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Biology-botany

Selection of *Cordia trichotoma* Vell. clones for adventitious rooting and determination of the plantlet quality produced by mini-cuttings

Seleção de clones de *Cordia trichotoma* Vell. para enraizamento adventício e determinação da qualidade de mudas produzidas por miniestaquia

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ABSTRACT

This study aimed to evaluate and define strategies for the selection of *C. trichotoma* clones with competence for adventitious rooting and production of high-quality plantlets by mini-cuttings. For adventitious rooting, mini-cuttings were treated with 3,000 mg L^{-1} of indole butyric acid and grown in 110 cm^3 tubes, consisting of equal proportions of the commercial substrate and vermiculite. The percentage of rooting, number of roots, and mini-cuttings rooted per mini-stump were evaluated after 30 days of cultivation in a humid chamber. The rooted mini-cuttings were transferred to a shade house and the survival percentage, stem diameter, height, and number of leaves were evaluated at 120 days. Data were analyzed using the restricted maximum likelihood/best linear unbiased prediction (REML/BLUP) method and Pearson´s correlation analysis. The number of rooted mini-cuttings and stem diameter presented the highest repeatability and accuracy values for rooting and plantlet growth, respectively. These traits also presented significant positive correlation estimations with others, indicating the possibility of indirect selection gain. *Cordia trichotoma* clones can be selected for vegetative propagation, considering the number of rooted mini-cuttings and the stem diameter of the plantlets produced by mini-cutting. Early selection for adventitious rooting and plantlet quality can aid in genetic improvement programs for the development of new cultivars for vegetative propagation via the use of mini-cuttings.

Keywords: Forest Improvement; Genetic gain; Mini-cuttings; REML/BLUP; Vegetative propagation

RESUMO

Os objetivos deste estudo foram avaliar e definir estratégias para a seleção de clones de *Cordia trichotoma* com competência para o enraizamento adventício e que resultem na produção de mudas por miniestaquia de alta qualidade. Para o enraizamento adventício, miniestacas foram tratadas com 3,000 mg L^{-1} de ácido indolbutírico e plantadas em tubetes de 110 cm^3, contendo iguais proporções de substrato comercial e vermiculita. Foram avaliadas a porcentagem de enraizamento, o número de raízes e de miniestacas enraizadas por minicepa aos 30 dias de cultivo em câmara úmida. As miniestacas enraizadas foram transferidas para casa de sombra e as mudas foram avaliadas para a porcentagem de sobrevivência, o diâmetro do colo, a altura e o número de folhas aos 120 dias de cultivo. Os dados foram analisados pelo método de máxima verossimilhança residual ou restrita e melhor predição linear imparcial (REML/BLUP) e correlação de Pearson. Foram observadas diferenças significativas para todos os caracteres de enraizamento e qualidade de muda, com exceção da altura e do número de folhas. Para o enraizamento, o número de miniestacas enraizadas apresentou os maiores valores de repetibilidade e acurácia, enquanto que para o crescimento das mudas foi para o diâmetro do colo. Esses mesmos caracteres apresentaram estimativas positivas e significadas de correlação linear com os demais, indicando a possibilidade de ganhos indiretos de seleção. Clones de *C. trichotoma* podem ser selecionados para propagação vegetativa, considerando o número de miniestacas enraizadas e o diâmetro do colo das mudas produzidas por miniestaquia. A seleção precoce para enraizamento adventício e a qualidade de muda pode contribuir nos programas de melhoramento genético para o desenvolvimento de cultivares para a propagação por miniestaquia.

Palavras-chave: Melhoramento Florestal; Ganho genético; Miniestacas; REML/BLUP; Propagação vegetativa

1 INTRODUCTION

The lack of information on the silviculture of native tree species for commercial purposes presents an obstacle to the diversification of raw materials in the forestry sector. It maintains an indirect dependence of exotic species with available silvicultural information for cultivar development, with most traits associated with a well-defined and established production chain. However, technological advances applied to the genetic improvement of native forest species seek to fill this gap, providing significant genetic gains for different traits and enabling the planting of these species on a large scale (Plath et al., 2011). It should be noted that the proper establishment of forest plantations is directly related to the quality of the genetic material and the produced seedlings, giving maximum yield when they become well adapted to the local ecological conditions (Oda et al., 2006).

