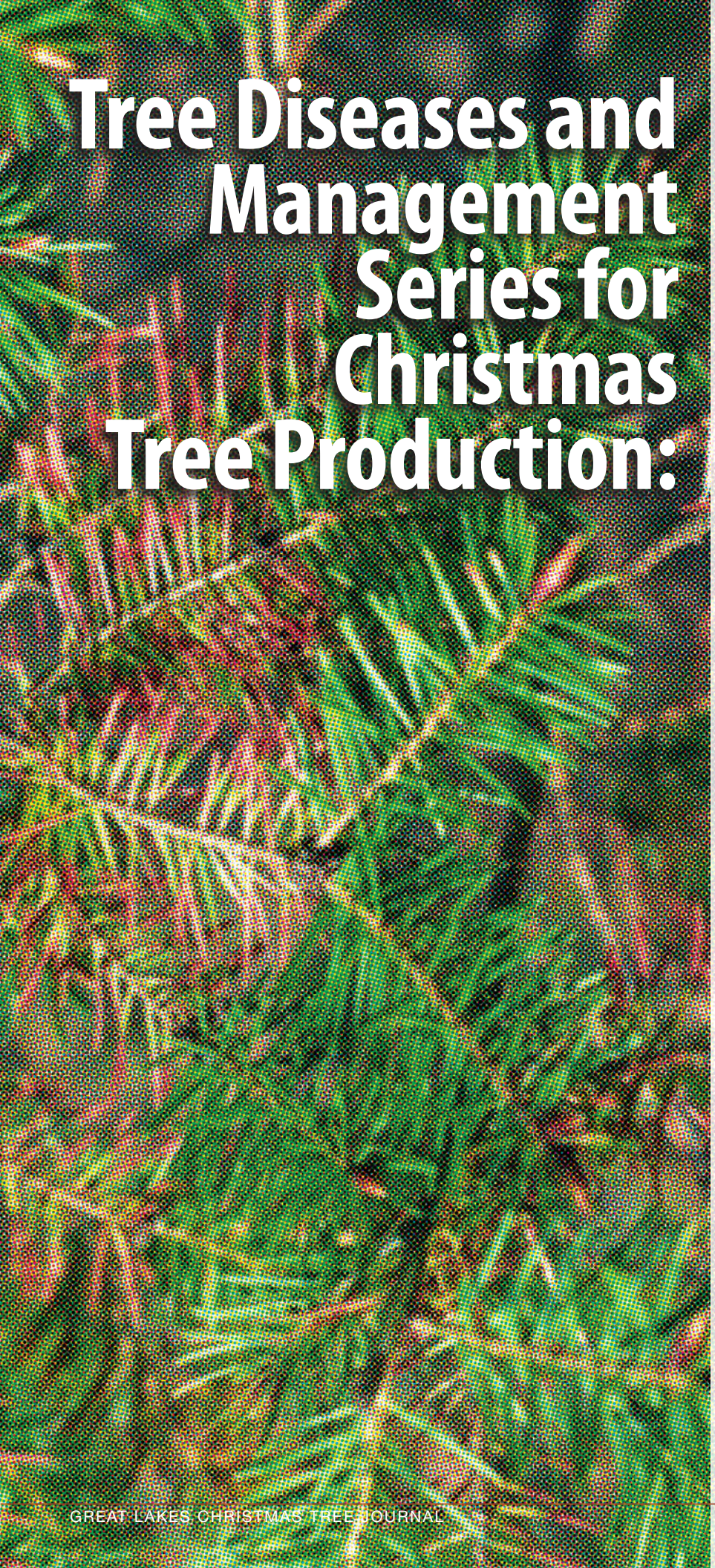

Tree Diseases and Management Series for Christmas Tree Production:

Biology and Management of Needlecast Diseases for Christmas Tree Production

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Introduction

Needlecast diseases present a major challenge for Christmas tree growers, threatening the health, appearance, and marketability of the trees. Caused by various fungal pathogens, needlecasts typically lead to older needles turning brown and falling off, resulting in a sparse and unattractive canopy. Repeated infections can cause branch dieback, further compromising tree health. Trees that appear perfect when tagged for sale in the summer may experience significant defoliation by fall, making them unsellable.

Spread by wind and moisture, needlecast diseases primarily affect evergreen species like spruce, fir, and pine (Kimberley et al., 2011; Lee et al., 2016). Dense plantings in nurseries, plantations, and landscapes provide ideal conditions for these pathogens to thrive. Unlike needle blights, which affect both needles and shoots within the same year, needlecasts result in the gradual loss of needles over time. For needlecast diseases to develop, three key factors must be present: a susceptible host, a virulent pathogen, and favorable environmental conditions, including high humidity and prolonged leaf wetness as shown in the disease triangle (Figure 1).

