

# Report on investigation of orchards in Brazil affected by *Ceratocystis fimbriata*

## Executive Summary

On 16<sup>th</sup> and 17<sup>th</sup> of January, Barry O’Neil and Dave Tanner visited orchards and researchers in the South Brazilian region of Farroupilha, to investigate the situation of kiwifruit vines dying from the fungal pathogen *Ceratocystis fimbriata*.

The first reports of vines dying from the disease were five years earlier, and since then limited research has been undertaken. Brazilian and American scientists have shown this fungal pathogen is causing the rapid vine collapse and vine death being observed in the region, but how infection is spreading and how the pathogen causes vine death is still unknown.

In Brazil the pathogen is present in the soil, and it would appear this is the major source of infection, and could be present in roots of a vine for some time, possibly years, but at a certain point the vascular system of the vine is blocked and the vine rapidly collapses. Wilting is the first symptom, with complete vine collapse occurring as quickly as three days. It also appears that growers have spread the disease from vine to vine by using orchard equipment that hasn’t been sanitised between vines.

No treatments have been successful to date, with phosphoric acid and fungicides being trialled by most growers. One of the worst orchards we visited 50% of the vines had died in one block over a five year period, with the other orchards visited having losses of 20-30% of their vines. The dead vines are adjacent to each other, creating a “circle of dead vines” as the disease moves most likely through soil and the root systems. Most growers are not removing dead material from the orchard.

Most alarming is that the complete vine dies rapidly, including the rootstock, and from what we observed Hayward on Bruno rootstock seemed to be affected more than other varieties on Bruno (Monty, Elmwood, Yellow Queen). Variable success is achieved when replanting in the areas where vines have died, with many of the replacement plants also dying at a young age.

While they believe they don’t have Psa, they haven’t undertaken any testing to determine the situation, and we did observe leaf symptoms suggestive of the disease.

This disease is of significant concern, and not only must it be kept out of New Zealand, but we need to understand how it is killing vines so that if it does arrive in New Zealand, or if it is already present here, we are able to effectively manage it before it devastates production like it is doing in Southern Brazil.

## Recommendations

1. A full literature review be commissioned to better understand what is known of the fungus in kiwifruit and other horticultural crops.
2. The genotype of the Brazilian strain be compared to the New Zealand genotype to determine how similar they are.
3. Consideration be given to the New Zealand strain being tested in containment on kiwifruit plants to determine whether it can induce disease.
4. Consideration is given to sending a Plant and Food researcher to the Embrapa research facility to work with their scientists in identifying any other pathogens that may be involved.
5. Information on the Psa testing options available is sent to Embrapa research facility.
6. KVH plant health protocol be shared with Embrapa.

## Background

*Ceratocystis fimbriata* is a fungus that has world-wide distribution, including in New Zealand where it was first identified in 1907 causing black rot on kumara. Over the last decade Brazil has reported on more significant disease impacts of plants exhibiting wilts, cankers and root infection, including in kiwifruit.

An initial literature search identified few specific research papers on the situation in kiwifruit, but did indicate this pathogen was causing serious problems in Eucalyptus, Mangoes, coffee and passion fruit in Brazil, as well as in other countries (Uruguay, Africa, and Asia). It is reported the fungus is naturally present in the soil in some specific regions of Brazil, and that disease results from a “species complex” many of the species have not yet been identified, but ideal temperatures for growth are between 20-25°C. The Brazilian strain of this fungus is known as the Latin American clade (also North American and Asian clades), and researchers believe that the strain that causes sweet potato black rot is of the same clade.

## Report

During a Government trade delegation visit to Brazil in 2013, the Zespri participants were concerned to hear of a disease killing kiwifruit vines in Southern Brazil claimed to be caused by a fungus *Ceratocystis fimbriata*. As a result, a visit to Brazil occurred in January 2014 involving David Tanner GM Innovation at Zespri, and Barry O’Neil CE KVH, along with Betina Kayloi the Zespri marketing manager based in Brazil. The trip involved visiting the affected region in Rio Grande do Sol, looking at orchards and meeting with researchers who had observed the situation.

The area visited was Farroupilha which is approximately 100km inland from the Southern Brazilian city of Porto Alegre, where there are 57 growers in the region growing approximately 100 hectares of kiwifruit. In total, Brazil has approximately 500 hectares of kiwifruit, most grown in the regions of Farroupilha and Santa Catarina.

While the initial kiwifruit variety planted in the late 80’s was Hayward on Bruno rootstock, Hayward hasn’t been a consistent producer and as such many other “older” varieties are also being grown including Monty, Abbot, Elmwood, Bruno, Golden King, Yellow Queen, and a gold variety also called Farroupilha.

