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Yield and genetic dissimilarity of sour passion fruit genotypes cultivated in the Southwestern Amazon

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ABSTRACT

The yield of yellow passion fruit often falls below 20% of its potential due to the use of non-recommended cultivars by producers. To address this issue, ten genotypes of *Passiflora edulis* Sims were introduced in the edaphoclimatic conditions of Mâncio Lima, located in the Juruá microregion, State of Acre, Brazil, to evaluate their performance and identify promising ones. A randomized complete block design was used with three replications and eight plants per plot, and the yield, and physical and chemical quality of fruits were evaluated. Data were analyzed using analysis of variance, and the means were compared using the Scott-Knott test at 5% significance. A multivariate analysis was performed to obtain the dissimilarity matrix based on the Mean Euclidean Distance, and Pearson's correlation analysis was used to establish the correlation network. Differences were found between genotypes and across evaluation months for the studied traits. Genotypes Acre Selection, BRS Rubi Cerrado, BRS Sol Cerrado, BRS Gigante Amarelo, FB 200, and CPAC VML x 325 showed superior agronomic performance and can be recommended for the passion fruit production system in the region.

Keywords: *Passiflora edulis,* Agronomic traits, Yield, Fruit quality.

Produtividade e dissimilaridade de genótipos de maracujazeiro-azedo cultivado no sudoeste amazônico

RESUMO

A produtividade do maracujazeiro-amarelo, em muitos casos, não chega a 20% do seu potencial em razão do produtor utilizar uma cultivar que, previamente, não tenha sido indicada pela pesquisa. Assim, com objetivo de avaliar genótipos de *Passiflora edulis* Sims e, por conseguinte, proceder à indicação de materiais genéticos promissores. O experimento foi conduzido utilizando 10 genótipos de maracujazeiro-azedo nas condições edafoclimáticas do município de Mâncio Lima, localizado na microrregião do Juruá, Estado do Acre, Brasil. O delineamento experimental utilizado foi de blocos casualizados, com três repetições, e oito plantas por parcela. Foram realizadas avaliações das características produtivas, qualidade física e química dos frutos. Houve diferenças entre os genótipos e entre os meses avaliados para as características estudadas. Os genótipos Seleção Acre, BRS Rubi do Cerrado, BRS Sol do Cerrado, BRS Gigante Amarelo, FB 200 e CPAC VML x 325, por apresentarem características agronômicas superiores, podem ser incorporados ao sistema de produção de maracujazeiro da região.

Palavras-chave: *Passiflora edulis,* Caracteres agronômicos, Produtividade, Qualidade de frutos.

1. Introduction

In 2021, Brazil produced approximately 684 thousand tons of passion fruit, with the Northeast Region contributing about 70% of this total (IBGE, 2023). However, although yellow passion fruit has a potential yield of over 75 tons per hectare (Faleiro et al., 2017), the national average is only 15.3 tons per hectare, representing 20.4% of its productive potential (IBGE, 2023). This discrepancy is primarily due to the use of cultivars not suited to the local soil and climatic conditions (Aguiar et al., 2015). For both industrial use and fresh consumption, passion fruit breeding programs aim to develop cultivars with superior fruit quality, high yield, and disease resistance (Ribeiro et al., 2019). In this scenario, Embrapa Cerrados, in collaboration with partner institutions, has been working on developing sour passion fruit cultivars to cater to various market segments (Greco et al., 2014). This effort is crucial for the advancement of passion fruit cultivation in Brazil (Abreu et al., 2009).

Despite significant progress in developing yellow passion fruit cultivars, extending these recommendations to the diverse Brazilian agroecosystems remains a challenge (Cavalcante et al., 2016). The success of passion fruit orchards, in terms of production and quality, depends on selecting the correct cultivar, one that has been tested and recommended for the specific cultivation region. This is due to genotype-environment interactions, which can result in varying productive traits depending on the cultivation location (Jesus et al., 2017). In regions lacking specific cultivar recommendations, the choice of cultivars is often based on results from other regions, and the high number of existing cultivars and significant genetic variability can lead to incorrect choices. In this scenario, Vieira et al. (2020) emphasize the need for developing new genetic materials and evaluating their adaptability and productivity across different production areas. According to Botelho et al. (2017), understanding the fruit quality of cultivars at the planting site helps producers select the appropriate genetic material that meets consumer demands.

In the northern Brazilian state of Acre, particularly in its various microregions with unique soil and climatic conditions, there is a paucity of studies comparing cultivars. This has created a demand for research aimed at introducing and evaluating passion fruit cultivars, so genotype recommendations for planting are based on agronomic and productive criteria (Andrade Neto et al., 2015). From this perspective, this study aims to evaluate the agronomic, productive, and quality traits of sour passion fruit genotypes under the climatic conditions of the southwestern Amazon region.

2. Material and Methods

The experiment was conducted at the Nova Vida site in the municipality of Mâncio Lima, State of Acre, located at 7°38’03.1” S and 72°51’39.1” W. According to the Köppen classification, the region's climate is type Af, i.e., tropical humid (Alvares et al., 2013), with average annual temperatures ranging from 72.5 °F to 89,6 °F, an average relative humidity of 83%, and annual rainfall exceeding 2,000 mm (INMET, 2022). Precipitation and temperature data during the experiment are shown in Figure 1.

