# Pitch canker:

# What we know…what we don't know.

Beccy Ganley

(FOA-funded Post-doc)

# Background

- B.Sc. and M.Sc. – Massey University

Characterisation of a global collection of *Dothistroma pini* isolates.

  - Developed a molecular identification technique to distinguish NZ strain of *D. pini* from global isolates.
  - Quantitfied dothistromin production in NZ and overseas isolates.

# Background

- Ph.D. – University of Idaho

Fungal endophytes of *Pinus monticola*: Diversity, function and symbiosis.

- Endophytes isolates were not genetically related to pathogens of *P. monticola*, instead closely related to pathogens of congeners of *P. monticola* – implication in priming host's resistance genes against pathogens.
- Demonstrated ability of fungal endophytes to induce resistance in *P. monticola* against the rust pathogen *Cronartium ribicola* (white pine blister rust).

# Now…

- Post-doc (FOA-funded)

Pitch canker - *Fusarium circinatum*

- Design and implement a programme of research to improve the understanding of pitch canker.
- Reviewing literature.
- Meeting researchers and groups involved in pitch canker in the US and South Africa.
- Establishing contacts worldwide with research groups and potential collaborators.

# Pitch canker:

# What we know…what we don't know.

Beccy Ganley

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# Pitch canker – general background

- Casual agent = *Fusarium circinatum.*
- Disease characterised by exudation of copious amounts of resin.
- Pathogenic to species of *Pinus* and one non-pine host, *Pseudotsuga menziesii.*
- Can suppress growth or kill the tree.
- All tissue susceptible - including seed

**Southeastern Forest Experimental Station**

# Symptoms

- **Mature trees:**
  - Needle wilting and discolouration
  - Exudation of resin from site of infection.
  - Mortality usually occurs from multiple crown infections, girdling stem canker or secondary factors.

University of California

- **Seedlings:**
  - Root rot, wilting, damping-off
  - Pre- and post-emergence mortality
- **Seed:**
  - External or internal infection.

M. Wingfield

# Global distribution of pitch canker

- **USA:** - southeastern states and California
  - Native and exotic pines.
  - *Pseudotsuga menziesii*.
- **Spain:**
  - *Pinus radiata* in nurseries and plantations, and *P. pinaster*.
- **South Africa and Chile:**
  - Present in nurseries but has not spread to adjacent plantations.
- **Haiti, Japan and Mexico:**
  - Causes little damage to pine species present and/or is not considered economically important.

Pitch canker is not present in New Zealand

but…

what is the risk of it becoming established?

PC-free NZ

Risk of entry

*Fusarium circinatum* introduced

Wounding agents

Wound created

# Known wounding agents

- Weather-related injuries
  - i.e. wind or hail damage
- Insects
  - i.e. insects that feed on pines
- Mechanical damage
  - i.e. cone shakers or pruning
- Animals
  - i.e. cattle or birds (branch bending rather than claw marks)

**Southeastern Forest Experimental Station**

# New Zealand wounding agents

- Weather-related injuries ➢wind or hail damage
- Insects ➢some insects present in New Zealand that feed on *P. radiata*
- Mechanical damage ➢pruning
- Animals ➢large birds (i.e. kaka), livestock, possums

Mitchell

PC-free NZ

Risk of entry

*Fusarium circinatum* introduced

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Wound created

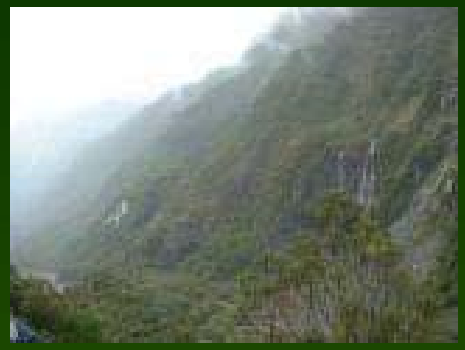
Spore vectors

Spores at wound site

# Vectors - New Zealand

- Water, Wind ➢ **Yes**
- Soil ➢ **Yes**
- Insects
  - Spores of *F. circinatum* have been found on most insects, including wasp and flies. ➢ **Yes**
- Contaminated machinery, plant material, people

➢ **Possum fir, feathers ???**



K. Harker

PC-free NZ

Risk of entry

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Wounding agents

Wound created

Spore vectors

Spores at wound site

Wound type, moisture, temperature, genetic resistance, silvicultural practices, induced resistance.

