



**Plant & Food
Research**
Rangahau Ahumāra Kai



Kiwifruit Trunk Disease: understanding our biodiversity and risk

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Kiwifruit trunk disease



Kiwifruit trunk diseases were first reported in about 2000 and have since increased in incidence and visibility. These have variously been referred to as:

- » Vine decline
- » Vine decay
- » Swollen trunk disorder
- » Crown decay disorder
- » Kiwifruit wood decay



Symptoms



- » Crown decay
- » Swollen or uniformly enlarged trunks
- » Discrete swellings of trunks or leaders ('bulges' and cracking)
- » Cankers
- » Sparse canopies
- » Dieback
- » Sudden death
- » Stained/discoloured wood



BS19004 Emerging risk of vine decline



- » Project started early 2019
- » Which pathogens are associated with vine decline?
- » Focussed on the fungal group Nectriaceae
 - » *Fusarium*
 - » *Cylindrocarpon*-type
- » Overseas, this group of fungi has been associated with wood decays of kiwifruit
- » Previous work in New Zealand has also indicated that this group is likely to be involved in vine decline here.
- » *Neonectria* canker appearing in Motueka



Methods



- » Surveyed one block on each of three orchards
 - » Paengaroa
 - » Te Puke
 - » Motueka
- » Assessed the amount of visibly diseased vines
- » Sampled 'trunks' of 10 asymptomatic and 10 diseased vines
 - » bark at the base of the vines
 - » 30 cm woody cores
 - » 100 cm woody cores
 - » leader cankers (Motueka)
- » Isolations across the length of the woody cores



Incidence of kiwifruit trunk disease



How prevalent is it?

- » 18-34% of vines were visibly diseased
- » 2-22% appeared to be replacement vines
- » Removed vines not included
 - » Due to disease
 - » Planned turnover
- » True incidence is likely higher
- » Asymptomatic vines often had stained core samples

Bay	Vine	Row 1	Row 2	Row 3	Row 4	Row 5	Row 6	Row 7	Row 8	Row 9	Row 10	Row 11	Row 12	Row 13	Row 14	Row 15
26	2	D	H	X	D	H	Y	X	H	H	H	H	H	H	H	D
26	1	X	X	H	H	Y	H	D	X	X	X	X	X	X	X	X
25	2	H	D	Y	Y	X	H	X	D	X	H	D	Y	H	D	D
25	1	X	H	X	X	Y	X	H	X	H	X	X	Y	D	X	Y
24	2	H	D	X	D	X	X	H	H	H	D	X	Y	D	H	H
24	1	X	Y	H	X	Y	X	X	X	H 3073.6	Y	Y	X	X	Y	X
23	2	D	H	X	H	H	X	H	H	D	D 3073.16	Y	D	D	D	H
23	1	X	X	D	X	Y	D	H	X	D	X	H	X	H	X	Y
22	2	H	H	X	D	D	H	H	H	X	D	X	D	X	H	X
22	1	X	X	X	H	X	X	X	X	D	Y	Y	Y	H	Y	Y
21	2	H	H	H	X	D	H	D	H	X	X	H	X	D	D	D
21	1	X	X	D	Y	Y	Y	H	X	D	Y	H	X	H	Y	D
20	2	D	D	X	X	H	H	Y	H	H	D	D 3073.15	X	X	H	D
20	1	X	Y	D	Y	X	Y	X	X	H	H 3073.5	D	H	X	X	Y
19	2	H	D	X	Y	H	X	D	H	X	X	Y	X	X	H	D
19	1	X	X	X	X	X	D	H	X	H	X	X	H	D	Y	D
18	2	D	X	H	H	Y	D	X	X	D	H	H 3073.4	D 3073.14	X	H	D
18	1	H	H	Y	Y	X	Y	D	H	X	X	H	H	H	Y	H
17	2	D	H	X	H	H 3073.9	X	H	H	H	Y	X	X	X	H	H
17	1	H	X	D	X	Y	Y	H	X	Y	X	Y	H	H	H	X
16	2	X	H	X	X	D 3073.19	H	X	H	H	H	D	X	H	X	Y
16	1	X	Y	X	H	X	X	X	X	X	Y	X	X	Y	X	X
15	2	H	H	H	X	H	H	H	H	H	H	H	H	H 3073.3	D	H
15	1	X	X	X	H	X	X	Y	X	X	X	Y	X	Y	X	X
14	2	H	H	H	Y	H	H	H	H	H	H	H	H	D 3073.13	H	H
14	1	X	X	X	H	X	X	X	X	Y	X	X	X	Y	X	X
13	2	D	H	D	X	D	H	Y	H	D	H	D	H	H	X	H
13	1	X	X	X	H	X	X	X	X	Y	H	Y	X	X	H	X
12	2	H 3073.10	H	H	X	H	H	H	H	D	X	H	H	H	H	H
12	1	Y	X	X	X	H	Y	Y	X	X	H	X	Y	Y	Y	Y
11	2	D 3073.20	H	H	D	X	X	H	H	D	X	H	X	H	H	D
11	1	H	H	X	X	Y	H	Y	X	X	X	D	H	H	H	Y
10	2	X	X	H	H	H	D	H	H	H	D	D	D	X	X	D
10	1	Y	H	X	H	X	H	Y	X	H	X	Y	Y	H	H 3073.2	Y
9	2	D	X	H	D	H	X	H	H	H	H	D	X	X	X	Y
9	1	X	D	H	H	H	X	Y	X	H	H	Y	Y	Y	X	X
8	2	H	X	D	X	D	D	X	H	X	X	D	H	X	D 3073.12	H
8	1	D	H	H	X	D	X	H	X	H	Y	D	H	X	Y	X
7	2	D	D	X	H	Y	H	D	X	H	X	X	X	D	D	H
7	1	X	Y	H	H	X	Y	Y	X	H	X	H	X	H	X	X
6	2	H	D	X	D	D	D 3073.18	D	H 3073.7	D 3073.17	D	D	X	H	X	H
6	1	X	H	X	D	Y	H	Y	X	X	Y	X	H	Y	H	H
5	2	H	D	H	X	H 3073.8	X	X	H	D	H	H	X	D	X	D
5	1	H	H	X	X	X	H	H	X	H	X	D	Y	Y	X	Y
4	2	X	X	H	H	D	X	X	H	X	H	X	D	X	H	H 3073.1
4	1	X	Y	X	Y	Y	X	D	X	Y	Y	X	X	Y	X	H
3	2	H	H	H	H	D	H	X	H	H	H	H	H	H	H	D 3073.11
3	1	X	Y	X	H	Y	H	H	X	X	X	X	X	X	X	Y
2	2	H	X	H	X	X	X	X	H	X	H	H	D	H	H	H
2	1	Y	H	Y	X	X	H	H	H	H	X	X	Y	H	Y	Y
1	2	H	D	H	X	H	X	D	X	H	H	H	X	X	D	D
1	1	Y	X	X	X	Y	H	Y	H	Y	X	H	X	Y	X	Y



