FUNGICIDES FOR DISEASE MANAGEMENT IN CHRISTMAS TREES



Understanding factors that affect fungicides efficacy and improve disease management outcomes.

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Producing quality Christmas trees can be challenging due to a variety of pathogens that cause diseases. Some pathogens can kill trees outright, (ex. Phytophthora root rot, Photo 1), while others create enough damage to makes the tree unsellable (ex. Delphinella shoot blight, Photo 2). To better control Christmas tree diseases, a key concept growers should consider is the disease triangle (Figure 1). For a pathogen to infect a host and cause subsequent disease, three factors must occur simultaneously. A pathogen must be present, a host must be susceptible, and the environment must be conducive for development.

Photo 1 – *Phytophthora root rot tree mortality in Fraser fir.* *Credit: Bill Lindberg, Michigan State University Extension.*

Successful disease management is based on accurate disease diagnosis and an integrated approach utilizing a variety of practices that modify one or more of the disease triangle factors. Practical examples of this could include:

- site selection
- the use of healthy planting stock
- preventing the movement of contaminated soil or stock from one field to another
- stump removal to reduce the risk of diseases, such as Armillaria and Annosus root rots
- improving soil drainage to reduce the risk of Phytophthora root rot
- basal pruning lower branches to improve air flow
- selecting a specific tree species (or seed source) that exhibits greater resistance to a specific disease.

In some situations, these practices may not be possible or offer inadequate impacts resulting in poor disease control. Depending on the pathogen, growers can also consider the addition of fungicide treatments to control diseases to enhance their ability to produce high quality Christmas trees (Photo 3, Photo 4)

There are many fungicides that are commonly used in Christmas tree production (Table 1). Fungicides vary in their effectiveness against specific diseases, so accurate disease diagnosis is important. Information on which diseases are controlled by which fungicides can be found on the product label or in Michigan State Christmas Tree Pest Management guide. Fungicides can be separated into two broad groups, protectants or systemic. Products with active ingredients such as chlorothalonil, mancozeb, and copper hydroxide are examples of protectant fungicides labeled for Christmas tree

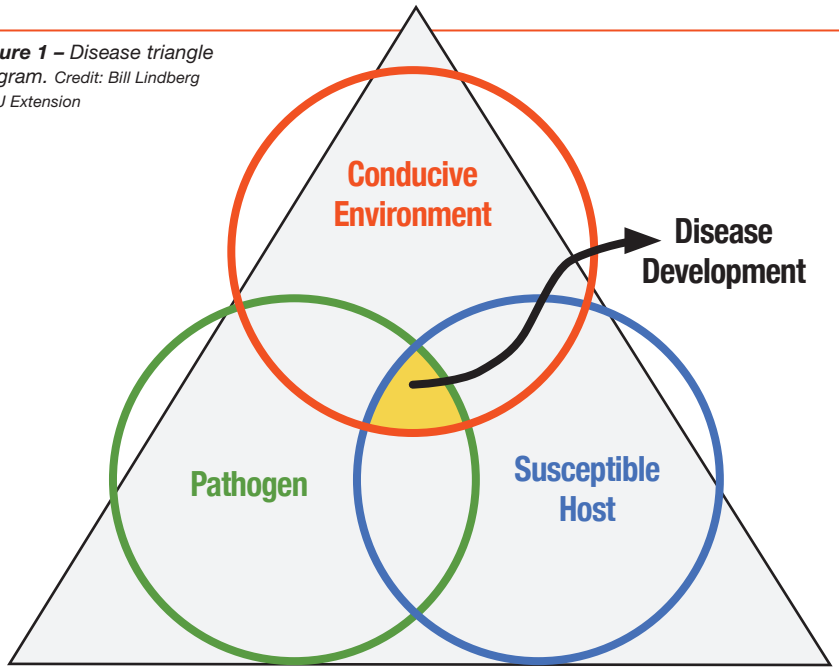


Figure 1 – *Disease triangle diagram.* *Credit: Bill Lindberg MSU Extension*



Photo 2 – *Delphinella shoot blight damage in concolor fir.* *Credit: Bill Lindberg, Michigan State University Extension*

