CABERNET SAUVIGNON IN TROPICAL SEMI-ARID CLIMATE (PERNAMBUCO – BRASIL)
Adaptation of some clones and their affinity to different rootstocks

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Summary

The variety Cabernet Sauvignon has revealed in the São Francisco Valley (9°02' S; 40°11' W) a high potential of quality, but with some limitations on its adaptation to this "*terroir*". The rootstocks with effective affinity are yet unknown and the material with many virus infections makes difficult its culture, particularly in terms of yield, which generally is very low.

With the objective to maximize the behaviour of this variety in this *terroir,* a field trial was installed in Vinibrasil – Vinhos do Brasil, SA to compare the relations "variety x rootstock", with 5 clones (15, 169, 191, 337 and 685) combined with 6 rootstocks (IAC-313, IAC-572, 1103-P, 420-A, 101-14 e SO4).

After seven harvests (two per year) consistent differences in yield were observed, mainly due to the rootstock. These disparities are due to the number of clusters and their medium weight. Autochthonous rootstocks (obtained at the Instituto Agronômico de Campinas), were those that generated the highest yield, with the IAC-313 the most productive. With regard to rootstocks commonly used in temperate climates, the 1103-P was one that showed behaviour closer to the Brazilian rootstock. The rootstocks with lower yields were generally the 101-14 Mgt and 420-A. At the qualitative level, we found only minor differences and not always in the same direction between the different rootstocks.

There were no significant differences in average yield or quality among the different clones. Overall, the sensory analysis of wines produced from the clones, indicates the clones 337 and 685 as being the most agreeable, especially in the parameters of the aroma. The colour intensity is another parameter where those two clones have higher comparative values. In another way, the clone with lower colour intensity is the 191, which shows the lower content of red anthocyanins.

These results show the possibility to growth C. Sauvignon in tropical semi-arid climate, with acceptable yields and high quality. On the another hand, in the establishment of new vineyards it is essential to choose the correct combination (clone x rootstock) and especially the appropriate rootstock.

1- INTRODUCTION

The Vitiviniculture of the São Francisco Valley region - northeast of Brazil, is relatively recent (Albuquerque *et al.*, 1987). This region is characterised by a BSwh' climate, according to the Köppen classification, which corresponds to an arid climate. In the annual course of the hydric regime, the water deficiency that occurs during the summer months is the most serious limiting factor of this region climate (Teixeira & Silva, 1999).

In this region, where the average annual temperature is around the 26 °C, the vine behaves as a perenifolium specie and the winter inactivity, typical of temperal regions, doesn't occur. So, the vegetative cycle is controlled through cultural practices such as pruning and irrigation. The beginning of the vegetative cycle is defined by the pruning date and the start of irrigation. The inactivity period, between harvest and pruning, varies from 1 to 2 months and is maintained by the non-irrigation (Cruz *et al.*, 2007). This climate allows to observe different vineyards in diverse phenological stages, during all year.

Due to the climatic conditions being so different between the two semesters of the year, also the obtained wines present very different characteristics between them. Typically, the grapes produced in the first half of the year originate less alcoholic, fresher and fruity wines, while the wines produced in the second half of the year, due to the warmest and dry climatic conditions, are more structured, with high alcohol content and more intense color.

In this *terroir*, the behaviour of many vine varieties and the most interesting rootstocks for each one of them are yet unknown. The aim of this work is to understand the performance of 5 different clones of the red vine variety Cabernet Sauvignon, grafted onto 6 rootstocks.

2- MATERIAL AND METHODS

The experimental trial was installed in "Santa Maria" farm, on a vineyard belonging to a private company (Vinibrasil-Vinhos do Brasil/GlobalWines). The farm is located at Lagoa Grande-Petrolina - Brazil (9° 2'S, 40° 11' W). The climate of this region is a BSwh' by the Köppen classification and the majority of soils are podzols. The vineyard is trained in vertical shoot positioning and pruning system is a unilateral spur pruned cordon. The density of plantation is 3333 vines/ha (3 m between rows and 1 m in row) and row orientation is North-South.

