agrostis. Copper spot and Microdochium patch are more active during cooler, wetter weather than BDS, and do not have the characteristic fruiting structures on affected leaves.

Favorable Conditions for Disease Development

Conditions that are favorable for BDS symptom expression are periods of dry weather with moderate temperature (75-85°F). BDS symptoms are most severe on exposed greens or portions of greens that are elevated, receive full sun, and have ample air circulation. To date, BDS has only been described from sand based putting greens (at least 80% sand) usually one to four years after establishment or reconstruction, however, the disease has been less frequently documented on greens less than one year, and as old as six years after seeding. The disease is usually most severe the first or second year symptoms are noticed and decline in subsequent years. It is hypothesized that newly constructed and fumigated greens have low microbial populations when compared to established greens or native soil greens. The buildup of organisms that are antagonistic to *O. agrostis* over time may explain the why disease is more prominent on young greens and decrease in severity with the passage of time. A similar decrease in disease severity over time has been demonstrated to occur with take-all patch of bentgrasses (Kaminski and Dernoeden, 2002a). The pathogen overwinters in leaf and stolon tissue as well as the resilient pseudothecia. In the following year, *O. agrostis* resumes growth when the air temperature reaches 68°F and peaks between 77°F and 86°F (Kaminski and Dernoeden, 2002b). BDS is spread by the mechanical movement of colonized plant debris as well as windblown ascospores that are released from mature pseudothecia. There is no evidence to suggest that BDS is seed transmitted (Wetzel and Butler, 2000).

Control of BDS

Cultural control techniques that may help reduce the severity of BDS include maintaining adequate soil moisture when conditions are favorable for disease development and planting resistant cultivars. Kaminski and Dernoeden (2002a) found significant differences in disease susceptibility between fifteen commercially available creeping bentgrass and two velvet bentgrass (Bavaria and SR7200) cultivars. The cultivars from most resistant to most susceptible are: Bavaria, Penncross, Backspin, Crenshaw, Pennlinks, Penn A-2, SR1119, Penn G-1, Providence, Penn G-6, Bardot, Century, Imperial, Penn A-4, L-93, Penn A-1, and SR7200. Several fungicides and combinations of fungicides have proven to provide adequate preventative control of BDS, whereas tank mixes of chlorothalonil + thiophanate methyl and chlorothalonil + iprodione have proven to be the most efficacious for curative applications. Recovery from BDS takes several weeks and patches may not heal before winter, therefore, it is recommended to frequently apply light rates of nitrogen to enhance regrowth of the plants (Wetzel and Butler, 1999; Wetzel and Butler, 2000; Towers et al. 2000).

If you have any questions regarding BDS please contact the TDL at 608-845-2535 or swa@plantpath.wisc.edu. Additionally, if you notice BDS symptoms on your greens, please contact the TDL or send in a sample so we can confirm the presence of this newly discovered pathogen in Wisconsin and begin working with it.

