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Formation pruning intensities and container volumes in the production of advanced sour passion fruit seedlings

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Abstract: The objective of this work was to evaluate the production of advanced seedlings of sour passion fruit (*Passiflora edulis* Sims.) in pruning intensities at different volumes of containers. The experiment was carried out in a production nursery, in Pedras Grandes, Santa Catarina state. The experimental design was a randomized block design and the treatments were arranged in a factorial scheme of five pruning intensities (control and pruning from the emission of 2, 4, 6, and 8 defined leaves) x 3 container volumes (1.0; 1.7 and 3.6 liters), with three replications and six plants per plot. The height and number of leaves (NF) of the seedlings were evaluated throughout the experiment and, at the end, the percentage of plants with a twisted root system (PSRE), root volume (VR), root dry mass (MSR), aerial part (MSPA) and total were measured (MST). The control treatment (without pruning) showed greater height, NF, MSPA and MST, regardless of container volume. The production of advanced sour passion fruit seedlings under pruning intensities reduced height, NF, MSPA and MST. Seedlings formed in larger volume containers provided greater height, NF, VR, MSR, MSPA and MST, in addition to the lowest PSRE. Therefore, pruning at an intensity of 6 leaves in a 1.7 liter container is recommended.

Index terms: *Passiflora edulis* Sims., Passion fruit woodiness virus, Propagation.

Intensidades de poda e volumes de recipiente na produção de mudas avançadas de maracujazeiro-azedo

Resumo: O objetivo deste trabalho foi avaliar a produção de mudas avançadas de maracujazeiro-azedo (*Passiflora edulis* Sims.), sob intensidades de poda, em diferentes volumes de recipientes. Realizou-se o experimento em viveiro de produção, em Pedras Grandes - SC. O delineamento experimental foi em blocos ao acaso, e os tratamentos arranjados em esquema fatorial, 5 intensidades de poda (controle e podas a partir da emissão de 2; 4; 6 e 8 folhas definidas) x 3 volumes de recipiente

(1,0; 1,7 e 3,6 litros), com três repetições e seis plantas por parcela. Avaliaram-se a altura e o número de folhas (NF) das mudas ao longo do experimento e, ao final, o percentual de plantas com o sistema radicular enovelado (PSRE), volume de raízes (VR), massa seca de raízes (MSR), parte aérea (MSPA) e total (MST). O tratamento controle (sem poda) apresentou maior altura, NF, MSPA e MST, independentemente do volume de recipiente. A produção de mudas avançadas de maracujazeiro-azedo, sob intensidades de poda, reduz a altura, NF, MSPA e MST. As mudas formadas em recipiente de maior volume proporcionam maior altura, NF, VR, MSR, MSPA e MST, além do menor PSRE. Assim, recomenda-se a poda na intensidade de 6 folhas em recipiente de 1,7 litros.

Termos para indexação: *Passiflora edulis* Sims., Virose do endurecimento dos frutos, Propagação.

Brazilian passion fruit production in 2022 reached 697.8 thousand tons, in a territorial area of 45.6 thousand hectares, with an average yield of 15.3 t ha⁻¹, which generated gross revenue of over R\$ 1.9 billion of reais. The leading producing states are Bahia, with 30.33 % of production, Ceará, with 25.92 %, and Santa Catarina, with 6.99 % (PAM/IBGE, 2024). Santa Catarina stands out for its commercialization in the main supply centers in the south and southeast regions during the first half of the year because of its high fruit quality and production in the northeast's off-season, which makes passion fruit industry an important source of income for family farmers in the south of Santa Catarina (PETRY et al., 2019).

The production of passion fruit can be limited by several factors, but the passion fruit woodiness disease, caused by cowpea aphid-borne mosaic virus, has strongly reduced fruit production and quality, which has generated significant losses for Brazilian passion fruit industry (QUARESMA et al., 2020). Among the practices for coexisting with the disease, it is recommended to use advanced seedlings, with a height greater than 80 centimeters when establishing orchards (PETRY et al., 2020). These seedlings, because they are advanced, have a longer formation period, thus a greater development of the architecture of the aerial part and the root system, in addition to being more structured for transplanting in the field, therefore promoting a high survival rate (STENZEL et al., 2019). Furthermore, the use of this type of

seedlings promotes early production, allowing the commercialization of fruits during a period of better fruit remuneration on the domestic market, guaranteeing better profitability for the passion fruit industry (PETRY et al., 2019).

