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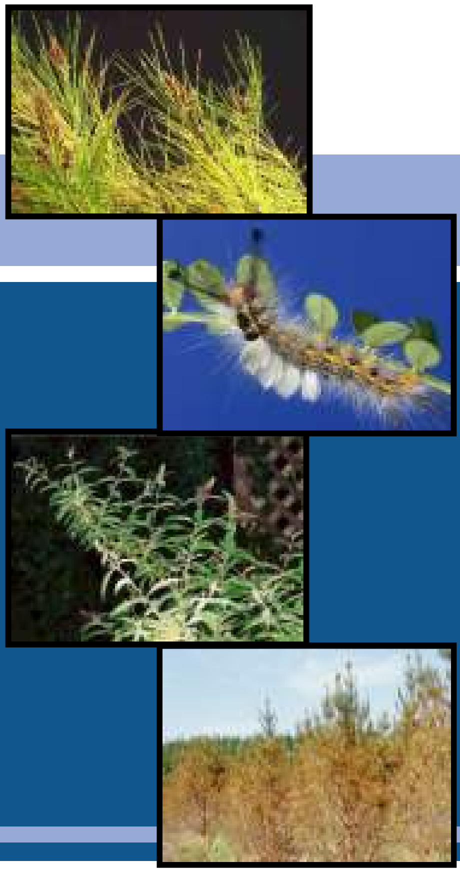
Lindsay Bulman

Forest Biosecurity and Protection



FBRC RESEARCH - Ensis Forest Biosecurity and Protection Unit

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Purpose of FBP Unit

- To ensure the productivity, quality, and sustainability of forests and crops and exports through the evaluation and mitigation of biosecurity risks

- Covers biotic and abiotic risk

Research Scope

- **Protecting our forests from damaging:**
  - Insects
  - Pathogens
  - Weeds
  - Fire
  - Wind
- **National interest research – FBRC and FRST**

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Biosecurity Research Themes

Pre border:
- Pest risk analysis
- Pathway analysis
- Quarantine treatments

Pre border:
- Western gall rust
- Pitch canker

Post border:

Pest Surveillance → Incursion Response → Forest weed and Pest management and Forest protection

Post border:
- Surveillance efficacy
- Nursery surveys

- Predicting pest mortality
- Spray application optimisation

- Cleopus release
- Nectria – ecology, surveys, susceptibility
- Paropsis biocontrol
- Stem injection
- Remote sensing

Ecosystem Health & Function:

Forest health and environment → Ecosystem resistance to pest impact

Ecosystem Health & Function:
- PNB
- Armillaria
- Cyclaneusma pest impact assessment
- Economics of pest impacts
- Strategic planning

Pre-Border – Molecular techniques for Western gall rust

DNA-based technology enables rapid diagnosis of diseases:

- Western gall rust – difficult to identify by traditional diagnostic means
- A rapid and successful DNA protocol has been developed for detection of *Peridermium harknessii*

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Pitch canker:

(What we know, what we don't know.)

Answers to some of the questions…

Forest Biosecurity and Protection

Beccy Ganley

(FBRC-funded Post-doc)

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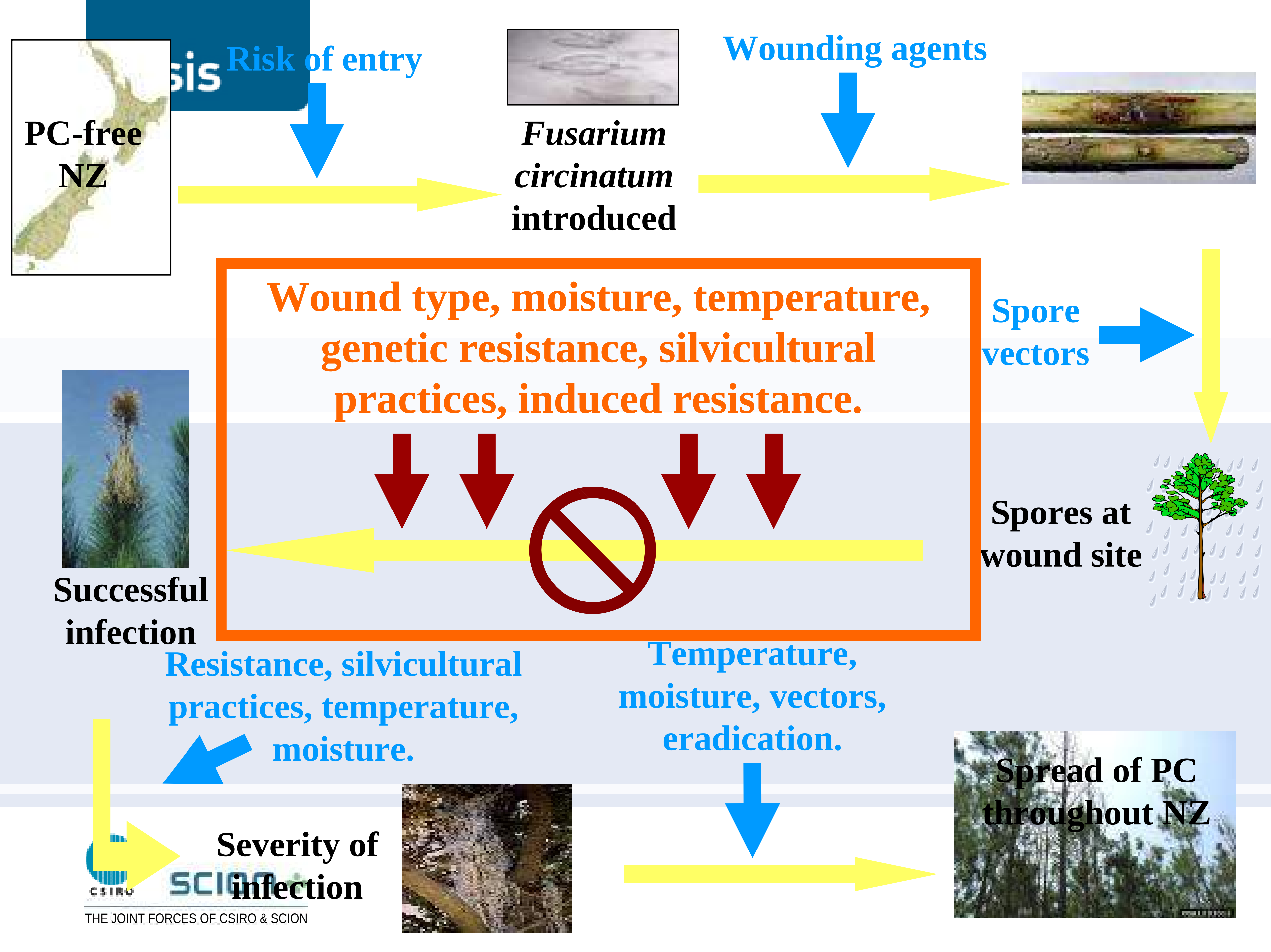
PC-free NZ
Risk of entry
Fusarium circinatum introduced
Wounding agents
Spore vectors
Spores at wound site
Wound type, moisture, temperature, genetic resistance, silvicultural practices, induced resistance.
Successful infection
Resistance, silvicultural practices, temperature, moisture.
Temperature, moisture, vectors, eradication.
Severity of infection
Spread of PC throughout NZ
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Wounding agents & vectors

- New Zealand's forests have wounds, wounding agents and vectors suitable for infection.

- However, in the absence of intricate insect-host systems, such as in California, the wounding agents present in NZ are unlikely to play a significant role in disease establishment or intensity.

Instead, environmental conditions and silviculture are more likely to influence disease establishment.

Critical factors

- Temperature
- Humidity
- Stand moisture
- Nutrient Levels

Establishment and severity of pitch canker appears to occur from a combination of these factors…

Temperature

In the laboratory: *F. circinatum* growth is suppressed under 10°C, upper temperature unknown.

In the field: Disease has been clearly limited in all locations visited when the temperature is too high or too low.

NZ:

- It is expected that temperatures prevailing in the majority of New Zealand's forests will be within the optimum range.
- Based on field observations, areas that receive snow would be low risk.