Successful infection

# What we know…

- Variation in infections between locations

| | Wound | |
|---|---|---|
| **Location** | **Weather/ injury** | **Insect** |
| **Southeastern USA** | Common | Common |
| **California** | Extremely rare | Common |
| **South Africa & Chile** | No | No |

# Temperature

Variation in infection of weather- and injury-related wounds between locations

- ➢ Suggests climate could be a factor

- Pathogen growth suppressed at 10$^{o}$C
  - Temperature limited spread of disease up to Canada?
- Upper temperature limit unknown

# Temperature – New Zealand

- **Southeastern USA** – warm all year round
- **California** – coastal forested regions are cool
- **Oregon to Canada** – cooler
  - **New Zealand** – cooler similar to coastal California and Oregon
- **Sierra Nevada** – hot (disease present)
- **South Africa & Chile** – encompass temperature ranges

No infection of weather or injury wounds

# Moisture

- Moisture required for successful infection
  - Artificial inoculations – droplet of water
  - Outbreaks occur during rainy season in southeast USA
  - Pitch canker more prevalent in coastal regions of California exposed to fog belt.

Moisture levels high in both USA locations…

➢ Temperature/moisture combination

↑ $^{o}$C temp, ↑ % humidity

# Moisture – New Zealand

- Sufficient moisture → temperature

Likelihood of infection of weather/injury wounds

Higher risk: Warmer coastal regions and Northland areas exposed to tropical-like conditions

Lower risk: Cooler inland regions

- ✓ South Africa and Chile
- ✓ Sierra Nevada

# Potential risk factors

1. Moisture/Temperature combination (-1)(+1)

California has a low frequency of infections of weather or injury related wounds

BUT…

insect wounds are successfully and commonly infected

**Why the difference?**

# Wounds type

Variation in infection has been attributed to the type of wound created

**Insect wounds:**

There are many insects that are capable of creating wounds on pine trees.

- Not all insect wounds result in infection.

1. Variation between weather and insects wounds.

2. Variation between the type of insect wound that can result in infection.

# Wound type

➢ Proposed that the type of wound created and/or the amount of resin produced may be influential.

- High risk: - deeper wounds that access host plant moisture
  - wounds that are less likely to dry out

G. Lenhard

i.e. *Pissodes nemorensis* Ω

- Low risk: - shallow wounds dependent on atmospheric conditions
  - wounds created that exude resin (seals off wound).

Cobb *et al.*

# New Zealand wounding agents

- Weather-related injuries ➢wind or hail damage
- Insects ➢some insects present in New Zealand that feed on *P. radiata*
- Mechanical damage ➢pruning
- Animals ➢large birds (i.e. kaka), livestock, possums

Mitchell

# New Zealand wound types

**Insects:** - 150 species of insects have been recorded on *P. radiata* in New Zealand.

- Those insects closely associated with pitch canker in the USA are not present.

i.e. *Ips* spp., *Pissodes nemorensis*, *Ernobius puntulatus*…

- Insects involved in the disease process vary between host tree species

i.e. exotic pines in California have less infections than native pines

# New Zealand wound types

- Unlikely that the insects present would be capable of creating wounds suitable for infection.

**Animals**: - possums and large native birds

- Would the type of wounds created be amenable to infection?

- ✓ South Africa – *P. nemorensis* – *P. elliottii* (27%)
- ✓ Chile – *Rhyacionia* spp. – *P. taeda* (?%)

# Potential risk factors

1. Moisture/Temperature combination (-1)(+1)
2. High risk wounds (-1)

   Low risk wounds (+1)

   New Zealand animals (?)

