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Spring bermudagrass dead spot turns lush green turf into unsightly brown patches.

Continued from page 39

ing this question is the key to developing effective, reliable recommendations for spring dead spot control.

Factors influencing control

Although the above-ground symptoms of spring dead spot are most striking, the disease actually develops below ground in the roots, rhizomes and stolons.

Three fungal species have been shown to cause spring dead spot: *Ophiosphaerella herpotricha*, *O. korrae*, and *O. narmari*. These fungi belong to a group of pathogens called the ectotrophic root infecting (ERI) fungi. Other pathogens in this group include *Magnaporthe poae*, which causes summer patch in the bluegrasses and *Gaeumannomyces graminis*, which causes take-all patch in bentgrasses.

For effective control of summer patch and take-all patch, the timing and method of fungicide application is critical. Applications must be initiated early, when the pathogens are just beginning to grow and infect roots. Infection of bermudagrass roots by *Ophiosphaerella* species is thought to occur in the fall, but the precise soil temperature that triggers disease development is unknown and must be determined so that applications can be timed accurately.

Application methods that move a fungicide into the root and crown area are most effective for control of take-all patch and summer patch. Increased water volumes (5 gallons water per 1,000 square feet), post-application irrigation (one-quarter inch of water), or fungicide injection (1 to 2 inches deep) significantly improve control, compared to standard applications in 2 gallons per 1,000 square feet.

Application method may also impact spring dead spot control, but its effect has not been studied in detail.

Differences in pathogen distribution may also be responsible for erratic control of spring dead spot. The *Ophiosphaerellas* are not known to vary in their response to fungicides, but they do differ in their aggressiveness, with *O. herpotricha* being more aggressive than *O. korrae*. Most attempts to control *O. herpotricha* with fungicides have failed, whereas control of *O. korrae* has been moderately successful.

In the Midwest, *O. herpotricha* is the predominant cause of spring dead spot, with *O. korrae* and *O. narmari* present at low levels. *O. korrae* is the predominant species in the eastern United States, but *O. herpotricha* may also be present in certain locations.

Tackling Spring Dead Spot

At North Carolina State University, we established a research project to identify the most effective and cost-efficient methods for spring dead spot control in bermudagrass. Field experiments were initiated in the fall of 2002 on Tifway bermudagrass maintained under athletic field conditions at the Walnut Creek Softball

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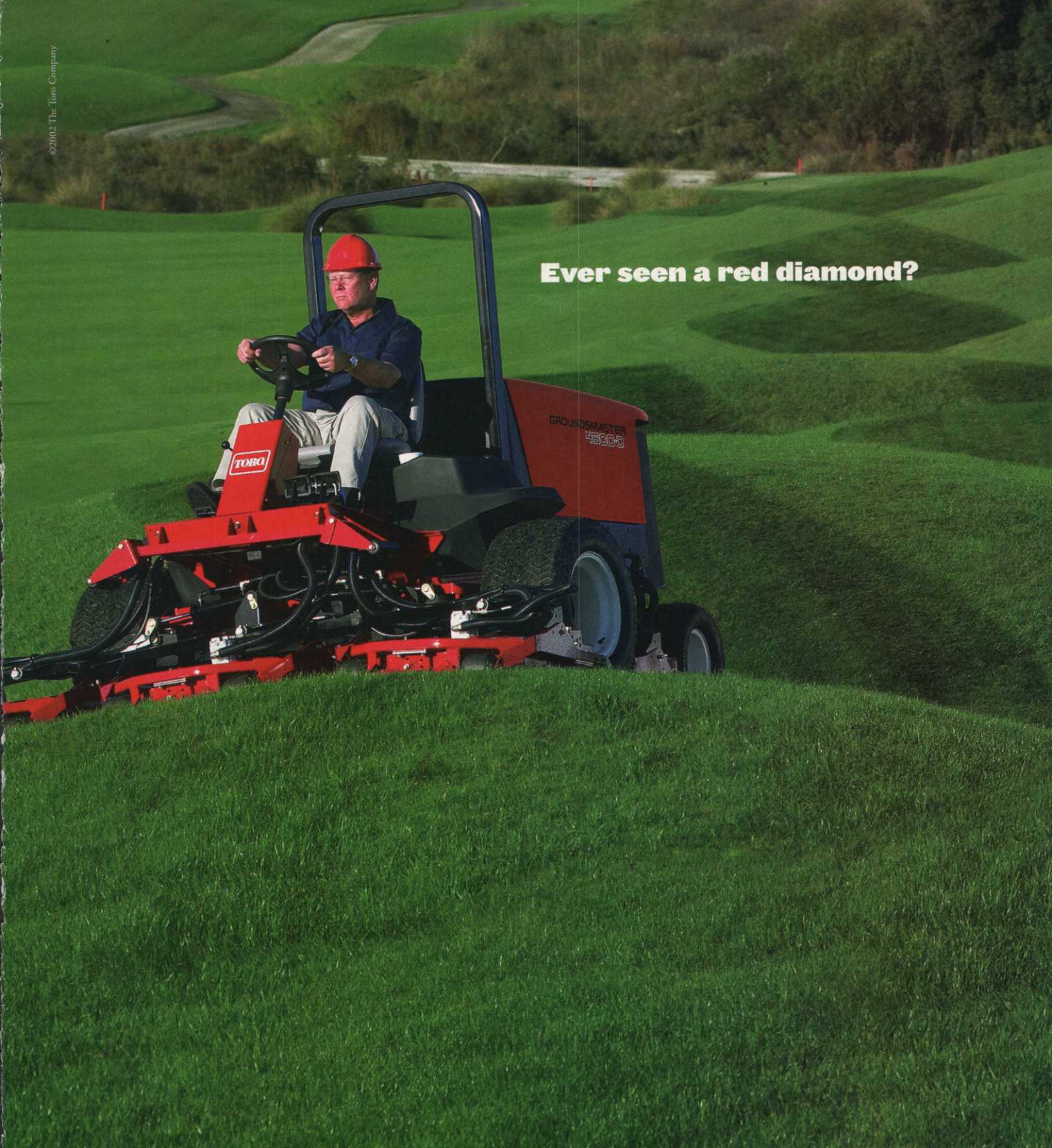

