Plant & Food Research
Rangahau Ahumāra Kai

TPP and Liberibacter Refresher

Jessica Vereijssen & Frances MacDonald

Workshop, Pukekohe, 26 June 2025

The New Zealand Institute for Plant and Food Research Limited

Presentation disclaimer

Presentation for
Zebra Chip (TPP / Liberibacter) seminar - update for Pukekohe growers, 26 June 2025, Pukekohe (in person and online)

Publication data:
MacDonald F and Vereijssen J. 06/2025. TPP and Liberibacter Refresher. A Plant & Food Research PowerPoint presentation. Job Code: N/A, SPTS No. 27405.

Presentation prepared by:
Frances MacDonald and Jessica Vereijssen
Researcher/Scientist, Biocontrol and Insect Rearing / Insect Dynamics, Ecology and Sustainability
June 2025

Presentation approved by:
Dave Bellamy
Science Group Leader, Adaptive Entomology
June 2025

For more information contact:
Frances MacDonald
DDI: +64 9 9263521
Email: Frances.MacDonald@plantandfood.co.nz

Jessica Vereijssen
DDI: +64 3 325 9566
Email: Jessica.Vereijssen@plantandfood.co.nz

This report has been prepared by The New Zealand Institute for Plant and Food Research Limited (Plant & Food Research).
Head Office: 120 Mt Albert Road, Sandringham, Auckland 1025, New Zealand, Tel: +64 9 925 7000, Fax: +64 9 925 7001.
www.plantandfood.co.nz

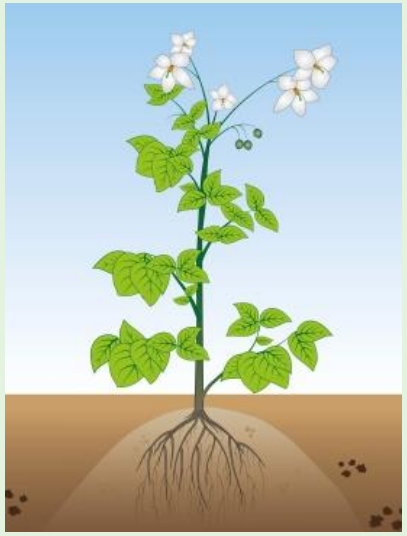
Plant & Food Research
Rangahau Ahumāra Kai

