Production of syrah wines in tropical conditions of northeast brazil

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Characteristics of the vitiviniculture area in NE Brazil

The Lower-middle São Francisco, located approximately between the 8° and 15° S latitude, presents a semi-arid climate (Tonietto & Teixeira, 2004), and it is one of the five physiographic regions of the São Francisco Basin (between 7° and 21° S latitude), in the Northeast Brazil. Inside the Lower-middle São Francisco, vitiviniculture has been developed since 1980's in an area between 8° and 10° S latitude, which is commonly refered as São Francisco Valley. This area presents a climate with intra-annual variability, with an annual average temperature of 26.4°C (21.0°C for minimum and 31.7°C for maximum temperatures), and it is located at 350 m above of sea level, in a flat landscape (Teixeira & Azevedo, 1996; Teixeira, 2001). The rainy season occurs from December to March, with about 567 mm of normal rainfall (Teixeira, 2001). The heliotermical availability (about 3000 hours of luminosity. year^{-1}) allows a continuous vegetative development, and then grapevine cropping is possible throughout the year. The soils are primarily classified as Latosols, with variations in depth and in physical and chemical characteristics.

This area differs from other traditional vitiviniculture areas of the world. The viticulture for table grapes has started in the Lower-middle São Francisco in the 1960's, but the winemaking process started twenty years ago, by migrants from the South of Brazil to produce tropical wines. Nowadays, there are six wineries producing fine wines (*Vitis vinifera L.*). The total area cultivated with all cultivars is about 700 ha, and the cultivars used for red wines are Syrah, Cabernet Sauvignon, Tannat, Alicante Bouschet, Ruby Cabernet and Touriga Nacional. More recently, Tempranillo was introduced and has been used. Syrah is the most cultivated cultivar in the region, with about 330 ha, for red and rose wines. For white wines, the cultivars used are Chenin Blanc, Moscato Canelli, and more recently, Sauvignon Blanc. In 2006, the production of fine wine in this area was about 7 millions of liters.

Wineries preffer to produce wines from April to December (outside of rainy season) to make the phytosanitary control in the

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Abstract

Twenty years ago, in the Northeast Brazil, a tropical semi-arid area, the production of tropical wines from some *Vitis vinifera L.* cultivars started. In this region, it is possible to harvest two times a year, between April and December, and nowadays Syrah is the most cultivated wine grape.

Research works about irrigation management in Syrah started in 2000 at Brazilian Agricultural Research Corporation (Embrapa). The aim of this paper is to introduce some characteristics about the region where Syrah grapevines is being cultivated under irrigation in Northeast Brazil, and to present some results obtained from field experiments as well as some grape and wine charcteristics already determined.

Résumé

Production des vins de Syrah dans les conditions tropicales du Nord-Est du Brésil

Il y a vingt ans, a commencé, au nord-est du Brésil dans une zone de climat tropical semi-aride, la production de vins tropicaux de quelques variétés *vitis vinifera L.*

Dans cette partie du Brésil, il est possible de vendanger deux fois par an, entre avril et décembre.

Actuellement la Syrah est le raisin de cuve le plus cultivé de cette région. Les travaux de recherche au sujet de la gestion de l'irrigation de la Syrah ont commencé en 2000 au sein du Centre Brésilien de Recherche Agricole (Embrapa). Le but de cet article est de présenter certaines caractéristiques sur la région du nord-est du Brésil où des vignes de Syrah sont cultivées avec irrigation, quelques résultats obtenus sur la base d'expérimentation terrain et certaines caractéristiques des raisins et des vins déjà identifiées.

field easier, and to enhance grape quality. Normally the wineries try to space out harvesting of different plots in the vineyard over the April - December period. These characteristics allow to build a smaller cellar than those in the temperate zone wineries, where the harvest is concentrated in few months (between August and October in the North Hemisphere and between February and April in the South Hemisphere). Depending of the genetic characteristics of the cultivars, it is possible to produce two or three times by year, and grape and wine quality differ among the harvesting times (Pereira et al., 2008). In this area, Syrah presents a growing season of about 120 days, from bud burst to harvesting, and can be harvested two times by year during the wine production period (April-December). The growing season period changes a little from the first to the second semester of the year due to the intra-annual variability of climate conditions.

The grapes are vinified traditionally (Peynaud, 1997). For commercial wines, wineries used to make younger wines, softs and easy to be tasted. Since two years ago, some wineries started to make solid wines, that are left in oak barrels (French and Americans) for six to eight months. The research works carried out by Embrapa have just started and data collection to explain and to present wine composition are going on.