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Continued from page 42

Complex in Raleigh, N.C. This location has a history of severe spring dead spot infestation, and the disease is well-distributed across several fields in the complex. Prior to our experiments, the fields had never been treated with fungicides for spring dead spot control.

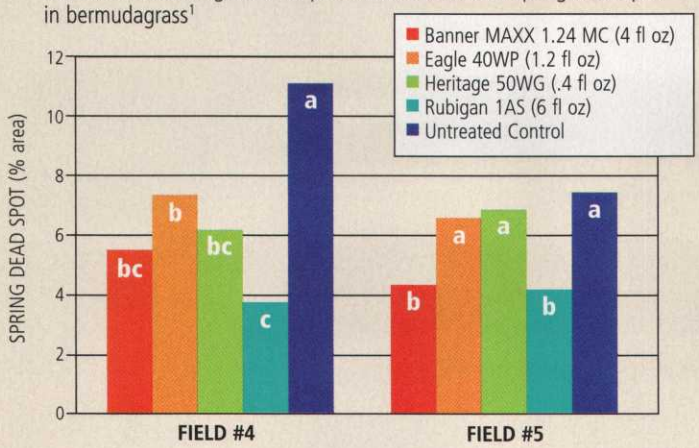
Two separate experiments were conducted in 2002-2003, one to evaluate application methods and another to evaluate application-timing regimes. Four fungicides were used in both experiments: Banner Maxx (4 fluid ounces per 1,000 square feet), Eagle (1.2 ounces per 1,000 square feet), Heritage (.4 ounces per 1,000 square feet), and Rubigan (6 fluid ounces per 1,000 square feet).

In the application-method study, each fungicide was applied on Sept. 24 and Oct. 31 using one of five different application methods: surface application in 2.5, 5 or 10 gallons water per 1,000 square feet, surface application (2.5 gallons per 1,000 square feet) watered in with one-quarter inch of water immediately after application, or subsurface injection to a depth of 1.5 inches to 2 inches using the Cushman Envirojet.

In the timing-regime study, each fungicide was applied in 5 gallons per 1,000 square feet using seven different application timing regimes.

