

Proportions of peat and carbonized rice husk as substrates for sour passion fruit seedlings

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Abstract – Choosing an ideal substrate is crucial for producing quality seedlings. This study aimed to evaluate the effect of different proportions of peat (P) and carbonized rice husk (CRH) on the production of sour passion fruit seedlings. The experiment was conducted in a randomized block design, using six substrate formulations (100% CRH, 80% CRH/20% P, 60% CRH/40% P, 40% CRH/60% P, 20% CRH/80% P, and 100% P), with four replicates and six seedlings per plot. Seedling height (cm), number of leaves, stem diameter (mm), root dry mass (RDM), and shoot dry mass (SDM) (g) were evaluated 150 days after sowing. The obtained data were subjected to polynomial regression analysis. Physical and chemical characteristics of the formulated substrates were also analyzed. The maximum seedling response was estimated at 64.3% peat for RDM, 70.2% for stem diameter, 71.9% for number of leaves, 82.1% for SDM, and 83.7% for height. These formulations showed high porosity, a more acidic pH, and high water retention capacity. Substrates with proportions ranging from 64% to 84% peat and 36% to 16% CRH promoted greater growth of sour passion fruit seedlings.

Keywords: *Passiflora edulis* Sims.; Vegetative growth; Physical-chemical characteristics.

Proporções de turfa e casca de arroz carbonizada como substratos para mudas de maracujazeiro-azedo

Resumo – A escolha de um substrato ideal é fundamental para a produção de mudas de qualidade. Objetivou-se avaliar o efeito de diferentes proporções de turfa (T) e casca de arroz carbonizada (CAC) na produção de mudas de maracujazeiro-azedo. O experimento foi conduzido no delineamento em blocos ao acaso com seis formulações de substrato (100% CAC, 80% CAC/20% T, 60% CAC/40% T, 40% CAC/60% T, 20% CAC/80% T e 100% T), com quatro repetições e seis mudas por parcela. Avaliaram-se altura das mudas (cm), número de folhas, diâmetro do caule (mm), massa seca da raiz (MSR) e da parte aérea (MSPA) (g) após 150 dias da semeadura, sendo os dados obtidos submetidos à análise de regressão polinomial. Foram analisadas também as características físicas e químicas dos substratos formulados. A máxima resposta das mudas foi estimada em 64,3% de turfa para MSR, 70,2% para diâmetro do caule, 71,9% para número de folhas, 82,1% para MSPA e 83,7% para altura. Estas formulações apresentaram alta porosidade, pH mais ácido e alta capacidade de retenção de água. Os substratos com proporções entre 64-84% de turfa e 36-16% CAC promovem maior crescimento de mudas de maracujazeiro-azedo.

Palavras-chave: *Passiflora edulis* Sims; Crescimento vegetativo; Características físico-químicas.

Choosing the right substrate is a fundamental practice for producing high-quality seedlings. To achieve this, substrate selection must consider its physical and chemical characteristics, composition, absence of contaminants, and be lightweight and inexpensive (Fermino, 2014). It is difficult to find a single substrate material that meets all desired characteristics, so it is common to use mixtures (base materials, supplements, and additives) in varying proportions to achieve the desired properties (Schafer; Lerner, 2022).

The southern region of Santa Catarina (SC) is experiencing an

expansion in protected environment cultivation, mainly due to passion fruit cultivation, and thus requires alternative materials for composing substrates with suitable characteristics (Back *et al.*, 2023).

Both carbonized rice husks and peat are potential raw materials for substrate composition, as they are not only readily available in the passion fruit-producing region but also have good complementary physical and chemical characteristics. Carbonized rice husk (CRH) is a lightweight material with high drainage capacity and excellent aeration, while peat has an acidic pH,

excellent nutrient availability, greater buffering power (high CEC), higher density, and high water retention capacity (Petry, 2008).

Therefore, the objective was to evaluate the effect of substrates formulated with different proportions of peat and carbonized rice husks on the production of passion fruit seedlings. The substrates were formulated with different proportions (v/v) of peat (P) and carbonized rice husk (CRH): 100% CRH, 80% CRH/20% P, 60% CRH/40% P, 40% CRH/60% P, 20% CRH/80% P, and 100% P. The peat was obtained from the company Turfa Fértil[®], which has an

