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LEAF RUSTS OF POPLARS AND WILLOWS IN THE MIDWEST

In the Midwest, premature defoliation of willows, poplars, aspens, and cottonwoods is often caused by three or four leaf rust fungi in the genus *Malampsora*. All North American willow rusts are currently assigned to the "group species" *M. epitea* mainly because they are morphologically indistinguishable from each other in their telial and uredinial states on willows. This group species includes the synonyms *M. abieti-capracearum* and *M. paradoxa* (also known as *M. bigelowii*) which occur in the Midwest. The leaf rust fungi that attacks poplars are named *M. medusae* (synonym *M. albertensis* and *M. abietis-canadensis*. The approximate host ranges of these fungi in the Midwest are given in Tables 1 and 2.

Figure 1. Leaf rust on poplar.

In wet years, young trees may be severely defoliated, suppressing growth 30 percent or more. In susceptible bottomland cottonwood stands, continued defoliation of successive flushes of growth by leaf rusts decreases vigor and indirectly increases the likelihood of winter injury as well as susceptibility to other diseases, such as Cytospora, Dothichiza, and Phomopsis cankers. Epidemics of leaf rusts are favored by growing susceptible clones of poplars and willows in crowded, monocultural stands where air movement is restricted.

Table 1. Willows (*Salix* species) susceptible to *Melampsora epitea* (equals *M. paradoxa* and *M. abieti-capracearum*) in the Midwest

Willow (*Salix*)	
Babylon weeping (*S. babylonica)*	Osier, common or basket (*S. viminalis*)
Bay or laurel-leaved (*S. pentandra*)	Peachleaf (*S. amygdaloides*)
Bebb (*S. bebbiana*)	Purple or purple osier (*S. purpurea*)
Black (*S. nigra*)	Pussy *(S. discolor*)
Crack (*S. fragilis*)	Shining (*S. lucida*)
Goat (*S. capria*)	Silky (*S. sericea*)
Gray (*S. cineria*)	White (*S. alba*)
Heartleaf (*S. cordata*)	Wisconsin (and Niobe) weeping (*S. blanda*)
Missouri (*S. missouriensis*)	Yellow (*S. lutea*)

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Table 2. Poplar, Aspen, and Cottonwood species (*Populus* species) susceptible to Leaf Rust Fungi (*Melampsora medusae* and *M. abietis-canadensis*) in the Midwest

Poplar, aspen, or cottonwood (*Populus*)	*M. medusae*	*M. abietis-canadensis*
Balsam poplar (*P. balsamifera*)	X	X
Black poplar (*P. nigra*)	X	X
Bolleana or Turkestan poplar (*P. alba* var. *pyramidalis*) . .		X
Eastern cottonwood (*P. deltoides*)	X	X
Golden aspen (*P. tremuloides* var. *aurea*) . . .	X	X
Gray poplar (*P. canescens*)		X
Great Plains cottonwood (*P. occidentalis*) . . .	X	X
Large-toothed aspen (*P. grandidentata*)	X	X
Lombardy poplar (*P. nigra* var. *italica*)	X	X
Trembling aspen (*P. tremuloides*)	X	X
Silver poplar (*P. alba* var. *nivea*)		X
White poplar (*P. alba*)		X

Symptoms

Small, yellow spots develop on the upper leaf surface of susceptible willows and poplars in early summer (Figure 1), especially on the lower branches. Bright, lemon-to-orange yellow, powdery pustules (or uredinia) form on the corresponding lower leaf surface (Figures 2 and 3). The pustules may be scattered on the leaves or be so crowded that the entire surface looks powdery and yellowish orange. The dusty pustules contain many thousands of microscopic spores (urediniospores). The spores are easily windborne to leaves in the upper branches and to nearby susceptible trees where infections occur in moist weather. Several generations of uredinia and urediniospores may be formed through the summer during humid or wet weather. By late summer to mid-autumn, the pustules turn dark brown to black and become crustlike. These dark pustules contain large numbers of thick-walled resting spores (teliospores) that overwinter in the fallen leaves.

Figure 2. Close-up of rust pustules on the underside of a poplar leaf (California State Department of Agriculture photo).

