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Effects of rootstock and environment on the behaviour of autochthone grapevine varieties in the Douro region

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ABSTRACT
In an experiment located at Quinta da Cavadinha, Sabrosa, Douro Region the behaviour of the varieties Touriga Nacional (TN), Tinta Barroca (TB), Touriga Franca (TF) and Tinta Roriz (TR), grafted onto the rootstocks Rupestris du Lot, R110, R99, 1103P and 196-17, was accessed over 11 years between 2001 and 2011. The main results point to a significant influence of the environmental conditions in different years, especially those providing reduced water availability and greater heat stress: 2004, 2005, and 2009. Crop yields followed the sequence TR, TF, TB>TN, with highest oenological aptitude for TN and climate adaptive capacity to the TF. In terms of the rootstocks we confirm the lower production induced by R. Lot compared with R99, whilst 196-17 offered a good compromise between yield and quality for a great amplitude of climate conditions.

Keywords: grapevines, rootstocks, yield, quality, Douro Region.

1 INTRODUCTION

Choice of rootstock is among the most important decisions a grower or vintner makes and the implications for quality are enormous [8]. Drivers for rootstock adoption are wide ranging with the more important being phylloxera, nematode and salt tolerance, but water-use efficiency and drought tolerance are increasingly important to achieve better performance, faced with a complex set of interactions [7].

In a grafted plant, the metabolic functions are divided between the two biontes. It's the root system of the rootstock that will ensure nutrition of all mineral and water, while it is the grape variety responsible by the carbohydrate [6, 5].

In the Douro Region located in Northeast Portugal, vines grow in a Mediterranean like climate with important inter-annual and spatial variability, consequently with a high vintage effect [1]. For this reason the choice of rootstock is of capital importance in the implementation and cultural decisions associated with different stages of construction and success of the vineyard. The aim of this work explores the effect of rootstocks and year effect on grapevines varieties of the Douro Winegrowing Region.

2 MATERIALS AND METHODS

The experimental block was located at Quinta da Cavadinha (Symington Family Estates), Sabrosa, Douro Region, at an altitude of 220m and it was planted in 1997. It has a schistous soil and lies on a moderate slope (26%) facing northeast. The vines are unirrigated, spur-pruned and trained to a bilateral cordon with vertical shoot positioning (VSP), usually with 10-12 buds per vine. The behaviour of the varieties Touriga Nacional (TN), Tinta Barroca (TB), Touriga Franca (TF) and Tinta Roriz (TR), grafted onto the rootstocks Rupestris du Lot (R. Lot), R110, R99, 1103P and 196-17, was evaluated over 11 years between 2001 and 2011. The rootstock-variety combinations were laid out in a randomised block design with four replications and 6 vines per plot. During the course of the study the dates of the main phenological stages were recorded along with climatic data from a meteorological station situated inside the property. During grape maturation berry samples were taken and analysed for their oenological properties, usually on three different dates (for this results only use the second date - in average near 10 Sept.), and at harvest yield parameters were also recorded. Subsequently vine vigour was quantified through pruning weights.

Table 1. **Average growing season temperature (GST), growing degree-days (GDD), number of days with temperature > 30ºC and 35ºC, and % of the days with temperature >35 ºC from June to August, and annual precipitation (2001-2011).**

Year	Rainfall (Nov-Out) (mm)	Rainfall (Mar-Sep) (mm)	Rainfall (Jul-Sep) (mm)	GST (Mar-Sep) (ºC)	GDD (Mar-Sep) (Cº units)	nº days (Mar-Sep) T>30 (ºC)	nº days (Mar-Sep) T>35 (ºC)	% days (J-J-A) T> 35 (ºC)
2001	1635	524	50	20,6	2258	86	36	27%
2002	578	319	178	20,4	2224	99	32	27%
2003	1115	284	18	21,5	2456	101	39	30%
2004	513	136	54	19,7	2087	86	21	18%
2005	276	118	28	20,5	2287	91	46	38%
2006	697	279	123	20,8	2328	92	43	33%
2007	580	201	47	19,2	1996	72	12	10%
2008	496	254	34	19,0	1925	56	21	18%
2009	527	102	7	21,1	2166	80	33	25%
2010	964	252	11	20,1	2194	96	45	37%
2011	533	125	37	20,3	2222	85	24	20%
Avg.	738	264	53	20,3	2190	87	33	26%

3 RESULTS AND DISCUSSION

During the study period the grapevine varieties experienced significant fluctuation in yield, as mainly result of higher fertility and of climate conditions. The highest yield was observed with TB, TR and TF. In opposite TN showed the lowest yield, cluster weight, high fertility and the highest values in acidity, phenols and anthocyanins.

