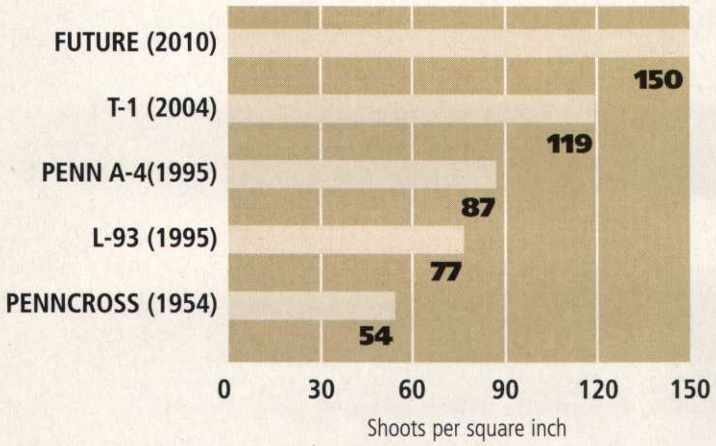
FIGURE 1

Progression of creeping bentgrass shoot density, from Penncross (released in the 1950s) to today's T-1 to future releases:



Continued from page 49

More plants means truer putting, more fullness and a visually appealing surface. But higher densities have another important function: There is a direct relationship between bentgrass shoot density and competitiveness with annual bluegrass. A bent that can generate a lot of lateral shoots will push *Poa annua* around.

Ten years ago I thought we'd seen the pinnacle of shoot density when retired Penn State breeder and my mentor, Joe Duich, released the Penn A series of bents. These bents set new density standards that persisted for a decade. This year, however, a variety will finally shatter that record (Figure 1). T-1, which I developed, is 36-percent denser than even Penn A-4 (photograph on page 49).

Over the next decade, I predict the record set by T-1 will be breached by even denser bentgrasses. The limiting factor, of course, will be thatch. Dense varieties sometimes develop thatch. It's as if their metabolic rate for shoots and thatch has been turned up on overdrive. But from what I've seen in my breeding plots, it is possible to select shoot density independently of thatch. In other words, it is entirely feasible to breed a low-thatching bent variety, with high shoot density. Such a variety would bring high-density greens to the average golf course.

Prediction: Bentgrass genetics will make a major leap in disease resistance.

When asked what they'd like to see in a future bentgrass variety, most superintendents answer, "Better disease resistance." Routine diseases like dollar spot have become so expensive to manage that disease resistance easily beats resistance to other pests in preference surveys.

L-93 was a major step forward in fungal resistance when it was released in the 1990s. Rutgers researcher Jim Murphy and his colleagues found that 88 percent fewer dollar spot fungicide applications were required to manage L-93, compared to susceptible varieties (Vaiciunas et al., 2002).

New research work is attempting to transfer additional dollar spot resistance from colonial and velvet bent into creeping bent. This process involves interspecific hybridization — the crossbreeding of two different grass species. Lead researcher Faith Belanger reports: "We have produced interspecific hybrids between creeping bentgrass and colonial bentgrass and field-tested them against dollar spot. Some of the hybrids had excellent dollar spot resistance, exhibiting essentially no disease symptoms" (Belanger, et al., 2004).

While this is a major advance, much work still remains to incorporate resistance to other diseases.

Future bentgrasses, I predict, may require only two or three fungicide applications per year for dollar spot, even in tough climates.

Furthermore, I predict these advances in disease resistance will come from conventional breeding, and not from laboratory gene insertion. Here's why:

Prediction: Biotechnology will play only a minor roll in turf varieties over the next decade.

Transgenic biotechnology makes it possible for scientists to move genes from anywhere — from animals, plants, and even bacteria and viruses — and insert them into grasses. This opens opportunities not possible with conventional plant breeding.

Among the agronomic crops, the impact of biotechnology has been stellar. This year more than 70 percent of the U.S. soybean crop was planted to transgenic seed.

