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Morphometry, floral resources and efficiency of natural and artificial pollination in fruit quality in cultivars of sour passion fruit

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Abstract - This study aimed to provide information on the biology and floral resources, stigmatic receptivity and viability of pollen grains during rainy season and dry season, and to evaluate the efficiency of natural and artificial pollination on quality of fruits of eight passion fruit cultivars sourced in Tangará da Serra - MT. Five commercial cultivars and three populations of the genetic improvement program of the sour passion fruit from the Universidade do Estado de Mato Grosso were evaluated. The climatic conditions of the rainy season favored the greater development of the floral pieces. The sugar concentration in the nectar presented higher averages in the rainy season, in all cultivars, except for FB 200. The climatic conditions of the dry season favored the replacement of the nectar volume. All cultivars evaluated presented pollen viability and stigmatic receptivity higher than 79% and 90%, respectively. The characteristics of fruit mass and percentage of pulp were better in artificial pollination, and the fruits obtained from natural and artificial pollination in all cultivars evaluated presented physical and chemical characteristics that are within the quality standards desired in the commercialization.
Index terms: Floral biology, climate, *Passiflora edulis.*

Morfometria, recursos florais e eficiência da polinização natural e artificial na qualidade de fruto em cultivares de maracujazeiro-azedo

Resumo - Este estudo visou a fornecer informações a respeito da biologia e dos recursos florais, da receptividade estigmática e da viabilidade dos grãos de pólen nas épocas de chuva e seca, e a avaliar a eficiência da polinização natural e artificial sobre a qualidade de frutos de oito cultivares de maracujazeiro-azedo, cultivadas em Tangará da Serra – MT. Foram avaliadas cinco cultivares comerciais e três populações do programa de melhoramento genético do maracujazeiro-azedo da Universidade do Estado de Mato Grosso. As condições climáticas da estação chuvosa favoreceram o maior desenvolvimento das peças florais. A concentração de açúcar no néctar apresentou médias mais elevadas na estação chuvosa, em todas as cultivares, com exceção de FB 200. As condições climáticas do período de seca favoreceram a reposição do volume de néctar. Todas as cultivares avaliadas apresentaram viabilidade polínica e receptividade estigmática superior a 79% e 90%, respectivamente. As características de massa de fruto e da porcentagem de polpa apresentaram-se melhores na polinização artificial. Os frutos obtidos de polinização natural e artificial, em todas as cultivares avaliadas, apresentam características físicas e químicas que estão dentro dos padrões de qualidade desejada na comercialização.
Termos para indexação: Biologia floral, clima, *Passiflora edulis*.

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Introduction

Brazil is one of the main centers of diversity of Passifloraceae family. Among the genera of the family, *Passiflora* sp. stands out and is the most representative with 139 species widely distributed in the national territory (BERNACCI et al., 2014).

The passion fruit, *Passiflora edulis Sims* is strongly influenced by climatic factors, such as temperature, precipitation and luminosity which together or alone, exert an important influence on plant longevity and yield (ZUCARELLI, 2011).

The temperature variation can influence the productivity of the sour passion fruit, directly affecting the fertilization. Environmental temperatures between 23 °C and 25 °C and precipitations between 60 mm to 120 mm monthly are considered optimal for the development of the crop (LIMA; BORGES, 2004; SÃO JOSÉ, 1993). High temperatures, higher than 37.5 °C during pre-flowering and flowering can cause low fertilization and crop irregularity reducing the effective period of stigmatic receptivity, and interfering with micros porogenesis or micro gametogenesis (SANZOL; HERRERO, 2001; SOUZA et al., 2002), in the number of pollen grains, viability, fertilization, and fruiting (HEDHLY, 2003).

Factors, such as day length, temperature, solar radiation and precipitation, are responsible for changing the nectar volume rate of the flowers (ATAÍDE et al., 2006). Concentrations and amounts of nectar are important in the energy balance of pollinators. The nectar concentration usually changes fundamentally under meteorological influence. In conditions of very dry climate and if the nectar is exposed it can crystallize in the nectary. On the other hand, nectar may also become aqueous on rainy days unless it is protected by the corolla tube (FAEGRI;PIJL, 1979).

