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BASAL SWELLING AND ROOT DETERIORATION OF CONTAINER-GROWN WESTERN LARCH SEEDLINGS - PLUM CREEK NURSERY, PABLO, MONTANA

R. L. James
Plant Pathologist

During the 1990 crop of container-grown western larch (*Larix occidentalis* Nutt.) at the Plum Creek Nursery, Pablo, Montana, growers noticed scattered seedlings with swellings at or near the groundline. Swellings were either globose (figure 1) or somewhat fusiform in shape and usually extended around the entire stem. Affected seedlings became noticeable about the time when growth was being curtailed by restricting irrigation and fertilization in order to set bud. Although some scattered seedlings were killed, most did not display noticeable foliar discolorations. Extent of the problem was at first considered minimal; but during lift and pack, more affected seedlings were found than was at first suspected. Also during packing, many seedlings with poorly-developed root systems were encountered. Affected seedlings usually lacked above-ground disease symptoms, but their roots were often extensively decayed, with epidermal and cortical tissues missing (figure 2). Because of the widespread nature of both basal swelling and root deterioration, growers requested an evaluation to determine possible associations of pathogenic fungi with the disorders.

Six seedlings with basal swellings collected during lift and pack were analyzed. Thirty-four seedlings with various levels of root deterioration were also analyzed. Estimates of extent of root decay were made for each of these seedlings based on percent of root system affected. Height from the groundline to the tip of the terminal bud was also measured.

Various amounts of roots from several seedlings were left in styroblock containers following extraction. Collections of these roots from several plugs were analyzed.

Root systems, detached roots, and stems with basal swellings were analyzed for presence of potentially pathogenic fungi. Tissues were washed several minutes under running tap water to dislodge particles of growing media. Sections of tissue through swellings were extracted with a sterile scalpel, surface sterilized in a 10 percent bleach solution (0.525 percent aqueous sodium hypochlorite) for 1 minute, and rinsed several times in sterile water. Root sections approximately 5 mm in length were cut from root systems and surface sterilized as described above. Ten root sections per seedling were sampled. Sections were randomly selected from detached roots (which remained in containers after seedling extraction) and surface sterilized, as well. All sampled tissues were placed on a medium selective for *Fusarium* and closely-related fungi (Komada 1975).

Plates were incubated under diurnal cycles of cool, fluorescent light at about 24 degrees C. for 7-10 days, after which emerging fungi were identified. Selected isolates of *Fusarium* and *Cylindrocarpon* were transferred to potato dextrose agar for identification, using the taxonomic guides of Nelson and others (1983) and Booth (1966), respectively.

Basal stem swellings were not infected with potentially pathogenic fungi assayed for in this evaluation (table 1). Tissues within swellings were either not colonized with any fungus or colonized with saprophytes such as *Penicillium* and *Trichoderma* spp. Although one of the swellings was colonized with *Phoma* spp., fungi which may cause above-ground disease symptoms of conifer seedlings (James and Hamm 1985), these organisms were not consistently associated with swellings. Examinations of seedling tissues around swellings revealed that cambial and phloem cells below swellings were often killed. Apparently, photosynthate produced in the foliage could not be translocated to the roots and thus accumulated above the killed tissues resulting in production of swellings. Roots of seedlings with swellings were also not colonized to a large extent with potentially pathogenic fungi (table 1). One root system was colonized by *Cylindrocarpon tenue* Bugn. and another by *Fusarium proliferatum* (Matsushima) Nirenberg. However, the other sampled root systems were not colonized by potential pathogens even though some had evidence of small amounts of decay.

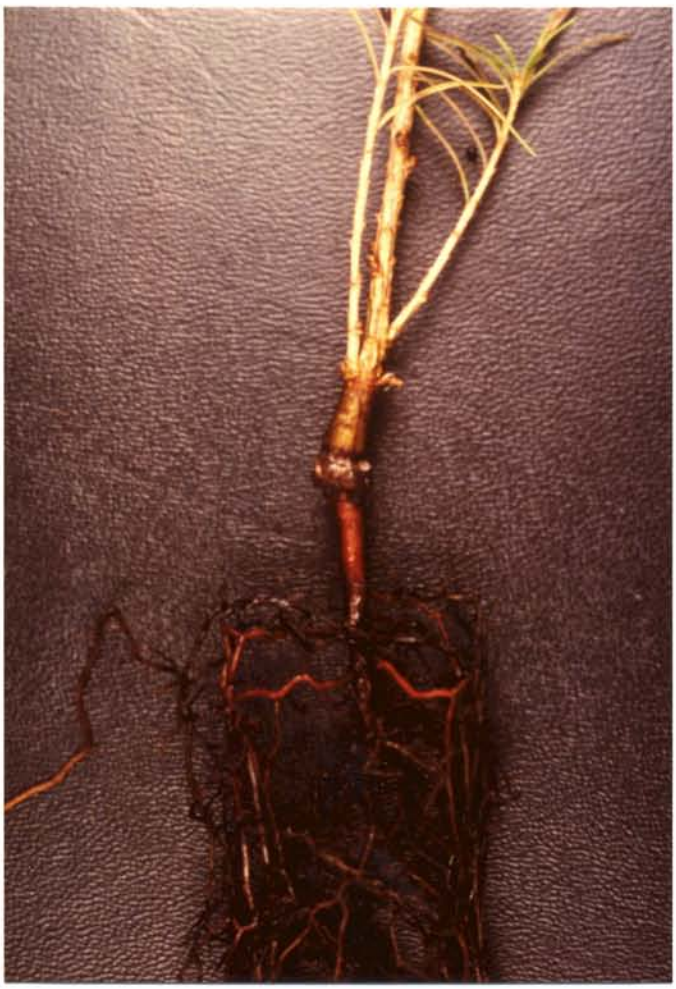

Figure 1. Globose basal swelling on container-grown western larch seedling - Plum Creek Nursery, Pablo, Montana.

