Needle disease strategy Research Programme

Healthy trees, healthy future Enabling technologies to combat *Phytophthora* diseases

SCION FORESTS • PRODUCTS • INNOVATION

Red Needle Cast – what we now know

Nari Williams, Lindsay Bulman, Carol Rolando, Rebecca McDougal and team



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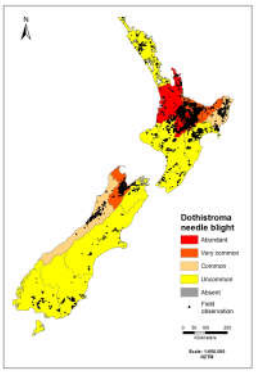
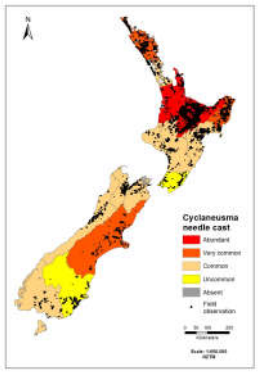
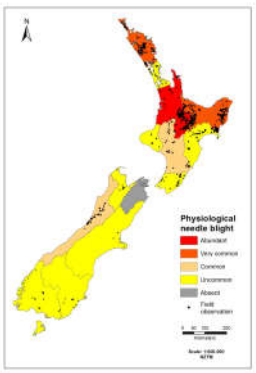
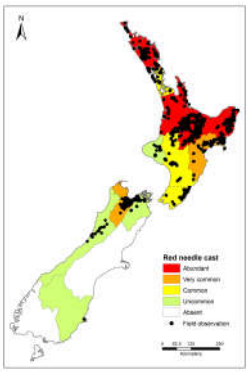
Foliar diseases of Pinus radiata in NZ



