



**Plant & Food  
Research**  
Rangahau Ahumāra Kai

# Understanding biosecurity risk of key orchard inputs (pollen and compost)

**Kerry Everett**



# Introduction



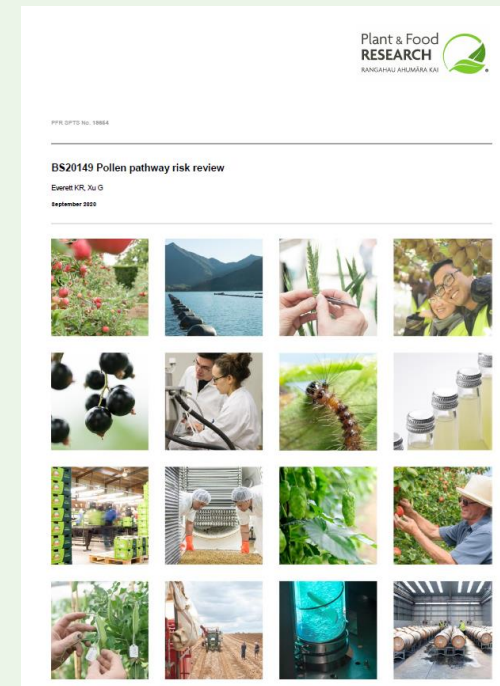
- » Tasked with providing expert opinion and review the literature on the risk of:
  - » Pollen
  - » Compost
  
- » to spread pathogens



# Introduction

» The pollen report is complete and an overview will be presented here

» The compost Project Description has been written

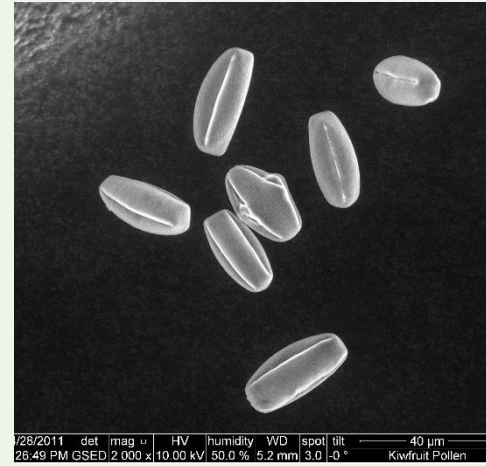




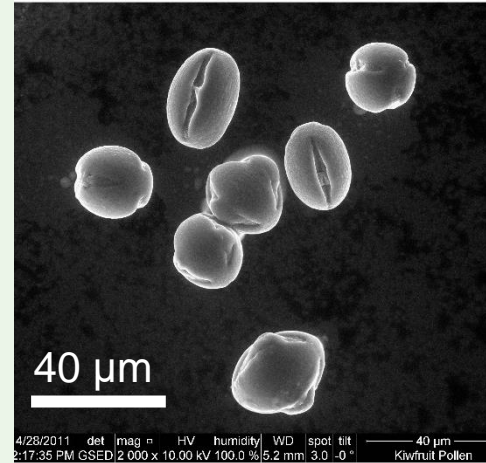
# Overview of Biology

# What does pollen look like?

» Dry pollen



» Hydrated pollen



» Germinating pollen



Pollen



Anthers



Male flowers



$\text{cm} = 10^{-2} \text{ m} \text{ (1/100)}$   
 $\text{mm} = 10^{-3} \text{ m} \text{ (1/1000)}$   
 $\mu\text{m} = 10^{-6} \text{ m} \text{ (1/1000000)}$   
 $\text{nm} = 10^{-9} \text{ m} \text{ (1/1000000000)}$

