

Learning from global orchardists' responses to the *Psa* epidemic

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Abstract. Recent outbreaks of *Pseudomonas syringae actinidae* (*Psa*) highlighted the challenges of crisis extension. Best practice bacterial disease techniques and sharing of field experiences were used to provide control recommendations. However the lack of an effective toolbox, misinformation and grower perception that a 'silver bullet' would be found, resulted in inadequate control. Grower stress contributed to irrational decision making with many failing to act appropriately. Zespri led the outbreak response. The more effective techniques included the rapid development of best practice material and weekly technical meetings with key technical staff. The use of influential orchardists was used to influence their peers. Overseas trips were arranged for key orchardists to educate them through interactions with affected growers overseas. Profiling worst case scenarios associated with inaction had to be carefully balanced to avoid creating a sense of helplessness. Adoption of best practice often began once an orchard contracted *Psa*, limiting its effectiveness. At the commencement of the global *Psa* epidemic, effective extension occurred with the delivery of consistent best practice messaging, largely derived from experience and delivered by knowledgeable professionals and influential growers.

Keywords: Kiwifruit, Zespri, stress, extension, crisis

Background

The recent outbreaks of Kiwifruit Bacterial Canker has had a significant economic impact around the world. Estimates of New Zealand's production loss alone is in the order of \$300-400M¹ over a five year period. However, this will be heavily dependent on the industry's ability to recovery from the epidemic.

Bacterial canker of kiwifruit is caused by the bacterium *Pseudomonas syringae pv actinidiae* (*Psa*). This organism was first recorded in Japan in 1984 and affects all commercial varieties of *Actinidia chinensis* (yellow and red fleshed) and *Actinidia deliciosa* (green fleshed). It is also present in China and Korea. It was first recorded in Italy on the Hayward variety in 1994, and as a more virulent pathovar on Hort16A (Zespri[®] Gold) in 2008, and then in NZ in 2010. Until recently, its economic importance worldwide has been relatively minor as growers, particularly in Asian countries, have developed management strategies to minimise its impact. However, in 2009, a serious outbreak occurred in the Latina region of Italy was followed by outbreaks in France and New Zealand with serious economic consequences (Greer and Saunders 2012). The bacteria present in Europe and New Zealand has been determined to be a different and more virulent pathovar than that originally reported in Japan and Korea. The disease has now been recorded as present in all major kiwifruit growing countries in the world, thought to have spread principally through the movement of infected or contaminated plant material.

Psa is a particular virulent and difficult to control disease for a number of reasons. It prefers cooler wetter conditions and can survive both externally and internally within the kiwifruit vine. There is little knowledge of its epidemiology and the few chemical control options that are available are only partially effective. Symptoms range from leaf spotting to flower bud death, shoot and cane dieback, cankers and severe decline which can occur over one to two seasons for the more susceptible varieties (KVH 2011). Latent infection can occur with vines being infected but not showing infection for several years. The bacteria may require an environment trigger (e.g. a specific combination of cold and wet) that allows a population explosion that then results in symptom expression.

The epidemics which occurred in Europe and New Zealand are considered to be linked to the recent commercialisation and associated plant movements of *Actinidia chinensis* varieties (yellow fleshed varieties). and to several consecutive wet cold growing seasons which favoured the development of an epidemic infection. Zespri's Hort16A was particularly susceptible.

Initial responses - Italy

In Italy, France and New Zealand where Zespri was at the forefront of managing the response to *Psa*, similar reactions by growers and associated industry parties were consistently observed when infection was first identified. When symptoms were first seen on Hort16A in Italy in summer of 2008, technical staff did not know what the disease was, but assumed it was a

bacterial infection and the advice offered to the initial affected grower was to remove infected material and spray copper. Unfortunately the grower applied a copper spray but did nothing about removing the infected material which resulted in a sufficient inoculum source which allowed the epidemic to develop across the Latina region the following spring. Once the disease was diagnosed and the level of infection seen in the following spring, Zespri rapidly developed best practice advice. This was provided to growers based on advice of bacteriologists familiar with plant diseases in perennial fruit crops. Dr. Joel Vanneste, a bacteriologist from Plant and Food Research was a key player, having had wealth of experience with fireblight (*Erwinia amylovora*) research and management as well as other *Pseudomonas* species.

Best practice was seen as the elimination of infectious material in the orchard to contain spread within orchard and to surrounding blocks. Actions to achieve this included:

1. Application of protectant copper sprays on a regular basis to prevent further new infection
2. Monitoring orchard regularly for signs of infection
3. The rapid removal and destruction of infected material by burning or burial.

