



Frost – Psa risk factor, or not?

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Zespri project
VI1784:

***Cold temperature and frost
effects on Psa***

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Orchard frosts

Frosts can cause injury to kiwifruit vines:

- Even mild frosts (0 to -0.5°C) can drop leaves in autumn and damage new growth in spring
- Ground frosts occur more often than air frosts (less than $< 0^{\circ}\text{C}$ at canopy height)
- It is the air frosts that cause the damage
- There are anecdotal reports in the industry that frost injury in orchards increases Psa and there is research that supports this.



Spring frosts

- Frost protection prevents shoot damage, but if shoots are killed by frost, the dead tissues cannot become infected by Psa
- But, the tissue injury could provide entry sites for Psa into the cane
- Early spring copper, starting at bud break, reduces the Psa bacterial load in the orchard and reduces frost-related Psa infection
- Copper also helps minimise risks of bud rot, leaf spotting and cane infection later.



Autumn frosts

- During leaf fall in autumn, frost can kill shoots and drop the remaining leaves off the vines
- Frost injury and leaf scars both provide potential entry sites for Psa
- Again, copper sprays during leaf fall, will reduce Psa bacterial load and reduce Psa infection risk.



Winter frosts

What about winter frosts when vines are dormant (late June – late August)?



Research on winter frost in Italy

- Frosts below -11°C killed fruit buds in 1985*
- Frost damage increased Psa growth inside canes in artificial inoculation experiments**

*Testolin R, Messina R, 1987. Winter cold tolerance of kiwifruit. A survey after winter frost injury in northern Italy. *New Zealand Journal of Experimental Agriculture* 15, 501–4.

**Ferrante P, Scortichini M 2014. Frost promotes the pathogenicity of *Pseudomonas syringae* pv. *actinidiae* in *Actinidia chinensis* and *A. deliciosa* plants. *Plant Pathology* 63: 12–19.



