BY LARRY STOWELL, PH.D. AND COLLEAGUES

Shed light on rapid blight

Cooperative effort leads to a better understanding of impact and strategies

Rapid blight discovery is the story of a new plant disease whose unusual biology, inconspicuous morphology and apparently low economic impact almost consigned it to oblivion. It's also a story of what can be so rewarding about plant pathology – the excitement of discovery; the appeal of unraveling the complex interactions among plant, pathogen and environment; and the joy of collaboration. For it was only through a cooperative effort among a privately funded researcher, a publicly funded university, USDA researchers and the golf course industry that the identity of a new terrestrial pathogen was discovered, its economic impact better understood and strategies for its management developed.

EARLY OBSERVATIONS

During the winter of 1995, David Zahrte, the golf course superintendent of Santa Ana Country Club in Southern California, submitted a sample to the PACE diagnostic lab. Zahrte, who manages 19 *Poa annua* (annual bluegrass) putting greens, was worried that his greens, which seemed fine on a Friday afternoon, were suddenly covered with mysterious-looking patches of dead turf on Monday. (Fig. 1)

Fig. 1. Initial observation of a mysterious disease (later to be named rapid blight) on an annual bluegrass putting green in 1997 illustrating large coalescing areas. Photo: Larry Stowell

The affected turf's foliage was yellow and brown and had a water-soaked appearance, yet the roots seemed unaffected. A microscopic observation of the sample revealed none of the usual winter time Poa diseases such as Fusarium patch. There were no obvious signs of fungal pathogen invasion such as mycelia or spores. No insect or nematode pests or their damage were observed, whereas nutritional and cultural problems such as anaerobic soils or nutrient imbalances were also ruled out. The only detected abnormality was the presence of many thin-walled, spindle-shaped cells, measuring 6 by 16 μm and packed inside the foliage mesophyll cells.

Were it not for the sheer number of the spindle-shaped cells, they easily could have been mistaken for cellular organelles belonging to the plant. In fact, one mycologist suggested the spindle cells of the suspected pathogen might be just that, plant chloroplasts. However, when turfgrass samples were maintained in the lab in a moist chamber, the disease spread from diseased to healthy plants. There was a constant association between the presence of the spindle cells and diseased plant tissue. Unfortunately, this organism didn't resemble any other type of documented turfgrass pathogen.

A SERIES OF DEAD ENDS

Early attempts to identify the organism causing the new disease were frustrating. Identification through standard taxonomic keys and attempted isolation on standard culture media were fruitless. Initially, the organism was tentatively identified based on the morphology of its cells as a chytridiomycete. But attempts by Jim Adaskaveg of the University of California, Riverside, to isolate a chytridiomycete on specialized media from infected samples were unsuccessful.

Mycologists suggested the organism might be a protozoan, a single-celled animal, instead. Protozoologists countered suggesting the organism most likely was a chytridiomycete. Both were mistaken. It was discovered this organism was a unique pathogen to turfgrasses and was the first observation of this organism type attacking any kind of land plants.

PUTTING OUT THE FIRE

From 1995 through 1998, an increasing number of infected annual bluegrass samples began to arrive at PACE's diagnostic laboratory from locations throughout California and Colorado. Additional samples of rough bluegrass (*Poa trivialis*), used for overseeded Bermudagrass putting greens, arrived from Nevada. At first, the problem appeared to be spreading; but it's equally likely word began to spread about a new and mysterious disease, making superintendents anxious to see if their turf was being damaged by the disease. Control methods for the disease were needed even though the causal organism hadn't yet been identified.

The late Houston Couch of Virginia Tech was contacted for input on potential control strategies. Based on PACE's descriptions of the thin-walled, spindle-shaped cells, Couch suggested mancozeb might be an effective control agent because of its mode of action as a general membrane disruptor. His guess was correct, and shortly afterwards, mancozeb became the first recognized treatment for prevention and to limit the spread of the disease. This material was used under FIFRA Section (2ee), which permits the use of a registered pesticide on a pest that doesn't appear on the label, as long as the product is used on a labeled crop and all use and handling conditions on the label are followed.

GAINING STEAM

Initially, there appeared to be little interest in this new turfgrass disease in the academic world or the agrichemical industry. However, as the disease was identified in additional hosts and from additional locations, interest slowly grew.

Rapid blight symptoms on ryegrass in Arizona. Photo: Larry Stowell

In 1999, four years after the disease was first described from California *Poa annua* greens, golf course superintendent Mick Twito of Estrella Mountain Ranch in Phoenix submitted samples from a third host, perennial ryegrass (*Lolium perenne*). And in December of 2000, the first sample from the eastern United States was diagnosed when Tommy Witt, then superintendent of Cassique Golf Course in Johns Island, S.C. and president of the Golf Course Superintendent's Association of America, submitted a sample of rough bluegrass containing the same spindle-shaped cells in diseased foliage.

The occurrence of the disease in South Carolina was important because it brought Bruce Martin, Ph.D., of Clemson University into the project. Martin's lab took rapid action in 2001 by initiating a series of chemical management, host range, cultural, biological and molecular studies. Steven Alderman, a USDA forage pathologist at Oregon State University also became involved, investigating the potential for infection and transmission within the perennial ryegrass and rough bluegrass production seed fields in the Pacific Northwest. Fortunately, he ruled out seed-borne transmission as the cause of the initial disease outbreaks.