One such native species with high economic potential is *Cordia trichotoma* (Boraginaceae), which is one of the best hardwoods available in Brazil, with easy workability and good durability (Zimmermann et al., 2017; Albuquerque et al., 2020). Density of 0.78 g cm^{-3}, little distinction between heartwood and sapwood, and a yellow-brown coloration make *C. trichotoma* valuable and useful in many applications, such as its use in the construction of luxury works, fine furniture, beams, frames, rafters, wainscoting, parquet, and shutters (Zimmermann et al., 2017).

Another factor that favors the establishment of forest plantations of *C. trichotoma* is its prevalence in Brazil, ranging from Ceará to Rio Grande do Sul in the deciduous and semi-deciduous seasonal forests, allowing it to be widely used in commercial plantations throughout the country (Albuquerque et al., 2020). The species also occurs naturally in Argentina, Bolivia, Paraguay, and Uruguay (Berghetti et al., 2021).

The propagation of *C. trichotoma* is usually carried out by seeds, which need to be sown soon after ripening, as they can lose viability when stored for long periods. The seeds of this species are frequently affected by pests, which feed on the endosperm, a nutritive tissue essential for seedling development. Thus, vegetative propagation by mini-cutting can be an alternative to contribute to the mass production of *C. trichotoma* plantlets, as already employed for exotic forest species.

Mini-cutting is a viable technique for vegetative propagation, as mini-cuttings are more responsive to adventitious rooting, especially when produced from the mini-stumps of young seedlings (Dias et al., 2012). This technique makes it possible to increase the rooting rates and the quality of the root system, and to reduce the time for plantlet growth and development. However, it is necessary to consider that the adventitious rooting process is a quantitative and complex process involving various genetic and environmental components (de Almeida et al., 2017).

The existence of a strong genetic component that controls adventitious rooting enables improvement and selection gains for traits related to vegetative propagation. In addition to selecting clones for adventitious rooting, plantlet quality is also an important step for vegetative propagation, as it can positively influence the production, development, and survival rate of plants in the field. Furthermore, the evaluation of plantlet quality must consider traits of the aerial part of the root system, the relationship between aerial parts and roots, and other traits associated with the success of field establishment of plants (Gasparin et al., 2014).

Considering the importance of the rhizogenic process and the quality of the plantlets for the selection of superior clones, the aim of this study was to evaluate and define strategies for the selection of *C. trichotoma* clones with competence for adventitious rooting and production of high-quality plantlets by mini-cuttings.

2 MATERIALS AND METHODS

This study was carried out at the Plant Breeding and Vegetative Propagation Center of the Federal University of Santa Maria, Santa Maria, RS. Twelve clones of *C. trichotoma* (13SM01, 13SM06, 13SM07, 13SM09, 13SM10, 13SM15, 13SM16, 13SM17, 13SM18, 13SM25, 13SM26 and 13SM32) were evaluated, which were established in a mini-clonal garden in closed cultivation system without soil, using thick sand as the substrate (Bisognin et al., 2015). From each clone, 12 plantlets produced by vegetative propagation were established (Bisognin et al., 2020a) in a polyethylene tray (55 × 34 × 15 cm), with a spacing of 10 × 10 cm (Kielse et al., 2015). After establishment, the plantlets were subjected to drastic pruning to form mini-stumps, which produced the shoots that were used for the preparation of mini-cuttings.

Macro and micronutrients were supplied via a complete nutrient solution described by Kielse et al. (2015) twice a day for 15 min, with the aid of a digital programmer and a submerged low-flow pump, until the substrate was completely drained. The pH of the solution was kept between 5.5 and 6.0 and the electrical conductivity at 1.5 dS m^{-1}; both were adjusted on a weekly basis.

The experiments were carried out between November 2018 and February 2021 with six shoot collections. Based on preliminary experiments, two-bud and multiplebud apical mini-cuttings, with leaves reduced to 50% of the original area, were evaluated. A hydroalcoholic solution of indole butyric acid (IBA) at a concentration of 3,000 mg L^{-1} was applied to the basal portion of the mini-cuttings by immersion for 10 s (Somavilla, 2018). Mini-cuttings were then cultivated in polypropylene tubes with longitudinal grooves and a volume of 110 cm^3, containing commercial substrate based on pine bark and vermiculite in a ratio of 2:1 (v/v).

Mini-cutting rooting was carried out for 30 days in an automated humidity chamber (HUMITECH III) at an average temperature of 32 °C, with nebulization every 30 min for 10 s, between 7:00 AM and 7:00 PM. After 30 days of cultivation, the mini-cuttings were evaluated for the percentage of rooting, number of roots, and number of rooted mini-cuttings per mini-stump. Mini-cuttings were considered rooted when they had at least one root, which was at least 0.1 cm long.

