BIOSCIENCE JOURNAL

AGRONOMIC ASSESSMENT OF 32 SOUR PASSIONFRUIT GENOTYPES IN FEDERAL DISTRICT

Michelle Souza VILELA[1], José Ricardo PEIXOTO[1], Samara Dias Rocha RAMOS[2], Rosa Maria de Deus de SOUSA[1], Assussena Pereira de OLIVEIRA[3], Marcelo de Abreu Flores TOSCANO[3], Antônio Alves de OLIVEIRA JUNIOR[3]

[1] Department of Agronomy and Veterinary Medicine, Federal University of Brasilia, Brasilia, Distrito Federal, Brazil.
[2] Graduate Program in Agronomy, Federal University of Brasilia, Brasilia, Distrito Federal, Brazil.
[3] Postgraduate Program in Agronomy, Federal University of Brasilia, Brasilia, Distrito Federal, Brazil.

Corresponding author:
Assussena Pereira de Oliveira
Email: assussena.oliveira@hotmail.com

How to cite: VILELA, M.S., et al. Agronomic assessment of 32 sour passionfruit genotypes in Federal District. *Bioscience Journal*. 2022, **38**, e38004. https://doi.org/10.14393/BJ-v38n0a2022-54231

Abstract
The production of passion fruit is important in Brazil. In order to contribute to the development of the most promising cultivars of passion fruit, this study aimed to evaluate the agronomic performance of 32 genotypes of passion fruit in Federal District of Brazil, and to estimate genetic parameters for use in breeding programs. Thirty-two genotypes were used in a randomized block design, with eight plants per plot and four replications. The experiment was conducted in field. Twenty-eight harvests were performed, and the variables analyzed were: productivity estimated, total number of fruits per hectare, average fruit weight and these characteristics following classification of fruits in five categories. The genotypes that presented the highest total yield estimated were MAR20 # 23, AR 01 and PLANTA 7. For industrial purposes, genotypes MAR 20 # 21 and BRS Gigante Amarelo were superior. For fresh consumption, the genotypes with the best performance were PLANT 7, AR 01 and MSC. Total productivity estimated and total number of fruits per hectare in the first-class classification showed high values of heritability and CVg/CVe ratio. These results indicate a favorable condition for selection.

Keywords: Genetic parameters. *Passiflora edulis* Sims. Productivity.

1. Introduction

In the national fruit culture, there are some fruits that launch Brazil to the position of great world producer. Passion fruit is one of the crops that contribute to this condition of Brazil as a world fruit producer, with an average productivity of 14t/ha in 2018 (IBGE 2018). The average productivity of passion fruit in recent years has varied from 12 to 15 tons per hectare, with potential for production of 30 to 35 tons per hectare (Silva et al. 2009). Elite genotypes, developed in research actions, can produce more than 50t/ha/year (Faleiro et al. 2011).

Fruit production stands out in the Northeast, Southeast, and South regions of Brazil. Bahia is the main producer, with 160,902 tons in 15,660 hectares, followed by Ceará, with 147,458 tons produced in 6,862 hectares. In third place in national production is the state of Santa Catarina with 53,961 tons in 2,270 hectares (IBGE 2018). In the Southeast region, passion fruit is one of the eight most cultivated fruit species in the extensive system, being preceded only by the cultures of orange, banana, lemon, mango, mandarin orange, pineapple, and grape (Meletti 2011).

The productivity of the passion fruit culture is considered low. Many factors influence this characteristic, the cultivation of inappropriate varieties being one of them (Nogueira 2016). Others refer to the genetic characteristics of the plant, edaphic, environmental conditions, biotic agents and the action of man (Faleiro et al. 2011).

According to Faleiro and Junqueira (2016), low productivity is one of the main problems of culture, emphasizing the need for research aimed at the development of improved varieties and the establishment of production technologies capable of providing increased productivity, possibility of increased survival of the culture and improvement of the quality of the fruits.

It has been observed, in recent years, that there is a lack of genetic materials with high productivity, fruit quality and resistance to phytopathogens, mainly due to the lack of research work in the various areas of knowledge and especially with genetic improvement of passion fruit (Faleiro et al. 2018).

According to Faleiro et al. (2011), the genetic improvement of passion fruit has several purposes depending on the product to be considered (fruits, leaves or seeds) and the region of cultivation. Increased productivity, fruit quality, resistance to diseases, nematodes and also an increase in the rate of fruit avenging are the main objectives of the improvement of the crop.

In the open field, agronomic performance and resistance to phytopathogens require continuous work of genetic improvement, since there are few passion fruit cultivars available to Brazilian producers and their productivity is considered to be regular to low (Faleiro et al. 2011). Another problem faced by the crop is the small longevity of the crop. In several areas of sour passion fruit planted at the end of the last century, crops in full production with up to 7 to 8 years of age were observed. However, in these same areas, recently, crops have not exceeded two years of age, and in many cases, total death occurs at just one year of age.

Productivity can be increased by reducing losses due to diseases, passion fruit culture has losses due to fungal, bacterial and virotic diseases. Phytosanitary control can be decisive in the production of passion fruit, but for the chemical control to be efficient, it is interesting that it is associated with a field with cultivars with a good genetic potential. Therefore, evaluating the performance of cultivars for the genetic improvement of passion fruit is important to ensure future production (Peruch et al. 2018).

In Brazil, most breeding programs are related to fruit, both in terms of productivity and quality. In qualitative terms, it is considered that a fresh variety, developed for the market must have large and oval fruits, in order to achieve good commercial classification, besides having a good appearance, being resistant to transport and loss of quality during storage and commercialization (Faleiro et al. 2018).

In this sense, the selection of passion fruit cultivars with good productivity and fruit quality is essential for the development of culture in Brazil. Thus, the work aimed to evaluate the agronomic performance of 32 genotypes of sour passion fruit in the Federal District, as well as to estimate genetic parameters to be used in genetic improvement programs of this culture.

2. Material and Methods

The experiment was carried out at Fazenda Água Limpa, belonging to the University of Brasília (UnB), located in Vargem Bonita, 25 km south of the Federal District of Brazil, with latitude of 16 ° South, longitude of 48 ° West and 1100 m of altitude. The climate of the region is of the AW type, characterized by rains concentrated in the summer, from October to April, and dry winters from May to September (Cardoso et al. 2014).

The experiment was installed in a Red-Yellow Latosol soil, clayey, deep, with good drainage. In the experimental area, liming and the incorporation of 1 kg of simple superphosphate per pit in pre-planting was carried out. The soil analysis showed the following results: Al (0.05 meq); Ca + Mg (1.9 meq); P (4.5 ppm); K (46 ppm); pH 5.4 and 4% Al saturation. The cover fertilizations were carried out in a circle, at a distance of 40 to 50 cm from the surface of the plant, while the superphosphate was incorporated into the soil.