To further support the productive collaboration and information exchange that was emerging among superintendents and turf researchers, a working group was formed in 2001. The group consisted of superintendents from 60 golf courses throughout the country that were affected by this disease

Martin and Stowell were uncomfortable with the fact that golf course superintendents and others were using the name 'chytrid' to describe this unknown disease. It was suspected to be caused by an unknown organism resembling those in the Chytridiomycota, but it hadn't been confirmed. So, Martin and Stowell coined the name 'rapid blight,' which adequately described the consequences of the disease when it occurred in epidemic proportions.

The working group's first action was to provide funds to support Martin's initial research about disease control. Although the funding was insufficient to support a full-fledged project, the U.S. Golf Association soon provided a substantial grant to Martin's group to support more research. At the same time, Kurt Desiderio, a PACE working group member from Saticoy Country Club, was frustrated by the incomplete control of the disease with mancozeb. Based on a quick screening trial that he conducted on the golf course, he found trifloxystrobin (Compass) was effective at stopping the disease. This was a surprise because repeated tests with the closely related azoxystrobin (Heritage) had yielded no positive results. But Martin immediately followed up by placing Compass and pyraclostrobin (which was soon to be labeled Insignia) in his next round of screening tests, and Desiderio's observation was confirmed. Trifloxystrobin was the first material shown to be more effective than mancozeb for controlling rapid blight. In 2003, Insignia was labeled for turf disease control and included rapid blight on the label.

IDENTIFYING THE CAUSE

The collaboration among scientists and superintendents received another boost when Mary Olsen, Ph.D., a plant pathologist at the University of Arizona, became involved because of an increasing number of Arizona golf courses that were suffering with the disease on greens, fairways and roughs. Working closely with Donna Bigelow, Dave Kopec and Robert Gilbertson, Olsen initiated lab and field research about rapid blight in 2002. The PACE working group was able to provide some funds to support the research. Olsen's work soon led to the long-awaited identification of the organism and the naming of a new species.

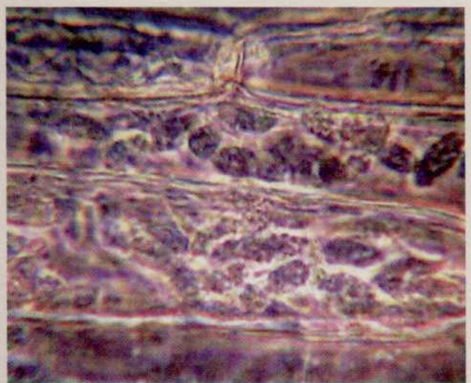
In 2002, Robert Gilbertson, professor emeritus of mycology at the University of Arizona, recognized the spindle-shaped cells in a rapid blight affected rough bluegrass sample from a golf course in central Arizona, similar to those that cause a disease of eelgrass in marine estuaries. The organism causing the wasting disease of eelgrass, *Labyrinthula zosterae*, is a marine slime mold. On the basis of shared morphological characteristics associated with the size and shape of its spindle-shaped vegetative cells and growth characteristics, Olsen and her associates proposed the rapid blight pathogen was a member of genus *Labyrinthula*.

Olsen subsequently was able to grow the cells isolated from diseased turfgrass tissue on an artificial medium developed specifically for *Labyrinthula*. Cells harvested from cultures were used to inoculate healthy *Poa trivialis* and perennial ryegrass. Symptoms identical to those observed in the field developed on all inoculated plants. *Labyrinthula* was then re-isolated from the inoculated diseased turfgrass. This technique of isolation, pure culture and reinfection is known as Koch's postulates and is considered proof the organism is the true pathogen and cause of disease. Olsen's group named the rapid blight-causing organism *Labyrinthula terrestris*. It's the only *Labyrinthula* known to attack a land plant. All others occur in marine environments.

LABYRINTHULA DESCRIPTION

Labyrinthula has been classified in different ways since it was first described in 1867. It's now placed in the kingdom Chromista (also called the Stramenopiles) with organisms such as diatoms and the Oomycetes (species of *Pythium* and *Phytophthora* are in this group), but it isn't closely related to these organisms.

Labyrinthula terrestris vegetative cells are fusiform, averaging about 6 by 16 µm and usually divide longitudinally. Labyrinthula terrestris forms digitate colonies in an extracellular network produced by specialized organelles called bothrosomes and can move along these networks at a notable speed. Cells contain various sized vacuoles, numerous lipid droplets and have a central nucleus with a large nucleolus. As cells multiply, colonial networks are formed and expand to as wide as 5/32 of an inch (4 millimeters) in 24 hours on agar culture media. After about a week, the cells migrate into rounded clumped aggregates ranging from 0.1 to 0.5 mm in diameter. Sori or reproductive cells have never been seen.



Spindle-shaped cells of the rapid blight pathogen in leaf tissue. Photo: Larry Stowell

Given the quick emergence and increasing incidence of rapid blight disease on golf course turf, a full characterization of the pathogen through DNA studies was critical. Paul Peterson, a postdoctoral fellow in Martin's group, collected isolates of *L. terrestris* from rapid blight-affected turfgrasses from the East Coast and West Coast as part of a USGA assisted, nationwide survey ("Rapid Blight - Disease, Water and Soil Survey") that Martin's group initiated in 2003. In close cooperation with the Fungal Genomics Laboratory at N.C. State University under the direction of Ralph Dean, the rapid blight *Labyrinthula* sp. were found to differ from other described and some nondescribed species of Labyrinthula such as *L. zosterae*, which causes wasting disease of eelgrass. This work confirmed and supported the original morphological characterization and identification of the rapid blight pathogen by Olsen. Additional gene sequencing to examine genetic diversity among rapid blight pathogens is under way.

