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Influence of Salt Creek rootstock on composition and quality of Shiraz grapes and wine

by

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Der Einfluß der Unterlage Salt Creek auf die Zusammensetzung und Qualität von Trauben und Wein der Sorte Shiraz

Zusammenfassung. — Die Unterlage Salt Creek modifizierte die Zusammensetzung und Qualität der Trauben und des Weines der Rebsorte Shiraz. Bei der Ernte hatten die Trauben auf Salt-Creek-Unterlage einen höheren pH-Wert und höhere Gehalte an titrierbarer Säure, Malat und Kalium, aber weniger lösliche Trockensubstanz als die Trauben wurzelechter Shiraz-Reben. Die aus diesen Trauben hergestellten Weine zeigten in ihrer Zusammensetzung ähnliche Unterschiede. Darüber hinaus hatten Weine von Pfropfreben niedrigere Konzentrationen an phenolischen Verbindungen, Anthocyanen (insgesamt und ionisiert) sowie Chloriden als Weine von wurzelechten Reben. Die Salt-Creek-Weine hatten eine weniger intensive Färbung, einen stumpferen Farbton und ein höheres „chemisches Alter". Auch bei der sensorischen Prüfung wurden Unterschiede zwischen diesen Weinen festgestellt. Die Weine von Reben auf Salt Creek wurden niedriger bewertet als Weine von wurzelechten Reben. Die unterschiedliche Beurteilung war nur teilweise auf Färbungsunterschiede zurückzuführen.

Introduction

The viticultural importance of *Vitis champini* rootstocks Dogridge and Salt Creek (RAMSEY) lies in their resistance to root-knot nematodes (LIDER 1960). They may also impart an added vigour to the grafted vine which is unrelated to their nematode resistance (SAUER 1968) and which gives promise of increased yields.

Recently, HALE (1977) reported that Sultana grapes from vines growing on Salt Creek and Dogridge rootstocks had a higher pH and higher concentrations of malate and potassium than grapes from vines growing on their own roots. He raised the possibility that these stocks might be unsuitable for wine grapes in grape growing areas where high pH associated with high malate levels is undesirable on grounds of biological and chemical stability of the wine (AMERINE 1956, CIRAMI 1973) or where the potassium content of the grapes is already excessively high (SOMERS 1975).

This paper reports on some effects of Salt Creek rootstock on the composition and quality of Shiraz grapes and wine. The experiment was done at Merbein, Victoria, in the warm Murray Valley viticultural region where grapes are grown under irrigation.

Materials and methods

The vines used in the experiment were growing in a Dareton Sand or a Dareton Sandy Loam (NORTHCOTE and BOEHM 1949) in a CSIRO vineyard near Merbein, Vic-

Table 1

Effect of Salt Creek rootstock on pH, weight and composition of Shiraz berries and on composition of Shiraz juice

Der Einfluß der Unterlage Salt Creek auf pH, Gewicht und Zusammensetzung von Shiraz-Beeren und auf die Zusammensetzung von Shiraz-Most

	Berries							Juices	
	Weight (g)	pH	% fresh weight					pH	°Brix
			Acidity	Malate	Tartrate	K	Soluble solids		
Own roots	1.44	3.81	0.73	0.37	1.03	0.33	23.6	3.63	24.0
Salt Creek	1.65	3.91	0.78	0.56	1.03	0.40	22.1	3.76	22.8
Significance of rootstock effect[1]	**	**	**	***	—	**	**	**	*

[1] *, **, ***: significant at 5, 1, and 0.1% respectively; —: not significant.

