Effect of Trellis Conversion on the Performance of Chenin blanc/ 99 Richter Grapevines

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To accommodate the excessive vegetative growth of a 9-year old, 3.0 m x 1.2 m spaced and vertically trellised Chenin blanc/99 Richter vineyard, vines were converted to double the original cordon length by removing alternate vines or by extending the cordon laterally in a horizontal plane as per Lyre trellising system. By extending the cordon, shoot vigour was reduced, resulting in an improvement in canopy appearance and microclimate, particularly in the case of the latter system (higher canopy:root volume ratio). Yield increased by 11% and 65% for the vertically trellised vines with extended cordon length and those on the Lyre system, respectively. Grape composition was not affected, whereas the severity of *Botrytis* infection tended to decrease. Wine typicity was enhanced by trellis conversion. Labour input in terms of pruning, harvesting and seasonal canopy management was lower for the vertically trellised vines with extended cordon length, but higher for the vines on the Lyre system; the additional yield, however, still resulted in respectively 15% and 69% higher total income. The results showed that the "original" vigour (growth capacity) was better accommodated and distributed by extending cordon length, particularly for the Lyre system, thereby resulting in higher yields of at least similar grape and wine quality and higher income than before conversion.

The trellis system has a critical role in the efficient accommodation of grapevine growth. According to basic canopy management principles, it must allow a uniformly distributed canopy with sufficient sunlight penetration for the continued production of healthy, equally ripened grapes of high quality (Kliewer, 1982; Smart, 1982, 1985, 1988; Smart *et al.*, 1990; Hunter, 1999).

Environmental factors such as the soil, available water and climate as well as cultural practices have a great impact on the eventual vigour of vines. Poor decisions can easily result in conditions under which vigour is stimulated, shoots are crowded, and high levels of shade are induced in the canopy interior (Smart, 1985). In order to rectify this, various seasonal canopy management practices (e.g. suckering of infertile and sub-standard shoots carrying clusters, shoot positioning, partial defoliation, tipping and topping) are normally applied (Kliewer *et al.*, 1988; Koblet, 1988; Hunter *et al.*, 1995; Hunter, 1999, 2000; Volschenk & Hunter, 2001). However, these practices, albeit effective to counteract the negative effects of vigorous growth and shade on grape and wine quality, do not offer a long-term solution and have to be repeated annually.

Therefore, this study endeavoured to achieve a more permanent solution by converting the standard vertical trellis of vigorously growing vines, using the principle of increasing the ratio of cordon length to root system volume as per Lyre trellis (Carbonneau, 1999; Carbonneau & Cargnello, 1999; Cargnello, 1999). Effects on carbon allocation, grape and wine quality, disease occurrence, and labour costs were investigated.

MATERIALS AND METHODS

Vineyard

A 9-year-old, vigorously growing *Vitis vinifera* L. cv. Chenin blanc (clone 3/1061)/99Richter (clone 1/1/13) vineyard was used. Vines were planted North-East to South-West and spaced 3.0 x 1.2 m. A vertical, five-strand Lengthened Perold trellising system (Zeeman, 1981) was used. Vines were spur pruned to two buds per spur. Further details of the experimental vineyard were given by Volschenk & Hunter (2001).

Treatments

The vertical trellis was converted to allow double the original cordon length of the vines by either removing alternate vines (extending the cordon in both directions – split cordon) or implementing a modified Lyre trellising system (extending the cordon laterally) (Fig. 1). The performance of vines on these systems was compared to control vines with standard trellising and spacing. The converted vines were pruned to 18 and the control vines to nine spurs per vine. Suckering, shoot positioning and topping were applied on all treatments as standard seasonal canopy management. The three treatments were replicated six times in a randomised block design.

Measurements

Canopy appearance and microclimate, yield, incidence and severity of *Botrytis*/sour rot, must composition, wine quality and labour requirements were determined as described in Volschenk & Hunter (2001).

