A regular feature to inform industry about research projects being undertaken for their benefit. Newly approved projects (when available) are briefly summarised and longer reports will describe what has been achieved so far. When completed, each project will be reported in full detail with references on nzwine.com

Fromm

Research Supplement

Information and updates on Bragato Research Institute research programmes.

CONTRACTED RESEARCH PROJECTS

Quality Wine Styles for Existing and Developing Markets

Breaking the quality-productivity see-saw in wine grape production (Pinot Noir Programme)
University of Auckland, Plant and Food Research and Lincoln University (Various) jointly funded by NZW and MBIE

Prevention of quercetin instability in bottled wine
Villa Maria Wines Limited (O Powrie)

The effect of winemaking decisions on polysaccharide content in wine
University of Auckland (B Fedrizzi)

Understanding green character in Pinot noir wine
Lincoln University (D Torrico)

Exploring reductive aromas in Pinot noir
University of Auckland (B Fedrizzi)

Precipitation of calcium tartrate and other compounds in wine
University of Canterbury (K Morison)

Effect of bentonite addition prior to cold soaking on Pinot noir wine colour, tannin and aroma profile
Lincoln University (B Tian)

National Vine Collection Virus Eradication
Bragato Research Institute (D Lizamore)

Pests and Disease

Improving remedial surgery practices for control of grapevine trunk disease to increase vineyard longevity
Linnaeus (E van Zijll de Jong)

Improving the outcomes of mealybug insecticide use in vineyards
Plant & Food Research (V Bell)

Weevils in New Zealand vineyards
Bragato Research Institute (L Ibbotson)

Cost Reduction/Increased Profitability

Long spur pruning as an alternative to cane pruning for Sauvignon blanc in Marlborough
Bragato Research Institute (C Vasconcelos)

The Vineyard Environment

Vineyard Ecosystems Programme
University of Auckland and Plant & Food Research (Various) Jointly funded by NZW and MBIE

The effect of herbicide, buffered herbicide and under-vine weeding on soil biological communities and other measures of soil health.
Bragato Research Institute (M Barry)

Development of an anaerobic chain-elongation bioprocess for grape marc valorisation
University of Auckland (S Yi)

Evaluating ecologically sustainable ways to disrupt the Hemiandrus bilobatus-vine association
Plant & Food Research (J Vereijssen)

Weather and Climate

Sauvignon Blanc Grapevine Improvement Programme
Bragato Research Institute (D Lizamore)

Microbial community and vine responses to increasing temperatures in the New Zealand context
University of Auckland (S Knight)

Assessing foliar fertiliser for grapevine frost recovery
Bragato Research Institute (L Ibbotson)

Managing hail damaged vineyards in New Zealand

KEY LESSONS FROM THE 2019 SPRING HAIL EVENTS IN HAWKE'S BAY AND NORTH CANTERBURY

Len Ibbotson, Bragato Research Institute

Hail events are often unforeseen and due to their random and somewhat rare occurrence, hail protection or prevention systems are not normally justified in New Zealand vineyards. The impact of hail damage to a vineyard can range from minor shoot and crop damage to total crop loss and may carry over into the subsequent season.

WHAT TO EXPECT AFTER HAIL

Impact on yield

Significant yield losses in grapevines are a common consequence of severe abiotic stress caused by frost and hail, and the resulting low crops can be linked to a combination of the loss of primary shoots, physical damage or the complete removal of fruit and disruption to plant growth causing sub-optimal conditions for shoot development, flowering and fruit set (2–8). The intensity of the hail event and the growth stage timing when it occurs will determine the impact on vine yield and fruit quality. Variables such as windspeed and direction, hailstone velocity, hailstone size and the duration of hail all differ between events leading to varying levels of damage to grapevines and other plants (3,5,9).

Early spring hail in Hawke's Bay (HB), which struck when Chardonnay vines had 2-8 leaves on shoots (EL-9 to EL-15), significantly reduced yields to 20-40% of the long-term average (LTA) (Figure 1). Merlot and Syrah were less affected, achieving 66-85% of the LTA. In North Canterbury (NC), hail which occurred just prior to flowering (EL-16-19) in the same season appeared to have minimal impact on the yields of Chardonnay and Pinot noir vines, despite causing severe leaf and shoot damage to some vines (Figure 2).

AUTHOR'S NOTE

This article has been produced as a supplement to the full report of a study carried out by Bragato Research Institute (BRI), which documented the impact and outcomes of two different hail events in New Zealand during spring 2019 (1).
The Australian Wine Research Institute released an updated Factsheet in 2021, which offers an excellent summary of considerations for growers managing grapevines after hail and should be reviewed alongside this document (2).

Figure 1: Hawke's Bay Chardonnay vine one month after the hail event (taken 1 Nov 2019)