Thirty-two genotypes were used, in a randomized block design, with eight plants per plot and four replications. The genotypes used were: PLANTA 6, MAR 20 # 40, PLANTA 1, MAR 20 # 29, MAR 22 # 2005, ROXO AUSTRALIANO, MAR 20 # 15, MSC, RC3, RUBY GIGANTE, ARO1, ARO2, MAR 20 # 49, BRS SOL DO CERRADO, MAR 20 # 6, PLANTA 5, MAR 20 # 23, PLANTA 4, PLANTA 2, PLANTA 7, MAR 20 # 03, EC30, MAR 20 # 10, MAR 20 # 34, MAR 20 # 21, FB200, FP01, BRS GIGANTE AMARELO, EC-RAM, GA2, REDONDÃO and MAR 20 # 39.

These genotypes were developed based on research carried out by the University of Brasília - UnB and Embrapa Cerrados. They originate from intraspecific and interspecific hybridizations and also from materials derived from mass selection made in productive orchards in southeastern Brazil.

The seedlings were produced by sowing in polystyrene trays (120 mL per cell) containing artificial substrate based on vermiculite plus *Pinus* sp. Bark, later transplanted to plastic bags containing soil sterilized with methyl bromide, remaining for about 90 days in a greenhouse at the Experimental Biology Station of UnB. On November 19 and 20, 2008, the seedlings were transplanted to the field, following the spacing of 2.75 m between rows and 3 m between plants, making a total of 1,024 useful plants with external borders.

The vertical spreader support system was used in the field, with posts five meters apart and two strands of straight wire nº 12, at 2.20 m above the ground (upper wire) and 1.60 m (lower wire), with formation pruning in the combed scheme. The irrigation system used was a daily drip (one day watering shift), applying around 5 mm per m2 (5 liters/m^2). The drippers were 30 cm apart.

The control of weed plants consisted of periodic mowing between lines and use of post-emergent herbicides in the lines - glyphosate, in the form of a directed jet. It was agreed not to do any chemical control of diseases during the whole work, until the end of the harvests. Manual pollination was not carried out.

Agronomic performance evaluations were carried out after one year of planting, from November 2009 to June 2010, totaling 28 harvests. The harvests were carried out collecting fruits with full maturity point, that is, fruits that were on the floor of the experiment. Each plot of the experiment was collected separately in plastic boxes identified according to the sketch of the experimental area. The boxes were taken to a shed for post-harvest evaluation, for the weighing procedure, which was followed weekly throughout the analysis period. The variables analyzed were: estimated productivity (kg ha^{-1}), considering 9,697 plants per hectare, number of fruits per hectare, average fruit mass (g), and these characteristics considering the classification of fruits in terms of equatorial diameter into five exemplified categories shown in Table 1.

Table 1. Classification of fruits according to their equatorial diameter (mm), used in the evaluation of 32 genotypes grown at FAL - UnB, 2009 to 2010, according to a proposal by Rangel (2002).

Classification	Equatorial Diameter (mm)
First class	Diameter less than 55
1 B	Fruit diameter greater than 55 and less than 65.
1 A	Diameter greater than 65 and less than 75
2 A	Diameter greater than 75 and less than 90
3 A	Diameter greater than 90

The experimental data were transformed by x + 1 root, submitted to analysis of variance and compared by the Tukey average test at 5% probability.

Estimates of the genotypic variances between accessions ($\hat{O}_g^2$), phenotypic at the level of mean ($\hat{O}_F^2$) and environmental mean ($\hat{O}_e^2$), (heritability at the level of mean (h^2), coefficients of environmental variation (CVe) and genetic (CVg) for total productivity characteristic were obtained, using the Genes program (Cruz 2013). Using the estimates of phenotypic, genotypic and environment variances and covariance, the CVg/CVe ratio and phenotypic correlations were determined with Genes estatistic software.

Linear correlation analyzes were performed between all studied variables, based on the significance of their coefficients. In the classification of intensity of the correlation to $0.05 \leq p \geq 0.01$, it was considered very strong (r ± 0,91 to ± 1,00), strong (r ± 0,71 to ± 0,90), average (r ± 0,51 to ± 0,70) and weak (r ± 0,31 to ± 0,50), according to Guerra and Livera (1999).

3. Results and Discussion

From the analyzed data, it was possible to observe significant statistical differences, over the 28 harvests, in the estimated productivity, productivity of first Class, 1B, 1A, 2A and 3A fruits, number of fruits, number of fruits in each classification, with the exception of 1A class, average mass and average mass for classifications, except for the average masses of 1B, 1A and 2A classes (Table 2).

Regarding the estimated productivity, based on the Tukey means comparison test, at 5% probability, five groups were distinguished. The genotype MAR20#23 had the highest productivity with 17,162 kg ha^{-1}, followed by AR 01 (15,626 kg ha^{-1}) and PLANTA 7 with 15,130 kg ha^{-1}, differing statistically from the genotypes MAR20#29, PLANTA 5 and EC-3-0, which presented the lowest productivity, with 4,762, 4,625 and 4,097 kg ha^{-1}, respectively (Table 2).

Moreira et al. (2018), studying the same genotypes, obtained similar results in 20 harvests, with estimated productivities values for the genotypes MAR20#23 (15,474 kg ha^{-1}), PLANTA 7 (14,663 kg ha^{-1}) and AR01 (13,996 kg ha^{-1}), differing statistically from genotypes MAR20#29 and EC-3-0, which had the lowest yields, with 4,219 kg ha^{-1} and 4,055 kg ha^{-1}. It was possible to observe that the MAR20#29 inferior performance data obtained in this work, corresponded to data found by these authors.

Cavalcante et al. (2016), evaluating agronomic characteristics of four commercial cultivars, obtained yields of 15,759 and 11,664 kg ha^{-1} for the BRS Sol do Cerrado and BRS Gigante Amarelo genotypes, respectively. In this study, the yield obtained for the BRS Sol do Cerrado were relatively lower (8,650 kg ha^{-1}), but the productivity of the BRS Gigante Amarelo were very similar (11,665 kg ha^{-1}) to the one obtained by these authors. The differences between these results may have occurred because the genotypes used in this study were selected from allogamous plants, thus segregation may occur, which may result in yields differences.

Dias et al. (2017), evaluating the effects of Nitrogen and Potassium fertilizations in different passion fruit genotypes on Minas Gerais state, obtained a higher yield for the BRS Gigante Amarelo and BRS Sol do Cerrado (44.89 and 45.96 t ha^{-1}, respectively). This yields differences obtained by Dias et al. (2017) can be explained by the field management used by these authors, in that case, the higher fertilizer doses, which was, in some treatments, almost two times higher than the recommended dose.

The results found in this work, show that the EC-3-0 genotype had the lowest productivity value among the studied genotypes (4,097 kg ha^{-1}). According to IBGE (2018), the average national passion fruit production was 602,651 tons with an average yield of 14.10 t ha^{-1}. It is interesting to note that there was no artificial pollination in the current study, a procedure that would probably increase the productivity of the experiment, as it increases the pollination success and, consequently, the quantity of fruits. This procedure is commonly carried out in most commercial orchards. Genetic improvement studies usually do not adopt artificial pollination, because this procedure can cause an interference in the results.