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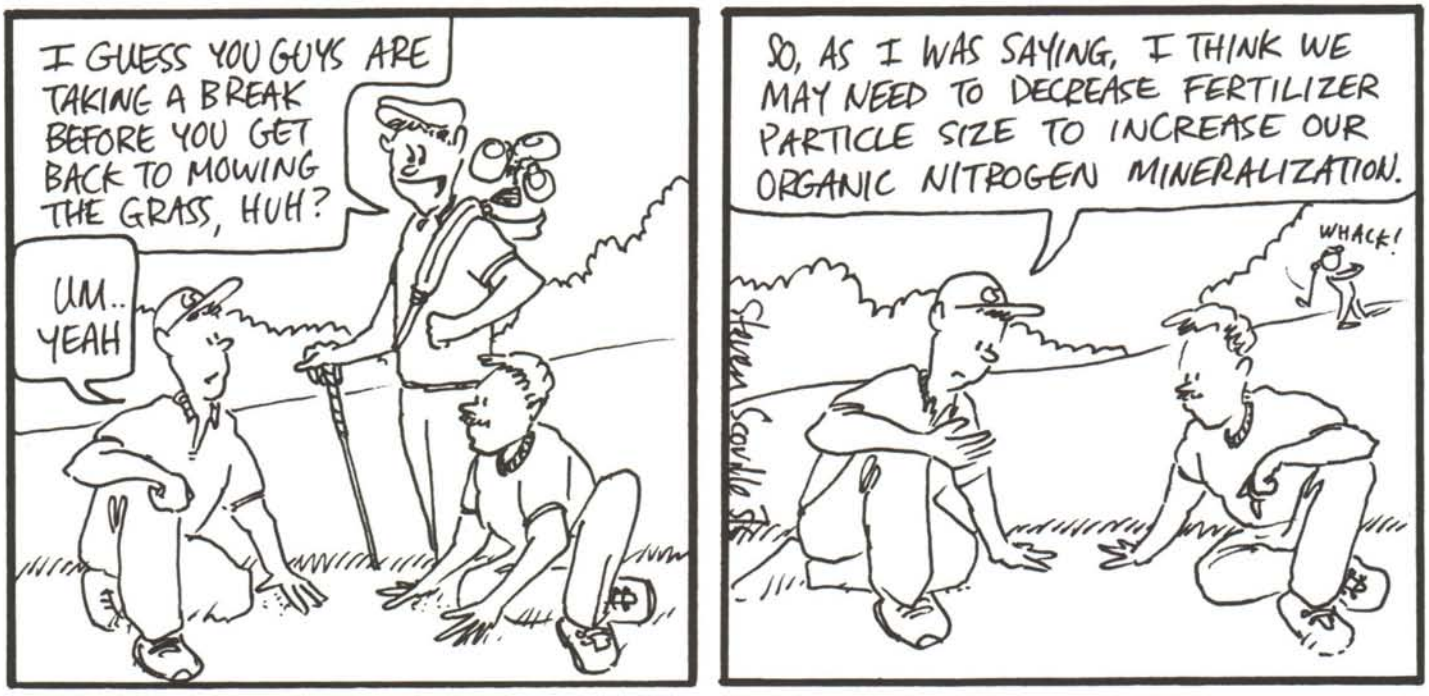
Endophyte-enhanced Turfgrasses: Are They Worth Their Weight?

By Dr. R. Chris Williamson, *Turfgrass and Ornamental Specialist, Department of Entomology, University of Wisconsin-Madison*

Endophytes are mutualistic symbionts; they are beneficial fungi that live between the cells of plants. Endophytes produce toxins that protect plants, but are not harmful to the plant itself. Acremonium endophytes are the predominant endophyte used in turfgrasses. Plant breeders enhance turfgrasses with endopyhytes to reduce maintenance costs, conserve and improve precious soil and water resources, ultimately enhancing the environment. Endophyte-infected turfgrasses have consistently shown dramatic enhancement of resistance to several foliage-feeding insects including armyworm, billbug, chinch bug, and sod webworm. However, because most (> 90%) of the toxins produced by endophytes are mainly located in above-ground plant tissues (i.e., above the crown), white grubs are not affected. Endophytes also provide valuable drought and stress tolerance as well as disease resistance. For these reasons, endophyte-enhaced turfgrasses are definitely worth their weight, especially since they have the ability to improve turfgrass performance.

Unfortunately, perennial ryegrass, *Lolium perenne* L., hard fescue, *Festuca longifolia* Thuill, Chewings fescue, *Festuca rubra* L, and turf-type tall fescue, *Festuca arundinacea* Schreb are the only commercially available endophyte-enhanced turfgrasses. As a result, unless you are managing and maintaining one of these aforementioned turfgrass species, the use of an endophyte-enhanced turfgrass is not an option. Moreover, not all insects are susceptible to endophytic turfgrasses; the black cutworm (i.e., an important insect pest of golf course turf, especially putting greens) has relatively low susceptibility to endophyte-infected turfgrasses. The good news is that turfgrass breeders are continuing to work on developing other endophte-enhanced turfgrass species such as creeping bentgrass, *Agrostis palustris* Hudson. Should they attain success, managing sod webworm larvae on golf course turf (i.e., creeping bentgrass) may be achieved with little reliance on conventional insecticides.