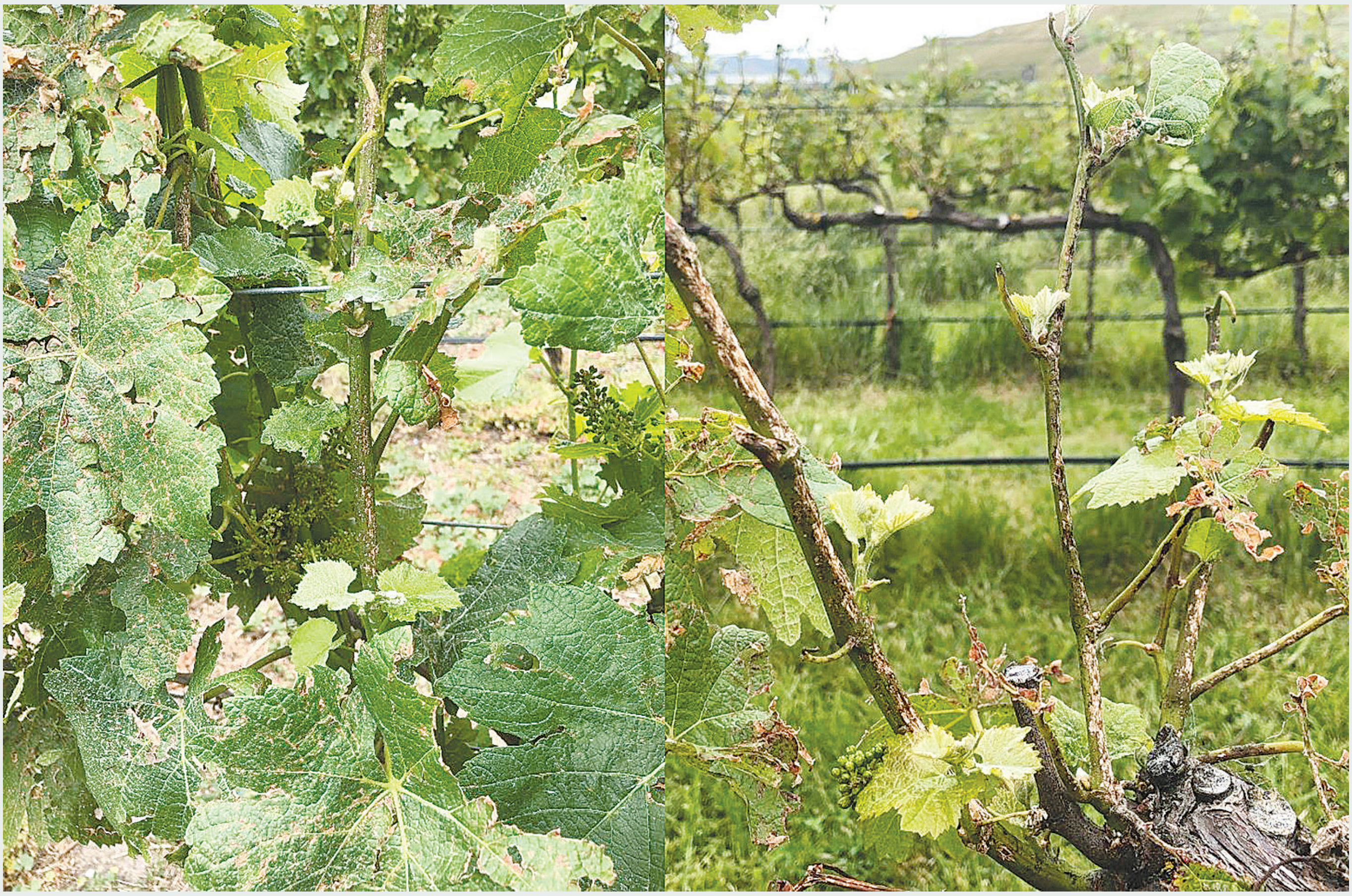

Figure 2: North Canterbury vines after hail in spring 2019. Damage ranged from mild (left) to severe (right) depending on location on hillslope, row density and canopy density

Impact on quality

Hail can reduce wine grape quality in several ways including by causing direct damage to inflorescences or bunches, increasing the risk of secondary pest or disease outbreaks, and by introducing a high level of variability in bunch size and maturity. The extent of the impact on quality will also depend on the timing and intensity of the hail event.

Variability in bunch maturity after early spring hail led to fruit being downgraded in all but one of the monitored vineyards in HB. Late spring hail in NC appeared to have much less of an impact on quality, despite significant damage to shoots and leaves on the southern side of the canopy. In NC, direct crop damage was limited to exposed inflorescences on one side of the canopy and almost no primary shoots were lost. Conditions during flowering and the remainder of the season were conducive to the production of a healthy, ripe and disease-free crop.

Depending on the timing, it may be difficult to assess the potential quality impact immediately after hail. Be prepared to increase the frequency of visits to recovering vines, monitoring for canopy and bunch development, disease, and fruit maturity.

Impact on pruning wood

Spring frost and hail events can negatively impact the availability of pruning wood in the following winter, possibly reducing yield potential for the following season (2,6–12). Negative effects of hail or frost damage on pruning wood availability include a lack of suitably positioned canes in the head or at spur positions, forced selection of less productive lateral or water shoots, physical damage and deformities to canes, and insufficient lignification of shoots.

Following the 2019 HB and NC events, pruning outcomes were better than expected, with shoots damaged by hail in early or late spring hail mostly able to be retained as canes in the following winter and target bud numbers normally achieved. There was no evidence that structural damage to canes led to widespread abnormal or poor shoot growth, and even the most severely damaged canes produced fruitful shoots beyond the zone of damage (Figure 3).

MANAGEMENT RESPONSE

Damage assessment

The initial impression of growers examining a hail damaged vineyard will not always be aligned with the eventual outcomes at harvest and pruning. Therefore, a careful and thorough objective evaluation immediately after hail is important to inform next steps, including a careful assessment of the size and condition of the remaining crop.

Figure 3: Pinot noir shoot severely damaged by hail in spring 2019

While damage to leaves and shoots may appear extreme, grapevines can recover quickly in terms of vegetative growth. To properly evaluate the impact of the event, it is important to carefully assess the number of shoots and bunches remaining, the proportion of shoot tips missing, and potential impact on next year's fruiting wood.

The BRI Hail damage assessment scorecard (available in the nzwinegrowers.com/members research library) creates a detailed record of the type and severity of damage, capturing critical information to inform an initial management response (13). The assessment results also provide a reference point against which to consider future outcomes and evaluate the management response. For the assessment, separate the vineyard into different sampling zones according to the following factors, all of which could influence damage severity and recovery:

- Variety and growth stage
- Row orientation
- Row spacing
- Aspect and slope
- Soil type and vine vigour
- Proximity to shelterbelts or other natural features

Conducting an initial assessment is important but depending on the vine growth stage, the full impact of damage may not be immediately apparent. Regular monitoring of the block during the season will continue to be important, as will close observation during pruning the following winter.

Next steps

Following the damage assessment and prior to any action, growers must consider the economic viability of the remaining crop, vine nutritional requirements, and whether any immediate intervention is required such as removing damaged tissues or fungicide sprays. The initial impact of hail and seasonal outcomes can be very different even between blocks immediately adjacent to each other. In some cases, vines may recover with only minor implications for crop and vine health.

If there is a viable crop, carefully consider whether any inputs that will incur an additional cost will improve profitability. This aspect of post-hail management was discussed in detail during Grape Days.

Viticultural and climate differences such as vine vigour, pruning type, length of growing season, and business factors such as the value of the fruit and the ability to utilize a secondary crop, can all influence what decisions a grower may make in response to hail damage.
Immediate considerations include:

- Is there enough fruit left to justify cropping in the current season or should the vineyard be mothballed for the summer?
- Is any immediate management intervention required?
- Is there a heightened disease risk? Should damaged shoots be removed?
- Are damaged shoots going to be suitable for pruning?
- Has next season's pruning wood been compromised?
- Will there be any need to make changes to irrigation, fertiliser or pesticide programmes?

