NDSU Extension Service
North Dakota State University

Tree Talk

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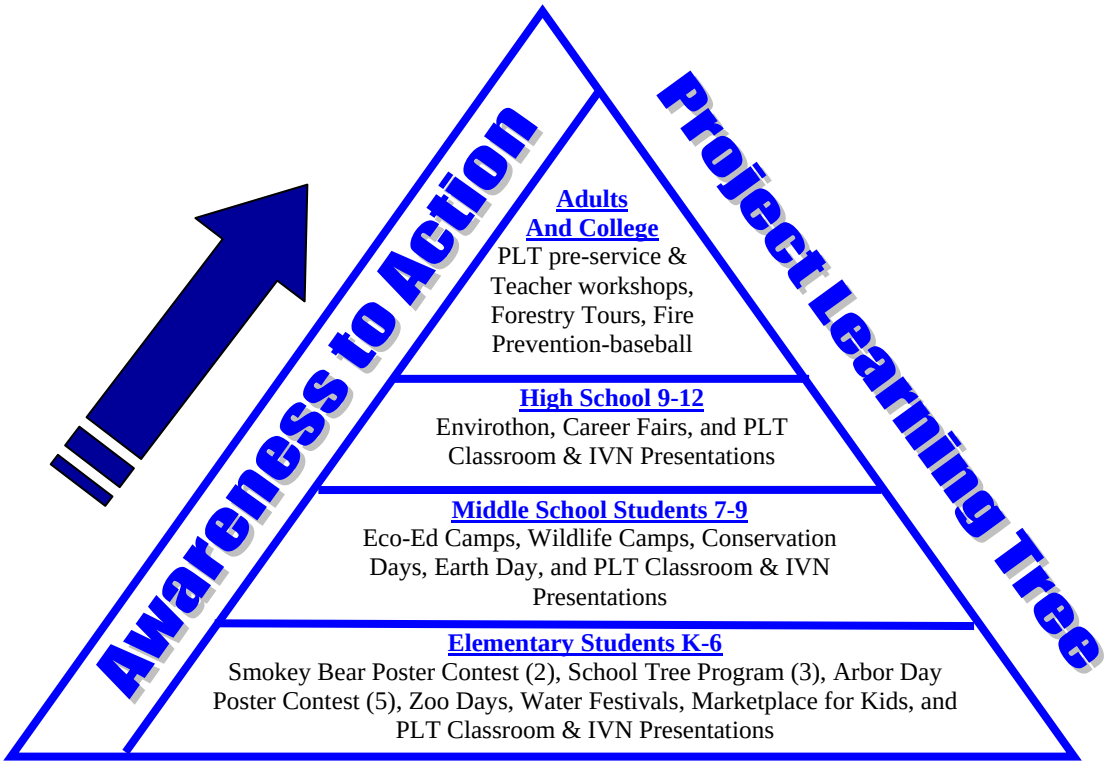
"Forests precede civilizations and deserts follow them."
- François-René, vicomte de Chateaubriand

Teaching About Trees and Forests

By Glenda Fauske, Information and Education Coordinator, N.D. Forest Service

The North Dakota Forest Service (NDFS) believes that people will make wise environmental choices and take personal responsibility for our forest resources when provided practical, relevant information from a reliable source. Therefore, the agency supports an Information and Education (I&E) Program with a commitment to serve the education community in the state through a variety of opportunities. The I&E mission is to help raise public awareness about natural resource values, support informed decision-making, and foster individual responsibility in stewards of all ages.

The I&E program provides educational activities targeted at different age groups. These lifelong learning opportunities give youth and adults the knowledge and skills they need to conserve, protect and improve our forest resources for future generations to enjoy. The majority of educational outreach utilizes Project Learning Tree (PLT) at every level. The chart below captures our efforts to move students from awareness to action as adults.



Youth education efforts support the idea that every student in every grade in every school should be learning about the environment, which results in respect for the places and people around them. Our efforts begin by starting with a foundation of awareness with the younger students, and each year providing forestry knowledge and skills that build on that foundation. Project Learning Tree is widely recognized as one of the premier environmental education curriculums that helps young people learn **how to think, not what to think,** through interdisciplinary activities. PLT activities can be integrated into classrooms for each of our learning opportunities. The education efforts are geared at moving individuals from awareness to action as responsible citizens in the future.

Learning about trees and forests begins with Smokey Bear. Fire prevention materials and resources are distributed in the fall during Fire Prevention Week to second-grade classes across the state upon request. These fire prevention materials can be integrated into classroom activities throughout the year to help educate children about the importance of preventing wildfires to save lives, property and forests. In the spring, the students are encouraged to participate in the Smokey Bear Poster Contest, which is sponsored by the NDFS and the North Dakota State Garden Clubs.

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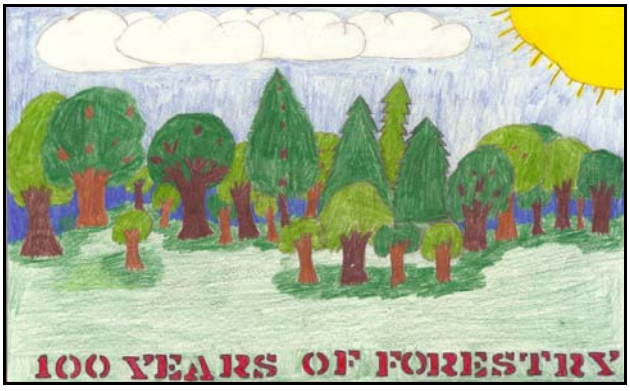
Second grader Katilyn Nelson of Park River was the first place Smokey Bear Poster Contest state winner in 2006 and received her award from first lady Mikey Hoeven.

The second-grade Smokey Bear Poster Contest and the fifth-grade Arbor Day Poster Contest are both part of the Keep North Dakota Clean (KNDC) poster contest for students in grades one through eight and special needs. The KNDC poster contest is the largest and longest running (39 years) poster contest in the state and annually has around 10,000 students participating. KNDC Incorporated is made up of a variety of sponsoring agencies and organizations. The first place state winners, along with their immediate family and teachers, get invited to an awards ceremony with the first lady, or a representative from the governor's office. At the awards ceremony, they receive a cash prize of $100, a gold medallion, certificate and get free admission to the Lewis and Clark Center in Washburn. The first place posters are made into a billboard and placed along a major transportation route close to the winner's home and fashioned into a bookmarker that is distributed to the schools and children at special events, such as Zoo Day, Marketplace for Kids and the annual North Dakota Instructional Conference.

Third-grade students are targeted with the School Tree Program. The goal is to teach young people how to plant and care for trees. Each third-grade student in North Dakota is offered a tree, along with a fact sheet of information on the tree. The following PLT activities complement this program: Adopt a Tree #21, Germinating Giants #66, Have Seeds Will Travel #43, How Plants Grow #41, Plant a Tree #31, Soil Stories #70, The Closer You Look #61, Three Cheers for Trees #30 and Trees in Trouble #77.

Fourth-graders have an opportunity to participate in a variety of water festivals, Earth Day events and zoo days in several cities across the state. North Dakota Forest Service personnel provide PLT activities at these events that demonstrate how trees impact water quality, clean the air, create a pleasant environment and provide wildlife habitat.



The KNDC Arbor Day Poster Contest appeals to all the fifth-grade students with a different theme and curriculum each year. This year, the NDFS celebrated its centennial and the theme was “100 Years of Forestry” in North Dakota. This 2006 winning fifth grade poster was made by Riley Jelinek of Lidgerwood. Each year, the NDFS forwards the winning state poster into the National Arbor Day Poster Contest sponsored by Toyota. Winners have a chance to win a $1,000 savings bond and a free trip for themselves, their parents and teacher to the National Awards Weekend in Nebraska.

Middle-school and junior high students hear forestry messages at Conservation Days, Marketplace for Kids, scouting and other youth group events, through individual staff visits to classrooms, forestry tours and at county Eco-Ed Camps. Eco-Ed Camps are organized by the Soil Conservation Districts in many counties and teach the basics of soils, water, wildlife and woodlands. The NDFS tries to have staff at each camp to provide PLT activities that focus on the numerous benefits trees provide daily, such as protecting our soil from wind erosion and increasing crop yields, providing food and agroforestry products, reducing energy costs, and absorbing pollutants. Tree identification and leaf collections are important to this age group, particularly the eighth-graders that learn about North Dakota’s trees. To assist students and adults, a set of 25 tree trading cards were made by the Coalition for Conservation and Environmental Education (C2E2). C2E2 is a state-level, nonprofit organization made up of more than 60 natural resource agencies, organizations and individuals committed to natural resource conservation and environmental education. Each card contains a photo of the tree and a leaf, as well as basic information on the native and most common found trees in the state. They can be ordered from the C2E2 web site at http://c2e2.gscience.org for $1 per set.

