Snow mold: Winter turfgrass nemesis

Numerous species of snow mold damage golf course turf in colder climates.

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Where winter is long and harsh, a deep, persistent layer of snow insulates the roots and crowns of turfgrasses, protecting them from winter injury caused by prolonged exposure to lethal and sublethal low temperatures. In Alaska, a difference of 27 to 45 F was observed between ambient and soil temperatures at a snow depth of 21 inches. For instance, when ambient temperatures were 5 F and -49 F, temperatures at the root zone registered 32 F and -4 F, respectively.

The dark, humid and relatively mild environment provided by the protracted snow cover prevents photosynthesis and drastically reduces plant metabolism. It also predisposes plants to attack by snow mold fungi by increasing contact of soilborne inoculum to plant tissues and by depleting carbohydrate reserves.

During the autumn and early winter, the gradual decrease in average ambient temperature induces a hardening process in plants, which is essential for the development of snow mold resistance.

Photos by J.H. McBeath

Snow mold patches on *Agrostis palustris* were caused by *Coprinus psychromobidus* at Chena Bend GC, Fairbanks, Alaska.

Important snow molds

Dark, humid environmental conditions favor the development of psychrophilic (cold-loving) microorganisms that are able to grow at 32 F and below and have a maximal growth rate at about 68 F. Snow molds are obligate or facultative psychrophilic fungi that can attack plants under snow cover. Snow molds inhibit the growth of snow-covered plants when the temperature at the snow-plant interface remains around 32 F. Snow molds, which may occur as a single species or in a group of several species, encompass more than a dozen species and occur more commonly in high-latitude regions.

On turfgrasses, the most important snow mold fungi are *Typhula incarnata*, *T. ishikariensis*, *Microdochium nivale* (= *Fusarium nivale*), *Coprinus psychromobidus*, sterile low-temperature basidiomycetes (LTB), *Myriosclerotinia borealis* and *Pythium iwayami*. In Alaska, *My. borealis*, *C. psychromobidus* and *Mi. nivale* are prevalent. *Typhula incarnata*, *T. ishikariensis* and *Pythium* species are economically important snow mold fungi of other temperate and subarctic regions but have not been found in Alaska.

KEY points
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Several species of snow mold cause turfgrass diseases.

The conditions under which snow molds thrive and the disease symptoms they cause vary from species to species.

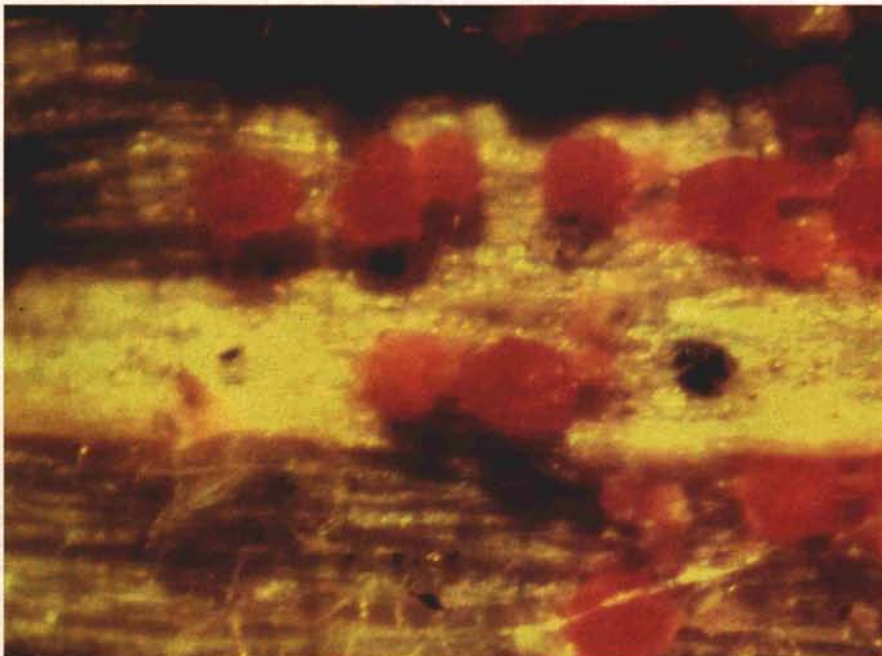
Snow mold diseases can be managed by using resistant cultivars, following correct cultural practices and employing chemical and biological controls.

