Psa-V in kiwifruit—bacterial disease comparison with stonefruit and citrus

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Introduction

Following the discovery of the bacterial disease Pseudomonas syringae pv. actinidiae (Psa-V) in Te Puke, New Zealand in late 2010, a huge amount of research has been undertaken to increase understanding of the disease in an attempt to find an effective control method.

Other horticultural crops have also experienced significant problems caused by bacterial diseases. These include the stone-fruit industry with bacterial blast (Pseudomonas syringae pv. syringae) and bacterial decline (Pseudomonas syringae pv. persicae); and the citrus industry with citrus canker (Xanthomonas citri subsp. citri).

A comparison was made between the kiwifruit industry and these other horticultural industries, including their experiences managing these significant bacterial diseases. Some commonalities are presented in the table below. From the comparison, it appears that messages about the nature and management of bacterial diseases in other horticultural crops could be beneficial in the case of Psa-V in kiwifruit.

	Kiwifruit	Stonefruit	Citrus
Common name	Psa-V	Bacterial blast and decline	Citrus canker
Causal agent	*Pseudomonas syringae pv. actinidia*	*Pseudomonas syringae* pv. s*yringae* (blast); *Pseudomonas syringae* pv. p*ersicae (decline)*	*Xanthomonas citri* subsp. c*itri*
Host range	*Actinidia* spp.	*Prunus* spp.	Most *Citrus* spp.
Symptoms	• Irregular leaf spots (with or without halo). • Curling of leaves • Shoot wilting and dieback. • Red or white exudate or cankers. • Fruit shrivel	• 1–3mm circular or angular leaf spots (halo dependent on host species). • Tip dieback and foliage wilt. • Fruit spotting.	• Raised lesions on leaf surfaces becoming corky and crater like and surrounded by a yellow halo. • Fruit lesions. • Defoliation. • Shoot dieback. • Fruit drop.
Susceptibility and contributing factors	• Young, lush tissues are more susceptible. • Wounds and natural openings provide an entry point for the bacteria. • Some varieties have increased susceptibility. • Stressed vines are more susceptible. • Frost prone sites—utilise frost protection. • Waterlogging and/or drought stress.	• Young, lush tissues are more susceptible. • Stressed trees are more susceptible. • Young trees are more susceptible. • Wounds and natural openings provide an entry point for the bacteria. • Soils which allow for drought stress or flooding. • Frost prone sites. Utilise—frost protection.	• Young, lush tissues are more susceptible. • Wounds and natural openings provide an entry point for the bacteria. • Early citrus varieties appear to have a higher level of susceptibility than later ones. • Plant attack by citrus leafminer (Phyllocnistis citrella) can increase levels of infection.
Disease cycle	• Spread primarily by weather events such as rain and high winds. • Primary infection occurs via leaf stomata and open wounds. • Once in the plant, bacteria move systemically to create secondary	• Bacteria splashed from leaf and fruit spots and enter leaf scars and other wounds. • Bacteria over-winter on weeds or in cankers. • Spring rains cause bacteria to be	• Bacteria ooze from leaf lesions during rainfall events. • Bacteria over winter in cankers on infected plant tissue. • Bacteria are spread by wind, which can drive bacteria into stomata and other

	symptoms. • Bacteria has been recorded on shelter species, orchard machinery, and in water, soil, and beehives.	splashed onto developing leaves and fruit causing infections. • Bacteria move systemically into younger tissues. Mature leaves are resistant to further infection. • Canker progression slows during summer due to callusing and cankers drying out.	wounds. • In most cases, infection will occur during the first six weeks of growth. • Bacteria can also be spread on hands, clothes and equipment. Therefore, working on trees in wet weather is avoided.
Climatic conditions favouring infection	• Rainfall • High winds • Frost damage • Cool temperatures.	• Frequent rainfall, • High humidity • Cool temperatures • Strong winds	• Rainfall • Wind speeds >30 km/h.
Spray practices	• Maintain an effective crop protection programme, integrating copper sprays throughout the growing season. • Streptomycin pre-flowering to reduce inoculum pressure. • Elicitors to stimulate plant immune response	• Control starts at planting and continues throughout the life of the plant. • Spray prior to leaf fall with weak Bordeaux mixture, copper or streptomycin. • Regularly apply Bordeaux mixture or coppers during autumn to prevent bacteria entering leaf scars. The leaf fall period can be shortened by using defoliants. • Apply copper protectants during the growing season. Ensure adequate protection is applied prior to rainfall events.	• No material has found to be more effective at controlling citrus canker than copper. • During early growth, copper protection is reduced due to rapid growth and needs to be maintained during this period. Two to three copper applications may be needed during the first 90 days post-fruit set to provide protection. • After 90 days post-fruit set, three to five applications of copper at 21-day intervals are recommended.
Cultural practices	• Remove secondary infections. • When pruning, target hardwood cuts as these are less susceptible to infection. • Avoid making cuts which will encourage new growth during the summer. Ideally, all growth should be	• Make shorter, more frequent daytime applications with overhead irrigation to reduce leaf wetting and infection risk. • Remove infected branches. • Avoid wounding during spring and autumn when inoculum levels are highest, or before rainfall events.	• Windbreaks should be established around, and within, blocks to reduce wind speeds to less than 30 km/h. • Prevent the transfer of plant material between blocks. • Clean all equipment thoroughly, including tools and machinery.

	hardened off before the start of autumn to reduce infection risk. • Seal or cauterise all wounds. • Clean all equipment thoroughly, including tools and machinery. • Do not transfer plant material between orchards. • Remove high growth from males. • A low vigour growing system will help to improve spray coverage	• Remove weeds which may provide an overwintering location for bacteria. • Reduce fertiliser inputs to limit the production of young, lush growth. • Pruning should not stimulate lush new growth. • Summer pruning should occur early enough for soft growth to harden off before frosts. • Winter pruning should be completed before sap flow begins. • Indication that stub cutting may prevent infection moving back into main trunk in sweet cherry. • A sweet cherry trial found copper sprays provided minimal protection to wounds. However, there was a benefit from inoculum reduction by copper.	• Remove infected material. • Only carry out pruning work during dry weather. • Severe pruning or chemical defoliation may provide some control. Defoliation or pruning should only be attempted during dry weather.

Conclusion

Overall, there are a large number of similarities between bacterial blast and decline in stonefruit, citrus canker in the citrus industry and *Psa-V* in kiwifruit. All these diseases produce similar symptoms, target the same tissue types in their host plants, and follow a similar disease cycle. Adopted methods of control for these bacterial diseases in the stonefruit and citrus industries also follow similar patterns. Firstly, exclude the disease from the orchard as vigorously as possible. If the disease infects the crop, remove the infected material in a timely manner.

Copper application provides the best proven defence and knockdown of bacterial diseases in both stonefruit and citrus. Additional changes to the cultural management in the orchard also pay huge dividends in reducing the impact of bacterial disease on the host crop. This includes minimising the presence of lush growth and reducing fertiliser inputs, to modifying irrigation systems to decrease the level of leaf wetting. As in the case of *Psa-V,* both the stonefruit and citrus industries have had a great deal of experience managing bacterial diseases in their respective crops. The kiwifruit industry would benefit to learn from these industries.

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