Control of Sudden Death in Cultivated Proteas from the Southwest of Western Australia

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Abstract

Phytophthora cinnamomi Rands is a common and devastating pathogen of cultivated proteas worldwide. Webb (1997) described a Sudden Death plant disease of proteas in Western Australia (WA) protea plantations. Proteas that suffer the syndrome display symptoms such as stunted growth, wilting, chlorosis and often death. In the current study, a number of protea plantations in the southwest of WA were visited to quantify the extent that *P. cinnamomi* was attributing to deaths of cultivated proteas. The survey indicated that *P. cinnamomi* is the major cause of Sudden Death in proteas. A range of other fungi (*Fusarium, Botryosphaeria, Pestalotiopsis, Alternaria*) and pests (nematodes, mealy bug, scale insects) were also identified to be contributing to protea death and decline in WA plantations. In many cases the factors contributing to protea disease appeared complex, with a range of physical factors or nutritional imbalances commonly associated with these pathogens and pests. As *P. cinnamomi* was the major cause of death of cultivated proteas the remainder of the experiments described in this dissertation investigated its control in horticultural plantings.

Biofumigation has the potential to become an important technique in an overall integrated management approach to *P. cinnamomi*. In this thesis, biofumigation refers to the suppression of pathogens and pests by the incorporation of *Brassica* plants into the soil. Two biofumigants (*Brassica juncea* (L.) Czern., *B. napus* L.) were screened for their effect on the *in vitro* growth of five common *Phytophthora* species (*P. cinnamomi*, *P. cactorum* (Lebert & Colin) Schroeter*., P. citricola* Sawada, *P. cryptogea* Pethyb. & Laff. and *P. megasperma* Drechsler). Growth was determined by the measuring dry weight and radial growth of vegetative hyphae. *B. juncea* was found to be superior in its suppressive effect compared to *B. napus*. There was also significant variation in the sensitivity of the *Phytophthora* species to the suppressive effects of the biofumigants. *P. cinnamomi* was the most sensitive of the five species investigated. Where the rates of the biofumigant were sufficient to suppress growth of *Phytophthora*, the suppressive effect was mostly fungicidal.

To determine how *B. juncea* and *B. napus* affect the infective ability and survival of *P. cinnamomi,* their effects on sporangia and chlamydospores production in soil was

investigated *in vitro*. *P. cinnamomi* colonised Miracloth discs were added to soil amended with the two *Brassica* species, before being removed every two days over an eight day period for the determination of sporangia production, chlamydospore production and infective ability. Only the soils amended with *B. juncea* significantly reduced sporangia production in *P. cinnamomi*. Both *Brassica* species increased the percentage of aborted or immature sporangia and reduced the infective ability of the pathogen. Neither *Brassica* species had any effect on zoospore release or chlamydospore production in *P. cinnamomi*.

Soil cores and soil leachate were collected from biofumigant-amended field soils to determine the inoculum potential and infective ability of the pathogen under glasshouse conditions. Amending the soil with both *Brassica* species had an immediate suppressive effect on the inoculum potential and infective ability of the *P. cinnamomi*. However, after this initial suppression there was a gradual increase in the recovery of the pathogen over the monitoring period of four weeks. To determine if the suppression would result in decreased disease incidence in a susceptible host, *Lupinus angustifolius* L. seeds were planted in the biofumigant amended soil. *B. juncea* amended soils reduced the disease incidence of *P. cinnamomi* by 25%. *B. napus* had no effect on disease incidence in *L. angustifolius.*

Although the current study had demonstrated that biofumigants could suppress the growth, sporulation and infection of *P. cinnamomi*, it was unclear if this would equate to a reduction in disease incidence when applied in the field. A field trial was conducted on a protea plantation in the southwest of Western Australia that compared biofumigation with *B. juncea* to chemical fumigation (metham sodium) and soil solarisation. The three soil treatments were used in an integrated management approach to control *P. cinnamomi* that included the use of a hardwood compost, mulch and water sterilisation. All treatments were monitored during their application to ensure the treatments were conducted successfully. The three soil treatments significantly reduced the recovery of the pathogen and the infective ability of the pathogen to a soil depth of 20 cm. Metham sodium was the most suppressive soil treatment and soil solarisation was the least suppressive treatment. Only the metham sodium treatment resulted in a

significant reduction in the incidence of root rot in *Leucadendron salignum* P.J. Bergius x *laureolum* (Lam.) Fourc (c.v. Safari Sunset) over the monitoring period of three years.

Another field trial was conducted on the same protea plantation to compare the effectiveness of *B. juncea* and *B. napus*, without the use of other control strategies, to reduce the incidence of *P. cinnamomi* infection of *Leucadendron* Safari Sunset. The concentration of isothiocyanates was monitored for seven days after the incorporation of the biofumigants. Although both *Brassica* species reduced the recovery and infective ability of the pathogen, neither biofumigant reduced the incidence of root rot in *Leucadendron* Safari Sunset.

In conclusion, *P. cinnamomi* is the most common and devastating pathogen in WA protea plantations. The current study demonstrated that *P. cinnamomi* is sensitive to the suppressive nature of biofumigants. Biofumigants can suppress the *in vitro* growth, sporulation, infective ability of *P. cinnamomi* and reduce the incidence of the disease caused by the pathogen in the glasshouse. Of the two *Brassica* species investigated, *B. juncea* was superior in its ability to control *P. cinnamomi* compared to *B. napus*. When applied in the field, biofumigation using *B. juncea* was found to be more suppressive that soil solarisation, but not as effective as metham sodium.