Fundamentals of TPP and Liberibacter

Jessica Vereijssen

The New Zealand Institute for Plant and Food Research Limited

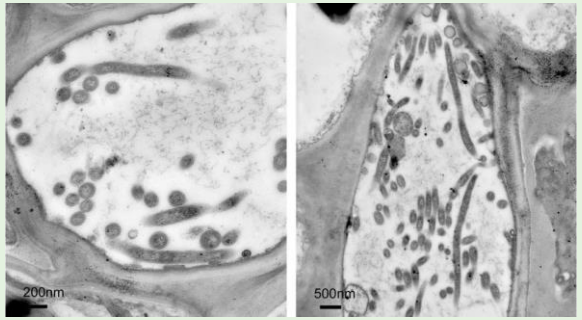
Our main players



A solanaceous plant: e.g., potato, capsicum, tomato, tamarillo, eggplant

The insect tomato potato psyllid (TPP), Western haplotype

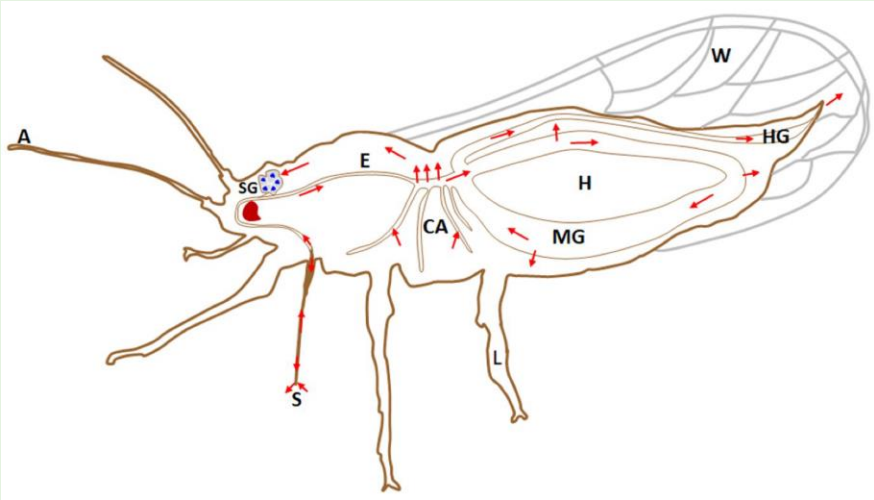
The bacterium *Candidatus* Liberibacter solanacearum (CLso or Liberibacter), Haplotype A



Liefting et al 2009

The Liberibacter bacterium

- In NZ is Haplotype A
- Is located in the phloem of the plant
- Can live in the plant
  - Circulates and propagates in plant
- Can live in the insect
  - Circulates and propagates in insect
- Cannot be grown in the lab for easy testing
- Can be detected in plant and insect using molecular methods
- Is present in 3–5% of individuals in the TPP population
- Changes psyllid behaviour and makes them attracted to clean plants
- Induces positive TPP to salivate more than negative TPP
  - negative TPP were more likely to ingest phloem than positive TPP



Red arrows show the pathway, which starts with acquisition from an infected plant through the stylet (S), moves along the esophagus (E), reaches the midgut (MG), where the bacterium is absorbed into the haemolymph (insect “blood”) (H), circulates and reaches the salivary glands (SG), from which it is secreted into the newly infected plant through the salivary canal in the stylet. A, antennae; CA, caeca (aids digestion and absorption); W, wings; HG, hindgut; L, leg.

Mishra and Ghanim 2022

The Liberibacter bacterium

- Was detected in NZ in:
  - Potato, tomato, capsicum, tamarillo, aubergine
  - Jerusalem cherry (*Solanum pseudocapsicum*)
  - Thorn-apple (*Datura stramonium*)
  - African boxthorn (*Lycium ferocissimum*)

- Was detected in carrot seed from 1973 in European Union: CLso has been present in carrot seeds in Europe for 52 years!

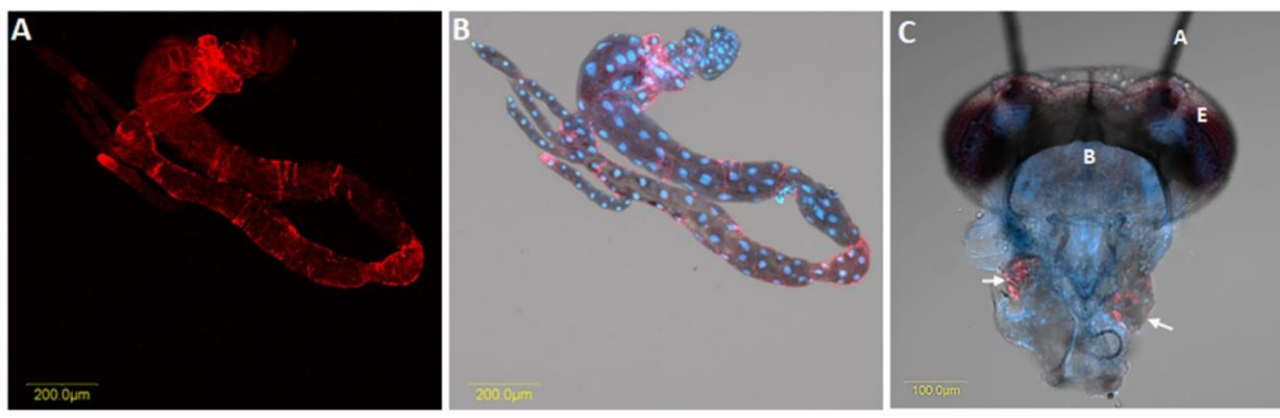
Haplotype	Host plants	Vector	
A & B	Potato, tomato, capsicum, eggplant	TPP	A & B: North America, Central America, Canada A: NZ, Norfolk Island
C, D & E	Apiaceous plants (carrot, celery)	*Bactericera trigonica*, *Trioza apicalis*	C: Northern Europe D & E: Southern Europe
F	Potato	?	Oregon (USA)
G	*Solanum umbelliferum*	TPP	Southern California (USA)
H	Convolvulaceae, Apiaceae, Polygonaceae	*Trioza urticae*	Europe, North America
U	Nettle	*Trioza urticae*	Southern Europe
Cras1 and Cras2		*Craspedolepta nebulosa,* and *C. subpunctata???*	Scotland
Aph1, Aph2, & Aph3		*Aphalara loca, A. persicaria,* and *A. curta*	Oregon