In the production of advanced seedlings of sour passion fruit, it is necessary to use a good strategy in their formation as one of the main criteria for a satisfactory seedling production is the size of the container, including its height and diameter. This factor directly influences the spatial distribution of the root system and the aerial architecture of plants, maintaining the balance between the aerial part and the root (SCHORN et al., 2019). In turn, pruning allows the maintenance of vigor and delimits the volume of the crown, through the removal of poorly distributed and vigorous branches. However, it is essential to highlight that the objective of this pruning is not achieved in just one action, but it requires continuous operations during plant development (SCARPARE FILHO, 2013).

The objective of this work was to evaluate the production of advanced seedlings of sour passion fruit (*Passiflora edulis* Sims.) under pruning intensities in different volumes of containers.

The experiment was carried out in the municipality of Pedras Grandes, state of Santa Catarina (SC) (28°30'25" S and 49°17'07" W, altitude of 253 m), in a nursery, with anti-aphid screen (40 mesh), plastic cover and

an antechamber with mismatched doors, according to seedling production rules SAR Ordinance No. 17/2022 (SANTA CATARINA, 2022). The climate, according to the classification of Köppen, is humid subtropical (Cfa), with an average annual precipitation of 1,500 mm, average annual temperature of 19°C, annual evapotranspiration of 900 mm, annual relative humidity of 83 % and an average sunshine duration of 5.2 h day⁻¹ (PANDOLFO et al., 2002).

The sour passion fruit seedlings were subjected to five levels of pruning intensity, determined by the number of leaves emitted. The treatments consisted of formation pruning from the emission of 2, 4, 6, and 8 defined leaves, in addition to the control treatment (without pruning).

Rigid containers with volumes of 1.0; 1.7 and 3.6 liters (11.0 x 11.0 cm; 18.0 x 11.0 cm and 16.5 x 16.5 cm (height x diameter), respectively) were filled with Araranguá peat SC and carbonized rice husk, in the ratio of 7:3 (v v⁻¹), respectively. The cultivar used was 'SCS437 Catarina', sown on March 20, 2021.

The experimental design was a randomized block design and the treatments were arranged in a 5 (pruning intensity) x 3 (container volume) factorial scheme, with three replications and six plants per plot. The data were subjected to analysis of variance, regression and a mean comparison test, using the test of Tukey, at 5% significance, with the aid of the statistical software RBio, version 130 (BHERING, 2017).

Weekly assessments of the height and number of leaves (NF) of the seedlings were carried out, using a graduated ruler and unit count, respectively, over the period from June 15 to August 24, 2021, which corresponds to 87 to 157 (DAS) days after seeding. Also, at 157 DAS, the percentage of plants with a root twisting system (PSRE) was determined through visual assessment by observing the occurrence or absence of twisting. Furthermore, the root volume (VR) was verified as shown in Figure 1, with the

aid of a graduated cylinder in which the root system was filled with a known volume and the root system was inserted, whereby the extrapolated volume was equivalent to the root volume of the seedlings. Finally, randomly, one plant from each plot, the dry mass of roots (MSR), aerial part (MSPA) and total dry mass (MST) was determined (dried in an oven at 60°C).



Figure 1. Representation of the evaluation of sour passion fruit seedlings, formed under five levels of pruning and three volumes of containers, at 157 days, in the production nursery. Pedras Grandes - SC.

Fertilization was performed only 75 days after sowing, where 10 g of NPK fertilizer (10-10-10) was added per plant. For phytosanitary control, as a preventive measure, lime sulfur mixture (2%) and mancozeb (2.0 kg ha⁻¹) were used. The plants were maintained under manual irrigation with approximately 300 mL of water per plant every three days, on average, and adjusted as needed, given the difference in containers and plant size throughout the cycle.

The seedlings were pruned at 72, 107 and 135 DAS for treatment after the emission of every two defined leaves; at 79 and 135 DAS after four defined leaves; at 93 and 156

DAS after six defined leaves and at 107 DAS after eight defined leaves. The parameter to determine the moment of pruning was the number of leaves, as this can be influenced by several factors such as temperature, light, water, nutrient level, resulting in etiolation and, consequently, growth arrest (WHATLEY; WHATLEY, 1982; COSTA et al.; 2008).

A significant interaction was found among the tested factors in relation to height and number of leaves (NF). The seedlings from the control treatment (without pruning) presented seedlings with higher height and NF compared to the other treatments, regardless of the container volume (Figure 2).

