AFC RWG 1 Perth 10th week, Sympe 9 Nov 88

RESISTANCE OF JARRAH (EUCALYPTUS MARGINATA) TO PHYTOPHTHORA CINNAMOMI

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BACKGROUND

Rehabilitation plantings of bauxite mine-pits and dieback "graveyard" sites in the jarrah (*Eucalyptus marginata* Donn ex Smith) forest have utilized mainly *Eucalyptus* species from eastern Australia, or other exotics such as pines. Jarrah was excluded due to its presumed general susceptibility to the dieback fungus, *Phytophthora cinnamomi* Rands. The emphasis has recently shifted back towards the use of indigenous species on these sites, and jarrah seed is now included in the routine seed mixture broadcast on mine pits.

Prior to the commencement of our project, there had been very little work done to evaluate the genetic variation in jarrah, either in terms of growth characteristics or resistance to diseases and pests.

McComb and Bennett (1982) had been successful in propagating jarrah by tissue-culture, and have subsequently demonstrated differences between jarrah clones in levels of infection by *P. cinnamomi* in glasshouse inoculation trials (McComb and Bennett, personal communication).

Our aims were :

1. To show, using inoculation trials, whether or not jarrah seedlings possess genetically - based resistance to *P. cinnamomi.*
2. If genetic resistance to *P. cinnamomi* is shown to exist in jarrah, to develop a strategy for seed collection so as to maximise the use of resistant types in future rehabilitation plantings.

STRATEGY

1. Seed Collection

   Open-pollinated seed was collected from individual jarrah trees during the summer of 1984-85. The parent trees were selected on a wide range of sites, including the high rainfall Northern Jarrah Forest (on the Darling Scarp), the low rainfall Northern Jarrah Forest (further inland), the Swan Coastal Plain and the Donnybrook Sunkland. The Southern Jarrah Forest and the outlying stands were not represented.

   Both healthy and diseased trees on dieback-infested sites were included; these were classified as "possibly resistant" or "possibly susceptible" to *P. cinnamomi* according to their crown symptoms. Trees on uninfested sites were included in a third group whose possible levels of resistance were unknown. Seed was only collected from trees whose flowering time was in sequence with neighbouring trees in the stand. Very little selection of parent trees for form or growth characters was possible, as jarrah seed production in 1984-85 was generally extremely poor.

2. Inoculation Trials

Three inoculation methods were employed concurrently, using separate lots of seedlings of 16 common jarrah families, as follows:

a. One-year-old seedlings growing in pots were exposed to *P. cinnamomi* using a soil inoculation technique in which *P. cinnamomi*-infested "plugs" of *Pinus radiata* wood were buried in the pots in spring. Mortalities were recorded through the summer-autumn period. (Butcher *et al* (1984) have used this technique successfully in the screening of *Pinus radiata* seedlings for resistance to *P. cinnamomi*).

b. One-year-old seedlings growing in pots were inoculated directly with *P. cinnamomi* using a stem-inoculation technique similar to that of Smith and Marks (1985). The development of lesions could be measured daily for up to 3 weeks; destructive sampling was not necessary during the measurement period as the lesions were clearly visible on the stem surface.

c. Seedlings were transplanted in winter 1985 into a specially cleared jarrah forest site, which had been severely affected by dieback. *P. cinnamomi* inoculum was added to the soil around each seedling to ensure that each was exposed to the fungus. Mortalities have now been recorded over three summers, and this trial is to be maintained as a long-term demonstration plot.

Seedling tissue was plated at appropriate times in each trial to confirm the involvement of *P. cinnamomi*.

RESULTS

Mortality and lesion extension data from the three trials are shown in Figure 1. Families exhibited widely differing levels of susceptibility to *P. cinnamomi*, as indicated by relative mortality numbers or stem lesion lengths.

Families within both the "possibly resistant" and "possibly susceptible" parent groups also had a wide range of susceptibility levels (differences were significant at $P < 0.001$ in the field trial), and there was no significant difference between these two groups. The parent tree of the highly resistant family 11, for example - a very healthy survivor on a site badly affected by dieback in the Donnybrook Sunkland - was classified "possibly resistant". On the other hand, the parent of family 12 was also originally placed in the "possibly resistant" group as it is an equally healthy tree on another infested site, yet family 12 is highly susceptible to *P. cinnamomi*. Presumably the latter parent escaped infection.

Family resistance cannot, therefore, be predicted from the health of the parent tree at the time of seed collection.

Certain families have consistently shown extreme responses across the three trial methods, while others showed intermediate levels of susceptibility. Spearman's rank correlation coefficients between the trials were all significant (between the two pot trials at $P < 0.01$ and between each pot trial and the field trial at $P < 0.05$), hence the performances of the 16 families are deemed to be consistent.

Family mean heritability of resistance to *P. cinnamomi*, calculated from transformed mortality data from the field trial, was surprisingly high at 0.86. (This is equal to the level of heritability of resistance to *P. cinnamomi* in a *Pinus radiata* field trial conducted by Butcher *et al.*, 1984). Significant gains can be expected from progeny test selection in the development of a *Phytophthora*-resistant jarrah population.

