To: Alex Chapman@Herb.sid,Barbara Komorek@COMO.SID,Bryan Shearer@COMO.SID,Margaret Byrne@Herb.sid,Mike Stukely@COMO.SID, Paul Gioia@Herb.sid,Richard Robinson@MANJ.SID,Stephen Carstairs@COMO.SID,Trevor Butcher@COMO.SID

26

From: Dave Coates@Herb.sid

Cc: Alex Moylett@BUNB.FMB,Ian Abbott@CRAW.CHQ,Jan Rayner@CRAW.CHQ, Keith Morris@WOOD.SID,Kevin Vear@como.fep,Mal Grant@ALBN.CONS, Neil Burrows@CRAW.CHQ,Neville Marchant@Herb.sid,Russell Smith@BUNB.FEP

Bcc:

Subject: Review of Phytophthora research

Attachment:

Date: 2/10/98 11:46 AM

As proposed by Neil Burrows (email 5 Dec 1997) there will be an internal CALM workshop to review Phytophthora research priorities on TUESDAY FEBRUARY 17, 9.00am in the UPSTAIRS BOARDROOM, CRAWLEY HEADQUARTERS.

All active researchers in the Phytophthora area are asked to prepare a brief (10min) review of their work to date and we will then have a general discussion of Phytophthora research priorities.

As indicated by Neil this is particularly important given the anticipated release of the National Threat Abatement Plan (NTAP) for Phytophthora and need to prepare final 1998/99 NHT funding proposals for Phytophthora work by the 27 Feb.

Kevin Vear (CALM Dieback Coordinator) will also give a brief overview of research issues associated with Phytophthora control and management, and likely recommendations from the NTAP.

see you there

David Coates

## REVIEW OF *PHYTOPHTHORA* RESEARCH 17/2/98

## M. STUKELY

### PROJECTS TO DATE

1. **Jarrah/Pc Resistance (POSTER)**
   - Selection & propagation of DRJ
   - Forest rehabilitation plots
   - Seed orchard establishment
   - Molecular markers [with M. Byrne] – joint project with CSIRO funded by RIRDC

2. ***Pinus radiata*/Pc Resistance (POSTER) [with T. Butcher]**

3. ***Banksia coccinea*/Pc Resistance (new SPP)** – Partly funded by Bankwest *Landscope* Conservation Visa Card Trust Fund

4. ***Phytophthora* species identification (POSTER)**
   - Identification work
   - Rapid identification of *P.* species [with S. Carstairs] – funded by MERIWA

### FUTURE RESEARCH PRIORITIES

1. **Jarrah/Pc Resistance**
   - Selection & propagation of additional DRJ lines
   - Additional forest rehabilitation plots
   - Seed orchard establishment, testing of progeny, and culling
   - Further investigation, application of molecular markers [with M. Byrne]

2. ***Banksia coccinea*/Pc Resistance**
   - Testing for genetically-based resistance
   - Selection and propagation of resistant lines, if feasible
   - Possible application of molecular markers [with M. Byrne]
   - Investigation of Pc resistance in other "priority" species

3. ***Pinus radiata*/Pc Resistance**
   - Further selections [with T. Butcher]

| |
|---|
| Dieback Review Panel (1996), Recommendation 16:<br>*The programs of breeding for resistance in* Pinus radiata *and jarrah be sustained and similar programs for other appropriate species be encouraged.* |

# Field response of *Pinus radiata* selected for resistance to *Phytophthora cinnamomi*.

T. B. Butcher and M. J. C. Stukely

Department of Conservation and Land Management, Western Australia.

*Phytophthora cinnamomi* is prevalent over much of the south-west of Western Australia. In 1975, the Donnybrook Sunkland afforestation project was proposed, to develop pine plantations in hardwood forest areas that had been devastated by this 'jarrah dieback' disease.

Butcher *et al.* (1984) showed that resistance in *Pinus radiata* to *P. cinnamomi* is under strong genetic control. There was very high correlation between glasshouse and field inoculation tests for seedling and young tree mortality (Figs. 1, 2, 3). The resistance was also stable in differing environments and for a wide range of pathogen isolates.

