The nature and control of snow mold of fine turfgrass in southern Ontario

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In southern Ontario snow mold in turfgrass is caused by *Fusariurn nivale* and *Typhula* spp. both usually occurring together with one or the other predominating. Chemical control trials with bentgrass *(Agrostis palustris)* over the past 5 years showed that fungicides with benomyl or related compounds as active ingredients failed to give satisfactory control where *Typhula* was predominant. Those containing chloroneb or chlorothalonil gave good control. For *Fusariurn,* both benomyl and chlorothalonil performed well and a mixture of chloroneb and benomyl at half-rate of each also gave excellent control. The possibility of a synergistic effect between these two materials is indicated. Disease control is dependent on the time of fungicide application and evidence was obtained to show that fungicides should be applied late in the season, probably not before November 1.

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En Ontario, deux moisissures niveales s'attaquent au gazon. Ce sont *Fusarium nivale* et *Typhula* sp. On les rencontre habituellement ensemble, l'une des deux en prédominance. Des essais de lutte chimique d'une duree de 5 ans ont revele que les fongicides a base de benomyl ou composes apparentes ne donnent pas de resultats satisfaisants lorsque *Typhula* est l'espèce dominants, a l'inverse des fongicides a base de chloronebe. Dans les cas de dominance de *Fusarium,* le benomyl et le chlorothalonil ont donne de bons résultats, de même qu'un melange de chloronebe et de benomyl a demi-dose. Il est possible que les deux produits agissent en synergie. L'efficacité du traitement depend du moment d'application des fongicides. Il semble que celle-ci doit se faire en fin de saison de preference apres le 1er novembre.

Snow mold is among the top two or three most troublesome diseases of turfgrass in Canada. Studies at Guelph have shown that at least two different fungi are involved as primary causal agents but that the distribution of these fungi is unpredictable. For example, on a naturally infested experimental area on the university campus the disease was caused by *Typhula* sp. with only trace evidence that *Fusarium nivale* was also present. In contrast, the disease on a golf course just 0.5 mile distant from the university plots was predominantly *F. nivale* with *Typhula* sp. occurring on most greens but only in small patches and only where deep drifts of snow accumulated. At the Cambridge Research Station where a newly established bentgrass area was artificially infested with heavily diseased material from the campus plots, the snow mold which developed was predominantly *Typhula* in 1972 and 1973 with a noticeably higher incidence of *Fusarium* in 1974. In 1975, the incidence of disease was low and was nearly all *Fusarium nivale.* Apparently local factors influence the development of these fungi to favor one or the other but the nature of these factors is not well understood.

Smith (1974) presented an excellent paper on snow molds in the province of Saskatchewan and reported six different fungi associated with the problem: the low-temperature basidiomycete (LTB) first reported by Broadfoot and Cormack (1941), *Fusarium nivale, Sclerotinia borealis, Typhula* spp., a sclerotial low-temperature basidiomycete (SLTB), and a fungus with orange rindless sclerotia (ORS). Smith did not state whether these were found in mixtures on the same turf area but this may be assumed from the statement that ORS was found on snow mold patches often associated with SLTB, *S. borealis.* and *Typhula* spp.

Some variability in symptoms of the snow mold disease in Ontario suggests the possibility that more than two fungi may be involved here too but this has not been confirmed. Sclerotia are not commonly found on bentgrass in the Guelph area but those that have been observed are typically those of *Typhula* spp., and an orange sclerotial form of a fungus resembling *Typhula* was found at the Cambridge Research Station in 1975.

Materials and methods

Chemicals tested included commercial products and experimental fungicides. Wettable powders were applied with a hand sprayer in 0.8 qt (0.9 liter) water per plot. Plots measured 50 ft^2 (4.65 m^2) and were replicated four times.

Disease readings were made each year in early April using the Horsfall and Barratt system of rating numbers modified to range from 0 to 11 instead of the original 1 to 12 (Horsfall and Vargas 1945, Redman et al. 1971).

Fungicides tested

Tersan 1991, benomyl 50%, WP, DuPont of Canada;
Tersan SP, chloroneb 65%, WP, DuPont of Canada;
Tersan 75, thiram 75%, WP, DuPont of Canada;

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Daconil 2787, chlorothalonil 75%, WP, Diamond Shamrock;
Daconil (Bravo), chlorothalonil 54%, flowable, Diamond Shamrock;
Mertect, thiabendazole 60%, WP, Merck & Co.;
NF-44, thiophanate methyl 70%, WP, Ciba-Geigy;
Proturf F II, chloroneb 6.8%, granular, O.M. Scott & Sons;
Proturf F III, dyrene 8.7%, granular, O.M. Scott & Sons;
Uniroyal 2010, experimental, WP, Uniroyal Chemicals;
Chipman PP395, experimental, slurry, Chipman Chemicals;
Dupont DPX-164, experimental, WP, DuPont of Canada;
Baydam 18654, experimental, WP, Chemagro;
Formaturf, experimental, liquid, Stephenson Chemicals.