Shoot removal

The rationale for removing damaged primary shoots after early season frost or hail can be to stimulate the production of secondary shoots, reduce lateral growth, improve the quality of fruiting wood, reduce crop and canopy variability, and reduce the risk of a carryover effect to the next season (2,6,7,12,14). There are only a small number of published studies on this subject and the benefit of shoot removal after frost and hail has not always been clear (6,12,15). There is a risk of unjustified cost and removing viable crop, particularly if a blanket approach is taken to a block where variability exists (6,12,15). Some researchers have commented on the high level of uncertainty associated with pursuing a secondary crop in grapevines due to the variability in fruitfulness and unreliability of fruit set, even in varieties known to have more fruitful secondary shoots (6,15).

The following points summarise key findings relating to shoot removal after the HB hail event in early spring 2019. Shoot removal was not considered to be a viable management option after the late spring event in NC.

- There was no clear benefit to shoot removal in mature Chardonnay vines – shoot removal added cost and there was an insufficient yield or quality advantage
- Shoot removal in mature 2-cane pruned vines did not result in increased buds being retained at pruning or a difference in yield in subsequent season
- Shoot removal resulted in hail affected blocks producing fruit that was less ripe, had less disease and lower juice yeast-available nitrogen compared to vines that did not have shoots removed after hail
- Cutting shoots was more expensive compared to breaking shoots, but cut vines had more yield compared to breaking when shoots were removed immediately after hail. There was no advantage to cutting if shoot removal was delayed by 3-4 weeks after hail
- Shoot removal did not appear to reduce variability associated with canopy architecture or fruit maturity
- If removing shoots, it was better to do it early in spring and immediately after hail. Delaying shoot removal by 3-4 weeks after hail resulted in an increased yield and fruit maturity penalty compared to non-shoot removal vines or vines that had shoots removed immediately after hail.

Perhaps the key lessons from this study relating to shoot removal are that vine capacity, crop expectations and the severity and timing of damage are likely to be very different between blocks and hail events. If a decision is made to intervene and remove shoots, this should be done early to maximise any potential benefit, increasing the potential maturity of the block and avoiding wasting vine reserves by producing lateral and secondary shoots prior to removal.

Pest and disease management

A major challenge for growers managing vines after a hail event relates to the change in vegetative structure after damage. Hail damage can lead to increased lateral growth and a highly variable canopy with shoots of many different growth stages, causing changes in canopy density, variability in crop yield and maturity, and a reduction in pruning wood quality (2,5,9,11).

Normal strategies for wire lifting and leaf removal may not be as effective at maintaining canopy shape or reducing leaf density in the fruiting zone, leading to increased disease risk. The variability in shoot type, bunch development and ripeness that occurs after early season frost or hail events in vineyards may also lead to increased disease risk at harvest. Riper bunches on primary shoots become increasingly susceptible to botrytis, while harvest is delayed waiting for the secondary portion of the crop to ripen adequately (12).

In HB, disease was not reported to be a major issue after hail, helped in part by dry conditions in the approach to harvest, except for one study block where powdery mildew became widespread, reportedly due to challenges managing a highly variable canopy.

In the NC study blocks, growers chose to make no significant change to their management programmes after the hail event. Conditions in the days immediately after hail were warm and dry, meaning disease risk was relatively low. Dry conditions continued for the remainder of the season and, except for some powdery mildew in the upper part of the canopy in localised areas, disease pressure was low.

Nutrition and irrigation

Every situation will warrant a different response by the grower depending on the timing of the event, the extent of damage, vine vigour, and whether the vineyard is being cropped. After an early season event, such as the 2019 HB hailstorm, vines must draw on significant reserves to produce replacement shoots and fruit (2). The capacity of vines to recover will vary depending on vine age, soil type, pruning type and vine size, including the root system, trunk, and cordon.

Arguably, there may be little to no benefit to apply fertiliser immediately after the event, during which time the vine may not be able to access or utilise additional nutrients (2). However, the loss of shoots and leaves early in the season may mean that any remaining primary crop is at risk of poor flowering and fruit set (2,5). Nutrient and water deficiencies could lead to reduced production in the following season due to poor latent bud initiation, carbohydrate reserves not being adequately replenished prior to dormancy or poor-quality pruning wood.

Conversely, there is a risk of over-watering and applying unnecessary fertiliser. An immediate reduction in crop size and vegetative mass due to hail damage may considerably reduce vine demand for water and nutrients (11). Excessive fertiliser or watering may simply promote the production of poor-quality fruiting wood from lateral shoots and undesirable second set. A resulting increase in canopy density could improve conditions for disease and low light conditions may reduce the fruitfulness of latent compound buds affecting the subsequent season's crop (2,8,9).

There are very few published studies examining the effect of fertiliser or water in response to hail or frost damage. In Romania, after a hail event that occurred at a similar growth stage to the HB event, researchers found that while an amino acid based foliar fertiliser improved vine fertility, vine recovery was more influenced by grape cultivar than fertiliser (4).

A complex mix of various foliar fertilisers applied to a heavily frosted vineyard in New Zealand appeared to improve yield, but not enough for the vineyard to reach an economic cropping level (16).

Pruning

In the NC and HB studies, shoots that were damaged by hail in either early or late spring healed, lignified and were able to be wrapped as canes during pruning the next winter with seemingly minimal negative impact on the subsequent season's crop.

A conversion to spur pruning could reduce yield potential in the subsequent season, particularly where the existing cane length may limit the number of spurs and buds that can be retained. For this reason, a conversion to spur pruning should only be considered after hail if canes are so badly damaged, they are unable to be wrapped. This should be assessed on a vine to vine, rather than a whole block, basis.

ACKNOWLEDGEMENTS

This study would not have been possible without the full co-operation, access to vineyards and professional insights of all growers involved in the study. Danielle McMillan (Thoughtful Viticulture) was instrumental in enabling the data collection, monitoring and photography of vines in the Hawke's Bay study sites. The Fruition Horticulture team also supported the harvest of Hawke's Bay trial vines. Several BRI staff also supported the project; Dr Fang Gou for statistical analysis, Dr Darrell Lizamore and Yuichi Ando for the harvest of North Canterbury trial vines.

