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Circle No. 104 on Reader Inquiry Card

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]
Necrotic Ring Spot[5] (*Leptosphaeria korrae*)	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 Patch[6] (*Limonomyces roseipellis*)	Spring & fall bentgrass, FINE FESCUE, PERENNIAL RYEGRASS	Follow balanced fertilization program.	Cadmium, Mancozeb
Pink Snow Mold -	see Fusarium patch		
Powdery Mildew (*Erysiphe graminis*)	July-Oct. KENTUCKY BLUEGRASS, fine fescue	Reduce shade. Increase air circulation by removing surrounding vegetation.	Triadimefon, Fenarimol, Propiconizol
Pythium Blight (*Pythium aphanidermatum, P. graminicola*)	June-Sept. BENTGRASSES, ANNUAL BLUEGRASS, PERENNIAL RYEGRASS, Kentucky bluegrass	Improve soil drainage. Increase air circulation by removing surroundign vegetation. Avoid mowing wet grass. Avoid excess watering.	Chloroneb, Etridiazole, Propamocarb, Metalaxyl, Fosetyl-Al, Mancozeb
Red Leaf Spot (*Drechslera erythrospila*)	June-Sept. BENTGRASSES	Remove clippings. Fertilize to maintain vigor.	Iprodione, Anilizine
Red Thread (*Laetisaria fuciformis*)	All seasons PERENNIAL RYEGRASS, FINE FESCUE, bentgrass, annaul bluegrass, Kentucky bluegrass	Follow balanced fertilization program.	Vinclozolin, Cadmium, Chlorothalonil, Thiophanate-ethyl, Thiophanate-methyl, Nancozeb, Triadimefon Propiconizole
Rhizoctonia Blight (Brown patch) (*Rhizoctonia solani* = *Thanatephorus cucumeris*)[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.	Anilizine, Chlorthalonil, Mancozeb, Benomyl[3] Maneb, Propiconizole, Pentachloronitrobenzene, Triadimefon, Thiophanate-methyl[3], Thiophanate-ethyl[3], Iprodione
Rust (*Puccinia spp.*)	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 (*Myxomycete*9	August-Sept. All Turfgrasses	Removing mechanically by mowing or raking.	Zineb, Mancozeb
Snow Mold -	see Fusarium Patch and Typhyula 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

You never know what's hit you when you see patch disease. It could be Fusarium blight. Or necrotic ring spot. Or summer patch. Or take-all patch. Or spring dead spot. Or any combination.

They all look very similar on turf. Only with a microscope can you tell them apart. So guessing which one's causing your patch disease still leaves your turf open to the other four.

That's why complete coverage pays. And only Rubigan is labeled to prevent and treat all five of these pathogens that cause patch disease.

Not to mention dollar spot, snow mold, copper spot, red thread and stripe smut. And this spring is an excellent time to begin your preventive program.

Why take chances controlling only part of the patch disease problem? Span the spectrum with Rubigan. See your Elanco distributor. Or call toll-free: **1-800-352-6776.**