Interactions of snow mold fungi and host plants

Snow mold damage to turfgrasses is generally governed by environmental conditions in fall and winter, depth and duration of snow cover and availability of disease inoculum. Snow mold fungi infect host plants in late fall or early winter when the soil is not yet frozen. From November to early March, snow mold fungi proliferate under a thick snow layer and spread in host tissues under dark, humid conditions.

Some snow molds remain dormant through the summer and overwinter in a vegetative state. Some psychrotrophic molds, such as *Mi. nivale*, can grow even in the summer without passing through a dormant stage. Beneath the snow on frozen ground, the optimal temperature for development is 27 F for LTB and 28 F for *My. borealis*.

Many snow mold fungi are capable of producing extracellular enzymes, which are believed to facilitate the maceration (soften-



Salmon pink-colored sporodochia of *Microdochium nivale* (shown here on a diseased leaf blade) give pink snow mold its name.

ing and breaking down by soaking) and degradation of plant tissues. In Alaska, little snow mold activity was detected when soil temperatures fell below 23 F. Peak snow mold activity on plants occurs during spring breakup (late March through mid-April) when soil temperatures are around freezing and the soil-snow interface is saturated with melting snow.

Resistance to snow mold infection in host plants appears to be correlated with total content of carbohydrates and fructan. Because it may be easier for snow mold fungi to metabolize fructan polymers than simple sugars, plants that maintain a higher proportion of soluble carbohydrates as fructan would be less susceptible to snow mold damage. Snow molds kill plants by maceration of plant tissues (leaves, sheaths and especially the crowns), leaching of plant cytoplasm, depletion of carbohydrate reserves and desiccation.

Snow mold diseases

Typhula blight

Typhula blight is also called gray or speckled snow mold because of its characteristic white to gray-white mycelial mat speckled with numerous sclerotia, which form a compact fungal mass that can survive unfavorable environmental conditions. In areas with protracted snow cover, the most important diseases of perennial grasses are caused by species of *Typhula*. Typhula blight occurs from cool-temperate to boreal regions of the Northern Hemisphere, except Alaska. According to a survey of golf course superintendents conducted in Canada, diseases caused by *Typhula* spp. were the second-most damaging to turfgrass and control of this disease might account for half of the chemical fungicides used on turfgrass.

Typhula blight is caused by *T. incarnata* and three biotypes of *T. ishikariensis*. Symptoms often appear first at snow melt as circular areas of straw-colored patches 2 inches to a yard or more in diameter. Leaves in affected areas are matted together and may be covered with a gray-white mycelium. As the grass dries, the mycelium disappears and the leaves become grayish to silvery white, brittle and encrusted over the patch. Large areas of turfgrass may be killed under optimal conditions for disease development. More often, however, only leaves are killed, and plant crowns produce new leaves during the spring.

Small, hard, spherical sclerotia form on or in infected leaves. The sclerotia are 0.007-0.2 inch in diameter; they are white, pink, amber or chestnut-colored when young and reddish brown to black when mature. The sclerotia are useful in differentiating Typhula blight from pink snow mold.

Typhula spp. survive as sclerotia during the summer. In late autumn, the sclerotia become exposed to wet, cool (optimum of 40-54 F) conditions that favor germination. *Typhula* spp. grow very well at temperatures