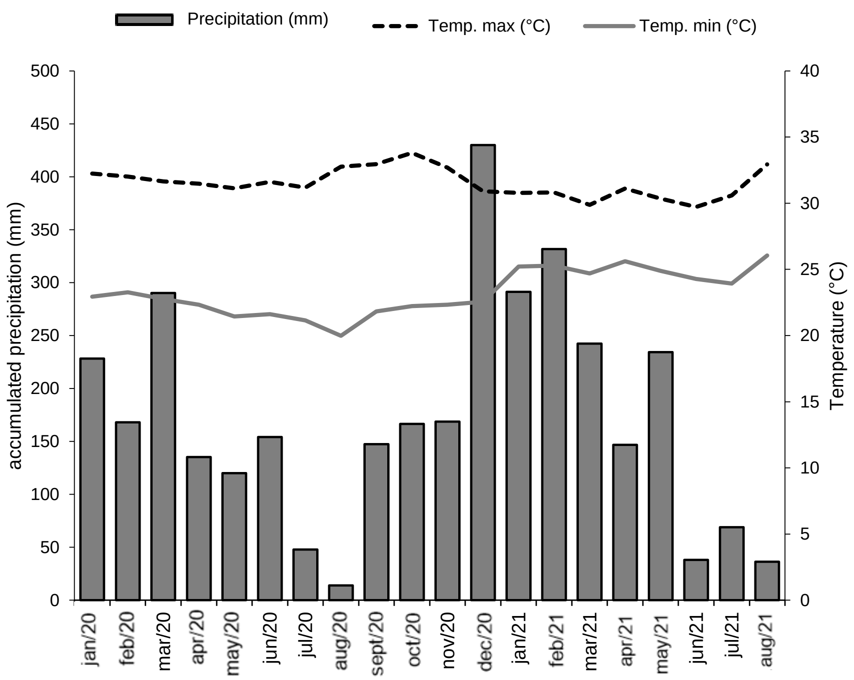


Figure 1. Accumulated precipitation data, maximum and minimum average temperature, determined during the execution of the experiment. Source: Inmet (2022)

The soil in the experimental area is a dystrophic Sandy Latosol, with a slope of less than 5% and good drainage, previously occupied by Brachiaria decumbens pasture. Soil analysis in the 0-20 cm layer revealed the following chemical and physical characteristics: pH = 5.16; Ca = 1.93 cmolc dm^{-3}; Mg = 0.85 cmolc dm^{-3}; K = 0.05 cmolc dm^{-3}; H + Al = 2.64 cmolc dm^{-3}; Al = 0.28 cmolc dm^{-3}; SB = 4.77 cmolc dm^{-3}; P = 11.794 mg L^{-1}; V% = 49.30; sand = 755.00 g kg^{-1}; clay = 175.00 g kg^{-1}; and silt = 70.00 g kg^{-1}.

The field experiment followed a randomized complete block design with three replications and eight plants per plot, evaluating six central plants per plot. Treatments included ten sour passion fruit genotypes: Acre Selection, BRS Gigante Amarelo, BRS Sol do Cerrado, BRS Rubi do Cerrado, Flora Brasil FB 200 "Yellow Master", FB 300 "Araguari", CPAC 325 x VML, IAC 277, IAC 275, and IAC 273.

Before setting up the experiment, the pasture was desiccated using glyphosate® at 2.5 l ha^{-1} with a spray volume of 300 l ha^{-1}. Holes measuring 0.3 m x 0.3 m x 0.3 m were dug, and 150 g of limestone (PRNT 95%) was mixed into the removed soil. After 30 days, 300 g of single superphosphate (18% P2O5, 16% Ca, 11% S), 50 g of micronutrient FTE BR 12 (B 1.8%, Cu 0.8%, Mn 2%, Mo 0.10%, Zn 9%), and 5 liters of poultry litter manure were added per hole before planting.

Seedlings were produced in a nursery with 50% shading. Seeds were initially sown in a 200-cell tray (15.58 mL per cell) containing the commercial substrate Vivatto®. After 49 days, the seedlings were transplanted to a 32-cell tray (188 mL per cell) containing a substrate made from *ingá* leaves, poultry litter, decomposed Kapok tree, and shredded grass in a 1:1:1:1 ratio. Seedlings were transplanted to the field 104 days after sowing, at a height of about 25 cm.

Planting was done in double rows (3.0 m x 10.0 m x 0.8 m), i.e., 3.0 m between single rows, 10.0 m between double rows, and 0.8 m between plants (628 plants ha^{-1}). The first topdressing was applied 45 days after planting with 100 g of granular N-P-K fertilizer (19-04-19) and 3 liters of poultry litter manure per plant. Subsequent fertilizations were done weekly via fertigation, providing 35 g $plant^{-1}$ of MAP (N 12%, P2O5 54%), 10 g $plant^{-1}$ of calcium nitrate (Ca 16%), 11 g $plant^{-1}$ of potassium chloride (K2O 60%), 7.4 g $plant^{-1}$ of urea (N 43%), 3 g $plant^{-1}$ of Harvaste More® (N 5%, P2O5 5%, K2O 45%), 2.36 g $plant^{-1}$ of magnesium sulfate (Mg 9%, S 12%), and every 15 days, 2.07 g $plant^{-1}$ of zinc sulfate (Zn 37%, S 17%).

