54. Environmental and Mechanical Damage

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Hosts

Abiotic damage from temperature extremes, wind, drought, and mechanical damage can affect all forest nursery seedlings. Seedlings grown from seed sources of a lower latitude or elevation are more susceptible to environmental damage.

Diagnosis

Diagnosis of abiotic damage is often determined by the damage pattern, tissue damage, and records on weather or cultural treatments. Environmental damage tends to be relatively uniform; often affecting a particular crop or seed source more than others (fig. 54.1). Seedlings affected by freeze damage, heat, or drought may go unnoticed for weeks or even months, until stunting or seedling mortality is obvious. Freeze or heat damage will eventually be visible as discolored foliage or inner tissue, stem constrictions, and lesions. Early visual assessment of lethal cold damage is possible following a freeze or unusual winter warming event. Place affected seedlings indoors at room temperature in a plastic bag or other containment to prevent desiccation; after 2 to 8 days look for brown or water-soaked tissue of the stem, buds, needles, or roots (container seedlings). Other more quantitative testing for injury is possible with measuring the level of electrolyte leakage or chlorophyll fluorescence emissions; however, these tests have some drawbacks aside from equipment and technical requirements. Electrolyte leakage must be compared with standard response curves for the species and seed source to be accurate. Chlorophyll fluorescence testing requires green tissue and cannot be used with hardwoods. These tests may not be as accurate in determining lethal damage as the more time consuming visual assessment.

Figure 54.1—*Germinating white oak seedlings were the only species damaged by a December freeze.* Photo by Michelle M. Cram, USDA Forest Service.

Seedling damage related to cultural or mechanical injury usually produces a systematic pattern within the nursery beds. Poor irrigation and shallow undercutting are examples of cultural or mechanical damage that produce systematic patterns. Diagnosis of mechanical damage can usually be confirmed visually. Occasionally, stunting related to irrigation or heat damage can be mistaken as a disease and may require a pathologist or soil testing to rule out pathogens or nematodes.

Specific Problems

Frost

Freeze injury occurs when seedlings are not cold-hardy enough to tolerate freezing temperatures. Foliage damaged by frost will turn from light yellow to red (fig. 54.2). Freeze damaged stem and root tissue becomes discolored and eventually turns the bark brown or red. A stem constriction can form on a frost-damaged seedling that is able to continue photosynthesis (fig. 54.3). These seedlings can go unnoticed until they become stunted and discolored during the growing season.

Figure 54.2—*Eastern white pine foliage damaged by frost.* Photo by Michelle M. Cram, USDA Forest Service.

Trees become acclimated to withstand freezing temperatures in response to shortened days, lower temperatures (accumulated chill hours), and reduced moisture. Frost damage is more likely in

Figure 54.3—*Freeze injury causing a constriction and inner tissue discoloration of a Fraser fir seedling.* Photo by Michelle M. Cram, USDA Forest Service.

years with unusually warm fall weather that encourages active growth. Similarly, unusual warm periods during the late winter and spring can cause some species or seed sources to break dormancy early, leading to tissue damage when freezing temperatures return.

Frost Heaving

In the fall and spring, soil in nursery beds can freeze during the night and thaw during the day causing the soil and seedlings to lift and fall in response (fig. 54.4). Frost heaving damages seedlings mechanically by breaking the roots and lifting the seedlings out of the ground. First year seedlings and transplants in wet, fine textured soils are most vulnerable to frost heaving.

Winter Burn

Seedling winter burn occurs when seedlings transpire in response to warm, windy weather when the ground is still frozen or dry. Under these conditions seedlings are unable to take up water and the exposed needles and stems become desiccated. Seedling needles turn yellow to red and appear scorched in response to desiccation. Seedlings in containers and in exposed locations have a greater winter burn probability.

Figure 54.4—*Seedlings and soil displaced by frost heaving.* Photo from USDA Forest Service Archives.

Heat Lesions

Seedlings develop lesions or are girdled when ground temperatures reach greater than 52 to 54 °C (126 to 129 ºF). Heat lesions on succulent seedlings can range from superficial white spots on stems facing the sunlight to a full constriction at the base (fig. 54.5). Young succulent seedlings with severe heat lesions will collapse and may be confused with damping-off. Older seedlings damaged by heat will often remain erect with a constricted base (fig. 54.6). Damaged seedlings with functioning xylem can become stunted and develop a slight swelling above the heat lesion where carbohydrates accumulate.

