Abstract  Phosphite is a cost-effective fungicide used to control the pathogen Phytophthora cinnamomi which is damaging the diverse flora of the southwest of Western Australia. Three annual species of the southwest jarrah (Eucalyptus marginata) forest of Western Australia (Pterocheata paniculata, Podotheca gnaphalioides and Hyalosperma cotula), were studied to determine the effect of the fungicide phosphite on the species’ reproduction. Phosphite at concentrations of 2.5, 5 and 10 g L⁻¹ reduced pollen fertility of Pt. paniculata when plants were sprayed at the vegetative stage. Pollen fertility of all three species was reduced when plants were sprayed at anthesis with 10 g L⁻¹ phosphite. Seed germination was reduced by phosphite in Pt. paniculata and H. cotula when plants were sprayed in the vegetative stage. Phosphite when sprayed at anthesis at a concentration of 5 g L⁻¹ reduced seed germination of H. cotula. Phosphite at concentrations of 5 and 10 g L⁻¹ killed a proportion of plants from all three species and up to 90% of Po. gnaphalioides plants. The frequent application of phosphite, therefore, may reduce the abundance of annual plants in this ecosystem.

Keywords Pollen fertility · Seed germination · Phosphite · Phytophthora cinnamomi · Australian native plants.

Introduction

Phytophthora cinnamomi Rands is a soilborne pathogen that is extremely damaging both in horticulture (Coffey et al. 1984) and in natural ecosystems (Shearer et al. 1991; Shearer 1994). The diverse flora of the southwest of Western Australia is particularly at risk since 2000 of the 9000 species present are susceptible to this introduced pathogen and large areas have already been damaged (Wills 1993). The pathogen kills its host by destroying the roots and girdling the base of the stem, depriving the plant of nutrients and water (Shearer et al. 1991; Shearer 1994). It is widespread in the jarrah forest (Eucalyptus marginata Donn ex Sm.) and is also damaging the diverse flora of the northern sandplains of Western Australia. The fungicide phosphite, the anionic form of phosphonic acid (HPO₃⁻²) provides a cheap and effective means of controlling P. cinnamomi in horticulture and native plant communities (Coffey and Bower 1984; Wicks and Hall 1988; Ouimette and Coffey 1989; Guest and Grant 1991; Guest and Grant 1991; Shearer 1994). Control of the pathogen is important for the conservation of biodiversity (Shearer et al. 1991). Spraying affected areas is carried out using backpack or aerial spraying.

Annuals form an important part of the jarrah forest vegetation and seeds from annual species dominate the northern jarrah forest topsoil seed reserves (Vlahos and Bell 1986; Ward et al. 1997). The majority of the annuals are monocarpic, therophytic ephemerals, which germinate with the winter rains. Seedling establishment is usually episodic and highest during the period of relatively open habitat following a fire (Gill 1981).

Fungicides may influence plant reproduction in a number of ways ranging from reduced germination and stunted plants (George et al. 1970) to genetic changes that include chromosomal and gene mutation leading to inherited alterations (Wuu and Grant 1966 a,b, 1967; Prasad and Pramer 1968). Phosphite as a systemic fungicide could influence plant reproduction. The aim of this study was to determine the effect of phosphite, sprayed to run-off, on pollen fertility and seed germination of some representative annuals of the jarrah forest of Western Australia.

Materials and methods

Species description and seed source

The annuals chosen, Pterocheata paniculata F. Muell. ex Benth. (formerly Waitzia), Podotheca gnaphalioides R.A. Graham, and Hyalosperma cotula Benth (DC), all occur in the jarrah forest and...
belong to the Asteraceae family. *Pterocheata paniculata* is an erect annual of 180 mm with a compound raceme of flowers which occurs in open woodland in a variety of soils (Marchant et al. 1987; Sharr 1988). It flowers between July and November and has been recorded on the Darling Scarp from Helena Valley to Byford and extends throughout the southwest of Western Australia (Marchant et al. 1987).

 Seeds of *Pt. paniculata* were obtained from the Alcoa World Alumina Australia Marrinup Nursery, Dwellingup, Western Australia. Seeds of *Po. gnaphalioides* and *H. cotula* were obtained from Nindethana Seed Service, Albany, Western Australia. All seeds were sprouted in steam-sterilised potting mix and plants were grown in an environmentally controlled glasshouse at Murdoch University. Seeds of *H. cotula* were soaked in 10% smoke water (Kings Park and Botanic Garden) (Dixon et al. 1995) for 24 h and dried at 37°C for 3 days before sowing.

### Phosphite treatments

All plants were sprayed to run-off with one of four concentrations (0, 2.5, 5 and 10 g L⁻¹) of phosphite (Foli-R-Fos 400, Unitec, Australia, a 40% w/v solution of mono-di-potassium phosphite) with 0.25% Synertrol oil (Organic Crop Protectants, NSW, Australia) as a sticking agent. Phosphite was applied to the plants by a hand-held spray bottle that was regularly agitated to mix the solution. Soil was not protected during spraying.

### Pterocheata paniculata

Twenty plants per phosphite concentration were sprayed in the vegetative stage (referred to as the S1 stage) when they were 4.1–5.6 cm tall, in September 1998. A further sample of 20 plants per phosphite concentration were sprayed between flower initiation and anthesis (referred to as the S2 stage) when plants were about 8.4 cm tall, in October 1998. Pollen fertility was assessed when plants flowered, which was 16–30 days after phosphite application.