What happens in the plant?

- Liberibacter modifies its hosts – plant and psyllid
- Liberibacter disrupts the function of the phloem
  - Plant is trying to seal and protect the phloem system, callose deposition
  - Plugging sieve pores to prevent sap loss and pathogen movement
- Liberibacter triggers a plant immunity response (symptoms), these symptoms are not the bacterium itself
  - premature cell death
  - callose deposition
  - phloem protein accumulation
  - causing a localised response and/or systemic effect on phloem transportation
- Liberibacter alters host physiology, including changes in compositions of amino acids and ‘reducing sugars’, and induction of plant defences
- Liberibacter reduces sugars in foliar tissues but increases sugars in tubers
- In potato, above-ground symptoms appear 3–4 weeks after Liberibacter infection
- So, a late infection may not show up at harvest!

Primary infection in potato: TPP

- TPP can acquire Liberibacter from the phloem through feeding
- Takes roughly 2 weeks to colonise the salivary glands of TPP
- Can then be transmitted to another plant by TPP feeding on the phloem
- Once in the phloem and salivating, Liberibacter can be transmitted in 5 min
- Circulates and multiplies in the insect and the plant
- As a result, once a TPP is infected it can keep transmitting Liberibacter.



Localisation of *Candidatus* Liberibacter solanacearum (CLso) in the midgut of an adult psyllid (**A**, **B**) and in salivary glands (**C**), using fluorescence in situ hybridisation (FISH). A (dark field), B (bright field) and C (bright field of an adult head) show the localisation of CLso (red) as a stripe-like pattern in the midgut and a scattered pattern in the salivary glands (white arrows). Blue in all images is DAPI staining of the nuclei. A, antennae; E, eyes; B, brain.

