Seedling Problems in Michigan Nurseries

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The nursery serves as the crucial link in managing plant disease problems for the plant industry. Decisions made at the nursery can have far reaching effects throughout the industry. The nursery can increase or decrease the cost of growing plants and maintaining plant health for many years after plants leave the nursery. Such long term consequences may be forgotten during the day to day operations of a nursery. For this reason plant pathologists hope to establish a distinct philosophy in plant production, that philosophy is summarized in a simple statement or rule. "A **nursery manager's goal is to produce pathogen-free stock, not just disease-free stock."**

The reason for such a goal should he clarified throughout this article as examples bring home the costs and damages that Michigan growers could suffer.

Seedling diseases of damping-off are well known to growers, and some of the pathogens are also known, for example *Pythium* and *Rhizoctonia*. Other pathogens are less well known, in particular *Phytophthora,Cylindrocladium* and *Fusarium*. *Phytophthora* and *Cylindrocladium* can he imported into a clean nursery on seeds and seedlings and cause devastating damage for many years. New diseases may also be imported and cause losses.

New pathogens are arriving primarily on seed and they are establishing themselves in Michigan nurseries because nursery persons have stopped practicing an old fundamental practice, coating seed with fungicides before sowing. **Seeds should be coated with a fungicide and a red dye before planting.**

This year three new pathogens were found in Michigan nurseries causing damage, *Alternaria solani* on Concolor fir seedlings, *Bipolaris* on taxus cuttings and *Phoma* on Colorado spruce transplants. These pathogens have never been reported in any state before as they are not listed in the new federal index of plant diseases.

Michigan's nursery industry produces over 10 million conifer seedlings a year. Many conifers are exotic and the seed collected from squirrel caches or off the forest floor worldwide likely harbor exotic pathogens. Native seed can also introduce pathogens to Michigan. Coating seed with a broad spectrum fungicide, in particular Captan or Thiram, is far more effective in reducing the importation of pathogens than soil drenching or infurrow dressing, and the methods of application should be combined routinely. It was once a widespread and routine practice for nursery operations to place seed in a rotating drum and tumble them along with some wettable powder or slurry of fungicide sometimes combined with talc. Alternatively seed with sturdy seed coats can be bleached for 5 minutes in a 10% dilution of household bleach containing one drop of liquid dish detergent, or soak in peroxide. Acid soaking for scaring/stratifying some seed also can destroy pathogens. Fungi sporulate and grow slowly in refrigerators so seed should be treated prior to stratifying at cool temperatures in moist moss to prevent spreading of pathogenic fungi from one contaminated seed to the neighbors. Fumigated nursery beds should certainly never be sowed with uncoated seed.

Fumigation of nursery beds can be of greater benefit to your customer than to you. Also because you as a nursery worker often are obtaining stock from other nurseries, their use of soil fumigation can be crucial to your success.

Yearly in Michigan more and more loss is occurring due to the purchase of "disease-free" but not "pathogen-free" stock from west coast and southern nurseries. The particular danger is *Phytophthora* a root rotting fungus prevalent in western and southern soils. This fungus is the most destructive nursery pathogen in those regions. It is so common that western and southern nurseries routinely treat many of their plants with Subdue, Ridomil, Aliette or Terrazole. The "disease-free" plants arrive at Michigan nurseries where we are unfamiliar with treating these plants. Then wet nursery soils or heavy nursery soils favoring *Phytophthora* infection stimulate the disease causing extensive loss of these plants.

Most Michigan nurseries are familiar with treating Rhododendrons with fungicide to control *Phytophthora.* But in the past few years more and more maples of all species are arriving with *Phytophthora* and many bare root and one to five gallon potted maples are dying before leaving the Michigan nurseries. Some are also dying in the landscape after obtaining large size but suffering mower injury and wet soils that stimulate *Phytophthora* crown rot. Orchard trees are particularly susceptible but Sargent cherry and other ornamental *Prunus* are being lost as well. Sometimes these trees are arriving with *Phytophthora* infection in the woody stems due to healing-over following grafting in Phytophthora-contaminated sawdust at the west coast nurseries. The fungus enters the wounds from clipped branches on the trunk or pruned suckers at the graft union. These trees may suffer trunk and main-stem cankers, and die slowly over 1-3 years as the nursery attempts to bring them up to selling size.