Humidity

- High humidity is required for severe infection.
- It is expected that humidity levels in New Zealand would be sufficient in most areas for establishment of the disease.
- The disease would be expected to be more severe in regions of New Zealand that frequently have fog belts or low lying mists.

However, optimum temperature and humidity does not mean that pitch canker will become established in an area.

Predict that the most important factors are stand moisture content and nutrient levels.

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Stand moisture

Currently setting up moisture stress trials in *P. radiata* seedlings to determine interaction.

New Zealand: Unlikely that moisture stress will be a problem in NZ as stands have low stock density and soil moisture levels are high. Disease may be more prevalent in regions prone to drought stress.

Nutrient levels

Currently setting up nutrient trials in *P. radiata* seedlings to determine the influence of P and N on disease establishment and severity.

New Zealand: High nutrient levels.

- Nutrient levels required in *P. radiata* to facilitate disease establishment or severity are unknown.
- Additional fertilisation would not be advised.

Nurseries and plantations:

Eradication – swift action and stringent sanitation procedures could prevent spread to adjacent forest lands or other nurseries.

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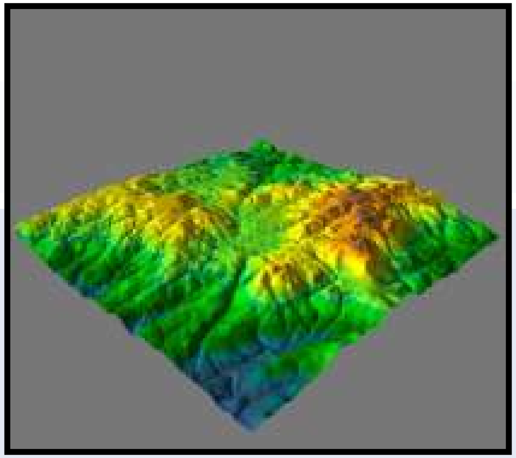
The good news…

- In the absence of cone-related insects, the transmission of *F. circinatum* to seed is low.
- In South Africa and Chile, pitch canker has not established in the plantations despite presence of inoculum in nurseries.
- Observed nurseries surrounded by highly infected PC plantations that are disease free – some of these nurseries have been operational for 8+ years without incident, despite *F. circinatum* inoculum.

Post-Border – Surveillance efficacy and modelling



Modelling the expected incidence and impacts of pests:

- After which we can then test different sampling methods and determine surveillance efficacy

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Post-Border – Nursery surveillance

- Review historical pest incursions and findings
- Carry out monthly assessments – record pest damage and test repeatability

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Post-Border – Mortality prediction

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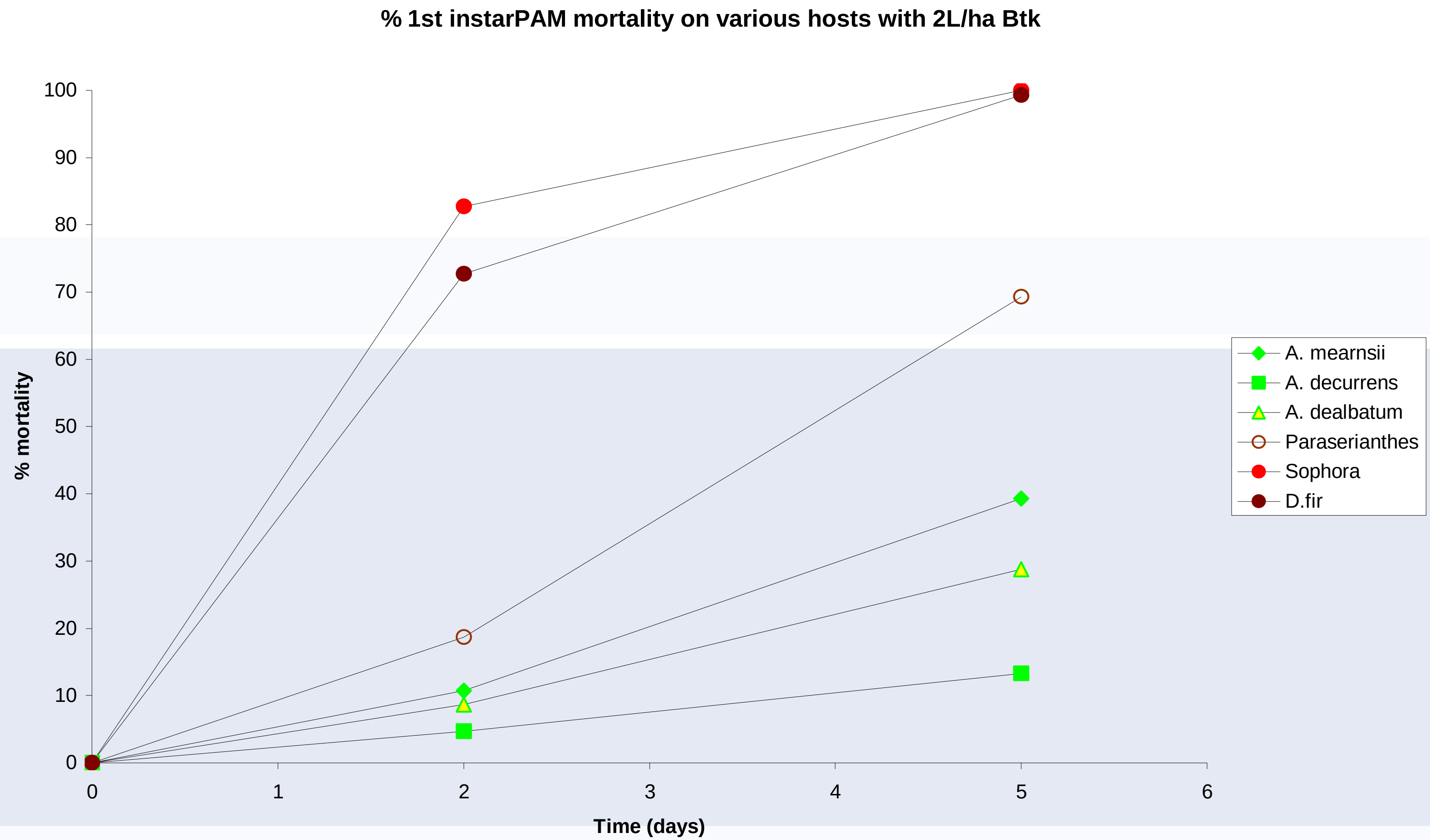
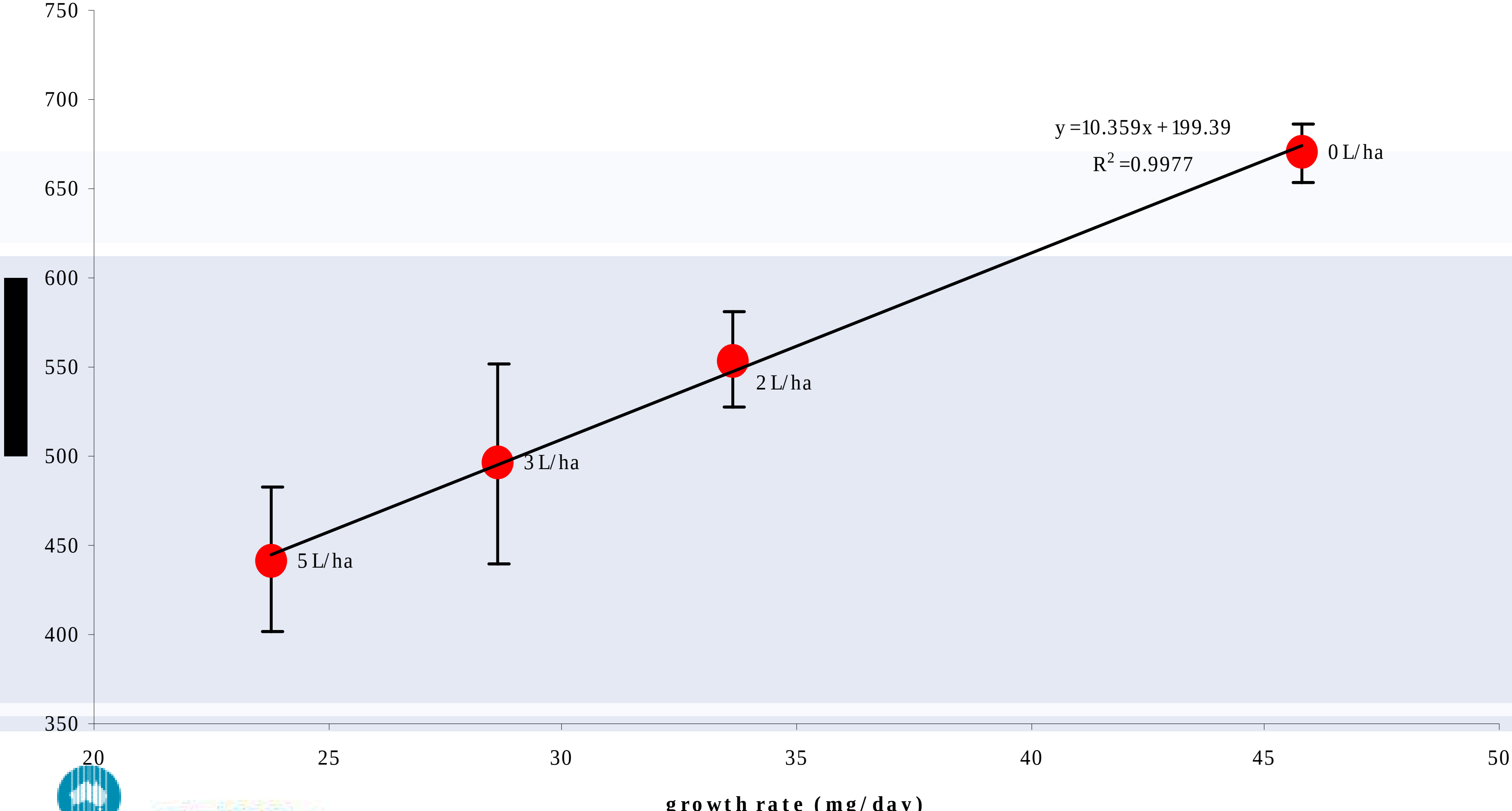
Post-Border – Mortality prediction