For this study, 5 clones of Cabernet Sauvignon red variety were chosen. The clones are: 15, 169, 191, 337 and 685. All of them are grafted onto 6 rootstocks: 101-14 Mgt, 1103P, 420 A, SO4, IAC313 and IAC572, the last 2 being from Brazil obtained at the Instituto Agronómico de Campinas (IAC). In total 30 different plots, each one represented by 30 vines, were established.

The presentation of the results is divided into two groups: the results of the harvests of the first and second semester of the year.

At harvest, number and cluster weight and number of clusters of each plant from each combination were collected. Berry samples were collected during ripening for must composition characterization.

The wines were made at the Embrapa Semi-árido laboratory, at Petrolina. The wine analysis and sensory analysis were done at the "Ferreira Lapa" laboratory of the Instituto Superior de Agronomia, in Lisbon.

3.1- RESULTS AND DISCUSSION

3.1 Climate characterization

The annual rainfall is arounds 570 mm and is concentrated in the period from December to April. During this period the irrigation needed for wine production is minimal. From May to November the rainfall occurrence is extremely low and vine survival is only possible with irrigation.

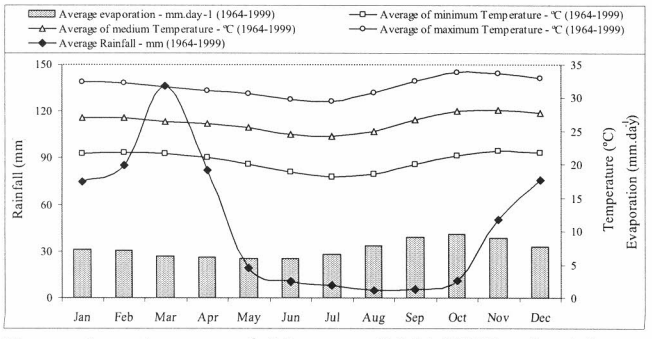

Figure 1 – Average of 36 years (1964-1999) of minimum, medium and maximum temperature, daily evaporation and monthly rainfall. Pernambuco, Northeast of Brazil.

In figure 1, we can observe the climatic conditions for a large number of years (1964-1999) in northeast of Brazil. The medium temperature reach high values during all year, and the annual average is around 26 °C. The hottest period is from September to December, when the evaporation rate is higher.

3.2- Yield components and grape composition

The results of the yield of the first seven harvests (October 2007, May 2008, November 2008, May 2009, November 2009, May 2010 and November 2010), are presented in Table 1.

Brazilian rootstocks (IAC-313 and IAC-572) led to a higher number of clusters per vine, heavier clusters and consequently a highest yield per hectare. The 1103-P and SO4 had intermediate values, while 101-14 Mgt and 420-A leads to lower values of these parameters. In these climatic conditions the choice of the right rootstock is a determining factor for the success of any investment.

Table 1 – Influence of rootstock on yield parameters, Cabernet Sauvignon variety at northeast of Brazil, Pernambuco. **Mean of 7 harvests**. **Note:** Sig. – Significance level; n.s. – non significant at 5% level by F test; significant at 5% level (*), by Tukey HSD test. Values followed by equal letters don't differ significantly, at 5% by Tukey HSD test.

Rootstock	Clusters/Vine	Yield (Kg/vine)	Cluster weight (g)	Yield (t/ha)
101-14	11.8 d	0.59 d	89.1 c	3.4 d
SO4	13.6 c	0.80 c	94.7 bc	4.3 c
1103-P	14.6 bc	0.75 c	89.5 c	4.6 c
420-A	11.2 d	0.60 cd	94.1c	3.7 cd
IAC-313	18.7 a	1.31 a	116.8 a	7.4 a
IAC-572	16.1 b	1.06 b	103.3 b	5.6 b
Sig.	*	**	*	**

Concerning the grape composition, no difference was observed among the different rootstocks (table 2).