CONCLUSIONS

Jarrah does possess genetically-based resistance to *P. cinnamomi*, and there are good prospects for selecting lines of jarrah with useful levels of resistance for use in

rehabilitation plantings. Clearly, more work must be done before we can make predictions about the durability of the resistance character through the full life of a jarrah tree. But the fact that the resistance operates effectively in the field during the very vulnerable seedling stage is encouraging.

The collection of seed exclusively from healthy-looking trees on dieback-affected sites will in no way guarantee dieback-resistant progeny. An extensive screening programme is required so that a wide range of resistant lines can be made available. Until this is done, the seed collection strategy should aim to provide a broad mix of seed with equal contributions from a large number of parent trees. Selection of the parents should follow the generally accepted rules for seed collection (e.g. Anon., 1985). This should lead to the inclusion of a reasonable proportion of resistant types in the seed mix.

CURRENT AND FUTURE WORK

1. Further screening of seedlings, including those from parents with superior form and vigour, is being carried out in conjunction with provenance trials.
2. Under a collaborative project with Dr J. McComb, selected seedlings, whose levels of resistance or susceptibility have been established in our pot trials, have been tissue-cultured for multiplication and further testing as clonal lines.
3. The first field trial of tissue-cultured clones was planted in winter 1988 and inoculated with *P. cinnamomi* in September. This will permit direct comparison of the performance of the clones with that of the seedlings from which they were cultured.

The results of the trials of the clonal lines will be critical to the future direction of the project.

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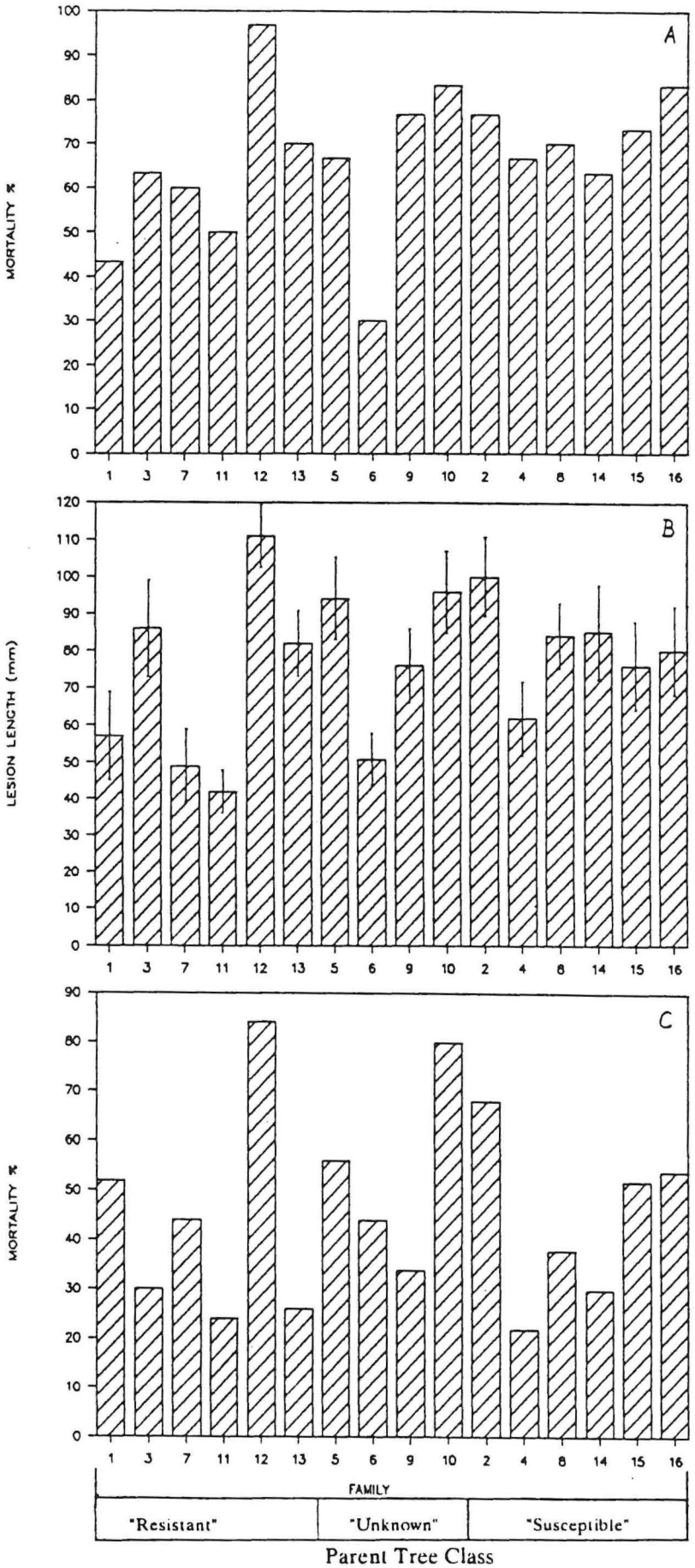

Figure1. **Results of inoculations of seedlings of 16 families of jarrah** (*Eucalyptus marginata*) **with** *Phytophthora cinnamomi*.

A. Percent mortalities in a pot trial 75 days after soil inoculation. Total mortality = 67%.

B. Distal stem lesion lengths in a pot trial, 13 days after stem-inoculation. (Bars indicate standard errors).

C. Percent mortalities in a field trial, three years after soil inoculation. Total mortality = 47%.