Post-Border – Mortality prediction



Mortality over time of first instar PAM larvae on hosts sprayed with 2L/ha Btk equivalent

pupal wt vs growth rate of 5th instar PAM fed *A. mearnsii* with Btk rates



Post-Border –
Pest ecology / Weeds

Buddleia:

- Significant weed
- ERMA approval for Cleopus release gained in 2005
- FBRC funding assisted with host testing needed for approval
- Mass release underway

Post-Border – Integrated pest management

Paropsis biocontrol

- Biological control using Cleobora
- Also testing theories on predation, feeding preferences and requirements

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FBP - Stem Injection of pesticides

- **Protecting trees by stem injection**
  - Uraba and Paropsis were the model targets
  - Insecticide was effective and persistent

Days after injection	10	20	30	40	50	0
1 Days	50	40	80	70	95	25
2 Days	20	55	70	100	80	45
8 Days	95	95	100	100	100	5
15 Days	100	100	100	100	100	15
22 Days	100	100	100	100	100	28
29 Days	100	100	100	100	100	85
43 Days	100	35	100	100	100	0
62 Days	50	40	95	100	100	0
128 Days	20	30	95	95	75	5

Post-Border – Remote sensing

Identify issues of importance

- Assessment and mapping of needle-cast, nutrient deficiencies
- Weed distribution and type
- Mortality
- Overall health score
- Crown density

Evaluate technologies

- Visual assessment
- Hyperspec and multispec
- LIDAR (in combination with hyperspec?)
- Photography

Post-Border – Nectria research

Research areas:

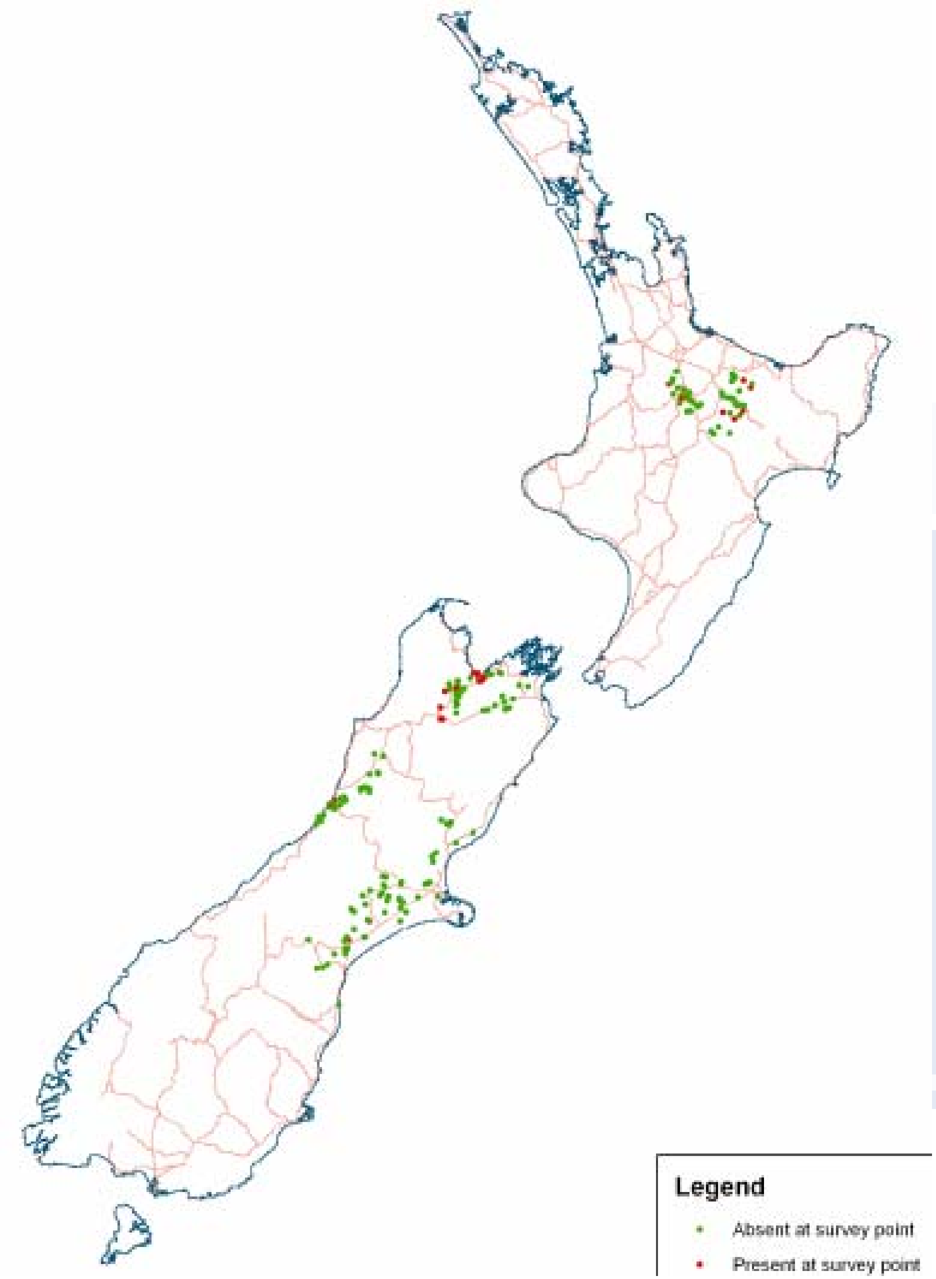
- Surveys
- Infection process and ecology
- Susceptibility

Post-Border – Nectria research

National Surveys

- Fluting recorded in 13% of stands surveyed – much lower than that found in Southland/Otago (90%)

