

Fusarium Stem Rot of Douglas-Fir Seedlings

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ABSTRACT

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Stem rot of Douglas-fir seedlings caused by *Fusarium roseum* 'Avenaceum' and *F. roseum* 'Sambucinum' is reported from Oregon. Infected seedlings were detected during the winter months. They showed chlorosis and wilting associated with stem lesions ranging from 1 to 15 mm from the root collar. An isolate of *F. roseum* 'Avenaceum' and one of *F. roseum* 'Sambucinum' were shown to be pathogenic on 1-yr-old Douglas-fir seedlings. Symptoms on infected seedlings were similar for both pathogens.

Many patches of 9-mo-old Douglas-fir (*Pseudotsuga menziesii*) (Mirb.) Franco seedlings wilted and died in a southwestern Oregon nursery during 1980. Inspection of dying seedlings revealed stem lesions without apparent root damage. Isolates made from the stem tissue yielded cultures of *F. roseum* (Lk.) emend. Snyder & Hans. 'Avenaceum' and *F. roseum* (Lk.) emend. Snyder & Hans. 'Sambucinum.'

F. roseum 'Avenaceum' is reported to be pathogenic on roots of lentils (7,13), sweet clover and alfalfa (4), oats and wheat (3), and potato tubers (11). Several reports also list *F. roseum* 'Sambucinum' as a cause of postharvest tuber dry rot of potatoes (5,6). The only report of *F. roseum* 'Avenaceum' as a cause of a stem disease, however, was on carnations (1).

Isolates identified only as *F. roseum* have been associated with damping-off of Japanese red pine, Japanese larch, Japanese cedar and cryptomeria (9), and longleaf pine (12). *F. roseum* 'Avenaceum' and *F. roseum* 'Sambucinum,' however, have not been reported previously as the cause of a stem disease of Douglas-fir seedlings. Therefore, studies were conducted to test the pathogenicity of *F. roseum* isolates on 1-yr-old Douglas-fir seedlings.

MATERIALS AND METHODS

Isolates. Two hundred ten Douglas-fir seedlings (8-11 mo old) showing symptoms of chlorosis and wilting were dug during 1980 from throughout the nursery for isolation. Several pieces of stem and root tissue about 5-10 mm long were cut from each seedling. Cuttings were taken above and below necrotic tissue and within stem lesions and healthy tissue. Stem and root pieces were rinsed

in tap water and in a tap water ultrasonic bath for 5 min before 1-min immersion in 0.5% NaOCl solution. After rinsing in sterile deionized water, the pieces were placed on potato-dextrose agar (PDA) (15) and incubated at 20 C for 14 days.

Cultures were tentatively identified and results of the isolations tabulated. Monosporic isolates of *Fusarium* sp. were sent to P. E. Nelson, Fusarium Research Center, Pennsylvania State University, and to S. Smith, University of California, Berkeley, for identification. Drs. Nelson and Smith identified seven isolates as *F. roseum* 'Sambucinum' and five isolates as *F. roseum* 'Avenaceum.'

Inoculation. Seventy-five 1-yr-old Douglas-fir seedlings were dug from seedbeds in May 1980. Each seedling selected was actively growing before being potted in Polycan (16 × 18 cm) plastic pots with unsterilized sandy loam nursery soil. Isolate F500 (*F. roseum* 'Sambucinum') and isolate F09 (*F. roseum* 'Avenaceum') were grown on moist autoclaved lima beans at 20 C for 14 days. Twenty-five seedlings were inoculated with each isolate by placing 10 g of the colonized lima beans in the soil adjacent to the root collar of each seedling. The remaining 25 control seedlings were inoculated with 10 g of autoclaved lima beans lacking either *F. roseum* isolate.

All seedlings were placed in a greenhouse and watered as needed. Symptoms were recorded weekly and all dying seedlings were removed for isolation. Plating techniques were similar to those described earlier. After about 60 days, the pathogenicity test was concluded and all remaining seedlings were examined for stem or root lesions. Seedlings with lesions were also processed for isolation.

RESULTS

Symptoms. Diseased 1-yr-old Douglas-fir seedlings were first observed in early February 1980. Many small seedlings less than 15 cm tall became chlorotic and

wilted and died before breaking dormancy in March 1980. A prominent lesion or several small lesions covering 10-15 mm of the stem was observed on these seedlings (Fig. 1). About 40% of the lesions were found a few millimeters above the root collar and the remainder were about 15-50 mm above the root collar (Fig. 1). Isolation from tissue surrounding lower and upper lesions yielded nearly equal numbers of either isolate of *F. roseum*. Seedlings with stem lesions 15-50 mm above the root collar were frequently encased in soil up to the foliage but those with lesions near the root collar were either free of soil or had only a short-stem soil collar.

A small percentage (<3%) of the seedlings that did not appear diseased in March had wilted foliage that turned brown in mid-May and June. Lesions on many large seedlings were coated with resin. They seldom encircled the stem. Although some of these affected seedlings died in July, many survived with prominent shoot damage that caused them to be discarded during the 1980-1981 harvest.

