ROOT DISEASE OF CONTAINERIZED DOUGLAS-FIR SEEDLINGS - POTLATCH NURSERY, LEWISTON, IDAHO

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Containerized Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) seedlings with needle tip dieback disease symptoms are often infected with species of *Fusarium*(James 1983; James 1984a; James 1984b). Severity of symptoms as indicated by degree of needle chlorosis and necrosis are often not well correlated with the amount of *Fusarium* that can be detected on roots (James 1986a; James 1986c). In previous investigations (James 1986b; James and Gilligan 1987; James et al. 1987), it appears that seedling roots may be extensively infected with *Fusarium* and yet lack any disease symptoms. By the time symptoms become evident, root systems are often extensively colonized.

Recently, containerized Douglas-fir seedlings displaying typical needletip dieback symptoms associated with root disease were encountered at the Potlatch Nursery in Lewiston, Idaho. Fourteen seedlings displaying a range of foliar symptoms were collected in order to assay their roots for extent of colonization by *Fusarium*. The seedlings were initially rated for severity of foliar symptoms using a rating system developed for containerized Douglas-fir seedlings (table 1)(James et al. 1987).

Table 1.--Descriptions of the root disease severity rating system for containerized Douglas-fir seedlings infested with *Fusarium*.

Rating	Description
0	No symptoms; seedling crown entirely green.
1	Seedling with slight needle tip dieback, particularly concentrated on the upper whorls of needles.
2	Seedling with lower whorl of needles partially or completely necrotic; seedling upright.
3	Seedling with needle tip dieback affecting at least one-half of the crown.
4	Seedling with one-half of its crown with necrotic foliage (upper or lower); seedling upright.
5	Seedling with one-half of its crown with necrotic foliage (upper or lower); seedling bent over.
6	Seedling with three-fourths of its crown with necrotic foliage; seedling may be upright or bent over.
7	Seedling with its entire crown necrotic; seedling may be upright or bent over.

Seedlings were then carefully removed from their containers and their root systems washed thoroughly under running tap water for several minutes to remove adhering soil particles. Entire root systems were then surface sterilized in 10 percent aqueous sodium hypochlorite for 2 minutes and rinsed with distilled water. Fifteen root tips were randomly selected from each root system for sampling. Root tips were aseptically cut and placed on an agar medium selective for *Fusarium* spp. (Komada 1975). Plates were incubated at about 22 degrees C under cool fluorescent light for 7-10 days and then examined for the presence of *Fusarium* originating from root tips. Percentage of root tips colonized was calculated for each seedling. Regressions were conducted comparing root disease severity rating (x) with percentage of root tips colonized with *Fusarium* (y). Percentages underwent arc-sin transformations prior to analyses.

Three seedlings with representative root disease symptoms are shown in figures 1-3. The first (fig. 1) has very limited needle tip dieback symptoms, whereas the other two (figs. 2 and 3) have progressively greater symptoms. Root disease severity ratings and extent of root tip colonization with *Fusarium* are summarized in table 2. All sampled seedlings were infected; however, correlations (coefficients of determination) between disease severity ratings and percentage of root tips colonized were not high, regardless of the type of curve to which the data were fitted (table 3). Therefore, it appears that these data substantiate previous investigations regarding lack of correlation between disease symptoms and root system colonization.

Figure 1.--Containerized Douglas-fir seedling with needle necrosis resulting from root infection by *Fusarium oxysporum*. This is number 8 with a disease severity rating of 2 (tables 1 and 2).

Figure 2.-- Containerized Douglas-fir seedling with needle necrosis resulting from root infection by *Fusarium oxysporum*. This is seedling number 2 with a disease severity rating of 5 (tables 1 and 2).

Figure 3.--Containerized Douglas-fir seedling needle necrosis resulting from root infection by *Fusarium oxysporum*. This is seedling number 13 with a disease severity rating of 6 (tables 1 and 2).

Table 2.--Colonization of roots of containerized Douglas-fir seedlings with *Fusarium oxysporum* - Potlatch Nursery, Lewiston, Idaho.

Seedling number	Root disease rating*	Percentage root colonization**
1	3	100.0
2	5	100.0
3	6	80.0
4	6	86.7
5	3	66.7
6	1	60.0
7	7	80.0
8	2	80.0
9	7	93.3
10	4	73.3
11	3	40.0
12	4	100.0
13	6	100.0
14	2	53.3
Average	4.2	79.5

*See table 1 for descriptions of root disease ratings.

**Percentage of 15 randomly selected root tips that were colonized by Fusarium oxysporum.

Table 3.--Regression equations for relationships between root disease severity ratings and percentage of root colonization by *Fusarium oxysporum*.

Linear Relationship

$r^2 = 0.29$ (coefficient of determination)

$y = 59.91 + 5.18x$

Exponential Relationship

$r^2 = 0.28$

$y = 56.37e^{0.07x}$

Logarithmic Relationship

$r^2 = 0.30$

$y = 55.30 + 18.50 \log x$

Power Relationship

$r^2 = 0.29$

$y = 54.98x^{0.26}$

Fusarium oxysporum Schlect. was the only *Fusarium* spp. isolated from sampled root tips. Also, only one morphologically distinct isolate of this species was obtained. This isolate produced abundant microconidia and floccose aerial mycelium that was light orange in color on the surface of potato dextrose agar.

Although occurrence of *Fusarium* root disease on containerized Douglas-fir seedlings is common at nurseries within the Northern Rocky Mountains (James and Gilligan 1987; James et al. 1987), the extent of damage found at the Potlatch Nursery was very low. Infected seedlings were being culled during routine examinations to reduce chances of spread to adjacent healthly seedlings. However, since not all infected seedlings display symptoms, it should be remembered that some infected stock may not be detected and could be shipped to the field for outlplanting. Inoculum sources at the Potlatch Nursery are unknown, but based on investigations at other nurseries (James 1985; James l987a; James 1987b), possible sources include infested seed, soil mixes, and containers. If disease increases in importance in the future, growers may need to initiate actions aimed at reducing levels of inoculum.

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