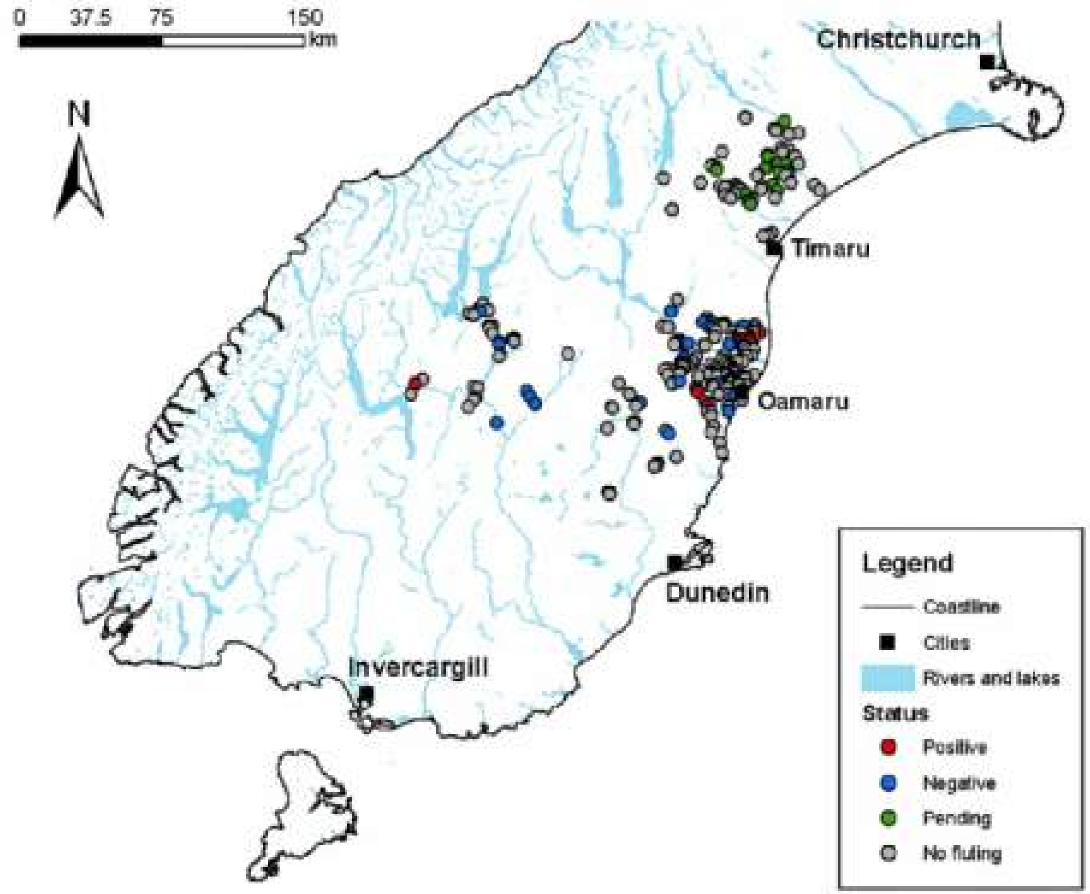
- Nectria not detected



Post-Border – Nectria research

Delimiting Survey

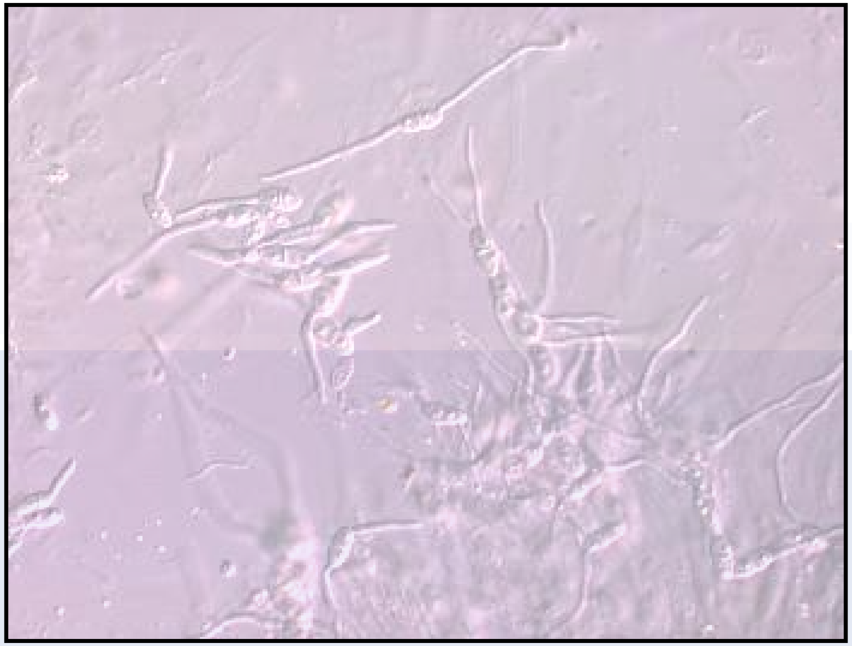
- Considerable preparation required
- Delays experienced
- Completed 26 February 2006
- Fluting and Nectria distributed throughout inspection zone, but less common in Central Otago.
- Likely that the survey will be extended



