EFFECTS OF SOIL AND CLIMATE ON WINE STYLE IN STELLENBOSCH: SAUVIGNON BLANC

W.J. Conradie [1*] and **M.P. Olivier** [1**]

1) ARC Infruitec-Nietvoorbij, Private Bag X5026, 7599 Stellenbosch, Republic of South Africa
E-mail address: conradiek@arc.agric.za

Key words: Soil, climate, wine style, Sauvignon blanc, Stellenbosch, South Africa

Abstract: A nine-year study was carried out in two non-irrigated, commercial Sauvignon blanc vineyards, grown at different localities (A and B) in the district of Stellenbosch. Two experimental plots, representing different soil forms, were identified within each vineyard. At both localities one of the soil forms showed signs of wetness with depth, while the other one was relatively dry. Despite their geographic proximity (9 km), meso-climate differed between the two localities, largely on account of A being situated at higher altitude (413 m) than B (148 m). Maximum temperature for February was 1.9ºC lower for A than for B, while night temperature was also lowest at A. Grapes at the cooler locality (A) were generally harvested two weeks later than those at the warmer one (B). At the cooler locality ripening was also affected by soil form, with grapevines on the drier soil being harvested approximately one week earlier than those on the wetter soil. Ripening was not affected by soil form at the warmer locality. At the cooler locality, wine from the wetter soil generally exhibited a prominent fresh vegetative character (grass, green pepper, eucalyptus, mint), in comparison to cooked vegetative (green beans, asparagus, olive, artichoke) and fruity characteristics for the one from the drier soil. Wine style was not affected by soil form at the warmer locality, with tropical fruit character being dominant. Results suggested that the style of Sauvignon blanc wines from Stellenbosch is not only affected by climate, but also by soil form.

Resumé: Une étude a été menée pendant neuf ans sur deux vignes non-irriguées de Sauvignon blanc commercialisés, plantées à différentes localités (A et B) dans le district de Stellenbosch. Deux parcelles expérimentales, situées sur deux formations géologiques différentes, ont été identifiées au sein de chaque vignoble. A chaque localité une des formations pédologiques montre des signes d'humidité en profondeur, tandis que l'autre est relativement sèche. Malgré leur proximité géographique (9 km), le méso-climat diffère entre les deux localités, principalement en raison de l'altitude, A étant situé à 413 m et B à 148 m d'altitude. La température maximale de février est 1.9ºC plus basse en A qu'en B, les températures nocturnes sont aussi les plus basses en A. Les raisins de la localité la plus fraîche (A) sont généralement récoltés deux semaines plus tard que ceux de la localité la plus chaude (B). A la localité la plus fraîche, la maturation est aussi affectée par la formation pédologique : les raisins issus du sol le plus sec ont été vendangés approximativement une semaine avant ceux ceux issus du sol plus humide. Cependant la maturation n'a pas été affectée par le sol à la localité la plus chaude. A la localité la plus fraîche, les vins issus du sol plus humide révèlent généralement un caractère végétatif frais prédominant (herbacé, poivre vert, eucalyptus, menthe) et ceux issus du sol plus sec des caractéristiques de légumes cuits (haricots verts, asperges, olive, artichaut) et de fruits. Le style de vin n'a pas été affecté par la formation pédologique à la localité la plus chaude oú les caractères de fruits tropicaux dominent. Les résultats suggèrent que le style du vin de Sauvignon blanc de Stellenbosch n'est pas seulement affecté par le climat, mais aussi par le sol

* Present address: Department of Soil Science, University of Stellenbosch, 7600 Stellenbosch, Republic of South Africa.
** Presenting author

INTRODUCTION

The Stellenbosch Region of South Africa has a Mediterranean climate, with mean annual rainfall around 690 mm (Conradie *et al.,* 2002). Dry conditions, with total rainfall of only 121mm, are experienced from November to March. It has been shown, however, that certain aspects of climate may vary considerably within the Region, in spite of a fairly uniform macro-climate, while the Region is also characterized by many diverse soil forms (Carey, 2001). Even though irrigation is increasingly being practiced within the Region, rain-fed vineyards are still commonly encountered in areas where irrigation water is not available. Within the Region the style of Sauvignon blanc wines from different localities was largely affected by seasonal variations in temperature and rainfall (Bonnardot *et al.,* 2000). However, soil type can also have a marked effect on wine quality under rain-fed conditions, due to the hydromorphic properties of the soil, in relation to the prevailing and seasonal climate (Saayman, 1977). Even though climate appears to be the most important driving force affecting grapevine performance, the effect of soil type can, therefore, not be discounted (Carey, 2002; Conradie *et al.,* 2002).

