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Original

Characterization of maturity and quality of Brazilian apirenic grapes in the São Francisco river Valley

Caracterização da maturidade e qualidade de uvas apirênicas brasileiras no Vale do São Francisco

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Abstract

The objective of this study was to characterize and correlate maturity and quality of the first varieties of Brazilian seedless grapes 'BRS Clara', 'BRS Linda', 'BRS Morena', and 'Advanced Selection 8' compared with the American variety 'Crimson Seedless' in compliance with the Brazilian Normative/2002 and export standards Advanced Selection 8' is dark reddish, has large clusters, and is a very large ellipsoid berry; 'BRS Morena' is black with medium sized clusters and large berry shaped as ellipsoid to globoid; 'BRS Linda' is light green and has large sized clusters; 'Crimson' is pink and has small clusters with berries varying from medium to large sizes and ellipsoid shaped; and 'BRS Clara' is green yellowish has medium sized clusters and small berry of elongated ellipsoid shape. All varieties evaluated meet the standard for domestic market established as berry size minimum diameter 12 mm. 'BRS Clara' does not meet the export requirements of diameter. Berries of the red grapes 'BRS Morena' and 'Crimson Seedless' are firmer. The pH, titratable acidity, and soluble solids meet the official standards. Larger clusters are less acidic and present higher soluble solids/titratable acidity ratios implying that they are the sweetest type when ripe.
Keywords: *seedless grapes; physical attributes; physicochemical attributes; quality standards; Vitis vinifera L.*

Resumo

O objetivo deste trabalho foi caracterizar e correlacionar a maturidade e qualidade das primeiras variedades de uvas apirênicas 'BRS Clara', 'BRS Linda', 'BRS Morena', mais a 'Seleção Avançada 8' em fase de lançamento, comparado-as com a variedade norte-americana 'Crimson Seedless', conforme as Normativas Brasileiras/2002 e os padrões para exportação. A Seleção Avançada 8 é avermelhada escura, possui cacho grande, com baga muito grande tipo elipsoide; a 'BRS Morena' é preta com cacho médio, baga grande tipo elipsoide a globosa; a 'BRS Linda' é verde clara, de cacho grande; e a 'Crimson', rósea de cacho pequeno, ambas, com bagas médias a grandes e elipsoides; a 'BRS Clara' éverde amarelada, possui cacho médio, baga pequena tipo elipsoide alongada.Todas atendem ao mercado nacional quanto ao diâmetro mínimo de 12 mm. A 'BRS Clara' não atende aos diâmetros exigidos para exportações. As uvas tintas 'BRS Morena' e 'Crimson Seedless' apresentam bagas mais firmes. O pH, a acidez titulável e os sólidos solúveis atendem aos padrões oficiais. Os cachos maiores são os menos ácidos e apresentam as melhores relações sólidos solúveis/acidez titulável, inferindo serem os mais doces, quando maduros.
Palavras-chave: *uvas sem sementes; atributos físicos; atributos físico-químicos; padrões de qualidade; Vitis vinifera L.*

1 Introduction

Viticulture is an important economic activity in Brazil. In the recent years, it has also become important in generating employment in large enterprises for production of table grapes (MELLO, 2010), mainly the seedless types (NACHTIGAL; CAMARGO; MAIA, 2005). The worldwide trend for the consumption of seedless grapes (*Vitis vinifera* L.) has increased the competition between producers, which direct efforts to meet a more demanding consumer market. In this context, concerned about the future of the national viticulture, Embrapa Uva e Vinho, a breeding program aimed at creating cultivars of fine seedless table grapes well adapted to the Brazilian tropical conditions, was created in 1997 in the city of Jales, SP, Brazil. In 2001, seven materials named Selection 1, 2, 3, 5, 6, 7, and 8 were obtained, selected from a batch of 1700 hybrids with chances of becoming new cultivars. In 2003, the first varieties of seedless grapes in Brazil called 'BRS Clara', 'BRS Linda', and 'BRS Morena' were released (CAPOBIANCO et al., 2002; NACHTIGAL; CAMARGO, 2004).

The introduction of new cultivars, however, requires the development of indexes of identity and quality, which would establish standards to identify these new materials

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in the market (CHITARRA; CHITARRA, 2005). These references are important in defining the harvest point (KAYS, 1997) and the identity and quality of sensory characteristics (MASCARENHAS et al., 2010) to minimize the physiological disorders and post harvest losses (KADER, 2002).

This study aimed to evaluate the levels of maturity and quality by establishing and correlating the physical and physicochemical characteristics (of the following first recently released cultivars of seedless grapes: 'BRS Clara', 'BRS Linda', 'BRS Morena', and also Selection 8, about to be released, in comparison with the traditional American 'Crimson Seedless'; each one grown at the agricultural pole of Petrolina-PE/Juazeiro-BA, Northeast Brazil, which accounts for about 90% of Brazilian's fine table grapes exports.