New Zealand research on winter frosts

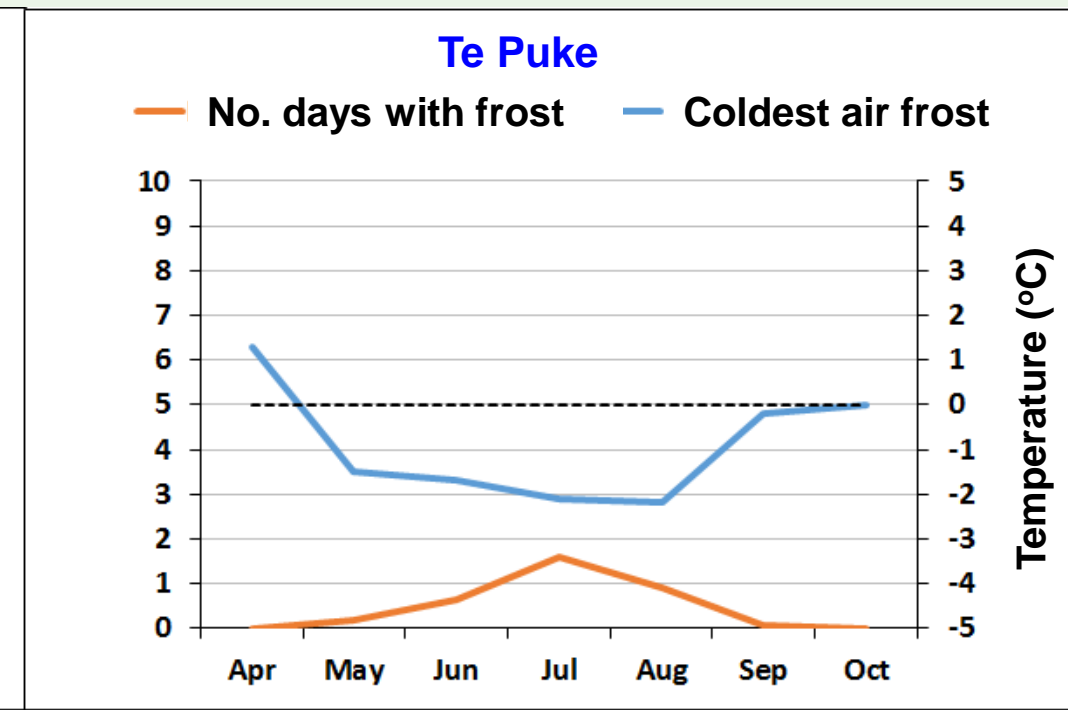
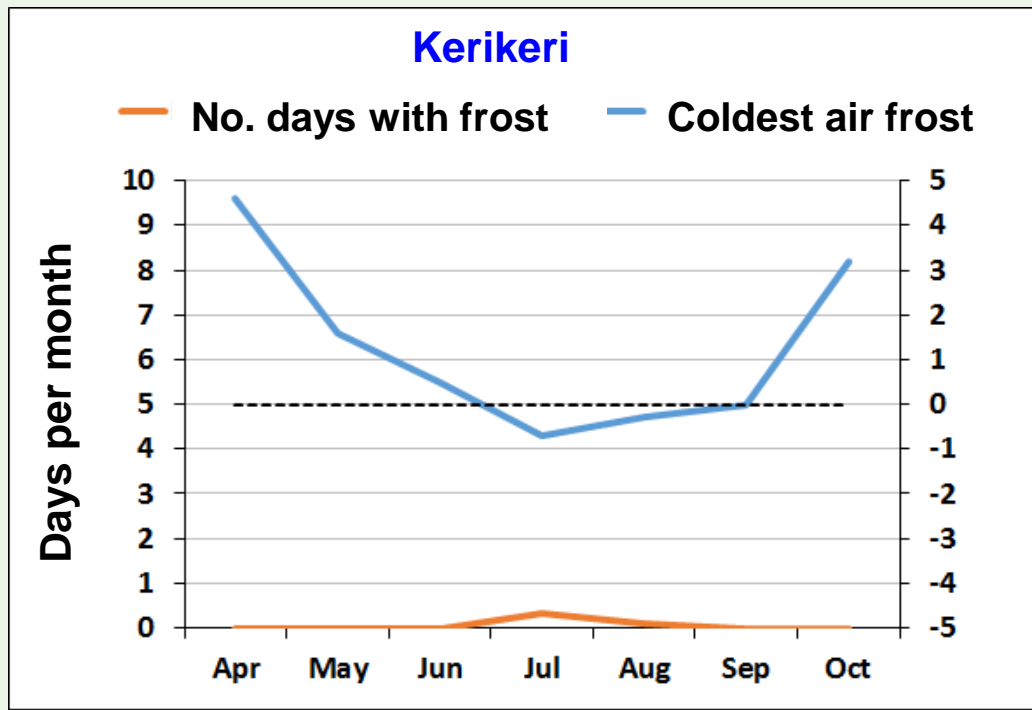


A three year Zepsri funded project examined effects of frost on damage to dormant vines in New Zealand orchards