I forecast we'll see a much slower adoption of biotech with turf than has occurred with farm crops. For one reason, turf isn't replanted each year like farm crops. And second, there are no slam-dunk traits that can easily be added with a single inserted gene. Unlike soybeans, weeds in turf are only a minor nuisance and herbicides are

Continued on page 54

Granular Carriers and DG Pro™ Technology

In recent years, the golf industry has become increasingly aware of the value of playing on well-maintained, smooth, fast greens, and the demand for such surfaces across the country continues to grow. In order to satisfy this increased demand for premium-quality playing surfaces, leading manufacturers have responded by reducing particle sizes for granular products, and by developing new control product carriers that disappear quickly into the turf canopy with a minimum of water. Particle size is very important, but the ability of the active ingredient to move off the carrier quickly is critical for effective control. State-of-the-art granular products from The Andersons provide both benefits. These technological developments enable granular products to be safely and uniformly applied, even to the lowest-cut turf.

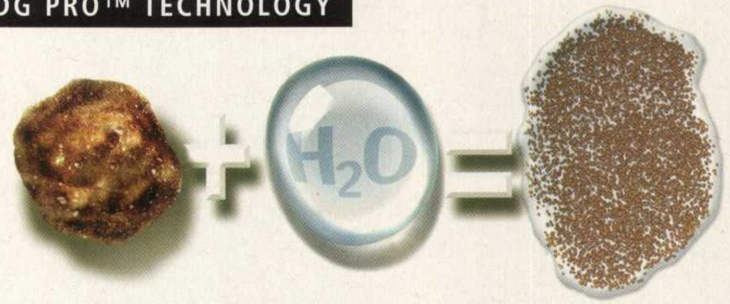
Granular carrier technology has evolved over the years from clay to corn cob to pulp to the latest innovation from the Andersons — DG Pro Technology. DG Pro, a proprietary water dispersible particle, represents a real breakthrough in granular carrier technology. DG Pro will be available in a variety of particle sizes ranging from SGN (Size Guide Number) 75 for low-cut greens to SGN 150 for fairway applications.

DG Pro™ technology is superior to other granular carriers for several reasons:

- Particles dissolve and become invisible after four to five minutes of irrigation or contact with dew.
- Mower pickup is virtually eliminated following irrigation or dew contact.
- Distribution of active ingredient is improved with over 56,000 dispersed particles per granule.
- More particles per square inch helps improve the efficacy of fungicide treatments.
- Particles are designed for minimum dust and drift to improve applicator and non-target safety.

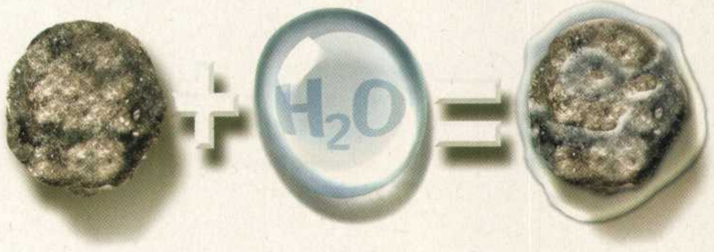
Several Andersons products utilizing DG Pro include: Fungicide VII (Triadimefon), Insecticide III (Chlorpyrifos), Golden Eagle (Myclobutanil), Systemic Fungicide (Triophanate-Methyl), KOG, 8% Carbaryl, 0.25% Dimension, and 0.48% Barricade.

