Snow mold control in bentgrass turf with fungicides, 1975[1]

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Heavy infections resulted from the application of inoculum of ***Sclerotinia borealis*** and ***Typhula*** FW grown on moist sterile rye to fine turf composed of the Seaside and Penncross cultivars of ***Agrostis stolonifera.*** Quintozene, R-28921 and benomyl were the most consistently effective materials against both pathogens; Arrest and benomyl effectively reduced severity of S. ***borealis*** damage; benomyl, LFA and chloroneb performed well against ***Typhula*** FW in individual tests. Chloroneb was not effective against S. ***borealis*** and Vitavax (oxathiin) performed poorly against ***Typhula*** FW. In the fall following fungicide application a moderately severe natural outbreak of disease caused by ***F. nivale*** developed on the same turf plots. R-28921 and benomyl showed marked residual effectiveness but on quintozene plots there was significantly more ***F. nivale*** than on untreated checks. Residues of the latter may suppress other fungi thereby favoring ***F. nivale.***

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L'inoculation de ***Sclerotinia borealis*** et de ***Typhula*** FW a des cultivars Seaside et Penncross d'***Agrostis stolonifera*** a provoque de fortes infestations. Le quintozene, R-28921 et le benomyl se sont reveles les plus efficaces contre les deux agents pathogenes. Par ailleurs, dans certains essais, Arrest et benomyl ont sensiblement reduit les dégâts causes par S. ***borealis,*** et le benomyl, LFA et le chloronebe ont donnes de bons resultats contre ***Typhula*** FW. En revanche, le chloronebe est reste inefficace contre ***S. borealis*** et Vitavax (oxathiine) a donne des resultats mediocres contre ***Typhyla*** FW. Au cours de l'automne suivant l'application des fongicides, une infestation naturelle moderement grave de ***Fusarium nivale*** s'est produite dans les mêmes parcelles. R-28921 et le benomyl ont affiché une efficacite residuelle prononcee. Toutefois, on a observe une beaucoup plus grande incidence de la maladie dans les parcelles traitees au quintozene que dans les parcelle temoins. Il y a donc lieu de croire que ce produit élimine d'autres champignons au profit de ***F. nivale.***

Previously results were presented on the performance of fungicides against the range of common snow molds on amenity turf of different types in Saskatchewan (3). The studies reported here were made to evaluate the effectiveness of standard and newer materials against disease produced by inoculating golf green type turf formed from cultivars of ***Agrostis stolonifera*** L. with cultures of ***Sclerotinia borealis*** Bub. & Vleug. and ***Typhula*** FW (5). Information was also obtained on the residual effects of the materials against a natural infection of ***Fusarium nivale*** (Fr.) Ces. a year after their application.

Materials and methods

Turf inoculation

Test turf at the experiment grounds at Saskatoon were inoculated with cultures of pathogenic isolates of *S.* ***borealis*** and ***Typhula*** FW grown on sterile, moist rye grain by hand broadcasting as previously described (5). The culture of S. ***borealis,*** strain De71***5,*** from bowling green turf in Saskatoon was applied at 25 g/m^2 on 6 August 1974. The ***Typhula*** FW inoculum comprised a mixture of nine isolates from turf grasses in Saskatchewan, Alberta, and British Columbia and was also applied at approximately 25 g/m^2 on 12 August, 1974.

Turf test plots

Tests 201 and 202 (Table 2) were on A. ***stolonifera*** cv. Seaside established by sprigging in summer 1971 and top-dressed in fall with a sand/soil/peat mixture. Plots for Tests 203 and 204 were of the same species and cultivar but sown in spring 1972. Tests 205 and 206 were sown with ***A. stolonifera*** cv. Penncross, also in spring 1972. All turf received topdressing applications in fall 1972, 1973, and 1974 and was irrigated and maintained in a moderate state of fertility from the outset. In 1974, before inoculation, it received 3.0 kg/ 100 m^2 of 23-23-0 granular fertilizer on 30 May, 3.5 kg/ 100 m^2 of the same material on 30 June, and 1 kg/ m^2 of 16-20-0 fertilizer on 2 August. All mowing was done with a 55 cm reel type greens mower as necessary and the cuttings were removed. Three snow fences 60 cm high were positioned in a north/south direction along the western and eastern edges of the tests and midway between these two (Fig. 1) to trap snow on the turf; these were erected on 10 October 1974 and removed on 6 May 1975. All tests were of randomized block design; plot size was 1.0 m^2 and treatments were replicated six times.

