

COOL-SEASON TURF DISEASES

Integrating new ideas and new tools with accepted knowledge and fungicides is the key to successful cool-season disease management.

by Dr. Bill Shane, Ph.D., Ohio State University

Cool-season turfgrass managers face a wide variety of diseases that reduce the quality of their grass. Choosing the proper strategies for managing these diseases depends greatly on being able to identify the disease.

Attention has centered recently on the subject of turfgrass patch diseases. Although much has been learned, confusion still remains in the minds of many turf managers when it comes to determining the cause of patches in their own situation.

This article will focus on the pathogens that infect primarily basal stem, crown and root tissues of plants. The diseases discussed here are summer patch, necrotic ring spot, take-all patch and yellow patch diseases of cool-season turfgrass.

Other diseases associated with patch symptoms, (brown patch, Pythium blight, copper spot) are primarily leaf, sheath, and basal stem problems.

A recent challenge to turf managers is determining the proper way to use the relatively new group of fungicides known as the sterol biosynthesis inhibitor compounds (SBI) (triadimefon, fenarimol, propiconazole).

Another new development is the availability of turf disease diagnostic kits. This is a rapid means to determine the cause of turf decline, but it requires some new thinking to use the tool properly.

As more information is gathered about patch diseases, it is becoming clear that not all patch diseases are prevalent in all areas where cool-season turfgrasses are grown. Necrotic ring spot has been common on Kentucky bluegrass in Washington, Colorado, New York, Wisconsin, and Minnesota but less common in Pennsylvania, Maryland and Ohio.

This disease may be prominent for a few years in a region but then become obscure. For example, necrotic

ring spot became very scarce in Wisconsin during the summer of 1988, according to Dr. Gayle Worf of the University of Wisconsin.

Summer patch

Summer patch, caused by the fungus *Magnaporthe poae*, is common in Kentucky bluegrass in Rhode Island, Maryland, New Jersey and New York, but apparently less so in other areas of the country. The region of the United States where summer patch is important is somewhat wider for the annual bluegrass form of the disease.

The disease has a fairly distinctive appearance on close-cut annual bluegrass/bentgrass greens. The annual bluegrass is affected whereas the bentgrass is essentially untouched.

Unfortunately, summer patch is difficult to distinguish from necrotic ring spot on Kentucky bluegrass. The most useful characteristic to distinguish the two diseases is that spots of summer patch on Kentucky blue-



Summer patch symptoms on an annual bluegrass/bentgrass green. Only the annual bluegrass plants are affected.



Rings on Kentucky bluegrass in a lawn due to yellow patch, which is caused by *Rhizoctonia cerealis*. Photos courtesy of Dr. Shane.

TABLE 1.

