TURFGRASS TRENDS

DISEASE MANAGEMENT

Study Examines Snow Mold Solutions for Northwest

By William J. Johnston and Charles T. Golob

Pink snow mold (*Mirodochium* patch) and gray snow mold (*Typhula* blight) are the most prevalent and destructive winter diseases on cool-season turfgrass in the northern United States. They are especially destructive in the Intermountain Northwest where deep snow cover may last four to five months.

Pentachloronitrobenzene (PCNB, Quintozene) has been use to manage these diseases in turf on golf courses for many years. When used alone over time, pathogen resistance may develop, as well as other turf and environmental problems. We sought to identify new chemistry and combinations of compounds that could be used in rotation with PCNB.

Gray snow mold is generally associated with deep prolonged snow cover, often greater than 100 days.

Research was conducted on golf course bentgrass (*Agrostis stolonifera* L.)/*Poa annua* golf greens and nurseries during a three-year period (2000-2003). In locations with mild to moderate winters, many of the older chemistry fungicides used alone, or in combination with a compound with newer chemistry, gave good control. In locations with prolonged snow cover, combinations of two and possible three fungicides are needed for adequate control.

Numerically (but not statistically different from all other treatments, overall sites and years), the treatment with the best control with good spring turfgrass quality was Medallion 50WP + Banner MAXX 1.3MEC + Daconil Ultrex 82.5WDG.

Traditionally, fungicide applications are the primary means to control or manage (terminology preferred by Vargas, 1994) pink snow mold and gray snow mold.

Evidence suggests that resistant strains of snow-mold fungi have developed with continued use of fungicides (Chastagner and Vassey, 1982). PCNB phytotoxicity has also been reported, especially when PCNB is used at the upper end of the labeled rate

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of application, when overlapping of application occurs or when applications are made during warm weather (Smith et al., 1989). Chlorsis has also been noted in turf and caution should be used with repeat applications after periods of rain or during mid-winter thaws (Burpee, 1988).

Nontarget effects, both detrimental and beneficial, have been reported on putting greens by Landschoot et al. (2001). Pentachloroaniline, a degradation product of PCNB, has been found in golf green leachate (Johnston and Golob, 2003 unpublished data). Therefore, it is desirable to identify efficacious alternatives to use in rotation with PCNB. Washington State University is currently conducting snow-mold fungicide trials in Washington, Idaho and Montana to identify such compounds (Golob et al., 2001). The availability of new snow mold products will be a major benefit to superintendents in areas of prolonged snow cover susceptible to snow-mold diseases.

We wanted to compare the efficacy of new and old fungicides, primarily combination products and new experimental chemistry, at several sites in the Intermountain Northwest.

A second goal was to assist manufacturers in obtaining labels for new products for use on golf courses in the Intermountain Northwest.

The Whitefish project

In late October/early November 2000 and 2001, treatments were applied to a Penncross

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TABLE 1

The efficacy of several different fungicide combinations, compared to PCNB, for pink snow mold and gray snow mold control on a creeping bentgrass/annual bluegrass practice green at Whitefish Lake Golf Course in Whitefish, Mont. Fungicides applied 10/31/00. Rated 3/29/01.

Fungicide Treatment	Rate (oz., fl. oz., or lbs./1,000 ft^2)	Disease area	*Turf quality
Medallion 50WP +	.25 oz.	1.3 a	5.3 ab
Banner MAXX 1.3MEC +	2 fl. oz.		
Daconil Ultrex 82.5WDG	2.4 oz.		
Chipco 26GT 2F+	4 fl. oz.	1.7 a	5.7 a
Signature 80WDG+	4 oz.		
Terraclor 75WP	4 oz.		
Medallion 50WP +	.25 oz.	2.7 a	4.7 abc
Banner MAXX 1.3MEC +	2 fl. oz.		
Terraclor 75WP	4 oz.		
Medallion 50WP +	.5 oz.	3.3 a	4.7 abc
Banner MAXX 1.3MEC	3 fl. oz.		
Medallion 50WP +	.25 oz.	3.3 a	4.7 abc
Banner MAXX 1.3MEC +	2 fl. oz.		
CGA 245704 50WDG	.4 oz.		
Chipco 26GT 2F+	4 fl. oz.	5.7 a	4.7 abc
Daconil Ultrex 82.5WDG+	3.6 oz.		
Terraclor 75WP	4 oz.		
Medallion 50WP	.5 oz.	6 a	5.3 ab
Medallion 50WP +	.5 oz.	6.3 a	4 d
CGA 245704 50WDG	.4 oz.		
Banner MAXX 1.3MEC +	.4 oz.	6.3 a	4.3 cd
CGA 245704 50WDG	3 fl. oz.		
Chipco 26GT 2F+	4 fl. oz.	6.7 a	5 abc
Prostar 70WP	3.75 oz.		
Terraclor 75WP	6 oz.	7.7 a	4.7 abc
Non-treated control	0	65.7 b	2.3 e
LSD (P=0.05)		16	1