Trellis system

Syrah grapevine is cultivated basically in two trellis systems, pergola (horizontal to the soil surface) and spalier (vertical). In this area, the oldest wineries, established more than ten years ago, are using the pergola trellis system. The wineries established about five years ago, started to produce vines cultivated in spalier. Embrapa is investigating the effects of trellis systems on grape and wine composition and qualitiy.

Rootstocks and cultivars

Different rootstocks have been used in this area. There are three very vigorous rootstocks for table grapes, developed by Campinas Agronomic Institute (IAC), Brazil, that have been used by wineries: IAC-572 (*Vitis caribaea* x 101-14 Mgt), IAC-313 (Golia x *Vitis caribeae*) and IAC-766 (106-8 x *Vitis caribeae*). Since two years ago, some experiments have been developed by Embrapa to compare effects of different rootstocks on grape and wine quality (Pereira et al., 2007). The rootstocks under evaluation are 420-A, SO4 and Paulsen 1103. Other rootstocks are being introduced to be evaluated, like Harmony, R 110 and R 99.

Many cultivars are used to the winemaking process in this area. In 2003, Embrapa introduced 28 cultivars from different places to be evaluated (Portugal, Spain, France, Italy and Germany). The aim of these experiments is to determine the adaptability of a specific grapevine and the wine characteristics that could be used by local wineries to make wines with high quality. The typicity of the tropical wines is being built, and the expectation is that some cultivars will be indicated soon.

Another research works have just started to evaluated different clones of many cultivars, like Syrah, Cabernet Sauvignon, Tempranillo, Tannat, and Sauvignon Blanc. The clones are being brought from many countries, like Australia, France, United States and others, to verify what are the cultivars, grafted on specific

rootstocks, which will allow to obtain gapes with high enological potential, and consequently, high quality wines.

Irrigation

The balance between the vegetative and reproductive development, or the vine balance, is considered an important practice to obtain the desirable wine grape quality. Since an excess of shoot vigour have undesirable consequences for fruit composition, the water control is an important tool to achieve this balance, particularly in irrigated vineyards.

Besides the normal rainfall above 500 mm, the rainfall distribution pattern is erratic in this vitivivinicultureare area. For example, it is common to have a 70 mm rainfall within some hours and then no more rain will come in the forthcoming months. Hence, irrigation pratice is needed to achieve the water demand by plants. All vineyards in São Francisco Valley are irrigated. The most common irrigation systems in wine grape farms are microsprinkler and drip, but the second one has been more suitable due to the predominacy of the vertical trellis system.

Irrigation has been scheduled basically by means of the reference evapotraspiration data, obtained from weather stations, and of the crop coefficient for a specific phenological stage, to estimated the crop evapotranspiration and then the depth of irrigation. Although growers have recognized the importance of a precise irrigation control, it is not being done correctly. Growers need to improve the control of the water application by monitoring the soil water content in the root zone and water plant status. Embrapa has promoted training courses to technicians with the purpose of enhance technician's capability for irrigation scheduling.

Some results obtained by Embrapa about crop coefficents and water use related issues for cv. Syrah are showed in **Tables 1, 2, and 3**.

Table 1: Crop coefficient (Kc) of Syrah grafted on rootstocks IAC 572 and 1103 P in Petrolina, Brazil, during vineyard formation.

Stages	Days after planting	1103 P	IAC 572
Initial development 1	125 - 384	0.7	0.7
Formation pruning 2 to flowering 3	12 - 40	0.5	0.5
Flowering to harvest 4	41 - 96	0.8	0.8

1- from planting (January 2003) to formation pruning (9th of October 2003);
2 - 19th of November, 2003;
3 - 26th of December, 2003;
4 - harvest on 26th of January, 2004. Source: Bassoi et al. (2007).

Root distribution

Some results presented by Bassoi et al. (2007) have shown that, after the plant formation period, the root length from IAC 572 and 1103 P rootstocks reached 1 m depth (vertical direction), but around 80% of roots from both rootstocks were found at 0.6 m soil depth. In the horizontal direction, the distance reached by the roots was greater (1.0 m) than the wetted area (0.5 from row in each side of the plant), but a sharp decrease has occurred beyond the distance of 0.4 m from the trunk. Around 59 and 51 % (0-0.2 m) and 32 and 32% (0.2-0.4 m) were found to 1103 P and IAC 572, respectively.

Table 2: Reference evapotranspiration (ETo, mm day^{-1}), crop evapotranspiration (ETc, mm day^{-1}) and crop coefficient (Kc) to the cv. Syrah grafted on rootstocks 1103 P and IAC 572 and under partial rootzone drying (PRD) and regulated deficit irrigation (RDI) in Petrolina, Brazil.

