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Forest Biosecurity and Protection

Physiological disease of
Pinus radiata

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Physiological diseases

What are they?

A range of disorders that are not caused by a biotic agent includes:

- **Direct environment damage**
 - ▶ e.g. frost kill of tissues
- **Indirect environmental damage**
 - ▶ e.g. crown death resulting from dry or excessively wet soil
- **The effects of nutrient deficiency, excess or imbalance**

- **Finding the cause of a disease when there is no easily recognisable primary pathogen can be a lengthy process**
- **Possible agents of the disease have to be critically evaluated and eliminated as the information accumulates**

Two disorders of *Pinus radiata*

**Upper mid-crown
yellowing (UMCY)**



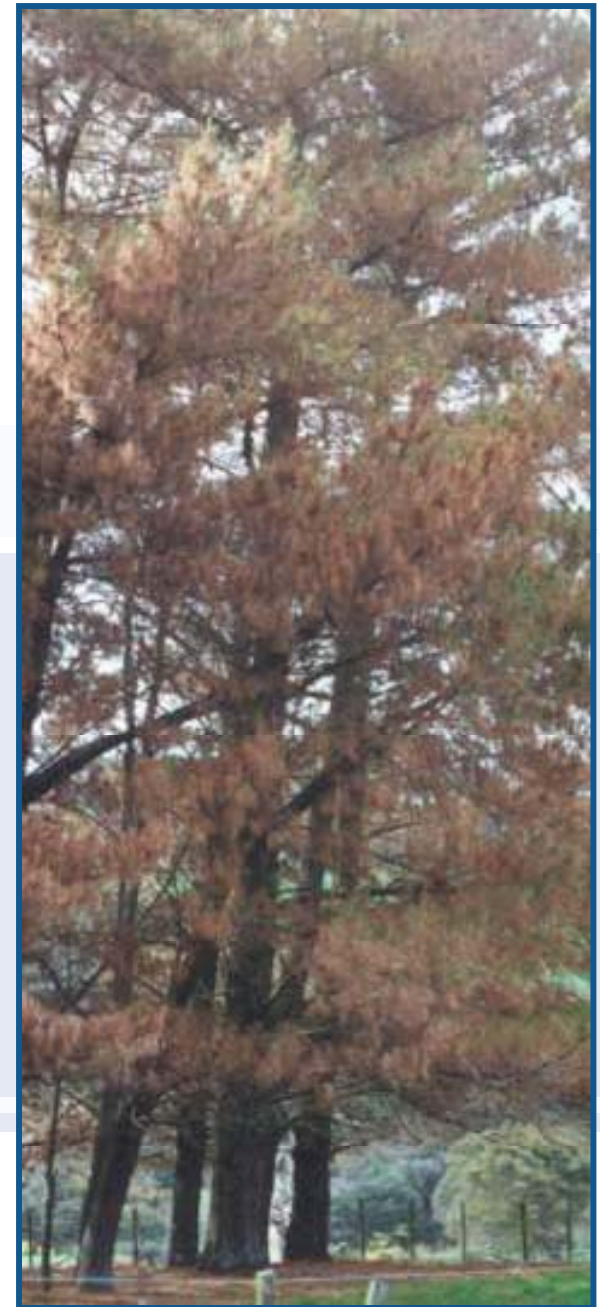
Physiological needle blight (PNB)

Physiological needle blight

- Extensive death of needles of trees over 12 years
- Commencing late winter, continuing through spring



- **Individual trees may be almost totally defoliated**
- **New season needles are not affected**



- **Disease severity is generally worst in gullies and ridge tops (sites where needle moisture levels are high)**



- **Parallels with Cyclaneusma needle cast**
 - ▶ time of year of symptom expression
 - ▶ age of needles affected
- **First recognised as distinct from classical Cyclaneusma needle cast in the 1980's**
- **Known variously as ...**
 - ▶ “atypical Cyclaneusma”
 - ▶ “red Cyclaneusma”
 - ▶ “Strasseria-associated needlecast”