The Farroupilha region is 700 metres above sea level, with rainfall of 1500mm, and temps of 30°C in summer down to zero in winter. However, winter temperatures fluctuate significantly with temperatures of 20°C also occurring therefore creating little winter chilling. The soil appeared very fertile with table grape and apple production being the main horticultural crops grown in the region, along with Eucalyptus forestry, and livestock farming.

Brazil started research into possible kiwifruit production in the 70’s at an agricultural research station in San Paulo. Material from this institute as well as plant imported from Chile in the 90’s form the basis of the genetic material being grown in the region (however there is also a suggestion that a Japanese grower in the Santa Catarina area may have illegally imported plant material from Japan).

According to growers and researchers visited, the disease was first identified five years ago, but many believe it has been present in the region for much longer. Little direct research has been done on kiwifruit, but researchers in the USA have looked at the genetic diversity and due to the low levels found, believe it has been recently introduced into kiwifruit (growers believe from the San Paulo institute where the original kiwifruit material came from), but the literature would also support it transferring from Eucalyptus trees that are widely grown in the region.

Dr Graziela Piveta from Santa Maria Federal University has looked at the fungus and its genome, and she has proved Koch’s postulates within kiwifruit, and published the results in her thesis. Contact has been made with Dr Piveta to further discuss the work she has done and is doing in this area.

## Orchard visits

### Silverstrin home orchard

2ha of Hayward on Bruno rootstock with Chieftain males, first noticed vines dying four years ago and so far 20% of the vines have died. Circular patterns of infection have been observed in the orchard (radiating out from earlier infected plants), with replanted Bruno also dying. Rapid collapse, dry canes/wood, and root lesions observed. Typical browning of the xylem seen in affected vines, moving from canes to leaders, trunks and even down to roots (or possibly spread had occurred from the roots). Some Psa-like leaf spotting seen.

Very low levels of production in the orchard, estimated at 5 tonne (with potential of 38 tonnes) in part to a frost event, but poor polination also being a contributing factor (no beehives used in orchard), along with the fungal disease.

### Sileteo Contini orchard

4ha Monty and Yellow Queen, with significant impacts from Phytophthora and Armillaria in the lower areas of the orchard due to wet conditions. Males have nearly died off completely and approximately 20% of females also had collapsed from what appeared to be a number of factors, including the fungal disease. Unable to find browning of the xylem in affected Monty plants, even though they were in advanced stages of the disease.

### Carlos-Bohn orchard

15ha of MG06, Monty, Bruno and Elmwood producing approximately 20 tonnes per ha. Phosphoric acid sprayed onto orchard (Aliett 400gm per 100l) 3 times a year and the growers believe this has helped. Also trialled injecting infected vines but no difference observed and vines still collapsed. When vines die, calcium is used on the ground before replanting. Pectobacterium-like fruit rot observed on fruit, which they put down to swelling of fruit after long dry period followed by rain. Only plant material introduced was scion wood ten years earlier. Approximately 10% of vines affected by this fungal disease, lower than the other orchards visited.

### Silverstrin fathers orchard

10ha Hayward and Farroupilha gold. Most severely infected orchard visited with symptoms first observed five years ago, with up to 50% of vines dead in some blocks. Aliett used every 20 days as a foliar spray, and vines injected with a fungicide (Alternate). Nothing seems to be effective in stopping vine death, and as a result of what we observed we questioned whether Hayward is more susceptible on Bruno rootstock than Monty on Bruno rootstock?

### Farroupilha State Research Orchard

This centre didn't have the fungal disease which is surprising as no hygiene measures are being employed. Small breeding program being conducted to identify a low chill kiwifruit variety, and orchard had multiple varieties (Monty, Elmwood, Bruno, Hayward, Golden King, Yellow Queen, Farroupilha gold) Hayward, Gloria and Aguta were also introduced into the centre in 1990 from Italy, and Hort 16A seedlings are being grown in the breeding program (but the majority are males).

### Embrapa (Ministry of agriculture)

As kiwifruit is a very small horticulture sector in Brazil, the government hasn't funded any significant work in determining the cause of the disease, or options for treating. Most of the work that has been completed is from collaboration with Universities in Brazil and North America.

The work that has been completed includes publishing advice to growers, field visits for technology transfer, and collection of samples from infected orchards (which haven't as yet been fully analysed).

Of the 23 samples that have been taken from diseased plants between May and November 2013 they have identified 19 (82%) with *Ceratocystis fimbriata*, along with a smaller number of other soil borne fungi. No bacterial or virus testing has been performed, but they are focusing on soil fertility as a possible factor involved.

They hope that in 2014 they will be able to fund further work looking at epidemiology and plant management, along with a plant health scheme for nurseries, and have requested New Zealand assistance.

**Appendix:** Photographs from the orchards visited.

**Silverstrin home orchard**







**Sileteo Contini orchard**





**Carlos-Bohn orchard**





**Silverstrin fathers orchard**