Phenology	ETo	RDI / 1103 P		RDI / IAC 572		PRD / 1103 P		PRD / IAC 572	
		ETc	Kc	ETc	Kc	ETc	Kc	ETc	Kc
P1	5.0	3.5	0.7	3.4	0.7	3.5	0.7	3.4	0.7
P2	4.0	4.1	1.0	4.5	1.1	4.1	1.0	4.5	1.1
P3	4.5	4.2	1.0	5.0	1.1	4.2	1.0	5.0	1.1
P4	4.3	3.3	0.8	3.6	0.9	3.6	0.8	4.3	1.0
P5	5.0	2.8	0.5	2.2	0.4	2.5	0.6	2.9	0.9

P1: Pruning to beginning of bud burst;
P2: beginning of flowering;
P3: fruit set;
P4: beginning of veraison;
P5: harvest. Source: Bassoi et al. (2007).

Table 3: Gross amount of irrigation water (Wg), accumulated crop evapotranspiration (ETc), soil water storage variation (ΔS), amount of consumed water (Wc), irrigation efficiency (IE), application efficiency (AE) and water use efficiency (WUE) to cv. Syrah grafted on rootstocks 1103 P and IAC 572, and irrigated according to partial rootzone drying (PRD) and regulated deficit irrigation (RDI).

	RDI / 1103 P	RDI / IAC 572	PRD / 1103 P	PRD / IAC 572
Wg (m³ ha^{-1})	1463.3	1463.3	1200.0	1200.0
ETc (mm)	425.7	381.4	418.2	530.3
ΔS (m³.ha^{-1})	208.2	171.1	141.9	191.6
Wc (m³ ha^{-1})	1401.6	1258.5	984.2	1260.0
IE (%)	83.9	77.0	73.3	90.5
WUE (kg m^{-3})	3.2	3.2	3.6	4.1

* between pruning day and harvest. Source: Bassoi et al. (2007).

Phenological stages and yield

Normally, the vines for wine production are pruned in March, followed by hydrogen cyanamide application to promote and homogeneize the bud burst and by irrigation to match the water demand by plants. After the grape harvest, about July, the vines are left to rest, by reducing the water applied by irrigation, for twenty to thirty days. Then, the vines are pruned again, followed by hydrogen cyanamide application and irrigation. Another growing season starts, and grapes are harvested in November and December.

The total length of Syrah growing season observed in some experiments carried out at Embrapa was 124 days (April to August, 2004), 124 days (August to November, 2005), and 134 days (June to October, 2006). From April to August 2004, the length of some phenologial stages observed were: 9, from pruning to bud burst; 25, from bud burst to flowering; 8, from flowering to fruit set; 41, from fruit set to veraison, and 41, from veraison to harvest (Bassoi et al., 2007). **Table 4** presents results about yield under different irrigation strategies. No significant differences were observed among them because soil physical condition (hardsetting horizon at 1-1.2 m depth) has reduced soil drainage, and soil water availability below 0.6 m depth did not differ too much among irrigation strategies. Consequently, physiological behavior did not differ among irrigation strategies too (Dantas et al., 2007). Further studies should be carried out to better understand irrigation strategies and grape yield and quality relationship in the edaphic and climatic conditions of São Francisco Valley. Some attention should be addressed to sites with constraints to drainage, a commom characteristic in several soil types of this vitiviniculture area.

Winemaking process

Grapes harvested in a field experiment carried out by Embrapa in 2006 were transported to the cellar and left for twelve hours in cold chamber at 10°C. Grapes were de-stemmed and crushed (but not pressed), an antioxidant was added. The alcoholic fermentation was carried out at about 25°C, with addition of artificial yeasts *(Saccharomyces cerevisiae)*, during about five to seven days. Then, the malolactic fermentation was carried out for twenty to thirty days, at 20°C. After that, the wines were stabilized for thirty days in a cold chamber at 0°C, bottled, analyzed and tasted. The wines produced were analyzed with the collaboration of Celito Crivellaro Guerra (enology researcher of Embrapa Grape & Wine). The results are showed in **Table 5**.