2 Material and methods

The study was conducted in the Sub-medium São Francisco river valley – Agricultural pole of Petrolina-PE/Juazeiro-BA, Brazilian Northeast - with semi-arid very hot climate, BSwh type, according to Köppen classification (AMORIM NETO, 1989). The research was registered and approved by the Ethics Committee of the Universidade Federal da Paraiba under the protocol CEP/HULW nº 364/09.

The samples consisted of fine table grapes (*Vitis vinifera* L.) harvest at commercial maturity, represented by the first Brazilian seedless grapes 'BRS Clara', 'BRS Linda', 'BRS Morena', and 'Advanced Selection 08' and the American 'Crimson Seedless', which was used for comparison. Each one was grafted on the 'IAC 766' rootstock and produced in commercial vineyards on the trellis driving system and drip irrigation system with micro-sprinklers. The harvest occurred in May 2008, between 6:00 and 8:00 am, and the grapes were immediately transported by van in lidded isothermal boxes to the Postharvest Laboratory of Embrapa Semiarido (Brazilian Agricultural Research Corporation), located in Petrolina, Pernambuco State, Brazilian Northeast, for physical and physicochemical evaluations). For the physicochemical evaluations, ten samples of clusters from each cultivar were harvested at random, comprising 10 replications. For the physical evaluations five clusters were selected, from each 10 berries were collected at random, totalizing 50 replications of berries per grape cultivar.

Physical and physicochemical evaluations were performed as follows:

Weight of Clusters and Berries, in grams (g): Obtained using a semi-analytical digital scale model "Quimis-BG - 440";

Length and Cluster Shoulder, in centimeters (cm): Performed using a caliper. The cluster shoulder was measured horizontally in the wider upper area. The length was measured from the apex to the base (polar axis) and the diameter measured at the major equatorial width transversal to the polar axis (LEÃO; SILVA; SILVA, 2004);

Sphericity of Barries, in percentage (%): Measured according to Peçanha and Massarani (1986), obtained by the ratio between the smallest and largest diameter of projected area on a stable surface. An adaptation was made in the present study, the value was multiplied by 100; hence, 100% represents a berry exactly spherical;

Berry firmness, in Newton (N): measured at the middle point of the fruit at the equatorial section (pulp) using a penetrometer, (Wagner - Fruit Pressure Tester), with a 6.0 mm probe;

pH: Determined using a digital potentiometer (Digimed model DMPH-2), calibrated with buffer solutions of pH 4.0 and 7.0 (ASSOCIATION…, 2002);

Soluble Solids (SS): Measured using a digital thermally-adjusted refractometer (20 °C) (model ABBE MARK-II, RICHERT) and results expressed in °Brix according to Association of Official Analytical Chemists (ASSOCIATION…, 2002);

Titratable Acidity (TA): Determined by titration, based on the consumed volume of sodium hydroxide solution 0.1 M, using phenolphthalein at 1% as indicator and results expressed in % of tartaric acid (INSTITUTO…, 2005; LIMA, 2007);

SS/TA Ratio: Relationship between the Soluble Solids (SS) and the Titratable Acidity (TA);

Statistical Analysis: It was applied a completely randomized block design with a minimum of three replications. The calculations were performed using the SPSS software for Windows, Evaluation Edition – 14.0, considering a margin of error (p) less than or equal (≤) to 5%. For greater consistency of data evaluation, the tests of Sampling Homogeneity and Normal Distribution - Kolmogorov - Smirnov (KS) were performed. The data were submitted to Analysis of Variance (ANOVA - F test). For data without Homogeneity between samples, the Robustness test of *Welch* was used followed by Duncan test. For correlations, Factorial Analysis of Principal Components (FAPC), the Pearson correlation coefficient (r), and Hierarchical Dendrogram (MAROCO, 2003) were used.

3 Results and discussion

For distinctions of indexes of maturity and quality, aiming to meet the market demands, it was taking into account the Normative/SARC Nº 1 - Annex II (BRASIL, 2002), which deals with the Brazilian classification for fine table grapes and divide them into: Group, Subgroup, Class, Subclasses, or Caliber and Categories.

3.1 Physical attributes

According to the Brazilian Normative Instruction number 1 (BRASIL, 2002), every grape used this study belongs to Group I, since they are seedless. The light green 'BRS Linda' and green yellowish 'BRS Clara' are included in Subgroup I, green color grapes. The colored grapes, 'BRS Morena' nearly black color, 'Advanced Selection 8' dark red, and the American 'Crimson Seedless', pink tone are included in the In Subgroup II, as shown in Figure 1, with physical attributes presented in Table 1.

