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METHODS OF PREPARING PROPAGULES FOR TROPICAL WOODY BAMBOO SPECIES

Erick Martins Nieri[1*], Rodolfo Soares de Almeida[2], Lucas Amaral de Melo[2], Rafael Torres Cartolano[2]

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ABSTRACT - The production of seminal bamboo seedlings is considered not viable, being this the biggest limiting factor. The tissue culture and minicutting are efficient, but very costly techniques, which makes it necessary to search for alternative techniques, such as propagation through culm sections. In this context, the objective of this study was to evaluate the efficiency of three methods of vegetative propagation with segments of the culm of the species *Bambusa vulgaris, B. variabilis, B. tuldoides and Dendrocalamus giganteus*. The experiment was carried out in a randomized block design, factorial scheme of four (4) species (*Bambusa vulgaris, B. variabilis, B. tuldoides and Dendrocalamus giganteus*) and three (3) methods of preparing the propagule (a single node, binodal propagule, and binodal propagule + H 2 O), with four replicates and plots of five propagules. The propagules were deposited in shallow pits kept in field conditions. At 45 days, the percentage of shoots was measured and analyzes of variance and Tukey were performed at 5% error probability. For *D. giganteus*, none of the methods of preparing the propagules proved to be efficient for their propagation. The species *B. vulgaris, B. variabilis and B. tuldoides* showed higher percentages of sprouting. The method of preparing propagules with a single node was more efficient for *B. variabilis, B. vulgaris and B. tuldoides*.
Keywords: *Bambusa, Dendrocalamus,* macropropagation, propagation, Stem segmentation.

MÉTODOS DE PREPARO DE PROPÁGULOS PARA ESPÉCIES DE BAMBUS LENHOSOS TROPICAIS

RESUMO - A produção de mudas seminais de bambus é considerada pouco viável, sendo este o maior fator limitante. A cultura de tecidos e a miniestaquia são técnicas eficientes, porém muito onerosas, o que torna necessário a busca por técnicas alternativas, como a propagação por meio de secções dos colmos. Diante deste contexto, o objetivo deste estudo foi avaliar a eficiência de três métodos de propagação vegetativa com segmentos do colmo das espécies *Bambusa vulgaris, B. variabilis, B. tuldoides e Dendrocalamus giganteus*. O experimento foi conduzido em delineamento em blocos casualizados, esquema fatorial de quatro (4) espécies (*Bambusa vulgaris, B. variabilis, B. tuldoides e Dendrocalamus giganteus*) e três (3) métodos de preparo do propágulo (um único nó, propágulo binodal, e propágulo binodal + H_2O), com quatro repetições e parcelas de cinco propágulos. Os propágulos foram depositados em covas rasas mantidos em condições de campo. Aos 45 dias, mensurou-se a porcentagem das brotações e foram procedidas as análises de variância e Tukey a 5% de probabilidade do erro. Para o *D. giganteus* nenhum dos métodos de preparo dos propágulos se mostrou eficiente para a sua propagação. As espécies *B. vulgaris, B. variabilis e B. tuldoides* apresentaram maiores percentuais de brotação. O método de preparo dos propágulos com um único nó foi mais eficiente para a *B. variabilis, B. vulgaris e B. tuldoides*.
Palavras-chaves: *Bambusa, Dendrocalamus,* macropropagação, propagação, segmentação de colmo.

INTRODUCTION

The *Bambusa* and *Dendrocalamus* genera are known as fast growing tropical woody bamboos, have versatile use, short production cycle and long vegetative life (LIMA NETO et al., 2009; PARMA et al., 2016). These characteristics combined with the demand for clean and renewable technologies that favor sustainable agriculture strengthen the importance of using and improving vegetative propagation techniques for the production of quality seedlings (HOSSAIN et al., 2018).

The production of seminal bamboo seedlings is considered not viable, being the biggest limiting factor, since most species have a long cycle for flowering, a large amount of sterile seeds, with low viability, which makes vegetative propagation the technique preferable when the intention is large-scale production (SINGH et al., 2013).

Tissue culture and mini-cutting are techniques that allow the production of high-quality and high-quantity bamboo seedlings. However, this technique is in development, and has a high cost, more technological structures, which makes access to rural producers difficult. For this reason, vegetative propagation through the rooting of cuttings and stems is a traditional and fast method for the production of seedlings by rural producers (BRAGA et al., 2017).

[1]Universidade Federal do Sul e Sudeste do Pará (Unifesspa), Instituto de Estudos do Xingu, São Félix do Xingu, Pará, Brazil. E-mail: ericknieri@unifesspa.edu.br. *Correspondenting author.
[2]Universidade Federal de Lavras (UFLA), Lavras, Minas Gerais, Brazil

To meet the demand for seedling production, the sections of stems, side branches and or rhizomes can be used for the propagation of the genera *Bambusa* and *Dendrocalamus* (ARAUJO et al., 2015; RIBEIRO et al., 2016). From the culm sections present in the bamboo, the portions for reproductive production can be removed from the basal, median and apex of the plant. However, the recommendation for producers is to remove the knots from the basal and median portions of the stem, as these are more youthful sections from an ontogenetic point of view and have less differentiated cells and with greater capacity to return to a meristematic stage, facilitating cell differentiation in other tissues, as well as roots (RICKLI et al., 2015; BRAGA et al., 2017).

