Managing Abiotic Problems in Christmas Tree Plantations

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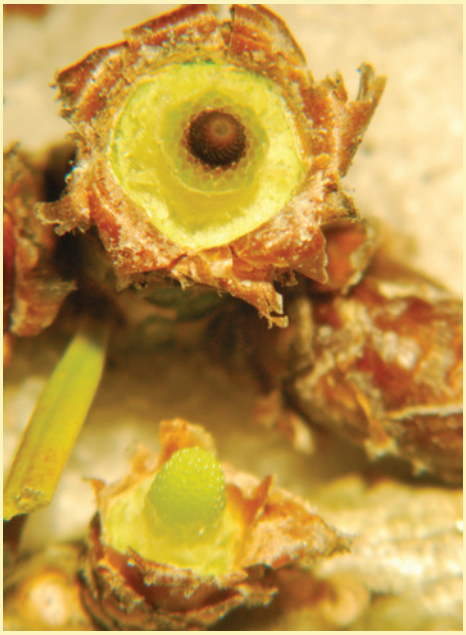
It's an old joke: "Everyone talks about the weather, but no one ever does anything about it." In many respects, this line also reflects the situation that Christmas tree growers face when dealing with abiotic or environmental plant injuries. Unlike insect or disease problems, there is usually no spray or treatment to remedy the problem. Christmas tree growers, however, are not completely at the mercy of the elements. In many cases, planning and forethought can help to reduce or eliminate many environmental tree injuries.



Growers can check the status of buds by removing the bud scales and examining the bud primordia. The bud on the top is dead; the bud on the bottom is alive.

What are abiotic injuries?

Abiotic injury (or abiotic disease) is a 'catch all' group of plant problems. In general, any plant problem that is not caused by living organisms such as insects, fungal pathogens, nematodes, or bacteria, can be considered an abiotic injury. Abiotic injuries are usually associated with environmental events such as temperature extremes or flooding but can also be related to genetic plant problems. It's a safe bet that every Christmas tree farm in the country loses some money due to abiotic plant problems each year. In many cases, the damage may be relatively minor and results in some growth loss or aesthetic damage that reduces the value of a crop. In other cases, however, an entire crop may be lost. There are a number of ways to classify abiotic injuries. In this article, I'll describe some of the most common abiotic problems encountered in Christmas tree production in the Great Lakes region as well as some guidelines for diagnosing and mitigating abiotic problems before they occur.

Wilting or drooping leaders is a sign of significant water stress in conifers.

Winter Injury

Winter injuries are probably the most common type of abiotic problems throughout the Great Lakes region. Winter injury actually encompasses a range of environmental problems that may include freezing injury, winter desiccation, and mechanical breakage.

Freezing injury occurs when plant tissues reach temperatures below their current level of cold hardiness. It is important to remember that cold hardiness varies widely throughout the winter. In the fall plants acclimate and increase their cold hardiness as days grow shorter and nighttime lows become colder. Most plants reach their maximum hardiness in mid-winter and then begin to de-acclimate, essentially reversing the acclimation process. Most conifers grown as Christmas trees in the Midwest can tolerate very cold temperatures when they are fully hardened and mid-winter freezing

injury is uncommon. However, late frost damage often occurs when trees de-harden during spring warm-ups, which are then followed by freezes.

Winter desiccation is a common form of winter injury in conifers. As the name implies, winter desiccation is actually a form of drought stress. On sunny, windy days in the winter, trees will begin to transpire water from their needles. If the ground is frozen, the water lost by transpiration cannot be replaced by absorption by the roots. The resulting water stress can cause needle browning. If snow cover is present during the winter desiccation event, a telltale 'snowline' where the damage occurred can be observed on the plants.

Drought and Heat

Tree moisture stress and extreme heat can kill trees, especially following transplanting (often referred to as transplant stress or transplant shock). Heat can cause direct injury to plants in extreme conditions, such as the record-breaking heat wave experienced in the Pacific Northwest last summer. However, the principle effect of heat on trees is increased water loss and plant moisture stress.

Wilting is the most common initial visual symptom of drought stress. Conifer leaders will begin to droop when they are under significant water stress and as the drought progresses, trees may begin to drop interior needles. Drought stress, however, reduces growth before visible symptoms become apparent. In order to understand plant water relations, it is important to remember that water forms a continuous path from the soil through the plant and into the atmosphere, which tree physiologists refer to as the Soil-Plant-Atmosphere continuum. Any factor that reduces water uptake from the soil (low soil moisture, loss of roots during transplanting) or increases evaporative demand and transpiration to the atmosphere (high temperature, low humidity) will ultimately increase tree moisture stress.