In sour passion fruit, in addition to climatic conditions, pollination efficiency is also associated with the morphological adaptations of the flowers to the temporal synchronization between the opening hours of the flower and the deflection of the stilettos to the collection of floral resources.

Considering the above, this study aims to provide information on floral morphometry, variations in the availability of floral resources during drought and rainy seasons, and to evaluate the efficiency of natural and artificial pollination on fruit quality of eight cultivars of passion fruit cultivated in Tangará da Serra - MT.

Material and methods

The experiment was conducted in the experimental area of the State University of Mato Grosso (UNEMAT), located in the municipality of Tangará da Serra - MT (14º37'10"S and 57º29'09"W, 321 m altitude).

Tangará da Serra has a humid tropical climate with two distinct seasons. The rainy season comprises the months of October to April, and the dry season from May to September. Annual average rainfall ranging from 1300 to 2000 mm and temperature between 16 to 36 °C (MARTINS et al., 2010). The climatic data referring to the rainy and dry periods of 2013 and 2014 were obtained through the meteorological station of UNEMAT Campus of Tangará da Serra - MT.

Five commercial cultivars ('BRS Sol do Cerrado', 'BRS Gigante Amarelo', 'BRS Rubi do Cerrado', 'FB 200', 'IAC 275') and three populations from the genetic improvement program of the sour passion fruit of UNEMAT , called UNEMAT S10, UNEMAT S5 and UNEMAT C5.

The evaluations of floral morphometry, nectar secretion volume and nectar sugar concentration, pollen viability and stigmatic receptivity were performed in two seasons. The first one was in the rainy season in January and February, and the second in the dry season in June and July, 2014. The experimental design was a completely randomized in factorial scheme 8 x 2 (genotypes x evaluation season) with four replications.

For the study of floral morphometry, 20 flowers of each plot were collected in each evaluated period. Completely opened flowers were collected between 2:30 p.m. and 3:30 p.m. where with a help of a digital caliper was evaluated: Length of sepals, Length of petals from the base of the structure of sepals and petals, respectively. Crown diameter, Length of crown filaments and Number of crown series, Length of anthers, Height of stamens measured from the base of the fillet to the apex of the anthers, Length of the androgynophore, Height of the pistil measured from the base of the stylus to the apex of the stigma, length of the stigmatic surface, distance from the nectariferous chamber to the surface of the anthers and percentage of flowers with fully curved stilettos.

For the nectar volume evaluation and sugar concentration in the nectar, five pre-anthesis flower buds per plot were bagged and marked for each evaluation period. The first nectar volume evaluation occurred at 1:00 p.m. (beginning of the anthesis) using a graduated micro-capillary (precision ± 0.2 µL). The total nectar content was withdrawn, measured and discarded and the flowers re-bagged. The calibration of the nectar volume was performed at 5:30 p.m. on the same day. The concentration of sugar in the nectar was performed using an Instrutherm® portable refractometer.

For pollen viability evaluation, flower buds were marked and pre-bagged in pre-anthesis during rainy and dry seasons. In the anthesis, five floral buds of each plot were collected, totaling 20 buds per cultivar. The pollen grains were collected and arranged on histological slides, being 160 slides analyzed. Then it added a drop of carmine acetic dye. It counted 200 pollen grains per slide.

Pollen grains stained in red were considered viable, while colorless grains were considered nonviable. The stigmatic receptivity was evaluated in five pre-anthesis floral buds for each plot, previously marked and bagged. In the evaluation, 3% of Hydrogen Peroxide and Alpha-Naphthyl Acetate were used to indicate the presence of peroxidase and esterase enzymes, respectively. The stigmas collected were immediately immersed in flasks containing the test solution. Afterwards they were observed under Leica S6D Microsystems stereoscopic microscope with coupled digital camera.