To assess the quality of the plantlets, the rooted mini-cuttings were transferred to a shade house, including covered and closed sides with a 50% solar permeability screen, equipped with automated irrigation twice a day for 15 min. The plantlets also received monthly cover fertilization, in the proportion of 1,000 g of ammonium sulfate and 300 g of potassium chloride per 100 L of water (Valeri and Corradini, 2005). Plantlets were evaluated at 120 days of cultivation for their percentage of survival, stem diameter (mm), shoot height (cm), and number of leaves.

One of the analyses was the Pearson linear correlation between all the rooting and plantlet quality-evaluated traits. The linear correlation between traits helps to define which traits should be considered in the direct and indirect selection of *C. trichotoma* clones for the vegetative propagation via mini-cutting. This analysis was performed using the RBio statistical software (Bhering, 2017).

The variance components were estimated by restricted maximum likelihood (REML) and the prediction of phenotypic and genotypic values was performed using best linear unbiased prediction (BLUP) method. For the analyses, the mean data of the evaluated traits for adventitious rooting and plantlet quality were used. These analyses were performed with the SELEGEN–REML/BLUP software, using the basic repeatability model, which is indicated when the collected data are repeated on individual plants, without the use of an experimental design (Resende, 2016). The model used consists of y = Xm + Wp + e, where "y" is the data vector, "m" is the vector of the measurement effects (assumed to be fixed) added to the overall mean, "p" is the vector of the permanent effects of plants (genotypic effects + permanent environment effects) (assumed to be random), and "e" is the vector of errors or residuals (random). Capital letters represent the incidence matrices of these effects (Resende, 2007). The significance of the model was determined via deviance analysis and the maximum likelihood ratio test (LRT). The deviances were predicted using the model with and without the respective effects, subtracting the deviance obtained in the complete model from the model without the effect, and comparing it to the chi-square value (χ^2), with one degree of freedom.

The average components (individual BLUPs), based on the permanent phenotypic effect of the 12 evaluated clones of *C. trichotoma*, were obtained to classify and identify superior clones for adventitious rooting and plantlet quality. The genotypic values of each clone were obtained by adding each genotypic effect to the overall mean of the experiment. The relative performance of each clone was determined by the relationship between the means of the improved population and the clone with the highest genetic value. The phenotypic values of each clone were added to a list corresponding to the values observed in the experiment. The selection was based on clones that presented a relative performance above 80%.

With the identification of the best clones, the selection genetic gain was calculated by subtracting the improved mean from the original observed mean. The genetic gain was equivalent to the mean of the predicted genetic effect vectors for each selected clone. The overall average added to the genetic gain resulted in an average for the improved population. The selection gains (G) and percentages (G%) were calculated using the following formulas: e , where MCS is the mean of the selected clones and MCO is the original mean observed.

3 RESULTS AND DISCUSSION

The clonal selection of *Cordia trichotoma* was based on REML/BLUP method, which is a standard procedure for estimating genetic parameters and optimizing the selection process in various species (Resende, 2016), including perennial ones. The main advantages of using this procedure are the possibility of comparing individuals or clones over time and space, the ability to simultaneously correct for environmental effects, estimation of variance components, prediction of genetic values, possibility of dealing with complex data structures, and the application to unbalanced data and non-orthogonal designs. Among the available models for this methodology, the repeatability model allows the establishment of the number of phenotypic observations necessary for selecting clones in an efficient way within a specific period of time (Cruz, & Regazzi, 2001). Repeatability consists of measuring the phenotype of the same clone over a period of time (Resende, 2015). Furthermore, this coefficient allows the evaluation to be carried out efficiently in a short time period with minimum labour usage (Bruna et al., 2012).

The deviance analysis showed a significant effect for the evaluated traits ($p<0.01$, $p<0.05$), both for adventitious rooting and plantlet quality (Table 1). With the exception of height and number of leaves, the complete model was the most suitable for adjusting the data of all other evaluated traits, indicating that the clone effect is useful for determining the trait under study. Furthermore, the likelihood principle (LRT) shows the existence of genetic variability or genotypic differences among the evaluated clones, which, in turn, indicates the possibility of obtaining gains from selection of the best clones of *C. trichotoma* (Sanchéz et al., 2017). On the other hand, the height and number of leaves were not significantly affected by the clone because of the lack of differentiation between the complete and reduced models.