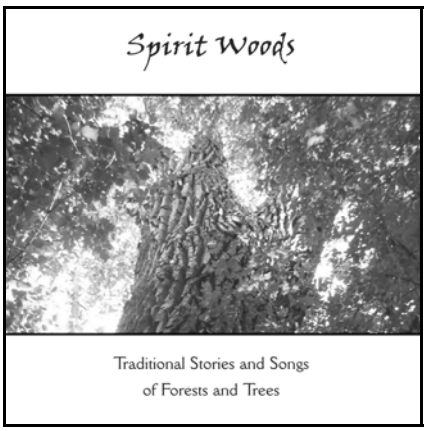
High school students have an opportunity to learn about forestry careers at career fairs and participate in the Envirothon. The Envirothon is a year-long study program of our natural resources – water, wildlife, soils and forestry – that culminates in the spring with a state competition. NDFS sponsors the forestry portion and supplies teams with PLT forestry modules and other tools in the fall that can be integrated into classroom studies during the year. The staff also designs the forestry test questions for three ecosystem trail tests and helps select the topic for the oral presentation when it is forestry related. The Envirothon program is organized and run by members of C2E2.

Adult training is targeted at leaders whose occupations routinely give them opportunities to explain natural resource connections to our daily lives. This is done by providing PLT workshops to teachers, youth leaders (scouts, 4-H, etc.) and natural resource professionals working with students in grades pre-kindergarten to 12. One-semester credit workshops are offered through the North Dakota State University (NDSU) Continuing Education program. Noncredit PLT workshops are provided by the NDFS.

PLT workshops for teachers also are available online, so you don't have to leave the comfort of home if you have an Internet connection. North Dakota has been part of this regional effort for three years. The instructor is in Alaska and the cost for one semester credit is $125. Details can be found at www.creative-conservation.com.

PLT training also is offered at several universities in the teaching methods courses for future elementary and high school teachers. Those participating currently include:

University of North Dakota – Dr. Mark Guy (elementary) and Dr. Lars Helgeson (secondary)
University of Mary – Dr. Gwyn Herman (elementary) and Dr. Linda Gutensohn (secondary)
Jamestown College – Dr. Carolyn Brauner (elementary and secondary)



Most of the educational activities the agency engages in often get directed at science teachers, but we are making an effort to identify new teaching tools to reach a larger audience. The NDFS, in partnership with the North Dakota Council on the Arts, released "Spirit Woods: Traditional Stories and Songs of Forests and Trees." This enhanced recording promotes the folk arts and culture of our area, and provides scientific and educational information on the trees found in North Dakota. The CD complements many activities in the PLT guidebooks and helps meet the No Child Left Behind initiative of strengthening language arts skills through interactive, multisensory stimulation. The CDs are available for $15.95 plus $3 for shipping by contacting glenda.fauske@ndsu.edu or (701) 228-5446.

Another teaching tool nearing completion is an updated PLT correlations document to the recently revised N.D. State Education Standards. To meet the needs of teachers, all the PLT guides, modules and kits are being correlated to the science, math, language arts and social studies standards. The correlations document will be available by the end of the year on the PLT Web site at www.plt.org and the N.D. Forest Service Web site at www.nd.gov/forest under I&E.

EDUTECH
education technology services

A future initiative is to meet the growing demand by teachers for distance education programs. Efforts to increase student knowledge and reach more classrooms with curriculum enrichment resources have resulted in a new partnership with EduTech. EduTech's mission is to provide K through 12 schools access to educational programs through remote instrumentation access over Internet2 and broadband networks.

The I&E program is preparing to offer sessions on the "Lewis and Clark Cottonwoods," "N.D.'s Trees and Forests" and the "True Story of Smokey Bear." The public's perception of the role trees and forests play in society is constantly changing. An understanding of our dependence on the land and its natural resources for survival is no longer inherent in many of our youth. Incorporating forestry education into youth and adult education efforts is a constant challenge that is best faced collectively. We would like to thank the following partners for their educational assistance: North Dakota State University, NDSU Extension Service, Coalition for Conservation and Environmental Education, EduTech, Keep North Dakota Clean, Inc., Lewis and Clark Coalition, North Dakota Council on the Arts and the North Dakota Soil Conservation Districts. May our cooperative and collective efforts continue to make a difference in environmental education!

Additional environmental education materials to help students and adults learn more trees and forests can be found at:

American Forests	www.amfor.org
Envirothon	envirothon.org
Coalition for Conservation and Environmental Education	c2e2.gscience.org
Keep North Dakota Clean Poster Contest	www.dot.nd.gov/kndc.htm
National Arbor Day Foundation	www.arborday.org/trees/treeguide
	www.arborday.org/kids
National Agroforestry Center	www.unl.edu/nac
Natural Resources Conservation Service	www.nrcs.usda.gov/feature/education
ND Tree Information Center	www.ag.ndsu.edu/trees
Project Learning Tree	www.plt.org
on-line PLT workshops	www.creative-conservation.com
Smokey Bear	www.smokeybear.com
	www.symbols.gov/smokey
US Forest Service - Conservation Education	www.na.fs.fed.us/spfo/ce

"In the end, we will conserve only what we love. We will love only what we understand. We will understand only what we are taught." - Baba Dioum

X-Disease of Chokecherry

By James A. Walla (NDSU Department of Plant Pathology) and W. David Dai (NDSU Department of Plant Sciences)

Author's Note: This information is a revision of a previously published paper (Walla 2004).

X-disease is one of the most limiting problems of chokecherry and other *Prunus* species (the stone fruits) in the north-central U.S. In North Dakota, X-disease commonly causes severe damage to chokecherry plantings and native stands, limiting the use of chokecherry in new plantings. Despite X-disease and other disease and insect problems, chokecherry should continue to be planted in resource conservation plantings and it will remain a part of our native woodlands. Awareness and understanding of X-disease can help improve the management of our natural resources.

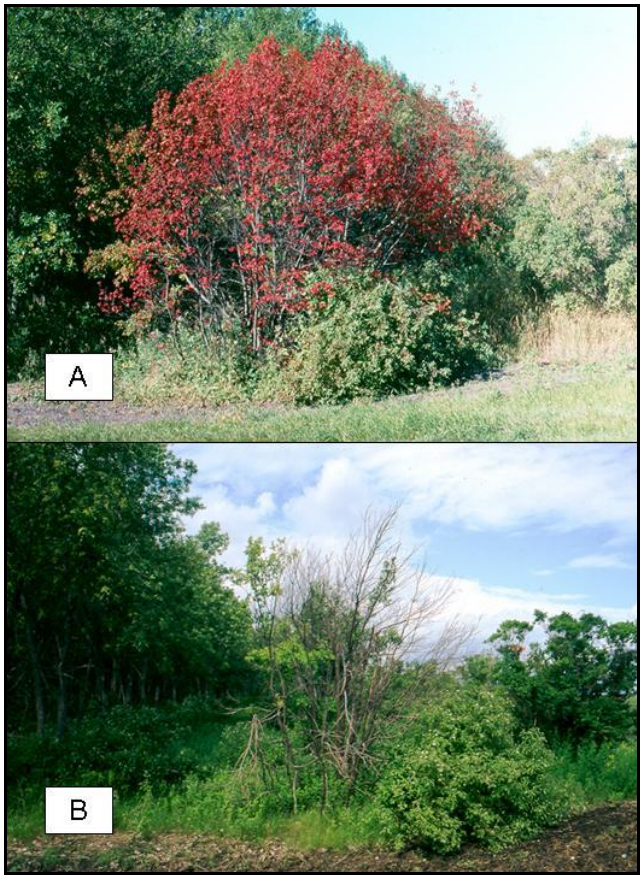


Figure 1. Increasing effect of X-disease in chokecherry. (A) In 1993, this severely diseased chokecherry plant had symptomatic red leaves, while other plants still had green leaves. (B) The same plant was nearly dead by 1997. Photos by Jim Walla.

The Pathogen

X-disease is very likely caused by phytoplasmas (formerly known as mycoplasma-like organisms or MLOs), which are a type of bacteria. This and other phytoplasmas live in phloem cells (and rarely in parenchyma cells) of plants and in certain insects, primarily leafhoppers. One part of proving pathogenicity requires that a pathogen be isolated into pure culture. That has not been accomplished with X-disease phytoplasmas or any other phytoplasmas, so we rely on other evidence to indicate the causal agent of X-disease.

Genetic characterization using molecular techniques is used to evaluate variation and relationships within and among phytoplasma groups. Using those techniques, X-disease phytoplasmas are included in phytoplasma group III-A (Gundersen et al 1996). The scientific name of the X-disease pathogen (and other group III-A phytoplasmas) likely will be *Candidatus* Phytoplasma pruni (IRPCM Phytoplasma/Spiroplasma Working Team–Phytoplasma taxonomy group 2004), indicating that the name would be in candidate status. Compared with other pathogens, phytoplasmas were discovered relatively recently, so there are still many gaps in our knowledge of X-disease phytoplasmas. X-disease phytoplasma infections only can be confirmed by nonconventional detection methods, such as ELISA (using X-disease phytoplasma-specific antibodies) and PCR (using specific DNA or RNA sequence information). This makes X-disease confirmation slow and costly.

Several strains of X-disease phytoplasmas have been described in different *Prunus* species and in different parts of North America. Phytoplasmas in chokecherry in the northern Great Plains are genetically uniform and similar to standard X-disease phytoplasma strains from eastern and western North America (Guo et al. 2000). Some phytoplasmas, such as ash yellows phytoplasmas (Sinclair 2000), vary in relative aggressiveness (severity of disease that is caused) among isolates. This appears to be true of X-disease phytoplasma isolates in chokecherry (Walla and Dai, unpublished).

