Obtaining and validating descriptors for the wild passion fruit 'BRS Pérola do Cerrado' ('BRS PC') in different yield systems

Fonseca, Kenia Gracielle[1,3], Fábio Gelape Faleiro[2], Nilton Tadeu Vilela Junqueira[2], Ana Maria Costa[2]

[1]Universidade de Brasília, UnB, Brasil; [2]Embrapa Cerrados, Brasil; [3]kenia.gfonseca@gmail.com

Fonseca, Kenia Gracielle, Fábio Gelape Faleiro, Nilton Tadeu Vilela Junqueira, Ana Maria Costa (2018) Obtaining and validating descriptors for the wild passion fruit 'BRS Pérola do Cerrado' ('BRS PC') in different yield systems. Rev. Fac. Agron. Vol 117 (2): 275-283.

Wild passion fruit specimens are alternatives to diversify the production system. Wild passion fruit 'BRS Pérola do Cerrado' ('BRS PC') was developed from *Passiflora setacea* species, and has increased yield, diseases resistance, it is also an alternative to the market of special fruits and has an ornamental potential. The purpose of the present study was to obtain and validate the descriptors used in the process of protecting the *Passiflora setacea* 'BRS Pérola do Cerrado' taking into consideration the commercial growth in different yield systems. Descriptors were obtained using 24 structures (branches, leaves, flowers and fruits) of plants conducted in trellis (conventional, organic and high technology) and in espalier systems (conventional and high technology). Analysis of frequency distribution and the multivariate analysis for the qualitative descriptors were carried out. The quantitative descriptors were evaluated through the analysis of variance and means comparison in each yield system. A high validation rate was found for descriptors from different systems. However, the analysis of variance showed significant differences among 10 quantitative descriptors in different yield systems. Higher differences were found for descriptors obtained in plants grown in an organic system. It is find that the descriptors are useful in the cultivar characterization and validation, but changes in the descriptors codification might occur due to the genotype × environment interaction.

Keywords: *Passiflora setacea*; variety protection; multivariate; analysis of variance; genotype × environment interaction.

Fonseca, Kenia Gracielle, Fábio Gelape Faleiro, Nilton Tadeu Vilela Junqueira, Ana Maria Costa (2018) Obtenção e validação de descritores para a cultivar de maracujazeiro silvestre 'BRS Pérola do Cerrado' ('BRS PC') em diferentes sistemas de produção. Rev. Fac. Agron. Vol 117 (2): 275-283.

Espécies silvestres de maracujazeiro são alternativas para diversificar os sistemas de produção. O maracujazeiro silvestre 'BRS Pérola do Cerrado' ('BRS PC') foi desenvolvido a partir da espécie *Passiflora setacea* e apresenta maior produtividade, resistência a doenças, além de ser uma alternativa para o mercado de frutas especiais e apresentar potencial ornamental. O objetivo deste trabalho foi obter e validar os descritores utilizados no processo de proteção do maracujazeiro 'BRS Pérola do Cerrado' (*Passiflora setacea*), considerando o cultivo comercial em diferentes sistemas de produção. Os descritores foram obtidos utilizando 24 estruturas (ramos, folhas, flores e frutos) das plantas cultivadas em latada (convencional, orgânico e alta tecnologia) e em espaldeira (convencional e alta tecnologia). Foram realizadas análises de distribuição de frequência e análises multivariadas para os descritores qualitativos. Para os descritores quantitativos foram realizadas análises de variância e comparação de médias dos descritores em cada sistema de produção. Observou-se alta taxa de validação dos descritores nos diferentes sistemas de produção. Entretanto, análises de variância mostraram diferenças significativas entre 10 descritores quantitativos nos diferentes sistemas de produção. Maiores diferenças foram verificadas para os descritores obtidos em plantas cultivadas no sistema orgânico. Verifica-se a utilidade dos descritores na caracterização e validação da cultivar, entretanto, podem ocorrer mudanças na codificação dos descritores devido à interação genótipo × ambiente.

Palavras-chave: *Passiflora setacea*; proteção de cultivares; multivariada; análises de variância; interação genótipo × ambiente.

Recibido: 21/02/2018
Aceptado: 07/11/2018
Disponible on line: 01/04/2019
ISSN 0041-8676 - ISSN (on line) 1669-9513, Facultad de Ciencias Agrarias y Forestales, UNLP, Argentina

INTRODUCTION

Passion fruit belongs to the Passifloraceae family, being largely found in the tropics (Oliveira, 1987). Several authors, including Ferreira (2005), report the wide genetic variability of passion fruit. Wild passion fruit specimens (*Passiflora* ssp.) are important alternatives to diversify the production system, presenting a high potential in the special sweet and acid fruits market and being also used as ornamental plants. Some of them present interesting features that might be used in genetic breeding programs (Junqueira et al., 2005; Faleiro et al., 2011).