Of particular concern to me is Fraser fir because the Michigan Christmas tree industry is seeking to plant large acreages to this cadillac of trees. I have found that Fraser fir seedlings grown in ground beds on the west coast arrive here with *Phytophthora* infestations. Planting such stock in a Michigan nursery with heavy soils or during a wet summer has led to rapid loss of the entire planting. Michigan seeded and grown Fraser fir from clean nurseries that fumigate their beds prior to planting are not infested. West coast stock grown in soil-less media in greenhouses generally are not heavily infested. I have been campaigning among the Christmas tree growers suggesting they buy only Michigan sowed and grown Fraser fir. This is particularly important because Fraser fir is the only fir that is so susceptible to *Phytophthora* that infected harvest-size trees can collapse and die rapidly in wet years such as 1992. Treatment with fungicides to save them is not cost effective due to the large amount of chemical needed to drench the root zone and the high cost of the chemical.

Other true firs and Douglas fir can die of *Phytophthora* root rot when they are seedlings and these also arrive from the west coast "disease-free" but not "pathogen-free." However, transplant mortality is seldom greater than 5 percent so most Michigan nurseries have not noticed the

mortality. These trees will seldom die after outplanting in Michigan so the consequences of importing the pathogen are not noticed by the Christmas tree grower.

Nursery managers should reflect here on what could build up in their soils if they do not fumigate and do import western and southern transplants ("southern" meaning Tennessee and "western" meaning coastal and arid states]. Christmas tree growers might also reflect on the wisdom of following a Douglas fir rotation with a Fraser fir planting. We do not know whether *Phytophthora* might increase in field soils from rotation to rotation in Michigan because we have not experienced the spreading of the pathogen along waterways and down slopes as is common in the west.

I have found that unfumigated nursery beds in Michigan accumulate low levels of infestations of two species of *Phytophthora* and other rare soil pathogens such as *Macrophomina* and nematodes. Occasionally Michigan nursery soils have become heavily infested with *Diplodia* or *Cylindrocladium*, two very damaging pathogens. *Verticillium* also can occur at high concentrations in field soils particularly if the fields had once been mint or potato farms.

Verticilliwn has a large host range and is known to be particularly hard to eliminate from soils, even with fumigation. *Cylindrocladium* is a very destructive pathogen, particularly on pines and spruce and fumigation often fails to eliminate it. Fumigants of choice for eliminating these two pathogens are those that contain the highest levels of Chloropicrin. *Cylindrocladium* often arrives on southern Rhododendrons as an unnoticed leaf pathogen but becomes a root pathogen of conifers in the north. *Diplodia* arrives from nearby Austrian or red pine landscape and windrow trees but becomes a vicious root and stem cankering pathogen on conifer seedlings and transplants. *Diplodia* is readily eliminated by fumigation or crop rotation if the source trees are removed.

Some pathogens such as *Fusariwn* and *Rhizoctonia* are readily killed by fumigation but recolonize fumigated soil so aggressively that they may become a worse problem than prior to fumigation. These two pathogens, particularly *Fusarium*, are carried on seed coats and failing to coat seeds with fungicides prior to sowing to fumigated soil can erase all benefits of fumigation in regard

to pathogens. Adding biological control amendments such as commercial products containing Gliocladium or Trichoderma directly to newly fumigated nursery beds should greatly improve biological control of such diseases by preventing the recolonization of the beds by pathogens.

Phytophthora and *Pythium* spread through nurseries whenever rains or irrigation leave saturated soils, standing water in puddles, or when clean soils come in contact with contaminated soil or water. Other pathogens that cause root rot spread when clean soils contact contaminated soils or contaminated water. Pathogens that cause foliar disease are spread by overhead irrigation or rainfall. The following practices in nursery design and management may appear excessive to Michigan nursery operators but have been adapted in other states through necessity because their climates and soils did not provide as much protection from devastating disease as ours have. The practices include construction of platforms to store clean media and pots, construction of the nursery production area, and drip irrigation. The potential problems of recycling pond water are also discussed.

Ideally in order to prevent disease spread the nurseries potting soil storage area should be a large high dry sloped concrete pad. Soil and fumigated (or clean) pots and containers should he stored on the pad together. Ideally the soil moving equipment should also remain on the pad. The same equipment used to carry clean soil and pots should not he used to carry away dead or rogued diseased potted plants and soil. When possible the entire area should he covered to prevent rains from saturating the soil mix.

