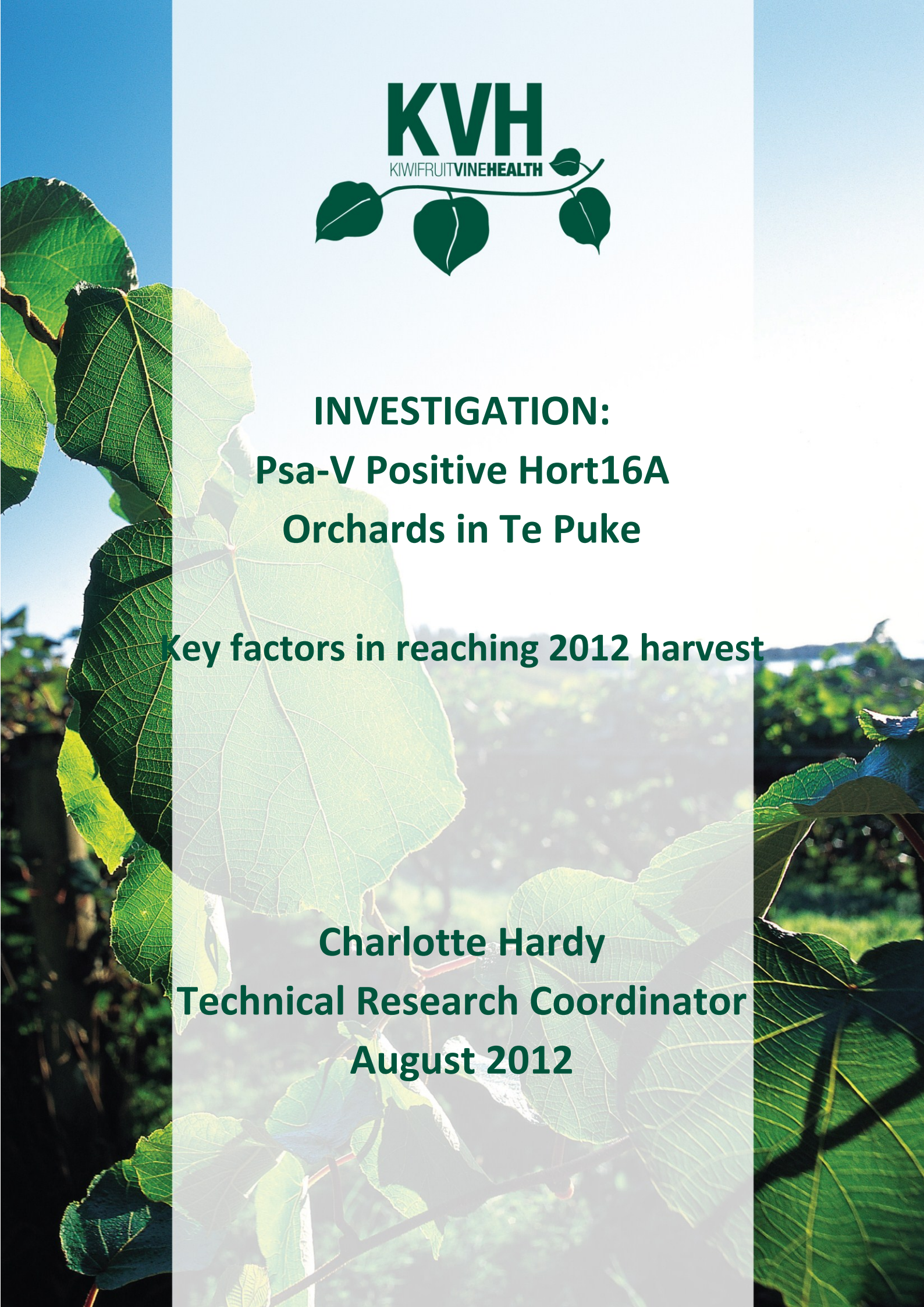

INVESTIGATION:
Psa-V Positive Hort16A Orchards in Te Puke

Key factors in reaching 2012 harvest

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August 2012

Executive Summary

- Industry observations suggested Hort16A orchards that became Psa-V positive going into winter 2011 were highly unlikely to make harvest the following autumn. An analysis confirmed fifty seven Te Puke Hort16A KPINs were Psa-V positive by June 2011. Of those 57 KPINs identified, nine were cut out before reaching 2011 harvest, and only six made it to 2012 harvest.
- KVH undertook a case study to determine the key management practices and strategies the six successful orchards used. Key messages and factors in their success are outlined in the following report. Factors included inoculum pressure, hygiene practices, spray programmes, stringing, pruning and girdling considerations, environmental variables, support networks, information sources, planning and strategy.
- Only one orchard was geographically isolated from other orchards. The other five orchards were within 50m to 1km of a potential Psa-V infection point.
- The first Psa-V symptoms observed in most Hort16A orchards were either leaf spot followed by dieback and ooze later in the season (spring), or ooze and dieback. In general, only mature vines were harvested. Vines younger than five years were often the first to be cut out.
- Airborne inoculum was viewed as the greatest pressure on orchards. However, insect attack, stringing, infected contractors and equipment were thought to be other possible sources.
- A range of strict on-orchard hygiene protocols were undertaken by all orchardists interviewed. These included covering hair, cleaning hands and footwear, machinery and vehicle wash-down and cleaning pruning tools. They all reduced visitor and contractor contact with the orchard where possible. A contributing success factor for these orchards was the ability to educate staff on hygiene practices and maintain practices throughout the season. Four of the six orchards interviewed had internal, long-term staff who worked solely for that orchard.
- All growers interviewed maintained a consistent copper spray programme during winter-spring and greater use of biologicals over the summer. The number of sprays at least doubled from winter 2011 to end of harvest 2012. October, December and March showed the highest amount of total rainfall. Coppers were used in October and March, while Serenade Max tended to be the spray of choice in December to protect vines from adverse weather events. Actigard was applied by five out of six growers, and KeyStrepto was applied by one.
- No summer pruning and reduced girdling were changes to the normal orchard management plan. On several orchards, males were cut back straight after flowering. Cutting out infected material was consistent, timely, and undertaken throughout the season.
- Small, well-sheltered blocks furthest from the main entrance or loading zones were the most likely to reach harvest.
- ZESPRI, KVH and industry consultants were used as information sources. Personal friends, other growers and product suppliers were also key for sourcing information. Some feedback suggested the information flow between ZESPRI, KVH and suppliers could be improved.
- Strategising and planning was integral to the success of managers going forward with the disease. Most growers were owner operators that had a personal interest in the success of their crops.
- All six growers believed that cutting out directly after the last harvest reduced management costs later. Once this decision had been made, it resulted in greater 'peace of mind'.