FIGURE 1

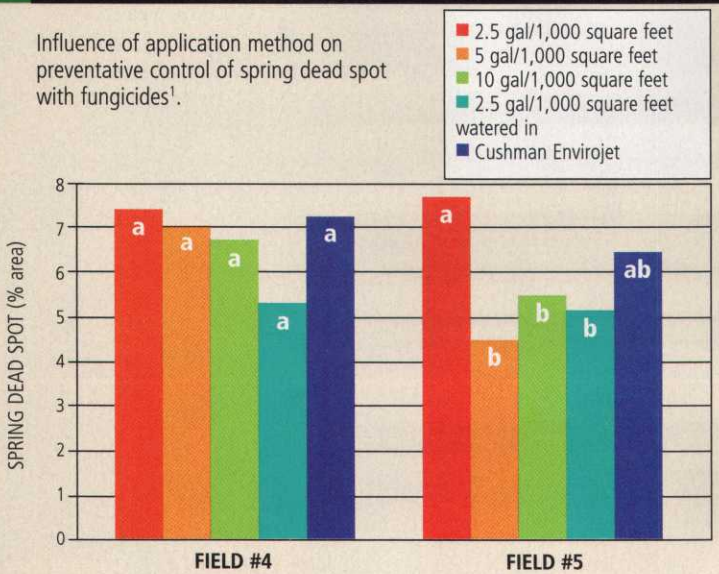
Effectiveness of fungicides for preventative control of spring dead spot in bermudagrass[1]



[1]Treatments were applied on Sept. 24 and Oct. 31, 2002. Data is an average of five application methods. Data bars containing the same letter are not statistically different.

FIGURE 2

Influence of application method on preventative control of spring dead spot with fungicides[1].



[1]Treatments were applied on Sept. 24 and Oct. 31, 2002. Data is an average of four fungicides. Data bars containing the same letter are not statistically different.

Bermudagrass varieties selected for cold-tolerance, such as Midiron, Vamont and Tifsport, tend to have increased spring dead spot resistance.

The application-method study was conducted twice, on Fields 4 and 5. The timing-regime study was conducted once on Field 5.

In the application-method study, Banner Maxx, Heritage, Eagle and Rubigan significantly reduced spring dead spot incidence on Field 4, but only Banner Maxx and Rubigan controlled the disease on Field 5 (Figure 1).

Overall, Rubigan provided the best control, reducing spring dead spot by 66 percent and 45 percent on Fields 4 and 5, respectively. Banner Maxx also performed well, reducing the disease by 51 percent and 45 percent on Fields 4 and 5, respectively.

The method of application had a significant impact on spring dead spot control on Field 5 but not on Field 4 (Figure 2). On Field 5, applications in 2.5 gallons per 1,000 square feet were less effective than applications in 5 or 10 gallons per 1,000 square feet, or 2.5 gallons per 1,000 square feet watered in with one-quarter inch of water. Using these methods improved spring dead spot control by 41 percent, 29 percent and 32 percent, respectively.

Fungicide injection, using the Cushman

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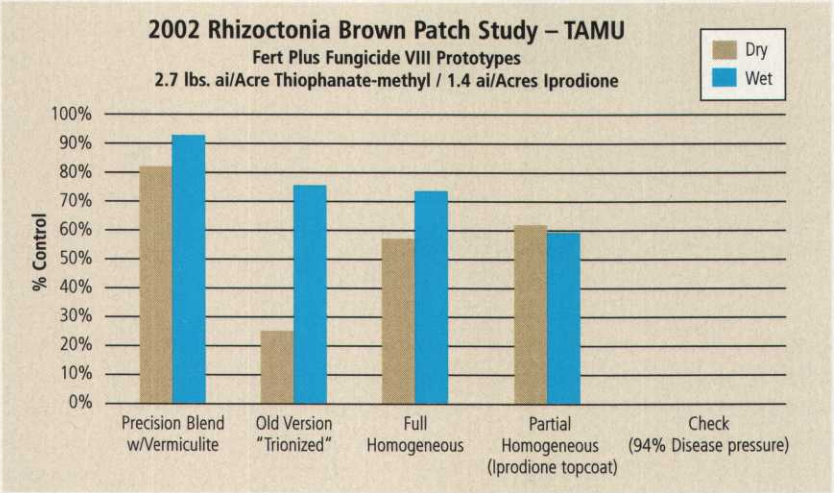
Granular Fungicides from The Andersons

The Andersons offers the widest array of granular fungicides on the market. The Andersons is basic in granular carrier technology. We have a 35-year history in manufacturing and marketing carriers and finished products. We pioneered the concept of Precision Blending for professional use, based on SGN/UI. Our production systems are uniquely capable of producing a granular product that dependably releases off the carrier for maximum uptake by the plant. The Andersons granular formulations utilize many of the popular active ingredients on the market. The actives we offer are both contact and systemic modes of action. Our granular formulations include single active ingredient on an inert carrier; combinations of two active ingredients on an inert carrier; or combinations of fungicide active ingredients on a fertilizer carrier.

