KVH Information Sheet

Male susceptibility to Psa-V

Tolerance of male selections to Psa-V in New Zealand

To gain a better understanding of the susceptibility of male pollinisers to Psa-V in New Zealand, the following three approaches have been used.

1. Clonal trials—looking at symptom development on a group of different males in the same block in a replicated design where the same spray programme is applied to all vines;
2. Industry observations— male polliniser performance in commercial blocks. Looking at what male pollinisers are withstanding Psa-V infection; and
3. Woody stem bioassay—testing the sensitivity of different cultivars to Psa-V infection.

All three approaches are able to provide some indication of the susceptibility of the different male pollinisers to Psa-V. However they do not guarantee the ability of any cultivar to survive Psa-V in all climates and conditions over the long term.

Image 1 Developing male flowers

1. Clonal trials—observations of male pollinisers

The level of Psa-V infection in male pollinisers in clonal trials provides a valuable indication of their tolerance to Psa-V in the Bay of Plenty. Data has been collected from 29 males in clonal trials located at Te Puke and Maketu. Psa-V tolerance data has been assessed by comparing the number of male vines that have Psa-V infection symptoms.

The New Zealand Institute for Plant & Food Research Limited (P&FR) has documented the number of vines with Psa-V symptoms on the two clonal trials over the last 14 months. This includes the secondary infections such as cankers and cane or shoot dieback leading to removal of shoots, canes or whole plants. P&FR ranked selections of male pollinisers for sensitivity to Psa-V by using the following approaches.

1. Firstly, by ranking the number of vines that had to be removed due to Psa-V infection.
2. Secondly, by ranking the average number of secondary infections on hardwood portions of the vine.
3. Thirdly, by ranking the average number of secondary infections on softwood portions of the vine.

Using the above approach, P&FR has ranked what was expected to be the least susceptible, to the most susceptible (**Figure 1**). Note—the data presented here is a snap-shot in time as at 21 March 2012. It combines observations from the Te Puke and Maketu clonal trials. P&FR are continuing to monitor and manage these plants.

The level of secondary symptoms showing could potentially influence how simple it would be to manage the selections in a Psa-V environment. High levels of dieback could also indicate the plant is unable to resist systemic infections and may not be able to survive long term.