Mishra and Ghanim 2022

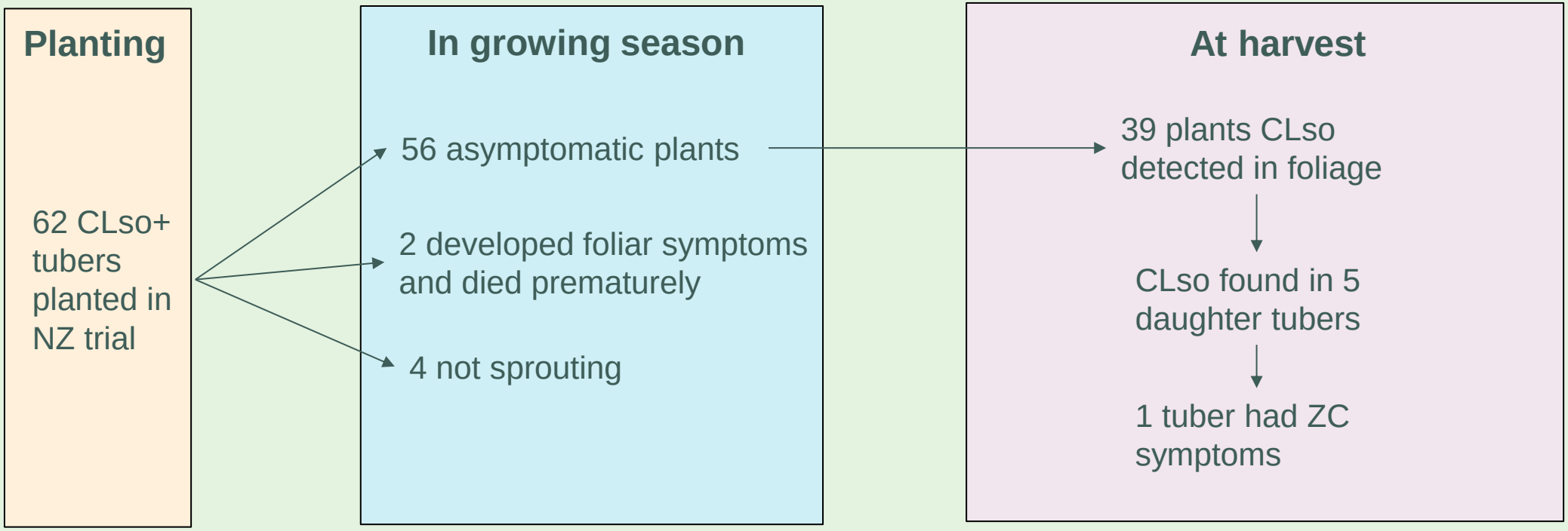
Secondary infection in potato: seed

- In the USA: Regardless of Liberibacter treatment, all daughter tubers were asymptomatic, and only 0.3% tested positive for Liberibacter in experiments conducted over 2 years.

  Swisher Grimm KD, Mustafa T, Cooper WR, Munyaneza JE. 2020. Growth and yield performance of *Solanum tuberosum* grown from seed potatoes infected with '*Candidatus* Liberibacter solanacearum' haplotypes A and B. Plant Disease 104: 688–693. doi:10.1094/PDIS-05-19-1125-RE

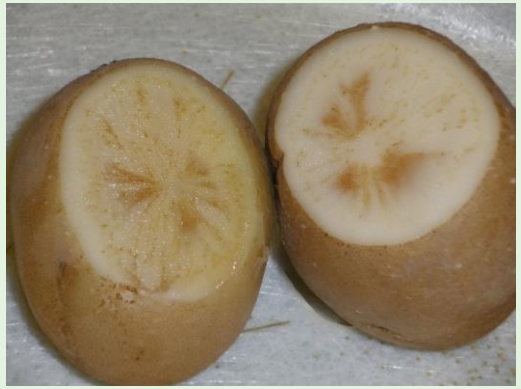
- In NZ: Liberibacter could be transmitted from the mother tubers both to the foliage of growing plants and to some daughter tubers, resulting in symptomatic and asymptomatic plants.

  Pitman AR, Drayton GM, Kraberger SJ, Genet RA, Scott IAW. 2011. Tuber transmission of 'Candidatus Liberibacter solanacearum' and its association with zebra chip on potato in New Zealand. European Journal of Plant Pathology 129: 389–398. doi:10.1007/s10658-010-9702-1



The Liberibacter bacterium

- Causes zebra chip disease in potato, yellowing of tomato plants and deformed fruit, yellowing in capsicum plants, tree death in tamarillos and deformed fruit.



Potato

Capsicum

Tomato

Photo: Phyllis Weintraub

Tamarillo

Photo: Phyllis Weintraub

Liberibacter symptoms in potato foliage

- Upward rolling of leaves
- Yellow to purple discoloration.

