Vine performance and physicochemical characteristics of berries of new wine grape cultivars in the São Francisco Valley

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Abstract. This study aimed to evaluate the performance and characteristics of the grapes as subsidies to the recommendation of new wine grape cultivars for the São Francisco Valley. An experiment was carried out in Petrolina, Pernambuco State, during four seasons in 2014 and 2015 and the treatments were represented by 10 cultivars and 3 breeding selections. A better balance between production and vigour was obtained in Grenache, Merlot and Tempranillo cultivars, presenting values of 7.56, 6.50 and 5.93 respectively, for Ravaz index. Grenache, Chenin Blanc and Tempranillo were the most productive cultivars with average yields estimated at 10.4, 8.7 and 8.4 ton/ha/season. 'Selection 14' had longer, wider and less compact clusters, which can reduce bunches rottenness. The percentage of sprouting ranged from 38.13% in 'Selection 14' to 77.6% in cv. Chenin Blanc. The average index of bud fertility was 0.79 bunches/bud, with no significant differences among cultivars. Greater potential for sugar accumulation was found in the selections 14, 46 and 47, while the titratable acidity ranged from 0.63% in cv. Merlot to 0.89% in selection 43. 'Grenache' and 'Tempranillo' have showed potential to obtain adequate yield and balanced vines, while 'Sauvignon Blanc', 'Chardonnay', 'Cabernet Sauvignon', 'Malbec' and 'Petit Verdot' presented low yield being necessary to select clones more productive and well adapted to the tropical conditions. Further information about the quality of grapes and wines should be added to these results to allow the recommendation of new cultivars or breeding selections of wine grapes for the São Francisco Valley.

1. Introduction

São Francisco Valley is one of the most important grape and wine producing region in the country. Although there is no official statistics for the production of wine in the Northeaster region of Brazil, it is estimated the production of 5 million litters, which gives this region the second position, behind the Rio Grande do Sul State (Sebrae, 2007).

The traditional production of wine in the world is on two regions, one located between latitudes 35-50°N, which includes the grape growing areas of California, in the United States and European countries (Portugal, Spain, France, Germany and Italy), and another between parallels 29-45°S, where are Chile, Argentina, South of Brazil, South Africa, Australia and New Zealand. The Semiarid region of Northeaster Brazil is located between parallels 8-10°S, with an average annual temperature of 26.5°C and insolation of 3,000 hours/year.

Viticulture in semiarid tropical climate began in the late 60s, with the introduction of grape for fresh consumption and wine purposes, advancing and developing one of the most peculiar wine regions in the world, as in tropical conditions, the vine does not come at rest, it maintain its vegetative growth throughout the year. So, it is possible meet plants in different growth stages in the same time and same production area, achieving up to two crops annually. The management of the vineyard requires the water supply for irrigation and the control of vegetative growth by a water stress for 30 to 60 days after harvest. The shoots have strong apical dominance and budding is obtained by the application of Hydrogen Cyanamid (Leão & Rodrigues, 2009).

The wines of the São Francisco Valley, known as 'sun wine' are characterized as young wines, fruity and aromatic, although they are also designed guard wines, which undergo some time in oak barrels, which promotes greater complexity of aromas and an improvement in the structure of the wines.

Thus, the São Francisco Valley has broken known wine world paradigms and overcome the disbelief of those who thought that was impossible to produce quality wines in tropical conditions. However, the appeal of tropical wines, distinction of product and versatility to

explore different types, varietals combinations and production times throughout the year bring many technological challenges. Among them, the differential potential of cultivars, characterizing and typicality of raw materials and finished products, the adjustment in management and winemaking techniques (Lima et al., 2013).

The most important cultivars of grapes for winemaking in the São Francisco Valley is ‘Syrah’ for red wines, 'Chenin Blanc' for white wines and muscat cultivars for sparkling wines. The last ones has emerged as the most appreciated and sales leader in the region.

Further studies, including cultivars already used by local wineries and other economically important in other countries of the world should be studied to identify grape cultivars well adapted to tropical conditions. Then, this study aimed to evaluate the yield performance and characteristics of the grapes as subsidies to the recommendation of new wine grape cultivars for the São Francisco Valley.

2. Material and Methods

The experiment was carried out in Bebedouro Experimental Station, Embrapa Semiárido, in Petrolina, Pernambuco State (9º09 'S, 40º22', 365,5m) over four production growing seasons during 2014 to 2015. According to the Köppen climate classification, the climate is tropical semi-arid, BSwh type, dry and warm, with average annual temperature around 26°C, annual rainfall of about 500 mm, concentrated between the months of January and April .