Ideally in order to prevent disease spread the pots and containers in the nursery production area must be off the ground away from contact with contaminated soil. The production area should be constructed to have a high crowned center and a slope of about 6 inches per 25 feet. The surface should be compacted and covered by plastic sheets and gravel to prevent puddling. Drainage ditches should be at the edges to carry away runoff.

To prevent the spread of foliar pathogens sprinkling irrigation should be done in early morning so that the foliage might dry before evening. The faster foliage drys the less likely fungi or bacteria pathogen can penetrate or enter the leaves. Spacing plants to permit air movement helps also and this practice is particularly beneficial in Michigan with potted Rhododendrons. But ideally nurseries should go to drip irrigation of pots. Nurseries that grow numerous cultivars of junipers yearly see the dramatic differences in cultivar susceptibility to the Juniper twig blight pathogen *Phomopsis*. The more susceptible cultivars become heavily damaged by the disease and are no longer carried by the nursery or are treated heavily with fungicides. Drip irrigation prevents such disease spread unless yearly rainfall highly favors it. Drip irrigation therefore is of more benefit in dry climates but this method of irrigation uses less water and may help reduce nitrate leaching into ground water or excessive runoff returning to the pond.

Recycling pond water is an increasing practice in Michigan nurseries. It has its benefits hut problems can arise. The most serious problem can be the recycling of herbicides that have entered the pond water in runoff. Also nitrates are recycled and these can confuse your fertilization schedule. In our northern area irrigation of plants with pond water may add excessive nitrogen fertilization in the early fall and interfere with the plants ability to reach winter hardiness. Pathogens, of course are recycled and can multiply in pond water, particularly *Pythium* and *Phytophthora*. Nurseries in North Carolina and on the west coast have significant experience in attempting to kill these pathogens by injecting gaseous chlorine into the water as it is being pumped. The chlorine needs to be alpha- and beta-dynes at 0.5 ppm. However effective chlorination requires that the water be stored with the chlorine for at best 4 hours and at least 20 minutes. Little is known about bromine treatment. Generally I am hearing of poor success with chlorination at the southern nurseries and pathologist are now suggesting that the recycling of pathogens may be more readily decreased by having the pond water intake pipe a minimum of three feet below the surface of the water.

Preventing disease spread in the propagation bench was best controlled in the past when nurseries steam sterilized their soils in situ by way of steam pipes under or over the propagation beds. Without steam, soil in propagation benches is too heavy to physically remove and replace between each cycle of use. Pathogen populations increase and become an excessive problem. It is not generally possible to use soil fumigants inside propagation houses because they are seldom empty of growing plants. More and more nurseries have adapted the use of perlite for a medium to stick cuttings in for rooting. It is clean and easily removed and replaced, but benches still must be disinfected.

With perlite as with other media the disinfection of all wood surfaces and working surfaces in the propagation area is essential in preventing disease spread. Quaternary ammonium chlorides (sold under frequently changing names such as "Physan") are perhaps the best because of efficacy, safety and low phytotoxicity. Formaldehyde at 37% was often used in the past particularly for dipping pots and tools in to kill pathogens. Such solutions were generally stored in large covered trash cans for many months. Formaldehyde was very effective but unfortunately many workers develop allergy or sensitivity to very low concentrations of the chemical in the air. 10% household bleach is very useful but when applied to wooden benches chlorine gas is released which is unhealthy and will damage many sensitive plants nearby in the same house. Buying wood that is pretreated with chromic-copper arsenicals or copper naphthenate is important in preventing pathogenic fungi from growing on wood surfaces. However, chromic treated wood is now considered a hazardous waste when discarded.

Today many nurseries grow tree seedlings in styroblocks in soilless media. The styroblocks are most easily cleaned between growing cycles by fumigation. With these clean practices one would expect disease-free plants particularly when preventative fungicide drenches such as Banrot are used. However, the weak link in this system is the seed. We receive blocks of these seedlings with disease and are asked for disease diagnoses. Often one seedling will be found to have died of one pathogen,

another from a different pathogen, etc., so that up to four or five fungal pathogens may be involved causing just occasional and widely separate diseases. These fungi are on and sometimes in the seed coat and coating seed with fungicide before planting prevents these disease occurrences.