CONDITIONS FAVORING RAPID BLIGHT

In most cases, rapid blight has been associated with saline irrigation water and an accumulation of salt in the soil. To further evaluate this relationship, Martin's group sent out a nationwide request to golf courses with suspected rapid blight to submit samples of affected turf, irrigation water and soil for analysis. Evaluation of the samples was carried out as part of the above-mentioned survey, and a database about soil, water and weather parameters associated with disease outbreaks was compiled. Interestingly, in the Carolinas, rapid blight outbreaks occurred concurrent with drought and applications of high salinity irrigation water (greater than 2.5 dS/m or greater than 1,600 ppm). However, on some Western golf courses, the disease might also occur at lower salinity levels (0.5 to 1.5 dS/m or 320 to 960 ppm) based on the survey.

Subsequent greenhouse trials showed that little disease occurred in susceptible perennial ryegrass and Kentucky bluegrass cultivars that received applications of irrigation water less than or equal to 1.3 dS/m. Disease severity increased with increased salinity. Results from Olsen's group were quite similar. Plants irrigated with low salinity water (0.5 dS/m) show no symptoms of disease but become infected. As salinity of the irrigation water increases from 0.8 dS/m to 4.0 dS/m disease severity also increases. Managing irrigation water to reduce salt accumulation in soils is an effective way to reduce rapid blight.

GEOGRAPHIC DISTRIBUTION AND HOST RANGE

Rapid blight was initially identified on golf

IMPACT ON THE BUSINESS

The rapid take on rapid blight

Santayana said that those who ignore history are doomed to repeat it. That's why it's enlightening to understand the detective work done by PACE labs and others in the late 1990s to identify the then-unknown pathogen that was eventually identified as "rapid blight."

After nearly a century of scientific research into turfgrass diseases, it's hard to believe that "new" pathogens are still being identified, yet it happens all the time. Now, with the application of genetic mapping and DNA technologies, we could be entering a time when we truly begin to understand the root causes of many diseases that were only vaguely defined previously.

Bentgrass decline and zoysia patch are examples of conditions that eluded us for years and just now are beginning to be understood. Spotting the symptoms is easy. It's finding and managing the actual pathogen that's so difficult.

BUSINESS APPLICATION

As a business issue, battling rapid blight could be a major factor in your fungicide budget. Rapid blight requires some serious treatments that will cost you big bucks if it gets out of hand.

More importantly, this disease mars courses in a way that can't be easily fixed. If you want to avoid ugly-looking spots on your course, preventive applications are key.

FIELD ASSESSMENT

If you manage annual bluegrass, rough bluegrass or perennial rye and you have saline irrigation or soils, you are potentially at risk for rapid blight. The rotation of your disease control tank-mix program will be critical, particularly in mid-spring and early summer.

A standard fungicide mix may not be enough, so make sure to consult with your local technical reps to make the right choice.

FUTURE OPPORTUNITY

Could genetically enhanced, disease-resistant turfgrasses be the answer? Perhaps. With so many chemical companies investing significantly in biotechnology (as opposed to traditional fungicide development), there's no question that resistant species are coming. But "minor" diseases like rapid blight are unlikely to be high on the research priority list, so traditional controls will be needed for the foreseeable future.

"In most cases, rapid blight outbreaks have been associated with saline irrigation water and an accumulation of salt in the soil."

— Larry Stowell

Symptoms of a disease, later identified as rapid blight appearing on bentgrass in Southern California. Photo: Larry Stowell courses in the United States on annual bluegrass, rough bluegrass and perennial ryegrass. Although the disease has been documented on creeping bentgrass by Martin and Stowell, it has occurred rarely. By 2005, C. A. Entwistle, in cooperation with Olsen, described the disease attacking colonial bentgrass and annual bluegrass golf course greens in the United Kingdom. The report from the U.K. was notable for its northern location. Until then, rapid blight had been isolated only from 11 U.S. states.

Peterson evaluated 49 different cool-season turfgrass species in hopes of identifying specific turfgrass species and cultivars with tolerance to rapid blight. All the grasses examined were susceptible to rapid blight but at markedly varying levels. Mean disease severity levels among the cultivars tested ranged from less than 1 percent to greater than 90 percent. Bentgrasses (colonial & velvet), bluegrasses (annual and rough), most ryegrasses, crested dogstail, hairgrass and wheatgrasses were susceptible. The grass species most tolerant to rapid blight were the slender creeping red fescues, creeping bentgrasses and some alkaligrasses. Similar results were obtained by Olsen's group in Arizona.

According to Olsen, Bermudagrass shows no symptoms of rapid blight, but in a survey of two golf courses where rapid blight occurred in cool-season grasses used for overseeding, *L. terrestris* was isolated from Bermudagrass roots and stolons during the summer after the cool-season turfgrasses had died out.