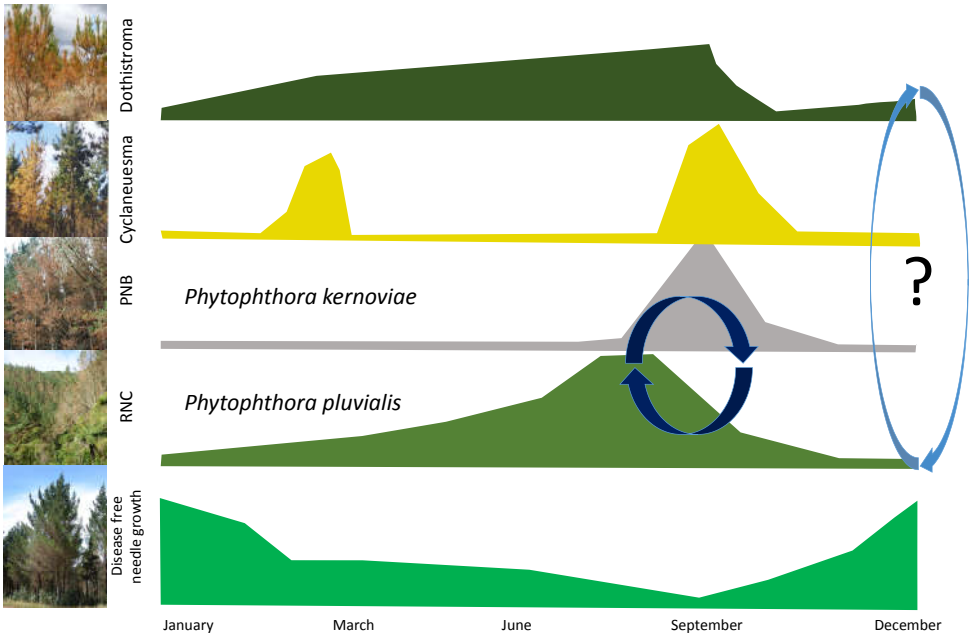





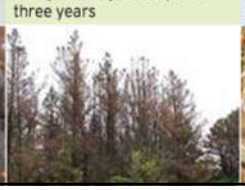




Seasonal expression of pine needle diseases



Symptoms associated with the four foliar needle diseases of *Pinus radiata*

Symptom	Cyclaneusma Needle Cast (CNC)	Physiological Needle Blight (PNB)	Red Needle Cast (RNC)	Dothistroma Needle Blight (DNB)
Time of year expressed	September to November	June to November	April to October	All year, first appears on current foliage about December
Incidence and severity	Scattered individuals, up to 90% severity on very susceptible trees	Localised distribution, very high incidence in affected parts of a stand	Localised/general distribution, almost every tree in affected parts of a stand	General distribution, almost every tree in affected parts, but tree to tree variation is apparent.
Needle colour	Yellow, then gold, then brown	Red, then red-brown, then grey	Oily green band, then yellow, then red	Brick red bands on green needles with black spots usually seen within the bands.
Needle wilt	No wilt	Wilt common at late stage of disease development	No wilt	Needles may wilt, but usually wither and turn brown/grey
Needle retention	Needles detach very readily	Needles retained	Needles detach readily	Needles die completely and are retained
Cambium and bark	No damage, no lesions, no resin	No damage, lesions, or resin	No damage, no lesions, resin blobs sometimes seen at needle base	No damage, no lesions, no resin
Tree age	Six to 20 years	Generally over 15 years	All ages, but generally over three years	From planting up to about 15 years
				

Understanding Phytophthora

- Microscopic fungal like organisms that infect and kill plants.
- Threaten the biodiversity and sustainability of agricultural and forest ecosystems worldwide
- *Phytophthora* is derived from Greek and literally means “plant destroyer”
- Traditionally thought to be soil-borne pathogens in forest systems

International examples

- *P. infestans* that caused the Irish potato famine of the 1840s
- *P. cinnamomi* which infects more than 3,000 plant species
- *P. ramorum* which causes sudden oak and larch death in US and UK.

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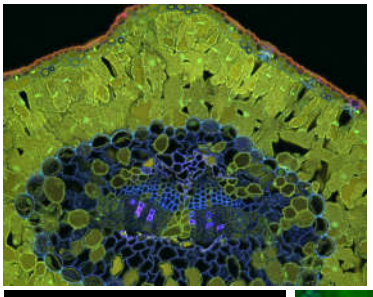
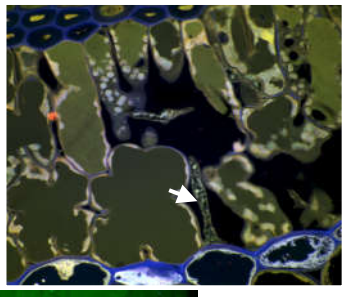
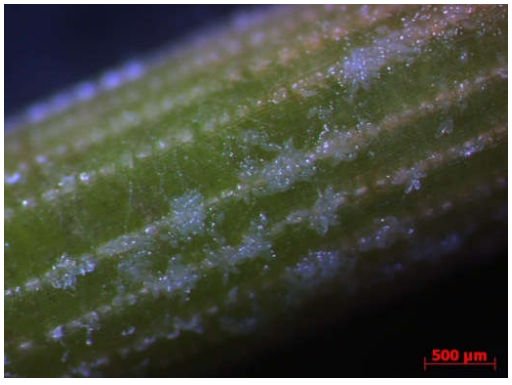
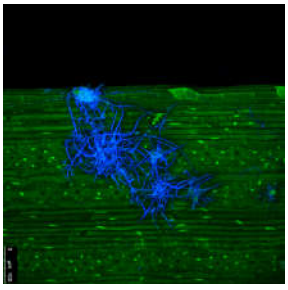
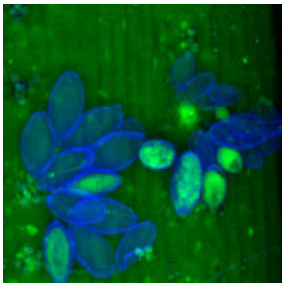
RNC – What do we know?











Lloyd Donaldson, Scion

- *Phytophthora pluvialis* infects through the stomata on the needles.
- Does not penetrate the vascular bundle.
- Sporulates on the needle surface

- Superficial infection vulnerable to environment and chemical control

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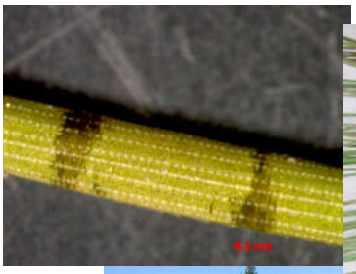
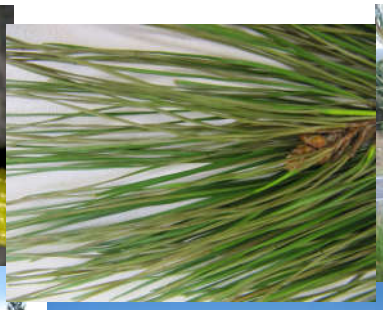
Phytophthora pluvialis – Red Needle Cast


