BY MICHAEL AGNEW, PH.D., AND MICHAEL FIDANZA, PH.D.

A manageable process

A solutions-based approach to disease control on *Poa*/bentgrass greens in the Northeast

Developing an effective disease control program for golf course turf requires a multifaceted approach. If superintendents break down the process into four steps, the process becomes manageable. This process should be done separately for greens, tees, roughs and fairways. Disease control of a mixed stand of creeping bentgrass and annual bluegrass on established greens is a solutions-based approach that can be applied to any turfgrass species on any part of the golf course. It's also a proactive way to keep a course disease free.

STEP 1: IDENTIFY TURFGRASS SPECIES.

The first step in the development of any disease control program is to identify the turfgrass species and to understand its strengths and weaknesses. The majority of golf course greens in the Northeast are a mix of annual bluegrass and creeping bentgrass.

Annual bluegrass can be found on all parts of a golf course as a winter annual weed (*Poa annua* var *annua*) or a weak perennial type (*Poa annua* var *reptans*). Annual bluegrass is a shallow-rooted plant that survives under adverse growing conditions and will produce copious amounts of seedheads from early April through June. This process channels much of the stored carbohydrates to the production of seedheads at the expense of root production.

It's possible to grow annual bluegrass as a desirable plant species, especially if the bulk of the annual bluegrass population is a perennial biotype. The strength of annual bluegrass is in its ability to adapt to poor growing conditions such as low mowing heights, compacted soils, low soil nitrogen and traffic. So, to maintain annual bluegrass as a desirable plant species, it's important to minimize mechanical and environmental stresses to the plant. While superintendents might not have control over all imposed stress, such as excessive rainfall or extremely high temperatures, they can control management practices to reduce environmental stresses.

Creeping bentgrass (*Agrostis stolonifera*) can be established on greens, tees or fairways. Within this plant species, there are many cultivars that have a wide genetic diversity. The most commonly used cultivar is Penncross. It was developed during a time when mowing heights were higher and emphasis on green speed wasn't as great. Newer high-density cultivars have a greater tolerance for lower mowing heights, thus a better choice for newly established greens. In general, creeping bentgrass is tolerant of cold temperatures but prone to winter desiccation. Creeping bentgrass also has poor shade tolerance, low soil O_2 levels and builds up thatch quickly. The primary quandary growing creeping bentgrass is the relative ease with which annual bluegrass invades the turfgrass stand. This forces superintendents to decide whether to control annual bluegrass or manage it on a golf course.

STEP 2: IDENTIFY KEY MANAGEMENT FACTORS THAT INFLUENCE DISEASE DEVELOPMENT.

The primary management factors that influence disease development on a *Poa*/bentgrass green include mowing, plant nutrition, cultivation, topdressing, seedhead control, irrigation and herbicide applications.

The effects of mowing on disease development can be enormous. To maintain acceptable playing conditions, mowing is a necessary physical stress on the turfgrass plant. If possible, raising mowing heights during periods where weather conditions are conducive to disease development can reduce disease significantly. The mowing height range for annual bluegrass greens is 0.15 to 0.25 inch. Mowing heights for creeping bentgrass range from 0.08 to 0.20 inch, with cutting heights of 0.125 or less for newer, high-density cultivars.

Double cutting, rolling and turf grooming also can encourage disease development. Double cutting increases wounding of the plant and soil

The key to controlling diseases such as summer patch is to know how and when conditions favor their development. Photo: BASF

compaction and wear, providing a point of entry for pathogens. If done too often, lightweight rolling also can increase soil compaction and wear, but rolling three times or fewer each week will increase greens speed without significantly impacting the soil. Grooved front rollers lead to increased wounding and should be avoided when anthracnose is active.

