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IN THIS ISSUE

- The Science of Spring Transition
- Bacterial Wilt: More Trouble for *Poa Annua*
- Chipco Proxy—A New Plant Growth Regulator for 1999
- Counting Wildlife—Is There More?
- Spring is the Best Time for Ant Control
- Research Summary: Assessment of Curative Controls for Surface Algae on Golf Greens
- JB Comments: ISTI Activities
- Enhancing Turf Recuperation of Tees
- Ask Dr. Beard

The Science of Spring Transition

James B Beard

The term "spring transition" refers to the change of a winter overseeded cool-season turfgrass community back to a green turf originating from the understory of a dormant warm-season turfgrass, typically bermudagrass (*Cynodon* spp.). Prior to the 1970s the spring transition problem was one in which the winter overseeded ryegrass (*Lolium* species) died before the bermudagrass (*Cynodon* species) greened up in the spring, thereby resulting in several weeks of a brown turf surface. This spring transition problem was particularly severe when annual ryegrass (*Lolium multiflorum*) was used. In contrast, the release of a number of improved turf-type perennial ryegrass (*Lolium perenne*) cultivars eliminated the period of brown vegetation during the normal transition period. However, a new problem emerged in that **the new turf-type perennial ryegrasses and other species including rough bluegrass (*Poa trivialis*) persisted for too long** a period of time, extending beyond the normal green-up period of the bermudagrass. Frequently associated with this persistence is loss of the bermudagrass turf. In some cases the perennial ryegrass persists into the summer period before it dies of heat stress. When this occurs there typically is not sufficient bermudagrass surviving, and thus replanting of the putting greens is necessary.

A number of potential causes for poor spring transition and loss of the winter overseeded bermudagrass have been proposed. Included are a weakened bermudagrass caused by improper autumn cultural practices and injury from such external stresses as spring root decline, direct low-temperature kill, plant water stress, diseases, and allelopathy. However, **by far the most important limiting factor causing poor spring transition due to death of the dormant bermudagrass under the overseeding canopy is light exclusion.** Thus, the first priority in spring transition is to reduce the canopy density of the winter overseeded cool-season grasses to the extent that sunlight is allowed to reach the underlying lateral stems of the bermudagrass. When the temperature rises to the induction threshold, the new leaves start to be initiated from nodes on the lateral stems of the bermudagrass. These leaves will die if there is not sufficient sunlight or radiant energy to sustain photosynthesis due to shading by the upper canopy of winter overseeded cool-season turfgrass. This mechanism is much like attempting to grow bermudagrass in the shade under a tree canopy. The

Continued on page 2

...Spring Transition...

Continued from page 1

bermudagrasses are not shade tolerant and do not form a turf of significant quality. Thus, by far **the most important objective in spring transition is timely reduction of the canopy light exclusion dimension.**

Alternatives in reducing the cool-season turfgrass canopy density include (a) lowering the cutting height, (b) vertical cutting, (c) chemical inhibition of shoot growth, or (d) the use of herbicides selective in killing only the overseeded cool-season turfgrasses. A number of attempts have been made to eliminate the problem of unfavorable spring transition and bermudagrass loss by switching from winter overseeded perennial ryegrass to rough bluegrass. However, at the temperatures during which bermudagrass initiates new leaves, the rough bluegrass is just as competitive in canopy sunlight exclusion as the perennial ryegrass.

A series of experiments were conducted at Texas A&M University by this author to evaluate cultural methods to reduce canopy sunlight exclusion and facilitate spring transition from the winter overseeding without the loss of the bermudagrass. It was found in studies with perennial ryegrass that the following cultural methods facilitated good spring transition. **Ranking most important was elevating the nitrogen fertility level** to a rate of 0.5 pound N/1,000 ft^2 per week (0.25 kg/100 m^2) versus the application of 0.5 lb/1,000 ft^2 every two weeks. **Second in importance was lowering the cutting height** by 1/32 inch (1.6 mm). Surprisingly, **the third most important cultural practice was moderate vertical cutting** at weekly intervals. Of course, the combination of all three cultural practices resulted in the best overall spring transition. This research was completed over 10 years ago. The findings have been successfully used in Texas. Also investigated was the development of a prediction model concerning when to initiate these spring transition enhancement cultural practices. Basically, **they should be initiated when the soil temperature at a 4 inch (100 mm) depth rises above 62°F (17°C).** A caution in utilizing this program is that the higher nitrogen fertilization program should not be used if spring root decline (SRD) has occurred on the bermudagrass. If SRD occurs the fertilization should be delayed for approximately 3 weeks after SRD occurs and bermudagrass root replacement is well advanced.