Foliar *Phytophthora* on radiata pine – identification and implications

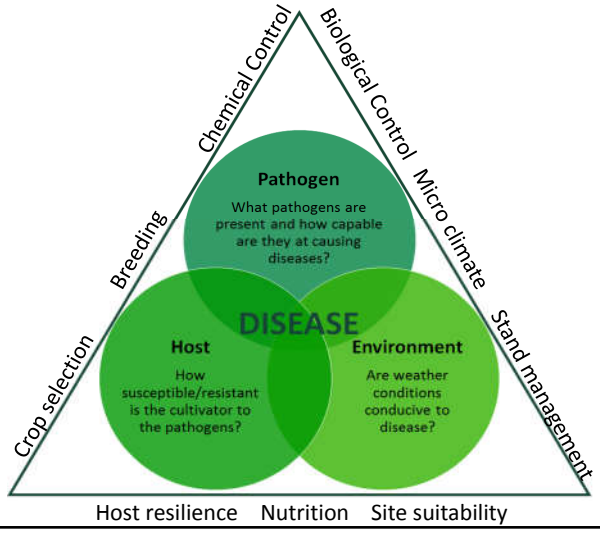
- *Phytophthora pluvialis* discovered in 2008
- Implications for trade primary concern
- Research to determine risk to trading partners given top priority
- Demonstrated inability of *Phytophthora pluvialis* to colonise or survive on logs
- Announced in conjunction with refereed publication allaying biosecurity concerns

Impact: Threat to export log trade $4.8 billion averted

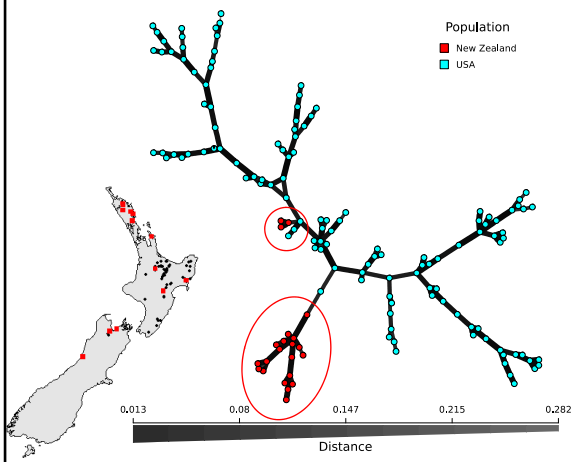


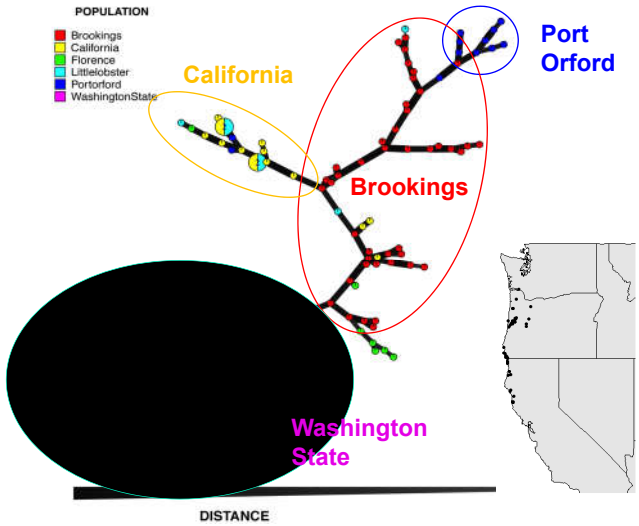
Integrated pest management of foliage diseases in forestry

Plant Disease Triangle



Possibly two introductions of *Phytophthora pluvialis* into New Zealand





Impacts:

- Demonstration of *Phytophthora pluvialis* introduction
- Opportunity to strengthen biosecurity
- Baseline population data

PhD student Simren Brar, Massey University (HTHF)

RNC on Douglas fir

Photos Brent Rogan

Phytophthora pluvialis on Douglas-fir

Mirea Gomez (Scion, PhD Student)

Impacts: Douglas fir is not an alternate crop in RNC prone areas

Breeding and selection- Lab Screening

More than 250,000 needles picked, inoculated, laid out, incubated for 2 weeks then assessed.

