



# ***Ceratocystis fimbriata* – a new fungal pathogen of kiwifruit in Brazil**

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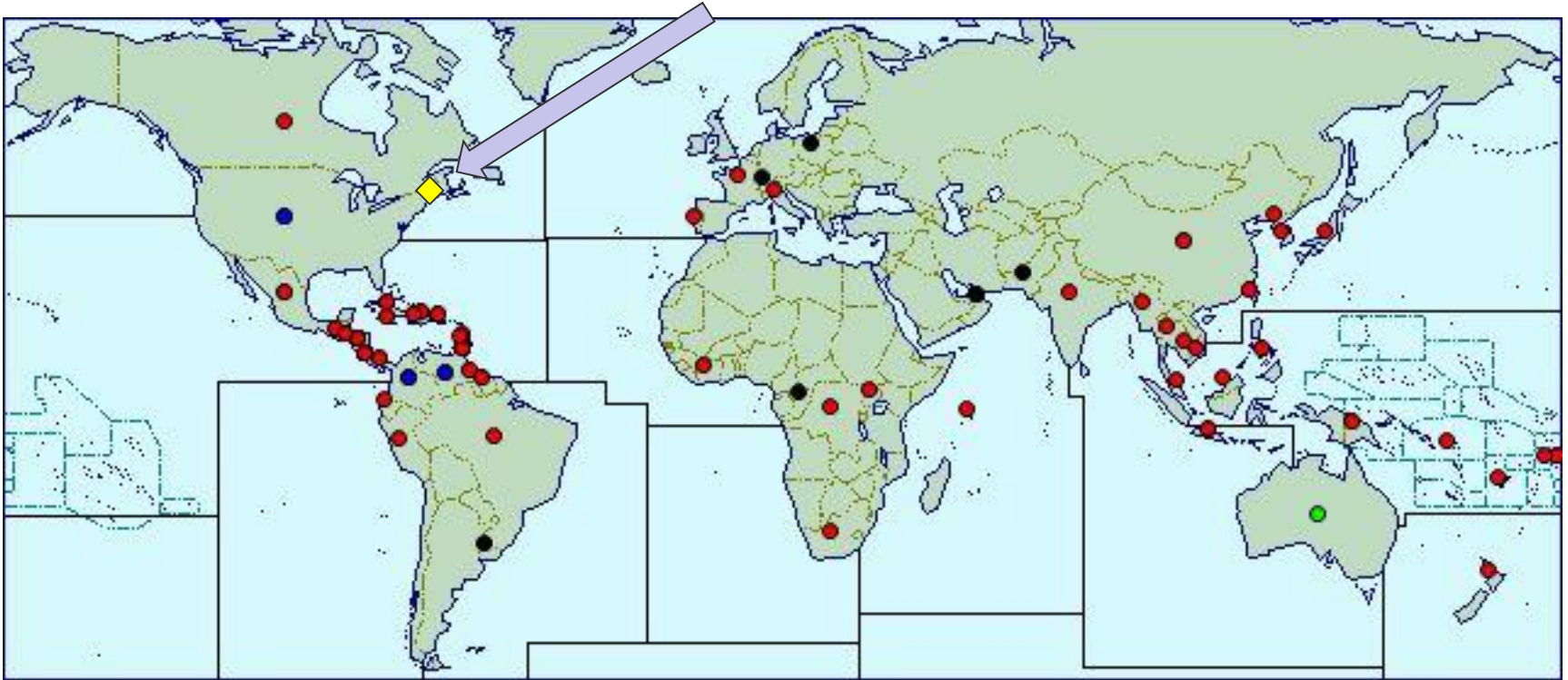
# Background – *Ceratocystis fimbriata*

- » Fungus first recorded in 1890
- » Post-harvest rot of *Ipomoea batatas* (kumara, sweet potato)
- » Broad host range – hosts in >22 plant families
- » Rots of storage roots and corms
- » Wilt and cankers on many woody plants
- » Several strains/races known worldwide, some are potentially different species (*C. platani*, 2005)
- » Some strains are more host-specific