# Genetic resistance

- Pine species vary in their susceptibility to pitch canker
  - *P. radiata* extremely low levels of resistance
    - Greenhouse trials NZ stock 0.3% - 2.1%
    - Resistance in field in California ~15%
  - *Pseudotsuga menziesii* moderate levels of resistance

➢ **Genetic resistance not the only form of resistance…**

# Induced resistance

- Apparent remission of disease in California in *P. radiata*

# Induced resistance

- Repeated inoculation with *F. circinatum* results in a decrease in lesion length and frequency (field and greenhouse expt)
  - Investigating mechanism and long-term effectiveness

➢ Effective in New Zealand?

➢ Other mechanisms of induced resistance?

# Potential risk factors

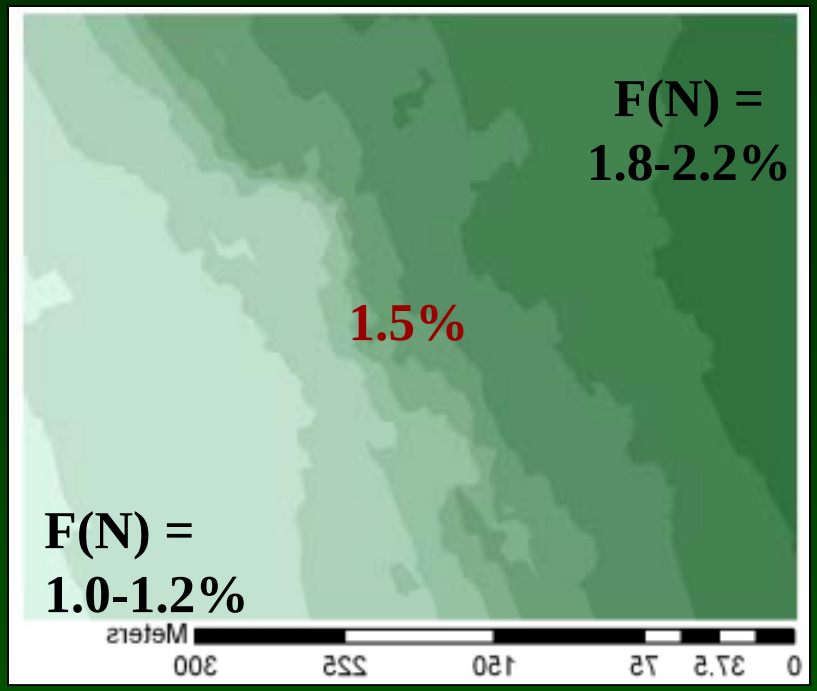
1. Moisture/Temperature combination (-1)(+1)
2. High risk wounds (-1)
   Low risk wounds (+1)
   New Zealand animals (?)
3. Genetic resistance (+1)
   Induced resistance (?)

# Silvicultural Practices

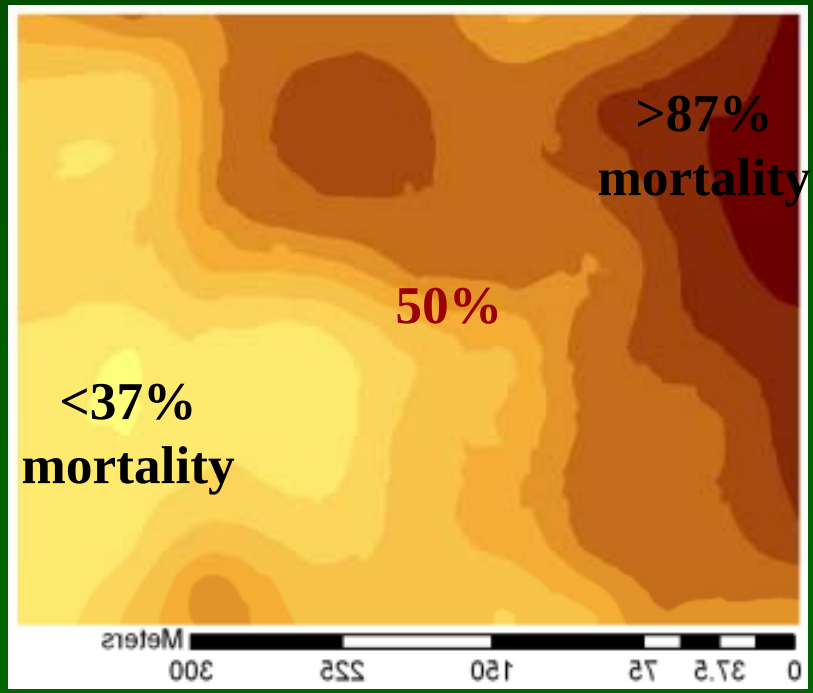
- **Fertilisation:** increased incidence and severity of pitch canker infections
  - Specifically nitrogen (N)
  - Other nutrients also shown to have an effect
- Florida – correlation between chicken houses and pitch canker

