



Yield and physicochemical characteristics of 'BRS Magna' and 'Isabel Precoce' grapes influenced by pruning in the São Francisco river valley

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ABSTRACT: *The objective of this study was to evaluate the productive performance and physicochemical characteristics of 'BRS Magna' and 'Isabel Precoce' grapes influenced by two types of pruning. The experiment was carried out during two growing seasons in a commercial vineyard of Petrolina, PE, in the period 2013-2014. Treatments were represented by two cultivars, 'Isabel Precoce' and 'BRS Magna', and two types of pruning, with selection during plant formation (P1) and without selection (P2) of lateral branches, using a randomized experimental block design, in subdivided plots and four replicates. After pruning P2, the amount of buds kept on vines was greater than after pruning P1, favoring an increase in yield. However, the sizes of bunches and berries, content of soluble solids, and titratable acidity were not influenced by the pruning type. In general, the sizes of bunches and berries in 'BRS Magna' were larger than in the 'Isabel Precoce' cultivar. Conversely, content of soluble solids and titratable acidity varied among cultivars as a function of production cycle and type of pruning; however, within the standards described for both cultivars and accepted by the Brazilian legislation.*
Key words: tropical viticulture; grapevine; juice grapes; *Vitis labrusca*.

Produtividade e características físico-químicas das uvas 'BRS Magna' e 'Isabel precoce' influenciadas pela poda no Vale do São Francisco

RESUMO: *O presente trabalho teve como objetivo estudar o desempenho produtivo e características físico-químicas das uvas 'BRS Magna' e 'Isabel Precoce' submetidas a dois tipos de poda. Um experimento foi realizado durante dois ciclos de produção, nos anos de 2013 e 2014, em um vinhedo comercial em Petrolina, PE. Os tratamentos foram representados por duas cultivares copa, 'Isabel Precoce' e 'BRS Magna', e dois tipos de poda, com seleção de ramos laterais na formação da planta (P1) e sem seleção de ramos laterais (P2), utilizando delineamento experimental em blocos ao acaso em parcelas subdivididas e quatro repetições. A quantidade de gemas mantidas na videira após a poda é mais elevada na poda P2, favorecendo o aumento da produtividade, mas o tamanho dos cachos e das bagas e o teor de sólidos solúveis e acidez titulável não foram influenciados pelo tipo de poda. O tamanho dos cachos e das bagas da cultivar 'BRS Magna' é, de modo geral, maior que os de 'Isabel Precoce'. Por outro lado, o teor de sólidos solúveis e acidez titulável variaram entre as cultivares em função do ciclo de produção e do tipo de poda, estando dentro dos padrões descritos para ambas cultivares e aceitos pela legislação brasileira.*
Palavras-chave: viticultura tropical; videira; suco de uva; *Vitis labrusca*.

INTRODUCTION

In recent years, the production of grape juice in Brazil showed a growth, especially the integral (33-52 million liters) and concentrated (156-178 million liters) juices (MELLO, 2016). The USA, Brazil, and Spain are highlighted as the world's largest juice producers (OIV, 2017).

The state of Rio Grande do Sul is responsible for 90% of the national supply of this beverage. However, other regions, such as the municipality of Novo Mutum (MT), have emerged in the Brazilian scenario in the last five years, and the semiarid region in the sub-middle region of the São Francisco river stands out. Currently, there are

at least six companies in this region, which produce concentrated and integral grape juices from the 'Isabel Precoce' and other ('BRS Magna', 'BRS Cora', and 'BRS Violeta') cultivars developed by the grape genetic breeding program at Embrapa.

The 'Isabel' cultivar and its mutant 'Isabel Precoce' are the basic raw material to make grape juice in Brazil. 'Isabel Precoce' has the same general characteristics of the 'Isabel' cultivar, but its maturation is about 33 days earlier in relation to this cultivar. 'Isabel Precoce' cultivar presents, on average, a yield in the range 25-30t/ha/crop, sugar content around 18-20 °Brix, titratable acidity of 57meq/L, and pH 3.22. The must color of this cultivar is more intense than that of 'Isabel', its original form (CAMARGO, 2004).