Contents

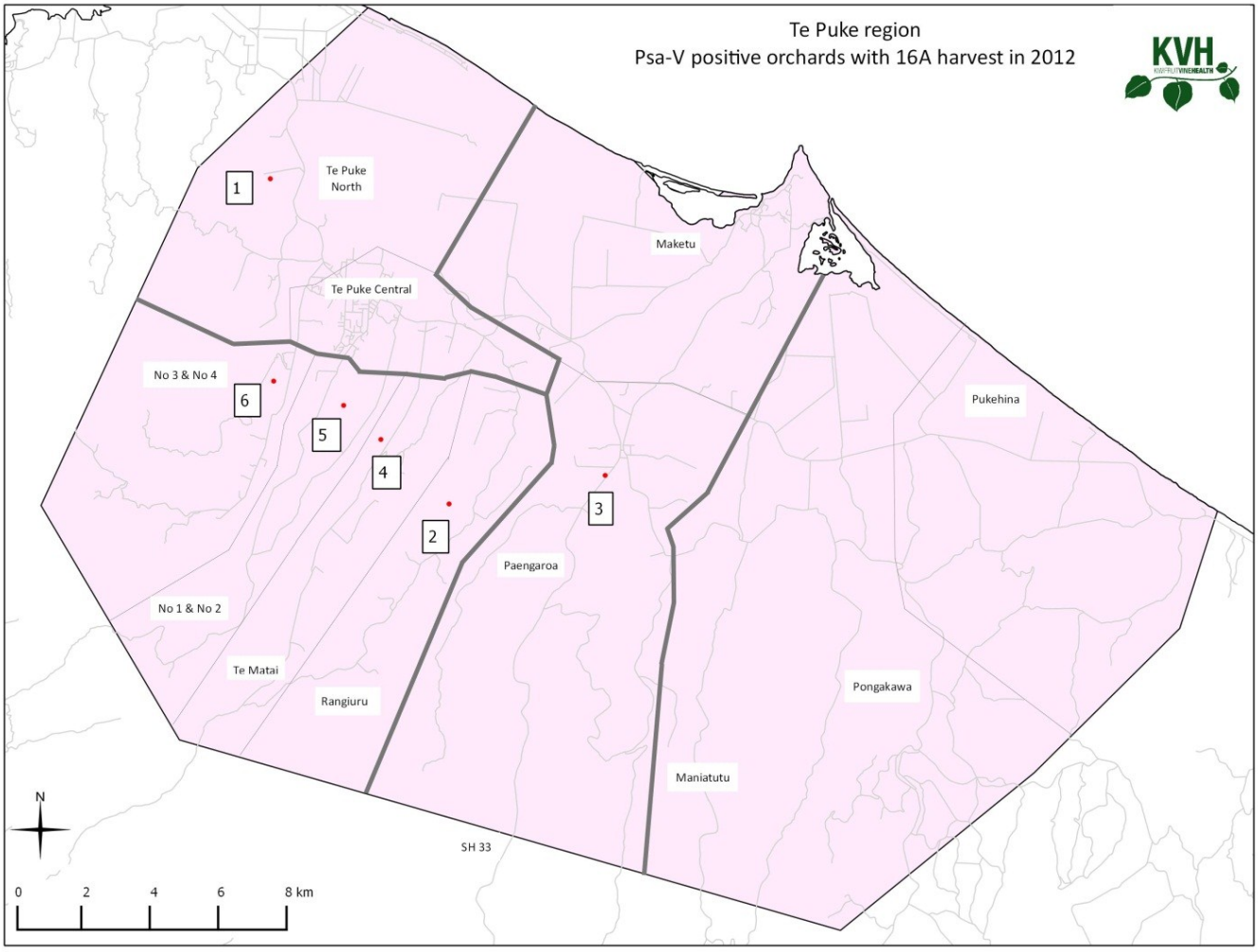


Figure 1: Psa-V positive Hort16A orchards (confirmed June 2011) that made 2012 harvest

Context

KVH recently completed audits for new variety licence applications to notch graft Gold3. Observations in some areas saw vines expressing more secondary Psa-V symptoms, going into winter 2012, than Te Puke orchards had been expressing at the same time in 2011. Data was reviewed to see how many Hort16A orchards in Te Puke, which were Psa-V positive by June 2011, made it to 2012 harvest. This provides an indication of the likely success of a 2013 harvest in other Psa-V positive regions—assuming that the disease progresses in other regions in a similar way to Te Puke.