DG PRO™ TECHNOLOGY



100 SGN Particle + Water = 56,000 Dispersed Particles

ORDINARY CARRIER GRANULE



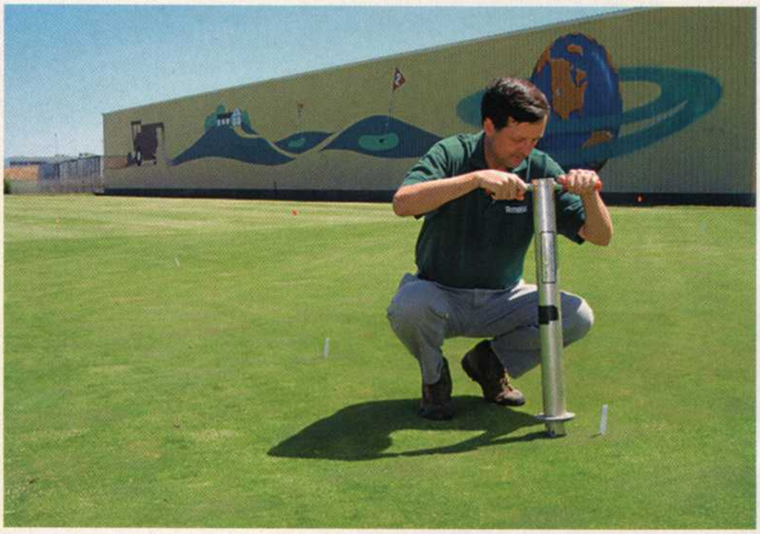
100 SGN Particle + Water = One Wet Particle

DG PRO™

DG Pro is a registered trademark of The Andersons Technologies Inc.

Andersons™
GOLF PRODUCTS

For more information, visit our web site: www.andersonsgolfproducts.com or call 1-800-253-5296.



Story author Doug Brede selects creeping bentgrass breeding strains at his research farm in Idaho.

Continued from page 52

relatively cheap and effective. Even annual bluegrass may be controllable with upcoming chemistry from Valent and Monsanto.

To borrow lingo from the software industry, turf biotech needs a killer application to create a successful product. A killer application is the ultimate must-have product — one that will do miraculous things.

Cost is another stumbling block to biotech. Transgenic varieties are regulated like a pesticide, requiring exhaustive federal testing and approval.

Prediction: More oddball grasses will hit the market, but sales will be slow.

Over the past decades, the vocabulary of the average turf manager has stretched to include such new terms as "improved buffalograss," "turf-type tall fescue" (an oxymoron), and other novelties. In the future I predict we'll see even more diversions from mainstream turfgrasses as breeders attempt to develop new tools to solve old problems.

James Reed, a breeder at Texas A&M's Dallas station, started this craze when he crossed Huntsville Kentucky bluegrass with a then-obscure native: Texas bluegrass, *Poa arachnifera*. Reed's program released "Reveille" hybrid bluegrass, which is sold through Gardner Turf Farms. Reed's idea was to create a bluegrass that would breach the transition zone and carry bluegrass south into Oklahoma and Texas.

A plethora of other new turf species are poised for launch. Many of these grasses solve longstanding problems such as waterlogged soils, heavy shade or salt.

But the southern trek hasn't been easy. Seed production of Texas bluegrass is nagged by low yields and cottony seed. Fuzzy seed clogs up most whirly bird and drop seeders and requires hydroplanting.

A plethora of other new turf species are poised for launch. Many of these grasses solve longstanding problems such as waterlogged soils, heavy shade or salt. But acceptance of these novel grasses by the industry is proving disappointing. One company blends off its new velvet bentgrass into its reclamation mixes, because demand has never developed for velvet bent golf greens.

Seed company administrators are becoming jaded about the idea of trying other oddball grasses. Thus, while I think you'll see many new grass species enter the trade in the future, sales will be unusually slow.

Doug Brede, research director and one of three operating officers for Jacklin Seed (part of the J.R. Simplot Co., in Post Falls, Idaho), has developed more than 60 popular turf varieties.

To see the full text of this article plus more predictions and a list of unusual turfgrass species to look for in the future, please go to:

turfgrasstrends.com

REFERENCES

Belanger, F.C., S. Bonos, and W.A. Meyer. 2004. "Dollar spot resistant hybrids between creeping bentgrass and colonial bentgrass." *Crop Science* 44:581-586.

Christensen, Dana. 2003. "Development of stress-tolerant, turf-type saltgrass varieties." *2003 Turfgrass and Environmental Research Summary*. P. 23.