The experiment was irrigated using a fixed micro-sprinkler system with microjet® micro-sprinklers (1 mm diameter, 40 l h^{-1} flow rate, and 15 mca pressure). Plants were trained using a vertical trellis system with smooth wire no. 12 placed 2 m high. Formation pruning was performed as recommended until the canopy was fully developed. Standard practices for plant training, pollination, phytosanitary control, and weed management were followed (Junghans and Jesus, 2017). Harvesting was done four times a week, collecting fallen fruits and those with 100% yellow peel. From July 2020 to August 2021, fruit mass, the number of fruits per plant, and yield were evaluated. Additionally, the mean number of fruits per plant over 14 months, the total accumulated number of fruits, and mean and total yield were also assessed.

For the physical and chemical parameters of the fruits, six fruits per plot from each treatment were harvested in the first half of May 2021 and taken to the Plant Science Laboratory at UFAC, Campus Floresta. The following measurements were realized: Fruit length (cm), measured with a digital caliper from the base (peduncle insertion) to the apex of the fruit; Fruit diameter (cm), measured perpendicularly at the largest dimension of the fruit with a digital caliper; Length-to-diameter ratio, calculated from fruit length and diameter; Peel thickness (epicarp + mesocarp - cm), measured with a digital caliper after the fruit was cut in half and the pulp removed. The pH was determined by potentiometry with a pH meter calibrated periodically with buffer solutions at pH 4 and 7.

The soluble solids (SS) were expressed in Brix, measured with a refractometer. Titratable acidity (TA) was determined by titration with 0.1M NaOH, according to the guidelines of the Adolfo Lutz Institute (2008). The soluble solids to titratable acidity ratio (RATIO) was obtained by the ratio of soluble solids to titratable acidity; Pulp yield (%) was calculated using the following equation: Pulp yield (%) = (Mass of raw pulp (g) - Mass of residue (g) / total fruit mass (g))*100.

The collected data were analyzed for outlier detection, error normality verification, and homogeneity of variances. Statistical analysis of the monthly determined variables was performed by considering a randomized complete block design in a split-plot arrangement over time, with months as subplots and genotypes as main plots. The data were subjected to analysis of variance, and when significance was found, treatments were compared using the Scott-Knott test at 5% probability with the Sisvar software (Ferreira, 2019).

For data collected over the fourteen months of evaluation (July to December 2020 and January to August 2021), the analysis considered a split-plot arrangement over time, with genotypes as main plots and evaluation months as subplots. Variables such as fruit mass, length, diameter, length-to-diameter ratio, peel thickness, total number of fruits, total yield, soluble solids, acidity, soluble solids-to-acidity ratio, pH, and pulp yield were subjected to multivariate analysis using

Genes software. A dissimilarity matrix was obtained based on the Euclidean Mean Distance, and the UPGMA method was applied to group similar treatments (Cruz, 2013).

Pearson correlation analysis was performed to establish the correlation network using RBio statistical software (Bhering, 2017). According to Epskamp et al. (2012): i) Variables (nodes) in these networks are connected by lines whose thickness is proportional to the absolute value of the correlation between them; ii) The length of the lines indicates the intensity of the correlations, with shorter lines representing stronger correlations; iii) Positive correlations are highlighted in green, whereas negative correlations are represented in red.

3. Results and Discussion

There was interaction between genotypes and the evaluation month only for the monthly fruit mass. The ‘Seleção Acre’ genotype showed the highest fruit mass in July 2020 and January 2021, as well as in August and September 2020 and May 2021, although in these last three months this genotype did not differ from the genotypes Rubi do Cerrado, Sol do Cerrado, FB 200, and CPAC 325 x VML (Table 1). The fresh fruit mass ranged from 190 g per fruit (FB 300) to 290 g per fruit (Seleção Acre) throughout the study period. According to McAtee et al. (2013), differences in fresh fruit mass among various passion fruit genotypes are related to fruit length and diameter, which are influenced by hormonal activity during growth and maturation, as well as genetic factors.

The variation in mean fruit mass across months is directly associated with differences in precipitation, temperature, and humidity. Rotili et al. (2013) state that fruit mass is crucial for the commercialization of fresh fruit since consumers purchase based on mass and appearance. Therefore, consumers prefer larger fruits weighing over 200 g, free from skin damage, with a good appearance and yellow coloration (Aguiar et al., 2015). The highest numbers of fruits per plant were recorded in January 2021 (Figure 2A). The months from July 2020 to August 2021 showed higher mean values for monthly yield (Figure 2D). Genotypes BRS Rubi do Cerrado, FB 300, IAC 273, IAC 275, and IAC 277 recorded 17.65% more fruits per plant compared to other genotypes during the study period (Figure 2B).