LITERATURE CITED

1. Ibbotson L. Climate Case Study : Managing hail damaged vineyards (Hawke's Bay and North Canterbury, Spring 2019) [Internet]. 2022. Available from: m/media/22492/nzw-19-109-hail-final-report-v4-final-2jul22.pdf
2. The Australian Wine Research Institute. Managing grapevines after hail damage [Internet]. 2021. Available from: wri.com.au/wp-content/uploads/2014/12/fact-sheet- hail-damage.pdf
3. Bal SK, Saha S, Fand BB, Singh NP, Rane J, Minhas PS. Hailstorms: Causes, Damage and Post- hail Management in Agriculture. Vol. 5, NIASM Technical Bulletin. 2014.
4. Baniță S, Baniță S, Sestraș A, Olteanu I, Călugăr A, Bunea CI. The Influence of Hail and Treatments With Amino-Acids on the Fertility and Biologic Balance of Grapevines. Rom J Hortic. 2020;1(1):111–8.
5. Gourieroux A, Fahey D, Englefield A. Grapevine management guide 2014-15 [Internet]. 2014. Available from: dpi.nsw.gov.au/ data/assets/pdf_file/0004/1158313/Hail- and-severe-storms.pdf
6. Jones JE, Wilson SJ, Lee G, Smith AM. Effect of frost damage and pruning on current crop and return crop of Pinot Noir. New Zealand Journal of Crop and Horticultural Science. 2010;38(3):209–16.
7. Krstic M, Essling M, Singh L. After the hail hits: best-practice recovery. Australian and New Zealand Grapegrower and Winemaker. 2017;(636):26–7.
8. Trought M, Howell G, Cherry N. Practical Considerations for Reducing Frost Damage in Vineyards [Internet]. 1999. Available from: nzwine.com/members/research- library/literature-review-98-001-reducing-frost-damage/
9. Petoumenou D, Biniari K, Xyrafis E, Mavronasios D, Daskalakis I, Palliotti A. Effects of Natural Hail on the Growth , Physiological Characteristics , Yield , and Quality of Vitis vinifera L . Agronomy. 2019;9(197):1–15.
10. Andrew R, Pecchenino D. Frost control in New Zealand vineyards [Internet]. New Zealand Winegrowers. 2015. Available from: nzwine.com/media/3459/frost-control- low-res.pdf
11. Krstic M, Essling M, Singh L. Managing grapevines post hail damage [Internet]. 2015. p. 2–4. Available from: mvwi.com.au/fact-sheet-categories/hail/
12. McArtney S, Chatterton D, Good M. Dealing with Frost : Describing vine response to frost damage and the impact of post-frost management on vine performance. 2003.
13. Bragato Research Institute. Hail damage assessment scorecard. 2022. p. 1–2.
14. Friend AP, Trought M, Stushnoff C, Wells G. Effect of delaying budburst on shoot development and yield of Vitis vinifera L. Chardonnay "Mendoza" after a spring freeze event. Aust J Grape Wine Res. 2011;17:378–82.
15. Kasimatis AN, Kissler JJ. Responses of Grapevines To Shoot Break-Out Following Injury By Spring Frost. Am J Enol Vitic [Internet]. 1974;25(1):17–20. Available from: ajevonline.org/content/25/1/17.article-info
16. Ibbotson L, Ando Y, Gou F. Assessing foliar fertiliser for grapevine frost recovery 2020-2021 Annual Report [Internet]. 2021. Available from nzwine.com/members/research-library/annual-report-20-117-post-frost- fertiliser

PINOT NOIR PROGRAMME

Identification of chemical markers contributing to Pinot noir quality through the integration of consumer sensory perceptions with phenolics and volatile compounds

Dr Rebecca Deed and Dr Lisa Pilkington, University of Auckland

The perception of wine quality by consumers is determined by numerous factors, with aspects that are inherent to the wine, such as appearance, nose, and palate playing a leading role. Such intrinsic cues are determined by the physicochemical composition of the wine itself, with the aroma profile and the concentration of different phenolic compounds being principal factors in determining wine quality.

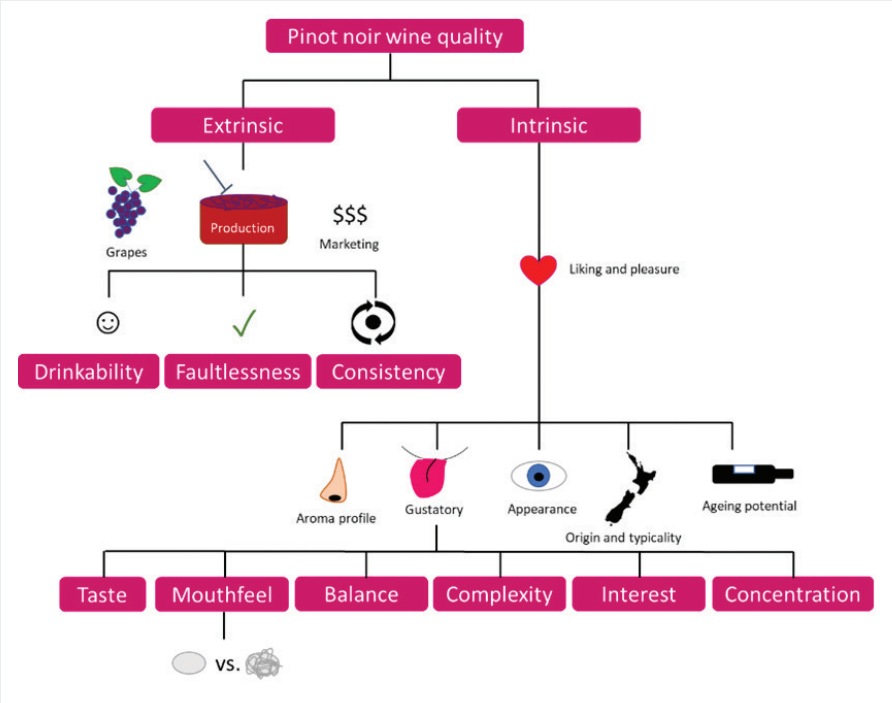

Figure 1. Simplistic depiction of the dimensions of quality in Pinot noir wine.

High-quality Pinot noir wines should have distinctive and ripe aromas of red fruits, floral notes and savoury aromas, with well-integrated tannins providing structure, and balanced acidity providing freshness. Pinot noir wine aroma is a function of multiple volatile aroma compounds working together, with the matrix of the wine influencing the perception of these volatiles.

Even though there are many styles of Pinot noir, the best examples exhibit complexity, harmony and varietal typicity. However, expertise is required in order to evaluate wine varietal typicity, so although this parameter is intertwined with wine quality, consumers tend to rate wine quality in terms of enjoyment, meaning the wines providing the most pleasure (with higher scores for liking) receive higher quality ratings. Figure 1 provides an overview of the dimensions of Pinot noir wine quality.