Symptom incidence



	# diseased vines	Collar rot	rot at/near graft	Swollen trunk	Swelling/cracking of leader	Canker	Sparse canopy
Orchard 1 (Paengaroa)	117	63%	8%	34%	0%	2%	12%
Orchard 2 (Te Puke)	73	79%	8%	19%	0%	0%	10%
Orchard 3 (Motueka)	165	28%	10%	1%	47%	30%	4%



» The three blocks had different main symptoms



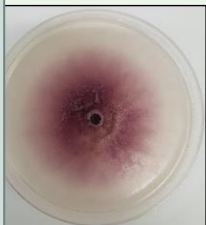
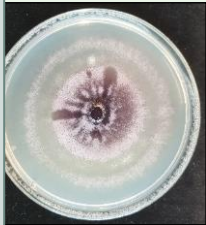
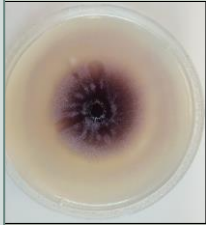
Fungal isolations



- » What did we find?
- » Each orchard block was different
 - » Most common symptom
 - » Most common species
 - » Overlap between the three blocks
- » Many species within the Nectriaceae
- » 3 major groups were more prevalent in the diseased vines
 - » *Neonectria microconidia*
 - » *Fusarium solani* complex
 - » *Ilyonectria* species group

Identifications

- » *Clonostachys* sp.
- » *Dactylonectria* sp.
- » *Mariannea* sp.
- » *Thelonectria* sp.
- » *Fusarium avenaceum*
- » *Fusarium cerealis*
- » *Fusarium equiseti*
- » *Fusarium oxysporum*
- » *Fusarium solani* complex
- » *Fusarium* sp.
- » *Fusarium venenatum*
- » *Ilyonectria europaea*
- » *Ilyonectria liriiodendri*
- » *Ilyonectria robusta*
- » *Ilyonectria* sp.
- » *Ilyonectria torresensis*
- » *Neonectria microconidia*



Neonectria microconidia



Neonectria microconidia

- *Neonectria* canker of kiwifruit

Close relative of *Neonectria ditissima*

- European canker of apple



- » Found in all 3 orchards
- » Not always associated with symptoms
- » Cankers in Motueka
- » Causes fruit rots of kiwifruit



