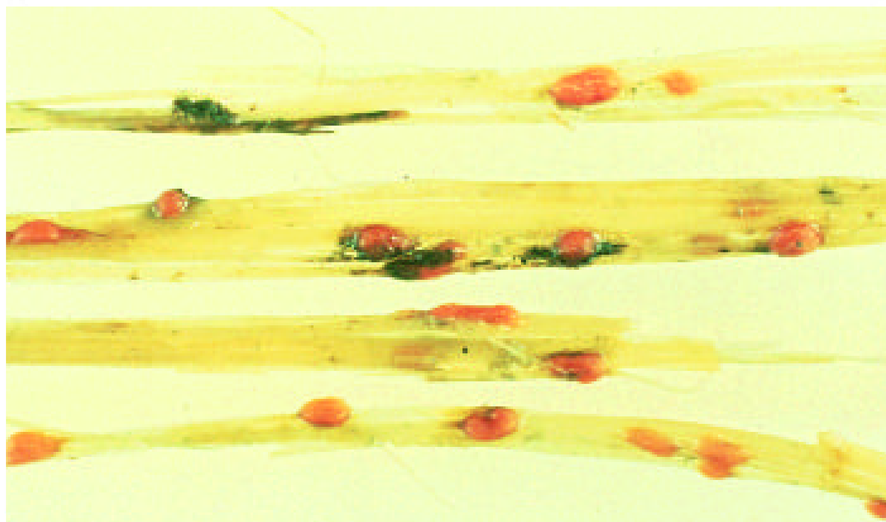
# Biological management of snow mold

Using natural organisms to control snow molds may allow superintendents to decrease their dependence on chemical fungicides.

**Jenifer Huang McBeath, Ph.D.**

Intensive management practices are necessary for golf course maintenance, but they frequently predispose turfgrasses to disease. In very cold areas, these practices may also interfere with the development of plants' winter hardiness and subject them to snow mold diseases in winter. The most common snow mold diseases in turfgrasses are pink snow mold, caused by *Microdochium nivale* (= *Fusarium nivale*); Typhula blight or gray snow mold, caused by *Typhula incarnata* or *T. ishikariensis*; snow scald, caused by *Myriosclerotinia borealis* (= *Sclerotinia borealis*); Coprinus snow mold, caused by *Coprinus psychromobidus* or sterile low-temperature basidiomycetes; and snow rot, caused by *Pythium iwayami*.





More than 20 years ago, researchers found that the low-temperature fungus *Acremonium boreale* (shown here on grass leaves) suppressed *T. ishikariensis*, *Microdochium nivale* and *Coprinus psychromobidus* in Canada.

## Restrictions on pesticide use

Presently, superintendents rely primarily on chemical fungicides to manage snow mold diseases. Public concerns about the effects of chemical pesticide use on the environment, wildlife and human health have resulted in numerous government regulations and restrictions on the use of many pesticides. In 2002, the Quebec government announced a list of pesticides (including iprodione and other fungicides commonly used for controlling snow mold and other diseases) that will be banned for most uses by 2005. Although golf courses are exempt for the moment, superintendents in Quebec will have to submit a pesticide-reduction plan to the government within three years. Other Canadian provincial and municipal governments are also seriously considering a sweeping ban on the urban use of pesticides.

The purpose of biological management is to harness naturally beneficial microorganisms, such as antagonists or competitors for nutrients of plant pathogens to enhance plant health. Biological means may be used in conjunction with chemicals (in reduced amounts), cultural or other management strategies to alleviate public concern.

## Challenges to biological control

The greatest challenge in biological management of plant diseases is the introduction and establishment of antagonists (beneficial microorganisms). This problem is especially acute with snow mold fungi, which have adapted to a harsh winter environment under prolonged snow cover or cool, wet conditions. To be successful, any antagonist must also be active at extremely low temperatures. Furthermore, combating snow mold requires a broad-spectrum antagonist capable of adequately protecting turfgrasses from snow mold diseases.

### KEY points

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**Intensive cultural practices** make turfgrasses more susceptible to snow mold damage in cold climates.

**Restrictions on pesticide use** have spearheaded the search for alternative means of snow mold control.

***Trichoderma atroviride,*** a hyperparasite and natural antagonist of snow mold fungi,effectively controls some species of snow mold in turfgrass.

## Interactions among snow mold fungi

Some snow molds remain dormant through the summer and spend the winter in a vegetative state. Others, such as pink snow mold, can grow in the summer without passing through a dormant stage. Climatic conditions in winter, such as temperature, precipitation, presence or absence of permanent snow cover, depth and duration of the snow cover, etc., create different climate zones, which attract different species, depending on their particular adaptations. Snow molds interact and compete with one another for plant nutrients. Sometimes they are compatible and sometimes not. Antagonism between one species of snow mold fungi and *Typhula incarnata* was reported as early as 1955.

Competition for limited resources under snow has also created intraspecific competition. For example, the biomass of *Pythium* species, especially *P. paddicum*, decreased drastically in the presence of *T. incarnata*, whereas *T. incarnata* biomass was rarely affected by the presence of *Pythium* species. *Typhula incarnata* appeared to be more competitive than *Pythium* species and also appeared to exploit them.