The Disease Name

X-disease was first noted in California in sweet cherry in 1928 and was called cherry buckskin (Gilmer and Blodgett 1974). It was subsequently thought that an unknown virus (called Virus X) caused the disease, resulting in the name being changed to X-disease. When similar diseases were described in other areas, the standard common name in the west became western X-disease. Similar diseases of stone fruits in other places received different names, such as peach yellows and eastern X-disease, but they are all now known to be caused by the same group of phytoplasmas. Now, all of the diseases caused by X-disease phytoplasmas can be called X-disease, but the older names (except Virus X, since a virus is not involved) still may be used when dealing with a specific set of symptoms in a specific host. Therefore, when X-disease occurs in chokecherry, it can simply be called chokecherry X-disease (Guo et al. 1998).

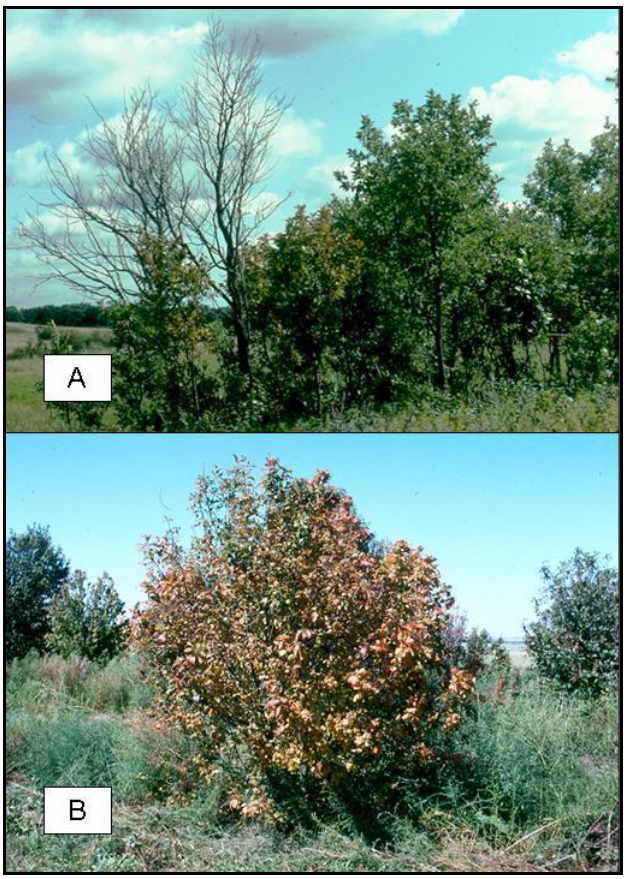


Figure 2. Variability of X-disease symptoms in chokecherry. (A) Some parts of the plant can appear healthy, while other parts are discolored, stunted or dead. (B) Whole plants can be affected uniformly. Photos by Jim Walla.

Hosts and Distribution

X-disease is an economically important and geographically widespread disease of stone fruit trees (Sinclair and Lyon 2005). It damages many *Prunus* species, most notably peach, sweet and sour cherries, chokecherry, Japanese plum, and nectarine. Some hosts, such as American plum (*P. americana*), do not show symptoms, even though they are infected by X-disease phytoplasmas. X-disease phytoplasmas also occur in many herbaceous plant species.

Since it was found in California in 1928, X-disease has been found in western stone fruit areas of Oregon, Washington, Idaho, Colorado, Utah and Texas. In 1947, X-disease was noted in Connecticut and soon found throughout most of the peach growing areas of New York, Ontario, Michigan, Ohio, and Illinois. Severe mortality attributed to X-disease (based on symptoms) in native and planted chokecherry was found in North Dakota in the 1940s (Schultz 1949, 1950). The first confirmation that phytoplasmas occur in chokecherry was reported from the northeastern U.S. in 1971 (Granett and Gilmer 1971). X-disease has now been confirmed in symptomatic chokecherries throughout North Dakota and confirmed in South Dakota, Minnesota, Nebraska, Saskatchewan and Manitoba (Guo et al. 1996, Walla, Guo, Cheng, Neill and Reynard, unpublished).

Infection and Development

Phytoplasmas primarily are spread from plant to plant (vectored) by leafhoppers (Sinclair and Lyon 2005). The leafhoppers ingest phytoplasmas when they feed on the phloem of an infected plant. The phytoplasmas go through the digestive system and into the salivary glands where they multiply. A few weeks later, when leafhoppers feed on phloem cells of other plants, they introduce phytoplasmas into the plant cells during the feeding process.

We don't know which specific leafhopper species are responsible for the spread of X-disease in the northern Great Plains. In other parts of the U.S., specific leafhopper vectors of X-disease have been identified (Sinclair and Lyon 2005). It is not clear whether any of these species occur in the Great Plains. Identification of leafhopper vectors of X-disease in the Great Plains is hindered by the lack of entomologists working on leafhoppers or woody plants in this region, by the high degree of difficulty

in identifying leafhopper species and by the difficulty of detection and identification of phytoplasmas in leafhoppers.

Phytoplasmas also are transmitted to other plants by grafting and by dodder (*Cuscuta* sp., a parasitic plant). They have not been mechanically transmitted to plants without using living plant tissue, and they have not been found to be spread in seeds (Sinclair and Lyon 2005).

Once plants are infected, the phytoplasmas gradually move to phloem tissues in all plant parts. Very low concentrations of phytoplasma cells in above-ground parts and relatively high concentration in roots occur during winter. This possibly indicates that phytoplasmas can not withstand freezing temperatures or inactive host tissue. In the spring, phytoplasma cell concentration gradually increases in above-ground plant parts. Based on research with other phytoplasmas, it appears that a phytoplasma isolate "claims" a plant that it has infected and other isolates cannot then infect that plant (Sinclair and Griffiths 2000). If this is true with X-disease, such cross-protection has important management and research implications.

Damage, Symptoms, and Diagnosis

X-disease causes a slow decline and eventual death of most infected chokecherry plants (Figure 1). Once the disease enters a chokecherry planting or stand, all trees at that site usually become infected. In Nebraska, 50 percent of test trees died within eight years of infection (Peterson 1984). In North Dakota, many infected plants with well-developed disease symptoms died within three years of having the infections confirmed (Walla, Guo and Cheng, unpublished). Although other problems may be worse at individual sites, X-disease overshadows all other chokecherry problems in the northern Great Plains because of its high potential to severely damage and kill chokecherry and the absence of reasonable management options. Plants with X-disease appear to be more susceptible to damage from other stresses. X-disease symptoms appear to develop sooner or become more severe with drought stress. Plants with more serious X-disease symptoms appear to be damaged more by hail compared with nonsymptomatic plants (Walla, unpublished).

Figure 3. X-disease causes leaves to become various shades of yellow, orange (A), and red (B) before normal fall color develops on unaffected plants (lower leaf in A). Severe symptoms include curling, deformation, and thickening of leaves (A). Photo A by Jim Walla, photo B taken by Bruce Neill, Prairie Farm Rehabilitation Administration (PFRA), Indian Head, Saskatchewan.

Symptoms in chokecherry include discoloration of the leaves, stunting of leaves, shoots and fruit, deformity and discoloration of fruit, late-season flowering, and reduced winter hardiness of current-year shoots. Sometime after symptoms develop, shoots, branches and whole plants may die (Peterson and Johnson 1986; Sinclair and Lyon 2005). X-disease symptoms are not all expressed the same on all infected plants. However, when a group of plants is infected, these symptoms usually will be predominant after a few years. Some reports state that shothole (small round holes in the leaves) is a symptom of X-disease, but, at least in chokecherry, it has not been proven that those leaves are not infected by fungal or bacterial pathogens that are known to cause shothole.

Figure 4. Leaves on severely affected plants can be clumped at the end of stunted twigs. Photos by Jim Walla.

At the early stage of X-disease development, the symptoms are so slight that the plants cannot be reliably differentiated from healthy plants or from plants with other problems. Symptom development can vary in occurrence and intensity on different parts of an infected plant, especially during early development (Figure 2A). In the early stages of disease, leaves and shoots are slightly stunted and the leaves develop slightly early "fall color." Some of the previous season's shoots may have died during the winter. As the disease develops in subsequent years, the leaves and shoots will be progressively more stunted, the "fall color" will develop earlier and more intensely, and symptoms will be relatively uniform over the entire plant (Figure 2B).