Light microscope



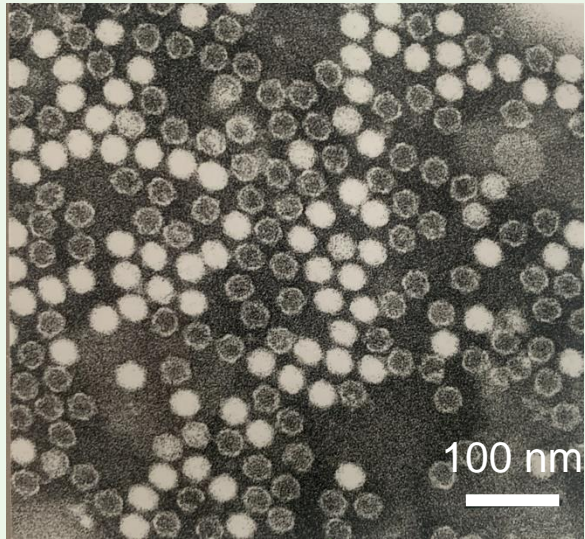
Eyes 



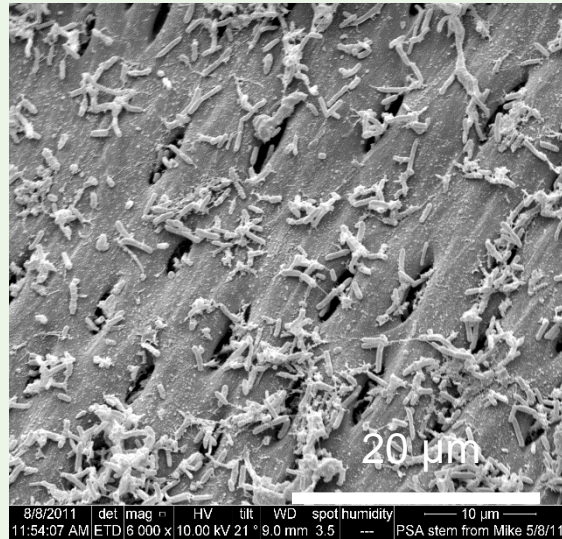
10 nm      100 nm      1 μm      10 μm      100 μm      1 mm      1 cm      10 cm