The floral morphometry, nectar sugar volume and concentration, pollen viability and stigma receptivity were submitted to analysis of variance, and the effects of the treatments were compared by the Tukey test at a 5% probability by statistical program Sisvar (FERREIRA, 2011). For the volume and sugar concentration characteristics of the nectar, the data transformation $\sqrt{x+0.5}$ was performed to maintain the homogeneity of variance.

The physical and chemical characteristics of fruits from artificial and natural pollination were performed on 20 floral buds of each plot.

In artificial pollination, pollen grains of 20 flowers of the same plot were collected manually and mixed in petri dish. Soon after, the pollen grains were deposited with a brush in the anthesis flowers, previously bagged according to Junqueira et al. (2001). After artificial pollination these flowers were re-bagged and thus remained until fruit formation or flower drop.

In natural pollination, 20 floral buds of each plot were identified in the pre-anthesis and left exposed to the floral visitors. The development and maturation of fruits was monitored weekly.

Fruits from natural and artificial pollination were collected manually and taken to the Post Harvest Laboratory where the following physical characteristics were evaluated: Fruit mass (g); fruit length (mm); fruit diameter (mm) obtained with the arithmetic mean of the transversal dimensions of the fruits and peel thickness (mm) determined by means of the arithmetic mean of the measurements on four points of the outer peel.

The evaluated chemical characteristics were: Percentage of pulp: obtained by weighing the pulp (seeds with aril), dividing this value by the fruits total weight; Total soluble solids content, Pulp coloration: obtained by the visual evaluation of the pulp color of the fruits, using a scale of notes adapted from Linhales (2007). Titratable total acidity was determined according to the methodology recommended by AOAC - Association of Official Agriculture Chemists (1990) and modified by Araújo (2001).

The physical and chemical characteristics of the fruits were submitted to analysis of variance and the effects of the treatments were compared by the Tukey test at 5% probability by the statistical program Sisvar (FERREIRA, 2011).

Results and discussion

The period and cultivar factors showed significant interaction only for the crown diameter in the rainy and dry seasons, for the cultivars UNEMAT C5 and IAC 275 (Table 1). In the cultivar UNEMAT S5 the effect was verified only in dry season (Table 1).

The climatic conditions of the study region in the rainy season, such as mean precipitation of 150 mm, mean temperature of 25 °C and day length above 12 hours of light (Figure 1), favored the greater development of floral characteristics, such as length of sepals, petals, corona filaments, anther, androgynophore, pistil and stigmatic surface in all analyzed cultivars (Table 2). Region where day length is greater than 11 hours of light and temperature, between 23 to 25 °C as observed in this study are considered ideal for the flowering of sour passion fruit (CAVICHIOLI et al., 2006; BORGES; LIMA, 2009).

The dry season favored the deflection of sour passion fruit stilettos. Fully curved stilettos were observed in 92.34% of analyzed flowers in this period (Table 2). There are no reports in the literature on which physiological processes allied to the climatic conditions can influence the stiletto deflection in Passifloraceae.

The length of the androgynophore ranged from 9.9 to 11.8 mm (Table 3). The passion fruit tree presents columnar androgynophore that supports the reproductive structures where its length has the function of limiting the favorable conditions so that the pollination is carried out by bees of medium or small size (OLIVEIRA et al., 2011). Similarly, the distance from the nectar chamber to the anthers surface ranged from 12.3 (IAC 275) to 13.8 mm UNEMAT C5 (Table 3). This distance between the nectary and the anthers is compatible with the size of carpenter bees and facilitates touching the flower reproductive structures at the moment they collect nectar, favoring cross-pollination.

No significant difference was observed for nectar volume produced by the eight cultivars evaluated in the rainy season (Table 4). In the dry season, only the cultivars BRS Rubi do Cerrado and IAC 275 presented significant differences for this characteristic (Table 4). The average volume of nectar produced in the dry season was 1.6 times higher when compared to the average volume of produced nectar during the rainy season (Table 4). In *Passiflora edulis* the replenishment of nectar is uninterrupted. Higher nectar replacement rates were observed in the dry season (mean of 30.68 µL) when compared to the rainy season (mean of 19.87 µL).