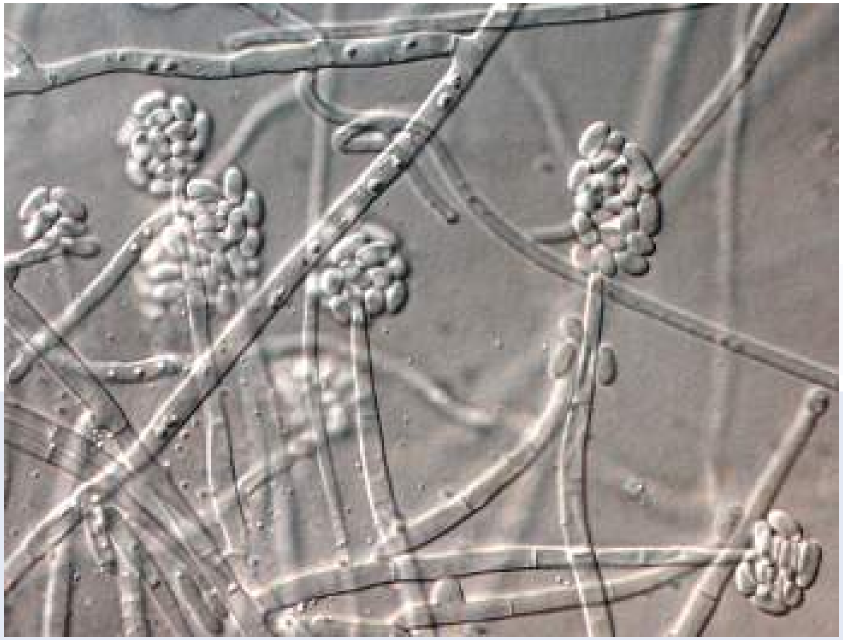
Post-Border – Nectria research

Ecology research

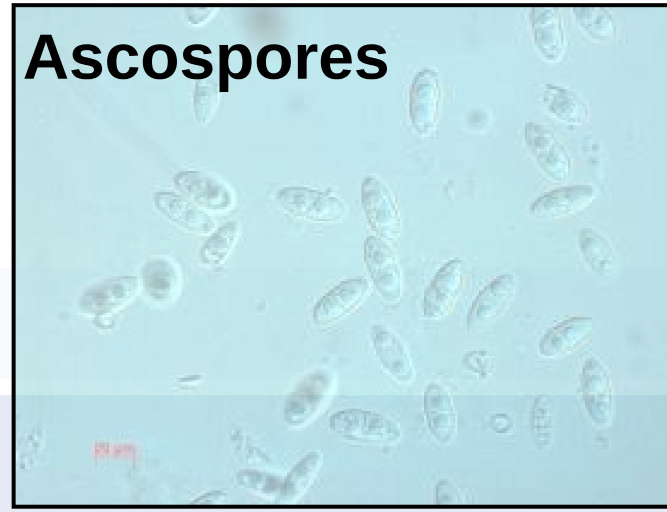
Patricia Crane
Post Doctoral
Researcher

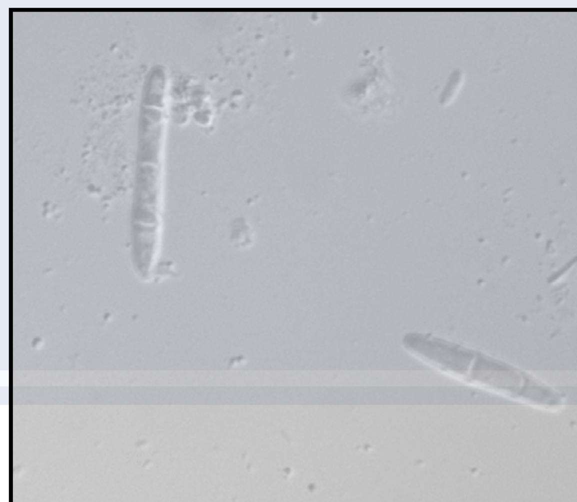


Nectria has 3 different spore states



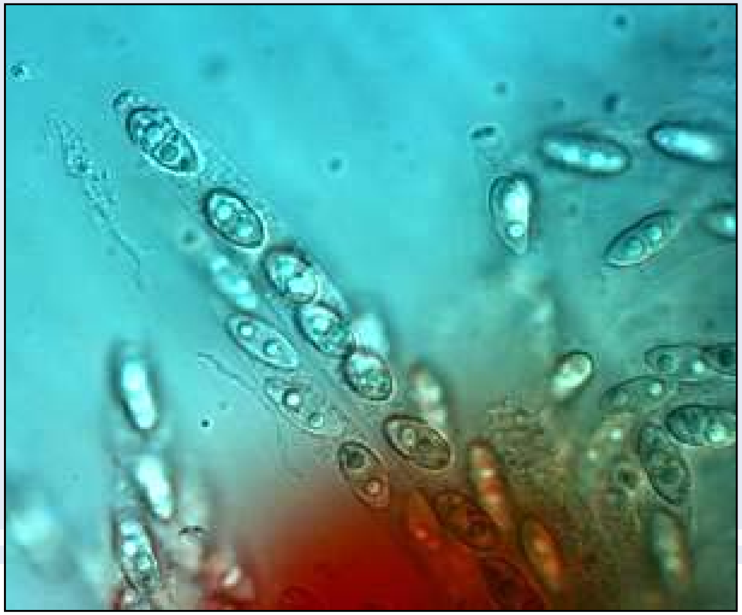
In culture





In nature, not common


Cross
section



Spore dispersal ---mainly by water, not wind

- Patchy distribution
- Slow spread

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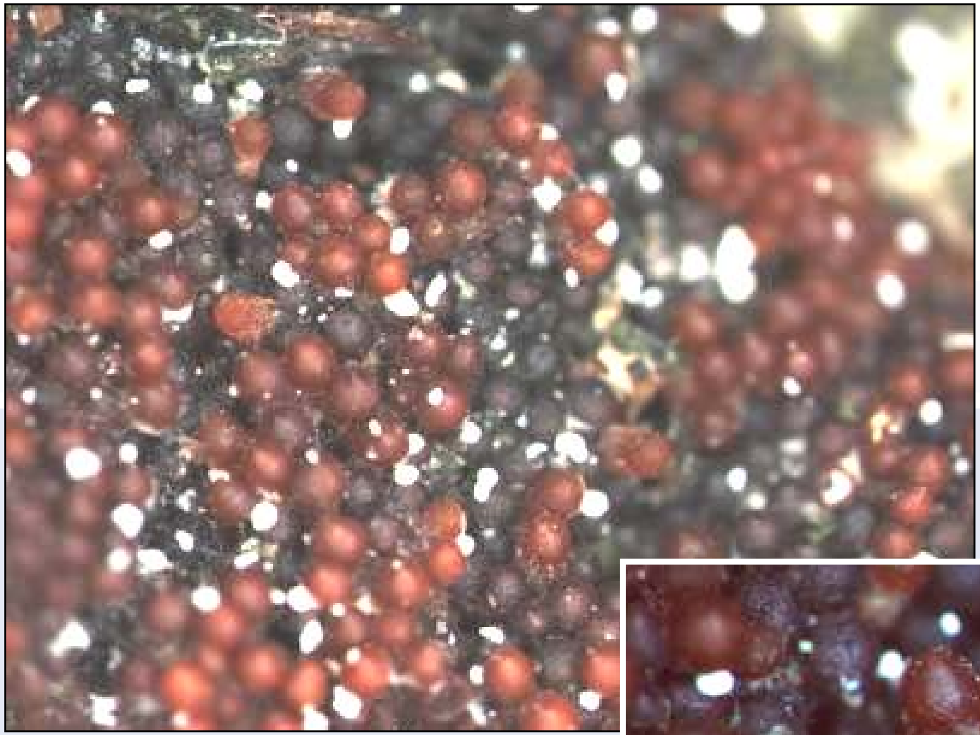
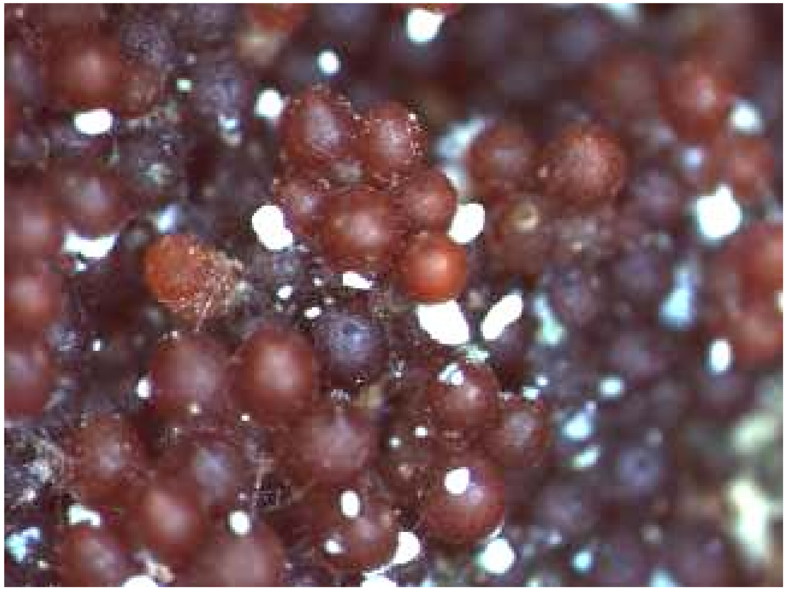
The evidence

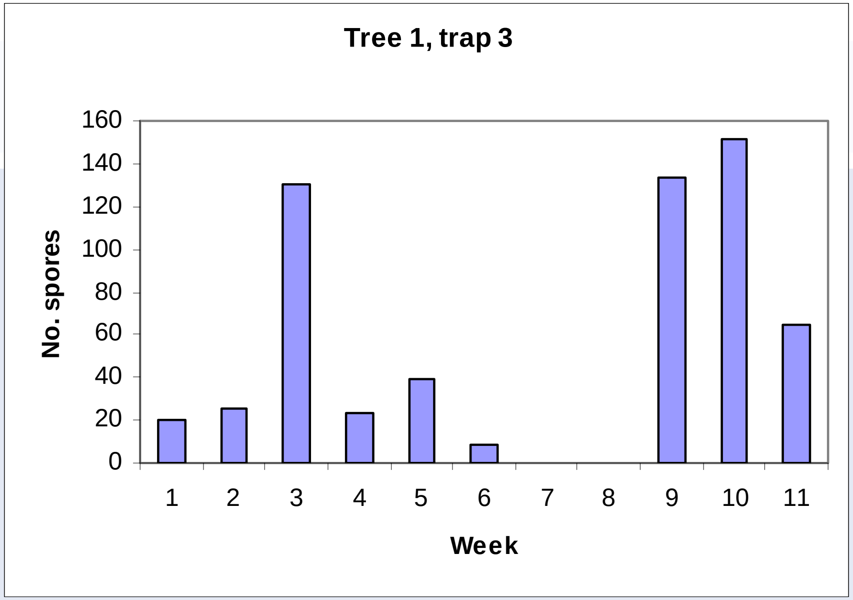


- Spores ooze out of fruit bodies when soaked in water or after a rain
- Spores dry in clumps on surface



