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Effect of pruning and mechanical fruit thinning on crop load and berry and wine composition of Tempranillo in Texas

>>> Tempranillo is the second most planted variety in Texas. However, over-cropping can be an issue. Crop load can be managed by pruning and mechanical fruit thinning. Mechanizing fruit thinning provides three benefits: yield reduction, berry thinning to decrease cluster compactness and reduce fungal disease and lower production costs than fruit thinning by hand[1]. In this study, crop load was manipulated by pruning and mechanical fruit thinning and its effect was determined on berry and wine quality. <<<

■ Experimental design

The experiment was established in a commercial vineyard in Texas, United States and performed on 12-year-old own-rooted Tempranillo (clone 02) vines during 2019. Three treatments that mimic the practices of the area were imposed: vines pruned to two buds per spur (2B), vines pruned to three buds per spur (3B), and vines pruned to three buds per spur and fruit thinned (3BFT). Fruit thinning was performed using a mechanical harvester at 30 days post-bloom. The ground speed of the harvester was 3 km per hour and the shaker speed was 315 bpm. All treatments reached bloom and veraison simultaneously, on May 16th and July 18th, respectively. Clusters were randomly collected per vine from each treatment at three different dates: August 20th, September 3rd and September 7th for berry chemistry analysis.
Total yield, number of clusters per vine, number of berries per cluster and cluster and berry weights were measured at harvest. Pruning weights, number of shoots per vine and cane weight were taken during dormancy.
Ravaz index was calculated as the ratio of yield at harvest on pruning weight.
Wines were produced by microvinification then bottled and stored at 13 °C. Wine chemistry was assessed 9 months after bottling. 101 panellists ranked the wines in order of preference based on aroma, taste, appearance, and colour.

■ Effects on vine performance

A significant effect of canopy management was observed on yield with 3BFT showing the lowest yield per meter, 62.8 and 64.6 % lower than 3B and 2B, respectively. These results demonstrate that fruit thinning can significantly affect vine final yield (Table 1).
An impact of the different treatments on the number of clusters per vine and the number of berries per cluster was not observed. However, a tendency was noticed with 3BFT showing the lowest numbers. Cluster and berry weights were not impacted by the different treatments. Yet, a trend was observed with 2B having the heaviest clusters and berries (Table 1). These results demonstrate that berry and cluster weights had more effect on yield at harvest than the number of clusters per vine[2].
The fact that 3BFT showed comparable number of clusters to 3B with a trend of lower cluster weight and lower number of berries per cluster indicates that fruit thinning using a harvester removes individual berries instead of whole clusters. Additionally, in this treatment, berries were heavier compared to 3B showing that vines compensate for the low cluster and berry numbers by increasing berry weight during the 30 days post-bloom phase.

Table 1. Effect of pruning and mechanical fruit thinning on yield components, biomass measures and Ravaz index per vine of Tempranillo in 2019.

	Berry weight (g)	Number of berries per cluster	Number of clusters per vine	Cluster weight (g)	Total yield per meter (kg)	Pruning weight per meter (kg)	Number of shoots per vine	Mean cane weight (g)	Ravaz index per vine
3BFT	1.66^{a}	51^{a}	31^{a}	85^{a}	2.2^{a}	0.39^{a}	17.4^{a}	26.76^{a}	5.64^{a}
2B	1.90^{a}	118^{a}	39^{a}	224^{a}	6.2^{b}	0.42^{a}	20.1^{a}	27.66^{a}	14.76^{ab}
3B	1.32^{b}	116^{a}	49^{a}	154^{a}	5.9^{b}	0.37^{a}	21.3^{a}	22.49^{a}	15.94^{b}

Means followed by different lowercase letters are significantly different at the 0.05 probability level according to Fisher's LSD test.

The different canopy management treatments did not impact pruning weight, the number of shoots per vine and mean cane weight (Table 1).
A highly significant effect of canopy management was observed on the Ravaz index per vine (RI). It was two to three-fold higher for 3B and 2B compared to 3BFT (15.94 and 14.76 versus 5.64).

■ Berry composition

Berry composition was monitored during the ripening period and all treatments were harvested when the most advanced treatment reached 24 °Brix, the standard ripening level of the region (Figure 1).
The lowest crop load treatment (3BFT) reached maturity earlier than 2B and 3B. during all sampling dates, it has the highest soluble solids (TSS), the highest sugar content, and the highest sugar per berry that was assessed to discern between changes in berry weight resulting from sugar accumulation versus incursion of water after a precipitation event. The 3BFT treatment also showed the highest pH and the lowest titratable acidity (TA) on August 20th and September 3rd. At harvest, it showed with 3B the lowest TA values compared to 2B.
When expressed as sugar per berry, the ripening data collected suggested that sugar accumulation in 2B and 3B had ceased between the second sample timing and harvest. Thus, additional hang time would not have resulted in higher TSS until berry dehydration commenced. Similar results were described by McDonnell in 2011[3]. Although hanging the fruit longer for 2B and 3B might be beneficial to reach the Brix target, the risk of high pH and potential winter damage can put these two treatments in detriment status.

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3BFT had a higher juice pH and a lower TA at most time points. However, this was not completely explained by differences in individual acids. The highest content of tartaric acid was observed in 3BFT. The authors believe that the resulting differences in acidity are likely a combination of acids and potassium which can substitute for protons resulting in an elevated pH[4]. This phenomenon is commonly observed in hot climates[5].
These results demonstrate that fruit thinning using a mechanical harvester is a tool for grape grower to correct crop load in a scenario of high yield vines to attain a grape chemistry desired for winemaking.