Logarithmic scale

Viruses



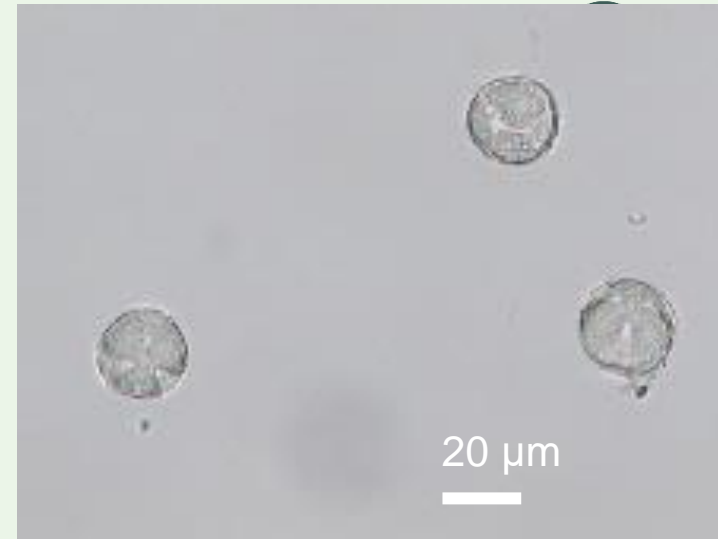
Bacteria



Fungi



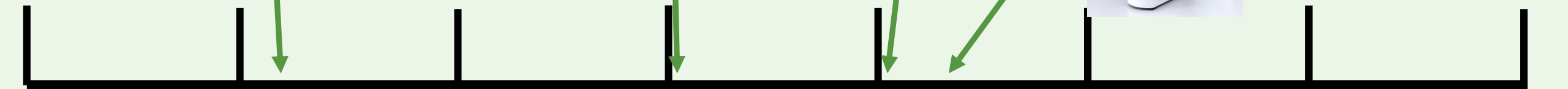
Pollen



Electron microscope

Light microscope

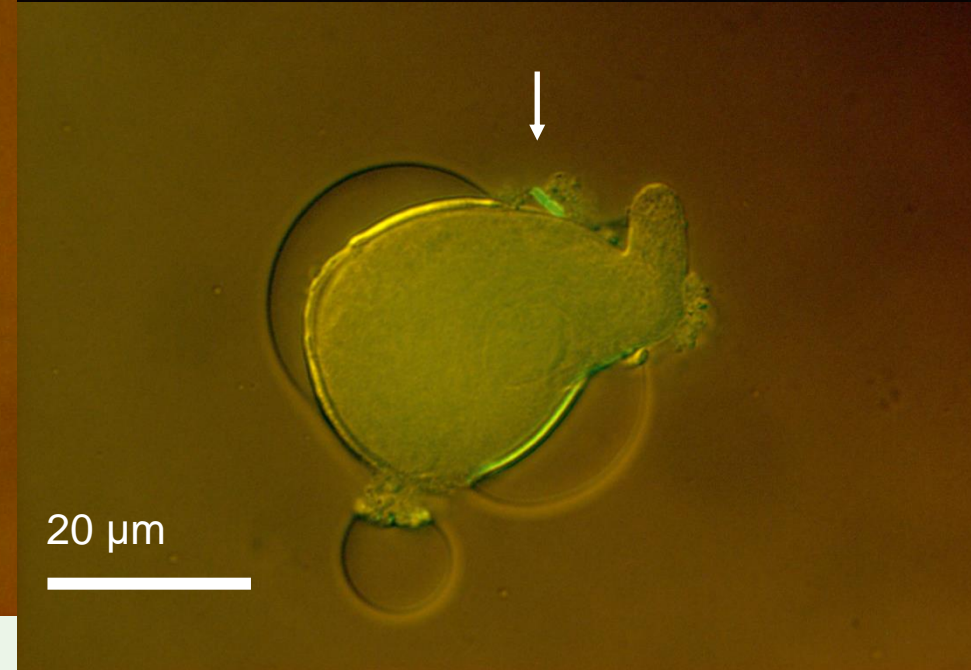