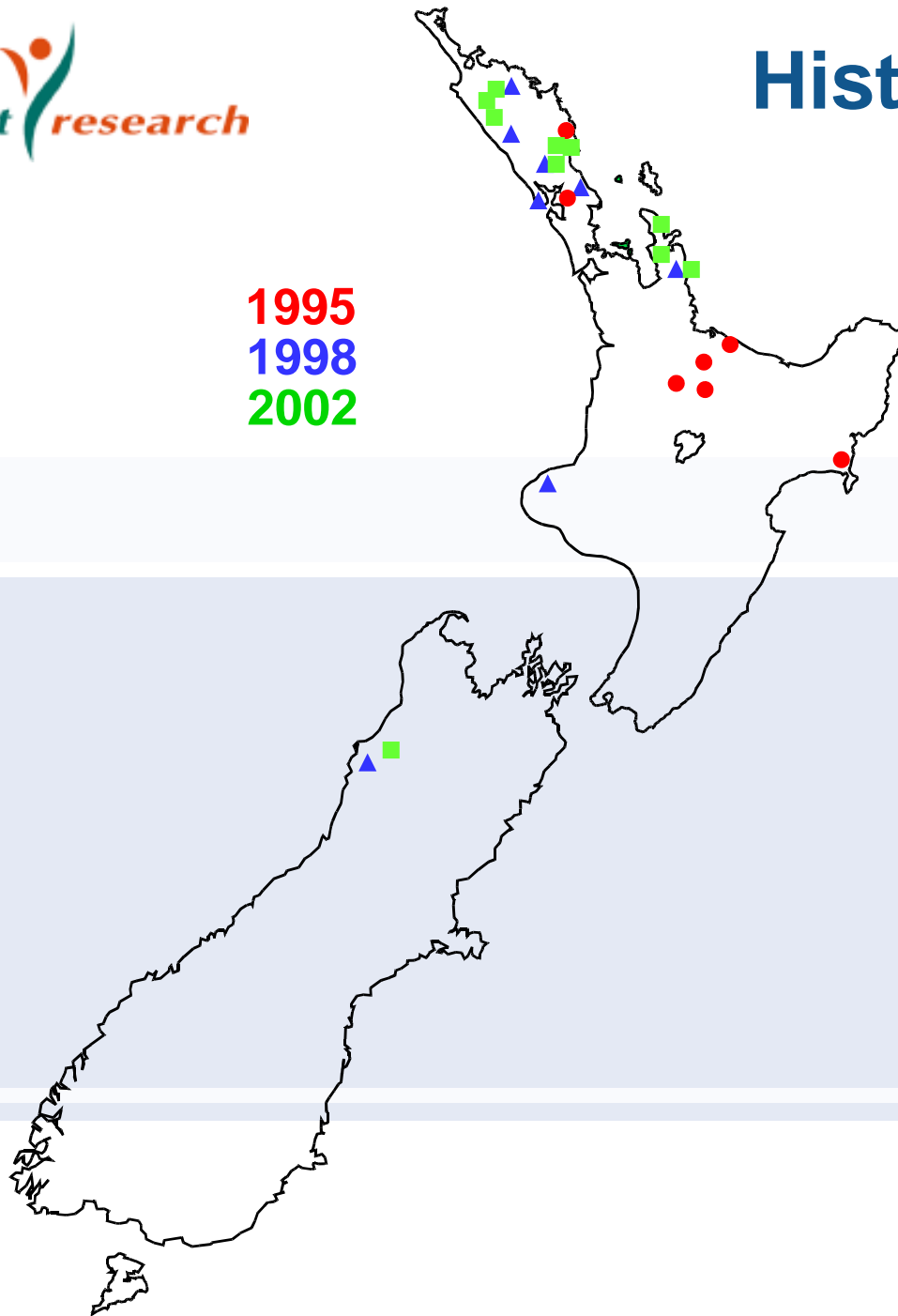
Needle symptoms

- **Banding or whole needle browning**
- ***Cyclaneusma minus* may or may not be present**
- **Needles colonised by a variety of saprophytic fungi**
- **Needles often decay on the trees**



History of outbreaks

1995
1998
2002



Outbreaks have been episodic in occurrence



Climate/outbreak relationship

- **Information in Forest Health Database examined to identify outbreaks – complicated by the use of many descriptors**
- **Examination of climate data in areas with outbreaks**
- **A relationship between needle death and higher than normal June/July rainfall found**
- **High temperatures often occur in one or both months**



Outbreaks of “PNB” and winter rainfall and temperature (% of normal)

Location	Year	Month	Rain	Rain days	Min. temp	Max. temp
<i>Wharerata</i>	1981	June	153%			102%
		July	154%		112%	103%
	1983	June	89%	106%	95%	97%
		July	135%		74%	94%
	1985	June	62%	94%	125%	97%
		July	137%	97%	124%	110%
<i>Tairua</i>	2002	June	118%	128%		
		July	93%	118%		
<i>Taranaki</i>	1998	June	96%	121%	99%	104%
		July	168%	164%	135%	110%
<i>Westland</i>	1998	June	100%	104%	114%	104%
		July	180%	132%	155%	107%
	2000	June	84%	97%	117%	104%
		July	68%	99%	145%	115