# Geographic distribution

New Jersey, USA



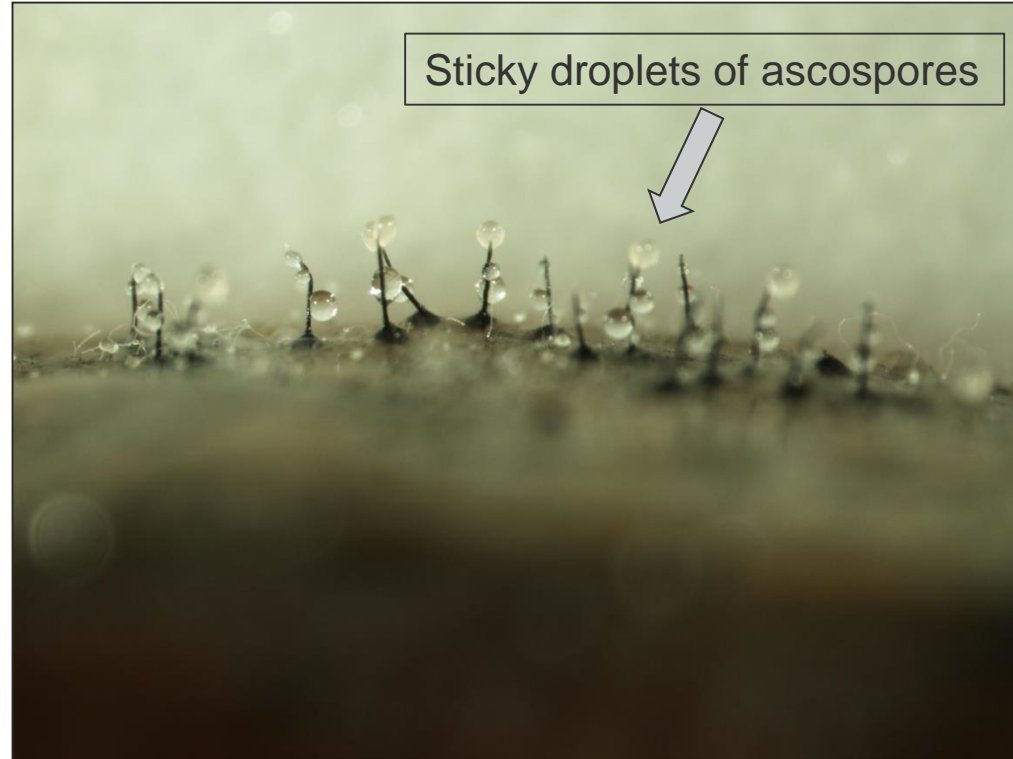
- » First identified in north-eastern USA (New Jersey, 1890)
- » Since then it has been widely reported around the world
- » Known in New Zealand for over 100 years (1907), only recorded on kumara

\*CABI distribution map - <http://www.cabi.org/isc/datasheet/12143>



# Identification

- » *Ceratocystis fimbriata* (in its wider form) is easily identified
- » Morphologically distinctive
- » Several very distinct spore types
- » Fruity aroma



