Managing True Fir Root Rots

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During the past 30 years there has been a significant increase in the production of true fir (*Abies*) Christmas trees. Fraser and noble fir have excellent postharvest moisture and needle retention characteristics and probably account for 35 to 40% of the total U. S. production. In the Pacific Northwest (PNW), slightly over half of the 13.2 million trees that are annually harvested are true firs with noble fir accounting for about 45% of the production. Since true fir production increased in the early 1980's, many growers have experienced problems with several root rot diseases. In most production areas, Phytophthora root rot is a common problem in many new plantations. With the increased production of Fraser and noble firs, which are very susceptible to Annosus root rot, and the increase in second and third rotation true fir plantations, this disease and Armillaria root rot have become more prevalent in some production areas.

Root rot symptoms – Above-ground symptoms associated with these root rots can include a general discoloration or yellowing of needles, delayed bud break, branch flagging, wilting of new growth, and death of the tree. There may or may not be any apparent reduction in the growth of diseased trees before they are killed. Symptoms may appear on trees within a couple of years of planting or near the end of the rotation. In some cases, infected trees do not show any above-ground symptoms prior to harvest. A dark staining of the older wood, which indicates that Annosus root rot is present, may be evident on the stump at the time of harvest.

General symptoms associated with Phytophthora, Annosus, and Armillaria root rot can be difficult to distinguish from each other as well as some types of cultural and/or environmental stress problems. Root diseases tend to occur in pockets in the field. In the case of Phytophthora root rot, which requires high levels of soil moisture, it tends to be limited to poorly drained areas or where there have been episodes of flooding. Symptomatic trees will generally have a canker just below the bark that extends up the stem of the tree. If symptoms are caused by Armillaria root rot, the trees will generally have a white fan-like fungal growth just below the bark near the base of the tree and/or the presence of dark root-like rhizomorphs on the below-ground portion of the trunk and roots. To distinguish Annosus root rot from Phytophthora and Armillaria root rot, growers can cut the tree off at the soil line and look for staining of the stump. If the stump and roots are dug, Annosus-infected trees may also have cream to buff-colored fruiting structures on the stump near the soil surface or on infected roots. Initially, it may help to send samples to a plant clinic for identification.

Distribution and impact - In an effort to better understand which root diseases are currently associated with noble fir tree mortality, a survey of noble fir plantations western Oregon and Washington was conducted during the 2000 growing season. Of the 67 plantations surveyed, 57 had dead trees with suspected root rot problems. Phytophthora, Annosus and Armillaria root rot accounted for about 83% of these dead and dying trees. Phytophthora root rot and stem canker occurred in 37.7% of the sites, Annosus root rot was found at 23.9% of the sites, and Armillaria root rot was found at 17% of the sites. Estimated mortality associated with these root diseases ranged from <1 to 30%. This survey indicates that Phytophthora root rot is still a common disease on noble fir Christmas trees in the PNW and that Annosus and Armillaria root rot have increased during the past 20 years.

Recent field observations and WSU-Puyallup Plant Clinic samples also indicate that Annosus root rot is causing mortality in plantations of other species, including Douglas-fir that have been planted next to stumps from a previous true fir crop. Annosus root rot has also been observed in a young noble fir seed orchard as well as former Christmas tree stands that have been converted to bough production.

The ability to produce high quality true fir Christmas trees, such as noble fir, gives growers an advantage in today's highly competitive market. If growers are going to be able to sustain the production of true fir Christmas trees, they need to utilize an integrated approach to managing these root diseases. In the case of Annosus and Armillaria root rots, it is likely that this will include removal of stumps and roots prior to replanting fields. Specific information relating to the development and management of each of these root rots follows. **Remember, prior to using any chemical treatment, examine the label and check with local authorities to ensure proper and legal use of the product.**

PHYTOPHTHORA ROOT ROT AND STEM CANKER

Phytophthora root rot and stem canker is a serious problem typically encountered within the first 3 to 4 years following the planting of noble fir seedlings in the PNW. Some growers report losses of 30% to 50%, particularly in low areas with saturated soils. At least eight species of *Phytophthora* have been associated with diseased trees in the PNW, but they vary in their ability to cause disease and in their distribution throughout the PNW.

Phytophthora spp. produce motile spores (zoospores) that swim in water. These spores are attracted to elongating or wounded rootlets where they incyst, germinate, and infect the root. The fungus spreads up the roots killing the cambium and inner bark. Once the fungus reaches the tree trunk, narrow cankers extend up the side of the tree, resulting in the death of branches. Eventually the cankers expand at the base of the tree, girdling the entire trunk and killing the tree. Some *Phytophthora* spp. produce resting spores in infected roots that enable the fungus to survive in the soil between crops or during unfavorable periods. Both resting and motile spores may spread in surface runoff or in irrigation water. In the presence of host roots or shoots, the spores germinate to repeat the disease cycle.

