Relative Resistance of Creeping Bentgrass Cultivars to Sclerotinia Homoeocarpa and Typhula Incarnata

By Dr. Paul Koch, Department of Pathology, University of Wisconsin - Madison and
Dr. Jim Kerns, Department of Pathology, North Carolina State University

Editors/Author's Note: T*he following article was previously published in Applied Turfgrass Science (10.1094/ATS-2012-1022-01-RS) and subsequently in the January 2013 issue of Golf Course Management. It is reproduced here in part due to the generous contributions of the Wisconsin Golf Course Superintendents Association, in particular Eagle River GC Superintendent Ken Smith.*

INTRODUCTION

Creeping bentgrass (*Agrostis stolonifera* L.) has long been the preferred species of turfgrass on most golf courses in temperate climates of the world. The bentgrass cultivar 'Penncross' was introduced in 1954 by Dr. H.B. Musser at Penn State University and was the first widely-used seeded type of creeping bentgrass, replacing many of the vegetatively-propagated bentgrasses that had predominated since the turn of the century (10). Despite its continued utility, Penncross creeping bentgrass does provide challenges for the modern golf course superintendent. Penncross can segregate into genetically-distinct clones, producing a patchy or mottled appearance over time (2). Penncross is susceptible to thinning when managed for modern-day putting green expectations, allowing for annual bluegrass (*Poa annua* L.) encroachment (7). Penncross is also susceptible to a number of turfgrass diseases, namely dollar spot (caused by *Sclerotinia homoeocarpa* F.T. Bennett), requiring repeated fungicide usage to maintain acceptable quality (4).

A number of bentgrass cultivars have been released in recent years with improved characteristics, including increased shoot density and drought tolerance (3, 6, 11). A few cultivars, most notably 'Declaration' and 'Memorial,' have demonstrated partial resistance to *Sclerotinia homoeocarpa* (4). Bentgrass cultivars with improved resistance to fungal pathogens could potentially reduce fungicide requirements. Reduced fungicide usage would save golf course managers thousands of dollars per year and lower the environmental impact of golf course management. Yet, the upfront costs of a golf course renovation easily exceed normal chemical and fertilizer budgets. It remains unclear whether choosing a cultivar based solely on resistance to fungal pathogens can lead to a reduction in fungicide usage substantial enough to justify the costs of renovation.

The majority of disease resistance breeding efforts have focused on developing bentgrasses with improved resistance to S. homoeocarpa (4). For many golf courses in the upper Midwest, however, snow mold management is just as important as any other turfgrass disease (5). Many golf courses in the region spend $10,000 to 20,000 annually to manage snow molds such as Microdochium patch and Typhula blight. Differences among bentgrass cultivars with regards to Microdochium patch (*Microdochium nivale* (Fr.) Samuels & I. C. Hallett) resistance have been documented, but little information exists for Typhula blight (*Typhula incarnata* Lasch, *T. ishikariensis* Imai) (1, 5)Typhula blight is commonly separated into gray snow mold (caused by *T. incarnata*) and speckled snow mold (caused by *T. ishikariensis*), primarily to separate for differences in conditions conducive for disease development. Gray snow mold requires a minimum of 60 days of continuous snow cover to develop while speckled snow mold requires a minimum of 90 days of continuous snow cover to cause disease (5). Without information regarding the level of resistance bentgrass cultivars have to the Typhula blight pathogens, golf course superintendents in climates conducive for Typhula blight development cannot make an informed decision regarding cultivar selection for their site.

Bentgrass cultivars that exhibit significant resistance to a variety of fungal pathogens may limit fungicide expenditures and provide a long-term strategy towards sustainability in golf turf management. The objectives of this study were to (1) evaluate the relative resistance of eight bentgrass cultivars to *S. homoeocarpa* in a reduced fungicide program to determine whether the inherent resistance might reduce fungicide usage, and to (2) evaluate the resistance of the same eight cultivars to *T. incarnata* in the absence of fungicides to determine if resistance to this important pathogen exists at all.