In general, the domestic market requires clusters of 50 g minimum weight and the export requirement is 150 g observing the maximum weight limit of 800 g (LIMA, 2007). The Brazilian

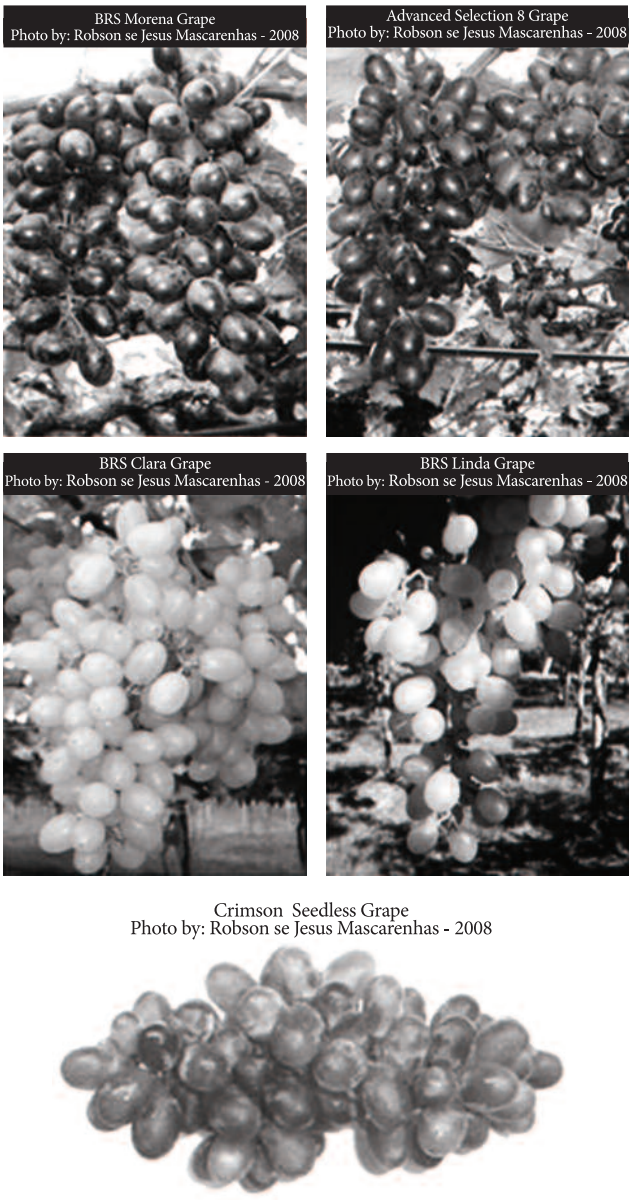

Figure 1. Clusters of Brazilian fine table grapes 'BRS Clara', 'BRS Linda', 'BRS Morena', Advanced Selection 8, and the American 'Crimson Seedless' produced in the Sub-medium São Francisco River Valley, Semi-arid Region of Brazilian Northeast - season May/2008.

Normative Instruction (BRASIL, 2002) classifies the clusters and defines them as numbers of classes. The Brazilian varieties, in particular, offer good potential in terms of cluster weights, and the 'Advanced Selection 8' is the heaviest cluster ($p \leq 5\%$), followed by 'BRS Morena', 'BRS Linda', and 'BRS Clara'. However, a high standard deviation was observed for 'Advanced Selection 8' weights, which indicates the need of very careful procedures to be adopted during commercial classification. According to the Brazilian Normative Instruction (BRASIL, 2002), it was detected that Brazilian seedless grapes have clusters included in Class 2, weighting from 328.30 to 478.58 g. In the 2008 harvest season, the 'Crimson Seedless' showed clusters included in Class 1; however, they could be classified as Class 2, based on the mean result of 367.4 g, reported by Leão (2001) and Mascarenhas et al. (2010). Clusters dimensions are usually observed in large markets (LIMA, 2007). Regarding length, as observed in Table 1, 'BRS Linda' presents higher uniformity, according to the lowest standard deviation obtained. There are three distinctions ($p \leq 5\%$) in which 'Crimson' alone showed the shortest clusters. The 'BRS Linda' and 'Advanced Selection 8' stood out together with the longest clusters, and 'BRS Clara' and 'BRS Morena' presented similar clusters of intermediate lengths. Therefore, Brazilian grapes with clusters from 16.24 to 19.92 cm meet the commercial standards which require lengths between 10 and 20 cm, according to Embrapa Quality Standards, as described by Leão, Silva and Silva (2004).

According to the classical standards of Galet (1985), 'Advanced Selection 8' and 'BRS Linda' present large clusters (greater than 18 cm), while 'BRS Morena' and 'BRS Clara' have medium size clusters, and 'Crimson' has small clusters, about 12.0 cm in length. The higher length of the Brazilian grapes' clusters is corroborated by results from Leão, Silva and Silva (2004), which in reference to 13 seedless varieties, report the traditional 'Thompson Seedless', as the highest in length with clusters of 13.7 cm. For the higher width or shoulder of the clusters, there was no significant difference, which follows the large standard deviations, possibly caused by cultural practices. Under these conditions, the clusters studied presented widths related to the 13 seedless cultivars reported by Leão (1999) averaging between 5.7 to 10.6 cm.

The berry diameter is a parameter rigorously observed by national and international systems of classification. Therefore,

Table 1. Physical characteristics of apirenic fine table grapes produced in the Sub-medium São Francisco River Valley, Semi-arid Region of Brazilian Northeast, season May/2008.