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extraction site in the southern region of Santa Catarina, and the carbonized rice husk was obtained from a company in the municipality of Araranguá/SC. The six formulations were analyzed at the Substrate Analysis Laboratory of the Federal University of Rio Grande do Sul (UFRGS) to determine physical characteristics (dry density in kg m⁻³, solids content, total porosity (TP), aeration space (AS), readily available water (RAW), buffering water (BW), remaining water (RW), and water retention capacity (WRC10 %) and chemical characteristics (pH in H₂O and electrical conductivity (EC) in mS cm⁻¹). To evaluate the effect of the formulations on sour passion fruit seedling growth, seeds of the cultivar ‘SCS437 Catarina’ were sown in polyethylene containers measuring 10 × 20cm (1.1L) filled with the different substrates, in a protected environment (28°31’57.10”S; 49°18’55.02”W) with anti-aphid screens on the sides and a plastic cover, as described by Petry *et al.* (2019). Irrigation was performed manually, keeping the container capacity constant. Nitrogen fertilization was applied at 90 and 120 days after plant emergence at a dose of 50mL per plant, using a 5g L⁻¹ urea solution. At 150 days after plant emergence, the following parameters were evaluated: plant height (cm) from the substrate surface to the apex using a measuring tape; stem diameter (mm) at 1 cm height using a digital caliper; number of developed leaves; and root and shoot dry weight (g), determined after oven-drying at 65°C until constant weight was achieved. The experimental design was randomized blocks, with four replicates and 15 plants per plot, the six central ones being assessed. Results were subjected to polynomial regression analysis at a 5% significance level using Python.

The physical composition of the substrates was influenced by the different proportions of peat and CRH (Figure 1). Dry density, water holding capacity, readily available water, and remaining water increased linearly with increasing peat proportion. Aeration space, in contrast, showed higher values in formulations with the highest CRH proportions. According to Fermino

(2014), WRC10 values ranging from 40% to 50% are considered ideal. Therefore, the 40% CRH/60% P formulation achieved the best results within this range.

Total porosity consists of macropores (air space) and micropores (water holding capacity), with 85% considered the reference value (Schafer; Lerner, 2022). Substrates with peat proportions from 60% and 80% presented values closest to ideal.

Substrate pH in H₂O ranged from 5.16 (100% P) to 6.48 (100% CRH) (Table 1). According to Fermino (2014), the ideal pH range for most plants is 5.5 to 6.5. However, Back *et al.* (2023) observed that passion fruit develops better in more acidic substrates, with pH below 6.

Electrical conductivity (EC) also showed a linear response, with substrates containing more peat

presenting higher values, reaching 1.33mS cm⁻¹ in the 100% P formulation (Table 1). According to Petry (2008), although EC is not generally a parameter for choosing a substrate for plant propagation-since inert materials are recommended to enable nutritional adjustments in the production system according to the crop’s needs and/or its growing phase-substrates with higher initial EC showed better results in sour passion fruit seedlings.

A quadratic trend was observed in the regression lines, with significant difference (p < 0.05) between substrate compositions for all parameters (Figure 2). With high coefficients of determination (R > 0.81 for RDM), the trend lines demonstrated that increasing peat content enhanced seedling growth, reaching a plateau at 64.3% peat for root dry mass (2.27g), 70.2% for stem diameter (5.02mm),

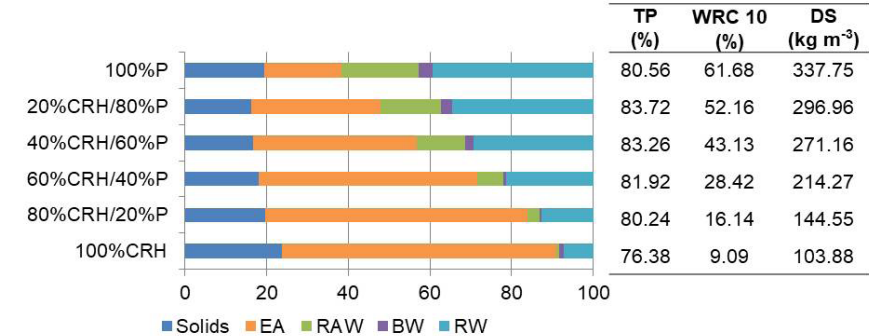


Figure 1. Physical composition (solids – solids content, EA - aeration space, AFD - readily available water, AT - buffering water, AR - remaining water), PT - total porosity and CRA - water retention capacity (WRC) in % and DS - dry density (Kg.m-3) of the substrates formulated with different proportions of peat (P) and carbonized rice husk (CRH).
Source: Elaborated by the authors (2025)
Figura 1. Composição física (sólidos - teor de sólidos, EA - espaço de aeração, AFD - água facilmente disponível, AT - água tamponante, AR - água remanescente, PT - porosidade total e CRA - capacidade de retenção de água em %, e DS - densidade seca em Kg.m-3) dos substratos formulados com diferentes proporções de turfa (T) e casca de arroz carbonizada (CAC)
Fonte: Elaborado pelos autores (2025)

Table 1. Chemical characteristics (pH and CE - electrical conductivity) of substrates formulated with different proportions of peat (P) and carbonized rice husk (CRH)