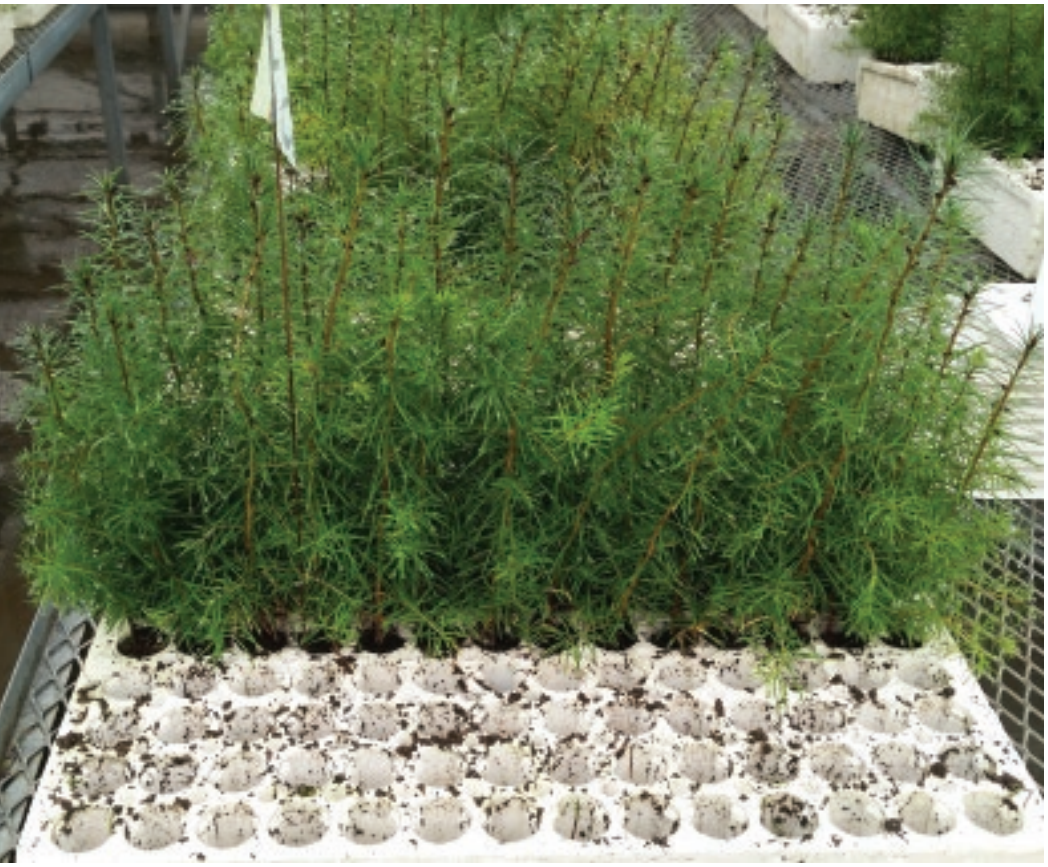


Photo 3 – *Interior needle blight on noble fir Christmas trees with (left) and without (right) early fungicide applications.* *Credit: Dr. Gary Chastagner, Washington State University*



Photo 4 – *Douglas-fir Botrytis gray mold trial with (top) and without (bottom) fungicide treatments.* *Credit: Gary Chastagner Washington State University*

production in Michigan. Protectant fungicide residues create a chemical barrier on the surface of tree tissue that inhibits spore germination and infection. Protective fungicides do not have curative activity and cannot stop the growth of fungal pathogens within host tissues once infection has occurred. This makes the timing of protective sprays especially important as residues need to be present prior to infection.

Systemic fungicides differ from protectants in that they are absorbed and translocated within the tree. They can be further divided into fully systemic, which move throughout the entire tree, or locally systemic which may move small distances. Similar to protectant fungicides, systemic products primarily protect tissue from infection, but certain systemic fungicides also have the ability to stop disease development after the pathogen has already infected the plant tissue. This "Kickback" or curative activity enables these systemic fungicides to control disease development on some hosts if applied within 24 to 72 hours after an infection has occurred. It is unclear what, or if any curative activity systemic fungicides have on Christmas tree diseases.

Most systemic fungicides move from the point of application upwards towards the growing tips of trees. When applied as soil drenches, they can be taken up by the roots and are translocated throughout the plant. Phosphites are a newer group of fully systemic fungicides that have been used to control Oomycete pathogens like *Phytophthora* on several horticultural crops. Unlike other groups of systemic fungicides, phosphite fungicides can be applied as foliar sprays and move through the plant's xylem and phloem, allowing for foliar applications to control root rot diseases.

While issues with the potential development of fungicide resistance of pathogens has not been a problem with protectant products containing multiple modes of action, the risk of fungicide

resistance reducing the effectiveness of newer fungicides with active ingredients which have single modes of action is much higher. Given that an active ingredient can be sold under multiple product names, the Fungicide Resistance Action Committee (FRAC, www.frac.info) lists different active ingredients in different "group" numbers based on their mode of action and risk that resistance will develop. These codes are included on fungicide product labels and help growers identify products with different modes of action to use in a rotation program to help prevent a pathogen from becoming resistant to a single mode of action.