Maintaining sufficient nutrients to the turfgrass plant can improve plant quality and reduce disease development. While all plant nutrients are essential, nitrogen is the most important by far when it comes to plant vigor. It's essential to provide adequate nitrogen to maintain a healthy, vigorous plant that can defend itself from infection. The amount of nitrogen will vary by site and with weather conditions. Sandy sites require greater amounts of nitrogen than heavier soils such as clays. Turf grown under dry conditions requires less nitrogen than turf growing under wet, warm conditions. Typical nitrogen rates will vary between 0.1 and 0.3 pound per 1,000 square feet. While appropriate levels of nitrogen are important, superintendents should avoid excessive nitrogen because this can lead to other problems such as poor surface quality, increased thatch and increased wear damage.

Cultivation practices are important tools for alleviating soil compaction and thatch. Superintendents should avoid summer cultivation practices that cause excessive plant wounding. A wounded plant will be more susceptible to attack by an opportunistic pathogen such as *Colletotrichum graminicola*, the causal agent for anthracnose.

Topdressing is used to reduce thatch and to provide a smooth, firm putting surface, but the topdressing process can result in plant injury, especially if the topdressing material is applied heavily and brushed in. If done during periods of high temperature stress, the abrasion of the topdress and associated processes can result in elevated levels of anthracnose.

Plant growth regulators and herbicides are used often to reduce annual bluegrass seedhead development. It's important to begin a fungicide program before applying PGRs to avoid injury and discoloration. Recent research also suggests increased anthracnose could result from the application of plant growth regulators.

Irrigation also influences the health of a turfgrass plant, and it's important to maintain a soil profile that's not too wet or too dry. This can be tricky during extremely wet years and droughts. To reduce disease activity, syringe the turf when soil temperatures are greater than 75 F. To avoid wilt stress, greens might need to be syringed several times during the late afternoon, typically from 10 a.m. to 5 p.m.

When developing a disease control program, it's important to understand adverse plant reactions to other plant protection products. Specifically, care should be taken when using preemergent herbicides on annual bluegrass stands. Many preemergent herbicides caution against use on desirable annual bluegrass. If using a preemergent herbicide, a strong fungicide program should be initiated before application.

STEP 3: IDENTIFY POTENTIAL DISEASES.
Many plant diseases attack annual bluegrass and creeping bentgrass, but some target one plant species or the other. In an established mixed

It's a science ... and an art

BY PAT JONES

Last month, I went to Lubbock, Texas, to give a speech to the West Texas GCSA. I talked with a dozen or so superintendents from the area and found that – although they often suffer from drought-related problems, fire ants, desert weeds and other problems typically associated with their part of the world – they rarely have to deal with disease.

Until this year, that is. Following an unusually wet spring, some courses were finding those nasty yellowish spots on greens. In some cases, it looked like take-all patch. In others, it could have even been pythium. A couple of guys told me it was the first time they'd sprayed fungicides in years. A few at higher-end facilities even said they had to spray monthly. Imagine that.

For a Yankee like me, it was interesting to hear about a different world of disease management where, in the worst case scenario, a 30-day application schedule was necessary for three or four months. Compare that to most of the rest of the golf world where two weeks is pushing the edge of the envelope. Such are the demands of growing plants at less than $^1/_8$ of an inch.

The article above describes a simple, four-step approach to establishing a sound disease management program. It's a good framework that allows you to examine or reexamine the foundations of your control efforts.

However, the science of disease management has to be combined with the art of greenkeeping to be successful. As the authors point out, weather patterns, cultural practices and changes in disease patterns need to be part of the equation as well.

But, keeping an ear to the ground is perhaps one of the most important parts of the art in the process. Comparing notes with neighboring superintendents, local reps and manufacturer's reps can be invaluable as well.

It's not unusual for fungicides to be the largest nonlabor expense in a golf course maintenance budget. Figures from a few years back suggest the national average spending for fungicides is about $22,000 per course. That includes facilities like those in west Texas and other parts of the West where disease pressure is nearly nil. So, it's not uncommon to find Northern private clubs spending $50,000 or more – in some cases way more – on disease management. It's simply the price most need to pay for stress-free turf.

