Wild Fire Orchards

September 2011

Investigating possible links to the severity of infection on Psa-V orchards within Te Puke

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Was there a reason why Psa-V ran like wildfire through some orchards last season while in others the disease progressed much more slowly? A KVH investigation was undertaken to see if there were possible explanations for the differences between orchards. The investigation identified stringing of replacement canes as really the only factor that may have influenced this. Over eighty per cent of the Grade 4 orchards (rapid progression) were strung versus only 40 per cent of the Grade 1 and 2 orchards (slow progression). An article presented by Lynda Hawes and Shane Max published in the May/June edition of the *New Zealand Kiwifruit Journal* explored a similar question, 'Why are there orchards free of Psa symptoms in the Te Puke Priority Zone?' In their report focus was given to: the growing system; canopy density; spray programme; male variety; summer pruning practice; and weather events (namely rainfall). The following key conclusions were made.

- 'There was no identification of any obvious common management factors, other than perhaps regular spraying, as to why these orchards remain free of Psa-V symptoms.'
- 'Generally, the New Zealand experience is that *chinensis* male vines (particularly Bruce and CK2) appear to be either more susceptible to infection or express a more rapid development of symptoms after infection, than other kiwifruit varieties.'
- 'Insufficient coverage may have resulted in a difference between the perceived versus actual maintenance of protection, on the most susceptible material, leaving an open window for infection.'
- 'It is more likely a combination of factors influence the susceptibility of an orchard. These will include its spray programme, product selections and application rates, the ability to achieve good coverage, orchard vigour, the timing of spraying and wound creation, the severity of natural and man-made wounds and the Psa-V inoculum pressure occurring and weather conditions at the time.'

And in 2009, ZESPRI field staff in Italy undertook a comprehensive paired orchard study looking at grower practices between infected and non-infected orchards. From the paired statistical analysis, overhead shelter appeared to decrease the level of infection. Other management factors that did not show statistical difference but did show suggestive trends for higher/more aggressive levels of infection were often associated with:

- higher nitrogen inputs;
- greater levels of irrigation applied per day;
- the absence of hail netting;
- more time spent pruning in the rain during winter;
- higher soil pH;
- lack of copper sprays postharvest and
- an infected orchard in the neighbouring area.

Both of these studies provide a valuable backdrop when interpreting the data collected in this particular case study. They suggest we are working in a way that seeks to address an orchard's potential for Psa-V infection—based on orchard set-up and orchard management/practice that may or may not attribute to greater or lesser levels of 'susceptibility'.

Wildfire orchards

The focus of this investigation was to assess orchard set up and orchard management/practice for various orchards (with a focus on Hort 16A orchards) with differing levels of infection to try and determine possible links to the severity of infection.

A total of 35 orchards, all within the Te Puke Priority Zone (as it stood in August), were sampled and investigated with regard to orchard set up and management as of November 2010 to present (August 2011). Orchards were subjectively rated in mid-July 2011 and scored based on the severity of infection and or the expression of visible symptoms at the time. Twenty five of these were heavily infected with Psa-V and respectively considered a Grade 4 orchard (reflecting strong infection). Five orchards were Grade 2 and another five orchards were from the Grade 1 pool (reflecting lower levels/expression of infection).

Due to the nature of this of investigation, that is, relying on the accurate account of orchard set up and management along with the existing gaps in our understanding of the nature and lifecycle of Psa-V, there were some significant limitations to the investigation. These included the following.

- Orchardists with high infection levels quickly removed entire blocks early in the year and, therefore, no data exists or is relevant regarding spray programme, pruning intensity, contractor movement, orchard hygiene practices etc.
- Orchards were graded on the severity of infection at the time—between the time the grade was issued and the time of the investigation many orchards had seen a progression in the level of infection and or the aggressiveness of Psa-V within their orchard and, therefore, no longer fall under their original grade.
- Due to the lack of knowledge around the historical presence and initial source of Psa in New Zealand, we currently do not know how far back orchard practice and set up has to go in order to assess/trace risk factors and possible vectors.
- The nature of how any of the given orchards became infected was not addressed or explored.
- The data produced revealed trends suggestive of a link, although these may not be scientifically quantifiable.

Avenues not addressed in the investigation that may have had significance include the following.

- Were shelters sprayed?
- When were shelters last trimmed?
- What happened with the prunings?
- Which shelter was first trimmed and where is this in relation to the first block infected?
- What variety was worst and first infected?
- When was Bruce introduced to the orchard?
- Following the use of artificial pollination (AP), what block did you start AP and where is this in relation to the first block infected?
- Where did the summer pruning start and where is this block in relation to the first block infected?
- Where was infection first seen within the block?
- How was the infection spread out through the block/orchard (wide or patchy)?