EXPERIMENTAL DESIGN AND PLOT PREPARATION

Eight cultivars of creeping bentgrass were established during the summer of 2009 at the OJ Noer Turfgrass Research and Education Facility (OJN) in Madison, WI in a randomized complete block design with four replications. The eight cultivars tested were 'Penncross', 'Declaration', 'Memorial', 'Penn A-1', 'Penn A-4', 'LS-44', 'Syn-96', and 'Penn G-1'. Individual plots measured 1.5 × 3 m with four replications, and each cultivar was seeded at 48.38 kg ha-1. The experimental area was fumigated using dazomet (tetrahydro-3,5,-dimethyl-2H-1,3,5-thiadiazine-2-thione) applied as Basamid (Certis USA, Columbia, MD) prior to seeding to kill viable annual bluegrass seeds. Cultivars were maintained at a fairway height of 1.25 cm and fertilized with approximately 98.0 kg N ha-1 annually. The experimental area was not inoculated with either pathogen throughout the course of the study.

FUNIGICIDE APPLICATIONS AND DISEASE RATING

Pesticides were not applied to the experimental area during cultivar establishment or during the fall of 2009. Monthly applications of propiconazole and chlorothalonil were made to all plots on approximately June 1, July 1, and August 1 in 2010 and 2011. Propiconazole was applied as Banner MAXX® (Syngenta Crop Protection, Greensboro, NC) at the rate of 0.5 kg a.i. ha-1 and chlorothalonil was applied as Daconil WeatherStik® (Syngenta Crop Protection, Greensboro, NC) at the rate of 8.03 kg a.i. ha-1. This reduced rate was selected to allow for dollar spot development without the risk of a total loss of the experimental area to disease. Fall fungicide applications targeting Typhula blight were not made in throughout the study in order to evaluate resistance to *T. incarnata*.

Typhula blight severity was visually assessed as percent area of the plot diseased immediately following snow melt on March 18th, April 7th, and March 18th in 2010, 2011, and 2012, respectively. Dollar spot severity was assessed by counting individual foci as epidemics developed every two weeks throughout the growing season. The two most severe ratings from each year were combined and used for analysis, with the exception of 2009 when only two ratings were used because of cultivar seeding in mid-summer. The most severe rating dates used were 14 Sep and 29 Sep in 2009, 21 Jun and 8 Jul in 2010, and14 Jul and 11 Aug in 2011. Disease severity values were subjected to analysis of variance (ANOVA; PROC MIXED) and means were separated using Fisher's protected LSD using PDMIX macro (8) in SAS (Version 9.1; SAS Institute, Cary, NC). Due to differences in disease development each year, years were analyzed separately.

DOLLAR SPOT DEVELOPMENT

Overall, dollar spot severity was greater in 2011 than both 2010 and 2009 due to prolonged periods of temperatures above 30°C and relative humidity greater than 85%. (Table 1). Creeping bentgrass cultivar did affect dollar spot severity in all three years (p *value* ≤ 0.05). Over the entire 3-year study, dollar spot severity was lowest for Declaration and Memorial (Table 1). In general, dollar spot severity on Penn A-1, Penn A-4, LS-44, Syn-96 and Penn G-2 was similar or greater when compared to Penncross throughout the 3-year study (Figure 1).

These results suggest that the cultivars Declaration and Memorial are more resistant to the dollar spot pathogen relative to the other six cultivars tested. Resistance in these two cultivars is partial, however; by 2011 foci numbers exceeded 200 on the three most severe rating dates. The epidemic occurred despite monthly applications of reduced-rate fungicides during the summer and would have been deemed unacceptable by most golf course superintendent's standards. The frequency and amount of fungicide applied in this study was reduced compared to a standard program golf course superintendents in the Upper Midwest utilize for fairway disease management. If the reduced fungicide program used in this study could not provide acceptable suppression of dollar spot throughout the growing season, then it remains unclear if significant reductions in fungicide usage could be obtained solely through the use of partially disease-resistant bentgrass cultivars in the Midwest. However, limited fungicide usage may be achieved when Memorial and Declaration are used in conjunction with disease suppressive cultural practices and warrants further investigation.