One of the more interesting approaches used at the Andersons is what we call the "multifunctional formulation." This is where multiple active ingredients are carried by specific granules, each of which has its own optimal target in the turf / thatch /soil system. A good example is our new Andersons Golf Course Fertilizer Plus Fungicide VIII, in which the foliage-contact fungicide **iprodione** is delivered by some fairly lightweight vermiculite granules, while the fertilizer and the root-absorbed systemic fungicide **thiophanate-methyl** is a heavier density component. When a product like this is applied, the foliar agent stays perched in the turf foliage, while the nutrients and systemic can fall into the thatch and soil area, so as to deliver optimal results. The predecessor Pro Turf Fertilizer Plus Fungicide VIII product was a simple homogeneous composition, which did not have this advantage. For this reason the new product performs significantly better, especially when applied to dry turf (see figure below).



The test conditions involved the use of heavy inoculation of the test areas, as well as environmental control devices designed to elicit maximum disease expression. The first pair of bars is for the new formulation, while the "Trionized" set was the old Pro Turf product, and the other products were other experimental formulations.

The Andersons fungicides on inert carriers are offered on corn cob, pulp or our latest DG Pro (dispersible granule). We are committed to providing the best granulars that deliver the labeled results to the turf manager. Our new DG Pro carrier is a proprietary water dispersible particle that represents a real breakthrough in granular carrier technology. The advantages to DG Pro, is that the particles become invisible after four to five minutes of irrigation or contact with dew. What this means is that mower pickup is virtually eliminated. Distribution of the active ingredient is improved with over 56,000 dispersed particles per granule. More particles per square inch helps improve the efficacy of fungicide treatments.

The advantages of using Andersons granular fungicides are:

- Ease of use. You can spread with a broadcast spreader with fewer equipment hassles. This provides better worker safety.
- Perfect for specialty uses. Low impact on wet turf. Excellent for use on new construction where heavy equipment can cause damage or ruts. Great for spot treatment of isolated outbreaks. Excellent for hard to reach areas such has bunker faces and small, elevated tees.
- An ongoing program of product improvement. The recent Scotts-Andersons professional business merger has provided the perfect excuse for us to redesign and improve what was already the best granular offering in the golf market.

Look to the Andersons Advantage when using granular fungicides. Better carriers, expert formulations and years of experience all add up to dependable products you expect from The Andersons.

Article contributed by Tom Wentz, Technical Service Manager and Tim Birthisel, Technical Development Manager.

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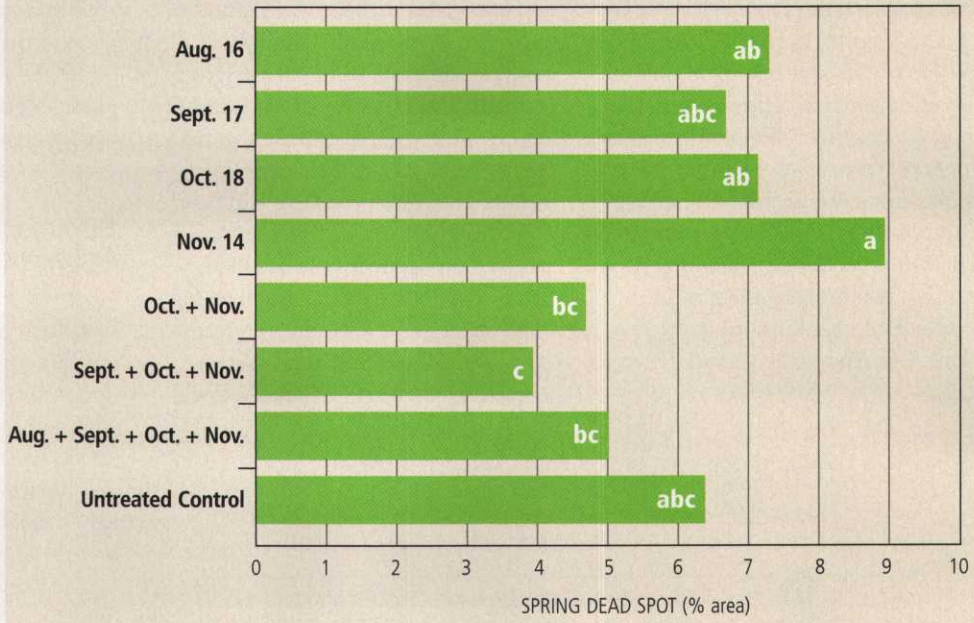
Currently, five fungicides are labeled for spring dead spot.

