest forest species diversity over the world (GIULIETTI *et al*., 2005), but, paradoxically, the same country is also the leader in area deforestation (FAO, 2011). This scenario creates an increasing demand for forest restoration projects, which require diverse seedlings with good quality that are rough and resistant to the adverse climatic conditions of degraded areas (RODRIGUES *et al*., 2009; RODRIGUES *et al*., 2011; BECHARA *et al*., 2016). The native tree seedlings height for tropical forest restoration in large scale is recommended to be, at least, 30-50 cm. The collar region should present maturity signs, as woody appearance, rough texture, and diameter, compatible with the aerial weight, in order to bear the plant. The ideal collar diameter for Brazilian tree species is suggested to range between 5-10 mm (GONÇALVES *et al*., 2005; DIAS *et al*., 2006).

Nurseries that produce seedlings for tropical forest restoration projects need to produce massive quantities of seedlings in a high diversity of tree species. However, not all seedlings are used at the same time, and they soon become leftovers in the nurseries. Seedlings that stay in the nurseries for an extended period are considered aged and frequently show vigor problems. Root-bound and etiolation result in seedlings with low performance in the field (especially in degraded and opened areas), since they tend to die or topple because they are too high, thin, and weak to endure the soil and climate adversities in marginal areas.

Therefore, these low-quality seedlings represent irrigation, substrate and space waste in the nursery and losses in the field. In contrast, top pruning on seedlings apical stems may recover photosynthesis capacity, allow new foliage formation, increase plant reserves and vigor, thicken the stems, and reduce the height, diminishing toppling probability and raising survival. Besides, it facilitates the production control in the nurseries and in the field since it provides size uniformity and enables to wait for the planting rainy season. Such technique may allow aged seedlings to be revitalized for planting, with even better quality (DURYEA, 1984; MARLER, 2019).

Considering there is a lack of studies in the literature about severe pruning in native tree seedlings in nurseries, the effects of top pruning were evaluated aiming the rejuvenation of aged seedlings for tropical forest restoration.

MATERIAL AND METHODS

This research was divided into two tests (TA and TB), conducted in two different nurseries: for TA, at Universidade Tecnológica Federal do Paraná (UTFPR), Dois Vizinhos, PR, Brazil (25°44’ S and 53°04’ W; Sep-Nov 2011); and for TB, at Companhia Paranaense de Energia, Usina Hidrelétrica de Salto Caxias, Capitão Leônidas Marques, PR, Brazil (25°28’ S and 53°36’ W; May-Nov 2015). Both places are located at the southwestern of Paraná state, southern Brazil. According to Köppen, the climate of the region is classified as humid subtropical mesothermic, Cfa type (*apud* ALVARES *et al*., 2013).

TA was conducted in a randomized block experimental design, factorial 2 × 30 (apical height pruning × species), with four replicates of 20 seedlings. Pruning height was performed at two levels on the apical stem: top pruning at 15 and 30 cm from the root collar. Pruning shears with horizontal blades were used. The seedlings were placed in dark polyethylene bags of 2 liters, kept outdoors (0% sunlight blocking) and watered three times a day. All were produced from seeds and were at least 50 cm high.

The species factor was composed by the following species: *Albizia polycephala* (Benth.) Killip, *Allophylus edulis* (A. St.-Hil., Cambess. & A. Juss) Radlk., *Annona cacans* Warm., *Araucaria angustifolia* (Bertol.) Kuntze, *Balfourodendron riedelianum* (Engl.) Engl., *Calliandra tweedii* (Benth.), *Campomanesia xanthocarpa* (Mart.) O. Berg., *Ceiba speciosa* (A. St.-Hil.) Ravenna, *Celtis* sp., *Cordia americana* (L.) Gottschling & J.E.Mill., *Eugenia involucrata* DC., *Eugenia pyriformis* Cambess., *Ficus enormis* (Miq.) Miq., *Handroanthus heptaphyllus* (Mart.) Mattos, *Lafoensia vandelliana* Cham. & Schltdl, *Machaerium stipitatum* DC., *Myrocarpus frondosus* Allemão, *Myrsine umbellata* Mart., *Ocotea porosa* Nees & Mart., *Parapiptadenia rigida* Benth., *Peltophorum dubium* Spreng., *Plinia trunciflora* (O. Berg) Kausel, *Podocarpus* sp., *Prunus myrtifolia* (L.) Urb., *Randia ferox* (Cham. & Schltdl.) DC., *Strychnos brasiliensis* (Spreng.) Mart., *Tabebuia roseoalba* (Ridl.), *Trema micrantha* (L.) Blume, *Xylosma* sp., and *Zanthoxylum rhoifolium* Lam. The survival (%), number of sprouts, and total height (cm) were analyzed 60 days after the top pruning.