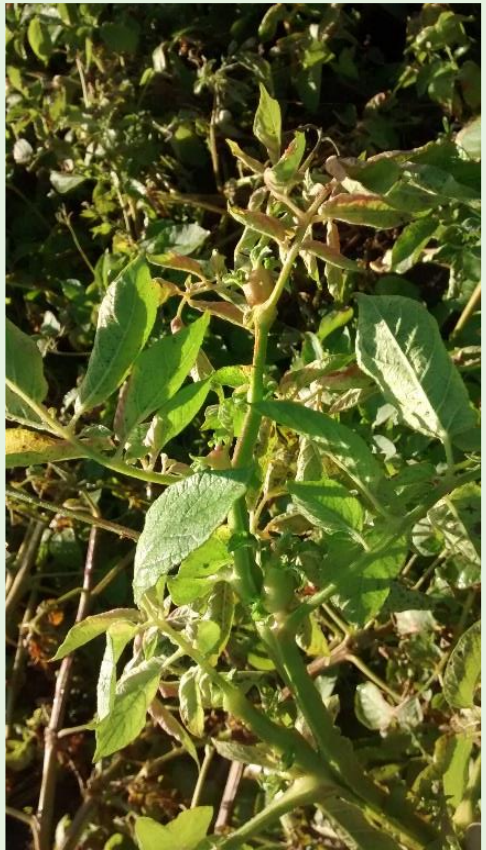



Liberibacter symptoms in potato foliage

- Bushy new growth at the top.

Liberibacter symptoms in potato

- Swollen nodes
- Axillary bud proliferation
- Aerial tubers.