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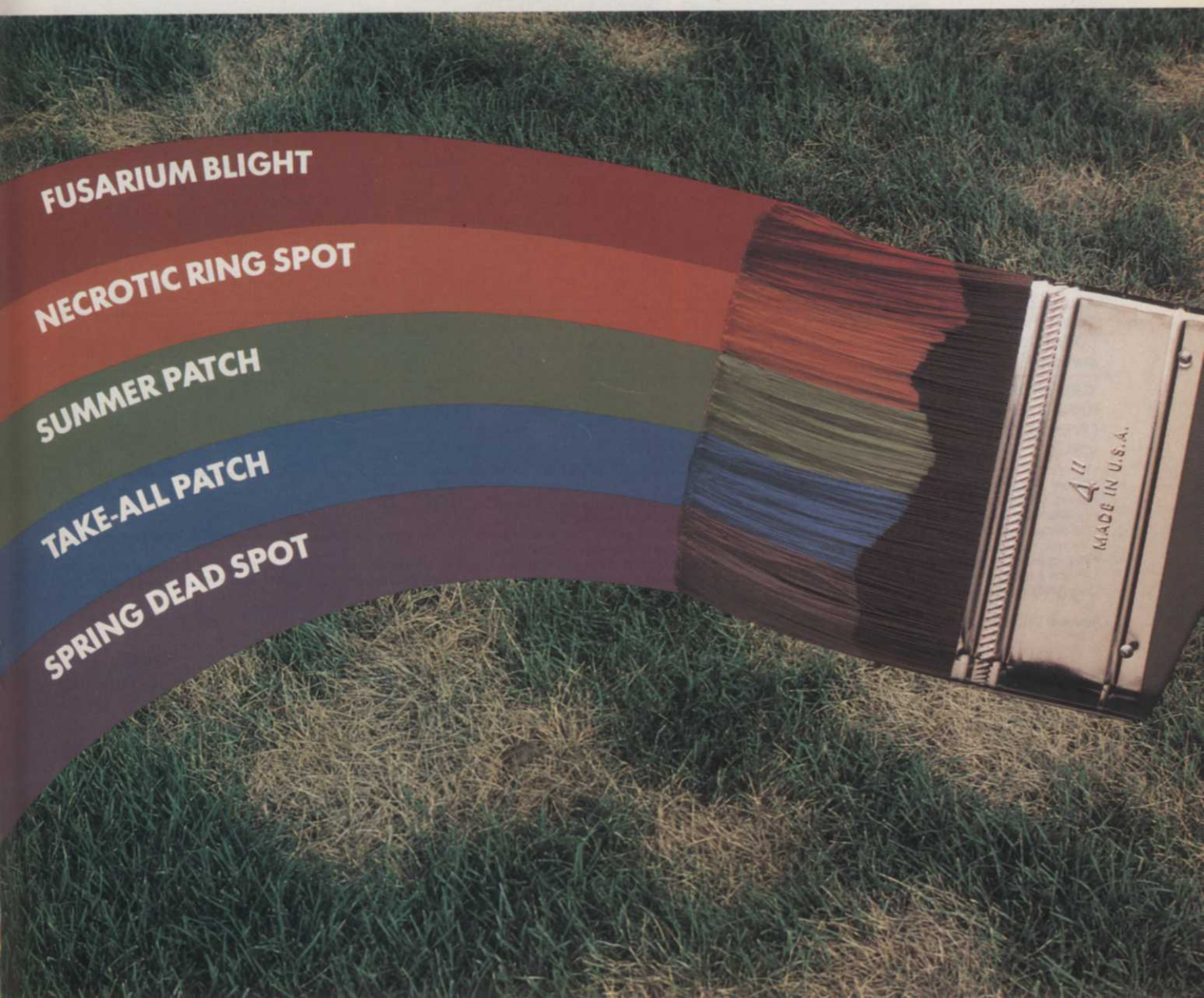

TABLE 1. TURF Guide DISEASE

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

DISEASE	SEASON AND/OR SUSCEPTIBLE TURFGRASS[2]	CULTURAL	FUNGICIDE/NEMATICIDE ACTIVE INGREDIENT[4]
Strip Smut (*Ustilago striiformis*)	Spring & fall KENTUCKY BLUEGRASS, Bentgrasses	Avoid drought stress. Avoid excess nitrogen.	Propiconizole, Triadimefon, Benomyl, Thiophanate-ethyl *Notes.* Apply extra water for crown penetration. Apply in late fall or early spring
Summer Patch[5] (*Magnaporthe ssp.*, formerly *Phiaophora graminicola*)	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 (*Ophiobolus patch) (gaeumannomyces graminis* var *avenae*)	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) (*Typhula 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, Anilizine, Pentachloronitrobenzene, Mercury Chlorides, Thiram
Yellow Patch (*Rhizoctonia cerealis*)	Spring & fall Bentgrasses Bluegrasses	Reduce excessive thatch. Avoid excessive watering.	None
Yellow Tuft (Downy mildew) (*Sclerophthora 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 ans 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 contorl of this disease at this time.
7 Anothe fungus, *Rhizoctonia zeae*, is also capable of causing brown patch-like symptoms on bluegrass and bentgrass. Benzimidazole type (Tersan 1991, Benomyl, Fungo 50, Clery 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

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Table 2.