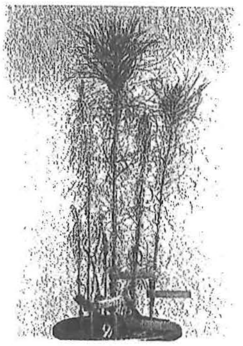

**Fig. 1.** Disease response of *Pinus radiata* seedlings, 240 days after inoculation with *P. cinnamomi*.

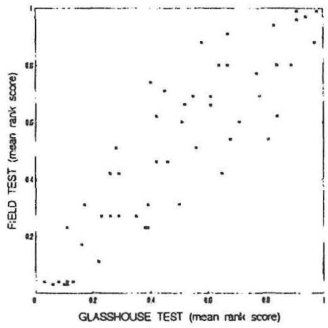


**Fig. 2.** Comparison on ranking seedling and young tree mortality, associated with *P. cinnamomi*, for *Pinus radiata* families common to glasshouse and field tests.

Tree death in 'susceptible' families after 4yr at the field site was about 30% (Fig. 4), which is well below the 67% mortality after 1yr in the glasshouse trial. This suggests that a considerable number of diseased trees survive in the field; they cannot achieve their genetic potential for growth and may die at any stage during the plantation rotation.

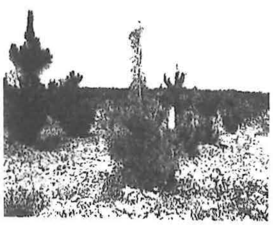

**Fig. 3.** Two-year-old *Pinus radiata* tree of susceptible family 60017 killed by *P. cinnamomi*.

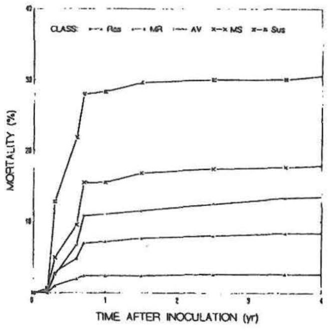


**Fig. 4.** Progressive mortality of young *Pinus radiata* up to 4yr after inoculation with *P. cinnamomi*, for the five disease response classes.

Data are grouped in Tables 1 and 2 in *P. cinnamomi* disease response classes for *Pinus radiata* families as defined by the glasshouse tests. On the diseased site (Table 1), trees of resistant families had better survival and diameter growth than those of susceptible families.

Data for resistant and moderately-resistant disease response classes were combined to simulate the "*P. cinnamomi* resistant" breed of seed produced from Unit 2 at West Manjimup Seed Orchard. "Resistant" trees produced 21m$^2$ha$^{-1}$ basal area, which was 24% greater than the trial average (Table 1). By contrast, on the *P. cinnamomi* disease-free site at Collie, there was no difference in survival or diameter of trees for the disease response classes (Table 2; Figs. 5, 6).

**Table 1.** Growth and survival of 10-year-old *Pinus radiata*, with known disease response, on a *P.cinnamomi*-infested site at Busselton.

| Disease response class | | Survival (%) | Diameter (cm) | Basal area (m$^2$ha$^{-1}$) |
|---|---|---|---|---|
| 1 | resistant | 90 | 17.9 | 25.4 |
| 2 | moderate-res | 83 | 15.6 | 18.4 |
| 3 | average | 76 | 15.3 | 16.6 |
| 4 | moderate-sus | 74 | 15.3 | 15.8 |
| 5 | susceptible | 60 | 14.2 | 11.4 |
| | | | | |
| 1,2 | "resistant" | 86 | 16.5 | 21.1 |
| 4,5 | "susceptible" | 67 | 14.9 | 14.0 |
| | | | | |
| Trial mean | | 77 | 15.6 | 17.4 |

**Table 2.** Growth and survival of 9-year-old *Pinus radiata*, with known disease response, on a dieback-free site at Collie.

| Disease response class | | Survival (%) | Diameter (cm) | Basal area (m$^2$ha$^{-1}$) |
|---|---|---|---|---|
| 1 | resistant | 93 | 17.4 | 22.7 |
| 2 | moderate-res | 91 | 17.6 | 22.8 |
| 3 | average | 93 | 17.5 | 23.0 |
| 4 | moderate-sus | 95 | 18.2 | 25.3 |
| 5 | susceptible | 95 | 17.8 | 24.5 |
| | | | | |
| 1,2 | "resistant" | 92 | 17.5 | 22.8 |
| 4,5 | "susceptible" | 95 | 18.0 | 24.9 |
| | | | | |
| Trial mean | | 93 | 17.6 | 23.4 |

**Fig. 5.** Comparison of resistant *Pinus radiata* family 80007 (centre row), and susceptible family 60017 (right row) and *P. attenuradiata* hybrids (left row) as 9-year-old trees growing on the *Phytophthora*-infested field site.