Table 1. Summary of variance analysis for the characteristics of sepal length (SL) (mm), petal length (PL) (mm), crown diameter (CD) (mm), crown filament length (CFL) (mm), anther length (AL) (mm), anther height (AH) (mm), androgynophore length (andH) (mm), stigma height (SH) (mm) , stigmatic surface length (SSl) (mm), distance from the nectariferous chamber to the anthers surface (DNAS) (mm) and totally curved stiletto (TC) (%) in eight cultivars of passion fruit, Tangará da Serra - MT, 2014

FV	GL	Average square of evaluated characteristics										
		SL	PL	CD	CFL	AL	AH	andH	SH	SSl	DNAS	TC
Period (P)	1	230.35**	93.8**	4.05^{ns}	93.9**	3.04**	.03^{ns}	8.65**	57.89**	8.25**	0.03^{ns}	17226.56**
Cultivar (C)	7	8.63*	15.7**	68.2**	28.6**	1.09**	1.31*	2.52**	1.75^{ns}	0.42^{ns}	1.82**	98.21^{ns}
PxC	7	1.79^{ns}	5.42^{ns}	59.7**	11.1^{ns}	0.05^{ns}	0.64^{ns}	0.25^{ns}	1.27^{ns}	0.23^{ns}	0.60^{ns}	227.45^{ns}
Error	48	2.99	3.36	17.3	5.77	0.34	0.54	0.67	2.29	0.20	0.39	229.94
Total	63	-	-	-	-		-	-	-	-	-	
Mean	-	34.2	35.5	68.4	31.8	13.4	10.1	17.18	14.43	3.56	13.11	75.93
CV(%)	-	5.06	5.16	6.08	7.54	4.36	7.31	4.78	10.50	12.8	4.76	19.97

^{ns}Not significant. **and* Significant at 1 and 5% probability, respectively, by the test F.

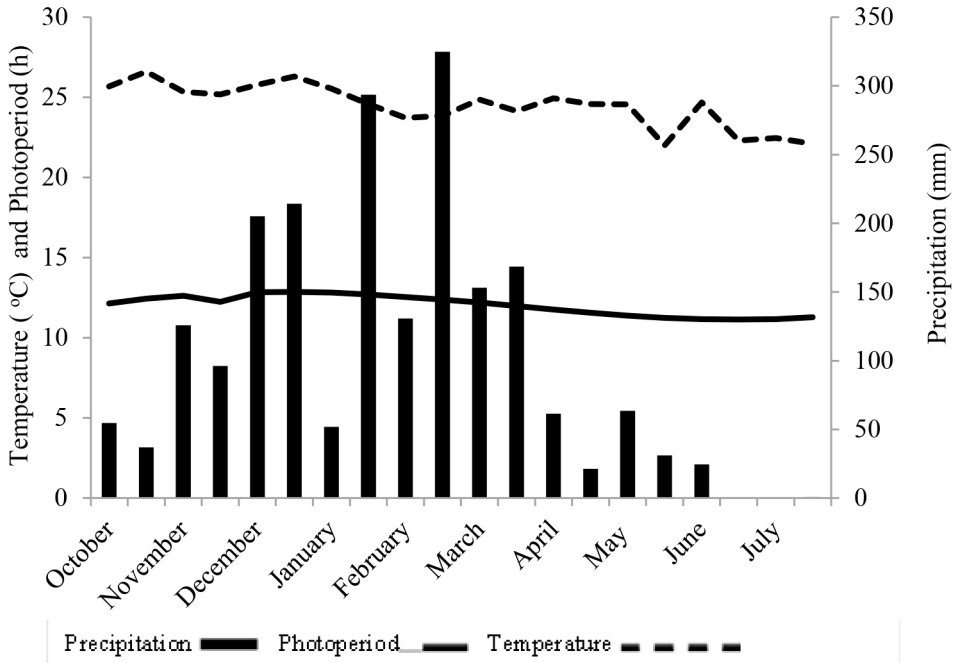

Figure 1- Meteorological variables observed every two weeks from October 2013 to July 2014, Tangará da Serra – MT.