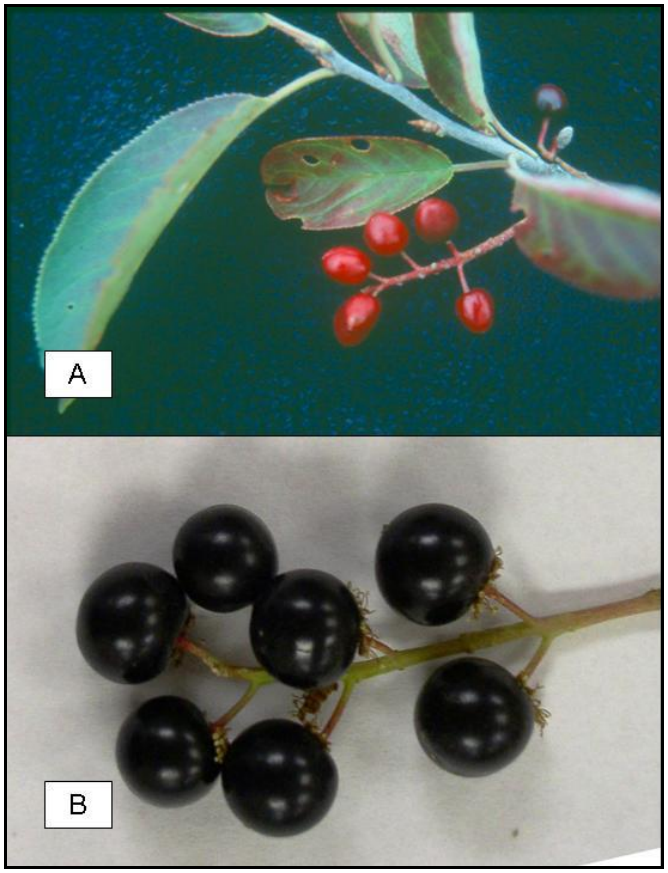


Figure 5. X-disease can cause fruit to remain red and pointed (A) compared with the normal dark purple and round berries on unaffected plants (B). Photo A by Bruce Neill (PFRA), photo B by Joe Zeleznik.

On plants in which the disease is well-developed, X-disease symptoms can appear soon after leaf-out as greenish-yellow leaves. The leaves gradually change color during the season, becoming bright orange or red by midsummer (Figure 3). The leaves remain relatively small and become curled and leathery. The shoots are reduced in length, and rosettes of leaves occur at the shoot tips due to the shortened internodes (Figure 4). Fruits are smaller, more pointed and lighter in color than normal fruits, and sometimes remain red instead of becoming dark purple to black (Figure 5). Flowers, usually stunted and deformed, may be produced at the end of the growing season (Figure 6). Twigs from the previous season may not grow in the spring and may be dead by midsummer (Figure 7A). As the disease develops further, larger twigs may die (Figure 7B), then whole branches and stems, and finally the whole plant dies (Figure 1B).

Figure 6. X-disease can cause stunted, deformed flowers to be formed late in the season. Photo by Bruce Neill, PFRA.

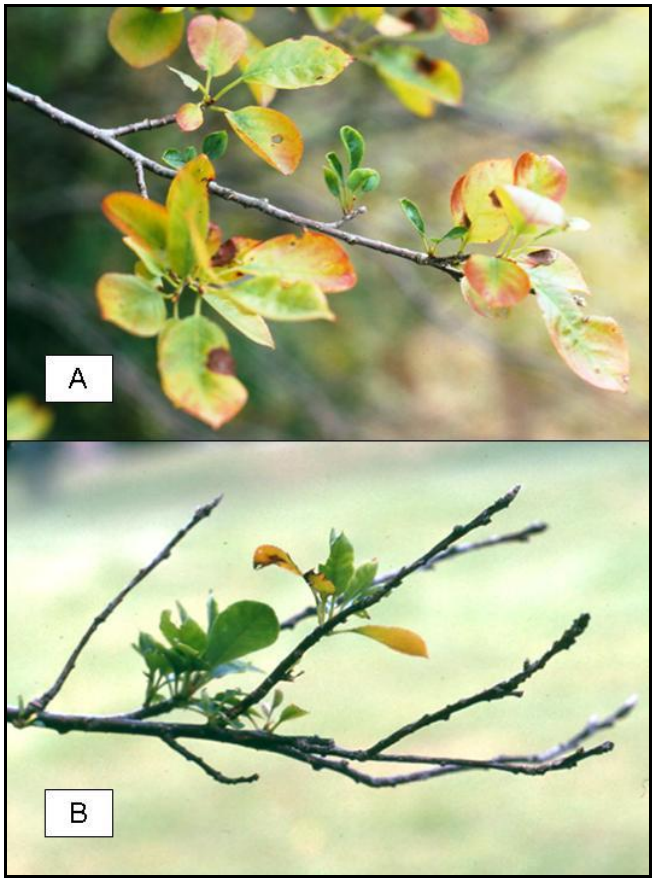


Figure 7. X-disease can cause small amounts (small twig tip in center of A) or large amounts of (B) twig dieback. Photos by Jim Walla.

Other phytoplasmas have been reported to cause severe root stunting and deformation (Sinclair et al. 1996). The affects of X-disease on roots have not been described in chokecherry, but inoculated and symptomatic seedlings in pots have poor root systems (Walla, unpublished).

Diagnosis of X-disease is most commonly done by experienced diagnosticians based on the presence and pattern of symptoms within and among plants. Early-season reddening and leathery texture of leaves and stunting of leaves and shoots are good indicators of X-disease in chokecherry in North Dakota. Where the disease has developed adequately, symptom-based diagnosis is usually reliable. However, the only definitive proof for X-disease is assays using X-disease phytoplasma-specific serology or molecular techniques, such as PCR with X-disease phytoplasma-specific primers. The North Dakota State University Plant Diagnostic Laboratory http://www.ag.ndsu.nodak.edu/diaglab/ offers such assays for a fee. However, because essentially nothing can be done to deal with X-disease in chokecherry, diagnosis is generally only justified for research or to discern the role of other possible chokecherry problems.

Other problems that can cause some similar symptoms include herbicides, drought, Valsa canker and bark beetles. However, the patterns of symptom development of these problems in plants will not be the same as that of X-disease. When multiple possible causes are present, it can be very difficult to sort out the primary cause of the plant damage. Even if X-disease phytoplasmas are present in some or all of the affected plants, it does not mean that they are causing the problem because some infected plants can remain vigorous. Thus, assessments of the cause of plant damage need to be made on a site-by-site basis.

Although X-disease occurs widely across North America, it has not been reported to cause substantial damage in some locations, such as the prairie provinces of Canada. X-disease has been confirmed in multiple chokecherry samples from Manitoba and Saskatchewan (Neill, Reynard and Walla, unpublished). The reasons for lack of recognized damage are not known. Some possibilities are that the disease is not spread as quickly due to the shorter seasons or different leafhopper occurrence or habits, disease symptoms may not fully develop in cooler environments, the chokecherry germplasm has more resistance or the damage has gone unrecognized. Because severe disease occurs in chokecherry in North Dakota within a few miles of the Canadian border, substantial differences in leafhopper populations or climate are unlikely. There does appear to be variation in susceptibility among seed sources

(Walla et al. 1996, 2005), so chokecherries in the prairie provinces could be more resistant.

This report covers the details of the disease and its potential effects. While a severe infection of X-disease will cause an extremely shortened lifespan of a stand of chokecherries (from a potential of 70+ years down to as low as 15-20 years), the shortened lifespan may be enough to provide the benefits desired. In addition, a few individual plants and whole plantings may escape infection for many years. Though this possibility of a shortened lifespan might cause one to consider not planting chokecherries, they still can provide some benefits during a short lifespan, such as fruit production, wildlife habitat and streambank stabilization.

Disease Management

There is much to learn about X-disease before effective management techniques are developed. No direct controls are appropriate for chokecherry X-disease in most instances. Recommendations for X-disease management in commercial stone fruit orchards in other regions include planting disease-free stock, using insecticides to control leafhoppers, removing diseased plants, treating diseased plants with oxytetracycline, removing chokecherry and other wild host plants from the vicinity and planting less susceptible crops. In-the-field management of X-disease in chokecherry in the Great Plains essentially consists, in most cases, of ignoring the problem or not planting chokecherry.

In our region, three primary reasons – slow development of symptoms, difficulty of definite diagnosis and the relatively low value of the plants – make control of chokecherry X-disease ineffective. Removal of diseased trees could be done, but it may not be effective because the pathogen might have spread into the surrounding plants before symptoms occur.

Some actions likely would reduce damage by X-disease, although no direct research has been done to support them. Because the root system of affected plants likely is damaged, the ability of diseased plants to take up water and nutrients is reduced. If soil moisture is limiting or of poor quality, providing good quality supplemental water should slow the progression of X-disease. In the same way, the addition of supplemental nutrients, especially in a readily available form, should help the plant. If so, it likely would be appropriate to apply foliar fertilizer if the roots are already in poor condition. Control of competing weeds or other plants would reduce competition for water and nutrients, but care must be taken to avoid damaging the chokecherries with tillage equipment or herbicides.

Figure 8. Chokecherry plants vary in tolerance to X-disease. Some plants are severely damaged in just a few years, while nearby infected plants remain vigorous for many years. Photo by Jim Walla.