Most growers did not respond appropriately, failing to comprehend what was in front of them, believing somehow that their orchard would respond differently to those falling to the disease around them. Common responses observed included:

1. Spraying: The spraying of copper sprays to prevent infection was not initially widely taken up. Most growers only started spraying once infection was seen, a time when protectant sprays are relatively ineffective (Figure 1). Fear of leaf and fruit damage from sprays contributed to the slow response.
2. Monitoring: In controlling any epidemic knowing where, and how severe the disease is, is useful in developing control strategies. However, given the level of spread both within and across orchards this was difficult to achieve. Most growers reported the first incursion but saw little value in monitoring or reporting change in their orchard situation as within one week the levels of infection could change significantly. In Italy, Hort16A was a minor proportion of the total kiwifruit area and while relatively reliable data could be achieved on the presence in the different Zespri Hort16A orchards, the uncoordinated nature of the Italian industry made gathering accurate data from Hayward orchards impossible.
3. Removal: It quickly became apparent that whole vine removal including surrounding buffer vines was required if infection was to be contained. However, as this required the removal of seemingly healthy vines, it was not widely accepted by Hort16A growers in Italy or later in NZ, as it came with a significant short term economic cost. Hort16A orchardists orchard gate returns (OGR) are considerably higher than the alternative Hayward crops (e.g. NZ 2011/12 OGR were NZ\$33,000/ha compared with NZ\$91,000/ha for Hayward and Hort16A respectively).

Figure 1. Copper spraying after *Psa* infection has occurred



Source: Personal file

The decision to start spraying once symptoms were observed in the orchard and its subsequent lack of success at eliminating infection resulted in growers doubting copper sprays were effective. Several years on we now know copper provides a reasonable level of control particularly when used in conjunction with other sprays and management tools.

This resulted in many Italian agents promoting products that offered the silver bullet to cure *Psa*. Growers frustrated at the seemingly low level of control copper provided, started using these other products, often replacing copper, which further compounded the infection and spread. Even those in the Italian science community, many affiliated with commercial companies, started providing conflicting advice to growers on what to spray and how to manage the disease. Many of the products promoted were unregistered, or were plant health products not requiring registration. However, the growers were desperate and prepared to try anything to save their vines.

The conflict in the science community was heightened by the perception that foreigners were providing the advice. The initial incursion was largely a Hort16A issue and so Zespri spear-headed the response with what it considered the best expertise available. While appreciated by the majority of growers, a number of local scientists resented Zespri's use of outsiders and provided conflicting messaging to the industry's technical staff with whom Zespri was engaging on a regular basis to share experiences and information.

Initial responses - New Zealand

Many of the initial grower responses observed in Italy were also seen in New Zealand and France, but having experienced the Italian situation and with more resourcing available in New Zealand, a greater response was able to be undertaken. Spring 2010 in New Zealand initially saw three orchards express *Psa* symptoms. Given the experience in Italy, best practice was considered to be complete cutting back of infected Hort16A orchards. Two of the three orchardists undertook this relatively quickly and before any formal compensation was in place. These growers are to be commended for their actions as it is an extremity difficult decision to remove an orchard based on the advice of experts when they had never experienced the devastation that *Psa* causes. Government assistance was sought and granted but unfortunately, encouraged by a wet summer, the disease quickly spread across the Te Puke area and cutting out gangs could not keep pace with the spread of disease. This resulted in the stopping of compensation payments for removal in late summer 2011 as it was considered that eradication would not be possible. A significant number of growers did not start preventative copper sprays until after their orchard become infected which could have helped to hasten the rate of spread across the district. Interestingly, even after harvest when there was no risk of fruit damage and when compensated to spray, only 70 per cent of growers in the affected areas did so!

Monitoring programmes were put in place to understand the spread of the disease within the Bay Of Plenty but was severely hampered by the PCR testing procedure that was also detecting a closely related but non aggressive bacteria – *Psa LV* (low virulent). Field symptoms became a more reliable tool or diagnosis, at least on Hort16A.