The combined observations of these experiments showed several cool-season turfgrasses to be tolerant of rapid blight under conditions of moderately high salinity stress. Some of these grasses might be suitable for overseeding where rapid blight is a chronic problem. In South Carolina, some golf courses are using seed blends of rough bluegrass and alkaligrass with acceptable results. Potential exists for the use of certain creeping bentgrass cultivars or slender creeping red fescues for overseeding as well, although slow rates of germination and establishment might be complicating factors to consider.

OTHER FACTORS

A thorough knowledge of the biology and lifestyle of a disease organism is helpful when managing and controlling disease caused by that organism. For this purpose, Martin's and Olsen's groups conducted a series of controlled environment experiments to determine the growth characteristics of the pathogen.

In lab studies, Olsen found *L. terrestris* grew well at 15 C to 30 C but grew slowly at 4 C and not at all at 40 C. Peterson found similar results when he evaluated the relative growth of 14 different *L. terrestris* isolates collected throughout the United States under varying degrees of temperature and levels of salinity. Growth parameters were studied and measured on solid media. The results of these experiments from Martin's lab indicated that L. terrestris grew best in a range between 22 C to 26 C.

L. terrestris isolates grew well over a relatively wide range of salinity levels from 3.5 to 10.5 dS/m. These results suggest that different *L. terrestris* isolates vary in their salt requirements and that East Coast isolates might require higher salinities for optimal growth than West Coast isolates.

Wounding isn't necessary for *L. terrestris* to enter the plant, and *L. terrestris* moves easily from infected plants to noninfected plants when only a few leaves are touching or when plants share common drainage water.

CHEMICAL AND CULTURAL CONTROL

Field trials to determine efficacy of selected chemicals for control of rapid blight have been conducted at several sites. The most effective chemicals for prevention of rapid blight identified so far are pyraclostrobin (Insignia), trifloxystrobin (Compass) and mancozeb (Fore, Protect). Compass or Insignia mixed or rotated with mancozeb gives good control if applied preventively, while curative applications of chemicals might contain the disease but don't eradicate it.

Cultural control requires a variety of strategies including leaching programs to reduce soil salts, but leaching alone isn't sufficient in many cases. For this reason, the selection of rapid blight-tolerant overseeding varieties holds promise. Blending fast-establishing susceptible grasses (rough bluegrasses or moderately susceptible grasses like the perennial ryegrasses) with tolerant grasses (alkaligrasses, creeping bentgrasses and slender creeping red fescues) might help to reduce the risk of devastating epidemics of rapid blight.

COMING AND GOING

If the preliminary results of molecular analysis by Martin's group continue to yield genetic sequence data that lacks variation, there might be a recent common ancestor of the rapid blight pathogens. That ancestor appears to be most closely related to a *Labyrinthula* species that attacks *Spartina alterniflora*, a true grass (family *Poaceae*) in marine environments. When and how the jump from marine environments to terrestrial plants was made might never be known, but the search for the answer is intriguing and will occupy plant pathologists for years.

There are many more questions to answer concerning rapid blight and *Labyrinthula* as a plant pathogen. From what we know, rapid blight affects a broad range of cool-season turfgrasses that show an increased severity of symptoms as soil salinities increase. Soil salinity problems are likely to increase as competition for high-quality water, increased use of recycled water on golf courses and drought conditions occur. As a result, turf managers will need to develop management strategies that cope with the potential for increased rapid blight attacks. In the meantime, a successful integrated approach has been identified that relies on a combination of cultural practices and chemical control. **GCI**

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Literature cited for this article can be found on our Web site, www.golfcourseindustry.com, posted with this article.

BY HARRY NIEMCZYK, PH.D AND DAVID SHETLAR, PH.D

Head them off

A look at preventive approaches to destructive turf insects

Preventive insecticide programs are implemented based on the theory that one pest or group of pests often is the primary, but not necessarily the only, focus of treatments. This is called the primary target. However, a treatment's impact on other pests causing damage at application time also should be considered.

An insecticide or other form of insect control generally should be applied only when its use is justified. The major justification for implementing a preventive program is a past history of infestation and/or damage and confidence damage will reoccur. Such history is based on previous years' experiences, observations, monitoring and knowledge of the seasonal spectrum of pests.

WHITE GRUBS

In the North, if grubs (black turfgrass *Ataenius*, *Aphodius*, Japanese beetle, masked chafer, European chafer, Asiatic garden beetle, Oriental beetle) are the primary target and a preventive program is selected, early May is the optimal time to apply imidacloprid (Merit) or clothianidin (Arena). In addition to providing season-long control of these grubs, other secondary pests in the spectrum (billbug larvae, first generation cutworm larvae, and probably greenbug aphids and frit fly) will be prevented. Turfgrass ants (*Lasius neoniger*) also will be suppressed.

However, in June, it's too late to prevent the first generation of cutworms and probably billbug larvae by applying imidacloprid or clothianidin. Billbugs are a significant pest on tee and bunker banks and in roughs. Applications from July to mid-August will prevent annual grubs, including green June beetle, but it's too late to control most other secondary pests in the spectrum during that time.

An application of thianicotinyl, thiamethoxam (Meridian) in May or June or July will preventively control Japanese beetles, masked chafers and BTA grubs. Larvae of billbugs, cutworms, sod webworms and chinch bugs existing during and after the time of application can be controlled, too.