- Did gangs ever prune or lay canes down in wet conditions?
- Where is the closet neighbouring infected orchard?

Results

Historically, we have seen vines in the six–seven year bracket (and younger) aggressively affected by Psa— this trend was upheld in our data. While variety 'first and worst' infected was not directly addressed (nor the gender ratio of infected vines) Bruce, CK2 and CK3 were of the widest reported infected varieties. The main point of interest however, was the ratio of strung canopies versus non-strung canopies. Of the Grade 4 orchards, 84 per cent (21/25) were growing up on strings at the time of infection. A similar trend was seen with the Grade 2 orchards where 60 per cent (3/5) were stung canopies while 40 per cent (2/5) were non-stung canopies (table 1). In all, a total of 26/35 Psa-V affected orchards had strung canopies while 9/35 were not – seventy five per cent of the investigated orchards (tables 1, 2, and 3). It is estimated by Packhouse technical representatives that 65–70 per cent of GOLD orchards in Te Puke use strings to grow replacement canes.

Table 1: Grade 4 orchards

Grade 4 orchards	Variety	Male variety	Male growing system	Shelters
1	16A	Ck2–Ck3	Strings	Cryptomeria
2	16A	Ck2–Ck3	Conventional	Cryptomeria
3	16A	Ck2–Ck3–Bruce	Conventional	Cryptomeria
4	16A	Ck2–Ck3	Strings	Casuarina–Crow's nest poplar
5	G9	–	Strings	Poplar
6	16A	Ck3–Bruce	Strings	Cryptomeria – Casuarina
7	G9	Bruce	Strings	Cryptomeria–Casuarina
8	16A	Ck2–Ck3–Bruce	Partial Strings	Cryptomeria–Gum
9	16A	Ck2–Ck3	Conventional	Cryptomeria
10	16A	Ck2–Ck3	Strings	Cryptomeria
11	16A	Ck2–Ck3–Bruce	Strings	Gum
12	16A	Ck2–Ck3–Bruce	Strings	Cryptomeria
13	16A	Ck2–Ck3–Bruce	Strings	Cryptomeria–Cypras–Poplar
14	G9	Mix	Strings	Cryptomeria–Pine
15	G9	Bruce–Sparkler–M33	Strings	Cryptomeria–Casuarina
16	16A	Ck2–Ck3–Baker	Strings	Cryptomeria
17	G9	Bruce–other	Strings	Pine
18	16A	Ck2–Ck3–Bruce	Strings	Cryptomeria
19	16A	Ck2–Bruce	Strings	Cryptomeria–Casuarina
20	G9	MS1–Ck2–Bruce	Strings	Cryptomeria–Pine
21	16A	Ck2–Ck3–Bruce	Conventional	Cryptomeria
22	16A	Ck2–Ck3	Strings	Casuarina
23	16A	–	Strings	Cryptomeria–Gum
24	16A	Ck2–Ck3–Bruce	Strings	Cryptomeria–Casuarina
25	16A	Ck2–Ck3–Bruce	Strings	Cryptomeria

Table 2: Grade 2 orchards

Grade 2 Orchards	Variety	Male variety	Male growing system	Shelters
1	16A	Sparkler –Ck2–Ck3–Bruce	Strings	Bamboo–Pine–Artificial
2	16A	Ck1–Ck2–Bruce	Conventional	Pine–Willow
3	16A	Ck2–Ck3	Conventional	Casurina–Artificial
4	16A	Ck2–Ck3	Strings	Cryptomeria–Artificial
5	16A	Bruce	Strings	Cryptomeria

Table 3: Grade 1 orchards

Grade 1 Orchards	Variety	Male variety	Male growing system	Shelters
1	G9	Bruce	Conventional	Cryptomeria
2	G9	Bruce	String	Cryptomeria
3	G9	Bruce	String	Cryptomeria
4	Hw	Chieftain–N52	Conventional	Cryptomeria–Artificial
5	16A	Bruce–Ck3	Conventional	Cryptomeria–Artificial

Discussion and considerations

Growing systems—strung canopies

Several growers commented that infection was first seen in strung canes (*Illustrations 1 and 2*). This is unlikely to be coincidental but rather a direct result of the challenge faced by strung canopies in achieving effective protective spray coverage. Effective spray coverage is influenced by the complexity and 'openness' of the canopy. If the canopy is dense—as in little grass grows below—it is not possible to achieve complete spray coverage on the upper layer of your canopy. This is supported by coverage research undertaken by Gaskin et al, which showed adequate coverage was not been achieved even with a combination of ground and aerial spraying last season.