TURF *Guide* DISEASE

COOL-SEASON TURF DISEASES, TURF DISEASE AND CONTROLS

DISEASE	SEASON AND/OR SUSCEPTIBLE TURFGRASS ²	CULTURAL	FUNGICIDE/NEMATICIDE ACTIVE INGREDIENT ⁴
Algae	All turfgrasses	Reduce shade. Avoid excessive fertilization. Improve soil drainage.	Mancozeb
Anthraxnose (<i>Colletotrichum graminicola</i>)	July-August; ANNUAL BLUEGRASS, BENTGRASS, Fine Fescue	Fertilize and water to maintain vigor. Syringing may help to prevent stress.	Benomyl ³ , Triadimefon Thiophanate-Methyl ³ Propiconazol, Fenarimol, Chlorothalonil
Brown Patch -	See <i>Rhizoctonia blight</i>		
Dollar Spot (<i>Lanzia</i> and <i>Moellerodiscus</i> spp., formerly <i>Sclerotinia homeocarpa</i>)	Late June-Oct. BENTGRASSES BLUEGRASSES Fescues Ryegrasses	Avoid nitrogen deficiency. Remove dew from greens by mowing, dragging with a hose or pole. Choose more resistant grass varieties.	Chlorothalonil, Cadmium ³ , Benomyl ³ , Anilazine ³ , Fenarimol, Iprodione ³ , Propiconazol, Thiophanate-ethyl ³ , Thiophanate-methyl ³ , Thiram, Triadimefon, Vinclozolin ³
Fairy Rings (Basidiomycete soil fungi)	April-October All turfgrasses	Remove infested sod and soil, replace with clean soil and reseed or sod. Improve water penetration. Increase N fertilization.	Methyl bromide or Formaldehyde fumigation will eradicate fungus but will also kill turf
Fusarium Blight ⁵ (<i>Fusarium poae</i> , <i>F. vulmorum</i> , <i>F. crookwellense</i>)	July-August Bluegrasses Bentgrasses Fescues	Reduce heat stress during dry periods by light, frequent watering. Do not cut Kentucky bluegrass or fescues under 2 inches. Reduce excessive thatch (over ¾ inch).	Triadimefon, Fenarimol Benomyl ³ , Iprodione, Thiophanate-methyl ³ , Thiophanate-ethyl ³
Fusarium Patch (Pink Snow Mold) (<i>Fusarium nivale</i>)	Nov.-April Bluegrasses Bentgrasses Fescues Ryegrasses	Avoid late fall fertilizing. Rake leaves and cut short. Control drifting snow.	Triadimefon, Benomyl ³ , Fenarimol, Iprodione ³ , Mancozeb, Mercury chlorides, Pentachloronitrobenzene, Thiram, Thiophanate-methyl ³ , Vinclozolin
Grey Snow Mold-	see <i>Typhula blight</i>		
Leafspot/Blight /Melting out (<i>Drechslera</i> & <i>Bipolaris</i> spp.)	Leafspot: Spring & fall; Blight & Melting out: June-Aug. KENTUCKY BLUEGRASS BENTGRASSES FINE FESCUE, ryegrasses, tall fescue	Remove clippings. Raise cutting height. Avoid excessive nitrogen. Avoid light, frequent watering.	Cycloheximide, Iprodione, Chlorothalonil, Mameb, Mancozeb, Vinclozolin, Pentachloronitrobenzene
Nematodes	All turfgrasses		Fenamiphos, Ethoprop

grass tend to remain small (3 to 10 inches in diameter) compared to necrotic ring spot (5 inches to 2 feet).

Until recently, identification of summer patch by plant disease clinics has been hampered; the causal fungus displays no consistent distinguishing features when grown on agar in a petri plate.

Formerly, the causal agent was thought to be the fungus *Phialophora graminicola*. This was a major source of confusion to plant pathologists because this fungus was known to be a

non-pathogen on cereal crops.

A breakthrough

A major advance in our understanding of summer patch occurred when Peter Landschoot (now at Pennsylvania State University) and Noel Jackson (University of Rhode Island) discovered that there are two mating types, 'A' and 'a', for the causal agent now known as *Magnaporthe poae*. If a suspected *M. poae* strain is paired with the proper mating type, the sexual spore stage (ascospores) is formed

and positive identification can be made. Thus, identification of summer patch is now possible, but still takes up to two months.

Yellow patch

Yellow patch, caused by *Rhizoctonia cerealis*, is frequently found on Kentucky bluegrass in Ohio and apparently less frequently in Michigan and Illinois. It is rarely reported in Wisconsin and Minnesota. The bentgrass version of the disease is more often seen in the northern