Foliar N:

- Background levels ≈ 0.9%
- Normal fertilization ≈ 1.2%,
- Intensive fertilisation ≈ 1.5%




Chicken houses




## New Zealand foliar N levels:

<1.2% = deficient

1.2%-1.5% = slightly deficient

>1.5% = not deficient

Barnard *et al.* 2005


Chicken houses
“Ground zero”

# Silvicultural Practices

- **Stock density:** PC incidence and severity higher in overstocked stands
  - Thinning - reduces incidence and severity
  - Thinning & fertilisation – increased incidence and severity
- **Moisture stress:** irrigation reduces incidence and severity

➢ **Stress-related disease**

# Potential risk factors

1. Moisture/Temperature combination (-1)(+1)
2. High risk wounds (-1)
   Low risk wounds (+1)
   New Zealand animals (?)
3. Genetic resistance (+1)
   Induced resistance (?)
4. Fertilisation (+1)
   Stand density (esp. thinned stands) (-1)
   Moisture stress (-1)

PC-free NZ

Risk of entry

*Fusarium circinatum* introduced

Wounding agents

Wound created

Spore vectors

Wound type, moisture, temperature, genetic resistance, silvicultural practices, induced resistance.

Spores at wound site

Successful infection

Resistance, silvicultural practices, temperature.

Severity of infection

# Factors that influence severity

- ✓ Host susceptibility ➢ *P. radiata* highly sus
- ? Induced resistance ➢ if functional in NZ
- ✓ Fertilisation ➢ frequently applied
- X Stand density ➢ low, esp. thinned stands
- X Moisture stress ➢ low
- X Temperature ➢ low for most regions


Risk of entry

*Fusarium circinatum* introduced

Wounding agents

Wound created

Spore vectors

Wound type, moisture, temperature, genetic resistance, silvicultural practices, induced resistance.

Successful infection

Spores at wound site

Resistance, silvicultural practices, temperature, moisture.

Severity of infection

Temperature, moisture, vectors, eradication.

# Spread throughout New Zealand

- Vectors – soil, wind, rain, insects, animals? → **YES**

BUT…

also need suitable wound types and/or optimal climate conditions

- Suitable wounds
  - High risk: Insects → **NO**; Animals → **???**
  - Low risk: weather, insects, animals → **YES**
- Temperature/moisture combination
  - Vary throughout New Zealand
- Eradication – swift action could prevent spread

# The good news…

- **New Zealand:**
  - Has many of the low risk factors but only a few high factors.
  - Temperature/moisture combination potentially would not increase the chance of establishment.
- **South Africa and Chile:**
  - Exotic plantations including *P. radiata.*
  - *F. circinatum* spores are present BUT no natural infections in the field.

# …the bad news

- **New Zealand:**
  - The high risk factor we do have are HIGH RISK.
    - i.e. highly susceptible species, high foliar N levels ~ >50% mortality.
- **Spain:** (the spanner in the works)
  - Exotic *P. radiata* plantations.
  - Pitch canker prevalent in nurseries and plantations – apparently spreading throughout Spain.
  - No idea why pitch canker has become established.

# SPAIN

What factors were involved in establishment??? How do they relate to the findings presented here??? What is the rate of spread of disease??? What is the the severity??? **So much we don't know.**

M. Wingfield

M. Wingfield


Thank you