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PYTHIUM ROOT DISEASE OF DOUGLAS-FIR AND GRAND FIR SEEDLINGS at the COEUR d'ALENE NURSERY, IDAHO

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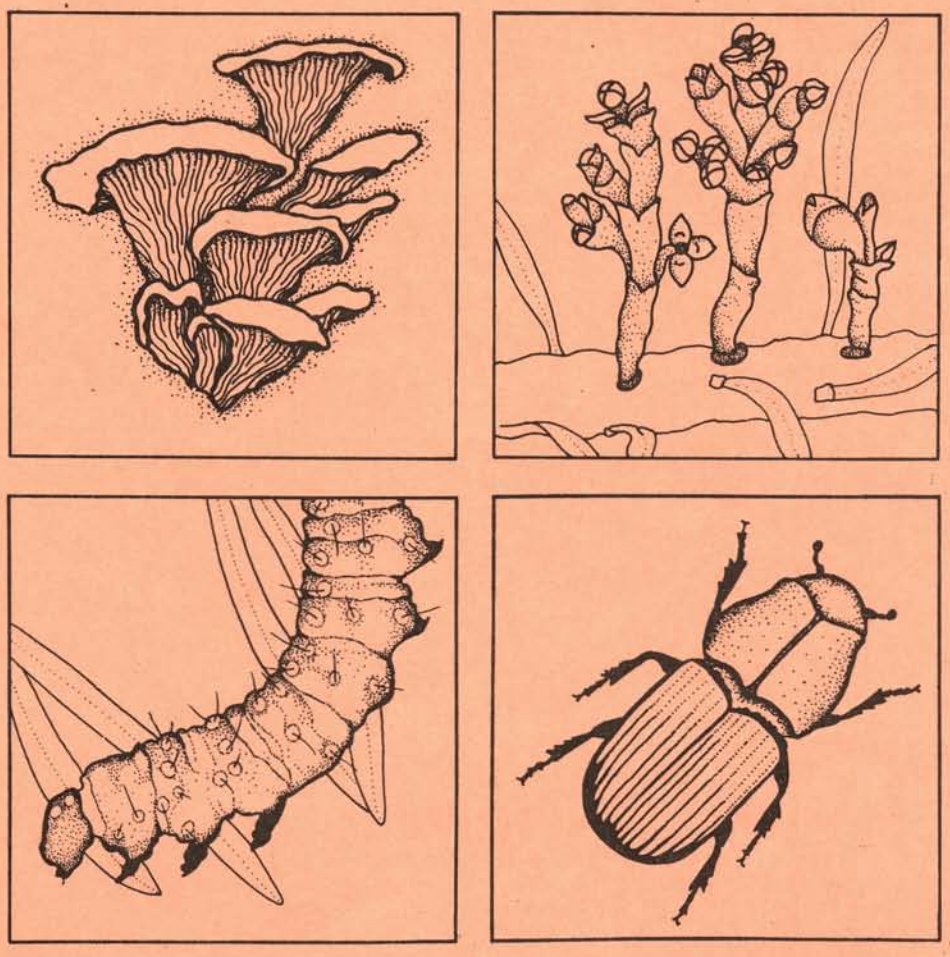

PYTHIUM ROOT DISEASE OF DOUGLAS-FIR AND GRAND FIR SEEDLINGS AT THE COEUR d'ALENE NURSERY, IDAHO

ABSTRACT

An evaluation was conducted at the Coeur d'Alene nursery in northern Idaho to determine the cause of decline and mortality of Douglas-fir and grand fir seedlings and formulate recommendations for reducing future losses. Affected trees were grouped at the east end of several seedbeds which had been flooded from excessive rains prior to symptom development. Symptomatic trees had extensive root system necrosis. Isolations from necrotic roots commonly yielded the soil-borne pathogens Pythium ultimum and P. aphanidermatum; these fungi are probably responsible for seedling mortality. Improving water drainge within seedbeds, providing satisfactory soil fumigation before planting, and spot treatments with selected fungicides should help alleviate future problems from this disease.

INTRODUCTION

Root diseases are common problems in forest tree nurseries and may cause extensive losses (Filer 1972; Hodges 1972; Sutherland and van Eerden 1980). Root disease losses generally occur during periods of conducive soil moisture and temperature when host roots are susceptible and pathogen populations are high (Singh 1978; Sutherland, Lock and Sluggett 1975). Losses are most often ameliorated by soil fumigation designed to kill propagules of soil pathogens (Smith and Bega 1966; Wilhelm, Stocken and Wilhelm 1974). However, root diseases may occur in spite of soil fumigation. Pathogens may reinvade fumigated seedbeds (Vaartaja 1967), fumigants may be nonuniformly distributed within soil (Munnecke and Van Gundy 1970), and propagules of pathogens may be resistant to fumigants (Sutherland, Adams and True 1966).