Passiflora setacea is commonly known in Brazil as "maracujá-do-sono", "maracujá-sururuca", "maracujá-de-boi" and "maracujá-do-cerrado". It is a wild species, resistant to diseases such as anthracnose, scab and septoria blotch, also showing tolerance to fruit woodiness. In the Federal District (Brazil), this kind of fruit is harvested all year round, including the off-season period of the commercial varieties of sour passion fruit, making it important for the breeding programs, and also for the diversification of the passion fruit production system. *P. setacea* is a vine specie with nocturnal anthesis, generally pollinated by bats (*Chiropterophily*) or moths (*Phalenophily*), vigorous and drought tolerant (Braga et al., 2006).

Wild passion fruit 'BRS Pérola do Cerrado' ('BRS PC') was obtained through a mass selection of population by using several accesses of *Passiflora setacea* developed by Embrapa and associates in 2013 (Embrapa, 2015), showing huge commercial perspectives. The purpose of the genetic breeding was to increase the yield and fruit size, and also its resistance to the main diseases. Besides these features, it is also an alternative to the market of special fruits used in juices, ice creams, desserts and fresh consumption, having an ornamental potential for large areas because of its dense ramification and beautiful white flowers (Embrapa, 2015).

In order to obtain new cultivars, it is important and necessary to register and protect the genetic material. As a requirement to its protection, the National Plant Varieties Protection Service (SNPC), a Department associated to the Brazilian Ministry of Agriculture, Livestock and Food Supply, established and published official instructions, including guidelines on how to obtain descriptors. The safe and effective use of these descriptors require their experimental validation in several known cultivars (Brasil, 2016).

The purpose of the present study was to obtain and validate descriptors used to protect the wild passion fruit 'BRS Pérola do Cerrado', considering its commercial growth in different yield systems.

MATERIAL AND METHODS

Five treatments were used (Table 1) to obtain and validate 33 descriptors of the 'BRS Pérola do Cerrado' ('BRS PC') proposed by the National Plant Varieties Protection Service (SNPC), a department linked to the Brazilian Ministry of Agriculture, Livestock and Food Supply (Brasil, 2016). The evaluation of the passion fruit grown in the conventional system was performed at the experimental field of Embrapa Cerrados, located at Planaltina, DF, Brazil (15°39'84" S latitude, 47°44'41" W longitude and elevation 1.000 m), while the study of passion fruit belonging to the organic system was carried out in a rural property in Sobradinho/DF (Brazil) and the ones grown in high technology system in Planaltina de Goiás/GO (Brazil).

The technical recommendations established for the 'BRS Pérola do Cerrado' were used in the conventional system (Guimarães et al., 2013), while the fertirrigation was used in the high technology system (12.5 g urea + 12.5 g ground white potassium chloride + 5 g phosphoric acid per week per plant). An organic composite (Bokashi) and a biofertilizer (Supermagro) containing organic matter, minerals, manure and water were used for the organic system.

In 2014, the evaluations were performed and 24 plant structures (branches, leaves, flowers and fruits) for each treatment were analyzed.

All 33 morphoagronomic descriptors were obtained according to the instructions for the tests of distinctness, uniformity and stability (DUS) of *Passiflora* spp. published in 2008 (Brasil, 2016), being 19 qualitative/pseudo-qualitative and 14 quantitative.

Qualitative features were evaluated, such as: color of the branch, leaf shape, division of the leaf blade, sinus, sinus depth, wrinkling, leaf hairiness, position of the glands in the petiole, hypanthium shape, prevailing color of the perianth, prevailing period of anthesis, prevailing color of the corona, banding at the corona longest filaments, number of colored rings in the longest corona filaments, longest corona filaments, fruit shape, prevailing skin color, lenticel distributed in an striated pattern and pulp color. Numeric sequential codes were assigned according to the descriptors for *Passiflora* spp. (Brasil, 2016).

The following quantitative features were evaluated: leaf blade length (LBL); leaf blade maximum width (LBMW); petiole length (PL); bract length (FLBL); sepal length (FLSL); sepal width (FLSW); petal length (FLPL); corona ends diameter (FLCED); longitudinal diameter of fruit (LDF); transverse diameter of fruit (TDF); skin thickness (ST); seed size (SS); total soluble solids content (TSS) and seeds number (SN).

Table 1. Origin, yield system and type of training for each type of evaluated treatment for wild passion fruit 'BRS Pérola do Cerrado'

Treatment	Origin	Yield system	Training system
1	Embrapa Cerrados (Planaltina - DF)	Conventional	Trellis
2	Rural property (Planaltina de Goiás - GO)	High technology	Trellis
3	Rural property (Sobradinho - DF)	Organic	Trellis
4	Embrapa Cerrados (Planaltina - DF)	Conventional	Espalier
5	Rural property (Planaltina de Goiás - GO)	High technology	Espalier

These features were measured by using a digital caliper except for the seed number and content of total soluble solids which were measured by a digital refractometer to obtain a reading in °Brix. The analysis of fruits were performed at the Laboratório de Ciência e Tecnologia de Alimentos da Embrapa Cerrados. After the measurements, numeric sequential codes were assigned according to descriptors for *Passiflora* spp. (Brasil, 2016).