Fricker, C.R., et al. 2004. Field day 22. Pure Seed Testing, Inc., Hubbard, Ore.

Read, J.C., J.A. Reinhart, P.F. Colbaugh, and W.E. Knoop 1999. "Registration of 'Reveille' hybrid bluegrass." *Crop Science* 39:590.

Vaiciunas, J.N., J.A. Murphy, and B.B. Clarke. 2002. "Response of bentgrass cultivars to dollar spot under different cultural and chemical management practices." *Phytopathology* 92:S146.

Waldron, B.L., K.H. Asay, K.B. Jensen, and P.G. Johnson 2001. "RoadCrest: A grass for semiarid regions: In spring and fall, new crested wheatgrasses compare favorably with bluegrass." *Golf Course Management*. 69(6):71-74.

The new Toro® Workman e2050 electric utility vehicle. It has more power and runtime than any other electric in its class. Yet it still won't disturb your guests. To find out more, and learn about financing options, visit toro.com/workmane2050.

*under typical task and driving conditions

TORO **Count on it.**

Southern Turf Managers Face Pest Management Challenges

Nematodes, mole crickets among problems

By David Held and Alan Henn

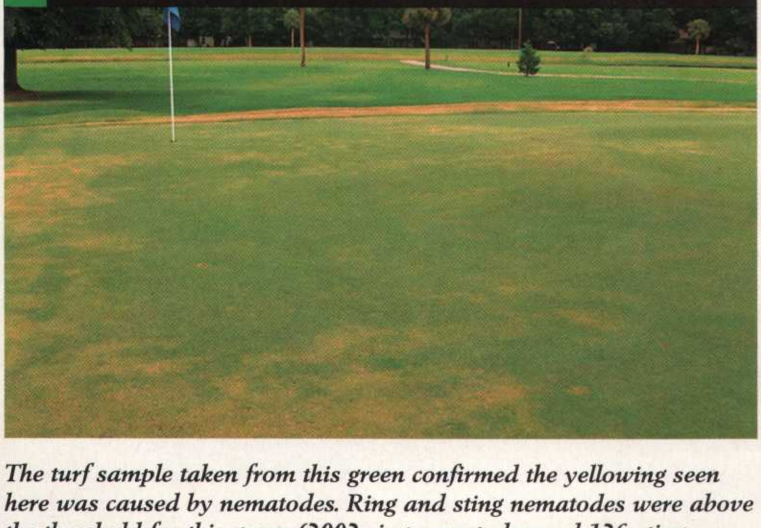
Turfgrass managers in the southern United States and especially the Gulf Coast region are faced with new and old challenges in pest management. Disease and insect pests exploit the high-quality, high-maintenance turfgrass on golf courses. This article highlights the pest management challenges facing Southern superintendents and the progress being made toward solving those problems.

Pathology challenges

Turf nematodes are worm-like animals that are less than one-eighth of an inch long. Because they can't be seen by eye or hand lens, live hidden in the soil and cause no specific symptoms in turfgrasses, nematode damage goes unnoticed or is explained away to other problems, such as poor fertility, soil compaction, watering or diseases.

The first symptom of nematode damage is wilting of the turf during the heat of the day and its recovery during the night. The turf may turn off-color, often a lighter shade of green or slightly tinged with yellow (Figure 1).

FIGURE 1



The turf sample taken from this green confirmed the yellowing seen here was caused by nematodes. Ring and sting nematodes were above the threshold for this green (2002 ring nematodes and 126 sting nematodes per pint of soil).

As the nematodes increase, the number of turf roots often decrease, causing the turf to thin out. Nematode-weakened turf can't compete well with weeds and many weeds are not as favored a food for nematodes. Thus, weedy turf sometimes indicates a nematode problem. Sedges and spurges are common invaders in warm-season turf grasses damaged by nematodes.