Mortality of 1-0 Douglas-fir (Pseudotsuga menziesii Franco) and grand fir (Abies grandis (Dougl.) Lindl.) seedlings at the Coeur d'Alene forest tree nursery in northern Idaho was of concern to growers. Therefore, a field evaluation of the problem was conducted. Symptomatic seedlings were examined and several representative samples were transported to the laboratory for isolation of associated fungi.

SYMPTOMS AND DISTRIBUTION

Affected seedlings were located at the east end of several seedbeds. Portions of seedbeds with diseased seedlings were poorly drained. Heavy rains during the early summer of 1981 resulted in flooding of several seedbeds, submerging many seedlings. Within 7-10 days after the water had receded, groups of seedlings began to turn chlorotic and die. Symptomatic seedlings often occurred in small groups (figure 1); recently killed trees had yellow to reddish brown foliage. Several dozen Douglas-fir and grand fir were symptomatic. Trees outside the portions of beds which had been covered with water lacked symptoms.

Examination of chlorotic and recently killed trees revealed extensive root necrosis. Infected roots had blackened epidermis that easily sloughed off, lacked fine root hairs, and were becoming decayed. Several large brown lesions were found on the roots of slightly discolored seedlings.

ASSOCIATED ORGANISMS

Isolations from necrotic roots surface sterilized with 10 percent aqueous sodium hypochorite yielded several different fungi. The major pathogens isolated were identified as Pythium ultimum Trow. and P. aphanidermatum (Eds.) Fitz. using several taxonomic keys (Matthews 1931; Middleton 1943; Waterhouse 1967; Waterhouse 1968). Other fungi isolated included Alternaria spp., Penicillium spp., and Trichoderma viride Pers. ex Fr. These latter fungi are common soil inhabiting saprophytes which often colonize dead organic matter (Griffin 1972).

Figure 1.--Grand fir seedlings with Pythium root disease at the Coeur d'Alene nursery. Trees with different levels of infection are indicated by varying foliage discoloration. Root systems of red-brown trees have extensive infection.

Both P. ultimum and P. aphanidermatum are common nursery pathogens (Agnihotri and Vaartaja 1967; Edmonds and Heather 1973; Hendrix and Campbell 1973; Vaartaja and Bumbieris 1964), often causing disease in poorly drained, saturated soils (Drechsler 1946; Hendrix and Campbell 1973; Hickman and Ho 1966). Although pathogenicity tests (inoculating seedlings with these fungi in order to reproduce disease symptoms) were not conducted, such tests previously done have verified their ability to elicit disease (Bielenin, Borecki and Millihan 1976; Hendrix 1974; Stanghellini and Hancock 1971; Trow 1901). Therefore, P. ultimum and P. aphanidermatum were probably the cause of the disease. The following discussion focuses on aspects of the biology of Pythium which affects disease initiation and epidemiology.

BIOLOGY OF PYTHIUM

Pythium spp. are common pathogens of a wide variety of plants, causing primarily root disease (Edmonds and Heather 1973; Hendrix and Campbell 1973; Singh 1978), although aerial portions of plants may sometimes be affected (Braun 1924; Gay and McCarter 1968; Moore and Couch 1961). They are common soil inhabitants and survive in soil by saprophytic growth and resistant resting structures (Hendrix and Campbell 1973). They are not vigorous competitors and their saprophytic activities occur only when other organisms are either not present or have greatly reduced activity (Barton 1958; Barton 1961). High soil moisture generally favors saprophytic activity of Pythium spp. (Mircetich 1971). Also, tolerance of poor gas exchange conditions which accompanies high soil moisture provides an ecological advantage to these fungi (Griffin 1963).

Survival by resistant resting structures is more important than saprophytic persistence in soil (Hendrix and Campbell 1973). Mycelium of Pythium spp. lyses as food sources are depleted or become colonized by competing organisms (Barton 1961; Stanghellini and Hancock 1971). The chief mechanism of survival is by zoospores and sporangia for short and intermediate periods, and oospores for longer periods (Hendrix and Campbell 1973). Oospores may remain viable in soil for many years (Hoppe 1966; Munnecke and Moore 1969), whereas zoospores survive for a few days (Luna and Hine 1964) and sporangia for a few months (Stanghellini and Hancock 1971).