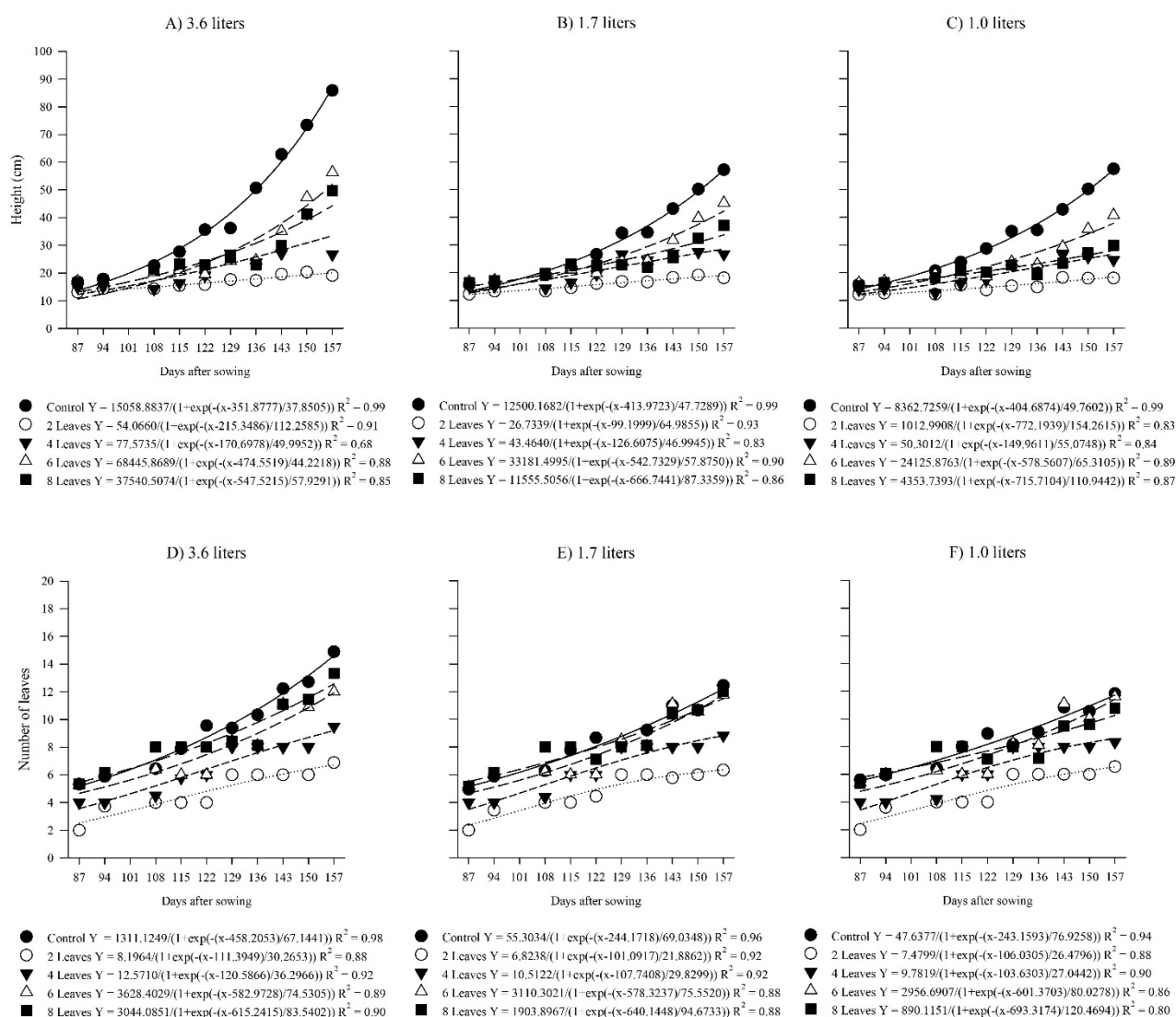


Figure 2. Height (Figures 2A, 2B and 2C) and number of leaves (Figures 2D, 2E and 2F) of sour passion fruit seedlings, formed under five pruning intensities and three container volumes, throughout the first half of 2021, in a production nursery. Pedras Grandes - SC.

These results can be justified by the absence of pruning, as these seedlings showed continuous growth when compared to the other treatments, where pruning was carried out. Furthermore, these plants presented greater height and NF when they were produced in the largest volume containers, with 3.6 L (Figure 2A and 2D).

