Escarpment

Research Supplement

A regular feature to inform and update the wine industry on research projects being undertaken for their benefit. Newly approved projects when available are briefly summarised. Ongoing projects have longer articles that describe progress and what has been achieved so far. When completed, each project report will be shared in full detail in the Research Library on nzwine.com.

Current research projects

Bragato Research Institute conducts research in-house or collaborates with research organisations throughout New Zealand. The main research providers for each project are listed.

Viticulture

Pinot Noir Programme
University of Auckland, Plant & Food Research, Lincoln University

Improving remedial surgery practices to increase vineyard longevity
Linnaeus, SARDI

Long spur pruning as an alternative to cane pruning for Sauvignon blanc
Bragato Research Institute

Weevils in New Zealand vineyards
Bragato Research Institute

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

Evaluating water use efficiency and drought tolerance of various rootstocks grafted to Sauvignon blanc
Bragato Research Institute

Grapevine Improvement

Sauvignon Blanc Grapevine Improvement Programme
Bragato Research Institute, Plant & Food Research, Lincoln University

National Vine Collection virus eradication
Bragato Research Institute

Tuned Vines
Bragato Research Institute

Wine Science

Prevention of quercetin instability in bottled wine
Indevin

The effect of winemaking decisions on polysaccharide content in wine
University of Auckland

The importance of green: understanding 'green' and 'herbaceous' characters in Pinot noir wine and their role in driving judgements of perceived quality
Lincoln University

Exploring reductive aromas in Pinot noir
University of Auckland

Precipitation of calcium tartrate and other compounds in wine
University of Canterbury

Potential applications of nanotechnology for wine growing in New Zealand
University of Auckland

Winealyse Lab on a Chip
University of Canterbury

Sustainability

Microbial responses to under vine treatment
Bragato Research Institute, AERU, Lincoln University

Shared vision for land use in Marlborough
Bragato Research Institute, Meihama, AgResearch, Tipuake systems, Market Economics

Regenerating Vineyard Soils - Phase One
Bragato Research Institute

Development of an anaerobic chain-elongation bioprocess for grape marc valorisation
University of Auckland

Evaluating ecologically sustainable ways to disrupt the wētā-vine association
Plant & Food Research

Bud sports spontaneously occur in vineyards but are usually lost at pruning

PINOT NOIR PROGRAMME

Does bunch or berry size matter?

Martin D, Holland M, Oliver R, Birch S, Schaare P. (Plant & Food Research)

The purpose of this research aim was to positively influence Pinot noir wine composition through grading and sorting of bunches. Along the way, we found that the size of the berries was more critical to final wine composition and we developed prototype in-winery methods to non-destructively assess the quality potential of a grape crop.

Pinot noir berry size and colour affect wine quality

Pinot noir grape size and colour are important to winemakers because large berries with insipid colour do not make good wine. Results from the "Ideal Vine" part of the Pinot Noir Programme have shown that wine composition depends on grape berry size, as larger berries (above 1.2 g) have both poor skin colour and low skin:juice ratios that result in lower value wines.

In three recent research projects, scientists at The New Zealand Institute for Plant & Food Research Limited (PFR) have made encouraging progress in accurate real-time measurement of both berry size and colour in Pinot noir grape berries. The prototype hardware and software they developed have been made available to the Bragato Research Winery to develop further in upcoming vintages.

Bunch size sorting

The industry perception of smaller bunches as better quality for winemaking had never been tested, so we first looked at that assumption. Early results indicated that >70% of the crop would have to be moved into an alternative, probably less valuable, product stream for a winemaker to benefit from the wine compositional gains achieved in the remaining minor bunch fraction. The wide distribution of bunch sizes encountered between

the 2018 and 2019 seasons also made this bunch sorting too challenging. So our approach changed, away from bunch sorting and towards individual berry quality grading instead. This change also responded to the establishment of the Bragato Research Winery and its state-of-the-art bunch destemming equipment.

Berry size imaging

Knowing that berries no bigger than about 1.2 g are optimal, we sought to provide winemakers with better grading techniques, specifically berry quality grading. Ideally, this grading should be fast, non-destructive, done in real-time, and be as early as possible in the processing stage to assist with forecasting wine quality prior to key fruit batching/streaming decisions.