Phytophthora spp. also can cause a shoot blight when Christmas trees are overhead irrigated.
This occurs when growers use contaminated irrigation water or when overhead irrigation splashes infested soil onto the lower branches of the tree.

Phytophthora spp. can attack a number of species of true fir, true cedars, white cedar, large cone pines, spruce, yew and Douglas-fir in nurseries. However, in PNW Christmas tree plantations, most of the damage appears in plantings of noble fir. Shasta fir, white fir and Fraser fir also are highly susceptible to Phytophthora root rot. Shoot blight has been observed on noble, alpine, Algerian, balsam, red and white firs. Some true firs in greenhouse tests have shown limited susceptibility to Phytophthora root rot. They include Turkish, European silver, Veitch, Momi, and Nordmann fir.

Disease management - Because of the importance of high soil moisture in the development of this disease, avoid wet areas when planting highly susceptible conifer species. Growers can alleviate these conditions by installing drain tiles or possibly planting in raised beds. Avoid overhead irrigation to prevent shoot blight. If shoot blight damage is limited, you can remove affected branches below the infected area and destroy them.

Because of the potential for Phytophthora root rot in bareroot nurseries, growers should only buy their seedlings from reputable companies. Few cultural options can control this disease once it has been introduced into a Christmas tree planting. Removal of dead trees, while having little impact on disease spread, will improve the appearance of fields when you show them to buyers.

Soil fumigation is commonly used in nurseries to control Phytophthora root rot, but this technique is generally not practical in a Christmas tree plantation. Applications of selective systemic fungicides are registered for use in nurseries, but these materials have not been effective in controlling the disease in most Christmas tree situations.

ANNOSUS ROOT ROT

Although considerable information is available regarding Annosus root rot in forest situations, very little information is available concerning its development and the extent of losses that growers might expect as a result of this disease in Christmas tree plantations.

During 2001, 19 field plots were established to obtain a better understanding of the extent of mortality that can result from Annosus root rot. About 31,000 trees that had been planted between 1997 and 2000 were examined for above-ground symptoms such as branch flagging, wilting, and death. The percentage of symptomatic trees in these plots ranged from 0.3 to 13.6%. If missing and replanted trees were included, the maximum percentage reached 29.9%. Annosus root rot was associated with 87.8% of the dead and dying trees in these plantations and was detected on noble, Fraser, Nordmann, and grand fir, as well as Douglas-fir. Noble and Fraser fir appear to be very susceptible to this disease. These field plots will continued to be monitored through harvest to determine the rate of disease spread and level of mortality due to Annosus root rot, but it is clear that this disease is already causing thousands of dollars in losses in some fields.

Annosus root rot is caused by the fungus, *Heterobasidion (Fomes) annosum*. It spreads via two methods. Initial infections in Christmas tree plantations probably occur when fruiting bodies on diseased trees and stumps in nearby forests release airborne spores that colonize freshly cut stumps or wounds on trees in plantations. In forest studies, spore dispersal has been shown to occur throughout the growing season, but is greatest in the fall when Christmas trees are harvested.

Once the disease becomes established in a Christmas tree plantation, fruiting structures can be produced on trees or stumps and once again spread the disease to nearby freshly-cut stumps during harvest. After the spores land on freshly-cut stumps, which are susceptible to infection for only a short period of time, they germinate and begin to colonize it. The fungus spreads to the stump's roots and then into the roots of adjacent healthy trees that are in contact with the colonized roots. In addition, seedlings can also become infected when their roots come in contact with the diseased roots and stumps left over from the previous crop. Unlike a needle cast disease that can build up quite rapidly, the buildup of Annosus in a plantation takes place over a period of years.

Disease management - Limited information is available regarding the effectiveness of the various control practices that are used in forest situations to control this disease in Christmas tree plantations. Stump treatments are often recommended to protect freshly-cut stumps from infection by spores in forest situations and are likely to be beneficial in Christmas tree plantations. Preliminary data from a laboratory trial indicates that covering stump surfaces with Sporax, a 20% urea spray mixture, or soil right after cutting appears to be effective in preventing infection of the stump by spores. Work is underway to confirm the effectiveness of these treatments under field conditions. If growers are going to treat stumps, it must be done when the trees are cut.