	Attribute	Samples of apirenic grapes, means, and Standard Deviation (± SD)									
		'BRS Clara'		'BRS Linda'		'BRS Morena'		Selection 08		'Crimson'	
		Mean	± DP	Mean	± DP	Mean	± DP	Mean	± DP	Mean	± DP
Cluster	Weight (g)	348.63^{b}	61.78	328.30^{b}	64.31	335.87^{b}	81.83	478.58^{a}	105.81	179.71^{c}	28.01
	Length (cm)	16.24^{b}	2.49	18.92^{a}	0.72	16.18^{b}	1.81	19.42^{a}	2.28	12.64^{c}	1.99
	Girth (cm)	12.68^{a}	2.34	10.28^{ab}	3.74	12.36^{a}	1.80	10.52^{ab}	2.79	8.30^{b}	1.79
Berry	Weight(g)	3.39^{c}	0.45	5.39^{b}	1.29	5.89^{b}	1.05	7.35^{a}	0.71	5.10^{b}	0.57
	Length (mm)	22.70^{c}	1.26	25.40^{b}	1.73	25.26^{b}	1.17	27.66^{a}	2.17	25.18^{b}	1.43
	Diameter(mm)	15.46^{c}	0.76	18.72^{b}	1.82	20.50^{a}	0.57	21.10^{a}	0.47	18.54^{b}	0.94
	Sphericity (%)	68.15^{c}	2.00	73.58^{b}	2.46	81.21^{a}	1.67	76.76^{ab}	7.67	73.67^{b}	2.02
	Firmness(N)	5.80^{b}	0.32	3.96^{d}	0.22	6.65^{a}	0.37	5.13^{c}	0.66	6.62^{a}	0.66

Different letters in the same line indicate significant difference with probability of ≤5% of error by the Anova and Duncan Test. ± DP = Standard Deviation N = Newton; g = gram; mm = millimeter; cm = centimeter.

commercially, 'BRS Clara' is included in Subclass 14, 'BRS Linda', and 'Crimson' in Subclass 18, and, together, 'BRS Morena', and 'Advanced Selection 8' in Subclass 20. Thus, 'BRS Morena' and 'Advanced Selection 08' provided the largest berries. The second largest berries ($p \leq 5\%$) were observed in the group composed by 'BRS Linda' and 'Crimson' with barriers of intermediate size, while the 'BRS Clara', presented ($p \leq 5\%$) the smallest diameter. All varieties being studied meet the Brazilian berry diameter standards for marketing, which establishes the minimum of 12 mm, according to Lima (2007) and Brasil (2002). The export regulations, in general, establish berries diameter from 18 to 26 mm (CHOUDHURY, 2001; LIMA, 2007). The United States require at least 17.5 mm (GONÇALVES, 1996). According to the United Kingdom and part of Europe, the seedless grapes must have diameters from 17.0 mm (CHOUDHURY; COSTA, 2004). Therefore, 'BRS Clara' presents berry diameters bellow the desirable size established by major Brazilian grapes importers.

Still regarding the berry's length, it appears that the berries of 'BRS Clara' stands out as the smallest ($p \leq 5\%$). 'BRS Linda', 'BRS Morena' and 'Crimson' comprise a group ($p \leq 5\%$) with medium berries, while 'Advanced Selection 8' presents, significantly, longer berries. Leão (1999) reports that berry of the traditional 'Superior Seedless' has length of 22.33 mm. This information infers that, in that respect, the Brazilian varieties can be considered commercially competitive. As for weight (Table 1), the 'Advanced Selection 8' had the largest mass berry ($p \leq 5\%$), followed by 'BRS Morena', 'BRS Linda', and 'Crimson', while 'BRS Clara' presented berries with the lowest weight ($p \leq 5\%$). However, 'BRS Clara' may be heavier since Nachtigal, Camargo and Maia (2005) produced berries of 4.56 g for this variety using growth regulators. For the seedless 'Emerald', 'Flame', 'Ruby', 'Imperatriz', 'Arizul', 'Paulistinha', 'Marroo', 'Saturn', 'Canner', 'A1105', 'Thompson', 'Delight', 'CG 39915', 'Pasiga', 'Loose Perlette', 'Beauty', 'A1581', 'Venus', and 'Moscatel', Leão, Silva and Silva (2004) reported berries weight varying from 2.1 to 4.8 g.

Grapes dimensions were compared to the classical models established by Bioletti (apud SOUSA, 1996) that, as measured here, describes the following sphericity: globoid = 100%; flattened = 90%; ellipsoid = 70%; elongated ellipsoid = 55%; ovoid = 72%; oval = 65%; obovoid = 67%; and elongated curved = 55%. Next, the berries were typified, according to Figure 2.

The physical results characterize 'BRS Morena' berries as large size and ellipsoid to nearly globular shape; 'Advanced Selection 8' as very large size and ellipsoid shape berries. On the other hand, according to those results, 'BRS Linda', similarly to 'Crimson Seedless', offer berries varying from medium to large sizes and ellipsoid shaped, while 'BRS Clara' has small berries of elongated ellipsoid shape.

It is important to emphasize that 'Advanced Selection 8' showed the highest sphericity standard deviation demanding especial attention during classification and packaging.