Flooding

While we usually think of drought as a limiting factor for trees, excess water can also be a problem. Many conifers grown as Christmas trees are poorly tolerant of wet soils. Flooding causes several problems for trees. Without oxygen, roots begin to undergo anaerobic respiration which results in the production of toxic compounds in the plant. Moreover, poorly drained sites are also conducive to root pathogens, such as phytophthora and other root rots.

Nutrient problems

Nutrient issues are among the most common abiotic problems in Christmas tree plantations. An in-depth discussion of managing soils and nutrition is beyond the scope of this article but further information can be found in the article by Bill Lindberg in this issue. Nutrient problems rarely kill trees outright, but proper nutrient management is essential to optimizing tree growth and maintaining good tree color. The extent and nature of nutrient deficiencies can depend on several factors including tree species and soil type. Nitrogen is usually the key element in most nutrient management programs as it is the element trees need in the largest quantities. In the upper Midwest, the common elemental deficiencies we observe are phosphorus, potassium, iron, magnesium and manganese.

Rapid spring warm-ups followed by freezing temperature can often result in late frost damage, such as on this Douglas-fir.

The snow-line on these Serbian spruce trees is a common indicator of winter desiccation injury. Shoots beneath the snow were protected when drying conditions occurred.

Chemical Exposures

Exposure to various chemicals can cause either chronic or acute plant injury depending on the type and duration of the exposure.

Salt damage can result from the application of deicing salts that can cause direct toxicity due to excess sodium or chloride in the soil solution or salt spray to aerial portions of the plant. Excessive road salt and some fertilizers can lead to osmotic stress or 'fertilizer burn', which limits water uptake from the soil and causes drought injury.

Herbicide exposure. Conifers are relatively tolerant of contact herbicides compared to broad-leaved plants due to the waxy cuticle on their needles. However, damage can often occur when herbicides drift onto newly emerging shoots or if soil-active herbicides are applied near the tree's root zone. Herbicide injury symptoms vary depending on the product applied, but frequently appear as stunting, twisting, or curling of shoots and needles.

Diagnosing abiotic problems

Determining the cause(s) of an abiotic problem is often challenging and frequently becomes a process of elimination. Sometimes a 'smoking gun' will be obvious, but more commonly diagnosing environmental problems requires detective work.

Look for symptom patterns. Abiotic problems will often follow a pattern across the farm. For example, winter desiccation injury often appears on the south or southwest side of trees where needles warm and begin to transpire. Problems associated with poor drainage may increase toward the bottom of a slope. Exposure to deicing salts can show a pattern of decreasing damage with distance from the roadway.

Crop history. There is no substitute for keeping careful records. Keeping track of irrigation, fertilization and pesticide applications can be invaluable in tracking down the source of abiotic problems. Growers should also keep weather records for their location. These are available via university or government websites, such as Michigan State University's EnviroWeather.

Know your trees. Some species are prone to certain abiotic problems. For example, Concolor fir and Douglas-fir often break bud early and are prone to late frost injury, so growers should try to avoid planting them in frost pockets.

Know your site. Successful Christmas tree production requires an intimate knowledge of the soils, drainage, frost pockets and other micro-sites of your farm. Poor drainage can be especially problematic. Water is usually more difficult to get rid of than it is to add.

Scout. Managing abiotic stresses and keeping trees healthy is part of an overall integrated pest management (IPM) strategy. A key component of IPM is scouting. Regular scouting allows growers to know which pests may be affecting their crops and better able to determine if a problem is due to a pest or related to an abiotic factor.

Dealing with abiotic problems

As I noted at the outset, managing abiotic problems may seem akin to trying to change the weather. However, there are steps growers can take to reduce or mitigate many environmental problems.

Develop a nutrition management plan. Poor nutrition can reduce tree performance even in the absence of visible deficiency symptoms. Soil and foliar nutrient testing should be a key component of nutrient management plans as well as an aid in trouble-shooting. Combined with notes on crop performance, regular soil and foliar testing provides growers with a standard of comparison if problem should arise.

Develop an irrigation management plan. Over-irrigating wastes water and money and can cause as many problems as too little water. Consult with local Extension personnel and other experts in your area to develop a water management program that supplies adequate water without over-applying.

Plant selection. Match species to site – planting species such as Fraser fir in a wet area is a problem waiting to happen.

Minimize drift when applying pesticides. Finding the perfect time to apply pesticides is always a challenge. However, getting up early or staying out late to spray when the wind is calm can help to keep herbicides and other pesticides on the intended target and off of your trees.

Identifying patterns is often key to diagnosing abiotic injuries. Winter desiccation typically occurs on the south or southwest side of trees.