The vines were planted in June 2013 grafted on rootstock 'IAC 766', spaced 3,0m x 1,0m and drip irrigated.

The canopy management included pruning and shoot thinning. As the shoots were grown, they were attached to the trellis wires and trimmed at the top of the trellis. Other cultural practices were weed control by applying herbicides and trench, fertigation and phytosanitary treatments as recommended for viticulture in the São Francisco Valley (Leão & Rodrigues, 2009).

The vines have been trained in a vertical upward shoot positioned trellis, spur pruned on bilateral cordon with an average of six spurs per plant.

The treatments were represented by 10 grape cultivars and 3 Embrapa grape breeding selections for winemaking: Grenache, Tempranillo, Merlot, Cabernet Sauvignon, Malbec, Petit Verdot and Syrah for red wines and Sauvignon Blanc, Chardonnay, Chenin Blanc and breeding selections 46, 14 and 47 for white wines.

The experimental design was a randomized block with four replications and 2 plants per plot. They were evaluated in four consecutive growing seasons for the following variables: sprouting (%), bud fertility rate (bunch/shoot), Ravaz index (kg of grapes/kg of pruned branches), production (kg/vine); number of bunches per vine; weight (g), length (cm) and width of bunch (cm); weight (g) and volume of 100 berries (mL), soluble solids (°Brix) and titratable acidity (% of tartaric acid).

On the pruning dates, all the branches of the plants were eliminated and leaves removed. The leaves and herbaceous branches removed from the pruned material were gathered up and weighed. At harvest, the bunches were counted and weighed. Mean bunch weight was obtained by dividing the total weight of the bunches by the number of bunches for each plant. The ratio of bunch weight and branch weight was calculated, obtaining the Ravaz index. During the sprouting phase and initial shoot growth, the number of buds, shoots, and bunches was registered, obtaining the sprouting percentage (number of sprouted buds X 100/number of buds) and bud fertility (number of bunches X 100/number of shoots).

During the harvest, all bunches of evaluated plants were counted, harvested and weighed to obtain the production per plant. A sample of five bunches was taken to the Embrapa Semárido. Postharvest Physiology Laboratory, to determine the measures of length and width of the bunch, weight and volume of 100 berries. Soluble solids content was obtained in a Abbe digital refractometer (AOAC, 1992) as well as titratable acidity was determined by titration in a 0.1 M NaOH solution (AOAC, 1992).

Mean data from four production growing seasons were submitted to variance analysis and comparison of means by Tukey test at 5% probability.

3. Results and Discussion

There was influence of genotype of wine grapes cultivars and breeding selections on the components of production and physicochemical characteristics of bunches and berries, with the exception of bud fertility where there was no difference between cultivars.

The percentage of sprouting ranged from 38.13% in selection 14 to 77.59% in the cultivar Chenin Blanc. Sprouting lower and less than 55% were obtained in ‘Malbec’, ‘Petit Verdot’ and selections 47 and 14 (Table 1). Although it was not observed differences among cultivars and selections, the bud fertility rates were high, from 0.79 (‘Cabernet Sauvignon’) to 1.10 (‘Syrah’).

The cultivars Grenache and Tempranillo for red wines and ‘Chenin Blanc’ for white wines were the most productive, with significant differences compared to ‘Sauvignon Blanc’, ‘Chardonnay’, ‘Cabernet Sauvignon’, ‘Malbec’ and ‘Petit Verdot’, whose productions were less than 1 kg per vine (Table 1). These results allow estimating average yield around 10.4; 8.7 and 8.3 tons/ha/growing season respectively for 'Grenache', ‘Chenin Blanc’ and ‘Tempranillo’ (Figure 1).

The production per vine and estimated yield observed in this study was less than those obtained for the same cultivars and same region (Camargo et al. 2004). On the other hand, Camargo et al. (2004) also mentioned higher yield, bunch and berry weight in cultivars Grenache and Tempranillo, which is in agreement with the results obtained in this study. ‘Cabernet Sauvignon’ growing in Maringá, north region of Paraná State, Brazil, also showed higher yield than those observed in this work (Sato et al., 2011). Miele and Rizzon (2003) had mentioned that ‘Merlot’ growing in Bento Gonçalves,

Rio Grande do Sul State, showed higher bunch and berry weight than those obtained in this study. These differences among the same wine grape cultivars can be explained by variations among different clones, environmental conditions and vineyard management. However, it is possible that these cultivars have less adaptation and capacity in semi-arid tropical conditions.