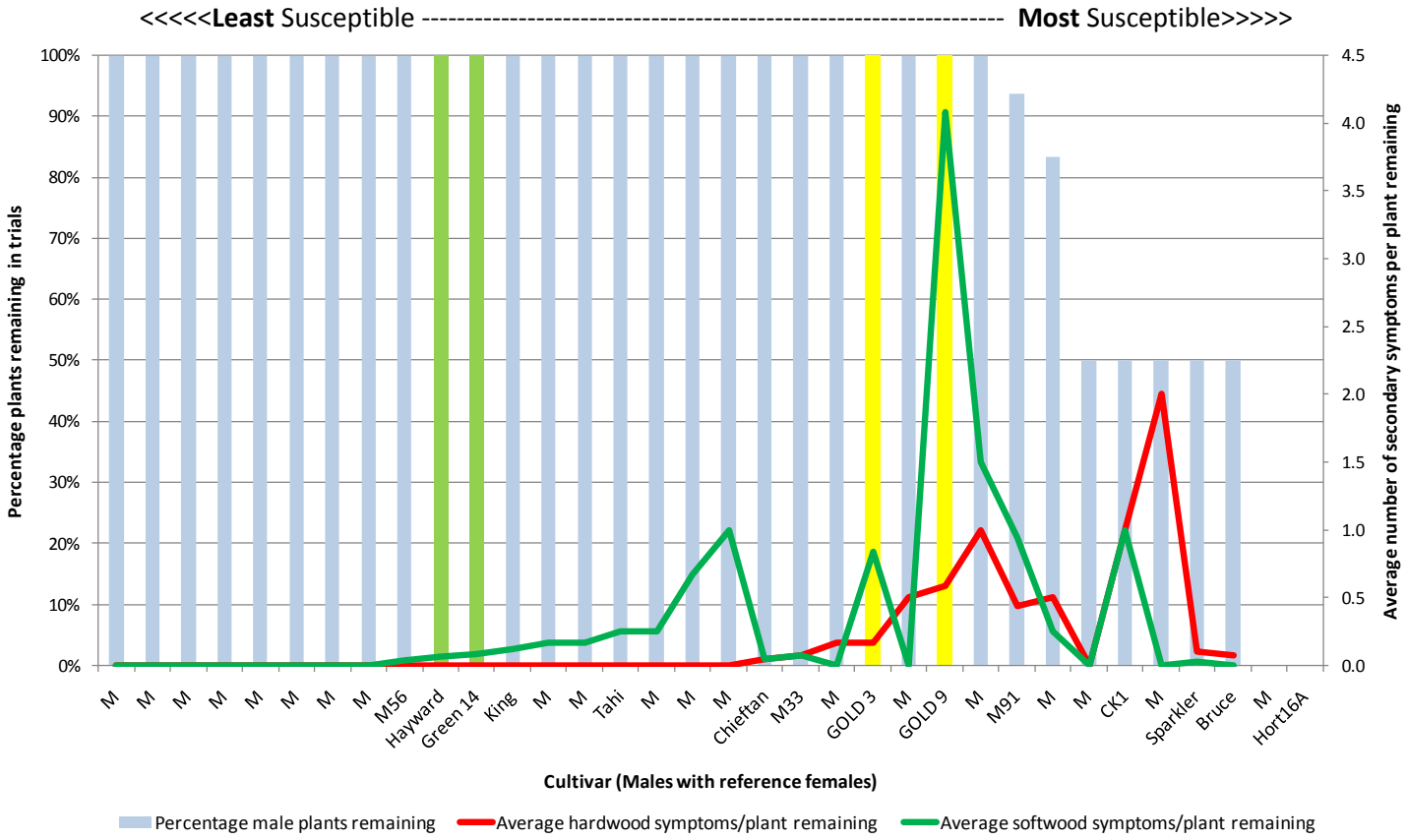

Figure 1. Surviving vines. Hardwood and softwood average counts per vine for male pollinisers at Te Puke and Maketu. The graph includes commercial females as reference point to susceptibility of the selection. M=Male in development.

Image 2 Male vine just after bud break

2. Industry observations

Growers in both Psa-V positive and Psa-V free regions were contacted by KVH. They were asked to provide information on all male varieties growing in their orchard(s). This information included the number of vines removed due to Psa-V, rootstock age and variety, vine vigour, floral load, and factors they thought impacted on floralness as well as male management techniques.

The most common male varieties included M91, M33, M56, Bruce, Chieftain, King, Sparkler (CK2), and Metor (CK3). The purpose of this survey was to determine which male varieties growers felt were more Psa-V tolerant and the factors that impacted on variability in Psa tolerance levels. **Table 1** below outlines grower observations on the perceived Psa-V tolerance of different males. When consolidating information from growers, there were three common themes which growers felt impacted on Psa-V tolerance: vine age scion and rootstock, environmental impacts and management techniques.

Female Variety	Male Variety (Ploidy)	Grower perceived Psa-V tolerance High - Medium - Low	RECOMMENDATIONS	
			Psa-V affected region	Non Psa-V affected region
Gold 3				
	Bruce (2x)	Low	Replace	Plan to replace
	CK2 (2x)	Low	Replace	Plan to replace
	M91 (4x)	Medium/ Low	Monitor/ remove infection	Monitor
	M33 (4x)	High	Introduce / increase vine numbers	Introduce / consider notch grafting
Gold 9				
	Bruce (2x)	Low	Replace	Plan to replace
	CK2 (2x)	Low	Replace	Plan to replace
	M91 (4x)	Medium/ Low	Monitor / remove infection	Monitor
	M33 (4x)	High	Introduce / increase vine numbers	Introduce / consider notch grafting
	M56 (6x)	Medium/High	Monitor / remove infection	Monitor
Green 14				
	Chieftain (6x)	Medium/High	Monitor/remove infection	Monitor
	M91 (4x)	Medium/ Low	Monitor/ remove infection	Monitor
	King (6x)	Medium	Monitor / remove infection	Monitor
	M33 (4x)	High	Introduce / increase vine numbers	Introduce / consider notch grafting
	M56 (6x)	Medium/High	Monitor / remove infection	Monitor
Hort16A				
	Bruce (2x)	Low	Remove if last harvest. Introduce males for New Varieties	Plan to replace
	Baker (2x)	Low		Plan to replace
	CK2 (2x)	Low		Plan to replace
	CK3 (2x)	Low		Plan to replace
Hayward				
	Matua (6x)	Medium	Monitor/remove infection	Monitor
	M. Series 6x)	Medium	Monitor/remove infection	Monitor
	Chieftain (6x)	Medium /High	Monitor/remove infection	Monitor

Table 1 Consolidation of New Zealand grower observations on the perceived Psa-V tolerance of males

Scion and rootstock age

Growers reported vine age as a key factor that impacted on male vine in Psa-V tolerance. Younger vines appear to be more susceptible to Psa-V than more mature vines. First dieback was also often seen in young growth first. Very susceptible varieties were impacted the same—irrelevant of scion age.