Field expts: Spore trapping

- To show when dispersal occurs
- The effect of weather on dispersal



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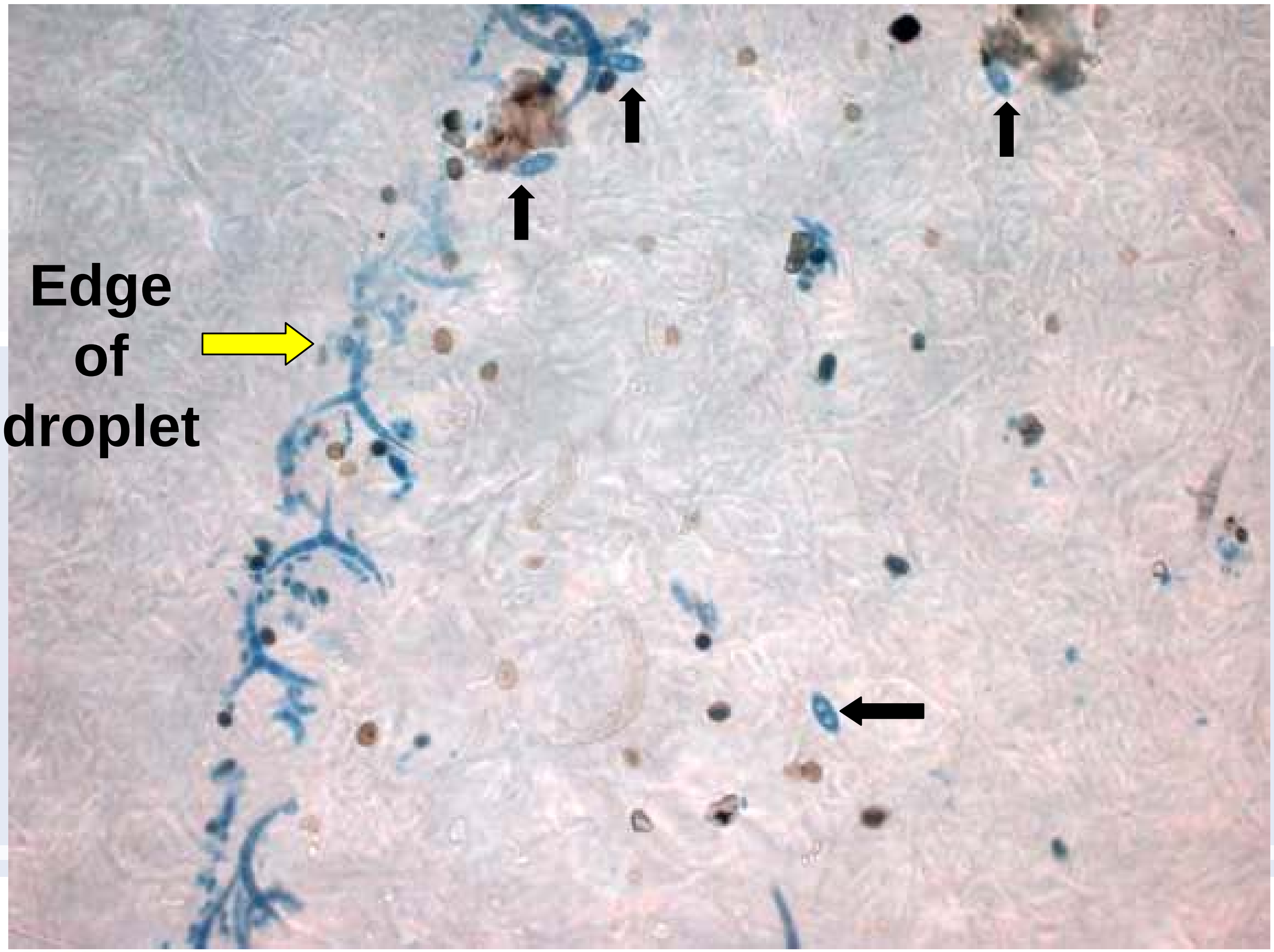
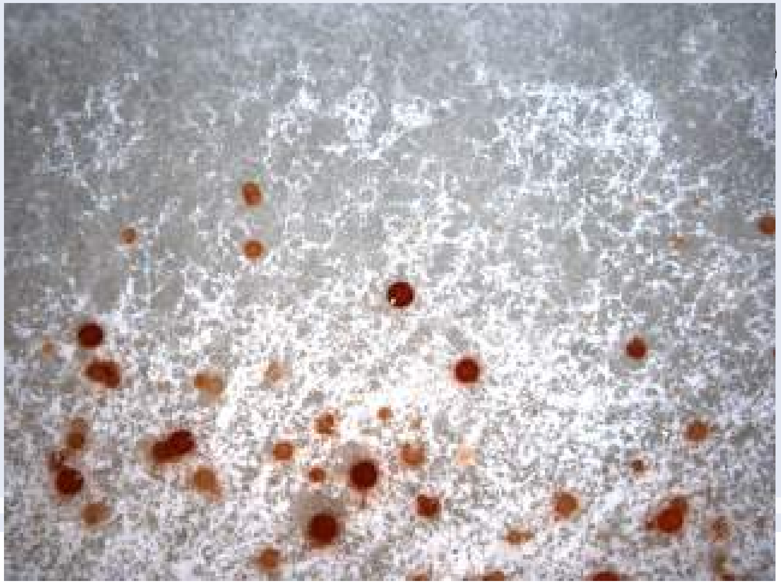
Assessing spore traps



Lab expts. 1. Factors that control fruit body production

- Two compatible mating types are needed
- Suitable nutrient



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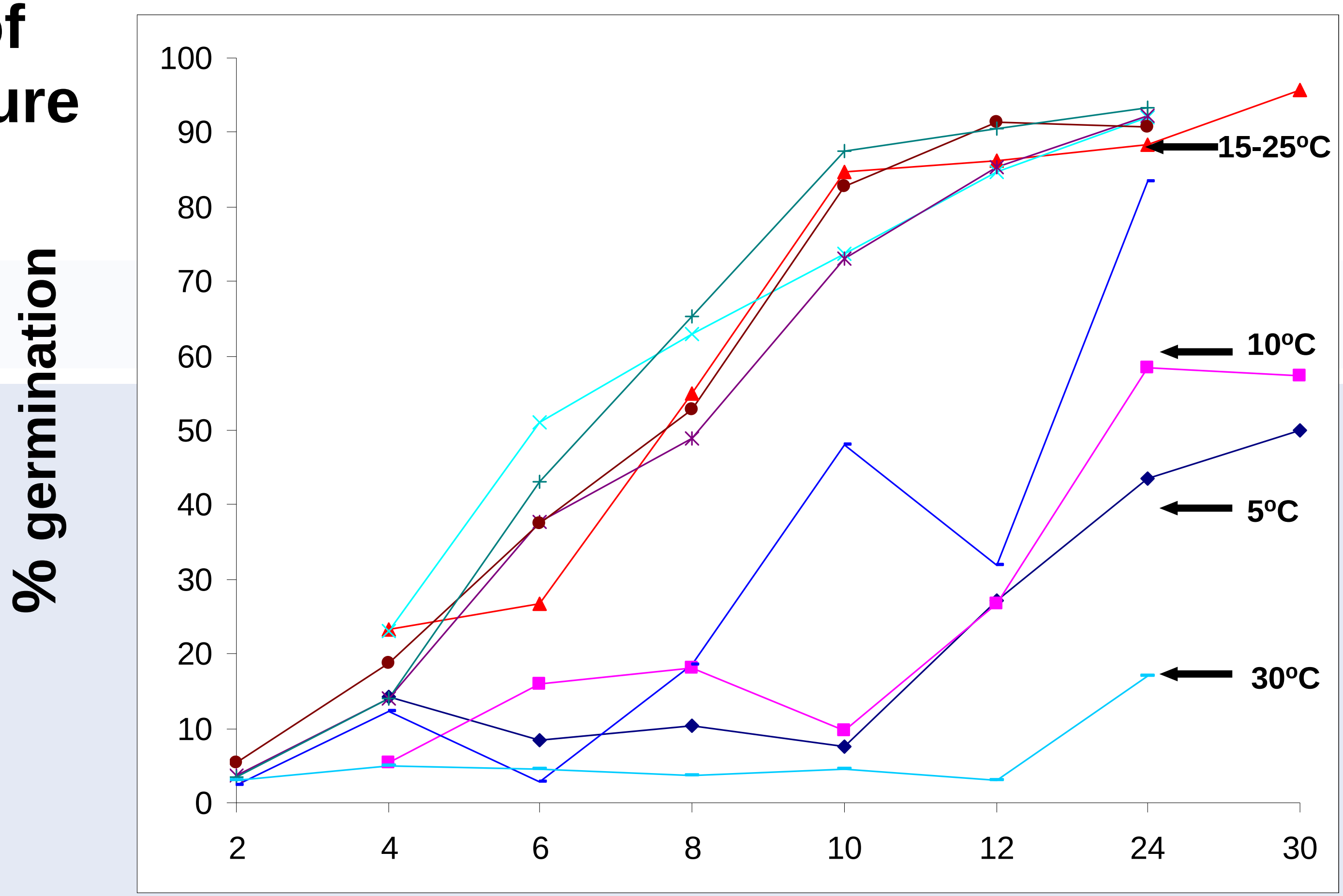
2. Conditions that induce spore germination