TB was also conducted under randomized block experimental design, but in factorial 3 × 8 (pruning apical height × species), with four replications of 10 seedlings. The pruning levels in the apical stem were characterized by:

- no pruning (control);
- severe pruning at root collar level;
- top pruning at 15-cm height from the root collar.

The species factor was constituted by: *A. edulis*, *Aspidosperma polyneuron* Müll. Arg., *Bauhinia forficata* Link., *Cabralea canjerana* (Vell.) Mart., *C. xanthocarpa*, *Cedrela fissilis* Vell., *Eugenia uniflora* L. e *Inga marginata* Willd. The initial (after 90 days) and final resprouts height (cm), leaf area (cm^2), root length (cm), root collar diameter (mm), aerial (resprouts) and root dry mass (g) were evaluated after 150 days.

Regarding the data analysis, TA data were subjected to the Lilliefors normality test by GENES™ software and later transformed by Arcsen . Then, the data were subjected to variance analysis, and the averages were compared by Duncan's test (α = 0,05), using the SANEST™ software. TB data followed the same statistical protocol used in the first one. However, the total height, root collar diameter, and root dry mass were transformed by .

RESULTS

The results obtained on TA demonstrated 100% of survival in 24 species (80%), while survival rates of 75% were observed in the other six ones. The treatment that resulted in higher survival rates was 30-cm pruning. Resprouts were verified on all seedlings. Results also suggested an effect for the pruning apical height × species, both for the number of sprouts and total height (Table 1).

Table 1 – Survival, number of resprouts and height of native tree species seedlings top pruned at 15 and 30 cm (height from root collar). Data collected after 60 days, Dois Vizinhos, PR, Brazil*.

Species (% survival at 15 and 30 cm)	Number of resprouts		Total height (cm)	
	15 cm	30 cm	15 cm	30 cm
Albizia polycephala (100, 100)	2.47 jklm A	3.20 ijklm A	14.08 bcde A	6.50 defghi B
Allophylus edulis (100, 100)	5.34 abcdefg B	7.84 bcd A	11.02 cdefghA	5.39 fghij B
Annona cacans (100, 100)	3.14 ghijkl A	3.54ghijklm A	11.01 cdefghA	5.03 ghijk B
Araucaria angustifolia (100, 100)	4.67 bcdefghi A	3.20 ijklm A	1.63 k A	1.63 kl A
Balfourodendron riedelianum (100, 100)	4.60 cdefghi A	4.27 fghijkl A	6.72 ghi A	2.85 hijk B
Calliandra tweedii (100, 100)	4.81 bcdefgh A	2.61 klm B	4.33 ijk A	0.46 l B
Campomanesia xanthocarpa (100, 100)	6.84 abc A	7.32 bcde A	10.13 defgh A	7.43 cdefg A
Ceiba speciosa (100, 100)	1.12 m A	1.17 n A	10.11 defgh A	4.23 ghijk B
Celtis sp. (100, 100)	6.38 abcde B	11.32 a A	10.45 defgh A	1.89 jkl B
Cordia americana (100, 100)	7.84 a A	10.21 ab A	7.12 fghi A	2.56 ijkl B
Eugenia involucrata (75, 100)	7.07 abc B	10.32 ab A	9.73 efgh A	6.61 defghi A
Eugenia pyriformis (100, 100)	5.72 abcdef A	6.27 cdef A	9.69 efgh A	6.68 defghi A
Ficus enormis (100, 100)	4.26 defghij A	4.40 fghijkl A	13.39 bcde A	7.05 cdefgh B
Lafoensia vandelliana (100, 100)	7.34 ab A	7.49 bcde A	13.50 bcde A	12.64 abc A
Machaerium stipitatum (100, 100)	2.29 jklm A	3.01 jklm A	19.95 ab A	14.99 ab A
Plinia trunciflora (100, 75)	3.74 fghijk B	5.91 cdefg A	4.48 ijk A	3.92 ghijk A