In 2012, the 'BRS Magna' cultivar was developed and recommended for cultivation, as an alternative for improvement in the color, sweetness, and flavor of Brazilian grape juices. It resulted from the cross between 'BRS Rubea' and 'IAC 1398-21 (Traviú)', with high bud fertility, yield potential of 25-30t/ha/crop, sugar content around 17-19° Brix, and mean titratable acidity of 90meq.L⁻¹. Juices of the 'BRS Magna' cultivar have an intense violet color and can be consumed pure or in cut with juices from other cultivars (RITSCHER et al., 2014). This cultivar showed to be well suited to the tropical conditions of the São Francisco river valley, arousing a great interest mainly due to its high yield and grape quality. The phenolic composition of commercial juices from 'BRS Magna' produced in the São Francisco river valley is inferior only to that of juices from 'BRS Violet'. They have a high antioxidant activity, exhibiting a potential for use in commercial assembly (LIMA, 2014).

The diversification of viticulture for juice production in the region of the São Francisco river valley, especially with the growth of *Vitis labrusca* and hybrid grapes, suggests a need for research focused on the development of production systems adjusted to these cultivars.

Pruning is an essential practice in vineyards, and plant formation and production are among its functions to obtain the desired quantity and quality of fruits. Furthermore, rejuvenation pruning is also performed to change the training system or canopy management (SALAZAR; MELGAREJO, 2005). They are classified according to the intensity in short, medium, and long pruning. There is also mixed pruning, in which spurs and canes are combined simultaneously on the same vine (LEÃO; RODRIGUES, 2009).

The pruning intensity or load of buds to be kept in the plant after pruning may vary according to the genetic characteristics of grape cultivar, climate, and management adopted in the vineyard (including spacing, training system, nutrition, irrigation). The amount of buds kept after pruning influences the carbohydrate stocks in the plant (PELLEGRINO et al., 2014), and can affect grape yield and quality. However, the responses vary depending on the grape cultivar (DOBREI et al., 2016; CHOUGULE et al., 2008; BENISMAIL et al., 2007; SOMKUWAR e RAMTEKE, 2006).

No information on proper pruning management of juice grape cultivars in the region of the São Francisco river valley is currently available in the scientific literature. Therefore, the objective of this study was to evaluate the productive performance and physicochemical characteristics of the 'BRS Magna' and 'Isabel Precoce' grapes subjected to two different types of pruning in the San Francisco river valley.

MATERIALS AND METHODS

An experiment was carried out in a commercial vineyard of the 'BRS Magna' and 'Isabel Precoce' cultivars at the Senator Nilo Coelho irrigation project in Petrolina, PE (9°13'S 40°29'W). Climate of the region is characterized as semi-arid tropical or, according to Köppen, as BswH, dry and hot, with a rainy season in the period January-April, with an average annual rainfall of 540mm and a mean temperature of 26.2°C (EMBRAPA SEMIÁRIDO, 2015). Average, maximum, and minimum temperatures, precipitation, and radiation data during the work are shown in figure 1.

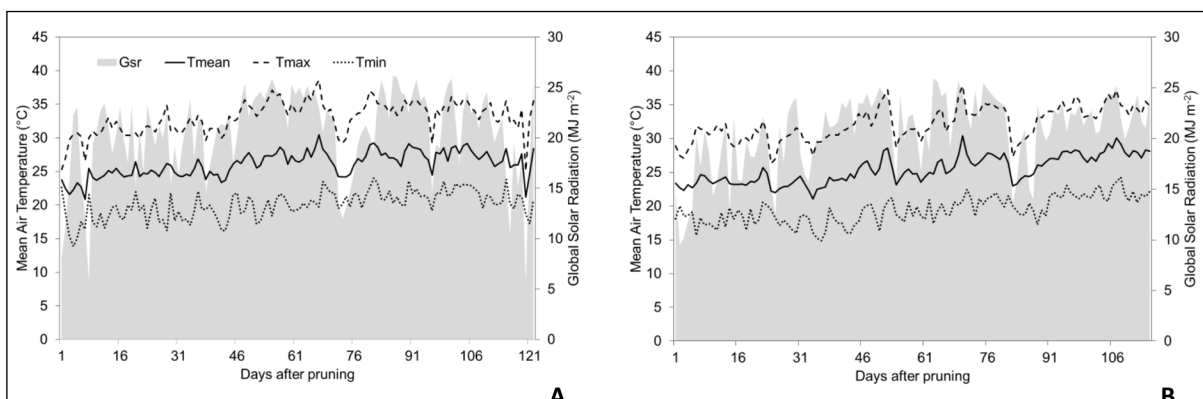


Figure 1 - Mean (Tmean), maximum (Tmax), and minimum (Tmin) temperatures and global solar radiation (Gsr) during the first (A) and second (B) growing seasons in the experimental vineyards of 'BRS Magna' and 'Isabel Precoce', Timbaúba Farm, Petrolina, PE, 2013 and 2014.

