Research Summary: Ceratocystis Readiness Program (BS20150)

Summary is current as of July 2023

Ceratocystis fimbriata is a fungal species that consists of many strains. *C. fimbriata* strains have a wide and unpredictable host range, both as a simple wound coloniser and as an aggressive tree killer. In the past 15 years, new host crops and new epidemics of *Ceratocystis* wilt have been reported worldwide, especially in Brazil and Asia. It has been recognized that isolates of *C. fimbriata* are generally not host specialized, and that can have different levels of aggressiveness to different hosts or even cultivars of the same host.

In kiwifruit, the disease can reduce fruit size, form lesions, and sometimes kill the vine. The first reports of this pathogen on kiwifruit, were in Brazil in 2010, causing some cultivars to experience up to 50% vine loss on-orchard. These impacts and the lack of control tools has ranked this pathogen as a significant biosecurity threat to the New Zealand kiwifruit industry and is the highest-ranking pathogen on KVH's 'Most Unwanted' list of threats. KVH has been working in partnership with Biosecurity New Zealand (BNZ) on readiness plans for this threat, and with Zespri Innovation to deliver research to ensure we have the tools and knowledge to respond or withstand an incursion of this organism.

Below is a summary of the research completed from our most recent research program for *C. fimbriata* (BS20150) which is looking to improve the kiwifruit industry preparedness through targeted research funded through Zespri Innovation and in partnership with KVH.

Dissemination of *Ceratocystis fimbriata* via pruning tools

Purpose: Spread of *Ceratocystis* in other hosts mainly occurs by insects, infected rootstock or grafted plants and infested pruning tools and equipment. In the hosts that need pruning, like kiwifruit, pruning tools could disperse the pathogen from infected plants to healthy plants. Therefore, it is important to determine if *C. fimbriata* can be disseminated in kiwifruit by infested pruning tools which will help to develop strategies to control and eradicate the disease in orchards.

Objective: To evaluate the dissemination of *C. fimbriata* by pruning tools on kiwifruit.

Result: It was found that *C. fimbriata* can be spread from a diseased plant to a healthy plant by contaminated pruning tools in the two tested kiwifruit cultivars (Monty BR and Gold3 NZ). This highlights that tool hygiene is important to prevent the spread of pathogens like *C. fimbriata.*

Effectiveness of fungicides against *Ceratocystis fimbriata*

Purpose: Pruning is a common and frequent management practice in kiwifruit orchards, and it plays a major role in getting a consistent and quality yield each season. However, pruning of kiwifruit branches may become an important entrance gateway for many pathogens, including *C. fimbriata*. Little is known about the feasibility and effectiveness of using fungicides.

Objective: To evaluate the in vivo effectiveness of two fungicides and one commercial plant growth promoter against *C. fimbriata*

Result: It was proven that *C. fimbriata* can infect kiwifruit through pruned branches and that some fungicides can reduce the pathogen colonization.

Several fungicides were tested in the laboratory to determine their ability to inhibit mycelial growth and spore germination. Of the four fungicides tested two fungicides (Ridomil Gold® MZ and Comet®) showed promising results, these two fungicides were then tested on kiwifruit plants. Only Ridomil Gold® MZ reduced infection progress of *C. fimbriata* on cultivar Monty BR but not Gold3, however there will need to be considerations around use of this fungicide under the current CPS.

An elicitor Bion 500® was also tested on kiwifruit plants and was shown to significantly reduced legion size compared to the control in Monty BR and Gold3. Work to confirm the efficiency of Bion 500® as elicitor against *C. fimbraita* on kiwifruit is underway.

Effectiveness of sanitisers against *Ceratocystis fimbriata*

Purpose: Tool hygiene and good biosecurity practices are essential to managing spread. Ensuring the disinfection of all tools, equipment, machinery, and footwear with an effective sanitiser is key to managing any infection and mitigating spread.

Objective: To evaluate the efficacy of different disinfestation treatments (Vet+20®, Hot water (80°C) and Ridomil Gold®) of pruning tools against *C. fimbriata* in kiwifruit cultivars.

Results: Of the three sanitisers tested in this project, one (hot water at 80˚C for 15 seconds) was proven to be most effective. However, we understand that using hot water on orchard to sanitise tools is impractical, therefore Vet+20®, in which SteriGENE can be used as a proxy for, may be a good alternative to use on orchard when sanitising pruning tools with suspected *C. fimbriata* spores.