A number of proposed causes for the loss of bermudagrass during winter overseeding were listed in the front of this article. Under certain conditions they can be contributing factors in bermudagrass loss, particularly when occurring in combination with canopy sunlight exclusion. Improper autumn cultural practices that weaken the bermudagrass prior to entering the dormant period can be a significant contributing factor. **Moderate autumn nitrogen fertilization should be practiced, which allows carbohydrate accumulation to occur.** High nitrogen rates—which cause excessive shoot growth—tend to minimize carbohydrate accumulation. **Examination of the lateral stems of healthy bermudagrass should reveal a plump, thick-diameter condition,** whereas bermudagrass that has been weakened by the autumn cultural practices will be spindly and very narrow in diameter.

A cultural practice that has been recommended by some turf specialists is to induce water stress during the spring transition, on the premise that the bermudagrass is more drought tolerant than the cool-season turfgrasses and thus will transition readily. However, this relative ranking is based on actively growing bermudagrass, which has adequate storage carbohydrates. In early spring the bermudagrass has used most of its storage carbohydrates. If this limitation is combined with spring root decline, the water stress will actually accelerate death of the bermudagrass. It also should be indicated that excessive nitrogen fertilization, which prevents carbohydrate accumulation, also will increase the potential for direct low-temperature kill of the bermudagrass.

Excessively close mowing heights also significantly increase the proneness to bermudagrass low-temperature kill. It generally is a good strategy to elevate the cutting height for at least 3 weeks prior to and during the winter low-temperature kill period in order to minimize potential turf loss in those regions prone to low-temperature kill stress.

Finally, there are those who continue to seek a turfgrass species/cultivar that will transition easily to bermudagrass. To date this has not been a successful approach. **This author would rather induce the transition by cultural techniques at a time selected, rather than depending on the vagaries of mother nature to accomplish this transition.** On those sites where spring transition continues to be a problem, one should consider initiating a cultural program of the type just described to determine its appropriateness in that particular climatic-cultural situation.

FEATURE ARTICLE

Bacterial Wilt: More Trouble for *Poa Annua*

Peter H. Dernoeden

Bacterial diseases are uncommon in turfgrasses. Plant pathogenic bacteria are single-celled, usually rod-shaped, and they have rigid cell walls. They reproduce by binary fission and they may or may not be mobile. **Bacteria have no means of penetrating cells, so they must enter plants through natural openings such as stomates and hydathodes, or through wounds.** Once inside plants they cause injury by producing toxins, or they can plug vascular tissues. By occluding vessels, for example, they prevent the movement of water and nutrients, which causes plants to die, primarily due to lack of sufficient water. There is only one recorded bacterial disease of turfgrasses in the United States, and it is caused by *Xanthomonas campestris.*

The first recorded host for bacterial wilt in the United States was "Toronto" (also known as C-15) creeping bentgrass (*Agrostis stolonifera*). Because the cause of the disease was initially unknown it was referred to as "C-15 Decline." In creeping bentgrass the disease only has been reported to attack vegetatively propagated cultivars such as Cohansey, Nimisilia, and Toronto (Vargas, 1994). Since the original report of C-15 Decline in the early 1980s in the Midwestern United States, there have been no other formal reports of the disease in creeping bentgrass. **A closely related biotype, *X. campestris* pathovar *poannua*, causes a wilt disease in annual bluegrass (*Poa annua*). A biotype of this bacteria is being developed as a biological agent for annual bluegrass control and is sold under the trade name of XPO®.**

Currently, bacterial wilt is primarily considered a disease of annual bluegrass when grown on putting greens. Most of what we know about the nature of this disease was described by researchers at Michigan State University (Roberts et al., 1981). In "Toronto" creeping bentgrass, the bacteria are primarily limited to xylem vessels in roots, but it may be detected in crown and leaf tissue. **Once the xylem elements of a large number of roots become plugged with masses of bacterial cells, plants begin to wilt. Initial symptoms therefore appear as wilt and the leaves develop a blue-green color.** This stage is short-lived, and the leaves rapidly turn brown and shrivel. Large areas are destroyed in a nonuniform pattern within a few days. Adjacent "Toronto" in higher-cut collars or fairways displayed little or no injury. This disease is favored by periods of heavy rainfall followed by cool nights and warm and sunny days. Hence the disease is most likely to appear in the spring and autumn.