Variability in resistance to X-disease is not known within *Prunus* species, but is known within host species to other diseases caused by phytoplasmas. Chokecherry resistance to X-disease might be expected to occur because both organisms are apparently native to North America. Variability in resistance often occurs in host populations that have had a long exposure to a pathogen. Such resistance has not been confirmed, but research is underway to do so (Walla et al. 1996, 2005, Walla and Dai, unpublished). In USDA experimental plantings, several plants remain healthy while nearby plants have been severely affected by X-disease (Figure 8). This vigorous condition has persisted for several years after they were confirmed to be infected by X-disease phytoplasmas. This may be due to plant tolerance, which is a form of disease resistance. It may be that those healthy plants are infected by a nonaggressive X-disease phytoplasma isolate. If some of those plants prove to be tolerant to X-disease, use of this material will be the most appropriate manner to manage the disease. Additional research (Dai and Walla, unpublished) is aimed at characterizing the genetic basis of disease tolerance, possibly leading to further improvements

in chokecherry or to developing disease tolerance in other stone fruits.

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Editor's note: No insect-of-the month article appears in this issue of *Tree Talk*. Instead, this second disease article was added because of the potential importance of this disease to North Dakota's forest resources.

Stigmina lautii discovered on spruce in North Dakota

By Jim Walla (forest pathologist) and Kasia Kinzer (plant pest diagnostician), NDSU Department of Plant Pathology

History of spruce needlecast in North Dakota

Rhizosphaera needlecast has periodically caused serious problems on spruce in North Dakota during the last 30 years. It was at a very low level in the late 1970s. It increased in extent and severity and caused substantial defoliation in the early and mid 1980s to the point that it was a factor in decisions whether to include Colorado blue spruce (*Picea pungens*) in individual plantings in eastern and northern North Dakota. There was a major decline in the extent and severity of Rhizosphaera needlecast during the dry years of the late 1980s and early 1990s. Following 1993 and subsequent wet years, *Rhizosphaera* increased to a level more widespread and severe than in the early 1980s. White (Black Hills) spruce (*Picea glauca*) often was unaffected, or at least less affected by *Rhizosphaera* than Colorado blue spruce.

Throughout this period, there was at least occasional confirmation that the pathogen causing spruce needlecast in North Dakota was *Rhizosphaera kalkhoffii*. In the last decade, with Rhizosphaera needlecast being so common, people stopped checking closely to confirm the identity of the pathogen. However, Marcus Jackson, former NDSU Extension forester and N.D. Forest Service forest health specialist, attempted to confirm the identity on several samples in 2001. He found that at least one of those samples had fruiting bodies with elongated spores, rather than the globoid spores of *Rhizosphaera*. The identity of that fungus was never determined.

***Stigmina* identified**

In May and June of 2006, Mary Ann Hansen of Virginia Tech notified plant diagnosticians across the country to watch for *Stigmina* on spruce samples that appeared to have *Rhizosphaera*. Photos were sent that showed fruiting bodies similar to those on samples previously received by the NDSU Diagnostic Lab. Marcus Jackson was contacted and asked if that is what he had seen in 2001. He indicated that the photo of *Stigmina* fruiting bodies on needles looked very familiar, but could not be sure that the *Stigmina* spore photos were what he had seen.

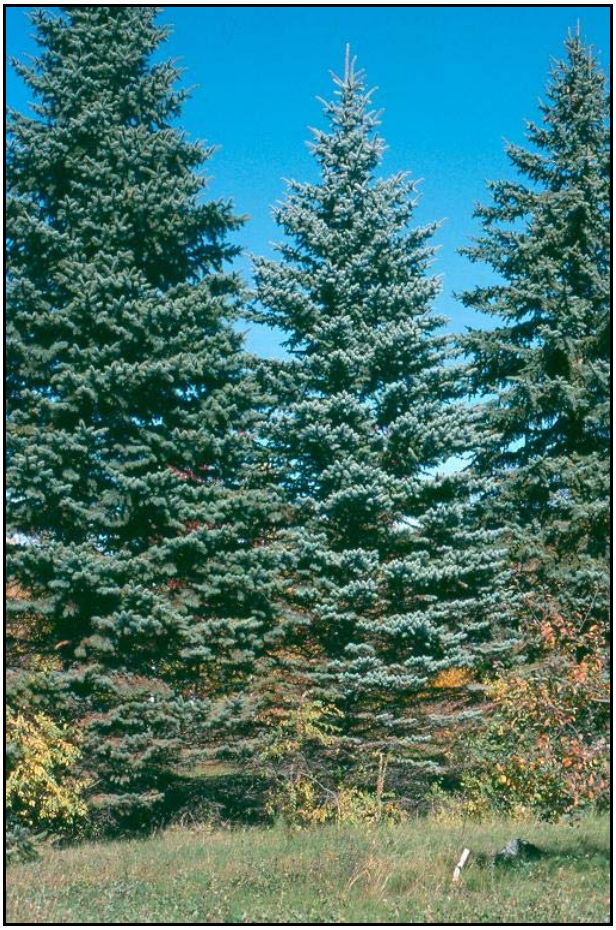

Figure 1. Defoliation and discoloration of needles apparently caused by *Stigmina lautii* on Colorado blue spruce. Effects are greatest in the lower crown. Trees with *Rhizosphaera* could look the same. Photo by Jim Walla.

Following the alert from Hansen, the next spruce sample that came to the NDSU Plant Diagnostic Lab with *Rhizosphaera*-like symptoms was found to have *Stigmina*. Samples were soon collected from several spruce trees around eastern and central North Dakota that had *Rhizosphaera*-like symptoms. Every sample had *Stigmina*, but *Rhizosphaera* was not found on any of them. Two main *Stigmina* species affect spruce trees, *S. lautii* and *S. verrucosa*. The species found in North Dakota is *S. lautii*.

In North Dakota, *S. lautii* has been found on Colorado blue spruce and white spruce. It was not found on Norway spruce, Serbian spruce (*P. omorika*), or on a Colorado blue spruce x Engelmann spruce (*P. engelmannii*) hybrid at a location where it is severe on adjacent Colorado blue spruce and white spruce. In 2006, of the spruce

samples received by the NDSU Diagnostic Lab or those collected by Jim Walla and Joe Zeleznik that showed needlecast symptoms, all were infected with *S. lautii*. Samples were collected from Cass, Barnes, Benson, Cavalier, Grand Forks, LaMoure, Stutsman and Towner counties. With that range, it is likely present throughout eastern and central North Dakota.

When did *Stigmina* get to North Dakota?

We don't know. It seems likely that what Marcus Jackson observed in his 2001 collections was *Stigmina*. The fungus was first described from samples collected in Manitoba and Saskatchewan in the early 1970s, so *Stigmina* could have been here at least since then. However, numerous observations over many years, in North Dakota and elsewhere in the U.S., found no indication of *Stigmina* until the late 1990s.

In 2005, one Colorado blue spruce variety, 'Mission Blue', had almost no needlecast while other surrounding named Colorado blue spruce varieties were heavily infected (Walla, unpublished). It appeared that 'Mission Blue' spruce was resistant to needlecast, then assumed to be caused by *Rhizosphaera*. One year later, that variety was severely infected by *Stigmina*. It is difficult to explain a sudden change like that. If *Stigmina* was present much before 2005, then why wasn't that variety affected like it is now? One explanation would be that the resistance that 'Mission Blue' exhibited was indeed to *Rhizosphaera* and that *Stigmina* arrived to cause severe infection of that variety. With fruiting on second year needles in September 2006, it was likely infected at least by early summer 2005 or earlier. In this case, it appears that *Stigmina* did not cause substantial needlecast until 2006.

Scientific literature for *Stigmina lautii*

There is very little literature covering *Stigmina lautii*. Sutton (1973) described *S. lautii* from samples on white and black (*P. mariana*) spruce in Manitoba and Saskatchewan. He distinguished it from the previously described *S. verrucosa* on spruce primarily by the number and location of fruiting bodies; needles with multiple fruiting bodies in stomata were infected by *S. lautii* while needles with a single fruiting body not in stomata were infected by *S. verrucosa*. There is a report that *S. lautii* was seen causing needle spots on *P. glauca* in British Columbia in 1973 (Anonymous 1974). Hodges (2002) published a report that *S. lautii* had been found in North Carolina, the first and only report of the fungus in the U.S. That report indicated that *S. lautii* had been identified on Colorado blue spruce and Norway spruce (*P. abies*) samples from three noncontiguous counties in western North Carolina. *S. lautii* was found fruiting on the same needle as *Rhizosphaera kalkhoffii* in one of the North Carolina samples. In addition to that official report, online records indicate that *S. lautii* (reported as *S. verrucosa*) has been found in Virginia at least since 1998 (Hansen 1998-2005). In Virginia, both *Stigmina* and *Rhizosphaera* continue to be found on spruce. *Stigmina* recently has been observed in at least four other states in eastern and central United States (personal communications). In all of these locations, early diagnosis was delayed because of the similarity of *Stigmina* and *Rhizosphaera*.

The literature regarding *S. lauttii* is somewhat difficult to interpret because it appears that there is a high likelihood of confusion between *S. lautii* and *S. verrucosa*. While *S. verrucosa* is distinct from *S. lautii*, it is often not clear that authors publishing reports of spruce needle diseases were aware of or distinguished between the two species. For this article, except for the misidentified records from Virginia Tech (M.A. Hansen, personal communication), we considered the name actually used in a report to be accurate.