> The industry perception of smaller bunches as better quality for winemaking had never been tested, so we first looked at that assumption.

Destemmed individual Pinot noir grape berries were imaged using an industrial camera and lens suitable for real-time control from an attached PC. Custom software recorded all berries passing along a conveyor, classified them as damaged or undamaged, recorded their estimated weights, and allowed operators to capture and display relevant statistics for individual runs of the conveyor in real time. (See image 1)

With fruit passing under the imaging set-up at rates of between 2 and 3 T/hour, it was possible to make accurate real-time measurements of berry size of multiple and varied Pinot noir crops while concurrently identifying the proportion of the crop that was above the optimal 1.2 g berry size.

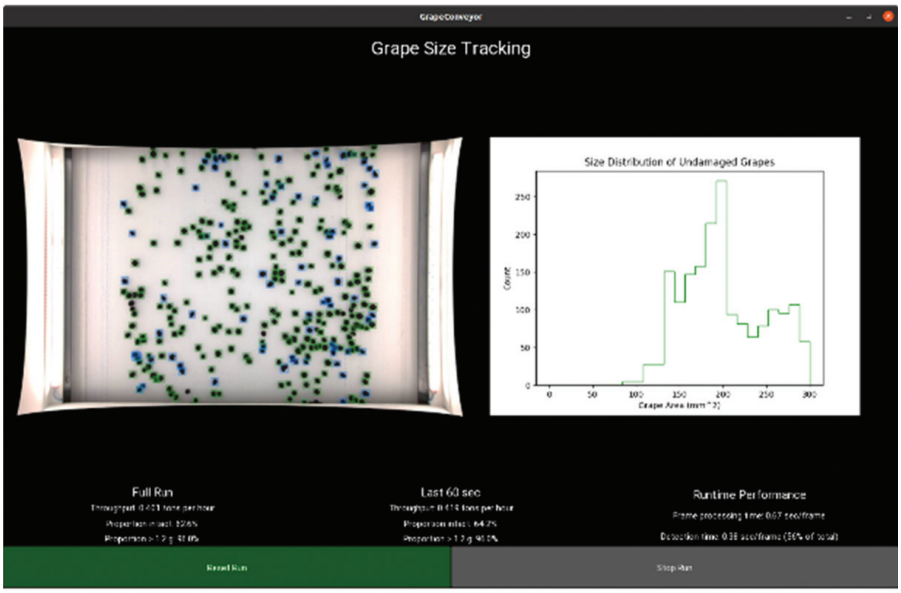

Image 1. Screenshot showing the software interface developed to scan individual Pinot noir grape berries to assess their size and display real-time statistics

Rapid berry colour measurement

Pinot noir berry colour is a concern for New Zealand's wine industry because colour hue and density at the berry stage are correlated to the concentrations of phenolic compounds in the resulting wine, especially anthocyanins; these compounds are critical for a bright and stable red colour as the wines age.

Using a vertically aligned laser underneath a mini-conveyor belt, single grapes were illuminated from beneath. A first light detector directly in line with the laser detected the presence of a grape when it interrupted the laser beam and a second detector at an angle of approximately 30° from the laser beam detected light transmitted through the grape (See image 2).

