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Seedling development of *Melochia pyramidata* in different substrates and pot sizes

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Abstract
Native plants such as *Melochia pyramidata* have been targeted in various scientific studies due to their potential uses. From this perspective, the present study aimed to separately evaluate the effect of different substrates and pot sizes on the production of seedlings of *M. pyramidata* genotypes propagated by cuttings. The experiment was conducted in a plant nursery at the Center of Agricultural Sciences of the Federal University of Paraíba, Areia, PB, Brazil. The experimental design was completely randomized and arranged in a 3 x 2 factorial design with three substrate types (sand, commercial substrate Plantmax®, and sand + manure) and two genotypes (MP1 and MP2), with five replications. Pot size evaluation used a 2 x 2 factorial design with two pot sizes (V1: 1.8 L and V2: 0.9 L), two genotypes (MP1 and MP2), and four replications. The evaluations began seven days after the cuttings were planted in tubes and continued weekly for two months by evaluating the number of sprouts and leaves. After two months, these seedlings were transplanted to pots and evaluated for the number of sprouts, leaves, fruits, flower buds, leaf width, and leaf length. The data were subjected to analysis of variance and test of means (Tukey) at 5% probability. The cuttings of *M. pyramidata* developed best in washed sand and in the commercial substrate Plantmax®. The genotypes developed best in 1.8-L pots, showing more leaves, flower buds, and fruits.
Keywords: Characterization; ornamental plant; vegetative propagation; containers.

Desenvolvimento de mudas de *Melochia pyramidata* em diferentes substratos e tamanho de vasos

Resumo
As plantas nativas, como a Melochia pyramidata, têm sido alvos de vários estudos científicos devido suas potencialidades de usos. O objetivo deste trabalho foi avaliar, separadamente, o efeito de substratos e tamanhos de vasos na produção de mudas de genótipos de M. pyramidata pelo método da estaquia. O experimento foi conduzido em casa de vegetação no Centro de Ciências Agrárias da Universidade Federal da Paraíba, Areia, PB, Brasil. O delineamento experimental foi inteiramente casualizado, em esquema fatorial 3 x 2, com três tipos de substratos (areia, substrato comercial Plantmax® e areia + esterco) e 2 genótipos (MP1 e MP2.), com 5 repetições. Para a avaliação feita em diferentes tamanhos de vasos, utilizou-se o esquema fatorial 2 x 2, com 2 tamanhos de vasos (V1: 1,8 Litros e V2: 0,9 Litros) e 2 genótipos (MP1 e MP2), com 4 repetições. As avaliações iniciaram-se após sete dias do plantio das estacas nos tubetes, e continuaram, semanalmente, por dois meses, avaliando o número de brotações e o número de folhas. Após os dois meses, estas mudas foram transplantadas para vasos, onde avaliou número de brotações, número de folhas, número de frutos, número de botões florais, largura da folha e comprimento da folha. Os dados foram submetidos à análise de variância e teste de médias (Tukey) a 5% de probabilidade. As estacas de M. pyramidata apresentaram melhor desenvolvimento em areia lavada e substrato comercial Plantmax®. Os genótipos se desenvolveram melhor em vasos de 1,8 litros, com maiores quantidades de folhas, botões florais e frutos.
Palavras chaves: Caracterização, planta ornamental, propagação vegetativa, recipientes.

1. Introduction

The genus *Melochia* comprises 60 species mainly distributed across tropical regions but predominantly in the American continent. Twenty of these are found in Brazil (GONÇALEZ; ESTEVES, 2017). This herb is considered a genetic resource with ornamental potential due to its morphological features, including a branched stem, simple and alternate leaves, inflorescences in the axils of the last leaves, and five-petaled flowers with a dark pink color (LEAL; BONDI, 2006).

Moreover, the early development of the species is crucial for its field establishment, and it is well-known that reliable and good-quality seedlings usually generate healthy and vigorous plants. Therefore, vegetative propagation becomes advantageous as it allows faster seedling production (GONÇALEZ, 2013) and provides superior genotypes (CRISPIM *et al*., 2015). However, there are no studies on the vegetative propagation of *M. pyramidata* by cuttings.