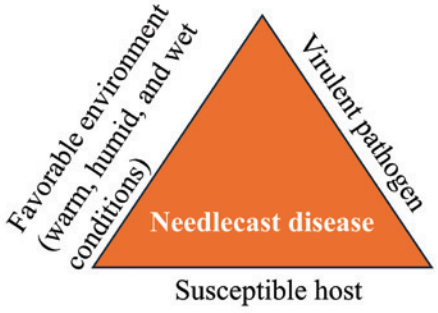

Figure 1 – *Disease triangle showing three factors are important for disease to occur, favorable environment, virulent pathogen, and susceptible host.*

Disease cycle

Needlecast diseases follow a cyclic pattern where fungal pathogens overwinter in infected needles. In the spring, fungi infect young, growing needles. Symptoms typically appear the following spring, and spores are produced later in the season. As the season progresses, these spores are released, continuing the cycle (Figure 2). Infected needles usually shed the year after infection, although some fungi may persist and continue to produce spores even after the needles have dropped (Bergdahl & Hill, 2016).

Not all needlecast diseases follow this exact pattern. Some infect current-year needles, while others affect needles from the previous two years. In certain cases, the fungi spread into stems and branches, leading to dieback or even tree death if defoliation occurs over multiple seasons.

Accurate diagnosis is crucial for managing needle cast diseases. Because spores appear at different times, multiple samples may be needed for lab testing.

Some of the common needlecast diseases in Christmas trees plantations are:

Rhizosphaera needlecast, caused by *Rhizosphaera kalkhoffii,* primarily affects Colorado blue spruce (*Picea pungens*), though other conifers like Norway (*P. abies*) and white spruce (*P. glauca*) and Douglas-fir (*Pseudotsuga menziesii*) can also be susceptible. Early symptoms include purpling or browning of the innermost needles on lower branches, while the youngest needles at the branch tips often remain unaffected. A key sign of infection is the presence of small black spheres, the fungal fruiting bodies, which appear in rows along the underside of affected needles (Figure 2A; Bergdahl & Alison, 2016).

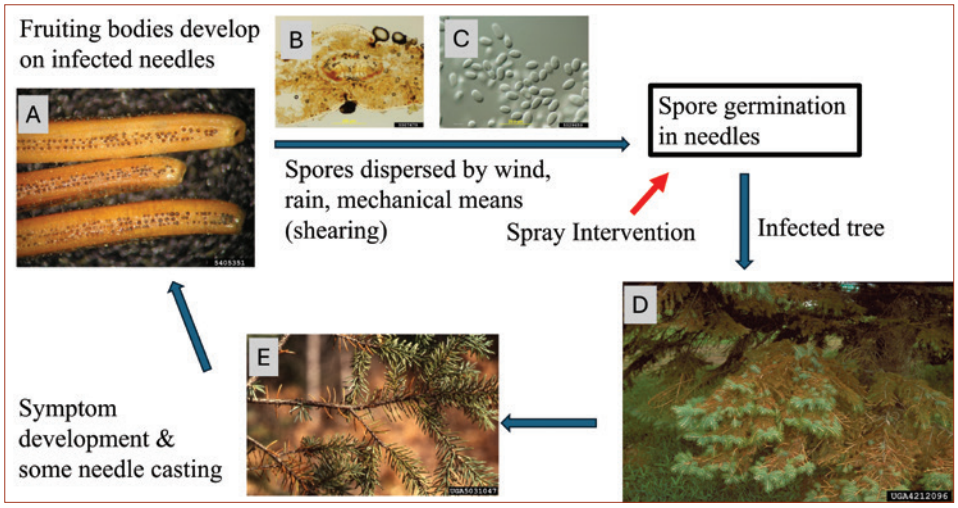

Figure 2 – *Disease-cycle of Rhizosphaera needlecast on Spruce: A: Brown, infected needle with fruiting body of the fungus, Picture source (PC): Paul Bachi, University of Kentucky Research and Education Center, Bugwood.org; B: Cross section of needle showing fungal fruiting body, PC: Bruce Watt, University of Maine, Bugwood.org; C: Asexual Spore, PC: Bruce Watt, University of Maine, Bugwood.org; D: Rhizosphaera needlecast symptoms on Spruce, PC: USDA Forest Service, Bugwood.org; E: Infected foliage, PC: Joseph OBrien, USDA Forest Service, Bugwood.org.*

Stigmina needlecast is caused by *Stigmina lautii* and primarily affects blue and white spruce, though it has also been reported on black (*P. mariana*) and Norway spruce. Its symptoms, including needle browning and premature drop, closely resemble those of Rhizosphaera needlecast, often leading to misdiagnosis. A key sign for identification is the appearance of fungal fruiting bodies. *Stigmina lautii* produces irregular, fuzzy structures, while *Rhizosphaera kalkhoffii* forms smooth, neatly aligned rows on the underside of needles. Microscopic examination is often necessary for accurate diagnosis (Bergdahl & Alison, 2016).