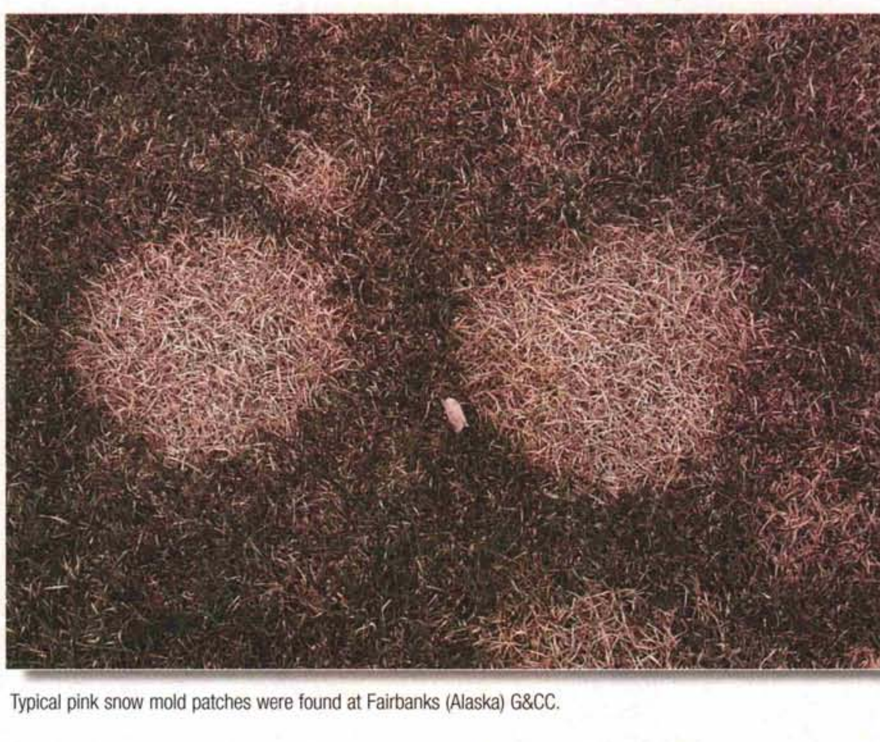


Photo by J.H. McBeath © 2002 by APS

Typical pink snow mold patches were found at Fairbanks (Alaska) G&CC.

just above freezing (34-36 F). The disease is most severe when deep snow or heavy mulch covers a wet turfgrass canopy when soil is not frozen for a long period. Applying high rates of nitrogen fertilizer before winter dormancy may favor the disease by promoting succulent leaf tissue.

Pink snow mold and Microdochium (Fusarium) patch

Pink snow mold is named because of the salmon-pink colored mycelia and sporodochia that appear on grasses after the snow recedes. *Microdochium nivale* requires little or no snow cover to cause disease. In some cool, humid regions, damage caused by *M. nivale* can be observed year round in nearly all grass species. *Microdochium nivale* can attack all plant parts during wet, cool periods in autumn and spring. At temperatures below 41 F, it is less virulent than other snow mold fungi.

Under favorable conditions, patches of affected turf first appear as small water-soaked spots less than 2 inches in diameter. These spots rapidly change color from orange-brown to dark brown and finally become light gray with brown or pink margins. The spots are usually less than 8 inches in diameter. In low-cut turf, ringlike patches may appear, and the outer perimeter of the patch may have a water-soaked, greenish black margin.

Microdochium nivale survives unfavorable periods in infected grass plants and dead debris as mycelia and spores. When conditions are favorable, mycelia of the pathogen grow from infected debris or from germinating spores to infect leaves. The disease is most severe when turf with heavy thatch is growing slowly under prolonged cool (32-46 F) and wet conditions. Alternate thawing and snow cover, repeated frosts, cold fogs and light drizzling rain are particularly favorable for leaf-to-leaf spread of the fungus.

High nitrogen fertility, which promotes succulent grass, can increase turfgrass susceptibility, whereas high levels of potassium tend to suppress the disease. Poor drainage and long leaf blades that become matted down, producing pockets of high humidity, also favor disease development. Spores and infected debris are easily disseminated through equipment, wheels, mowers, animals and shoes.

Coprinus snow mold

Where Coprinus snow mold is active, receding snow reveals the presence of circular or irregularly shaped snow mold patches with white to gray, woolly or sparse mycelium of *Coprinus psychromobidus*. Infected plants have rotten, water-soaked leaves or leaf lesions. The lesions, or leaves, become pale brown when dry and have dark red to brown margins.