Considering the fruit production per hectare, there was statistical differences between the evaluated genotypes. The genotypes that stood out with the greatest amount of fruit produced were PLANTA 1, FB 200 and MAR 20#23 with 156,026, 150,545, and 136,901 number of fruits per hectare, respectively. The PLANTA 5 genotype obtained the lowest amount of fruits per hectare (32,042 fruits) (Table 2), demonstrating the differences that can be observed between passion fruit genotypes.

Table 2. Estimated productivity and number of fruits per hectare for 32 genotypes of passion fruit cultivated at Fazenda Água Limpa during 28 harvests. Brasília-DF, 2020.

GENOTYPES	Estimated productivity kg ha^{-1}	Number of fruits per hectare
PLANTA 6	12,770.00^{abc}	95,482.00^{Ab}
MAR 20#40	10,001.00^{abc}	89,402.00^{Ab}
PLANTA 1	9,802.00^{abc}	156,026.00^{A}
MAR 20#29	4,762.00^{bc}	41,210.00^{Ab}
MAR 22#2005	10,405.00^{abc}	85,265.00^{Ab}
ROXO AUSTRALIANO	5,930.00^{abc}	77,285.00^{Ab}
MAR 20#15	13,690.00^{abc}	107,585.00^{Ab}
MSC	5,626.00^{abc}	48,842.00^{Ab}
RC3	6,242.00^{abc}	52,442.00^{Ab}
RUBI GIGANTE	11,026.00^{abc}	94,865.00^{Ab}
AR 01	15,626.00^{ab}	116,282.00^{Ab}
AR 02	10,001.00^{abc}	82,945.00^{Ab}
MAR 20#40	8,837.00^{abc}	78,401.00^{Ab}
BRS SOL DO CERRADO	8,650.00^{abc}	71,825.00^{Ab}
MAR 20#06	13,457.00^{abc}	111,557.00^{Ab}
PLANTA 5	4,625.00^{bc}	32,042.00^{B}
MAR 20#23	17,162.00^{a}	136,901.00^{Ab}
PLANTA 4	11,882.00^{abc}	93,637.00^{Ab}

PLANTA 2	12,545.00abc	112,897.00Ab
PLANTA 7	15,130.00abc	108,242.00Ab
MAR 20#03	13,925.00abc	110,890.00Ab
EC-3-0	4,097.00c	38,026.00Ab
MAR 20#10	9,802.00abc	99,226.00Ab
MAR 20#34	11,237.00abc	102,401.00Ab
MAR 20#21	14,885.00abc	131,770.00Ab
YELLOW MASTER FB200	10,817.00abc	150,545.00A
FP 01	11,026.00abc	91,810.00Ab
BRS GIGANTE AMARELO	11,665.00abc	114,922.00Ab
EC-RAM	7,057.00abc	57,122.00Ab
GA 2	11,665.00abc	101,762.00Ab
RENDONDÃO	8,465.00abc	74,530.00Ab
MAR 20#39	6,242.00abc	55,226.00Ab

*Means followed by the same letters do not differ by the Tukey test at 5% probability.

Regarding the estimated productivity and the number of fruits when related to the size classification, the 32 genotypes showed statistically significant differences, except for the 1A class, where the number of fruits did not show any statistical difference (Table 3).

It is worth mentioning that First class and 1B fruits are considered ideal for the industry, as they are not accepted in markets due to their small size. The other classes (1A, 2A and 3A) are destined for the in natura commercial markets (Pires et al. 2011).

Regarding the fruit average mass classification, the studied genotypes showed statistically significant differences, in the F test at 5% of significance, only in the first and 3A classifications. For the first-class fruits, the average mass ranged from 37g (genotypes Roxo Australiano, MAR 20 # 40 and EC-RAM) to 65g (PLANTA 7). In fruits classified as 3A, the highest average mass value was observed in the MSC genotype with 170g (Table 3). Moreira et al. (2018) observed similar results, with, first class average fruit mass ranging from 38 g in EC-RAM to 71 g in MAR20#15 and for the fruits classified as 3A, the MSC genotype also presented higher average mass, with 168g.

Cavalcante et al. (2016) obtained average fruit mass values in the order of 256.91g for the BRS Gigante Amarelo genotype, the highest average fruit mass achieved in his research. However, the cultivar FB 200 had the lowest fruit mass with an average value of 182.7g. In a study with thirty-five hybrids evaluated by Zaccheo et al. (2012), the average fruit mass varied between 130 and 205g. Jesus et al. (2018) pointed out that the highest average fruit mass obtained for the cultivars BRS Gigante Amarelo and BRS Sol do Cerrado, were 215g and 210g, respectively. Again, the cultivar FB 200 presented the lowest average among the three with 128g.

The genetic parameters for the estimated productivity, number of fruits and average mass variables are shown in Table 4. The observed heritability for estimated productivity was 62.6%. Heritability measures the degree of correspondence between phenotypic and genetic values, and high values of this parameter indicate that simple selection methods such as mass selection can lead to considerable gains, considering that the environment has little influence (Falconer 1987).

The ratio between coefficient of genetic variation and environmental variation, CVg/CVe ratio, indicate the relation between the genetic and environmental variability, and a value higher than one unit indicate a favorable situation for the genetic selection. The ratio observed in this study was 0.64, which reflects an unfavorable condition for selection, since the genetic variance was lower than the environmental variance. According to Cruz et al. (2013), values of this magnitude indicate that the use of simple improvement methods (i.e., mass selection) will not provide significant gains during the selection process. The use of breeding methods based on the performance of families is more appropriate than those that use selection based on the performance of individual plants.

For the number and average fruit mass, the heritability values and CVg/CVe ratio were 55% and 0.53; 22% and 0.26, respectively (Table 4). Among the classes, the number of fruits and estimated productivity showed the following heritability values (Table 5), in order: first class fruits (79% and 79%), 1B (54% and 62%), 1A (12% and 57%), 2A (44% and 61%) and 3A (62% and 61%).

Similar results were found by Moreira et al. (2018), who observed a heritability of 65% and CVg/CVe value of 0.69 for total yield, with 32 genotypes and 20 harvest. Viana et al. (2017), working with 95 sour passion fruit progenies, obtained heritability values and CVg/CVe ratio for estimated productivity of 63.01%. Silva et al. (2012) found different results, in a work carried out with 140 genotypes of complete siblings, where the estimates of heritability coefficients ranged from 19.54 to 71.38%. Two importantevaluated characteristics, number of fruits (NF) and estimated production (PT), showed low heritability estimates, with 39.19 and 28.04% respectively.

The CVg/CVe ratio was lower than one unit for most variables. However, for the estimated productivity and the number of first-class fruits classification (Table 5), the values of the CVg/CVe ratio were very close to 1 (0,98 and 0,96, respectively). These values indicate a favorable condition, since the genetic variance exceeds the environmental variance (Vencovsky 1987). The estimated heritability for these variables were also the highest found, contributing to the values of the CVg/CVe ratio.