The degree of resistance to pressure, or fruit firmness, provides a parameter to optimize the point of harvest and supports the decisions of transport and storage for fruits (SANTOS et al., 2004). The results for firmness (Table 1) indicate

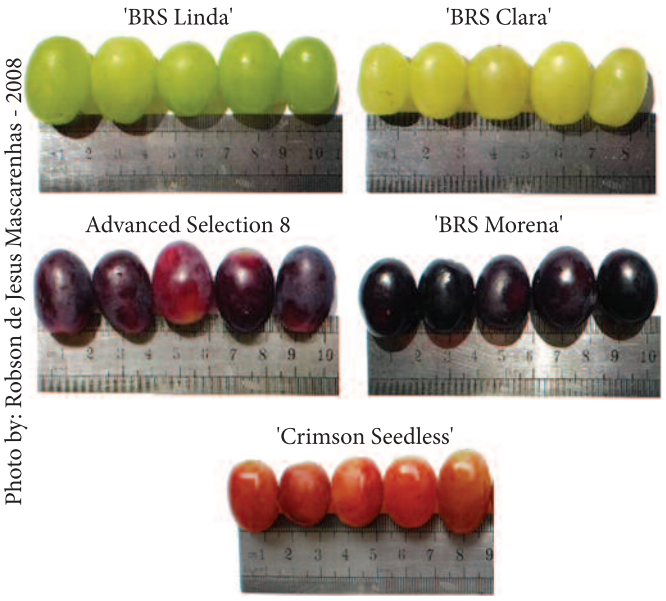

Figure 2. Berries of the Brazilian fine apirenic table grapes and the American 'Crimson Seedless' produced in the Sub-medium São Francisco River Valley, Semi-arid Region of Brazilian Northeast, season May/2008.

the jointed superiority ($p \leq 5\%$) of 'BRS Morena' and 'Crimson Seedless', followed by 'BRS Clara' and 'Advanced Selection 8'. All of these values indicate suitable fruit firmness. However, 'BRS Linda', differently from the others ($p \leq 5\%$), presented the least berry firmness. It was observed during the tests that, despite their less firmness, 'BRS Linda', were more strongly vattached to the pedicle. In contrast, 'BRS Morena' with good firmness, presented accentuated berry drop during laboratory handling. Marinho et al. (2009), in experiments with 'Superior Seedless', found values for firmness varying from 6.11 to 7.71N thus rating them as very firm berries. Gomes and Ferraz (2007) reported 4.74N of firmness, using flat plates, for 'Niagara Rosada' on the first day postharvest.

3.2 Physicochemical attributes

Grape 'BRS Linda' presented the highest pH, followed by the red 'Advanced Selection 8' and the green 'BRS Clara', while 'BRS Morena' was came in third (Table 2). The American 'Crimson Seedless' had the lowest pH reflecting its higher acidity ($p \leq 5\%$).

Santos et al. (2004) studying 'Superior Seedless' grape in the São Francisco Valley, found pH of 3.8 in ripe berries. Studies by Freitas (2006) reported pH ranging from 3.44 and 3.61 for 'Rubi' and 'Benitaka' red grapes, respectively.

As for Titratable Acidity (TA), Choudhury (2001) recommended the maximum level of 1.50% of tartaric acid for table grapes. The grapes in this study presented satisfactory acidity contents. 'Crimson' presented the highest TA content, about 0.60%, reported by Lima (2007). The next TA content found comprises de group of 'Advanced Selection 8' and 'BRS Morena', which did not differed from 'BRS Clara'. However, 'BRS Linda' produced ($p < 5\%$) less acidic berries. In general, Brazilian seedless grapes presented TA ranging from 0.41 to 0.58%, which

is similar to the popular 'Superior Seedless', 0.50% on average (MASCARENHAS et al., 2010).

The content of soluble solids (SS) determined in the berry juices, indicates sweetness and according to international standards of marketing the minimum values vary from 14 to 17.5 °Brix (BARROS; FERRI; OKAWA, 1995). Brasil (2002) recommends levels from 14 °Brix. BRS Clara presented the highest content of SS ($p < 5\%$), followed by the group of 'BRS Morena' and 'Crimson Seedless'. On the other hand, the 'BRS Linda' and 'Advanced Selection 8' showed the lowest SS content. Therefore, in general the values meet the commercial requirements for seedless table grapes. However, in the second semester of every year, higher concentrations of sugars will can possibly be obtained due to higher temperatures. According to Lima (2007) and Chitarra and Chitarra (2005), Brazilian Standards for the Integrated Production System for table grapes establish that the harvest point must also be based on the SS/TA ratio, which accounts for flavor, a determinant element in the process of accepting the grape on the Spanish market (PIVA; LOPEZ; MORGAN, 2008). Therefore, it appears that the grapes 'BRS Clara' and 'BRS Linda', with SS/TA close to 35.0 units had higher quality ($p \leq 5\%$). 'BRS Morena', which came next, showed good SS/TA. The grapes 'Crimson' and 'Advanced Selection 8' presented the lowest ratios, but are still considered commercially attractive since Gayet (1993) and Lima (2007) reported that seedless grape must present SS/TA above 20 units. Lima (2007) reported that 'Superior Seedless' reached values of SS/TA ratio close to 30 units, and Mascarenhas et al. (2010) found values higher than 30 units.

