ROOT DISEASE OF BAREROOT 1-0 ENGELMANN SPRUCE SEEDLINGS
USDA FOREST SERVICE NURSERY, COEUR D'ALENE, IDAHO

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During routine examination of bareroot nursery stock at the USDA Forest Service Nursery, Coeur d'Alene, Idaho, scattered mortality of 1-0 Engelmann spruce (Picea engelmanni Parry) seedlings were noticed at greater than normal levels. Affected seedlings were several months old and often grouped near each other (Fig.1). Seedling density was generally uneven, i.e., there were often gaps between groups of seedlings. Affected seedbeds had been fumigated with Basamid[R] during the late summer of 1987 and sown the spring of 1988. Basamid[R] has been employed by the nursery as a possible replacement fumigant for methyl bromide/chloropicrin, which has been used previously for several years at the nursery.

Examples of recently-killed and adjacent nondiseased (based on appearance of healthy foliage) seedlings were carefully extracted from the soil so that as much root tissue as possible could be analyzed. Roots of dead seedlings were extensively decayed with epidermal tissues being detached easily. However, roots of nearby nondiseased seedlings were for the most part without decay or necrotic lesions when examined under the microscope.

Roots from all seedlings were washed thoroughly under running tap water to remove adhering soil particles. They were then surface sterilized in a 10% aqueous bleach solution (actived ingredient = sodium hypochlorite) followed by rinsing with sterile distilled water. Ten root pieces (2-3 cm in length) were aseptically cut from each root system and placed on a medium selective for Fusarium (Komada 1975). Root tips were preferentially selected for this sample. Plates were incubated under cool fluorescent light for 7-10 days at about 22°C. Root pieces were then examined for fungal colonization. Selected Fusarium isolates were transferred to potato dextrose and carnation leaf agar for identification using the taxonomic scheme of Nelson, Toussoun and Marasas (1983).

All sampled seedlings had roots which were infected with Fusarium spp. (table 1). Percentage root colonization averaged 84% for the dead seedlings and

Figure 1. Bareroot Engelmann spruce seedlings killed by Fusarium oxysporum at the USDA Forest Service Nursery, Coeur d'Alene, Idaho.

Table 1. Occurrence of Fusarium on the roots of bareroot 1-0 Engelmann spruce seedlings - USDA Forest Service Nursery, Coeur d'Alene, Idaho.

Seedling Number	Infected with Fusarium	Percent Root Colonization
Dead		
1	+	70
2	+	100
3	+	100
4	+	100
5	+	100
6	+	60
7	+	100
8	+	40
9	+	80
10	+	90
Ave.		84
Nondiseased		
1	+	60
2	+	50
3	+	10
4	+	60
5	+	40
6	+	50
7	+	30
8	+	60
9	+	20
10	+	10
Ave.		39

39% for the nondiseased seedlings. Fusarium isolates on roots of all seedlings were identified as F. oxysporum Schlecht. Other fungi commonly isolated from roots included Cylindrocarpon, Phoma, Trichoderma, and Penicillium.

This investigation indicated that F. oxysporum was most likely responsible for mortality of young bareroot Engelmann spruce seedlings during their first growing season. Although soil populations of Fusarium were not monitored in the particular field where mortality was occurring, it is possible that levels were sufficiently high to cause greater than normal root disease losses. Previous monitoring of populations elsewhere in the nursery has indicated that levels are usually low. However, they may fluctuate greatly from place to place and often vary with different seasons (James unpublished; James and Gilligan 1986). It has been suspected that the low levels of Fusarium recently found in nursery soil were due to several successive cycles of fumigation with methyl bromide/chloropicrin which probably greatly reduced these organisms.

Reports from other nurseries (Campbell and Kelpsas 1988; Hoffman and Williams 1988) have indicated that although Basamid[R] may initially reduce levels of Fusarium in the soil, populations may increase to pre-fumigation levels quickly. On the other hand, experience with methyl bromide fumigation indicates that soil fungal populations remain low for longer time periods (Campbell and Kelpsas 1988). Although it is possible that spruce seedling mortality at the Coeur d'Alene Nursery was due to increasing soil populations of Fusarium, another possibility might be high pathogen levels on sown seed. Engelmann spruce seed commonly harbor Fusarium spp. capable of causing diseases (James 1985; James and Gilligan 1985) and certain seedlots may be extensively contaminated (James 1985). The erratic seedling density in affected beds may have been due to reduced seed germination and/or damping-off associated with seed-borne fusaria.

Fusarium oxysporum is an important soil-borne nursery pathogen capable of attacking many different conifer species. It also commonly colonizes roots of nondiseased (asymptomatic) seedlings (Hansen and Hamm 1988; James and Gilligan 1988). This fungus not only causes root disease (Bloomberg 1971), but can also incite hypocotyl rot of young seedlings (Brownell and Schneider 1983; Hansen and Hamm 1988). It is suspected that certain strains of F. oxysporum attack specific seedling parts at specific seedling ages (Bloomberg and Lock 1972). Above-ground cankers associated with hypocotyl rot were not found on the spruce seedlings at the Coeur d'Alene Nursery.

It has been suggested that Fusarium infects seedlings shortly after seed germination (James 1986; Sinclair, Sylvia and Larsen 1982). However, disease symptoms may not appear until much later when seedlings either become stressed or the colonizing fungus becomes more aggressive (James 1986). It is possible that the spruce seedlings killed by F. oxysporum had been stressed to the point where they were unable to resist disease development by the fungus. On the other hand, nondiseased seedlings may have been "resistant" enough to keep the fungus from becoming pathogenic. Much additional work is needed to clarify and quantify the role of stress in Fusarium root disease development of conifer seedlings.

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