TURF *Guide* DISEASE

TABLE 1

COOL-SEASON TURF DISEASES, TURF DISEASE AND CONTROLS

DISEASE *	SEASON AND/OR SUSCEPTIBLE TURFGRASS ²	CULTURAL	FUNGICIDE/NEMATICIDE ACTIVE INGREDIENT ⁴
Necrotic Ring Spot⁵ (<i>Leptosphaeria korrae</i>)	Spring & fall KENTUCKY BLUEGRASS, annual bluegrass ryegrasses	Avoid low mowing heights (below 2 inches). Reduce excessive thatch (over ¾ inch). Use Kentucky bluegrass and perennial ryegrass mixtures.	Fenarimol, Propiconizol
Pink Patch⁶ (<i>Limonomyces roseipellis</i>)	Spring & fall bentgrass, FINE FESCUE, PERENNIAL RYEGRASS	Follow balanced fertilization program.	Cadmium, Mancozeb
Pink Snow Mold -	see Fusarium patch		
Powdery Mildew (<i>Erysiphe graminis</i>)	July-Oct. KENTUCKY BLUEGRASS, fine fescue	Reduce shade. Increase air circulation by removing surrounding vegetation.	Triadimefon, Fenarimol, Propiconizol
Pythium Blight (<i>Pythium aphanidermatum</i> , <i>P. graminicola</i>)	June-Sept. BENTGRASSES, ANNUAL BLUEGRASS, PERENNIAL RYEGRASS, Kentucky bluegrass	Improve soil drainage. Increase air circulation by removing surrounding vegetation. Avoid mowing wet grass. Avoid excess watering.	Chloroneb, Etridiazole, Propamocarb, Metalaxyl, Fosetyl-AI, Mancozeb
Red Leaf Spot (<i>Drechslera erythrospila</i>)	June-Sept. BENTGRASSES	Remove clippings. Fertilize to maintain vigor.	Iprodione, Anilazine
Red Thread (<i>Laetisaria fuciformis</i>)	All seasons PERENNIAL RYEGRASS, FINE FESCUE, bentgrass, annual bluegrass, Kentucky bluegrass	Follow balanced fertilization program.	Vinclozolin, Cadmium, Chlorothalonil, Thiophanate-ethyl, Thiophanate-methyl, Nancozeb, Triadimefon Propiconizole
Rhizoctonia Blight (Brown patch) (<i>Rhizoctonia solani</i> = <i>Thanatephorus cucumeris</i>) ⁷	July-August BENTGRASS, ANNUAL BLUEGRASS, TALL FESCUE, Kentucky bluegrass, fine fescue	Avoid excess nitrogen fertilization. Increase air circulation. by removing surrounding vegetation. Avoid excessive watering.	Anilazine, Chlorothalonil, Mancozeb, Benomy ³ Maneb, Propiconizole, Pentachloronitrobenzene, Triadimefon, Thiophanate-methyl ³ , Thiophanate-ethyl ³ , Iprodione
Rust (<i>Puccinia spp.</i>)	August-Oct. PERENNIAL RYEGRASS, KENTUCKY BLUEGRASS	Avoid nitrogen deficiency. Use resistant varieties of Kentucky bluegrass and perennial ryegrass.	Mancozeb, Propiconizole, Cycloheximide, Chlorothalonil, Triadimefon, Fenarimol
Slime Molds (<i>Myxomycete</i> ⁹)	August-Sept. All Turfgrasses	Removing mechanically by mowing or raking.	Zineb, Mancozeb
Snow Mold -	see Fusarium Patch and Typhula Blight		

United States and Canada.

Two features are useful in distinguishing yellow patch from necrotic ring spot and summer patch. Plants suffering from yellow patch display a white, shredded appearance of the basal stem tissue. In addition, leaf spots somewhat reminiscent of dollar spot are sometimes present on the portion of the leaf blade closest to the leaf sheath.

Yellow patch is generally a less severe disease problem than summer patch and necrotic ring spot but will on occasion cause unsightly patches and scars on Kentucky bluegrass turf.

Take-all patch

Take-all patch, also known as Ophiobolus or Gaeumannomyces patch, is primarily restricted to bentgrass. It is most common to the

Pacific Northwest, Northeast and mid-Atlantic regions of the country. It has been reported less frequently in other states such as Wisconsin, Pennsylvania, Michigan and Ohio.

The key for identifying this disease is to watch for it on newly-established greens, especially those greens with high soil pH (> 7). It is also primarily a problem only on bentgrass.

Why these various patch diseases

TURF *Guide* DISEASE

TABLE 1.

