To avoid over-interpretation or relying solely on your laboratory's (or consultant's) interpretations of your soil-testing results, I recommend you compare your results with PACE Turf's Minimum Level for Sustainable Nutrition guidelines which can be found here: www.paceturf.org/PTRI/Documents/1202_ref.pdf.

Instead of drawing their interpretations from a single study, these minimum levels are based on a very large database of soil testing results where the turf was deemed to be performing average or above average (all soil samples from poor performing turf were thrown out).

The "minimum level" was set at the lower one-third of the dataset.(2) That means about 33% of the soil samples with good turf had soil test levels (for potassium or phosphorus, etc.) below that minimum level. While you could argue this remains a conservative approach, the minimum levels published by PACE are drastically lower than many traditional soil test interpretations, and likely more accurate.

In conclusion, soil testing can be useful for fertilizer planning, but is far from a perfect system. More research is required to continue to defining and re-defining optimum soil test levels for the multitude of soil types and grass varieties. While our soil testing methods have come a long way in the last 85 years, there is still a tendency to place undue emphasis on the value of soil testing.

For best results:

1. Make sure you have a consistent depth when you pull your soil samples.
2. Send your samples to the same reputable laboratory year after year, and ensure they are using a proper extractant based on your soil pH.
3. Don't over interpret your soil test results. Avoid balancing cations and double check the laboratory or consultant's recommendations with the PACE Turf's MLSN Guidelines before making decisions on corrective action.

"Notes"

(1) For an extensive summary of this research, check out "A review of the use of the basic cation saturation ratio and the 'ideal' soil" by Drs. Peter Kopittke and Neal Menzies in the March/April 2007 edition of the *Soil Science Society of America Journal.*

(2) It's actually a bit more complicated than this, and you can read more here: http://www.plantmanagementnetwork.org/pub/ats/proceedings/2013/rootzones/8.htm

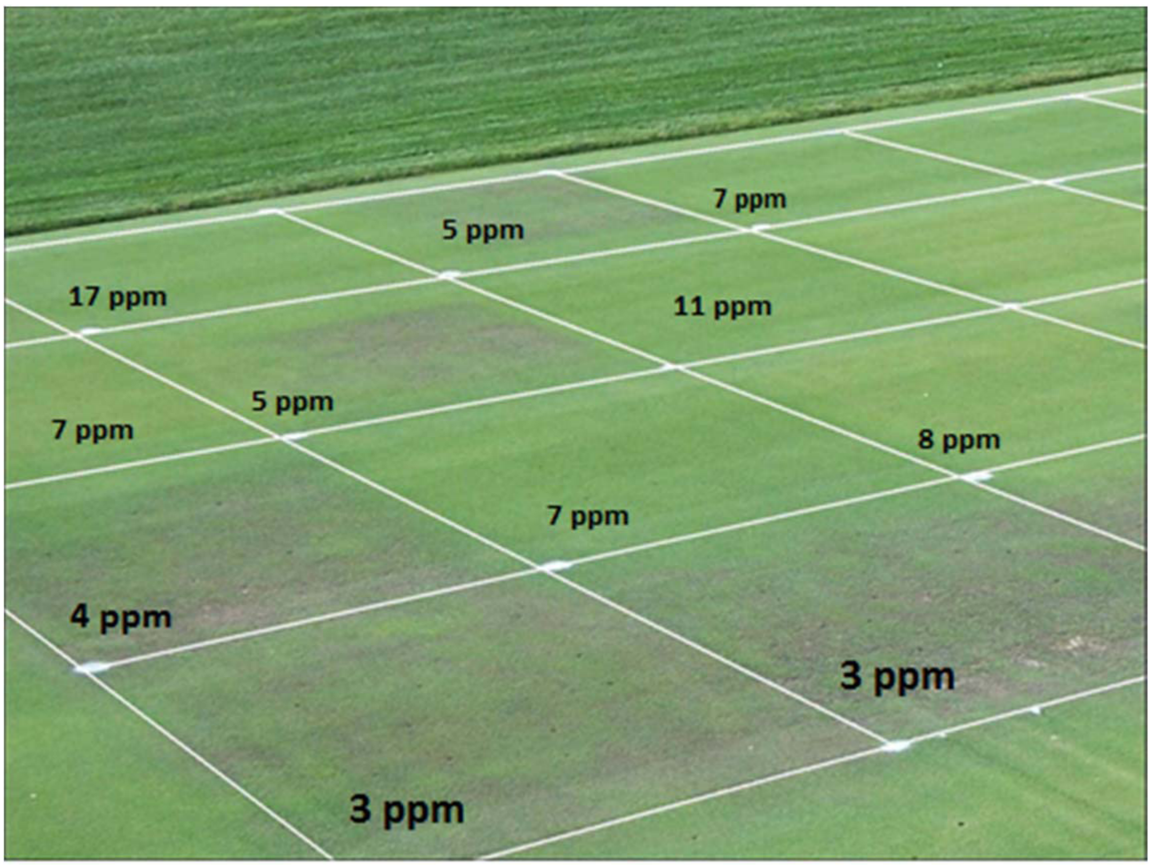

Figure 1. Phosphorus deficiency of creeping bentgrass on a high pH sand based root zone. Deficiency symptoms disappear above 5 ppm Mehlich-3 extractable soil phosphorus.