Now more than ever, especially due to the growing public concern as well as the banning of the use of pesticides in some U.S. cities, endophyte-enhanced turfgrasses should be considered when applicable. However, endophytes are not the end-all-cure-all, they are merely another turfgrass management option. Always consider the most environmentally responsible, effective, and economical approach when making a turfgrass management decision.



Spring Business Meeting ~ A Testament to Value

By Dave Van Auken, *Golf Course Superintendent, Royal St. Patrick's Golf Links*

The annual Wisconsin Golf Course Superintendents Association Spring Business Meeting was held on Monday, March 1, 2004 at the Ramada Plaza Hotel in downtown Fond du Lac. The event was well attended with members representing nearly every area of the state. They did not leave disappointed as the information presented covered a wide array of issues that we confront on a daily basis.

This valuable information began with Dr. John Stier and Dr. Geunhwa Jung offering not only the latest in their research findings but also a sincere appreciation for the funding and sponsorship provided by our organization. Their research discoveries are valuable to us.

This was followed by a very informative talk on developing and implementing a "Maintenance Inspection Program" for your golf course water supply system, presented by Jeff Gibson of Layne - Northwest. In the context of well pumps or irrigation supply pumps, Jeff detailed what your maintenance inspection program should include and what this will enable you to do: AVOID CATASTROPHIC FAILURE! Does that have value or what?

Following Jeff was Dan Peplinski of Layne-GeoSciences and his presentation on "Well Rehabilitation & Development." Dan followed a very practical cost/benefit equation outlined in a very easy to understand format. Dan detailed the goals, benefits, causes and remedies should we realize a substantial decrease in our well pumping capacity. I was struck with how simply we can overlook one of the most valuable resources we utilize and how with just a little effort on our part we can protect our water supply systems for years to come.

Carl Grassl received a 25-year member plaque from Eric Jasin.

Eric Jasin presented a 25-year member plaque to Mike Kilpatrick.

After a great lunch served up by the always courteous staff at the Ramada Plaza, the WGCSA convened for the annual spring business meeting. Presentations were made by each of the WGCSA board members who chair a committee. As an organization that works on behalf of each and every member, the WGCSA and the current officers are continually providing valuable services, resources and information for its membership. Thank them when you have the chance.

In addition to the typical business meeting, recognition and much deserved applause was given to Monroe Miller as the recipient of the USGA Green Section Award and for receiving an award on behalf of his selfless efforts as editor of the Grass Roots for, get this: the 20th consecutive year! I don't think I can express how valuable that is to me. I heard that some members join the WGCSA just so they can receive this publication and reap the benefits of the great information contained within its pages. On behalf of all the members and me in particular, thanks again Monroe.

We are also very blessed to have Danny Quast as a longtime

Dan Peplinski addressed subjects relating to water sources. He is an employee of Layne-GeoSciences.

Jeff Gibson from Layne-Northwest lectured about pump station maintenance.

member of our organization. Danny was recognized by the GCSAA and received the Distinguished Service Award in San Diego last month. His years of experience at the pinnacle of our profession contribute immensely to the value of our organization as a whole. Be sure to take every advantage of this you can.

Longevity in our organization also has value and this was never more evident than it was on March 1st, as we recognized Carl Grassl, Dave Helke, (not present) and Mike Kilpatrick for 25 years as members of the WGCSA. Each of these individuals has something to bring to the table and I urge each of you to get to know them while you can. Their experiences have contributed to the level of recognition and knowledge we all benefit from and there is nothing more valuable than to be able to share in their experience.

Valuable information, valuable experience, valuable affiliations — all part of the WGCSA experience.

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WGCSA Research Project: Managing the New Bentgrasses and Perennial Annual Bluegrasses for Putting Greens

By Dr. John Stier and Mr. Andrew Hollman, *Department of Horticulture, University of Wisconsin-Madison*

What's the Big Deal?