Outbreaks of “PNB” and winter rainfall and temperature (% of normal)

Location	Year	Month	Rain	Rain days	Min. temp	Max. temp
<i>Mahurangi</i>	1995	June	99%	117%	111%	96%
		July	134%	152%	98%	94%
	1998	June	96%	162%	122%	109%
		July	315%	146%	151%	66%
<i>Whangarei</i>	1995	June	85%	129%	106%	96%
		July	89%	156%	101%	95%
	1998	June	99%	94%	128%	106%
		July	212%	117%	145%	112%
<i>Waipu</i>	2000	June	122%	94%	112%	101%
		July	202%	117%	145%	106%
	2002	June	194%	137%	133%	106%
		July	128%	123%	111%	102%
	1998	June	86%	91%		
		July	339%	106%		
	2000	June	87%	70%		
		July	112%	113%		
2002	June	205%	147%			
	July	133%	100%			

Waipu Forest 1998

- A severe outbreak in Waipu Forest in 1998 was observed from State Highway 1 (crossing the Brynderwyns) and aroused intense public interest

Waipu	1998	Month	Rainfall	Raindays
		June	86%	91%
		July	339%	106%



Surveys in regions where disease often recorded

Objectives

- To determine the incidence and severity of the eco-physiological disorder
- To test the hypothesis that outbreaks are related to very high June/July rainfall and number of raindays

- **Results of aerial surveys carried out in 2002 and 2003**

	Northland 2002	Northland 2003	East Cape 2002	East Cape 2003
Severity ¹	56	0	0	0
Incidence ²	23	0	0	0

¹ Severity is the average percentage of affected foliage for all assessed trees

² Incidence is the percentage of trees affected by the disorder

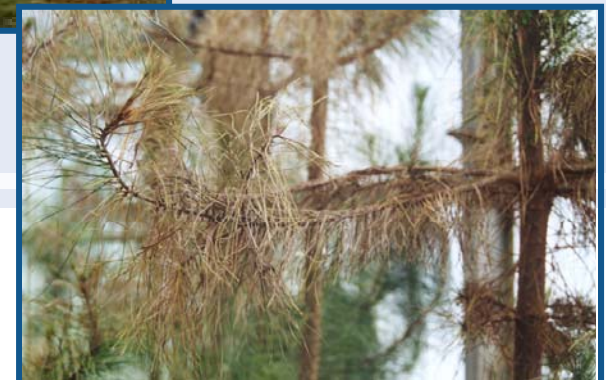
- **Needle disease was not present in the forests surveyed in 2003**
- **Remnant effects from the Northland 2002 outbreak were seen in a few stands**

	Northland 2002	Northland 2003	East Cape 2002	East Cape 2003
June/July rainfall (mm)	516	210	520	399
June/July raindays	46	41	30	24