Bacterial wilt is a disease on the rise in annual bluegrass on putting greens. The increased incidence of the disease may be due in part to the trend for very low mowing heights and a higher frequency of topdressing. It primarily has been observed in the Mid-Atlantic and Northeastern regions of the United States. In annual bluegrass grown on greens, the disease generally first appears in late May or June, but may remain active throughout the summer. Individual infected annual bluegrass plants turn reddish-brown or yellow and die in spots about the size of a dime. When there is coalescence of numerous dead plants, the nonuniform browning can mimic anthracnose (*Colletotrichum graminicola*). **The disease should be confirmed by a pathologist.** In the laboratory, a diagnostician will cut leaves with a razor blade and look for oozes or streaming of bacterial cells on a microscope slide. Slow oozes from yellow or senescent tissues are common, but rapid streaming of cells from vascular bundles of mostly green leaves or roots is the best indicator of bacterial wilt. Unfortunately, it is very difficult to isolate and identify *X. campestris.*

Management

Increasing the mowing height reduces disease severity dramatically, but also slows the speed and therefore playability of putting greens. **Mowing turf when leaves are dry may slow the progression of the disease. Should the disease be restricted to one or a few greens, a "dedicated mower" should be used.** It is best to use a lightweight, walk-behind greens mower. **The dedicated mower should be disinfected with a 10% Clorox® solution or similar disinfectant after use, and the mower should not be used on disease-free greens. Topdressing should be avoided when the disease is active.** This is because sand abrades and wounds tissue, and creates openings for easy entry of the bacteria. Antibiotics suppress bacterial wilt, but they are very expensive, difficult to handle, and generally do not provide an acceptable level of control (Vargas, 1994). Products containing copper, such as copper hydroxide (Kocide®), may provide good short-term control. Kocide is labeled for algae control in turfgrass and may be tank-mixed with fungicides. Kocide is primarily used to control bacterial diseases in fruits and vegetables. There are, however, no label recommendations for using the product for bacterial wilt control in turf. Depending on formulation, the rate that is labeled for algae control in turfgrasses (0.5 to 1.0 lb/1,000 ft^2; 225 to 450 g/93 m^2) would likely severely injure greens. Anecdotal observations suggest that rates in the range of 0.5 to 2.0 oz/1,000 ft^2 (15 to 60 g/93 m^2) are relatively safe for

Continued on page 5

FEATURE ARTICLE

Chipco Proxy—A New Plant Growth Regulator for 1999

Fred Yelverton

In the previous issue of Turfax, we discussed a new herbicide (Drive) which is registered for use in turf for 1999. In this issue, we will discuss Proxy, which is a new plant growth regulator that has obtained EPA registration for use in turf. In addition, another herbicide, Lontrel Turf and Ornamental, is scheduled to be available for the third quarter of 1999. Lontrel will be discussed in a future issue. It is noteworthy that at least 3 new herbicides or plant growth regulators will be available in 1999. This is indicative that the turf market is growing and the basic manufacturers are optimistic about the future of turfgrass management.

The common name for Chipco Proxy is ethophon. Unlike other currently registered plant growth regulators such as Primo, Cutless, and TGR Turf Enhancer, which work by temporarily inhibiting gibberellin biosynthesis in plants, the mode of action for Proxy is associated with the release of ethylene gas in plant tissues. Ethylene is a naturally occurring plant growth hormone that generally occurs in very small quantities (usually less than 0.1 ppm) in plant tissues. However, ethylene is responsible for a number of growth responses in plants, including leaf bending (epinasty), leaf abscission, stem swelling, inhibition of stem growth, fruit ripening, and flower petal discoloration. **Proxy retards foliar growth by stimulating the production of ethylene in plants.**

Ethophon is currently registered as a plant growth regulator for several other agronomic and horticulture crops. Because other formulations of this product are currently registered with the EPA, the registration of Proxy was very fast. **As a result, there is limited research on the effects of this plant growth regulator on turf.** However, data from a few researchers across the country indicate that Proxy can be effective in reducing vegetative growth of turf. In a year or two, much more will be known about this product.