Growers reported that the grafting of males into more established rootstocks achieved greater scion tolerance than grafting into less established rootstocks or planting young grafted plants. In a Psa-V environment, there was a significant reduction in graft success when grafting into an *Actinidia chinensis* (Hort16A) stump compared to grafting into an *A. deliciosa* (Bruno/ Hayward) stump. *A. chinensis* rootstocks appear to be more susceptible to Psa-V than *A. deliciosa* rootstocks.

There are a number of factors that could have an influence on male variety Psa-V tolerance. A newly planted vine is often more exposed, with a smaller root system and has predominantly current season or one year growth. The carbohydrates in the vine are partitioned towards growth rather than plant defence. There is also the potential for nutrient imbalances within the vine. This can have an impact on plant defence as potassium deficiency is known to stimulate and increase in jasmonic acid production which can in turn, suppress salicylic acid production (Armengaud *et al.,* 2004). The immature periderm/bark which has not yet

become hard and woody is very susceptible to wire rub, wind damage, and frost damage. All these wounds are possible infection points for Psa-V.

Orchards with newly-grafted top-worked rootstock will face many of the same challenges as a young vine, as well as the potential for re-infection from the infected trunk. However, the new graft will benefit from a more diverse and well-established endophytic community within the trunk of the vine. It will also benefit from a larger, more established, root mass and a more diverse and well-established rhizobacterial community in the rootzone.

Both scenarios will face significant challenges if the orchard was previously infected due to the potentially high inoculum load.

All these factors highlight the importance of protecting young vines. Adequate shelter, frost protection, nutrition and protective spray coverage should be provided. They also heighten the need to reduce orchard and environmental inoculum levels through timely removal of all Psa-V infected plant material from the orchard.

Image 3 Mature male flowers

Environmental factors which may impact in variability of male vine Psa tolerance.

Growers reported that male vines in more shaded areas of the orchard, or in areas where the water table is quite high and areas of unfavourable soil conditions, have higher disease incidence and are often less floral. Vines that were stressed were often first to express Psa-V symptoms in the orchard. These observations suggest that any form of plant stress will lower the tolerance of the male vines to Psa-V.

Male vines located within orchards exposed to wind events or frost regularly showed more Psa-V symptoms and often expressed symptoms before male vines in well-sheltered areas of the orchard. This highlights the importance of adequate shelter to help reduce wounds created from wind damage.

Male management techniques

Growers reported vines grown under a low-vigour system, which resulted in a reduction in pruning cuts and pruning rounds, expressed less Psa-V disease symptoms. Vines that were severely pruned were stressed and often expressed more Psa-V symptoms in the new growth.

Flower synchronisation

The timing of male flowering generally varies with geographic location, altitude and season. Flowering variation is primarily due the average temperature decreasing and the number of days between budburst and flowering increasing (Goodwin, 2000).

Data was collected from growers according to the flowering times of their males in the 2011 season, and how well they overlapped with female flowering. It is important to note that it is undesirable to have only one male polliniser as synchronicity from year to year with each cultivar is not possible to guarantee. For more information on Flower synchronisation please consult the ZESPRI New Variety Information Guides on The Canopy.

3. Woody Stem Bioassay—for Male Pollinisers

P&FR have developed a woody stem bioassay as an indicator of tolerance to Psa-V. The bioassay is still in the early stages of development and should not be interpreted as an absolute measurement of Psa-V tolerance. In particular, the woody stem bioassay index (WSBI) values have not been constant when different samples have been collected over time. The data in Figure 2 was collected at the same time and from the same location as Figure 1 (Te Puke) so the relativity of the WSBI score is therefore likely to have less error in the relative scores of Psa tolerance. While the WSBI should not be relied on as the sole measure of tolerance, it is providing some indications consistent with field observations. This includes the higher susceptibility of Sparkler and Bruce, and the greater tolerance of M33 and Chieftain.