An experimental randomized blocks design was used to analyze the data, with five treatments (trellis/conventional, trellis/high technology, trellis/organic, espalier/conventional and espalier/high technology) and four repetitions, where which repetition is the mean of six structures. Through the morphoagronomic characterization based in 33 qualitative/pseudo-qualitative and quantitative categorical features, the multivariate analysis was performed to estimate the genetic distance among the accesses. This was done by using the simple correspondence analysis allowing the exploitation of a set of multivariate data of "n" individuals evaluated in "p" category variables. Besides, the analysis of frequency distribution and analysis variance and means comparison of quantitative descriptors were carried out for each system of production. All statistics analysis were performed by using the *Genes* software (Cruz, 1997).

The genetic distance matrix for five yield systems of the 'BRS Pérola do Cerrado' was calculated based on 32 morphological descriptors obtained. The matrix was utilized to perform the cluster analysis through dendograms, using as a criterion the UPGMA (*Unweighted pair-group method arithmetic average*).

RESULTS AND DISCUSSION

Thirty-two of thirty-three descriptors were obtained (Table 2), since BRS Pérola do Cerrado cultivar did not show colorful rings in the corona longest filaments. The descriptors validation rate, that is, the coincidence rate of descriptors in relation to descriptors belonging to BRS Pérola do Cerrado cultivar used in the protection system was high in different yield systems. The highest rates were found in the systems grown in espalier and the lowest in organic systems (Figure 1). This small difference among the descriptors obtained in different yield systems was also observed in the cluster analysis performed based on the multivariate analysis of descriptors (Figure 2). The cluster trend in different yield system evidences an environmental influence when obtaining and validating the descriptors.

A percentage and frequency of each class-feature in different treatments were obtained through the code assignment of phenotypical classes of the qualitative characteristics. Most of the features showed similar results in different yield systems. The plants showed cracked, tri-lobed leaves, sinus of average depth, hairiness, lack of wrinkled leaves, cylindrical hypanthium, white perianth and corona, nocturnal anthesis, corona did not show bands on the longest smooth filaments, the fruits are oval and generally green.

Hairiness tri-lobed leaves, cylindrical-campanulated calyx tube and ovoid fruits are similar features to the ones reported by Cervi (1997) when studying the *Passiflora setacea.* Besides this author, Oliveira and Ruggiero (2005) and also Ataíde et al. (2012) reported oval fruits. The nocturnal anthesis was also mentioned when Junqueira et al. (2005), Santos et al. (2014) and Paiva et al. (2014) studied the *P. setacea*. Paiva et al. (2014) evidenced white flowers and straight, long corona filaments, however the bell-shaped hypanthium was a contrasting finding. The white corona color and green fruits when ripe were also found by Santos et al. (2014), but the author reported a higher percentage of ellipsoidal-shaped fruits.

The feature "branch color" had four categories in the organic system (light green, dark green, purplish-green and purple), three categories in the conventional system (light green, dark green and purplish-green) and two in the high technology yield system (Table 3). However, the highest percentages classified the branches as light green in the conventional system and high technology (espalier) and purplish-green in the organic and high technology system grown in trellis (Table 2).

As for the feature "position of nectary," the classification obtained for all yield systems was glands along the petiole (Table 2). However, only the conventional system (trellis and espalier) showed a 100% of this characteristic (Table 3). Santos et al. (2014) investigated the *P. setacea* from Bahia state, Brazil, and reported a different outcome where the petiole glands were located close to the branch insertion.

In the evaluations, the fruits were oval-shaped, however, except for the organic system, the other systems showed a small percentage of round fruits (Table 3).

The pulp color was the most heterogeneous qualitative feature showing four classes (yellow-greenish, yellow, yellow-orange and orange) in the conventional (trellis and espalier) and high technology (espalier) systems and two classes in the high technology (trellis) and organic system . Most of the fruits assigned to the high technology system (trellis and espalier) had a yellow pulp. The pulps in the conventional (trellis) and organic systems were yellow-orange; being orange in the conventional system grown in espalier. Santos et al. (2014), when evaluating the *P. setacea,* also found more than one category for pulp color, but the authors observed that the majority of the fruits had a yellow-greenish color (50%), followed by light yellow (30%) and yellow-orange (20%) pulps.

The analysis of variance showed the significant effect of the production systems in 10 of the 14 quantitative features that were evaluated. Only the descriptors "bract length", "transverse fruit diameter", "seeds size and number" were the same for different treatments when using the F-test at 1% probability (Table 4). The coefficients of variation were low, evidencing the experimental data accuracy. On the other hand, the coefficients of determination showed high values for features that showed significant differences, evidencing the accuracy and reliability of the experimental data (Cruz et al., 2004).

Regarding the quantitative features (Table 5), for the leaf blade length and width, the highest means were found in the high technology production systems grown in espalier (10.64 cm and 11.59 cm, respectively).