The viability of this technique depends on the ability of the plant to form adventitious roots, which differs for each genotype with regard to the quality of the root system formed and the subsequent plant development (FACHINELLO *et al*., 2005). Rosa *et al*. (2017) observed that the genotypes had a significant effect on root induction in cuttings of *Prunus ssp.* The intrinsic factors that influence rooting in each genotype are endogenous hormonal balance, the consistency of cutting tissues, and the thickness of the sclerenchyma ring.

Other factors are essential to promote seedling quality. The quality of the substrate and pot size, for example, are determinants of early plant establishment, providing the appropriate conditions for germination, root formation, and early seedling development (SILVA *et al*., 2009). According to Gomes *et al*. (2015), the ideal substrate should have low density, good water absorption and retention capacity, good aeration and drainage, and be free of pests, diseases, and toxic substances. Zietemann and Roberto (2007), evaluating the effect of different substrates on the production of guava seedlings, stated that the material chosen as a substrate should meet all requirements to allow the rooting and sprouting of cuttings. The substrates used in seedling production can be produced from different materials, e.g., vermiculite, sand, and organic compost (LONE *et al*., 2010).

From this perspective, this study aimed to separately evaluate the effect of different substrates and pot sizes on the production of seedlings of *M. pyramidata* genotypes propagated by cuttings.

2. Material and Methods

The experiment was developed in a plant nursery at the Laboratory of Plant Biotechnology and Breeding of the Center of Agricultural Sciences of the Federal University of Paraíba (CCA/UFPB) - Campus II – Areia, Paraíba, Brazil.

The plant material consisted of cuttings from two parent plants of *M. pyramidata* (MP1 and MP2) collected at different locations of the CCA/UFPB.

Two experiments were conducted. The first assay used a randomized block design in a 3 x 2 factorial. Treatments consisted of three substrate types (sand, commercial substrate Plantmax®, and sand + manure) and two genotypes (MP1 and MP2), with five replications and one cutting per plot, totaling six treatments and 30 cuttings per genotype. The organic compost consisted of a manually homogenized mixture of bovine manure and washed sand at a 1:1 ratio. The cuttings were removed from the middle third of the plants, the region with the greatest bud uniformity and thickness (0.05 cm), measuring 20 cm in length.

The tubes were kept in the plant nursery after the cuttings were planted, where manual irrigation was performed daily to maintain the appropriate moisture for sprouting and plant development. The number of sprouts and leaves per cutting was evaluated every seven days for two months.

The second assay was established as a completely randomized design arranged in a 2 x 2 factorial composed of two parents of *M. pyramidata* (MP1 and MP2) and two pot sizes (V1: 1.8 L and V2: 0.9 L) used in studies with ornamental native species (Pessoa et al., 2021), with four replications and one plant per plot (pot). The washed sand substrate was used in this assay.

The weekly evaluations began seven days after transplantation and lasted three months. The variables analyzed were the number of sprouts, leaves, fruits, and flower buds, leaf width, and leaf length.

The data obtained were subjected to analysis of variance, and the means were subsequently compared by the Tukey test at 5%

probability. All analyses were performed with the statistical software Genes (CRUZ, 2013).

3. Results and Discussion

There was no significant interaction between any of the evaluated traits of *M. pyramidata*, suggesting that the studied substrates and genotypes are independent. On the other hand, there was a significant effect of the substrates on the number of sprouts and number of leaves (Table 1), indicating that the type and/or formulation of the substrate influenced seedling growth in this species. Furthermore, Andrade Júnior *et al*. (2019) and Neves *et al*. (2021) observed significant differences between substrates used to produce native seedlings, influencing the performance of the different traits.