Table 2. Yield attributes, vigour, and fruit composition at harvest. Values represent the mean for the years studied for the ensemble of the varieties. Means followed with different letters are significantly different at *P*<0.05, (*na*) data not available.

	Clusters/ vine (nº)	Yield /vine (kg)	Cluster weight (kg)	Pruning weight (kg)	Berry weight (g)	ºBrix	Acidity (TA) (g/l)	pH	Phenols (IFT)	Antho-cyanins (mg/l)
2001	21.9^{a}	3.13^{a}	0.15^{b}	0.75^{a}	1.86^{ef}	21.4^{de}	4.23^{def}	3.56^{bc}	*n.a.*	*n.a.*
2002	13.4^{def}	2.15^{b}	0.20^{a}	0.58^{b}	2.02^{cde}	23.6^{ab}	4.29^{de}	3.60^{b}	*n.a.*	*n.a.*
2003	14.5^{cdef}	2.67^{a}	0.20^{a}	0.68^{a}	2.08^{cde}	24.2^{ab}	3.82^{f}	3.74^{a}	*n.a.*	*n.a.*
2004	15.6^{bcde}	2.16^{b}	0.14^{bc}	0.53^{bc}	2.14^{bc}	20.3^{e}	4.50^{bcd}	3.41^{d}	*n.a.*	*n.a.*
2005	16.0^{bcde}	2.03^{b}	0.14^{bcd}	0.41^{e}	1.69^{f}	22.1^{cd}	4.72^{bc}	3.49^{c}	*n.a.*	*n.a.*
2006	14.7^{cdef}	1.79^{bc}	0.13^{bcd}	0.51^{bcd}	1.92^{de}	22.3^{cd}	4.33^{cd}	3.62^{b}	*n.a.*	*n.a.*
2007	17.5^{bcde}	1.95^{b}	0.11^{d}	0.43^{de}	2.35^{a}	22.5^{bcd}	4.80^{b}	3.50^{c}	59^{b}	1099^{b}
2008	17.0^{bcde}	2.16^{b}	0.14^{bcd}	0.52^{bcd}	2.10^{bcd}	20.8^{e}	5.40^{a}	3.36^{d}	63^{b}	1792^{a}
2009	11.9^{f}	1.36^{c}	0.12^{cd}	0.47^{cde}	2.14^{abc}	22.7^{bc}	4.70^{bc}	3.58^{b}	64^{b}	1267^{b}
2010	13.0^{ef}	1.72^{bc}	0.14^{bc}	0.50^{bcd}	2.17^{abc}	22.6^{bc}	4.58^{bcd}	3.63^{b}	81^{a}	1159^{b}
2011	15.6^{bcde}	2.08^{b}	0.14^{bc}	0.71^{a}	2.29^{ab}	22.7^{bc}	3.94^{ef}	3.75^{a}	64^{b}	1188^{b}

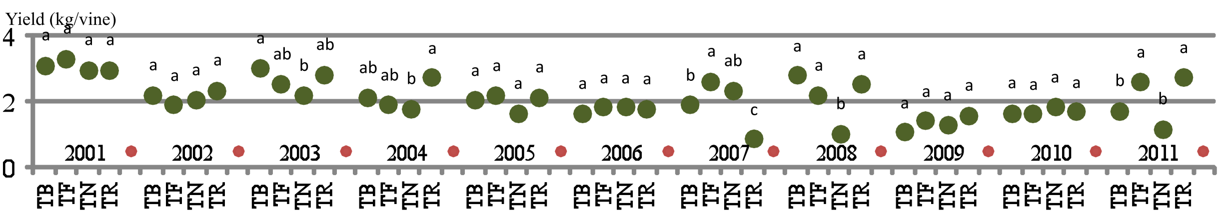

Figure 2. Effect of the year on the yield from the grapevine varieties (TB, TF, TN and TR).
Means followed with different letters are significantly different at *P*<0.05.