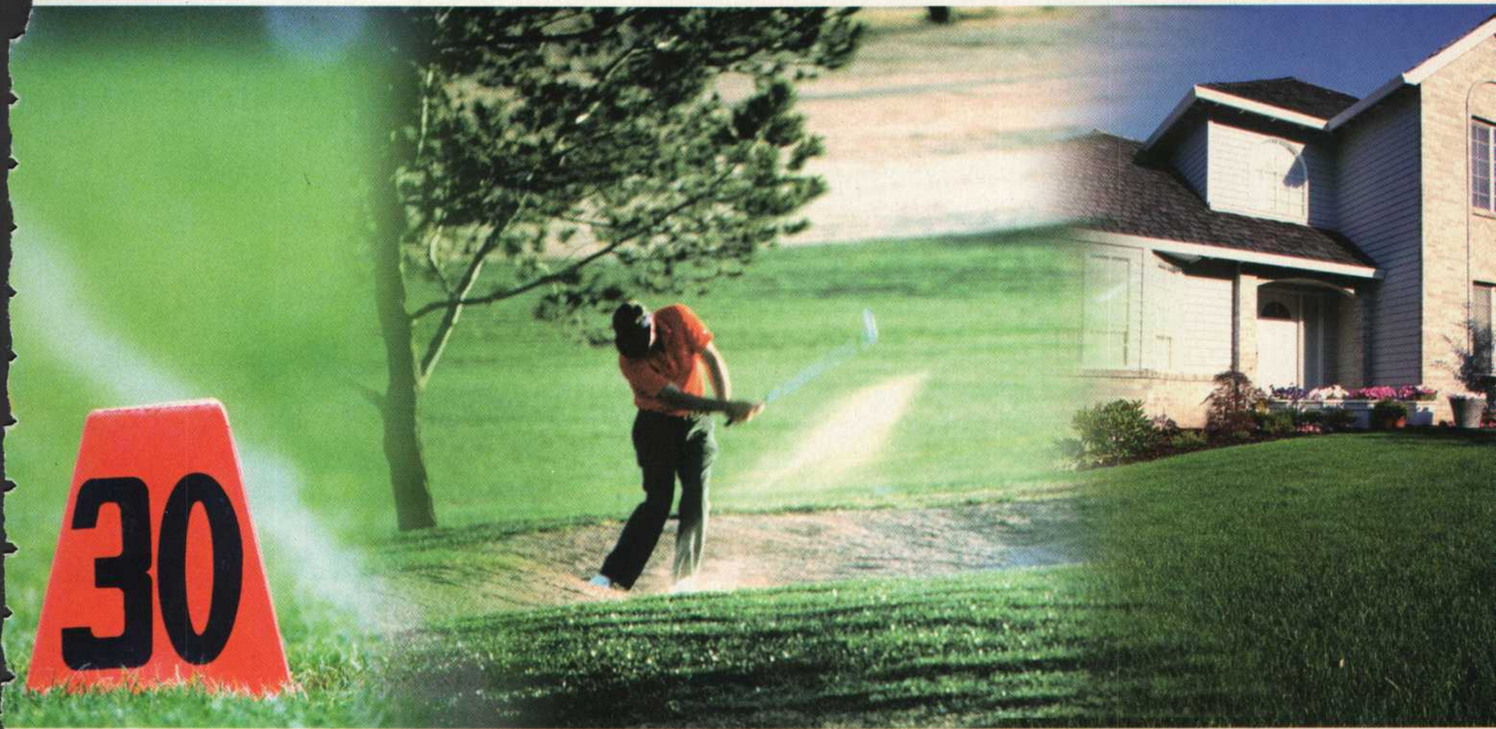
The roots of nematode-damaged turf may not show symptoms. If they do, damaged roots are usually dark or have dark lesions on them. They are usually short, often with few lateral roots. Root rot is often present. Turf root systems attacked by ring nematodes may appear as if a dinitroaniline (DNA) type herbicide had been applied; they will be short and stunted with a slight swelling at the root ends. Turf attacked by root-knot nematodes may have short, twisted roots with small swellings.