In Te Puke, only six Hort16A orchards out of the 57 that tested positive by June 2011 made it to harvest the following autumn. Table 1 shows the number of infected KPINs across time in three time periods; Nov 2010-June 2011, July-December 2011 and January-June 2012. The rest of the table shows the reduction in Hort16A fruit submitted over the last three harvest seasons, and the number of trays submitted in 2012 as a percentage of 2011 harvest. The closer Psa-V was identified to harvest on an orchard, the more likely that orchard was going to make it to harvest.

Table 1. Hort16A production and trays submitted during 2010, 2011 and 2012 seasons

		Million trays of 16A submitted			Trays Submitted in	H16A yield - trays per hectare		
Date Psa-V identified	Infected KPINs	2010 harvest	2011 harvest	2012 harvest	2012 as % of 2011	2010 harvest	2011 harvest	2012 harvest
Nov 10 - June 2011	57	2.0	1.6	0.1	5%	11,404	9,314	421
July - Dec 2011	212	9.4	13.4	6.0	45%	9,729	13,767	6,202
Jan - June 2012	14	0.4	0.5	0.4	87%	8,703	11,232	9,749

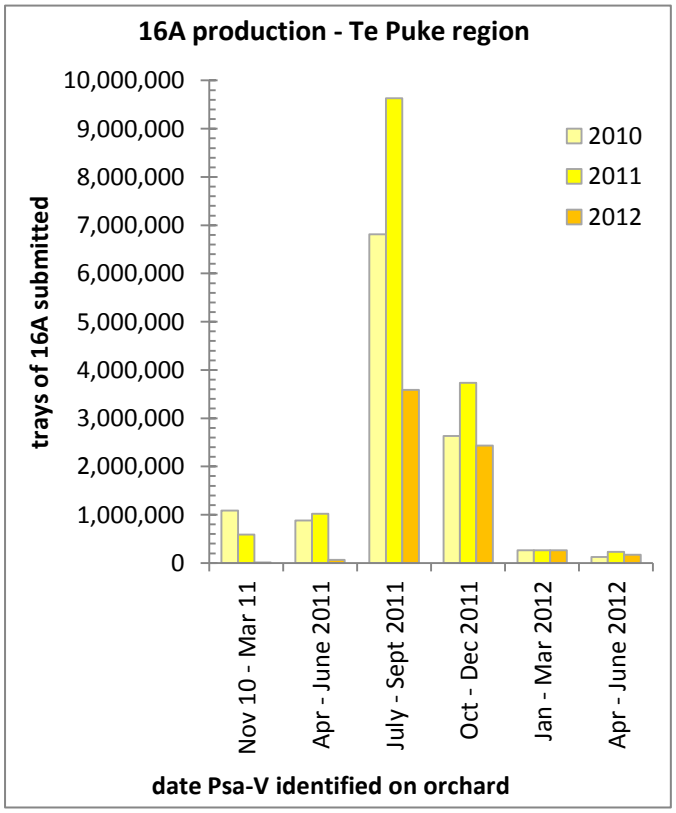


Figure 2: Hort16A Production in Te Puke

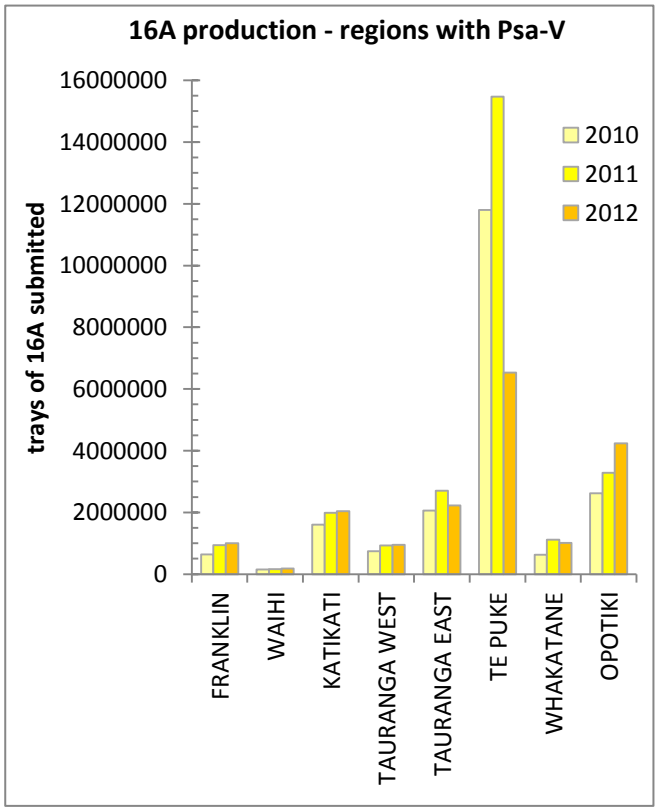


Figure 3: Hort16A Production in other regions

Figure 3 shows an increase in Hort16A production in Franklin, Katikati and Opotiki this year. As new Hort16A orchards become ready for cropping, it is important that observations on disease progression and good on-orchard practices are communicated to these regions. This report captures the experience and advice from growers who had a final Hort16A harvest in 2012. All six orchards represented in this case study cut out after harvest and have since grafted to new varieties. Production in each case was down on previous years. There was an average of 31 per cent of the previous years' (2011) production of fruit submitted in 2012 across the six KPINS, with a maximum of 60 per cent for one of the growers. Based on

the experience in Te Puke, it is not likely that regions with Psa-V will succeed in Hort16A harvests beyond 2013.

Psa-V confirmation and progression of symptoms

In five of the orchards featured in this case study, symptoms were seen in other varieties, in particular Hayward, before infection was seen in Hort16A blocks. However, in one case infection was seen in Hort16A before Hayward symptoms appeared. In most cases, symptoms in other parts of the orchard were usually noted well in advance of positive confirmation of Psa-V in Gold (up to six months). The most common symptom first seen in Hayward was spotting, and in Hort16A a range of symptoms were first identified from spotting and cane dieback to ooze.