Similar results were observed by Ribeiro et al., (2005), Costa et al., (2009) and Sousa et al., (2020) who observed passion fruit seedlings of greater height and NF in treatments in larger volume containers. According to Silva et al., (2018), this behavior is particularly related to the volume of substrate available for the root system to explore, that is, a larger volume container provides greater plant growth due to the greater supply of nutrients present there.

In the present work, it was found that seedlings formed under the most drastic pruning levels result in plants with lower height and NF, especially when compared to plants subjected to less drastic levels or, even, in seedlings without pruning. According to Almeida et al., (2019), more drastic pruning causes a reduction in the aerial part and, consequently, reduces the height and NF of the plant that was subjected to such an operation. Additionally, these results can be justified by the recurrent frequency of pruning.

The variables related to the root architecture of the seedlings, such as the percentage of plants with a twisted root system (PSRE), root volume (VR) and root dry mass (MSR), did not exhibit significant interactions between the tested factors, but only showed simple effect between the different container volumes, as shown in Figure 3. Thus, the PSRE was lower in the 3.6 L container with 78.7 %, differing from the 1.0 L containers with 94.7 %, and 1.7 L with 96.0 %, unlike the VR whose 3.6 L container led to the best result with 43.55 mL plant⁻¹, differing from the 1.7 L containers with 24.09 mL plant⁻¹ and of 1.0 L with 19.41 mL plant⁻¹. MSR had the best results in the 3.6 L container with 13.24 g plant⁻¹, followed by

the 1.7 L container with 11.39 g plant⁻¹ and the 1.0 L with 10.87 g plant⁻¹.

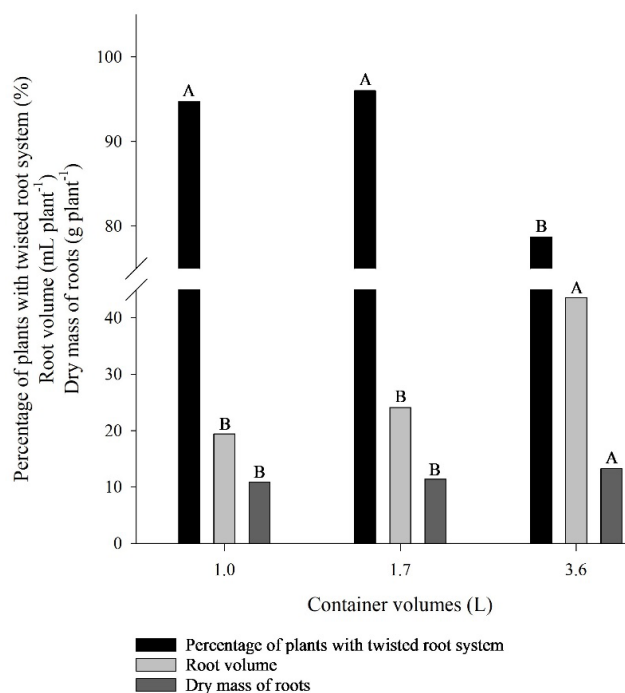


Figure 3. Mean values of the percentage of plants with root system curl, root volume and root dry mass of sour passion fruit seedlings, formed under pruning intensities and three container volumes, at the end of the first half of 2021, in production nursery. Pedras Grandes - SC.

However, larger volume containers exhibit better results, but according to Chagas et al., (2006), in addition to the positive influence of the larger container, the remaining period also influences the increment of the root system. Likewise, for the manifestation of PSRE, it is related to the container volume and the seedling formation period.

Thus, it can be stated that the increase in VR, MSR and PSRE will be related to the container volume. Also, the longer the seedling formation period, the greater the development of the plants root system, promoting the increase in VR and MSR, as well as the reduction of the PSRE. Although the appearance of PSRE is a negative characteristic in seedlings, the container with 3.6 L exhibited the lowest PSRE, indicating its suitability for the type of seedling produced with greater height and consequently greater VR and longer formation period.

Other authors such as Ribeiro et al., (2005), Silva et al., (2010), Costa et al., (2011) and Sousa et al., (2020) also found that sour passion fruit seedlings formed in larger volume containers outperform those produced in smaller volume containers in terms of quality, such as greater increase in height, NF, VR, MSR and PSRE, those produced in smaller volume containers.

