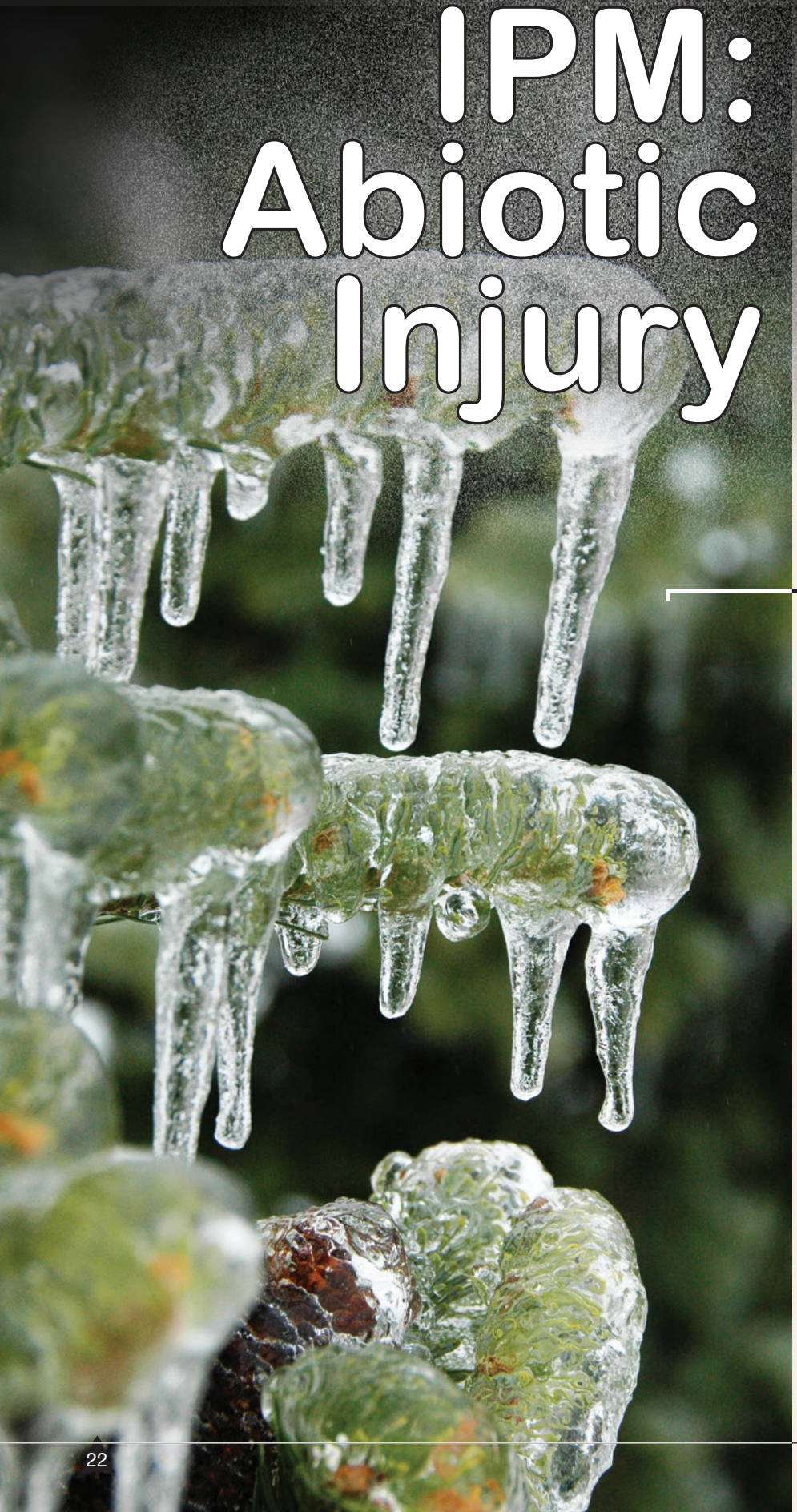
How to Speak Christmas Tree:

IPM: Abiotic Injury



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Photos by Bert Cregg, except as noted.

In this edition of How to Speak Christmas Tree, we are continuing our discussion of Integrated Pest Management, or IPM. In particular we will discuss ***abiotic injuries*** *in Christmas trees. These may also be referred to as* ***environmental injuries, physiological disorders,*** *or* ***abiotic diseases.*** *Abiotic injuries are tree issues that are often caused by environmental factors such as extreme temperature, drought, or chemical exposure – essentially any plant problems that are not caused by insect pests, mites, pathogens, or nematodes. Note that nutrient-related plant problems also fall within the realm of abiotic injuries. However, because soil and plant nutrition is such a large topic and is frequently covered in the Great Lakes Christmas Tree Journal, we will focus this discussion on other tree problems that are related to the environment.*

