2. Cylindrocarpon Root Disease

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Hosts

Cylindrocarpon species have very wide host ranges, including many agricultural, natural, and nursery plant species. In forest nurseries, the major affected species include five-needle pines, especially western white pine and whitebark pine, Douglas-fir, true fir, and occasionally other pine species and western larch.

Distribution

Cylindrocarpon-associated diseases probably occur at some level in most bareroot and container nurseries in the Western United States. Most damage has been associated with bareroot nurseries in the Pacific Northwest and container nurseries in both inland and coastal areas.

Figure 2.1—*Foliar symptoms associated with Cylindrocarpon root disease.* Photo by Robert L. James, USDA Forest Service.

Damage

Damage on container white pine and whitebark pine can be substantial within container nurseries (fig. 2.1). *Cylindrocarpon* may cause severe root decay, with epidermal and cortical tissues in both the primary and secondary roots being affected. Although diseased container seedlings may sometimes appear dwarfed, aboveground symptoms are not often evident. Root decay can be extensive, however, and is noticed after seedlings are lifted from containers. Although seedlings with severe root decay must be culled, those that are slightly affected usually perform satisfactorily after outplanting on forest sites. *Cylindrocarpon* is often rapidly replaced with other, nonpathogenic fungi after outplanting.

Container or bareroot transplants may become seriously diseased by *Cylindrocarpon* species after transplanting in nursery soils. Affected seedlings often have chlorotic or necrotic foliage, bottle brush appearance of recent growth, and blackened or decayed roots. Severely affected seedlings are killed.

Diagnosis

Typical root disease symptoms may not occur on container stock with extensive root decay induced by *Cylindrocarpon*. Root decay becomes evident after lifting diseased seedlings from containers. On bareroot and transplant stock, typical root disease symptoms are common, including foliar chlorosis and necrosis, reduced growth, black or decayed roots, and mortality. Other nursery pathogens, however, species such as *Fusarium, Pythium,* and *Phytophthora,* may cause similar symptoms. Therefore, isolations from diseased seedling roots onto selective media are required for pathogen identification.

Biology

The most commonly isolated *Cylindrocarpon* species from diseased conifer seedlings is *C. destructans*. Other species, however, including *C. didymum, C. tenue*, and *C. cylindroides*, are sometimes associated with disease. *Cylindrocarpon* species are commonly soilborne and are especially prevalent within the rhizosphere of many plants. At least three spore types are produced by most *Cylindrocarpon* species: multicelled macroconidia (fig. 2.2), one- or two-celled microconidia, and thick-walled resting spores called chlamydospores. Macroconidia and microconidia are produced from phialides located on various branched conidiophore types. Chlamydospores form within plant tissues following nutrient extraction and within macroconidia. When susceptible hosts are present, carbohydrate exudates from roots stimulate chlamydospore germination in soil. *Cylindrocarpon* rapidly colonizes the

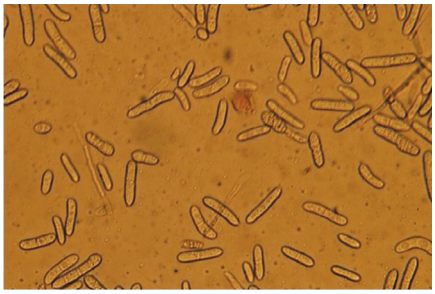

Figure 2.2—*Multicelled macroconidia typical of those produced by* Cylindrocarpon *species.* Photo by Robert L. James, USDA Forest Service.

rhizosphere, invades cortical and vascular tissues, and induces root decay. In some cases, *C. destructans* can induce cortical tissue necrosis without actually invading cortical cells by producing plant toxins. After colonization, roots are decayed or host plants are killed, chlamydospores form and the cycle is repeated. Although some *Cylindrocarpon* species have perfect (sexual) states, which may produce other spores called ascospores, the imperfect (*Cylindrocarpon*) state is the most important for disease epidemiology.

Control

Cultural

Roots from a previous susceptible seedling crop can be an important *Cylindrocarpon* inoculum source in nursery soil. By rotating a nonsusceptible crop into infested soils or by fallowing for at least one growing season (accompanied by periodic fallowed soil tilling), damage from *Cylindrocarpon* can be decreased. In container nurseries, *Cylindrocarpon* species are usually most damaging to over-watered seedlings. Therefore, proper irrigation regulation and the use of well-drained growing media are both important in limiting damage to container stock.

Chemical

Preplant soil fumigation reduces or eliminates potentially pathogenic fungi in nurseries, including *Cylindrocarpon*. Most fumigants that are effective against other soilborne pathogens adequately control *Cylindrocarpon. Cylindrocarpon* can be introduced into nursery soils on infected transplant roots; this introduction may be especially serious if transplanting into fumigated soil because few other organisms remain after fumigation to limit pathogen inoculum buildup. Careful transplant culling for root decay and fungicide root dips prior to transplanting may help limit disease severity. Drenching soil with fungicides is usually ineffective in seedbeds or transplant fields after disease symptoms become evident.

Cylindrocarpon can be introduced into container stock on reused containers that have been inadequately sterilized prior to using for a new seedling crop. Hot water or chemical (bleach, copper, and sodium metabisulfite) treatment is necessary for reducing pathogen inoculum on reused containers.

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