In this study, we employed univariate and multivariate analyses of consumer sensory data, featuring 150 panellists, with chemical analyses on phenolics and aroma compounds, for two sets (B and C) of Marlborough Pinot noir wines from the 2019 vintage.

The aim was to discover chemical markers contributing to the perception of Pinot noir quality for New Zealand wine consumers. To investigate the effect of vine yield, set B was composed of six research wines generated from the Pinot Noir Programme's vine ideotype study, produced from grapevines with differences in initial yield, plus one commercial barrel sample. To investigate the effect of different phenolics, set C featured six commercial wines, each with different phenolic profiles.

Pearson correlation coefficients between the sensory attributes measured by consumers showed that all were significantly positively correlated to each other ('Colour Liking', 'Aroma Liking', 'Overall Flavour Liking', 'Full-Bodied Flavour', 'Silky Texture', 'Aftertaste Liking', 'Overall Liking', and 'Quality Rating'). 'Colour Liking' had the weakest correlation with the other attributes. This observation agrees with evidence in the scientific literature that consumers rate wine quality based on hedonic aspects of overall liking and pleasure. Comparisons between the wines in each set for the consumer ratings of quality showed that there were no significant differences based on the initial yields for the set B research wines, even though there was a slight trend between higher quality and lower initial yield.

The commercial barrel sample had significantly lower quality than the other wines. Therefore, chemical markers linked to quality in set B would only tentatively be able to determine any chemical links to differences in initial yields. Significant differences in 'Quality Rating' were found within the six set C commercial wines, with higher phenolic profiles correlating with lower quality.

Pearson correlation coefficients between chemical markers in set B and set C identified a subset of compounds that were positively or negatively correlated to 'Quality Rating' by consumers. In addition to this first univariate analysis, using analysis of variance (ANOVA), 'Quality Rating' was also modelled against chemical compounds using the multivariate partial least squares regression (PLSR) analysis. Two statistical techniques were used to ensure that any markers found were conserved when different techniques are employed.

A subset of explanatory variables associated with quality were identified in both statistical analyses. In set B, 'Silky Texture', the phenolics trans-caftaric acid and trans-coutaric acid, and ethyl ester ethyl 2-hydroxy-4-methylpentanoate were positive explanatory variables for 'Quality Rating', while the C6 alcohol 1-hexanol was a negative explanatory variable.

Higher concentrations of trans-caftaric and trans-coutaric acid may indicate the presence of fewer volatile phenol off-odours in higher quality wines, or reduced browning, while ethyl 2-hydroxy-4-methylpentanoate has been associated with imparting a blackberry aroma in red wines. 1-Hexanol may be implicated in the perception of negative green herbaceous aromas in lower quality wines.

Fewer chemical markers were significantly associated with 'Quality Rating' for the set C commercial wines. In set C, 1-hexanol demonstrated a positive association to 'Quality Rating', indicating that the wine matrix and concentration of certain volatiles can influence whether consumers positively or negatively perceive them. 1-Hexanol can impart positive grain or nutty notes, or it can be associated with positive herbaceousness with the inclusion of whole cluster fermentation in higher quality commercial wines. The flavonol kaempferol was identified as a negative explanatory variable for the set C commercial wines in both statistical analyses. Kaempferol is known to have a strong and unpleasant bitter taste. The greater concentration of kaempferol in lower quality wines agrees with the initial choice of these wines for their higher phenolic profiles. Consumers have been shown to associate bitterness and astringency with lower quality red wines. PLSR enabled more relationships to be shown between quality and chemical compounds when the set B and set C datasets were analysed separately, rather than together. Therefore, studies involving research wines should keep in mind that research wines are not always representative of commercial wines, and any chemical markers identified may not be applicable in terms of quality.

Future work could include a larger set of wines to confirm the relationships between chemical markers and quality, as well as studies on experts to determine whether the same chemical markers are linked to quality as for consumers. It would be beneficial to include a greater diversity of chemical compound families, including the volatile sulfur compounds (VSCs), varietal thiols and methoxypyrazines, which also have a role in Pinot noir aroma. Studies investigating synergistic, masking, and additive effects of different volatile and non-volatile compounds (and modelling these relationships), would also be important to investigate in future research. Lastly, studies involving mouthfeel perceptions should include lipids, proteins, and polysaccharides in addition to phenolic compounds, based on the known role of these key chemical components on body and smoothness.

The Pinot Noir Programme is a multi-year partnership between New Zealand Winegrowers and the Ministry for Business, Innovation and Employment that is managed by Bragato Research Institute. The programme aims to grow returns through disassociating quality from yield in New Zealand Pinot noir production.

Viticultural treatments for improving Syrah quality: A summary

Dr Chandré Honeth (Eastern Institute of Technology); Dr Mark Krasnow (Thoughtful Viticulture)

Investigation into the production of Syrah in Hawke's Bay has highlighted specific problems faced by producers in terms of ripening and quality. The cultivar's own physiology forms part of the issue.

Syrah is naturally very vigorous, which contributes to a poor microclimate in the canopy and around the bunches. This in turn increases the disease pressure, making Syrah prone to Botrytis infections. Its propensity for infection forces producers to harvest before the berries are optimally mature. The shaded and dense canopies also negatively affect colour and flavour development in the grape berries. In addition, Syrah has a tendency to ripen to a point and then stall.

To address these problems, it was proposed that either the ripening be sped up or the berry be equipped to better stave off infection. To improve ripening, both a deficit irrigation and root pruning treatment were proposed. Induced stress in the vineyard has been shown to decrease vegetative growth and encourage berry development while improving composition. Additionally, a calcium foliar spray was trialled to increase skin toughness and thereby reduce Botrytis infection.

DEFICIT IRRIGATION

The association between water stress and grapevine growth has been extensively studied in previous years. In general, studies have shown that a moderate amount of stress can contribute positively to berry quality (Chaves et al., 2010 and references therein). Despite these positive results, the role of water stress in berry growth and development is not completely conclusive. Variation in site, cultivar, rootstock, season and experimental design have produced variable results.