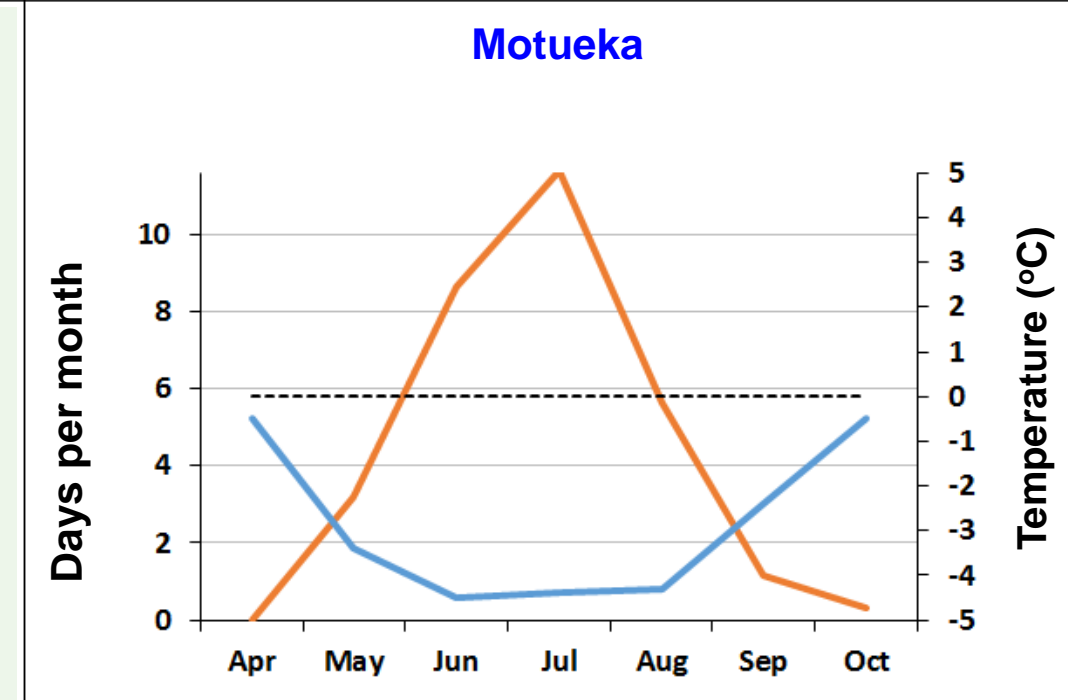
- Aim was to determine whether frosts during June, July and August could cause injury that would increase Psa occurrence
- First, we looked at the frequency and severity of frosts in kiwifruit growing regions.



10-year
average
data



- Temperatures below -5°C are rare in coastal areas, even down south
- Colder temps could occur inland and at higher altitude
- -10°C is very rare in NZ kiwifruit regions.