*Table 2. Characteristics (descriptors) of wild fruit passion 'BRS Pérola do Cerrado' ('BRS PC') and under five yield systems: trellis/conventional (TC), trellis/high technology (THT), trellis/organic (TO), espalier/conventional (EC) and espalier/high technology (EHT). UnB/Embrapa Cerrados, Brasília, DF, 2014. - absence of character. *Descriptors belonging to 'BRS Pérola do Cerrado' ('BRS PC') used in the protection process.*

Descriptors	Identification of the characteristic	PC*	TC	THT	TO	EC	EHT
1. Branch: color	light green (1), dark green (2), green-purplish (3), purple (4)	1	1	3	3	1	1
2. Leaf blade: shape	lanceolate (1), ovate (2), cordate (3), oblong (4), elliptic (5), split (6), cracked (7), sectioned (8)	6	6	6	6	6	6
3. Leaf blade: division	simple (1), bi-lobed (2), tri-lobed (3), penta-lobed (4), seven-lobed (5)	3	3	3	3	3	3
4. Leaf blade: length	short (3), average (5), long (7)	5	5	5	5	5	5
5. Leaf blade: maximum width	narrow (3), average(5), wide (7)	5	5	5	5	5	5
6. Leaf blade: sinus	absent (1), present (2)	2	2	2	2	2	2
7. Leaf blade: sinus depth	shallow (3), average(5), deep (7)	5	5	5	5	5	5
8. Leaf blade: wrinkle	absent (1), present (2)	1	1	1	1	1	1
9. Leaf blade: hairiness	absent (1), present (2)	2	2	2	2	2	2
10. Petiole: length	short (3), average (5), long (7)	7	7	7	5	7	7
11. Petiole: glands position (nectary)	adjacent to leaf blade (1), near the middle of the petiole (2), adjacent to the insertion of the branch leaf (3), distributed along the petiole (4)	4	4	4	4	4	4
12. Flower: hypanthium shape	flat (1), campanulated (2), cylindrical (3)	3	3	3	3	3	3
13. Flower: predominant color of perianth (sepals and petals, internally)	white (1), pinkish (2), red (3), red-purplish (4), purple (5), blue-purplish (6), blue (7)	1	1	1	1	1	1
14. Flower: predominant period of anthesis	morning (1), afternoon (2), nocturnal (3)	3	3	3	3	3	3
15. Flower: bract length	short (3), average (5), long (7)	5	5	5	5	5	5
16. Flower: sepal length	short (3), average (5), long (7)	5	5	5	5	5	5
17. Flower: sepal width	narrow (3), average (5), wide (7)	3	3	3	3	3	3
18. Flower: petal length	short (3), average (5), long (7)	5	5	5	5	5	5
19. Flower: corona diameter	small (3), average (5), big (7)	3	3	3	3	3	3
20. Flower: predominant corona color	white (1), pinkish (2), red (3), red-purplish (4), purple (5), blue-purplish (6), blue (7)	1	1	1	1	1	1
21. Flower: banding (rings in different colors, including white) in the corona longest filaments	absent (1), present (2)	1	1	1	1	1	1
22. Flower: number of color rings (except the white ones) in the corona longest filaments	one (1), more than one (2)	-	-	-	-	-	-
23. Flower: corona longest filaments	smooth (1), wavy (2)	1	1	1	1	1	1
24. Fruit: shape	oval (1), oblong (2), round (3), oblate (4), ellipsoid (5), fusiform (6), obovate (7)	1	1	1	1	1	1
25. Fruit: longitudinal diameter	small (3), average (5), big (7)	5	5	5	5	5	5
26. Fruit: transverse diameter	small (3), average (5), big (7)	3	5	3	5	3	3
27. Fruit: skin predominant color (epidermis)	green (1), yellow (2), orange (3), pinkish (4), red (5), purple (6)	1	1	1	1	1	1
28. Fruit: lenticels distributed in an striated pattern	absent (1), present (2)	1	1	1	1	1	1
29. Fruit: skin thickness	very thin (1), thin (2), average (3), thick (4), very thick (5)	2	2	2	2	2	2
30. Fruit: seed size	small (3), average (5), big (7)	5	5	5	5	5	5
31. Fruit: pulp color	whitish (1), yellow-greenish (2), yellow (3), yellow-orange (4), orange (5), dark orange (6), red (7)	3	4	3	4	5	3
32. Fruit: content of total soluble solids	very low (1), low (3), average (5)high (7), very high (9)	7	7	5	7	7	5
33. Fruit: seeds number	very small (1), small (3), average (5), (7), very big (9)	5	5	5	5	5	5

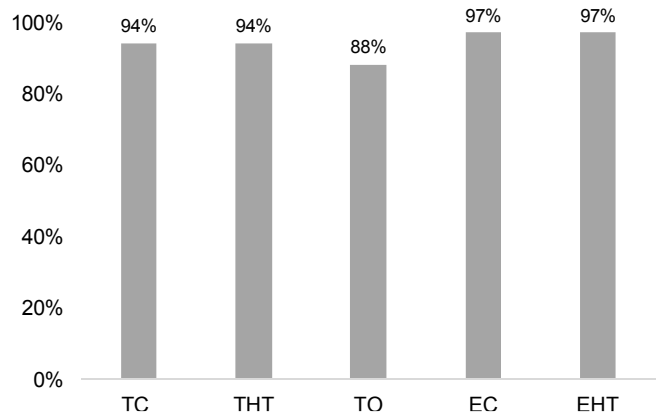

Figure 1. Validation rate of descriptors in the different yield systems of wild passion fruit 'BRS Pérola do Cerado' ('BRS PC'): trellis/conventional (TC), trellis/ high technology (THT), trellis/organic (TO), espalier/conventional (EC) and espalier/high technology (EHT). UnB/Embrapa Cerrados, Brasília, DF, 2014.