It might sound overly simplistic, but disease management is the trickiest and most expensive part of the art and science of golf course maintenance. Thus, it should require the most thought and examination. By using a simple approach as described in the article above, you can bring a little more science to the art ... and maybe even sleep better.

An example of a programmatic approach for turfgrass disease control compared with single products

FUNGICIDE	RATE	PERCENT DISEASE		TURFGRASS QUALITY	
	AMOUNT OF PRODUCTS PER 1,000 FT²	JULY 20, 2005	AUG 18, 2005	JULY 20, 2005	AUG 18, 2005
SYNGENTA PROGRAM*	SEE BELOW	6.3	0.4	7.0	7.8
CLEARY'S 3336	4.0 OZ	22.5	3.5	5.5	6.5
DACONIL ULTREX	3.2 OZ	12.5	1.6	6.3	6.3
BANNER MAXX	1.0 FL OZ	13.0	1.1	6.3	6.3
UNTREATED		41.3	11.2	5.0	4.5

Data from efficacy trial conducted at Bethlehem (Pa.) Municipal Golf Course (Fidanza, 2005)

* Syngenta Program (all rates are based on amount of product per 1,000 square feet applied at 14-day intervals)
Application 1: Banner Maxx 2 fl oz., Daconil Ultrex 3.2 oz., Primo Maxx 0.125 fl oz.
Application 2: Medallion 0.25 oz., Daconil Ultrex 3.2 oz., Primo Maxx 0.125 fl oz.
Application 3: Heritage TL 2 fl oz., Banner Maxx 1 fl oz., Daconil Ultrex 1.8 oz., Primo Maxx 0.125 fl oz.
Application 4: Medallion 0.25 oz., Banner Maxx 1 fl oz., Daconil Ultrex 1.8 oz., Primo Maxx 0.125 fl oz.
Application 5: Heritage TL 2 fl oz., Subdue Maxx 1 fl oz., Daconil Ultrex 3.2 oz., Primo Maxx 0.125 fl oz.
Application 6: Medallion 0.25 oz., Banner Maxx 1 fl oz., Daconil Ultrex 1.8 oz., Primo Maxx 0.125 fl oz.
Application 7: Heritage TL 2 fl oz., Subdue Maxx 1 fl oz., Daconil Ultrex 3.2 oz., Primo Maxx 0.125 fl oz.
Application 8: Medallion 0.25 oz., Banner Maxx 1 fl oz., Daconil Ultrex 1.8 oz., Primo Maxx 0.125 fl oz.
Application 9: Cleary's 3336 4 oz., Daconil Ultrex 1.8 oz., Primo Maxx 0.125 fl oz.

stand of annual bluegrass and creeping bentgrass, primary diseases will be anthracnose, dollar spot, brown patch, leaf spots, Pythium blight and summer patch. The key to controlling these diseases is to know how and when conditions favor their development.

Anthracnose is most destructive during warm weather but can occur at any time of year. It causes irregularly shaped patches that range from yellow to brown in color. Leaf lesions that are yellow with black centers might also occur. Anthracnose also causes a basal stem rot from late winter to fall. Infected shoots are detached easily. Dead foliage and stems become covered with acervuli – tiny, spined, black fruiting bodies.

Anthracnose development is favored by temperatures warmer than 78 F. It occurs in areas that experience more than 10 hours a day of leaf wetness for several consecutive days. Soil compaction, low mowing heights and low amounts of nitrogen fertility also contribute to this disease.

Dollar spot causes sunken, circular patches that measure as wide as two inches in diameter on golf greens and several inches on higher turf heights. The patches turn from brown to straw in color and might eventually coalesce, forming irregularly shaped areas. Infected leaves might display small lesions that turn from yellow-green to straw color with a reddish-brown border. The lesions can extend the full width of the leaf. Multiple lesions might occur on a single leaf blade.