Where dieback and ooze were the first symptoms identified in Gold vines, it is likely infection was already present, or more prevalent, before symptoms were first observed. Symptoms progressed throughout the season moving rapidly in spring. During drier periods in summer symptom progression slowed down or appeared to stop completely.

Young vines recently grafted, between two to four years prior, were the first to succumb to infection and showed more severe dieback that mature Gold blocks. These younger blocks were usually the first to die back and be cut out (See Matrix in Appendix 1).

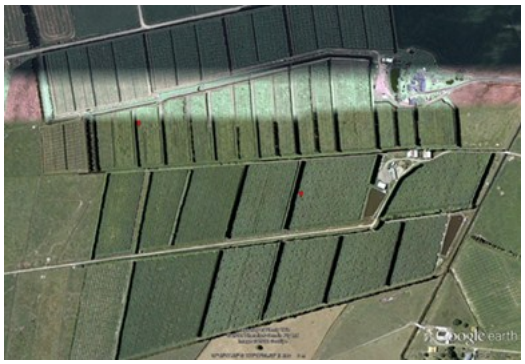
Inoculum Pressure

On a landscape scale only one of the six orchards in this case study had relative isolation from Psa-V positive neighbours and inoculum pressure (Orchard 2). A significant contributing factor of infection spread on that orchard was thought to be the prevalence of south easterly weather systems during 2011-2012. This wind direction was thought to have spread inoculum by passing directly over some of the initial infection sites in Te Puke. The grower thought initial infection could also have come from several alternative sources, including contractors, equipment, or fruit bought in accidentally on used packing bins.

In all other cases, orchards were within 50m-1km of another infected, or potentially infected, orchard. Several orchards were close to where the first Psa-V symptoms were identified in late 2010. Growers viewed airborne inoculum as the greatest potential source of the disease, with other factors like contractor-spread infection possibly playing a lesser role in disease spread.

Aerial photographs of orchards

Orchard 1



Orchard 2 (relative isolation from other KPINs)

Orchard 3

Orchard 4

Orchard 5

Orchard 6

In one case, a shared driveway had cut out stumps and left soil in a big pile beside it. The pile was uncovered and exposed to the environment over summer and beyond harvest (See Images 7-8 below). The grower thought this material from another orchard was a likely source of inoculum transported by people moving along the shared driveway. On a localised scale within each orchard, the size of blocks, how far they were from the first badly infected vines on the orchard and the quality of shelter belts were significant factors in the likelihood of a block getting through to harvest.

Aspect and prevailing wind direction were also thought to have had an effect. Smaller, more protected blocks with shelter species such as Cryptomeria, and had no gaps in the shelter belts fared better than bigger, more open blocks with shelter gaps. Blocks closer to a roadside or load out area for the orchard, appeared to be more at risk. As hygiene practices were rigorous in all cases, it seems that within less-exposed blocks infection could be restricted and managed more easily.

Image 7: Cut out material beside driveway

Image 8: Stumps and vines exposed to air

Hygiene Practices

A range of strict on-orchard hygiene protocols were undertaken by all orchardists interviewed. These included covering hair, cleaning hands and footwear, machinery and vehicle wash-down and cleaning pruning tools. Where possible, all growers reduced visitor and contractor contact with the orchard. A

significant success factor for these orchards was the ability to educate staff well on hygiene practices and maintain practices throughout the season. Four of the growers interviewed had internal long-term staff who worked solely for that orchard.

Table 2 below shows the range of hygiene practices implemented. Many were added to the management programme before Psa-V was confirmed. Generally, as the season progressed and Psa-V infection spread through an orchard, it became harder to maintain the hygiene level set when first infected. Realistic measures will never eliminate risk 100 per cent, but trying for best practice was the aim of each KPIN.

Hygiene practices were seen as one of the key factors in the success of an orchard making harvest. However, feedback suggested a balance between economics and practicality had to be reached. For example, where a sealant paste had been applied to pruning wounds earlier in the season, many growers started opting for copper protection immediately after a pruning round as each block was completed late season. Initially, people were bagging cut-out infected material, then burning or burying leaders and trunks. Later in the season when there was more cut-out, infected material was dropped to the ground then sprayed with either sterilant or copper sprays and mulched.

Table 2. The range of hygiene practices followed during the 2011-2012 season

	Hygiene Protocols					
Head/hair	Hairnets					
Footwear	Footbaths	Cleaning footwear				
Hands	Hand sanitiser	Disposable gloves				
Clothing	Separate overalls by blocks	Separate overalls by variety	Changed or washed daily			
Pruning tools	Separate set by block	Separate set by variety	Sterilised between vines	Sterilised between cuts	Chair to put tools on	Pouch emptied of plant material
Pruning wounds	Sealed every cut with sealant	Burnt major cuts and girdles	Copper protectant sprays after pruning	No summer pruning	Reduced number of girdles	
Machinery	Used all own equipment	Sprayed orchard themselves	Plant material and soil water blasted off wheels	Separate machinery by block	Mulcher and sprayer hosed, especially fans and undersides	
Visitors and contractors	Minimised numbers of people on orchard	Outside contractors limited or cancelled	Smaller experienced teams	Task specialisation eg. for cutout	Education of staff a priority	
Vehicles	Restricted entry	Park on gravel only	Washed tyres	No visitor vehicles on orchard		

Spray Programme

Spray programmes varied between organic and conventional growers. The number of available sprays for Psa management on organic orchards is limited to biological controls and copper. One orchard ceased organic block status and went through to harvest as conventional. The one fully organic orchard maintained

a steady copper, and then Serenade Max programme throughout the season and got 60 per cent of his normal Hort16A crop to harvest. Across the board the number of sprays used for Psa-V management at least doubled between 2011 and 2012 (see Figure 4 below). The only products common to all orchards were some type of copper and Serenade Max. In three cases, Serenade Max was applied by helicopter for at least one application. There were varying degrees of comfort with copper use, but all managers and owners agreed it was a product they felt confident had really worked. Although Serenade Max was used on all KPINs, it was perceived as being the least value for the money spent.