Most Pythium spp. infect mainly juvenile or succulent tissues (Hendrix and Campbell 1973). Therefore, parasitism is often restricted to seedlings or the feeder roots or root tips of older plants. Pythium spp. also commonly infect seed causing seed rot and preemergence damping-off (Sutherland, Lock, and Sluggett 1975; Sutherland and van Eerden 1980).

Germination of survival structures is necessary for Pythium to successfully attack plants; germination is either by germ tubes or zoospores (Drechsler 1946; Hendrix and Campbell 1973). Dormant spores usually must be activated before they will germinate. Activation mechanisms include increased soil moisture (Hancock 1981; Hoppe 1966), and stimulation by seed or host root exudates (Chang-Ho 1970; Kraft and Erwin 1968). Root exudates made up primarily of sugars and organic acids also attract Pythium spp. zoospores to feeder roots where infection occurs (Ho and Hickman 1967; Royle and Hickman 1964a; Royle and Hickman 1964b).

When zoospores come into contact with a suitable infection site, they encyst (lose their flagella and round up) and germinate (Drechsler 1946). Pythium spp. do not spread widely throughout host cells and are quickly followed by more aggressive or faster growing fungi (Hendrix and Campbell 1973). Therefore, host tissue necrosis occurs rapidly; symptoms develop on infected trees soon after infection.

Tree mortality within nursery beds typically occurs in groups because the pathogen spreads via root contacts and short distances in soil via zoospores (Hendrix and Campbell 1968; Sutherland, Adams, and True 1966). Most affected trees occur in portions of beds where soil moisture is maintained at high levels because of the association between moisture and infection (Vaartaja and Bumbieris 1964). Resting structures are formed following tree death and often remain in soil following removal of dead plants. Successive periods of infection will likely lead to build-up of propagules in the soil unless procedures are taken to reduce their numbers (Hine 1961).

CONTROL

Most soil pathogens including Pythium spp. are controlled in forest tree nurseries by fumigating seedbeds with methyl bromide-chloropicrin mixtures. Fumigation does not kill all soil organisms. Shortly after fumigation, bacterial populations increase rapidly followed by other soil organisms (Hendrix and Campbell 1973). The soil flora is altered by removal of competitors to Pythium spp. If Pythium spp. are reintroduced, they may offer greater threats to plants than before fumigation (Kraft, Haglund, and Rieling 1969; Vaartaja 1967). Therefore, care must be taken to avoid reintroducing these pathogens. Proper sanitation methods, including maintaining clean cultivation equipment and storing dead plant material and debris away from seedbeds, will help alleviate problems of reintroducing pathogens. In addition, soil fumigation should be uniform to avoid "islands" of nonfumigated soil from which pathogens can spread (Hendrix and Campbell 1973; Vaartaja 1967). Seed contaminated with pathogens should not be sown in fumigated soil. Proper chemical seed treatment may be necessary (Short and Lacy 1976).

Several chemical fungicides have been used to control Pythium spp. in nurseries. Dexon® applied at low rates has been successful in preventing reinfestation of fumigated soils by Pythium spp. (Hendrix and Powell 1970). Banrot®, Truban®, and Subdue® are effective fungicides against Pythium spp. and other water mold fungi. These chemicals applied as soil drenches can help reduce root disease losses in selected portions of seedbeds. Effectiveness of widespread application of soil drenches over entire fields is questionable (Littrell, Gay and Wells 1969). Other chemicals that have proven efficacy against Pythium spp. include chloroneb, captan, ferbam, thiram, and zineb (Cox 1969; Littrell, Gay and Wells 1969; Tamman, Muse and Hass 1961).

Soil amendments such as sawdust, bark, and green manuring have been used to control Pythium root diseases in nurseries and field crops (Vaartaja and Bumbieris 1964). These amendments are effective because they encourage

soil flora antagonistic to Pythium spp. Improvement in plant growth and survival that often result from soil amendments stimulate root formations that may counterbalance roots killed by pathogens. In nurseries, soil amendments may pose nutrient problems that may be more difficult to correct than problems associated with Pythium spp. and other pathogens (Hendrix and Campbell 1973).

The standard recommendation to control diseases caused by Pythium spp. and other water mold fungi is fumigation or use of soil fungicides and proper regulation of environmental factors such as moisture control, fertilization, soil temperature (Hanan, Langhans, and Dimock 1963; Kraft, Haglund, and Reiling 1969; Littrell, Gay and Wells 1969). Environmental factors can be controlled to a reasonable extent in greenhouses; however, regulation in nursery seedbeds is more difficult and chemicals probably must be used more extensively.

This publication refers to pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed have been registered.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife--if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

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