Stigmina lautii* compared to *Rhizosphaera kalkhoffii

It is premature to discuss symptoms of *Stigmina lautii* until it is proven to cause a disease. Therefore, the discussion that follows should be considered tentative until proof is obtained. However, the subsequent description of *S. lautii* signs (e.g., fruiting bodies, spores) is valid regardless of the pathogenicity of the fungus.

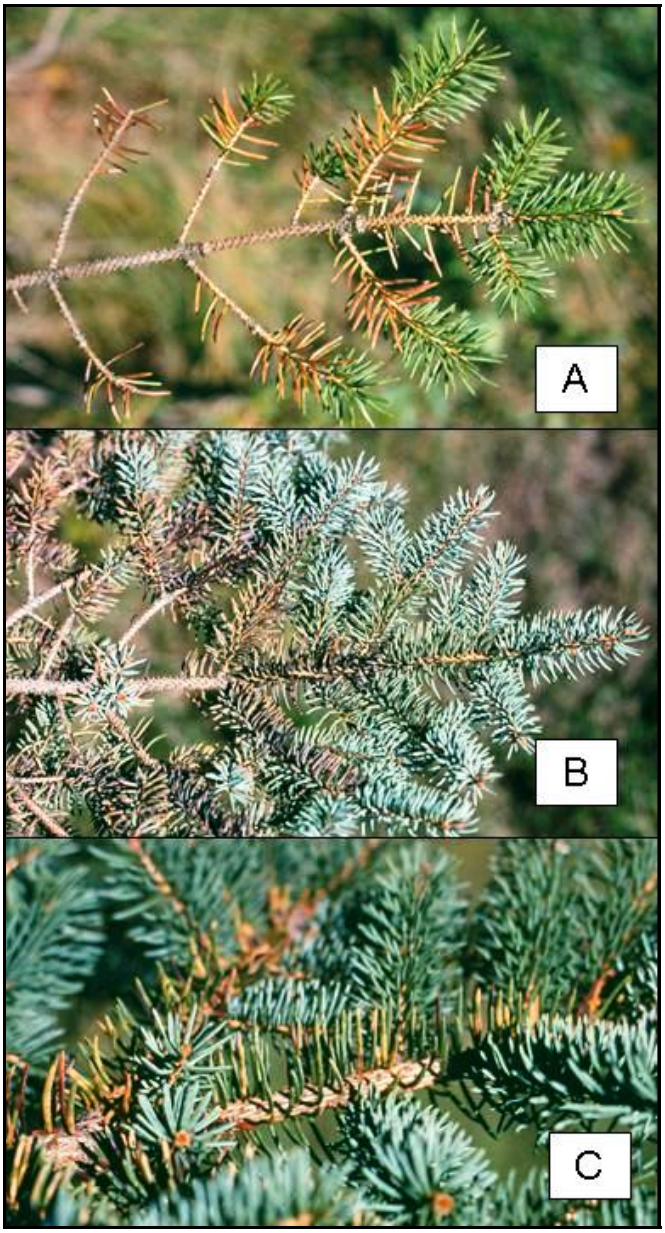

Figure 2. Symptoms of *Stigmina lautii* on Colorado blue spruce, September 2006. Second-year needles show varying symptoms. They may be partially or completely yellow, tan, brown reddish-brown (A, C), grayish-green with some brown tips (B) or they may have dropped (A). Photos by Jim Walla.

No studies have been done on the biology of *S. lautii* and very little is known of its effect on spruce. The report from North Carolina (Hodges 2002) and clinic records from Virginia Tech (Hansen 1998-2005) indicate that *Stigmina* causes a needlecast similar to that of *Rhizosphaera*. *Stigmina* produces fruiting bodies on green needles and on necrotic needles (Hodges 2002), as we have observed with *Rhizosphaera* in North Dakota. Our observations indicate that the pattern of needlecast on trees (Figure 1) appears similar to that of *Rhizosphaera*, with the highest incidence and severity lower in a tree and on the north side of a tree. Current-year needles appear to be unaffected. By late summer, fruiting bodies can be present on second-year needles. Initial observations indicate that the symptoms on second-year and older needles range from a general off-green color to individual bands of yellow, tan, brown, reddish-brown or purple. Eventually, the entire needle may become any of these individual colors (Figure 2).

Necrotic needles may remain attached to the tree for years, with symptoms likely progressing to a more advanced stage over time, or may be cast the same season as symptoms develop. All of these symptoms can be caused by *Rhizosphaera* (Figure 3). We do not have enough years of observations to know if severe defoliation by *Stigmina* can result in branch death, but we speculate this will happen because *Rhizosphaera* can eventually kill branches.

Figure 3. Symptoms of *Rhizosphaera kalkhoffii* on Colorado blue spruce, May 1985. Third-year needles are green, yellow, or brown. Photo by Jim Walla.

One difference between *Stigmina* and *Rhizosphaera* appears to be the age class of affected needles. *Rhizosphaera* tends to be quite variable in its effect from tree to tree, likely due to variation in resistance of the different trees (Walla 1990). Tree to tree variation appears to be much less for *Stigmina*; all trees that we have observed that are affected with Stigmina have symptoms on second-year needles.

Stigmina lautii produces fruiting bodies in stomatal pits of spruce needles (Figure 4). When there are multiple fruiting bodies on a needle, the normally white rows of wax become black rows of fruiting bodies similar to those caused by *Rhizosphaera* (Figure 5). Preliminary observations indicate that

there are fewer fruiting bodies with *Stigmina* than with *Rhizosphaera*, so the black lines are less continuous with *Stigmina*. **The two fungi cannot be distinguished without magnification of about 20X or more.** If fruiting bodies are observed with a strong hand lens or a microscope, fruiting bodies of *Stigmina* and *Rhizosphaera* can be distinguished. Most *Stigmina* fruiting bodies appear to be feathery (Figure 4), while most *Rhizosphaera* fruiting bodies appear to be smooth (Figure 5). Confirmation of identity requires observation of the spores using a compound microscope.

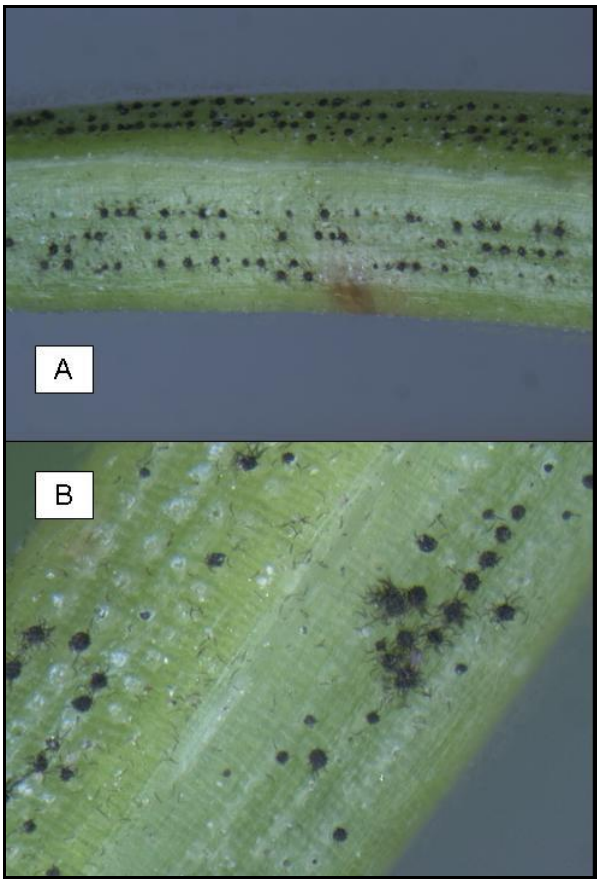

Figure 4. *Stigmina lautii* sporodochia (asexual fruiting bodies) on spruce needles. The fruiting bodies are in the stomatal pits of the needles. Fruiting bodies may occur in most of the stomata (A), resulting in black rows replacing the white rows of wax, or the fruiting bodies may be more scattered (B). The spores appear as tendrils sticking out from the central fruiting body(s) (B). Some non-sporulating fruiting bodies appear smooth, similar to pycnidia of *Rhizosphaera*. Photos by Justin Knott.

Figure 5. *Rhizosphaera kalkhoffii* pycnidia (asexual fruiting bodies) on spruce needles. As for *Stigmina*, the fruiting bodies are in the stomatal pits. With *Rhizosphaera*, the wax plug from the stomatal pit will often be found on top of the pycnidia. Photo by Kasia Kinzer.

Is *Stigmina lautii* a pathogen?

There is no evidence either way in the literature. *S. lautii* could be a plant pathogen, an endophyte that normally grows in needles without causing damage unless the tree is under unusual stress, or it could be a parasite on other fungi (mycoparasite). Other *Stigmina* species are reported to be plant pathogens. If it is an endophyte that fruits only when the needles are stressed or senescing, then there must be a stress that is now widespread in North Dakota and other parts of the United States. If it is a parasite on other fungi, the only likely host would be *Rhizosphaera*. The strong similarity in occurrence of fruiting bodies and in apparent symptoms fits this scenario. Not finding *Rhizosphaera* on multiple random samples indicates that *S. lautii* would either be a widespread tree pathogen or an unusually efficient mycoparasite. However, similar "replacement" episodes have been reported for other mycoparasites of other needle pathogens in the past (e.g., *Sarcotrochila piniperda* as a mycoparasite on *Lirula macrospora* (Lagerberg 1928)).