Results

Chemical control

For many years, fungicides containing mercury occupied top position in recommendations for control of snow mold. With increasing fears of mercury in the environment as a hazardous pollutant some of these fungicides were taken off the market and those that remained became less widely used as effective nonmercurial fungicides became available. In an effort to keep recommendations for Ontario reasonably well documented a program of testing fungicides for control of snow mold and other diseases of turf was initiated at Guelph in 1967. The early trials showed that materials such as Daconil and Demosan were as effective as the mercurials for snow mold control in the Guelph area. Both commercial and experimental fungicides have been tested each year on bentgrass *(Agrostis palustris* Huds.) plots on the university campus, then at the Cambridge Research Station when facilities were developed there. The results which follow are a summary of data obtained over the years beginning with 1970 when the program was officially recognized.

1970-71 trial

Nine different materials at 2 dosage levels were tested at both the Guelph and Cambridge locations. These included both dry and spray applications of benomyl, thiabendazole, and chloroneb. Of these, only the chloroneb formulations (Tersan SP and Scotts F-5076) gave satisfactory control. Benomyl and thiabendazole gave no indication of control whatsoever. The causal fungus at both locations was *Typhula* sp.

1971-72 trial

This trial was similar to that conducted the previous year except that some of the ineffective materials were replaced by formulations of Daconil (WP and flowable), Dyrene, thiram and thiophanate. Again, excellent control was achieved with the chloroneb formulations (both wet and dry); good control with Daconil (chlorothalonil) but only at the higher dosage (6 oz active); moderate control with Dyrene and only at the high dosage of 12 oz active; poor control with thiram and thiophanate.

1972-73 trial

This trial was conducted at the Cambridge Research Station only, the campus plots having been taken over by buildings. An important objective in this trial was to determine effect of treatment date. To do this, one series of plots was treated on October 20 and provision made for another series to be treated 4 weeks later. A heavy snow fall on November 15 prevented treatment on the scheduled second date. With no sign of a thaw an attempt was made to remove the snow and apply the treatments on December 1.

Although materials containing chloroneb or chlorothalonil gave good control when applied in October none of the treatments gave satisfactory control in the December 1 application. This is attributed to improper placement of the material rather than timing. All of the ice and snow could not be removed from the turf prior to treatment and much of the fungicide was applied onto a thin layer of ice and snow. The trial failed to provide information on the importance of timing of treatments but impressed the importance of getting it done before the snow falls so that the material is all placed in direct contact with the turf.

1973-74 trials

One trial was conducted at the Cambridge Research Station where the causal fungus was predominantly *Typhula* sp. and another on the practice green at the Cutten Golf Club where the fungus was predominantly *Fusarium nivale.* The test materials were all applied at 2 dosage rates and on 2 dates, namely, October 3 and November 4 at Cambridge, October 11, and November 5 at the Cutten Club.

The results can be summarized as follows: At the Cambridge site, good control was obtained with Tersan SP (chloroneb), Daconil 2787 (chlorothalonil), Proturf F II (chloroneb), Proturf F III (dyrene), and Proturf BSF (PMA-thiram) at both dates of application, but control was noticeably better where the materials were applied at the later date. Uniroyal 2010 gave good control in the November treatment only. Tersan 1991 (benomyl) was unsatisfactory at either date.

At the Cutten Club site, Daconil flowable (chlorothalonil) gave excellent control at both dates of application, Tersan 1991 (benomyl) was good at the late date only and Tersan SP was unsatisfactory. These were the only materials used at this site because of limited space.

These results can be interpreted to indicate the following:

1. That fungicides for snow mold control should be applied late in the season, probably not before November 1.
2. That not all fungicides recommended for snow mold control will control both *Typhula* and *Fusarium;* hence it is important to be able to recognize the disease caused

Table 1. Snow mold incidence in turf plots treated with fungicidal chemicals, Cambridge, 1975

Product	Dosage (product) (oz/1000 ft^2)	Dosage (product) (g/m^2)	Percent disease* *Fusarium*	Percent disease* *Typhula*	Percent disease* Total	Percent control
Tersan 1991	2	0.6	0.6	0.0	0.6	91
	4	1.2	1.2	0.6	1.8	74
Tersan SP	6	1.8	1.2	***0.0***	1.2	83
	9	2.8	0.6	***0.0***	0.6	91
Daconil (Bravo)	12	3.7	2.3	***0.0***	2.3	67
	16	4.9	1.6	***0.0***	1.6	77
Uniroyal 2010	4	1.2	2.3	***0.0***	2.3	67
	8	2.4	1.2	***0.0***	1.2	83
Chipman PP 395	5	1.5	4.1	***0.0***	4.1	27
	10	3.0	1.8	***0.0***	1.8	74
Dupont DPX-164	4	1.2	1.2	***0.0***	1.2	83
	8	2.4	1.8	***0.0***	1.8	74
Baydam 18654	4	1.2	4.2	1.2	5.3	24
	8	2.4	2.3	1.6	3.9	44
Formaturf	6	1.8	2.3	12.3	14.5	0
	12	3.6	2.9	25.8	28.7	0
Check (no treatment)			4.7	2.3	7.0	

* Disease readings according to Barratt-Horsfall rating numbers converted to percent according **to** Elanco Conversion Tables **(see text).**

by each of these fungi if fungicides such as chloroneb and benomyl are to be used effectively.