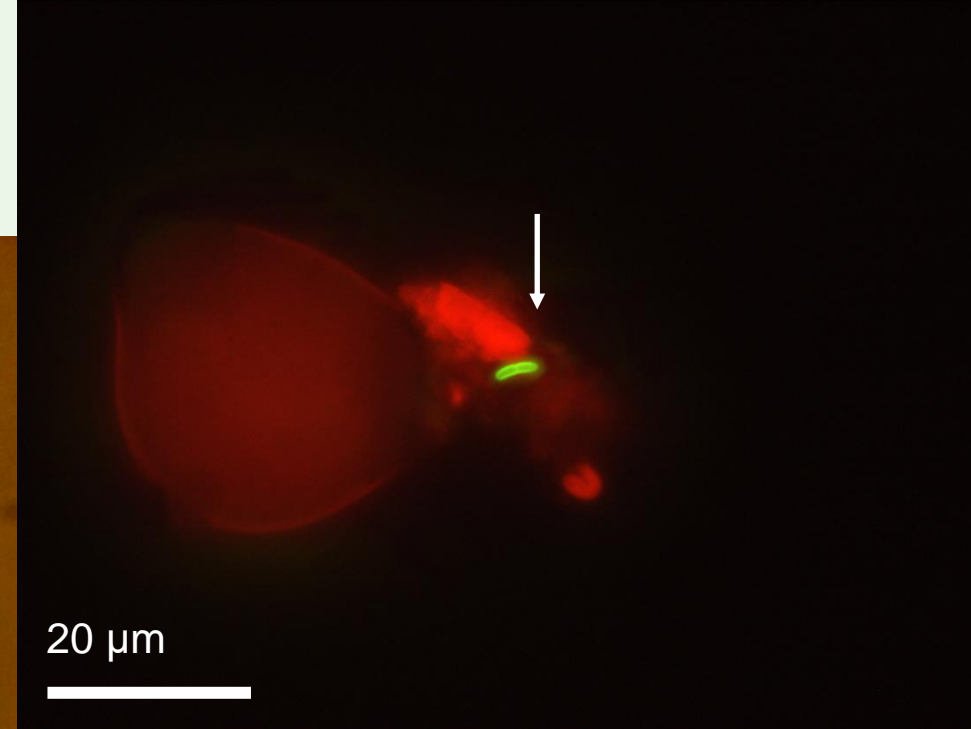
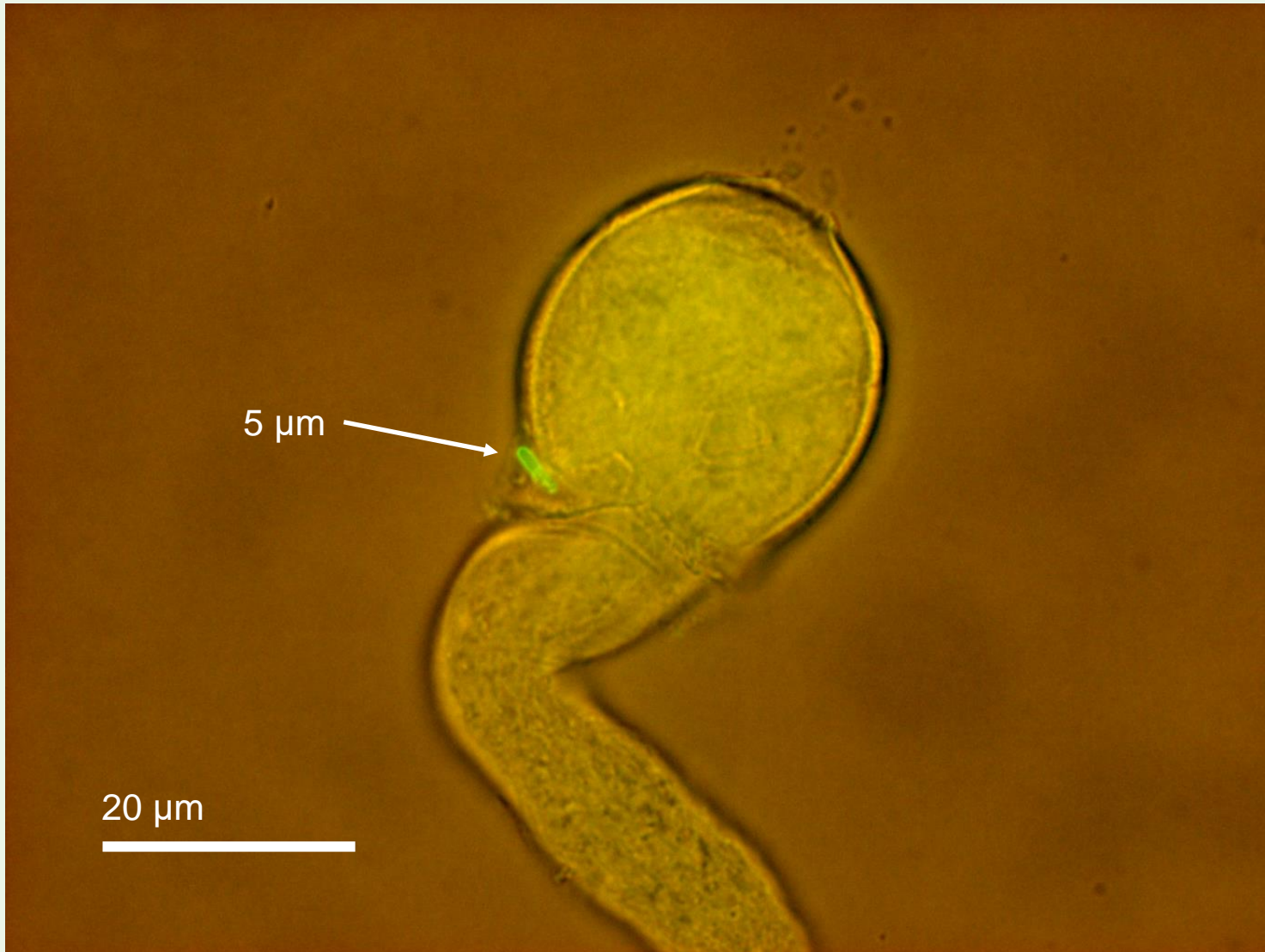
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1 nm      10 nm      100 nm      1 μm      10 μm      100 μm      1 mm      1 cm