**Turf quality rated 1-9; 9 = excellent. Figures labeled with the same letters are statistically the same.*

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creeping bentgrass/*Poa annua* (10 percent) practice green at the Whitefish Lake Golf Course. Treatments were also applied in 2002, but disease development was not severe enough to warrant rating in spring 2003.

Treatments were applied with a carbon dioxide(CO_2)-pressurized (40 pounds per square inch) (psi) boom sprayer with XR11004 VS flat-fan TeeJet nozzles using a 52-gallon per acre water carrier rate. Individual plots were 5 feet by 10 feet in a randomized complete-block experimental design with three replications.

During both winters, snow cover began in late November and remained on the plots approximately four months. Plots were rated in late March/early April for disease (2001, about 70 percent gray snow mold, *T. ishikariensis*, and 30 percent pink snow mold; 2002, essentially 100 percent gray snow mold, 90 percent *T. ishikariensis* and 10 percent *T. incarnata*, with a trace of pink snow mold) and turfgrass quality (quality rated 1-9; 9 = excellent turf quality).

Disease infection was high (nontreated control 66 percent) at Whitefish during the winter 2000-2001 (Table 1). All fungicide treatments had significantly less disease than the nontreated control. Although not statistically different from several other treatments, numerically the best control (less than 2 percent disease) was given by Medallion + Banner MAXX + Daconil Ultrex and Chipco 26GT + Signature + Terraclor 75WP. No fungicide treatment was statis-

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TABLE 2

The efficacy of several different fungicide combinations, compared to PCNB, for pink snow mold and gray snow mold control on a creeping bentgrass/annual bluegrass practice green at Whitefish Lake Golf Course in Whitefish, Mont. Fungicides applied 11/1/01. Snowcover 11/26/01 to 4/7/02 (132 days). Rated 4/10/02.

Fungicide Treatment	Rate (oz., fl. oz., or lbs./1,000ft^2)	Disease area	*Turf quality
Medallion 50WP +	.5 oz.	.7 a	7 a
Heritage 50WDG	.4 oz.		
Heritage 50WDG +	.4 oz.	1.7 a	6 a
Banner MAXX 1.3MEC +	3 fl. oz.		
Daconil Ultrex 82.5WDG	5 oz.		
Medallion 50WP +	.33 oz.	2.3 a	6.3 a
Banner MAXX 1.3MEC +	3 fl. oz.		
Daconil Ultrex 82.5WDG	5 oz.		
Turfcide 400	12 fl. oz.	2.3 a	6 a
Medallion 50WP +	.5 oz.	2.5 a	6 a
Banner MAXX 1.3MEC	4 fl. oz.		
FF II w/14-3-3	6.5 lbs.	2.7 a	7 a
Medallion 50WP +	.3 oz.	2.7 a	6 a
Heritage 50WDG +	.4 oz.		
Daconil Ultrex 82.5WDG	5 oz.		
Medallion 50WP +	.5 oz.	3 a	6 a
Daconil Ultrex 82.5WDG	5 oz.		
Chipco 26GT 2F	4 fl. oz.	3 a	6 a
Daconil Ultrex 82.5WDG+	5.5 oz.		
Turfcide 400	8 fl. oz.		
Fungicide V	6 lbs.	19 b	4.3 b
Medallion 50WP	.5 oz.	22.3 b	3.7 bc
**Plant Helper	5.9 fl. oz.	63.3 d	1.7 c
Non-treated control	0	36.7 c	2.7 c
LSD (P=0.05)		13.8	1.4

**Turf quality rated 1-9; 9 = excellent. Figures labeled with the same letters are statistically the same.*
***Plant Helper is a liquid concentrate that contains a fungus:* Trichoderma atroviride

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tically better than PCNB (Terraclor 75WP) for disease control.

All treatments had turfgrass quality superior to the nontreated control (Table 1). Although not statistically different from several other fungicide treatments, numerically the best spring turfgrass quality was given by Chipco 26GT + Signature + Terraclor 75WP.

