CHAPTER TWO

Fusarium Hypocotyl Rot

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Disease and hosts

Fusarium hypocotyl rot is caused by the fungus *Fusarium oxysporum*. It occurs primarily on Douglas-fir, and to a lesser extent on Shasta red fir, western larch, sugar pine, white fir, and ponderosa pine, in the Pacific Northwest. Symptoms usually begin to appear after the first period of high temperatures (above 32 degrees C or 90 degrees F) in late June or July. The disease continues to cause damage through August or September. Fusarium hypocotyl rot is the greatest single cause of loss of postemergent seedlings in Pacific Northwest nurseries.

Fusarium hypocotyl rot may be confused with:
Damping-off
Fusarium root rot
Heat damage
Mechanical damage

Figure 2-1. Random mortality of Douglas-fir in the field **due to Fusarium hypocotyl rot. Photo courtesy of Alan Kanaskie.**

Symptoms

Random mortality begins in seedbeds in June (Figure 2-1) and continues through October. Mortality is highest in July and early August. Top symptoms are similar to those caused by Fusarium root rot, but careful observations made just as the seedling tops begin to turn yellow reveal a discolored region of dead tissue on the hypocotyl, that portion of the stem between the ground and the two lowest needles, or cotyledons (Figure 2-2). This discolored region quickly expands, girdling the stem and killing the top while the roots remain healthy. The roots then become discolored and decay in the same way as do roots infected with Fusarium root rot. Seedlings remain erect. White mycelia with pink or orange spore pustules can be seen occasionally on infected seedlings at or above the soil line. The sickle-shaped spores are readily identifiable under a microscope (Figure 2-3).

Fungus biology

Fusarium oxysporum is a common soilborne fungus. It forms thick-walled resting structures called chlamydospores in plant material such as residue from previous crops or weeds. Chlamydospores are known to germinate in the presence of susceptible tissue such as roots, and presumably act as one source of primary inoculum for infection. Another potential source of infection is conidia, which are thin-walled, sickle-shaped spores that can be produced in large numbers on infected tissue. It is not known whether conidia serve as primary or secondary inoculum. Infection occurs shortly after the seeds germinate, but symptoms usually do not develop until mid-summer.

Infection by *F. oxysporum* does not necessarily lead to mortality. Recent findings indicate that most healthy-looking seedlings have *Fusarium* already on or in the hypocotyl region at emergence or soon after. If

seedlings are not stressed by high soil temperatures or low moisture, they remain healthy.

Loss potential

Greater than 50 percent mortality has been reported in sugar pine, red fir, and white fir in two California nurseries. Damage on Douglas-fir is highly variable. During 1983 and 1984, losses at three nurseries in western Oregon and Washington averaged nearly 10 percent, whereas in 1987, five of seven nurseries surveyed reported less than 3 percent loss and the other two reported 10 percent loss. In the past, losses due to Fusarium hypocotyl rot were probably attributed to Fusarium root rot because the above-ground symptoms are similar, and the causal agent is the same.

Fusarium hypocotyl rot symptoms appear:

1 **+0**

Summer through early fall

Management

Soil fumigation in the fall prior to sowing is likely the best consistent control of this disease when coupled with proper irrigation practices. In nurseries where comparisons were made between seedling survival in non-fumigated and fumigated soil during the first growing season, higher survival was most often found in fumigated areas. While mortality in those cases included all losses, a component was Fusarium hypocotyl rot. The kind of soil fumigant used probably does not matter.

A carefully timed watering schedule is also important. Warm soil temperatures seem to increase mortality because seedling moisture stress is also increased. Deep, infrequent watering, enough to ensure complete wetting of the root zone, reportedly lowers disease losses by decreasing moisture stress and heat stress on seedlings. In one study, seedlings that were watered more heavily, because they were closer to sprinkler heads, had less disease. Mulching may help by reducing loss of moisture from the soil.

Figure 2-2. Healthy (left) and *Fusarium*-infected Douglas-fir seedlings. Note that the diseased seedling on the right has a white taproot but a brown and sunken stem below the cotyledons. Photo courtesy of Alan Kanaskie.

Several fungicides have been tested for control of this disease, but with limited success—probably because there is no good systemic fungicide, and none that can adequately penetrate the soil to protect roots or hypocotyl before emergence. A fungicide with these characteristics is needed, particularly to fight infection occurring before or at seedling emergence. Benomyl, applied to seedbeds at 2-week intervals beginning after emergence and continuing through September, has been most effective. The efficacy of late-season applications of benomyl has not been shown.

Selected references

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Figure 2-3. Microscopic spores produced by *Fusarium oxysporum*.