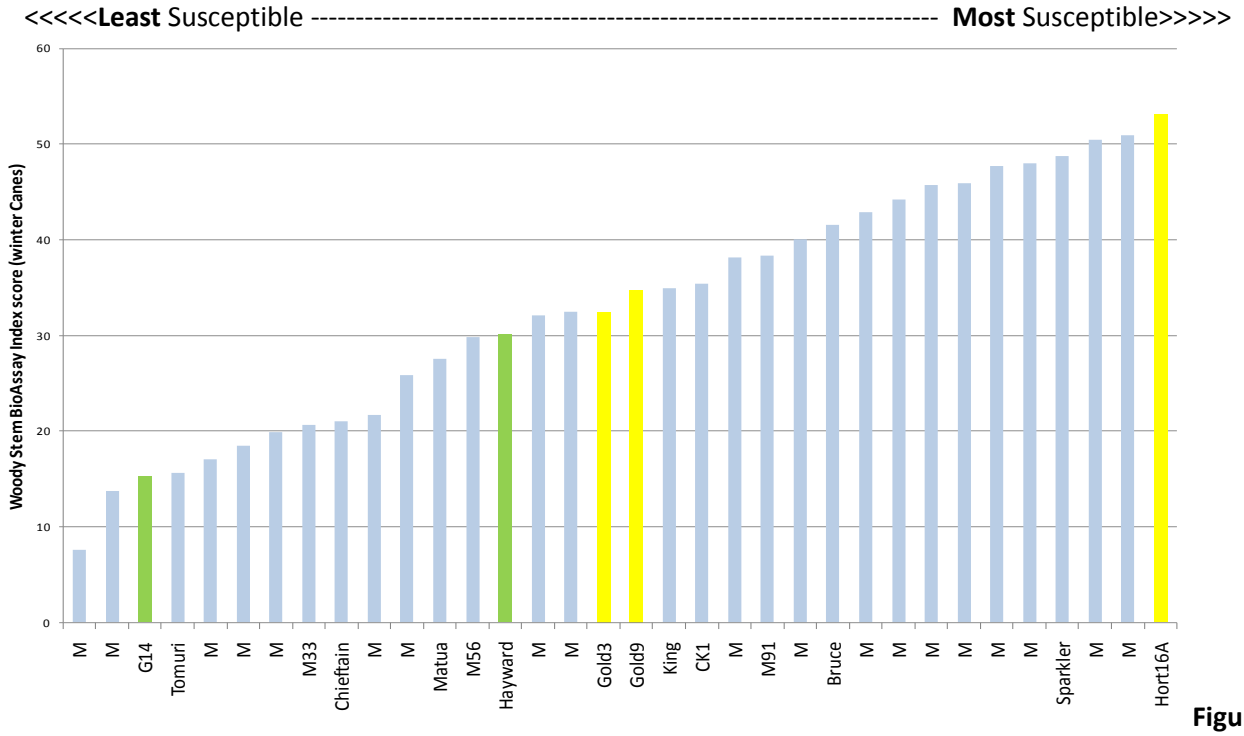

Figure 2. Woody Stem Bioassay Index Scores for male pollinisers from Te Puke in winter 2011. The graph includes commercial females as reference point to susceptibility of the selection. M=Male in development.

New Males are in development

As indicated in Figure 1 and Figure 2, there are a number of new males currently in development at the clonal trial stage. The most promising of these were placed into pre-commercial block trials this winter for budwood bulk-up and to gain a better understanding of the polliniser synchronicity with the target female. Trials will be undertaken in a number of locations to understand regional differences in performance. A better understanding of the new male's tolerance to Psa-V will also be developed. The most promising males will be released to New Zealand growers as soon as they have demonstrated commercial value.

Conclusions

It is clear from clonal trials, bioassay and grower feedback that different males have different tolerance to Psa-V. The clonal trial work is limited, but highlights there are significant variation in the vines' ability to resist systemic infection. It also shows there are a number of promising males under development. Feedback from growers outlined there are a number of factors that could impact on a vine's ability to manage within a Psa-V environment. Growers indicated the age of both the scion and rootstock was an important factor modifying Psa-V tolerance of the male scion. Environmental impacts and management techniques were also observed to modify Psa-V tolerance levels. The male varieties M33 and existing *A. deliciosa* males show the best tolerance to Psa-V. Vine management and modification of the environment to reduce the wounding and stress on the vines is an important consideration for all male varieties.

References:

Armengaud.P, Breitling. R, and Amtmann. A, (2004) The Potassium-Dependent Transcriptome of Arabidopsis Reveals a Prominent Role of Jasmonic Acid in Nutrient Signaling, Plant Physiol. Vol. 136,
Goodwin. R.M, (2000) The Kiwifruit Pollination Manual, available on ZESPRI canopy

Photography: Victor Jones.