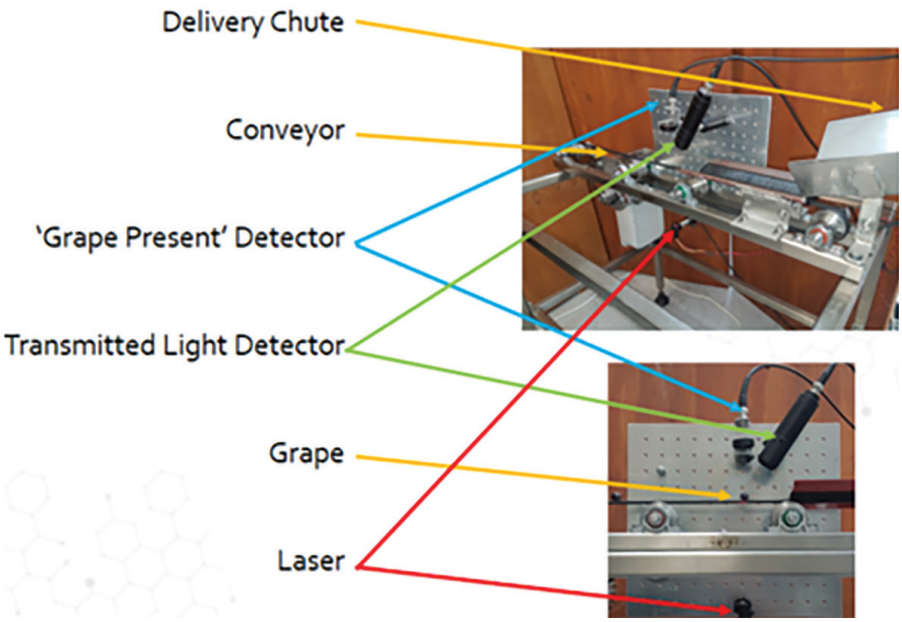

Image 2. Laser-scanning apparatus used to measure the colour of individual Pinot noir grape berries

PFR scientists also successfully developed a modified Australian Wine Research Institute (AWRI) grape berry phenolic analysis method that is both faster and more accurate than previous methods. In collaboration with Marama Labs using their CloudSpec™ spectrophotometer during the 2021 and 2022 vintages,

Pinot noir berry colour is a concern for New Zealand's wine industry.

PFR found that the CloudSpec instrument performed well in rapid colour measurement of grape berries. Using this method, a prediction of wine colouration as well as the potential for oxidative browning of the wines can be made as early as the berry stage from the resulting laser absorbance measurements.

This successful pilot study shortcuts the centrifugation, acidification and sample dilution steps of the reference AWRI method, thereby providing winemakers with a useful early decision-support tool that uses non-destructive, real-time and speedy measuring of grapes as they arrive at the winery. This will inform downstream harvesting, winemaking and blending decisions, to optimise wine quality potential. In summary, significant progress has been made towards finding in-winery solutions to identify and compensate for larger berried and/or poorer coloured Pinot noir grapes that are most detrimental to wine quality potential. ⬢

About the programme:

The Pinot Noir Programme was a multi-year partnership between New Zealand Winegrowers and the Ministry for Business, Innovation and Employment that was managed by the Bragato Research Institute. The research programme ended in September 2022, aiming to grow returns through disassociating quality from yield in New Zealand Pinot noir production. This article concludes the findings of research aims relating to Bunch Sorting (4.1) carried out by Plant & Food Research. For more information about the programme and these research aims, including full reports and methods used, please visit the research library in the members' section of nzwine.com.

PINOT NOIR PROGRAMME

Field Trials: Results from alternating bud load trials

Martin D, Grose C, Theobald J, Neal S, Stuart L, Yang L, Yvon M, McLachlan A (Plant & Food Research)

In the previous edition of New Zealand Winegrower Magazine we presented Pinot Noir Programme results from five years of study across the Ideal Vine network. Within the three study regions (Wairarapa, Marlborough and Central Otago) 13% of the vine x season combinations simultaneously achieved yield and quality metrics. Another key observation from the study was that only 52 vines out of 994 vines (5%)

in the overall vine x season dataset produced yields at more than 2.0 kg/m and berries that were less than 1.2 g mean weight. Of those vines, only four plants produced this 'Ideal' combination in more than one year, and no vines met the target more than two years out of five. This result strongly suggests that environment and management factors that promote higher berry numbers (i.e., more and larger bunches) also force vine performance towards the production of larger berries.

To break the yield-quality see-saw by growing vines with high numbers of smaller berries will require some disruption to current Pinot noir growing systems and/or the development of novel clones.