Why did New Zealand (and French growers) initially react very similarly to their Italian counterparts despite the additional knowledge? Key factors that are likely to have influenced this include:

- A general lack of knowledge or awareness of the potential impact on their business.
- The belief that the New Zealand environment was sufficiently different to overseas and so *Psa* would not be as virulent here.
- The inability to predict what the possible final outcome would be in New Zealand, or France, e.g. it might be better next year?
- Some innate belief that 'my orchard would be different as I am a better grower'.
- The financial strain that cutting out an orchard would have on the owner and what the future would then hold especially for orchardists whose orchards were young and from which they had not yet received much income. Increased anxiety levels which often resulted in the inability to make a decision.
- So called 'experts' with no experience with *Psa* – publicly stating Zespri and Kiwifruit Vine Health (KVH), an industry group set up to manage the *Psa* response, was overreacting.
- Lack of experience with copper spraying and lack of spraying capacity.
- Growers of other varieties believing it was Hort16A problem.

Crisis extension activities

Irrespective of nationality, it was apparent that growers more than anything else preferred to communicate face-to-face, and preferably one-on-one, through the *Psa* crisis. This reflects the need not only for information but for emotional support. Constant repetition of key messages was needed in these discussions, as growers in a heightened state of anxiety, do not assimilate information as effectively or efficiently as when more relaxed. Clearly this creates unique

challenges especially when working across different nationalities where interpreters are required.

In New Zealand, one-on-one meetings utilising knowledgeable extension staff was impossible given the size of the industry. A more pragmatic approach was required utilising the extension network in the various industries.

Various methods were utilised. These included:

- Written material: Agreement and development of written best practice material which was updated as new knowledge became available
- Technical discussions
- Identification and regular contact with key influencers
- Grower tours
- Use of electronic media
- Support of robust grower trials and analysis of industry databases.

Published material

The development of best practice material allows key technical staff to agree on key messaging which can then be extended to industry extension networks. While a lot of the initial practices were a 'best guess', it was imperative that consistent messaging was provided as a stressed anxious grower's reaction to inconsistent messages was typically to do nothing!

Several years on from the outbreaks, much of what was written remains unchanged, as it was based on the principles of bacterial disease control. While considerable investment was, and is continued to be placed into research, by nature it is difficult to gear up and provide understanding quickly. In some ways this is fortunate as although growers were advised that as our knowledge grew, advice would change, this creates additional challenges for extension staff, not only in ensuring all growers hear and react to the new information quickly, but also on the effect change in information has on grower anxiety.

Initially, written information took the form of regular newsletters which then evolved into a comprehensive series of fact sheets and visual aids covering a wide range of topics developed by researchers and Zespri staff. With the formation of KVH, a Management Guide(KVH 2013) was created that summarised key management information and made reference to other resources. This included staff and orchard hygiene, vine management, agrichemical and disposal options.

Technical meetings

In several countries weekly technical meetings were set up. Initially these provided a forum for packhouse technical staff, consultants and Zespri personnel to come together to discuss what was been observed in the field and what we could learn from it. This was a rather unusual experience as historically most of the attendees would have considered themselves competitors. Zespri played a facilitator role and got agreement of what messaging should be delivered from what was being observed. It also provided moral support to technical staff, who in sharing their experiences realised they were not alone. Furthermore staff from facilities in areas where *Psa* has not yet reached gained some knowledge of what to expect both in terms of the disease and the grower reaction to it. Where there were key influencers missing from the meetings, Zespri staff would ensure they were informed afterwards. This assisted with consistent messaging. Over time, formal meeting minutes were taken and distributed to any interested parties. In New Zealand these forums have continued under the guidance of KVH. They have evolved to provide a forum for discussion of draft KVH policy and initial research findings as well as field observations.

Wider grower meetings were held in all growing regions at key times to reinforce key messages and disseminate new knowledge. In-field events were difficult as infected growers did not want to host them nor did they want to attend events on infected orchards for fear of their orchard getting infected. This was despite hygiene procedures being in place. In presentations a balance had to be struck between informing uninfected growers about what lay ahead without creating too high an anxiety level. Creating a sense of helplessness would drive inaction or irrational action. Thus, meetings typically delivered a combination of what to expect and what to do to mitigate the impact.

One particularly noteworthy success was the KVH 'three wise men' meetings. In 2012 three well known and reputable Bay of Plenty growers who had lived through a season of *Psa* were profiled at meetings in other districts (and via video). They discussed their business and management approaches and the results; messages were well aligned with industry best practice. It is well

recognised in the kiwifruit industry that other growers are very effective in influencing change management with other growers.