Table 2. Averages for the characteristics of the sepal length (SL) (mm), petal length (PL) (mm), crown filaments length (CFL)(mm), anther length (AL) (mm), androgynophore length (andL) (mm), stigma height (SH) (mm), stigmatic surface length (SSl) (mm), and percentage of totally curved stylet (TC) in eight cultivars of sour passion fruit, Tangará da Serra- MT, 2014

Season	SL	PL	CFL	AL	andL	SH	SSl	TC
Rain	36.1a	36.7a	33.0a	13.6a	17.5a	15.3a	3.9a	59.5b
Dry	32.3b	34.3b	30.6b	13.1b	16.8b	13.4b	3.2b	92.3a

Means followed by the same letter in the column did not differ statistically by the Scott-Knott test at 1% probability.

Table 3. Averages for the characteristics of the sepal length (SL) (mm), petal length (PL) (mm), crown filaments length (CFL) (mm), anther length (AL)(mm), anther height (AH) (mm) androgynophore length (andL) (mm), distance from the nectariferous chamber to the anthers surface (DNAS) (mm) in eight cultivars of sour passion fruit, Tangará da Serra-MT, 2014

Cultivars	Evaluated Characteristics						
	SL	PL	CFL	AL	AH	andH	DNAS
BRS Sol do Cerrado	34.8a	37.0a	33.0a	13.3ab	10.5a	11.1ab	13.4ab
BRS Gigante Amarelo	32.9a	35.1ab	29.9ab	13.6a	10.0a	10.9ab	12.8bc
BRS Rubi do Cerrado	34.2a	35.5ab	30.5ab	13.7a	9.7a	11.4a	13.0abc
FB 200	33.5a	34.4ab	31.4ab	13.5a	9.7a	11,2ab	12.7bc
UNEMAT S5	35.2a	37.1a	33.7a	13.3ab	10.3a	11.8a	13.4ab
UNEMAT S10	35.1a	36.1a	33.6a	13.4a	9.6a	11.2ab	13.2abc
UNEMAT C5	35.1a	35.9a	33.5a	13.5a	10.7a	11.6a	13.8a
IAC 275	32.6a	32.9b	28.8b	12.5b	9.9a	9.9b	12.3c
Means	34.2	35.5	31.8	13.3	10.1	17.18	13.1
CV(%)	5.0	5.1	7.5	4.3	7.3	4.78	4.7

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

Table 4. Mean values of nectar volume (NV) (µL) in eight cultivars of passion fruit during rainy season (October to April) and dry season (May to September), Tangará da Serra - MT, 2013-2014.

Cultivars	Season	
	Rain	Dry
BRS Sol do Cerrado	13.0bA	22.5aAB
BRS Gigante Amarelo	15.0bA	25.0aAB
BRS Rubi do Cerrado	13.0bA	34.0aA
IAC 275	12.5 aA	8.5aD
FB 200	14.5bA	23.0aAB
UNEMAT S5	15.0aA	15.5aBC
UNEMAT S10	13.0aA	14.0aBC
UNEMAT C5	12.0aA	15,0aBC

Means followed by the same lowercase letter in the row and upper case in the column do not differ from each other in the Tukey test at the 5% probability level.