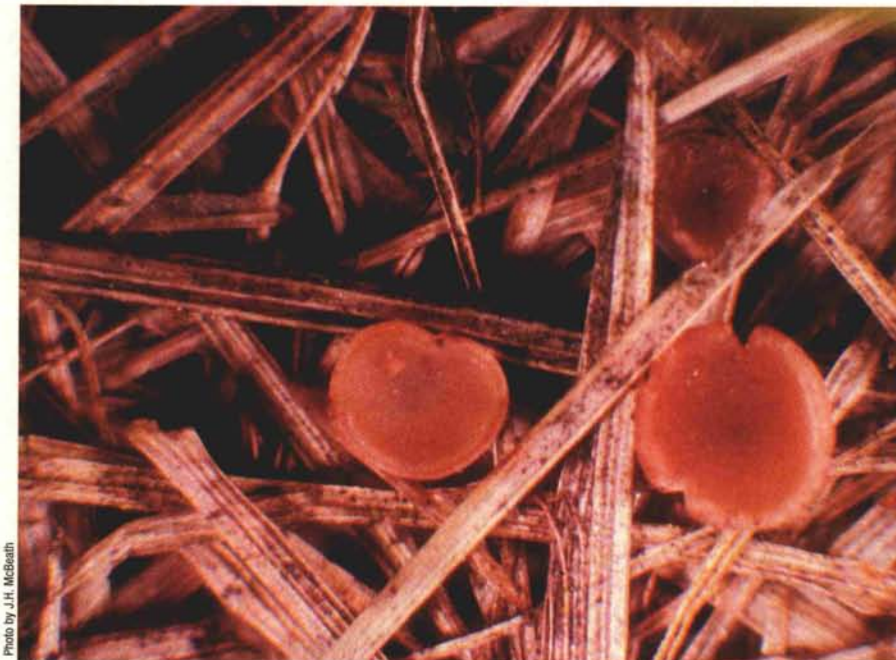


Photo by J.H. McBeath

Apothecia of *Myriosclerotinia borealis* disseminate snow scald by producing massive numbers of ascospores, which are dispersed by wind.

Coprinus snow mold, also called cottony snow mold, is caused by sclerotial and nonsclerotial strains of *C. psychromobidus*. The nonsclerotial strains (= low-temperature basidiomycete [LTB]) are caused by sparse to abundant white to gray mycelia that have clamp connections. The sclerotial strains (= sclerotial low-temperature basidiomycete [sLTB]) are similar, but they produce abundant, small (0.04-0.12 inch in width) sclerotia that are white first and then mature to become brownish black, irregularly shaped and flattened. The nonsclerotial strains tend to grow faster and have a more cottony appearance than the sclerotial strains. They also produce patches that are somewhat larger and whiter than those formed by the sclerotial strains.

Protracted snow cover favors the development of Coprinus snow mold. Beneath the snow on frozen ground, the optimal temperature for development of LTB is 27 F. Although prolonged exposure to zero or subzero temperatures is necessary for the snow mold to parasitize turfgrass plants, Coprinus snow mold fungi grow optimally in sterile growth media from 50 to 59 F. Extracellular enzymes produced by sLTB facilitate the degradation of host plant tissues and contribute to disease development.

In Canada, sclerotia of sLTB are formed primarily on leaf surfaces. In Alaska where winter temperatures are more severe, sclerotia are found in the inner layer of the sheath tissue of the plant. The discrepancy may be an indication of adaptation. Sclerotia serve as the survival structure of the sclerotial strains. It is not known where the nonsclerotial strains survive.

Snow scald

Snow scald is caused by *Myriosclerotinia borealis* (syn. *Sclerotinia borealis*). Disease development is favored by prolonged periods of deep snow cover on frozen soil. Patches of grayish fungal mass appear as the snow recedes. Leaves are initially water-soaked and covered with a sparse gray mycelium and tan sclerotia. Later they are bleached to white in color and become desiccated. The optimal temperature for development of *M. borealis* is 28 F.

Sclerotia of *M. borealis* are variable in size and shape. They may be spherical, oval or flakelike and are 0.02-0.28 inch long. The intact sclerotia, under unfavorable conditions, may remain dormant in soils for years.

Under humid, favorable conditions, sclerotia germinate to produce apothecia, which are cup- or saucer-shaped fruiting bodies up to 0.2 inch in diameter and are borne on a stipe (stalk) up to 0.24 inch high. The apothecia produce massive numbers of ascospores, which are dispersed by wind.