Disease infection was moderate (nontreated control 37 percent) at Whitefish during the winter 2001-2002 (Table 2). There were statistical (P = .05) differences among treatments. Except for Plant Helper, which showed no disease control, all fungicide treatments had significantly less disease than the nontreated control. Although not statistically different from several other treatments, numerically the best control (less than 1 percent disease) was given by Medallion + Heritage. No fungicide treatment was statistically better than PCNB (Terraclor 75WP) for disease control.

April 2002 most treatments had turfgrass quality superior to the nontreated control (Table 2). Although not statistically different from several other fungicide treatments, numerically the best spring turfgrass quality was given by Medallion + Heritage and FF II with 14-3-3.

The McCall project

In late October 2000 and 2001, treatments were applied to a Providence creeping bentgrass nursery at the McCall (Idaho) Golf Course.

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TABLE 3

The efficacy of several different fungicide combinations, compared to PCNB, for pink snow mold and gray snow mold control on a creeping bentgrass nursery at McCall (Idaho) Golf Course. Fungicides applied 10/26/00. Rated 4/30/01.

Fungicide Treatment	Rate (oz., fl. oz., or lbs./1,000ft^2)	Disease area	*Turf quality
Medallion 50WP +	.25 oz.	10 a	6.7 a
Banner MAXX 1.3MEC +	2 fl. oz.		
Daconil Ultrex 82.5WDG	2.4 oz.		
Medallion 50WP +	.5 oz.	20 ab	5.7 ab
Banner MAXX 1.3MEC	3 fl. oz.		
Banner MAXX 1.3MEC+	.4 oz.	21.7 ab	5.7 ab
CGA 245704 50WDG	3 fl. oz.		
Medallion 50WP +	.25 oz.	28.3 abc	4.7 bc
Banner MAXX 1.3MEC +	2 fl. oz.		
Terraclor 75WP	4 oz.		
Chipco 26GT 2F+	4 fl. oz.	35 abcd	5 abc
Daconil Ultrex 82.5WDG+	3.6 oz.		
Terraclor 75WP	4 oz.		
Medallion 50WP +	.25 oz.	41.7 bcd	5 abc
Banner MAXX 1.3MEC +	2 fl. oz.		
CGA 245704 50WDG	.4 oz.		
Chipco 26GT 2F+	4 fl. oz.	50 cde	3.3 cde
Prostar 70WP	3.75 oz.		
Chipco 26GT 2F+	4 fl. oz.	56.7 de	4.3 bcd
Signature 80WDG+	4 oz.		
Terraclor 75WP	4 oz.		
Terraclor 75WP	6 oz.	68.3 ef	3.3 cde
Medallion 50WP	.5 oz.	84 f	2.7 de
Medallion 50WP +	.5 oz.	91.7 f	2 e
CGA 245704 50WDG	.4 oz.		
Non-treated control	0	94 f	1.7 e
LSD (P=0.05)		26	1.7

**Turf quality rated 1-9; 9 = excellent. Figures labeled with the same letters are statistically the same.*

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Treatments were also applied in 2002. However, disease development was slight and no treatments were significantly better than the nontreated control in spring 2003.

Treatments were applied with a CO_2-pressurized (40 psi) boom sprayer with XR11004 VS flat-fan TeeJet nozzles using a 52-gallon per acre water carrier rate. Individual plots were 5 feet by 10 feet in a randomized complete-block experimental design with four replications.

Continuous winter snow cover is common at McCall. During both winters, snow cover began late October to mid-November and remained on the plots 132 and 167 days in 2000-2001 and 2001-2002, respectively. Plots were rated for disease in late April 2001 (90 percent gray snow mold, 10 percent pink snow mold) and early May 2002 (essentially 100 percent gray snow mold, 95 percent *T. ishikariensis* and 5 percent *T. incarnata*) and turfgrass quality (quality rated 1-9; 9 = excellent turf quality).

Disease infection was severe (nontreated control 94 percent) at McCall during the winter 2000-2001 (Table 3). Several treatments had less disease than the nontreated control. Although not statistically different from several other treatments, numerically the best disease control (10 percent disease) was given by Medallion + Banner MAXX + Daconil Ultrex. Also, the lack of disease control (68 percent disease) when PCNB (Terraclor 75WP) was used alone indicated possible pathogen resistance to PCNB had developed at this location, probably because of long-term continuous use (Table 3).

