How to Speak Christmas Tree:

IPM: Disease Management

In the previous edition of 'How to speak Christmas tree,' I introduced the concept of Integrated Pest Management, or IPM, as it applies to Christmas trees. To recap, IPM is a systematic approach to dealing with pest issues that uses a variety of techniques, including cultural and chemical, to manage pests in an economic and environmentally sustainable manner. In this and upcoming articles, I will consider the major causes of losses in Christmas tree plantations (diseases, insect pests, weeds, and abiotic factors) and how we can approach them through an IPM lens. While I will present some specific examples, the goal of the articles is to provide an overview of IPM, rather than provide details on control of individual pests or weeds. For this article we will turn our attention to tree diseases.

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Figure 1 – *Fungi often consist of a visible fruiting body that produces spores and root-like structures (mycelia) that are often unseen. In this case, the fruiting body is a mushroom assotiated with a beneficial mycorrhizal fungus.*

Figure 2. – *Dothistroma needle blight causes dead needle tips and banding (lesions) on the needles.* Image: Paul Bachi, University of Kentucky Research and Education Center, Bugwood.org.

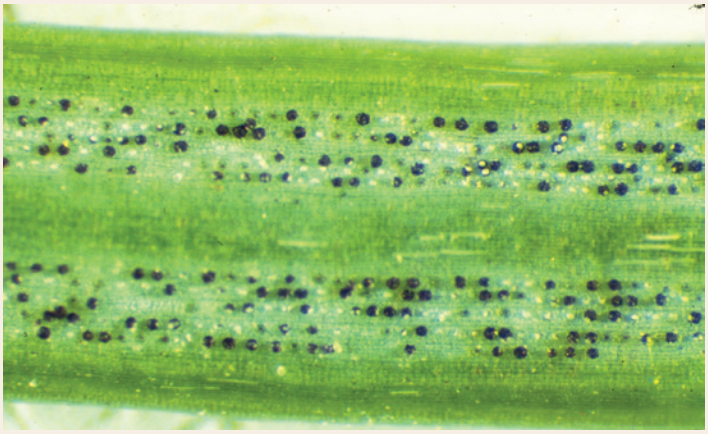

Figure 4 – *Fruiting bodies of Swiss needle cast emerging from pores (stomata) on the underside of a Douglas-fir needle.* Image: Susan K. Hagle, US Forest Service, Bugwood.org.

Figure 3 – *Rhizosphaera needle cast on Colorado blue spruce.* Image: USDA Forest Service - North Central Research Station, USDA Forest Service, Bugwood.org.

What causes tree diseases?

Just like diseases of humans, diseases of plants can be caused by viruses, bacteria, or fungi. Gardeners may be familiar with mosaic disease in tomatoes, which is caused by a virus. Leaf scorch in oaks can be caused by a bacterial infection. However, the vast majority of diseases that cause damage in conifers grown as Christmas trees are associated with fungal pathogens. Fungi are higher organisms that are closely related to plants. In fact, if you find an old enough biology textbook, you'll see that fungi were once considered part of the plant kingdom. One of the key attributes of fungi is that they are not photosynthetic. This means that, unlike plants that can store energy through photosynthesis (autotrophic), fungi need to get their energy elsewhere (heterotrophic). Many fungi are decomposers and live off of dead biomass (saprophytic) and some form mutually beneficial, or symbiotic, relationships with living plants, such as mycorrhizae. However, some fungi are parasitic, taking energy reserves from the host plant without providing any benefit in return. This weakens, and in some cases, kills the host. A key attribute that is important for understanding and managing fungal diseases is that fungi are often cryptic; that is, they are often unseen and casual observers may only notice their fruiting bodies, such as mushrooms (Fig. 1). Also, fungi often have complex life cycles which, in some cases, can involve a secondary host. For example, white pine blister rust, which is a serious disease of white pine, requires the presence of currant bushes (*Ribes* sp.) to complete its life cycle. In certain instances, it may be possible to disrupt the fungus's life cycle and control white pine blister rust by eliminating currant bushes in the vicinity of white pines.

What kinds of diseases affect Christmas trees?