For dry mass of the shoot (MSPA) and total mass (MST), a significant interaction between the tested factors (Figure 4) was observed. The highest MSPA values were

in the control treatment (without pruning), regardless of the container volumes, except for the container with 1.7 L and subjected to pruning every six leaves, as it did not differ from the control treatment, which may be related to the number of leaves as the seedlings showed similar NF between these treatments (Figure 1E). According to Mauad et al. (2015), the increase in dry mass is associated with the accumulation of nutrients by the plant. Furthermore, MSPA is an indicator of growth closely related to productivity.

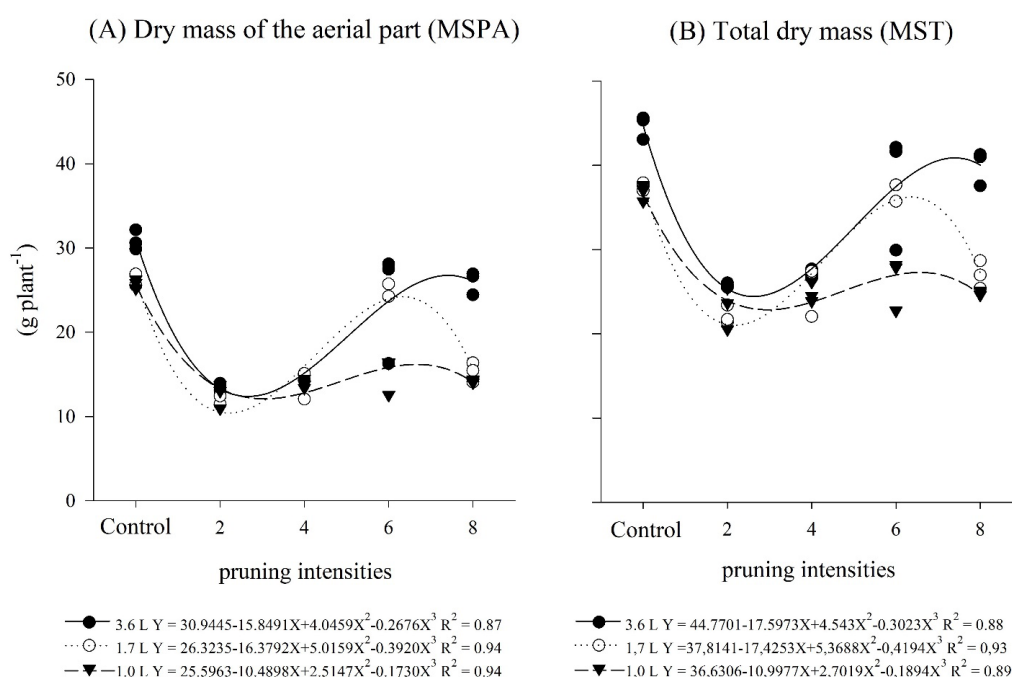


Figure 4. Dry mass of the aerial part (A) and total dry mass (B) of sour passion fruit seedlings formed under five pruning intensities and three container volumes, at the end of the first half of 2021, in a production nursery. Pedras Grandes – SC.

Sá et al., (2014), when evaluating the production of conventional sour passion fruit seedlings under two container volumes (1.0 and 2.0 L) depending on percentages of goat manure in the substrate composition, observed, at 60 DAS, the effect of container size over MSPA with higher values in 2.0 L containers.

In the present study, the container with a volume of 3.6 L (Figure 4A) showed lower MSPA at pruning intensities to form two and four leaves. These results can be explained

by a consequence of more drastic pruning, which promoted a reduction in the aerial part of the plant and, consequently, the dry mass of the aerial part.

For MST (Figure 4B), as well as for height and number of leaves (Figure 2), the highest values were obtained for the control treatment, when compared with the other formation pruning intensities, except for the pruning intensity of six leaves in a 1.7 L container, which did not differ from the control treatment. Furthermore, the 3.6 L volume also

showed greater accumulation of MST compared to the other containers.

Costa et al., (2011) evaluated the production of sour passion fruit seedlings in three volumes of containers, which were polyethylene bags measuring 15 x 21.5 cm; 10 x 16.5 cm and 7.5 x 11.5 cm in height x diameter, six substrates and three protected cultivation conditions, and found a greater accumulation of dry mass MST in plants grown in containers with greater volume. In the same direction, Viana et al. (2008) concluded that as the volume of the container and, consequently, the substrate increases, there is a greater availability of water, air and nutrients, which justifies the

gain in MST in seedlings formed in 3.6 L containers.