To break the yield-quality see-saw by growing vines with high numbers of smaller berries will require some disruption to current Pinot noir growing systems and/or the development of novel clones. In particular, high berry numbers (greater numbers of, and more differentiated primordia) are a function of the vigour of the previous season's shoot that is retained at winter pruning, and are thus a priori dependent on the bud load, and the water and the nitrogen (N) supplied to the vine in the previous season. Conversely, to produce smaller berries (when flowering conditions are favourable), a growing system should look to limit shoot vigour, water and N supply in the current season — a switch of vine equilibrium that is very difficult to introduce within a season, and one that is not compatible with producing high berry numbers in the subsequent (third) year.

This conundrum is what the "Alternating Bud Load" experimental work undertaken in two of Marlborough's Brancott Valley vineyards in the 2021 and 2022 seasons was trying to resolve (i.e. to grow vines with high numbers of smaller berries). In essence, the trial attempted to greatly increase the vigour and fertility of the canes grown in the Low Bud Load (Short) first year, so that then in the High Bud Load (Long) second year, the shoots that grew from the retained (high vigour) canes could have much lower vigour allied with mild water and N deficits to restrict berry growth. The vine could then be then severely pruned back to the Short mode in year three, in preparation for Long mode in year four and so forth (Figure 1).

In the vineyard and consistently for both seasons, the high bud/crop load (Long) pruning treatment generated lower shoot vigour than the conventional bud/crop load (Control). From early to mid-season, shoot length in Long treatment vines was always lower than in Control vines in both seasons. In the 2020/21 season, vines of both treatments appeared to have sufficient availability of nitrogen (N) up to flowering, but then the N pool available was allocated amongst more shoots in Long treatment vines, relative to Control. This was confirmed by several different physiological approaches for determining leaf N, chlorophyll and whole canopy 'greenness', with values lowest in Long treatment vines compared with the Control. In contrast in season 2021/22 (after the previous season's higher-yielding Long pruned vines had been alternated), the physiological patterns of response were reversed: Long pruned treatment leaves contained significantly more N and chlorophyll, and had the greenest canopies. The higher shoot numbers in the Long treatment were competing for a limited pool of the vine's stored carbon and N in the spring. Interestingly across treatments and seasons, the date of véraison did not appear to be sensitive to vigour, resource allocation or yield. The 33% higher bud load reduced the pruning weight per shoot by an average of 37%, while the trial was designed to have a relatively constant shoot density of 17 shoots/m for both treatments, resulting in a less dense canopy in the Long treatment.

Pruning treatments had a significant influence on the yield component parameters in both 2021 and 2022 (Table 1). However, difficult spring conditions (frost events and cool flowering) at both sites in the spring of the 2020/21 season resulted in low yields. Yields in 2022 were normal at Vineyard A but were again well below

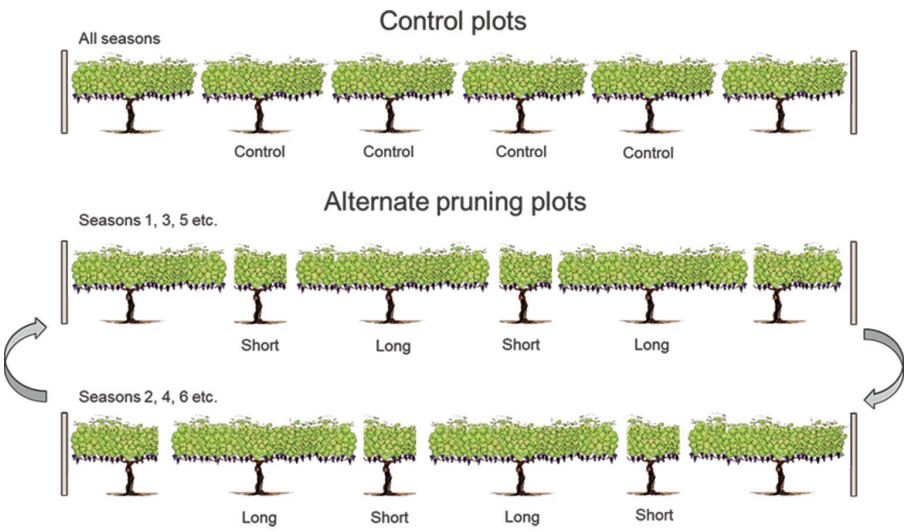

Figure 1. Schema of Control (conventional bud load) and alternate Short (low bud load) and Long (high bud load) cane pruning plots on the same individual grape vines from season to season. Graphic credit J. Theobald, The New Zealand Institute for Plant and Food Research Ltd