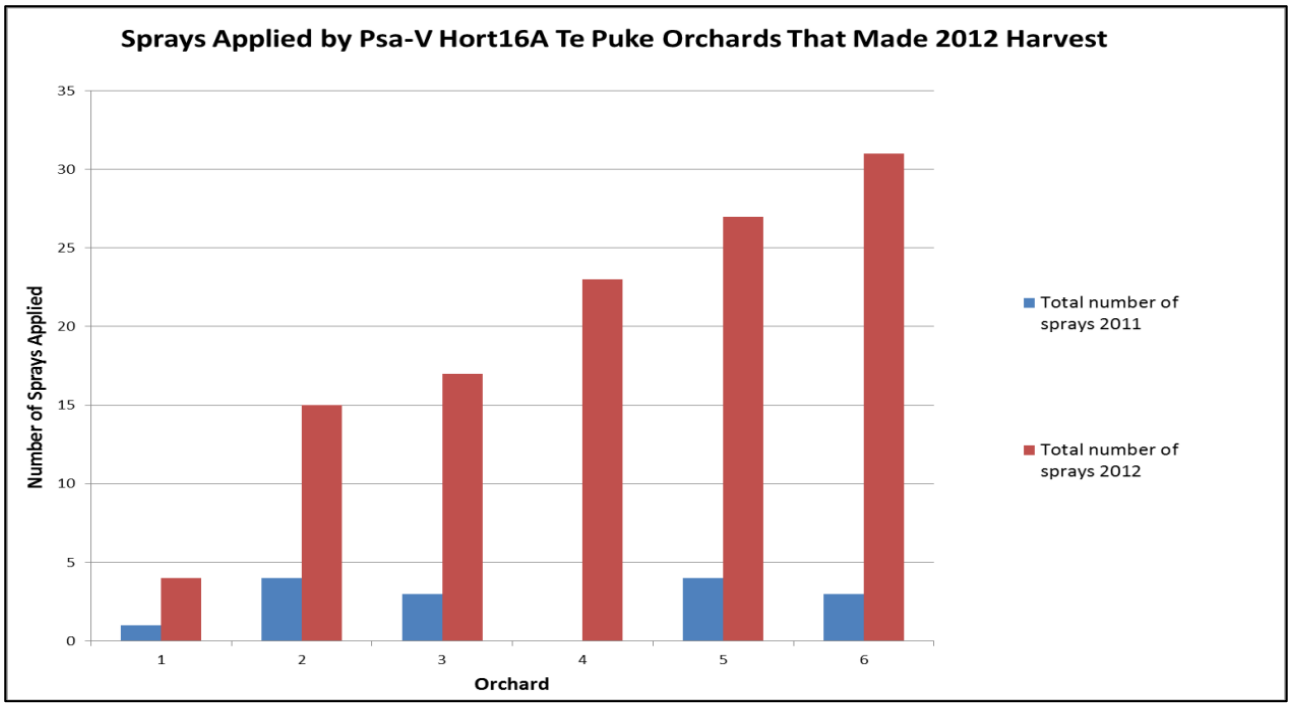


Figure 4: Total sprays applied in 2011 and 2012 seasons

Copper use had a distinct pattern from when Psa-V was identified on an orchard through to harvest (Figure 5). Figure 5 shows the total number of copper sprays applied for any given month from April 2011-April 2012. A higher number of coppers were applied in winter from June 2011 through to October 2011. Winter pruning was done on all orchards. Copper was used either as a protectant for pruning wounds or as protection against adverse weather events (applied prior). Copper Sulphate was used both as a winter clean-up spray to induce leaf drop, and also as a Psa-V management product. From November there was a drop in the number of copper applications. This reflected grower understanding that new growth was more susceptible to phytotoxicity from copper. Over the summer months copper products were gradually replaced with biologicals and applications of foliar fertilisers and fruit growth enhancers.. Summer pruning was only undertaken on one orchard. Copper use peaked again from February through to April.