FIGURE 3

Influence of application timing on preventative control of spring dead spot with fungicides[1].



[1]Treatments applied in 5 gallons of water per 1,000 square feet on Aug. 16 , Sept. 17, Oct. 18, and/or Nov. 14. Data was collected on May 13, 2003, and is an average of four fungicides. Data bars containing the same letter are not statistically different.

Continued from page 44

Envirojet, provided an intermediate level of disease control (Figure 2).

In the timing-regime study, few significant differences were observed among the seven application timing treatments, but some trends can be noted (Figure 3). A single application made in August, September or October was more effective than a single application made in November, and multiple applications were more effective than the single applications.

According to soil temperature data, fungicide applications were most effective when average daily soil temperatures were between 60 degree Fahrenheit and 80 degree Fahrenheit (Figure 4). The growth of bermudagrass roots is severely diminished when soil temperatures are below 60 degree Fahrenheit, and their capacity absorb systemic fungicides may also be reduced.

Do fungicides speed spring recovery?

Some turf managers have observed that preventative fungicide applications in the fall can increase the rate of recovery from spring dead spot in the spring. Is this wishful thinking or a real phenomenon?

In an attempt to answer this question, we rated spring dead spot incidence in the above experiments every two weeks, beginning at green-up and continuing until full recovery. From this data, statistical analysis was used to estimate the rate of recovery for each plot. No differences in recovery rate were observed on Field 5. On Field 4, fungicides did not increase the rate of recovery from spring dead spot (Figure 5).

Surprisingly, Banner Maxx, Heritage and Rubigan applications actually slowed the rate of bermudagrass recovery compared to the untreated plots. More research is needed to investigate potential negative side-effects resulting from fall application of fungicides to bermudagrass.

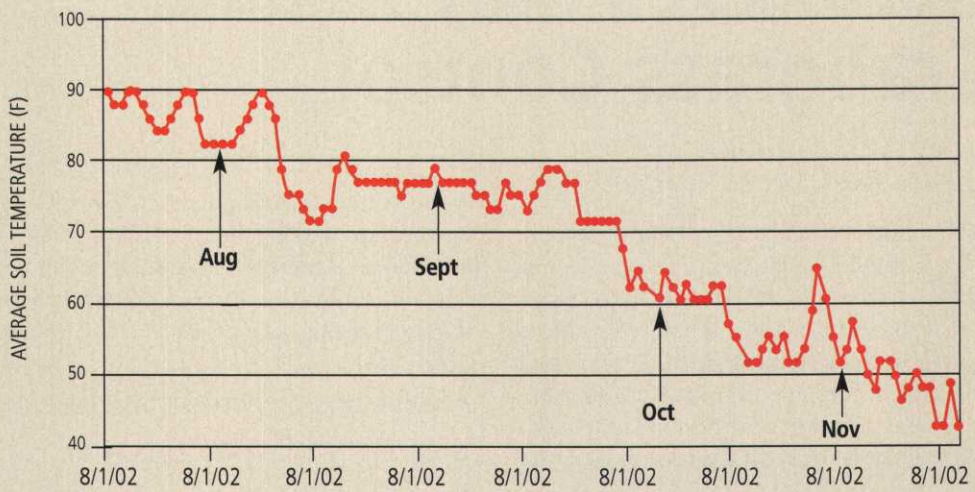
Summary and conclusions

For decades, turfgrass researchers have attempted to develop effective methods for spring dead spot control. Therefore, it is no surprise that we did not identify the magic bullet after only one year of field research.

We did, however, observe several important trends:

FIGURE 4

Average daily soil temperature (4-inch depth) in Raleigh, N.C., from August to November, 2002. Arrows indicate timing of monthly applications in timing regime experiment (Figure 3).