Table 3. Yield attributes, vigour, and fruit composition at harvest. Values represent the mean (2001-2011, *2007-2011) for the varieties TB (Tinta Barroca), TF (Touriga Franca), TN (Touriga Nacional) and TR (Tinta Roriz), and for the rootstocks 1103P, 196-17, R110, R99 and Rupestris du Lot (R. Lot). Means followed with different letters are significantly different at P<0.05.

	Clusters/ vine (nº)	Yield /vine (kg)	Cluster weight (kg)	Pruning weight (kg)	Berry weight (g)	ºBrix	Acidity (TA) (g/l)	pH	Phenols* (IPT)	Antho-cyanins* (mg/l)
TB	13.2^{b}	2.14^{a}	0.16^{b}	0.58^{a}	2.39^{a}	23.2^{a}	4.59^{b}	3.61^{b}	62^{b}	845^{c}
TF	12.7^{b}	2.21^{a}	0.18^{a}	0.52^{b}	2.17^{b}	20.3^{c}	4.34^{c}	3.56^{c}	65^{b}	1394^{b}
TN	22.8^{a}	1.86^{b}	0.09^{c}	0.57^{a}	1.54^{c}	23.0^{ab}	5.01^{a}	3.46^{d}	74^{a}	1737^{a}
TR	13.5^{b}	2.22^{a}	0.16^{b}	0.55^{b}	2.18^{b}	22.6^{b}	3.99^{d}	3.65^{a}	65^{b}	1228^{b}
1103P	15.0^{bc}	2.26^{a}	0.16^{a}	0.56^{b}	2.14^{ab}	22.3^{ab}	4.60^{b}	3.58^{a}	64^{a}	1239^{a}
196-17	14.3^{c}	1.90^{b}	0.14^{b}	0.51^{bc}	1.92^{b}	23.2^{a}	4.30^{b}	3.59^{a}	71^{a}	1489^{a}
R110	16.7^{ab}	2.35^{a}	0.14^{c}	0.56^{b}	2.03^{ab}	22.1^{bc}	4.41^{b}	3.55^{a}	63^{a}	1276^{a}
R99	17.2^{a}	2.45^{a}	0.16^{ab}	0.65^{a}	2.24^{a}	21.4^{c}	4.80^{a}	3.54^{a}	67^{a}	1105^{a}
R.Lot	14.6^{c}	1.60^{c}	0.12^{d}	0.51^{c}	2.04^{ab}	22.3^{bc}	4.37^{b}	3.57^{a}	67^{a}	1395^{a}

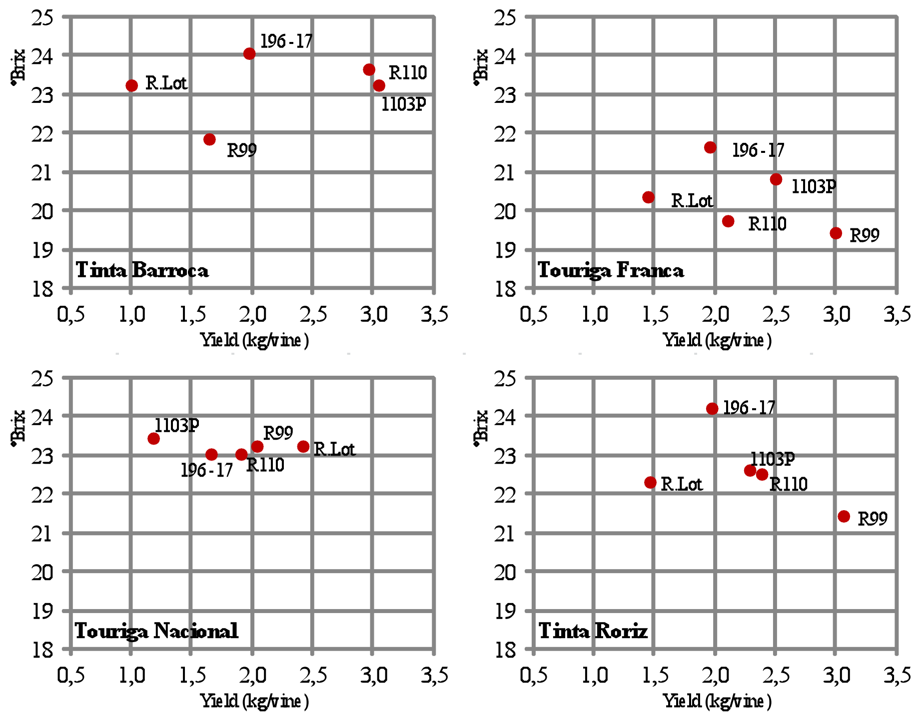

Figure 2. Effect of the rootstock in the yield *vs.* quality relationship, for the varieties studied. Values represent the average 2001-2011.