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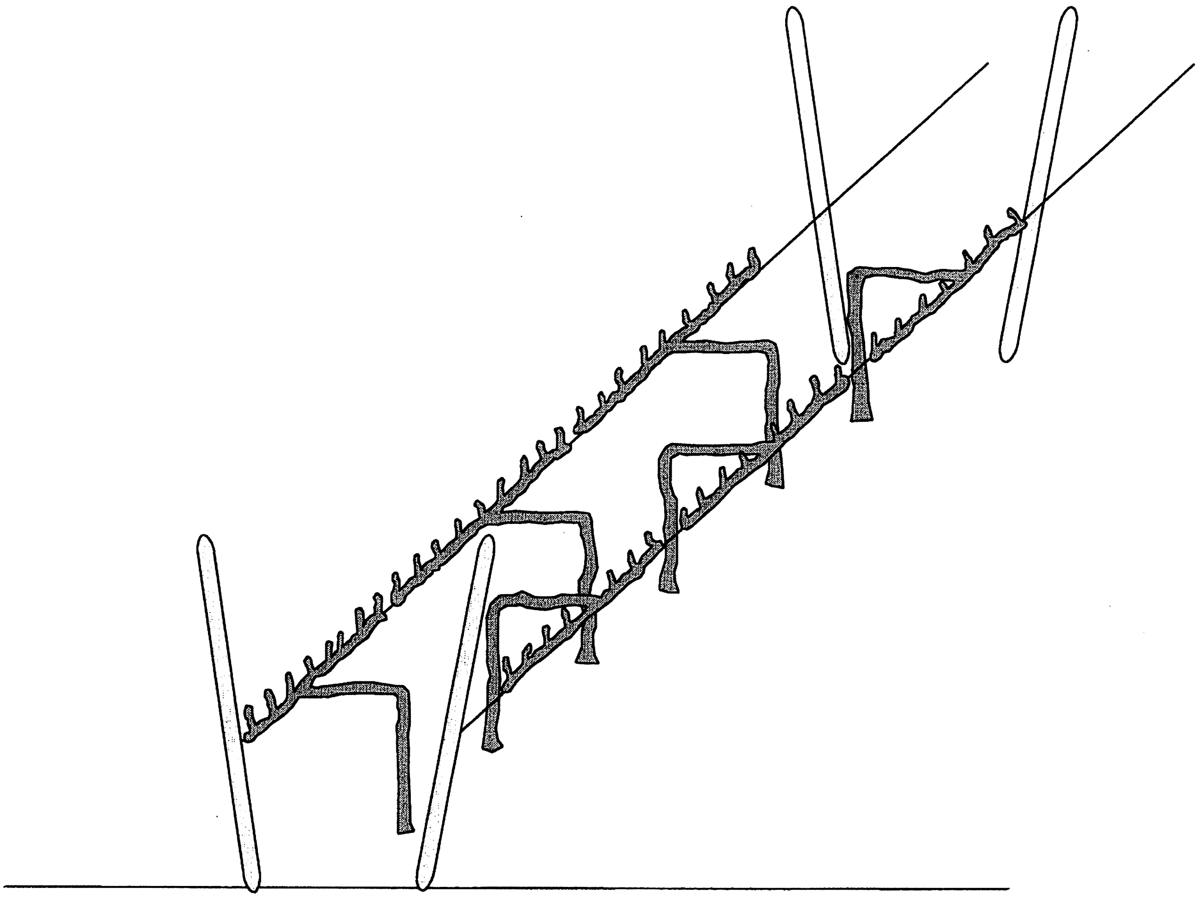

FIGURE 1
Modified Lyre trellising system (as converted from a standard Vertical system).

Statistical analyses

Vines were evaluated for five years. Statistical analyses were performed on data of the last three years. Wine quality was determined during the last two seasons only. Grapes from replicates 1, 2 and 3 and from 4, 5 and 6 were combined for winemaking purposes. The least significant difference at a 5% level was used to compare treatment means.