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Continuação da tabela 1

Species (% survival at 15 and 30 cm)	Number of resprouts		Total height (cm)	
	15 cm	30 cm	15 cm	30 cm
Myrocarpus frondosus (100, 100)	5.58 abcdef A	5.33 defghi A	10.38 defgh A	10.28 bcdef A
Ocotea porosa (75, 100)	2.09 klm A	2.39 lmn A	4.19 ijk A	1.74 kl A
Parapiptadenia rigida (75, 100)	2.68 hijkl B	5.80 cdefgh A	13.25 bcde A	5.75 efghi B
Peltophorum dubium (100, 75)	1.59 lm A	2.06 mn A	17.89 abc A	10.67 bcdef B
Podocarpus sp. (100, 100)	4.06 efghij A	5.02 efghij A	2.86 jk A	2.10 hijk A
Prunus sellowii (100, 100)	2.3 jklm A	3.46 hijklm A	6.74 ghi A	3.13 ghijk A
Randia ferox (100, 100)	3.72 fghijk A	4.46 fghijk A	5.55 hij A	5.48 fghij A
Rapanea umbellata (100, 100)	3.11 ghijkl A	4.01 fghijkl A	3.36 jk A	2.56 ghijk A
Strychnos brasiliensis (75, 100)	4.64 cdfghi A	6.25 cdef A	14.93 bcde A	12.13 abcd A
Tabebuia heptaphylla (100, 100)	3.14 ghijkl A	3.87 fghijklm A	19.34 ab A	18.83 a A
Tabebuia roseoalba (100, 100)	2.62 ijkl A	3.08 ijklm A	25.42 a A	18.83 a A
Trema micrantha (100, 100)	6.74 abcd A	4.36 fghijkl B	11.68 cdefg A	4.11 ghijk B
Xylosma sp. (100, 100)	5.91 abcdef A	8.26 bc A	16.71 bcd A	13.67 ab A
Zanthoxylum rhoifolium (100, 100)	4.25 defghij A	4.58 fghijk A	13.05 bcdef A	10.93 bcde A
CV (%)	15.88		21.23	

*Average followed by different letters, lowercase on line and uppercase on row, differ by Duncan's test (α = 0,05); CV: coefficient of variation.

Source: primary.

Considering the 15 cm-height pruning, the highest number of resprouts were statistically observed in 10 species, as following: *C. americana*, *L. vandelliana*, *E. involucrata*, *C. xanthocarpa*, *T. micrantha*, *Celtis* sp., *Xylosma* sp., *E. pyriformis*, *M. frondosus* and *A. edulis*. For 30 cm-height pruning, the superiority in number of resprouts was registered just for five species: *Celtis* sp., *E. involucrata*, *A. edulis*, *P. trunciflora* and *P. rigida*. When analyzing pruning height within each species, most of them showed no significant difference among the number of resprouts.

Pruning at 15 cm-height also generated higher total height compared to 30 cm-height in all species, but statistically for: *P. dubium*, *A. polycephala*, *F. enormis*, *P. rigida*, *T. micrantha*, *A. edulis*, *A. cacans*, *Celtis* sp., *C. speciosa*, *C. americana*, *B. riedelianum* and *C. tweedii*. Regarding to the total height, the highest averages occurred in *T. roseoalba*, *M. stipitatum*, *T. heptaphylla* and *P. dubium*.