June applications of halofenozide (Mach 2) provide season-long preventive control of BTA and *Aphodius*, Japanese beetle and masked chafer grubs. Control of European chafer and Asiatic garden beetle is limited. Infestations of billbugs, cutworm and sod webworm larvae existing at the time of application also might be controlled with treatment at this time.

Application of halofenozide from July thru early August may also prevent infestation of grubs, and controls existing infestations of cutworm and sod webworm. Treatments applied from mid-August to mid-September control Japanese beetle and masked chafer and might provide a degree of control of sod webworm larvae that normally overwinter.

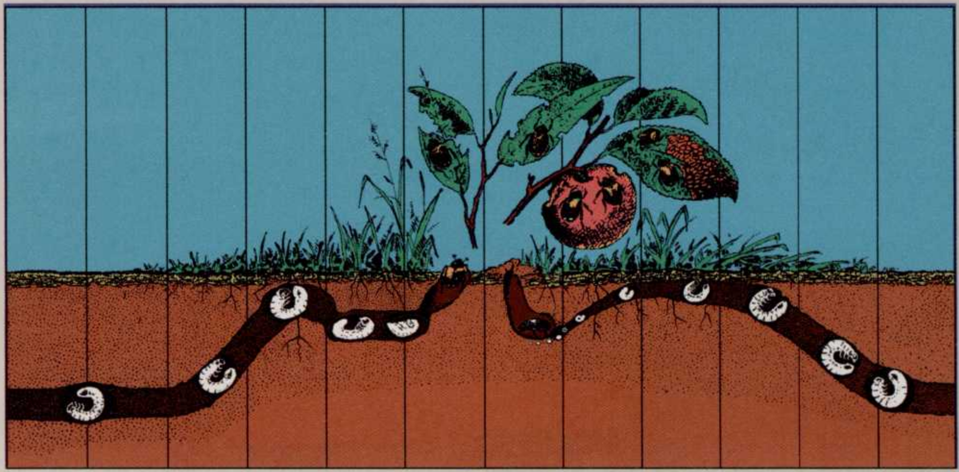
ANNUAL BLUEGRASS WEEVIL

Where grubs and annual bluegrass weevil are major targets, a combination of imidacloprid and a pyrethroid insecticide or clothianidin applied from mid- to late April prevents damage from first and second generation annual bluegrass weevil larvae. This treatment also should prevent larval infestations of billbug, BTA, Japanese beetle, masked chafer, European chafer and first generation cutworms.

Where the grub species aren't major targets, an application of the labeled pyrethroid insecticides during the third week of April has prevented damage from annual bluegrass weevil larvae. The principle of this approach is to target overwintered adults as they return to annual bluegrass to begin laying eggs. Timing is critical. However, recent studies have confirmed the existence of annual bluegrass weevil resistance to the pyrethroid bifenthrin on some East Coast courses.

The impact of a preventive program on the spectrum of secondary target pests occurring at

First, second and third instar grubs. The first and second instar larvae are most susceptible to curative controls. Photo: Dr. David Shetlar, The Ohio State University.



Prevention of grub damage can be accomplished with application of an insecticide from early May through mid-July. Photo: Dr. David Shetlar, The Ohio State University.

the time of application hasn't been studied well. However, because these insecticides are labeled for and known to be residually toxic to BTA and billbug adults, larval infestations of these pests also should be prevented.

BLACK TURFGRASS ATAENIUS

Where BTA is the only grub of concern, another preventive option has been used successfully. Principle control involves application of chlorpyrifos (Dursban) or a labeled pyrethroid to target overwintering adults just as egg laying begins. In the Northern states, this event coincides with the onset of full bloom of Vanhoutte spirea (*Spirea vanhouttei*), usually early to mid-May. The treatment's objective is to deposit the insecticide into the first 1/4-inch of thatch so residues kills adults as they land on the turf to hide, feed on organic matter and/or burrow to lay eggs. Treatments should be syringed immediately after application to wash the insecticide off the grass blades into the thatch.

A preventive application of imidacloprid, clothianidin or thiamethoxam during the first week of May or halofenozide in early June to control other major grub targets also controls BTA, *Aphodius* and a spectrum of other pests. These insecticides also can be used successfully when BTA is the primary target.

BLUEGRASS BILLBUG

The bluegrass billbug causes significant damage to Kentucky bluegrass and nonendophytic perennial ryegrass around greens and sand bunkers, on tee and green banks, in roughs and turf around the clubhouse. Damage can be as subtle as a chronic thinning of the stand. Symptoms often are misdiagnosed as irrigation not reaching the turf, drought or disease such as dollar spot. If uncontrolled for extended periods, the Kentucky bluegrass portion of a sward continues to diminish. Kentucky bluegrass varieties vary in their susceptibility to this pest.

Applying imidacloprid, clothianidin or thiamethoxam during the first week of May for prevention of major target pests also prevents bluegrass billbug damage.

OTHER PEST INSECTS/CUTWORMS

When cutworms (mainly the black cutworm) are the primary concern, a preventive approach isn't recommended. We discourage adding an insecticide to a treatment of which the objective is fertilization and/or growth regulation and/or disease control just in case there might be cutworms. Instead, we recommend a curative approach and application of a control when evidence of damage first appears.

A program of regularly scheduled applications, beginning when the first eggs begin to hatch and continuing at a 14- to 21-day interval, thereafter, has been shown to prevent damage. Affected larvae die in their burrows, not on the turf surface.

