The Old and the New:
Two Needle Diseases of Spruce in North Dakota

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Spruce (*Picea* spp.) is commonly planted in urban and rural landscapes in North Dakota and frequently suffers from needle loss. In general, healthy spruce retain four or more age classes of needles (Fig. 1). Over time, older needles get shaded out by younger needles, resulting in natural shedding of some older needles each autumn. Premature needle loss of spruce is the result of a variety of causes: improper planting, environmental stress, insect pests and disease. Rhizosphaera needle cast and stigmina needle cast are two of the most common diseases associated with premature spruce needle loss in North Dakota (Fig. 2).

Needle diseases cause the most damage when the needles on the lower branches, the shady or wind-protected side and the interior crown stay wet for extended periods or when irrigation water contacts trees. If conditions favor disease development, the symptoms typically progress from the areas that are the most favorable to those that are less favorable during the course of several years (Fig. 2). This may result in only the current-year needles remaining green (Fig. 3), giving trees a sparse and hollow appearance.

Rhizosphaera needle cast and stigmina needle cast infect Colorado blue spruce (*Picea pungens*), white spruce (Black Hills) (*Picea glauca*), Norway spruce (*Picea abies*) and Meyer spruce (*Picea meyeri*). Both diseases have similar signs and symptoms but can cause different amounts of damage and require somewhat different management strategies, making disease diagnosis essential.

Both pathogens may be present at the same location and even on the same needle. Confirmation of pathogen identity usually requires microscopic observations and measurement of the spores. With experience, Stigmina can be distinguished from Rhizosphaera using a hand lens if there is good sporulation, except about the two days after a washing rain. Rhizosphaera cannot be reliably identified using a hand lens. For a small fee, samples can be submitted to the NDSU Plant Diagnostic Lab for disease identification. See www.ag.ndsu.edu/pdl for instructions on how to submit a sample and a mailing or shipping address.

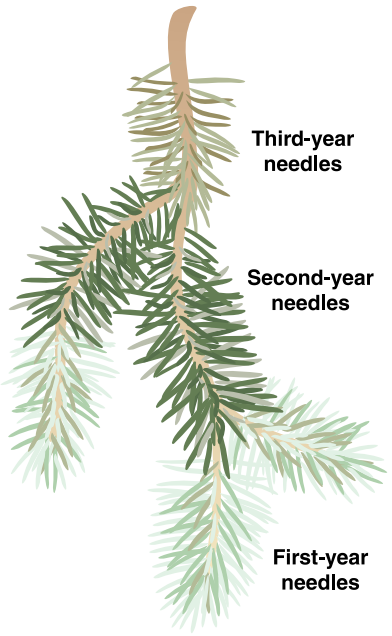

Fig. 1. A diagram of a spruce branch depicting three different age classes of spruce needles.

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Fig. 2. Spruce trees infected by a needle cast disease with typical needle loss symptoms on the bottom two-thirds of each tree.

Fig. 3. Two spruce branches showing the typical range of needle cast symptoms on infected needles.

Rhizosphaera Needle Cast

Rhizosphaera needle cast is caused by the fungus *Rhizosphaera kalkhoffii*. This historically has been the most common spruce disease in North Dakota.

Signs and symptoms of the disease – The first symptom that appears is a faint yellow band on a needle. The band expands and, in as little as two months, changes from yellow to brown to reddish brown or purple. Discolored needles may fall off the tree by the spring after infection or remain attached for up to two years. The characteristic sign of this disease is rows of small dark brown or black smooth spherical fruiting bodies (pycnidia) that emerge through the stomatal pores on all sides of infected needles (Fig. 4). Pycnidia are observed easily with a hand lens when mature. On severely infected needles, the pycnidia may appear to the naked eye as continuous fine black lines up and down the length of the needle. When severe, thinning of the foliage commonly occurs on the lower one-fourth of the crown of shaded trees.

Disease cycle – Rhizosphaera needle cast has a one-year life cycle. In North Dakota, pycnidia produce spores in late May through July. These spores are spread by splashing water and will infect all age classes of needles. The first symptoms of the disease on newly infected needles will not appear until spring of the following year. Pycnidia often appear by late May, and spores are produced soon after. Needles that remain attached to the tree and those that recently fell to the ground may continue to produce spores.

Disease management

Species selection – Spruce species and individual trees within each species generally have different levels of resistance to rhizosphaera needle cast. Colorado blue spruce are the most susceptible, white spruce are intermediate and Norway spruce are resistant. Meyer spruce appears to be relatively resistant to rhizosphaera needle cast, but more research is needed. If rhizosphaera needle cast is a concern, consider planting Norway, white or Meyer spruce. However, white spruce appears to be highly susceptible to stigmina needle cast. Because needle cast fungi are often present on larger trees even when the fungi cannot be found, to avoid severe infection pressure from Rhizosphaera needle cast, do not plant susceptible spruce trees within about 75 feet of spruce trees that are 15 or more feet tall.

Cultural control – Ensure adequate spacing between trees, maintain new spruce trees in sunny locations so needles dry quickly, facilitate air movement to promote needle drying by pruning lower branches of spruce trees and ensure that irrigation water does not wet trees in the early morning or late evening. Removal of severely infected trees or branches will reduce the source of spores causing new infections. Interplanting different tree species among spruce trees also will help limit the tree-to-tree spread of this disease. Carefully inspect any new spruce trees that will be planted to ensure they are free of signs and symptoms of the disease. Finally, maintain vigor by including supplemental fertilization

if needed, avoiding sites or conditions too wet or dry for spruce, avoiding damaging herbicide application near the tree, reducing root competition with other plants and avoiding mechanical damage to tree roots.

