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ROOT DECAY OF CONTAINER-GROWN LODGEPOLE PINE AND WESTERN WHITE PINE SEEDLINGS - USDA FOREST SERVICE NURSERY, COEUR D'ALENE, IDAHO

R. L. James
Plant Pathologist

During the second 1990 crop of container-grown seedlings at the USDA Forest Service Nursery in Coeur d'Alene, Idaho, several lodgepole pine (***Pinus contorta*** Dougl.) and western white pine (***Pinus monticola*** Dougl.) turned chlorotic in September after they were about 3 and 1/2 months old. Examination of the roots of chlorotic seedlings revealed presence of extensive decay, i. e., epidermal tissues were easily sloughed off and cortical tissues were dark brown to black and appeared water-soaked. Growers felt that the chlorotic foliage was the result of roots being decayed by pathogenic organisms. Seeding with slight chlorosis usually had extensive root decay, i. e., 90+% of the roots had some level of decay. Investigations were conducted to determine association of potential pathogenic organism with decayed roots.

Forty-three lodgepole pine seedlings from three seedlots (Table 1) with various intensities of chlorotic foliage were collected from affected areas within greenhouses. Nine western white pine seedlings of one seedlot (Table 1) with slightly chlorotic foliage were also collected for analysis. Seedling roots were washed thoroughly under running tap water for several minutes to remove particles of growing media. The were then cut into pieces 2-3mm in length, which were surface sterilized for 1 min. in a 10% bleach solution (0.525% aqueous sodium hypochlorite), rinsed in sterile water, and aseptically placed on a selective medium for ***Fusarium*** and closely associated fungi (Komada 1975). Plates were incubated at about 24°C under diurnal cycles of cool, fluorescent light for 7-10 days. Fungi emerging from root pieces were identified to genus using the taxonomic treatment of Barnett and Hunter (1972). Selected isolates were transferred to potato dextrose agar for identification. ***Fusarium*** isolates were identified using procedures outlined by Nelson and others (1983). ***Cylindrocarpon*** isolates were identified according to the monograph by Booth (1966), and ***Phoma*** isolates were identified using descriptions by Dorenbosch (1970).

Isolation results indicated a preponderence of ***Cylindrocarpon destructans*** (Zins.). Scholtan on roots of decayed lodgepole and western white pine seedlings (Table 2). All sampled seedlings were infected with this fungus and a large percentage of the sampled root pieces (61%) were colonized. Two ***Fusarium*** species, ***F. oxysporum*** Schlecht. and ***F. sporotrichioides*** Sherb., were also isolated from some seedlings. Although ***Fusarium oxysporum*** was isolated from almost one quarter of the seedlings, the fungus only colonized a small portion of each root system. ***Fusarium sporotrichioides*** was found on only one lodgepole pine seedling and none of the white pine. Other fungi isolated from decayed roots included ***Phoma eupyrena*** Sacc., which is a common colonizer of nursery soils but may be capable of eliciting disease of conifer seedlings, particularly above the groundline (James and Hamm 1985). Two groups of common saprophytes, ***Trichoderma*** and ***Penicillium*** were also isolated.

Table 1. Lodgepole pine and western white pine seedlots analyzed for root decay - USDA Forest Service Nursery, Coeur d'Alene, Idaho.

Species	Seedlot	No. Seedlings Analyzed	Ranger District	National Forest
Lodgepole Pine	1846	10	Big Timber	Gallatin
Lodgepole Pine	4785	9	St. Maries	Idaho Panhandle
Lodgepole Pine	6345	14	Hebgen Lake	Gallatin
White Pine	6396	9	St. Maries	Idaho Panhandle

Table 2. Colonization of roots of container-grown lodgepole pine and western white pine seedlings with selected fungi - USDA Forest Service Nursery, Coeur d'Alene, Idaho.

Percent Colonization[1]

S+ecies/Lot[2]	CYDE[3]	FOXY	FSPO	PHEU	TRI	PEN
Lodgepole Pine						
1846	62 (100)	13 (60)	0 (0)	2 (10)	38 (90)	20 (70)
4785	58 (100)	7 (33)	0 (0)	4 (22)	33 (89)	43 (78)
6345	60 (100)	11 (71)	1 (7)	1 (7)	39 (93)	11 (71)
Subtotal	60 (100)	11 (51)	1 (3)	2 (12)	37 (91)	23 (73)
Western White Pine						
6396	64 (100)	17 (67)	0 (0)	0 (0)	34 (78)	9 (44)
Total	61 (100)	36 (88)	1 (1)	2 (9)	36 (88)	20 (67)

[1] Numbers in table are percent of sampled root pieces colonized with appropriate fungi. Those in parentheses are percent of sampled seedlings colonized.
[2] See table 1 for number of seedlings sampled and seedlot information.
[3] CYDE = ***Cylindrocarpon destructans***; FOXY = ***Fusarium oxysporum***; FSPO = ***Fusarium sporotrichioides***; PHEU = ***Phoma eupyrena***; TRI = ***Trichoderma*** spp.; PEN = ***Penicillium*** spp.