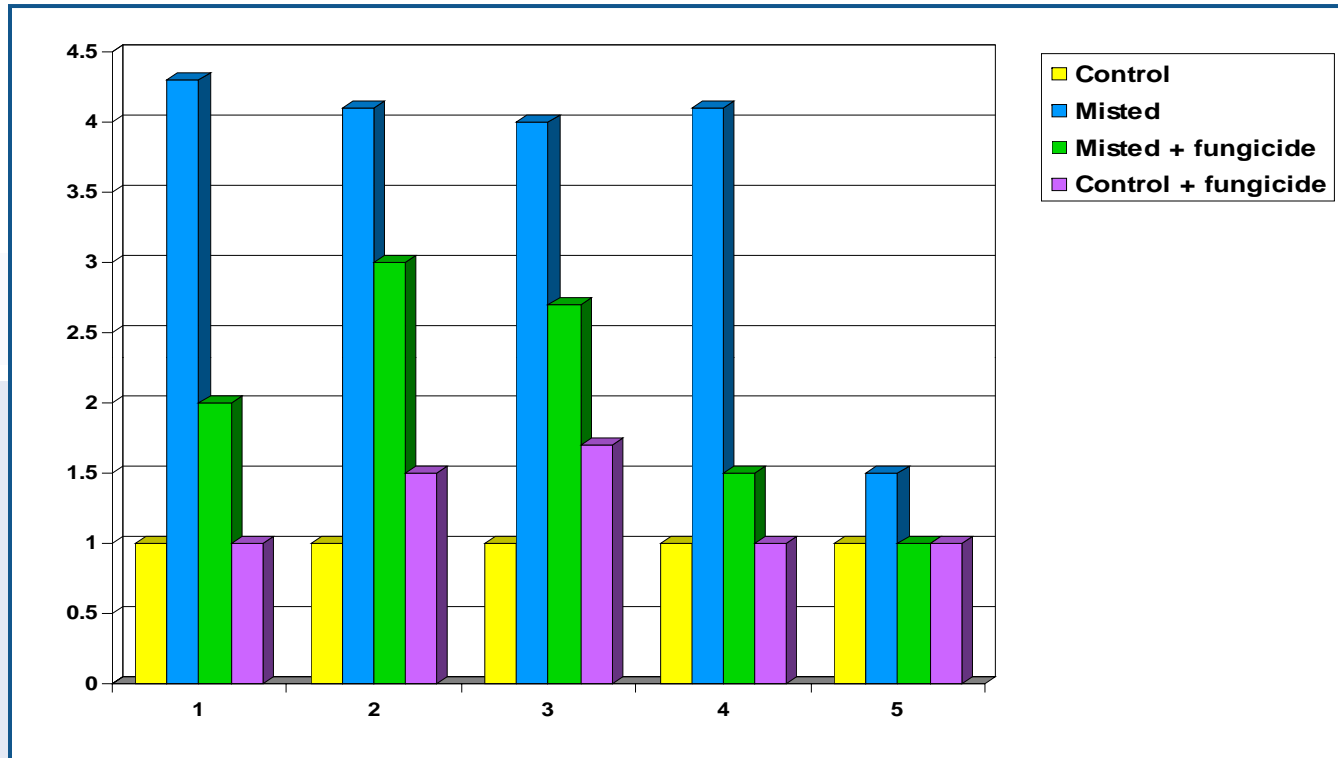
- **High rainfall and number of raindays in Northland 2002**
- **High rainfall and standard number of raindays in East Cape (44% total June/July rainfall on 3 days)**
- **Supposition that symptom expression is associated only with sustained precipitation**

Prolonged needle wetness

- **Overhead misting applied to 5 year-old trees**
 - ▶ treatments with and without fungicide applications
 - ▶ 160 trees, 5 clones
- **Chlorosis, needle banding develop after 6 weeks**
- **Older needles affected first**



Average needle score at 10 weeks

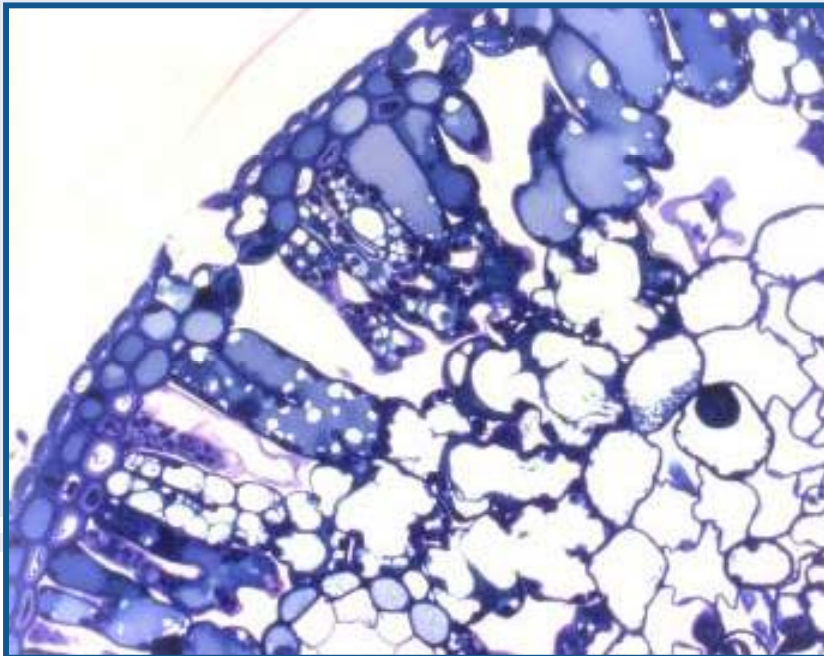


- **Constant needle wetness caused breakdown of current season and older needles**
- **Fungicide applications reduced needle death**
- **Only recognised saprophytes were isolated**