One of the most effective cultural methods of controlling Annosus root rot in forest settings is the removal of stumps and roots prior to replanting. The effectiveness of this method is dependent on the size of the residual pieces of stumps and roots that are left in the field. The fungus that causes Annosus root rot does not compete well against other microorganisms that are present in the soil. Thus its potential to cause disease in a new planting is largely dependent on the size of the pieces of infected roots and stumps that are left in the field, the susceptibility of the newly planted trees, and the time it takes for the seedling's roots to come in contact with infected roots and stumps. Trials are currently underway to examine the effectiveness of the various types of stump/root extraction or grinding equipment that are available for use in Christmas tree plantations that may help to control this disease. The use of a fallow period and/or various cover crops following stump removal may also be beneficial in limiting the amount of inoculum that is present at the time of planting.

One of the important questions is how many diseased trees can be present in a field before a grower needs to think about removing all of the stumps and large roots prior to replanting. If a grower plants a susceptible species next to a diseased stump, it is likely that this tree will be killed prior to harvest. What is unknown at this point is how many of the nine replanted trees surrounding the diseased stump will be killed prior to harvest. In some cases it might be all of them. This would mean that for every diseased stump that a grower sees in the field, they may lose from 1 to 10 of the trees that are replanted around each stump. Clearly, if there are many diseased stumps in the field at the time of harvest, growers need to remove them and as many of the roots as possible prior to replanting in order to minimize future losses.

It is interesting to note that in our 2001 study, in the five fields where no Annosus root rot was found, three of them had had the stumps and larger roots from the previous rotation removed prior to planting noble, Fraser, and grand fir seedlings. While it is not realistic to expect that stump removal will eliminate Annosus root rot, it is likely that it will reduce the extent of losses from this disease. Stump removal may also have some additional benefits such as reducing soil compaction which improves the growth of replanted trees. Where it is not practical to remove stumps, it may be possible to limit disease spread by digging a 2 to 3-foot-deep trench to isolate infected trees. This would prevent the roots of the healthy trees from coming in contact with those of the diseased trees.

ARMILLARIA ROOT ROT

The fungus disease Armillaria root rot can be a serious problem in Christmas tree plantations. Trees established on land recently cleared from forest stands where Armillaria root rot was present are at particular risk. Although there are at least 12 different species of *Armillaria* that have been described as the cause of root rots on numerous host plants, *Armillaria ostoyae* is considered the aggressive pathogen that attacks conifer species in western forests. Most conifers that are grown as Christmas trees are susceptible to this disease. Because of the white mycelial fans and rhizomorphs associated with diseased trees, this root rot can easily be diagnosed in field situations.

Armillaria can survive for extended periods of time (decades) in infected stumps and roots. The fungus can spread by means of the root-like rhizomorphs to adjacent plants where new infections are possible. Rhizomorphs are branched and have white interiors made up of

tightly packed fine mycelial strands of the fungus. An outer rind surrounds the rhizomorph. It is first brown and eventually becomes dark brown to black. The decaying roots and stump provide the fungus with the needed energy to spread and cause further infections.

During the fall of the year in mild climates, mushrooms arise from the decaying roots and rhizomorphs following moist weather. These honey-colored to tawny brown mushrooms stand 2 to 6 inches tall with caps that vary in size from 1½ to 6 inches. The spores produced from the gills of these mushrooms are thought to be of little importance in the life cycle of this pathogen. Germinating spores could possibly infect stumps or wounded roots but the primary means of spread of this disease is by the rhizomorphs.

Disease management - Growers will need to evaluate the management practices outlined below for their particular situation. In Christmas tree plantings, it may not be economically practical to follow some of these practices. In some situations, abandonment of Christmas tree production might be the only alternative in sites having a high *Armillaria* population.

- Avoid establishing plantations in areas where the previous stand of trees showed symptoms of Armillaria root rot.
- Avoid planting sites likely to result in tree stress, such as those excessively wet or prone to drought. Provide adequate nutrient levels for good tree growth.
- Establish plantings using local seed sources. These may have some resistance to the local strain of *Armillaria.*
- If the disease is already present, remove and destroy stumps and roots of diseased trees. The more thorough this removal, the greater the degree of control. This practice may not eliminate the disease from the site, but it should limit losses since the trees will likely be harvested before the disease has had time to spread from tree to tree. Trenches that are 2 or 3 feet deep can also be dug to isolate infected trees. The trench inhibits the spread of rhizomorphs from the infected tree and prevents healthy roots from invading the infested area. A plastic barrier or root curtain can be placed in the trench to allow backfilling for safety or aesthetic reasons.
- Soil fumigation prior to planting to eliminate the fungus from soil and small root fragments left in the field after removal to the stumps and large roots. Good soil preparation are necessary to ensure the effectiveness of these fumigants.

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