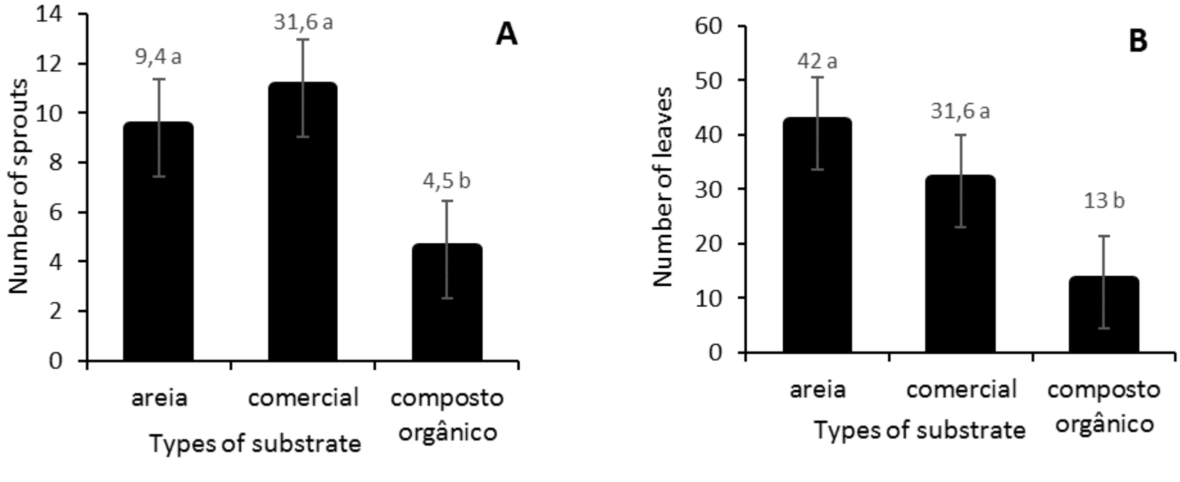
Table 1. "F" values for the number of sprouts (NB) and number of leaves (NF) of seedlings of *M. pyramidata* genotypes propagated by cuttings in different substrates.

FV	NB	NF
Substrates	67.5*	2,158.53**
Genotypes	114.7^{ns}	0.13^{ns}
Substrates x Genotypes	39.7^{ns}	678.93^{ns}
Residue	23.5	253.51
CV (%)	58.40	55.15

ns = non-significant; * = significant at 5%; ** = significant at 1% probability.

The number of sprouts and leaves per seedling showed the best results and similar behaviors when using sand and the commercial substrate Plantmax® (Figure 1). These traits play an essential role when recommending a species for ornamental purposes since plant architecture, the number of leaves, and the number of sprouts contribute to canopy closure, providing greater harmonization between plant and environment.

Figure 1. Mean values of the number of sprouts (NB) (A) and number of leaves (NF) (B) in cutting seedlings of *M. pyramidata* genotypes grown in different substrates. *Means followed by the same lowercase letter in the column do not differ by the Tukey test at 5% probability.



The sand substrate promotes greater porosity, increases aeration, and decreases waterlogging, thus favoring plant development. From this perspective, a good substrate is not necessarily nutrient-rich, but it should retain moisture, have aeration, and show an ideal pH, among other factors that favor plant development (CRISPIM *et al*., 2015).

In *Syzygium malaccensis*, propagation by cuttings was also favored by the sand substrate (LIMA *et al*., 2007). In another study, Gomes *et al.* (2015) evaluated different substrates in the propagation of *Vernonia polyanthes* Less by cuttings and reported that medium-textured or clayey soils added with humus resulted in the best development for this species. Therefore, it is evident that each species has particularities that provide affinity to specific substrates.

An isolated substrate usually does not have the exact ideal conditions for appropriate seedling development and, therefore, should be mixed with other materials whose summed properties provide an appropriate product for that purpose. From this perspective, Gomes *et al*. (2015) observed that the mixture of rice husk and soil resulted in an appropriate substrate to produce *V. polyanthes* L., meeting the requirements of the crop.

The organic compost resulting from the mixture of sand and manure did not produce a satisfactory substrate to propagate *M. pyramidata* by cuttings (Table 2). Based on this finding, other studies are recommended to evaluate the effect of new sources of organic matter to produce cutting seedlings of this species.