Table 1 – Deviance values and estimates of genetic parameters for the percentage of mini-cutting rooting (R%), number of roots per mini-cutting (NR) and number of rooted mini-cuttings per mini-stump (NM) at 30 days of cultivation in the humidity chamber as well as the survival (S%), stem diameter (D, mm), height (H, cm), and number of leaves (NL) at 120 days of cultivation in the shade house, in six evaluations of 12 clones of *Cordia trichotoma*

Effect	**Adventitious rooting**			**Plantlet quality**			
	R %	**NR**	**NM**	**S %**	**D**	**H**	**NL**
Permanent	620.24	60.57	130.10	583.32	-0.70	198.33	100.79
Full model	607.60	48.79	111.60	573.23	-10.87	197.59	100.72
LRT[1]	12.64**	11.78**	18.50**	10.09**	10.17**	0.74^{ns}	1.00^{ns}
Parameters[2]							
Vpp	91.53	0.15	0.43	153.81	0.09	0.36	0.025
Vte	246.21	0.43	0.85	418.52	0.20	4.57	1.24
Vp	337.74	0.58	1.29	572.33	0.29	4.93	1.27
$r = h^2$	0.27 ± 0.15	0.26 ± 0.15	0.34 ± 0.17	0.27 ± 0.16	0.30 ± 0,71	0.07 ± 0.08	0.02 ± 0.04
Rm	0.75	0.74	0.80	0.72	0.75	0.35	0.12
Acm	0.86	0.86	0.89	0.85	0.87	0.59	0.35
General mean	38.81	2.44	1.68	60.53	1.70	4.97	1.98

[1]Maximum likelihood ratio test Significant at *0.05 and **0.01 probability by χ^2 test with 1 deg of freedom; ns: not significant. [2]Vpp: permanent phenotypic variance among plants (genotypic variance plus permanent environment variance over crop seasons). Vte, temporary environment variance; Vp, individual phenotypic variance; $r = h^2$, individual repeatability and its confidence interval; rm, repeatability of the average of crop seasons or repeated measures; Acm: selection accuracy based on the average of m crop seasons or repeated measures.

Source: Authors' (2021)

The estimates of the variance components (Table 1) indicate that a large part of the individual phenotypic variance (Vp) corresponded to the temporary variance of the environment (Vte) for all evaluated traits. This shows that *C. trichotoma* clones respond differently to environmental variations resulting from different samplings, both during adventitious rooting and plantlet growth in the greenhouse. These varied responses can be explained by the different concentrations of phytoregulators and primary metabolites that interact with the environment to regulate in time and space the steps of the complex adventitious rooting process (Taiz, & Zeiger, 2013; Lakehal,

& Bellini, 2019). This information shows the possibility of selecting more stable clones throughout the year for adventitious rooting, or less affected by environmental variations, which is essential for the mass production of plantlets. These results are in agreement with those observed in *Cabralea canjerana* (Burin et al., 2020) and *Ilex paraguariensis* (Pimentel et al., 2019) in where significant differences in the competence for adventitious rooting of clones occurred between mini-cutting samplings.

The permanent variance between plants, which contains the genotypic variance, of the number of mini-cuttings rooted per mini-stump corresponded to 33.3 % of the individual phenotypic variance (Vp), which was relatively higher than the percentage of rooting (27.1%) and number of roots (25.9%) (Table 1). Furthermore, individual repeatability or heritability was moderate (r=0.339) for the number of rooted mini-cuttings, compared with the heritability considered of low magnitude for the percentage of rooting (r=0.271) and for the number of roots (r=0.260) (Resende, 2015). These results show that it is possible to select clones based on the number of rooted mini-cuttings during the adventitious rooting process, which corroborates the results obtained by Burin et al. (2020) and Pimentel et al. (2019).

Through the individual repeatability coefficient (r), it is possible to predict the ability of clones to express a trait similarly over time, which is nothing more than phenotyping the same clone repeatedly under different conditions over time (Resende, 2015). Furthermore, as heritability informs about the genetic control of a trait, the greater the heritability, the greater the genetic control, which indicates greater ease in carrying out the improvement of that trait, expresses confidence, and serves as a reference for the phenotypic value of genetic control (Cruz, & Regazzi, 2001).