SOD WEBWORM

Generally, sod webworms haven't been considered a pest worthy of concern on golf courses. But based on observations and communication with golf course superintendents from Ohio to Nevada to Florida, they are.

Sod webworm larvae commonly overwinter in greens, practice greens and tees. The overwintered larvae resume feeding in early spring by constructing a C-shaped cover of webbed-together topdressing over its burrow. The sand cover is just below the turf's mowing level. The larva feeds on the turf under the cover, which is made larger as more food is required. During the summer, more irregular tunnels with covers can be constructed in the turf.

In addition to the sand covers being unsightly and interfering with ball roll, the larvae under them are a major reason for the probing of starlings and other birds in early spring. When necessary, spring damage can be prevented by treating the turf areas of concern with an insecticide from late September to mid-October to kill the larvae that would otherwise overwinter. An imidacloprid application in May for preventive control of grubs or other primary targets hasn't controlled overwintered sod webworms. Application of clothianidin or thiamethoxam has been effective.

MOLE CRICKETS

In the South, the most difficult time to control mole crickets is late fall and early spring when adults are flying to relocate and mate. These adults might burrow deep in the soil profile during cool or dry soil conditions, and therefore, are less prone to feed, which minimizes their exposure to control materials. Little can be done to prevent this movement and damage.

At sporadic times, usually associated with warm and rainy weather, adults move to the surface, tunnel extensively, fly in mass and mate. Research shows moist but not saturated sites with dense turf or weed growth are highly

Thinning and damage spots are caused by bluegrass billbugs that prefer the sunny, dry bunker banks of golf courses.
Photo: Dr. David Shetlar, The Ohio State Univ.

attractive to spring-active adults. Eggs will be concentrated in such sites.

In spring, areas where mole crickets are most actively tunneling, emerging and digging back into the soil are where most of the eggs will be laid. A visual inspection of each area should allow for easy detection of mole cricket hot spots. With experience, turf managers will learn to differentiate between light, moderate and extensive mole cricket activity.

Constructing maps of each fairway, turf managers should draw rough outlines of areas with extensive mole-cricket tunneling. These high-risk areas will have significant turf loss from mole cricket nymphal populations. Such sites are candidates for preventive control.

Insecticides with moderately-long residual activity (isofenphos and isazofos) can be applied to high risk areas at the beginning of mole cricket egg hatch (usually late May to early June). Because fipronil (Chipco Choice) applied with subsurface placement equipment provides season-long control of hatching mole cricket nymphs, most other preventively used insecticides have lost favor.

However, subsurface application of fipronil appears to have little activity against other soil-inhabiting insect pests of turf. Turf managers using this tactic have experienced increased white-grub damage and damage from animals digging for grubs. Apparently, these grubs were controlled or suppressed when the more traditional insecticides (isofenphos, isazofos) were used to control mole crickets.

Applied when mole crickets first hatch eggs, surface application of imidacloprid, clothianidin or thiamethoxam adequately prevents mole cricket nymphal damage. The application date varies considerably from South to North where mole crickets are.

For example, tawny mole cricket egg laying might begin as early as late March in South Florida, mid-April in North Florida and early May in South Georgia, with egg hatch occurring about 20 days later. Generally, each major biological event in the life history of mole crickets is delayed one week as one moves 100 miles south to north. Coastal and island areas can vary from this rule.

A single surface application of imidacloprid, clothianidin or thiamethoxam (at the highest label rate) made within the first three weeks of first egg hatch should prevent damage from tawny and southern mole crickets. One of these insecticides, applied within this time period should suppress (if not control) the first new generation of cutworms, fall and true armyworms and tropical sod webworm for 25 to 30 days after application, thereby eliminating the need for a surface insecticide treatment during this time.

Chlorpyrifos, acephate (Orthene) or a registered pyrethroid might be applied to mapped areas that were determined to have considerable adult tunneling activity in April and early May. The insecticide is applied at egg hatch and every three weeks thereafter until egg hatching stops (usually after two to three applications). These applications also will control secondary targets such as cutworm, armyworm and sod webworms but won't control grubs effectively.

Surface applications of fipronil (Chipco Choice) made after egg hatch until the mole cricket nymphs are medium sized have provided good control and also suppresses fire ant populations.

The key to using imidacloprid, clothianidin or thiamethoxam successfully is to determine when mole crickets are ready to lay eggs. This will require weekly sampling of adult mole crickets on the course, starting when spring flights and digging is prevalent.

Turf managers can flush adult mole crickets to the surface using a soap irritant so they can be inspected carefully. They should capture three to five female mole crickets from several locations on the sites that previously were identified as hot spots. With a sharp knife, open the abdomens of the female crickets and look at the developing eggs. If the eggs are flat to slightly oval and are soft and yellow-green, the female isn't ready to lay eggs. If the eggs are rounded, hard and dark yellow, egg laying will occur within five to 10 days.

First egg hatch normally occurs 20 days after egg laying. Again, a soap irritant solution can be used to detect the first instar nymphs.

An April or May application of imidacloprid, clothianidin or thiamethoxam has enough residual efficacy to control secondary pests such as masked chafer or annual species of May/June beetle grubs that appear within 60 to 90 days after the application.

Grub adults that lay eggs in August might not be controlled. Spring applications also appear to control hunting billbug.