**Fig. 6.** Resistant *Pinus radiata* family 80007 (yellow ribbon) and susceptible family 60017 (green ribbon) as 14 year-old trees growing on a dieback-free site at Nannup.

*Pinus radiata* seed with *P. cinnamomi* resistance has been available for plantation deployment since 1983. Culling susceptible clones from the orchard will have increased the proportion of disease-resistant pollens and this will further enhance gains. Disease resistance was very important in the 1980s for the Sunkland afforestation project, and it is still important as one third of the annual planting requires propagules of *Pinus radiata* that have improved resistance to *P. cinnamomi*.

## REFERENCE

Butcher, T.B., Stukely, M.J.C., and Chester, G.W. (1984). Genetic variation in resistance of *Pinus radiata* to *Phytophthora cinnamomi*. For. Ecol. Manage. 8:197-220.

## CURRENT RESEARCH

## PHYTOPHTHORA

### Optimising Phosphite Prescriptions

- **Micro Plots to Test Aerial Application Options**
  - An experimental system has been developed that will allow
  - economical testing of a range of options for aerial application of phosphonate. The system uses a combination of mini plots, a hand held applicator and controlled introduction of inoculum.
  - Plots in disease centres of *P. cinnamomi* at Eneabba and Gull Rock have been established, pre-treatment monitoring undertaken and sprayed.
  - Controlled planting and inoculation plots are being established at in a disease centre at Lakes Rd.
- **Surfactants**
  - Selecting site.
- ***Phytophthora megasperma***
  - Plots in a disease centre of *P. megasperma* in the Fitzgerald River National Park have been established, pre-treatment monitoring undertaken and sprayed.
  - Shadehouse experiment established.

### Other Phosphite

- **Armillaria**
  - Injection trials established in Wandoo and *Banksia*. Monitoring in progress.
- ***Phytophthora* and *Eucalyptus marginata* growth**
  - Treatments applied at three sites, monitoring in progress.
- **Monitoring of existing plots**

### Vulnerability of Soils of the Fitzgerald River National Park (FRNP)

- Eight major soils of the FRNP and region selected (Nyerilup Sand Dry and Gravelly Phase, Qualinup Sand Shallow and Deep Phase, Perkins Sandy Loam, Red Loam, Ravensthorpe Sandy Loam and Laterite).
- Sporangium stimulation of *P. cinnamomi* and *P. megasperma* determined for each soil for two seasons.
- Pathogenicity test to be undertaken in the shadehouse in March.

### Susceptibility of Endangered Flora — TFSC

- To date 38 Taxa from 66 accessions have been transplanted into pots.
- Inoculations will commence mid-summer when plants will be of a suitable size and environmental conditions will be favourable for infection. Rate of mortality and inoculum build up in the pot will be determined in comparison to controls that will include pots of each

species not inoculated together with inoculation of pots of *Banksia brownii* and *B. grandis* with each rare flora X isolate combination.

**CRYPTODIAPORTHE / BANKSIA COCCINEA**

**Variation in the Pathogen**

- Variation in morphology of the pathogen determined. Tested the pathogenicity of 67 isolates on three hosts.

**Variation in Resistance in the Host**

- Over 400, 3-yr-old *B. coccinea* plants have been grown in the shadehouse. Variation in host resistance to be determined in inoculations in March.

**Cross Protection**

- Low virulent isolates identified.
- Test inoculations next year.

**FUTURE RESEARCH**

**PHYTOPHTHORA**

**Optimising Phosphite Prescriptions** Response markers (biochemical indicators)

- ~~Mode of action~~
- Application Technology
  - Surfactants
  - Seasonality + timing (diurnal)
  - Canopy structure
  - Fire —— sdlgs after fire ? spraying impact ? residual impact after fire from spraying
- Efficacy
  - Duration - phosphite levels v challenge by pathogen.
  - Phytotoxicity.
  - Effect on pathogen population structure.
- → Monitoring of veg. structure & floristics

**Susceptibility of Endangered Flora**

Infection by *P. cinnamomi.*
Phosphite phytotoxicity.

**Vulnerability of Soils in Major National Parks to infestation by *Phytophthora cinnamomi***

Sporulation.
Pathogenicity.

**CRYPTODIAPORTHE / BANKSIA COCCINEA**

- Cross Protection from avirulent isolates.
- Site interactions.