Every once in a while a new turfgrass type comes along that galvanizes and excites the industry. In the mid 1990s a suite of grasses known as the A and G series was released by Dr. Joe Duich at Pennsylvania State University. The grasses were developed from clones selected from putting greens in Augusta, Georgia, giving rise to the designation "A" and "G". The six new varieties released were 'A-1', 'A-2', 'A-4', 'G-1', 'G-2', and 'G-6'. All were characterized by their narrow leaf texture and upright growth, with tremendous density that helped resist *Poa annua* invasion (Beard et al., 2001; Fraser, 1998). Evidence also suggested they had better disease resistance and summer stress tolerance than other bentgrasses (Fraser, 1998; Landry and Schlossberg, 2001.

Due to their extreme density, and apparently rapid growth rate, Dr. Joe Duich recommended lower than normal cutting heights (typically 0.1 to 0.125 inch) and more frequent topdressing to combat thatch development. Fraser (1998) surveyed some of the earliest superintendents who were managing A and G series greens and found a variety of management programs were used. Topdressing frequencies ranged from once every two to four weeks and core aeration varied from two to six times annually. In Wisconsin, superintendents discussed their concerns with me regarding what was seen as unknown or unrealistic management requirements for the A and G bentgrasses. A very specific concern was that the high turf density would prevent all but the smallest topdressing particles from entering the turf, resulting in a fine textured sand over a coarser root zone that would reduce drainage rates.

After years of development a perennial, stoloniferous type of annual bluegrass (*Poa annua var. reptans*) was released for use on putting greens by Peterson Seed Co in 1997. The grass had been a long-term project in Dr. Don White's breeding program at Minnesota, with financial support provided by the USGA. The feeling was that since *Poa annua* existed throughout the country and usually became a primary grass on most putting greens over time, why not develop a variety specifically for putting greens? I had seen Dr. White's putting green plots at the university and was quite impressed with the uniformity, density, and complete lack of seedheads. As with the A and G series bentgrasses, though, a lack of research on the management requirements could choke its acceptance by the industry. Originally named DW-184, it is now sold under the name of 'Tru-Putt'.

In 1998 the WGCSA agreed to fund a three-year project to investigate the management requirements of A-4, G-2, and DW-184. The objectives were to evaluate thatch development and topdressing losses compared to 'Penncross', as influenced by different aeration and topdressing programs. Data collection was completed the end of 2001, data were analyzed and a scientific manuscript were submitted in 2002, with publication during autumn 2003.

How was the project conducted?

Establishment and maintenance. Plots were seeded on a USGA-specified sand-based root zone at the O.J. Noer Turfgrass Research and Educational Facility in September 1998. Following grow-in, turf was fertilized four times annually for a total of 3.5 lb N per thousand square feet using a 21-3-12 fertilizer with 80% water-insoluble nitrogen. Plots were mowed six days weekly using a walking greensmower with clippings removed. Turf was irrigated daily to replace 100% of the moisture lost based on evapotranspiration rates. Curative applications of fungicide were applied during the summer to allow some estimate of susceptibility to dollar spot disease.

Treatments. Treatments consisted of A-4, G-2, Penncross, and DW-184 each planted in three repetitions (replicates) measuring 180 square feet. The plots were split, one-half receiving core aeration once each October using 0.5 inch tines with the other half aerated four times annually using quadratines for all but the October aeration. Plots were further split to receive topdressing at monthly intervals, biweekly with verticutting, or biweekly without verticutting. An 80:20 sand:peat mixture was used for topdressing, and aeration was timed so that all plots were topdressed within 24 hours. The topdressing was brushed and watered in after application. The monthly topdressing rate was 0.1 cubic yards per thousand square feet, equal to a depth of 0.03 inches, or about one-quarter the cutting height. Topdressing at the two-week intervals was applied at

half the rate (see Beard, 2002, for additional information on rates).

Data collection. Sand topdressing removed by mowing the day after application was collected from each plot, separated from clippings, oven-dried, sieved according to USGA specifications, then each fraction was weighed to determine the percentage of topdressing removed based on known weights of topdressing applied. Thatch depth was measured each autumn of 2000 and 2001. Turf was rated visually each growing month from 1999 through 2001 for color, quality, and disease. Additional details are provided in Stier and Hollman (2003).