Table 2 – Influence of the rootstock on grape composition at harvest, Cabernet Sauvignon variety at northeast of Brazil, Pernambuco. **Mean of 7 harvests**. **Note:** Sig. – Significance level; n.s. – non significant at 5% level by F test; significant at 5% level (*), by Tukey HSD test. Values followed by equal letters don't differ significantly, at 5% by Tukey HSD test.

Rootstock	Berry weight (g)	PAC (% v/v)	Titrable Acidity (g tar. ac./l)	pH
101-14	1.35	11.9	6.8	3.56
SO4	1.26	11.7	7.3	3.52
1103-P	1.09	11.6	7.1	3.58
420-A	1.10	11.8	7.2	3.51
IAC-313	1.22	11.6	7.0	3.53
IAC-572	1.16	12.5	7.4	3.64
Sig.	*ns*	*ns*	*ns*	*ns*

When the behaviour of the five clones was compared, no difference was found, neither at yield nor at quality level (table 3 and 4). These results indicate that in new vineyards, the choice of clone is a less important factor than the correct choice of rootstock.

Table 3 – Influence of the clone on yield parameters, Cabernet Sauvignon variety at northeast of Brazil, Pernambuco. **Mean of 7 harvests**. **Note:** Sig. – Significance level; n.s. – non significant at 5% level by F test; significant at 5% level (*), by Tukey HSD test. Values followed by equal letters don't differ significantly, at 5% by Tukey HSD test.

Clone	Clusters/ Vine	Yield (Kg/vine)	Cluster weight (g)	Yield (t/ha)
15	14.2	0.81	98.4	4.8
169	15.4	0.93	100.5	5.3
191	14.6	0.90	97.6	5.0
337	13.9	0.83	97.8	4.7
685	13.6	0.79	95.8	4.5
Sig.	*ns*	*ns*	*ns*	*ns*

Table 4 – Influence of the clone on grape composition at harvest, Cabernet Sauvignon variety at northeast of Brazil, Pernambuco. **Mean of 7 harvests**. **Note:** Sig. – Significance level; n.s. – non significant at 5% level by F test; significant at 5% level (*), by Tukey HSD test. Values followed by equal letters don't differ significantly, at 5% by Tukey HSD test.

Clone	Berry weight (g)	PAC (% v/v)	Titrable Acidity (g tar. ac./l)	pH
15	1.17	11.8	7.3	3.56
169	1.12	12.1	7.0	3.57
191	1.22	11.6	7.4	3.54
337	1.16	11.6	7.1	3.54
685	1.16	12.1	7.1	3.56
Sig.	*ns*	*ns*	*ns*	*ns*

In Tables 5 and 6 the results of the different harvests are presented, grouped by semester. In the first half of the year (Table 5), a greater number of clusters is observed, but lighter, leading to lower yield per hectare, mainly in the Brazilian rootstocks, which are most affected by the rainy conditions in the first semester.

However, the biggest difference between semesters lies at the level of quality characteristics. In fact, the need for the harvest to be done at an earlier stage of the cycle, due to climatic conditions, influences the must composotion, that is less sugar accumulation and more acid concentration.

Table 5 – Influence of rootstock on yield parameters, Cabernet Sauvignon variety at northeast of Brazil, Pernambuco.
Mean of 3 harvests of the first semester.
Note: Sig. – Significance level; n.s. – non significant at 5% level by F test; significant at 5% level (*), by Tukey HSD test. Values followed by equal letters don't differ significantly, at 5% by Tukey HSD test