Beneficial Insects: Our Most Loyal Employees

By Glen R Obear and PJ Liesch, Department of Entomology, UW-Madison

We are all very familiar with problematic insect pests, but what about insects that do NOT cause damage? It turns out that despite the huge diversity of insect life in the world— 700,000 to over 1,000,000 discovered species—less than 1% of them are actually pests. So what are 99% of insects doing if they are not causing a problem? It turns out that a large group of insects, referred to as "beneficial insects," are controlling our insect pests for us. However, we still do not understand these insects fully, despite the valuable services they provide.

Insects can be classified based on the ecological niche they fill—in other words, how and what they eat. Most of the insects that we consider to be pests of turfgrass feed on plant tissue. These insects are very diverse, including many species of beetles, butterfly/moth larvae, and "true bugs" with piercing-sucking mouthparts.

There are some insects that strictly feed on other insects, called predators. Common predators are also quite diverse, including tiger beetles, ground beetles, rove beetles, ladybugs, dragonflies, praying mantids, and ants (just to name a few). Many of these predators tend to be generalists, meaning they feed on a number of different species of insects.

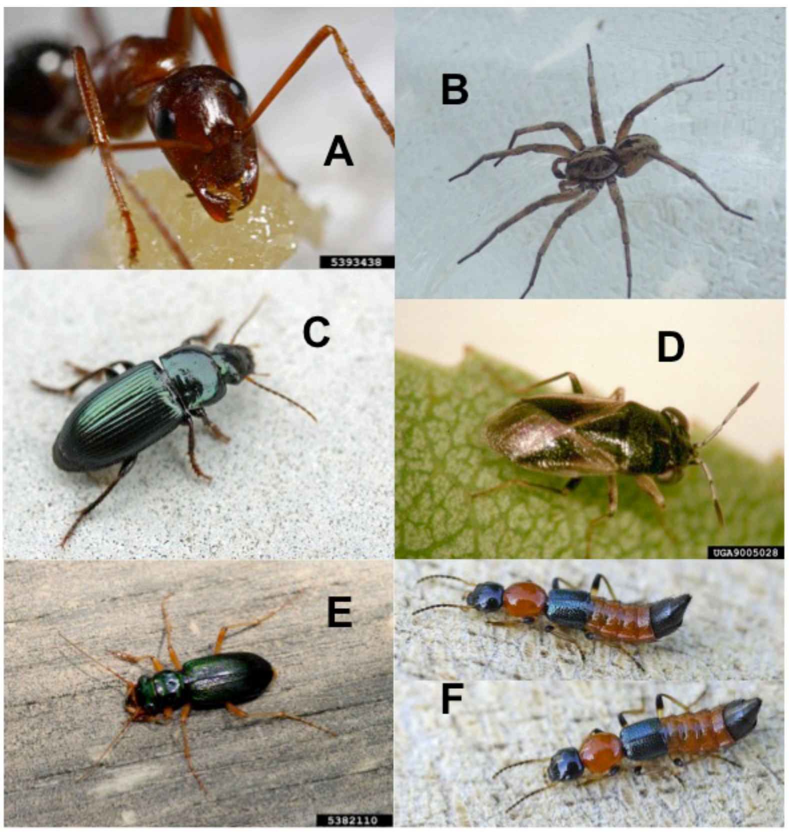

Figure 1. Common groups of arthropod predators in turf systems. A. Ant (photo: Joseph Berger, Bugwood.org); B. Wolf spider (photo: Patrick Edwin Moran, 3 October 2005, central North Carolina, USA. Hogna helluo (male), a species of wolf spider.) C. Ground beetle (photo ©entomart; Wikipedia Commons). D. Big-eyed bug (photo: Bradley Higbee, Paramount Farming, Bugwood.org). E. Tiger beetle (photo: Whitney Cranshaw, Colorado State University, Bugwood.org) F. Rove beetle (photo ©entomart; Wikipedia Commons).