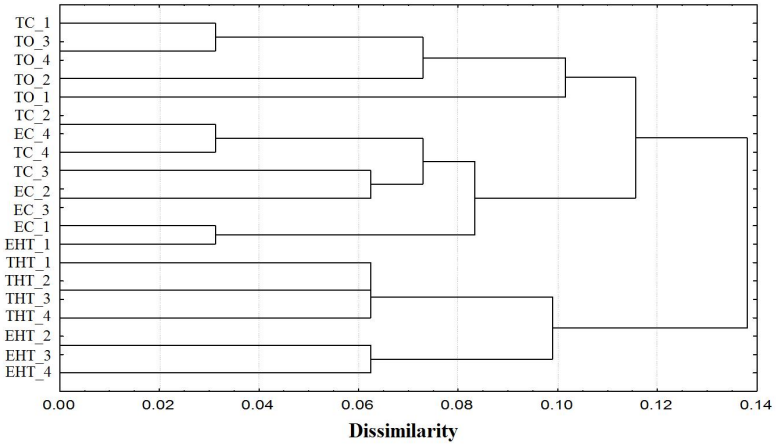

Figure 2. Cluster analysis of wild passion fruit 'BRS Pérola do Cerrado' in five yield systems: trellis/conventional (TC), trellis/high technology (THT), trellis/organic (TO), espalier/conventional (EC) and espalier/high technology (EHT) in 4 repetitions, based on the dissimilarity matrix, calculated using 32 descriptors. UnB/Embrapa Cerrados, Brasília, DF, 2014.

These means are higher than the ones related by Cervi (1997) when botanically describing the *P. setacea*, suggesting that the leaves measures of 5-8 cm × 6-10 cm. Santos et al. (2014), on the other hand, found the highest mean for leaf length (11.853 cm) and lowest leaf blade width (11.49 cm) for *P. setacea* collected in the state of Bahia, Brazil.

The highest mean petiole length was also found for plants using the high technology system grown in espalier (5.08 cm), a figure higher (4.898 cm) than the one reported by Santos et al. (2014).

No statistically significant difference was found for the features "bract length", however, plants grown in trellis in a high technology system showed the highest average (2.71cm). This length was greater than the ones found by Cervi (1997) and Santos et al. (2014), 1.5-2 cm and 1.853 cm, respectively.

As for the sepal length, the highest mean was found in the organic system (3.89 cm), very close to the mean (3.92 cm) found by Santos et al. (2014) and within the patterns suggested in the description by Cervi (1997), which was from 3.5 to 4 cm.

The highest mean for sepal width was found in the high technology system trained in trellis (0.98 cm), a higher value when compared with the one observed by Cervi (1997), which was from 0.5 to 0.7 cm and Santos et al. (2014), who found an average of 0.94 cm.

When evaluating the feature "petal length" in the high technology system grown in espalier, the highest average (3.75 cm) was observed compared with other systems and also in relation to the mean (3.26 cm) reported by Santos et al. (2014) and 2–2.5 cm evidenced by Cervi (1997).

Table 3. Characteristics (descriptors) and percentages of wild passion fruit 'BRS Pérola do Cerrado' ('BRS PC') in five yield systems: trellis/conventional (TC), trellis/high technology (THT), trellis/organic (TO), espalier/conventional (EC) and espalier/high technology (EHT). UnB/Embrapa Cerrados, Brasília, DF, 2014. - absence of caracter.