Where leaf rusts are common and severe, poplar and willow leaves may be distorted, wither and drop prematurely reducing growth. The more susceptible a tree is to leaf rust(s), the more rapidly the disease develops and the sooner defoliation starts. Growth loss due to rust is often masked by the normally rapid growth of poplars and willows and can best be detected by comparing the growth of infected trees with comparable healthy trees protected by fungicide sprays.

Disease Cycle

Rust fungi have complex life cycles involving up to five different spore stages. These fungi often require two unrelated host plants to complete their full life cycles.

Figure 3. Rust pustules on the lower leaf surface of a willow. (Courtesy Pacific Forest Research Centre, Canadian Forestry Service).

Malampsora medusae (synonym *M. albertensis*), which causes the disease known as conifer-aspen rust, is one of the two leaf rust fungi that attack native poplars and introduced species. Conifer-aspen rust occurs throughout nearly the entire range of poplars worldwide. In the Midwest, this fungus has as alternate hosts alpine larch (*Larix lyallii*), tamarack or eastern larch (*L. Laricina*), Douglas fir (*Pseudotsuga menziesii*), and ponderosa pine (*Pinus ponderosa*). The fungus produces scattered, pale yellow spots (spermagonia) on the upper leaf surface and pale yellow pustules (aecia) on the lower leaf surface of the current year's needles. When conifer-aspen rust is severe, the conifer needles are distorted, turn yellow, shrivel, and drop early. The aecia of *M. medusae* produce large numbers of orange-yellow aeciospores formed in chains, that are airborne to aspen, cottonwood, and poplar leaves, where infections result in golden yellow uredinial pustules on both leaf surfaces. In the Midwest, *Melampsora medusae* survives the winter only as the nearly black teliospores in fallen poplar leaves. In spring, basidiospores from telia in dead poplar leaves infect young, current-season needles of coniferous hosts. These new infections produce spermagonia and then yellow aecia within about two weeks, thus completing the disease cycle.

Mild wet weather favors infection of both poplars and conifers. At 65°F (18°C), more than 24 hours of free moisture on larch needles is necessary for infection by basidiospores; more than 48 hours are needed for maximum infection. The production of urediniospores on aspens and poplars is favored by humid weather and temperatures of 59° to 68°F (15° to 20°C). Hot dry weather limits rust infections. *Melampsora medusae* populations tend to increase in late summer and early autumn after the host has completed most of its year's growth.

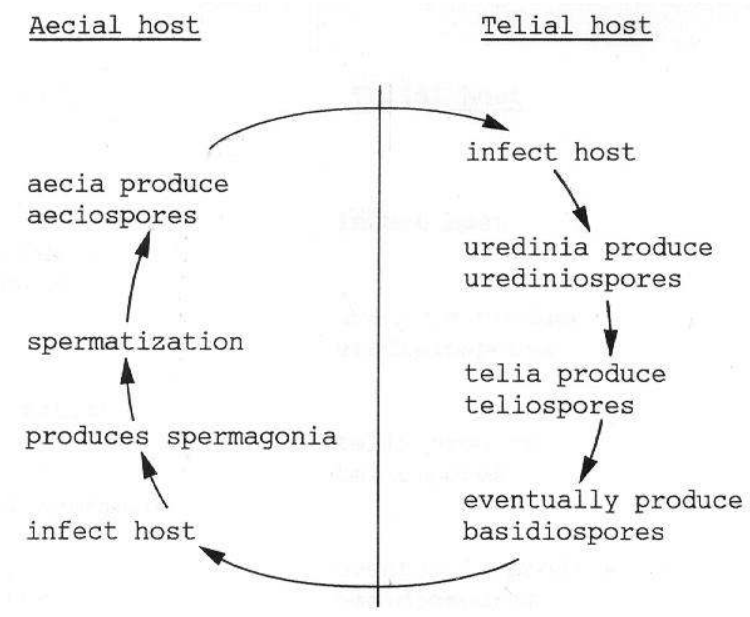

Figure 4. Disease cycle of leaf rusts of poplars and willows.