3.3 Interactions between maturity and quality indexes of grapes

In the graph of FAMC (Figure 3), the correlations were graphically marked based on the Correlation of Pearson test presented in Table 3.

Table 2. Physicohemical characteristics of fine apirenic table grapes produced in the Sub-medium São Francisco River Valley, Semi-arid Region of Brazilian Northeast, season May/2008.

Parameter	Samples of apirenic grapes, means, and Standard Deviation (±DP)									
	'BRS Clara'		'BRS Linda'		'BRS Morena'		Seleção 08		'Crimson'	
	Mean	±DP	Mean	±DP	Mean	±DP	Mean	±DP	Mean	±DP
pH	3.92[b]	0.05	4.08[a]	0.02	3.85[c]	0.02	3.95[b]	0.01	3.70[d]	0.04
SS (%)	18.66[a]	0.72	14.12[c]	0.72	17.02[b]	1.09	13.50[c]	0.27	16.22[b]	0.33
TA (%)	0.53[c]	0.01	0.41[d]	0.03	0.56[bc]	0.03	0.58[b]	0.03	0.68[a]	0.04
SS/TA	35.10[a]	1.86	34.32 [a]	3.89	30.40[b]	0.81	23.35[c]	1.69	23.99[c]	1.40

Simbology: Different letters in the same line indicate significant difference with probability of ≤5% of error by the Anova and Duncan Test. ± DP = Standard Deviation; SS = Soluble Solids; pH = Hydrogen potential; TA = Titratable Acidity (tartaric acid); SS/TA = ratio.

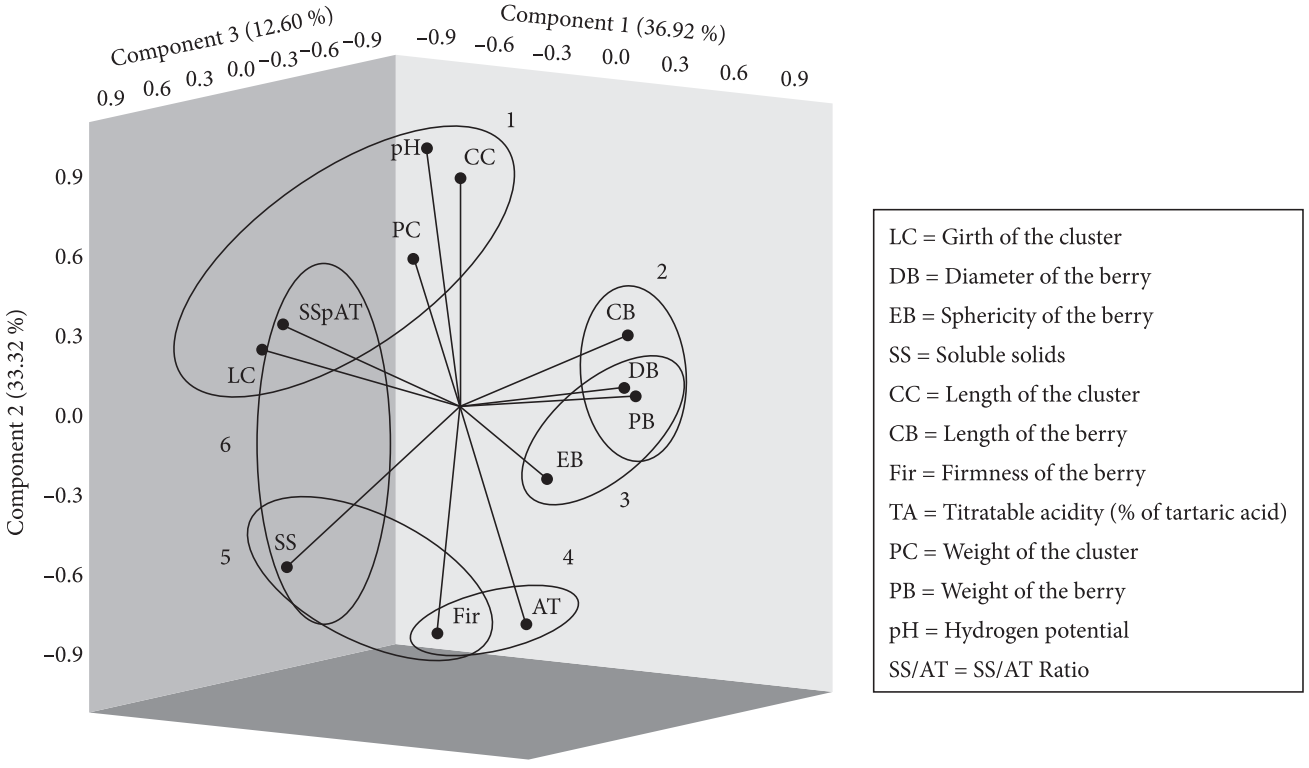

Figure 3. Factorial tri-dimentional Analysis of the Main Components (FAPC), among the quality attributes of Brazilian fine table grapes 'BRS Clara', 'BRS Linda', 'BRS Morena', Advanced Selection 8, and the American 'Crimson Seedless', produced in the Sub-medium São Francisco River Valley, Semi-arid Region of Brazilian Northeast, season May/2008. Cycle = probability of ≤5% of error, based on the Pearson correlation.