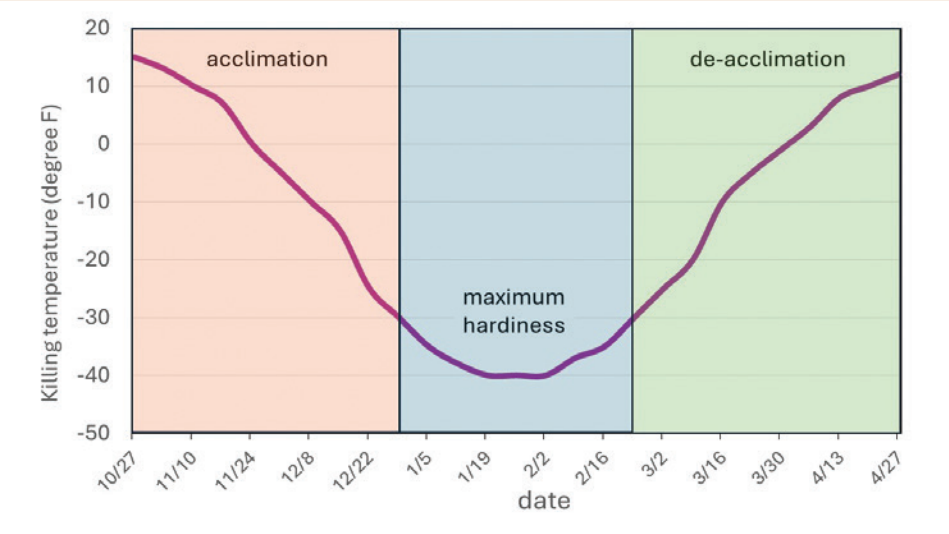

Figure 1. – *Generalized pattern of the development of cold hardiness in conifers. Cold hardiness increases (tissue able to withstand lower temperatures) during acclimation in fall/early winter. Maximum cold hardiness occurs in mid-winter, and then trees de-harden in response to warming temperatures and increased daylength.*

Figure 2. – *Early freezing injury on Canaan fir in November 2019.* Photo: Dull's Tree Farm.

Common forms of abiotic injury

An array of environmental factors can lead to damage to Christmas trees. Commonly the symptoms of abiotic injury are dead or brown needles, or the entire tree may die, but other symptoms may also be present. It is important to note that the symptoms associated with abiotic injuries can often be similar to those caused by insects or pathogens, so diagnosing abiotic problems often becomes a process of elimination. Maintaining good records of your operations and access to weather data, such as the Michigan State University Enviroweather system, can be helpful to reconstruct events after the fact when assessing potential causes of injury.

Year in and year out ***winter injuries*** are among the most common form of abiotic injuries that occur in Christmas trees. This is in part because our region has tough winters but also reflects the fact that winter injury encompasses a range of problems that can occur in trees during the winter. Examples of potential winter injury include ***freezing damage, winter desiccation,*** and damage from ***mammals***. In order to understand how freezing injury occurs in Christmas trees it is important to understand the dynamics of plant cold hardiness. Simply put, ***cold hardiness*** is the ability of plant tissue to withstand cold temperatures without damage. In the fall as nighttime temperatures begin to decrease and days get shorter, trees begin to acclimate and undergo physiological changes that enable them to withstand progressively colder temperatures (see Figure 1). If plant tissues are exposed to temperatures colder than their hardiness level during acclimation, we refer to this as early ***freezing injury*** (i.e., damage occurred early in the winter). In the Great Lakes this is relatively uncommon but does occur occasionally. For example, in November 2019 some growers in the region experienced cold damage on Canaan firs when nighttime temperatures plummeted on Veteran's Day (Figure 2). However, it is much more common in the Great Lakes region to experience ***late freezing injury*** or ***late frost injury;*** that is, cold damage that occurs as trees are de-hardening. A common late winter injury scenario is that temperatures warm in March, shoots de-acclimate, and then temperatures drop, killing the emerging shoots (Figure 3). In some cases, the buds may de-harden and are killed by cold temperatures before they emerge (Figure 4). The third, and least common cold injury scenario is mid-winter damage. As indicated in Figure 1, trees reach their maximum hardiness (able to survive the coldest temperatures) in January and February when we typically experience our coldest weather. Most conifers used as Christmas trees are normally able to withstand our coldest temperatures, but occasionally we can see extreme events such as the 2014 and 2015 polar vortex winters, which did result in needle loss and bud kill.

In addition to direct damage from cold, trees can also experience ***winter desiccation*** (Figure 5). This typically occurs on warm sunny days in the winter and may be exacerbated by snow-cover, which increases the reflected radiation impinging on the trees. As the needles begin to warm, they lose water via transpiration but cannot replace the water lost because water in the soil is still frozen. This type of injury is most common on the south or southwest side of trees.