In addition, sclerotia can also produce mycelia directly. When maintenance activities (mowing) or weather conditions (freezing and thawing) cause cracks and nicks on sclerotia, mycelia germination occurs. This mode of germination is especially common under arid conditions. Ascospores and mycelia growing from the sclerotia or sclerotia fragments infect leaf blades and sheath of plants near the soil surface. Mycelia of *M. borealis* primarily enter host plants through the stomata, but direct penetration through the cuticle has also been observed.

Snow rot or snow blight

In cold weather, Pythium snow rot is well known on pooid (*Poa* spp.) grasses in Japan and has been observed in Canada. This foliar blight is favored by high soil fertility, poor drainage and saturated soil underlying deep snow. At least six *Pythium* spp. are known causal agents of snow blight.

Small tan or orange spots may appear on the turf, or large areas of turf may be uniformly blighted. Rotted leaf tissue appears brown or light tan and is filled with oospores of the pathogen. Roots are mostly unaffected, but crowns can suffer extensive rotting. Plants with infected crowns die quickly.

Management of snow mold diseases

Resistant cultivars

The use of suitable resistant turfgrass species and cultivars is recommended. Most of the commonly used cool-season turfgrasses are susceptible to *My. borealis*. Perennial ryegrasses appear to be the turfgrasses most susceptible to *Typhula* blight; creeping bentgrasses are a close second.

Speeding snow melt

Promote rapid drying and warming of disease-prone areas in early spring by speeding snow melt.

Water management

Because diseases caused by *Pythium* spp. and *Mi. nivale* depend heavily on wet soils and foliar moisture, drainage is extremely important in reducing the potential for disease.

Proper fertilization regime

Lack of nitrogen and consequent low vigor and slow recovery from disease should be avoided, but excessive nitrogen fertilization in late summer and fall will delay dormancy and acclimation and encourages microdochium patch and other snow mold diseases.

Chemical control

Fungicides are useful as preventive measures when applied in autumn, but they are usually not effective as a curative measure in late winter or early spring. Chemical control may or may not provide adequate control of crown and root rot. Repeated fungicide applications during midwinter thaws increase protection against *Typhula* blight.

Selection of a fungicide for snow mold control should take into account complexes with other snow molds and diseases. For instance, the DMI fungicides (for example, fenarimol, triadmefon and propiconazole) are effective against *Typhula incarnata*, but not against *T. ishikariensis*.

Biological control

Research has demonstrated biological control of *My. borealis* and *Typhula* spp. in perennial ryegrass (*Lolium perenne*). Details of that research will be discussed in a subsequent article in *GCM*.

Snow mold on perennial ryegrass (*Lolium perenne*) was caused by *Myriosclerotinia borealis* and *Microdochium nivale* at Fairbanks (Alaska) G&CC, the northernmost golf course in the United States.

Acknowledgments

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References

1. Gaudet, D.A., and A. Laroche. 1999. Snow mold crop-environment interactions. p. 191. *In:* R. Margesin and R. Schinner (eds.), Biotechnological applications of cold-adapted organisms. Springer-Verlag, New York.
2. Hsiang, T., N. Matsumoto and S.M. Millett. 1999. Biology and management of *Typhula* snow molds of turfgrass. *Plant Disease* 83:783-798.
3. McBeath, J.H. 2002. Snow mold-plant-antagonist interactions: Survival of the fittest under the snow. www.apsnet.org/online/feature/snowmold/ Verified Nov. 29, 2002.
4. Smiley, R.W., P.H. Dernoeden and B.B. Clarke. 1992. Compendium of turfgrass diseases. 2nd ed. APS Press. St. Paul, Minn.
5. Smith, J.D., N. Jackson and A.R. Woolhouse. 1989. Fungal diseases of amenity turfgrasses. F. & F.N. Spon, London.
6. Takenaka, S., and M. Arai. 1993. Dynamics of three snow mold pathogens *Pythium paddicum*, *Pythium iwayamai*, and *Typhula incarnata* on barley plant tissues. *Canadian Journal of Botany* 71:757-763.
7. Vargas, J.M. Jr. 1994. Management of turfgrass diseases. 2nd ed. Lewis Publishers, Boca Raton, Fla.

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