In the evaluation of growth and quality of *C. trichotoma* plantlets produced by mini-cutting, the traits with the highest proportion of genotypic variance in relation to individual phenotypic variance were observed for survival percentage and diameter (Table 1). Heritability estimates were of low and moderate magnitudes for survival percentage and diameter, respectively (Resende, 2015). Thus, the diameter of the plantlets has greater genetic control and greater ability to repeat its expression over time compared to the other evaluated traits.

The selection accuracy characteristics based on the mean of repeated measures (Acm) presented in this study were of high magnitude (Resende, 2016) for all traits, except for height and number of plantlet leaves. The highest Acm values were observed for the number of rooted mini-cuttings (0.896) and diameter (0.867), values that represent high reliability in the evaluation, and in the predicted genetic value for a given clone. Accuracy estimation depends on the repeatability and heritability values of the selected character, as well as on the quantity and quality of information and procedures used in the prediction of genetic values (Bruna et al., 2012). The greater the selection accuracy, the greater the confidence in the evaluation and in the predicted genetic value for the clone, as this measure is associated with selection accuracy and refers to the correlation between predicted and true breeding values of a clone (Pimentel et al., 2014). Therefore, the high estimates of selection accuracy show that the selection of *C. trichotoma* clones for rooting competence and plantlet quality should be carried out based on the number of rooted mini-cuttings and stem diameter, respectively.

The linear correlation analysis showed positive and significant ($p<0.05$) correlation estimates between traits related to mini-cutting rooting, and between those related to plantlet quality of *C. trichotoma* (Table 2). This confirms the indication of accuracy estimates that indicated that the selection of clones should be carried out based on the number of rooted mini-cuttings and stem diameter. These results indicate that indirect genetic gains will be obtained for the percentage of rooting, number of roots per mini-cutting, and percentage of survival and height of *C. trichotoma* plantlets produced by mini-cutting.

Table 2 – Pearson's correlation estimations for the percentage of mini-cuttings rooting (R%), number of roots per mini-cuttings (NR), and number of rooted mini-cuttings per mini-stump (NM) at 30 days of cultivation in the humidity chamber as well as the survival (S%), stem diameter (D, mm), height (H, cm), and number of leaves (NL) at 120 days of cultivation in the shade house in six evaluations of 12 clones of *Cordia trichotoma*

Traits	**Adventitious rooting**			**Plantlet quality**		
	R %	**NR**	**NM**	**S %**	**D**	**H**
NR	0.852*					
NM	0.593*	0.492*				
S (%)	0.104ns	0.077ns	0.092ns			
D	0.178ns	0.120ns	0.031ns	0.920*		
H	0.323*	0.288*	0.117ns	0.662*	0.789*	
NL	0.154ns	0.085ns	0.007ns	0.603*	0.630*	0.665*

* Significant at 5% probability of error, Student's t-test; ns = not significant

Source: Authors' (2021)

An important aspect is that when the rooting is correlated with the quality of the plantlet, the number of rooted mini-cuttings and the diameter did not present a significant correlation with each other (Table 2). In contrast, height was significantly correlated with the rooting percentage and number of roots. This result is interesting, as it demonstrates a balance between rooting and plantlet quality, an important factor for the production of plantlets with great vigor and quality for new forest plantations. Furthermore, plantlets with well-developed root systems are likely to have higher survival rates, both in nurseries and during field establishment, in addition to having more vigorous and rapid development, which reduces mortality losses.

These results are in agreement with those obtained in *Ilex paraguariensis*, for which linear correlation estimates indicate that the number of rooted mini-cuttings per mini-stump can be used to identify clones with high adventitious rooting competence (Gazzana et al., 2020). Similarly, the number of rooted mini-cuttings in *Cabralea* *canjerana* showed a high and positive correlation with the percentage of rooting (Burin et al., 2020). High correlation estimates between traits associated with plantlet quality were also observed in *Myrocarpus frondosus*, indicating that indirect selection gains are expected (Bisognin et al., 2020b). The strategy of selecting for a trait (in this case, for the number of rooted mini-cuttings and diameter) and providing indirect gains for other associated traits with adventitious rooting and the quality of the produced plantlets maximizes efficiency, facilitating and simplifying the process of selection of clones of *C. trichotoma* for vegetative propagation by mini-cutting. Furthermore, studies combining selection for vegetative propagation via mini-cutting, simultaneously considering adventitious rooting and quality of produced plantlets, were not found in the literature to date.