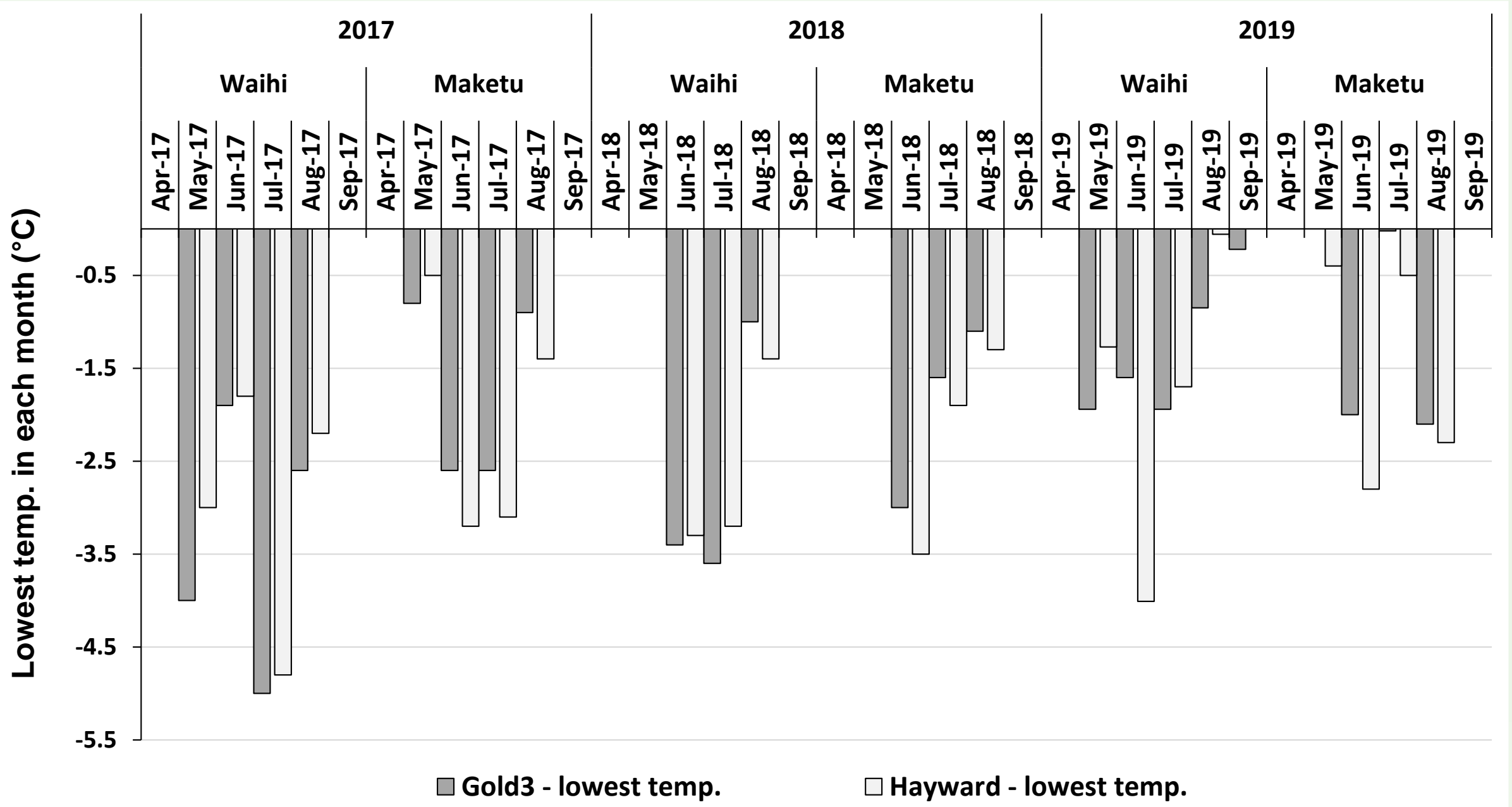
Field frost studies

Two sites: Maketu 11 m altitude
Waihi 120 m altitude

Two blocks 'Hayward'
at each site: Gold3

- Over three years, the coldest frost was -5°C at Waihi in July 2017
- No frosts recorded in April or in September.

3 years of frosts – monthly minimum temperatures



Field frost studies

Two sites: Maketu 11 m altitude
Waihi 120 m altitude

Two blocks 'Hayward'
at each site: Gold3

- In these orchards, no frost damage was observed on dormant canes
- Psa cankers were present, but their development could not be linked back to occurrence of frosts.

Detached cane studies



Dormant canes were collected monthly from the study orchards, subjected to different frost temperatures in the laboratory and to wounding & inoculation with Psa

We measured growth of stem cankers with and without Psa inoculation over 3 weeks.



