# Effects of spur or cane pruning on fruit composition of 'Cabernet Sauvignon' grapes

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***Abstract***

**During the 2011-2012 season, a trial was conducted on mature 'Cabernet Sauvignon' vines in San Bernardo, Región Metropolitana, Chile, on a Mediterranean climate. The design was completely randomised blocks, with 12 replicates, and each vine corresponded to a block. The six-year old vines were trained to a bilateral cordon and pruned to 16 buds per vine. Randomly, one side was pruned leaving 4 spurs with 2 buds each; the other side was pruned to one 8-bud cane. The budbreak percentage, shoot growth, fruit yield and soluble solids, titratable acidity and pH of fruit were evaluated. On 100 berry skins, total anthocyanin content, and skin and seed total phenols and total tannins were measured by spectrophotometry, with anthocyanin and phenol composition measured by HPLC-DAD. Additionally, a fruit sensorial analysis was done at the time of harvest. The following winter, pruning weight was registered. Total shoot growth and average shoot length at the beginning of the season were higher on the spur-pruned treatment. Pruning weight was also superior on spur-pruned cordons. Although bud break was significantly higher on spur-pruned cordons, total fruit weight was the same between treatments. Cluster weight was statistically not different between spur and cane pruned cordons. Soluble solids, pH and TA were also similar between treatments. Total phenols, anthocyanins and tannins in the skins and seed phenols and tannins were not different between spur and cane treatments. Phenol composition showed no differences in skin or seeds from the fruits of each treatment. Sensorial analysis was similar for both treatments. The results for fruit parameters suggest that either pruning system can be used for optimal yield and fruit quality.**

**Keywords:** bud position, phenolic compounds, quality

## INTRODUCTION

Grape phenol composition can be modified by environmental and vineyard factors (Bergqvist et al., 2001; Bravdo et al., 1985; Downey et al., 2004; Haselgrove et al., 2000; Holt et al., 2008). Pruning is a critical practice that determines yield and also influences budbreak and fruit light exposure. Besides the effects on the vineyard yield and quality, pruning type also differs according to speed and cost, with cane pruning being slower and more expensive than spur pruning (Jackson, 2008). 'Cabernet Sauvignon' fruit developed from different bud positions could show differences in fruit phenolic composition, but most pruning studies consider different bud numbers per vine, adding the crop load factor to the analysis. 'Cabernet Sauvignon' vines have traditionally been cane-pruned following old recommendations concerning yield and fruit quality (Bioletti, 1897; Weaver, 1976), but the higher costs associated with cane pruning plus the current high agriculture labour prices make it convenient to review the more appropriate pruning, without affecting fruit yield or quality.

## MATERIALS AND METHODS

'Cabernet Sauvignon' plants from a commercial vineyard in San Bernardo, Región Metropolitana, Chile (33°36'39.28"S, 70°44'21.36"W) were used for the trial. Vines were six years old, grafted on 'P-1103' rootstock, planted 1 m apart in rows separated by 2 m; vines were drip-irrigated and trained to a bilateral cordon. On August 2011, 12 uniform vines were selected and, randomly, one side of the vine was pruned to four 2-bud spurs, while the opposite side of the vine was left with one 8-bud cane. Bud break percentage and shoot length were evaluated on 3rd November, three weeks after the bud break started. Based on fruit maturity and logistics, company winemakers determined the harvest date (April 26th, 2012). At harvest yield per plant, mean cluster weight and soluble solids, titratable acidity and pH of fruit were evaluated. Also, a sample composed of 100 berries from each treatment was collected and frozen for skin total anthocyanin and skin and seed total phenol and total tannin analysis. Berries were peeled and the skin and seeds were separated and then ground. The powder was placed into a 200 mL solution using 20 mL of a hydroalcoholic solution (10:90 v/v ethanol/water) and water. The solution was then agitated for 2 h, centrifuged and filtered through a 0.45 μm pore membrane. Measurements of the solution were performed by spectrophotometry at 280 nm or 520 nm, and anthocyanin and phenol composition were also analysed by HPLC-DAD using formic acid/acetonitrile or acetic acid/acetonitrile-acetic-water/methanol, respectively, as solvents. Two days prior to harvest, a panel of five wine industry judges ran a fruit sensory analysis. Sensory analysis included colour intensity and colour varietal characteristics of the juice, green and fruit aroma, mouthful concentration, astringency and equilibrium. In August 2012, pruning weights of each plant side were recorded.