The insect parasitic nematodes, *Steinernema* *scapterisci* and *S. riobravae* have been touted as providing permanent, long-term preventive control of mole crickets. However, these nematodes, while often becoming permanently established in an area, don't produce the desired level of control expected by golf course managers, especially in high maintenance, irrigated turf. The nematodes might be useful in roughs, wetland sites and other lower-maintained turf areas.

GRUBS

If grubs are determined to be the primary target and a preventive program is selected, the first priority is to determine which species or species complex is present.

In many Gulf States, masked chafers and annual forms of May/June beetles are the most common grub pests. In Texas, Oklahoma and the West, the Southwestern masked chafer and annual May/June beetles are the common pests. The adults of these southern grubs usually fly and lay eggs when the rainy season begins or when summer rain fronts pass through.

Flights of the Southern and Southwestern masked chafers are common in late July through August. The May/June beetles fly from May to August, depending on the species. Knowing which species is dominant and when it flies and lays eggs is essential.

May and early June applications of imidacloprid generally provide control of masked chafer and annual May/June beetle grubs except where the adults delay flight until mid- to late August. This application also should control secondary targets such as mole crickets, cutworms, armyworms, tropical sod webworms and hunting billbugs.

Where green June beetle also is present or late flying masked chafers or annual May/June beetles occur, imidacloprid, clothianidin or thiamethoxam applications should be delayed until mid-July. This treatment will provide season-long control of the grubs and suppress secondary pests such as cutworms, armyworms, tropical sod webworms and hunting billbugs. However, it's too late to provide mole cricket control.

May and early June applications of thiamethoxam or clothianidin should provide control of masked chafer and annual May/June beetle grubs and should also control secondary targets such as mole crickets, armyworms, cutworms, tropical sod webworms and hunting billbug.

June application of halofenozide has been shown to control masked chafer and annual May/June beetle grubs in July and August. Application at this time also will control secondary pests, such as cutworms, armyworms and sod webworms.

FIRE ANTS

Generally, fire ant control requires curative and preventive approaches. Two effective programs have been developed: the two-step and ant-elimination methods are satisfactory approaches for golf courses.

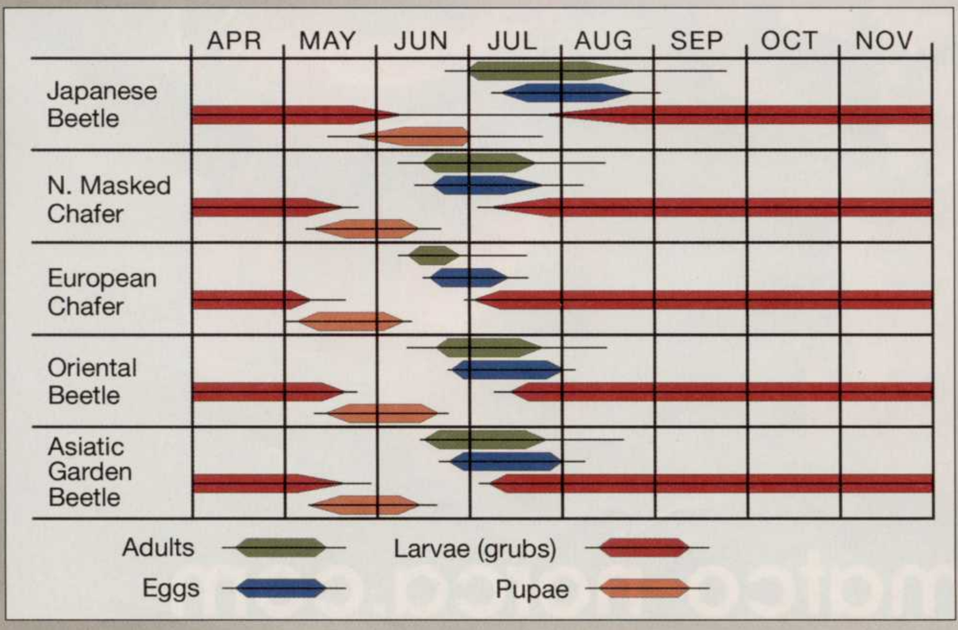
Two-step approach requires an annual or twice-a-year application of a bait-formulated insecticide first applied over the entire turf area. The principle is to allow sufficient time for the fire ant workers to pick up these baits and take them back to the colony for distribution throughout the individuals. Hydramethylnon baits provide control three to five weeks after broadcast, while fenoxycarb baits provide maximum mound control four to nine months after application.

One to three weeks after the bait is broadcast (to allow ants time to pick up the baits and take back to the colonies), the second step is to treat remaining, conspicuous or persistent mounds directly. Persistent mounds can be drenched, dusted, treated with granules, or aerosol injection with one of a range of insecticides registered for this purpose.

Once fire ants in an area have been brought under control, the two-step approach can be used every year to prevent further buildup of new colonies. This is best done by applying the baits in the fall and treating persisting mounds in the spring. If mounding becomes extensive, baits may be reapplied.

The ant-elimination approach is used where fire ants can't be tolerated and requires broadcasting a bait-formulated insecticide and/or spreading granules around individual mounds. After two to three days, a contact insecticide is applied to the entire area every four to eight weeks to kill any foraging fire ant workers. When chlorpyrifos, acephate or a pyrethroid is used, secondary pests such as cutworms, armyworms and sod webworms also will be controlled. If applications are made when mole cricket eggs are hatching, many of the young mole cricket nymphs also will be killed.

