Effect of soil type on Sauvignon blanc and Cabernet Sauvignon wine style at different localities in South Africa.

Effet du type de sol sur le style des vins issus des cépages Sauvignon blanc et Cabernet Sauvignon à différents endroits en Afrique du Sud.

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Abstract

The wine producing regions of South Africa are characterized by climatic diversity. The Coastal Region has a Mediterranean climate, with a mean annual rainfall of *c.* 690 mm, whereas the Breede River Valley has a semi-arid climate with an annual rainfall of less than 300 mm.

Although irrigation is increasingly practiced, rain-fed vineyards are still commonly encountered in the Coastal Region. Wine styles differ in these vineyards. These differences are due, amongst other factors, to variations in climate and topography. They are also influenced by variations in soil type, notable with regard to water-holding capacity. In contrast to the Coastal Region, all grapevines in the Breede River Valley are irrigated. Under these conditions, in which the effects of soil type, and of water holding capacity, are moderated by scientific irrigation, wine style may be expected to be mainly affected by climate.

The aim of this investigation was to quantify the effect of soil type on wine style in rain-fed Sauvignon blanc and Cabernet Sauvignon vineyards in the Coastal Region, and in irrigated vineyards of the same cultivars in the Breede River Valley. Two experimental plots, representing different soil types, were identified within each vineyard. Experimental wines were prepared separately for each soil type.

Results showed that the styles of Sauvignon blanc, and of Cabernet Sauvignon wines from the Coastal Region, and from the Breede River Valley, were affected by both climate and soil type. The effect of soil type was moderated, but not entirely eliminated, by scientifically scheduled irrigation.

Key words: Breede River Valley, Cabernet Sauvignon, Coastal Region, Sauvignon blanc, South Africa

Introduction

Diverse climates are common to the wine producing regions of South Africa, ranging from Mediterranean to semi-arid (Carey *et al*., 2004). The Coastal Region has a Mediterranean climate, with a mean annual rainfall of *c*. 690 mm, whereas the Breede River Valley has a semi-arid climate with an annual rainfall of less than 300 mm. Rain-fed vineyards are still commonly encountered in the Coastal Region. Within this Region, the style of Sauvignon blanc wine from different localities in Stellenbosch/Klein Drakenstein was largely affected by seasonal variations in temperature and rainfall (Bonnardot *et al.,* 2000). Different wine styles could also be identified in the Stellenbosch/Durbanville area for rain-fed Sauvignon blanc vineyards from different terrains, each with a unique topo-climate (Conradie, 1998). The foregoing appears to be in agreement with the hypothesis that climate will usually have a dominant effect on wine character in warmer wine producing countries (Rankine *et al*., 1971; Winkler *et al*., 1974). However, the different wine producing regions of South Africa are also characterized by many diverse soil types within each region. Studies performed in the 1970's (Saayman, 1977), suggested that soil type can have a marked effect on wine quality under rain-fed conditions, due to the differing hydrological properties of soils, these being compounded by seasonal climatic variability. In a study with Cabernet Sauvignon in Stellenbosch and its surroundings, the

acidity of the sub-soil appeared to be a dominant area-related factor, affecting the grapevine and wine characteristics (Carey, 2002). This was ascribed to the negative effect of sub-soil acidity on root growth, thereby also affecting the water status of the grapevine. It is nevertheless generally accepted that the hydrological properties of soil is the most important soil related factor with regard to wine quality (Seguin, 1986).

In contrast to the Coastal Region, all grapevines in the Breede River Valley are irrigated on a regular basis. Under these conditions, it may be argued that wine style will be affected mainly by climate, the effects of soil type having been eliminated by the scientifically scheduled irrigation.

Over the past decade, a number of long-term studies have been initiated to quantify the effect of soil type on wine style under rain-fed conditions in the Coastal Region and also under irrigation in the Breede River Valley. In both cases Sauvignon blanc and Cabernet Sauvignon were used as test material. These investigations have not, as yet, been finalized, Preliminary results have nevertheless been reported (Conradie, 2002; Conradie and Bonnardot, 2004; Conradie and Olivier, 2004). This article presents a synopsis of the above-mentioned results, concentrating on the effect of soil type on wine style.

Materials and methods

The research was conducted in four commercial vineyards. These included a Sauvignon blanc and a Cabernet Sauvignon vineyard, both rain-fed, in the Coastal Region, and two irrigated vineyards of the same cultivars in the Breede River Valley.

Within each vineyard two contrasting soil types were identified using the South African Soil Classification System (Soil Classification Working Group, 1991). These sites were not more than 100 m apart. At each site an experimental plot was designated. Each such plot consisted of two adjacent rows, with 20 adjacent vines in each row.