The design of the experiment was completely randomised blocks with two treatments and 12 replicates (plants). The experimental unit corresponded to half a plant. Results were analysed by ANOVA (after verification of error terms assumptions) and if significant differences were detected, the Tukey Multiple Comparison test (5%) was used. Cluster number per experimental unit was included as a covariate when significant. Sensorial analyses were performed two days prior to harvest and the results were analysed using the Friedman non-parametric test, with a scale of 1 to 9, where 1 represented the minimum of the character and 9 was the maximum. Analyses were performed using Infostat software (Di Rienzo et al., 2013).

## RESULTS AND DISCUSSION

Budbreak and shoot growth at the beginning of the season were higher on spur-pruned vine-sides (Table 1). Pruning weight was also higher on spur-pruned vines. Despite the larger shoot growth and number observed on spur-pruned sections at harvest, no differences were observed on yield (Table 2). Spur-pruned vine sections produced an equivalent to 6.912 ton $ha^{-1}$, while cane-pruned vines reached 8.291 t $ha^{-1}$; however, statistically, yields were equal. Kasimatis et al. (1985) also observed higher pruning weights on spur-pruned versus cane-pruned vines but no differences in yield. The individual cluster weight, soluble solids, pH and titratable acidity of clusters developed on shoots from spur or cane elements were also similar (Table 2). Cluster number was a significant covariate for titratable acidity (data not shown) but the Tukey test did not detect any differences. Holt et al. (2008) found differences in ‘Cabernet Sauvignon’ fruit and wine from different treatments, but the machine-, spur- and cane-pruning treatments of that trial differed by bud number per vine. Different total soluble solids, pH and acidity, influenced by bud numbers per vine, were not consistent. Moreover, regardless of the pruning treatment, Holt et al. (2008) observed that larger differences resulted from different vintages. A comparison between spur- and cane-pruned ‘Cabernet Sauvignon’ vines with similar bud numbers per vine (Kasimatis et al., 1985) showed the same yield and cluster weight, soluble solids and acidity, but a slightly higher pH in fruit from spur pruned vines. In the present study, since bud number per vine and crop load were the same, no differences were expected between fruit from shoots developed on spurs or canes.

Table 1. Effect of pruning type on bud break, shoot growth and pruning weight of 'Cabernet Sauvignon' vines.

| Treatment | Budbreak (%) | Mean shoot length (cm) | Total shoot growth (cm $plant^{-1}$) | Pruning weight (g) |
|---|---|---|---|---|
| Spur-pruned | 97.50 b | 24.34 b | 386.60 b | 467.24 b |
| Cane-pruned | 77.50 a | 11.15 a | 178.40 a | 196.92 a |

Different letters in the same column indicate significant differences according to multiple comparison test of Tukey ($p<0.05$, $n=12$).

Table 2. Effect of pruning type on yield, cluster weight, fruit soluble solids, pH and titratable acidity of 'Cabernet Sauvignon' grapes at harvest.

| Treatment | Yield $vine^{-1}$ (g) | Mean cluster weight (g) | Soluble solids (°Brix) | pH | Titratable acidity (%) |
|---|---|---|---|---|---|
| Spur-pruned | 1382.50 a | 48.33 a | 25.61 a | 3.85 a | 0.43 a |
| Cane-pruned | 1658.16 a | 53.57 a | 25.80 a | 3.87 a | 0.43 a |

Different letters in the same column indicate significant differences according to multiple comparison test of Tukey ($p<0.05$, $n=12$).

Skin and seed analysis showed similar results regarding total phenol content, tannins and skin anthocyanins (Table 3). No relationships were found between variables considered on the sensory analysis (data not shown). There was a high variability of the data, but no clear effect of pruning type. Comparing fruit from machine-, cane- or spur-pruning, in general, Holt et al. (2008) found more anthocyanins, phenolics and tannins on fruit from machine-pruned vines, but the wine score from this treatment was the lowest. Although spur- and cane-pruned vines in the study of Holt et al. had slightly different bud numbers per vine, phenolic composition and wine scores of fruit from spurs or canes were the same. Seasonal variances could influence results by environmental factors (Bergqvist et al., 2001; Downey et al., 2004; Haselgrove et al., 2000), but the results from this trial suggest that pruning itself does not alter the fruit composition or phenolic content. The total content of phenolics and anthocyanins were evaluated, with no changes observed for any component regarding pruning type (data not shown). For all samples, malvidin-3-glucoside was the more abundant pigment, followed by malvidin-3-*O*-acetylglucoside.

Sensorial analysis of fruit juice showed no differences in any character (Table 4); fruits developed on shoots from spurs or canes have similar mouth and nose quality.