RESULTS AND DISCUSSION

Cordon length/vine of both the converted trellises was double that of the control, whereas the Lyre system had double the cordon length on a hectare basis as well (Table 1). The increase in cordon length/vine resulted in a higher cane mass/vine. The vines on the vertical trellis with extended cordon length had the lowest and those on the Lyre system the highest cane mass/ha. It is, however, evident that growth of individual shoots on the Lyre system was much reduced compared to that on the other two systems. The similar cane mass/m cordon in the case of vines trained to the vertical and the vertical with extended cordon space systems points to less lateral growth on the latter system. The reduced shoot growth resulted in a more acceptable canopy appearance of vines on both the converted systems (Table 2) (cf. also Smart, 1985; Hunter, 1999). Canopy gaps, the number of leaf layers and the exposure of bunches were improved by extending the cordon. The best canopy appearance was achieved by converting to the Lyre system. Notably, this was achieved without leaf removal.

By extending the cordon, light penetration into and air flow through the canopy were improved (Table 3). Although the highest cane mass/ha was found using the Lyre trellising system (Table 1), the distribution of these shoots and the reduction in individual shoot growth resulted in a more favourable canopy microclimate than when alternate vines were removed (Table 3). Interestingly, relative humidity, temperature and evaporation were not affected. In the case of the converted vines, an increase in temperature was most probably prevented by the increase in air flow through the canopy.

Considering cane mass/ha of the different treatments (Table 1), the increase in yield obtained by converting the standard vertical trellis system is remarkable (Table 4). Yield of vines on the vertical trellis with extended cordon length increased by 11%, whereas that of vines on the Lyre system increased by 65%. This indicates greater shoot efficiency (i.e. in terms of photosynthetic activity, and bud differentiation and fertility) and utilisation of land surface as a result of more balanced growth and improved canopy microclimate. This is in agreement with the findings of many investigators (Hofäcker, 1978; Kliewer, 1982; Smart, 1982, 1985, 1988; Candolfi-Vasconcelos & Koblet, 1990; Smart *et al.*, 1990; Hunter & Visser, 1988a, 1988b, 1990; Hunter *et al.*, 1995; Koblet *et al.*, 1996; Hunter, 1999, 2000).

Trellis conversion had little effect on the incidence of bunch rot (percentage bunches infected), but reduced the severity of bunch

TABLE 1
Effect of trellis conversion on the number of vines, cordon length and cane mass.

Trellising system	Number of vines/ha	Cordon length /vine (m)	Cordon length/ha (m)	Cane mass (kg/vine)	Cane mass (kg/ha)	Cane mass/ m cordon (kg/m)
Vertical	2 778	1.2	3 333.6	0.74c	2 044b	0.612a
Vertical (extended)	1 389	2.4	3 333.6	1.23a	1 712c	0.514b
Lyre	2 778	2.4	6 667.2	0.86b	2 396a	0.359c

Values designated by the same letter do not differ significantly ($p \leq 0.05$).

TABLE 2
Effect of trellis conversion on canopy appearance at ripeness.

Trellising system	Canopy gaps (%)	Number of leaf layers	Bunch exposure (%)
Vertical	15	4.5	15
Vertical (extended)	25	3.5	25
Lyre	30	3	30

TABLE 3
Effect of trellis conversion on canopy microclimate and evaporation at ripeness.

Trellising system	Light penetration (% of ambient)	Air flow (m/s)	Relative humidity (%)	Temperature (°C)	Evaporation (mL water/24h)
Vertical	2.83b	0.36b	36.4a	25.85a	18.98a
Vertical (extended)	3.83ab	0.40ab	36.7a	25.84a	17.75a
Lyre	4.47a	0.46a	36.7a	25.77a	18.68a

Values designated by the same letter do not differ significantly ($p \leq 0.05$).

rot (percentage berries infected), albeit not significantly (Table 4). The improved canopy appearance and microclimate (Tables 2 & 3) most probably played a big role in the ostensible reduction of *Botrytis* severity and would increase the effectiveness of pest and disease control in general (Koblet, 1988; Thomas *et al.*, 1988; English *et al.*, 1989; Stapleton & Grant, 1992).

Grape composition was not affected by trellis conversion (Table 4). Trellis conversion showed a tendency to increase the tropical fruit aroma (pineapple, banana, guava) and to decrease the tree fruit aroma (apricot, peach, apple) (Table 5). The typical flavour of the cultivar therefore seemed to be enhanced. Seasonal canopy management had a similar effect (Volschenk & Hunter, 2001).

