SECTION 4

SEED AND SEEDLING DISEASES

reading Read the commentary, then answer the self-testing/review questions.

Up to this point, this course has dealt with diseases of particular tissues and organs. We have discussed root diseases, decay of wood, and diseases of bark, foliage, and the vascular system. That covers nearly all tree parts (nothing about flowers and fruits so far), and you may well wonder what else there is to discuss. From here on, this course deals with diseases caused by special groups of pathogens, namely the rusts and the dwarf mistletoes, and, in this section, diseases of seedlings. Seedling diseases deserve a special category because seedlings in nurseries are exposed to special and artificial conditions that lead to a set of diseases that are rare or absent in the field, and because young seedlings consist largely of succulent tissues not protected by periderms, and they don't have the energy reserves of larger trees to respond to diseases and to repair damage.

Seedlings occur in two kinds of places: as natural regeneration in the forest, and in nurseries (both bare-root and container). Virtually nothing is known about seedling diseases in the forest, while the nursery situation has been intensively studied. Stands of mature trees produce large quantities of seed. Seed fall often exceeds a million live seeds per hectare. Some of this seed is eaten by rodents, some is killed during the winter months while it lies dormant on the seedbed, and some if it germinates in the spring, and then dies within a short period of time. Causes of death after germination can include drought, grazing by rodents, insects and slugs, and diseases. Sometimes the forest floor microbial community includes potent pathogens of seed and seedlings. This is the case, for instance, for Engelmann spruce and subalpine fir seed deposited on undisturbed forest floors in the ESSF. Interestingly, seed deposited on nurse logs or on exposed mineral soil in these forests does not suffer nearly as much from these diseases., and that may be why these are the only successful seed beds in this zone. Much needs to be learned in this regard, and as silvicultural alternatives to clearcutting and planting are being explored, more will be learned about the pathology of natural seedlings in various seed beds.

Conifer seed can be destroyed by pathogens before it begins to germinate. The seed fungus, *Calocypha fulgens,* is commonly the cause. *C. fulgens* occurs naturally in the forest floor. Cones that are in contact with the forest floor can become infected, and the seed in such cones is destroyed. The typical symptom is that the endosperm and embryo remain firm but somewhat shrunken and mummified. In contrast, pre-emergence damping-off is a condition in which the seed contents become soft, rotten, and water-logged. *C. fulgens* can spread from seed to seed while seeds are in storage, and particularly during stratification.

Thus a few infected seeds in a seed lot can result in major losses. The remedy is to avoid prolonged contact of cones with the forest floor during cone collection and storage. Infected seed lots require the use of fungicides during stratification to avoid further spread.

Damping-off is a disease in which succulent stem tissues are invaded shortly after germination, and the seedling is killed. This can be caused by a large number of pathogens, all producing similar symptoms. In **pre-emergence** damping-off, infection occurs shortly after the radical begins to emerge from the seed, and the seedling never emerges above the soil surface. In **post-emergence** damping-off the attack usually occurs at the ground line. Initially the cortex is invaded and it becomes brown and shrunken. The seedling then topples over, but the cotyledons remain green and turgid for a while. The common pathogens causing damping off are various species of *Fusarium, Pythium, Phytophthora, Rhizoctonia,* and *Cylindrocladium.* In all cases the inoculum is present in the soil as dormant spores, and these germinate in the presence of young roots, presumably following stimulation by root exudates. Continued use of the same nursery beds will serve to increase the inoculum and the severity of the problem from year to year. However, environmental conditions are also critical. Most damping-off fungi are favoured by a soil pH higher than about 5.7, and therefore also somewhat higher than the optimum for seedling growth. Water logging also promotes damping-off. Thus good soil management techniques, combined with crop rotation, can minimize losses. When the epidermis on seedling stems and roots is replaced with the first periderm, four to eight weeks after emergence, damping off ceases because (1) exudates are greatly reduced and (2) the pathogens cannot penetrate the periderm readily.

Older bare-root seedlings are also affected by a number of pathogens. Various species of *Fusarium* also attack older seedlings. Sometimes the stem is invaded and the upper part of the seedling killed; sometimes invasion is through the roots, and tops look stunted. The other pathogens that cause damping-off may also continue to infect larger older seedlings, causing lesions on stems and roots. In all these cases, the growing conditions are critical. Apparently several of these pathogens may be present on, and even inside, seedlings without causing any symptoms, until times of unusual stress such as extreme heat, flooding or drought. Such periods of stress cause a change in behaviour: instead of acting as endophytes, roots and stems are rapidly invaded and killed. Sometimes these pathogens are carried on or in asymptomatic seedlings, and are expressed after the seedlings are planted in the field.

Sirococcus blight caused by *Sirococcus strobilinus* can be serious in container nurseries. In most cases, the pathogen is introduced on the seed. The typical symptoms are necrosis of the base of the cotyledons, while their tips remain green for a while. The fungus produces abundant asexual spores on the dead tissue, resulting in rapid spread within the nursery, and, if uncontrolled, in large losses. Container nurseries are also subject to grey mold caused by *Botrytis cineria. B. cineria* is a weak pathogen and a common saprophyte on dead organic matter. Spores are

present everywhere. The fungus becomes established on dying needles low within the dense stands of seedlings. In that moist, shaded environment, spore production is rapid, and all the lower needles become infected. From such needles the pathogen spreads into the stem, causing small lesions, and sometimes girdling seedlings. The simplest cure, increased aeration around the base of seedlings, lowers the relative humidity within the seedling canopy, and reduces both spore production and infection to tolerable levels.

A final problem is that of storage molds. Many regeneration systems require that seedlings be stored under cold and dark conditions for months before planting. Temperature is critical during storage. At one or a few degrees below zero, mold pathogens do not develop. However it is a common practice to allow a thawing period of a week or more, and this plus even longer periods at just above zero during transportation and storage in the field, is the critical time. Such conditions are ideal for various molds. Seedlings that were green when placed in storage may be totally molded and essentially dead when they are finally taken out of the box. At one time the fungicide captan was widely used to prevent storage molds. However prolonged exposure to that fungicide experienced by planters has had negative health impacts, and the practice has pretty well been discontinued. It now appears that care during transportation and storage, so that the temperature is not allowed to rise above zero until the last possible moment, will effectively remove the problem. Even a few days at an elevated temperature can result in significant molding.

SECTION ASSIGNMENT

SELF-TESTING/REVIEW QUESTIONS

Test your understanding of the material in this section by attempting to answer these questions. Do not proceed to the next lesson until you are satisfied with your proficiency in this section.
Do *not* send your answers to the tutor for marking. If you continue to have difficulty with a question after you review the relevant material, you may wish to discuss it with your tutor.
After you answer the questions in this part, proceed to Appendix A and complete Assignment #2 for submission to your tutor for marking.

1. Why is it useful to consider seedling diseases as a special category of diseases?
2. What are the symptoms of "damping off"?
3. Seedling diseases of bare-root nurseries often involve pathogens that differ from seedling diseases that are common in container nurseries. Why is this?
4. hat conditions are required for the development of gray mold?
5. How can damage by "storage molds" be prevented?