The average components estimated for the number of rooted mini-cuttings and stem diameters were used to classify and select the clones of *C. trichotoma*. For adventitious rooting, clones 13SM01, 13SM09, 13SM10, 13SM15, 13SM17, and 13SM26 showed relative performance above 80% (Table 3), which corresponds to 50% of the selected clones. When considering the diameter, all clones presented a relative performance above 80% and, by this criterion, they could be selected based on the quality of the plantlets produced by mini-cutting.

It is important to select superior individuals for the two stages of vegetative propagation, as clones that have high multiplication rates combined with good quality of the produced plantlets can be used to enable vegetative propagation. Therefore, considering these two traits, six superior clones were identified (13SM01, 13SM09, 13SM10, 13SM15, 13SM17, and 13SM26) that allowed a selection gain of 30.3% for the number of rooted mini-cuttings and 8.4% for stem diameter (Table 4). The selection gain values observed during the first stage of vegetative propagation were considered satisfactory. For *Ilex paraguariensis,* the genetic gain has been estimated at 48.4% for the number of mini-cuttings rooted per mini-stump (Gazzana et al., 2020). For *Myrocarpus frondosus*, on the other hand, selection for height resulted in a genetic gain of 15.1%

(Bisognin et al., 2020b).

Table 3 – Permanent phenotypic effect (Pp), permanent phenotypic value (u+Pp), genetic gain (GS), new mean (Nm), and relative performance in percentage (DR) of the ordering of *Cordia trichotoma* clones for adventitious rooting competence obtain from the character of mini-cuttings rooted by mini-stump and to determine the quality of the plantlet by the stem diameter

Clones	Rooted mini-cuttings per mini-stump					Stem diameter				
	Pp	u + *Pp*	GS	Nm	DR	Pp	u + Pp	GS	Nm	DR
13SM01	0.85	2.53	0.89	2.57	98.3	0.2	2.06	0.20	2.06	100.0
13SM06	-0.75	0.93	0.07	1.75	67.0	-0.12	1.74	0.04	1.90	92.4
13SM07	-0.32	1.36	0.23	1.91	72.8	-0.27	1.59	0.00	1.86	90.4
13SM09	0.05	1.73	0.48	2.16	82.5	0.18	2.04	0.19	2.05	99.6
13SM10	0.11	1.79	0.57	2.24	85.8	0.11	1.97	0.17	2.03	98.5
13SM15	0.2	1.89	0.68	2.36	90.1	0.02	1.88	0.12	1.98	96.4
13SM16	-0.48	1.2	0.16	1.84	70.1	0.18	2.04	0.19	2.05	99.4
13SM17	0.94	2.62	0.94	2.62	100.0	-0.11	1.75	0.06	1.92	93.3
13SM18	-0.27	1.41	0.29	1.97	75.4	-0.07	1.79	0.08	1.94	94.3
13SM25	-0.81	0.87	0	1.68	64.2	-0.14	1.72	0.02	1.88	91.6
13SM26	0.72	2.4	0.84	2.51	96.1	-0.02	1.84	0.10	1.96	95.4
13SM32	-0.25	1.43	0.38	2.06	78.5	0.05	1.91	0.14	2.00	97.4

Source: Authors' (2021)

Table 4 – Overall average, improved average, total selection gain, and selection gain (%) for the number of rooted mini-cuttings per mini-stump and stem diameter of the *Cordia trichotoma* clones

Parameters	Rooted mini-cuttings per mini-stump	Stem diameter (mm)
Overall average	1.7	1.9
Improved average	2.4	2.0
Selection gain	0.5	0.1
Selection gain (%)	30.3	8.4

Source: Authors' (2021)

Based on the results obtained in this study, the traits related to adventitious rooting presented a satisfactory genetic control, mainly for the number of rooted mini-cuttings with moderate heritability, which facilitates its use in breeding programs for vegetative propagation via mini-cutting. It can be inferred that the mini-cuttings that present good rhizogenic development during the rooting process, a fundamental step for the production of plantlets, will possibly result in plantlets exhibiting better growth in a greenhouse, with increased chances of survival in the field. Therefore, the selection for adventitious rooting based on the number of rooted mini-cuttings per mini-stump and for plantlet quality based on the stem diameter can be used in genetic improvement programs of *C. trichotoma* for vegetative propagation via mini-cutting to obtain satisfactory selection gains.

4 CONCLUSIONS

C. trichotoma clones can be selected for vegetative propagation, considering the number of rooted mini-cuttings and the stem diameters of the plantlets produced by mini-cutting. Early selection for adventitious rooting and plantlet quality can be used in genetic improvement programs for the development of new cultivars for propagation via mini-cutting.

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