On TB, effects were observed both for initial and final resprouting height, although the initial ones did not show similar results after 90 and 150 days for *C. canjerana*, *C. xanthocarpa*, *A. edulis*, *C. fissilis* and *I. marginata* (Table 2).

Considering the final heights (150 days), *E. uniflora* and *A. polyneuron* showed the highest averages with no pruning (control) and with severe pruning at root collar level as well. *Aspidosperma polyneuron* also kept its superiority on 15 cm-height top pruning, followed by *E. uniflora*.

When there were different pruning treatments within each species, the results were distinct. No pruning (control) was the most effective treatment for *C. xanthocarpa*, *I. marginata* and *C. fissilis*. Severe pruning (root collar) was the best treatment for *E. uniflora*, *B. forficata* and *A. edulis.* Top pruning (15 cm-height) was the most successful for *A. polyneuron* and, again, *A. edulis* and *C. fissilis*. *Cabralea canjerana* did not show statistical differences.

Table 2 – Initial (after 90 days) and final (after 150 days) resprouts height, leaf area, root length, root collar diameter, aerial and root dry mass of native tree species seedlings subjected to: no pruning, severe pruning at root collar level, and 15 cm-height top pruning. Data collected in Capitão Leônidas Marques, PR, Brazil*.

Scientific name	No pruning		Severe pruning		Top pruning	
Final height (cm)						
Eugenia uniflora	0.95	aB	1.16	aA	0.87	bB
Aspidosperma polyneuron	0.86	aC	1.11	aB	1.47	aA
Bauhinia forficata	0.52	bcB	0.72	bA	0.23	eC
Cabralea canjerana	0.27	dA	0.34	dA	0.24	eA
Campomanesia xanthocarpa	0.41	cA	0.21	eB	0.02	fC
Allophylus edulis	0.24	dB	0.51	cA	0.46	dA
Cedrela fissilis	0.55	bA	0.27	deB	0.63	cA
Inga marginata	0.42	cA	0.34	dAB	0.31	eB
CV (%)			2.23			
Initial height (cm)						
Eugenia uniflora	0.87	aB	1.09	aA	1.11	bA
Aspidosperma polyneuron	0.84	aC	0.94	bB	1.48	aA
Bauhinia forficata	0.58	bB	0.69	cA	0.02	dC
Cabralea canjerana	0.02	dA	0.02	eA	0.02	dA
Campomanesia xanthocarpa	0.02	dA	0.02	eA	0.02	dA
Allophylus edulis	0.02	dB	0.15	dA	0.15	cA
Cedrela fissilis	0.16	cA	0.14	dA	0.15	cA
Inga marginata	0.15	cA	0.16	dA	0.14	cA
CV (%)			1.18			
Leaf area (cm²)						
Eugenia uniflora	223.03	cC	359.20	bB	542.80	aA
Aspidosperma polyneuron	368.40	bAB	329.03	bcB	443.81	bA
Bauhinia forficata	228.00	cB	558.71	aA	212.86	cB
Cabralea canjerana	398.45	bB	508.54	aA	274.96	cC
Campomanesia xanthocarpa	444.32	bA	172.37	eB	0.02	dC
Allophylus edulis	276.65	cB	234.82	deB	550.29	aA
Cedrela fissilis	755.31	aA	332.86	bcC	565.28	aB
Inga marginata	361.80	bA	264.55	cdB	361.04	bA
CV (%)			13.89			
Root length (cm)						
Eugenia uniflora	24.35	aB	17.02	bcC	29.87	aA
Aspidosperma polyneuron	22.53	aA	26.47	aA	22.25	bA
Bauhinia forficata	11.06	cB	19.62	bA	15.74	cdA
Cabralea canjerana	16.22	bA	20.25	bA	11.53	dB
Campomanesia xanthocarpa	17.84	bA	24.02	cdA	0.02	eB
Allophylus edulis	14.29	bcB	20.90	bA	20.34	bcA
Cedrela fissilis	23.11	aA	12.38	cdB	18.75	bcA
Inga marginata	15.56	bcA	11.25	dA	13.9	dA
CV (%)			15.62			