Proxy is a foliar-absorbed product that should be applied to actively growing turf. The plant growth re-

Continued on page 5

Counting Wildlife—Is There More?

James B Beard

The number and diversity of birds and other animals present is a key indicator of the environmental health of a golf course. The presence of these animals in a landscaped golf course environment is an added beneficial feature for individuals playing a round of golf.

During the past decade considerable emphasis has been placed on counting the actual number and diversity of birds and other animals present on a golf course. Golf course officials are encouraged by wildlife specialists to provide an environment that is increasingly hospitable to a diversity of wildlife, including the construction of artificial features and structures. **The implied philosophy to date has been "the more wildlife the better."**

However, is this approach really appropriate and realistic? There are numerous examples around the world where man has attempted to enhance wildlife numbers that have resulted in excessive populations, e.g., Canada geese, deer, wild pigs, and others. The result has been a deterioration in the animal's natural habitat, and in some cases has presented human health hazards as well as habitat loss or imbalance relative to other desirable wildlife species.

Would not the better approach be to assess the existing and potential natural habitat carrying capacity for each golf course site in terms of the range in wildlife species and specific numbers that can be realistically supported? Threshold levels should be established as to the maximum, balanced numbers of wildlife for a range of the appropriate animal species. Then subsequent plant and animal surveys can determine if those population thresholds have been reached, which will signal an alert when an excessive population is developing. This is especially important where man-made structures have been constructed that may need to be removed to avoid an animal population level that overburdens the local habitat, and causes significant habitat deterioration on the golf course. Also, one should recognize that humans are a component of the Animal Kingdom that occurs on the golf course.

An even greater question is "do wildlife scientists know what species and populations levels can be realistically supported by each individual type of soil-climate ecosystem?" Is this important basic principle being ignored in the rush to improve the image of golf courses through wildlife habitat enhancement?

Chipco Proxy...

Continued from page 4

tardant effects usually are apparent after about 7 to 10 days. Proxy is currently only registered on several cool-season turfgrass species. They are as follows:

- Kentucky bluegrass (*Poa pratensis*)
- Perennial ryegrass (*Lolium perenne*)
- Bentgrass (fairway height) (*Agrostis* spp.)
- Tall & fine-leaf fescue (*Festuca* spp.)

Proxy maybe used on fairways, roughs, and other commercial turfgrasses. Currently, the label prohibits its use on putting greens. The use rate for Proxy will be 5 oz/1,000 ft^2 and should be applied in 0.5 to 4 gallons of water/1,000 ft^2. The use of surfactants is not recommended. Reapplications may be made at the following intervals:

• Kentucky bluegrass:	7 weeks
• Perennial ryegrass:	7 weeks
• Bentgrass:	4 weeks
• Tall & fine-leaf fescues:	4 weeks

As with any plant growth regulator, proxy should only be applied to actively growing turf under favorable growth conditions. Applications of Proxy should be avoided during periods of stress. As with any new product, Proxy should be tested under local conditions prior to wholesale application.

Bacterial Wilt...

Continued from page 3

greens. Some discoloration may be masked by tank-mixing Kocide with chelated iron or slow-release, liquid forms of nitrogen. Kocide should be applied in at least 5.0 gallons of water/1,000 ft^2 (19 L/93 m^2). Using lower water dilutions when applying Kocide could intensify turf injury. In situations where the disease is chronically severe, greens composed primarily of annual bluegrass may have to be renovated.