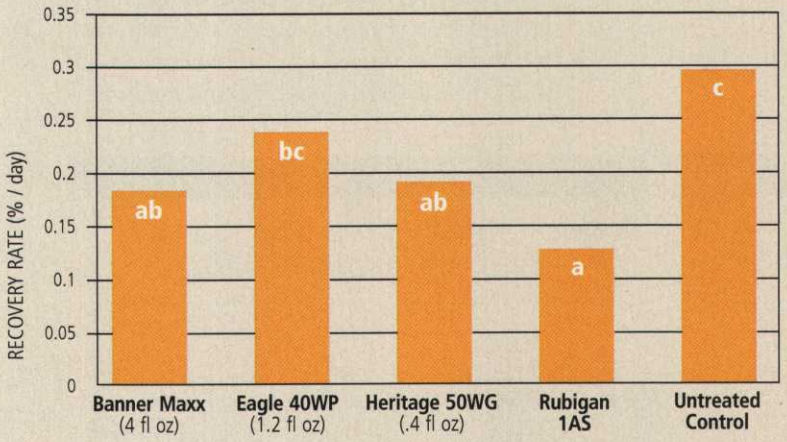


(1) Rubigan and Banner Maxx were more effective for spring dead spot control;
(2) Fungicides that were applied in high volumes of water, or watered in after application, were more effective than standard surface applications;
(3) Fungicide applications were most effective when average daily soil temperatures were between 60 degrees Fahrenheit and 80 degrees Fahrenheit.
(4) Regardless of timing, single fungicide applications did provide significant control of spring dead spot, whereas multiple applications did tend to suppress the disease; and
(5) Fungicide applications did not increase the rate of bermudagrass recovery in the spring. In fact, some fungicides actually reduced the recovery rate.

It is also important to note that our research areas had never been treated for spring dead spot prior to our experiments. Many turf managers have observed that spring dead spot control improves after several successive years of preventative applications. While Rubigan and Banner Maxx appear to be more effective in the first year, Cleary 3336, Eagle, and Heritage may be viable options for spring dead spot control in successive years.

FIGURE 5

Rate of bermudagrass recovery from spring dead spot injury in response to preventative fungicide applications[1].



[1]Treatments were applied on Sept. 24 and Oct. 31, 2002. Data was collected on bi-weekly intervals from May 13 to June 24, 2003, and is an average of five application methods. Data bars containing the same letter are not statistically different.

Tredway is an assistant professor and extension specialist in the Department of Plant Pathology at North Carolina State University. Butler is an agricultural research technician in the Department of Plant Pathology at North Carolina State University.
The authors thank research assistants David Lee, Patrick Gregg, Chuck Cambell and Brandon Cawthorne for their assistance during this project.

Tank Mixing Iron with Herbicides May Reduce Crabgrass Control

By Brian Tucker and Bert McCarty

Smooth crabgrass (*Digitaria ischaemum* [Schreber], Schreber) is a common invasive weed throughout the United States. It is a summer annual capable of prostrate growth and reproduces primarily by seed. Crabgrass occurs in most crops, turfgrasses and landscapes. It can grow in most soil types while also tolerating low fertility and dry conditions (Uva et. al., 1997).

A variety of chemical agents target postemergent control of crabgrass. Traditionally, organic arsenicals such as MSMA and DSMA, have been used for postemergent crabgrass control.

Presently, additional control options exist with each having varying levels of effectiveness (Street and Sherratt, 2002). However, these herbicides often cause unacceptable discoloration to the desired turfgrass. A common practice to mask this damage is applying micronutrients with the herbicide. The most commonly used nutrient for masking purposes is iron, which is involved in several plant processes including production of chlorophyll, heme and cytochromes. It's also a major component of reducing com-

A common practice to mask damage is applying micronutrients with the herbicide.

plexes associated with photosynthesis.

Iron typically increases color and is often used for color enhancement without excessive shoot growth in most turfgrass species (McCarty, 2001). Additionally, iron has also been shown to help certain species tolerate heat and drought stress (Glinski, 1992).

A potential negative side effect of using iron as a masking agent is the possible antagonistic effect it may have on the efficacy of some herbicides. Previous research demonstrates postemergent crabgrass control with MSMA and Drive was slowed and decreased when iron was added to these (Dernoeden, 2003; Coats et. al., 2001). To ascertain the severity of this antagonism, a study was conducted at Clemson University to evaluate tank-mixing iron on the efficacy of several herbicides on postemergent smooth crabgrass control.