Logarithmic scale

# Bacteria on pollen



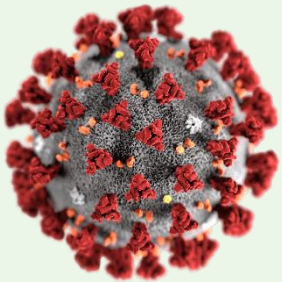
Photos courtesy of Paul Sutherland, Plant & Food Research



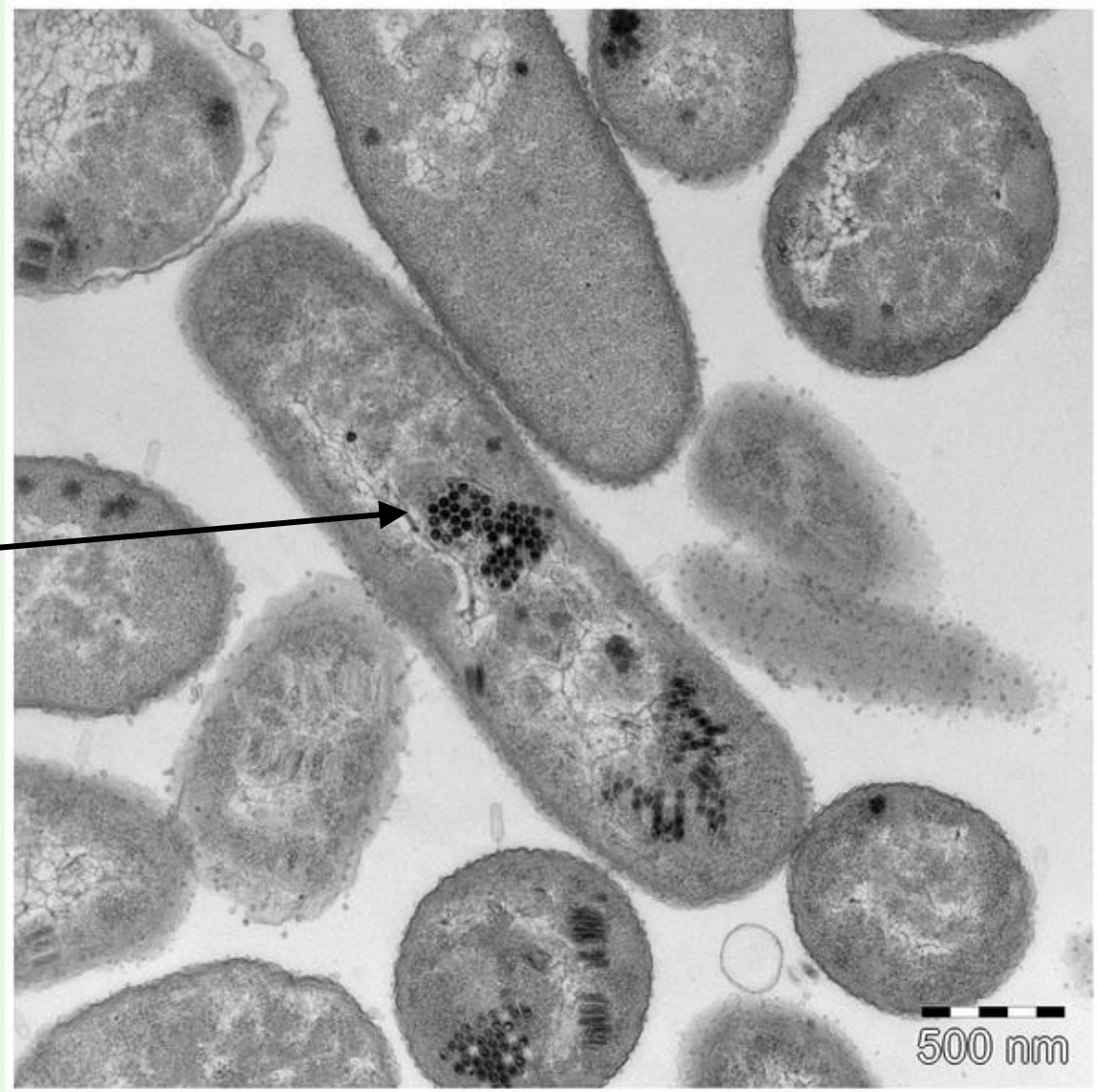
# Viruses on bacteria

Figure 3. Ultra-thin section electron microscopy SU10. Phage empty capsids are attached to the bacterial surface receptors and their genomes are injected to the host.

Phage = 137 x 30 nm



SARS-CoV-2 = 60-140 nm



Mirzaei MK, Eriksson H, Kasuga K, Haggård-Ljungquist E, Nilsson AS (2014) Genomic, Proteomic, Morphological, and Phylogenetic Analyses of vB\_EcoP\_SU10, a Podoviridae Phage with C3 Morphology. PLOS ONE 9(12): e116294.  
<https://doi.org/10.1371/journal.pone.0116294>  
<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0116294>



# Outcomes

# Literature reviewed included:



- » Pollen production
- » Kiwifruit pollen and plant pathogens that infect kiwifruit flowers
- » Reports of pathogens on pollen of other plants
- » Evidence for pollen transmission of bee, human and plant pathogens
- » Mitigation methods used to control bee, human and fresh food pathogens that could be used on pollen.



# Pollen is contaminated with plant debris

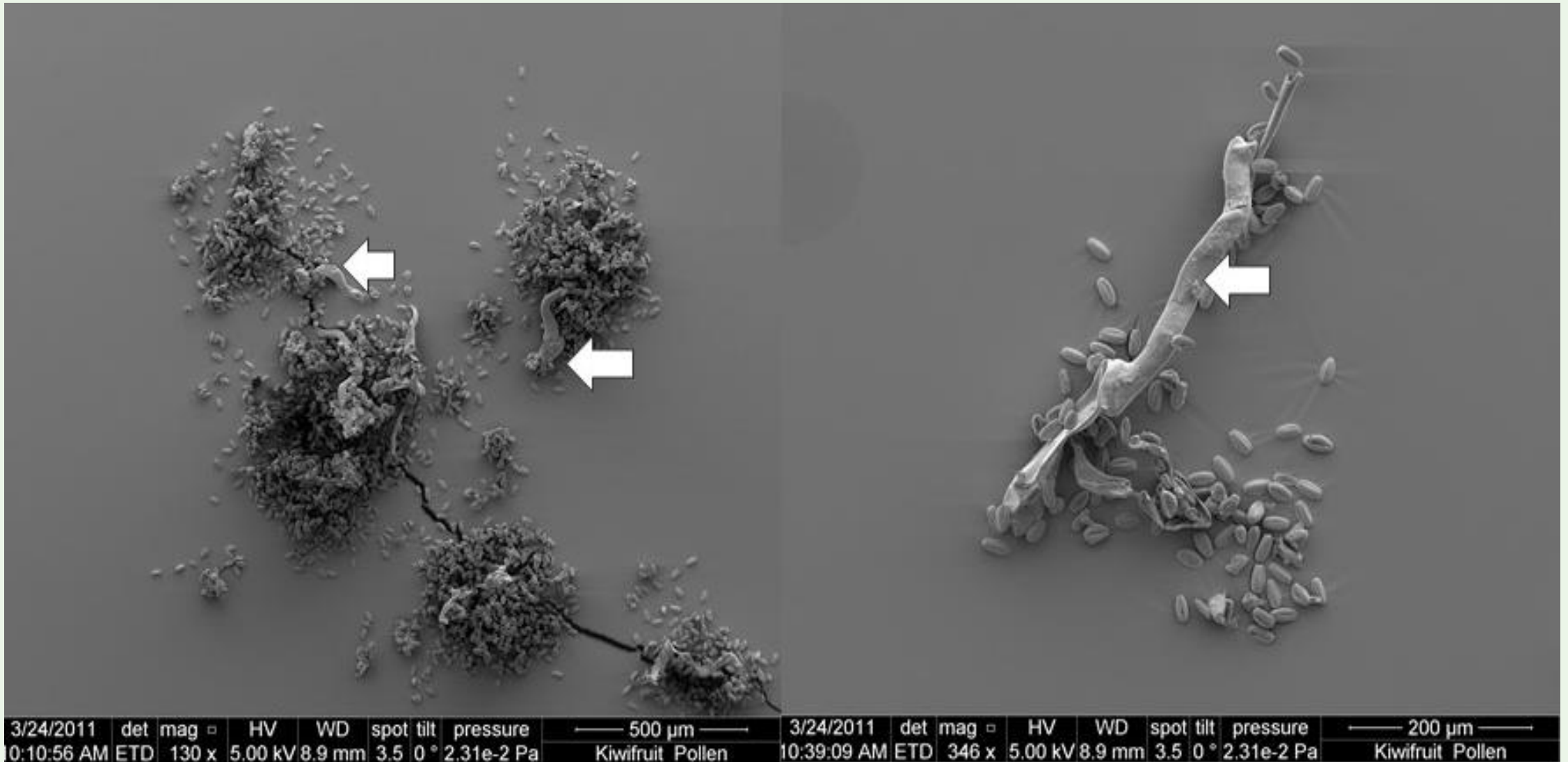
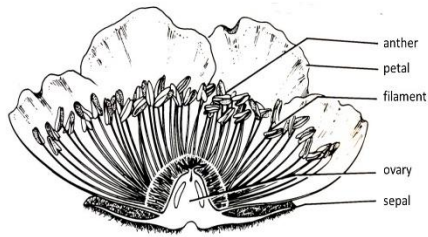
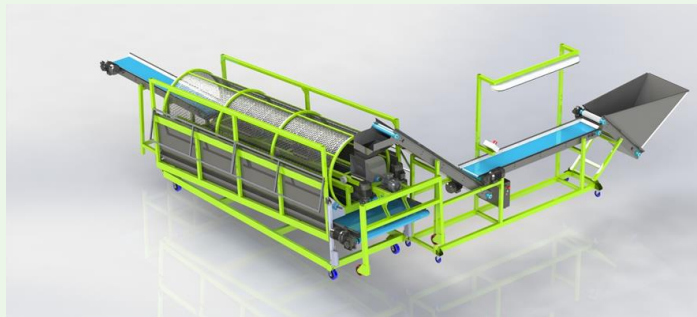