Diagnosis of nematode problems must be confirmed by counting the number and type of nematodes extracted in a soil sample. The handling of the soil sample can greatly influence the quality of your results. For example, soil cores should be pulled, mixed, and immediately placed in a plastic bag out of the heat and sun. They should be shipped overnight to ensure that nematodes are still alive when they arrive. Nematodes samples can be processed by extension service personnel located at most state land grant institutions. They use state or regional threshold levels to aid superintendents in making a decision to treat with a nematicide.

Proper diagnosis, however, is only the starting point to management. Limited treatment options make nematode management a challenge. Nemacur (fenamiphos) is being phased out by the U.S. Environmental Protection Agency. Curfew (dichloropropene), an alternative to Nemacur, is available in several Southern states (Alabama, South Carolina,

Continued on page 58

The Choice is Yours.



Introducing a series of seed blends that produce the highest quality turf... from Scotts®/Landmark, the industry's most widely known and respected turf science expert. Double Eagle® brings you –

- Blends or mixtures that contain NTEP highly rated varieties
- Available in Platinum Tag® quality–the highest standard of purity in the industry
- Available in Premium Tag® quality–a higher standard than Blue Tag certified
- Superior performance in any application
- Superior turf with excellent color
- Rapid establishment, tolerance to low mowing and excellent disease resistance
- Unmatched technical support. From now on, think Double Eagle. Because no other seed brand can benefit you more. Contact your local Scotts or Landmark distributor for more information or contact Scotts or Landmark at 937-644-7270 or 1-800-268-2379.

DOUBLE EAGLE™
SCOTTS® PREMIUM SEED

Scotts Premium Tag® is the highest standard of purity available–four times as stringent as Gold Tag sampling.

To see the full text of this article plus a chart comparing the efficacy of fipronil to shorter residual insecticides, please go to:

turfgrasstrends.com

Continued from page 56

Georgia, and Florida) via custom applicator. In these states, superintendents using Curfew can indirectly control mole crickets when using the high label rate (5 gallons of product per acre). Superintendents that can't use these products because of label restrictions or economics are then faced with reducing the stress on their greens, which can be difficult during June through August in the South.

Entomology challenges

Before and after nematode season, Southern turf is ravaged by the burrowing of earthworms and mole crickets. Most superintendents realize the benefits that earthworms provide, including the breakdown of thatch and soil aerification. On green and tees, however, hundreds of mounds (called castings) produced by these beneficials can cause trouble (Figure 2).

Superintendents are forced to knock down the castings before mowing; otherwise flattened castings will smother the grass, turning a green into a muddy mess. The roller and bed knife on a greens mower often require additional maintenance because castings cake the roller and dull the blade.

Books, research articles, and even an entire discipline of biology called vermiculture are dedicated to the biology and ecology of earthworms and their castings. Despite this, data on managing castings and earthworms in close-mown turfgrass are few. Most of what is presently known about earthworms in golf turf originates from observations and studies on the indirect effect of pesticide. Fortunately, the USGA and other industry groups have identified earthworms as a priority and have funded research on earthworm management.

Based on research and observations, what can be done to manage earthworms? First, castings appear to be more problematic on push-up greens, especially during the spring and fall.

About 20 years ago research was conducted to raise awareness about the impact of turfgrass pesticides on earthworms. This work has inadvertently become the basis for superintendents to manage earthworms on greens. Rightly so, no pesticide is labeled for control of earthworms. However, some pesticides that were found to be most toxic to earthworms in that study (namely, thiophanate-methyl and carbaryl) are now being applied for labeled pests, with the intention of indirectly suppressing or eliminating castings.

FIGURE 2

A common sight for the greens crew in the spring and fall: hundreds, if not thousands, of surface castings left by earthworms.

Fortunately, a recent study suggests that off-label use of pesticides may not be the only way to manage earthworms on golf courses. Use of irritants or abrasives applied during the spring or fall may reduce castings on greens. Angular aggregates such as crushed coal slag have been shown to provide short-term reductions in surface castings. These results suggest that angular materials may irritate the worms enough to drive them out of the greens. This is not surprising considering that diatomaceous earth, which works to abrade the cuticle of insects, has been a favorite tool of organic gardeners for years. Although progress is being made, preserving the benefits of earthworms while reducing or eliminating castings remains an arduous challenge.