## Interaction of snow mold and antagonists

Harsh climatic conditions in winter attract microorganisms (bacteria and fungi) that tolerate low temperatures and may prey on or compete with snow molds. Some antagonistic species prey on specific snow molds, whereas others consume a broad spectrum of snow mold fungi.

In Canada, researchers found that *Typhula phacorrhiza* (isolated by Schneider and Seaman) was pathogenic to winter wheat. In 1987, L.L. Burpee and co-workers applied a nonpathogenic strain of *T. phacorrhiza* at 446 to 1,784 pounds/acre to creeping bentgrass and controlled Typhula blight successfully to a level comparable to that achieved by using the chemical control pentachloronitrobenzene (PCNB or iprodione) applied at a rate of 27 pounds/acre.

*Typhula phacorrhiza* produces no antibiotics and is not parasitic on other *Typhula* species. The mechanism of disease suppression has not been fully elucidated, but laboratory studies indicate that competition for substrates and nutrients is a probable mechanism for suppression of *T. ishikariensis* and *T. incarnata*.

In 1979 other researchers found that the low-temperature fungus *Acremonium boreale* suppressed *T. ishikariensis*, *Microdochium nivale* and *Coprinus psychromobidus* in Canada. In 1987, a low-temperature-tolerant bacterium, *Pseudomonas fluorescence*, was found to be antagonistic toward *T. ishikariensis* and capable of reducing gray snow mold damage.

## A hyperparasite

### *What is* Trichoderma atroviride?

*Trichoderma atroviride* is a cold-tolerant, versatile hyperparasite (a microorganism that parasitizes other microorganisms) isolated from the subarctic region of Alaska. It parasitizes a wide range of economically important plant pathogens, including *Coprinus psychromobidus*, *Microdochium nivale*, *Myriosclerotinia borealis*, *Pythium* species, *Typhula incarnata*, *Typhula idahoensis* and *Typhula ishikariensis*.

*Trichoderma atroviride* grows best at moderate temperatures but is well adapted to cold environments. It has a temperature range of 39 F (and less) to 91.4 F, which makes it useful in controlling pathogens that can inflict damage on roots, stems and other plant tissues under cool temperatures when plant tissues are particularly vulnerable.

*Trichoderma atroviride* is fast growing, produces profuse spores and is naturally resistant to metalyxyl, captan and pentachloronitrobenzene (PCNB) and iprodione, and has a high tolerance to mancozeb and other chemical fungicides.

### Trichoderma *as a biological control*

*Trichoderma atroviride* is capable of using snow mold fungi as a food source. Besides directly parasitizing the snow mold, *T. atroviride* produces enzymes that seem to play a significant role in mycoparasitism of snow mold fungi. For example, in *Myriosclerotinia borealis*, the sclerotia are highly resistant to chemical fungicides, but *T. atroviride* can parasitize these sclerotia and use them as a food source.

In studies of snow mold on winter wheat, *T. atroviride* seemed to forge a symbiotic relationship with the roots of winter wheat plants with no adverse effects on the plants.

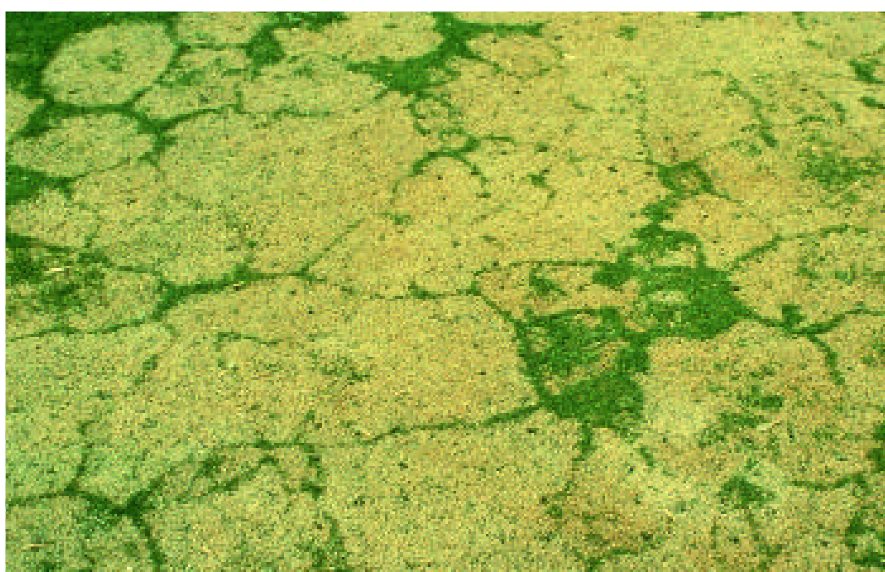
*Trichoderma atroviride* did not cause phytotoxicity in turfgrass. In many cases, plants treated with *T. atroviride* demonstrated marked increases in growth. Growth promotion characteristics have been observed in plants germinated from *T. atroviride*-treated seeds or seedlings in the absence of plant pathogens. Treated plants were bigger and more robust and had well-developed root systems.