The effects of different environmental factors (geology, soil, climate) on phenology and grape composition, for Sauvignon blanc under rain-fed conditions, have already been described (Conradie *et al.,* 2002). In this presentation the effect of soil and climate on wine style is illustrated for two terroirs, with different meso-climates.

MATERIALS AND METHODS

The study was carried out over nine seasons (1994/1995 to 2002/2003), in two commercial Sauvignon blanc vineyards (A and B) in the district of Stellenbosch. The vineyards were 9 km apart, with A situated at a higher altitude (413 m) than B (148 m). Within each vineyard two contrasting soil forms (not more than 60 m apart) were identified, using the South African Soil Classification System (Soil Classification Working Group, 1991). Physical and chemical characteristics of the different soils, as well detailed experimental procedures, have been described (Conradie *et al,* 2002). Experimental plots were selected on each soil type, with climatic parameters being recorded at each locality. The water-holding capacities of the soils (2.5 kPa to 100 kPa) were measured on undisturbed soil cores, using standard pressure-plate equipment. Leaf water potentials (pressure chamber technique of Scholander *et al.* (1965)) were measured once per week from November to March. Measurements were done between 12:00 and 15:00, using uncovered, fully mature sunlit leaves. Dates of budburst, flowering and harvest were recorded annually. Budburst was noted when 50% of the buds had reached stage 4 and flowering at stage 23 of the modified E-L system (Coombe, 1995). Grapes were harvested at optimal ripeness. This was considered to be at approximately 23°B, at a titratable acidity of 8 g/L and a pH of between 3.0 and 3.3. Experimental wines were prepared annually according to standard Nietvoorbij procedures, as summarized by Jolly *et al.* (2003). Wines were evaluated, six months after production, by 12 trained wine tasters. A ten-centimetre unstructured line scale was used and the judges were asked to rate wines for aroma components (undetectable to prominent), based on the standardized system of wine aroma terminology (Noble *et al.,* 1987).

RESULTS AND DISCUSSION

Climate: Maximum temperature for February was 1.9ºC lower for A than for B (Table 1). Fewer hours with temperature > 30ºC, and a higher number of hours with temperature < 12ºC was experienced at A than at B. Cooler conditions at A may have been on account of the higher altitude.

Soils: One soil (Tukulu) at the cooler locality showed signs of wetness with depth, while the other (Hutton) was well-drained (Table 2). Water-holding capacity was slightly higher for the Tukulu than for the Hutton. One of the soils (Tukulu) at the warmer locality also showed signs of wetness with depth, but on account of a high percentage of stone and gravel (Conradie *et al.,* 2002), water-holding capacity was lower for the Tukulu than for the better-drained Avalon.

Water status: Leaf-water potentials, measured between 12:00 and 15:00 on fully mature sunlit leaves (midday Ψl), were comparable for the two soils at the cooler locality until mid December (pre-véraison). During January and February, however, grapevines on the Hutton soil were usually subjected to higher water stress, as shown for 2001/2002 (Figure 1). At the warmer locality (B) leaf-water potential was not affected by soil form (data not shown).

Phenology and juice analysis: Locality or soil type did not affect date of budbreak (Table 3). At the cooler locality ripening was affected by soil form, with grapevines on the drier soil being harvested approximately one week earlier, in comparison to those on the wetter soil. This may have been on account of grapevines on the Hutton soil being subjected to higher water stress during January and February (Figure 1). At the warmer locality (B), date of harvest was not affected by soil form, probably on account of similar levels of water stress. However, grapes at the warmer locality were harvested at least two weeks earlier than those at cooler one. Sugar content (ºB) and titratable acidity were not affected by locality and/or soil type, but juice-pH was highest at the warmer locality.

Wine Style: The effects of soil and climate on wine style will be illustrated for the 2001/2002 season (Table 4). At the cooler locality, fresh vegetative (grass, green pepper, eucalyptus, mint) and dry vegetative characteristics (hay/straw, tea, tobacco), were scored as being more intense for wines produced from grapevines on the Tukulu soil form. 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 form. Comparable results were obtained during each season, with differences being more or less prominent depending on the season. A prominent grass character could generally be detected in wine from the grapevines on the Tukulu soil form, compared to an asparagus/fruity character for the wine originating from grapevines on the Hutton soil form. Despite the different styles for the wines from the two different soil forms, quality was regarded as being equally good. Wine style was not affected by soil form at the warmer locality, with tropical fruit character being dominant.