Fungal pathogens can cause a wide array of diseases and damage in Christmas trees. Often, diseases affect a particular species or group of species within a genus. Therefore, knowing which type of tree is affected is a critical step in

Figure 5 – *Mortality of noble fir in the Pacific Northwest associated with Phytophthora root rot. Note the mortality is nearly 100% in the lowest-lying part of the field.* Image: Gary Chastagner, Washington State University.

diagnosing a suspected disease issue. A complete discussion of diseases of Christmas trees in the Great Lakes region literally fills volumes. Therefore, the objective here is to highlight the main types of diseases that growers are likely to encounter and some of the terminology associated with tree diseases.

Needle casts and needle blights are fungal diseases that cause browning (necrosis) of needles. Needle blights can occur in nearly all conifers but are particularly common in pines such as Austrian pine and Scotch pine (Fig. 2). The typical symptoms associated with needle blight are browning of the ends of needles and the appearance of dark bands or lesions on the needles. In the case of needle casts, the disease progression will cause needles to senesce and drop off the tree prematurely, ultimately leaving branches bare. Needle cast infections frequently begin at the bottom of the tree and progress upwards (Fig. 3). Using a hand lens, it is often possible to see the fruiting bodies of needle cast fungi emerging from the pores (stomata) on the underside of needles (Fig. 4). Needle blights and needle casts do not usually kill trees outright by themselves, but they can render trees unsalable and may weaken trees to the point that they become susceptible to other pests or stresses.

Root rots are among the most serious diseases that infect conifers in Christmas trees because they can kill trees quickly and can affect a large number of trees in a given field. Trees are often predisposed to root rots when they are grown in soils with poor drainage (Fig. 5). Ironically, although root rots are associated with wet soils, the symptoms of root rots mimic those of drought stress. Growers may observe drooping or wilted leaders on infected trees, which then may take on a greyish cast before turning brown or red. The progression of root rot symptoms reflect the fact that infected roots are unable to take up water from the soil. As the tree crown continues to lose water through transpiration, trees cannot replace the water they have lost, resulting in drought stress and death of needles. Root rots often progress quickly, and it is not uncommon for trees to go from appearing healthy to dead in a matter of weeks. Phytophthora root rot, which is actually a water mold and not a fungus, affects firs, especially Fraser fir, and is the most common and problematic root rot in the Great Lakes region. Armillaria root rot also affects firs as well as other conifers grown as Christmas trees (Fig. 6).

Cankers result from fungal infections on branches or the trunk of the tree. As the disease develops, water and nutrient transport is affected and can result in the death of individual branches or a

portion of the tree crown. Unlike needle casts, which often start at the bottom of the tree crown, cankers can affect individual branches and may result in decline or death of random branches within a tree.

Rusts can affect needles or stems and the disease name reflects the fact that these diseases produce conspicuous orange spores. Needle rusts can result in needle browning or death, while stem rusts can cause branch dieback or tree death.

Tip blights are diseases that affect newly emerging shoots, resulting in die-back at the end of branches. Diplodia tip blight is probably the most familiar tip blight in the Great Lakes region, but other tip blights can affect conifer species. Tip blights are not usually fatal but can cause multiple leaders and other defects that will render trees unsalable (Fig. 7).

How can I reduce the impact of tree diseases on my farm?

The disease triangle is a fundamental concept in understanding and managing fungal diseases in plant systems, including Christmas tree plantations. Based on the disease triangle, three factors must be present in order for disease to occur: a susceptible host, a favorable environment, and a virulent pathogen (Fig. 8). In order to eliminate or reduce the incidence of diseases; we need to address at least one part of the triangle.

Figure 6 – *Diseases often go unnoticed until trees begin to decline. In this case, the white material under the bark of the tree is from mycelia associated with Armillaria root rot.* Image: William Jacobi, Colorado State University, Bugwood.org.

Avoid susceptible hosts

The most effective way for growers to prevent a particular disease from occurring is to avoid planting species that are susceptible. For example, if a grower is concerned about Phytophthora root rot on Fraser fir on a poorly drained section of a field, they could address the problem by planting a less susceptible species, say, concolor fir or spruces, in that section. Of course, all trees are susceptible to some diseases, so this approach may feel like a case of 'pick your poison'. However, when dealing with a disease that is likely to be fatal, such as root rot, growers may be better off facing other issues that are more likely to be manageable.