It is concluded that the pruning intensities in the production of advanced sour passion fruit seedlings reduce the height, number of leaves, and dry mass of the aerial and total parts. Thus, it can be recommended as a practice to keep plants for a longer period in the production nursery due to this operation, mainly pruning at the intensities of six leaves in a 1.7 L container. Seedlings formed in larger volume containers provide greater height, number of leaves, root volume, root dry mass, aerial part dry mass and total dry mass, in addition to fewer plants with a twisted root system.

References

- ALMEIDA, G.K.; GONZATTO M.P; MARODIN, G.A.B.; PETRY, H.B. La fisiología de la poda de otros frutales. In: HERNÁNDEZ, D.D.; RODRÍGUEZ, E.A.G.; ALONSO, N.B.; ALMEIDA, G.K.; GONZATTO M.P; MARODIN, G.A.B.; PETRY, H. B. **Poda y manejo de luz en el cultivo de cacao y otros frutales**. Bogotá: Fedecacao, 2019. p.42-53.
- BHERING, L.L. Rbio: a tool for biometric and statistical analysis using the r platform. **Crop Breeding and Applied Biotechnology**, Londrina, v.17, p.187-190, 2017. <https://doi.org/10.1590/1984-70332017v17n2s29>
- COSTA, A. de F.S. da; COSTA, A.N. da; VENTURA, J.A.; FANTON, C.J.; LIMA, I. de M.; CAETANO, L.C.S.; SANTANA, E.N. de. **Recomendações técnicas para o cultivo do maracujazeiro**. Vitória (ES): Incaper, 2008. 56 p. (Documentos, 162)
- COSTA, E.; RODRIGUES, E.T.; ALVES, V.B.; SANTOS, L.C.R. dos; VIEIRA, L.C.R. Efeitos da ambiência, recipientes e substratos no desenvolvimento de mudas de maracujazeiro-amarelo em Aquidauana. **Revista Brasileira de Fruticultura**, Jaboticabal, v.31, n.1, p.236-44, 2009. <https://doi.org/10.1590/S0100-29452009000100033>
- COSTA, E; SANTOS, L.C.R; CARVALHO, C.; LEAL, P.A.M; GOMES, V. A. Volumes de substratos comerciais, solo e composto orgânico afetando a formação de mudas de maracujazeiro-amarelo em diferentes ambientes de cultivo. **Revista Ceres**, Viçosa, MG, v.58, n.2, p.216-2, 2011. <https://doi.org/10.1590/S0034-737X2011000200013>
- CHAGAS, I.M. da.; TAVARES, J.C.; FREITAS, R. da S. de.; RODRIGUES, G.S. de O. Formação de mudas de maracujá amarelo em quatro tamanhos de recipiente. **Revista Verde**, Mossoró, v.1, n.2, p.122-33. 2006.
- MAUAD, M.; GARCIA, R.A.; SILVA, R. M. M. F.; SILVA, T. A. F.; SCHROEDER, I. M.; KNUDSEN, C. H.; QUARESMA, E.V.W. Produção de matéria seca e acúmulo de macronutrientes na parte aérea das plantas de niger. **Revista Brasileira de Ciência do Solo**, Viçosa, MG, v.39, p.533-40, 2015. <https://doi.org/10.1590/0100683rbcs20140391>
- PAM/IBGE. **Produção agrícola municipal 2022**. Rio de Janeiro: IBGE, 2024.
- PANDOLFO, C.; BRAGA, H.J.; SILVA JÚNIOR, V.P.; MASSIGNAN, A.M.; PEREIRA, E.S.; THOMÉ, V.M.R.; VALCI, F.V. **Atlas climatológico do Estado de Santa Catarina**. Florianópolis: Epagri, 2002. CD-ROM.