Furthermore, Syrah vines are classified as anisohydric, meaning that they do not readily close their stomata on experiencing soil drying (Coupel-Ledru et al., 2014; Schultz, 2003; Soar et al., 2006). This "optimistic" strategy means that Syrah vines maintain a high level of photosynthetic activity (and water loss) even under relatively dry soil conditions. The ABA-induced stress response which triggers a closure of stomata will only occur once the plant starts experiencing more severe water shortages. This makes deficit irrigation management

Figure 1. Pressure bomb measurements were done in the vineyard to assess irrigation timing

Block	Rootstock	Clone	Planted	Soil type	Soil characteristics
TA 2020	3309	470	2002	Sandy loam on gravel	Moderately well-drained Moderate to low soil moisture
TA 2021	Schwarzman	470	2013	Sandy loam on gravel	Moderately well-drained Moderate to low soil moisture

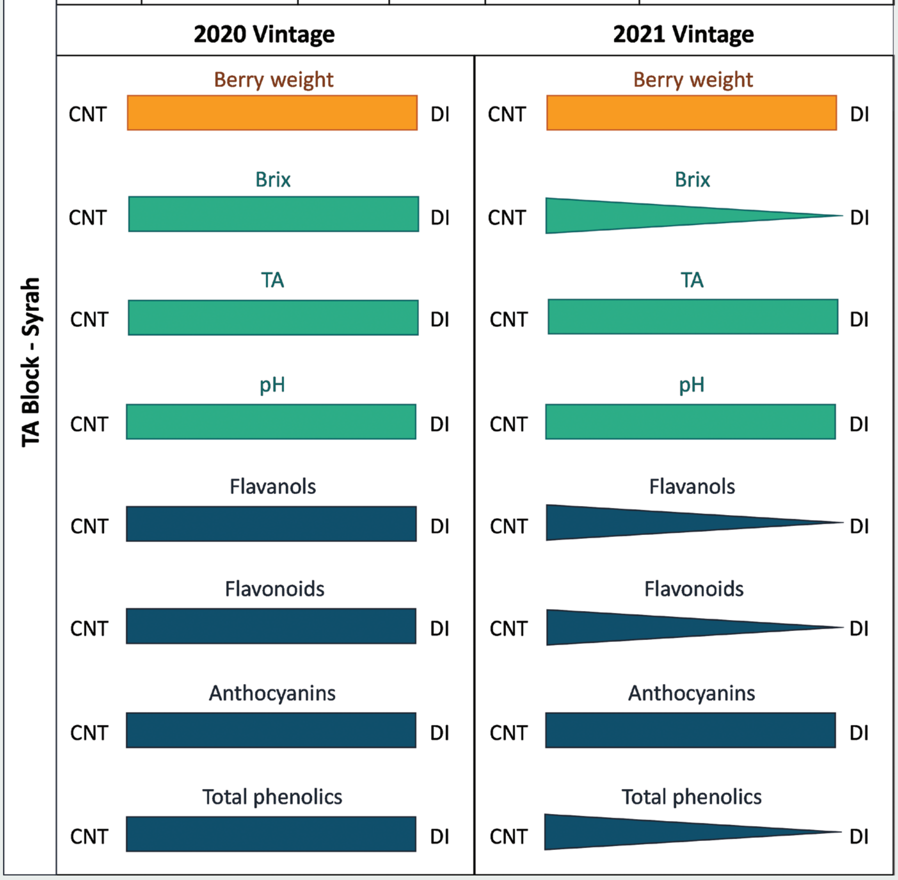

Figure 2. A summary of the analytical data from berries sampled in the TA block over the 2020 and 2021 vintages. The arrows indicate an increase or decrease, while the rectangles indicate no difference. The TA 2020 block was pulled out prior to the second vintage and a second block nearby was found, namely the TA 2021 block.

more challenging as a fine line exists between moderate stress, which elicits positive fruit attributes, and severe stress, which leads to defoliation and a reduction in photosynthesis.

To investigate the viability of manipulating vine water stress as a tool to improve Syrah quality in Hawke's Bay, controlled deficit irrigation in two vineyards was trialled over two vintages. Both vineyards were set up as a split plot, with different irrigation regimes applied to each half separately. One regime was the grower's standard irrigation regime, informed by soil probes. The other half of the vineyard was not irrigated until the average stem water potential (SWP) reached a specific target. The target in the 2020 vintage was -1.6 MPa and the target in the 2021 vintage was -1.3 MPa. In each vineyard half, six sampling locations were used for SWP measurements, yield assessments and berry composition analysis.

In the first vintage, a controlled deficit irrigation was shown to elicit changes in Syrah berries, however the blocks (IS & TA) responded differently to the treatment. The TA block did not respond significantly to the deficit irrigation (Figure 2), while the IS block showed what can be taken as a negative response. The increase in water stress led to a decrease in berry weight, a reduction in the accumulation of soluble solids during ripening, a lower final sugar content at harvest, and a decrease in certain phenolic compounds (Figure 3). This indicated a severe stress response, and the target stem water potential (SWP) measurement was therefore decreased from -1.6 MPa to -1.3 MPa in the second vintage.
The following vintage displayed different results. In the TA block, the deficit irrigation did not elicit any significant changes in average berry weight, titratable acidity or pH. A higher Brix level was however measured in the control berries (average difference of 1.17°B). Furthermore, most of the phenolic compounds measured were reduced in the treatment plots, including the flavanols, flavonoids and total phenolics. The anthocyanins remained unaffected (Figure 2).

> "Despite its success as a method of improving berry composition, there is a risk associated with using deficit irrigation in Syrah vineyards and relying on one output from a single tool to inform decisions on when to irrigate."

In the IS block, it was observed that sugar concentration was not affected by the deficit irrigation, however the acids were significantly higher in the deficit irrigation plots resulting in a higher titratable acidity (average difference of 0.64g/L) and lower pH (average difference of 0.06) at harvest. All of the measured phenolic compounds were also significantly increased with a deficit irrigation treatment (Figure 3).
The variability in results is quite telling in that it highlights not only the intricacies involved with conducting this type of trial on different soil types, but also emphasises the challenges of

working with certain cultivars in different environments. Imposing a water stress during berry ripening has become a routine strategy for the modulation of grape berry composition and wine characteristics, however responses of Syrah to deficit irrigation have been variable. Despite its success as a method of improving berry composition, there is a risk associated with using deficit irrigation in Syrah vineyards and relying on one output from a single tool to inform decisions on when to irrigate. This deficit irrigation trial highlighted the difficulty in assessing the appropriate stress point for anisohydric cultivars, but also provided further insights into using deficit irrigation as a tool for improving quality parameters in Syrah in Hawke's Bay.