Ilyonectria species

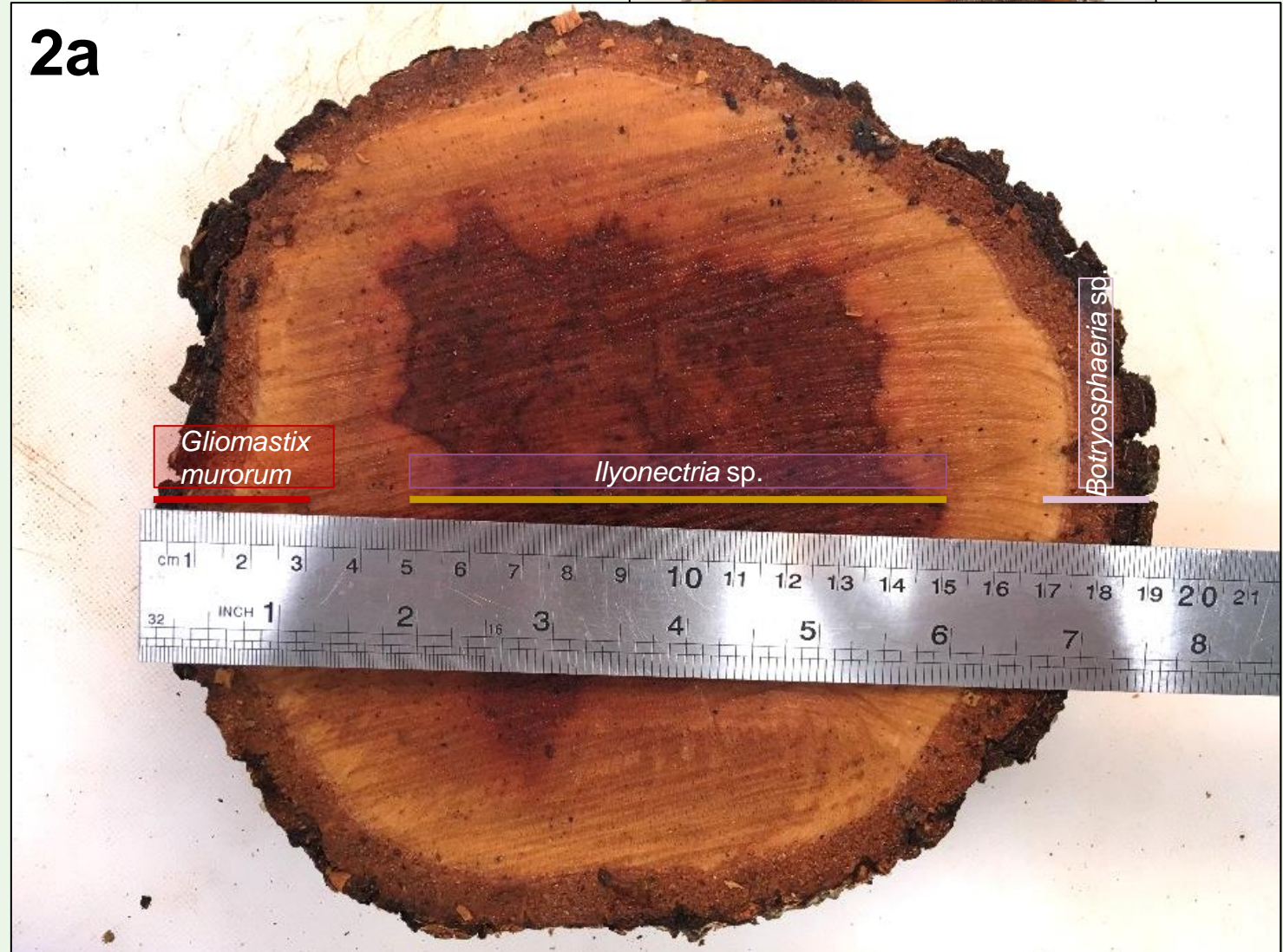
Four *Ilyonectria* species found in kiwifruit wood

- » *Ilyonectria europaea*
- » *Ilyonectria liriodendri*
- » *Ilyonectria robusta*
- » *Ilyonectria torresensis*

Ilyonectria species:

- » Black foot of grapevines
- » Overlapping set of species
- » Root or crown disease
- » *Pathogenicity unknown*

2a



Fusarium solani complex

- » *F. solani* in all 3 orchards
- » The major group in the diseased vines of Orchard 2
- » Well-known pathogen
- » Previously found associated with **sudden death** of vines in several orchards
- » Tends to be the major organism found in cross-sections of the trunks of these vines
- » Genetic diversity within the group of *Fusarium solani* isolates from the 3 orchards.