More work is underway to research the efficacy of New Zealand based sanitisers that are commonly used by growers for pruning tool disinfestation to reduce Psa spread. This will help inform which of those sanitisers available in New Zealand are most effective against *C. fimbraita.*

Movement of *Ceratocystis fimbriata* within the plant

Purpose: Observations in kiwifruit vines revealed that most infections on kiwifruit plants start through the roots, due the presence of the *C. fimbriata* in the soil, but it is also known that it can be disseminated from infected plants to healthy ones by infested pruning tools. Different sites of infection can affect the disease progress. From the roots, the disease progresses upwards, unlike infection via branch pruning, which would be downwards. Therefore, understanding the disease progress may help to adopt strategies for the disease management and eradication of a recent introduced pathogen.

Objective: Evaluation of the upwards and downwards progress of Ceratocystis wilt in kiwifruit plants

Results: We found that disease progress was much faster upwards than downwards for both cultivars. This means that if *C. fimbriata* infects a kiwifruit plant via a wound in the leader the disease will spread slower through that plant than if the wound was located at the trunk base. This alludes to the fact that if *C. fimbriata* infects through wounds higher in the vine, there may be options to prune out the infection, whereas if infection is from the soil, pruning management is unlikely to be effective.

Host specificity of *Ceratocystis fimbriata*

Purpose: The *C. fimbriata* complex is formed by a group of very similar fungi and with a high number of isolates, some species are related to single hosts or geographic regions, while others infect a range of hosts. New Zealand does have a strain of *C. fimbriata*, first identified in 1907 causing black rot on kumara. We have since determined that this isolate is not pathogenic to kiwifruit. However, a commissioned literature review highlighted that there are several higher risk isolates found in other hosts which could pose a risk to our industry.

Objective: Evaluate the pathogenicity of ten *Ceratocystis spp*. isolates from different hosts and geographic regions in two kiwifruit cultivars.

Results: The results from the project highlight that there were a few *Ceratocystis* isolates from hosts outside of kiwifruit that were pathogenic to kiwifruit. The degree of aggressiveness was varied, with isolates from teak and ʻŌhiʻa (a close relation to the Pōhutukawa) showing the highest level of aggressiveness in Gold3 and Hayward respectively.

On the back of this new information, KVH informed Ministry for Primary Industries (MPI) to ensure that the entry risk pathways into New Zealand are sufficiently managed. KVH is confident that the nursery stock pathway remains well managed as import requirements for this pathway are robust and MPI has good diagnostic tools for identifying *Ceratocystis*.

***Ceratocystis fimbriata* resistance in Bruno rootstock**

Purpose: With most *Ceratocystis* diseases, there is substantial variation in aggressiveness in the pathogen and there is substantial variation in resistance among host species and within host species or hybrids. Selection for resistance and elimination of susceptible cultivars have been major tools for managing *Ceratocystis* in many crops, such as mango, cacao, and sweet potato.

There is potential to identify and utilize resistance in kiwifruit. The three tested cultivars in Rio Grande do Sul all appear to be highly susceptible, but it may be possible to develop resistant rootstocks over the longer term (15 years+). Highly aggressive isolates should be used to select resistant rootstocks. Bruno are open pollinated and seed propagated giving high genetic diversity to select for resistance.

Objective: Screening “Bruno” seedlings for resistance to the most aggressive *C. fimbriata* isolates from kiwifruit available to be used as resistant rootstock.

Results: We found that there were two Bruno genotypes that appear highly resistant to infection by *C. fimbriata* with another considered moderately resistant. These clones were vegetative propagated and are under further evaluation in kiwifruit orchards with *C. fimbriata* naturally infested soil in Farroupilha, Rio Grande do Sul state of Brazil, as rootstock with susceptible cultivars as scion

Current research is looking to better understand if resistance from rootstocks is conferred to the grafted scion. Results are due end of 2023.

Next steps

We still have a number of projects planned under the *Ceratocystis* programme of work. Future research includes, further sanitiser testing, determining *C. fimbriata* survival in the soil and exploring biocontrols, to name a few.

As each new piece of information is available, a summary will be added to this document.