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Continuação da tabela 2

Scientific name	No pruning		Severe pruning		Top pruning	
Root collar diameter (mm)						
Eugenia uniflora	10.43	cB	14.65	bA	10.49	cB
Aspidosperma polyneuron	15.19	bA	9.97	cC	12.39	bB
Bauhinia forficata	17.21	aA	8.25	dB	2.56	fC
Cabralea canjerana	3.52	dB	3.84	eB	5.33	eA
Campomanesia xanthocarpa	2.97	deA	1.88	fB	0.02	gC
Allophylus edulis	2.62	eC	9.16	cdB	14.97	aA
Cedrela fissilis	10.48	cB	13.9	bA	9.92	cB
Inga marginata	15.02	bB	17.87	aA	7.69	dC
CV (%)			3.72			
Aerial dry mass (g)						
Eugenia uniflora	55.94	aA	47.34	abB	42.33	cB
Aspidosperma polyneuron	33.66	dB	51.98	aA	54.54	abA
Bauhinia forficata	35.98	dB	38.24	cdB	46.95	cA
Cabralea canjerana	34.45	dB	43.76	bcA	33.56	dB
Campomanesia xanthocarpa	43.82	cA	32.88	dB	0.02	eC
Allophylus edulis	44.15	cB	52.32	aA	47.38	cAB
Cedrela fissilis	52.89	abA	38.65	cdB	49.3	bcA
Inga marginata	48.19	bcB	44.92	bcB	60.86	aA
CV (%)			9.05			
Root dry mass (g)						
Eugenia uniflora	70.14	aA	47.74	dC	57.74	bB
Aspidosperma polyneuron	49.46	deC	59.47	bC	66.67	aA
Bauhinia forficata	47.3	eB	64.5	aA	62.35	aA
Cabralea canjerana	65.72	abA	68.72	aA	52.86	cB
Campomanesia xanthocarpa	53.53	cdB	58.28	bA	0.02	fC
Allophylus edulis	45.21	eC	57.1	bA	49.49	cdB
Cedrela fissilis	56.36	cA	52.47	cA	40.43	eB
Inga marginata	61.52	bA	43.04	eB	45.96	dB
CV (%)			2.50			

*Distinct lowercase letters on lines and uppercase letter on rows in each variable differ among them by Duncan's test ($\alpha = 0.05$).

Source: primary.

Interactions were also observed for leaf area, root length and collar diameter (Table 2). The best treatments regarding to leaf area development varied: no pruning and 15 cm-height top pruning for four species, and severe pruning for two of them. The highest leaf area results were noted for *C. fissilis* (no pruning and top pruning), *B. forficata* and *C. canjerana*, with severe pruning; and for *A. edulis* and *E. uniflora*, with 15 cm-height top pruning.

Considering root length, the best treatments were top and severe pruning for four species each, and no pruning for three species. The highest root length averages were obtained by *E. uniflora* (top and no pruning), *A. polyneuron* (severe and no pruning), *C. xanthocarpa* (severe pruning) and *C. fissilis* (no pruning).

In terms of root collar diameter, the best treatments were severe and no pruning for three species each, and top pruning for two species. *Inga marginata* presented the highest values with severe pruning; *B. forficate*, with no pruning; and *A. edulis*, with top pruning.

The aerial dry mass showed the highest averages for top pruning (five species), followed by severe and no pruning (three species). The highest leaf area results were noted for *I. marginata* and *A. polyneuron*, both with top pruning; *E. uniflora* and *C. fissilis*, with no pruning; and *A. polyneuron* again and *A. edulis*, using severe pruning (Table 2).

Regarding to the highest values for root dry mass, severe pruning was the best for five species, while no pruning for four species and top pruning for just two of them. The highest averages were noted for *E. uniflora* and *C. canjerana*, with no pruning; *B. forficata* and again *C. canjerana*, with severe pruning, and again *B. forficata* and *A. polyneuron*, with top pruning.