A further point of interest which has been highlighted by this trial is the potential impact of the rootstock. Different rootstocks are known to impart various characteristics on the scion including a tolerance to drought (Serra, Strever, Myburgh, & Deloire, 2014). Further investigation into how different rootstocks may be utilised in conjunction with water deficit would provide added insights into their potential use and impacts on grapevine physiology and berry development.

Rootstock	Clone	Planted	Soil type	Soil characteristics
Riparia Gloire	470	2006	Ashy sandy loam on gravel	Moderately well-drained Moderate to low soil moisture

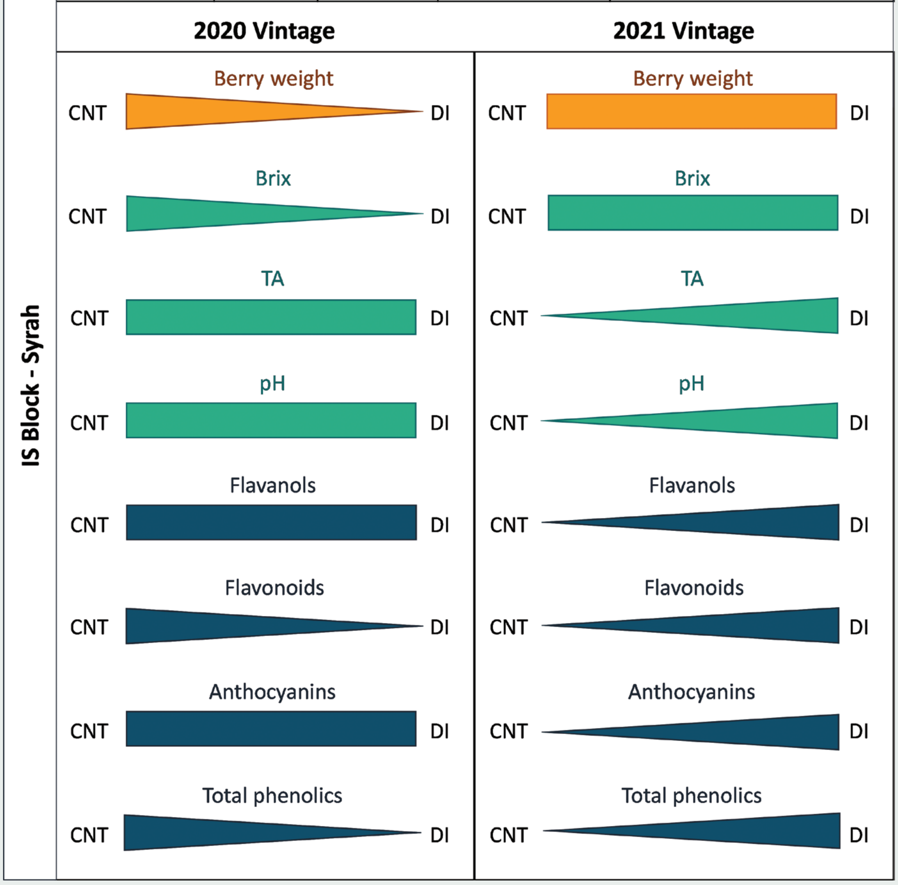

Figure 3. A summary of the analytical data from berries sampled in the IS block over the 2020 and 2021 vintages. The arrows indicate an increase or decrease, while the rectangles indicate no difference.

ROOT PRUNING AS A TOOL TO IMPROVE SYRAH QUALITY

Root pruning has been used as a tool to limit vine growth, reduce vigour and thereby improve the bunch microclimate. This practice carried out at budburst aims to limit growth through reducing the available resources for new shoot growth (Winkler, 1965) as well as by reducing the effective surface area for absorption of water and nutrients (Dry & Loveys, 1998).

The success of root pruning however has been shown to be variable based on time of pruning, the biomass of roots removed (Geisler & Ferree, 1984), soil type and grapevine morphology (Centinari, Vanden Heuvel, Goebel, Smith, & Bauerle, 2016; Giese, Velasco-Cruz, Roberts, Heitman, & Wolf, 2014)

To investigate the use of root pruning as a tool to improve Syrah quality in Hawke's Bay, root pruning down to at least 500 mm was performed prior to budburst in four rows on both sides of the vine in two Syrah blocks.

Shoot growth and vine vigour were measured from budburst through to the first trim to assess the impacts of root pruning on vine growth.

At harvest, berry samples were analysed for Brix, TA, pH and phenolic compound composition to determine whether root pruning elicited any changes in berry composition. On observation of the data, it was apparent that both blocks did not show any significant response to the root pruning treatment. Although this technique has been shown to reduce vine growth rate (Giese, Wolf, Velasco-Cruz, Roberts, & Heitman, 2015), there is little consensus on the effectiveness of root pruning as a tool to limit grapevine vigour and improve berry and wine quality. It seems that it is a technique to be assessed on a case-by-case basis as it is dependent on a multitude of factors.

CALCIUM BUNCH SPRAYS AS A TOOL TO IMPROVE BERRY RESISTANCE TO FUNGAL INFECTION.

Calcium is an important mineral nutrient for the integrity of plant tissues, particularly those of the epidermis, which form a barrier protecting the plant cell from invading pathogens. Calcium ions form the cross-links between

Figure 4. Root pruning being applied on either side of the treatment vines.

pectins in the plant cell wall, thereby reinforcing their structure and increasing skin toughness consequently reducing the fruit's susceptibility to bunch rots (Decreux & Messiaen, 2005; Hocking, Tyerman, Burton, & Gilliham, 2016; Martins, Billet, Garcia, Lanoue, & Gerós, 2020). Calcium sprays can therefore potentially be used as a tool to allow extended hang-time of Syrah grapes, thereby allowing for full flavour development.

To investigate its efficacy in Hawke's Bay Syrah vineyards, select rows in four individual blocks were sprayed with calcium chloride (Stopit) at 5 L/ha two weeks after véraison and twice more at approximately two week intervals. The berries were sampled at harvest and analysed for Brix, TA, pH and phenolic compound composition. A rot assessment was also done and the berry skin toughness assessed.

The results from this study indicated that a bunch-line calcium spray applied during ripening increased the skin toughness of the Syrah grape berries without significantly affecting berry composition (Figure 6).

Figure 5. Root pruning in the vineyard

Similar results were reported by Martins et al. (2018 & 2020) who proposed a number of different hypotheses including a greater deposition of pectin-like material in the cell wall of the berry skins, a greater aggregation of hydrated Ca-linked gel structures and a consequent increase in cell wall stiffness and a downregulation of the genes responsible for the loosening and expansion of plant cell walls.