Table 2

Effect of Salt Creek rootstock on composition and colour of Shiraz wines

Der Einfluß der Unterlage Salt Creek auf die Zusammensetzung und Färbung von Shiraz-Weinen

	Own roots	Salt Creek	Level of Significance[1]) Rootstock effect	Rootstock-trellis interaction[2])
pH	4.01	4.19	*	*
Acidity (g/l)	6.1	6.5		*
Malate (meq/l)	44.5	62.5		*
Tartrate (meq/l)	32.6	31.7	—	—
Potassium (meq/l)	46.9	66.1		**
Chloride (meq/l)	5.6	4.4	***	—
Nitrogen (mg/l)	150	350		**
Total phenolics (absorbance units)	54	43	**	—
Anthocyanins (mg/l)	454	267	**	—
Degree of ionisation of anthocyanins (α)	11.4	9.8	—	—
Ionised anthocyanins (mg/l)	50	25	***	—
"Chemical age" index (i)	0.34	0.48	**	—
Colour density	7.73	5.35	***	—
Colour hue	0.73	0.86	***	—
Free SO_2 (mg/l)	2.30	2.17	—	—

[1]) *, **, ***: significant at 5, 1 and 0.1% respectively; —: not significant.

[2]) When trellis-rootstock interaction is significant rootstock and trellis effects cannot be separated.

Table 3

Mean scores of wines from vines on own roots (Sh) and Salt Creek (SC) when tasted from clear (maximum score 20) and black glasses (maximum score 17). Each value is the mean of 12 wines

Mittlere Punktezahl von Shiraz-Weinen aus wurzelechten Reben (Sh) und aus Pfropfreben auf der Unterlage Salt Creek (SC) bei Verkostung aus klaren und aus schwarzen Gläsern (maximale Punktezahl: 20 bzw. 17). Jeder Wert stellt das Mittel aus 12 Weinen dar

Taster	Clear			Black		
	Sh	SC	Rootstock Effect[1])	Sh	SC	Rootstock Effect[1])
A	15.8	13.1	**	10.8	9.7	***
B	16.0	13.0	***	11.8	9.8	***
C	14.1	11.2	**	11.0	8.7	**
D	16.0	12.8	**[2])	11.9	10.9	*
E	17.2	14.3	**	12.4	10.2	**
F	12.8	9.7	—	11.0	10.0	—[2])
G	17.3	13.8	***[2])	13.4	11.3	**[2])
H	14.0	10.3	**	11.2	8.0	**

[1]) *, **, ***: significant at 5, 1 and 0.1% respectively; —: not significant.

[2]) significant rootstock-trellis interaction.

toria. The vineyard was originally planned for investigations of machine harvesting and the special needs for this led to difficulties in the design of the present experiment which was carried out in 1976.

Shiraz and Salt Creek vines were planted in 1970 and the Salt Creek stocks were field grafted to Shiraz scions in 1970 and 1971. Each combination, Shiraz on own roots (Sh) and Shiraz on Salt Creek stock (SC), was trained on trellises 0.3, 0.9 or 1.3 m wide. There were 6 treatments corresponding to a 3×2 factorial combination of rootstock and trellis. One trellis type was used for all vines in each of 3 blocks. Each block of 40 vines was divided into 2 sub-blocks of 20 vines and Sh and SC was allotted at random to one of the sub-blocks. Each sub-block was further sub-divided into 2 plots of 10 vines each of which was treated independently for taking samples of berries, harvesting and subsequent processing. There were thus 12 plots.

When the grapes were harvested (26 February) a sample of 200 berries (5 berries from each of 4 bunches per vine) was taken from each plot for analyses. The berries were weighed and frozen and then held at —20 °C until required. Aqueous extracts of the berries were prepared for analyses by the methods described by HALE (1977). They were analysed for pH, titratable acidity, soluble solids, malate, tartrate and potassium. The results are expressed on a fresh weight basis. After harvest the grapes from each plot were crushed and divided into 2 sub-samples for fermentation replicates. Samples of juice were taken for determination of pH and soluble solids.

The wines were made by the small scale methods described by ANTCLIFF and KERRIDGE (1976). The finished wine was bottled in August and tasted in December. Except for soluble solids, the wines were analysed for the same constituents as were the grapes and in addition for chloride, nitrogen, total phenolic compounds, and anthocyanins.