Correlation is an important parameter in breeding programs since it allows simultaneous or indirect selection, especially when the character of interest has problems with measurement and identification or low heritability (Cruz et al. 2012).

Table 3. Number of fruits, Productivity (kg ha^{-1}) and Average mass (g) by fruit classification regarding the equatorial diameter. 2020.

PROGENIES	PT 1ª	NF 1ª	MM 1ª	PT 1B	NF 1B	MM1B	PT 1A
PLANTA 6	1,765.00^{abcde}	28,901.00^{abcdef}	50^{abc}	7,570.00^{abc}	50,177.00^{ab}	145^{a}	3,137.00^{abc}
MAR 20#40	2,602.00^{abc}	40,805.00^{abcd}	65^{abc}	5,777.00^{abc}	41,210.00^{ab}	145^{a}	1,370.00^{abc}
PLANTA 1	1,157.00^{abcde}	21,610.00^{abcdef}	50^{abc}	5,930.00^{abc}	48,401.00^{ab}	122^{a}	2,117.00^{abc}
MAR 20#29	677^{cde}	12,770.00^{cdef}	50^{abc}	3,250.00^{abc}	24,026.00^{ab}	122^{a}	785^{bc}
MAR 22#2005	1,850.00^{abcde}	31,330.00^{abcde}	65^{abc}	6,085.00^{abc}	42,437.00^{ab}	145^{a}	2,117.00^{abc}
ROXO AUSTRALIANO	901^{bcde}	19,601.00^{bcdef}	37^{c}	3,845.00^{abc}	42,850.00^{ab}	101^{a}	1,090.00^{abc}
MAR 20#15	2,117.00^{abcd}	35,722.00^{abcde}	65^{abc}	8,465.00^{abc}	57,601.00^{ab}	145^{a}	2,602.00^{abc}
MSC	290^{e}	5,330.00^{f}	50^{abc}	2,602.00^{c}	29,242.00^{ab}	101^{a}	1,850.00^{abc}
RC3	677^{cde}	14,162.00^{cdef}	50^{abc}	3,722.00^{abc}	29,242.00^{ab}	122^{a}	1,601.00^{abc}
RUBI GIGANTE	1,850.00^{abcde}	33,857.00^{abcde}	50^{abc}	6,725.00^{abc}	49,285.00^{ab}	122^{a}	2,210.00^{abc}
AR 01	1,850.00^{abcde}	31,330.00^{abcde}	50^{abc}	8,837.00^{abc}	63,505.00^{ab}	122^{a}	3,970.00^{a}
AR 02	901^{bcde}	18,226.00^{bcdef}	50^{abc}	5,777.00^{abc}	47,962.00^{ab}	122^{a}	2,810.00^{abc}
MAR 20#40	1,090.00^{abcde}	24,650.00^{abcdef}	37^{c}	4,625.00^{abc}	37,637.00^{ab}	122^{a}	2,501.00^{abc}
BRS SOL DO CERRADO	901^{bcde}	16,385.00^{cdef}	50^{abc}	4,901.00^{abc}	41,210.00^{ab}	101^{a}	2,402.00^{abc}
MAR 20#06	2,117.00^{abcd}	35,345.00^{abcde}	65ab^{c}	8,650.00^{abc}	63.002.00^{ab}	122^{a}	2,602.00^{abc}
PLANTA 5	530de	8,650.00^{ef}	65ab^{c}	2,602.00^{c}	16,642.00^{b}	145^{a}	1,297.00^{abc}
MAR 20#23	3,026.00^{ab}	45,797.00^{abc}	65^{ab}	10.001.00^{a}	71,825.00^{a}	145^{a}	3,845.00^{ab}
PLANTA 4	962^{bcde}	17,690.00^{cdef}	50^{abc}	7,057.00^{abc}	55,226.00^{ab}	122^{a}	3,137.00^{abc}
PLANTA 2	2,602.00^{abc}	42,026.00^{abcd}	50^{abc}	6,890.00^{abc}	55,226.00^{ab}	122^{a}	2,501.00^{abc}
PLANTA 7	2,117.00^{abcd}	30,977.00^{abcde}	65^{a}	8,101.00^{abc}	54,757.00^{ab}	145^{a}	4,226.00^{a}
MAR 20#03	1,937.00^{abcd}	34,970.00^{abcde}	50^{abc}	8,465.00^{abc}	59,537.00^{ab}	14^{a}	3,026.00^{abc}
EC-3-0	677^{cde}	11,665.00^{def}	50^{abc}	2,705.00^{bc}	21,317.00^{ab}	122^{a}	626^{c}
MAR 20#10	2,305.00^{abcd}	44,522.00^{abc}	50^{abc}	5,626.00^{abc}	44,522.00^{ab}	122^{a}	1,765.00^{abc}
MAR 20#34	2,305.00^{abcd}	41,210.00^{abcd}	50^{abc}	6,562.00^{abc}	49,730.00^{ab}	122^{a}	2,026.00^{abc}
MAR 20#21	3,601.00^{a}	55,226.00^{ab}	50^{abc}	9,802.00^{ab}	68,645.00^{a}	122^{a}	1,522.00^{abc}
YELLOW MASTER FB200	2,026.00^{abcd}	29,242.00^{abcdef}	65^{ab}	7,226.00^{abc}	62,501.00^{ab}	122^{a}	1,445.00^{abc}
FP 01	1,522.00^{abcde}	27,890.00^{abcdef}	50^{abc}	7,226.00^{abc}	52,901.00^{ab}	122^{a}	2,117.00^{abc}
BRS GIGANTE AMARELO	3,482.00^{a}	59,050.00^{a}	50^{abc}	6,242.00^{abc}	46,657.00^{ab}	122^{a}	1,682.00^{abc}
EC-RAM	785^{bcde}	17,425.00^{cdef}	37^{bc}	3,845.00^{abc}	28,562.00^{ab}	122^{a}	1,937.00^{abc}
GA 2	1,522.00^{abcde}	30,277.00^{abcdef}	50^{abc}	7,570.00^{abc}	59,050.00^{ab}	122^{a}	2,210.00^{abc}
RENDONDÃO	1,445.00^{abcde}	26,570.00^{abcdef}	50^{abc}	5,330.00^{abc}	40.001.00^{ab}	122^{a}	1,601.00^{abc}
MAR 20#39	1,025.00^{bcde}	19,045.00^{bcdef}	50^{abc}	3,722.00^{abc}	28,225.00^{ab}	122^{a}	1,226.00^{abc}

NF1ª: Number of first class fruits/ha, PT1ª: Estimated productivity for first class fruits (kg ha^{-1}), MM1ª: Average mass of first class fruits in g, NF1B: Number of 1B fruits/ha, PT1B: Estimated productivity for 1B fruits in kg ha^{-1}, MM1B: Average mass of 1B fruits in g, NF1A: Number of 1A fruits/ha, PT1A: Estimated productivity for 1A fruits in kg ha^{-1}, MM1A: Average mass of 1A fruits in g, NF2A: Number of 2A fruits/ha, PT2A: Estimated productivity for 2A fruits in kg ha^{-1}, MM2A: Average mass of 2A fruits in g, NF3A: Number of 3A fruits/ha, PT3A: Estimated productivity for 3A fruits in kg ha-^{1}, MM3A: Average mass of 3A fruits in g. Averages followed by the same letters do not differ by Tukey's test at the 5% level.