Dollar spot is favored by temperatures between 59 F and 86 F and continuous high humidity. Warm days, cool nights and intense dews particularly contribute to this disease. It infects areas with low levels of nitrogen and becomes more severe in dry soils.

The symptoms of brown patch can vary depending on the grass cultivar, climatic and atmospheric conditions, soil and intensity of turfgrass management. This disease typically causes rings or patches of blighted turfgrass that measure from 5 inches to more than 10 feet in diameter. It also causes leaf spots and "smoke rings" – thin, brown borders around diseased patches that appear most frequently in the early morning dew. After the leaves die in the blighted area, new leaves can emerge from the surviving crowns.

High relative humidity and temperatures of warmer than 85 F during the day and 60 F at night favor brown patch. It also occurs in areas that experience more than 10 hours a day of foliar wetness for several consecutive days.

Leaf spot (melting-out) causes purplish-brown to black spots with tan centers on the leaf blade and sheath. Leaf spot favors temperatures between 40 F and 80 F. It occurs in areas that experience more than 10 hours a day of foliar wetness for several consecutive days and also favors high amounts of nitrogen and low mowing heights. Lower leaves of infected plants become shriveled and blighted. When infection is severe, almost all leaves and tillers die, causing severe thinning of the stand or melting-out. On cool-season turfgrasses, melting-out typically follows the appearance of leaf spots.

Pythium blight appears suddenly during hot, humid weather. It's common in the wettest areas of turf, such as drainage patterns. This disease causes greasy, brown circular spots that are initially about $^{3}/_{4}$ inch to 2 inches in diameter and then rapidly enlarge in size. The spots are water-soaked and dark-colored early in the morning. They also form fluffy white masses of fungal mycelium (cottony blight) and can coalesce to form large, irregular areas of dead turf. Infected patches might appear bronzish-orange in color.

Pythium blight is favored by night temperatures warmer than 68 F. It occurs in areas that experience more than 10 hours a day of foliar wetness for several consecutive days. It's found in areas with poor drainage and air circulation as well as in locations that are high in nitrogen.

Summer patch is a root disease. It appears as circular or irregularly shaped patches that measure from several inches to several feet in width. The patches are bronzish-yellow to straw-colored and can coalesce as they increase in size. The leaves of the plant turn yellow to brown from the tip to the base. The roots turn moderate to dark brown. Summer patch can also cause frog-eye – a symptom in which a less susceptible grass survives inside the diseased patch.

Root infection is initiated when soil temperatures at a 2-inch depth exceed 65 F. Foliar symptoms of summer patch occur six to eight weeks after root infection begins and are favored by temperatures warmer than 85 F during the day and warmer than 70 F at night. It's also commonly found in areas with alkaline soils, high soil moisture, compaction, poor drainage and low

mowing height. This disease is typically more severe in turfgrass that has been fertilized with nitrate-nitrogen.

STEP 4: MAP OUT THE POTENTIAL TIMES FOR DISEASE PRESSURE AND FUNGICIDE APPLICATIONS. After the diseases requiring control has been identified, the next step is to map the potential times for disease pressure. Typically, history is the best guide. There are tools that offer historical data to help determine these times.

The mapping process is done by creating a series of boxes representing each month of the year and marking them accordingly. In months where disease activity frequently occurs, the box is colored green. In months where disease activity occasionally occurs, the box is colored yellow. If disease rarely occurs during a month, the box is left uncolored. This practice helps superintendents visualize the development of a disease control program.

Next, place a star in the month when you plan to make a fungicide application to control the particular disease.

This process should be done for each disease on your list. The final step is to create a spray schedule that accomplishes all that is mapped out. In creating a schedule, list all fungicides that will control each disease. Look for broad-spectrum fungicides that control multiple diseases, as this increases efficiency of fungicide applications.

Once the program is committed to paper, it's easy to add other scheduled management practices. One that shouldn't be forgotten is fertilization. It's critical to maintain good plant vigor when dealing with diseases such as anthracnose, dollar spot and summer patch.