Similar occurrences of diseased Douglas-fir seedlings with stem lesions were noted during the late winter and early spring of 1981 and 1982. Sampling of symptomatic seedlings yielded cultures of *F. roseum* 'Sambucinum' and *F.*

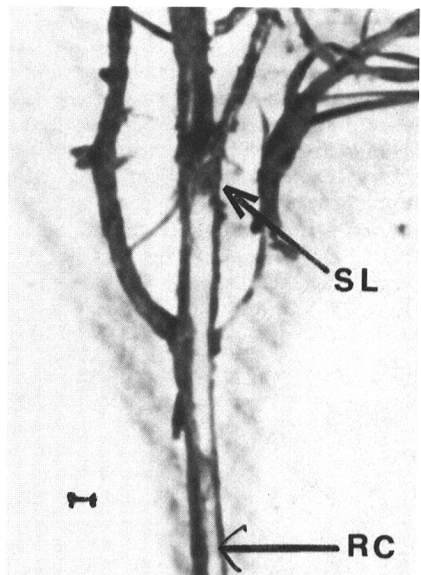


Fig. 1. One-year-old Douglas-fir seedling with stem lesion (SL) about 45 mm above the root collar (RC) caused by a *Fusarium* stem rot disease. Bar = 3 mm.

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Fig. 2. Dead 1-yr-old Douglas-fir seedling with rows of sporodochia of *Fusarium roseum* 'Avenaceum' on the stem. Bar = 3 mm.

roseum 'Avenaceum' from stem tissue adjacent to necrotic lesions.

Sporodochia of *F. roseum* 'Avenaceum' and *F. roseum* 'Sambucinum' were observed from May through July on dead stem tissue of infected seedlings (Fig. 2). *F. roseum* 'Avenaceum' sporodochia were pink to salmon, relatively large (1.0 × 0.5 mm), and aligned in rows 10–15 mm long. *F. roseum* 'Sambucinum' sporodochia were white to cream and somewhat smaller (0.25 × 0.5 mm).

Frequency of isolation. About 80% of the 210 seedlings gathered from various seedbeds yielded isolates of *F. roseum* 'Avenaceum' (67 seedlings), *F. roseum* 'Sambucinum' (52 seedlings), or both fungi (50 seedlings). Several saprophytic fungi, eg, species of *Trichoderma*, *Penicillium*, and *Epicoccum*, were isolated from tissue within the stem lesions. No fungi were isolated from the root tissue plated.

Inoculation. Fifteen of the 25 seedlings inoculated with *F. roseum* 'Sambucinum' wilted and died about 3 wk after inoculations. These seedlings had prominent stem lesions slightly above the root collar that yielded cultures of *F. roseum* 'Sambucinum.' At the end of the test, similar stem lesions were found on three other seedlings inoculated with *F. roseum* 'Sambucinum' that had no obvious external symptoms. They also

yielded cultures of *F. roseum* 'Sambucinum.'

Only slightly fewer (13) seedlings inoculated with *F. roseum* 'Avenaceum' wilted and died from 3 to 4 wk after inoculation. Prominent stem lesions were also found within a few millimeters of the root collar on these seedlings. No stem lesions were found on seedlings lacking symptoms. Isolation from dying seedlings yielded cultures of *F. roseum* 'Avenaceum' from each tree. Two of the control seedlings died within the first week of the test, but no stem lesions were observed and no pathogenic fungi were isolated. Apparently, these two seedlings were stressed or injured during potting and died of planting shock.

DISCUSSION

Fusarium stem rot of 1-yr-old Douglas-fir seedlings differs from other *Fusarium* diseases commonly found at forest tree nurseries. First, the most frequently described *Fusarium* diseases of Douglas-fir seedlings are root rots caused by *Fusarium oxysporum* Schlecht. (8) or *F. solani* (Mart.) Appel. & Wr. emend Snyd. & Hans. (10). Lock (8) states that *F. oxysporum* invades succulent root cells and grows upward to within about 2.5 cm of the soil surface. Second, symptoms of these root rot diseases are commonly observed during warm dry summer months (14). Third, Fusarium root rot and damping-off generally affects and kills 60- to 90-day-old seedlings (8,14), although infection of older plants has been reported (10). Bloomberg (2) reported that symptoms of Fusarium root rot caused by *F. oxysporum* appear within a month after spring sowing and peak in late August. He also noted that *F. oxysporum* grows most vigorously in warm dry soils at 24 C. In contrast, Fusarium stem rot diseases caused by *F. roseum* 'Avenaceum' and *F. roseum* 'Sambucinum' affect stems rather than roots, produce symptoms observed in the winter or early spring months, and cause stem lesions or mortality of 9- to 16-mo-old Douglas-fir seedlings.

These new *Fusarium* diseases of Douglas-fir have the potential of causing economic losses at forest tree nurseries. About 4% of the Douglas-fir crop at a southwestern Oregon nursery was lost to Fusarium stem rot in 1980 and 1981, but losses in 1982 may be 20% of the Douglas-fir crop. Samples from other nurseries in

the Pacific Northwest indicate they are not a local phenomenon but are scattered throughout the region. These two diseases have also been found recently in New South Wales, Australia, on *Pinus radiata* (R. Keirle, personal communication). Studies are under way to investigate the biology and epidemiology of *F. roseum* 'Avenaceum' and *F. roseum* 'Sambucinum' and to develop methods to control the stem rot diseases they cause.

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