Sticky droplets of ascospores

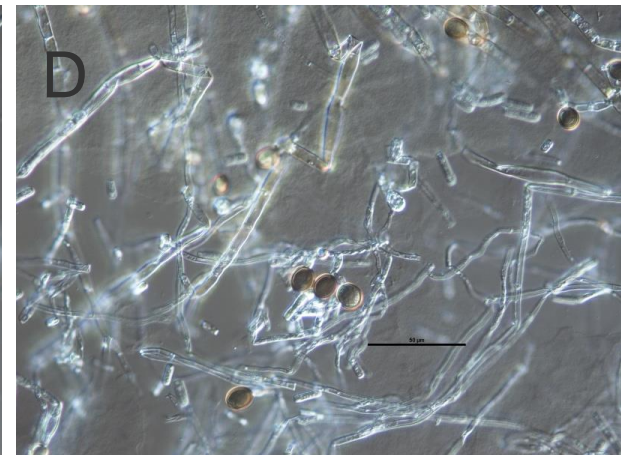
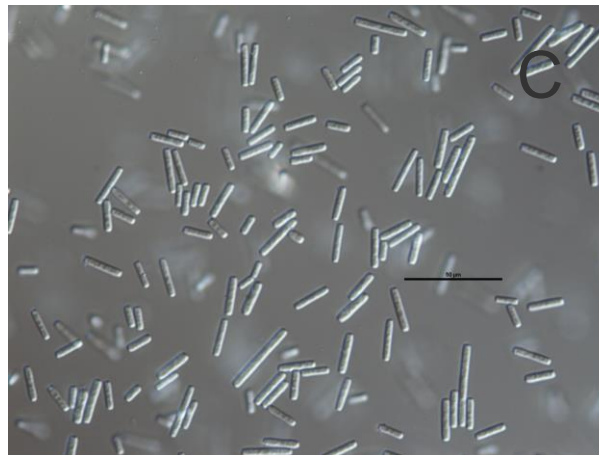
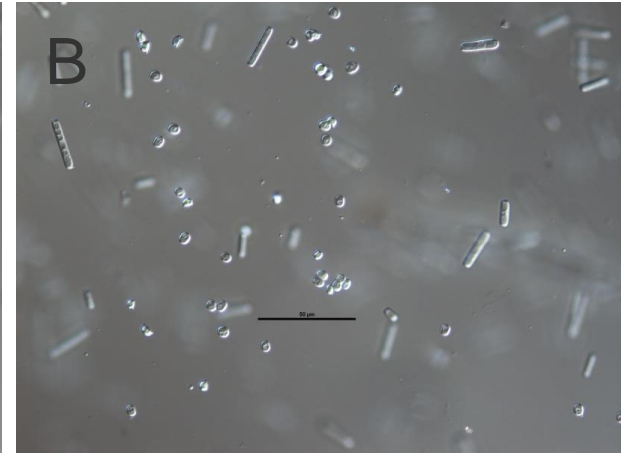
*Ceratocystis fimbriata* perithecia



# Identification

*Ceratocystis fimbriata*:

- A) perithecial beak
- B) hat-shaped ascospores
- C) cylindrical endoconidia
- D) dark aleurioconidia (chlamydospores, survival structures)



# First report on kiwifruit

- » In 2010, it was reported that this fungus was causing wilt and death of kiwifruit vines in Brazil.
- » Losses of up to 50% of vines were reported on some orchards.
- » This was a new host association.

## References:

Sonego et al. 2010. First report of *Ceratocystis* wilt in kiwi. Tropical Plant Pathology 35 (Suplemento): S233.

Piveta et al. 2016. *Ceratocystis fimbriata* on kiwifruit (*Actinidia* spp.) in Brazil. New Zealand Journal of Crop and Horticultural Science 44(1): 31-24.



Farroupilha, Rio Grande do Sul

# New Zealand response:

- » 2014 - Industry representatives visited Brazil to observe the disease
- » 2015 - PFR scientists visited Brazil.
- » KVH commissioned projects to test the aggressiveness of the New Zealand and Brazilian 'strains' of *Ceratocystis fimbriata* against various kiwifruit cultivars.
- » Pathogenicity testing of
  - » New Zealand isolates from kumara
  - » Parallel tests at Viçosa University in Brazil using the Brazilian isolates from kiwifruit.



Viçosa, Minas Gerais

# Brazil, 2015

- » Visit affected orchards
  - » see the disease *in situ*
  - » obtain field experience with the pathogen
  - » enable New Zealand scientists and the kiwifruit industry to recognise the field symptoms should it reach New Zealand
- » Meet with Prof. Acelino Alfenas and staff at Viçosa University who are testing Brazilian isolates on kiwifruit cultivars in Brazil
- » Align methods of pathogenicity testing
- » Take part in a workshop on *Ceratocystis* diseases
- » Meet international experts on *Ceratocystis*, including Professor Tom Harrington (Iowa State University)