When planning a disease control program for greens, it's best to not extend any application longer than two weeks. Plant protection is limited by how long the fungicide can remain in or on the plant. The residual activity of fungicides is affected by many factors, including rainfall/irrigation, height of cut, frequency of cut and depth of roots. **GCI**

Michael Agnew, Ph.D., is a field technical manager for Syngenta Professional Products and can be reached at michael.agnew@syngenta.com. Michael Fidanza, Ph.D., is courtesy professor of turfgrass science at Penn State University and can be reached at maf100@psu.edu.

Example of a fungicide spray program for *Poa annua*/bentgrass greens using a solutions approach to disease control

Diseases of bentgrass: Dollar spot (DS), anthracnose (A), Pythium blight (PB), brown patch (BP), yellow patch (YP), fusarium patch (FP)
Diseases of *Poa annua*: Dollar spot (DS), anthracnose (A), brown patch (BP), Pythium blight (PB), leaf spot (LS)

APPLICATION	TIMING	FUNGICIDE/PGR	RATE/1000 FT²	TARGET PATHOGEN
1	APRIL 1	BANNER MAXX DACONIL ULTREX PRIMO MAXX	2 FL OZ 3.2 OZ 0.125 FL OZ	A, LS, YP, FP
2	APRIL 15	BANNER MAXX DACONIL ULTREX PRIMO MAXX	1.0 FL OZ 1.8 OZ 0.125 FL OZ	A, LS
3	MAY 1	MEDALLION CHIPCO 26GT DACONIL ULTREX PRIMO MAXX	0.25 OZ 2 OZ 1.8 OZ 0.125 FL OZ	A, LS, YS, FP
4	MAY 15	HERITAGE BANNER MAXX PRIMO MAXX	0.4 OZ 1.0 OZ 0.125 FL OZ	A, DS, LS, SP
5	JUNE 1	CLEARY'S 3336 DACONIL ULTREX PRIMO MAXX	4 OZ 3.2 OZ 0.125 FL OZ	A, DS, BP, LS
6	JUNE 15	HERITAGE MEDALLION DACONIL ULTREX PRIMO MAXX	0.4 OZ 0.25 OZ 1.8 OZ 0.125 FL OZ	A, DS, BP, SP, PB
7	JULY 1	BANNER MAXX SUBDUE MAXX DACONIL ULTREX PRIMO MAXX	1.0 FL OZ 3.2 OZ 1.0 FL OZ 0.125 FL OZ	A, DS, BP, PB
8	JULY 15	HERITAGE MEDALLION DACONIL ULTREX PRIMO MAXX	0.4 OZ 0.25 OZ 1.8 OZ 0.125 FL OZ	A, DS, BP, SP, PB
9	AUG. 1	BANNER MAXX DACONIL ULTREX SUBDUE MAXX PRIMO MAXX	1.0 FL OZ 3.2 OZ 1.0 FL OZ 0.125 FL OZ	A, DS, BP, PB
10	AUG. 15	BANNER MAXX MEDALLION DACONIL ULTREX PRIMO MAXX	1.0 FL OZ 0.25 OZ 1.8 OZ 0.125 FL OZ	A, DS, BP
11	SEPT. 1	CLEARY'S 3336 DACONIL ULTREX PRIMO MAXX	4 OZ 1.8 OZ 0.125 FL OZ	A, DS, BP
12	SEPT. 15	BANNER MAXX DACONIL ULTREX PRIMO MAXX	.5 FL OZ + 1.8 OZ 0.125 FL OZ	A, DS
13	OCT. 1	BANNER MAXX DACONIL ULTREX PRIMO MAXX	1.0 FL OZ 1.8 OZ 0.125 FL OZ	A, DS
14	NOV. 1	MEDALLION BANNER MAXX DACONIL ULTREX	0.5 OZ 2 FL OZ 5.1 OZ	A, YP, FP