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DISEASE PROBLEMS IN THE PRODUCTION OF CONTAINERIZED FOREST TREE SEEDLINGS IN NORTH AMERICA 1/

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Abstract.--Severe losses of Douglas-fir and other conifer seedlings by grey mold (Botrytis cinerea) can be expected in greenhouses if humidity remains high in vicinity of seedlings. Damping-off losses are also likely to be high if high moisture conditions are maintained. Losses can be reduced by increased movement of air near seedlings, by fungicides, and by sanitation. A number of pathogens causing damage to aerial parts of seedlings in conventional nurseries can be a threat to greenhouse seedlings if spores of the pathogens are air-borne. The threat can be reduced by removing spore sources from vicinity of greenhouses and by reducing length of time humidity is high and free water is present on seedlings.

INTRODUCTION

To what extent are pathogens (fungi, nematodes, bacteria) causing damage in containerized forest tree production facilities in North America? The answer to this question is not readily apparent, since as yet there are few articles in the scientific journals on diseases of containerized forest tree seedlings. Furthermore, though there are many reports regarding production of containerized seedlings, these seldom contain information on diseases; and when they do, quantitative information on losses is usually not included. Accordingly, disease information has been sought directly from production managers and from plant pathologists who have had experience with diseases in containerized facilities. This has enabled me to present information on some of the current disease problems.

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GREY MOLD

The grey mold fungus, Botrytis cinerea, has caused higher losses in more containerized facilities than any other pathogen. Douglas-fir seedling mortality by grey mold has exceeded 20 percent in some greenhouses. A good description of the grey mold disease is contained in USDA Handbook No. 470, Forest Nursery Diseases in the United States, which will be released in late 1974. B. cinerea has a wide host range. Most forest tree seedlings are susceptible; some are very susceptible (redwood, giant sequoia). This fungus is almost universally present on dead and dying vegetable matter. Usually it must first become established on dead or moribund parts of a host. It then can spread into adjacent healthy tissues. A few conifer species are so susceptible that the fungus directly infects healthy green tissue. Juvenile bracts and young branches are infected; then the fungus grows into stems, killing infected tissues. Succulent stems are girdled.

Plants exposed to high relative humidity for prolonged periods, as frequently occurs in enclosed container facilities, are especially vulnerable. Water applied to seedlings by overhead irrigation often remains on foliage for long periods. Losses can usually be prevented or reduced if air movement can be increased to shorten the length of time water remains on foliage.

Protective fungicides are also effective against this disease. Some managers routinely apply fungicides at frequent (usually weekly) intervals. Sanitation in and around facilities will be required for this and other diseases. The manual edited by Baker (1957), though out-of-date in some respects, points out a number of factors that need to be considered if healthy container-grown seedlings are to be produced.

DAMPING-OFF, ROOT ROT, AND NEMATODE DISEASES

Fungi which cause damping off, such as species of Pythium, Rhizoctonia, Phytophthora, and Fusarium, are being encountered. Damping-off losses have apparently been quite low in a number of installations using a vermiculite, peat, or perlite growing medium. Losses have been higher where unfumigated top soil or humus has been used. The moisture regime in enclosed facilities favors development of water molds such as Pythium. Pythium species are also causing damage after the period in which damping-off is usually most severe (30-40 days after emergence). This late damage by Pythium has been encountered in facilities when high humidity has been maintained for extended periods. Nitrogen fertilizer applied before or during the period of susceptibility may increase losses. Because tissues infected by Pythium are frequently overgrown by Fusarium species, Fusarium may incorrectly be implicated as the cause of damage.

Damping-off has been especially severe where the moisture in growing media is continuously maintained at high levels. Some managers now routinely treat growing media with fungicides to control damping-off. Experience has shown that fungicides applied after damping-off is evident are usually not effective. Some nurserymen have tried coating seeds with fungicides, but no success has been reported, and treatments frequently reduce seedling emergence.

Experience with fungicides for control of soil-borne pathogenic fungi on containerized southern pines is reported in another paper in this proceedings by Pawuk and Barnett.