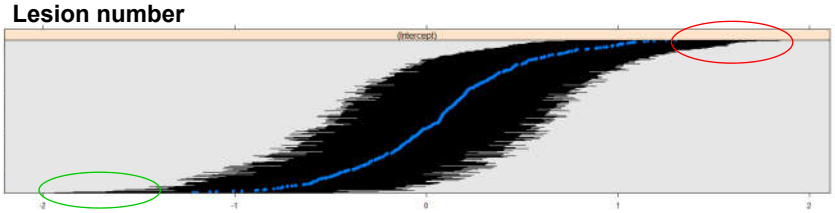




Lab screening – rankings of radiata pine genotypes for RNC lesions

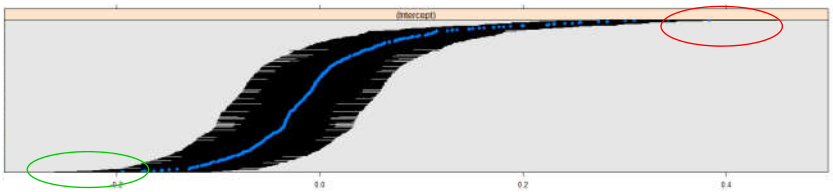
Susceptible

Lesion number

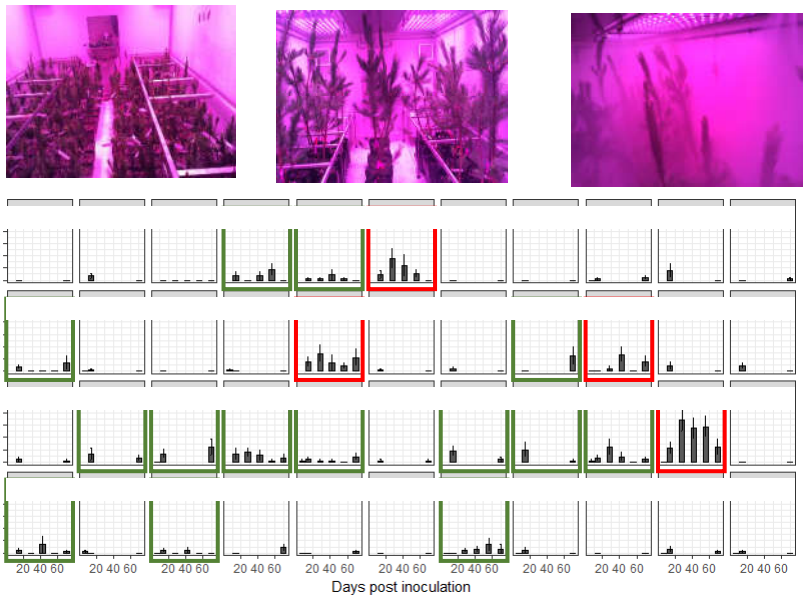


Resistant

Lesion Length

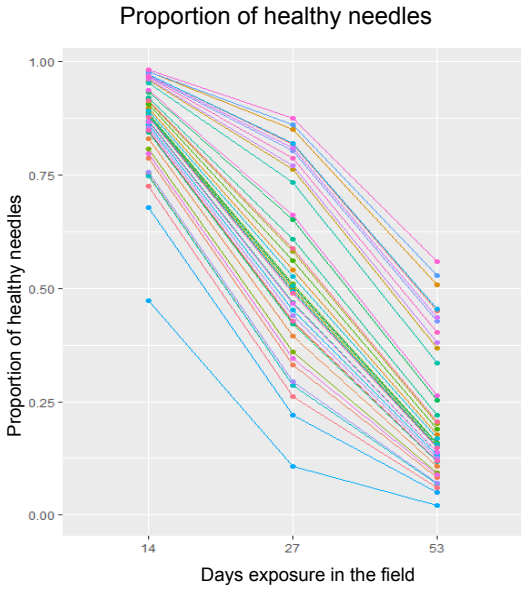


Screening radiata pine in the fog chamber



Taking it to the field – screening clones relevant to industry

Industry relevant clones



- Plants placed in forest under high disease pressure
- Variation in susceptibility across genotypes identified