The Big Picture

As expected both A-4 and G-2 had much better turf quality than Penncross (Fig. 1). A-4 tended to have a darker green color while G-2 had more of a candy-apple green color which was quite beautiful. Both had a more uniform appearance, and much better density, than Penncross. The DW-184 was disappointing: abundant seedheads throughout 1999 indicated the seed lot was likely infested by seed of annual *Poa annua*. Quality did improve over time as the perennial types seemed to displace much of the annual types, but turf quality of DW-184 was never excellent or even acceptable. Surprisingly, A-4 had five times or more dollar spot development than Penncross, while DW-184 had even more. G-2 and Penncross had the least amount of dollar spot (data not shown).

Both A-4 and G-2 produced more organic matter in the upper soil profile than Penncross or DW-184 (Fig. 2). All topdressing regimes, though, appeared to be sufficient to effectively dilute the thatch and prevent the greens from becoming "puffy", so the organic matter we measured was more appropriately termed "mat"

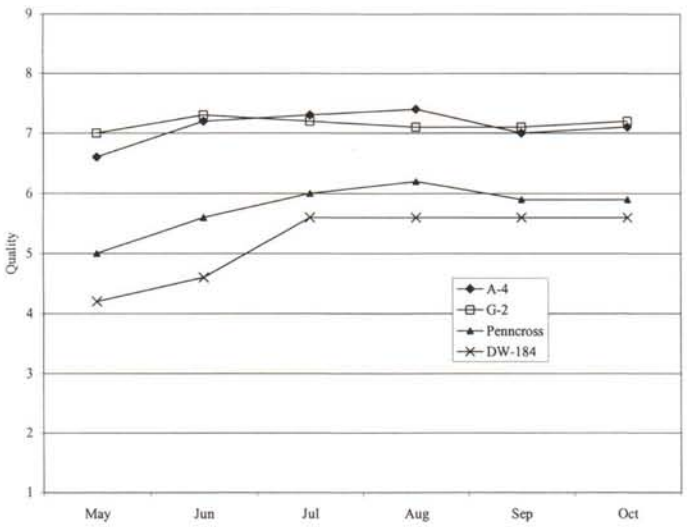

Fig. 1. Turf quality of three creeping bentgrass cultivars and DW-184, a *Poa annua* var. *reptans*, in Wisconsin averaged over 2000 and 2001. A-4 and G-2 had significantly greater quality ratings on a one to nine scale than Penncross or DW-184 at a P value of < 0.05.

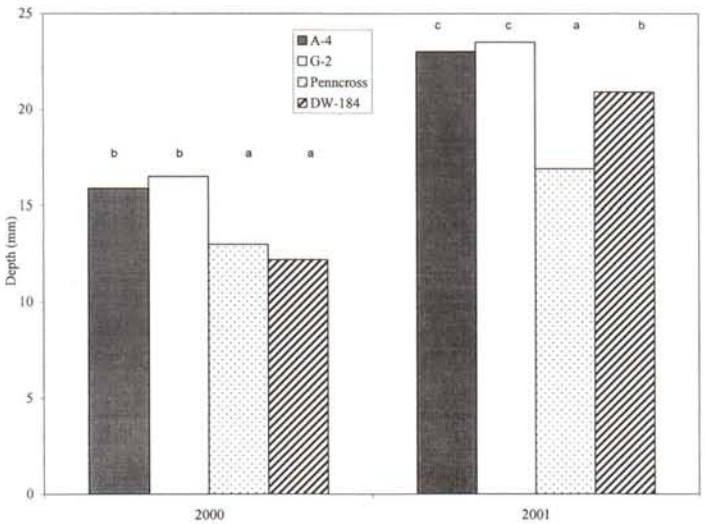

Fig. 2. Thatch/mat layer of three creeping bentgrass cultivars and DW-184, a *Poa annua* var. *reptans*, as a putting green turf in Madison, WI.