	2021				2022			
	Vineyard A		Vineyard B		Vineyard A		Vineyard B	
Vine variables	Control	Long	Control	Long	Control	Long	Control	Long
Bunch count/vine	38.3	51.5	23.4	38.5	29.8	45.6	15.1	24.8
Yield/vine (kg)	1.88	2.76	0.74	1.37	3.00	4.27	1.24	2.25
Average bunch weight (g)	49	54	31	35	101	94	82	89
Average berry weight (g)	0.95	0.98	0.76	0.72	1.24	1.19	1.51	1.55
Bunch count/shoot	2.0	2.1	1.4	1.5	1.5	1.5	0.9	0.9
Yield/shoot (g)	100.0	111.0	42.0	52.0	153.0	144.0	69.0	85.0
Pruning weight/shoot (g)	35	29	55	40	45	29	66	48

Table 1. Effects of Control and Long cane treatments on yield and yield components in Pinot noir vines

	2021				2022			
	Vineyard A		Vineyard B		Vineyard A		Vineyard B	
Juice variables	Control	Long	Control	Long	Control	Long	Control	Long
Total soluble solids (°Brix)	21.7	21.5	25.2	25.4	21.8	21.5	20.8	21.0
Acidity (pH)	3.51	3.49	3.65	3.69	3.52	3.49	3.53	3.54
Titratable acidity (g/L)	5.3	5.5	4.9	4.8	6.0	5.9	6.3	6.3
Ammonium (mg N/L)	58	63	103	100	56	47	86	86
Primary amino acids (mg N/L	133	130	238	239	208	189	240	247
YAN (mg N/L)	190	193	342	339	264	236	326	334
Tartaric acid (g/L)	4.2	4.5	4.0	3.8	4.5	4.7	4.2	4.0
Malic acid (g/L)	2.5	2.4	2.6	2.6	3.5	3.4	3.8	4.0
Potassium (mg/L)	1,190	1,180	1,680	1,490	1,634	1,580	1,490	1,610

Table 2. Effects of Control and Long cane treatments on Pinot noir juice composition

	2021				2022			
	Vineyard A		Vineyard B		Vineyard A		Vineyard B	
Wine variables	Control	Long	Control	Long	Control	Long	Control	Long
Marc:Wine ratio	0.22	0.22	0.30	0.29	0.24	0.25	0.20	0.19
Alcohol content (v/v%)	12.9	12.8	15.5	15.6	12.7	12.7	12.0	12.2
Acidity (pH)	3.73	3.68	3.63	3.63	3.75	3.72	3.69	3.72
Titratable acidity (g/L)	4.9	5.0	5.2	5.3	5.2	5.1	5.2	5.1
Tannins (mg/L E)	1,530	1,470	1,540	1,600	471	558	400	370
Monomeric anthocyanins (m	580	570	819	801	262	256	250	240
Total anthocyanins (mg/L)	794	777	1,150	1,150	373	360	358	349
Colour density (AU)	7.5	7.1	14.2	15.0	3.9	3.8	3.5	3.5
Hue	0.60	0.60	0.65	0.64	0.76	0.78	0.71	0.72
SO_2-resistant pigments (AU)	0.46	0.46	1.13	1.18	0.31	0.32	0.25	0.25
Total phenolics	2,150	2,310	2,810	2,960	1,280	1,320	1,160	1,120

Table 3. Effects of Control and Long cane treatments on Pinot noir wine composition

expected at Vineyard B. There were proportionally higher bunch numbers per vine and higher vine yield for the Long pruning than for the Control. At both vineyards and in both seasons, there was no significant treatment effect on average berry weight at harvest between the Long and Control vine treatments. There were, however, repeated treatment effects on average bunch weight (except for Vineyard A in 2022), a yield component which is typically hard to positively influence when increasing bud numbers in pruning trials. Overall, Long mode did not promote an increase in berry size but resulted in vines that carried higher yields comprised of more berries per shoot within a lower vigour canopy.