The vines were grafted on the rootstock IAC 572, and planting was carried out in 2011. Vines were trained in the trellis system, with spacing of 3.5m x 1.5m between plants (1,904 plants/ha) and localized drip irrigation. Two growing seasons were carried out in 2013 and 2014, and the pruning and harvesting dates in each growing season are shown in table 1.

The experimental design was completely randomized in subdivided plots, considering the cultivar as the main plot and the two types of pruning as the subplot, totalizing four treatments, four replicates, and one plant per replicate. The main treatments were represented by the 'BRS Magna' and 'Isabel Precoce' cultivars, whereas the secondary treatments consisted of two types of pruning. Pruning 1 (P1) was characterized as a pruning with selection of lateral branches, maintaining six lateral branches or secondary branches per plant after formation pruning, whereas in pruning 2 (P2) the lateral branches were not selected, keeping all branches in the main arm of the vine during formation pruning. In each plant, the buds (which were kept in the vines after pruning) were counted and are shown in table 1.

Variables evaluated were as follows: production measured as the weight of all bunches per plant at the time of harvest, number of bunches by counting of all bunches per plant, and mean bunch mass obtained by the ratio production (kg)/number of bunches per plant. At the time of harvest, a five-bunch sample per replicate was collected for evaluation of: mass (g), length (cm), and width of bunches (cm), whereas a 50-berry sample was collected from the five bunches to determine mass (g), length (mm), and berry diameter (mm); content of soluble solids (SS; Brix) was determined in a digital refractometer (ABBE type), with a 0-65°. Brix variation scale, (AOAC, 1992), and titratable acidity (TA; g tartaric acid/100mL), which was determined diluting 1g of pulp in 50mL of distilled water, titrating with

0.1N NaOH solution, and using phenolphthalein as indicator to check the turning point (from colorless to permanent light pink (AOAC, 1992).

The data were submitted to analysis of variance and comparison between means using the Tukey's test (5% probability level) in the SAS statistical software.

RESULTS AND DISCUSSION

Table 1 shows that formation pruning, in which the lateral branches were not selected (P2), increased the amount of buds kept in the vine after the production pruning in both growing seasons. In this type of pruning, the 'Isabel Precoce' cultivar showed increases in the first (17%) and second (38%) growing seasons, similar to 'BRS Magna', which showed 20% and 40% more buds in the first and second growing seasons, respectively.

Results presented in tables 2 and 3 indicated that a significant interaction between cultivars and pruning types occurred in each cultivar during two production cycles.

Pruning with branch selection (P1) significantly reduced the production of the 'BRS Magna' and 'Isabel Precoce' cultivars in the first (36%) and second (31%) growing seasons, which resulted from the smaller amount of buds in this type of pruning (Table 1). Production showed significant differences between the 'BRS Magna' and 'Isabel Precoce' cultivars only in pruning P1, with a higher production in the 'Isabel Precoce' vines in the first growing season and 'BRS Magna' in the second growing season. Pruning without branch selection (P2), resulted in smaller differences between cultivars of juice grapes in both growing seasons as assessed in this study, besides favoring an increase in production (Table 2). In this type of formation pruning all lateral branches were kept. Therefore, the vines presented a greater amount of buds. According to PELLEGRINO et al. (2014), light

Table 1 - Dates of pruning and harvesting, and average number of buds after pruning, in two growing seasons in the 'BRS Magna' and 'Isabel Precoce' cultivars, Petrolina, PE, 2013-2014.

Cultivars	-----First growing season-----					-----Second growing season-----				
	Pruning dates	Harvest dates	-----Number of buds-----			Pruning dates	Harvest dates	Number of buds		
			P1	P2	Dif. ¹			P1	P2	Dif. ¹
'BRS Magna'	12/08/13	02/12/13	198	248	+ 20	15/07/14	05/11/14	105	185	+ 43
'Isabel Precoce'	01/08/13	14/11/13	160	192	+ 17	17/07/14	06/11/14	133	214	+ 38

¹Dif: Percentage difference in the number of buds after P1 and P2 (%).

Table 2 - Mean values and coefficients of variation (CV) for the production, number of bunches, mass, length, and width variables of grape bunch in the 'Isabel Precoce' and 'BRS Magna' cultivars submitted to two types of pruning in two growing seasons, Petrolina, PE, 2014.