When discussing IPM, ***mammal damage*** is often grouped with abiotic injuries. Even though mammals are clearly living organisms, their damage is often due to ***mechanical injury*** so is considered separate from insect or disease issues. Mammals that commonly damage Christmas trees include deer, mice, voles (Figure 6), and rabbits. Mammals are especially problematic in the wintertime when their usual food sources are

Figure 3. – *Late winter injury on concolor fir.*

Figure 4. – *Late winter injury on Colorado blue spruce. Note that shoots at the bottom of the tree, which were protected by snow during the cold event, have flushed but buds above the snow-line were killed.*

exhausted. For most growers, deer usually cause the greatest damage, but voles can gnaw on trunks of young trees and cause extensive damage as well. As we've discussed in past issues of the GLCTJ, deer pressure is high throughout most of the Great Lakes region, and deer fencing is the most effective approach to manage deer damage. For smaller mammals, good weed control can help to reduce cover from their predators. Some growers also use perches to improve habitat for raptors.

Heat and drought often take their toll on Christmas trees, especially in young plantations. Even under ideal conditions, transplanting is stressful on young trees (Figure 7). Trees experience drought stress when water loss from the needles exceeds absorption of water by the roots. This imbalance can be due to drying atmospheric conditions (warm temperatures, low humidity, high winds), low available soil moisture, or both. Early signs of drought stress in conifers include ***drooping or wilting*** leaders (Figure 8), or needles may take on a greyish cast. As drought progresses, needles begin to brown and senesce. Cultural practices that conserve soil moisture, such as good weed control and mulching, can help to reduce drought injury. Irrigation, of course, is the ultimate solution for lack of moisture. Growers that do not have permanent irrigation installed may have to rely on travelers or hand watering during acute droughts.

Flooding – Many conifers that are grown for Christmas trees are intolerant of flooding, and even a few days of inundation can cause severe problems. Depending on the water depth, flooding can cause root death due to lack of oxygen in saturated soils or can suffocate trees if the tops of the trees are covered. In general, trees are more tolerant of flooding in the winter than during the active growing season. Growers should also be aware that trees that initially survive flooding may be predisposed to further injury including root rots or drought damage due to loss of roots during flooding.

Chemical injury – Exposure to various chemicals can often lead to tree damage. Pesticides, especially herbicides, can damage needles and often lead to a condition known as ***epinasty,*** which is characterized by ***twisted or stunted growth*** (Figure 9). Some insecticides and fungicides can also cause phytotoxicity due to interactions of pesticides or adjuvants such as surfactants on the leaf surface, especially during hot, sunny weather. Growers should always read and follow label directions. When applying any herbicide, pay particular attention to sections of the label related to avoiding damage to non-target plants. Avoid spraying herbicides when drift can occur or during air inversions.

Figure 5. – *Winter desiccation on the south side of eastern white pine trees.* Photo: Jill O'Donnell.

Figure 6. – *Vole damage on concolor fir. In this section of the plantation, voles had girdled all the concolor firs.*

Figure 7. – *Drought injury to newly-planted trees. Note that buds at the top of the trees are flushing and trees should recover.* Photo: Bill Lindberg.

Figure 8. – *Wilting or drooping leaders is a common symptom of drought stress in conifers.*

Figure 9. – *Curled needles associated with herbicide exposure.* Photo: Bill Lindberg.

Figure 10. – *Fertilizer burn associated with hand-applied fertilizer. Photo: Great Lakes Christmas Tree Growers Facebook page.*

Fertilizers can sometimes cause injury in Christmas trees. When granular fertilizers are broadcast-applied over the tops of trees, fertilizer prills can catch in the foliage and can result in needle burn if the prills are not blown off by wind or washed off by rain or irrigation. High concentrations of fertilizers associated with hand-applied fertilizers can result in hot-spots that can lead to ***fertilizer burn*** and reduce water uptake from roots (Figure 10).

Growers that have plantations near heavily traveled roads may experience damage from ***deicing salt*** (sodium chloride). Among trees commonly grown as Christmas trees in the Great Lakes, eastern white pine is especially sensitive to salt drift from road treatments (Figure 11). Growers should avoid planting white pines near roads that are heavily traveled and likely to receive salt treatments in the winter.

Figure 11. – *Deicing salt damage on eastern white pine.*

Summary – Abiotic injuries can be vexing for Christmas tree growers as they are often caused by extreme weather events or other factors out of the grower's control. Abiotic problems can also be difficult to diagnose because the damage may not be apparent until the event or the exposure has passed. Oftentimes, environmental injuries do not leave a 'smoking gun', and determining the cause often requires detective work to eliminate other potential causes, such as insect pests or fungal pathogens. Some common clues to look for when diagnosing suspected

abiotic problems include: extreme weather events, recent pesticide applications, damage that occurs in a pattern (e.g., damage occurs on one side of trees, all trees affected above snowline), and damage that affected multiple species. Unfortunately, remedying abiotic injuries is also a challenge, and growers are often left to 'wait and see' or prune out affected parts of the trees. For suspected winter injury, inspecting buds can be helpful to assess damage. By removing the outer bud scales, growers can inspect the bud primordia (Figure 12). Buds that are brown have been killed, while those that are green are still alive and will flush normally in the spring.

***Figure 12.** – Removing bud scales and inspecting bud primordia can provide an early indicator of cold injury. The brown bud at the top is dead, green bud (bottom) is alive.*