Rootstock	Clusters/ Vine	Cluster weight (g)	Yield (t/ha)	PAC (% v/v)	TA (g tar. ac./l)	pH
101-14	14.6	70.1	3.4	10.5	7.2	3.39
1103-P	14.0	63.3	3.0	10.1	7.7	3.36
420-A	10.3	78.8	2.8	9.8	7.9	3.26
IAC-313	17.3	94.8	5.5	10.3	7.2	3.35
IAC-572	16.1	78.9	4.3	10.3	8.4	3.31
SO4	15.4	81.6	4.2	9.9	7.7	3.28
Sig.	*	*	**	*ns*	*ns*	*ns*

Table 6 – Influence of rootstock on yield parameters, Cabernet Sauvignon variety at northeast of Brazil, Pernambuco.
Mean of 4 harvests of the second semester.
Note: Sig. – Significance level; n.s. – non significant at 5% level by F test; significant at 5% level (*), by Tukey HSD test. Values followed by equal letters don't differ significantly, at 5% by Tukey HSD test.

Rootstock	Clusters/Vine	Cluster weight (g)	Yield (t/ha)	PAC (% v/v)	TA (g tar. ac./l)	pH
101-14	9.5	105.5	3.5	13.2	6.5	3.74
1103-P	15.3	110.5	5.8	13.2	6.5	3.80
420-A	11.8	106.6	4.4	13.3	6.5	3.79
IAC-313	19.8	135.2	9.0	13.4	6.8	3.79
IAC-572	16.1	123.7	6.7	13.5	7.0	3.78
SO4	12.2	105.6	4.5	13.6	7.0	3.77
Sig.	*	*	**	*ns*	*ns*	*ns*

3.3- Wine analysis and organoleptical results

In Table 7 the results of the wine analysis are presented. Only small differences were observed between the five clones. Clone 191 has a slightly lower alcohol content.

Table 7 – Influence of the clone on wine characteristics, Cabernet Sauvignon variety at northeast of Brazil, Pernambuco

Clone	Alcohol content (%v/v)	pH	Titrable Acidity (g tar. ac./l)
15	12.3	4.03	4.46
169	12.6	4.01	4.31
191	11.5	3.99	4.12
337	11.8	4.01	4.61
685	12.3	4.03	4.46

Concerning colour parameters, clone 685 presented the highest total anthocyans and phenols. The wine of this clone presented the more intense colour, whereas clone 191 showed the least color intensity.

Table 8 – Influence of the clone on wine colour characteristics, Cabernet Sauvignon variety at northeast of Brazil, Pernambuco

Clone	Total Anthocyans (mg/l)	Stained anthocyans (mg/l)	Total Phenols (IFC)	Colour intensity
15	176	29	30.7	7.14
169	216	30	34.5	6.53
191	203	16	30.6	5.17
337	187	30	32.7	7.27
685	224	23	35.7	8.51

The sensory analysis of wines produced from the clones, indicated that clones 337 and 685 are the most agreeable, especially regarding aroma.

4- CONCLUSIONS

In semi-arid tropical climate, where the behaviour of different vine varieties and their clones and rootstocks isn't well known, these studies are essential in order to chose the most adjusted combinations. It also has a special relevance in a region where the production of grapes for wine is relatively recent.

In a general way we are able to say that the yield was more influenced by the rootstock than by the clone. The rootstocks IAC-313 and IAC-572 showed higher yield (due to higher cluster number and cluster weight), while no difference in grape composition was found among the six rootstocks.

Similar results were obtained, by Cruz *et. al.* (*2008*), in this region with ten clones of Tempranillo variety, grafted on the same six rootstoks.

In these climatic conditions, big differences are found between the two semesters of the year concerning the yield parameters, but principally, on grape and must composition.

Normally, the grapes produced in the first half of the year present less alcoholic, fresher and fruity wines, while the wines produced in the second half of the year, due to the warm and dry climatic conditions, are more structured, with higher alcohol content and more intense color.

Regarding the influence of the clone on wine characteristics, clone 685 showed the highest values for the color components, whereas clone 191 had the lowest values.

In regions where winemaking is not a traditional activity, these results are essential for the correct choice of plant material to be installed in new vineyards.

LITERATURE

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