Figure 1. Mean yield of wine grape cultivars and breeding selections in four consecutive growing seasons, Petrolina, Pernambuco State, 2014-2015.

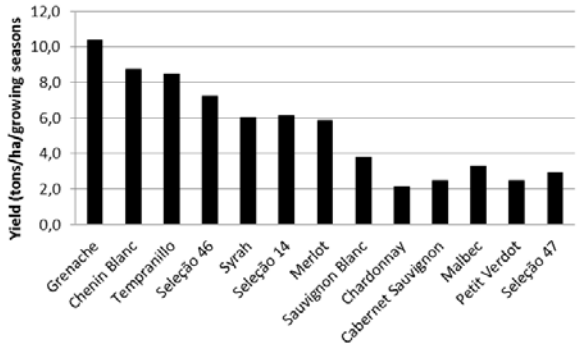

Table 1. Mean values and coefficient of variation of sprouting (SP, %), bud fertility rate (BF, bunch/shoot), production (PR, Kg) and number of bunches (NB) per vine of wine grape cultivars and breeding selections, Petrolina, Pernambuco State, 2014-2015.

Cultivars/ Selections	SP	BF	PR	NB
Grenache	69.30 ab	0.96^{ns}	3.11 a	11.79 bcd
Chenin Blanc	77.59 a	0.98	2.62 ab	12.26 bcd
Tempranillo	61.44 ab	0.96	2.53 ab	10.61 bcd
Selection 46	68.81 ab	0.99	2.17 b	13.06 bc
Syrah	68.19 ab	1.10	1.81 bc	14.07 ab
Selection 14	38.13 c	0.95	1.83 bc	18.16 a
Merlot	57.80abc	0.84	1.76 bc	8.64 d
S.Blanc	72.07 ab	0.86	1.14 cd	11.60 bcd
Chardonnay	68.21 ab	0.82	0.64 d	9.51 cd
C. Sauvignon	55.36abc	0.79	0.74 d	13.20 bc
Malbec	52.30 bc	0.91	0.99 cd	9.98 bcd
Petit Verdot	54.78 bc	0.85	0.73 d	10.51 bcd
Selection 47	51.31 bc	0.88	0.87 bc	11.08 bcd
Mean	**61.18**	**0.92**	**1.61**	**11.88**
CV (%)	**18.31**	**22.74**	**41.65**	**25.12**

Means followed by the same letter in the column do not differ (Tukey's test, $p < 0.05$).

The ratio between fruit weight and pruned branch weight defined by the Ravaz index (Smart & Robinson 1991) differed significantly among cultivars and breeding selections. 'Grenache', 'Merlot' and 'Tempranillo' showed satisfactory balance between production and plant vigor and differed significantly from most other cultivars. In the other cultivars and selections, the values were below the minimum limits mentioned by Smart and Robinson (1991), indicating an imbalance, consequence of low production and intense vegetative development.

Selection 14 and 'Syrah' showed the highest number of bunches per vine (Table 1). However, the bunches had lower mean weight, which did not contribute to the increase in production in these cultivars. Bunches with higher mean weight were found in the cultivar Grenache (Table 2), differing from all other cultivars and selections. Moreover longer and wider bunches were obtained in the cultivar Tempranillo and selections 14, 47 and 46. The lower compactness of bunches in breeding selections could contribute to reduce the incidence of common pests and diseases problems in wine grapes, as honeydew moth, *Cryptoblabes gnidiella* (Lepidoptera: Pyralidae) and bunch rots of ripening grapes.

'Cabernet Sauvignon', 'Sauvignon Blanc', 'Chardonnay' and 'Petit Verdot' had small bunches and low mean weight, less than 110g (Table 2). Then, those cultivars have showed less adapted to the tropical semiarid conditions, being important to select and evaluated other clones in this region.

Table 2. Mean values and coefficient of variation of Ravaz Index (RI, kg of grapes/kg of branches), bunch weight (BW, g), bunch length (BL, cm) and bunch width (BWi, cm) of wine grape cultivars and breeding selections, Petrolina, Pernambuco State, 2014-2015.