XPO® – The Biological Agent

Eco-Soil Systems® of San Diego, California, is developing ***X. campestris*** **pathovar** ***poannua*** **as a biological agent for annual bluegrass control on golf courses.** The biotype being developed was discovered by Dr. Joseph M. Vargas, Jr. of Michigan State University. According to tests reported by Eco-Soil Systems, the XPO biotype does not infect creeping bentgrass. Various biotypes of *X. campestris* have been tested in the United States. The reported levels of annual bluegrass control with some *X. campestris* biotypes have varied from 0 to 82% (Johnson, 1994; Zhou and Neal, 1995). Like all biological agents, the level of control will vary from year to year and possibly from region to region. This is because most biological agents require some very specific environmental conditions in order to incite disease.

Currently, the XPO bacterial must be fermented on-site using the Bioject System®. After a suitable fermentation period, the liquid is pumped into and delivered by a conventional sprayer. **It is recommended that XPO be applied four times in the spring and autumn.** The bacteria are sensitive to UV light. Therefore, the product should be applied in the evening when the turfgrass leaves are dry. **Immediately following application, the treated turf must be mowed.** The mowing creates wounds, which allows for the entry of the bacteria. According to Mr. John Lensing of Eco-Soil Systems®, the company has an aggressive research program planned for 1999. These research efforts should contribute a lot of new information regarding how best to achieve maximum annual bluegrass control with XPO. According to some initial estimates, levels of annual bluegrass control in the 5 to 10% range typically occur. However, the use of gibberellic acid to stimulate elongation of annual bluegrass leaves prior to applying XPO may boost control into the range of 50% or higher. There also is some evidence that XPO can infect rough bluegrass (*Poa trivialis*). Obviously, extensive field testing in various climatic zones will be required to provide more meaningful information on how best to use the product.

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FEATURE ARTICLE

Spring is the Best Time for Ant Control

Daniel A. Potter

Lately, my research team has been investigating new approaches to managing mound-building ants on golf courses. **The results have been promising and may be helpful to superintendents who need to control ants on their putting greens and tees.**

Surveys of mound-building ants on putting greens in Kentucky revealed that virtually all of the problems are caused by one species, *Lasius neoniger*. This also seems to be the main nuisance ant on golf courses throughout much of the U.S. Workers of this ant excavate underground nest chambers, pushing up small mounds of soil that deflect golf balls, dull mower blades, and smother patches of turf. This ant is also common in roughs, fairways, and other sunny turf sites, although the mounds are less conspicuous in such areas.

Ant problems in turf seem to be increasing nationwide. One theory to explain this is that residues of chlordane and other highly persistent turf insecticides used in the 1960s and early 1970s have finally declined. Another theory is that replacement of diazinon—which is highly active on ants—with newer, more target-selective grub control products has allowed ants to gain a foothold on golf courses. Whatever the reason, I'm getting more inquiries about ant control than ever before.

Effective management of these pests starts with understanding their habits. *Lasius neoniger,* like all ants, is a social insect. It lives in colonies that consist of 100s or 1,000s of sterile worker ants, but only one reproductive queen. The nest consists of shallow, interconnected chambers, seldom more than 10 to 15 inches (25–38 cm) deep. **Passages to the surface are topped by small mounds, each with a central opening. The number of mounds varies from just a few to 10 or more per nest, and generally increases as the colony grows.** The queen ant, with her eggs and larvae, remains underground to be fed and tended by worker ants. The workers forage on the surface for protein foods, especially small insects and insect eggs, and may also tend subterranean root aphids for honeydew, a watery, sugar-rich fecal material. These ants are beneficial, except in close-cut creeping bentgrass, because they prey upon cutworms and other pests.

Where do ants on putting greens originate from? As colonies build up in late summer, new virgin queens and males are produced. These winged reproductive ants swarm out of the nests in late summer or autumn (August to October). After mating, the young queens shed their wings and enter small, self-made cavities in the ground. They remain there over the winter, and normally don't start to lay eggs until spring. Successive broods are produced until the colony is large enough to produce new males and queens. Individual queens and colonies may live for several years.

Controlling ants is difficult because fast-acting insecticides usually kill only a portion of the workers foraging on the surface, but fail to eliminate the queen. Pyrethroids, such as bifenthrin (Talstar®), cyfluthrin (Tempo®), deltamethrin (DeltaGard®), and lamda-cyhalothrin (Scimitar®), and organophosphates such as chlorpyrifos (Dursban) often will suppress mound-building for a few weeks after treatment. Treating for cutworms usually reduces the buildup of ants, too.