Modify the environment

Most needle diseases are favored by warm, moist conditions, so taking steps to improve air flow near the base of trees – planting at a wide spacing, basal pruning, controlling weeds – can help reduce disease pressure. In the case of root rots that are favored by wet soils, growers may look to reduce water ponding by changing grades or installing drain tiles.

Sanitation

Addressing the third leg of the Disease Triangle – eliminating the presence of the pathogen – is often the most difficult approach to disease management. Pathogen spores are often ubiquitous, and many are long lived. For example, Phytophthora can produce resting spores (chlamydospores) that can remain viable in soil for years. Nonetheless growers can reduce the amount of spores (inoculum) that trees are exposed to by adopting good sanitation practices such as removing and disposing of dead and diseased trees from their fields.

Fungicides

In some instances, chemical fungicides can be useful in managing tree disease. Fungicides can be curative (i.e., can cure a tree once a fungal infection has occurred);

Figure 7 – *Diplodia tip blight on Austrian pine.* Image: Ryan Armbrust, Kansas Forest Service, Bugwood.org.

but more commonly, fungicides are applied as a preventative or prophylactic treatment. A common example of this is managing needle cast diseases in Douglas-fir. Growers can prevent new infections by spraying trees with fungicides in the spring as new shoots are emerging. The fungicide coats the needles and prevents spores that land on the foliage from infecting the needles. Good coverage is essential to this control strategy and growers usually

need at least two sprays to maintain adequate coverage to prevent infection. With proper application techniques and timing, prophylactic treatments can be effective. Once infections have occurred, however, curative sprays are usually ineffectual and grower efforts are better spent on preventing infections.

For more information:

Diagnosing and managing tree diseases requires much more information than can fit into one article such as this. Many of the disease symptoms mentioned in this article could also be related to insect infestations or abiotic disorders, so it is essential that growers make a correct diagnosis before embarking on a control program. There are several key resources to help growers trouble-shoot and manage diseases in their plantations. These include the *Christmas Tree Pest Manual* and *Michigan State University Pest Management Guide*. The Christmas Tree Pest Manual is a full-color publication that provides information on diagnosing and managing common disease and pest problems in Christmas tree plantations. It is available in electronic form (Google: Christmas Tree Pest Manual) or as a hardcopy from the MSU Extension Bookstore for $5.00 (Google: MSUE Bookstore Christmas Tree Pest Manual). The MSU Christmas Tree Pest Management Guide is a comprehensive guide for Christmas tree growers that includes disease management and registered fungicides (Google: MSU Christmas Tree Pest Management). To aid in diagnosing on-going tree health issues, growers can submit samples to the MSU Plant & Pest Diagnostics Laboratory. For plant diseases, the diagnosticians may be able to culture and identify the fungal pathogen or may be able to identify the disease using molecular techniques. Details on fees and procedures for submitting samples are available on the Plant & Pest Diagnostics website www.canr.msu.edu/pestid/. Growers outside Michigan can also submit samples to MSU Plant & Pest Diagnostics (note: out of state surcharge may apply) or refer to the National Plant Diagnostic Network (npdn.org) to find a plant diagnostic lab in your state.

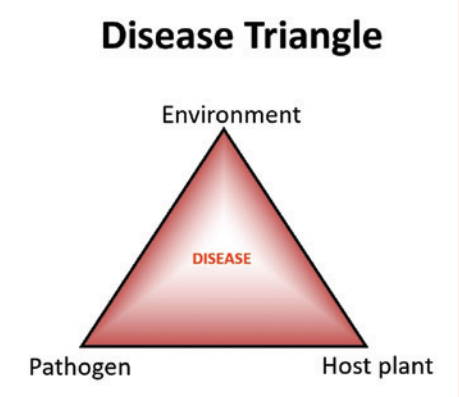

Figure 8 – *The Disease Triangle. In order for a plant disease to occur, all three components of the triangle, pathogen, conducive environment, and susceptible host, need to be present.* Image: University of California Agriculture and Natural Resources.