Chemical control – Fungicide applications at appropriate times are a management tool for rhizosphaera needle cast. Protect new needles from new infections for a minimum of two months early in the growing season for two to three years. The timing of these applications is extremely important. Complete the first application just after bud break when needles are about half the size of the previous year's needles. Timing of the second application depends on which fungicide is used. Carefully follow all label directions. Protect the new needles for two to three years to allow infected needles to be shed and decompose. Use equipment that is large enough to get fungicide onto the lower two-thirds of treated trees. Follow label directions for optimum coverage.

Stigmina Needle Cast

Stigmina needle cast is associated with the fungus *Stigmina lautii*. This disease rarely was recognized before 2006, but it now is known to be widespread east of the Rocky Mountains in the United States and Canada.

Signs and symptoms of the disease – Symptom development is similar to that of rhizosphaera needle cast. Infections result in narrow, light yellow bands and immature fruiting bodies that are not easily visible until the following year. Multiple bands and areas of fruiting bodies may develop on a single needle. The bands or entire needles may change color, becoming darker yellow, purple, tan, reddish brown or brown. Discolored needles typically remain attached to the tree for an additional year following discoloration. When severe, thinning of the foliage commonly occurs over the lower two-thirds of the crown of open-grown trees. The characteristic sign of this disease is the fruiting bodies (sporodochia) that appear when mature and sporulating as small, black, fuzzy, round masses in the stomatal pores on all sides of infected needles (Fig. 4). These structures are much easier to detect on green than on brown needles. In North Dakota, sporulation can occur when the temperature is above about 40 F for a few days. Sporodochia are very small and not sporulating from late fall to early spring in North Dakota, making microscopic identification difficult during this period without incubation and detailed spore observations.

Disease cycle – *Stigmina lautii* has a two-year life cycle. On most trees, sporodochia develop by late spring the year after infection, mature that fall and produce spores under conditions that allow infections the next spring. Spores typically develop in the spring when high temperatures are consistently above 40 F for a few days and have been observed to develop as early as mid-March. These spores can infect any age class of needle throughout the growing season whenever temperatures are above about 50 F with free moisture.

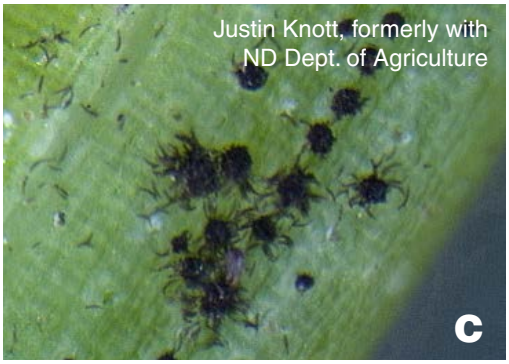

Fig. 4. Comparison of (A) uninfected needle with white stomatal pores, (B) needle infected with *Rhizosphaera kalkhoffii* with characteristic smooth black pycnidia and (C) needle infected with *Stigmina lautii* showing sporodochia and spores. When not sporulating, Stigmina is nearly impossible to distinguish from Rhizosphaera.

Disease management

Species selection – Planting tree species other than spruce should be considered in areas where stigmina needle cast is causing substantial damage (all of eastern and some of central North Dakota), particularly if the disease is present in the same planting. Most Colorado blue spruce and white spruce are highly susceptible. The susceptibility of Norway and Meyer spruce is unclear, although there have been reports of these species infected by *Stigmina lautii*. Meyer spruce can be infected, but all observed trees are relatively young and not in situations where stigmina needle cast has become severe. Royal Splendor® Norway spruce appears to be immune to stigmina and rhizosphaera needle cast.

Cultural control – The cultural control methods described above for rhizosphaera needle cast may reduce stigmina needle cast but are not adequately effective without concurrent chemical control. To avoid severe infection pressure on young trees, do not plant susceptible spruce trees within about 125 feet of spruce trees that are 15 or more feet tall.

Chemical control – For landscape trees, shelterbelts and Christmas tree plantations, protect needles for two months after bud break. Spraying should occur every year to ensure that three or more age classes of green needles are retained on trees (Fig. 1). For nurseries, where certification requires that plants be disease-free, needles should be protected for the entire infection period (about six months in North Dakota, from mid-May to mid-October) until infected needles are no longer found, likely after four or five years.

General Considerations for Spruce Needle Cast Management

Several tools are available for the management of needle cast diseases of spruce. Using them in the appropriate situations and combinations is the best way to reduce the impact of these diseases.

Disease threshold – Determine the threshold of acceptable disease when evaluating whether to implement disease management actions. The threshold differs depending on the expected tree function. A specimen tree may be expected to maintain a full complement of green needles, while trees in a windbreak may achieve their function with substantial needle loss and some branch death. Needle loss that causes growth reduction for two to three years threatens the long-term health of a tree.

Typically, new shoots on a branch will have reduced growth if less than three age classes of green needles are present for two consecutive years. Needle loss caused by these diseases is usually restricted to the lower crown. However, reduced growth in the upper crown also can occur if the bottom one-third of the crown has severe needle loss, retaining less than three age classes of needles for two or more years. The impact on growth also depends on other factors, such as nutrient availability and stress.

Pesticide management of needle diseases – Fungicides labeled for needle diseases prevent new infections, so apply before spores and free moisture are present long enough for infection. Fungicides may be used if they are registered for the target site in the state where applied (for North Dakota, see the North Dakota Department of Agriculture pesticide database at www.kellysolutions.com/nd/pesticideindex.asp. Of these, chlorothalonil was used in North Dakota experiments and proved effective. Before selecting and applying a pesticide, always read and follow the product label; it is the law.

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