The propagation through culm sections and internodes with buds without the use of rooting regulators are questions to be addressed scientifically to corroborate and validate the best method of preparing the propagule for the propagation of bamboo proposed by Braga et al. (2017). In this context, the objective was to evaluate the efficiency of vegetative propagation from *culm* segments of the species *Bambusa vulgaris, B. variabilis, B. tuldoides and Dendrocalamus giganteus*.

MATERIAL AND METHODS

The experimental area is located in the southern region of Minas Gerais, under geographical coordinates of 21º13'40" S and 44º58'11" W at an altitude of 920 m. The region's climate is classified, according to Köppen, as *Cwa*, with an annual average temperature of 20.4ºC and annual precipitation of 1460 mm (ALVARES et al., 2013). The experimental soil is classified as Latossolo Vermelho with a clay texture (66% clay) (EMBRAPA, 2013).

The soil preparation was carried out by harrowing in a total area and scarification with the opening of furrows 20 cm deep. Tropical woody bamboos were collected using a chainsaw close to the study area, located at the geographic coordinates: *Bambusa vulgaris* (21º13'29.4" S 44º58'01.9" W), *B. variabilis* (21º13'40.6" S 44º58'25.6" W); *B. tuldoides* (21º13'40.4" S 44º58'25" W) and *Dendrocalamus giganteus* (21º13'37.8" S 44º58'19" W). After being collected, they were kept in polystyrene boxes with ice and water, in less than 20 min. until planting.

The culm preparation consisted of pruning and sectioning, taking into account the number of nodes in each section. The sections were divided into propagules with a single node (PM1), propagules containing two nodes (PM2) and propagules containing two nodes with the inter-node filled with mineral water (PM3) (Figure 1). The planting took place in the rainy season (December), with the propagules allocated in a horizontal position and covered with a 5 cm layer of soil. Subsequently, irrigation was carried out, providing 1 L of water for each propagule.

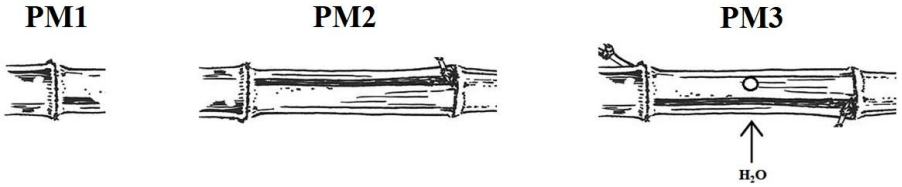

FIGURE 1 - Representation of the methods of preparing the propagules of *Bambusa vulgaris*, *Bambusa variabilis*, *Bambusa tuldoides* and *Dendrocalamus giganteus* being propagules with a single node (PM1), propagules containing two nodes (PM2) and propagules containing two nodes with the node filled with the node filled with mineral water (PM3). Source: Nieri et al. (2020).

The experiment was carried out in a complete randomized block design, in a 4 x 3 factorial scheme, with four replications of five propagules per plot. The first factor consisted of the four species, while the second factor consisted of the methods of preparing the propagules. At 45 days after planting, enough time to verify the emergence and growth of sprouts (BRAGA et al., 2017), the percentage of sprouting of propagules for each species was evaluated.

The obtained data were submitted to the Shapiro-Wilk normality test (p <0.05) and to the Barttlet homogeneity test of variance, afterwards the data were submitted to analysis of variance. When the effects were significant, the Tukey test was applied, with a 5% probability of error. All analyzes were performed using the Sisvar *software* (FERREIRA, 2019).

RESULTS AND DISCUSSION

Table 1 presents the results of the analysis of variance for the sprouting percentage data for the four tropical woody bamboo species as a function of the three propagation methods, 45 days after planting. The results of the analysis of variance show that there was a significant interaction between the four species of tropical woody bamboo and the three methods of preparing the propagules, making it necessary to carry out the necessary splits (Table 2).

When comparing the methods of preparing propagules within each species, it appears that the species of *Bambusa vulgaris, B. tuldoides* and *Dendrocalamus giganteus* did not show any significant difference. However, for *B. variabilis*, the method of preparing the propagules using a single node provided budding percentages higher than the other methods. These results are similar to those found by Braga et al. (2017), who

studied different methods of preparing propagules for *B. vulgaris*, obtained a higher percentage of rooting for propagules with a single node.