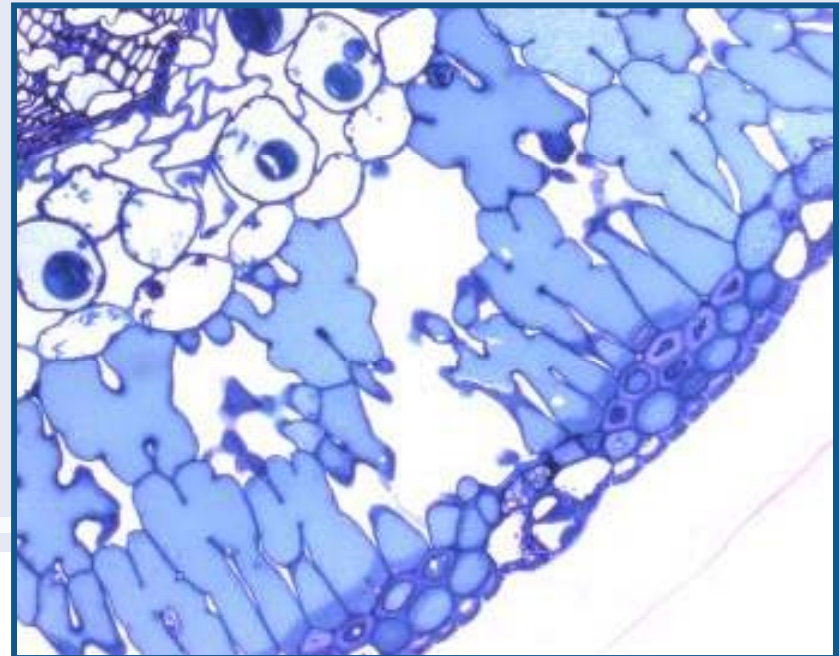
Microscopic examination

- Loss of chloroplasts in treated needles
- Breakdown of mesophyll tissue

Control



Treated



- **The hypothesis that outbreaks are a consequence of above average rainfall and raindays in June and July has been supported by the findings of aerial surveys undertaken during two spring seasons**
- **The disorder is physiological in origin**
- **The physiological nature of the needle breakdown is not understood**
- **Weakly pathogenic and saprophytic fungi accelerate death of needles in a stressed state**

Physiological needle diseases overseas

- ***Pinus strobus*** – Ontario
- ***Pinus resinosa*** – middle USA
- ***Pinus halepensis*** – USA and Israel
- ***Pinus elliottii*** – Southern USA
- ***Pinus taeda*** – Southern USA

Impact

- **Has not been measured**
- **Occasional outbreaks unlikely to have an effect over the rotation**

Control

- **Based on present knowledge, selection for tolerant genotypes the only management option**

Knowledge gaps

- **Validation of hypothesis is required. Can outbreaks be predicted?**
- **What is the mechanism of needle breakdown?**
- **Why are older trees affected? (*P. radiata* loses susceptibility to *Dothistroma* ~ age 15)**
- **Is there a relationship with heavy soils prone to waterlogging?**
- **Is increment loss associated with this disorder? Does it matter over a rotation? Climate change?**
- **Is there potential for management through genetics?**

Industry response

- **Industry is aware of increasing incidence over the past 5 years**
- **The management response has been to support research and undertake surveys and monitoring**
- **There is no operational response**

Upper mid-crown yellowing (UMCY)

- Needles in sub-apical part of crown become yellow, needle retention is poor, branch dieback occurs



- **Mg deficiency symptoms in radiata pine - over 10 years-old.**
- **Now recognised as Mg/K imbalance**
- **Susceptibility to UMCY is highly heritable**
- **Environment/site? Is there a G x E effect?**
- **Some genotypes exhibiting moderate-severe UMCY have good growth (cause/effect?)**
- **Costs to industry not established**

- **Do clones behave consistently across sites?**
- **40 clones installed in trials around the country**
- **Sites encompass**
 - ▶ coastal and inland
 - ▶ different altitudes
 - ▶ range of soil types
- **Assessment programme for UMCY has not been planned**

Industry response

- **Industry became aware of increasing incidence over the 1980s -1990s**
 - **The management response was to install trials to monitor the effects**
 - **Trials showed that UMCY does not significantly affect growth**
 - **Some companies are continuing with independent research**
-
- **There are no significant operational response options available**



General industry response to physiological disorders

- **Physiological disorders are problematic - difficult to monitor over time with no guarantee of payback for any investment**
- **Genetics may play a part in susceptibility - and may be the answer to some of our problems**