Cultivars/Prunings	Production (kg.plant ⁻¹)		Number of bunches		Bunch mass (g)		Bunch length (cm)		Bunch width (cm)	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
-----First growing season-----										
'Isabel Precoce'	18.27 ^{aA}	20.63 ^{aA}	180 ^{aA}	233 ^{aA}	105 ^{aA}	216 ^{aA}	10.82 ^{aA}	9.86 ^{aB}	6.17 ^{aA}	6.18 ^{aB}
'BRS Magna'	8.5 ^{bB}	13.19 ^{aA}	60 ^{aB}	79 ^{aB}	92 ^{aB}	183 ^{aA}	12.78 ^{aA}	11.76 ^{aA}	8.33 ^{aA}	8.43 ^{aA}
CV (%)	16.30		23.99		28.45		11.01		16.68	
-----Second growing season-----										
'Isabel Precoce'	16.83 ^{bB}	24.35 ^{aA}	155 ^{bA}	196 ^{aA}	110 ^{aB}	125 ^{aA}	9.00 ^{aB}	9.43 ^{aB}	4.68 ^{aB}	4.91 ^{aB}
'BRS Magna'	30.12 ^{aA}	32.39 ^{aA}	149 ^{aA}	177 ^{aA}	20 ^{3aA}	182 ^{aA}	14.43 ^{aA}	13.77 ^{aA}	10.19 ^{aA}	11.25 ^{aA}
CV (%)	15.68		10.24		10.39		5.61		12.49	

Means followed by the same lower-case letter in the line and upper-case in the column do not differ by the Tukey's test ($P < 0.05$).

pruning resulted in a greater carbohydrate store in the trunk and branches due to the larger plant size. However, they had a little influence on the levels of carbohydrates stored in tissues and berries, and yield.

Therefore, pruning without selection of branches (P2) favored yield increases during the second growing season, as estimated for the 'Isabel Precoce' (46t/ha) and 'BRS Magna' (62t/ha) cultivars. These values are considered very high yields as compared to those obtained with these same cultivars in other regions of the country, such as 25-30t/ha for 'BRS Magna', which is cultivated in the states of Rio Grande do Sul, São Paulo, and Mato Grosso (RITSCHER et al., 2014), and 'Isabel Precoce' (CAMARGO et al., 2004).

The type of pruning had a smaller effect on the number of bunches per plant, and significant differences were observed in pruning P1 only in the 'Isabel Precoce' cultivar and in the second growing season, although a tendency to reduce the number of bunches in this pruning was observed in both cultivars studied and growing seasons. In the first growing season, the number of bunches in the 'Isabel Precoce' cultivar was higher than that in the 'BRS Magna'. However, a high number of bunches was observed in both cultivars in the second growing season, and significant differences between them were not found. The 'Isabel Precoce' and 'BRS Magna' cultivars are characterized by the high fertility of their buds, about 2.0 bunches per shoot (RITSCHER et al., 2014), which explains the high number of bunches obtained in both cultivars, regardless of the type of pruning performed.

Biometric characteristics of bunches were not affected by the pruning types, but the responses were different depending on the cultivars. The bunch mass in 'BRS Magna' was greater than that in 'Isabel Precoce' in the second growing season, when pruning P1 was performed. Conversely, the length and width of bunches in 'BRS Magna' were larger than those in 'Isabel Precoce' in this same growing season in both types of pruning. Bunches of 'BRS Magna' also presented a greater length and width in the previous growing season, but only in pruning P2. These results showed that generally the bunches of 'BRS Magna' are larger than those in 'Isabel Precoce'.

The mass, length, and diameter of berries were higher in the 'BRS Magna' cultivar when pruning P1 was performed in both growing seasons. However, differences between cultivars of juice grapes were not observed for these variables in pruning P2. Regarding berry size, the differences observed between the 'BRS Magna' and 'Isabel Precoce' cultivars stem from their genetic characteristics, being in agreement with the description of cultivars, in which the berries of 'Isabel Precoce' (17.2x18.7mm) are smaller than those of 'BRS Magna' (18.0x20.0mm) (RITSCHER et al., 2012; CAMARGO et al., 2004).

The type of pruning did not influence the content of soluble solids (SS) and titratable acidity (TA) of the 'BRS Magna' and 'Isabel Precoce' grapes in both growing seasons evaluated in this study. This observation is in agreement with PELLEGRINO et al. (2014), who observed that light pruning in three wine grape cultivars had little effect on

the content of soluble sugars. In addition, SASE and TAMBE (2015) also observed no effect of density of shoots on the content of soluble solids in the 'Thompson Seedless' cultivar. Conversely, BENISMAIL et al. (2007) observed a reduction in the content of soluble solids with the increase in bud load in pruning the 'Cardinal' cultivar.