Photo courtesy of Paul Sutherland, Plant & Food Research

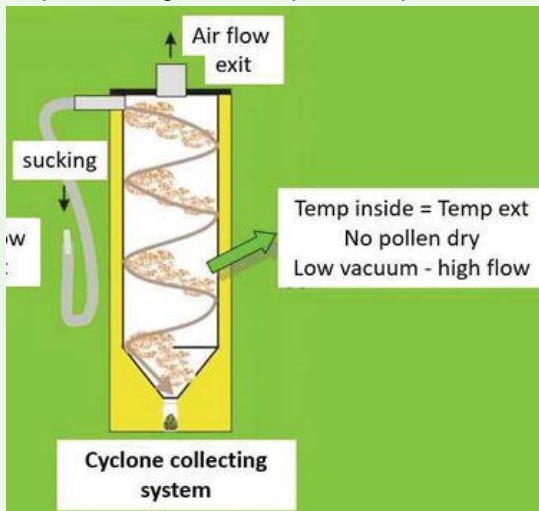
# Pollen production



After Hopping (1990)



<https://frasergear.co.nz/products/pollen-extraction/tri-mill>



<https://www.intechopen.com/books/pollination-in-plants/artificial-pollination-in-kiwifruit-and-olive-trees>






- » Pollen produced on male flowers and transferred to female flowers by bees and other insects
- » Male flowers are harvested at 'popcorn' stage
- » Flowers are roughly cut, then milled by passing through a rotating drum made of a metal sieve
- » Anthers fall through the metal sieve onto a conveyer
- » Anthers are then placed on trays and dried overnight (25°C for 12-16 hours)
- » Pollen is separated from anthers in a cyclone separator
- » Flower debris with similar mass to pollen will not be separated



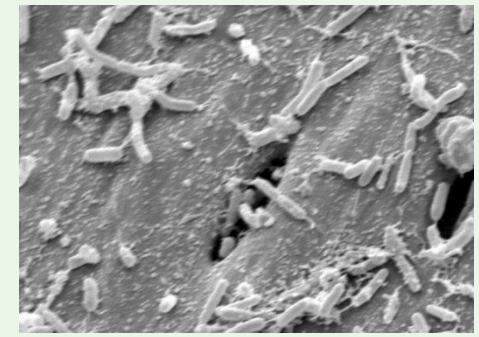
# **Pathogens on pollen and flowers**



# Fungi



Host	Bacterium or group	Pollen	Flowers	Transmissible
Bee pathogens	<i>Ascosphaera apis</i> (Chalkbrood)	yes	?	yes
Plant pathogens	<i>Botrytis cinerea</i> 	yes	yes	?
	<i>Thecaphora capensis</i>	yes	yes	yes
	<i>Colletotrichum acutatum</i> 	yes	yes	yes
	<i>Sclerotinia sclerotium</i> 	yes	yes	yes