Automatic weather stations, erected halfway between the two plots at each locality, recorded temperature, rainfall, radiation, hours of sunshine, wind speed and direction.

Changes in soil water content were measured weekly by means of neutron probes. Measurement depth intervals were 300 mm, to a depth of 1 200 mm deep. The water-holding capacities of these soils (2.5 kPa to 100 kPa) were measured using standard pressure-plate equipment. Leaf water potentials (pressure chamber technique of Scholander *et al*., 1965) were measured once per week for the months November to March.

Grapes were harvested at optimal ripeness. Experimental wines were prepared annually according to standard Nietvoorbij procedures, as summarized by Jolly *et al*. (2003). Experimental wines were vinified separately from grapes from the different soil types. Wine did not undergo any wood maturation. Various aroma components were evaluated after six months storage by an experienced wine tasting panel according to the method described by Noble *et al*. (1987).

Results and discussion

Coastal Region

Sauvignon blanc

Soils: Two soil types were identified, namely a Tukulu, which showed signs of wetness with depth, and a Hutton, which was well drained. Water-holding capacity was slightly higher for the Tukulu than for the Hutton.

Plant Water Status: Leaf water potentials (midday Ψ1) were comparable for the two soils until mid December (pre-véraison). During January and February, however, grapevines on the Hutton soil were usually subjected to higher water stress.

Wine Style: Fresh vegetative (grass, green pepper, eucalyptus, mint) and dry vegetative characteristics (hay/straw, tea, tobacco), were regarded as being more intense for wines produced from grapevines on the Tukulu soil type (Table1). In contrast, cooked vegetative (green beans, asparagus, olive, artichoke) and tropical fruit characteristics (pineapple, melon, banana, guava) tended to be more intense for wines produced from grapevines on the Hutton soil type. Comparable results were obtained during each season.

Soil type	Wine aroma descriptions [1]				
	Fresh vegetative[2]	Cooked vegetative [3]	Dry vegetative [4]	Tropical fruit [5]	Overall quality
Tukulu (wetter)	4.12 a [6]	2.90 ab	1.94 a	2.99 a	5.07 a
Hutton (drier)	2.37 b	3.46 a	0.70 b	4.09 a	5.29 a

Table 1 Effect of soil type on Sauvignon blanc wine style in the Coastal Region (2001/2002 season).
[1] Evaluated by an experienced panel on a ten-centimeter unstructured line scale (undetectable/unacceptable = 0, prominent/excellent = 10).
[2] Grass, green pepper, eucalyptus, mint
[3] Green beans, asparagus, olive, artichoke
[4] Hay/straw, tea, tobacco
[5] Pineapple, melon, banana, guava
[6] Different letters within the same column denote significant differences ($p \leq 0.05$).

Cabernet Sauvignon

Soils: Two soil types (Sterkspruit and Oakleaf) were identified in this vineyard. The most important difference between the two soils was an improved rooting system and a slightly higher water retention capacity in the case of the Oakleaf.

Plant Water Status: Leaf water potentials indicated that water stress was lower in vines growing on the Oakleaf.

Wine Style: Aroma intensity and fullness were comparable for wines from the two soils (Table 2). Where water stress was highest (Sterkspruit), vegetative character (grass/sweet pepper) was dominant, while vegetative character was less distinctive in vines experiencing less water stress (Oakleaf). In the latter instance berry character (raspberry/strawberry) was very prominent, while spicy character (aniseed/black pepper) could also be observed. Consequently wine styles differed largely.

Soil type	Wine aroma descriptions [1]				
	Aroma Intensity	Vegetative [2]	Berry [3]	Spice [4]	Overall quality
Sterkspruit (drier)	7.71 a [5]	5.93 a	3.85 c	1.66 a	6.45 a
Oakleaf (wetter)	6.94 a	3.56 bc	5.84 a	2.13 a	6.64 a

Table 2 Effect of soil type on Cabernet Sauvignon wine style in the Coastal Region (2000/2001 season).
[1] As evaluated by an experienced panel on a ten-centimeter unstructured line scale (undetectable/unacceptable = 0, prominent/excellent = 10).
[2] Grass, green pepper, blue gum, hay/straw, tobacco.
[3] Blackberry, raspberry, strawberry, black currant.
[4] Liquorice, aniseed, black pepper, clove.
[5] Different letters within the same column denote significant differences ($p \leq 0.05$).

Breede River Valley

Sauvignon blanc

Soils: Fernwood and Valsrivier soil types were identified in this vineyard. The Fernwood (loamy sand) contained only 3.7% clay, in comparison to 21.0% for the Valsrivier (sand clay loam), while the former also contained a high fraction of stone and gravel (56.1%). Consequently water-holding capacity of the loamy sand (62 mm/m) was less than half of the clay loam (157 mm/m).