There are also insects called parasitoids. These insects actually lay their eggs either inside (endoparasitoid) or outside (ectoparasitoid) the body of other insects. When the eggs hatch, the larvae begin growing and feeding on its host, where they grow to adulthood. At this point, they leave their host and fly away to mate and find a new host for their offspring. Parasitoid insects primarily include many families of small wasps, and these insects tend to be highly specific in the hosts they choose.

Predators and parasitoids can help to keep pest populations in check. The trouble is that it is difficult to determine the economic value of biological control, and these beneficial insects work on their own time, not ours. Still, beneficial insects provide us with free biological control of our insect pests, so we certainly owe it to them to gain a better understanding of who they are, what kind of services they provide, and how our management practices might affect them.

Beneficial Arthropods in Turfgrass

A study at Auburn University (Auburn, AL) was conducted to identify predators of black cutworm larvae. Larvae were pinned in place into the surface of putting greens at a research station and on a golf course. The cutworms were put out just before dusk, and then they were monitored every 30-40 minutes until 1:00-3:00AM. Using flashlights, the researchers collected insects that were seen to be feeding on the cutworms, and took them back to the lab for identification. We replicated this study on putting greens and fairways at University Ridge Golf Course, and the O.J. Noer Turfgrass Research and Education Facility.

From our study and the Auburn study, a number of black cutworm predators were identified on putting greens, including tiger beetles, rove beetles, ground beetles, click beetles, assassin bugs, ants, wolf spiders, and even earwigs (Fig. 1). Many of these predators are also known to eat the eggs and larvae of other turfgrass pests, including white grubs. There is much less known about parasitoids of insect pests, but these insects have been shown to target white grubs, caterpillars, and mealybugs.

Minimize Our Impact, Maximize Their Services

Chemical control is certainly a valuable tool— a well-timed insecticide application can often save us from sustaining significant damage from an insect infestation. However, certain products that we use are more toxic than others, and this has implications for beneficial insects. Kentucky bluegrass plots treated with isazofos and carbaryl had 70% less predation of Japanese beetle eggs, and lower predator abundance. Plots treated with these products during the Japanese beetle oviposition period actually experienced higher infestations of white grubs relative to untreated plots, suggesting that the beneficial insects may provide significant control of Japanese beetle eggs (Terry et al., 1993). By ignoring the role of beneficial insects, we are potentially missing out on a great gift from nature- free control of our insect pests.

There are some things that we can do to minimize our impact on beneficial insects, thus maximizing their services. The insecticide industry has experienced a broad shift since the 1990's from curative control to preventive control, and the newer insecticide chemistries have relatively low toxicity to mammals and birds (Held and Potter, 2012). There are a few promising products on the market that selectively target our pest species, leaving beneficial insects relatively unharmed.

Chlorantraniliprole, an anthranilic diamide insecticide, has a very favorable environmental profile. This product displays a >500 fold differential selectivity towards insects over mammals, and features an LD50 of >5000 mg/kg and no signal word (i.e., CAUTION, WARNING, or DANGER) (Cordova et al., 2006). This product has excellent long-term residual activity, and can provide control of most of our major turfgrass pests with relatively low use-rates.

Spinosad is a reduced-risk insecticide that comes from the fermentation of an actinomycete fungus. This product has short residual efficacy, but can provide effective against most of our major turfgrass pests if applied during at the correct time. This product also tends to be more selective towards pests, with lower risks to beneficial insects. One study investigated the activity of spinosad on over 100 species of predator insects, and found that the product was non-lethal to 70-80% of them. The researchers did find that this product was lethal to 75-85% of parasitoids tested (Williams et al., 2010). However, due to the short residual efficacy of this product, a carefully timed application could control insect pests without posing a great risk to beneficial insects.

Figure 2. Sign highlighting environmentally-friendly practices being conducted at University Ridge Golf Course in 2010. Some examples include Audubon Cooperative Sanctuary program certification (A), examples of wildlife on the course (B), the use of a hybrid greens mower (C), and information about the Ice Age Trail (D), which is open to the public and runs through wooded and natural areas of the golf course. This sign was strategically placed near a tee where golfers often wait several minutes for the group ahead of them before hitting their tee shot, giving them plenty of time to check it out.

In addition to chemical control options, growing diverse plant communities also increase the number and diversity of predators in the area, and these predators in turn can help reduce pest populations. Incorporating natural areas adjacent to turf on the golf course increases biological control of insect pests, including Japanese beetle eggs, fall armyworm eggs and larvae (Braman et al., 2002), and black cutworm larvae (Frank and Shrewsbury, 2004).