The influence of climatic and management conditions in each growing season seem to be greater than that of pruning on the attributes of grape quality, because the SS content in the second growing season was higher than that in the first growing season mainly in the 'Isabel Precoce' grapes, after pruning P1 (22.6° Brix) and P2 (21.4° Brix) (Table 3). In the 'BRS Magna' cultivar, close SS contents were observed in pruning P1 (19.4°Brix) and P2 (17.6°Brix) in the second growing season, which is in agreement with the contents reported in the literature (17-19°Brix) for this cultivar (RITSCHER et al., 2015). The SS contents obtained in this study also meet the requirements of the Brazilian Legislation (BRASIL, 2000), in which 14°Brix is the minimum content required. PEREIRA et al. (2008) and SATO et al. (2008) reported SS contents around 15°Brix in different juice grape cultivars in the south and north regions of the state of Minas Gerais, respectively, where temperatures are lower than those observed in the São Francisco river valley. As can be seen in figure 1, temperatures remained high during the grape maturation phase in both growing seasons from 90 days on after pruning. According to LIMA and CHOUDHURY (2007), a greater accumulation of SS in the berries is expected under high temperature conditions such

as those that occur in the São Francisco river valley.

Influence of genetic characteristics of the cultivar was also likely to have occurred, and the lowest values for SS were found in 'BRS Magna' in both types of pruning performed during the second growing season.

Determination of organic acids is one of the main criteria recommended to define the ideal harvest point (GUERRA et al., 2003). In this study, higher values for titratable acidity (TA) were reported in the BRS Magna grapes during the first growing season, but differences between cultivars were not observed in the next season. Mean values were calculated for TA in the first (0.74g/100mL) and second (0.59g/100mL) growing seasons of 'BRS Magna' grapes, and in the first (0.51g/100mL) and second (0.61g/100mL) growing seasons of 'Isabel Precoce' grapes. These values are within the range of 0.5-0.9g of tartaric acid/100mL, as determined by GUERRA et al. (2003), as necessary to produce high-quality juices.

Values for titratable acidity, which were reported in the 'Isabel Precoce' cultivar, are in agreement with the values obtained in previous studies in this region (RIBEIRO et al., 2012), but were below those for titratable acidity of 0.8g of tartaric acid/100mL obtained for the 'Isabel Precoce' cultivar in the south of Minas Gerais State (PEREIRA et al., 2008).

CONCLUSION

Formation Pruning with branch selection reduced the yield of the 'BRS Magna'

Table 3 - Mean values and coefficients of variation (CV) for berry mass, length, and diameter, and total soluble solids (SS) content and titratable acidity (TA) variables of grapes in 'Isabel Precoce' and 'BRS Magna' cultivars submitted to two types of pruning in two growing seasons, Petrolina, PE, 2014.

Cultivars/Prunings	Berry mass (g)		Berry length (mm)		Berry diameter (mm)		SS (°Brix)		TA (%tart.ac.)	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
-----First growing season-----										
'Isabel Precoce'	2.39 ^{aB}	2.36 ^{aA}	16.64 ^{aB}	16.39 ^{aA}	15.19 ^{aB}	15.00 ^{aA}	15.50 ^{aB}	15.85 ^{aA}	0.52 ^{aB}	0.50 ^{aB}
'BRS Magna'	3.24 ^{aA}	3.03 ^{aA}	17.94 ^{aA}	17.27 ^{aA}	16.93 ^{aA}	16.64 ^{aA}	17.58 ^{aA}	17.50 ^{aA}	0.76 ^{aA}	0.72 ^{aA}
CV	5.63		2.85		1.96		3.82		10.31	
-----Second growing season-----										
'Isabel Precoce'	2.69 ^{aB}	2.73 ^{aA}	17.09 ^{aB}	17.29 ^{aA}	15.68 ^{aB}	15.84 ^{aA}	22.58 ^{aA}	21.40 ^{aA}	0.65 ^{aA}	0.57 ^{aA}
'BRS Magna'	3.37 ^{aA}	3.04 ^{ba}	19.36 ^{aA}	18.68 ^{ba}	17.21 ^{aA}	16.55 ^{ba}	19.43 ^{aB}	17.57 ^{aB}	0.59 ^{aA}	0.59 ^{aA}
CV	2.74		1.27		1.47		4.00		13.36	

Means followed by the same lower-case letter in the line and upper-case in the column do not differ by the Tukey's test ($P < 0.05$).

and 'Isabel Precoce' cultivars but did not affect the size of bunches and berries, soluble solids content, and total acidity of the grapes.

The 'BRS Magna' and 'Isabel Precoce' cultivars exhibited a high yield, confirming their ability for cultivation and juice preparation in the tropical conditions of the São Francisco river valley.

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