Pathogenicity testing

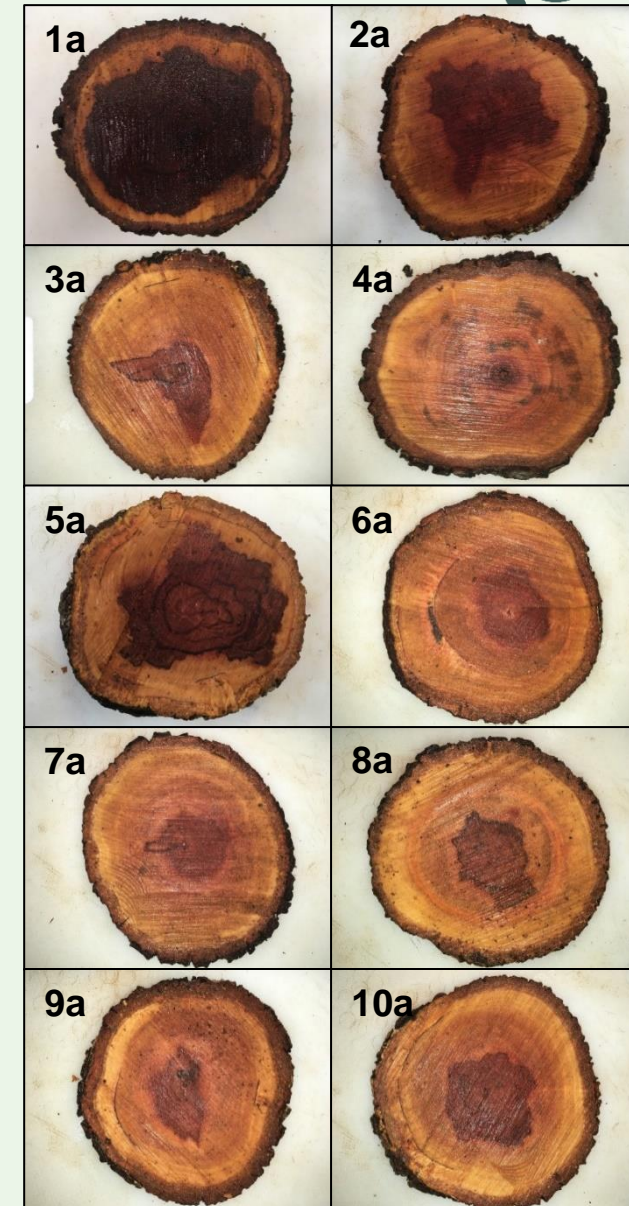


- » Status as pathogens of kiwifruit are unknown
 - » Are they opportunistic?
 - » Are these fungi causing or contributing to the disease?
 - » Which are most aggressive?
-
- » This uncertainty is currently being assessed in other projects for *Neonectria microconidia* and for the *Ilyonectria* species group – pathogenicity testing is already in progress for these.
-
- » Testing needs to be done across the range of the *Fusarium solani* complex
 - » Wide genetic diversity
 - » More adaptable
 - » More difficult to control



Kiwifruit trunk diseases (KTDs)

- » Trunk diseases of kiwifruit are a complex problem, likely caused by a complex of fungi.
- » Similar to GTDs (grapevine trunk disease)
 - » 100 years of research
 - » Increasing in incidence
 - » Still a limiting factor for grape production
- » Barely scratching the surface. Needs research to unlock:
 - » the different fungal combinations involved
 - » sequence of infection, source of inoculum, species epidemiology
 - » other fungi that are not in the Nectriaceae e.g. *Neobulgaria alba* (Orchard 1)
 - » effect of cultivar, rootstock, orchard age, environment
 - » **points of intervention, control**
- » What we have (current biodiversity)
- » What is new (incursions)



KTD management

(current KVH recommendations)

- » Regular orchard monitoring. Tag vines with unusual symptoms, avoid these when conducting orchard practices that involve open wounds on trunks and leaders.
- » It is unlikely that seriously affected vines can be cured (e.g. significant trunk damage). These vines should be removed and replaced, and a replanting strategy developed.
- » In some cases, infections isolated to leaders may be managed by removing the affected part of the plant and re-developing a replacement leader (e.g. *Neonectria* cut-out).
- » Tool hygiene is key. Sanitise tools as often as possible. Ideally between vines, but between rows or blocks should be routine. Always sterilise tools before entering a different orchard.
- » The use of wound protectants containing fungicides should be used to protect wounds where possible, particularly in orchards where there is evidence of vascular diseases.
- » Report the unusual!





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