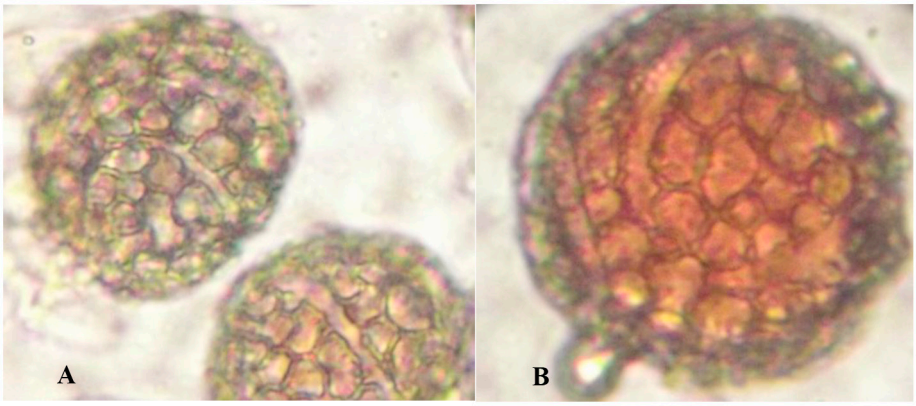

Figure 2- A - Unviable pollen grains (uncolored grains) and B - Viable pollen grains (color of protoplast carmine).

Higher nectar production may be associated with pollinating insects behavior (VARASSIN et al., 2001) which flowers tend to be more visited (STOUT; GOULSON, 2002), leading to an increase in the reproductive success of individuals (REAL; RATHCKE, 1991).

The sugar concentration in the nectar of the present study cultivars did not differ significantly between rainy and dry seasons. For the rainy season this concentration varied from 42.0% in BRS Rubi do Cerrado to 49.1% in BRS Sol do Cerrado. During the dry season this variation was 41.2% in the BRS Rubi do Cerrado cultivar to 50.0% in FB 200. In studies conducted in the state of Paraná, Varassin et al. (2012) found a mean sugar concentration in the nectar of 57%.

All cultivars evaluated had a percentage of pollen viability and stigmatic receptivity above 80%. The evaluated pollen grains presented carmine protoplast color when viable and transparent and not colored when not viable (Figure 2). Souza et al. (2002) and Cobra et al. (2015) in studies with *P. edulis* obtained pollen viability greater than 88%.

The viability of pollen grains is important in the knowledge of the reproductive biology of the species (SEREJO et al., 2012). However, climatic factors such as relative air humidity and temperature can influence the viability of these grains (FERREIRA et al., 2007). When the anther opening coincides with high air humidity, the high osmotic pressure of the cellular content in the pollen grain, together with the low resistance of its peel, decreases this viability (SOUSA, 1994). In studies by Souza et al. (2002) pollen grains were observed anucleated and unviable or with retracted cytoplasm. The authors believe that the temperature (37.5 °C) may have interfered with micro sporogenesis or micro gametogenesis.

In the evaluation of fruit quality, no significant interaction between the pollination factor and cultivar was observed for the evaluated characteristics (Table 5). Our results demonstrate that the pollination type interfered only with fruit mass characteristics and percentage of pulp (Table 5).

The fruit mass from artificial pollination was 12.52% higher than the fruit mass originated from natural pollination (Table 6). The percentage of pulp in fruits from artificial pollination presented an average of 19% more pulp compared to fruits from natural pollination (Table 6).

When the pollination methods are disregarded, the fruit mass and percentage of pulp recorded in this study are similar to the results reported by Cavalcante et al. (2016) for the same cultivars and same study area. According to Meletti et al. (2000) the fruits of larger sizes are desirable to meet mainly the *in natura* market.

The characteristics of total soluble solids, pulp color, pH, ratio, fruit length, peel thickness and fruit length / fruit diameter allow to evaluate the organoleptic and flavor properties of the fruit, guaranteeing their quality for fresh and industrial consumption (BRAGA et al., 2005). In this study it was verified that the pollination type did not interfere significantly in these characteristics (Table 6).

Regarding to fruit length characteristic the highest value was observed in the cultivar FB 200 (93.6 mm) (Table 7). Lower values (87.4 mm) were recorded by Ferreira et al. (2016) with the same evaluated cultivar.