Mole cricket management may not be as complex an issue as earthworms, partly because of ChipcoChoice (fipronil). The challenge that presents itself is more an economic and not an entomological one. In light of a recovery economy and reduced pesticide budgets, municipal courses and some private courses simply cannot afford to use fipronil. One solution that Mississippi superintendents have adopted is to just treat greens and tees, leaving fairways to chance.

There are alternative insecticides to fipronil. These are shorter residual insecticides or synthetic pyrethroids (Talstar). How do they perform relative to Choice, the unofficial industry standard? From 2001 to 2003, two experiments were published in the journal *Arthropod Management Test Reports* that can help to answer that question. The journal, published by the Entomological Society of American, serves as one of the primary places to publish the results of insecticide control studies on agricultural and horticultural pests. In these tests, treated turf is rated on a scale from 0 to 9. A rating of 0 corresponds to no damage, whereas a rating of 9 indicates turf was severely damaged. In these controlled studies, plots are typically 200 square feet or more and ratings are taken from several 10-square-foot areas within each plot.

The first test, conducted in North Carolina, had severe damage to untreated plots of grass indicated by ratings as high as 7.25. The results of the test suggest that a single application of Orthene may not perform as well as one application of granular fipronil under heavy insect pressure.

Other tests published in the same journal suggest that under light-to-moderate insect pressure, a single application of Orthene can significantly reduce the amount of damage relative to untreated plots. Statistical significance, however, does not tell whether the degree of control was acceptable.

The second test, conducted in Florida, evaluated two formulations of Talstar against fipronil. Damage from mole crickets in untreated turf appeared to be less, given the low to moderate damage ratings in those plots. Damage ratings from plots treated with either fipronil or Talstar were never greater than 1, indicating little damage. Other studies published in the journal suggest that other pyrethroids such as DeltaGard and Scimitar provide similar control.

Factors that could reduce the effectiveness of pyrethroids against mole crickets are late application date (August) or a more severe infestation level a the time of treatment. Under these circumstances, a single application may not be adequate to reduce damage.

It is clear that there are effective alternatives to fipronil for mole cricket control. For superintendents with limited budgets, these products may be their only option for mole cricket management.

There also appears to be an increased interest in biological controls of mole crickets among professional turf managers. For example, this spring Becker-Underwood, the company that manufacturers Nematac-S, sold out of the product because of increased demand from the golf industry. Nematac-S is a commercial product that contains the entomopathogenic nematode *Steinernema scapterisci*. Control or damage reduction following application of Nematac is measurable. However, consistent control is often not comparable to that of common soil insecticides, especially fipronil.

Nematac-S occupies a niche because it is perceived as a self-perpetuating or sustainable control. Once applied to a site, it can remain active in that population and disperse to new areas on the course in infected crickets during the mating flight.

ANOTHER CHALLENGE

The good news is that these pest management challenges provide great opportunities for state extension specialists to do applied research on golf courses. However, as land grant universities are forced to cut entomology and pathology programs and shift their pest management focus away from applied research, who will do this applied research? This may be the greatest challenge yet to be resolved.

Extension specialists will continue to serve the turfgrass industry as best they can, but some states have lost these positions through retirement, perhaps never to refill them. The turf industry and state associations should reach out to their legislators and make them aware of their needs. Progress can easily be made in this area by taking every opportunity to educate and inform state and federal legislators about the positive impact of turfgrass and golf on the economy. This could be as simple as inviting them to field days or asking them to provide a keynote address at a state or regional conference. This challenge is indeed different from others but equally as important.

David Held is an assistant professor of entomology with Mississippi State University. His office is located in the Coastal Research and Extension Center in Biloxi, where he can be reached at dheld@ra.msstate.edu. Alan Henn is an extension plant pathologist with Mississippi State University. He is graduate of the University of Florida. His e-mail is ahenn@ra.msstate.edu .