TABLE 1
COOL-SEASON TURF DISEASES,
TURF DISEASE AND CONTROLS

DISEASE	SEASON AND/OR SUSCEPTIBLE TURFGRASS ²	CULTURAL	FUNGICIDE/NEMATICIDE ACTIVE INGREDIENT ⁴
Strip Smut (<i>Ustilago striiformis</i>)	Spring & fall KENTUCKY BLUEGRASS, Bentgrasses	Avoid drought stress. Avoid excess nitrogen.	Propiconazole, Triadimefon, Benomyl, Thiophanate-ethyl <i>Notes.</i> Apply extra water for crown penetration. Apply in late fall or early spring
Summer Patch ⁵ (<i>Magnaporthe</i> spp., formerly <i>Phiaophora graminicola</i>)	June-August ANNUAL BLUEGRASS, KENTUCKY BLUEGRASS	Avoid low mowing height. Reduce excessive thatch. Light, frequent watering during dry periods to reduce heat stress. Use slow-release nitrogen to avoid nutrient depletion. Use Kentucky bluegrass and perennial ryegrass mix.	Fenarimol, Triadimefon; Materials must be applied preventatively.
Take-all Patch (<i>Ophiobolus patchi</i>) (<i>gaeumannomyces graminis</i> var <i>avenae</i>)	Spring & fall BENTGRASS	Avoid topdressing soil with pH greater than 6.0 Avoid use of lime, especially small particle type, where take-all is a problem. Use ammonium chloride, or second best, ammonium sulfate fertilizers.	PMA (not labelled for this disease, but may be effective)
Typhula Blight (Grey Snow Mold) (<i>Typhula</i> spp.)	Nov.-April fine fescue, BENTGRASS, ANNUAL BLUEGRASS, Kentucky bluegrass, tall fescue, perennial ryegrass	Avoid heavy fall nitrogen promoting late lush growth. Rake leaves and cut short. Control drifting snow.	Triadimefon, Cadmium, Chloroneb, Anilazine, Pentachloronitrobenzene, Mercury Chlorides, Thiram
Yellow Patch (<i>Rhizoctonia cerealis</i>)	Spring & fall Bentgrasses Bluegrasses	Reduce excessive thatch. Avoid excessive watering.	None
Yellow Tuft (Downy mildew) (<i>Sclerophthora</i> spp.)	Spring & fall Bentgrass		Metalaxyl

¹ Before using any pesticide, read and follow all label instructions.

² Grass types listed in capital letters have been observed to be especially susceptible to the pathogen.

³ Continued or sole use of these materials may favor build-up or resistant fungal population.

⁴ Products containing these active ingredients are listed in the following table. Read the product label to see if it is labelled for the disease of concern. Follow all label instructions.

⁵ Necrotic ring spot and summer patch are known to cause symptoms once attributed solely to Fusarium blight.

⁶ Pink patch disease was recently found to be a disease distinct from red thread. Thus, there are few fungicides specifically registered for control of this disease at this time.

⁷ Another fungus, *Rhizoctonia zaei*, is also capable of causing brown patch-like symptoms on bluegrass and bentgrass. Benzimidazole type (Tersan 1991, Benomyl, Fungo 50, Clerly 3336) are not effective against this pathogen.

Source: Dr. Shane

are prevalent in different regions of the country is still unclear. Most likely reasons are the result of climatic differences and because the causal fungi have not spread to all cool-weather turf growing areas.

Our picture of the diseases in each region of the country is still fragmentary, largely because the diseases are difficult to identify in the field and laboratory.

An exciting development for the turfgrass disease industry has been a

new class of fungicides collectively known as the sterol biosynthesis-inhibiting fungicides (SBI) (Table 3). Three are currently labelled for turfgrass diseases, and more are being developed.

Welcome SBI fungicides

Most fungi attacking turf synthesize ergosterol, a sterol used in their cell membranes. The SBI fungicides control many fungi by blocking the synthesis of ergosterol. For this reason, an

alternate name, ergosterol biosynthesis inhibitors (EBI), is sometimes used. Fungi, such as those causing Pythium blight and downy mildew that do not manufacture ergosterol, are not controlled by these fungicides.

SBI fungicides are systemic. They have a rather broad spectrum of activity, although not as broad as chlorothalonil or mancozeb (Table 4). Most SBI fungicides do not have good protectant action but rather work best

Table 2.