At both sites and in both years, Control and Long pruning treatments had no major effects on pre-fermentation juice composition, with the exception of ammonium and Yeast Available Nitrogen (YAN) at Vineyard A in 2022 Pruning treatments had no major effects on wine composition at either vineyard or in either year, with the exception of higher tannins content in wines made from the Long pruning treatment than in wines made from the Control in 2022 (Table 3).

Pruning treatments (Control, Long) applied in two vineyards for both the 2021 and 2022 growing seasons had a significant influence on the yield component parameters for the grapes used for winemaking. Overall, grape juice and wine composition from the Long (high bud load) pruning treatment were largely indistinguishable from those of the Control treatment, despite yields that were 40% to 80% higher per vine. The potential for vines to carry higher yields with similar bunch weights and no increase in average berry weight, with little or no influence on juice and finished wine composition, is an important step towards increasing Pinot noir productivity while maintaining wine quality. ⬢

Acknowledgement

The authors would like to thank the participating wine companies for providing the study vineyards and grape samples. This type of research is made possible by the intellectual contributions and passion of winemakers and viticulturists. For more information about the programme and these research aims, including full reports and methods used, please visit the research library in the members' section of nzwine.com.

About the programme:

The Pinot Noir Programme was a multi-year partnership between New Zealand Winegrowers and the Ministry for Business, Innovation and Employment that was managed by Bragato Research Institute and conducted by Plant & Food Research. The research programme ended in September 2022, aiming to grow returns through disassociating quality from yield in New Zealand Pinot noir production. This article concludes the findings of alternating bud load studies within Research aim 4.2 – Validation Wines.

A remediated Sauvignon Blanc vine three years after remedial surgery

Management of grapevine trunk disease using remedial surgery

Eline van Zijll de Jong (Linnaeus Ltd) and Mark Sosnowski (South Australian Research and Development Institute)

Grower reliance on remedial surgery to improve vine productivity and longevity is expected to increase as New Zealand's vineyards continue to decline due to grapevine trunk diseases Botryosphaeria (BD) and Eutypa (ED) dieback.

These diseases are typically caused by spores that infect vines through pruning wounds. The fungi as they move down the trunk, destroy the woody tissue, disrupting the movement of water and nutrients. This leads to stunted shoot growth and death, decreased fruit yield and quality, and eventual vine death.

Internal trunk staining and necrosis can be widespread by the time external dieback symptoms are visible.

Remedial surgery is being used to manage trunk disease in the absence of any curative treatments. This practice seeks to "renew" and extend the life of infected vines by removing the diseased trunk above the graft union and growing a new shoot to replace the old trunk. Because the established root system is retained, remediation is usually more cost-effective for growers than replacement. Efficacy is dependent on the removal of infected wood and recovery of watershoots.

A current project from the Vineyard Ecosystems Programme is developing best practice guidance for managing trunk disease using remedial surgery. Grower practices are being improved based on new findings on the progression of disease and distribution of pathogens, and the recovery, health and productivity of vines following remedial surgery.

About the trials

Three trials were established in 2019, in mature commercial vineyard blocks

that ranged from 18-21 years of age. One trial occurs in an organic block of Sauvignon Blanc in Marlborough, and the other two in conventional Cabernet Sauvignon and Merlot blocks in Hawke's Bay.

In each trial, remedial surgery is performed in winter and spring over five years. Data is being collected on the progression of trunk disease and recovery of watershoots, and crop yields over time as well as on the distribution of trunk pathogens in existing and new trunks. Reworked vines are being compared in each trial against untreated controls.