rather than thatch. Ideally we would have continued to collect data on thatch production and green speed over a 5 to 10 year period, but the cost of maintaining the plots and collecting the data were prohibitive compared to the additional information that might have been gleaned. It's safe enough to say that superintendents do have cause to be watchful for thatch buildup with the A and G bentgrasses, though it shouldn't become a problem if topdressing applications are sufficient to dilute the thatch. Our rates were on the moderate side: in normal practice, rates and frequency should be based on mowing height and growth rate which will vary according to local conditions. In general, a greater frequency of topdressing is more important than infrequent, heavy topdressings which might produce a layered effect, ultimately inhibiting drainage and rooting.

The type of grass had minor

effects on the size fraction of topdressing removed by mowing. Data indicated approximately 21% of the very coarse sand in the topdressing mix was removed from Penncross, compared to 24.5 and 24.0% removed from A-4 and G-2, respectively (Table 1). On the other hand, slightly more medium-sized topdressing was removed from Penncross compared to A-4 and G-2.

Statistically, the topdressing method showed differences in the total amounts of topdressing removed depended on the turf type (Fig. 3). In general, monthly topdressing resulted in more topdressing removed by mowing than biweekly topdressing, while biweekly topdressing and verticutting resulted in the least amount of topdressing removed. Although these differences were statistically significant, they likely have little practical significance because mowing only removed approximately 1 to 2% of the topdressing applied.

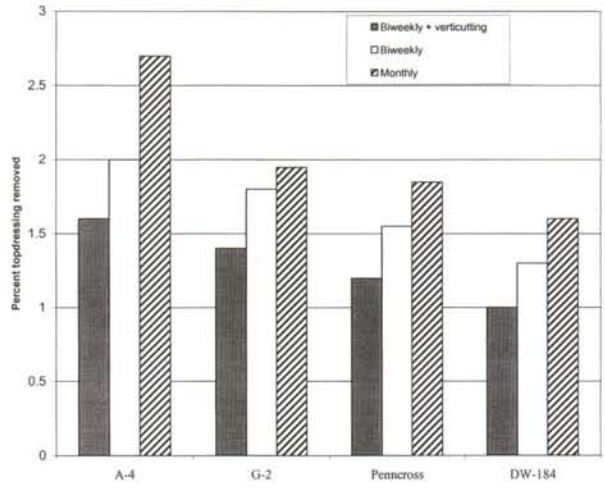

Fig. 3. Effect of topdressing frequency and verticutting on topdressing removal from three creeping bentgrass varieties and DW-184 (*Poa annua* var. *reptans*), averaged over 2000 and 2001 in a putting green situation at the O.J. Noer Turfgrass Research and Educational Facility, Madison, WI.

Table 1. Proportion of topdressing sizes removed by mowing from three bentgrass cultivars and *Poa annua reptans* 'DW-184', O.J. Noer Turfgrass Research and Educational Facility, Verona, WI, 28 July 2001.

	Particle size					
	mm					
	>2	2-1	1-0.5	0.5-0.25	0.25-0.15	<0.15
	% Fraction in Original USGA-spec Topdressing					
	0.94	3.30	17.99	65.62	12.15	---
	% of total sand topdressing removed by mowing					
A-4	7.2	24.5 bc†	33.6 b	32.0 a	2.7	---
G-2	7.7	24.0 b	33.3 b	32.4 a	2.6	---
Penncross	9.8	21.1 a	31.7 ab	35.4 bc	2.9	---
DW-184	10.3	22.6 ab	29.9 a	34.2 ab	2.8	---

† Numbers followed by the same letter, or no letters at all, are not significantly different from one another.

The Bottom Line

Both A-4 and G-2 provided far superior turf quality to Penncross. Results over 3 years indicated topdressing and aeration practices don't need to be significantly different than normal management practices, assuming topdressing is applied at least monthly (2 to 3 week intervals may be better). From a practical standpoint, verticutting is not needed to ensure topdressing enters the turf canopy as usually less than 2% of the topdressing is removed anyway. There were no important differences in the size of topdressing removed by mowing based on grass type.