Table 1. Fruit mass (kg) of sour passion fruit genotypes between July and December 2020 and between January and August 2021**.**

Genotypes	Mean Fresh Fruit Mass (kg)					
	2020					
	July	August	September	October	November	December
Seleção Acre	0.44 Aa	0.36 Ab	0.32 Ac	0.26 Ad	0.29 Ac	0.30 Ac
Gigante Amarelo	0.30 Ba	0.23 Bb	0.22 Bb	0.19 Ab	0.19 Ab	0.22 Ab
Rubi do Cerrado	0.28 Ba	0.32 Aa	0.28 Aa	0.20 Ab	0.22 Ab	0.21 Ab
Sol do Cerrado	0.31 Ba	0.29 Aa	0.30 Aa	0.21 Ab	0.22 Ab	0.22 Ab
FB 200	0.30 Ba	0.32 Aa	0.29 Aa	0.30 Aa	0.22 Ab	0.23 Ab
FB 300	0.22 Ca	0.21 Ba	0.22 Ba	0.17 Aa	0.17 Aa	0.17 Aa
CPAC 325 x VML	0.30 Ba	0.30 Aa	0.29 Aa	0.20 Ab	0.22 Ab	0.22 Ab
IAC 273	0.29 Ba	0.26 Ba	0.22 Bb	0.18 Ab	0.20 Ab	0.19 Ab
IAC 275	0.21 Ca	0.30 Ba	0.20 Bb	0.17 Ab	0.17 Ab	0.17 Ab
IAC 277	0.21 Ca	0.22 Ba	0.21 Ba	0.17 Ab	0.18 Ab	0.20 Ab

Genotypes	Mean Fresh Fruit Mass (kg)							
	2021							
	January	February	March	April	May	June	July	August
Seleção Acre	0.34 Ab	0.23 Ab	0.28 Ac	0.30 Ac	0.30 Ac	0.22 Ad	0.25 Ad	0.24 Ad
Gigante Amarelo	0.22 Bb	0.20 Ab	0.16 Ab	0.22 Ab	0.20 Bb	0.23 Ab	0.27 Aa	0.21 Ab
Rubi do Cerrado	0.21 Bb	0.20 Ab	0.20 Ab	0.24 Ab	0.25 Ab	0.21 Ab	0.26 Aa	0.24 Ab
Sol do Cerrado	0.22 Bb	0.21 Ab	0.20 Ab	0.24 Ab	0.25 Ab	0.21 Ab	0.23 Ab	0.16 Ab
FB 200	0.20 Bb	0.21 Ab	0.23 Ab	0.24 Ab	0.23 Ab	0.22 Ab	0.25 Ab	0.21 Ab
FB 300	0.19 Ba	0.18 Aa	0.19 Aa	0.19 Aa	0.18 Ba	0.18 Aa	0.21 Aa	0.19 Aa
CPAC 325 x VML	0.20 Bb	0.22 Ab	0.22 Ab	0.20 Ab	0.24 Ab	0.22 Ab	0.22 Ab	0.23 Ab
IAC 273	0.21Bb	0.19 Ab	0.19 Ab	0.21 Ab	0.20 Bb	0.20 Ab	0.22 Ab	0.19 Ab
IAC 275	0.20 Bb	0.19 Ab	0.16 Ab	0.19 Ab	0.19 Bb	0.17 Ab	0.26 Aa	0.30 Aa
IAC 277	0.20 Bb	0.19 Ab	0.16 Ab	0.18 Ab	0.18 Bb	0.19 Ab	0.22 Ab	0.28 Aa

Means followed by the same letter, with uppercase letters in the column and lowercase letters in the row, do not differ from each other according to the Scott-Knott and Tukey tests, respectively, at a 5% significance level.