Potassium, malate (grapes only) and tartrate were determined by methods described by HALE (1977), malate of wines by malate dehydrogenase (MAYER and BUSCH 1963), nitrogen by the macro-Kjeldahl method, titratable acidity by titration to pH 8.5 end point and soluble solids by refractometer. The pigment and phenolic composition of the wines was measured using the analytical concepts and spectral methods of SOMERS and EVANS (1977). Measurements were obtained for colour density, colour hue, total phenolics, anthocyanins, degree of ionisation of anthocyanins [α] (percentage of anthocyanins in the coloured or flavylium ion form) and "chemical age" index [i] (ratio of polymeric pigment to total colour at wine pH). Free SO_2 was also calculated from the spectral measurements because it influences anthocyanin equilibria (SOMERS and EVANS 1977).

The wines were evaluated by 8 experienced tasters using the 20 point scoring system (3 for colour, 7 for bouquet, 10 for palate) used in Australian show judging (RANKINE 1974). The tasting was held in 6 sessions over one day. The 8 wines from each block were presented to each taster twice in successive sessions, the first time in clear and the second time in black glasses. Because there were obvious differences in wine colour, the black glasses were used to eliminate the effect of colour on the evaluation of the wines.

The significance of treatment effects was tested by analysis of variance. The scores of each taster were analysed separately because analysis of similar data has shown that tasters differ significantly in their evaluation of a wine (BRIEN, private communication). Treatment effects were completely confounded with positional effects because of the experimental layout. However, the difference between rootstock means was attributed to the effect of rootstock when the line for trellis-rootstock interaction was not significant. The reasons for this are given in the Appendix.

Results

Berries from SC vines had lower soluble solids and higher pH, titratable acidity, malate and potassium than berries from Sh vines (Table 1). The differences in composition were also reflected in the juice (Table 1) and wine (Table 2). The chloride content of the wines from SC vines (SC wines) was less than that of the Sh wines.

The SC wines were less dense and had a duller hue than the Sh wines (Table 2). They also had lower values for total phenolics, anthocyanins and ionised anthocyanins, but there was no difference in the degree of ionisation of anthocyanins. The "chemical age" of the SC wines was greater than that of the Sh wines.

The tasters were able to distinguish between the Sh and SC wines and showed a clear preference for the former (Table 3). The difference between each taster's scores for Sh and SC wines was less when the wines were tasted from black glasses, indicating that the Sh wines had a more acceptable colour than the SC wines.

Discussion

Salt Creek is a vigorous rootstock and the SC vines were obviously more vigorous than the Sh vines. Their average yield over 1973 to 1976 was 8% higher than that of the Sh vines (May and Clingeleffer, private communication). This difference in yield is not thought to have contributed to the differences found in grape composition.

Ough *et al.* (1968) found that the more vigorous of the two stocks they used yielded fruit with higher pH, acidity, nitrogen, potassium, phosphorous and tannins. Except for tannins and phosphorous which were not measured our results are in agreement. Ough *et al.* (1968) related the brush-weight/fruit-weight ratio with the berry content of nitrogen, potassium and phosphorous. Since the malate, acidity and pH of berries are influenced by potassium (Hale 1977) and anthocyanins by nitrogen (Kliewer 1977) it is possible that undesirable effects of Salt Creek stock on berry composition could be reduced by modifying the foliage/fruit ratio.

The results show that Salt Creek rootstock modified the composition of Shiraz grapes in the same way as it did Sultana grapes (Hale 1977). The higher values for pH, titratable acidity, malate and potassium in the SC wines cannot be attributed conclusively to a rootstock effect because of significant rootstock-trellis interactions. However, it is thought that a large part of the differences was due to rootstock because of the relationship between grape and wine composition and the lack of any measurable effects of trellis width on grape composition or wine quality in the experiments on Sultana, Crouchen and Shiraz vines (May *et al.* 1973, 1976, May, personal communication).

Anthocyanin content and the degree of ionisation of anthocyanins are the two factors which largely determine the colour density of young red wines (Somers and Evans 1977). The SC and Sh wines showed a large difference in anthoycanin content but no difference in the degree of ionisation of anthocyanins so it is concluded that the difference in colour density was due to the difference in anthocyanin contents of the wines.