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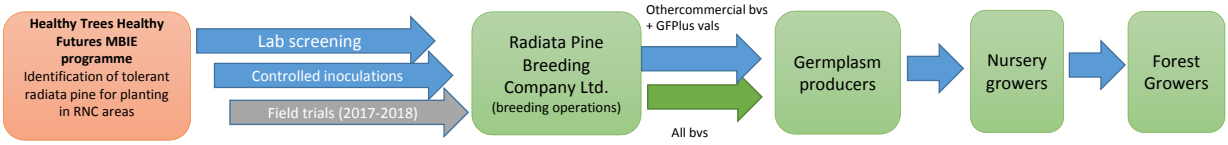
Implementation and availability of RNC resistant lines



Impact: RNC resistant material available for breeding programme

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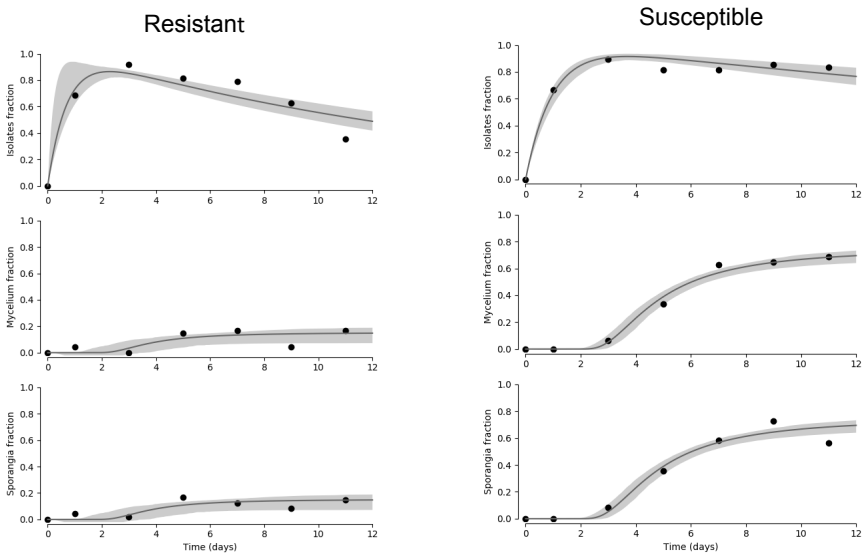
The dynamics of infection on susceptible and resistant host material



Impact:

- More susceptible material drives disease epidemic through higher spore production
- Resistant material combined with chemical control offers long term disease mitigation

RNC Expression

- Severe in 2017
- Past experience shows repeated defoliation is rare
- Volume growth loss significant in first year after an outbreak
  - 40% year one
  - 15% year two
  - 0% year three, if no further defoliation occurs

RNC 2008-2009

2008

2009

RNC 2008-2010

22 July 2008

26 August 2009

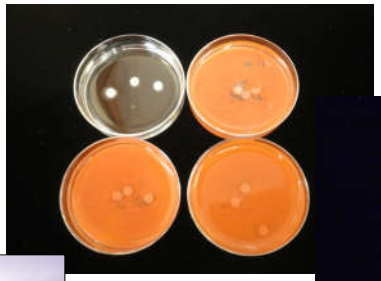
4 October 2010

Chemical control of red needle cast in *P. radiata*

- Objective
  - Develop a cost effective (aerially applied) chemical control treatment for red needle cast.
- Outcome
  - Industry has chemical control strategy to manage RNC in existing mature stands
- Benefit
  - Increased productivity
  - Protection of stands at risk
  - Retain LTO

Chemical control of red needle cast

- Range of chemicals (12) tested in laboratory, pot and field trials



Copper and phosphite the most promising active ingredients for RNC control


SAFETY DATA SHEET

chemet

SECTION 1. Identification of the Substance and Manufacturer

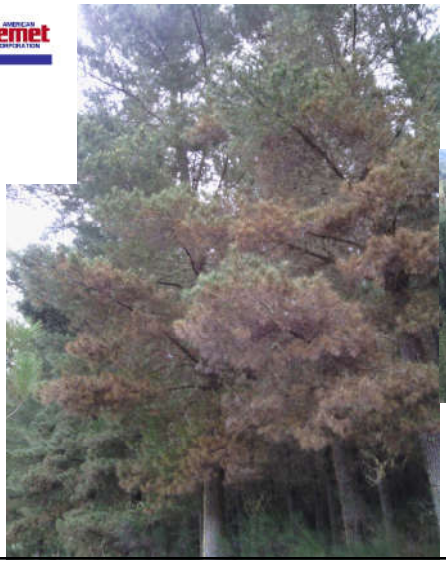
Product: AG Copp 75

Common uses: Agricultural Fungicide

Manufacturer: American Chemet Corporation www.chemet.com
148 HWY 282 / P.O. Box 1180
East Helena, MT. 59635 U.S.A.
+1(406) 227-5302 (Phone) +1(406) 227-6047 (Fax)