The cultivars BRS Sol do Cerrado and UNEMAT S10 presented significant differences in relation to the ratio (Table 7). Cavalcante et al. (2016) reported ratio values ranging from 3.15 to 3.99 in seven out of eight cultivars analyzed in the present study, and Greco et al. (2014) found values varying from 2.12 to 3.02.

The ratio indicates the equilibrium degree between the sugar and organic acids contents of the fruit and is therefore an important characteristic to be considered in the selection of "table varieties", that is, for fresh consumption (COHEN, 2008). Usually, the higher the ratio value, more palatable is the fruit juice or pulp (GRECO et. al., 2014).

The largest diameter of the fruit was observed in the cultivar BRS Gigante Amarelo (86.93mm) (Table 7). Aguiar et al. (2015) when working with hybrids of sour passion fruit observed production of fruits with diameter greater than (55 mm).

Fruits of sour passion fruit are classified commercially in relation to the measure of their diameter (KRAUSE et al., 2012). This characteristic is considered a very useful parameter for fruits destined to the fresh market that have preference for large and oval fruits (CAVICHIOLI et al., 2011).

The thickness of the peel varied between (10.13 mm) in the cultivar BRS Gigante Amarelo and (7.31 mm) in IAC 275 (Table 7). The obtained results in this study are similar to those observed by Cobra (2015), when working in the same study area, where the averages ranged from (6.7mm) to (12.2mm), and Figueiredo et al. (2015) that obtained values between (7.48mm) to (9.53mm). Brito et al. (2005) in studies using treatments with different sources, and doses of organic fertilizers in passion fruit registered differences in the peel thickness evidencing that this characteristic is directly linked to nutritional factors.

Fine peel fruit meets a requirement of the fruit processing industry while a thicker peel is a desirable feature to meet the fresh market, as it gives the fruit greater resistance to transport and loss of quality during storage and marketing (ABREU et al., 2009).

The fruits of sour passion fruit, regardless of pollination method, should have characteristics that are the primary parameters evaluated by consumers. According to Balbino (2005) the quality fruit is one that meets the expectations of the different consumer segments in their internal and external characteristics.

Out of eight floral characteristics evaluated in the rainy and dry periods, four were influenced by the rainy season and two influenced by the dry season. The artificial pollination favored the characteristic of fruit mass and pulp percentage.

Table 5. Summary of the analysis of variance for the fruit mass (FM), percentage of pulp (PP), total soluble solids (TSS), pulp color (PC), hydrogenation potential (pH), total titratable acidity (TTA), ratio (TSS / TTA), fruit diameter (FD), fruit length (FL), fruit length / fruit diameter ratio (FL / FD), and peel thickness (PT) in eight cultivars of passion fruit, Tangará da Serra - MT, 2014

FV	GL	Average square of evaluated characteristics										
		FM	PP	TSS	PC	pH	TTA	TSS/TTA	FD	FL	FL/FD	PT
	3	3427.7	21.79	6.66	0.26	0.09	0.28	0.51	27.38	118.4	0.09	0.67
Pollination Blocks (P)	1	13685.78*	1476.09**	7.68^{ns}	0.01^{ns}	0.00^{ns}	0.37^{ns}	0.11^{ns}	5.42^{ns}	53.49^{ns}	0.02^{ns}	3.68^{ns}
Cultivar (C)	7	8083.0**	88.17^{ns}	3.90^{ns}	0.40^{ns}	0.03^{ns}	0.49^{ns}	0.59^{ns}	161.8**	259.1^{ns}	0.03^{ns}	7.26*
PxC	7	5558.3^{ns}	141.1^{ns}	5.47^{ns}	0.01^{ns}	0.04^{ns}	0.09^{ns}	0.39^{ns}	20.23^{ns}	134.8^{ns}	0.03^{ns}	1.05^{ns}
Error	45	2376.1	83.88	2.54	0.28	0.02	0.39^{ns}	0.32	37.12	186.5	0.02	2.52
Total	63	-	-	-	-		-	-	-	-	-	
Mean	-	219.39	45.85	10.9	4.35	3.31	3.42	3.32	80.16	89.06	1.11	9.21
CV (%)	-	22.22	19.98	14.5	12.3	.99	18,28	17.25	7.60	15.34	14.26	17.25