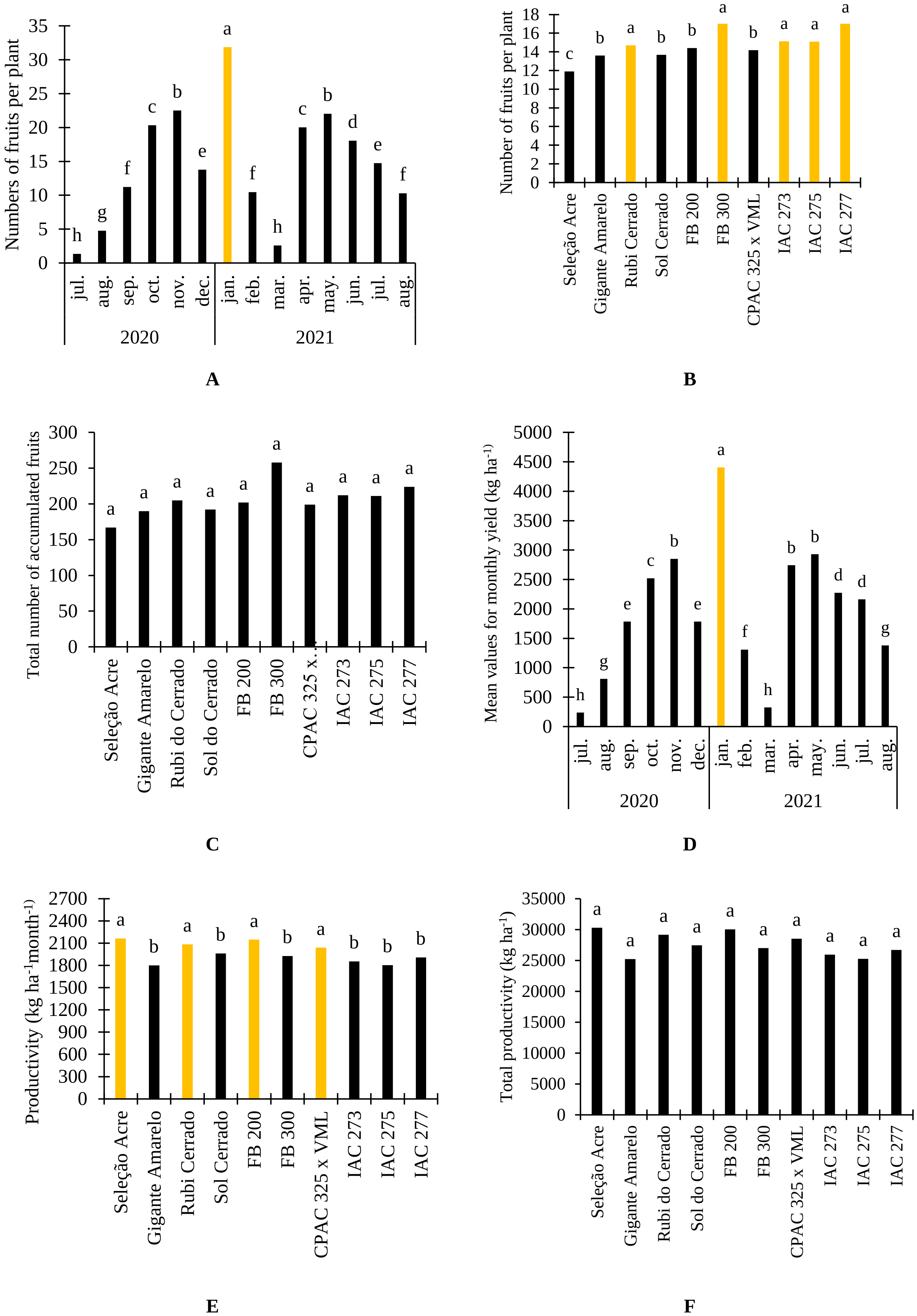


Figure 2. Number of fruits per plant (A), productivity per plant (B), monthly number of fruits (C), monthly productivity (D), total number of accumulated fruits (E) and total accumulated productivity (F) of yellow passion fruit genotypes. Means followed by the same between bars do not differ from each other by the Scott Knott test at 5% significance. Orange bar: better treatment.

With regard to the total number of accumulated fruits (Figure 2C) and the cumulative fruit yield (Figure 2F), no significant difference was observed between genotypes. In terms of monthly fruit yield during the evaluated period, genotypes Seleção Acre, BRS Rubi Cerrado, FB 200, and CPAC 325 x VML showed higher values (Figure 2E). The total yield recorded in this study exceeds the national mean of approximately 14.9 t ha^{-1} (IBGE, 2022), as well as the results determined by Krause et al. (2012). According to Stenzel et al. (2019), the yield tends to gradually increase from the second year onwards, as this is when the plant achieves its highest productive potential. However, according to these authors, there is a tendency for yield to decrease and the productive cycle to end in the third year, especially when passion fruit is cultivated in tropical areas.

Jesus et al. (2018) observed that, under the conditions of the northern portion of the Brazilian state of São Paulo, yellow passion fruit production started 229 days after planting, which was 69 days later compared to what was determined in the present study. These results highlight the need to study the behavior of passion fruit varieties launched in different Brazilian agroecosystems. Furthermore, when considering the same evaluation period as in the present study (550 days after planting), the genotypes evaluated by Jesus et al. (2018), namely: BRS Sol do Cerrado, BRS Rubi do Cerrado, and Giant Yellow FB 200, showed less fruit accumulation compared to the present study, largely due to the agroecosystem differences in the study locations.

Genotypes Seleção Acre, BRS Rubi do Cerrado, BRS Sol do Cerrado, and FB 200 were grouped with longer fruit lengths ranging from 10.69 cm to 11.13 cm (Figure 3A). With regard to fruit diameter, the genotypes were grouped into 4 categories, with Seleção Acre and BRS Sol do Cerrado standing out with diameters of 9.5 cm and 9.4 cm, respectively (Figure 3B). These values, both for length and diameter, are higher than those identified in the literature (Silva et al., 2016; Greco et al., 2014; Krause et al., 2012) and fall into Class 5, according to the Brazilian Program for Improvement of Commercial Standards and Packaging of Horticultural Products established by CEAGESP in 2001.