Liberibacter discolouration and curling in other crops

Photo: Phyllis Weintraub

Tamarillo

Photos: Charles Merfield, BHU

Tomato

Capsicum

Liberibacter bushy growth in tamarillo

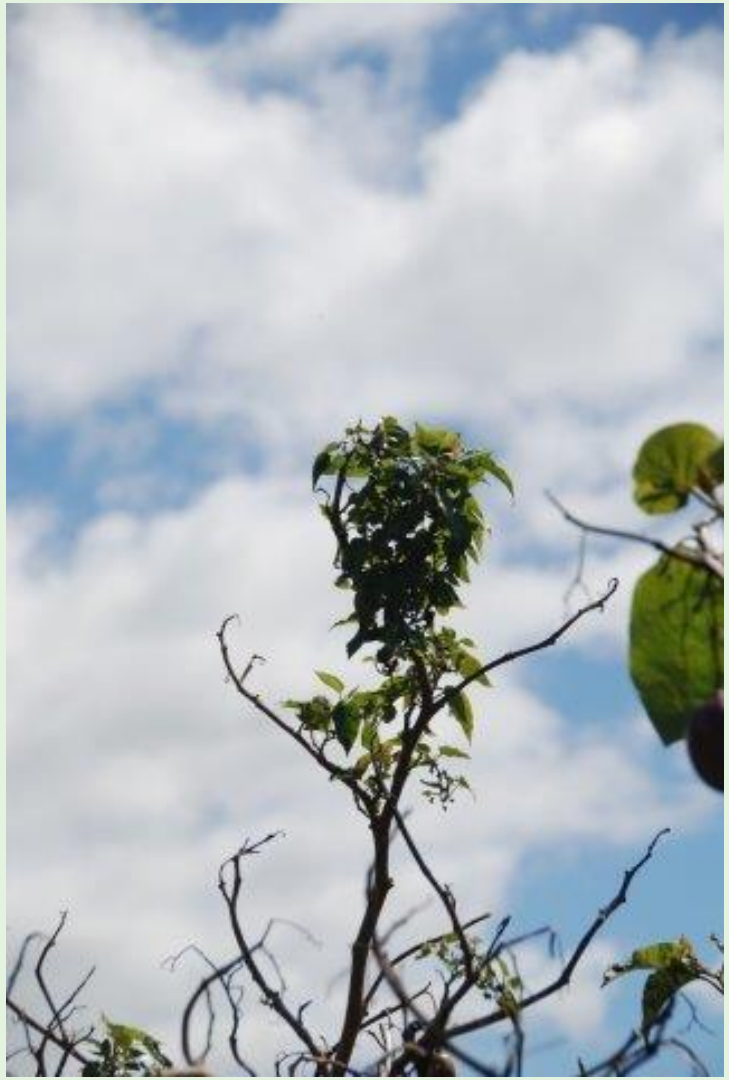


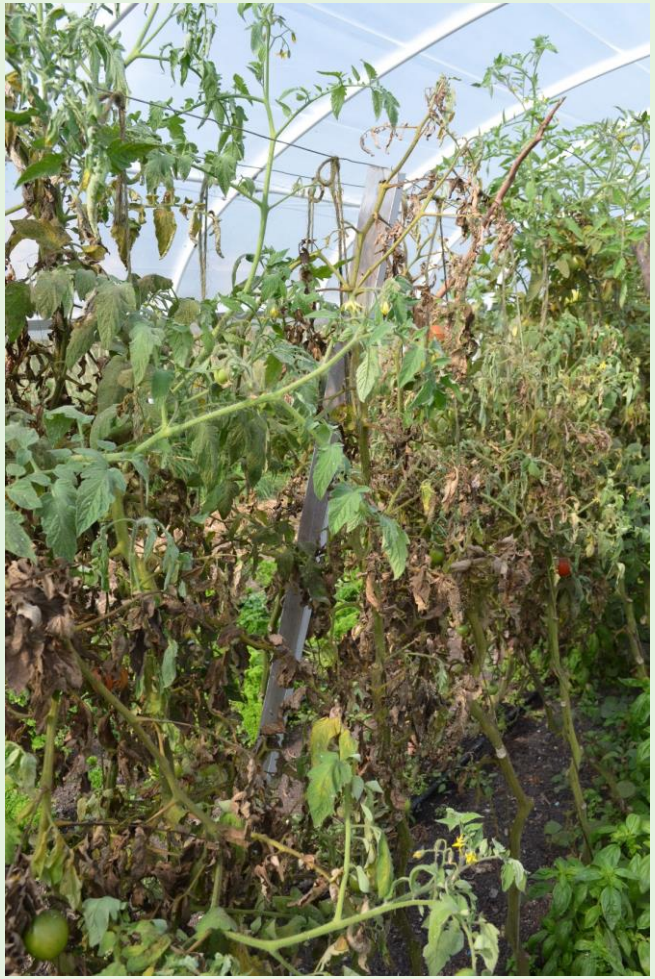
Photo: Phyllis Weintraub

Liberibacter can lead to plant death

Photo: Nina Jorgensen, PFR

Photo: John Anderson, PFR

Potato



Tomato

Photo: Phyllis Weintraub

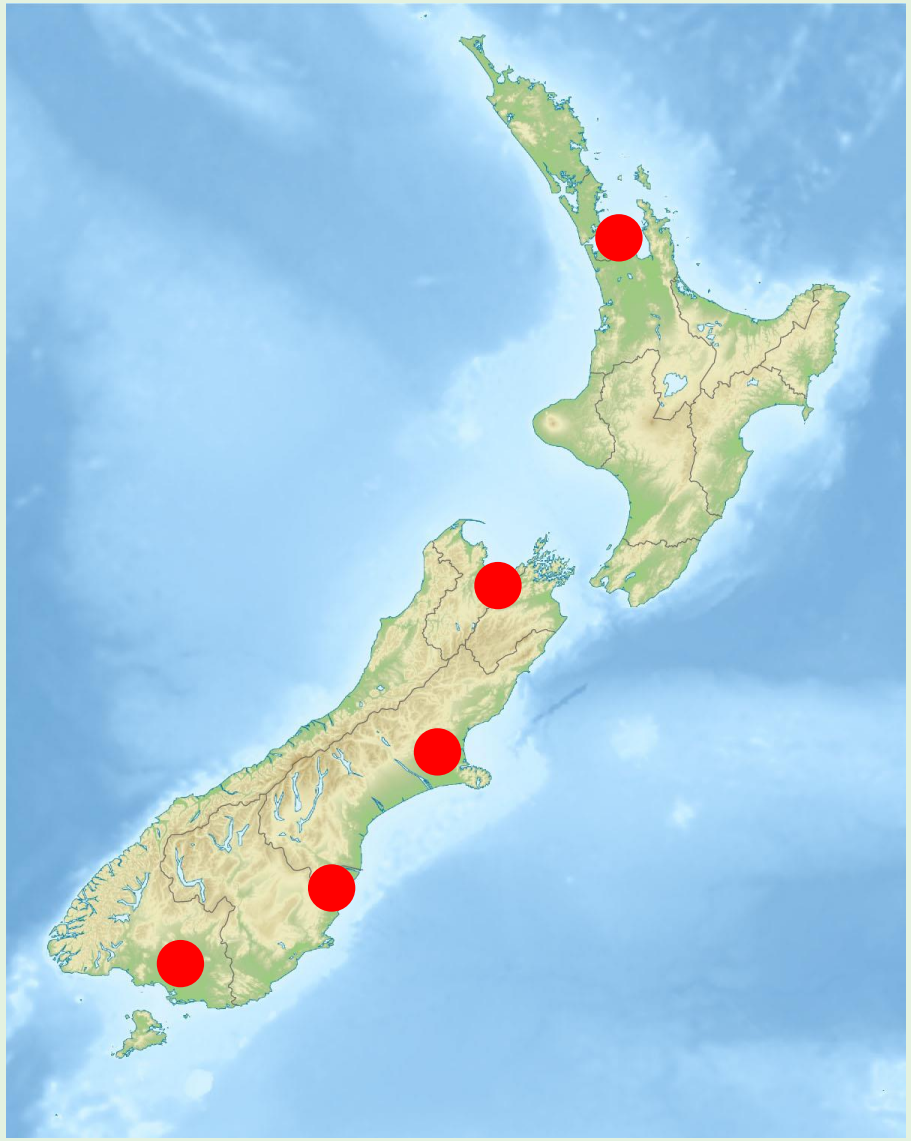
Tamarillo

Seed infection

- Many thin sprouts
- Stunted plants
- Rock hard mother tubers can be found at harvest
- Infected mother tubers can grow healthy, Liberibacter-negative plants, sometimes though a diseased plant (Liberibacter-positive).

Photo: Mark Paget, PFR

History of TPP in New Zealand



First report in NZ, March 2006 – very likely from TPP population in California, USA

South Island, June 2007

Mid-Canterbury, February 2008

Oamaru, January 2009

Southland, January 2012

The tomato potato psyllid life cycle

Egg on a stalk (pedicel) on edge of potato leaf

Halo of eggs on African boxthorn leaf

TPP eggs