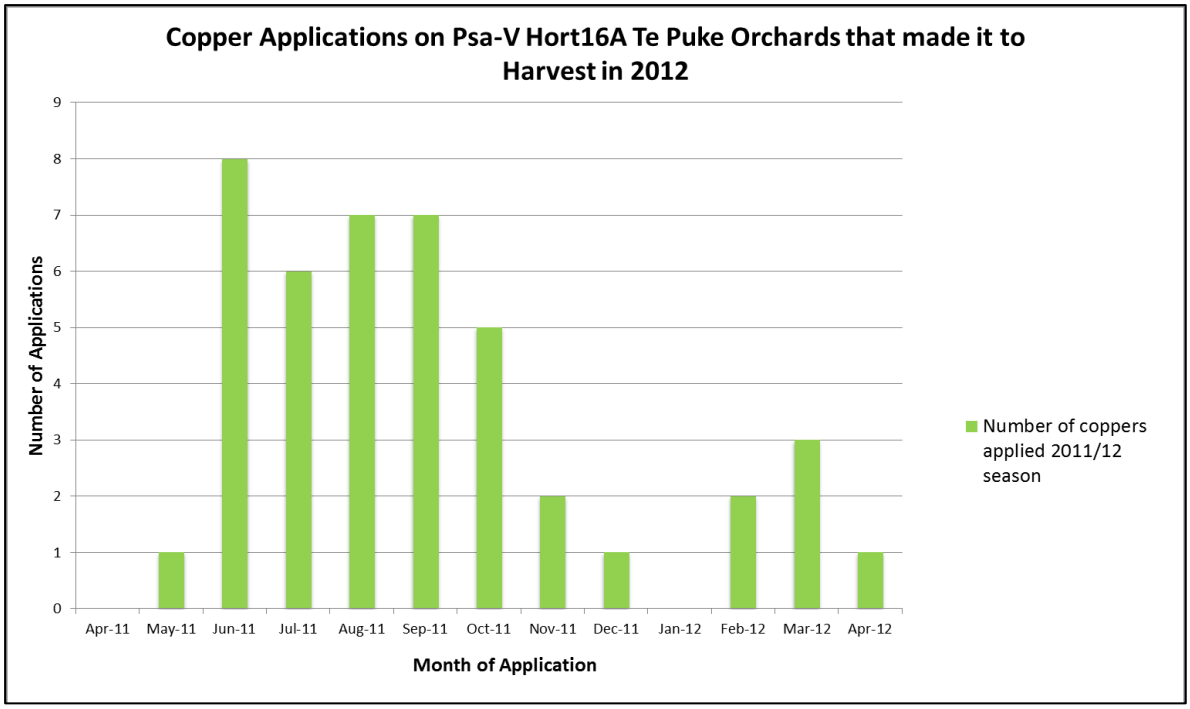


Figure 5: Copper use across the 2011-2012 season with peak use periods highlighted

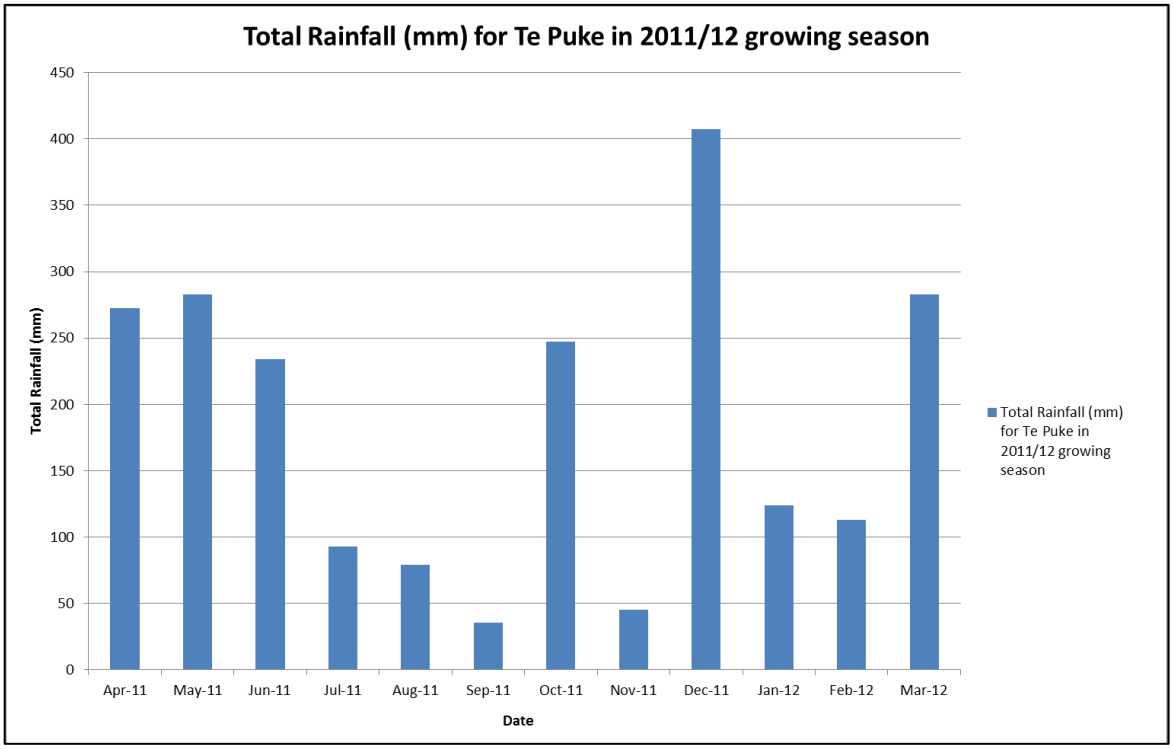


Figure 6: Total monthly rainfall in Te Puke from April 2011-March 2012

Data collected from the Plant and Food Research Te Puke weather station from April 2011 showed the months with highest total rainfall outside of winter were October, December and March (Figure 6 above). Copper use in October and March fell within the peak periods for its use. Biologicals were used during December as a copper alternative for protecting against rain events. Figure 7 below shows peak use of biological sprays occurred from October to March. Sprays with biological components included Serenade Max, Blossom Bless, Fulzyme Plus and Plant Shield.

