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PHYTOPHTHORA CINNAMOMI

As part of the general aim to identify key site indicators that can be used to predict impact of *Phytophthora cinnamomi* in the northern jarrah forest, the research programme at Dwellingup is divided into three main areas.

1. Prediction of impact.

Significant progress has been made towards developing methods to predict impact of *P.cinnamomi* in upland areas of the northern jarrah forest. Over 300 upland sites infected with *P.cinnamomi* have been described according to disease expression, topography, geology, soils and vegetation. Uninfected upland sites were also described. Data from sites in the high rainfall zone has been analyzed and indicators identified. Five impact types are now recognized for the high rainfall zone. Work is now in progress to analyze data from the intermediate and low rainfall zones and develop a system for use by operations.

2. Processes within sites.

The amount of subsurface flow of water within a site has an important influence on survival, sporulation, dispersal and impact of *P.cinnamomi*. To help predict changes in disease development with time the objectives of processes within sites were to relate variation of subsurface flow, within and between sites, to rainfall event and site characteristics.

An upland moderate and high impact site were instrumented with throughflow trenches, piezometers and tensiometers and monitored over the last year. Perched water tables developed on the sandy clays beneath the laterite more rapidly, were more sustained and more extensive in the high than the moderate impact area. These differences in hydrological response between impact areas were related to a reduced infiltration capacity due to fewer cracks and vertical channels passing through the lateritic duricrust and to finer clay textures in the high impact area. In the high impact area, *P.cinnamomi* was consistently recovered from throughflow above the laterite high in the landscape. Inoculum was also recovered from up to 2.8m below the soil surface, mostly in the lower slope positions. Dispersal of inoculum occurred throughout winter, but very little subsurface flow and dispersal occurred in an above average rain event in summer.

3. Assessment of damage.

Little is known of the amount of damage that occurs to the roots of live jarrah trees growing in infected moderate impact sites; the objective was to quantify this damage.

Twenty six and eight live trees have been excavated from infected and uninfected moderate impact sites, respectively. Excavation and assessment of a tree takes 2 wk. *Phytophthora cinnamomi* was recovered from the large roots of 16 of the trees in infected sites and from none of the roots of trees in the uninfected control sites. In one tree the fungus was recovered from 11 roots. Analysis of the results is in progress.

ARMILLARIA

Armillaria luteobubalina was widespread and caused damage in the jarrah forest of southwestern Australia. Over 200 infection centres were identified during the last five years. Deaths of five *Eucalyptus* species associated with *A.luteobubalina* have been observed: *E.calophylla*, *E.gomphocephala*, *E.marginata*, *E.wandoo* (all endemic to the region) and the introduced species, *E.saligna*. Death of understorey and overstorey hosts was greater in infection centres in the intermediate or low rainfall zones of the eastern jarrah forest than in centres in the high rainfall zone at the western edge of the Darling Scarp. Although *A.luteobubalina* basidiomes were found originating from roots of 34 plant species, incidence of basidiomes was greatest on *E.marginata* roots.

Root systems were excavated and patterns of *A.luteobubalina* invasion recorded. The host species varied in their susceptibility to the fungus. *Eucalyptus wandoo* invariably died once *A.luteobubalina* reached the base of the stems. This species lack of resistance to tangential spread often meant death by the time the fungus had advanced columns of decay into the lower stem or butt. The ability of *E.marginata* individuals to restrict tangential spread and prevent girdling of stems was indicated by the presence of old scars or 'inverted-V-shaped-lesions'. Lesions in *E.calophylla* stems were different to those described for *E.marginata*; they did not have a definite V shape and decay penetrated deep into the sapwood.

SUSCEPTIBILITY OF EUCALYPTUS SPECIES TO *BOTRYOSPHAERIA RIBIS*

As part of studies into the cause of death of *E.radiata* in arboreta, *E.calophylla*, *E.cladocalyx*, *E.marginata* and *E.radiata* were inoculated with *B.ribis*. In a glasshouse, *E.calophylla* contained longitudinal and tangential extension by the fungus (Fig.) and containment of lesions was associated with rapid callus formation. Lesions in *E.cladocalyx* stems were long and narrow. Necrophylactic periderms formed the boundaries of the lesions which ceased to extend tangentially. Lesion development in *E.marginata* was the reverse to that in *E.cladocalyx*; while longitudinal extension was limited, tangential extension was not. Only in *E.radiata* did *B.ribis* lesions extend both longitudinally and tangentially. Field inoculations confirmed observations in the glasshouse. The long, but narrow lesions in *E. cladocalyx* stems illustrates the need to determine tangential as well as longitudinal spread when assessing resistance to *B. ribis*.