What Pre-emergent Herbicides Are Safe for Ultradwarf Bermudagrass?

PART 3 of a three-part series on ultradwarf bermudagrass. To see the first two entries, please go to:

turfgrasstrends.com

By Patrick McCullough, Bert McCarty, Vance Baird, Haibo Liu and Ted Whitwell

In previous articles we discussed the sensitivity of dwarf-type bermudagrasses to growth regulators and herbicides as well as the susceptibility of the grasses to forming off-type mutations. Despite the improved putting green qualities of the ultradwarf cultivars, problems of off-types developing five to 10 years after planting may still exist. It was also discussed how mitosis-inhibiting pre-emergent herbicides may enhance the formation of off-type mutations in these grasses by disrupting genetic replication and DNA sequences.

Based on this information, pre-emergent herbicide safety will be critical for successful long-term ultradwarf bermudagrass culture. For many years, turf scientists have considered oxadiazon as one of the safest pre-emergent herbicides for high-quality turfgrasses (McCarty and Murphy, 1994). Oxadiazon inhibits the enzyme protoporphyrinogen oxidase necessary in the syntheses of chlorophyll and cytochromes (Rao, 2000). As an uncontrollable accumulation of protoporphyrin IX occurs in the thylakoid membrane, the formation of lipid radicals and lipid peroxidations causes membrane destruction and cell death.

Oxadiazon effectively controls summer and winter annual weeds in bermudagrass turf. On Tifgreen bermudagrass, oxadiazon gave 100-percent control of large crabgrass (*Digitaria sanguinalis* L. Scop.) in three consecutive years (Callahan and High, 1990). When applied 60 days before overseeding, oxadiazon at 2.2 kilogram (kg) hectare per week (ha^{1}) provided 90-percent annual bluegrass (*Poa annua* L.) control in overseeded bermudagrass putting greens (Toler et al., 2003). Tifway bermudagrass treated with single oxadiazon applications at 1.12 kg ha^{1} and 2.24 kg ha^{1} provided 70-percent pre-emergent control of Cocks-Comb Kyllinga (*Kyllinga squamulata* Thonn. Ex Vahl) 18 weeks after initial treatments (Bunnell et al., 2001).

A popular pre-emergent herbicide for summer annual weeds on putting greens is the combination of oxadiazon with bensulide. Dernoeden et al. (1984) found oxadiazon plus bensulide at 1.7 kg active ingredient (ai) ha^{1} and 6.7 kg a.i. ha^{1}, respectively, provided effective control of *Eleusine indica* and *Digitaria spp*. Bensulide applied at 14 kg a.i. ha^{1} and 28 kg a.i. ha^{1} on dormant Tifgreen bermudagrass has shown minimal to no foliar injury during spring transition and summer growth (Callahan, 1976). Additionally, Johnson (1980) reported that oxadiazon at 4.5 kg ha^{1} and 13.4 kg ha^{1} did not affect Tifdwarf or Tifway bermudagrass rooting.

Based on these findings, it is believed oxadiazon will be a suitable pre-emergent herbicide for ultradwarf bermudagrass cultivars. However, the combination of oxadiazon plus bensulide is the only oxadiazon-containing product that is labeled for bermudagrass putting greens. Furthermore, the combination with bensulide, a potential root inhibitor, may reduce the safety of oxadiazon on the new ultradwarf bermudagrass cultivars relative to exclusive oxadiazon applications. Therefore, information is currently warranted on the safety of this herbicide combination for use on the ultradwarfs. The objective of this research was to evaluate the response of five ultradwarf bermudagrass cultivars to oxadiazon plus bensulide during active growth.

Turfgrass rooting is strongly influenced by shoot growth competition for stored root carbohydrates.

Materials and methods

Two studies were conducted at the Clemson (S.C.) University Greenhouse Research Complex from October to November 2003 (Study 1) and January to February 2004 (Study 2).