The method of preparing propagules containing a single node for *Bambusa variabilis* (62.50%) was more effective and showed superior results to the species of *B. vulgaris* (43.70%), *B. tuldoides* (12.50%) and *Dendrocalamus giganteus* (0.00%). This method has as advantages the greater use of the planting area or production of seedlings, since the smaller size of the propagules makes it possible to implant them in smaller spaces. The smaller size of the propagules also provides operational facilities for transporting and planting them. Palanisamy and Bisen (2001) reinforce that single node cuttings present a simple and excellent cost-effective preparation process when compared to propagules based on culm cuts with double nodes, since they produce twice as many propagules.

TABLE 1 - Summary of the analysis of variance for the sprouting percentage of the species *Bambusa vulgaris, B. variabilis, B. tuldoides* and *Dendrocalamus giganteus* and three methods of preparing the propagules, 45 days after planting.

Variation Font	Degrees of freedom	Medium squares
Bamboo species (BS)	3	0,367**
Propagation methods (PM)	2	0,030*
Block	3	0,028*
BS x PM	6	0,057**
Error	33	0,008
Coefficient of variation (%)		37,90
Overall mean (%)		24,80

*Significant at 5% probability of error, by the F test, ** Significant at 1% probability of error, by the F test.

TABLE 2 - Sprout percentage of tropical woody bamboo species for each method of preparation of the propagule and of these for each species, at 45 days after planting.

Bamboo species	Propagation methods		
	PM1 (%)	PM2 (%)	PM3 (%)
Bambusa vulgaris	43,70 Ba*	31,20 Aa	28,10 Aa
Bambusa variabilis	62,50 Aa	25,00 Ab	37,50 Ab
Bambusa tuldoides	12,50 Ca	28,10 Aa	25,00 Aa
Dendrocalamus giganteus	0,00 Ca	0,00 Ba	5,00 Ba

*Averages followed by the same capital letter, in the column and lower case in the line, do not differ, by Tukey's test, at 5% probability of error. PM1 = propagule with a single node, PM2 = propagule with two nodes, PM3 = propagule with two nodes, with the inter-node filled with water.

When comparing the methods of preparing propagules containing two nodes (PM2 and PM3), it is noted that for the species of *Bambusa vulgaris*, *B. variabilis* and *B. tuldoides*, the percentage of sprouting was higher than that of *Dendrocalamus giganteus*, which depicts a similar behavior of the methods. The filling with mineral water in the internode (PM3) showed no significant difference in relation to PM2. This result demonstrates that the use of PM3 is optional, however, this method has a major disadvantage in its implementation and implementation in the field. However, Drumond and Wiedman (2017) recommend the use of a propagule with two or three nodes. Rasvi et al. (2015), however, suggest the use of binodal propagule (with two nodes) without the use of growth promoters for the propagation of *D. giganteus*.

The seasonal variation in the conduct of shoots and bamboo seedlings affects the rates of rooting and sprouting, according to Rasvi et al. (2015) in their work with cuttings from the branches of *Dendrocalamus giganteus* observed that the rooting gradient is closely linked to the precipitation and average temperature of the season, where high rainfall and summer temperatures promote greater rooting, in contrast to low rainfall and the mild winter temperatures that stop the process. However, it is observed that even with the planting carried out in the summer (December), *D. giganteus* did not show the same behavior observed by Rasvi et al. (2015).

The results demonstrate the potential of using propagules for the production of seedlings of three of the four bamboo species tested, since the preparation methods are simple to perform and have low cost, in addition to being used without the need for special structures or laboratory techniques for the species *Bambusa vulgaris*, *B. variabilis* and *B. tuldoides*. However, for *Dendrocalamus giganteus*, none of the tested propagules present percentages of setting higher than 5%, and further research is needed to study other methods of propagation for this species, other methods of propagation for this species are necessary. The use of branch cuttings for propagation without the use of growth regulators, promoted 80% of rooting in *D. giganteus* (NAUTIYAL et al., 2007), another successful technique is tissue culture with the use of acetic acid naphthalene at a concentration of 0.1 mg L^{-1}, which promoted 88% rooting in *D. giganteus* (A-AMID; EL-ATRACH, 2012).

In general, it was found that the methods of preparing the propagules of *Bambusa vulgaris*, *B. variabilis* and *B. tuldoides* showed satisfactory budding results, but the need to elaborate studies with the use of

growth regulators in the preparation of the propagules by the stem segmentation for these species. However, for *D. giganteus*, the importance of carrying out future studies with the propagation of bamboo by means of branch cuttings with and without the use of growth regulators to verify the setting and the percentage of sprouts of the propagules is emphasized.

CONCLUSIONS

The species of *Bambusa vulgaris, B. variabilis and B. tuldoides* showed higher percentages of sprouting.

The method of preparing the propagules with a single knot was more efficient for *Bambusa variabilis, B. vulgaris and B. tuldoides*.

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