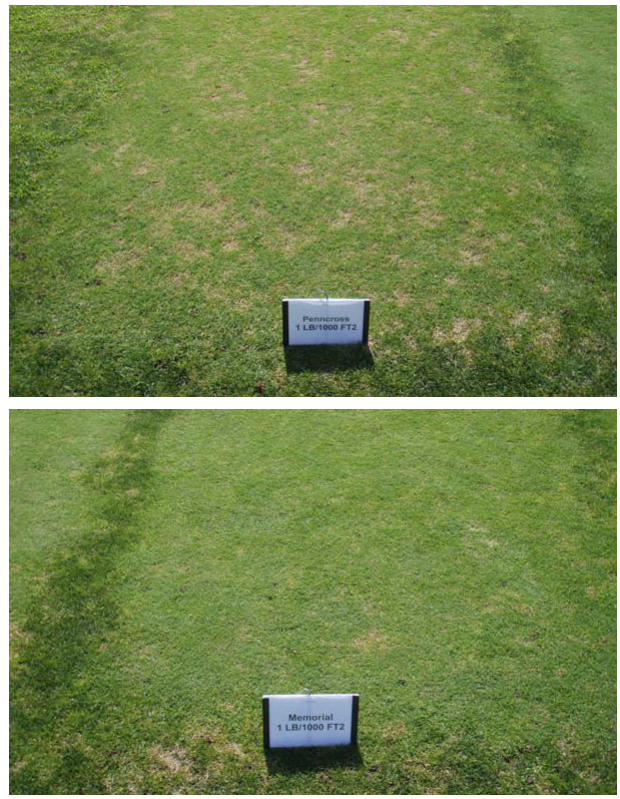

Figure 1. Dollar spot development on 'Penncross' compared to 'Memorial' creeping bentgrass on August 11th, 2011 at Eagle River GC in Eagle River, WI.

TABLES AND FIGURES

Table 1. Dollar spot severity on eight creeping bentgrass cultivars in 2009, 2010, and 2011 at the OJ Noer Turfgrass Research Facility in Madison, WI.

	Number of Dollar Spot Foci[y]		
Cultivar	2009	2010	2011
Penncross	135 a[z]	113 b	359 b
Declaration	60 bc	61 c	228 c
Memorial	44 c	36 c	275 c
Penn A-1	91 abc	76 bc	388 b
Penn A-4	101 ab	206 a	380 b
LS-44	99 ab	99 bc	388 b
Syn-96	104 ab	175 a	518 a
Penn G-2	109 ab	199 a	542 a

[y] Dollar spot severity was estimated when disease developed through the summer months. Data represents mean number of dollar spot foci per plot calculated from the two most severe ratings in each year. Plots were 4.5m^2.

[z] Means with the same lower case letter within a year are not statistically different according to Fisher's Protected LSD.

TYPHULA BLIGHT DEVELOPMENT

Typhula blight, caused by *Typhula incarnata*, was the only snow mold observed within the experimental area in all 3 years. Typhula blight severity was highest in 2011 and 2012 (*p value* ≤ 0.05) [Table 2]. Throughout the study, Typhula blight severity was lowest on Memorial followed by Declaration and LS-44 (Figure 2). Penncross displayed the highest amount of disease in 2010 and 2011, but the least in 2012. Though unclear exactly why so little disease developed on Penncross in 2012, high variability existed between replications and does not appear to indicate any disease suppressive characteristics of Penncross.

Fungicides were not applied to the research area to prevent Typhula blight development, and these results clearly show differences in the degree of resistance that select bentgrass cultivars have against *T. incarnata*. On fairway turfgrass in the upper Midwest, however, most golf course superintendents would consider Typhula blight severity above 5-10% on fairways unacceptable. This disease is of paramount importance in the upper Midwest because of the effects on spring and early summer golf course revenue, and prior to this study research investigating the resistance of modern bentgrass cultivars to Typhula blight was mostly absent. Most golf course superintendents would not risk going into winter unprotected against Typhula blight development, and typically make one fungicide application shortly prior to expected snow cover.. However, with declining budgets, the widespread and costly fungicide applications made to manage Typhula blight in the upper Midwest may be a potential area of financial savings. Since fungicides were not applied to these plots to manage Typhula blight, it remains unclear whether reduced rates of fungicides could be used on the partially resistant cultivars for acceptable Typhula blight suppression and should be an area of future research.

Figure 2. Example of Typhula blight (Typhula incarnata) development on 'Penncross and 'Declaration' creeping bentgrasses on March 18, 2010 at the OJ Noer Turfgrass Research Facility in Madison, WI.