Table 3. Pearson correlation between the quality attribute of the Brazilian grapes 'BRS Clara', 'BRS Linda', 'BRS Morena', Advanced Selection 8, and the American 'Crimson Seedless', produced in the Sub-medium São Francisco River Valley, Semi-arid Region of Brazilian Northeast, season May/2008.

Itens	Correlation between quality attributes of the apirenic fine table grapes 'BRS Linda', 'BRS Clara', 'BRS Morena', Selection 8 and 'Crimson'											
	pH	SS	AT	SS/AT	P.C	C.C	L.C	P.B	C.B	D.B	E.B	Fir
pH	**1.00**	−0.45*	−0.87*	−0.45*	0.49*	0.77*	0.27	0.08	0.11	0.06	−0.31	−0.78*
SS	-	**1.00**	0.20	0.46*	−0.32	−0.43*	0.26	−0.68*	−0.68*	−0.62*	−0.23	0.59*
AT	-	-	**1.00**	−0.76*	−0.34*	−0.58*	−0.27	0.05	0.10	0.11	0.08	0.77*
SS/AT	-	-	-	**1.00**	0.04	0.22	0.36*	−0.51*	−0.52*	−0.52*	−0.25	−0.31
P.C.	-	-	-	-	**1.00**	0.78*	0.54*	0.31	0.27	0.20	0.01	−0.33
C.C.	-	-	-	-	-	**1.00**	0.32	0.28	0.20	0.23	0.15	−0.60*
L.C.	-	-	-	-	-	-	**1.00**	−0.32	−0.35*	−0.28	−0.07	0.00
P.B.	-	-	-	-	-	-	-	**1.00**	0.79*	0.94*	0.60*	−0.13
C.B.	-	-	-	-	-	-	-	-	**1.00**	0.78*	0.14	−0.11
D.B.	-	-	-	-	-	-	-	-	-	**1.00**	0.72*	−0.01
E.B.	-	-	-	-	-	-	-	-	-	-	**1.00**	0.11
Fir.	-	-	-	-	-	-	-	-	-	-	-	**1.00**

Simbology: (*) indicates the probability of ≤ 5% of error, based on the Pearson correlation; (–) line guide; pH = Hydrogen potential; SS = soluble solids; TA = titratable acidity (% of tartaric acid); SS/TA = SS/AT ratio; P.C. = Weight of cluster; C.C. = length of cluster; L.C. = Girth of cluster; P.B. = Weight of berry; CB. = Length of berry; D.B. = diameter of berry; E.B. = sphericity of berry; Fir. = firmness of berry. Extreme values of the correlation = from (–)1 to +1.