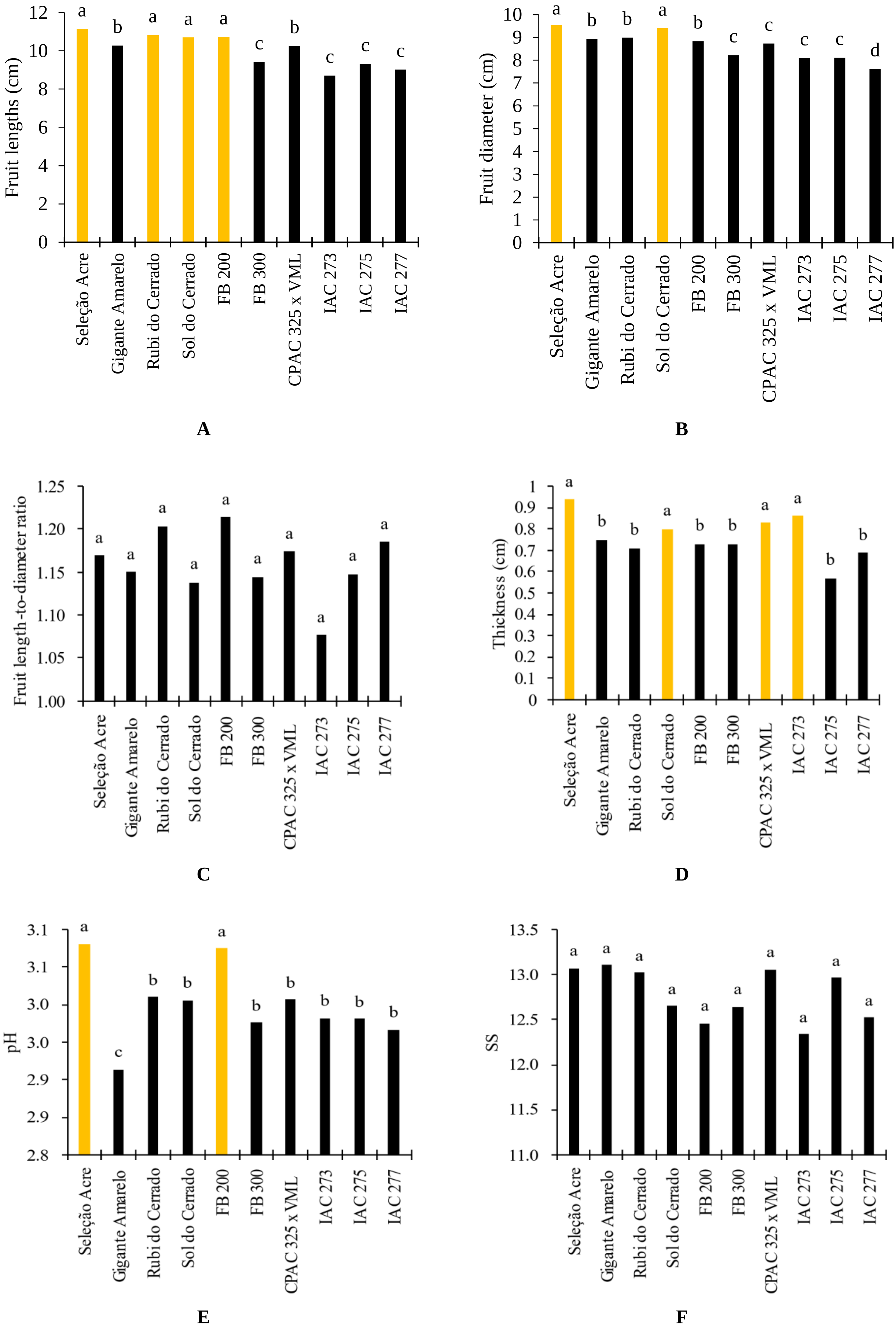
There was no difference among genotypes regarding the fruit length-to-diameter ratio (Figure 3C), which is an important trait as these variables are used by consumers at the time of purchase (Silva et al., 2015), resulting in greater added value to the product (Rocha et al., 2013). According to Nóbrega et al. (2021), the industry prefers oblong fruits with greater length than diameter, as they have higher pulp yield, tend to be heavier, and have thinner skins compared to rounded fruits. Thus, all evaluated genotypes tended towards an oval shape, showing promise both for fresh consumption and for the processing industry.

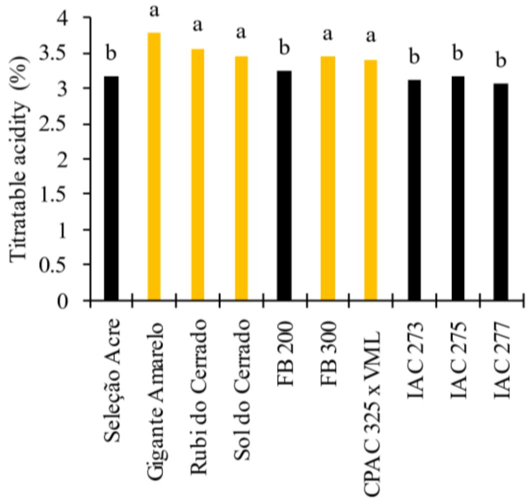
With regard to peel thickness, genotypes Seleção Acre, BRS Sol do Cerrado, CPAC 325 x VML, and IAC 273 had the highest mean values (Figure 3D). According to Krause et al. (2012), fruits with thicker skins are preferable for fresh consumption as they are more resistant to damage during transport. On the other hand, Freire et al. (2014) report that, for industrial use, fruits with thinner skins and a smaller internal cavity are preferred due to their higher pulp yield. The values detected in the present study fall within the range determined by Neves et al. (2013) and Nóbrega et al. (2021).