Table 3 (continued). Number of fruits, Productivity (kg ha^{-1}) and Average mass (g) by fruit classification regarding the equatorial diameter. 2020.

PROGENIES	NF 1A	MM 1A	PT 2A	NF 2A	MM 2A	PT 3A	NF 3A	MM 3A
PLANTA 6	13,925.00^{a}	226^{a}	290a^{b}	1,297.00^{ab}	226^{a}	10^{b}	37^{b}	65^{a}
MAR 20#40	6,725.00^{a}	197^{a}	10^{b}	37^{b}	50^{a}	0^{b}	0^{b}	0^{a}
PLANTA 1	52,901.00^{a}	122^{a}	485a^{b}	7,570.00^{a}	197^{a}	5^{b}	10^{b}	26^{a}
MAR 20#29	3,845.00^{a}	170^{a}	5^{b}	10^{b}	26^{a}	0^{b}	0^{b}	0a
MAR 22#2005	9,802.00^{a}	197^{a}	226a^{b}	901^{ab}	226^{a}	0^{b}	0^{b}	0^{a}
ROXO AUSTRALIANO	6,085.00^{a}	170^{a}	37^{ab}	2,210.00^{ab}	65^{a}	10^{b}	37^{b}	17^{a}
MAR 20#15	11,882.00^{a}	226^{a}	145a^{b}	577^{ab}	145^{a}	0^{b}	0^{b}	0^{a}
MSC	9,802.00^{a}	197^{a}	577a^{b}	2,305.00^{ab}	257^{a}	122^{a}	401^{a}	170^{a}
RC3	8,101.00^{a}	197^{a}	145a^{b}	730^{ab}	197^{a}	0^{b}	0^{b}	0^{a}
RUBI GIGANTE	10,405.00^{a}	197^{a}	170a^{b}	677^{ab}	145^{a}	0^{b}	0^{b}	0^{a}
AR 01	18,770.00^{a}	197^{a}	626^{a}	2,501.00^{ab}	257^{a}	17^{ab}	37^{b}	82^{a}
AR 02	14,401.00^{a}	197^{a}	290^{ab}	1,090.00^{ab}	257^{a}	0^{b}	0^{b}	0^{a}
MAR 20#40	12,322.00^{a}	197^{a}	577^{ab}	2,210.00^{ab}	145^{a}	0^{b}	0^{b}	0^{a}
BRS SOL DO CERRADO	11,882.00^{a}	197^{a}	197^{ab}	842^{ab}	226^{a}	10b	26b	26a
MAR 20#06	12,322.00^{a}	197^{a}	145^{ab}	577^{ab}	257^{a}	0^{b}	0^{b}	0^{a}
PLANTA 5	5,626.00^{a}	226^{a}	145a^{b}	577^{ab}	122^{a}	0^{b}	0^{b}	0^{a}
MAR 20#23	18,497.00^{a}	197^{a}	170a^{b}	730^{ab}	197^{a}	0^{b}	0^{b}	0^{a}
PLANTA 4	16,901.00^{a}	170^{a}	485a^{b}	2,210.00^{ab}	226^{a}	0^{b}	0^{b}	0^{a}
PLANTA 2	12,997.00^{a}	17^{a}	401a^{b}	1,445.00^{ab}	257^{a}	17^{b}	37^{b}	26^{a}
PLANTA 7	19,601.00^{a}	197^{a}	485a^{b}	2,026.00^{ab}	145^{a}	0^{b}	0^{b}	0^{a}
MAR 20#03	13,690.00^{a}	226^{a}	40^{ab}	1,601.00^{ab}	257^{a}	17^{ab}	50a^{b}	82^{a}
EC-3-0	3,845.00^{a}	170^{a}	26^{ab}	101^{b}	65^{a}	0^{b}	0^{b}	0^{a}
MAR 20#10	8,837.00^{a}	197^{a}	65^{ab}	290^{b}	101^{a}	0^{b}	0^{b}	0^{a}
MAR 20#34	10.001.00^{a}	197^{a}	145^{ab}	577^{ab}	122^{a}	0^{b}	0^{b}	0^{a}
MAR 20#21	7,397.00^{a}	197^{a}	50^{ab}	226^{b}	145^{a}	0^{b}	0^{b}	0^{a}
YELLOW MASTER FB200	43,265.00^{a}	122^{a}	65^{ab}	290^{b}	122^{a}	10^{b}	26^{b}	26^{a}
FP 01	10,202.00^{a}	197^{a}	65^{ab}	226^{b}	257^{a}	0^{b}	0^{b}	0^{a}
BRS GIGANTE AMARELO	8,282.00^{a}	197^{a}	65^{ab}	401^{ab}	122^{a}	0^{b}	0^{b}	0^{a}
EC-RAM	9,217.00^{a}	197^{a}	82^{ab}	325^{b}	122^{a}	0^{b}	0^{b}	0^{a}
GA 2	11,237.00^{a}	197^{a}	122^{ab}	626^{ab}	197^{a}	0^{b}	0^{b}	0^{a}
RENDONDÃO	7,745.00^{a}	197^{a}	50^{ab}	226^{b}	145^{a}	0^{b}	0^{b}	0^{a}
MAR 20#39	6,725.00^{a}	197^{a}	82^{ab}	362^{ab}	122^{a}	0^{b}	0^{b}	0^{a}

NF1ª: Number of first class fruits/ha, PT1ª: Estimated productivity for first class fruits (kg ha^{-1}), MM1ª: Average mass of first class fruits in g, NF1B: Number of 1B fruits/ha, PT1B: Estimated productivity for 1B fruits in kg ha^{-1}, MM1B: Average mass of 1B fruits in g, NF1A: Number of 1A fruits/ha, PT1A: Estimated productivity for 1A fruits in kg ha^{-1}, MM1A: Average mass of 1A fruits in g, NF2A: Number of 2A fruits/ha, PT2A: Estimated productivity for 2A fruits in kg ha^{-1}, MM2A: Average mass of 2A fruits in g, NF3A: Number of 3A fruits/ha, PT3A: Estimated productivity for 3A fruits in kg ha-^{1}, MM3A: Average mass of 3A fruits in g. Averages followed by the same letters do not differ by Tukey's test at the 5% level.

Table 4. Estimates of phenotypic (Vf), genotypic (Vg), environmental (Ve), wide sense heritability (ha2), genetic variation coefficient (CVg) and ratio between genetic and environmental variance coefficient (CVg/CVe), using 28 harvests data from 32 sour passion fruit genotypes in the Federal District, described for 3 response variables. Brasília, 2020.