Following discussion from a field day provided for cut out growers, a suggestion was put forward addressing this thinking by means of altering the structure of strung canes, namely the angle of the strings and consequently the height of cane growth up the strings and the resultant implication for improved spray coverage. This thinking will be one of the many revised orchard set-up that will be part of the long-term management/prevention of Psa-V.

Illustration 1: Hort16A blocks with strung cane appeared to be more prone to leaf spotting

Illustration 2: On some Hort16A orchards leaf spotting progressed to cane collapse in late summer

Male susceptibility

A significant number of growers commented that males were the first and worst infected in their blocks. However, since the time of the investigation, an equal number of reports and recordings have come in about female vines affected by Psa-V—whether this is cross contamination from male affected vines or natural infection is another unknown.

Marco Mastrolelo (APOFRUIT Italy) reported on male susceptibility (as seen in Italy) at one of the weekly KVH technical representative meetings and confirming the same trend was observed in Italy—males are first and worst affected. Following this observation [they] went ahead and removed all males from some blocks thinking this would eliminate/reduce the risk of [re]infection. However, this was not the case. Following the total removal of males, females became infected and just as badly as the males; this supports the thinking expression is favoured/worse in the males but is not limited to male vines. It might also underline infection may have occurred sometime before symptoms were expressed in female vines.

Vine damage

A number of growers commented that Psa-V had clearly entered (and was seen) though cicada wounds (Illustration 3). Shane Max, ZESPRI, previously addressed the link between cicada damage and Psa infection in the May/June edition of the *New Zealand Kiwifruit Journal* concluding, '[his study] strongly supported the thinking that cicada egg nests are an entry point for Psa, [however, also recognising] cicadas are not the only means by which strung canes get infected with Psa'.

Illustration 3: Cicada wounds are potential entry points for Psa-V

Shelters

Joel Vanneste and his team at Plant & Food Research Ltd explored Psa-V's survival on various natural shelter species as well as artificial shelters and found Psa-V survived longer than two weeks on Cryptomeria species in contrast to Casuarina species which was only 24 hours (table 1). Artificial shelters were seen to still have detectable live Psa-V up to five days. The implications of this are formidable if findings hold true for shelter in the natural environment as 75 per cent of the investigated orchards had natural Cryptomeria shelters, and their use is widespread within the kiwifruit industry. Therefore, it is not hard to imagine a disturbance event, ie wind, rain, shelter trimming, that would see the movement of Psa-V from Cryptomeria onto the vine canopy.

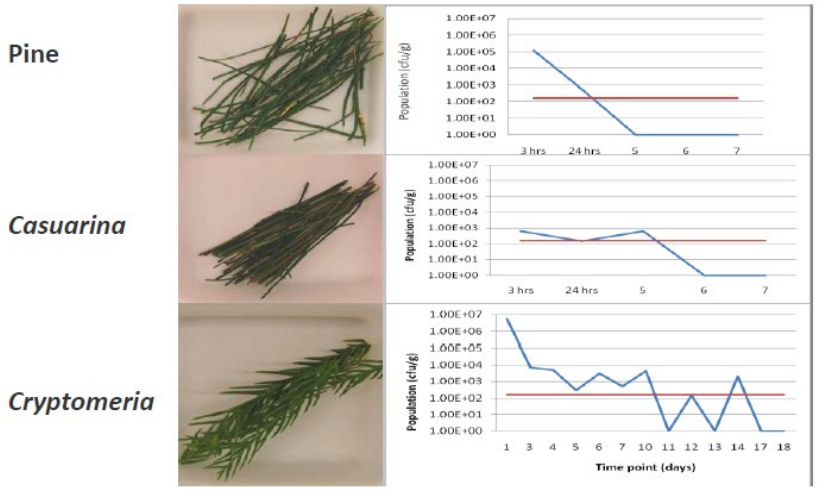

Illustration 4: Psa survival on natural shelter species

Outcomes

The relationship between strung canes and effective spray coverage is such that KVH is not recommending stringing replacement canes unless adequate spray coverage can be achieved throughout the whole season. Strung canes are considered high risk to Psa infection because of the challenge faced in effectively penetrating the canopy with protective sprays targeting strung canes. As part of the summer management programme KVH recommends the following regarding canopy structure.

- Aim for a flat canopy with evenly distributed and well-spaced canes to improve airflow and spray coverage.
- Select low to minimum vigour wood which requires minimum intervention.
- Assist spray coverage by removing excess growth and clear out leader zones of new growth frequently to minimise wound size. Include spurs, blank shoots and excess replacement canes.
- Maintain a gap along the centre of each row, where row width or the intended use of strung canopies would otherwise compromise spray coverage.
- Address and canopy structures that promote clutter or excessive seasonal growth.
- Reassess and refocus on dense areas within the canopy as the season progresses.

References

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Acknowledgements

The author would like to thank all 35 growers who took part in this case study.