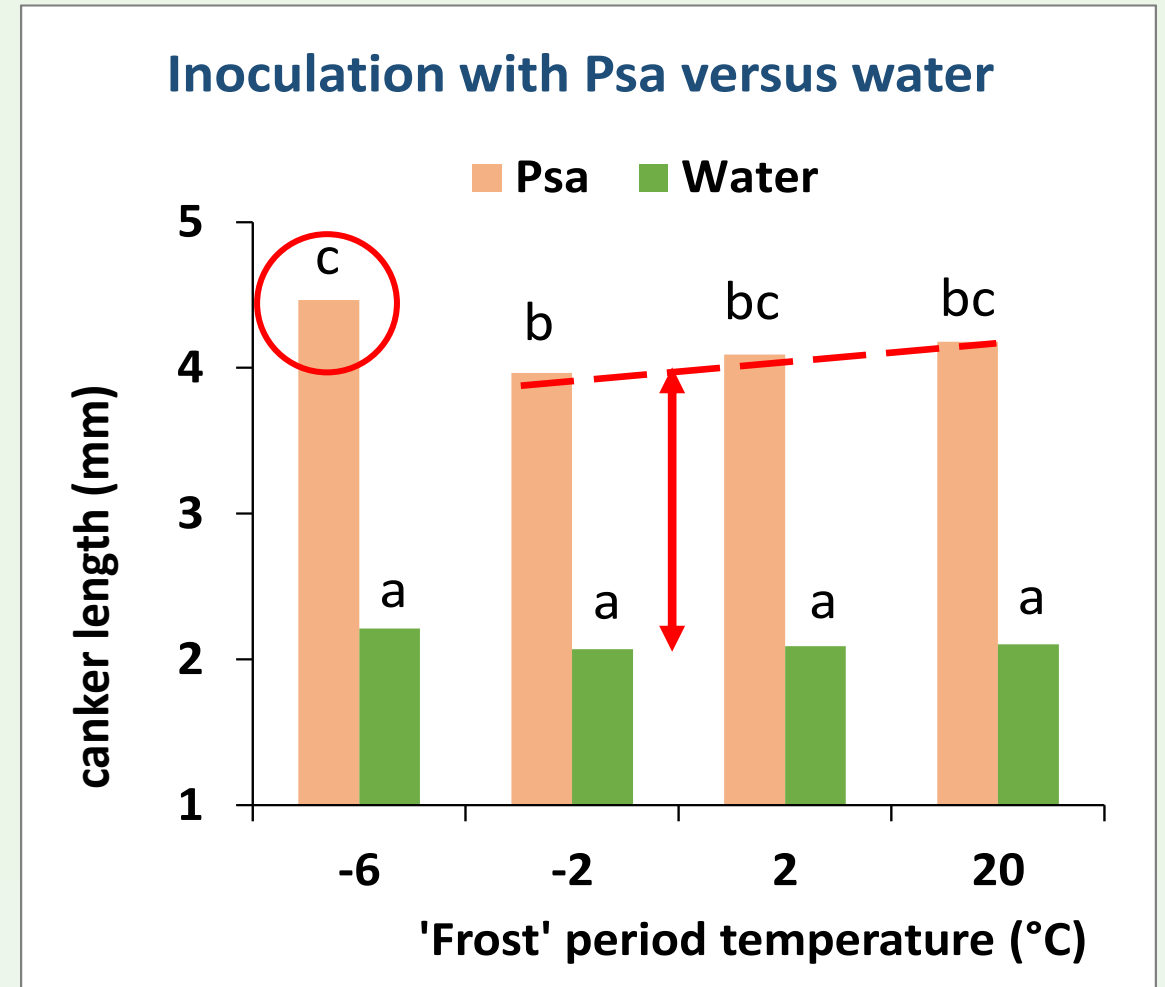
'Frost' treatment temperatures

Temperatures used: -6°C, -2°C, +2°C, +20°C

Significant increase in canker length with Psa inoculation

Frost injury caused increased canker length at -6°C

Where there was no frost injury, there was a trend for canker length to increase slightly with temperature.