Genetic Parameters	PT	NF	MMT
V_f (average)	316.99	2,978.02	0.46
V_e(average)	118.36	1,382.71	0.36
V_g(average)	198.62	1,594.31	0.10
h_a^2(average family)	62.65 %	53.53	22.12
CV_g	14.05%	13.40	3.00
CV_g/CV_e	0.64	0.53	0.26

PT: Estimated productivity in kg ha^{-1}, NF: Number of fruits per ha, MMT: Average fruit mass (g).

The phenotypic correlation values are shown in Table 6. From the evaluated data, it was possible to observe a strong positive phenotypic correlation between the estimated productivity and number of fruits (rf = 0.86). The estimated productivity and number of fruits for each classification also showed a positive and very strong phenotypic correlation (first class, rf = 0.98; 1B, rf = 0.96; 2A, rf = 0.82; 3A, rf = 1.00). Values of this magnitude indicate that the characters mentioned are directly related to the increase in the quantity of fruits, and estimated productivity observed in the experimental field.

Strong positive correlation values were found between the estimated productivity and estimated production for First class class (rf = 0.80), as 1B (rf = 0.98) and as 1A (rf = 0.78). In addition, the estimated productivity was also positively and strongly correlated with the number of fruits of the first and 1B classes (rf = 0.78 and 0.94 respectively). For the 3A fruits, very strong positive correlations were observed for the estimated productivity of 3A fruits and the average mass of fruits 3A class (rf = 0.92), shown in Table 6.

Similar results were found by Santos et al. (2017) and Moreira et al. (2018). Pimentel et al. (2008) affirm that these results favor the breeder's decision making, since when they select for plants with a higher number of fruits, it occurs indirectly selection for greater productivity.

It was possible to observe that in all fruit classifications, the estimated productivity showed a higher phenotypic correlation with the number of fruits than with the mass of the fruits (Table 6). Similar data were found by Silva et al. (2015), in which the estimated productivity showed a greater correlation with the number of fruits (rf = 0.971) and with the fruit mass (rf = 0.196), indicating that high productivity necessarily involves the selection of plants with a larger number of fruits.

Negative correlation values were found between the number and average fruit mass (rf = -0.25). Negative and significant phenotypic correlation values were observed between the number of 1A fruits and the average mass of 1A (rf = -0.60); average 1B fruit mass and estimated productivity, number of fruits and average fruit mass of 3A classification (rf = -0.5; rf = -0.53; and rf = -0.37, respectively). Similar results were observed in other works (Silva et al. 2015; Moreira et al. 2018).

This result indicate that a greater quantity of fruits means a lower average fruit mass. From these results, it appears that with the increase in the number of fruits, there may be a progressive reduction in their size. The negative correlation between number of fruits and average weight of fruits is an indication that the excessive number of fruits can lead to the production of fruits with less mass, with less commercial value (Koetz et al. 2010).

Negative correlations between these characters suggest that a breeding program need to increase the number of fruits to a level that does not cause excessive competition between fruits, causing a reduction in the average mass.

Table 5. Estimates of phenotypic (Vf), genotypic (Vg), environmental (Ve), wide sense heritability (ha²), coefficient of genetic variation (CVg) and the genetic variation coefficient and the environmental variation coeficient ratio (CVg/CVe), using data from 28 harvests of 32 genotypes of sour passion fruit in the field in the Federal District. Brasília, 2020.

Genetic Parameters	PT 1ª	NF 1ª	MM 1ª	PT 1B	NF 1B	MM 1B	PT 1A
V_f (average)	116.46	1620.93	0.22	198.19	1205.37	0.33	88.79
V_e(average)	23.88	34-.35	0.08	73.95	542.78	0.24	37.49
V_g(average)	92.54	1280.57	0.13	124.24	662.59	0.08	51.30
h_a^2(average family)	79.48	79.00	60.44	62.68	54.97	26.25	57.77
CV_g	24.39	21.75	4.83	14.42	12.08	2.59	15.59
CV_g/CV_e	0.98	0.96	0.61	0.64	0.55	0.29	0.58

NF1ª: Number of first class fruits/ha, PT1ª: Estimated productivity for first class fruits (kg ha^{-1}), MM1ª: Average mass of first class fruits in g, NF1B: Number of 1B fruits/ha, PT1B: Estimated productivity for 1B fruits in kg ha^{-1}, MM1B: Average mass of 1B fruits in g, NF1A: Number of 1A fruits/ha, PT1A: Estimated productivity for 1A fruits in kg ha^{-1}, NF2A: Number of 2A fruits/ha, PT2A: Estimated productivity for 2A fruits in kg ha^{-1}, MM2A: Average mass of 2A fruits in g, NF3A: Number of 3A fruits/ha, PT3A: Estimated productivity for 3A fruits in kg ha-^{1}, MM3A: Average mass of 3A fruits in g.

Table 5 (continued). Estimates of phenotypic (Vf), genotypic (Vg), environmental (Ve), wide sense heritability (ha²), coefficient of genetic variation (CVg) and the genetic variation coefficient and the environmental variation coeficient ratio (CVg/CVe), using data from 28 harvests of 32 genotypes of sour passion fruit in the field in the Federal District. Brasília, 2020.

Genetic Parameters	NF 1A	PT 2A	NF 2A	MM2A	PT 3A	NF 3A	MM3A
V_f (average)	1230.62	43.16	276.34	8.36	4.23	14.90	10.53
V_e(average)	1072.43	16.60	153.37	7.97	1.61	5.66	5.31
V_g(average)	158.19	26.55	122.97	0.38	2.62	9.24	5.21
h_a^2(average family)	12.85	61.52	44.49	4.64	61.91	62.01	49.54
CV_g	11.51	38.13	37.58	4.84	82.57	108.39	82.59
CV_g/CV_e	0.19	0.63	0.44	0.11	0.63	0.63	0.49

NF1ª: Number of first class fruits/ha, PT1ª: Estimated productivity for first class fruits (kg ha^{-1}), MM1ª: Average mass of first class fruits in g, NF1B: Number of 1B fruits/ha, PT1B: Estimated productivity for 1B fruits in kg ha^{-1}, MM1B: Average mass of 1B fruits in g, NF1A: Number of 1A fruits/ha, PT1A: Estimated productivity for 1A fruits in kg ha^{-1}, NF2A: Number of 2A fruits/ha, PT2A: Estimated productivity for 2A fruits in kg ha^{-1}, MM2A: Average mass of 2A fruits in g, NF3A: Number of 3A fruits/ha, PT3A: Estimated productivity for 3A fruits in kg ha-^{1}, MM3A: Average mass of 3A fruits in g.

Table 6. Estimates of phenotypic correlation values between characters from 32 genotypes of sour passion fruit cultivated at Fazenda Água Limpa. Brasilia, 2020.