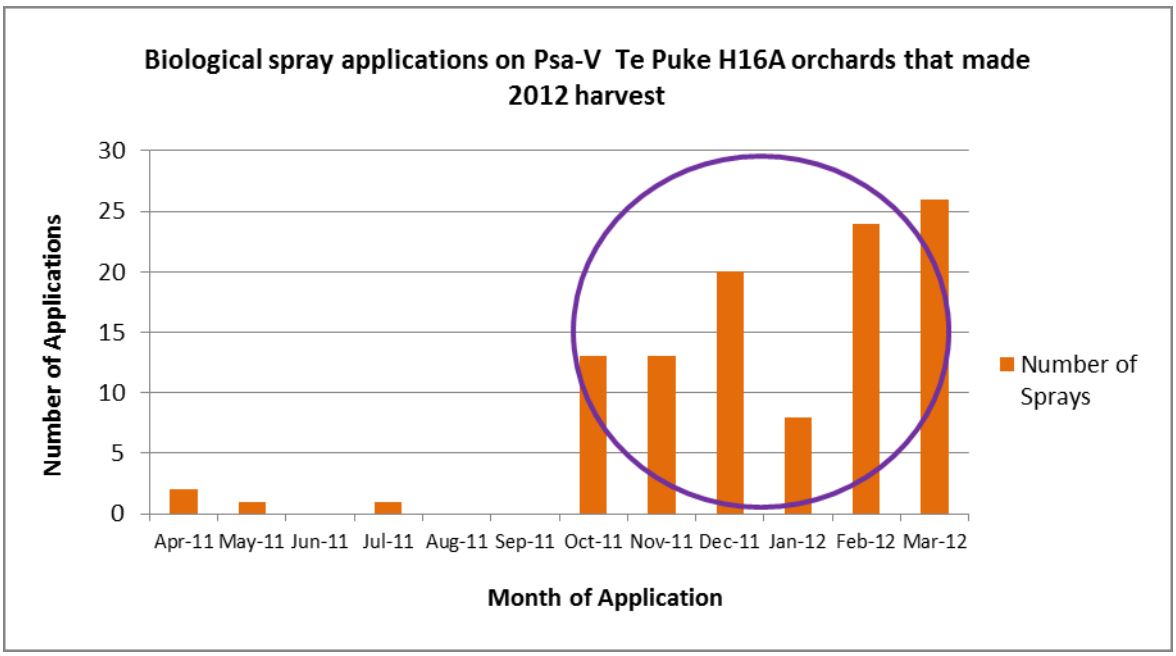


Figure 7: Biological spray use across the 2011-2012 season with peak use period highlighted

Actigard was generally viewed positively. Five of the six orchards used the product with mixed results occurring only where vines were already under significant stress. In one orchard, Actigard stunted growth on stressed vines, with vines producing fruit but not growing any further after spray application. Other areas of the same orchard where Actigard was applied showed no negative results. Only one grower interviewed chose to apply KeyStrepto.

Stringing, Pruning and Girdling

Winter prune and leaf drop applications of copper sulphate after harvest were maintained as standard practice. One grower, who would not normally need to apply copper sulphate, used this chemical for Psa-V management Copper products were used to protect freshly-pruned vines over winter. All orchards continued with a normal winter prune.

In three orchards, males were cut out after flowering in spring to reduce infection sources in the orchard.

Summer pruning was only undertaken on one of the orchards.. The risk of infection to young soft tissue was perceived as the greatest infection risk on the orchard. Where people had strung young vines, the general observation was that these vines succumbed faster to Psa-V than those which had not been strung. This may have resulted through wind and cicada wounds. In two cases, because of the altitude (near or above 100m asl), clapping cicada were a significant problem and were thought to have been the primary source of infection on strung vines. Cicadas attack the growing canes, and make deep incisions during feeding. These wounds elevated up strings would have had a greater exposure to airborne Psa-V. It is more difficult to get adequate spray coverage through the canopy onto young vines to protect wounds from Psa-V.

Girdling was reduced, or stopped entirely, during 2011-2012 season. In four cases, late summer girdling in February did not occur. In one case where girdling was continued on the trunk, significant ooze was seen in many trunks about a foot above the girdle. Because it was a ‘last crop’ scenario, the grower was keen to push the vines to the best production possible before cutting off and grafting new varieties. The other grower who continued girdling saw no evidence of increased infection above girdling wounds. Copper was sprayed directly on the girdle after the girdle was applied, and chains were cleaned between each vine.

All orchards were monitored intensively and regularly. Infection was cut out as soon as it was seen, and disposed of in a timely manner. Continuous cut out throughout the season until harvest was considered vital in terms of reducing inoculum load on the orchards.

Support Networks and Information Sources

All interviewees made use of information from one or more of the following sources: ZESPRI, KVH, suppliers, industry consultants and packhouse technical staff. Personal friends, other growers and suppliers of chemical products were also important. There was an impression that the amount of information available was huge, and filtering for the right advice, and best practice, came from a combination of personal research, and using a technical person in the industry. Feedback suggested the information flow between ZESPRI, KVH and product suppliers could be improved. There was sometimes a disjunct between ZESPRI and KVH recommendations and what suppliers were recommending at times. Support networks were utilised. These included locally initiated groups, groups previously belonged to, family members and orchard staff.