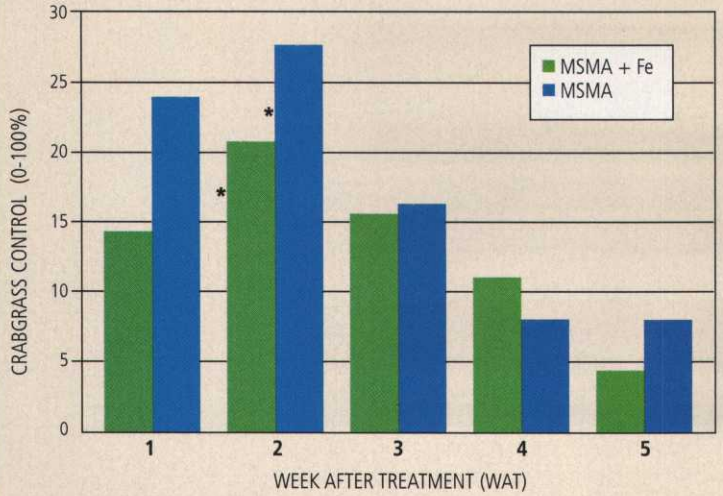
Materials and methods

Two studies were conducted in the Clemson greenhouses in Clemson, S.C., with the first study conducted from February–March 2002 and repeated from April-May 2002. Smooth crabgrass was grown from seed in 6-inch diameter pots. The study was a completely randomized design with three replications of each treatment.

Table 1 describes the treatments applied in this study. Each treatment was applied with a carbon

FIGURE 1

Iron effect on postemergent crabgrass control with MSMA. Visual injury ratings were taken weekly for five weeks after treatment (WAT).



* indicates a difference between treatments according to Fisher's Lowest Statistical Difference (.05).

dioxide (CO_2)backpack sprayer at 20 gallons per acre (gpa). The iron source for this study was a dissolved granular containing 20 percent soluble iron derived from ferrous sulfate ($FeSO_4$), applied at a rate of .5 pounds of iron (Fe) per 1,000 square feet. All herbicide treatments were sprayed immediately after iron application.

Crabgrass control was visually rated on a 0-percent to 100-percent scale, with 100 percent equal to complete control and 0 percent equal to no control. Visual ratings began one week after treatments were applied and continued weekly for five weeks. Data were analyzed using PROC GLM in SAS and means were separated using Fisher's LSD=.05.

Results

In the first study, the only treatments exhibiting an antagonistic effect from iron were MSMA and Acclaim Extra. Crabgrass control one week after treatment with MSMA was reduced 40 percent when added with iron, but unaffected thereafter (Figure 1).

Acclaim Extra and Acclaim Extra plus iron had little influence on crabgrass control two weeks after treatment, but by the third week and thereafter significant reductions occurred (Figure 2). Crabgrass control with Acclaim Extra plus iron was reduced 34 percent, 44 percent and 62 percent at three, four and five weeks after treatment, respectively. The addition of iron to all other herbicides examined in the first study had no antagonistic effect on weed control.

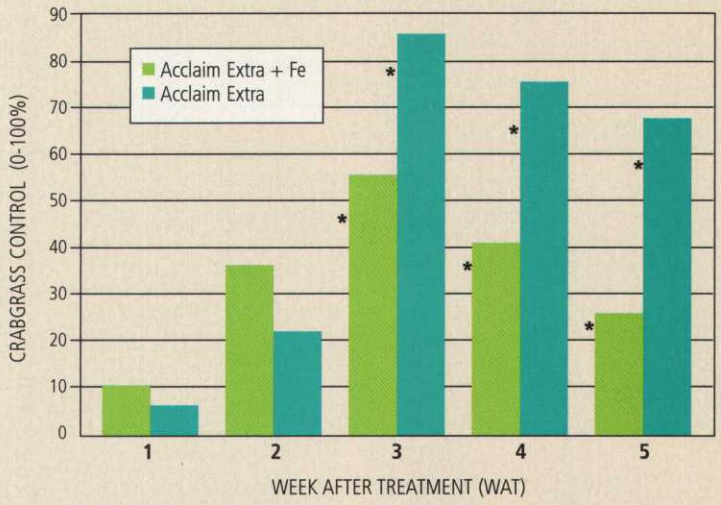
Acclaim Extra was most affected by tank mixing with iron.

In the second study, the only antagonistic effect observed was with the herbicide Drive. Iron did not have a negative effect on MSMA or Acclaim Extra in this study, as in the first. At two weeks through four weeks after treatment, Drive with iron was significantly lower than Drive without iron. During weeks two through four, crabgrass control with Drive plus iron was reduced by 20 percent when compared to Drive applied alone. By five weeks after treatment, both Drive plus iron and without iron had similar control (Figure 3).