Table 4: Yield and bunch and berries characteristics of grapes cv. Syrah grafted on rootstocks 1103 P and IAC 572, and irrigated according to partial rootzone drying (PRD) and regulated deficit irrigation (RDI)

	RDI	PRD	1103 P	IAC 572
yield (kg ha^{-1})	5286.8 a	5187.4 a	4774.0 a	5700.2 b
bunch (plant^{-1})	27.0 a	25.5 a	25.4 a	27.1 a
average bunch weight (g)	100.9 a	111.1 a	93.1 a	118.9 b
average berries (bunch^{-1})	92.6 a	92.8 a	93.6 a	91.7 a
average berries weight (g)	1.1 a	1.2 a	1.0 a	1.3 b
TSS (o brix)	19.9 a	20.0 a	19.4 a	20.5 b
TTA (% tartaric acid)	0.90 a	0.87 a	0.90 a	0.87 a
anthocyanins (mg 100g^{-1})	206.71 a	217.53 a	204.82 a	219.42 a
phenols (g 100g^{-1})	0.22 a	0.27 b	0.23 a	0.26 a

Values followed by the same letter in factors (RDI and PRD) and e (1103 P and IAC 572) did not differ by F test (P>0.05). Source: Bassoi et al. (2007).

Table 5: Syrah wine compositions according to three irrigation managements (PRD: partial rootzone drying; RDI: regulated deficit irrigation; FI: full irrigation) and two rootstocks.

	PRD		RDI		FI	
	IAC 572	1103 P	IAC 572	1103 P	IAC 572	1103 P
Alcohol degree (°GL)	10.50	12.52	11.46	11.63	11.63	11.63
pH	4.04	4.13	4.07	4.16	4.07	4.16
Total acidity (g. L^{-1} tartaric ac.)	6.0	6.0	5.6	5.8	6.0	6.0
Volatile acidity (g.L^{-1} acetic ac.)	0.66	0.60	0.66	0.66	0.66	0,60
Total SO_2 (mg.L^{-1})	73.8	72.0	69.2	71.4	704	73.5
Free SO_2 (mg.L^{-1})	31.4	34.5	33.8	34.7	31.3	34.9
Reductor sugars (g.L^{-1})	2.88	3.80	3.02	3.23	4.07	4.16
Dry extract (g.L^{-1})	26.2	27.1	25.9	25.9	26.2	26.6
IPT	55	81	64	76	68	74
Total anthocyanins (mg.L^{-1})	316.8	270.7	344.1	258.8	351.5	259.0
Total tanins (g.L^{-1})	2.11	3.71	2.70	3.85	2.36	3.87

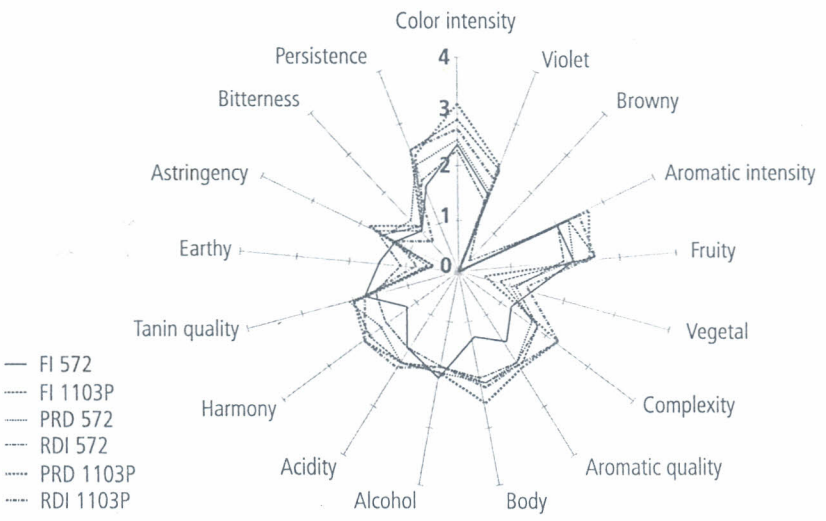
The most interesting results in **Table 5** are about the total anthocyanins and tannins for different rootstocks. For all irrigation managements tested, wines from Syrah grafted on IAC-572 presented higher total anthocyanins than Syrah wines from 1103 P. Nevertheless, Syrah wines from Paulsen 1103 presented higher total tannins than wines from Syrah on IAC-572.

Taste evaluation according to the irrigation management and rootstock

A tasting was performed to compare the Syrah wines according to irrigation managements and rootstocks used. With the combination of PRD and 1103 P, there were obtained wines with higher color and aromatic intensites, aromatic quality, body and a soft adstringency **(Figure 1)**.

Finally, research on Syrah wine production in Northeast Brazil has recently started. The initial results obtained by Embrapa, some of them herein briefly reported, are exciting and research activities must continue to improve the tropical winemaking in the Brazilian semi-arid region.

Figure 1: Results of taste analyses of Syrah wines released by a panel of eight tasters according to three irrigation managements and two rootstocks.



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