FUNGICIDE DIRECTORY

TRADE NAMES OF TURFGRASS FUNGICIDES AND NEMATICIDES

Active Ingredient	Some Common Trade Names ¹
FUNGICIDES	
Anilazine	Dyrene, Lescorene, Proturf Fungicide III, Lofts Lawn Fungicide
Anilazine + maneb w/ zinc	Faesy & Besthoff Lawn and Turf Fungicide
Benomyl	Tersan 1991, Rockland Benomyl, Lebanon Fungicide Type B
Cadmium chloride	Caddy
Cadmium chloride + thiram	Dexol Thiram Plus Lawn Fungicide, Lesco Snow Mold Turf Fungicide, Cleary's Granular Turf Fungicide, Cleary's Cad-Trete, Lebanon Fungicide Type T
Cadmium chloride + thiram + zineb	Bonide Lawn Fungicide
Cadmium sebacate + thiram + potassium chromate	Kromad
Cadmium succinate	Cadminate
Chloroneb	Tersan SP, Teremec SP, Proturf Fungicide II
Chlorothalonil	Daconil 2787, Lebanon Fungicide Type D
Cycloheximide	Acti-dione TGF
Cycloheximide + PCNB	Acti-dione RZ
Cycloheximide + thiram	Acti-dione Thiram
Ethazol (etridiazole)	Koban, Terrazole
Fenarimol	Rubigan
Fosetyl-AI	Aliette
Iprodione	Chipco 26019, Proturf Fungicide VI
Mancozeb	Fore, Formec, Dithane M-45, Dithane F-45, Lesco 4, Manzate 200 DF
Maneb	Dithane FZ, Dithane M-22
Maneb + zinc sulfate	Tersan LSR, Dithane M-22 w/Zinc, Lesco 4 F w/Zinc
Mercury chloride	Calo-chlor, Calo-gran
Metalaxyl	Subdue, Proturf Pythium Control
Pentachloronitrobenzene (PCNB, quintozene)	Terraclor, Turfcide, Lawn Disease Preventor, Lesco PCNB
Phenylmercuric acetate	PMAS
Phenylmercuric acetate + thiram	Proturf Broad Spectrum Fungicide, 24-5-3
Propamocarb	Fertilizer Plus Fungicide
Propiconizol	Banol
Thiabendazole	Banner
Thiophanate-ethyl	Tobaz, Mertect 140F
Thiophanate-ethyl + thiram	Cleary's 3336 F, Cleary's 3336 WP
Thiophanate-methyl	Bromosan WP, Bromosan F
Thiophanate-methyl + mancozeb	Fungo 50, Spot-Kleen, Topsis M, Proturf Systemic Fungicide
Thiophanate + iprodione	Duosan
Thiram	Proturf Fluid Fungicide, Disease Control Plus Fertilizer 23-3-3
Triadimefon	Tersan 75, Spotrete, Thiramad
Triadimefon + metalaxyl	Bayleton, Proturf Fungicide 7, Lebanon Turf Fungicide
Triadimefon + thiram	Proturf Fluid Fungicide II
Vinclozolin	Proturf Fluid Fungicide III
Zineb	Vorlan
	Zineb
NEMATICIDES	
Ethoprop	Mocap
Fenamiphos	Nemacur

Source: Dr. Shane

¹Many products may be available only through specialized dealers or only in large quantity. Some products can be purchased and applied only by licensed pesticide applicators. This list is presented for information only. No endorsement is intended for products mentioned, or is criticism meant for products not mentioned.

systemically. SBI fungicides are particularly effective against powdery mildew, rusts and stripe smut.

Jury still out

Information is still incomplete for the activity of these fungicides against the slow-growing root and crown diseases necrotic ring spot, summer patch and yellow patch. Current opinions are that fenarimol and possibly propiconazole provide good action against necrotic ring spot.

Triadimefon is reported to have action against summer patch; effectiveness of fenarimol and propiconazole against this disease is not clear.

With all these patch diseases it is important to apply the fungicides before the symptoms appear. No chemical has been shown to be effective against yellow patch in the field.

Fungicide resistance

Resistance of fungi to fungicides is a constant threat, especially those with systemic action. Resistance of fungi to MBC-releasing fungicides (benomyl, methyl- and ethyl- thiophanate), acylalanine (metalaxyl), and iprodione and vinclozolin fungicides has occurred where the compounds have been used frequently.

Resistance of turf disease fungi to SBI fungicides has not yet been reported. Resistance to SBI has been noted for other systems such as apple scab on apples and powdery mildew on ornamental plants.

It is prudent to assume that resistance to SBI fungicides can and will occur with turfgrass diseases.

Although it appears that a variety of SBI fungicides can be chosen, in actuality all the products being developed for turf have the same mode of action. If a fungus develops resistance to one, it will have resistance to them all.

With most fungicides the appearance of resistance is "all or nothing"—meaning that a fungus with resistance is able to tolerate very high concentrations of the fungicide.

With SBI fungicides, resistance is cumulative; meaning the fungus can still be controlled (for a while) at a higher fungicide dose. As a result, resistance of fungi to SBI fungicides will be more difficult to detect because the fungicides will still control the pathogen, although less satisfactorily.

Basic rules apply

As with any fungicide, it is important to switch or tank mix fungicides with different modes of action to delay or avoid resistance build-up.

Another well-documented effect

TABLE 3.