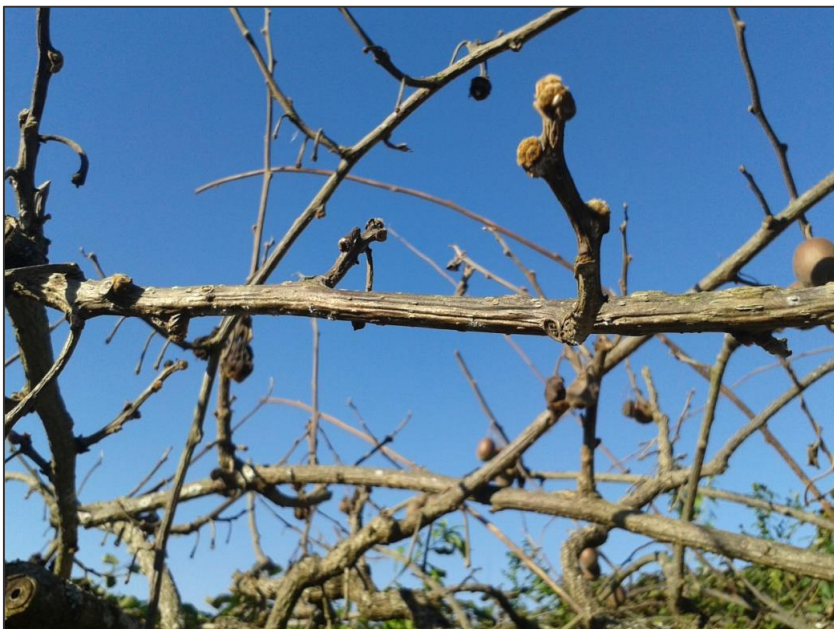
# Disease symptoms



Leaf wilt and curl



# Disease symptoms



Shrivelled canes





# Disease symptoms



Darkened xylem tissues



# Observations in Brazil

- » Kiwifruit was one of the most profitable crops in Brazil
- » Reduces the number of harvestable fruit
- » Most affected vines eventually die





# Means of spread

## Natural spread is limited:

- » Soilborne fungus
- » Root grafts
- » Potentially some movement by wood-boring beetles
- » Wind-blown sawdust and frass from borers

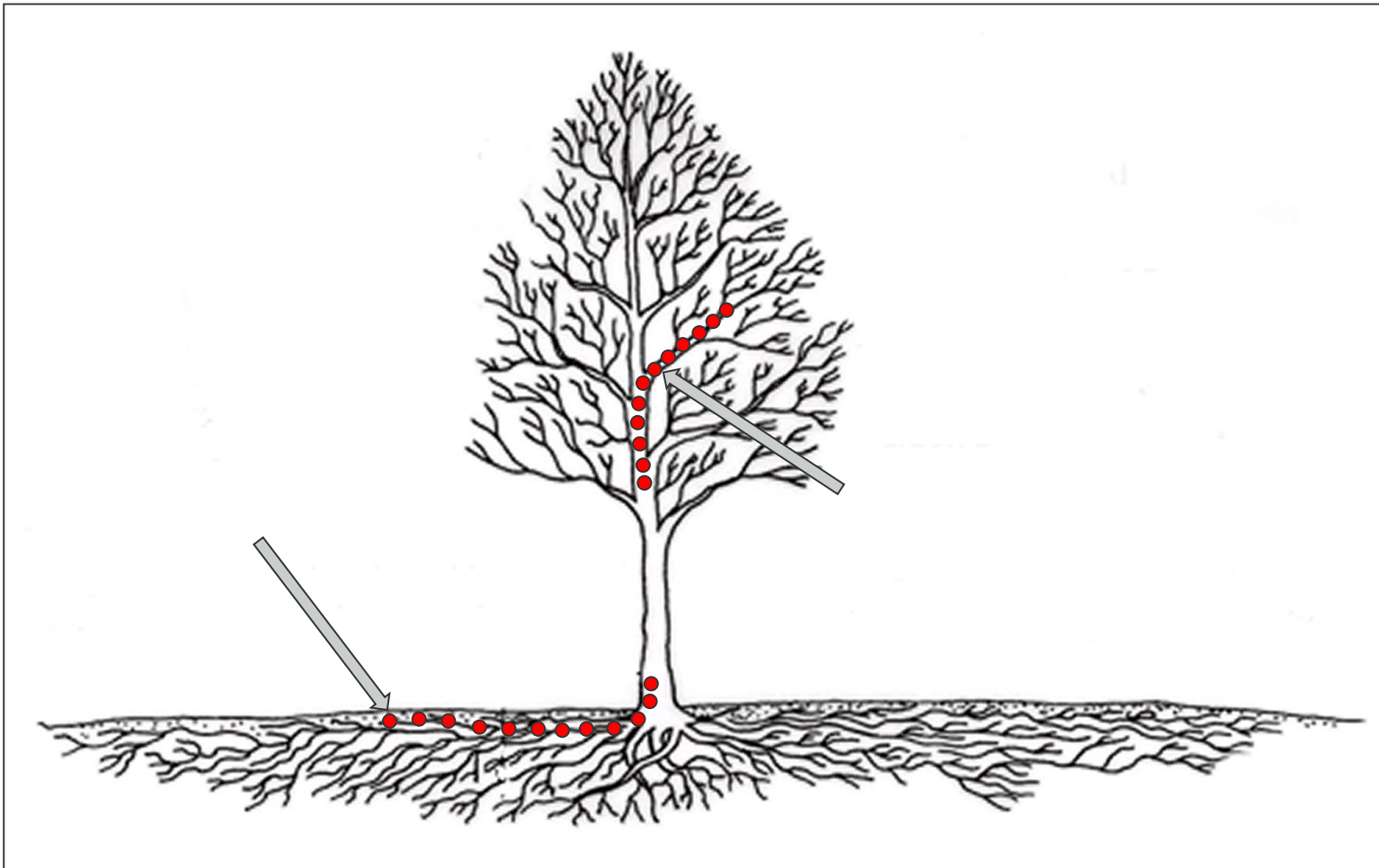
## Human-assisted spread:

- » Propagative material (e.g. cuttings)
- » Pruning tools, packing material
- » Other equipment



# Life-cycle / disease cycle

» Wound-parasite. Cannot invade through an intact epidermis.



# Brazils response to the threat

- » *Ceratocystis* wilt already a problem
  - » *Eucalyptus*
  - » taro
  - » fig
- » Focus on hygiene
  - » clean planting stock
  - » clean tools
  - » fungicide clean-up
- » Resistance testing of *Eucalyptus* lines





# Brazils response to the threat

- » Focus on hygiene
- » Resistance testing
- » Strain identification
  - » origin of kiwifruit strain

The kiwifruit isolates fall into three groups:

- » Similar to the *Eucalyptus* strains
- » Similar to taro strains
- » High diversity group that is native to Brazil

**\*more than one 'kiwifruit' strain of *Ceratocystis fimbriata*\***





# New Zealand situation

- » *Ceratocystis fimbriata* has been known in New Zealand since 1907
- » Never recorded on kiwifruit
- » Only recorded on kumara
- » Many different strains/clades of *Ceratocystis fimbriata* are known worldwide – a few affect only one host, others are polyphagous
- » Host specific?
- » Geographic isolation?

# Pathogenicity testing - isolates

To detect pathogenicity differences in NZ *Ceratocystis* population:

- » 5 isolates
- » collected over 40 years
- » range of sites



Accession Number	Collection date	Location
ICMP 894	Dec. 1961	Auckland, Mt Albert
ICMP 1731	Jul. 1966	Auckland
ICMP 2085	Oct. 1967	Northland, Ruawai
ICMP 13575	May 1998	Northland
ICMP 13968	Jul. 1999	Northland, Ruawai



# Pathogenicity testing - cultivars

To detect any differences kiwifruit species-specific sensitivities to the NZ *Ceratocystis*:

- » four cultivars
- » three *Actinidia* species

<i>Actinidia</i> species	Cultivar
<i>A. deliciosa</i>	'Hayward'
<i>A. chinensis</i>	G3
<i>A. deliciosa</i> x	G14
<i>A. macrosperma</i>	'Bounty'



# Inoculation



- » Five cultivars
- » Five *Ceratocystis* isolates + water control
- » Five plants (replicates) for each treatment