Isolation results and the appearance of decayed roots implicate ***C. destructans*** as the primary cause of the disorder.fungus has been associated with extensive root decay of western white pine (James and Gilligan 1990) and other conifer seedlings (James 1988).is a very common colonizer of seedling roots and an important microorganism in the rhizosphere (Domsch and others 1980; Matturi and Stenton 1964). It is sometimes an aggressive pathogen (Bloomberg and Sutherland 1971; Vaartaja and Cram 1956), but more commonly an facultative parasite that usually does not become pathogenic unless seedlings are stressed (Domsch and others 1980). ***Cylindrocarpon destructans*** has been implicated in several types of diseases of conifer seedlings including damping-off (Kluge 1966; Vaartaja and Cram 1956) and root disease (James and Gilligan 1990). On the other hand, it may also be a common endophyte of seedling roots and not elicit disease responses in infected seedlings (Matturi and Stenton 1964) or reside outside root cells in the rhizosphere and produce substances toxic to hosts (Evans and others 1967).

The other fungi associated with root decay were probably not as important as ***Cylindrocarpon*** in causing disease. ***Fusarium oxysporum*** is commonly isolated from seedlings at the Coeur d'Alene Nursery either as a pathogen (James and others 1989) or a saprophyte on roots (James and Gilligan 1988). The other ***Fusarium*** species, ***F. sporotrichioides***, was found at very low levels and its role in pathogenesis is unknown.

Maintaining non-stressed, vigorous seedlings is important in preventing root damage from ***Cylindrocarpon*** and other opportunistic pathogens. Proper maintenance of moisture levels within plugs of container-grown seedlings is especially important. If seedling roots are waterlogged for extended time periods, proper aeration of root zones is impossible, root growth is restricted, and seedlings become stressed. On the other hand, if insufficient moisture is provided, seedlings are water-stressed and more susceptible to parasitism by the fungus (James 1988). It is also important to maintain proper nutrient regimes, imbalances of which may also stress seedlings. Unfortunately, root diseases of container-grown seedlings are not easily controlled with fungicide applications once disease symptoms become apparent (Shrimpton and Williams 1989). Therefore, prevention is the best approach to reducing losses from these diseases.

LITERATURE CITED

Barnett, H. L. and B. B. Hunter. 1972. Illustrated genera of imperfect fungi. Burgess Publishing Co., Minneapolis, MN. 241p.

Bloomberg, W. J. and J. R. Sutherland. 1971. Phenology and fungus-nematode relations of corky root disease of Douglas-fir. Ann. Appl. Biol. 69:265-276.

Booth, C. 1966. The genus ***Cylindrocarpon***. Mycological Papers No. 104. Commonwealth Mycological Institute, Kew, Surrey, UK. 56p.

Domsch, K. H., W. Gams and T. H. Anderson. 1980. Compendium of soil fungi. Academic Press, London. 859p.

Dorenbosch, M. M. J. 1970. Key to nine ubiquitous soil-borne ***Phoma***-likefungi. Persoonia 6:1-14.

Evans, G., J. B. Cartwright and N. H. White. 1967. The production of a phytotoxin nectrolide by some root surface isolates of ***Cylindrocarpon radicicola*** Wr. Plant and Soil 26:253-260.

James, R. L. 1988. Diseases of conifer seedlings associated with ***Cylindrocarpon*** species: a review. USDA Forest Service, Northern Region. Nursery Disease Notes # 76. 14p.

James, R. L., R. K. Dumroese, C. J. Gilligan and D. L. Wenny. 1989. Pathogenicity of ***Fusarium*** isolates from Douglas-fir seed and container-grown seedlings. Idaho Forest, Wildlife and Range Exp. Sta. Bull. No. 52. 10p.

James, R. L. and C. J. Gilligan. 1988. Association of ***Fusarium*** with nondiseased containerized ponderosa pine seedlings at the USDA Forest Service Nursery, Coeur d'Alene, Idaho. USDA Forest Service, Northern Region. Rept. 88-5. 10p.

James, R. L. and C. J. Gilligan. 1990. Root decay of container-grown western white pine seedlings - Plum Creek Nursery, Pablo, Montana. USDA Forest Service, Northern Region. Rept. 90-10. 18p.

James, R. L. and P. B. Hamm. 1985. Chlamydospore-producing species of ***Phoma*** from conifer seedlings in Pacific Northwest forest tree nurseries. Proc. Montana Academy of Sciences 45:26-36.

Kluge, E. 1966. Pathogenitat gengenuber Kiefernsamlingen und Toxinbildung bei ***Cylindrocarpon radicicola*** Wr. Phytopathologische Zietschrift 55:368-371.

Komada, H. 1975. Development of a selective medium for quantitative isolation of ***Fusarium oxysporum*** from natural soil. Rev. Plant Prot. Res. 8:114-125.

Matturi, S. T. and H. Stenton. 1964. Distribution and status in the soil of ***Cylindrocarpon*** species. Trans. Brit. Mycol. Soc. 47:577-587.

Nelson, P. E., T. A. Toussoun and W. F. O. Marasas. 1983. ***Fusarium*** species: an illustrated manual for identification. The Pennsylvania State University Press, University Park. 193p.

Shrimpton, G. and F. Williams. 1989. Benomyl drenches: no control for ***Fusarium*** **or** ***Cylindrocarpon*** caused root rot of container-grown conifer seedlings. FRDA Research Memo No. 128. Canada-British Columbia Research Development Agreement. 1p.

Vaartaja, O. and W. H. Cram. 1956. Damping-off pathogens of conifers and of Caragana in Saskatchewan. Phytopathology 46:391-397.