The pH was significantly higher in genotypes Seleção Acre and FB 200, both with 3.08 (Figure 3E), and therefore higher than those found by Nóbrega et al. (2021) and Silva et al. (2016); similar to those detected by Silva et al. (2015) and Vieira et al. (2020); but lower than the values reported by Rinaldi et al. (2021) and Cavalcante et al. (2016). The soluble solids (SS) content ranged from 12.3 to 13.1, with no difference among the genotypes (Figure 3F). However, all of them are adequate since the minimum required content is 11 º Brix (MAPA, 2003). According to Gama et al. (2013), fruit quality traits, including soluble solids, work as a function of the greater photosynthetic efficiency shown by the cultivars.

For titratable acidity, genotypes BRS Gigante Amarelo (3.78%), BRS Rubi do Cerrado (3.56%), Sol do Cerrado (3.46%), FB 300 (3.44%), and CPAC 325 x VML (3.41%) showed the highest mean values compared to the other genotypes evaluated (Figure 3G). Acidity is a very important variable for product industrialization, as it hinders the action of microorganisms that could deteriorate the product and facilitates the preparation of beverages (Dell'Orto Morgado et al., 2010). Different acidity values can be attributed to edaphoclimatic conditions, irrigation, nutrition, and cultivars (Reis et al., 2018).

The ratio ranged from 3.4 to 4.2, with Seleção Acre (4.2), FB 200 (3.9), CPAC 325 x VML (4.0), IAC 273 (4.1), IAC 275 (4.1), and IAC 277 (4.1) standing out for this variable (Figure 3H). This parameter varies greatly depending on the passion fruit species and among genotypes of the same species, as reported by Jesus et al. (2022), in whose study this value ranged from 2.01 to 25.47, but is also influenced by harvest time (Silva et al., 2016) and cultivation location (Botelho et al., 2017). The highest pulp yield was detected in genotypes BRS Sol do Cerrado (51.10%) and FB 200 (50.06%) (Figure 3E). Additionally, genotypes Seleção Acre, Gigante Amarelo, Rubi do Cerrado, Sol do Cerrado, FB 200, and CPAC 325 x VML, with yields above 40%, are also promising (Vieira et al., 2023).


Fruit lengths (cm)
Seleção Acre
Gigante Amarelo
Rubi do Cerrado
Sol do Cerrado
FB 200
FB 300
CPAC 325 x VML
IAC 273
IAC 275
IAC 277
A
Fruit diameter (cm)
B
Fruit length-to-diameter ratio
C
Thickness (cm)
D
pH
E
SS
F



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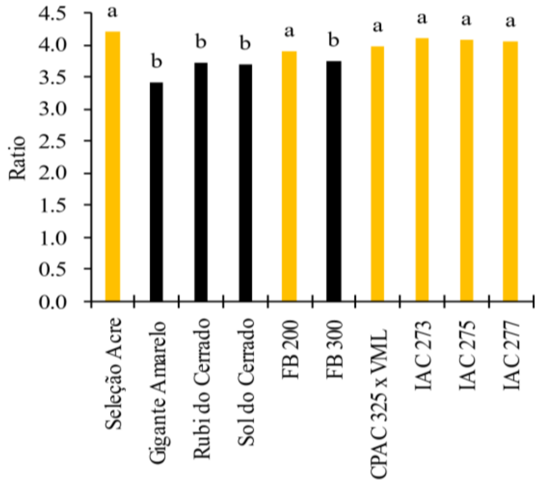

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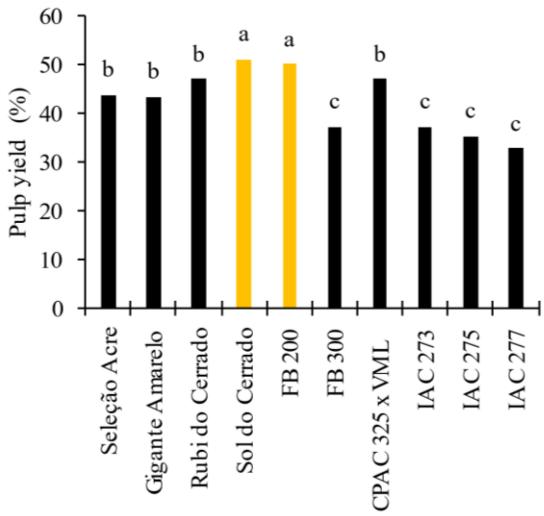

I

Figure 3. Fruit length (A), fruit diameter (B), ratio between fruit length and diameter (C), peel thickness (D), pH (E), soluble solids (F), titratable acidity (G), relationship between soluble solids and acidity – ratio (H) and pulp yield (I) of yellow passion fruit genotypes. Means followed by the same between bars do not differ from each other by the Scott Knott test at 5% significance. Orange bar: best treatment

When considering the rule established by Hinkle et al. (2003), Pearson's correlation was significant, positive, and very strong (0.9 to 1) between CF and DF and between NTFP and FRac; and significant, positive, and strong (0.7 to 0.9) between CF and MF, CF and Prod, DF and RS, DF and MF, EC and MF, RS and MF, and MF and PROD (Figure 4). On the other hand, it was significant, strong, and negative (-0.7 to -0.9) between CF and Ratio, DF and NTFP, DF and FRAC, DF and Ratio, MP and Ratio, AT and Ratio, RS and Ratio, MF and NTFP, and MF and FRAC.