The application of calcium did not however result in a difference in botrytis incidence, although the disease pressure was very low due to the hot dry weather in both years of the study.

The application of a bunch-line calcium spray certainly showed some promise in improving berry skin toughness. Future work could include a fine-tuning of timing of application to ascertain when the most benefit will be gained.

To read the full report go to nzwine.com/syrah-quality-2021

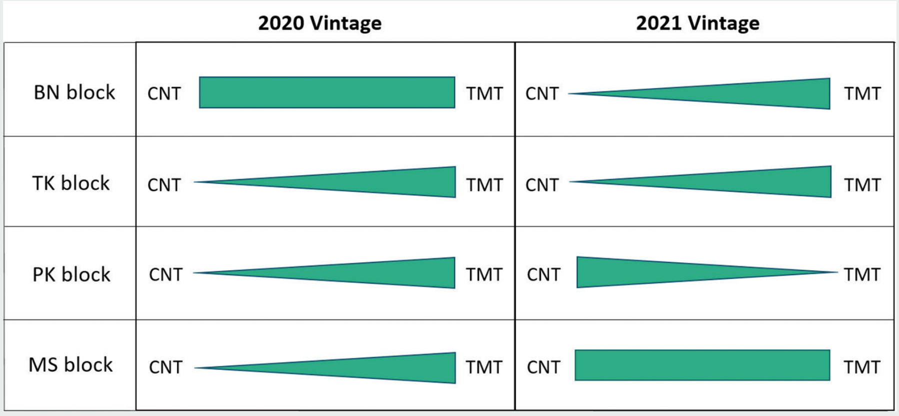

Figure 6. A summary of the skin toughness of berries sampled from the four experimental blocks over the 2020 and 2021 vintages. The arrows indicate an increase or decrease, while the rectangles indicate no difference.

REFERENCES

Centinari, M., Vanden Heuvel, J. E., Goebel, M., Smith, M. S., & Bauerle, T. L. (2016). Root-zone management practices impact above and belowground growth in Cabernet Franc grapevines. Australian Journal of Grape and Wine Research, 22(1), 137–148. https://doi.org/10.1111/ajgw.12162

Chaves, M. M., Zarrouk, O., Francisco, R., Costa, J. M., Santos, T., Regalado, A. P., … Lopes, C. M. (2010). Grapevine under deficit irrigation: hints from physiological and molecular data. Annals of Botany, Vol. 105, pp. 661–676. https://doi.org/10.1093/aob/mcq030

Coupel-Ledru, A., Lebon, É., Christophe, A., Doligez, A., Cabrera-Bosquet, L., Péchier, P., … Simonneau, T. (2014). Genetic variation in a grapevine progeny (Vitis vinifera L. cvs Grenache×Syrah) reveals inconsistencies between maintenance of daytime leaf water potential and response of transpiration rate under drought. Journal of Experimental Botany, 65(21), 6205–6218. https://doi.org/10.1093/jxb/eru228

Decreux, A., & Messiaen, J. (2005). Wall-associated Kinase WAK1 Interacts with Cell Wall Pectins in a Calcium-induced Conformation. Plant and Cell Physiology, 46(2), 268–278. https://doi.org/10.1093/pcp/pci026

Dry, P. R., & Loveys, B. R. (1998). Factors influencing grapevine vigour and the potential for control with partial rootzone drying. Australian Journal of Grape and Wine Research, 4(3), 140–148. https://doi.org/10.1111/j.1755-0238.1998.tb00143.x

Geisler, D., & Ferree, D. (1984). The influence of root pruning on water relations, net photosynthesis, and growth of young Golden Delicious apple trees. Journal of the American Society for Horticultural Science, 109(6), 827–831. Retrieved from https://agris.fao.org/agris-search/search.do?recordID=US19850058657

Giese, G., Velasco-Cruz, C., Roberts, L., Heitman, J., & Wolf, T. K. (2014). Complete vineyard floor cover crops favorably limit grapevine vegetative growth. Scientia Horticulturae, 170, 256–266. https://doi.org/10.1016/j.scienta.2014.03.011

Giese, G., Wolf, T. K., Velasco-Cruz, C., Roberts, L., & Heitman, J. (2015). Cover crop and root pruning impacts on vegetative growth, crop yield components, and grape composition of cabernet sauvignon. American Journal of Enology and Viticulture, 66(2), 212–226. https://doi.org/10.5344/ajev.2014.14100

Hocking, B., Tyerman, S. D., Burton, R. A., & Gilliham, M. (2016, April 29). Fruit calcium: Transport and physiology. Frontiers in Plant Science, Vol. 7. https://doi.org/10.3389/fpls.2016.00569

Martins, V., Garcia, A., Costa, C., Sottomayor, M., & Gerós, H. (2018). Calcium-and hormone-driven regulation of secondary metabolism and cell wall enzymes in grape berry cells. Journal of plant physiology, 231, 57 - 67. doi.org/10.1016/j.jplph.2018.08.011

Schultz, H. R. (2003). Differences in hydraulic architecture account for near-isohydric and anisohydric behaviour of two field-grown Vitis vinifera L. cultivars during drought. Plant, Cell and Environment, 26(8), 1393–1405. https://doi.org/10.1046/j.1365-3040.2003.01064.x

Serra, I., Strever, A., Myburgh, P. A., & Deloire, A. (2014). Review: the interaction between rootstocks and cultivars (Vitis vinifera L.) to enhance drought tolerance in grapevine. Australian Journal of Grape and Wine Research, 20(1), 1–14. https://doi.org/10.1111/AJGW.12054

Soar, C. J., Speirs, J., Maffei, S. M., Penrose, A. B., McCarthy, M. G., & Loveys, B. R. (2006). Grape vine varieties Shiraz and Grenache differ in their stomatal response to VPD: Apparent links with ABA physiology and gene expression in leaf tissue. Australian Journal of Grape and Wine Research, 12(1), 2–12. https://doi.org/10.1111/j.1755-0238.2006.tb00038.x

Winkler, A. J. (1965). General Viticulture (Revised). Retrieved from https://books.google.co.nz/books?hl=en&lr=&id=TjkclVCbrYC&oi=fnd&pg=PA1&ots=Pkk4EBzOO0&sig=N15eknpucWimk71RrTruhMtuNhE&redir_esc=y#v=onepage&q&f=false