Several commercial **ant baits** are highly effective for controlling ants infesting homes and other structures. These baits contain delayed-action insecticides formulated on granules with food substances that attract the foraging ants. **The workers carry the bait back to the nest, where it is fed to the queen and her brood. Once the queen is eliminated, the colony dies out and the mounds are not rebuilt.** Last summer, we tested a range of these baits against ants on golf courses.

Our research showed that **Maxforce Granular Insect Bait®** (Clorox Co., Oakland, CA) **and Advance Granular Carpenter Ant Bait** (Whitmire Micro-Gen, St. Louis, MO) **are highly effective against *Lasius neoniger*. Sprinkled around the mounds, a small amount of either bait will eliminate a nest in about 2 days.** Once the mounds are raked or knocked down by mower blades, they will not be rebuilt. Minimum effective rates are still being tested, but about 1/8 teaspoon of bait per mound worked well in our trials. Withhold irrigation for at least a few hours to allow the ants to take the bait. Both baits worked equally well, but Maxforce is less noticeable on putting greens because of its smaller granule size and dark-brown color.

Maxforce bait is marketed in 10 oz. shaker cans, 6 lb jugs, and 25 lb bags. One 6 lb jug contains enough bait to spot-treat about 4000 mounds. Combined retail cost of a jug and a shaker can is only about U.S. $70.00. The shaker can is useful for application. I recommend purchasing both, and refilling the shaker can as necessary.

These baits are too expensive for broadcasting on fairways, but **they *are* cost-effective for spot-treatment on putting greens. Several golf superintendents who have tried them also report excellent control.** Neither of these baits is specifically marketed for use against ants on putting greens. However, registrations of both products list

Continued on page 7

...Ant Control

Continued from page 6

turf and golf courses as approved sites, and do not specify that they cannot be used against *Lasius* ants on putting greens. Thus, their use is allowed under Section 2ee of the Federal Insecticide, Fungicide, and Rodenticide Act, so long as labeled rates are not exceeded. As with all pesticides, specific restrictions may apply in some states (e.g., California). Questions regarding labeling of these baits should be directed to their manufacturers. (Maxforce: 1-800-322-2802, ext. 8824; Advance: 1-800-777-8570.)

Maxforce Granular Insect Bait and Advance Granular Carpenter Ant Bait are available through pesticide distributors who carry products for the structural pest control industry. Note that a similar-sounding product, Advance Granular Ant Bait, was not as effective in our tests. So, if you try the Advance bait, be sure to specify the Granular **Carpenter** Ant Bait.

Regardless of the method, ants are usually easiest to control in spring, soon after the mounds appear. At that time, the colonies founded by new queens are still small, and nests that persist from the previous year are weakened from overwintering. By getting the jump on them, you can avoid the rapid expansion of colonies and mounds that normally occurs in late spring and summer.

Daniel A. Potter is Professor of Turf and Landscape Entomology at the University of Kentucky. His new book, *Destructive Turfgrass Insects: Biology, Diagnosis, and Control,* is available from Ann Arbor Press.

RESEARCH SUMMARY

ASSESSMENT OF CURATIVE CONTROLS FOR SURFACE ALGAE ON GOLF GREENS

An assessment of curative chemical controls for algae was conducted on an 8-year-old turf of Penncross creeping bentgrass (*Agrostis stolonifera*) at Griffin, Georgia, during the summer of 1998. The turf was maintained at a cutting height of 5 mm and a mowing frequency of 5 times per week. Plot size was 3 by 3 feet in a randomized complete block design with four replications. The blue-green algae, primarily *Oscillatorie* species, were induced on the surface of the root zone, by pretreatment with two DMI fungicides that have a growth suppression effect on the grass shoots, which allows sunlight penetration to the soil surface. The fungicide and algicide treatments were applied on August 12, 1998. Estimates of the percent algae present were made at 7-day intervals following the initial treatment. Mancozeb + copper hydroxide, (Junction®) at the 4 and 8 ounce per 1,000 ft^2 rates and copper sulfate at 2 ounces per 1,000 ft^2 were the only treatments that provided acceptable suppression of less than 3% algae for the duration of the study. Daconil Zinc, Consyst, and calcium hydroxide provided marginally acceptable control of less than 10% algae. Fore 80, Daconil Ultrex, Heritage, ProStar, BannerMAXX, potassium sorbate, and QuickStop did not provide acceptable levels of algae suppression. At the peak algae coverage of August 19th through September 2nd, all treatments except the potassium sorbate provided significant suppression of this algae. Editor's note: More than six different algae species may occur on putting greens during a single growing season. It is possible that a chemical that controls certain algae species may not control a different algae species. **Source: Curative Control of Surface Algae on Golf Greens, 1998, by L.L. Burpee and S.L. Stephens.** 1998 University of Georgia, Turfgrass Pathology Research Report, pp. 1–4.

