Stem Splitting and Cankering in Pacific Northwest Douglas-fir Seedlings

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Abstract

Stem splitting, most likely due to rapid seedling growth, can lead to significant nursery losses if the splits become cankered from secondary infection. This paper describes the incidence and pattern of stem splitting and cankering. In addition, we offer discussion about the causes and control of stem splitting and cankering.

Introduction

Recently, some Pacific Northwest (PNW) nurseries have experienced unacceptably high cull rates in coastal Douglas-fir (*Pseudotsuga menziesii Mirb. Franco*) seedlings because of cankered stem splits. These cankers develop when splits in the stem fail to heal over and are therefore prone to secondary infection. In bareroot nurseries, stem splitting is usually observed during the second growing season for 2-yr-old stock and is located a few centimeters above bud break. In container nurseries, stem splits can occur from a few centimeters above the growing medium to a few centimeters below the apical meristem. As seedling tissues expand with diameter growth, stem splits widen.

Cankering may be higher in bareroot nurseries because of potentially higher soil inoculum levels. An intensive integrated pest management (IPM) program is necessary to minimize inoculum for secondary infections and to encourage callusing of the splits. Generally, healed (calloused) splits are no longer visible after a couple of seasons and have no lasting effect on seedling quality and performance. Frequent fungicide application (every 2–4 wk) during periods when seedlings exhibit open splits has been likened to applying antibiotic ointment to a cut. However, many would rather prevent the wound than treat the wound.

Some nurseries must cull more than others because of these cankers. Therefore, variations in soil properties, temperature, and nursery cultural practices such as fumigation, irrigation, fertilization, and pesticide application may be contributing factors. Nutrient imbalances are suspected as a possible cause for the inability of seedlings to heal splits. In particular, discussions among nursery growers have led to speculation that the N/Ca ratio may be correlated with stem splitting. However, stem splits have been found in one PNW nursery with very high calcium levels in the irrigation water (which corresponded to high foliar Ca levels in the seedlings)(unpublished data). Another possible cause may be water relations, such as the wet-dry cycle. There are, however, few scientific data to support any of the speculations as to the cause of splitting and cankering. Correspondingly, there is no clear understanding of how to prevent its occurrence.

The general consensus is that rapid growth is the primary cause of stem splitting. It has been observed in many forest nurseries, both bareroot and container, that rapidly elongating Douglas-fir seedling stems are prone to splitting, often with multiple splits on the same seedling. Stem sinuosity (sometimes referred to as “speed wobble”) may also be evident in fast-growing seedlings. Stem splitting does not occur exclusively in the nursery. Field observations indicate that naturally regenerating seedlings exhibit stem splitting during years when precipitation is high and growing conditions are optimum. Furthermore, stem splits have been observed in the field on third-, fourth-, and fifth-yr stems of both nursery-grown and naturally regenerated seedlings (figure 1).

As nursery technology has improved over the past couple of decades, so too, have seedling growth rates. The demand for larger stocktypes with greater morphological specifications has resulted in seedlings being pushed to their utmost growth rates. Supplying normally growth-limiting factors—reducing moisture stress through frequent irrigation and providing all mineral nutrients, especially nitrogen—can generate seedling growth rates that are many

Figure 1. Example of stem splitting observed in 4th-yr growth of field seedlings.

times faster than normal. With such accelerated growth, current growing regimes may result in seedlings approaching a physiological threshold at which a greater incidence of stem splitting occurs. This is evident because the tallest seedlings tend to have the most splits, as do those from faster-growing seedlots. Stem splitting and the resulting vulnerability to cankering is very undesirable in high-value genetically improved lots. Similarly, earlier-growing, overwintered bareroot stock (such as fall-transplants and 2+0) tend to have more splits than spring-transplanted stock. The same symptoms are observed far less frequently in slower-growing interior Douglas-fir lots.

Methods

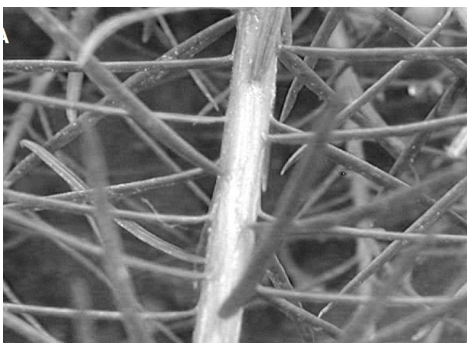
In a 2005 project, the Nursery Technology Cooperative (Department of Forest Science, Oregon State University) completed a monitoring trial to better understand the incidence and severity of stem splitting in Douglas-fir seedlings. Plug seedlings of the same seedlot from the same container nursery were transplanted in August 2004 in two different western Washington bareroot nurseries. Every 2 wk from June to August 2005, 10 plots were randomly chosen. Seedlings in the selected plots were measured for height and stem diameter. In addition, seedlings with stem splits were tallied and evaluated for number of splits, condition of splits, and location of splits. Split condition was rated as 0 for a cankered split and on a scale of 1–5 for noncankered splits (1=fresh split, ranging to 5=completely calloused) (figure 2).

Results and Discussion

Results were as follows:
June 1: very few splits were observed at either nursery
June 18: nearly every plot had one or more seedlings with fresh splits (rated 1–3)
July 1: splits were found in all plots; the majority were mostly calloused (rated 3–5)
July 18: splits, including several fresh splits, were found in all plots; some cankering was noted
August 1: splits were found in all plots; the majority were mostly calloused (rated 3–5); some cankering was noted

These data show that the "growth spurts" occurring in May and June were accompanied by incidence of fresh splits approximately 1 mo later with some cankering evident after another 4 wk. One of the nurseries had a greater incidence of cankering and attributed that to later initiation of fungicide applications than at the other nursery.

Although there has been considerable discussion about stem splitting in the past couple of years, cankering of stem splits is not a new issue. In 1990, Hamm described upper stem canker as a disease caused by the fungi *Phoma eupyrena* and *Fusarium roseum* and noted that "cankers initially appear as sunken areas centered most often on a bark fissure, a wound on the stem that occurs natu-



(A) freshly split

(B) mostly callused

(C) cankered

Figure 2. Examples of stem splitting conditions on Douglas-fir seedlings

rally when the bark is expanding during periods of rapid growth." He noted that these fungi are common soil inhabitants and are found on healthy seedlings; they don't cause disease until finding a suitable court, such as a stem split.

As long as the demand for large seedlings remains, stem splitting is likely to continue to be a factor in Douglas-fir seedling production. Aggressive IPM can reduce the subsequent development of cankers. Ideally, future research will provide a greater understanding of the occurrence of stem splits and will result in nursery growers being better able to prevent the problem while achieving acceptable morphological specifications.

References

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