Pathogens, including damping-off fungi, can be introduced into facilities on seed or on debris accompanying seed. Most installations do not treat seed with disinfectants. Disinfecting seed with hydrogen peroxide, may be desirable with special seed lots, such as those from breeding programs. Also if there is evidence that pathogens are being introduced with seed, use of surface sterilants is indicated.

Root rots caused by Phytophthora species are commonly encountered on conifer and broadleaf species in conventional forest tree nurseries. Containerized woody ornamentals (rhododendrons, azaleas) also are often damaged by Phytophthora. Phytophthora root rot damage to containerized forest tree seedlings will likely be minimal, however, because of the growing media used. Pathologists have found that if the "drained air space" in media is 25 percent or more, Phytophora root rots are prevented or reduced. Growing media used for containerized forest tree seedlings usually have a high percentage of "air space."

Mycorrhizae protect short feeder roots from infection by water molds such as Phytophthora and Pythium, as has been shown by Marx (1969) and others. However most containerized forest tree seedlings are not receiving this protection since, in most facilities, no attempt is made to introduce mycorrhizal fungi. Although air-borne spores of mycorrhizal fungi do enter and are deposited on growing media, limited checks of seedlings grown under such conditions indicate that mycorrhizae are sparse or absent on short feeder roots.

Facilities providing stock for planting in areas where seedlings must be mycorrhizal before they reach the planting site--such as in many areas of the Great Plains--do not rely on natural spore dispersal; they introduce mycorrhizal fungi into growing media. If protectant fungicides are applied to seedlings in such facilities, care must be exercised to see that the fungicides do not seriously reduce infection by mycorrhizal fungi. Dr. Marx, in another paper in this symposium, stresses that several fungicides (and other biocides) now in use evidently are compatible with mycorrhizal fungi, since seedlings grown in conventional nurseries which routinely use fungicides have good mycorrhizal development.

Pathogenic nematodes cause considerable damage and require costly control methods (soil fumigation) in conventional forest tree nurseries; however, they have not been a problem in containerized facilities. Pathogenic nematodes could be introduced into greenhouses via irrigation water, however, if the source of water includes runoff from agricultural fields. There have been no reports of damage to containerized forest tree seedlings by pathogenic bacteria.

CHLOROSIS

Chlorosis or yellowing of seedlings has been observed in some greenhouses. In most instances, the cause of chlorosis has not been determined. This is not surprising since many factors can cause chlorosis: nutrients (deficiency, excess, imbalance), pH, poor mycorrhizal development, pathogenic fungi,

pesticides. The resolution of chlorosis problems may be difficult during this period of rapid development of containerized facilities, because for each new seedling crop a number of changes are often made in factors that influence growth.

FOLIAGE DISEASES

A number of pathogens which infect the aerial parts of seedlings cause extensive damage in conventional forest tree nurseries. Some of these pathogens are spread by air-borne spores. Examples of these diseases are: southern fusiform rust, western gall rust, Scleroderris canker, and Lophodermium needle cast. Because the air-handling systems used in most greenhouses provide for exchange of air with the outside, these spores can readily be brought into the greenhouse. Once inside, all that is needed is the susceptible host and conditions (primarily moisture and temperature) favorable for infection. The range of temperatures favorable for growth of seedlings encompasses the range of temperatures favorable for most pathogens. Thus the critical factor determining whether or not infection will occur is moisture. There is a minimum time that high moisture (relative humidity, free water on foliage) must be maintained for spores to germinate and the fungus to infect plants. This time will vary with the temperature in the greenhouse. Thus the threat posed by air-borne spores can readily be reduced by: (1) preventing spores from entering greenhouses by removal of spore sources outside the greenhouse (such as alternate hosts or, in the case of western gall rust, susceptible pines); and (2) reducing the length of time that humidity is high and free water is present on seedlings.

Some pathogens cause latent infections. That is, symptoms do not appear until long after infection takes place. For some diseases this period will be longer than the period seedlings are kept in greenhouses. Thus evidence of infection in the greenhouse will have to be obtained by observing seedlings on the planting sites.

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