In preliminary tests conducted on a sod farm, treating turfgrass with formulated *T. atroviride* seemed to improve root health and turfgrass color. However, these anecdotal accounts need to be confirmed with rigorous research.

## Fairbanks G&CC

Snow mold is one of the most difficult problems the superintendent faces at the Fairbanks Golf and Country Club, the northernmost golf course in the United States, located approximately 100 miles south of the Arctic Circle. Because of the harsh, long winter (six to eight months), chemical fungicide treatments were ineffective.

In late September 2000, immediately before the grounds became snow covered, Plant Helper (AmPac Biotech, formerly Ag Tech), containing 106 colony-forming units/gram (cfu/g) of *Trichoderma atrovride*, was applied on nine of the greens at Fairbanks G&CC, at the rate of 20 pounds per acre. Tee areas, fairways and other parts of the golf course were left untreated. From



Coprinus snow mold caused by *Coprinus psychromobidus* is one of the most commonly found snow mold diseases in turfgrasses.

late April to mid-May, after spring thaw, snow mold surveys were conducted on all the greens (*T. atroviride*-treated) and the tee areas, fairways and other untreated areas to evaluate the percentage of snow mold damage to turfgrasses.

The biological and environmental conditions at Fairbanks G&CC, from late September 2000 through mid-April 2001, appeared to be very conducive to the development of snow mold disease. Numerous bleached to light brown-colored grass patches in circular to irregular patterns of various sizes were observed in the untreated areas.

In one season of preliminary tests (September 2000-April 2001), snow mold damage on greens treated with formulated *T. atroviride* seemed to be much lower than damage on untreated greens. Again, rigorous scientific testing will be necessary to substantiate these observations. No visible snow mold damage was found on turfgrasses grown where appropriate dosages of *T. atroviride* had been applied.

## Application

In early spring, raking and other cultural practices can effectively spread snow mold in turfgrass. Applying beneficial microorganisms (antagonists) directly to snow mold patches after the snow has receded and before raking or other cultural practices may facilitate mycoparasitism of snow mold fungi (especially on sclerotia) and deter disease development in the fall. Application in early spring also allows the plant to benefit from the plant growth promotion provided by the beneficial microorganisms. A thorough application of beneficial organisms in the fall will be needed to provide plants adequate protection in winter.

Applications are best made in the early morning or at dusk to avoid intense solar radiation.

## Conclusions

Biological controls are generally thought to be environmentally benign and safe to humans and other animals. *Trichoderma atroviride* may also reduce inoculum of pathogens and alleviate disease pressure by parasitizing sclerotia of snow mold fungi.

However, biological management is no silver bullet. As a part of natural biological warfare, beneficial microorganisms (antagonists) can be overwhelmed by heavy snow mold disease pressure. For consistent results, frequent applications and higher dosages may be necessary. The use of *T. atroviride* or other beneficial microorganisms in snow mold management is a preventive measure that cannot cure existing infections. Biological controls work best as part of a total management strategy.

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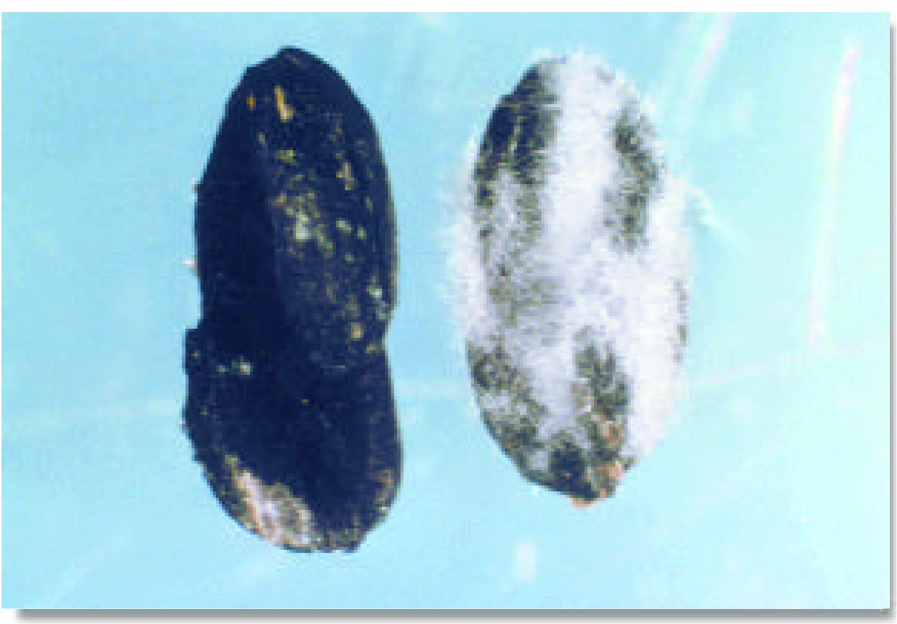



A sclerotium of the snow mold *Myriosclerotinia borealis* treated (right) with *Trichoderma atroviride* shows obvious damage compared to an untreated sclerotium (left).

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