Some government people have been discouraging their nursery operators from using fumigation in the last 5 years. I strongly oppose this view. Fumigation of nursery beds and containers eliminate pathogens and weeds from a small area of land that is very densely planted, and help in the production of pathogen-free plants. Heavy use of fungicides and other pesticides in the nursery bed, I also strongly support. By professionally applying pesticides and fumigants on these very limited acres of plants we often prevent the need for application of large amounts of pesticide over large areas of land such as in Christmas tree plantations and landscapes not to mention eliminating much of the need for nonprofessional applications of pesticides in home yards and landscaped gardens.

The great majority of pesticide usage in Michigan on woody ornamental and landscape plants is due to the purchase of infected but "disease-free" symptomless plants.

There are many examples among the foliar pathogens of conifers and these examples concern extensive plantings due to Michigan's enormous Christmas tree and landscaping industry.

A number of foliar pathogens have spread by way of infested nursery stock, and now the diseases are statewide and very costly to control. We know they were spread from nursery stock because of the characteristics of the particular fungi. For example the needle cast of spruces, particularly Colorado spruce, is caused by a fungus *Rhizosphaera* which spreads by way of rain splashed spores that are not blown distances by wind. These spores are killed quickly (within a week) by sunlight ultraviolet waves and cannot survive a day of dry weather. The disease spreads only from neighbor tree to neighbor tree and is so sensitive that it seldom is able to infect any needles except those on the lowest branches of the tree, where leaves remain wet by dew or rain for longer periods of time than those needles higher in the canopy. The pathogen fails to spread from one plantation

to another. However, nursery stock, usually stock grown near spruce windbreak rows and shelter belts, becomes entirely infected but shows absolutely no symptoms visible to inspectors or growers. The reason no symptoms generally are seen at the nursery is due to the nature of the disease. In conifers, needle pathogens infect newly expanding needles but do not discolor or cause the needles to shed until the needles are generally 2-3 years old. The primary needles generally do not become infected because the seedlings are not yet crowded enough for leaves to remain wet sufficiently long for infection to succeed. Therefore nursery seedlings that are infected do not show symptoms unless they remain beyond 3 years in the establishment.

Swiss needlecast of Douglas fir and *Dothistroma* needleblight of Austrian pine are similar diseases caused by rain splashed foliar pathogens that are difficult to detect in nursery stock. When such pathogens appear in Michigan we assume that they at one time were imported with the plants because the fungi are found only on the exotic host plant. *Lophodermium* and *Cyclaneusma* pathogens on scotch pine and *Diplodia* on Austrian and Scotch pine are fungi with airborne spores that were likely imported more than once hut have spread statewide on the winds. Recent research has found that the *Diplodia* on Austrian, Mugo and Scotch pine is genetically different from native strains that occur in Jack and Red pine woods.

Trees used as wind breaks and shelterhelts are a common source of pathogens potentially infecting seedlings. Nurseries with Scotch pine trees serving as wind breaks can spell disaster to Christmas tree growers who buy infected Scotch pine seedlings. But finding a species of tree suitable for wind rows is difficult because of the wide range of species grown in nurseries in Michigan. Spruce and red cedar are perhaps the most common species employed in wind breaks. Both are unsuitable because they harbor diseases and both are widely purchased as nursery seedlings and planted in Michigan. *Thuja* may be a better choice. We greatly need to develop a list of suitable plants for planning plantings at new nurseries or for replacing existing trees. Hopefully we can identify some plants that would not have the potential of harboring either diseases or insects that

growing stock are susceptible too. But then again such plants may exist only in dreams of utopia.

Exotic pathogens we have avoided include the Brown spot needlecast fungus that attacks Scotch pine in Wisconsin and *Hypoderma lethale* on Austrian pine in Pennsylvania *Rhabdocline* on Douglas fir has entered the state but has not spread. All cause devastating diseases.

Routine applications of broad spectrum fungicides to nursery seedlings would be expected to dramatically decrease the spread of many of these diseases to Michigan Christmas tree plantations. What are needed in addition to fungicide preventative programs are methods to determine when nursery stock is infected but symptomless. Such methods would also improve research evaluations, of effectiveness of different fungicides, of different application timings, and of different formulations. Current research at Michigan State University is aimed at developing sensitive detection systems to identify when conifer needles have become infected by pathogens, years before the damage becomes apparent.