Drought

Moisture stress can occur in forest nurseries if irrigation patterns are poor or fail altogether due to either mechanical or human error. Similar damage occurs if seedling transpiration rates exceed the ability of the roots to absorb moisture

Figure 54.5—*Heat lesions on loblolly pine seedlings.* Photo by Michelle M. Cram, USDA Forest Service.

under periods of high heat and dry winds. Slight moisture stress damage can go unnoticed initially. Seedlings that receive less water due to poor irrigation patterns can become stunted, especially in dry years, giving the nursery beds a systematic wavy pattern (fig. 54.7). Other visible symptoms of moisture stress include wilting, graying of foliage, needle and leaf scorch, and premature foliage drop (fig. 54.8). Aboveground symptoms of drought can appear similar to root diseases, injury, or flooding damage.

Wind Abrasion

Seedlings develop lesions and calluses at the groundline in response to soil particles hitting the stems during high winds. Wind abrasion occurs more often in nurseries with sandy soil and in open and exposed fields.

Mechanical

Mechanical injury can be diagnosed based on the damage pattern, cultural records, and interviews with nursery personnel. Damage to seedlings can include severe root pruning, hand weeding, rough handling, and stripped roots at lifting. Seedlings with severe root loss from mechanical injury will have symptoms similar to drought stress.

Prevention

Frost

Freeze injury can often be controlled by sowing species or seed sources that are well adapted to the local conditions. Avoid late summer applications of nitrogen fertilizer and allow seedlings to harden prior to damaging frosts. Protect container seedlings until they are able to

Figure 54.6—*Pine stem girdled by heat and blocking movement of carbohydrates causing the stem to swell above the damaged phloem.* Photo by Edward L. Barnard, Florida Division of Forestry.

Figure 54.7—*Systematic spots of stunted pine seedling caused by a poor irrigation pattern.* Photo by Michelle M. Cram, USDA Forest Service.

Figure 54.8—*Drought damage due to lack of irrigation for 4 days.* Photo by Michelle M. Cram, USDA Forest Service.

withstand freezing cold by maintaining them under cover or insulated from the cold until frost damage is unlikely. Irrigation can be used to prevent frost when the temperatures are above -7 °C (19 ºF); however, it is important to apply enough water to continue the freezing process (liquid to solid), which releases heat and maintains seedlings temperature just above freezing.

Frost Heaving

The frequency and severity of frost heaving can be reduced with cultural practices that increase soil drainage and prevent rapid soil temperature fluctuation between freeze and thaw. Mulch use insulates the ground and reduces the effect of the day-to-night temperature changes. Shade in the form of manmade covers or natural shading by vegetation will also protect seedlings from frost heaving. Uniform seedling beds with larger root systems and full crown closure will provide natural shading and reduce frost heaving.

Winter Burn

Windbreaks help protect overwintering seedlings from drying winds that lead to winter burn. Fencing or vegetation windbreaks work best when perpendicular to the direction of the wind. Other cultural techniques to protect seedlings from winter burn include thick mulches, shade cloth, bed frames, or cold protection fabric. In North Central States, snow blowers have been used to coat seedlings in snow to protect from winter burns (fig. 54.9). In Southern States, overwintering conifers may be subjected to unusual warm periods (18 to 28 °C, 64 to 82 ºF) and require irrigation if beds become too dry.

Heat Lesions

Seedbed orientation along the sun's summer path, plus optimum seedling density allows for mutual shading. Sow seedlings early enough so that seedlings are older when temperatures reach damaging levels and have a protective bark layer. If a crop must be sown late in the growing season, shading may be required for young and vulnerable seedlings. Frequent irrigation during extreme heat periods can be used to cool ground temperatures. Avoid using dark-colored mulches that absorb sunlight.

Drought

Seedling damage from drought can be avoided through proper irrigation. Uniform water distribution is especially important to avoid under-irrigated areas. Maintain soil water potential to field capacity and carefully monitor soil water during seedling germination and early growth. Increasing the soil organic matter of well-drained soils will increase the soil's water holding capacity. Mulch use on seedbeds can help prevent evaporation and reduce water runoff.

Wind Abrasion

Windbreaks reduce soil particle movement that causes wind abrasion damage. Soil stabilizers such as mulches and polymeric adhesives can significantly reduce soil movement. Other cultural techniques to stabilize soil include irrigating the soil surface and sowing cover crops in fields out of production.

Figure 54.9—*Snow blowers are used in Northern States to coat seedlings in snow for protection from winter burns.* Photo from Minnesota Department of Natural Resources.

Mechanical

Well-trained and skilled nursery equipment operators are essential to avoiding mechanical damage. The condition of the soil, seedlings, and weather should be taken into consideration prior to any cultural or lifting operations. Ensure that seedlings have adequate field moisture following mechanical treatments to the root systems to prevent moisture stress.

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