One of our observations indicates it is a pathogen. In late September 2006, a row of about 100 large Colorado blue spruce was observed. Every observed tree had *Stigmina* fruiting bodies on at least some second-year needles. Such uniformity would be very unusual for *Rhizosphaera*, where considerable tree-to-tree variation in fruiting and disease severity is normal. Thus, because of the different patterns of appearance, it is unlikely that *S. lautii* is a

mycoparasite of *R. kalkhoffii*. We therefore conclude that *S. lautii* is likely a pathogen of spruce trees.

If *Stigmina lautii* is a pathogen, what can be done to manage it? Some observations and speculation.

Again, there is no literature to help in making management decisions. If it is a pathogen, it appears to be causing damage very similar to that caused by *Rhizosphaera*. The fact that *S. lautii* fruits on second-year and older needles would indicate that it can infect first-year needles. There are no observations on when during the year the initial infection could occur. If infection occurs with the beginning of branch growth in early June, then production of fruiting bodies in July on second-year needles shows it can sporulate within13 months after infection. It is not known if spore production varies with host susceptibility or environment, as occurs with *Rhizosphaera*. With these unknowns, it is difficult to speculate on what time of year that fungicides should be applied, how many years of fungicide application are needed or which fungicides would be useful.

Observations at one site may provide some supporting information with regard to management. In 2003, needle blight caused by *Lirula macrospora* was found to have built up to damaging levels on white spruce in a mixed planting of white and Colorado blue spruce. That year, what was thought to be *Rhizosphaera* needlecast was at a relatively low level on those trees. In early June 2004, the needlecast had increased substantially. Fungicide applications had already been planned for the *Lirula* (chlorothalonil applied in early June and early July for three years). The same fungicide and application timing for two years (instead of three) is recommended to manage *Rhizosphaera,* so it was assumed that both diseases would be reduced by the fungicide applications. The third year of applications was completed in July 2006 and there was no longer any apparent damage from needle blight or needlecast. Upon discovery of *Stigmina lautii* in North Dakota, those trees were observed in early September 2006. During cursory observations of a few white and one Colorado blue spruce, *Stigmina* was found fruiting on one third-year white spruce needle and several old (older than third-year) needles on the dense interior of a Colorado blue spruce. *Rhizosphaera* was not found. The presence of *Stigmina* suggests (but does not prove) that the assumption of *Rhizosphaera* in 2003 was incorrect and that *Stigmina* was responsible for the observed needlecast. If *Stigmina* is a pathogen and if it was responsible for the needlecast at this site in 2004, these observations indicate that chlorothalonil applied in early June and early July for three years will effectively minimize damage from the disease. It is not known if two applications per year or three years of applications are needed or adequate.

What does the future hold?

So, what does the identification of *Stigmina lautii* in North Dakota mean? It means you will need to confirm whether it is *Rhizosphaera* or *Stigmina* on spruce trees with needlecast before management options can be determined. It means we need to start finding the answers to management questions, including:

1) Is *S. lautii* a pathogen of spruce? Plans are underway to make this determination, but will likely take two to four years to complete.

2) What are management options?

A) Are cultural management options (promoting air movement, removal of lower branches, not artificially wetting the needles, increasing species diversity) appropriate for *Stigmina* as they are for *Rhizosphaera*?

B) Which fungicides are effective? What application schedule is needed? Are any fungicides labeled in such a way that they could be used?

3) Is *Rhizosphaera* still present in North Dakota? If not, we would not need to consider *Rhizosphaera* in our spruce plantings, at least not at this time.

You can help answer some of the questions.

Your observations and awareness of situations can help in unraveling the biology and management issues for *Stigmina*. Watch for trees with different levels of resistance to *Stigmina* (this can generally only be observed when most trees in a planting are severely infected). Watch for *Stigmina* on nursery stock. Take note of situations and results where fungicides have been applied to control *Rhizosphaera* in settings where *Stigmina* is present. If you observe anything that can help us understand or deal with *Stigmina*, **PLEASE** let us know.

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Observations and photos in this article are by J.A. Walla or K. Kinzer unless otherwise noted.

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European mountain-ash

By Bryan Gaschk, Fargo Forestry Department

One of the most beautiful small to medium sized trees for planting in our region is European mountain-ash (*Sorbus aucuparia*). With its multiseasonal effect of late spring flowers, dark green summer foliage, late summer fruit display, and sometimes brilliant reddish to nearly purple fall color, this tree has much to offer.

Figure 1. Fall foliage of the European mountain-ash. Photo by Dale Herman.

European mountain-ash, or Rowan tree, is a member of the rose family (*Rosaceae*). It is native from Europe to western Asia and Siberia, and has become naturalized in most of North America. It has pinnately-compound leaves usually with nine to fifteen dull, dark green leaflets (Figures 1 and 2). Leaflets are oblong to oblong-lanceolate, mostly serrate with the lower third of each leaflet being entire. Leaves are borne of hairy buds, a large terminal with reduced laterals, alternately on young pubescent branches that become glabrous grayish brown with age. Mature bark often is grey to brown and smooth, although it can become roughened on older trunks. Its growth habit tends to be upright in youth, but becomes more spreading with age. The white flowers (Figure 2) are borne in flat topped corymbs usually in early June in North Dakota with the orange-red berry-like pomes showing in late August or early September. The fruits (Figure 3) may persist for a time, but often are eaten away by birds.

Figure 2. Flowers of the European mountain-ash usually are borne in early June in North Dakota. Photo by Dale Herman.

If planted on too tough of sites, European mountain-ash could be a very short-lived tree. The most common problem is fireblight and the cankers associated with a fireblight infection (Figure 4). Such weakened and poorly growing trees become habitat for secondary insects, such as borers. The best defense is to have vigorously-growing, healthy trees. This can be achieved by proper site selection and cultural practices.

Figure 3. The showy fruit of the European mountain-ash give the tree a distinctive look in August and September. They eventually are eaten by birds. Photos by Boris Hrasovec, www.forestryimages.org.

In selecting a planting site for a European mountain-ash, keep in mind that it can be a very picky tree. It does best on a well drained loam soil that receives adequate moisture throughout the growing season. Proper planting depth also is critical. Sunscald and main-stem cankers are seen often on European mountain-ash and most times these problems can be traced back to improper planting. Mulching correctly, not too deep and not against the trunk, enhances soil conditions favorably for the tree. Due to its upright habit in youth, there may be some weakly attached branches that should be pruned out. Any pruning should be done in the dormant season due to its susceptibility to fireblight and other cankers. With a hardiness zone rating of 3, European mountain-ash should do well throughout most of our region.

Figure 4. A European mountain-ash tree located on the North Dakota State University campus, suffering from fireblight. The tree was dead within five years of taking this picture. Photo by Dale Herman.

The best mountain-ash that I ever observed were growing in Bozeman, Mont. If you have a north- or east-facing slope that is cool and moist, it may be a good place to plant a European mountain-ash.

Small Talk – December 2006

USDA expands emerald ash borer quarantine in Illinois, Indiana and Ohio

A recent press release from the U.S. Department of Agriculture's Animal and Plant Health Inspection

Service (APHIS) announced the expansion of its emerald ash borer (EAB) quarantine to include the entire states of Illinois, Indiana and Ohio. This action more than doubles the previously quarantined area which included the entire lower peninsula of Michigan. The new quarantine became effective on December 1 following the issuance of a federal order.

The federal order restricts the interstate movement of regulated articles that originate within the quarantine area. Regulated articles include ash nursery stock and green lumber, any other ash material including logs, stumps, roots, branches, as well as composted and uncomposted wood chips. Due to the difficulty in distinguishing between species of hardwood firewood, all species of hardwood firewood are considered to be "regulated articles."

Everyday human activity facilitates the long distance spread of EAB, expanding the extent and range of the infestation in North America. The movement of ash tree products has been found to advance the spread of EAB much more quickly than it would spread on its own. Currently, EAB is responsible for the death and decline of more 25 million ash trees in the United States and it has the potential to kill all ash trees in North Dakota.

Timber harvest in northeastern North Dakota likely to decrease next year

The Fall 2006 issue of "The Market Place," a Minnesota DNR publication regarding the state's forest products industry, began with an in-depth article entitled, "Minnesota forest products industry mill shutdowns and the current reduced demand for wood." The article stated that three mills producing oriented strand board (OSB) have recently shut down, including a permanent shutdown of an older production line at the Ainsworth Lumber Co. Ltd. facility in Bemidji, MN. The newer, second line in Bemidji will continue to operate.

The mills have shut down for a combination of reasons, including reduced demand for OSB by the U.S. housing market, an increase in U.S. OSB supply and rising production costs at the mills. Before the shutdowns, though, in 2004-5 the market for standing timber was "overheated," and many of the Minnesota mills were stockpiling logs. Several Minnesota loggers came to northeastern North Dakota in search of harvestable timber as their local supplies dwindled. Then, the market for OSB softened rapidly, but there was already a glut of raw materials in the system. The permanent line shutdown in Bemidji resulted in a reduction of around 160,000 cords of annual wood demand.