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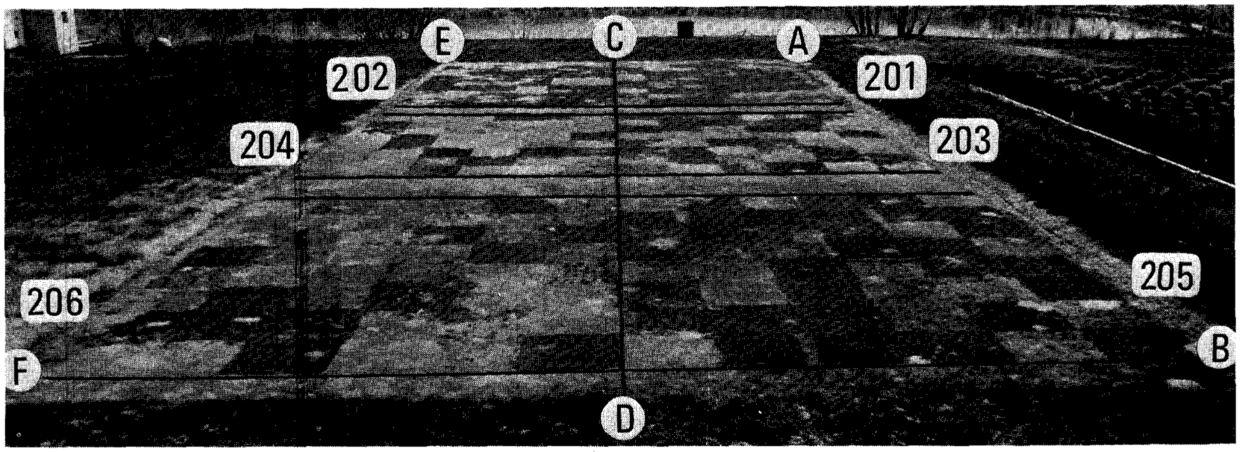

Figure 1. Appearance of test in early May 1975. Tests 201 and 202 were inoculated with S. borealis and Tests 203 - 206 with *Typhula* FW. Snow fences were positioned A to B, C to D, and E to F.

Fungicide applications

Fungicide sprays were applied in 107 ml water/m^2 (10 ml/ft^2) with 1 litre capacity pneumatic hand sprayers. Sulphur as a wettable powder was applied in a water suspension with a sprinkling can. Two applications of each material were made, the first between 9 and 11 September 1974 and the second on 8 and 9 October before any disease was apparent. The common and product names, percent active ingredients, formulations, and sources of fungicides are given in Table 1.

Rating of disease

An estimate was made of the percentage area of turf affected by disease caused by *S. borealis* and *Typhula* FW in each plot on 7 May and 2 June 1975. A moderately severe natural infection with *F. nivale* which developed in the fall of 1975 was rated in a similar fashion on 7 October 1975.

Results and discussion

An even snow cover resulted from the suitable placing of the snow fences. This cover was present on the test areas for approximately 130 days, which was less than the average for the previous 33 years of 143 days. Snowfall for the winter at Saskatoon was 1015 mm, only slightly less than the average of 1087 mm for the 33 winters previous to 1974 (personal communication, Dr. J. Maybank, Physics Department, Saskatchewan Research Council, 19 August 1974). In early May, just after complete snow melt it was apparent that uniform infections typical of severe disease caused by S. *borealis* and *Typhula* FW had resulted from the heavy inoculation of the turf. Symptoms of other snow molds were not observed on the test blocks except for a few scattered patches caused by the non-sclerotial low-temperature basidiomycete, LTB (Fig. 1). Some of this disease occurred on the east side of the most easterly snow fence on *Poa pratensis* L. turf adjacent to Test 206 where the snow had remained longer in drifts (Fig. 1); generally the disease was light on susceptible turf in the vicinity of the fungicide tests. At the first rating, on 7 May, disease severity was similar in both Seaside (Table 2, Tests 201-204) and Penncross check plots (Table 2, Tests 205-206). Sown Penncross had less *Typhula* FW damage than sown Seaside bent at the second rating on 2 June, i.e. its recovery was more rapid. Severe damage from S. *borealis* persisted longer than that from *Typhula* FW but the latter pathogen left turf scars which had not completely healed by late fall 1975. Some antagonism between colonies produced from the different isolates of *Typhula* FW that had been used as inoculum was seen on plots where infection had been partly controlled by fungicides (6). However, all signs of competition between colonies were blotted out where infection was overwhelmingly heavy. Considerable recovery from damage occurred between 7 May and 2 June but the degree of recovery could not be related either to the initial level of infection or to the particular material used.