FUNGICIDE DIRECTORY

Sterol biosynthesis-inhibiting fungicides labelled for or being developed for turfgrass disease control.

ACTIVE INGREDIENT	TRADE NAME	OTHER NAME	COMPANY	CHEMICAL CLASS
LABELLED				
fenarimol	Rubigan	—	Elanco	pyrimidine
triadimefon	Bayleton	—	Mobay	triazole
propiconazole	Banner	Tilt	Ciba Geigy	triazole
EXPERIMENTAL				
penconazole	Spotless	—	Uniroyal	triazole
—	Lynx	HWG 1608	Mobay	imidazole
prochloraz	—	—	Noram	imidazole
flusilazol	Nustar	—	DuPont	triazole

Source: Dr. Shane

TABLE 4.

FUNGICIDE DIRECTORY

Activity of sterol biosynthesis inhibiting fungicides against selected diseases of turfgrass.

ACTIVITY	DISEASES
poor	leafspot (<i>Drechslera</i> and <i>Bipolaris</i> species)
fair to good	brown patch (<i>Rhizoctonia solani</i>) anthracnose (<i>Colletotrichum graminicola</i>)
good to excellent	rust (<i>Puccinia</i> species) powdery mildew (<i>Erysiphe</i> species) stripe smut (<i>Ustilago striiformis</i>) dollar spot (<i>Lanzia</i> and <i>Moellerodiscus</i> species)

Source: Dr. Shane

of SBI fungicides is their growth-regulating effect on the turfgrass plant. High rates of fenarimol can depress *Poa annua* growth. Some SBI fungicides may induce a noticeable greening of other grass species.

There are some indications that high rates of SBI fungicides may in some instances slightly retard the growth of grass types other than *Poa annua*. This is not detrimental except in cases where vigorous growth of turf is desirable; for example, if leaf production is needed to fill out a poor grass stand.

Disease detection kits

A new approach has been developed for the age-old problem of identifying

turf diseases. Antibodies—tiny proteins in the immune system of mammals—allow the recognition and neutralization of invading pathogens.

With current technology it is possible to produce antibodies to recognize turf pathogens for diagnostic purposes. With this approach a small sample of leaves suspected of harboring a plant pathogen is ground. The sap is then tested for the proteins or carbohydrates specific to the pathogen.

Agri-Diagnostics and Associates (Cinnaminson, NJ 08077) has developed a kit (Reveal) that positively identifies dollar spot, warm-weather Pythium blight, and brown patch in 10 minutes.

An innovative feature of the Reveal kit is that positive and negative controls are included with each test to insure that it is done correctly.

More kits to come

Antibody-based diagnostic tests for other turf diseases such as necrotic ring spot and summer patch are being developed in other laboratories. These kits allow disease problems to be quickly identified so that proper selection of fungicides can be made.

A knowledgeable turf manager can identify most common turf diseases when the symptoms are typical. However, even the most careful observer can be misled when disease symptoms and signs are atypical or non-definitive. For example, mycelial growth on tall-cut grass can be due to Pythium blight, brown patch, or Nigrospora blight.

As with traditional methods for diagnosing disease, the quality of the grass sample collected for diagnosis is important for successful use of antibody-based techniques. The pathogen responsible for a patch symptom on a grass stand will usually decline to undetectable levels within a few days of symptom expression.

Note kit selectivity

It is also important to know the selectivity of the tests used. For example, the Agri-Diagnostic test for brown patch used in 1988 was specific for *Rhizoctonia solani* and did not react to most isolates of *Rhizoctonia zea*, a fungus that also may cause brown patch symptoms.

The antibody kits will react against living and non-living forms of the target fungus. Some turf managers may use the kits to see if a fungicide application was effectively stopping a disease epidemic. However, sufficient time must be given for a fungicide to act and the fungal population to decline through mowing and deterioration before the grass is tested again. Experience has shown that 2 or 3 days are needed to see the results of a fungicide application with the antibody kits.

An attractive aspect of antibody-based diagnostic kits is that the turf manager can in some instances very quickly determine (or at least rule out) one possible cause of a turf problem.

Costs for the diagnostic kits may be an issue, especially for lawn care companies and diagnostic clinics. Current costs for the rapid assay format of the Agri-Diagnostic kits is more than \$15 per test. The kits may be economical for golf course settings, in situations where lawsuits may be pending, or for special customer-relation cases. **LM**