What does this mean for timber harvesting in North Dakota? Most likely, timber harvesting will be substantially reduced. There is still a small local sawmill industry that will continue to need raw materials. However, the hot market that we saw for the last two years is likely gone until there is new demand at the mills. And that is unlikely to happen unless the U.S. housing market heats up again.

Gypsy Moth Update

The gypsy moth (*Lymantria dispar*) is a non-native defoliating insect pest that feeds on numerous deciduous trees. Since its introduction to the U.S. in 1896, the moth has spread across the northeast and Midwest, damaging millions of acres of forestland.

The N.D. Forest Service, N.D. Department of Agriculture, USDA Forest Service and the USDA Animal Plant Health Inspection Service conduct annual statewide gypsy moth detection surveys. There were 419 and 365 gypsy moth detection traps placed in 2005 and 2006, respectively. These traps were distributed throughout the state to encompass major forest types at risk of gypsy moth introduction.

There were no gypsy moths caught in North Dakota in 2005 and 2006. The gypsy moth has been detected periodically in past years; single egg masses and larvae can be transported long distances on cars, recreational vehicles, nursery stock and other items. One gypsy moth was detected in 2003 and two additional gypsy moths were detected in 2004. Despite those isolated detections, there are no known established gypsy moth populations in North Dakota as of December 2006. Trapping efforts will continue and include new areas of potential risk.

Juneberry disease control trials

Jim Walla and Harlene Hatterman-Valenti recently completed two years of fungicide evaluations for management of Entomosporium leaf and berry spot on juneberry. The research was made possible by funding from the State Board of Agricultural Research and Education (SBARE). Differences

across test locations, dates and years resulted in enough variation to prevent blanket statements as to which fungicides performed statistically better than the control. However, some general conclusions can be reached.

PropiMax, Nova, and Nova alternated with Abound performed best at reducing leaf spots. Nova alternated with Switch was slightly less effective at one site. Captan reduced leaf spots at two of the three test sites. Kumulus reduced disease at only one of the three test sites and was dropped from the experiment after the first year. Of these, only Abound and Switch are currently labeled for use on juneberry. Kumulus had a special use label, but that has expired. Manufacturers of the others all indicated they would be interested in pursuing use on juneberry. Data from these experiments will be used to pursue registration of those that performed well but that are not labeled for use on juneberry.

Active ingredients for the fungicides that we tested are: Abound – azoxystrobin; Captan 50WP – captan; Kumulus DF – sulfur; Nova 40W – myclobutanil; PropiMax EC – propiconazole; and Switch 62.5WG – cyprodinil and fludioxonil. An article providing results of this research will be prepared for Tree Talk Newsletter next spring.

North Dakota Forest Health Report

A state report describing the health and conditions of North Dakota's forested resources is now available. The 2003-2004 North Dakota Forest Health Report summarizes forest pest conditions observed within the state over the past two years. This report is a product of a biennial reporting process that assesses the impacts of insects, diseases, and other factors on forests.

The report provides a thorough description of the forest resource types in North Dakota including native forests, rural plantings, community forests, and the importance of each. In addition, the general condition of each forest resource type is discussed to provide the reader with a broader understanding of the factors that influence the health and sustainability of these importance resources. Lastly, the biology, distribution across the state, and impact on forest health of specific insect and disease problems are described.

The report is a useful guide to anyone who is interested in gaining a greater understanding of forest health management. The report is not excessively technical so that a broader audience can appreciate its content. Other highlights of the report include color photos, graphs, and maps. An electronic copy of the report may be obtained from the North Dakota Forest Service website.

Latest research on "oak tatters"

In the June 2005 issue of *Tree Talk*, we discussed a report from Illinois on a malady called "oak tatters." The authors suggested that abnormal leaf development in the white oak group (oak leaf tatters) may be due to drift of chloroacetamide herbicides. However, the results were not conclusive and no causal mechanism has been described.

Updated research results were recently described in a poster presentation at the American Society for Horticultural Science 2006 Conference in New Orleans. The authors tested three different chloroacetamide herbicides alone or in combination with atrazine, applied to red and white oak trees that were at the leaf unfolding stage. When chloroacetamides were applied with atrazine, the dominant symptoms were those of leaf tatters. However, not all replicates showed injury, suggesting that differences in susceptibility to herbicide injury may be due to slight growth stage differences or genetic differences. Seedlings that showed symptoms of tatters usually produced new growth approximately one month later in the growing season that did not show leaf tatter injury.

Our native bur oak is part of the white oak group, but oak tatters has not been reported in North Dakota. Hackberry has also shown tatters symptoms in Minnesota. More information on this research is available through the University of Illinois, Department of Natural Resources and Environmental Sciences.

Preliminary report – Timber harvests not detrimental to rattlesnakes

A recent article in the Forestry Source (July 2006. Volume 11(7): 10) reported on a study in Pennsylvania which suggests that humans are more detrimental to rattlesnakes than is timber harvesting. The study is being conducted by the Pennsylvania

Department of Natural Resources Bureau of Forestry. The question of the effects of harvesting on timber rattlesnake populations was raised because the snake is a candidate for the state's threatened or endangered species lists.

To determine the effects of harvesting, the researchers took to the Tiadaghton State Forest in the spring of 2002. They captured 39 rattlesnakes of different sexes and sizes and surgically implanted radio transmitters in them. The researchers currently know the whereabouts of 20 of the studies original 39 "participants."

Although the study is ongoing, so far the data collected by the researchers suggest that the timber rattlesnakes are not avoiding logged areas. Positioning piles of logging debris on the north and northwest sides of a logging site so that they are exposed to direct sunlight is a proactive step that managers can take to enhance rattlesnake habitat on logged sites.

New "Bark Beetles" website now available

The Bugwood Network recently announced the availability of Bark and Wood Boring Beetles of The World www.barkbeetles.org. This Web site features over 4,000 images and information on over 400 species of economically important beetles that feed on the cambium layer or wood of living or recently killed trees and shrubs.

Bark and Wood Boring Beetles of The World is a complete rework of the former Bark Beetles of North America Web site. This project should make it easier for users to find images and information about a wide array of bark and wood boring beetles.

The developers chose to implement the "NEW Taxonomy" that re-names the Scolytidae as Subfamily: Scolytinae within Family: Curculionidae. They also provide pathways to a selected set of comprehensive sites, instead of providing an exhaustive list of links.

The Bugwood Network builds through collaboration. As with all other Bugwood Web sites, all images are available for download and educational use at no cost as long as the photographer and the website are credited. If you are not familiar with the Bugwood Network, please visit www.Bugwood.org.

Deep planting reduces tree survival and increases formation of girdling roots

A recent article in the journal Arboriculture and Urban Forestry (Wells et al. 2006. 32: 305-311) reported the effects of planting depth on the survival and formation of girdling roots in red maple (*Acer rubrum*) and Yoshino cherry (*Prunus* x *yedoensis*) trees. Trees were planted either at-grade, 6 inches below grade or 12 inches below grade.

Deep planting – at either depth – reduced survival of the cherry trees by 50% within two years of transplanting; cherry trees planted at-grade had 100% survival. However, deep planting did not affect survival of maple trees, compared to planting at-grade. No additional mortality of cherry trees was seen after the first two years.

While deep planting did not reduce survival of maple trees, it did result in an increase in girdling or potentially girdling roots. Control maples had 14% of their trunk circumference encircled by girdling or potentially girdling roots; this number rose to 48% and 71% in 6-inch and 12-inch deep-planted maples, respectively. There were no treatment-related differences in girdling root development in the cherries.

The authors speculated that the maple health and survival will not be affected by the girdling roots until the trees reach 8-10 inches in caliper, many years into the future. Nevertheless, the few extra minutes spent identifying the root collar and properly planting the tree initially, can mean the difference between long-term survival and failure.

Does sugar enhance salt tolerance of trees?

A recent article in the journal Arboriculture and Urban Forestry (Al-Habsi and Percival. 2006. 32: 277-285) describes a group of experiments on the interaction between sugar and salt in trees. Salt stress affects trees by reducing photosynthetic capacity and inducing a buildup of oxidative compounds. Applying sugar may reverse these effects.

In the first experiment, the authors applied sucrose (table sugar) at rates of 0, 3.4 or 6.8 oz/gal as a root drench, to seedlings of English oak (*Quercus robur*) and holly (*Ilex aquifolium*). Three days later, the roots were drenched with sodium chloride (table salt) at rates of 114 or 228 oz/gal. Fifteen days after

the salt treatments, several physiological variables indicated that pre-treating the trees with sugar enhanced their recovery.

In the second experiment, salt was applied first, with sugar being applied two, four and six weeks later. Sugar-treatment, especially at the 3.4 oz/gal rate, helped the salt-stressed trees to recover more quickly, increasing the chlorophyll content of the leaves and the overall growth of the trees.

Can sugar help salt-stressed trees in North Dakota? While these results are promising, they were done using tree seedlings, with measurements taken over the course of just a few weeks. Long-term results with larger trees in a field setting have not yet been demonstrated. Nevertheless, this could be an opportunity for exciting research in the northern Great Plains.