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Title: **"Crop thinning (hand *versus* mechanical), grape maturity and anthocyanin concentration: outcomes from irrigated Cabernet Sauvignon (*V. vinifera* L.) in a warm climate"**

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This article studies whether a grape harvester can be efficiently used to thin vines while respecting wine quality, and how the results compare with a manual operation.

- The authors compared 4 treatments: 1) **Control**, or un-thinned vines, 2) **Mechanically thinned** vines, 3) **Hand-thinned** vines, with clusters removed from positions similar to mechanically thinned vines, and 4) **Mechanically thinned vines followed by hand-thin** to remove damaged clusters. Thinning was conducted at pea-size.

- The trial was carried out at 2 sites. The vines in both sites were trained to a 2-wire vertical trellis. The only difference was: Site 1 was thinned with a Gregoire G65 harvester, and used three pairs of bow rods to thin the lower third of the canopy. Site 2 used a URM Vinestar harvester, and used four pairs of bow rods to thin the lower half of the canopy. The reason only a portion of the canopy was targeted in both sites was to limit the amount of damaged clusters to a smaller area, as well as to facilitate the estimation of percentage fruit removed, thus avoiding over-thinning.

- **Yield and cluster number.** All the thinning treatments caused a decrease in cluster number and yield at both sites (24% reduction at site 1, 45% reduction at site 2). The hand thinning successfully decreased yield at similar levels to the mechanical thinning, for both sites. In contrast, cluster weight and berry number were unaffected by thinning.

- **Berry weight.** All the thinning treatments caused an increase in berry weight at site 2. In contrast, at site 1, which was the site with an overall smaller yield reduction, the hand thinning also caused smaller berries, but the mechanical thinning showed a berry weight similar to the control.

- **Brix.** All the thinning treatments caused an increase in Brix, or soluble solids, for both sites studied. Interestingly, the thinning did not affect the rate of soluble solid accumulation, as shown by the identical slopes of the maturity graphs for all treatments. Thinning only caused a given Brix target to be reached earlier. As the authors note, this can only be explained if differences in sugar content happened very early after the thinning, well before the first sampling of the sugar accumulation study took place.

- **Anthocyanins and phenols**. These grape compounds were increased for all thinning treatments for site 2. For site 1, with the overall lower yield reduction, anthocyanins and phenols only increased in the mechanical thinnings (by itself or with hand follow-up), whereas they remained unchanged in the hand thinning treatment.

- **Wine color.** Wine was made only for site 1. Both mechanical thinnings increased wine color when compared to the control (20 liter fermentation scale). The color increase of the hand thinning was not significant from that of the control.

- **Berry weight distribution.** Besides studying the effect of thinning on mean berry weight, the authors also explored what the effect of the method of thinning (mechanical versus hand) was on the berry weight normal population distribution, that is, the number of berries in each weight category. They found that both types of thinning shifted the distribution towards lower berry weight values. But the amount of shifting of the mechanical thinning was twice as much that of the hand thinning. In other words, mechanical thinning reduced berry size more than hand thinning. (This is called skewness, and more precisely, positive skewness, which means the new distribution has a longer right tail than a normal distribution). They also found that the hand thinning, unlike the mechanical thinning, caused a flattening of the distribution, that is, it had a uniforming effect on berry weight . (This is called kurtosis, and more precisely, negative kurtosis, which means that the deviations from the mean berry weight were more frequent but smaller in magnitude).

- **Berry Brix distribution.** In a similar way as for berry weight, the authors studied how mechanical vs. hand thinning affected the berry Brix distribution. They found that the thinning in general shifted the population towards higher Brix values (negative skewness, or longer left tails). Once again, the effect was more pronounced for mechanical than for hand thinning. As for any "flattening effect" on the distribution, all the thinning treatments actually had the opposite effect: they increased the "peakedness" or heterogeneity of the Brix value population. Once again, this effect was three times higher in the mechanical thinning than in the hand thinning. In other words, hand thinning produced more homogeneous Brix. (This is called positive kurtosis, which means that the deviations of values from the mean berry Brix were infrequent but larger).

- What the previous population shifts mean is that, when you thin by hand, the berries are more likely to be homogeneous in size, and this size is, in general, smaller than the control berries. Similarly, the berries will likely be more similar in Brix, and this Brix will be higher than in the control berries. In contrast, when you thin mechanically, berry size is more uneven, but much smaller, on average, than the control. Brix content of these berries is also more uneven, but much higher than the control, as well as also higher than those that had been thinned by hand.

In summary, mechanical thinning distorted the data distribution for Brix and berry weight when compared to hand thinning, but was able to increase wine color. The authors therefore see a good potential of mechanical thinning as a means of regulating crop in a quick and cost-effective manner. They note that the practice is particularly suited for minimal pruning situations. Here, instead of reducing yields early in the season through pruning, you could wait to do it later in the season through thinning, when some information of degree of fruitfulness for the current year might become available. The table below summarizes the author's results.

Effect of thinning on	Site 1	Site 2
Cluster number/Yield	↓	↓
Cluster weight	–	–
Berry number	–	–
Berry weight	↑ (hand only)	↑
Brix	↑	↑
TA	–	↓
pH	–	↑
Anthocyanins	↑ (mech. only)	↑
Phenols	↑ (mech. only)	↑
Wine color	↑ (mech. only)	(No wine)

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