Another index of colour composition affected by rootstock was "chemical age". Since the formation of polymeric pigments is an artifact of the wine making process (Somers and Evans 1977), the greater "chemical age" of the SC wines indicates that in these wines there was a more rapid shift in pigment composition from the monomeric to the polymeric form.

The evidence presented here and that of the effects of Salt Creek, Dogridge and Harmony (a nematode resistant stock with some *V. champini* parentage) on grape composition (DOWNTON 1977, HALE 1977) indicate that the pH and the malate and potassium contents of wines made from grapes grown on these stocks would be higher than those from grapes grown on their own roots. In view of the high pH values of many Australian dry red wines (SOMERS 1975) such shifts in wine composition would be undesirable from considerations of the biological and chemical stability of the wine (RANKINE *et al.* 1970).

It is known that rootstocks can influence grape colour (RIVES 1971, WINKLER *et al.* 1974), polyphenols (TREIB 1967), nitrogen (OUGH *et al.* 1968) and chloride (DOWNTON 1977) and it seems likely that the differences between the anthocyanin, phenolic, nitrogen and chloride contents of Sh and SC wines were due to an effect of rootstock on grape composition.

The SC wines were also assessed to be lower in quality by subjective criteria. Apart from colour, the differences between tasters' scores cannot be related with any certainty to differences in composition. The higher pH of the SC wines could have contributed to their lower scores because wines become flat and unbalanced to the taste with increasing pH. It is possible that the concentration of phenolic compounds was also a factor because of their importance to red wine quality. Differences in the pH and nitrogen content of the musts may have an indirect influence on wine quality through their effects on the nature of the fermentation, metabolism of yeasts and production of by-products, oxidations and chemical stability of wine constituents particularly phenolic compounds (AMERINE and JOSLYN 1970) but there is no evidence of such effects in the present experiment.

Summary

Salt Creek rootstock modified the composition and quality of Shiraz grapes and wine. At harvest, grapes from vines grown on Salt Creek stock had a higher pH and higher levels of titratable acidity, malate and potassium and a lower level of soluble solids than grapes from vines grown on their own roots. Wines made from these grapes showed similar differences in composition. In addition, wines made from vines on Salt Creek had lower concentrations of phenolic compounds, anthocyanins (total and ionised) and chloride than wines from ungrafted vines. The Salt Creek wines were less dense in colour, duller in hue and had a greater "chemical age". Sensory evaluations also revealed differences between the wines. Wines from vines on Salt Creek were scored lower than the wines from ungrafted vines. Only part of the difference was due to colour.

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Appendix

In this appendix the problem of confounding (see Methods) is discussed. In the scheme of the analysis of variance (Table 4) the indentation of the line for a treatment indicates confounding with the first unindented line above it.

Because effects of rootstock and trellis treatments are completely confounded with effects of field position, conclusive inferences about the treatments are not possible. However, differences between rootstock means will be attributed to rootstock effects in the special case when the trellis-rootstock interaction is not significantly greater than the variability of plots within sub-blocks. This would arise in either of two situations:

1. Where there is no detectable differential response by the rootstocks to the different trellis types and where the differences due to the positional effects of sub-blocks are no greater than would be expected from plot to plot variation.

2. The differential response of the rootstock to trellis type compensates for the positional effects of the sub-blocks.

It is assumed that the compensating effects described in the second situation did not occur and that a test of rootstock main effect was noted when the rootstock-trellis interaction was not significant. Such an assumption is supported by the use of randomisation in allocating trellises to blocks and rootstocks to plots within a block. No conclusions have been drawn about the trellis effects nor have inferences about the rootstock main effect and trellis-rootstock interaction been attempted when the interaction was significant.

Table 4

Analyses of variance. Indentation of a treatment line means that it is confounded with the first unindented line above it

Varianzanalyse. Einrückung der Zeile für eine Behandlung bedeutet, daß diese mit der nächst höheren nichteingerückten Zeile vermengt ist

Source of variation	Degree of freedom	
Blocks	2	
Trellis		2
Sub-blocks within blocks	3	
Rootstock		1
Trellis-roostock		2
Plots within sub-blocks	6	
Fermentation replicates within plots	12	
Total	23	

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