Effect of temperature



Hours

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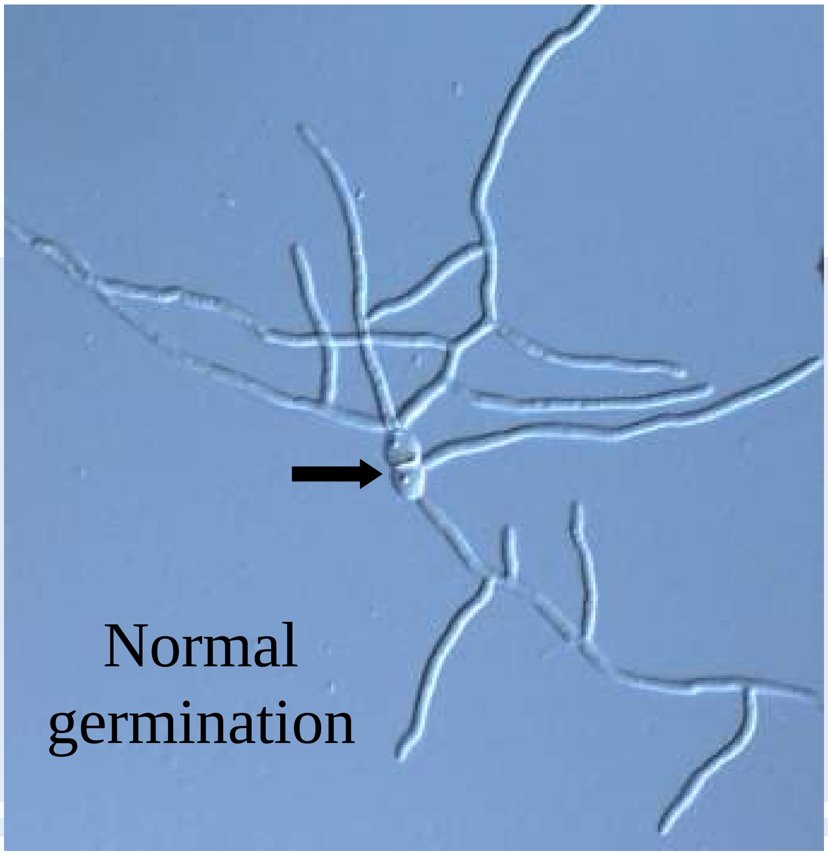
Conditions that induce spore germination

- **Free water is required**



Normal germination

Abnormal germination at 30 C

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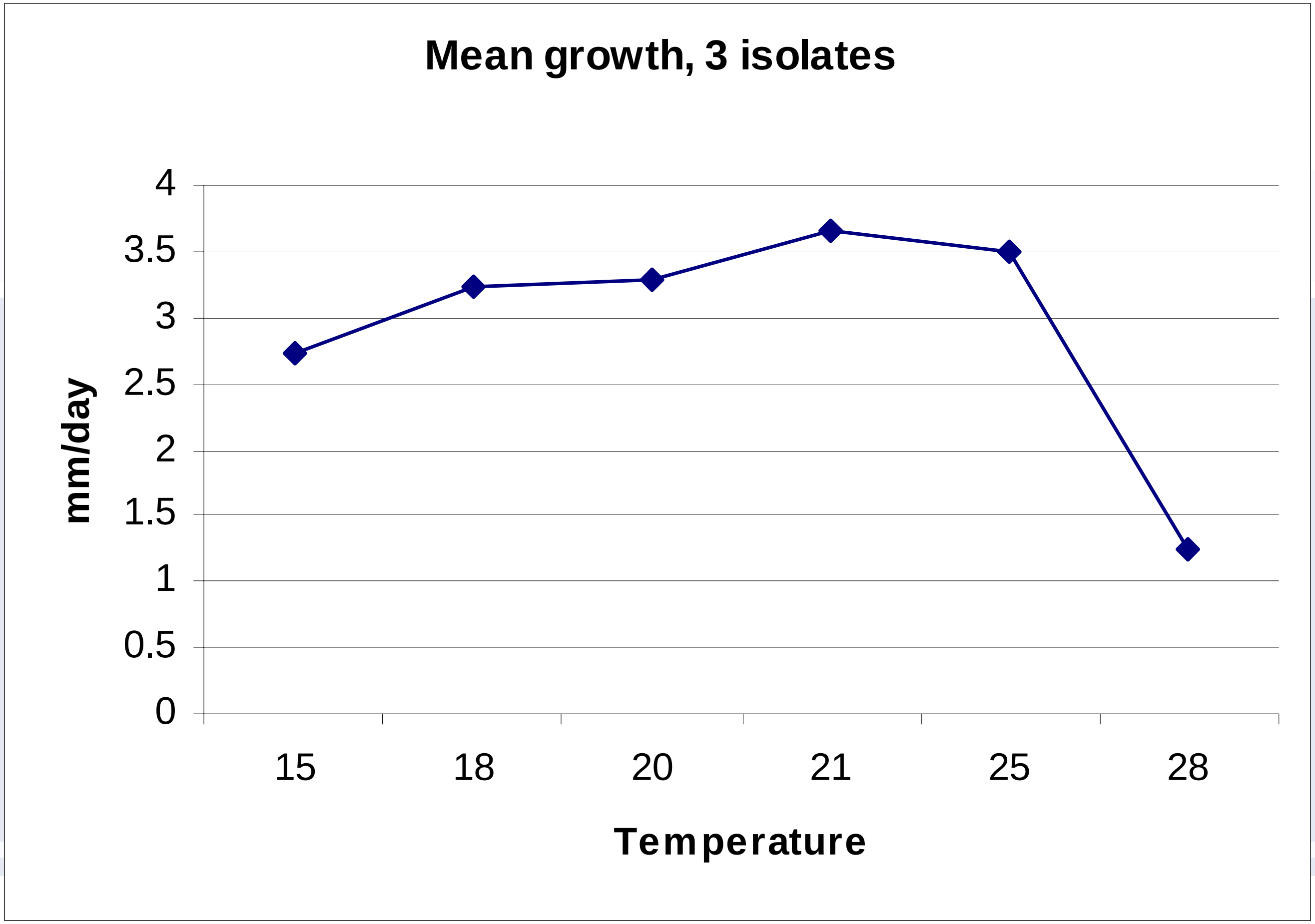
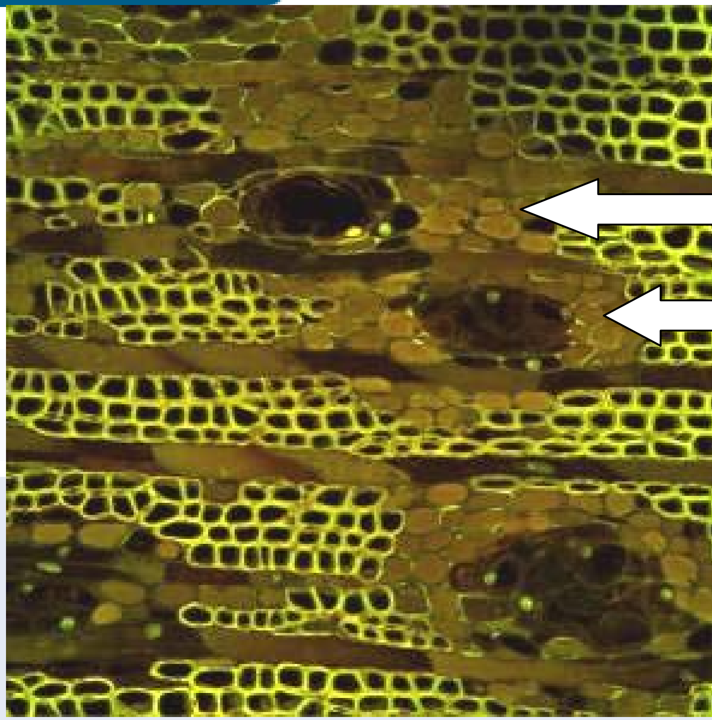
3. Optimum temperatures for growth of cultures agree with spore germination data