1974-75 trials

These trials were laid out in essentially the same way as in the previous year but the incidence of *Typhula* turned out to be negligible at both sites hence the results are primarily for the control of *Fusarium nivale.* The summary results are given in Tables 1 and 2 for the Cambridge Station and Cutten Club sites respectively.

Disease incidence was low at both sites but particularly so at the Cambridge Station. Furthermore, distribution of disease over the test areas was so uneven that none of the results are statistically significant. Nonetheless, the results do show practical levels of control. In the data for *Fusarium* (Table 1) values of less than 2.3% were derived from individual rating numbers of 0 and 1, the latter representing a trace of disease with negligible damage. The value of 4.7% recorded for the check plots was derived from individual rating numbers ranging from 1 to 3, the latter representing up to 12% disease. Visually this is a substantial amount of disease with appreciable damage. Thus, all materials except Formaturf, Bay Dam 18654, and PP 395 at the lower dosage, provided a practical degree of controlling *Fusarium nivale.* There was insufficient *Typhula* disease generally to give any indication of control. Of some interest is the series of plots treated with Formaturf which developed up to 10 times the disease in the check plots. This may have been due to the phytotoxic nature of this chemical. No injury was evident after application on November 12, at which time the grass was essentially in a dormant state; however when the material was used for dollar spot control in June and August phytotoxic effects were severe.

Concerning data given in Table 2, all three materials (Tersan 1991, Tersan SP, and Daconil) gave satisfactory control at dosages recommended by the manufacturer. Tersan SP performed well against *Fusarium* although it is not recommended for this purpose because past performance has been less effective. Excellent control was obtained when Tersan 1991 and Tersan SP were applied together, each at half the recommended dosage. The performance of this combination appears to be superior to that obtained with the regular dosage of one or the other chemical alone. This would not be expected unless there was some kind of synergistic effect. This possibility is being investigated in laboratory studies.

Discussion and conclusions

The snow mold disease of turfgrass in southern Ontario **is** caused by *Fusarium nivale* and *Typhula* spp. usually

Table 2. Snow mold incidence in turf plots treated with fungicidal chemicals, Cutten Club, 1975

Product	Dosage (product) (oz/1000 ft^2)	Dosage (product) (g/m^2)	Percent disease* *Fusarium*	Percent disease* *Typhula*	Percent disease* Total	Percent control
Tersan 1991	2	0.6	3.5	0.6	4.1	69
	4	1.2	1.8	0.6	2.4	82
Tersan SP	4	1.2	2.4	1.2	3.6	73
	6	1.8	1.2	0.6	1.8	87
	9	2.8	1.2	0.0	1.2	91
1991 + SP	2 + 3	0.6 + 0.92	**0.0**	0.6	0.6	95
Daconil (Bravo)	12	3.7	0.6	**0.0**	0.6	95
	16	4.9	0.6	**0.0**	0.6	95
Check (no treatment)			11.1	2.3	13.4	

* Disease ratings according to Barratt-Horsfall rating numbers converted to percent according to Elanco Conversion Tables (see text)

occurring together with one or the other predominating. The identity of the *Typhula* spp. have not been determined but two distinctly different sclerotial forms have been observed indicating that two species at least are present. An effort is being made to identify these species.

The control of snow mold is complicated by the fact that it is usually caused by more than one of these fungi occurring at the same time. Apart from proper management to avoid predisposition of turf to disease the only known control is the use of fungicides in the late fall. Until recent years broad spectrum fungicides containing mercury were reasonably effective. As more specific-acting nonmercurials replace the mercuries, chemical control becomes more complicated because not all fungicides recommended for snow mold control are effective against all the fungi that may be involved. For example, benomyl, which is effective against *Fusarium* is unsatisfactory against *Typhula,* while chloroneb, which gives excellent control of *Typhula* is only partially effective against *Fusarium.* Consequently, it is important to know what fungus predominates before one of these fungicides is used.

Concerning timing of treatment, the common recommendation to apply the fungicide as late as possible prior to permanent snowfall is risky as was proven by the 1972-73 trial when a permanent snowfall occurred on November 15. Normally this does not occur until early December in the Guelph area. Vargas and Beard (1971) showed that at Harbor Springs, Michigan, chloroneb and Calo-Gran can be applied as early as mid-October with results equally as good as when applied 1 month later. This would probably apply for the Guelph, Ontario, area as well. The 1973-74 trials showed that treatment in early October was generally inferior to early November for *Typhula* control. For fusarium snow mold, control was achieved only at the later of the two treatment dates October 11 and November 5. These results indicate that treatment for snow mold, should be done no earlier than mid-October.

Literature cited

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