Psyllid sugars

Large nymph (4^{th}–5^{th} instar)

Small nymphs (1^{st}–2^{nd} instar)

TPP nymphs (5 instars, small to large)

Two adult TPP

TPP don’t have seasonal flights like aphids and life cycles overlap/are not synchronized.

Timeline of life stages

Development depends on temperature

Day

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

NZ lab 25°C

Egg	1st instar	2nd instar	3rd instar	4th instar	5th instar	Adult

Day

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

Field, Weslaco Texas

Egg	1st instar	2nd instar	3rd instar	4th instar	5th instar	Adult

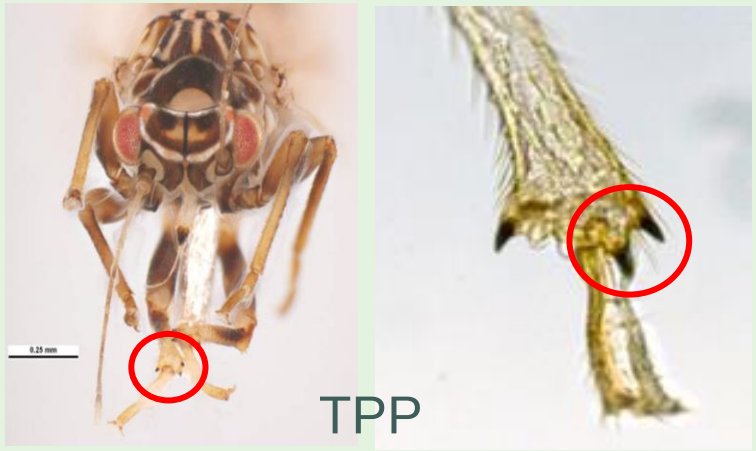
The tomato potato psyllid

- Western haplotype in NZ
- Adults are yellow/green when emerging from nymph, then turn dark
- Liberibacter-negative psyllids feeding
  - USA: symptoms observed caused by toxin in TPP saliva (psyllid yellows), but never detected
  - NZ: never observed strong psyllid yellows symptoms, it may have been a result of undetectable levels of Liberibacter.
- Some native psyllids in potato may look like TPP, you need a microscope to distinguish!