Cultivars/ Selections	RI	BW	BL	BWi
Grenache	7.56a	306.89a	13.62bc	9.37bc
Chenin Blanc	4.60bcd	223.12b	12.70cd	8.25cd
Tempranillo	5.93ab	242.60b	15.52a	10.71a
Selection 46	4.53bcd	161.87c	14.04abc	10.60ab
Syrah	4.29cde	141.90cd	11.88d	7.12 def
Selection 14	3.44def	118.02cde	15.61a	11.54a
Merlot	6.50ab	110.45def	11.53de	7.10def
S. Blanc	2.57defg	106.65def	9.68fg	6.59efg
Chardonnay	2.78defg	94.87fg	8.87fg	6.00fg
C. Sauvignon	1.07g	68.63g	8.36g	5.47g
Malbec	2.37efg	133.05cde	11.60de	7.95d
Petit Verdot	2.75defg	101.34efg	10.16ef	7.49de
Selection 47	2.05fg	89.93fg	14.59ab	11.27a
Mean	**3,88**	**146.10**	**12.17**	**8.42**
CV (%)	**42.88**	**14.91**	**8.51**	**13.94**

Means followed by the same letter in the column do not differ (Tukey's test, $p < 0.05$).

The greatest weight and volume of berries were observed in selection 46, 'Chenin Blanc' and 'Grenache' (Table 3) which can explain the higher average weight of bunches and production presented in the last two cultivars.

Considering the soluble solids, three groups of cultivars with higher, intermediate and low contents can be distinguished, characterizing grapes with different enological potential. The Embrapa breeding selections and cultivar Petit Verdot presented soluble solids contents above 23ºBrix, showing high capacity to accumulate sugars (Table 3). Four cultivars showed intermediate contents, ranging from 20,9ºBrix (Chenin Blanc) to 22,3ºBrix (Tempranillo). Lower soluble solids contents were found in cultivars Malbec, Merlot, Chardonnay, Grenache and Cabernet Sauvignon.

There were also significant differences among cultivars regarding the titratable acidity (Table 3). However, most of them showed values above 0.75% tartaric acid. 'Merlot' and 'Tempranillo' had the lowest values, and the first one differed significantly of the others cultivars and selections.

Table 3. Mean values and coefficient of variation of berry weight (BeW, g), volume of 100 berries (V, mL), soluble solids content (SS, °Brix) and titratable acidity (TA, % of tartaric acid) of wine grape cultivars and breeding selections, Petrolina, PE, 2014-2015.

Cultivars/ Selections	BeW	BeV	SS	TA
Grenache	1.75 b	154.38 bc	19.1 g	0.82 abc
Chenin Blanc	1.74 ab	160.21 b	20.9 cd	0.86 ab
Tempranillo	1.59 cd	146.39 cd	22.3 def	0.72 cd
Selection 46	1.99 a	177.50 a	23.3 c	0.81 abc
Syrah	1.52 cde	135.42 de	21.0 def	0.76 bc
Selection 14	1.47 de	125.42 e	25.6 b	0.76 bc
Merlot	1.16 f	99.44 fg	19.8 efg	0.63 d
S.Blanc	1.53 cd	110.21 f	21.2 de	0.79 abc
Chardonnay	1.40 e	110.63 f	19.7 fg	0.82 abc
C.Sauvignon	1.07 fg	93.54 g	18.8 g	0.78 abc
Malbec	1.60 c	135.28 de	19.8 efg	0.76 bc
Petit Verdot	0.97 g	89.58 g	23.1 c	0.88 a
Selection 47	1.12 f	98.89 fg	27.2 a	0.89 a
Mean	**1.49**	**125.91**	**21.7**	**0.79**
CV (%)	**7.11**	**7.83**	**4.35**	**8.84**

Means followed by the same small letter in the column do not differ (Tukey's test, $p < 0.05$).

4. Conclusions

Cultivars Grenache and Tempranillo showed better agronomic performance being good new options for red wines.

Traditional cultivars as 'Sauvignon Blanc', 'Chardonnay', 'Cabernet Sauvignon', 'Malbec' and 'Petit Verdot' presented low yield and unbalanced vines, being necessary to select better clones.

'Petit Verdot', despite its low yield, highlighted by the high content of sugars and acidity of their grapes, which can be interesting for high quality wines.

Further studies on physical-chemical and sensory characteristics of the wines are necessary to enable the indication of wine grape cultivars with potential for the São Francisco Valley.

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