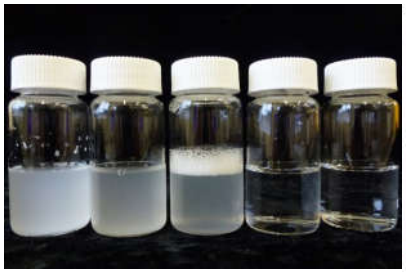
24-Hour Emergency: 3E Company

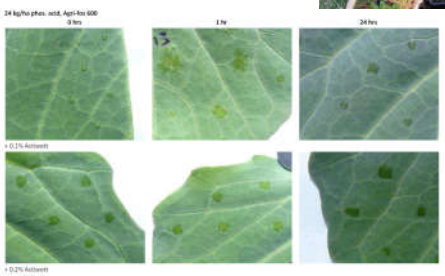
American Chemet Corporation/3E Company Global Incident Response Access Code: 334129
American Chemet Corporation/3E Company Contract Number 14882



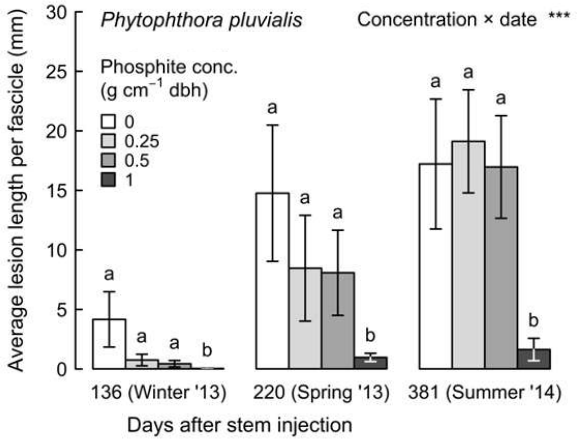
Phosphite for control of RNC

- Trials have been carried out to determine:
  - Effect of method of application on efficacy and persistence of phosphite
  - Effect of dose, formulation and adjuvant on needle uptake of phosphite
  - Effect of dose (and formulation) on efficacy
  - Efficacy when applied at operational scale on mature trees





Phosphite for control of RNC – What we know



- Results with phosphite are inconclusive and highly variable

Early trials with stem injection very promising

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Phosphite for control of RNC – What we know

- Later trials with foliar application resulted in more variable responses
  - Is variability related to foliar uptake, active ingredient or testing methodology?
  - Uptake studies show excellent uptake at foliar level (>50%) – what is limiting efficacy?
- Persistence is lower than expected – protection for only one season likely
  - "fertilizer" effect at higher rates of application (above 12 kg/ha)
- Understanding limited by difficulties to detect phosphite

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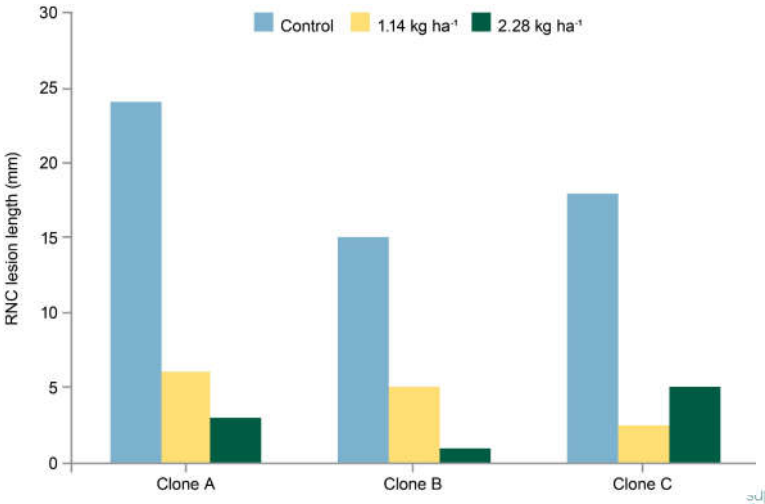
Chemical Control