Figure 2. Deteriorated root system of container-grown western larch seedling - Plum Creek Nursery, Pablo, Montana.

Results of isolations from the 34 seedlings with various levels of root deterioration are summarized in table 2. Intensity of root deterioration was estimated on the percent of root decay, i.e., loss of epidermal and cortical tissues with presence of intact stele (table 3). *Fusarium* spp. were detected on roots of only a few seedlings (14.7 percent) and colonized roots at very low levels. Three *Fusarium* spp. were isolated: *F. proliferatum*, *F. sambucinum* Fuckel, and F. *acuminatum* Ell. & Ev. *Cylindrocarpon* spp. were also detected at low levels on roots of seedlings, but at higher levels on roots detached and left in containers after seedling extraction (table 2). Two species of *Cylindrocarpon* were isolated: *C. destructans* (Zins.) Scholten and *C. tenue* Bugn. Other fungi isolated on Komada's medium included *Trichoderma*, *Penicillium*, and *Phoma* spp. These are mostly saprophytic, although species of *Phoma* may occasionally cause disease (James and Hamm 1985).

Seedlings with more extensive root decay were generally shorter than seedlings with less root decay (table 3). Therefore, although root decayed seedlings lacked above-ground disease symptoms, their growth was adversely affected. If seedlings with extensive root decay were in an environment other than the nursery where they were not given all the nutrients and moisture needed, they might have developed disease symptoms. In any event, seedlings with poor root development and extensive decay are usually discarded during lift and pack operations.

Table 1. Isolation results from container-grown western larch seedlings with stem swellings - Plum Creek Nursery, Pablo, Montana.

Isolated Fungi

Swellings	*Fusarium*	*Cylindrocarpon*	*Trichoderma*	*Penicillium*	*Phoma*
Percent Seedlings	0.0	0.0	50.0	100.0	16.7
Percent Pieces[1]	0.0	0.0	33.3	72.7	9.1

Roots	*Fusarium*	*Cylindrocarpon*	*Trichoderma*	*Penicillium*	*Phoma*
Percent Seedlings	16.7[2]	16.7[3]	100.0	33.3	100.0
Percent Pieces[1]	5.0	3.3	30.0	3.3	68.3

[1] Five or six pieces of swelling tissue and ten root pieces assayed per seedling.

[2] All isolations yielded *Fusarium proliferatum*.

[3] All isolations yielded *Cylindrocarpon tenue*.

Table 2. Isolation results from roots of seedlings with various levels of root deterioration and detached roots - Plum Creek Nursery, Pablo, Montana.

	Seedlings With Root Decay		
Isolated Fungi	**Percent Infected**	**Percent Root Pieces Infected**	**Percent Detached Roots Infected**
Fusarium			
F. proliferatum	2.9	0.3	0.7
F. sambucinum	5.9	0.6	0.7
F. acuminatum	5.9	0.6	0.7
All *Fusarium*	14.7	1.5	2.1
Cylindrocarpon			
C. destructans	5.9	1.5	15.0
C. tenue	2.9	0.3	0.7
All *Cylindrocarpon*	8.8	1.8	15.7
Trichoderma spp.	88.2	47.1	47.1
Penicillium spp.	20.6	7.3	0.0
Phoma spp.	85.3	47.9	32.9

Table 3. Relationships between extent of root deterioration and height of container-grown western larch seedlings, Plum Creek Nursery, Pablo, Montana.

Root Decay Rating Rating[1]	Number of Seedlings Sampled	Average Seedling Height (mm)
0	2	158.0
1	4	164.8
2	3	155.7
3	8	142.4
4	17	140.2
Totals	34	146.0

[1] Based on percent of root system with noticeable decay (loss of epidermal and cortical tissues and persistence of stele - figure 2).

0 = no decay
1 = 0-10% of the root system decayed
2 = 10-25% of the root system decayed
3 = 25-50% of the root system decayed
4 = More than 50% of the root system decayed

It is possible that root decay was mostly caused by *Pythium* or associated water mold fungi for which assays were not made during this evaluation. Previous experience at the Plum Creek Nursery indicated that root decay of conifer seedlings is often associated with extensive infection by *Cylindrocarpon* spp. (James and Gilligan 1990). Therefore, assays were restricted to these and similar organisms in this evaluation. However, they were not recovered at high enough levels to be responsible for the amounts of root decay present. Although decay appeared to be due to pathogenic organisms, additional sample seedlings were not available for screening of Pythiaceous fungi.

Western larch are susceptible to stem damage due to either chemicals and/or environmental temperature extremes, particularly when seedlings are young and succulent (James 1986). Damaged seedlings sometimes do not exhibit symptoms for a long time after the injury-causing event occurs. It is possible that seedlings with basal swellings were damaged by some abiotic factor (particularly sudden extreme heat) to the extent that phloem and cambial tissues were killed. This would result in accumulations of photosynthate just above the damaged area. There were no indications that pathogenic organisms were involved in development of swellings. Therefore, it is likely that the cause was abiotic.

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