Anatomy of the disease



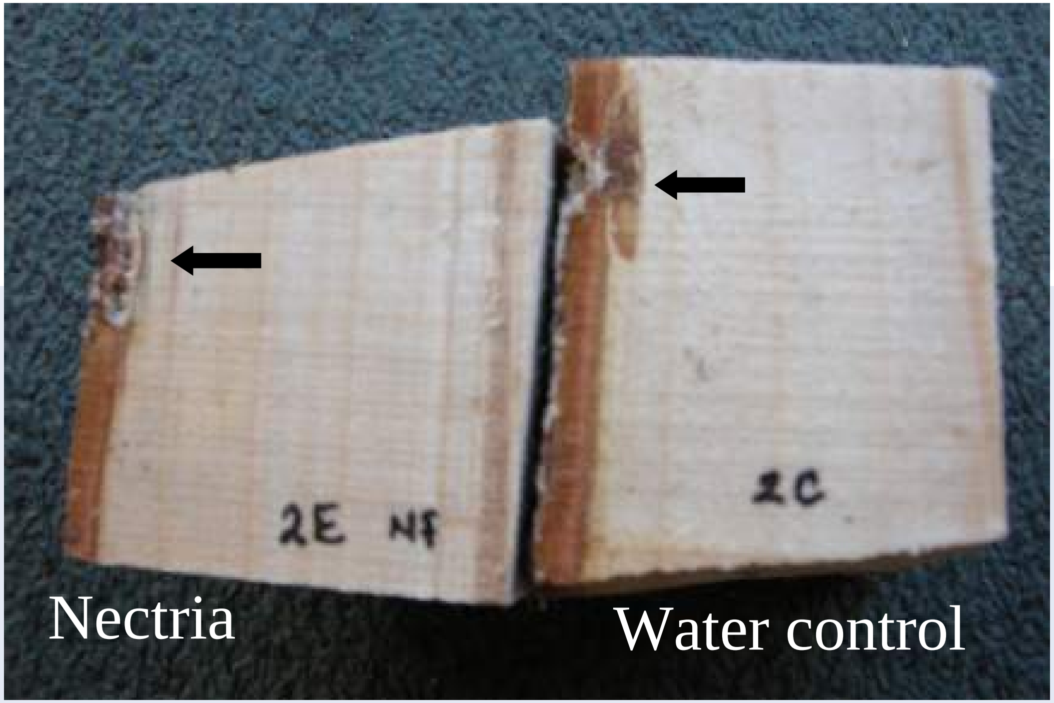
2-yr-old infection: resistance responses (resin ducts, tannins, phenolics)

Healthy side of the same disk does not have those features

Early disease development and effect on host

Early infection stages, Nov. 2005

- Inoculated 8 trees
- Harvest 2 trees every 2 months
    - Reisolate fungus
    - Study changes in wood and bark



Experiment to assess effect of spore type and inoculation method

April 2005

- 45 trees
- 3 inocula
  - Ascospores
  - Conidia
  - water
- 3 types of wounds

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Results after 7 months

- Some trees of all treatments are showing fluting
- Fluting is usually greater with Nectria than with water treatment
- Type of wound has more effect than type of spore used
- Deep wounds show greater fluting than shallow wounds

What do we know so far?

- Ascospores are present in fruit bodies in all seasons
- A cluster of fruit bodies probably remains active for many months
- Moisture is required for spore release and probably dispersal
- *N. fuckeliana* grows best at warm temperatures, but can probably grow to some extent year-round in NZ
- Spore trapping will allow correlation of spore release with weather conditions
- Successful fruit body production in culture
- Infected radiata pine shows active resistance response. Study of early disease development is in progress.

Post-Border – Nectria research - susceptibility

Seedlings v. cuttings

- Plants wounded, inoculated, and then tested in lab (in containment)
- *Nectria* was re-isolated after 6 weeks, but….
- Field trails established
- Recovery was higher in seedlings than in cuttings
- There was no sign of disease – discolouration due to wound response

Treatment	% *Nectria* recovery after 3 months	Average discolouration (mm)
Seedlings inoculated	24	2.91
Seedlings uninoculated	2	2.93
Cuttings inoculated	7	3.02
Cuttings uninoculated	0	6.87

Post-Border – Nectria research – species susceptibility

Other conifers

- Primary hosts overseas are spruce and fir
- Are conifers other than *P. radiata* susceptible in NZ?
- Field trails established April and June 2005
- November 2005 assessments showed some results
- Early days, but all species affected to some degree

Species	Depression treatment (%)	Depression control (%)	Stain treatment (mm)	Stain control (mm)
P. radiata	90	100	-	-
P. ponderosa	11	0	48	12
Douglas fir	11	15	0	0
C. macrocarpa	35	20	34	6
S. sempervirens	0	0	58	36
Larix decidua	0	0	-	-
P. contorta	-	-	-	-

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Forest Health and environment – Armillaria review

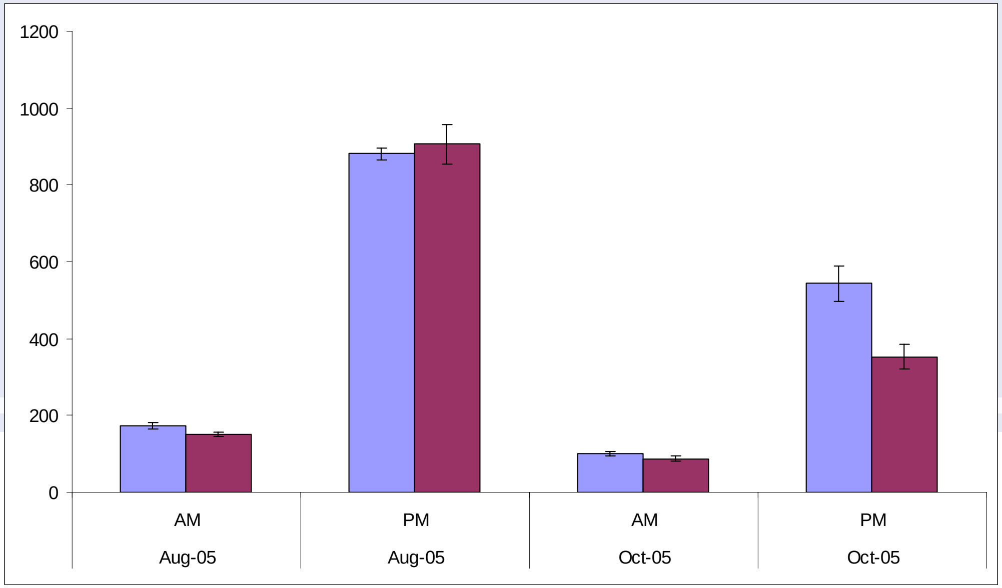
Review Armillaria research

- To develop a strategy for future research
- Report nearly completed

Forest Health and environment – PNB

Physiological needle blight

- Pre-dawn water potential measurements made
- Differences between pre-dawn and midday, but not between “treatments” – difficult to select target trees
- Root waterlogging a possible cause
- Age effect may be due to increased stomatal resistance with age
- More work on needle physiology planned



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Forest Health and environment – Cyclaneusma

Economic impact assessment

- Aerial survey completed throughout NZ
- Low impact year – almost no Cyclaneusma in Northland, low levels elsewhere
- Will repeat survey next year to gather more data

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Forest Health and environment – Economics of pest impacts, planning

Economic impact assessment of pests

- Document produced – widely quoted

Strategic planning for forest health research

- resulted in development of FBRC research strategy
- determined process for setting research priorities
- defined research goals

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