Table 3. Effect of pruning type on skin and seed total phenols and total tannins, and total skin anthocyanins of 'Cabernet Sauvignon' grapes at harvest.

| Treatment | Skin | | | Seed | |
|---|---|---|---|---|---|
| | Phenols (mg $L^{-1}$) | Tannins (g $L^{-1}$) | Anthocyanins (mg $L^{-1}$) | Phenols (mg $L^{-1}$) | Tannins (g $L^{-1}$) |
| Spur-pruned | 367.93 a | 0.969 a | 353.29 a | 759.11 a | 2.12 a |
| Cane-pruned | 379.84 a | 0.983 a | 354.06 a | 804.50 a | 2.23 a |

Different letters in the same column indicate significant differences according to multiple comparison test of Tukey ($p<0.05$, $n=12$).

Table 4. Effect of pruning type on sensorial characters on 'Cabernet Sauvignon' fruit juice.

| Treatment | Colour intensity | Varietal colour | Green characters | Fruit aroma | Mouthful concentration | Astringency | Equilibrium |
|---|---|---|---|---|---|---|---|
| Spur-pruned | 6.1 a | 5.9 a | 4.5 a | 5.5 a | 5.7 a | 5.0 a | 5.1 a |
| Cane-pruned | 6.3 a | 6.2 a | 4.7 a | 5.5 a | 5.2 a | 5.0 a | 4.9 a |

Different letters in the same column indicate significant differences according to Friedman non-parametric test ($p<0.05$, $n=12$).

## CONCLUSIONS

Pruning type itself, maintaining the total bud number per vine, does not affect fruit composition nor phenolic content and profile. The results for fruit yield, composition and phenolics suggest that it is possible to determine pruning type based on the more convenient economic aspects, with no concerns in relation to fruit and wine quality.


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## Literature cited


Bergqvist, J., Dokoozlian, N., and Ebisuda, N. (2001). Sunlight exposure and temperature effects on berry growth and composition of 'Cabernet Sauvignon' and 'Grenache' in the central San Joaquin valley of California. Am. J. Enol. Vitic. *52*, 1–7.

Bioletti, F.T. (1897). Vine pruning. Univ. Calif. Agricultural Experiment, Station, Berkeley, Cal., Bull. *119*, 20.

Bravdo, B., Hepner, Y., Loinger, C., Cohen, S., and Tabacman, H. (1985). Effect of crop level and crop load on growth, yield, must and wine composition, and quality of 'Cabernet Sauvignon'. Am. J. Enol. Vitic. *36*, 125–131.

Di Rienzo, J.A., Casanoves, F., Balzarini, M.G., Gonzalez, L., Tablada, M., and Robledo, C.W. (2013). InfoStat version 2013. (Argentina: Grupo InfoStat, FCA, Universidad Nacional de Córdoba), http://www.infostat.com.ar.

Downey, M.O., Harvey, J.S., and Robinson, S.P. (2004). The effect of bunch shading on berry development and flavonoid accumulation in 'Shiraz' grapes. Aust. J. Grape Wine Res. *10* (*1*), 55–73 http://dx.doi.org/10.1111/j.1755-0238.2004.tb00008.x.

Haselgrove, L., Botting, D., Van Heeswijck, R., Hoj, P.B., Dry, P.R., Ford, C., and Land, P.G.I. (2000). Canopy microclimate and berry composition: the effect of bunch exposure on phenolic composition of *Vitis vinifera* L cv 'Shiraz' grape berries. Aust. J. Grape Wine Res. *6* (*2*), 141–149 http://dx.doi.org/10.1111/j.1755-0238.2000.tb00173.x.

Holt, H.E., Francis, I.L., Field, J., Herderich, M.J., and Iland, P.G. (2008). Relationships between berry size, berry phenolic composition and wine quality scores for 'Cabernet Sauvignon' (*Vitis vinifera* L.) from different pruning treatments and different vintages. Aust. J. Grape Wine Res. *14*, 191–202.

Jackson, R.S. (2008). Wine Science, 3rd edn (Academic Press), pp.776.

Kasimatis, A.N., Bowers, K.W., and Vilas, E.P. (1985). Conversion of cane-pruned 'Cabernet Sauvignon' vines to bilateral cordon training and a comparison of cane and spur pruning. Am. J. Enol. Vitic. *36*, 240–244.

Weaver, R.J. (1976). Grape Growing (John Wiley & Sons, Inc. Wiley-Interscience Publication), pp.371.