Key questions growers often have regarding fungicides:

Why didn't my fungicide sprays control my trees needle cast and blight diseases?

The most common reason is that the initial fungicide application was likely applied after infection of the newly emerging needles had already occurred. It is commonly recommended that needle casts and blights be controlled starting at least 3 years prior to anticipated harvest. This will help ensure that trees have multiple age classes of healthy needles on them at harvest. The initial application should be applied when about 50% of the trees have 1 to 2 inches of new growth. If anticipated weather conditions are likely to be unfavorable for spraying, it is better to apply a treatment slightly earlier than late. Depending on disease pressure, an additional application should be made 1 to 2 weeks later to protect the needles on trees with late bud break.

What is the length of time a residual fungicide spray will be effective for?

The residual efficacy and longevity of control of different fungicides varies. Very few residual studies have been done on conifers. Factors which can affect the residual activity of fungicides include that rate of application, adjuvants, level of disease inoculum, weather conditions, spray coverage, host susceptibility, and the persistence of the residue. While dew, overhead irrigation, and precipitation can help redistribute fungicide residues on the surface to needles and shoots, they can also wash off residues and reduce the residual activity. While systemic fungicides that are taken up by the plants are not as impacted by weathering, the concentration of the fungicide within the plant can be diluted by growth and broken down physiologically within the plant. In general, growers could expect that a fungicide that is effective on a given needle cast or blight disease would have a couple weeks of longevity.

Will fungicides work in preventing Phytophthora root rot (PRR) disease?

PRR is caused by several species of *Phytophthora*, which is an Oomycete, or water mold that produces swimming zoospores during periods of soil saturation. It is favored by poorly drained soils and high levels of precipitation or irrigation that result in saturated soils. Cultural practices, like site selection, improving soil drainage, and host susceptibility are the primary means of limiting PRR. While fungicides are used to help manage the development of PRR on other horticultural crops, their effectiveness in controlling PRR in Christmas tree plantations has been variable, particularly in sites that are conducive to development of this disease.

There are several challenges relating to the potential use of fungicides to help manage PRR in Christmas tree production. Some of these include the spotty nature of where the disease occurs, a poor understanding of the frequency of infection periods during the growing season, the lack of good solid information on the residual activity of fungicides, and the need for a better understanding of the timing and number of fungicide applications that are needed to limit disease development. The Real Christmas Tree Board, WSDA Specialty Crop Block Grant program, A GIFT SEED project, and the IR-4 Environmental Horticulture program are currently supporting projects at Washington State University relating to these research needs. We are also evaluating the effectiveness of foliar applications of phosphite types of fungicides and soil applications or other fungicides in controlling PRR. Results from these trials and additional large scale field trials will help determine the feasibility of growers using fungicides in their PRR management program.

The label lists a range in use rate, what rate is recommended?

Product labels will typically list specific use rates based on what disease is being targeted. In the Pacific Northwest, growers use a variety of methods to apply fungicides to control needle casts and blights on trees. If disease pressure is high, or if applications are being made with helicopters growers should use the higher end use rate. With the increased use of drones to apply fungicides, research is needed to determine what effect rates have on treatment effectiveness with this method of application. Remember to always follow label instructions.

How important is spray coverage in fungicide effectiveness?

Spray coverage, particularly with protectant fungicides, is extremely important. Unlike insects which can come in contact with insecticide spray residues as they move around and feed, sufficient fungicide residue has to be present where fungal spores land on needles and shoots to inhibit their germination and infection. There may

be some redistribution of fungicide residues on trees after application, however the vast majority of control will be based on the uniform distribution of spray residues. Systemic products offer some leeway as these fungicides are absorbed and can move internally.

Disclaimer: Discussion of pesticide products does not supersede label instructions. The label is the law. Applicators should read product label instructions and follow instructions for the safe use of pesticide products. For more general information on Christmas tree diseases, labeled pesticide products, consult the 2026 Michigan Christmas Tree Pest Management Guide.

Table 1 – Common Christmas tree fungicides

Active Ingredient	Protective/Systemic	FRAC Code
Thiophanate-methyl	Systemic	1
Myclobutanil	Systemic	3
Triflumizole	Systemic	3
Metalaxyl	Systemic	4
Mefenoxam	Systemic	4
Triadimefon and Trifloxystrobin	Systemic	3 & 11
Azoxystrobin	Systemic	11
Fluopicolide	Systemic	43
Copper hydroxide	Protective	M01
Mancozeb	Protective	M03
Ziram	Protective	M03
Chlorothalonil	Protective	M05
Phosphorous acid, mono and dibasic sodium, potassium, and ammonium salts	Systemic	P07

*Not all products are labeled in all states or for all tree species. Follow label directions

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