These results differ from those determined by Nóbrega et al. (2021), who found a very strong, positive, and significant correlation between CF and MF, and between pH and Ratio; and a strong, positive, and significant correlation between CF and CFDF, CF and EC, pH and SS, and Ratio and SS. On the other hand, in general, they agree with the results found by others authors. (Grego et al., 2014; Alves et al., 2012; Dell'Orto Morgado et al., 2010). These latter researchers highlight that negative correlations between pulp quality traits and some production factors are due to competition for photoassimilates. Joseph et al. (2021) found very strong and positive correlations between DF and MF, and DF and RS. These authors report that correlation studies are useful for selecting more productive passion fruit genotypes based on fruit mass, diameter, circumference, and pulp mass variables. Vieira et al. (2023) found a strong negative correlation between pulp yield and soluble solids, probably due to dilution effects.

Two groups of genotypes were formed, the first by FB 300, IAC 273, IAC 275, and IAC 277, and the other by the rest of the genotypes (Figure 5). A divergent result was obtained by Cavalcante et al. (2016), as they formed three groups using the UPGMA method, with genotypes BRS Sol do Cerrado and BRS Rubi do Cerrado in the second group and BRS Gigante Amarelo isolated in the third group. The cophenetic correlation coefficient was 0.83, indicating, an adequate fit of the UPGMA clustering method to confirm similarity between treatments, according to Streck et al. (2017).

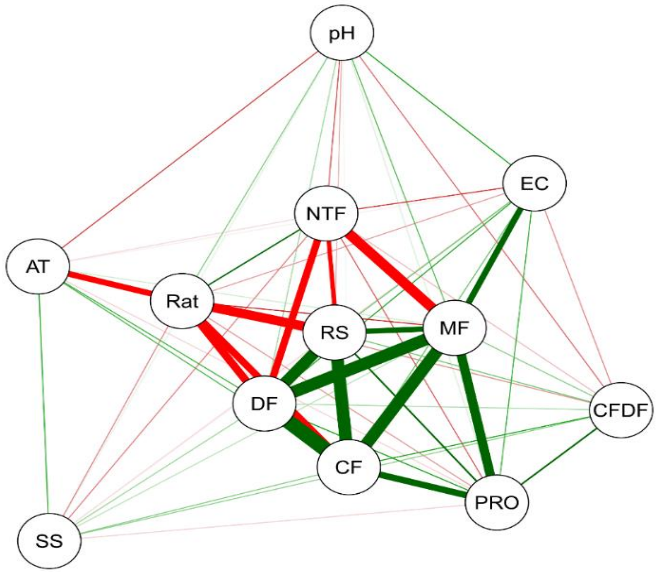

Figure 4. Correlation network among the variables fruit mass (MF), fruit length (CF), fruit diameter (DF), fruit length-to-diameter ratio (CFDF), peel thickness (EC), total number of fruits (NTF), total yield (PRO), soluble solids (SS), acidity (AT), soluble solids-to-acidity ratio (Rat), pH, and pulp yield (RS).

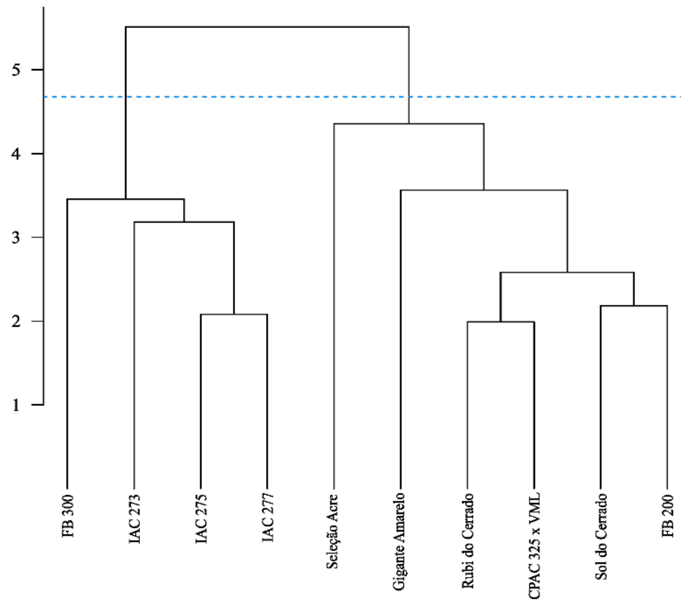

Figure 5. Dendrogram generated by the UPGMA method using dissimilarities through the Euclidean Mean Distance among sour passion fruit genotypes based on 13 variables of fruit quality and production.

4. Conclusions

Genotypes Seleção Acre, BRS Rubi do Cerrado, BRS Sol do Cerrado, BRS Gigante Amarelo, FB 200, and CPAC VML x 325, due to their superior agronomic traits, can be incorporated into the passion fruit production system of the region.

Authors' Contribution

Everyone participated in the study, where each one, within their expertise, made their respective contributions. James Maciel de Araújo, Romeu de Carvalho Andrade Neto, Leonardo Barreto Tavella, Hugo Mota Ferreira Leite, and Lauro Saraíva Lessa conceptualized the work, were responsible for data collection and analysis, experiment monitoring, and

article writing. Marcos Giovane Pedroza de Abreu contributed to data analysis and article writing.

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