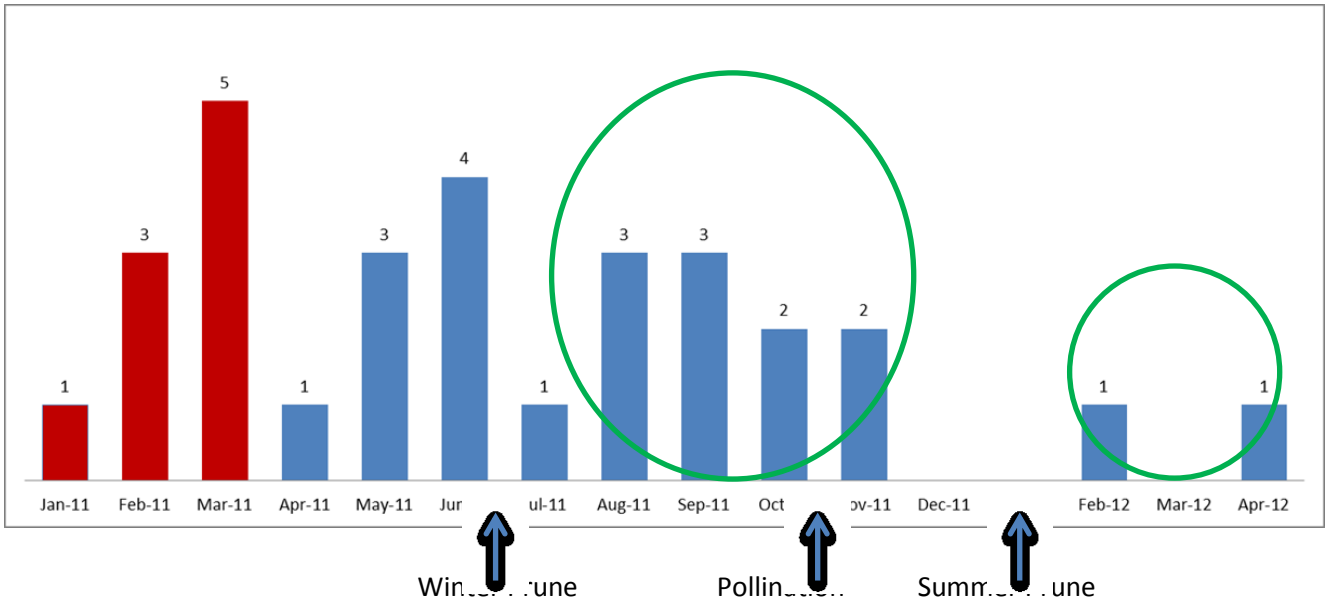
Strategy and Planning

In all cases, immediate and considerable time was spent strategising and planning. This usually consisted of early decision making about what the outcome was going to be, ie, going for harvest or continuing organic production. Then looking at all the options for management and where they would take you. For example, the use of particular products, and decisions about which blocks to cut out and which to continue on with. Managers communicated regularly, and throughout the season with staff. Sitting down and doing a financial audit of the orchard and understanding what was possible was empowering and positive in most cases. Overall a positive attitude and "sheer bloody mindedness" in the words of two growers, was a major part of their success. Four of the five growers interviewed were owner operators, who spent a large amount of time on orchard, and had a personal interest in their crop making harvest.

Timing of cut out in 51 KPINs

Of the 51 orchards that cut out before 2012 harvest, data was collected on the dates of final cut out for 30 of these. Data cover KPINs associated with five different pack houses. The subset of 30 are shown in Figure 8 below. The majority cut out from Feb 2011 through to November. The first nine data points in red were orchards that became Psa-V positive early in 2011 and then cut out shortly after the confirmed result. None of these orchards made harvest in 2011. The 13 that cut out from March through to June would most likely have cut directly after a last harvest in 2011. The key time periods highlighted were during winter and spring after winter pruning and pollination in summer.

Figure 8: Timeline of orchard cut out



The growers interviewed believed that cutting out after your last harvest reduced management costs later on, and once this decision was made resulted in greater 'peace of mind'

Conclusions and Key Messages

- All orchards followed KVH recommended best practice for Psa-V management.
- Primary sources of inoculum were thought to be weather systems, equipment, contractors or insect attack.
- Strict on-orchard hygiene practices and disposing of inoculum sources quickly was considered vital.
- Apply a steady spray programme with copper during winter and biologicals over leaf development phase in spring/summer.
- No or less summer pruning, reducing risk of cutting young soft tissue.
- Male management included cutting males right back after flowering to reduce inoculum.
- Hort16A vines younger than five years old, and strung vines were the first to be cut out.
- Smaller blocks with tall, complete shelter with no gaps, and blocks furthest from main entrance or loading zones seemed to be least affected.
- Use of support networks and information sources was high amongst these growers.
- Having a plan that included consideration of financial circumstances and understanding the options available was essential going forward with the disease.
- Cutting out directly after last harvest saves management costs of cutting later in the season, and brings greater 'peace of mind'

Acknowledgements

I would like to thank the growers and orchard managers who participated in interviews and gave their time and information to make this study possible. Also KVH staff who provided initial concept, background information, and statistical analysis. Thanks to Victor Jones and Linda Peacock for their help with interviews and Victor for production of the videos that accompany this report.

Appendix 1: Matrix of Psa-V Infection Factors

	Isolated by > 1km from other infected orchards	Internal or external orchard staff:	Location of first H16A infection in orchard	Hygiene; shoes hands tools vehicles machinery	Elevation above sea level	Summer prune	Prevailing wind direction	Primary infection sources – grower view of risks	Age of vines that survived	Two most used products	Key Strepto/ Actigard Applied
1	Yes	Internal	Entrance	High	Sea level	No	SW	SE weather system	Mature; cut out 2yr old vines	Copper Sporekill	KS – No A - Yes
2	No	Internal	Main loading zone	High	80-100m	No	W/SW	Equipment in landing zone, or SE weather system	Mature	Copper Serenade Max	KS – Yes A - No
3	No	External but always the same people	Block closest to highway	Medium - High	15-30m	Yes	SW	Hygiene at harvest 2011, weather	Mature	Copper multiple products single app	KS – No A - Yes
4	No	Internal	Entrance	High	80-100m	No	SW	SE weather system	Mature; cut out 3-4yr old vines	Copper Serenade Max	KS – No A - Yes
5	No	Internal	H16A block closest to entrance	High	At 100m	No	SW	Cicada wounds on strung vines	Mature; cut out 2yr old vines	Serenade Max Copper	KS – No A - No
6	No	External	Entrance	High	Just over 100m	No	SW	Contractors	Mature	Copper Serenade Max	KS – No A - Yes