Skin from old nymph (exuviae)

Young TPP adult, no white stripe

Two “old” TPP adults, with white stripe



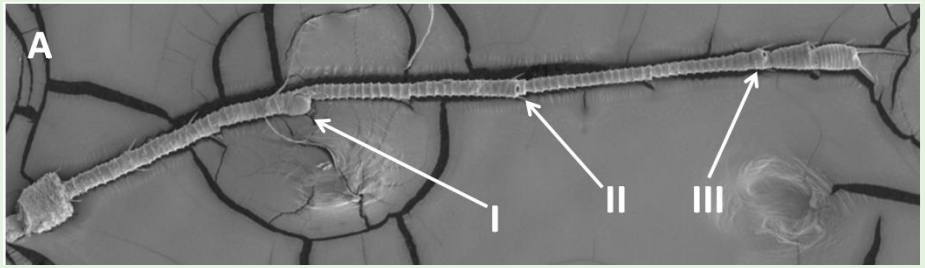
TPP

Pittosporum psyllid

What is still unknown or works in the lab but not in the field?

- How the presence of predators and parasitoids affects zebra chip disease incidence
- Why there are ZC hot spots in certain areas
- How exactly does Liberibacter manipulate the insect and plant
- How we can successfully culture Liberibacter in the lab
- TPP vision to attract or deter the insect
  - e.g. wave-lengths that deter TPP worked in a petri dish, but not in greenhouse or field
- TPP olfaction – e.g. for development of a lure
  - Looked at sensilla on antennae and there are olfactory receptor neurons, responses in lab, but 23 compounds or blends (tomato, potato, African boxthorn) were not attractive in the field

- Why do some things work in the lab and not in the field?
  - TPP may use different cues depending on whether they are walking or flying



Antennae of TPP. Three prominent placoid-type (involved in olfaction) sensilla (I, II, III). Photo: Kye Chung Park

Keep on top of haulm desiccation and check results

Don’t leave bags with rogued plants or sprouting tubers in the field

Plants grown from tuber or still green and TPP will find them!

Monitoring for Liberibacter and TPP

This is what you see when you walk or drive past… it is not scouting your crop.

Scouting for Liberibacter and TPP

- Early season – secondary (seed) infection
  - Late emergence
  - Yellow, red foliage
  - Stunted, gnarly looking plants.
- Later in season, symptoms because of TPP feeding, do you see:
  - Psyllid sugars?
  - TPP life stages? Eggs on new growth, other life stages on older leaves
  - Discoloured leaves?
- Scout new leaves (eggs, adults) and middle leaves (nymphs, adults, beneficials)
- Not one symptom that proves it is Liberibacter – you need to come to the conclusion by deduction.
  For potato, it could also be:
  - Rhizoctonia
  - Verticillium
  - Virus.

Acknowledgements

Big thank you to

- all the NZ growers who allowed us to conduct trials in their crops
- all the PFR colleagues who contributed to TPP and Liberibacter research
- agronomists, scouts, and agchem industry for their support, help, and insights
- Sustainable Farming Fund, Potatoes NZ, Canterbury Potato Liberibacter Initiative, Australian Plant Biosecurity Cooperative Research Centre, Ministry of Business, Innovation & Employment, and Plant & Food Research for funding the research.

Plant & Food Research
Rangahau Ahumāra Kai

Thank you

Jessica.Vereijssen@plantandfood.co.nz

A smart green future. Together.

plantandfood.co.nz