The main principle of using fire ant baits is to let the ants have time to pick up the bait and transport it to the nest for further distribution throughout the colony. If transport of the bait to the nest is disrupted by the application of other insecticides, the long-lasting effects normally obtained with baits won't be achieved.



Understanding when grubs lay eggs and early instar grubs begin feeding determines the best time to make preventive control applications. Photo: Dr. David Shetlar, The Ohio State Univ.

OTHER PESTS

Cutworms, common armyworm, fall and yellow-striped armyworm, sod webworm and tropical sod webworm rarely become the primary target of concern on Southern golf courses, therefore, a preventive approach isn't recommended.

We discourage applying an insecticide along with a fertilizer, herbicide and/or disease control as extra insurance to control any larvae that might be present. Instead, we favor a curative approach when evidence of damage first appears .

We suggest using a daily visual monitoring of greens, tees and approaches for early signs of thinning or ragged leaf margins (grass blades often appear white). These are indicators of early armyworm and tropical sod webworm activity.

Regular and persistent bird feeding in an area also is an indication that armyworms or tropical sod webworms are active. It might be advisable to apply insecticide like chlorpyrifos or a pyrethroid every three to four weeks to prevent armyworm damage. Applications of insecticides for control of armyworms also control other insects present such as fire ants, billbug adults and young mole cricket nymphs.

Damage from hunting and phoenician billbugs commonly is misdiagnosed on Bermudagrass because it resembles damage caused by the disease, spring dead spot and delayed spring green-up. When careful inspection of the turf indicates signs of billbug activity (chewed stolons) or larvae are found, a curative program should be used. If damage is extensive, a preventive approach should be considered for the next season.

Preventive application of imidacloprid, clothianidin, thiamethoxam or halofenozide in May or early June normally will provide sufficient residual effect to kill billbug larvae that begin feeding in June through August. This approach reduces the population so few larvae will remain to overwinter and cause damage the following spring. Application at this time also will control or suppress mole crickets, grubs and larvae of cutworms, armyworms and sod webworms. GCI

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This article was excerpted from "Destructive Turf Insects" which is available for purchase in the GCI online book store at www.golfcourseindustry.com.

IMPACT ON THE BUSINESS BY CINDY CODE

Field experience dictates application timing

Controlling insect damage on a golf course is generally not an easy proposition. Balancing when to apply insecticides preventively vs. waiting for a more targeted, curative approach is often difficult to quantify. And, a miscalculation can result in unsightly damage and an angry clientele.

Further muddying the picture is identifying which insecticide, or combination of products, to use to manage undesirable insect pests.

University research certainly goes a long way in providing superintendents with background needed to effectively keep pest outbreaks to a minimum. But trial and error is oftentimes the most comfortable fit for a superintendent once he has lived through a number of seasons and pest cycles.

David Webner, superintendent for Westwood Country Club, Rocky River, OH, says his insect treatment program varies from year to year.

"Right now I'm debating a wholesale treatment for grubs and masked chafers or whether I should spot treat where I've had problems. I'm still deciding what I'm going to do this year," Webner says. "There's such a cost difference."

Timewise, if Webner's crews spot treat, he says they can finish the job in about five hours. But if he treats greens, tees, fairways – as well as around the fairways – it amounts to about16 man hours.

"It's more to do with budgets. We're trying to keep it tight," he says. "It may cost us more on the back end. It's a balancing act."

After seven years at Westwood, Webner says he knows the areas of his course that will definitely experience a pest problem. Those spots are always treated preventively.

In Palm Beach Gardens, FL, superintendent Kevin Downing says he is planning three to four applications this year predominantly for grub and mole cricket management. His plan is to increase the number of areas on the course that are treated.

"We'll act more preventively on the fairways and tees for grubs, primarily, and for some increase in mole crickets," he says of his course, BallenIsles Country Club. "It's a switch from last year. We continue to evaluate conditions and hot strike areas. Obviously, this program represents more expenditure of finances than last year, but last year we played two months catch-up for areas we didn't pre-treat."

Downing observes that the contingent of year-round residents living in Florida can be more sensitive to the conditions of the course in the off-season. Thirty to 40 percent of BallenIsles stay year-round.

Financially, preventive treatments will cost about $50,000, but improved conditions are the end-result.

"We're making these changes based on experience," he says. "It's more involved to pre-treat, but if we have to replace it with sod or treat poor playing conditions, it'll cost money there too."

Both Webner and Downing plan to use two to three different products to manage grubs this year.

Webner says he tries to mix up his product selection from year to year to vary the mode of action. Sometimes a predominantly grub control product will also provide some first generation control of surface-feeding insects, but generally that's considered a bonus.

Surface-feeders present additional problems. When cutworms, armyworms or sod webworms appear on a handful of greens they're treated right away. "We're not going to wait. At the first sign of damage we treat and repeat as necessary," Webner says.

Product choice is a continual process that's always under evaluation, according to Downing. He advises assessing new single or combination products on a test area first before widespread use.

Downing says he generally treats for grubs once a year unless he's working in a curative situation. Surface-feeders, on the other hand, are tackled two to three times a year.

Both superintendents say they review university research for timing recommendations and product efficacy results, but there's nothing better than on-the-job experience to keep one step ahead of the pest.