Descriptor	Identification of the characteristic	TC	THT	TO	EC	EHT
Branch color	light green (1), dark green (2), green-purplish (3), purple (4)	1 (58%) 2 (21%) 3 (21%)	1 (42%) 3 (58%)	1 (21%) 2(33%) 3(42%) 4 (4%)	1 (50%) 2 (12.5%) 3 (37.5%)	1 (71%) 2 (29%)
Shape of leaf blade	lanceolate (1), ovate (2), cordate (3), oblong (4), elliptic (5), split (6), cracked (7), sectioned (8)	6(100%)	6(100%)	6(100%)	6(100%)	6(100%)
Division of leaf blade	simple (1), bi-lobed (2), tri-lobed (3), penta-lobed (4), seven-lobed (5)	3(100%)	3(100%)	3(100%)	3(100%)	3(100%)
Sinus	absent (1), present (2)	2(100%)	2(100%)	2(100%)	2(100%)	2(100%)
Sinus depth	shallow (3),average (5), deep (7)	5(100%)	3 (4%) 5(96%)	5(100%)	5(100%)	5(100%)
Wrinkles	absent (1), present (2)	1(100%)	1(100%)	1(100%)	1(100%)	1(100%)
Hairiness	absent (1), present (2)	2(100%)	2(100%)	2(100%)	2(100%)	2(100%)
Position of nectary	adjacent to the leaf blade (1), close to the middle of the petiole (2), adjacent to the insertion of the leaf blade (3), distributed along the petiole (4)	4(100%)	2(17%) 3(17%) 4(67%)	2(4%) 3(4%) 4(92%)	4(100%)	3(17%) 4(83%)
Hypanthium shape	flat (1), campanulated (2), cylindrical (3)	3(100%)	3(100%)	3(100%)	3(100%)	3(100%)
Predominant color of perianth (sepals and petals, internally)	white (1), pinkish (2), red (3), red-purplish (4), purple (5), blue-purplish (6), blue (7)	1(100%)	1(100%)	1(100%)	1(100%)	1(100%)
Predominant period of anthesis	morning (1), afternoon (2), nocturnal (3)	3(100%)	3(100%)	3(100%)	3(100%)	3(100%)
Predominant corona color	white (1), pinkish (2), red (3), red-purplish (4), purple (5), blue-purplish (6), blue (7)	1(100%)	1(100%)	1(100%)	1(100%)	1(100%)
Bands in the longest corona filaments	absent (1), present (2)	1(100%)	1(100%)	1(100%)	1(100%)	1(100%)
Number of color rings in the longest corona filaments	one (1), more than one (2)	-	-	-	-	-
Longest corona filaments	smooth (1), wavy (2)	1(100%)	1(100%)	1(100%)	1(100%)	1(100%)
Fruit shape	oval (1), oblong (2), round (3), oblate (4), ellipsoid (5), fusiform (6), obovate (7)	1(96%) 3(4%)	1(79%) 3(21%)	1(100%)	1(96%) 3(4%)	1(92%) 3(8%)
Predominant skin color	green (1), yellow (2), orange (3), pinkish (4), red (5), purple (6)	1(100%)	1(100%)	1(100%)	1(100%)	1(100%)
Lenticels distributed in a striated pattern	absent (1), present (2)	1(100%)	1(100%)	1(100%)	1(100%)	1(100%)
Pulp color	whitish (1), yellow-greenish (2), yellow (3), yellow-orange (4), orange (5), dark orange (6), red (7)	2(4%) 3(8%) 4(50%) 5(38%)	3(75%) 4(25%)	4(50%) 5(50%)	2(21%) 3(12,5%) 4(29%) 5(37,5%)	2(4%) 3(50%) 4(29%) 5(17%)

The highest mean corona diameter was found in the organic system (4.38 cm), a lower value than the one (5.225 cm) verified by Santos et al. (2014).

In relation to the fruits descriptors, the highest average for longitudinal diameter was found within the conventional system (espalier), followed by the conventional system (trellis), 5.98 cm and 5.94 cm, respectively.

Table 4. Significance (probability in % using the F-test) of data related to the quantitative characteristics of wild fruit passion 'BRS Pérola do Cerrado' ('BRS PC'): leaf blade length (LBL), leaf blade maximum width (LBMW), petiole length (PL), bract length (FLBL), sepal length (FLSL), sepal width (FLSW), petal length (FLPL).

Source of variation	LBL	LBMW	PL	FLBL	FLSL	FLSW	FLPL
Probability	0**	0**	0**	0.1^{ns}	0**	0**	0**
Average	9.68	10.60	4.59	2.59	3.67	0.90	3.53
CV (%)	6.02	4.55	10.53	5.85	4.16	2.60	3.48
Coefficient of determination (%)	85.93	90.34	81.11	60.12	91.03	93.34	93.06

*Table 4 (continuation). Significance (probability in % using the F-test) of data related to the quantitative characteristics of wild fruit passion 'BRS Pérola do Cerrado' ('BRS PC'): corona ends diameter (FLCED), longitudinal diameter of the fruit (LDF), transverse diameter of the fruit (TDF), skin thickness (ST), seed size (SS), total soluble solids content (TSS), seeds number (SN), evaluated in five yield systems. UnB/Embrapa Cerrados, Brasília, DF, 2014. **Significant at 1% probability. ^{ns}Nonsignificant. - no estimate was possible due to the lack of variance for the treatments effect.*

Source of variation	FLCED	LDF	TDF	ST	SS	TSS	SN
Probability	0**	0**	0.7^{ns}	0**	100^{ns}	0**	100^{ns}
Average	4.03	5.53	4.93	0.50	0.59	12.58	162.80
CV (%)	3.21	4.18	4.23	7.53	1.80	6.50	12.87
Coefficient of determination (%)	97.46	91.87	63.54	82.12	-	82.65	-

Table 5. Quantitative characteristics of wild fruit passion 'BRS Pérola do Cerrado' ('BRS PC'): leaf blade length (LBL); leaf blade maximum width (LBMW), petiole length (PL), bract length (FLBL), sepal length (FLSL), sepal width (FLSW), petal length (FLPL).