CONCLUSIONS

Results confirmed that certain aspects of climate may vary considerably within the Stellenbosch Region, in spite of a fairly uniform macro-climate. Wines with a more "typical" Sauvignon blanc character will, generally, be obtained at the cooler localities. However, wine style is not only affected by climate, but also by soil form. Under rain-fed conditions, fruity characteristics may be dominant for wine from drier soils, while wine from wetter soil may exhibit a more pronounced fresh vegetative character.

LITERATURE CITED

Bonnardot, V., Carey, V., & Schmidt, A., 2000. The effect of vintage and location on Sauvignon blanc wine aroma in the Stellenbosch-Klein Drakenstein winegrowing area (Vintages 1996-1999). Wineland, October, 114-118.

Carey, V., 2001: Spatial characterization of natural terroir units for viticulture in the Bottelaryberg-Simonsberg-Helderberg winegrowing area. M.Sc. Thesis, University of Stellenbosch, Private Bag X1, Matieland, 7602, South Africa.

Carey, V.A., 2002. Cultivar X environment interaction: example of Cabernet Sauvignon in the Stellenbosch-Drakenstein wine growing area, South Africa. Communication at Groupe d'Éxperts: Zonage, March 2002.

Conradie, W.J., Carey, V.A., Bonnardot, V., Saayman, D. & Van Schoor, L.H., 2002. Effect of different environmental factors on the performance of Sauvignon blanc grapevines in the Stellenbosch/Durbanville districts of South Africa. I. Geology, Soil, Climate, Phenology and Grape Composition. S. Afr. J. Enol. Vitic. 23, 78-91.

Coombe, B.G., 1995. Adoption of a system for identifying grapevine growth stages. Aust. J. Grape Wine Res. 1, 104-110.

Jolly, N.P., Augustyn, O.P.H. & Pretorius, I.S., 2003. The effect of Non-*Saccharomyces* yeasts on fermentation and wine quality. S. Afr. J. Enol. Vitic. 24,55-62.

Noble, A.C., Arnold, J., Buechsenstein, A., Leach, E.J., Schmidt, J.O. & Stern, P.M., 1987. Modification of a standardized system of wine aroma terminology. Am. J. Enol. Vitic. 38, 143-146.

Saayman, D., 1977. The effect of soil and climate on wine quality. In: Proc. Int. Symp. Quality of the Vintage, February 1977, Cape Town, South Africa. pp. 197-208.

Scholander, P.F., Hammel, H.T., Bradstreet, E.D. & Hemmingsen, E.A., 1965. Sap pressure in vascular plants. Science 148, 339-346.

Soil Classification Working Group, 1991. Soil classification – A taxonomic system for South Africa. Department of Agricultural Development: Memoirs on natural agricultural resources of South Africa No15, Department of Agricutural Development, Pretoria, South Africa.

TABLE 1
Climatic parameters at two different localities, situated at different altitudes, in Stellenbosch (mean for the period 03/1994 to 03/2001).

Locality	**Altitude (m)**	**February Max. temp (°C)**	**February Mean temp (°C)**	**Temp. > 30 °C for December – February (number of hours)**	**Temp. <12 °C December – February (number of hours)**
A (cooler)	413	27.9 a [1]	21.3 a	125 a	86 a
B (warmer)	148	29.8 b	22.2 b	195 b	39 b

[1] Different letters within the same column denote significant differences ($p \leq 0.05$).

TABLE 2
Characteristics of the soils at two localities in Stellenbosch.

Locality	**Soil**	**Description**	**Water holding capacity (mm/m)**
A (cooler)	Tukulu	Medium textured, yellow-brown, weakly structured, slight signs of wetness with depth	136
	Hutton	Medium textured, reddish-brown, very weakly structured, well-drained	120
B (warmer)	Avalon	Medium textured, yellow-brown, weakly structured, mottled subsoil	149
	Tukulu	Medium textured, yellow-brown, weakly structured, signs of wetness in subsoil	118

TABLE 3
Effect of locality and soil form on phenology and juice analysis for Sauvignon blanc/99 Richter (mean from 1994 to 2001).