DISCUSSION

TA suggested that post-pruning behavior differ among species, but top pruning at 15 cm-height generated higher heights with high levels of survival, although the number of sprouts seemed to be not related. McCreary & Tecklin (1993) already verified that the apex pruning at 15 cm of height on *Quercus* sp. seedlings 25-30 cm high enabled higher survival, vigor, and growth rates, as well as faster development of seedlings on field, compared to non-pruned seedlings. Larson (1975) verified that top pruning on *Quercus rubra* L. (red oak) seedlings produced more new shoots in pruned seedlings than in the unpruned ones.

One of the main goals of pruning aged saplings is to reestablish the functional balance between aerial and root parts (MCCREARY & TECKLIN, 1993; RENA *et al.*, 1998). The aerial part height is commonly used on seedlings classification and selection, and it is an easy way to measure and assess the seedling quality at the nursery stage. Too tall seedlings present imbalance between the root and aerial parts and have lower survival probability after planting, due to toppling (GOMES, 1978; JOSÉ *et al*., 2005). A good ratio between plant height and root collar diameter is necessary to guarantee the seedlings quality and field resistance.

Root collar diameter is another easily measured variable, and it is the most assessed to indicate the survival capacity of a seedling on the field. This variable, by itself or associated with height, is one of the best morphological characteristics to predict the forestry seedlings quality. The height (cm)/collar diameter (mm) ratio is an index related to plant toughness, and it is considered one of the best seedlings quality indicators, because it is precise, non-destructive and provides the information of how slim the plant is (GOMES *et al*., 2002). Thin and tall seedlings are inferior in terms of quality, compared to small and thick ones (GOMES & PAIVA, 2004; VIANA *et al*., 2008).

Overall, in TB, there was no pruning apical height to be highlighted, although 15 cm-height top pruning and severe pruning at root collar level presented higher values. It's important to consider that this test might have been influenced by the season during which pruning was conducted (pruning started on May, which corresponds to fall season in Brazil). Larson (1975) observed that late pruning reduced seedling vigor the next spring for red oak, and the author did not recommend top pruning this time of the year. Instead, he suggests adopting this practice on spring.

Each species reacted differently to each pruning treatment applied, and some species accepted two different kinds of pruning. *Eugenia uniflora* and *A. polyneuron* were the species with the best performance on most of the analyzed variables, despite the pruning management adopted. This fact is possibly related to the ability of each species to recover growth and relocate energy to produce new leaves and restart the photosynthetic activity.

Pruning on aged seedlings is a common practice to rejuvenate old seedlings of *Coffea arabica* L. Laviola *et al*. (2008) verified that pruning on the third pair of leaves on this species (the highest pruning applied) showed higher averages of total height, bud foliar area and aerial dry mass, compared to the pruning on first and second pair of leaves. Similar results were obtained by Carvalho *et al*. (2007), who confirmed that pruning was a useful technique to recover aged saplings of *C. arabica*. Also, Pereira *et al*. (2008) observed longer sprouts, higher number of leaves and foliar area on *C. arabica* when pruning was conducted after the second pair of leaves. However, a negative effect of pruning on root system may occur due to less photosynthetic activity, which does not generate the necessary carbohydrates to guarantee its growth (CARVALHO & CALDANI, 1984).

Besides being a rejuvenation potential method for seedlings, drastic pruning is also efficient on controlling fungal diseases on the aerial part. The technique is usually used on fruit cultivation, such as vines, apples, and olives (SALOMÃO *et al*., 2018). Another advantage of this method is to avoid the disposal of these plants, which reflects in economic and silvicultural costs, such as yield and quality (SOSNOWSKI *et al*., 2012).

CONCLUSION

The native tree species analyzed showed good tolerance to pruning in both experiments. Therefore, pruning at nurseries is a recommended strategy to retake growth and achieve a better height/diameter ratio in most native tree species and, probably, increase survival on the field, especially in tropical degraded areas to be reforested. Besides, studies about the regrowth behavior of pruned native tree saplings on the field are suggested. Finally, the results obtained here may be related to the conditions of the nurseries, the genetic characteristics, and the time of year when the pruning was carried out, which, together, should also be better investigated in future studies.

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