Tabela 1. Características químicas (pH e CE - condutividade elétrica) dos substratos formulados com diferentes proporções de turfa (T) e casca de arroz carbonizada (CAC)

Unit		100% CRH	80%CRH/ 20%P	60%CRH/ 40%P	40%CRH/ 60%P	20%CRH/ 80%P	100%P
pH	H ₂ O	6.48	6.1	5.88	5.86	5.69	5.16
CE	mS cm ⁻¹	0.11	0.35	0.71	0.96	1.14	1.33

Source: Elaborated by the authors (2025)
Fonte: Elaborado pelos autores (2025)

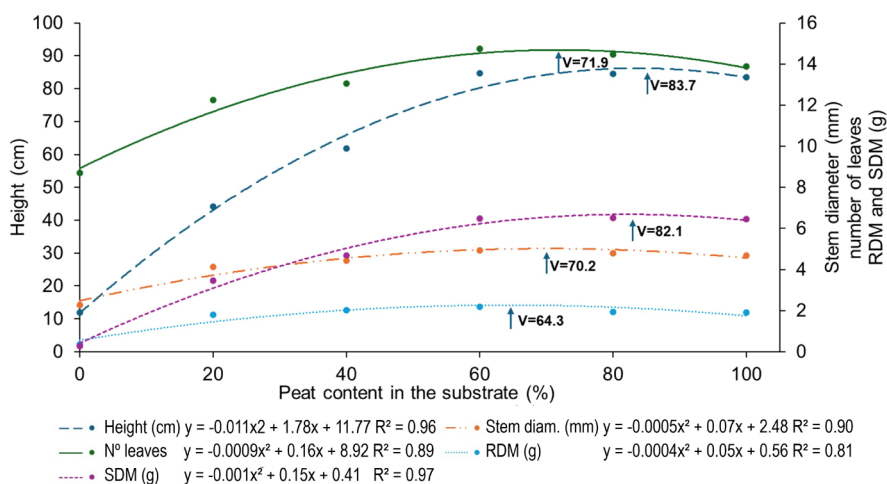


Figure 2. Height (cm), diameter (mm), number of leaves, root dry mass (RDM), and shoot dry mass (SDM) (g) of passion fruit seedlings subjected to different substrates with varying proportions of peat and carbonized rice husk after 150 days of sowing. V = vertex of the parabola (maximum peat content in the substrate)

Source: Elaborated by the authors (2025)

Figura 2. Altura (cm), diâmetro (mm), número de folhas, massa seca da raiz (MSR) e da parte aérea (MSPA) (g) das mudas de maracujazeiro-azedo submetidas a diferentes substratos com proporções de turfa e casca de arroz carbonizada após 150 dias da semeadura. V = vértice da parábola (teor máximo de turfa no substrato).

Fonte: Elaborado pelos autores (2025)

71.9% for leaf number (14.48), 82.1% for shoot dry mass (6.69g), and 83.7% for height (86.21cm). Above these levels, higher peat contents lead to a reduction in the growth of passion fruit seedlings.

According to Sônego *et al.* (2017), a standard passion fruit seedling suitable for field planting should have a height above 80 cm, adequate leaf number, stem diameter, and root system. Formulations with peat contents from 64.3% to 83.7% were found to meet this premise.

These results can guide passion fruit nurseries in formulating their own substrates, considering desired characteristics. Among the most suitable formulations, those with higher CRH content, for example, promoted better root growth, an important factor for the initial establishment of these seedlings in the field. This also reduced cost per m^3 of substrate (CRH being cheaper than peat) and made the mix lighter, facilitating handling and transport.

Better seedling development was observed in substrates with good water retention capacity, high porosity (air and water space), and lower pH. Similar

results were reported by Back *et al.* (2023) when evaluating commercial substrates for the growth of passion fruit seedlings. They concluded that substrates with a peat content ranging from 64% to 84% and CRH ranging from 36% to 16% provide greater vegetative growth in passion fruit seedlings.

Author contributions

Marina Martinello Back: conceptualization, data curation, formal analysis, investigation, methodology, project administration, visualization [of data (infographic, flowchart, table, graph)]; writing – first draft, writing – review & editing; **Henrique Belmonte Petry:** conceptualization, funding acquisition, project administration, resources, supervision, validation, visualization [of data (infographic, flowchart, table, graph)], writing – review & editing; **Darlan Rodrigo Marchesi:** conceptualization, supervision, validation, writing – review & editing; **Gilmar Schafer:** conceptualization, methodology, supervision, writing – review and editing

Research data

Data will be made available upon direct request to the authors.

Conflict of interest

The authors declare no conflict of interest in this work.

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