International grower tours

The power of growers educating growers was also utilised in Zespri facilitated international growers tours. These had been successfully used prior to *Psa* in the sharing of ideas across Zespri's global grower base. With the arrival of *Psa* into all countries over a short time frame, grower tours between New Zealand, France, Italy and Korea occurred. This allowed growers to see first-hand how the disease was impacting others in different environments and what approaches were being taken to disease management. When tours were organised for New Zealand growers to Italy, Zespri targeted a number of key influencers in the industry to attend these. Upon returning to New Zealand these influencers became strong advocates of best practice management, having been strongly affected from seeing first-hand the effect the disease was having on their Italian counterparts. A similar result was seen from later visits from Zespri's Korean and French growers visiting New Zealand.

Electronic media

A number of e-initiatives were developed. The first significant one was the setting up of an international website in 2009 (www.batteriosi.com). This provided information about the disease and its control in three languages, English, French and Italian. This was initiated by Zespri with the support of some of its Italian suppliers to ensure all growers in Italy and France had a reliable source of information. European kiwifruit industry and government agencies are relatively poorly organised relative to NZ and Zespri was simply able to respond much faster. Over time and with the growing complexity of information and the costs of keeping the website current, the website was terminated. By this time however, other organisations were more actively involved in disseminating information and had developed their own websites. The rapid improvement of internet translation sites also meant there has been much greater use by Europeans of the comprehensive KVH website over the last couple of years.

Electronic newsletters in Italian were also initially produced for Zespri's Italian growers but these were encouraged to be circulated to all interested parties. This later occurred in France as well. The rapid response and willingness to share with all growers had an additional benefit; Zespri's reputation, as a responsible corporate who supports its growers, grew significantly.

In New Zealand, KVH developed a comprehensive website and weekly e-newsletter which over the last two years has gone through several upgrades as the level of content has grown. A risk model, used as a management and spraying decision-support tool was developed in conjunction with NIWA and Plant and Food Research and is located in a secure part of the site, only accessible to New Zealand growers.

Another successful initiative has been the use of short video clips both of techniques and experts which allows the rapid dissemination of new ideas or observations to be shared across all the growing regions. These are typically recorded by extension staff. All substantive growers meetings are professionally recorded and posted to You-Tube or made available to growers via DVD.

Grower trials

The arrival of *Psa* demonstrated the lack of knowledge of the bacteria and control options. The re-direction of industry research expenditure and the initial reaction to look for radical quick fixes initially hampered knowledge that could be utilised by growers. Fortunately, Zespri's global technical transfer staff had developed sound grower trial skills over recent times and these came to the fore in the initial years of the outbreak. The number of questions growers wanted answered was immense, from spray product efficacy and their side effects, to appropriate cutting and disposal techniques. Numerous robust replicated field trials were set up in conjunction with orchardist collaborators in all growing countries. This provided some sound information on which to improve best practice advice. The ability to make use of both northern and southern hemisphere countries allowed rapid gains in knowledge, e.g. New Zealand growers did not have to wait a year for the answer. A trial set up in Europe to answer a NZ spring related question had results available before spring in New Zealand. Extension staff also found grower trials useful to refute misinformation being provided by so called experts with no experience with *Psa*.

In summary, a wide range of traditional and new extension techniques have been used in the management of *Psa*. The response is notable for the speed of development and execution of extension programmes due largely to the seriousness of the situation, the abilities of a well-coordinated industry with a central commercial industry body and the commitment of the

extension staff within. Despite a reduction in income, Zespri increased its expenditure in extension related activities, recognising the benefits of a rapid change in orchard management to minimise the impact of *Psa* would have across the whole industry.

What of the future

The Zespri 'Recovery Pathway' was initiated in the winter of 2011. Initiated by technical and extension staff, it advocated the complete removal of all Hort16A due to the inability to effectively control the disease and continued commercial cropping with the management tools available. The Recovery Pathway proposed, and now implemented, was for all Hort16A growers to be encouraged to swap out of Hort16A to a new recently released Zespri licenced variety, all three of which were perceived to be a lower *Psa* risk than Hort16A. The Recovery Pathway saw the complete re-grafting of all Hort16A vines in the Te Puke area in 2012, with most other areas, both in New Zealand, and overseas following suite.

Is it working? It is still early days but despite several hiccups it appears that without infected Hort16A, and its associated high *Psa* inoculum loads, success with the present tools may be possible. One of the replacement varieties, Gold3, while not resistant to *Psa*, is showing good tolerance and acceptable production levels two years on from the *Psa* incursion.

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