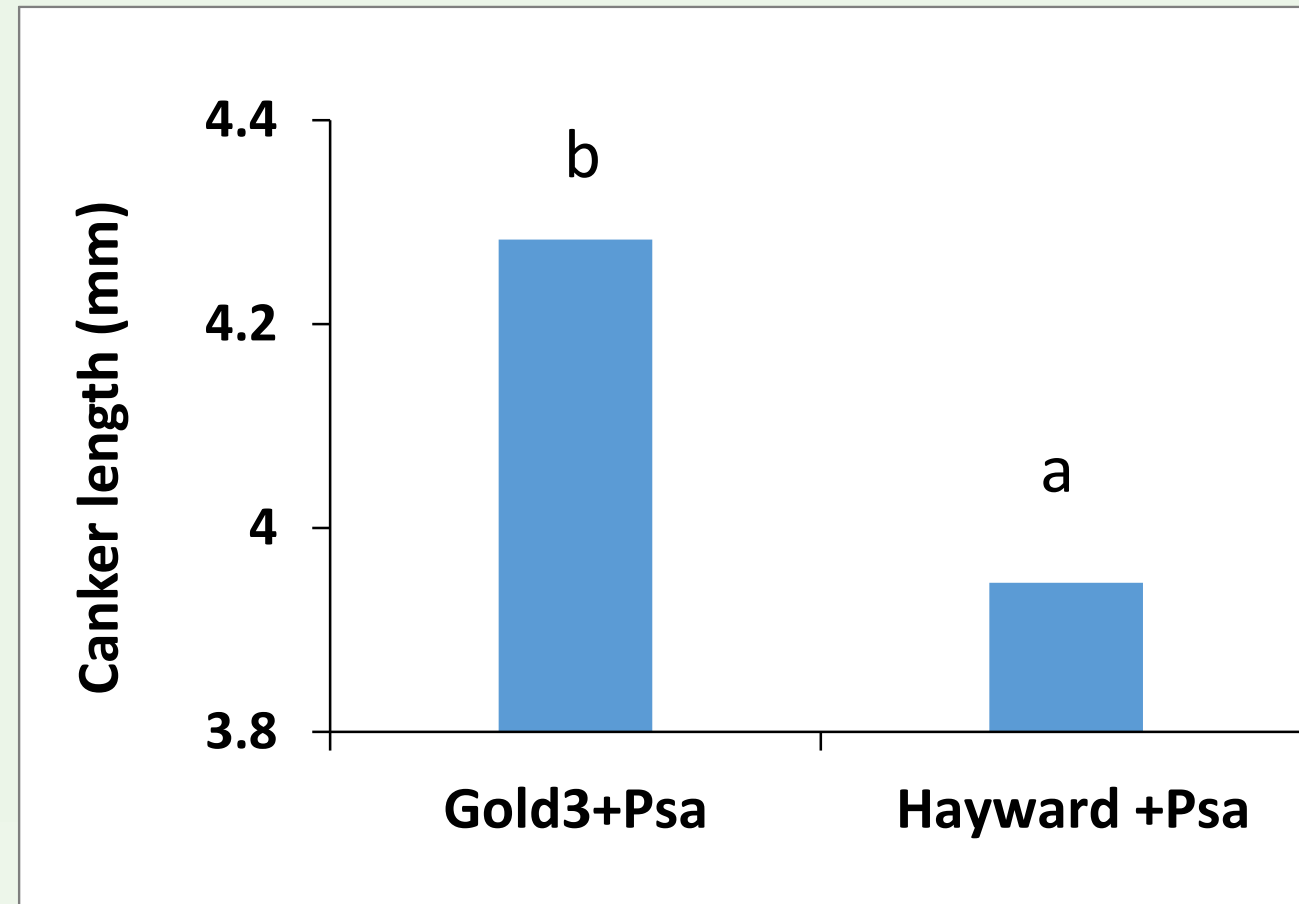


Site and cultivar differences

Frost temperature effects were the same for canes from Maketu and Waihi

For temperatures where there was no frost injury (down to -2°C), Gold3 developed longer Psa lesions than 'Hayward'

