Department of Environment and Conservation

Information Sheet 45 / 2012
Science Division

Armillaria root disease in karri regrowth forests

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Background

In Western Australia, armillaria root disease (ARD) is caused by the endemic pathogen, *Armillaria luteobubalina*. The pathogen colonises sapwood and spreads from tree to tree below ground via root contacts. It is widespread in south-west native forests, woodlands and coastal heathlands causing scattered mortality and windthrow. Major impacts of ARD in karri (*Eucalyptus diversicolor*) forest are: juvenile tree mortality, root mortality resulting in reduced growth rate, an increased probability of windthrow in mature trees leading to gap formation in stands, and loss of timber volume due to mortality and defect. The health and vigour of high quality karri regrowth is an important issue for ecologically sustainable forest management.

Symptoms of Armillaria root disease: *Armillaria luteobubalina* fruits prolifically in the autumn near the base of infected trees (left); disease spreads rapidly in the bark of young regrowth trees (centre); decay scars develop following infection and produce defect and eventual death of trees (right).

The distribution and impacts of ARD throughout the natural range of karri has been determined by monitoring disease impacts in regrowth thinning trials, undertaking extensive ground-based surveys for disease symptoms on trees in natural and regrowth forest, and applying whole tree extraction methods to examine infected root systems. Trials have also investigated whether inoculum build up in infected stumps can be controlled by fumigation and inoculation with competitive wood decay fungi.

Stump pulling trials are currently in progress to assess practical options and methods for disease control. Research and management trials undertaken in North American conifer forests suggest that whole tree harvesting or stump extraction are viable options for disease control as inoculum and potential inoculum are removed from the soil. An extensive adaptive management trial has been implemented in high quality karri regrowth in Warren and Dombakup forest blocks, south of Pemberton. The trial extends over 1150 ha of thinned regrowth forest, in which 543 ha were surveyed and all infected trees and stumps mapped. Within the surveyed area, all stumps within a 25 m radius of an infection point were extracted using an excavator fitted with a specifically designed stump extraction head.

Findings

- *Armillaria luteobubalina* causes scattered death of trees and a range of woody shrubs of all ages throughout the range of karri forests.
- Disease impacts are greatest in mature stands and regrowth forest on high quality sites.

- The spread of disease within regrowth stands is associated with infected stumps remaining from the original stand and the pathogen rapidly spreading within and into stumps resulting from thinning operations.
- The impacts of disease increase with increasing thinning intensity due to the greater number of cut stumps created.
- Only 50% of infected trees show above ground symptoms.
- Ground surveys in unthinned stands are time consuming, hazardous and have a low probability of detecting infected trees; post thinning surveys are time and cost effective, with few health and safety concerns and have a high probability of detecting infected trees in infested stands.
- The optimal time to undertake disease control treatments is immediately following first thinning of infested stands. On high quality sites this is generally between 20 and 25 years of age.
- An excavator fitted with a specially designed stump pulling head can pull juvenile regrowth stumps in an effective manner.
- Stump fumigation and inoculation with competitive fungi have the potential to reduce the spread of ARD in thinning stumps but are labour intensive, expensive and require the use of hazardous chemicals.

Management Implications

Silviculture guidelines for karri forest include specific provisions for management of infested stands on high quality sites. Stump extraction optimises disease control and reduces the spread of the pathogen by the direct removal of infected stumps, isolation of infected trees, and by breaking up root-to-root contact between infected and uninfected stumps and trees. Stump extraction is only viable at the time of first thinning; after this, stumps are too large to extract easily or with minimal disturbance. Stump pulling is best undertaken in late spring when soils are moist and coppice regrowth allows for easy location of stumps.

Stump pulling trial in Warren block: Stump extraction head on excavator (left); stump and regrowth tree showing scaring from *A. luteobubalina* infection (centre); thinned regrowth stand with stumps extracted (right).

Stump pulling trials will need to be monitored over a number of years to determine their effectiveness. Other factors associated with stump removal that need monitoring include crop tree damage caused by machinery, root damage caused by extracting stumps close to trees, and soil disturbance.

Other strategies for integrated disease control that can be examined as part of an adaptive management process include varying the timing and intensity of thinning, leaving heavily infested stands unthinned, and clear felling heavily infected stands at an earlier age.

Produced and published by the Science Division, Department of Environment and Conservation, Western Australia,
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