FUNGICIDE DIRECTORY

TRADE NAMES OF TURFGRASS FUNGICIDES AND NEMATICIDES

Active Ingredient	Some Common Trade Names[1]
FUNGICIDES	
Anilizine	Dyrene, Lescorene, Proturf Fungicide III, Lofts Lawn Fungicide
Anilizine + 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-Al	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 Fertilizer Plus Fungicide
Propamocarb	Banol
Propiconizol	Banner
Thiabendazole	Tobaz, Mertect 140F
Thiophanate-ethyl	Cleary's 3336 F, Cleary's 3336 WP
Thiophanate-ethyl + thiram	Bromosan WP, Bromosan F
Thiophanate-methyl	Fungo 50, Spot-Kleen, Topsin M, Proturf Systemic Fungicide
Thiophanate-methyl + mancozeb	Duosan
Thiophanate + iprodione	Proturf Fluid Fungicide, Disease Control Plus Fertilizer 23-3-3
Thiram	Tersan 75, Spotrete, Thiramad
Triadimefon	Bayleton, Proturf Fungicide 7, Lebanon Turf Fungicide
Triadimefon + metalaxyl	Proturf Fluid Fungicide II
Triadimefon + thiram	Proturf Fluid Fungicide III
Vinclozolin	Vorlan
Zineb	Zineb
NEMATICIDES	
Ethoprop	Mocap
Fenamiphos	Nemacur

Source: Dr. Shane.

[1]Many 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 propiconizole provide good action against necrotic ring spot.

Triadimefon is reported to have action against summer patch; effectiveness of fenarimol and propiconizole 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

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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
propiconizole	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 (*Drechslera* and *Bipolaris* species)
fair to good	brown patch *(Rhizoctonia solani)* anthracnose *(Colletotrichum graminicola)*
good to excellent	rust (*Puccinia* species) powdery mildew (*Erysiphe* species) stripe smut *(Ustilago striiformis)* dollar spot (*Lanzia* and *Moellerodiscus* 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 mislead 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 zeae*, 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**

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The cornerstone of quality sod is shear strength, which comes about only after strict turfgrass management principles are implemented.

by J.R. Hall III, Ph.D.,Virginia Tech

In sod production and athletic field management, strong, tear-resistant turf is desirable. Sod producers and installers want sod that holds together for trouble-free harvesting and installation. Athletic field managers want tough, shear-resistant turf to maximize footing and minimize player injury.

Anywhere turf is being used to provide stable footing for athletic or recreational use, good root systems are important. Recreational turf managers desiring to maximize turf shear strength need to set up management programs that put into practice principles that maximize sod shear strength.

Shear strength of turf is the force required to tear or break a turf apart. It is one of several components that influence the tendency of a turf to "fail" or provide inadequate footing. Other factors such as root-soil binding force, soil moisture and texture, leaf succulence, etc. can also influence the tear resistance of a turf. The force with which roots bind to soil is a major factor relevant to athletic field footing.

The force with which roots bind to soil is a major factor relevant to athletic field footing.

Cleat damage is one of the negative side effects of turfgrass with inadequate root development.

Binding tendencies

Anyone who has compared the force required to pull Kentucky bluegrass and goosegrass from the soil realizes there are great differences in root-soil binding tendencies of grass plants. Kentucky bluegrass does not appear to bind as strongly to the soil as perennial ryegrass. However, "knitting" together of Kentucky bluegrass by rhizomes does give bluegrass an ability to hold together as a sod better than perennial ryegrass.

Most work on turfgrass strength has been done measuring the force required to break the turf apart after it has been exposed to various management practices. Little work has been done on the other factors influencing the tear resistance of a turf. Developing a management system that maximizes root production is obviously important to maximizing turf strength whether one is managing weakly soil-blended Kentucky bluegrass or strongly soil-bound perennial ryegrass.

Rhizomes and stolons contribute to turfgrass strength. However, root mass near the surface of the soil and the tendency of the roots to bind to soil are also extremely important factors.

Other factors

Nutrition, genetics, moisture, temperature, mowing, light, hormones, compaction, herbicides, diseases, insects and nematodes are major factors that affect the development of a root system. All of these factors function as links in a chain. If any one of these is not being dealt with then root production can suffer.

Although all nutritional elements and soil pH are important to root production, phosphorus and nitrogen appear to be the most influential. Of these two, nitrogen is most often mismanaged.

Research and practical observation has illustrated that late fall fertilization of Kentucky bluegrass, creeping bentgrass and tall fescue leads to increased density, root growth, drought tolerance and fall to spring color, as well as decreased spring mowing (when contrasted with spring fertilization) and decreased weed and summer disease problems.

Excessive spring and summer nitrogen stimulation of cool-season grasses produces green, thin-celled leaf tissue at the expense of stored food reserves and root system. It is this same depleted, stored food energy pool that is called on to heal traffic damage, mobilize disease resistance mechanisms and provide energy during extended periods of drought. Therefore, depleting stored food reserves through nitrogen mismanagement is frequently the cause of poor summer turf quality.

The N factor

Research on tall fescue-Kentucky