Production systems	LBL (cm)	LBWM (cm)	PL (cm)	FLBL (cm)	FLSL (cm)	FLSW (cm)	FLPL (cm)
Conventional (trellis)	9.10ab	9.57b	4,63ab	2.61a	3.34c	0.8b	3.24c
High Technology (trellis)	9.22ab	10.98ab	4.75ab	2.71a	3.82ab	0.98a	3.62ab
Organic (trellis)	8.99b	9.98b	3.64b	2.55a	3.89 a	0.87b	3.71a
Conventional (espalier)	10.35ab	10.78ab	4.83ab	2.41a	3.46bc	0.88b	3.32bc
High technology (espalier)	10.64a	11.59a	5.08a	2.69a	3.86ab	0.93ab	3.75a

Table 5 (continuation). Quantitative characteristics of wild fruit passion 'BRS Pérola do Cerrado' ('BRS PC'): corona ends diameter (FLCED), longitudinal diameter of the fruit (LDF), transverse diameter of the fruit (TDF), skin thickness (ST), seed size (SS), total soluble solids content (TSS), seeds number (SN), evaluated in five yield systems. UnB/Embrapa Cerrados, Brasília, DF, 2014. Averages followed by the same letters in the column are not statistically different according to the F-test at 1% probability.

Production systems	FLCED (cm)	LDF (cm)	TDF (cm)	ST (cm)	SS (cm)	TSS (°Brix)	SN (cm)
Conventional (trellis)	3.82b	5.94a	5.00a	0.54a	0.59a	13.33a	169.25a
High Technology (trellis)	4.21a	5.14b	4.93a	0.43b	0.60a	12.18ab	164.00a
Organic (trellis)	4.38a	5.39ab	5.14a	0.54a	0.59a	13.20ab	164.75a
Conventional (espalier)	3.42c	5.98a	4.89a	0.50ab	0.59a	13.15ab	161.50a
High technology (espalier)	4.32a	5.19b	4.67a	0.50ab	0.60a	11.03b	154.50a

In the organic system, the fruits average longitudinal diameter was 5.39 cm, where the lowest mean found for the high technology system was 5.19 cm and 5.14 cm in espalier and trellis, respectively. In the conventional system, the means were higher than the description found by Cervi (1997), which was 4 cm and the mean (5.074 cm) observed by Santos et al. (2014) and 5.47 cm obtained by Ataíde et al. (2012) in a study performed in São Paulo state, Brazil.

No statistical difference was found when evaluating the transverse diameter of the fruit in different treatments, however, the highest mean was found in the conventional system grown in trellis (5 cm), being superior to the averages reported by Cervi (1997), Ataíde et al. (2012) and Santos et al. (2014), which were 3.0 cm, 3.79 cm and 4.04 cm, respectively. Fortaleza et al. (2005) highlighted that the longitudinal and transverse diameters of fruits are important variables since they determine the fruit shape.

The highest means for skin thickness (0.54 cm) were observed in the conventional (trellis) and organic systems (trellis), a value superior to the ones obtained by Ataíde et al. (2012) and Santos et al. (2014), 0.33 cm and 0.278 cm, respectively.

The mean seed size was 0.6 cm for the high technology system (trellis and espalier) and 0.59 cm for other yield systems, which did not show a significant effect in the yield system. Cervi (1997) and Santos et al. (2014) reported lower figures (0.5 cm and 0.429 cm, respectively).

As for the total solid soluble contents, the highest mean was observed in the conventional system trained in trellis with 13.33 °Brix. Higher values were found by Ataíde et al. (2012) and Santos et al. (2014) (16.52 °Brix, 17.84 °Brix, respectively). According to Nascimento et al. (2003), the high total soluble solids content is a very desirable feature for the industry and mainly for fresh fruit market.

The seeds number per fruit was statistically similar in different yield systems. A higher mean (169.25 seeds) in the conventional system (trellis) was found, with the value being similar to the one found by Santos et al. (2014), when studying the *P. setacea*.

CONCLUSIONS

1. The descriptors established at SNPC-MAPA are useful for the wild passion fruit 'BRS Pérola do Cerrado' characterization and validation.

2. Changes in the codification of descriptors for 'BRS Pérola do Cerrado' might occur because of the genotype × environment interaction, quantified by the influence of different yield systems.

REFERENCES

Ataíde, E.M., J.C. Oliveira & C. Ruggiero. 2012. Florescimento e frutificação do maracujazeiro silvestre *Passiflora setacea* D.C. cultivado em Jaboticabal, SP. Revista Brasileira de Fruticultura, Jaboticabal – SP, 34(2):337-381.

Braga, M.F., N.T.V. Junqueira, F.G. Faleiro, T.S. Agostini-Costa & L.C. Bernacci. 2006. Maracujá-do-cerrado. In: Vieira, R.F., T.S.A. Costa, D.B.da Silva, F.R. Ferreira & S.M. Sano (Ed.). Frutas nativas da região Centro-Oeste. Embrapa Recursos Genéticos e Biotecnologia, Brasília, p.216-233.