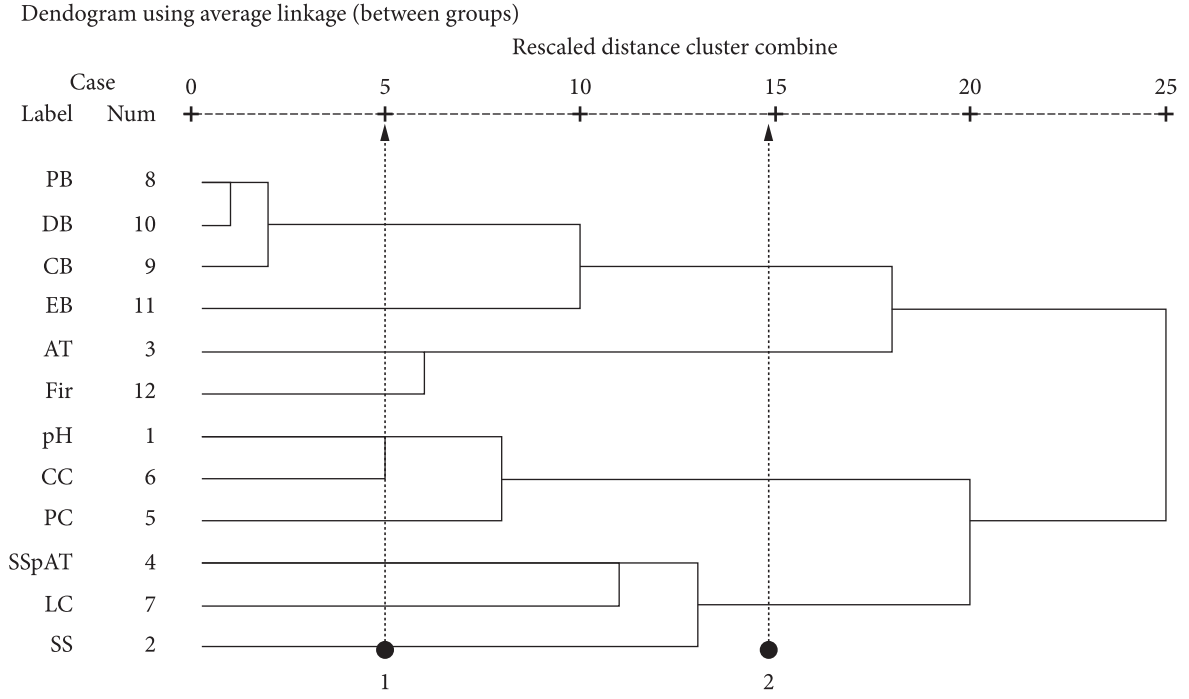

Figure 4. Dendrogram between quality parameters of Brazilian fine table grapes 'BRS Clara', 'BRS Linda', 'BRS Morena', Advanced Selection 8, and the American 'Crimson Seedless', produced in the Sub-medium São Francisco River Valley, Semi-arid Region of Brazilian Northeast, Season May/2008.

The Factorial tri-dimensional Analysis of the Main Components (FAMC) shows six groups of major importance among variables with groups 1 (partial), 2, 3, and 4 in the first dimension thus representing the most influential attributes on the grape marketing differences in this study. In the second dimension are the groups 5, 6, and the other part of group 1. Therefore, group 1 indicates that the larger the cluster, the higher the pH and higher the value of SS/TA ratio. On the other hand, groups 2 and 3 show the natural correlation between weight, length, diameter, and sphericity of the berries. In group 4, there is a very strong correlation between firmness (Fir) and TA, while group 6 showed a logic correlation of moderate type between SS and SS/TA. However, in this same group, there is also a substantial correlation between SS and firmness. The positive synergy between SS and Fir, probably at some point, became the opposite, by considering the quotes from Chitarra and Chitarra (2005) stating that the increase in SS is a key feature of maturation. Additionally, Lima (2007) suggests that reductions of pectins and hemicelluloses can start even before the beginning of maturation; yet it is in this stage that such changes are intensified, and the loss of firmness will be more clearly observed. Moreover, according to the same authors, just

before harvest there are increases in volume and firmness due to the accumulation of water inside the fruit, and such gain, of course, is accentuated by the irrigation on the day before harvest, common management practice among producers, aiming at increasing the weight of the berries (LEÃO; SILVA; SILVA, 2004).

Group 1 also showed that the ratio SS/TA ratio is positively influenced by the size of the clusters (CC and PC). This fact may probably be explained by the results of Koblet and Perret (1980 apud CHAVES, 1986) and Taiz and Zeiger (2004), who reported that concentrations of sugars in the clusters depend on the size of photosynthetic active leaf surface. The translocation of photoassimilates is favored at the end of vegetative growth by the water deficit and the balance between cluster volume/surface of assimilation. In summary, it indicates that the larger the leaf area of the plant, the more intense the rate of photosynthesis and, consequently, the SS accumulation.

The Dendrogram (Figure 4), in its function of showing the hypothesis and structural connections balancing the forces of correlations, indicates the strong correlation of TA with Fir. However, at the same time, it cancels the punctual relationship between SS and Fir considering that the combined power of the group of variables "SS – LC - SS/AT" correlates inversely and very strongly with the interaction "Fir – AT" thus supporting the evidence at the level of 20 point.

4 Conclusions

Clusters of grapes of the Advanced Selection 8 are larger, with large sized berries, dark reddish in color, and ellipsoid in shape; 'BRS Morena' presents medium size clusters, and the berries are nearly black, large sized, and ellipsoid to nearly globular in shape.

'BRS Linda' has large clusters and carries light green berries and 'Crimson Seedless' have small clusters with pink berries, and both are ellipsoid in shape with sizes varying from medium to large.

'BRS Clara', has green yellowish color, has clusters of medium size and carries small berry shaped as elongated ellipsoid.

All grapes evaluated meet the Brazilian Official standards for internal market presenting diameter of at least 12 mm; and, except for BRS 'Clara', the other grapes, 'BRS Linda', 'BRS Morena', Advanced Selection 8, and 'Crimson Seedless' have the minimum diameter requirement for the of grapes, 18 mm. The red grapes 'BRS Morena' and 'Crimson Seedless', have the firmest berries, followed, in that order, followed by 'BRS Clara', 'Advanced Selection 8', and 'BRS Linda'.

With regard to the Soluble Solids (SS), the 'Advanced Selection 8' with proximal value, 'BRS Linda' within the minimal limit, 'BRS Morena' and 'BRS Linda' with a good margin, and 'BRS Clara' with higher values meet the Brazilian standards, established as the minimum SS content of 14 °Brix.

The minimal SS/TA limit of 20 units was largely exceeded by 'BRS Clara' and 'BRS Linda', followed by 'BRS Morena' and 'Crimson Seedless', and 'Advanced Selection 8' grapes.

The largest clusters present the highest hydrogen potential and higher SS/TA ratio indicating that those are the sweetest when ripe.

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