# Bacteria



Host	Bacterium or group	Pollen	Flowers	Transmissible
Bee pathogens	<i>Paenibacillus larvae</i> (American foulbrood)	yes	?	yes
Human pathogens	<i>Pantoea</i> spp.	yes	?	yes
	<i>Pseudomonas</i>	yes	?	yes
Plant pathogens	Fire blight ( <i>Erwinia amylovora</i> )	yes	yes	yes
	Walnut blight ( <i>Xanthomonas juglandis</i> )	yes	yes (catkins)	yes
	Bacterial blast ( <i>Pseudomonas syringae</i> pv. <i>syringae</i> )	yes	yes	yes
	Psa 	yes	yes	yes
	Blossom blight ( <i>Pseudomonas</i> sp.) 	yes	yes	?
	<i>Erwinia stewartii</i> (maize bacterial wilt)	?	yes	?
	<i>Pseudomonas syringae</i> pv. <i>tabaci</i>	?	yes	?

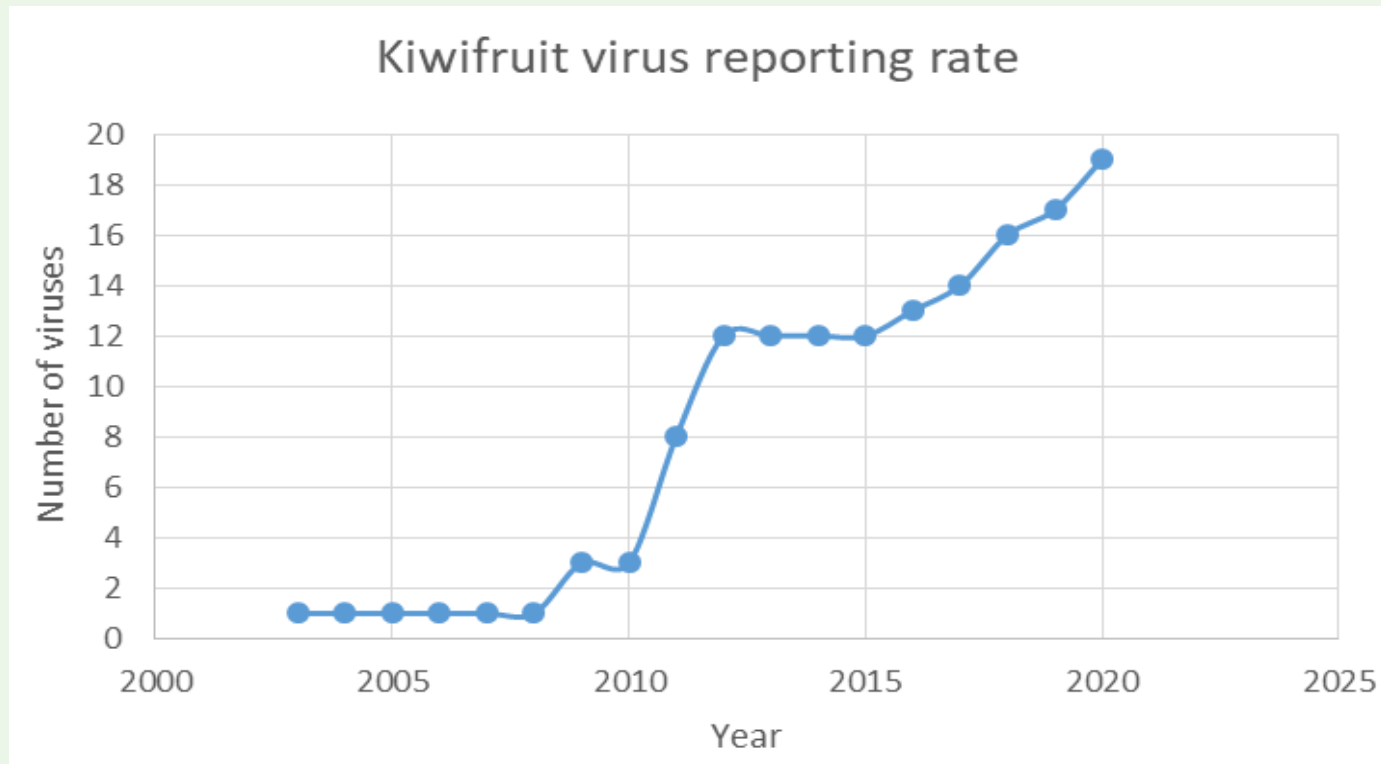


# Oomycetes






Host		Pollen	Flowers	Transmissable
Plant pathogens	<i>Phytophthora ramorum</i>	?	yes	?
	<i>Phytophthora spp.</i> 	?	yes	?
	<i>Phytophthora arecae</i>	?	yes	?
	<i>Phytophthora infestans</i>	?	yes	?
	Downy mildew of grapes <i>Peronospora</i>	?	yes	?
	Chromista- rotting pollen in ponds or on the ground	yes	?	?