Plant Water Status: In view of the grapevines being irrigated, leaf water potentials pointed towards similar levels of water stress.

Wine Style: Both wines scored relatively highly (Table 3) for tropical character (pineapple, melon, banana, guava), thus being in agreement with the fruity/tropical style expected for "warm climates" (Marais *et al*., 1999). Even though tropical character appeared to be identical for the two wines, aroma intensity, fresh vegetative character (grass, green pepper, eucalyptus) and cooked vegetative character (green beans, asparagus, olive), tended to be higher for the one from the loamy sand. The wine from this soil (Fernwood) was generally regarded as being more "typical", and of a superior quality, in comparison to the one from the sand clay loam (Valsrivier). Superior quality for Sauvignon blanc wines from sandy soils is in agreement with the experience of vintners in the Breede River Valley. The specific factors, causing this phenomenon, have not yet been identified. The effect of soil form on wine style could thus still be detected, in spite of the fact that the vineyards were intensively irrigated.

Soil type	Wine aroma descriptions [1]				
	Aroma Intensity	Fresh vegetative [2]	Cooked vegetative [3]	Tropical fruit [4]	Overall quality
Loamy sand	6.09 b	3.56 b	2.72 b	3.70 a	5.50 b
Sand clay loam	[5] 5.64 ab	3.23 ab	2.20 ab	3.74 a	5.05 ab

Table 3 Effect of soil type on Sauvignon blanc wine style in the Breede River Valley (mean values for three seasons: 2000/2001 to 2002/2003).
[1] As evaluated by an experienced panel on a ten-centimeter unstructured line scale (undetectable/unacceptable = 0, prominent/excellent = 10).
[2] Grass, green pepper, eucalyptus, mint.
[3] Green beans, asparagus, olive, artichoke.
[4] Pineapple, melon, banana, guava.
[5] Different letters within the same column denote significant differences ($p \leq 0.05$).

Cabernet Sauvignon

Soils: In this vineyard the two soil types identified were a Tukulu and a Fernwood. The Tukulu (sand clay) contained 37.3 % clay, in comparison to only 2.3 % for the Fernwood (sand). However, on account of a high fraction of stone and gravel (38.4%), in the case of the sand clay, water holding capacities (81 mm/m for the sand clay and 72 mm/m for the sand) were comparable for the two soil types.

Plant Water Status: Leaf water potentials did not differ significantly between grapevines on the two different soil types. However, it should be borne in mind that measurements were done only once every week. In view of sandy soils being badly buffered, soil water potentials may vary considerably from day to day. Grapevines on the sandy soil may well have been subjected to excessive water stress during specific periods.

Wine Style: Wine from the more clayey soil (Tukulu) was fuller on taste, while aroma intensity was also higher (Table 4), compared to wine from the more sandy soil (Fernwood). Vegetative characters were comparable, but berry- and spice characters were more prominent in wine from the clayey soil. Wine from the sandy soil exhibited a light style, which is not typical for Cabernet Sauvignon.

Soil type	Wine aroma descriptions [1]				
	Aroma Intensity	Vegetative character [2]	Berry character [3]	Spicy character [4]	Overall quality
Sand clay	6.29 a [5]	3.12 ab	4.99 a	2.25 a	5.76 a
Sand	5.27 b	2.97 a	3.73 b	1.83 a	4.51 b

Table 4 Effects of soil type on Cabernet Sauvignon wine style in the Breede River Valley (mean values for three seasons: 2000/2001 to 2002/2003).

[1] As evaluated by an experienced panel on a ten-centimeter unstructured line scale (undetectable/unacceptable = 0, prominent/excellent = 10).
[2] Grass, green pepper, blue gum, hay/straw, tobacco.
[3] Blackberry, raspberry, strawberry, black currant.
[4] Liquorice, aniseed, black pepper, clove.
[5] Different letters within the same column denote significant differences ($p \leq 0.05$).

Conclusions

Coastal Region

Under rain-fed conditions, fruity characteristics may be dominant for Sauvignon blanc wines from "drier" soils, while wines from "wetter" soils may exhibit a more pronounced fresh vegetative character. In the case of Cabernet Sauvignon, a relative "wet" soil may produce wine with a fairly prominent berry character. On "drier" soils, aroma may tend towards grass or sweet pepper.

Breede River Valley

A more "typical" Sauvignon blanc wine was produced on the loamy sand than on the sand clay loam. Overall quality was also higher for the wine that was produced on the loamy sand. It may be difficult to obtain a typical Cabernet Sauvignon wine from sandy soils. Under such conditions a lighter wine style is obtained. It may therefore be concluded that the effect of soil type was moderated, but not entirely eliminated, by scientifically scheduled irrigation.

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