Quintozene and R-28921 were the most consistently effective materials against both S. *borealis* and *Typhula* FW (Tests 202, 204, and 206). Arrest at the higher dosage and benomyl effectively reduced the severity of *S. borealis*. The effectiveness of the latter fungicide against S. *borealis* has been noted (5). In Test 205 benomyl was one of the most effective materials against *Typhula* FW: this was not expected because of its reported spectrum of activity (1) and since in previous tests it had shown little effectiveness against this pathogen, at least in disease complexes (5). Here the infection was almost completely due to *Typhula* FW. LFA at the lowest dosage effectively controlled *Typhula* FW in Test 203. Chloroneb, which with quintozene and mercury chlorides was very effective in previous tests where the LTB and *Typhula* FW were dominant in complexes (5), gave good control of *Typhula* in Test 205 on Penncross but was only moderately effective against

Table 1. Fungicides used in snow mold tests, 1974 – 75

Index no.	Product name	Active ingredient* %and formulation†	Source
1	Benlate	benomyl 50%, WP	Dupont
2	Tersan SP	chloroneb 65%, WP	Dupont
3	Chlorophenate	chlorophenate mixture 18%. Soln	Cleary
4	Metazoxolon	4 – (3 – chlorophenylhydrazone) – 3 – methyl – 5 – isoxazolone 40%. Slurry	Chipman
5	Daconil	chlorothalonil 75%, WP	Diamond–Shamrock
6	Vitavax	carbathiin 75%. WP	UniRoyal
7	LFA 2043	(1 – (isopropylcarbamoyl) – 3 – (3, 5 – dichlorophenyl) hydantoin 50%, WP	May & Baker
8	Mersil	mercurous/mercuric chloride mixture, Hg 42%. WP	May & Baker
9	R – 28921	2 – ((3′ – methoxycarbonyl) – thioureido) – 0, 0 – diethylphosphoranilide 50%. WP	Stauffer
10	PMA – 10	phenyl mercuric acetate 10%. Soln	Later
11	Terrachlor	quintozene (PCNB) 75%. WP	Olin
12	Sulphur	sulphur 90%.WP	Smith
13	Arrest	thiram 50%. carbathiin 20%, oxycarbathiin 5%. WP	UniRoyal

* Where the common name of the active ingredient is inconveniently long the product name may be used in tables and text.

† WP= wettable powder; P= powder; Gran= granular; Soln= solution.

this fungus on the more susceptible Seaside bent. As expected from previous tests (5), chloroneb was not very effective against *S. borealis.* The poor performance of Vitavax against the basidiomycete *Typhula* FW was not expected (Tests 204 and 206) since basidiomycetes are particularly sensitive to the oxathiins (Table 1) (1). At higher dosage Vitavax showed some activity against *S. borealis* (Test 201); however the oxathiin/thiram combination in Arrest was more effective with a much lower content of systemic oxathiin. On the basis of the early ratings on 7 May, apart from the materials already mentioned, significant reductions in disease severity were noted also with chlorothalonil and LFA 20403 against *S. borealis* in Tests 201 and 202 and with chlorothalonil against *Typhula* FW in Test 205. Both inorganic mercury chlorides and PMA gave poor control of both diseases. Previous results for these materials suggested that they could behave in an erratic fashion. Dosage of PMA was kept low in these tests because of the tendency of this material to be phytotoxic on fine turf. Sulphur was applied as a soil amendment rather than a fungicide. Since it reduces the pH of the turf surface (2) and this has an effect on the severity of some diseases (2). there was an interest in its effects on *S. borealis* and *Typhula* FW. It had no apparent effect on disease severity.

