



Hemlock twig rust caused by *Melampsora farlowii* (Arth.) Davis

Introduction

Twig rust, caused by the fungus *Melampsora farlowii* (Arth.) Davis, is a common disease of eastern (*Tsuga canadensis* Carr.) and Carolina (*T. caroliniana* Engelm.) hemlocks throughout eastern North America. Although not generally a problem in forests, hemlock twig rust can cause considerable damage in commercial tree nurseries, where cultural conditions favor the development of disease. Unlike related *Melampsora* species. (e.g., the poplar rust fungus—*M. medusae*), *M. farlowii* produces only two spore stages—teliospores and basidiospores—and does not alternate between hemlock and a taxonomically unrelated plant. Teliospores in dead twigs and fallen needles germinate in spring, producing basidiospores that are wind-dispersed and infect young cones, needles, and stems of *T. canadensis* and *T. caroliniana*.



Figure 2. Close and magnified view of young telia of *Melampsora farlowii* on the stomatal surface of current-year needles of *Tsuga canadensis* (New York, July).

Distribution and Host(s)

Melampsora farlowii is widely distributed throughout southeastern Canada (Nova Scotia) and the eastern United States including Georgia, Michigan, New Hampshire, New York, North Carolina, Pennsylvania, Vermont, Virginia, and Wisconsin. The fungus has been reported to infect eastern (*Tsuga canadensis*) and Carolina (*T. caroliniana*) hemlock, the former being most affected.



Figure 1. Dead shoot of eastern hemlock (*Tsuga canadensis*) caused by *Melampsora farlowii*. Infection results in the deformation—curly-cue like appearance—of current-season growth (New York, May).

Hemlock twig rust



Figure 3. Current-year infection of young hemlock twigs (*Tsuga canadensis*) by *Melampsora farlowii* (New York, July).

Symptoms and Signs

Initial symptoms appear in May–early June as yellowing of current-year needles approximately 1-month after bud burst. Shortly thereafter, the base of infected needles and twigs become orange-brown (Fig. 2, 3). Uninfected needles abscise (drop) from affected twigs resulting in few needles distal to the point of infection. Infected twigs later curl as the fungus invades the vascular tissue (Fig. 3). Infected cones do not produce seed; aborted cones often persist on affected trees.

Telia are the most conspicuous fruiting stage of *M. farlowii* (Fig. 2). Telia are reddish to rust-brown, waxy, linear, and confluent on affected needles or twigs. Teliospores are present in a column-like fashion (i.e., single-row) within mature telia immediately beneath and within the epidermis of infected needles. Teliospores are oblong–cylindric, and measure 7–10 x 35–58 μm . Basidiospores are globular, pigmented red-yellow, and approximately 8 μm in diameter.

Disease Cycle

Melampsora farlowii is an autoecious rust, producing only teliospores (probasidia) and basidiospores on attacked cones, needles, and twigs (Fig. 1). Given favorable meteorological conditions (i.e., cool, wet-weather), teliospores germinate in place producing basidiospores in spring and early summer (May–June). Basidiospores infect current year's growth and cones, and shortly thereafter (2–4 wks), telia appear on affected twigs and needles. Telia mature throughout the growing season and represent the overwintering stage of the fungus, giving rise to basidiospores the following spring.

As with many diseases, hemlock twig rust is significantly affected by prevalent weather conditions. In spring (late April–early June), ten or more continuous hours of precipitation appear to be required for teliospore germination and the resultant production of basidiospores. Thus, cool (50–64° F), wet weather lasting greater than one-day is sufficient for teliospore germination and the production of basidiospores. Factors influencing the germination of basidiospores are unclear; however, conditions conducive for teliospore germination appear to be sufficient for basidiospore germination and the infection of hemlock.

Management and Control

Recommendations—see **p. 111** of the Pest Management Guide for Commercial Production and Maintenance of Trees and Shrubs (2010).

Chemical control: Apply triadimefon, neem oil or mancozeb once when buds break and twice at 7–14-day intervals.

Cultural control: Where disease is severe, do not plant susceptible hemlocks. Inoculum produced within infected nursery beds or cultures will persist.

S. C. Kenaley^{1,*} and George W. Hudler²

¹Post-doctoral associate; Dept. of Plant Pathology and Plant Microbe-Biology, Cornell University; Ithaca, NY 14853

²Professor and Chair; Dept. of Plant Pathology and Plant-Microbe Biology, Cornell University; Ithaca, NY 14853

*Corresponding author. E-mail: sck26@cornell.edu Phone: (607) 255–2268