Over the years, it was noted that on average R110, R99 and 1103P rootstocks, induced higher yield, while 196-17 and mainly R. Lot had a tendency to have the lowest yield per vine (Table 3), with different effects on the varieties (Figure 2) to the yield and quality (sugar accumulation). The yield levels achieved by R110, R99 and 1103P rootstocks were similar to those confirmed by several authors [6, 1].

On the other hand, the results obtained by [3], in the warmest Sub-Region of Douro Superior, point to the maintenance of high yield on R99 and R110, and a weaker performance on 1103P, which would appear to suggest an ecological influence on the performance of this rootstock, also referred by [6].

It should be mentioned that the performance of the R. Lot rootstock, traditionally used in the past plantations in the Douro region through the mid-1980s, generally induces the lowest vigour expressed through the pruning weight, and unit yields without compensation in the sugar content, mainly in the Tinta Roriz.

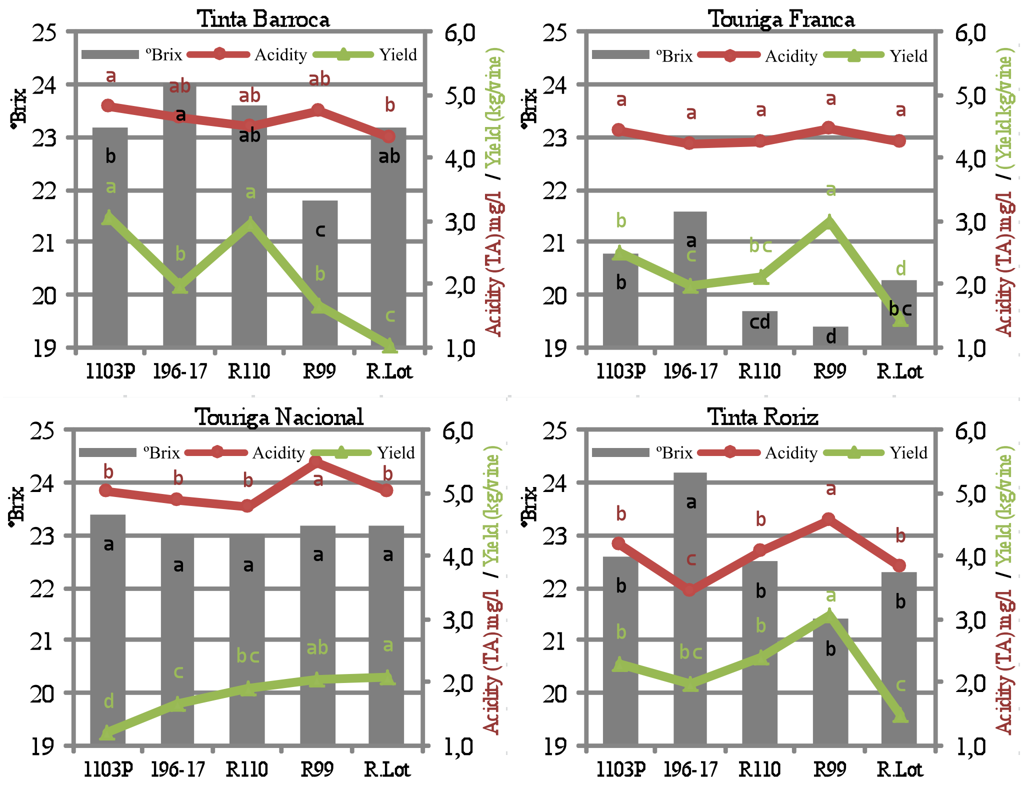

Figure 2. Effect of the rootstock on yield, total soluble solids (ºBrix) and acidity on the grapevine varieties Tinta Barroca, Touriga Franca, Touriga Nacional and Tinta Roriz. Values represent the average 2001-2011. Means followed with different letters are significantly different at $P<0.05$.

Sugar content, was regularly reached highest on 196-17 and while the lowest values were found for R99. In the results there are an influence of the rootstock on the acidity, higher on R99 (Figure 2) and no significant differences in pH, phenols and anthocyanins content for the ensemble of the grapevine varieties.