The future of insect pest control is moving towards an integrated approach- one that does not rely solely on chemical treatment. Furthermore, the attention given to negative effects on non-target insects is increasing, and pest control strategies will have to take these organisms into account. For example, neonicotinoid insecticides have been implicated in a recent decline in honeybee populations, referred to as colony collapse disorder, and this claim has been greatly debated in the scientific community. Whether the neonicotinoid insecticides are playing a role in colony collapse disorder, or whether it is a combination of other factors, one thing is certain: as people who use these products, the public eye is on us. It will be more important than ever to keep accurate records, follow product labels, and justify our actions when controlling pests. If we are proactive in adopting this integrated approach, we will be well prepared for potential future regulatory challenges.

Making our integrated approach highly visible to our club members, customers, and neighbors will go a long way towards improving society's perception of how we manage our pests. For example, the Audubon Cooperative Sanctuary certification program promotes wildlife preservation on golf courses. Strategically placed signs near cart paths can show pictures and highlight the practices we are doing to preserve wildlife on the golf course (Fig. 2). Maintaining a blog online can help communicate conservation practices to your members and the community. Finally, don't forget about things you might already be doing: raising mowing heights, adjusting fertility and irrigation, returning clippings, maintaining sharp mower blades, and overseeding insect-damaged areas are just a few examples of management practices that we might take for granted, but certainly help reduce pest-damage without insecticides (Held and Potter, 2012).

While we still don't understand them fully, beneficial insects might be our most loyal employees. These insects are helping to keep our pest populations down, so we have much to gain by working to minimize our impact on them, and allowing them to do what they are best at.

Literature Cited:

Braman, S.K., A.F. Pendley, and W. Corley. 2002. *Influence of commercially available wildflower mixes on beneficial arthropod abundance and predation in turfgrass.* Environ. Entomol. 31:564-572.

Cordova, D., E.A. Benner, M.D. Sacher, J.J. Rauh, J.S. Sopa, G. P. Lahm, et al. 2006. *Anthranilic diamides: a new class of insecticides with a novel mode of action, ryanodine receptor activation.* Pestic. Biochem. Physiol. 84:196-214.

Frank, S.D., and P.M. Shrewsbury. 2004. *Effect of conservation strips on the abundance and distribution of natural enemies and predation of Agrotis ipsilon (Lepidoptera: Noctuidae) on golf course fairways.* Environ. Entomol. 33:1662-1672.

Held, D.W., and D.A. Potter. 2012. *Prospects for managing turfgrass pests with reduced chemical inputs.* Ann. Rev. Entomol. 57:329-354.

Terry, L.A., D.A. Potter, and P.G. Spicer. 1993. *Insecticides affect predatory arthopods and predation on Japanese beetle (Coleoptera: Scarabaeidae) eggs and fall armyworm (Lepidoptera: Noctuidae) pupae in turfgrass.* J. Econ. Entomol. 86:871-878.

Williams, T., J. Valle, and E. Vinuela. 2010. *Is the naturally-derived insecticide Spinosad® compatible with insect natural enemies?* Biocont. Sci. and Tech. 13:459-475.

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

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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 ($p\ value \leq 0.05$). 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.

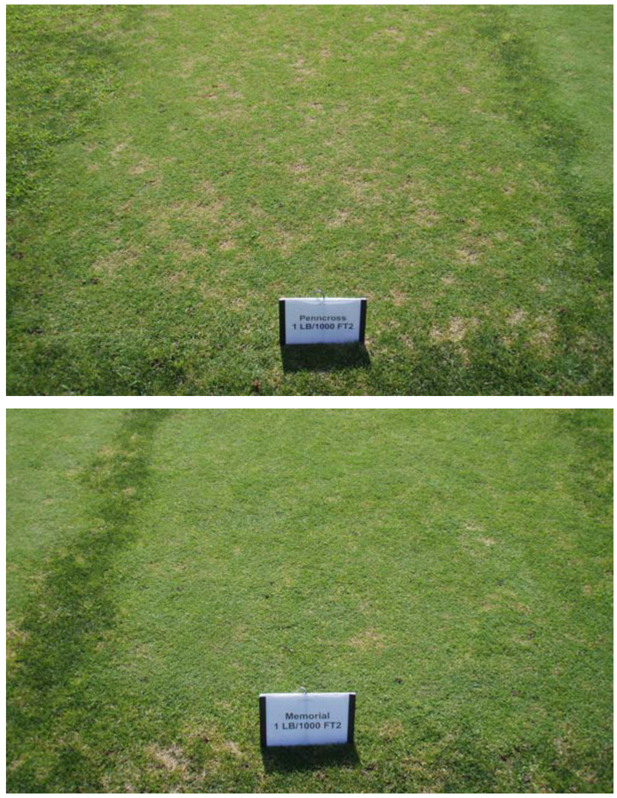

Figure 1. Dollar spot development on 'Penncross' compared to 'Memorial' creeping bentgrass on August 11th, 2011 at Eagle River GC in Eagle River, WI.

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.

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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.