Locality	**Soil**	**Date of budbreak**	**Date of harvest**	**Sugar (°B)**	**Titratable acidity (g/L)**	**pH**
A (cooler)	Tukulu (wetter)	17 September a [1]	1 March a	23.1 a	8.79 a	3.21 a
	Hutton (drier)	16 September a	24 February b	23.3 a	8.14 a	3.20 a
B (warmer)	Avalon (drier)	16 September a	10 February c	23.4 a	8.33 a	3.27 ab
	Tukulu (wetter)	16 September a	12 February c	22.8 a	7.74 a	3.35 b

[1] Different letters within the same column denote significant differences ($p \leq 0.05$).

TABLE 4
Effect of locality and soil form on wine aroma sensory scores for Sauvignon blanc in Stellenbosch (2001/2002 season).

Locality	**Soil**	**Leaf water potential (-MPa)**	**Wine aroma descriptions [1]**			
			Fresh vegetative [2]	**Cooked vegetative [3]**	**Dry vegetative [4]**	**Tropical fruit [5]**
A (cooler)	Tukulu (wetter)	1.38	4.12 a [6]	2.90 ab	1.94 a	2.99 a
	Hutton (drier)	1.43	2.37 b	3.46 a	0.70 b	4.09 a
B (warmer)	Avalon (drier)	1.34	2.15 b	1.72 b	1.10 ab	2.91 a
	Tukulu (wetter)	1.35	1.89 b	1.84 b	0.82 b	3.15 a

[1] Evaluated on an unstructured line scale of 10 cm
[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 ($p \leq 0.05$).

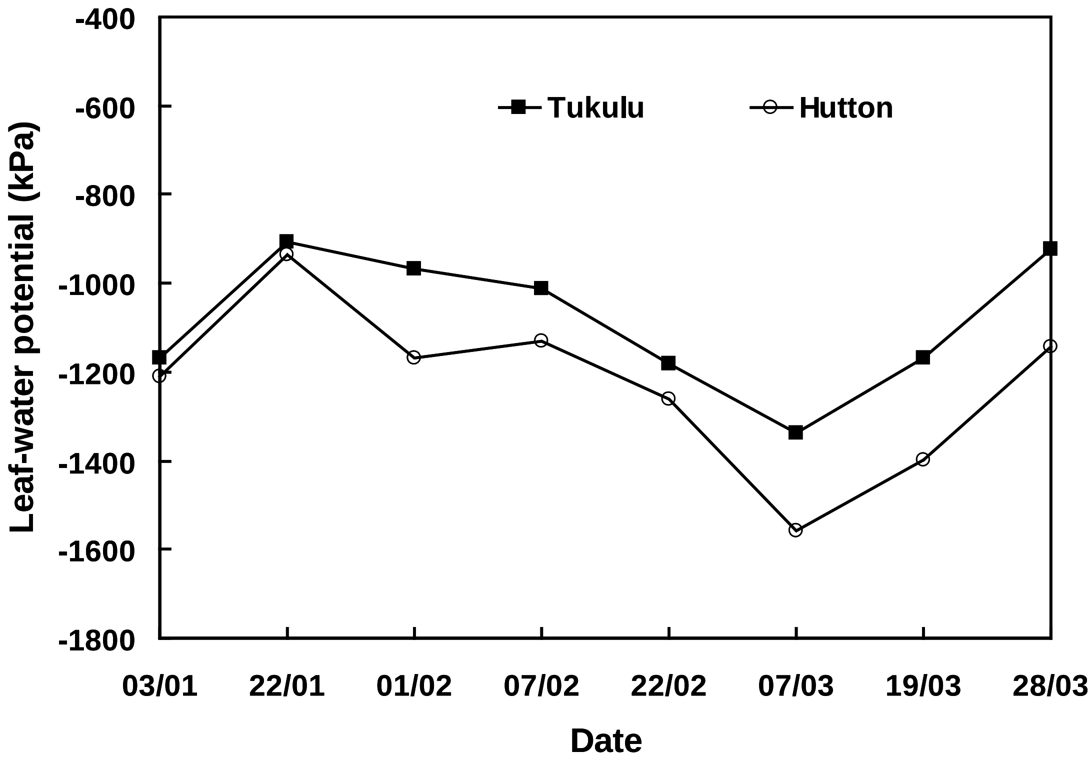

Figure 1. Mean midday leaf-water potentials for Sauvignon blanc on two different soil forms at the cooler locality (2001/2002).