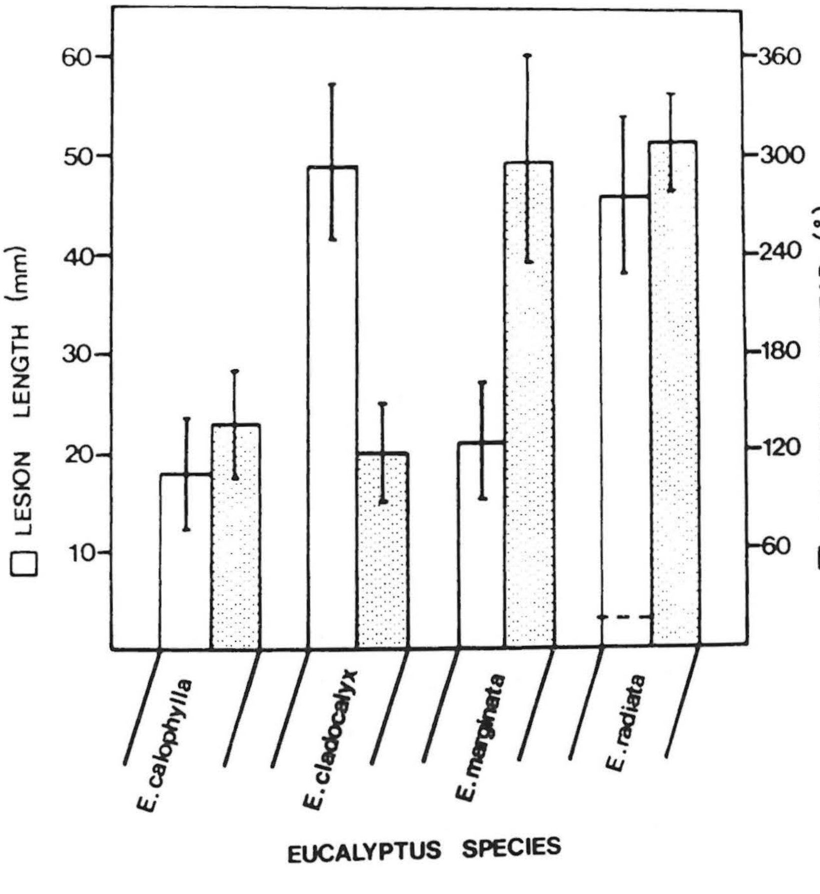

Fig. Lesion lengths and tangential spread (± standard error of the mean) of *Botryosphaeria ribis* in stems of four *Eucalyptus* species in a glasshouse 33 days after inoculation. --- indicates size of control inoculations.

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Jarrah Dieback

We are concerned primarily with the post-infection interaction of the fungal pathogen *Phytophthora cinnamomi* and the susceptible host, jarrah (*Eucalyptus marginata*). The outcome of the host-pathogen interaction is determined in part by the water status of the host which in turn reflects the hydrologic nature of the site on which it grows. By defining the relationships between site "wetness", disease development and symptom expression the ability to predict impact of *P. cinnamomi* on particular sites, and in response to events such as unseasonal rainfall, may be improved.

Results to date:

i) Phloem water relations and the rate of lesion extension.
The rate at which *P. cinnamomi* invades host tissue has been found to decrease as the host becomes water stressed. These effects have been demonstrated in the laboratory and in the field. Further, sites with the potential for severe dieback have been shown to maintain higher water potentials during summer than sites where disease expression is typically less severe.

ii) Root loss and jarrah water relations
The relationship between symptom expression and destruction of roots by *P. cinnamomi* was simulated by cutting roots from jarrah poles and monitoring the effects on tree water relations. Root loss had little effect on leaf water potentials until very severe levels of pruning (over 80% of roots cut). Stomatal conductances were reduced by much less severe root pruning (about 50% roots cut).

The results will be used to interpret changes in water relations of dieback affected jarrah in the field.

iii)Use of plants as soil tensiometers.

A number of species associated with jarrah, and having shallow (about 1m), moderate (penetrating to the impervious layer in the soil but not beyond), or deep (penetrating the impervious layer) root systems, as determined by root excavations, were selected for testing as in situ tensiometers. Measurement of predawn water potentials of these species over a dry summer confirmed that the water status of these plants behaved in a manner consistent with their root depth and soil drying patterns.

The 'plant tensiometer' approach appears therefore to be a suitable technique for the investigation of the relation between site 'wetness' and the potential for dieback impact on a particular site.

Causes of Wandoo Decline (Project supervised at Narrogin by Paul Brown).

Objectives of the study are:

To determine the causes of Eucalyptus wandoo decline in part of the wheatbelt of W.A. and to seek correlations between damage caused by insects and fungi with various environmental conditions.

There had been no detailed information available on any of the agents associated with crown decline of Eucalyptus wandoo in Western Australia. Therefore, the first phase of this project was to describe and record photographically the various types of external and internal damage to wandoo and to identify the causal agents associated with each damage type. During the first six months of the project we concentrated on recording the amount and types of damage to wandoo in the Narrogin region.

For many of the bole symptoms described there have been no casual agents yet identified. However, encouraging progress in identifying insects (mostly borers) and fungal organisms associated with various types of damage has been achieved. Some 5 insects have been identified to genera and a further 5 insects have been classified down to family level. All of the insects identified cause varying amounts of internal damage. However, only two - *Tryphocaria punctipennis* and the Xyloryctidid 'bark-cutter' moth larvae - appear to cause branch death in living *E. wandoo* by girdling ('ringbarking') branches.