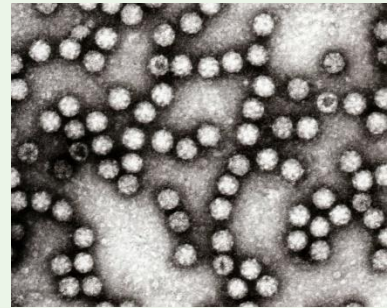
Viruses have only recently (2003) been discovered on kiwifruit



# Viruses



Virus	Acronym	Virus category*	Present in NZ		Pollen transmitted	
			Kiwifruit	Other plants	Kiwifruit	Other plants
<i>Actinidia citrivirus</i>	 AcCV	KA	+	-	?***	?
<i>Actinidia chlorotic ringspot-associated virus</i>	 AcCRaV	KA	-	-	?	?
<i>Actinidia emaravirus 2</i>	 AcEV-2	KA	-	-	?	?
<i>Actinidia virus 1</i>	 AcV-1	KA	-	-	?	?
<i>Actinidia virus A</i>	 AcVA	KA	+	-	?	?
<i>Actinidia virus B</i>	 AcVB	KA	+	-	?	?
<i>Actinidia virus C</i>	 AcVC	KA	-	-	?	?
<i>Actinidia virus X</i>	 AVX	KA	+	-	?	?
<i>Tomato necrotic spot- associated virus</i>	 TNSaV	KA	-	-	?	?
<i>Apple stem grooving virus</i>	 ASGV	NS	-	+	?	-
<i>Cucumber necrosis virus</i>	 CNV	NS	+	-	-	-
<i>Potato virus X</i>	 PVX	NS	+	+	-	-
<i>Ribgrass mosaic virus</i>	 RMV	NS	+	-	-	-
<i>Turnip vein clearing virus</i>	 TVCV	NS	+	-	-	-
<i>Actinidia seed-borne latent virus</i>	 ASbLV	KA	+	-	+	?
<i>Alfalfa mosaic virus</i>	 AMV	NS	+	+	?	+
<i>Cucumber mosaic virus</i>	 CMV	NS	+	+	?	+
<i>Cherry leaf roll virus</i>	 CLRV	KDV	+	+	?	+
<i>Pelargonium zonate spot virus</i>	 PZSV	KDV	-	-	?	+




No viroids or  
phytoplasmas

# Mitigation methods that have been used for kiwifruit pollen



## Used for Psa

Treatment	Pollen germination	Controls Psa
Chlorine dioxide	50%	✓
Benziothiazolinone	50%	✓
copper oxychloride	50%	✓
acetone	3% 	✓
heat/low humidity/N <sub>2</sub>	44%	✓ ✓
heat/low humidity/air	34%	✓
Nitric Oxide/low humidity/heat	17%	✓
ozone	46%	?

None have been commercialised as yet

# Other mitigation methods used for other plants, human medicine and fresh food processing that could be used for kiwifruit pollen



Treatment	Pathogen controlled
Modified atmospheres	Bacteria
Essential oils, natural products	Bacteria and fungi
Heat shock	Bacteria and fungi
Fungicides	Fungi
Biocontrol agents	Bacteria and fungi
High Health mother plants	Viruses

# Highest risks of pollen transmission and mitigation



## Highest risks of pollen transmission

### within NZ

Psa

*Cherry leaf roll virus*

*Actinidia seed-borne latent virus*

### from imported pollen

new strains of Psa

*Pelargonium zonate spot virus*

unknown viruses

Hurdle technologies  
High health mother plants

High health mother plants



# Safe movement of pollen



## Flower suppliers

Orchard operates to  
Any specific re  
detected orcha

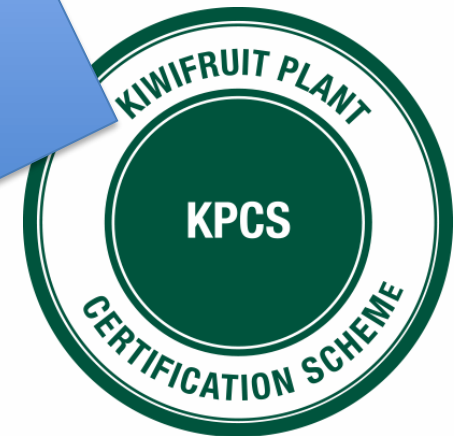
## Mills

- Register with
- Traceability and re
- Hygiene practices
- Source flowers from compliant s

## Suppliers

- Registration and Traceability

Pollen review has confirmed that existing protocols (Pathway Management Plan) are adequate for managing risk



(slide courtesy of Matt Dyck)

# Compost

- » A Project Description has been prepared to inform decisions for managing compost for the Pathway Management Plan
- » Compost is
  - » Raw compost
  - » Vermicompost/vermicast
  - » Mulch
- » If approved, report is due in late February 2021



<https://www.gardeningknowhow.com/>

<https://gardeningtips.in/>

<https://www.smithsonianmag.com/>





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