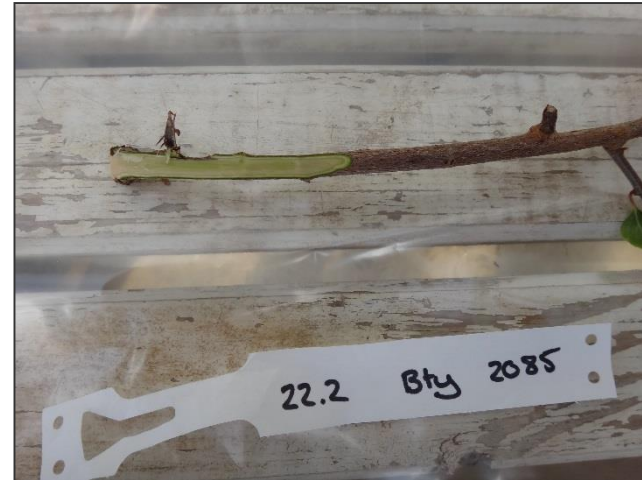




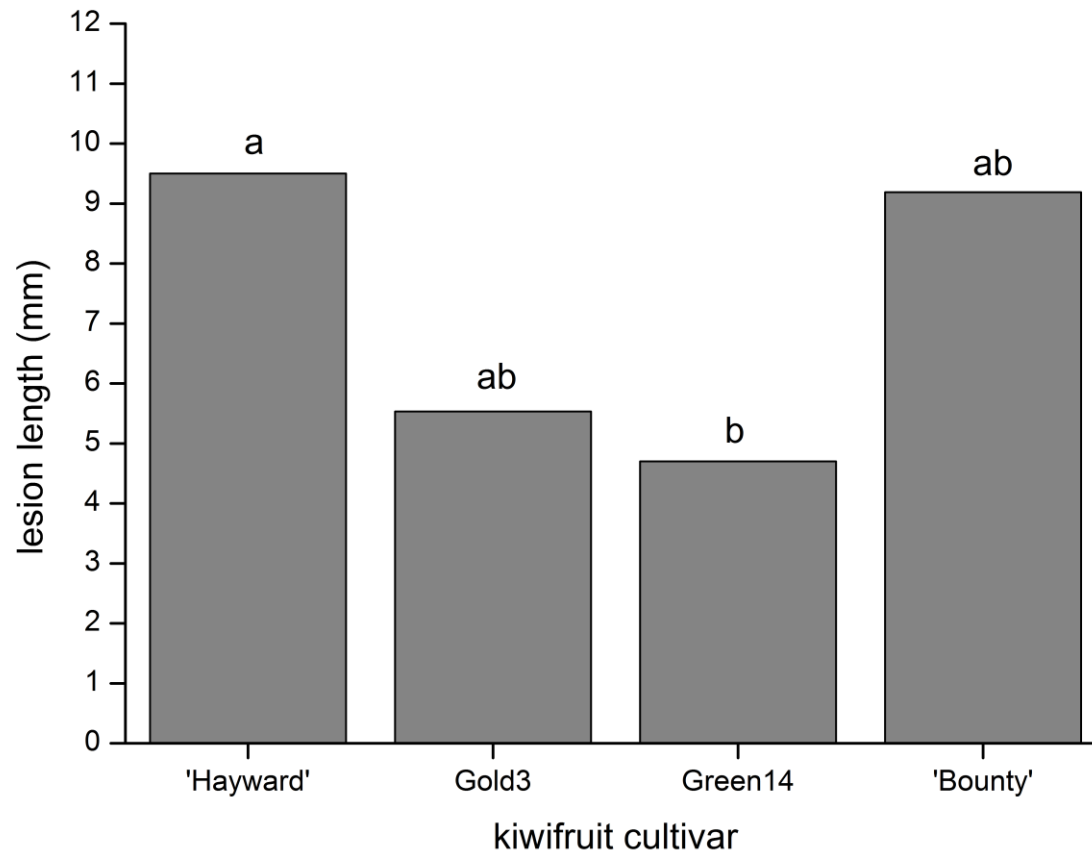
# 28 days incubation



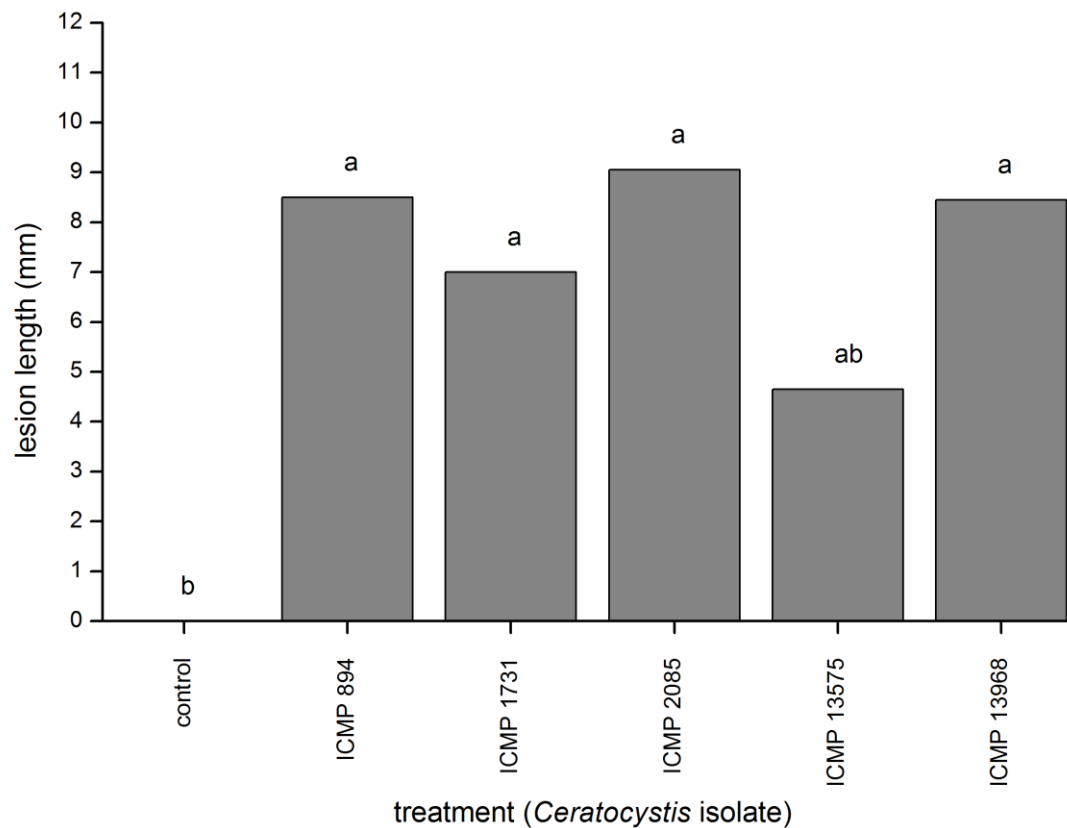
# Assessments



# Effect of kiwifruit cultivar on lesion length



# Effect of *Ceratocystis* isolate on lesion length





# Brazil pathogenicity tests



# New Zealand pathogenicity tests





# Conclusions

- » New Zealand *Ceratocystis fimbriata* strain was not pathogenic on kiwifruit
- » Host specific
- » Not a result of geographic isolation
- » International research on strains and clades of *Ceratocystis fimbriata* has found that the sweet potato strain, around the world, is one of the most host-specific strains

Brazil kiwifruit strain





# Conclusions

- » No action needs to be taken to mitigate the threat of the New Zealand kumara strain moving into kiwifruit orchards.
- » The New Zealand kiwifruit industry does need to be vigilant in monitoring for new *Ceratocystis fimbriata* strains.
- » The most likely pathway would be infected budwood.
- » Growers should be alert for symptoms similar to those described from Brazil orchards.



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# Control

## Kumara

- » Use disease-free planting material
- » Destroy all diseased plants
- » Removal of debris after harvest
- » Decontamination of equipment
- » Do not plant kumara in infested soil for several years
- » Crop rotation