^{ns}Not significant. **and* Significant at 1 and 5% probability, respectively, by the F test

Table 6. Means for the fruit mass (FM), percentage of pulp (PP), total soluble solids (TSS), pulp color (PC), hydrogenation potential (pH), total titratable acidity (TTA), ratio TSS / TTA), fruit diameter (FD), fruit length (FL), fruit length / fruit diameter ratio (FL / FD), and peel thickness (PT) with artificial and natural pollination. Tangará da Serra -MT, 2014

	Evaluated Characteristics										
	FM	PP	TSS	PC	pH	TTA	Ratio	FD	FL	FL/FD	PT
Pollination/	(g)	(%)	(°Brix)				TSS/TTA	----------(mm)---------			
Natural	204.7b	41.0b	10.6a	4.3a	3.3a	3.3a	3.3a	80.4a	89.9a	1.1a	9.4a
Artificial	234.0a	50.6a	11.3a	4.3a	3.3a	3.5a	3.2a	79.8a	88.1a	1.1a	8.9a

Means followed by the same lowercase letter in the column do not differ from each other by Tukey test at 5% probability

Table 7. Averages for fruit mass (FM), percentage of pulp (PP), total soluble solids (TSS), pulp color (PC), hydrogenation potential (pH), total titratable acidity (TTA), ratio (TSS / TTA), fruit diameter (FD), fruit length (FL), fruit length / fruit diameter ratio (FL / FD), and peel thickness (PT) in eight cultivars of passion fruit. Tangará da Serra -MT, 2014

Cultivars	Evaluated Characteristics										
	FM	PP	TSS	PC	pH	TTA	Ratio	FD	FL	FL/FD	PT
	(g)	(%)	(°Brix)				TSS/TTA	----------(mm)----------			
BRS Sol do Cerrado	240.9a	49.1a	11.0a	4.2a	3.2a	3.0a	3.7a	77.0bc	91.4a	1.2a	9.8ab
BRS Gigante Amarelo	227.5a	50.7a	10.9a	4.2a	3.3a	3.2a	3.6ab	86.9a	87.3a	1.0a	10.1a
BRS Rubi do Cerrado	238.1a	42,7a	10.5a	4.2a	3.4a	3.5a	3.3ab	84.0ab	88.0a	1.0a	10.0a
FB 200	219.2ab	43.5a	9.9a	4.4a	3.4a	3.8a	3.2ab	78.9abc	93.7a	1.2a	8.8ab
UNEMAT S5	241.2a	44.5a	11.2a	4.5a	3.3a	3.6a	3.3ab	82.0ab	93.1a	1.1a	9.9ab
UNEMAT S10	211.5ab	41.7a	10.3a	4.7a	3.3a	3.7a	2.8b	79.1abc	92.4a	1.2a	8.7ab
UNEMAT C5	231.5a	45.6a	11.8a	4.0a	3.3a	3.5a	3.4ab	81.1abc	90.2a	1.1a	8.9ab
IAC 275	145.2b	48.8a	11.9a	4.5a	3.3a	3.6a	3.2ab	72.2bc	76.2a	1.0a	7.3b

Means followed by the same lowercase letter in the column do not differ from each other by the Tukey test at 5% probability

Conclusions

The climatic conditions of the rainy season favor the better development of the floral pieces.

The volume of nectar was higher in the dry season in all cultivars, and the sugar concentration increased in the rainy season with the exception of cultivar FB 200.

The characteristics of fruit mass and percentage of pulp were higher by means of artificial pollination.

The fruits obtained from natural and artificial pollination in all evaluated cultivars have physical and chemical characteristics that are within the standard quality desired in the commercialization.

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