Against the moderately severe natural outbreak of disease caused by *F. nivale* in the fall of 1975, several materials applied in 1974 showed a considerable residual control effect. At all dosages the experimental fungicide R-28921 showed significantly greater effectiveness than any other material in Tests 202, 204, and 206. Benomyl, known to be effective against *F. nivale* from previous tests (5) was most effective in Test 203 and was apparently the best material in Tests 201 and 205. Mercurous/mercuric chlorides and PMA in Test 202 and PMA in Test 204 showed some residual control of the latter fungus. On the other hand, plots sprayed with quintozene showed more damage from *F. nivale* than any other treatment in all tests where it was employed and significantly more than the untreated check in Test 204. The practical implication of this is that it would be unwise to rely entirely on quintozene for winter disease control on fine turf in the prairie region. It effectively controlled snow mold due to the LTB, *Typhula*

Table 2. Effect of fungicides on severity of snow mold on turf of ***Agrostis stolonifera*** cultivars Seaside and Penncross; snow mold resulted from inoculation with ***Sclerotinia borealis*** (S.b.) and *Typhula* FW (T.FW) in August 1974 and also from natural infection by ***Fusarium nivale*** in October 1975; fungicides were applied twice. in September and in October 1974

			Percent area of turf affected on dates indicated in 1975*																	
			Seaside — sprigged						Seaside — sown						Penncross — sown					
			Test 201			Test 202			Test 203			Test 204			Test 205			Test 206		
	Index no.	Dosage	*S.b.*		*F.n.*	*S.b.*		*F.n.*	*T.* FW		*F.n.*	%FW		*F.n.*	TFW		*F.n.*	TFW		*F.n.*
Fungicide	(Table 1)	(a.i. g/m^2)	7/5	2/6	17/10	7/5	216	17/10	7/5	2/6	17/10	7/5	216	17/10	7/5	2/6	17/10	7/5	2/6	17/10
Benomyl	1	0.31	21a	15ab	1				43ab	43bc	33a				12a	13a	0a			
Chloroneb	2	1.59				61c	44bc	20cde	71cd	26ab	18cd				25ab	9a	1a			
Chlorophenate	3	0.88	82c	43de	24				99e	65cd	23cde				92c	41b	3ab			
Metazoxolon	4	0.50	97c	59ef	25															
Metazoxolon	4	1.00	91c	54def	23				98e	76d	22cde				87c	41b	2a			
Chlorothalonil	5	2.75	41b	25bc	14				82de	58cd	17bc				40b	15a	1a			
Vitavax†	6	0.46	84c	39cd	24							99c	59bcd	24bc				92c	38cde	10b
Vitavax†	6	0.92	53b	21ab	23							99c	50bc	27cd				94c	25abc	10b
Vitavax†	6	1.84	47b	13ab	22															
LFA 2043†	7	0.50				56c	57c	23de	22a	29ab	12b									
LFA 2043†	7	1.00				47c	47c	16cd							16a	15a	0a			
Mercurous/ Mercuric chlorides	8	0.51				82d	58c	11bc				96c	47b	20bc				93c	29bcd	6ab
R-28921†	9	0.31				48c	47c	5ab												
R-28921†	9	0.61				43bc	50c	4ab				20a	16a	3a				24b	20ab	1a
R-28921†	9	1.22				23ab	24ab	1a												
PMA	10	0.03				91d	80d	13bc				98c	73d	18b				92c	52e	9b
Quintozene	12	2.75				15a	14a	30e				38b	21a	33d				8a	10a	17c
Sulphur		10.00				99d	91d	27e				100c	70cd	20bc				99c	52e	9b
Arrest	13	1.22	52b	21ab	19															
Arrests	13	2.44	20a	5e	15				55k	17a	28e				35b	6a	4b			
Check, untreated			96c	68f	24	99d	89d	24de	97e	74d	25de	99c	65bcd	24bc	97c	38b	1a	99c	48de	12bc

* Within columns, figures subtended by the same letters do not significantly differ as determined by Duncan's multiple range test at the 5% level of probability.

† Product name (see Table 1)

FW, *S. borealis,* and *F. nivale,* alone and in complexes, in tests when applied in fall (3, 4, 5). However *F. nivale,* unlike the other snow mold pathogens, has been found to be the common cause of disease, more appropriately called fusarium patch than pink snow mold (2), in the prairie region in late summer and fall (4). Quintozene in low concentrations is used in selective culture media for the isolation of *Fusarium* spp. from soil (7). A possible explanation therefore, for the effect of the latter material in these tests, is that its residues from the previous fall applications suppressed organisms antagonistic to *F. nivale,* allowing the latter to develop and cause moderately severe disease.

Acknowledgments

We are indebted to Mr. E. E. Underwood for the photograph and to the chemical firms cited in Table 1 for the supply of chemicals.

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Correction

Basu, P.K., et al. Yield loss conversion factors for fusarium root rot of pea.
Volume 56, page 28, text col. 1, lines 1–4: delete the first sentence beginning "The actual. ..."

page 31, col. 1, para 4, lines 3–4:
% yield loss = % severely affected plants X 0.57