Swiss needlecast (SNC), caused by fungus *Nothophaeocryptopus gaeumannii,* affects Douglas-fir. Infected trees develop yellowing and browning needles, with black fruiting bodies forming in stomatal rows on the undersides of needles. These fruiting bodies appear as two tiny bands of structures on chlorotic or brown needles (Figure 3). Unlike other needlecast diseases, SNC often causes trees to retain infected needles for several years before they drop. Symptoms typically become noticeable 2 to 3 years after infection (Mulvey et al., 2013; Ritóková et al. 2021).

Rhabdocline needlecast, caused by *Rhabdocline pseudotsugae,* primarily affects Douglas-fir trees. Symptoms appear in late summer or fall as yellow or reddish-brown spots on both the upper and lower surfaces of the current season's growth (Figure 4). Affected needles may develop multiple spots that enlarge over time, potentially covering the entire needle. By late spring, the lesions swell and split lengthwise on the

needle undersides, releasing fungal spores that spread via wind and rain. The fungus infects young needles in the spring, with fruiting bodies producing spores the following year, continuing the infection cycle. In severe cases, trees may lose a significant portion of their needles by early summer.

Lophodermium needlecast caused by pathogenic species of *Lophodermium* is commonly prevalent in forest nurseries, Christmas tree farms, and landscaped areas. Scotch pine (*Pinus sylvestris*), red pine (*P. resinosa*), Austrian pine (*P. nigra*) and Eastern white pine (*P. strobus*) are susceptible to the disease. Infected Scotch pines develop irregular brown spots with yellow borders on their needles (Figure 5). In severe cases, the infection can cause entire trees to turn brown before bud break.

Managing Needlecast Diseases

To effectively manage needlecast diseases, it is essential to disrupt at least one component of the disease triangle. By doing so, growers can implement proactive strategies to prevent and control infections.

Plant disease tolerant tree species: Selecting tree species that are more resistant to needlecast diseases can help minimize the risk of infection. For example, needlecasts are less common on true firs (*Abies spp.*), so concolor fir (*Abies concolor*) may be a good alternative for growers that are struggling to control needlecasts in Colorado blue spruce or Douglas-fir.

Site selection and establishment: Choose locations with acidic, moist, well-drained soil and full sun exposure. Consider the spacing and number of trees planted per acre. A less dense tree planting will improve air circulation. Basal pruning and good weed control will also improve air circulation. Good air circulation helps reduce moisture and prevent fungal growth. Avoid overhead watering to minimize needle wetness, which contributes to disease development.

Monitoring and removing infected needles and trees: Regular monitoring and early intervention are crucial for preventing widespread infections. Since infections occur at least a year before symptoms appear, promptly removing and destroying infected needles reduces the spread of spores. Avoid leaving live branches on stumps after harvesting, and do not shear trees during wet weather. Always shear healthy trees first and disinfect tools frequently.

Chemical control: Monitoring needlecast levels in your plantings is essential before beginning a spray program. To determine if chemical management is necessary, inspect needles for fungal fruiting bodies, which produce spores that infect new growth as buds break. Fungicide

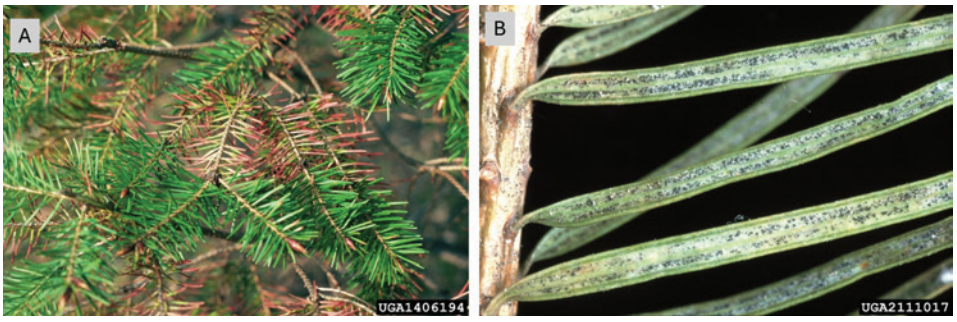

Figure 3 – *A: Douglas-fir showing symptoms of Swiss needlecast disease, PC: USDA Forest Service - North Central Research Station, USDA Forest Service, Bugwood.org; B: Fungal fruiting bodies on Douglas-fir needles, PC: Petr Kapitola, Central Institute for Supervising and Testing in Agriculture, Bugwood.org*