Acknowledgements *The authors would like to thank the Wisconsin Golf Course Superintendents Association for financial support of the research project, and Dr. Wayne Kussow for assistance and the use of his lab. Andrew Hollman completed his M.S. degree in April 2004 and has taken a position as research assistant for the University of Minnesota turf program.*

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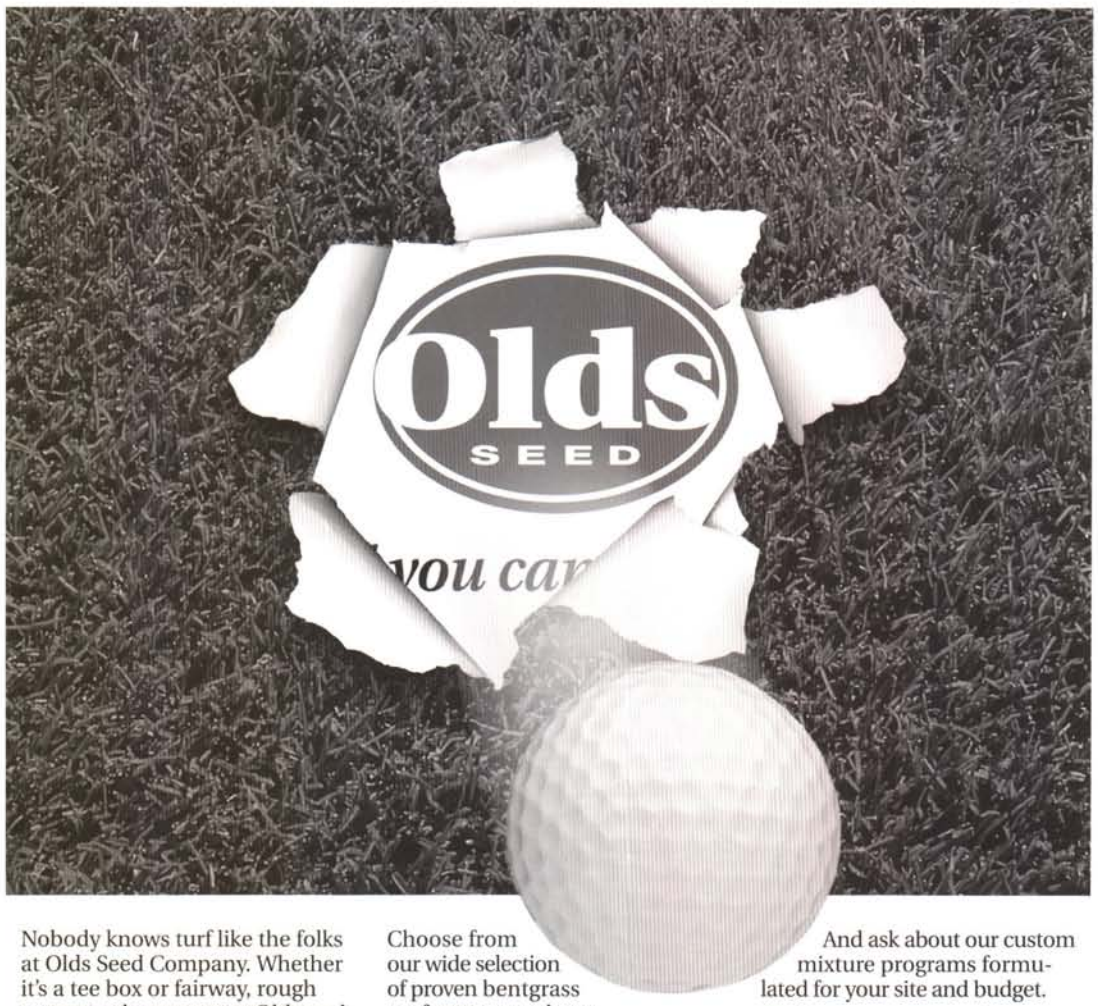
TURF PROS



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