Brasil. Ministério da Agricultura, Pecuária e Abastecimento. 2016. Formulários para proteção de cultivares: Formulário 3 – Espécies em regime de proteção: instruções de DHE e tabela de descritores mínimos. Available at: <http://www.agricultura.gov.br/vegetal/registros-autorizacoes/protecaocultivares/formularios-protecao-cultivares/MARACUJA_OUTRAS_SPP_FORMULARIO_16DEZ2008_P.doc.> Accessed on: Dec. 29 2016.

Cervi, A.C. 1997. *Passifloraceae* do Brasil. Estudo do gênero *Passiflora* L., subgênero *Passiflora*. Madrid, p.34-35.

Cruz, C.D. 1997. Programa GENES – Aplicativo computacional em genética e estatística. Viçosa: UFV, 442p.

Cruz, C.D., A.J. Regazzi & P.C.S. Carneiro. 2004. Modelos biométricos aplicados ao melhoramento genético. 3. ed. Viçosa: UFV, 480p.

EMBRAPA. Empresa Brasileira de Pesquisa Agropecuária. 2015. BRS Pérola do Cerrado. Cultivar de maracujazeiro silvestre com quádrupla aptidão: consumo *in natura*, processamento industrial, ornamental e funcional. Available at:http://www.cpac.embrapa.br/publico/usuarios/uploads/lancamentoperola/foldertecnico.pdf. Accessed on: 05 jan. 2015.

Faleiro, F.G., N.T.V. Junqueira, M.F. Braga & J.R. Peixoto. 2011. Pré-melhoramento do maracujá. In: Lopes, M.A., A.P. Favero, M.A.J.F. Ferreira, F.G.Faleiro, S.M. Folle & Guimarães, E.P. (Eds.), Pré-melhoramento de plantas: estado da arte e experiências de sucesso. Embrapa Informação Tecnológica: Brasília, DF, p.550-570.

Ferreira, F.R. 2005. Recursos genéticos de Passiflora. In: Faleiro, F.G., N.T.V. Junqueira & M.F. Braga (Eds.). Maracujá: germoplasma e melhoramento genético. Planaltina, DF: Embrapa Cerrados, p.41-51.

Fortaleza, J.M., J.R. Peixoto, N.T.V. Junqueira, A.T. Oliveira & L.E.P. Rangel 2005. Características físicas e químicas de nove genótipos de maracujá-azedo cultivada sob três níveis de adubação potássica. Revista Brasileira de Fruticultura. Jaboticabal, 27(1):124-127.

Guimarães, T.G., A.C. Dianese, C.M. Oliveira, J.O.M.Madalena, F.G.Faleiro, N.T.V. Junqueira, H.C.Lima & G.A. Campos. 2013. Recomendações técnicas para o cultivo de *Passiflora setacea* cv. BRS Pérola do Cerrado. Planaltina: Embrapa Cerrados, (Comunicado Técnico, N°174). 6p. ISSN 1517-1469.

Junqueira, N.T.V., M.F. Braga, F.G. Faleiro, J.R. Peixoto & L.C. Bernacci. 2005. Potencial de espécies silvestres de maracujazeiro como fonte de resistência a doenças. In: F.G. Faleiro, N.T.V. Junqueira, M.F. Braga (Ed.). Maracujá: germoplasma e melhoramento genético. Planaltina, DF: Embrapa Cerrados, p.81-108.

Nascimento, W.M. do, A.T. Tomé, M. do S.P. de Oliveira, C.H. Müller & J.E.U. Carvalho. 2003. Seleção de progênies de maracujazeiro-yellow (*Passiflora edulis* f. *flavicarpa*) quanto à qualidade de frutos. Revista Brasileira de Fruticultura, 25(1):186-188.

Oliveira, J.C. 1987. Melhoramento genético. In:

Ruggiero, C. (Ed.) Maracujá. Ribeirão Preto: Legis Summa, p. 218-246.

Oliveira, J.C. & C. Ruggiero. 2005. Espécies de maracujá com potencial agronômico. In: Faleiro, F.G., N.T.V. Junqueira & M.F. Braga (Ed.). Maracujá: germoplasma e melhoramento genético. Planaltina, DF: Embrapa Cerrados, p.143-158.

Paiva, C.L., A. Pio Viana, E.A. Santos, R.N.O. Silva & E.J. Oliveira. 2014. Diversidade genética de espécies do gênero Passiflora com o uso da estratégia Ward-MLM. Revista Brasileira de Fruticultura, Jaboticabal - SP, 36(2,)381 – 390.

Santos, E.A., A.P. Viana, J.C.O. Freitas, M.M. Souza, C.L. Paiva, D.L. Rodrigues & R.F. Tavares. 2014. Phenotyping of *Passiflora edulis*, *P. setacea*, and their hybrids by a multivariate approach. Genetics and Molecular Research 13 (4): 9828-9845.