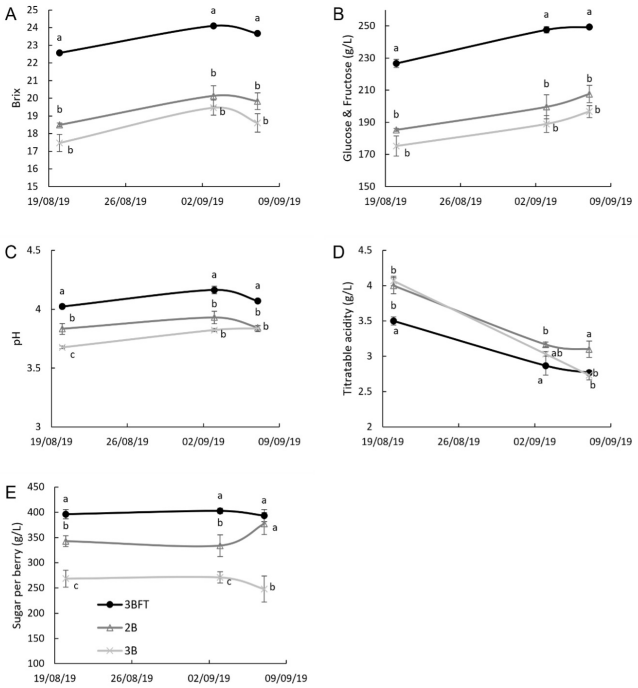

Figure 1. Effect of crop load level on soluble solids (A), glucose and fructose (B), pH (C), titratable acidity (D), and sugar per berry (E) of Tempranillo during 2019 season. Means followed by different lowercase letters are significantly different at the 0.05 probability level according to Fisher's LSD test.

■ Wine Composition and consumer preference

The pH and alcohol concentration of the finished wines varied greatly amongst all the treatments (Figure 2). Although 3BFT had the highest pH, it also had the highest TA, the highest concentration of tartaric and malic acids, the highest alcohol content and the highest colour intensity compared to the two other treatments. 3B showed the lowest percentage of alcohol with the lowest concentration of tartaric acid, despite displaying the lowest pH.
Although total anthocyanin content in the berry was not statistically significant, difference in colour was observed in the final wines showing an inverse relationship to crop load (Figure 2). 3BFT had a 58.5 % higher colour values than the treatment with the highest RI. This was likely a result of higher concentrations of anthocyanins and associated polyphenolics rather than berry size.
Regarding consumer preferences, no statistical differences were inferred other than wine appearance and wine colour (Figure 2).

■ Conclusion

In this study, fruit thinning using a mechanical harvester 30 days post-bloom affected vine crop load that in consequence influenced berry and wine quality.

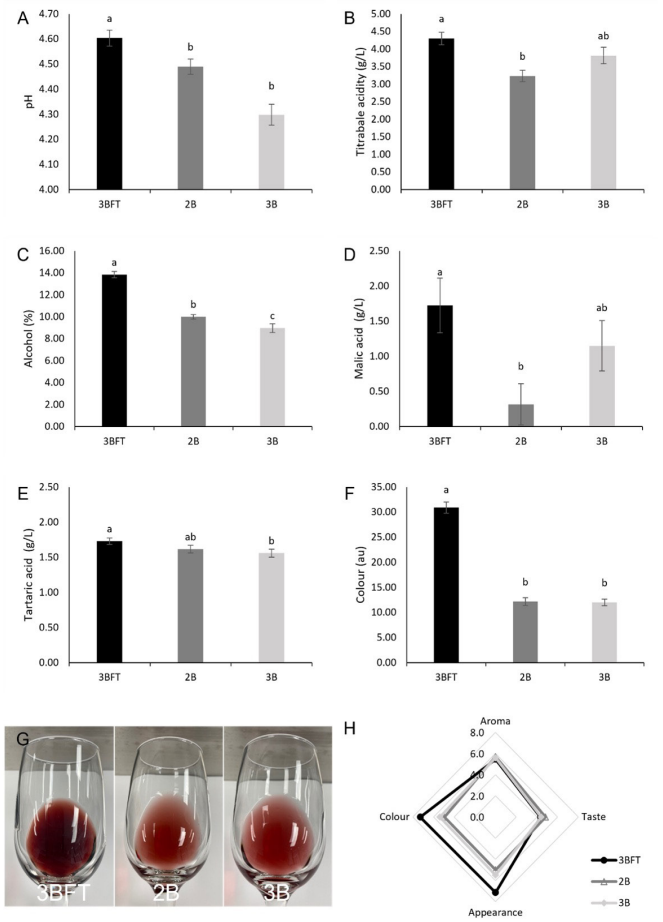

Figure 2. Effect of pruning and mechanical fruit thinning on finished wine pH (A), titratable acidity (B), alcohol percentage (C), malic acid (D), tartaric acid (E), colour (F-G) and consumer preference (H) of Tempranillo during 2019 season. Means followed by different lowercase letters are significantly different at the 0.05 probability level according to Fisher's LSD test.

This time and cost friendly technique appeared to be a tool for grape growers to manipulate yield to achieve desired berry and wine chemistry. Vines with the lowest crop load had faster berry ripening rate and wines with higher alcohol and pH. Such chemistry may not be desired for Tempranillo vines grown in a hot climate. ■

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