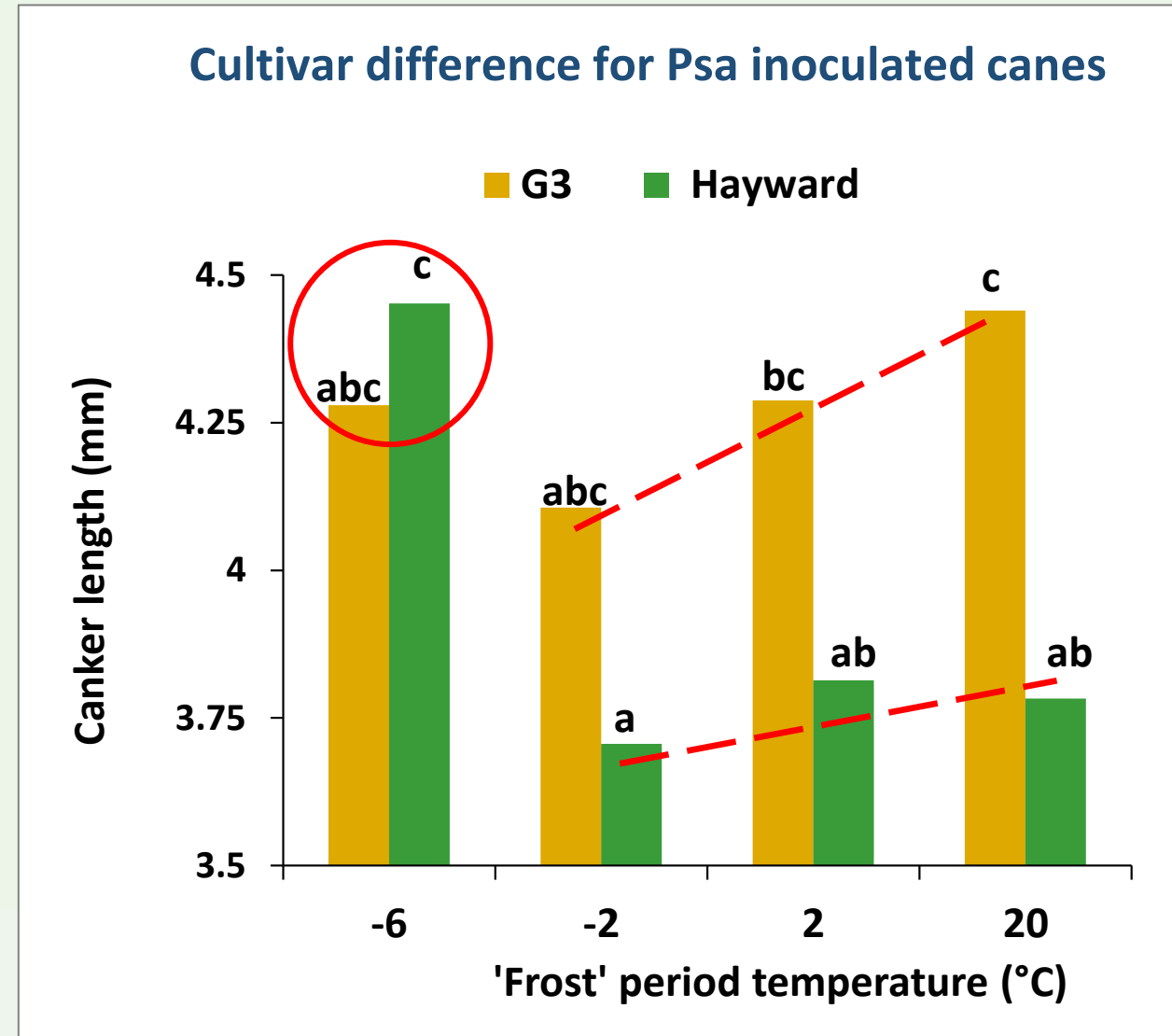
– Confirms the greater Psa susceptibility of Gold3 compared with 'Hayward'.



Cultivar differences under severe frost

Under severe frost conditions (-6°C), there was no difference in canker length between Gold3 and 'Hayward'

The increase in Psa canker length with temperature at non-damaging temperatures (-2 to 20°C) was greater in the more susceptible Gold3.



Winter frost conclusions

- Kiwifruit canes can be killed at air temperatures below -10°C and injured at air temperatures below -6°C
- In North Island kiwifruit regions, temperatures below -5°C are rare, except in the coldest parts of some orchards
- Winter frost damage to dormant canes leading to increased Psa infection is unlikely in most orchards, at least in the North Island.

Overall conclusions

- Gold3 is more susceptible to Psa than 'Hayward' in the absence of frost
- At frost temperatures below -6°C , Psa canker development resulting from frost injury is similar in both 'Hayward' and Gold3
- With climate warming, frosts will generally become less frequent, although occasional extreme weather events could still bring damaging frosts
- Copper applications to reduce Psa load in the orchard will help prevent Psa risk from occurrence of autumn and spring frosts.

Thank you

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