	PT	NF	MMT	PT 1ª	NF 1ª	MM 1ª	PT1B	NF1B	MM1B
PT	1	0.86*	0.21	0.80*	0.78*	0.51*	0.98*	0.94*	0.48*
NF	-	1	-0.25	0.77*	0.77*	0.41*	0.87*	0.92*	0.18
MMT	-	-	1	-0.09	-0.16	0.33	0.15	-0.04	0.60*
PT 1ª	-	-	-	1	0.98*	0.54*	0.80*	0.74*	0.47*
NF 1ª	-	-	-	-	1	0.40*	0.78*	0.73*	0.42*
MM 1ª	-	-	-	-	-	1	0.52*	0.40*	0.56*
PT 1B	-	-	-	-	-	-	1	0.96*	0.49*
NF 1B	-	-	-	-	-	-	-	1	0.23
MM 1B	-	-	-	-	-	-	-	-	1
PT 1A	-	-	-	-	-	-	-	-	-
NF 1A	-	-	-	-	-	-	-	-	-
MM 1A	-	-	-	-	-	-	-	-	-
PT 2A	-	-	-	-	-	-	-	-	-
NF 2A	-	-	-	-	-	-	-	-	-
MM 2A	-	-	-	-	-	-	-	-	-
PT 3A	-	-	-	-	-	-	-	-	-
NF 3A	-	-	-	-	-	-	-	-	-
MM 3A	-	-	-	-	-	-	-	-	-

PT: Estimated productivity, NF: Number of fruits, MMT: Average fruit mass, NF1ª: Number of first class fruits/ha, PT1ª: Estimated productivity for first class fruits (kg ha-1), MM1ª: Average mass of first class fruits in g, NF1B: Number of 1B fruits/ha, PT1B: Estimated productivity for 1B fruits in kg ha-1, MM1B: Average mass of 1B fruits in g, NF1A: Number of 1A fruits/ha, PT1A:

Estimated productivity for 1A fruits in kg ha-1, NF2A: Number of 2A fruits/ha, PT2A: Estimated productivity for 2A fruits in kg ha-1, MM2A: Average mass of 2A fruits in g, NF3A: Number of 3A fruits/ha, PT3A: Estimated productivity for 3A fruits in kg ha-1, MM3A: Average mass of 3A fruits in g. * Significant at 5% probability.

Table 6 (continued). Estimates of phenotypic correlation values between characters from 32 genotypes of sour passion fruit cultivated at Fazenda Água Limpa. Brasilia, 2020.

	PT1A	NF1A	MM1A	PT2A	NF2A	MM2A	PT3A	NF3A	MM3A
PT	0.78*	0.45*	0.15	0.35*	0.19	0.47*	-0.08	-0.10	0.08
NF	0.54*	0.70*	-0.30	0.24	0.32	0.32	-0.03	-0.05	0.11
MMT	0.49*	-0.17	0.65*	0.35*	-0.10	0.35*	0.05	0.02	0.05
PT 1ª	0.33	0.17	0.08	-0.11	-0.19	0.05	-0.28	-0.29	-0.17
NF 1ª	0.32	0.14	0.10	-0.12	-0.16	0.05	-0.31	-0.32	-0.20
MM 1ª	0.28	0.29	-0.02	-0.02	-0.18	0.14	-0.12	-0.15	-0.09
PT 1B	0.69*	0.44*	0.09	0.22	0.10	0.42*	-0.16	-0.18	0.01
NF 1B	0.66*	0.52*	-0.06	0.26	0.21	0.44*	-0.01	-0.02	0.12
MM 1B	0.34	-0.05	0.50*	-0.04	-0.28	0.03	-0.51*	-0.53*	-0.37*
PT 1A	1	0.47*	0.30	0.74*	0.49*	0.70*	0.13	0.11	0.26
NF 1A	-	1	-0.60*	0.50*	0.62*	0.39*	0.18	0.16	0.30
MM 1A	-	-	1	0.07	-0.27	0.17	-0.09	-0.08	-0.07
PT 2A	-	-	-	1	0.82*	0.69*	0.47*	0.45*	0.54*
NF 2A	-	-	-	-	1	0.48*	0.42*	0.42*	0.50*
MM 2A	-	-	-	-	-	1	0.35*	0.33	0.41*
PT 3A	-	-	-	-	-	-	1	1.00*	0.92*
NF 3A	-	-	-	-	-	-	-	1	0.92*
MM 3A	-	-	-	-	-	-	-		1

PT: Estimated productivity, NF: Number of fruits, MMT: Average fruit mass, NF1ª: Number of first class fruits/ha, PT1ª: Estimated productivity for first class fruits (kg ha-1), MM1ª: Average mass of first class fruits in g, NF1B: Number of 1B fruits/ha, PT1B: Estimated productivity for 1B fruits in kg ha-1, MM1B: Average mass of 1B fruits in g, NF1A: Number of 1A fruits/ha, PT1A: Estimated productivity for 1A fruits in kg ha-1, NF2A: Number of 2A fruits/ha, PT2A: Estimated productivity for 2A fruits in kg ha-1, MM2A: Average mass of 2A fruits in g, NF3A: Number of 3A fruits/ha, PT3A: Estimated productivity for 3A fruits in kg ha-1, MM3A: Average mass of 3A fruits in g. * Significant at 5% probability.

4. Conclusions

The genotypes that stood out with the highest total productivity estimated were MAR20 # 23, AR 01 and PLANTA 7. The genotype MAR 20 # 23 also showed one of the highest values in terms of total number of fruits produced per hectare.

For industrial purposes, the highest productivity and the largest number of fruits per hectare were found in genotypes MAR 20 # 21 and BRS Gigante Amarelo. For fresh consumption, the genotypes with the best performance were, respectively, PLANT 7, AR 01 and MSC.

Total productivity estimated and total number of fruits per hectare in the first-class classification showed high values of heritability and CVg/CVe ratio. These results indicate a favorable condition for selection.

Authors' Contributions: VILELA, M.S.: conception and design, acquisition of data, analysis and interpretation of data, drafting the article; PEIXOTO, J.R.: acquisition of data, analysis and interpretation of data; RAMOS, S.D.R.: acquisition of data, drafting the article; SOUSA, R.M.D.: acquisition of data, analysis and interpretation of data, drafting the article; OLIVEIRA, A.P.: acquisition of data, analysis and interpretation of data, drafting the article; TOSCANO, M.A.F.: acquisition of data, analysis and interpretation of data, drafting the article; OLIVEIRA JUNIOR, A.A.: conception and design, acquisition of data, analysis and interpretation of data, drafting the article. All authors have read and approved the final version of the manuscript.

Conflicts of Interest: The authors declare no conflicts of interest.

Ethics Approval: Not applicable.

Acknowledgments: The authors would like to thank the funding for the realization of this study provided by the Brazilian agencies CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil), Finance Code 001, and CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico - Brasil). The authors would also like to thank the University of Brasilia (UnB) for the support of infrastructure and technical.