Melampsora abietis-canadensis, the hemlock-poplar rust fungus, occurs from Nova Scotia and New England south to North Carolina and west to the Great Plains. The fungus infects the leaves of both aspens and poplars, as well as hemlock (*Tsuga canadensis*). The disease cycle for this rust fungus closely parallels that of the conifer-aspen rust (Figure 4). The yellow spermagonia and golden, powdery aecia form on the needles, green stems, and especially the cones of hem-

locks. Later, infected shoot tips die and the cones may shrivel, blacken, and hang as mummies. The aecia produce orange-yellow aeciospores that infect native and introduced poplar, aspen, and cottonwood leaves. The yellowish orange uredinia, with their powdery masses of urediniospores, soon appear. In late summer, the orange-yellow crusts become black as telia and teliospores form. In the spring, basidiospores are formed on fallen poplar leaves. These basidiospores then reinfect nearby susceptible hemlocks where the yellow spermagonia are formed, completing the life cycle. Since this rust occurs west of the range of hemlocks, it appears that the fungus might survive the winter as urediniospores or mycelium on or in poplars.

Melampsora paradoxa (synonym *M. bigelowii*), part of the group species *M. epitea*, infects the leaves of both willows and larches (*Larix* species), and is called larch-willow rust. The larch species that are attacked in the Midwest include the European larch (*L. decidua*), tamarack or eastern larch, and alpine larch. *M. paradoxa* overwinters in fallen willow leaves as dark, thick-walled teliospores. In the spring, the teliospores germinate to produce basidiospores. These are blown by air currents to nearby susceptible larches where infection of the young, expanding needles occurs during wet periods. Small yellow spots (spermagonia) soon appear on the upper surface of the needles, followed shortly by pale yellow pustules (aecia) on the corresponding lower leaf surface. If the disease is severe, rusted larch needles may turn yellow, wither, and drop prematurely.

The aecia produce chains containing large numbers of golden aeciospores that are carried by the wind to infect nearby willow leaves. The yellowish orange pustules (uredinia) appear about two weeks later. In the late summer to mid-fall, the uredinia turn dark with the production of telia and teliospores, thus completing the disease cycle. *M. paradoxa* can also overwinter as mycelium in willow catkins, terminal buds, and possibly young stems. By these means, the larch-willow rust fungus can survive and reproduce where its alternate host, the larch, is absent. The complete life cycle of the fungus occurs **only** where susceptible willows and larches are growing in fairly close proximity.

Melampsora abieti-capraearum, also part of the group species *M. epitea*, causes the widespread disease known as fir-willow rust. Golden yellow pustules form on willow leaves. The life cycle is like that of larch-willow rust (*M. Paradoxa*), except that spermagonia and aecia are produced on the current year's needles and occasionally the cones of balsam fir (*Abies balsamea*) and possibly other firs. The needles become discolored, may shrivel and die. Like *M. paradoxa, M. abieti-capraearum* may overwinter as mycelium, probably in willow buds. *Melampsora abieti-capraearum* can thus survive and reproduce independent of firs, its alternate host.

Control

1. In ornamental plantings of poplars and willows, where leaf rusts are a problem, collect and compost or burn the fallen leaves to destroy infective spores.

2. In areas where continuous and heavy infection occurs, new plantings of poplars and willows should be located as far away from susceptible conifers as possible.

3. In nurseries, willow stems or "rods" should be cut late in the spring. If an earlier cut is desired, the second crop of rods need to be cut back in summer, leaving the third crop to grow. The summer cut removes infected rods, so the third crop should be virtually disease-free.

4. In nurseries where leaf rusts are serious, poplars, and willows can be sprayed two or more times, 7 to 21 days apart, starting a week or two **before** the rust normally appears.

5. Poplar cultivars and hybrids differ greatly in their resistance to leaf rusts. Therefore, nurserymen and plantation owners should check with their District Forester or Illinois Extension Forester regarding the relative resistance or susceptibility of the poplars they plan to grow. Clones that are highly susceptible to rust should not be propagated. The rust fungi exist as many pathogenic races that vary in virulence on poplar cultivars and hybrids.