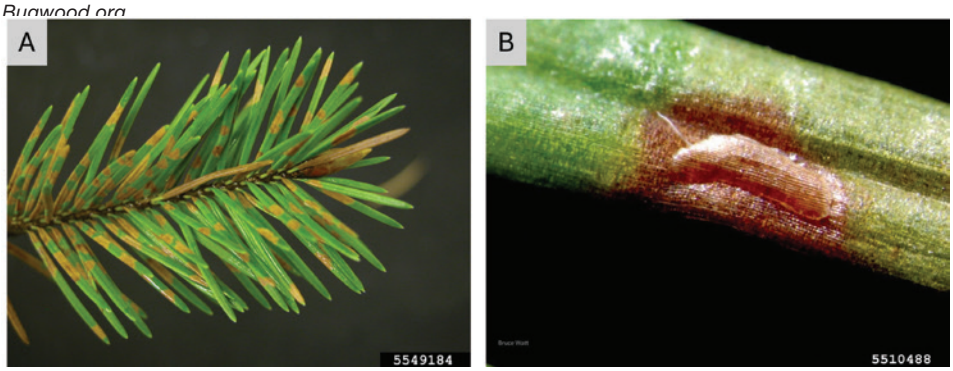

Figure – *Rhabdocline Needlecast in Douglas-fir; A: Symptoms of infection, PC: Penn State Department of Plant Pathology & Environmental Microbiology Archives, Penn State University, Bugwood.org; B: Infected needles with apothecia splitting open needle tissue, PC: Bruce Watt, University of Maine, Bugwood.org.*

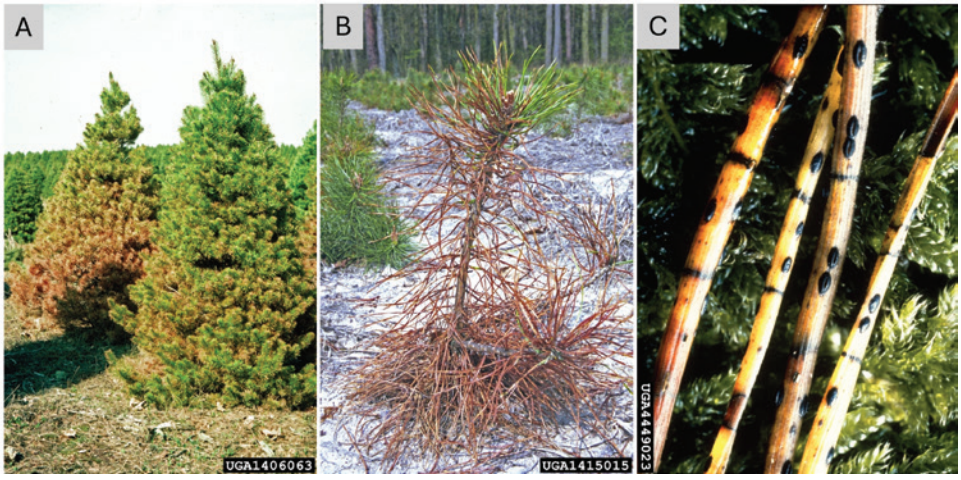

Figure 5 – *Lophodermium needlecast in Scotch pine; A: Symptoms of infection, PC: USDA Forest Service - North Central Research Station, USDA Forest Service, Bugwood.org; B: Symptoms of fungal infection in young tree, Andrej Kunca, National Forest Centre - Slovakia, Bugwood.org; C: Signs of infection on Scotch pine needles, PC: Petr Kapitola, Central Institute for Supervising and Testing in Agriculture, Bugwood.org.*

applications in late spring and early summer can help protect new growth, but they are not effective at curing needles that are already infected. To protect new needles from infection, use fungicides containing active ingredients like chlorothalonil, copper hydroxide, copper sulfate, or mancozeb. Start fungicide applications when the new growth is 1/2 to 2 inches long in the spring. Depending on the amount of disease pressure, subsequent fungicide applications may be required at about 3 to 4 weeks intervals (Linderberg et al., 2023). Successful control may require 2-3 years of consistent yearly fungicide treatments. Note that some chlorothalonil-based fungicides can cause needle discoloration on spruces, as phytotoxicity may occur when spraying at higher rates or using air-blast sprayers.

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