Continued on page 50

FIGURE 2

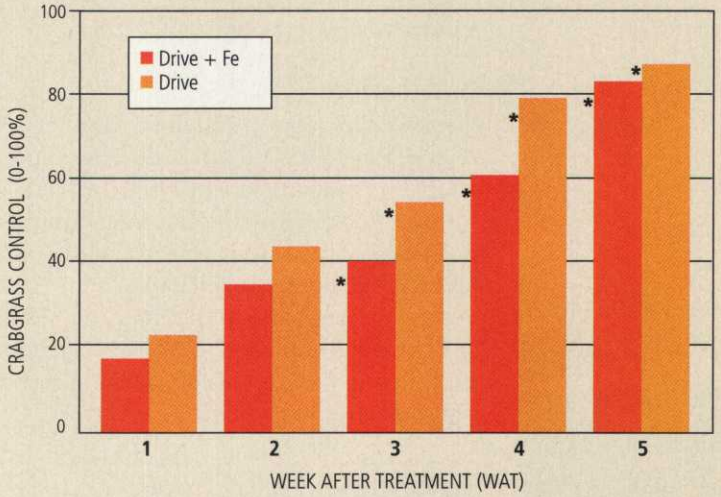
Iron effect on postemergent crabgrass control with fenoxaprop-ethyl (Acclaim Extra). Visual injury ratings were taken weekly for five weeks after treatment (WAT).



* indicates a difference between treatments according to Fisher's Lowest Statistical Difference (.05).

FIGURE 3

Iron effect on postemergent crabgrass control with quinclorac (Drive). Visual injury ratings were taken weekly for five weeks after treatment (WAT).



* indicates a difference between treatments according to Fisher's Lowest Statistical Difference (.05).

TABLE 1

Treatments used in determining potential antagonism of adding iron with postemergent herbicides for smooth crabgrass control.

TREATMENT	RATE
Iron 20 WP (FeSO4)	.5 lbs Fe/1,000 square feet
MSMA 6.6 L	1.5 pounds of active ingredient per acre (ai/A)
MSMA 6.6 L + Iron 20 WP	1.5 lbs ai/A + .5 lbs Fe/1,000 square feet
Asulox (asulam) 3.34 L	2 lbs ai/A
Asulox (asulam) 3.34 L + Iron 20 WP	2 lbs ai/A + 0.5 lbs Fe/1,000 square feet
Vantage (sethoxydim) 1.0 L	.25 lbs ai/A
Vantage (sethoxydim) 1.0 L + Iron 20 WP	.25 lbs ai/A + .5 lbs Fe/1,000 square feet
Acclaim Extra (fenoxaprop) 0.57 L	.17 lbs ai/A
Acclaim Extra (fenoxaprop) 0.57 L + Iron 20 WP	.17 lbs ai/A + .5 lbs Fe/1,000 square feet
Fusilade T&O (fluazifop) 2.0 EC	.10 lbs ai/A
Fusilade T&O (fluazifop) 2.0 EC + Iron 20 WP	.10 lbs ai/A + .5 lbs Fe/1,000 square feet
Drive (Quinclorac) 75 DF	.75 lbs ai/A
Drive (Quinclorac) 75 DF + Iron 20 WP	.75 lbs ai/A + .5 lbs Fe/1,000 square feet
Envoy (clethodim) 1 EC	.25 lbs ai/A
Envoy (clethodim) 1 EC + Iron 20 WP	.25 lbs ai/A + .5 lbs Fe/1,000 square feet

Continued from page 49

Conclusion

These studies suggest iron in the form of ferrous sulfate ($FeSO_4$) has little antagonistic effect on Asulox, Vantage, Fusilade T&O, or Envoy. Although inconsistent, an antagonistic response occurred when iron was added with MSMA, Acclaim Extra and Drive.

Iron appeared to slow the effects of MSMA and Drive, but ultimately — by five weeks after treatment — these herbicides had similar control with and without iron.

Acclaim Extra was most affected by tank mixing with iron. Five weeks after treatments, crabgrass control was reduced by more than 60 percent on plants treated with Acclaim Extra plus iron, compared to Acclaim Extra without iron.

Future research is needed to fully evaluate various iron sources on postemergent crabgrass control, including further examination of timing and rates of iron and herbicides application.

Tucker is a master's student at Clemson University in turfgrass management studying under McCarty and holds a bachelor's degree from Clemson University in microbiology.

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