The results are evidence that excessive vigour can be successfully accommodated to produce higher yields of good grape and wine quality; however, in this respect growth should be accommodated in such a way that a balance between subterranean growth (root distribution, number, and age) and above-ground growth (yield, composition of the canopy in terms of leaf number and age) is obtained. This will facilitate a proper canopy microclimate by which carbohydrate production by the leaves and contribution to the various sinks of the vine are adequately maintained (Koblet, 1984; Smart, 1985; Hunter & Le Roux, 1992; Edson *et al.*, 1993; Novello *et al.*, 1996; Miller *et al.*, 1997; Hummell & Ferree, 1998; Hunter, 1998, 1999, 2000; Hunter & Volschenk, 2001).

Compared to the control, the vertical trellis with extended cordon length required 17% less total labour input for pruning, seasonal canopy management and harvesting, whereas the Lyre trellis required 39% more than the control (Table 6). Extension of the cordon of the vertical trellis led to a decrease in labour input in the case of each of the measured practices, in addition to the 11% higher yield. Considering the fact that the Lyre trellis had double the cordon length on a hectare basis and yields were increased by 65%, labour input was decreased in comparison to the rest of the treatments. These results again point to more balanced growth, better distribution of shoots and less individual shoot growth in the case of converted vines, leading to a reduction in excessive growth and the occurrence of non-allocated and intertwined shoots; canopies were therefore easier to prune, manage and harvest. Assuming that costs for disease control, fertilisation, irrigation, etc. were similar between the different trellises and calculating the total labour input, cost for labour, and yield income, the total income/ha still increased by 15% and 69% for the vertical trellis with extended cordon length and the Lyre system, respectively.

TABLE 4
Effect of trellis conversion on Botrytis/sour rot infection, yield and must composition at ripeness.

Trellising system	Botrytis/sour rot (%)		Yield	Soluble solids	Titratable acidity	pH	FAN
	Incidence	Severity	(t/ha)	(°B)	(g/L)		(mg/L)
Vertical	49.5a	8.82a	23.1c	19.9a	7.74a	3.13a	903a
Vertical (extended)	49.8a	6.17a	25.6b	19.6a	7.93a	3.10a	909a
Lyre	50.1a	7.87a	38.1a	19.4a	7.82a	3.08a	822a

Values designated by the same letter do not differ significantly ($p \leq 0.05$).

TABLE 5
Trellis conversion effect on wine quality (% acceptability and perceptibility by sensorial evaluation).

Trellising system	Colour	Tree fruit	Tropical fruit	Acidity
Vertical	81.6a	16.7a	33.2a	58.5a
Vertical (extended)	84.5a	13.6a	37.2a	61.1a
Lyre	81.6a	9.8a	39.1a	58.9a

Values designated by the same letter do not differ significantly ($p \leq 0.05$).

TABLE 6
Trellis conversion effect on labour input for pruning, canopy management and harvesting (man hours/ha).

Trellising system	Pruning	Suckering	Shoot positioning	Topping	Harvesting	Total
Vertical	54.3b	83.6a	62.8b	22.8ab	91.8b	315.4b
Vertical (extended)	44.3c	58.0b	52.9c	19.3b	88.6b	263.0c
Lyre	76.8a	85.4a	87.5a	26.9a	160.4a	436.9a

Values designated by the same letter do not differ significantly ($p \leq 0.05$).

CONCLUSIONS

Individual shoots were de-vigoured by extending the cordon length of vigorous vines. A more pronounced effect was obtained by a higher canopy to root volume ratio per hectare and the number of shoots was increased. Canopy appearance and microclimate were improved and yields increased without a loss in grape quality. In fact, total grape quality was improved and apparently a more typical wine flavour obtained. The study showed that grape and wine quality can at least be maintained and income increased when balanced growth is created in vigorously growing vineyards that produce yields lower than capacity. The results also clearly showed that proper planning of long-term practices, based on the potential of the soil and climate for vigour, is imperative in creating balanced vineyards for quality wine and maximum income.

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