- PETRY, H. B.; MARCHESI, D. R. Passicultura catarinense se moderniza para continuar produtiva e rentável. **Agropecuária Catarinense**, Florianópolis, v.32, n.2, p.13-4, 2019.
- PETRY, H.B.; MORITZ, D.R.; SILVA, D.A.; MEES, A.; SANTOS, F.; MARCHESI, D.R.; TERNUS, R.M. Ações conjuntas entre produtores de maracujá e iniciativa pública no combate da virose-do-endurecimento-dos-frutos em Santa Catarina. **Agropecuária Catarinense**, Florianópolis, v.33, n.3, p.10-3, 2020. <https://doi.org/10.52945/rac.v35i3.1561>
- QUARESMA, J.P.; PACHECO, D.D.; SILVA, T.C.; BATISTA, C.H.A. Produção de mudas de maracujazeiro amarelo (*Passiflora edulis* Sims f. *flavicarpa*) em resposta a calagem, NPK e micronutrientes. **Research, Society and Development**, Itabira, v.9, n.8, p.1-25, 2020. <https://doi.org/10.33448/rsd-v9i8.6372>.
- RIBEIRO, M.C.C.; MORAIS, M.J.A. de; SOUSA, A.H. de; LINHARES, P.C. F.; BARROS JÚNIOR, A. P. Produção de mudas de maracujá-amarelo com diferentes substratos e recipientes. **Caatinga**, Mossoró, v.18, n.3, p.155-8, 2005.
- SÁ, F.V.S.; BERTINO, A.M.P.; FERREIRA, N.M.; BERTINO, A.M.P.; SOARES, L.S.; MESQUITA, E.F. Formação de mudas de maracujazeiro amarelo com diferentes doses de esterco caprino e volumes do substrato. **Magistra**, Cruz das Almas, V.26, n.4, p.482-92, 2014.
- SANTA CATARINA (Estado). Secretaria de Estado da Agricultura, da Pesca e do Desenvolvimento Rural. Portaria nº 17/2022, de 15 de março de 2022. Fica estabelecido o Vazio Sanitário para o cultivo do maracujazeiro-azedo (*Passiflora edulis*) em todo território catarinense. **Diário Oficial do Estado de Santa Catarina**, Florianópolis, p.20-3, 2022.
- SCARPARE FILHO, J. A. Poda de frutíferas. **Revista Brasileira Fruticultura**, Jaboticabal, v. 35, n.3, 2013. <https://doi.org/10.1590/S0100-29452013000300001>
- SCHORN, L.A.; PANDINI, G.; BITTENCOURT, R.; FENILLI, T.A.B. Definição de idades ótimas para expedição de mudas de *Araucaria angustifolia* (Bertol.) Kuntze (Araucariaceae) em função de sua qualidade e volume de recipientes. *Revista Biotemas*, Florianópolis, v.32, n.4, p.19-27, 2019. <https://doi.org/10.5007/2175-7925.2019v32n4p19>
- SILVA, E.A. da; MARUYAMA, W.I.; MENDONÇA, V.; FRANCISCO, M.G.S.; BARDIVIESSO, D.M.; TOSTA, M. da S. Composição de substratos e tamanho de recipientes na produção e qualidade das mudas de maracujazeiro 'amarelo'. **Ciência e Agrotecnologia**, Lavras, v.34, n.3, p.588-95, 2010. <https://doi.org/10.1590/S1413-70542010000300009>
- SILVA, R.S.; ARAÚJO NETO, S.E.; SILVA, N.M.; SILVA, D.F.; SOUZA, L.G.S.; UCHÔA, T.L. Produção de mudas orgânicas de maracujazeiro-amarelo com sistema radicular longo. **ACSA**. Patos, v.14, n.1, p.7-12, 2018.
- SOUZA, R.N.; MASSAROTO, J.A.; MARCOLIN, M.; ROCHA, R.R. Avaliação da produção de mudas de maracujazeiro-amarelo em diferentes volumes de recipientes de polietileno. **Revista de Ciências Agro-Ambientais**, Alta Floresta, v.18, n.2, p.100-3, 2020 <https://doi.org/10.5327/rcaa.v18i2.4635>
- STENZEL, N.C.M.; AULER, P.A.M.; MOLINA R.O.; SOARES JUNIOR, D. **Cultivo do maracujá-amarelo em áreas com ocorrência do vírus do endurecimento dos frutos**. Londrina: IAPAR, 2019. 29 p.
- VIANA, J.S.; GONÇALVES, E.P.; ANDRADE, L.A. de; OLIVEIRA, L.S.B. de; SILVA, E. de O. Crescimento de mudas de *Bauhinia forficata* Link. Em diferentes tamanhos de recipientes. **Floresta**, Curitiba, v.38, n.4, p.663-71, 2008.
- WHATLEY, F.H.; WHATLEY, F.R. **A luz e a vida das plantas**. São Paulo: EPUEDUSP, 1982. 101 p. (Temas de Biologia, 30)