4 CONCLUSIONS

In Mediterranean field conditions, as in the Douro Region, water deficits usually develop gradually during the summer and are normally associated with high temperature and irradiance stresses. The temperature and the heat load during summer expressed in growing degree days (GDD) and number of the days with temperatures above the optimum for photosynthetic activity shows substantial differences between years.

The Touriga Nacional, confirm his high potential to produce both Porto and Douro wines, while Touriga Franca seems to be best adapted to the climate variability.

Rootstocks can be a very important tool to manage the behaviour of the grapevines varieties under different climate conditions at Douro region.

Finally, rootstock selection therefore involves more compromises than would be desirable, taking into account the diversity of criteria affecting the choice, mainly due to interactions with both the environment and the variety grafted. It is thus advantageous for the selection process to be carried out using a process of elimination, in accordance with conditioning characteristics of the environment (e.g. drought, humidity, acidity, soil fertility, etc.).

Further work is needed to better explore the effect on vegetative growth of the vines, adaptation to stress and impact on ripening, in order to support the knowledge transfer to the growers by ADVID (Association for the Development of Viticulture in Douro).

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Influence of the vintage, clone and rootstock on the chemical characteristics of Syrah tropical wines from Brazil

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ABSTRACT
In the Northeast of Brazil, vines can produce twice a year, because annual average temperature is 26ºC, with high solar radiation and water availability for irrigation. Many cultivars have been tested according to their adaptation to the climate and soil, and the main variety used for red wines is Syrah. This work aimed to evaluate five clones of Syrah, grafted on two rootstocks, in two harvests of the second semester of 2009 and 2010, according to the chemical analyses of the wines.The clones evaluated were 100, 174, 300, 470 and 525, the rootstocks were Paulsen 1103 and IAC 313 (*Golia* x *Vitis caribeae*). Grapes were harvested in November 2009 and 2010 and the yield was evaluated. Climate characteristics of each harvest was determined and correlated to the results. Wines were elaborated in glass tanks of 20 L, with alcoholic fermentation at 25ºC for seven days, then wines were pressed and malolactic fermentation was carried out at 18ºC for 20 days. The following parameters were analyzed: alcohol content, dry extract, total anthocyanins, total phenolic index. High performance liquid chromatography was used to determine tartaric, malic, lactic and citric organic acids. Results showed that wines presented different concentrations of classical analyses, phenolics and organic acids according to the harvest date, rootstocks and clones. Principal component analysis was applied on data and clusters with wine samples were formed, explaining the variability, and results are discussed.

Keywords: **Vitis vinifera L.*****, organic acids, phenolic compounds, wines.***

1 INTRODUCTION

In the Northeast of Brazil, the states of Pernambuco and Bahia are the wine region of the Sub-middle São Francisco Valley, located in a tropical semi-arid region, between 8 and 9° of South latitude. The climate presents an intra-annual variability, which enables the production of grapes and wines during many months in the year (1). The wine grape quality depends of many factors: the climate conditions, soil characteristics, genetic of the vegetative material, viticulture practices and winemaking process, influencing wine composition (2-7). The clone of a cultivar can affect the performance, growth, berry size, yield, grape and wine composition (3, 8). Rootstocks present different vigor and can influence the vegetative growth, productivity, grape and wine composition (9, 10). The cv. Syrah has been used for red wines in the Northeast of Brazil (11-14). Studies to evaluate the adaptation of clones and rootstocks in the region have been made with different cultivars (15). In this way, this work aimed to evaluate grape production and Syrah wine quality according to different vintages, rootstocks and clones in the Northeast of Brazil.

2 MATERIALS AND METHODS

The experimental trial was installed in "Santa Maria" farm, belonging to a private company (Vinibrasil-Vinhos do Brasil/GlobalWines), located at Lagoa Grande-PE, Brazil (9º 2'S, 40º 11' W). The climate of this region is a BSwh' by the Köppen classification and the majority of the soils are podzols. The vineyard design was installed in casual blocks with two factors (rootstocks and clones), trained in vertical shoot positioning and unilateral spur pruned cordon. The density of plantation is 3333 vines/ha (3 x 1 m) and row orientation is North-South. In this study, 5 clones of Syrah were chosen and evaluated: 100, 174, 300, 470 and 525. All of them were grafted onto 2