In April 2001, several treatments had turfgrass quality better than the nontreated control (Table 3). As with disease control, numerically the best spring turfgrass quality was observed with Medallion + Banner MAXX + Daconil Ultrex.

Disease infection also was severe (nontreated control 95 percent) at McCall during the winter 2001-2002 (Table 4). Although not statistically different from several other treatments, numerically the best disease control (less than 7 percent disease) was given by Medallion + Banner MAXX + Daconil Ultrex and Heritage + Banner MAXX + Daconil Ultrex. As in 2001, the lack of disease control (78 percent and 92 percent disease) when PCNB (Turficide 400 and FFII with 14-3-3, respectively) was used alone indicated that possible pathogen resistance had developed (Table 4).

Several treatments had turfgrass quality better than the nontreated control. As with disease control, numerically the best spring turfgrass quality was observed in plots treated with Medallion + Banner MAXX + Daconil Ultrex and Heritage + Banner MAXX + Daconil Ultrex.

Correct pathogen identification

Proper pathogen identification is always important prior to making any chemical application. This is especially true when managing the snow mold complex of pathogens in the Intermountain Northwest. It is not uncommon to observe *M. nivale*, *T. incarnata*, and *T. ishikariensis* alone or together on golf greens, which typically depends on the severity and length of snow cover.

Vargas (1994) noted that Trizole fungicides are often effective against *T. incarnata* but not *T. ishikariensis*. Yet, Trizole fungicides are sometimes listed as controlling *Typhula* blight (Christians, 1998).

An interesting observation was that regardless of the dominant pathogen, combinations of products are needed to control snow mold in areas with prolonged snow. This was evident at McCall in 2001-2002 (Table 4). Visual observation in the spring 2002 indicated that the dominant pathogen was *T. ishikariensis* (95 percent) with minor *T. incarnata* (5 percent).

As expected, Fungicide V (chloroneb), which is effective against *T. incarnata* performed poorly (65 percent disease). However, Medallion 50WP (fludioxonil), which in

PINK SNOW MOLD

(or Microdochium patch)

Caused by the pathogen Microdochium nivale (Fr.) (Samuels & Hallett).

- Favored by cool, moist conditions of alternating snow and rain.
- Little or no snow cover needed.
- Circular patches 2 to 12 inches in diameter; most 2 to 3 inches in diameter.
- Patches following snow melt are tan to light gray or reddish bronze.
- Outer edge bronze fringe transitioning to pink upon exposure to sunlight.

GRAY SNOW MOLD TYPES

Caused by the pathogen *Typhula incarnata* Lasch ex Fr.

- In the fall, pink upright fruiting bodies.
- Generally associated with snow cover.
- Patches 6 inches to 2 feet in diameter; most 6 inches to 12 inches in diameter.
- Following snow melt, variable patches of gray-white matted turf.
- Sclerotia are large, up to 5 millimeters in diameter, and reddish brown.
- Generally less destructive that *T. ishikariensis.*

Caused by the pathogen *Typhula ishikariensis* Imai

- In the fall, silvery/white, very small fruiting bodies may be present.
- Generally associated with deep prolonged snow cover, often greater than 100 days.
- Following snow melt, bleached patches generally 6 inches to 12 inches in diameter.
- Sclerotia are small, less that 2 millimeters in diameter, and black.
- Generally causes more turf injury than *T. incarnata.*
- Most sever injury occurs with snow over unfrozen soil.

our testing appeared quite effective against *T. ishikariensis,* gave equally poor control. These results indicate that snow mold can cause considerable turfgrass injury if *T. incarnata* is present even when *T. ishikariensis* is the dominant pathogen and is controlled, at initially low disease pressure or in the absence of *T. ishikariensis* .

Finally, the possible resistance of gray snow mold to PCNB noted at McCall needs to be verified. Unfortunately for research (but fortunate for superintendents), these observations could not be confirmed because of the unusually low development of snow mold disease throughout the Northwest during the winter of 2002-2003. Additional testing during 2003-2004 may provide much needed information for the management of snow mold in the Intermountain Northwest.

Conclusions

Snow mold pathogens must be correctly identified for effective control. During moderate winters, more fungicide options are available to control snow mold. Try combining one new with one old chemistry fungicide.

PCNB resistance may have developed with repeat applications under conditions where severe winters are the norm. In these regions, fungicide combinations of two and possibly three fungicides are a must. Efficacious fungicides that can be rotated with PCNB to mitigate the potential for the development of pathogen resistance are available for use.

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