Fruit on a Sauvignon Blanc vine three years after remedial surgery

Insights from vineyard trials

Assessment of disease in the trials over the past four years has demonstrated that not only the canopy but also the trunks of vines need to be examined by growers internally for symptoms to determine when to intervene. External dieback symptoms in the canopy are more difficult to track in cane-pruned vines than spur-pruned vines because the disease can be masked by the frequent replacement of canes and spurs with cane-pruning. In contrast to the spur-pruned Cabernet Sauvignon and Merlot trials, dieback symptoms did not change significantly in the cane-pruned Sauvignon Blanc trial even though internal wood staining symptoms in the lower trunks increased significantly. The number of vines that need to be examined internally depends on the extent of disease in the trunk and the acceptable margin of error. In a Sauvignon Blanc block where half of the vines have staining in the lower trunk, at least one row of 100 vines would be required.

Extensive molecular diagnostic testing of Sauvignon Blanc, Cabernet Sauvignon and Merlot trunks from the trials have found that both BD and ED pathogens can move well in advance of the staining, sometimes over distances of >200 mm. This means that growers need to make remedial surgery cuts as low as practical on the trunk to improve chances of removing the disease, taking into consideration the occurrence of bud sites and natural dieback of the wood. Early intervention when staining is further up the trunk is strongly recommended to enhance efficacy.

In areas where vineyards are not exposed to late frosts, growers can be confident that the timing of cuts does not affect vine recovery from remedial surgery. Over the past four years, remedial surgery has been carried out in both winter and early spring in the trials and no differences were recorded in the recovery of Sauvignon Blanc, Cabernet Sauvignon and Merlot vines based on the timing of cuts. There was often more sap flow from the remedial cut site in vines cut in spring than in winter, and sometimes a second application of wound protection was required. That said, delaying remedial surgery until spring may improve recoveries in vineyards prone to late frosts because differences in shoot length early in the season suggest that buds push earlier in vines cut in winter than in spring.

Fruit on a Cabernet Sauvignon vine three years after remedial surgery

Fruit on a Merlot vine three years after remedial surgery

Disease data collected from the trials highlights the importance of growers not delaying intervention because this can reduce vine recoveries following remedial surgery. A significant increase was observed in disease in the lower trunks of Sauvignon Blanc, Cabernet Sauvignon and Merlot over four years and in the Sauvignon Blanc and Cabernet Sauvignon, there was a decline in vine recoveries the more severe wood staining symptoms were in lower trunk. In the Merlot, where vine recoveries were high because the vines produced ample watershoots, early intervention remains important for the successful removal of infected wood.

Yield data collected from the trials is beginning to quantify the cost of trunk disease on vine productivity and how this cost at least be reduced by remedial surgery. Yields in the untreated controls in the Sauvignon Blanc, Cabernet Sauvignon and Merlot trials have declined significantly over the past four years. In contrast, the yield in remediated vines continues to improve and for those reworked in the first year of the trial, the yield has already surpassed the control. There is also evidence that wine quality has improved, at least in Sauvignon Blanc, where wines produced by remediated vines had in comparison to the control, higher levels of the desirable distinctive green and grassy aroma, 2-methoxy-3-iso-butylpyrazine (IBMP).

Presently there are no signs of trunk disease in the remediated vines, but the long-term life of these vines remains to be determined.

Further research

Valuable data has been collected from the trials in Sauvignon Blanc, Cabernet Sauvignon and Merlot that is already informing best practice recommendations. In the remaining year of the project, data will continue to be collected from the trials on the progression of disease in the trunks and the recovery, health and productivity of vines following remedial surgery. Of particular focus will be understanding the effect of internal trunk staining at the time of remedial surgery on the risk of pathogen transmission and the performance of vines. This data will provide growers with more decision-making support on whether to rework or replant vineyard blocks. ⬢

Right: Yield in control and vine remediated in 2019. Note: Yield in Cabernet Sauvignon is recorded on a vine basis due to gaps from virus rouging. The error bars indicate the least significant difference at a significance level of 5%. The difference between treatment means must be equal to or greater than the LSD (5%) to be significant.

About the programme:

The Vineyard Ecosystems Programme was a multi-year partnership between New Zealand Winegrowers and the Ministry for Business, Innovation and Employment that was managed through the Bragato Research Institute. This research is a spin-off project, intended to increase the long-term resilience and profitability of the New Zealand wine industry by developing new research-based approaches to pest and disease management that will result in significant increases in vine longevity.