Dr Carol Rolando, Scion

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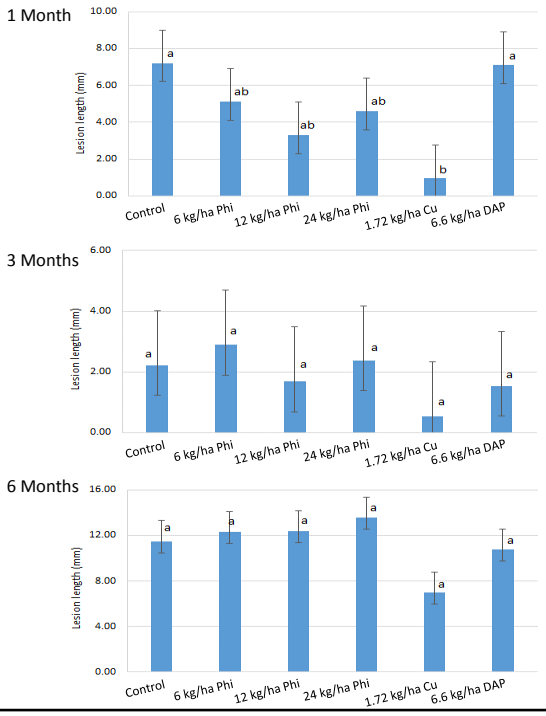
RNC control field trial 2016

- Copper differed from control 1 month after treatment and consistently lower up to 6 months after treatment.
- Phosphite ineffective when sprayed

- Copper is cheap and already in use
- Persists for up to 3-6 months
- Timing, economics and FSC considerations

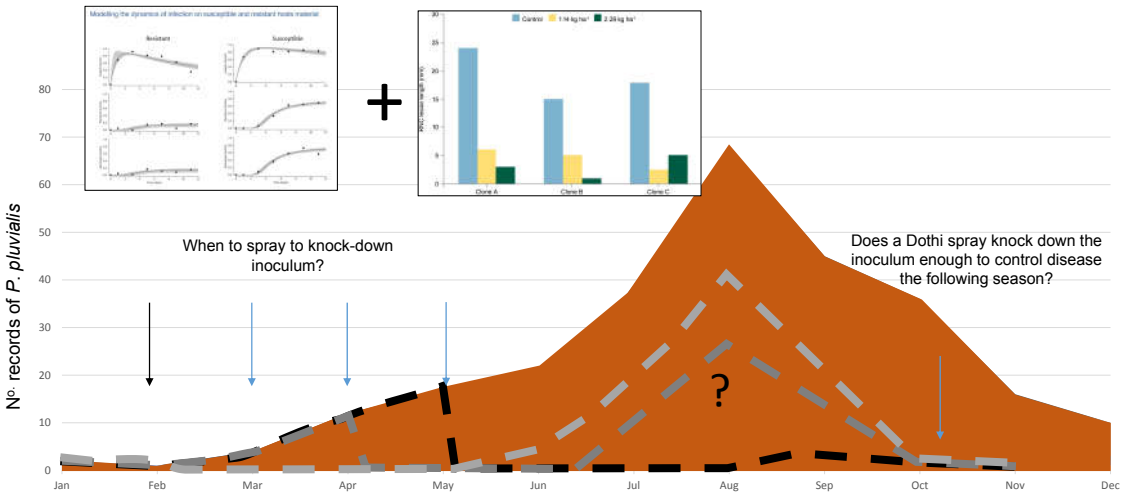


Monitoring of *P. pluvialis* in operationally sprayed blocks

Copper applied February 2017 at dothi standard

Impact: Efficacy of an operational application of copper in February established (2017)

When to spray to knock-down inoculum? What is the economic threshold of infection?



No. records of *P. pluvialis* in the Scion Forest Health Database from throughout New Zealand from 2008-2016 by month.

Impact: Optimal chemical control regime for RNC established and recommended to growers (2018)

Key achievements

- Understand infection cycle
  - Spores produced for the majority of the year when water is available
  - RNC peaks in August-September
  - *Phytophthora kernoviae* confirmed as the cause of “Physiological needle blight”
  - *P. pluvialis* induced “Green needle cast” on Douglas-fir

- Identified resistant germplasm
- Copper is effective in reducing infection by both *P. pluvialis* and *P. kernoviae* for 3-6 months

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Healthy trees, healthy future
Enabling technologies to combat *Phytophthora* diseases

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October 2017

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