Table 2. Typhula blight severity on eight creeping bentgrass cultivars in 2010, 2011, and 2012 at the OJ Noer Turfgrass Research Facility in Madison, WI.

	Typhula blight severity (%)[y]		
Cultivar	2010	2011	2012
Penncross	28 a[z]	68 a	10 d d
Declaration	11 bc	21 d	35 b b
Memorial	12 bc	21 d	24 c c
A-1	21 a	50 b	40 b b
A-4	13 bc	50 b	58 a a
LS-44	10 c	25 cd	38 b b
Syn-96	8 c	31 c	51 a a
G-2	18 b	64 a	54 a a

[y] Typhula blight severity was visually estimated as percent area of the plot diseased following snowmelt on March 18th, April 7th, and March 18th in 2010, 2011, and 2012, respectively. Plots were 4.5 m^2..

[z] Means with the same lower case letter within a year are not statistically different according to Fisher's Protected LSD.

CONCLUSION

New cultivars of creeping bentgrass released in the past decade have shown varying levels of resistance to numerous fungal pathogens. In this study, Declaration and Memorial were the only cultivars to consistently exhibit partial resistance to both dollar spot and Typhula blight in comparison to six other cultivars tested. This suggests that the resistance mechanism of these two cultivars may be broad and effective against a range of fungal pathogens. None of the cultivars tested suppressed dollar spot to acceptable levels even with monthly applications of reduced-rate fungicides. Suppression of Typhula blight on Declaration and Memorial was significant compared to the other cultivars tested, though disease severity was unacceptable on all cultivars tested despite the low to moderate Typhula blight pressure experienced in Madison, WI. It remains unclear whether reduced-rate fungicide applications can provide acceptable Typhula blight suppression on Memorial or Declaration. Planting these particular resistant cultivars may not lead to appreciable reductions in fungicide usage for the management of dollar spot without implementation of other disease suppressive cultural practices. Thus, it may take many years to recover the cost of converting fairways, tees, and/or putting greens to disease-resistant creeping bentgrass cultivars and attributes other than disease resistance should also be taken into account when considering golf course renovation.

LITERATURE CITED

1) Baldwin, C. B. 2010. Creeping bentgrass cultivar response to pink snow mold disease, 2009. *Plant Disease Management Reports* 4: T017.

2) Beard, J. B. 1973. *Turfgrass: Science and Culture*. Prentice Hall, Englewood Cliffs, NJ. p. 78.

3) Beard, J. B., Croce, P., Mocioni, M., DeLuca, A., Volterrani, M. 2001. The comparative competitive ability of thirteen *Agrostis stolonifera* cultivars to *Poa annua*. Intl. Turfgrass Soc. Res. J. 9: 828-831.

4) Bonos, S. A., Clarke, B. B., Meyer, W. A. 2006. Breeding for disease resistance in the major cool-season turfgrasses. Ann. Rev. Phytopath. 44: 213-214.

5) Hsiang, T., Matsumoto, N. Millett, S. M. 1999. Biology and management of Typhula snow molds of turfgrass. Plant Dis. 83: 788-798.

6) Liu, X., Huang, B. 2001. Seasonal changes and cultivar difference in turf quality, photosynthesis, and respiration of creeping bentgrass. *HortScience* 36: 1131-1135.

7) Samaranayake, H., Lawson, T. J., Murphy, J. A. 2008. Traffic stress effects on bentgrass putting green and fairway turf. *Crop Sci*. 48: 1193-1202.

8) Saxton, A.M. 1998. A macro for converting mean separation output to letter groupings in Proc Mixed. In Proc. 23rd SAS Users Group Intl., SAS Institute, Cary, NC: 1243-1246.

9) Settle, D., Fry, J., Tisserat, N. 2001. Dollar spot and brown patch fungicide management strategies in four creeping bentgrass cultivars. *Crop Sci*. 41: 1190-1197.

10) Stier, J. C. 2006. A short history of creeping bentgrass. *The Grass Roots*. 35(1): 4-9.

11) Stier, J. C., Hollman, A. B. 2003. Cultivation and topdressing requirements for thatch management in A and G bentgrasses and creeping bluegrass. *HortScience* 38:1227-1231.