None of the evaluated traits of *M. pyramidata* showed a significant interaction with the different pot sizes, except the number of flower buds ($p \leq 0.05$), indicating that the factors act interdependently on this trait (Table 2).

Table 2. "F" values for the number of sprouts (NB), number of leaves (NF), number of flower buds (NBF), number of fruits (NFR), leaf width (LF), and leaf length (CF) of cutting seedlings of *M. pyramidata* genotypes as a function of different pot sizes.

FV	NB	NF	NBF	NFR	LF	CF
Genotypes (G)	0.006^{ns}	0.024^{ns}	0.476^{ns}	12473**	0.3489^{ns}	0.929^{ns}
Pots (V)	0.006^{ns}	15.834**	51929**	18600**	11829^{ns}	37872**
G x V	1139^{ns}	0.293^{ns}	8681*	0.093^{ns}	1527^{ns}	23682^{ns}
CV (%)	31.720	19.240	9.640	25.420	15.750	18.240

ns = non-significant; * = significant at 5%; ** = significant at 1% probability.

The analysis of the genotypes for each pot size reveals that, in the 1.8-L pot, genotype MP2 had the highest number of flower buds. *M. Pyramidata* is a shrub from 1 to 1.5 meters high, highly branched, with purple flowers (Johnatan *et al*., 2018), small and in large numbers. Thus, growing this species in pots for use in indoor environments could be an innovation for the floriculture market.

There was no difference between genotypes in the 0.9-L pot (Table 3). The analysis of the pot size factor for each genotype reveals that genotype MP2 in the 1.8 L pot had the highest number of flower buds. However, there was no difference between pots for the other genotype.

Table 3. Mean values of the number of flower buds of *M. pyramidata* genotypes grown in different pot sizes.

GENOTYPES (G)	POTS (V)	
	V1 (1.8 L)	**V2 (0.9 L)**
MP1	379.50Bb	307.75Ab
MP2	440.75Aa	269.75Ab

Means followed by the same lowercase letter in the rows and uppercase in the columns do not differ statistically by the Tukey test at 5% probability.

Genotype MP2 showed higher fruit production than MP1 (Table 4). These differences are related to several aspects, including the genetic factor. Therefore, different genotypes may respond differently to vegetative propagation by cuttings. From this perspective, Franzon *et al*. (2010) also observed differences in vegetative propagation between Surinam cherry genotypes (*Eugenia uniflora* L.).

Table 4. Test of means for the number of sprouts (NB), leaves (NF), flower buds (NBF), fruits (NFR), leaf width (LF), and leaf length (CF) in the different genotypes and pot sizes.

Treatments	NB	NF	NFR	LF (cm)	CF (cm)
Genotypes (G)					
MP1	39.62 a	649.00 a	379.50 b	2.39 a	3.70 a
MP2	40.13 a	658.75 a	440.75 a	2.18 a	3.87 a
Pots (V)					
V1 (1.8 L)	39.62 a	779.00 a	307.75 a	2.49 a	4.30 a
V2 (0.9 L)	40.13 a	528.75 b	269.75 b	2.08 a	3.27 b

*Means followed by the same lowercase letter in the column do not differ by the Tukey test at 5% probability.

Pot size significantly influenced the number of leaves, fruits, and fruit length, with pot V1 showing the best results. When small, pot size may limit plant development due to the substrate volume contained. However, this limitation is associated with developing species and the evaluation time (ALMEIDA *et al*., 2014). Seedlings of different species grown in larger containers have high quality. From this perspective, there are studies with *Mimosa scabrella* in which seedlings grown in large containers showed greater stem diameter and shoot and root dry matter weight than those grown in small containers (STURION, 1981). Finally, in agreement with the present study, Carvalho Filho et al. (2004) observed that the increase in pot size positively influenced the number of leaves in seedlings of *Andira fraxinifolia* Benth.

4. Conclusion

Cuttings of *M. pyramidata* can be grown in sand and commercial substrate, with sand resulting in lower costs for seedlings production. Both studied genotypes developed best in 1.8-L pots, showing more leaves and flower buds. In addition, MP2 developed a higher number of fruits.

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