References

CARDOSO, M.R.D., MARCUZZO, F.F.N. and BARROS, J.R. Classificação Climática de Köppen-Geiger para o Estado de Goiás e o Distrito Federal. *Acta Geográfica*. 2014, **8**, 40-55. http://dx.doi.org/10.5654/acta.v8i16.1384

CAVALCANTE, N.R., et al. Productivity, fruit physicochemical quality and distinctiveness of passion fruit populations. *Revista Brasileira de Fruticultura*. 2016, **38**(4), e-142. https://doi.org/10.1590/0100-29452016142

CRUZ, C.D., REGAZZI, A.J. and CARNEIRO, P.C. *Métodos biométricos aplicados ao melhoramento genético*. 4th ed. Viçosa, MG: Universidade Federal de Viçosa, Imprensa Universitária, 2012.

CRUZ, C.D. GENES: a software package for analysis in experimental statistics and quantitative genetics. *Acta Scientiarum. Agronomy*. 2013, **35**(3), 271-276. https://doi.org/10.4025/actasciagron.v35i3.21251

DIAS, D.G., et al. Production and postharvest quality of irrigated passion fruit after n-k fertilization. *Revista Brasileira de Fruticultura*. 2017, **39**(3), e-553. https://doi.org/10.1590/0100-29452017553

FALCONER, D.S. *Introduction to quantitative genetics.* Viçosa, MG: Universidade Federal de Viçosa, Embrapa Arroz e Feijão, 1987.

FALEIRO, F.G., et al. Germoplasma e melhoramento genético do maracujazeiro: histórico e perspectivas. Planaltina: *Embrapa Cerrados,* 2011. Available from Internet: https://ainfo.cnptia.embrapa.br/digital/bitstream/item/76032/1/doc-307.pdf

FALEIRO, F.G., et al. 2018. Avanços e Perspectivas do Melhoramento Genético de Passifloras no Brasil In: MORERA, M.P., et al. *Maracujá: dos recursos genéticos ao desenvolvimento tecnológico*. Brasília, DF: Embrapa Cerrados, pp. 85-95. Available from Internet: https://www.embrapa.br/en/busca-de-publicacoes/-/publicacao/1101174/maracuja-dos-recursos-geneticos-ao-desenvolvimento-tecnologico

FALEIRO, F.G. and JUNQUEIRA, N.T.V. Maracujá: 500 perguntas e 500 respostas. Brasília, DF: Embrapa Informação Tecnológica, 2016. Available from Internet: https://www.embrapa.br/en/busca-de-publicacoes/-/publicacao/1061917/maracuja-o-produtor-pergunta-a-embrapa-responde

GUERRA, N.B. and LIVERA, A.V.S. Correlação entre o perfil sensorial e determinações físicas e químicas do abacaxi cv. Pérola. *Revista Brasileira de Fruticultura*. 1999, **21**(1), 32-35.

IBGE - Instituto Brasileiro de Geograria e Estatística. *Produção Agrícola Municipal*. 2018. Available from Internet: https://www.ibge.gov.br/estatisticas/economicas/agricultura-e-pecuaria/9117-producao-agricola-municipal-culturas-temporarias-e-permanentes.html?=&t=resultados

JESUS, C.A.S. de, et al. Fruit quality and production of yellow and sweet Passion fruits in northern state of São Paulo. *Revista Brasileira de Fruticultura*. 2012, **40**(2), e-968. https://doi.org/10.1590/0100-29452018968

KOETZ, M., et al. Qualidade de frutos do maracujazeiro-amarelo em ambiente protegido e natural produzidos sob diferentes regimes de irrigação. *Revista Brasileira de Agricultura Irrigada*. 2010, **4**(2), 115-126.

MELETTI, L.M.M. Avanços na cultura do maracujá no Brasil. *Revista Brasileira de Fruticultura*. 2011, **33**, 83-91. https://doi.org/10.1590/S0100-29452011000500012

MOREIRA, H.S.M., et al. Agronomic characterization and genetic parameter estimation in yellow passion fruit. *Bioscience Journal*. 2018, **34**(6), 58-70. https://doi.org/10.14393/BJ-v34n6a2018-39919

NOGUEIRA, I. *Caracterização agronômica e fisíco-química de progênies de maracujazeiro azedo (Passiflora edulis Sims) no Distrito Federal.* Brasília: Faculdade de Agronomia e Medicina Veterinária, Universidade de Brasília, 2016. Masters Dissertation.

PERUCH, L.A.M., COLARICCIO, A. and BATISTA, D.C. Controle de doenças do maracujazeiro: situação atual e perspectivas. *Agropecuária Catarinense.* 2018, **31**(1), 37-40. https://doi.org/10.22491/RAC.2018.v31n1.2

PIMENTEL, L.D., et al. Seleção precoce de maracujazeiro pelo uso da correlação entre dados de produção mensal e anual. *Pesquisa Agropecuária Brasileira*. 2008, **43**(10), 1303-1309. https://doi.org/10.1590/S0100-204X2008001000007

PIRES, M.M., JOSÉ, A.R.S. and CONCEIÇÃO, A.O. *Maracujá: avanços tecnológicos e sustentabilidade.* Ilhéus: Editus, 2011, pp. 237.

RANGEL, L.E.P. *Desempenho agronômico de nove genótipos de maracujazeiro-azedo cultivados sob três níveis de adubação potássica no Distrito Federal*. Brasília. Universidade de Brasília, 2002. Masters Dissertation.

SANTOS, C.L., et al. Relationship between yield and fruit quality of passion fruit c03 progenies under different nutritional levels. *Revista Brasileira de Fruticultura*. 2017, **39**(2), e-691. https://doi.org/10.1590/0100-29452017691

SILVA, F.H.L., et al. Generating relevant information for breeding *Passiflora edulis*: genetic parameters and population structure. *Euphytica*. 2015, **208**(3), 609–619. https://doi:10.1007/s10681-015-1616-8

SILVA, M.G.M., et al. Seleção recorrente intrapopulacional no maracujazeiro amarelo: Alternativa de capitalização de ganhos genéticos. *Ciência e Agrotecnologia*. 2009, **33**(1), 170-176. https://doi.org/10.1590/S1413-70542009000100024

SILVA, M.G.M., et al. Biometria aplicada ao melhoramento intrapopulacional do maracujazeiro amarelo. *Revista Ciência Agronômica*. 2012, **43**(3), 493-499.

VENCOVSKY, R. 1987. Herança quantitativa. In: PATERNIANI, E. and VIEGAS, G.P. (Eds.). *Melhoramento e produção de milho no Brasil*. Campinas: Fundação Cargil, pp. 137-214.

VIANA, A.P., et al. Implementing genomic selection in sour passion fruit population. *Euphytica*. 2017, **212**(10), Article number 228. https://doi.org/10.1007/s10681-017-2020-3

ZACCHEO, P.V.C., et al. Production and qualitative characteristics of the fruits of yellow passion fruit hybrids. *Revista Brasileira de Fruticultura*. 2012, **34**(4), 1113-1120. https://doi.org/10.1590/S0100-29452012000400019

Received: 26 April 2020 | **Accepted:** 22 July 2020 | **Published:** 16 February 2022