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JB COMMENTS

ISTI ACTIVITIES

A question asked fairly frequently is what are the activities of the International Sports Turf Institute (ISTI)? First a definition might be in order. **The geographical scope of the Institute activities extends throughout the United States and worldwide.** The Affiliates with which the ISTI is actively involved are developed based on specific requests from an individual governmental agency, sports federation or association, philanthropic agency, company, or individual. Long-term associations are preferred to one-time interactions. Included under the term of sports turf are all phases, including golf courses, sport fields, race tracks, bowling greens, recreational grounds, and sod production operations. The activities of ISTI can be grouped into four categories as follows.

Education. Approximately 40% of the effort is devoted to educational activities involving lectures at turf conferences and presentations of 1- to 3-day seminars in various countries around the world. A seminar presentation also may involve the writing of a coordinated manual that is translated into the specific language of the host country. **ISTI seminars were presented in England, Germany, Ireland, the Netherlands, Sweden, and the United States during 1998.**

Research. ISTI has research contracts in a number of countries, which accounts for 30% of the activities. The contracts involve research planning, staff training and monitoring, data collection and analysis, and research report preparation. Turfgrass research plots are currently under contract in Torino, Italy; Rome, Italy; and Chiba Prefecture in Japan. Specific research projects ongoing in the United States are located in College Station, Texas; Houston, Texas; Palm Springs, California; and Phoenix, Arizona. **Associate Agronomist Sam Sifers devotes a considerable portion of his time to these research efforts.**

Technical Writing. Approximately 15% of the Institute's efforts are devoted to writing scientific papers, technical articles, and books. **The full-color, second revision of *Turf Management for Golf Courses* is scheduled to be available in September of 1999.**

Turfgrass Technical Assistance. Technical assistance involving on-site visitations to assess existing or potential turfgrass-soil problems is provided worldwide. These activities allow real-world interaction with the various segments of the turfgrass industry.

ENHANCING TURF RECUPERATION OF TEES

In northern Italy there are golf courses utilizing an innovative approach to the mowing strategy on tees. Specifically, the portion of each tee that has been subjected to intense divoting is mowed on a less frequent basis to allow enhanced turfgrass regrowth. The concept being that the resulting greater leaf area will cause an increase in carbohydrate production to enhance the speed of turf recovery. This approach is most appropriate on closely mowed tees. In addition, the less frequent mowing should be a moderate adjustment that does not result in such excessive leaf growth that a degree of scalping occurs. There have been several new strategies for golf course culture that have evolved from Italy. An earlier development was frequent topdressings of sand onto clay-based fairways combined with intense, deep-core cultivation. This is now widely used in many parts of the world. It will be interesting to see whether this technique for enhanced divot opening recovery for tees will find more widespread use.

ASK DR. BEARD

Q. What are the negatives of mowing putting greens in the evening?

A. The major factor in mowing putting greens in the evening will be a slower putting speed or a shorter distance of ball roll during the subsequent day. In the order of 60 to 65% of the daily vertical leaf extension occurs during the nocturnal period. During darkness the stomata are closed and water loss by evapotranspiration essentially ceases. However, root water uptake continues and a strong positive water balance and high tissue turgidity results. Since the vertical leaf extension involves principally cell elongation and water is the key component in cell elongation, the result is much greater vertical leaf extension at night than during daylight. This occurs even when the daylight period is much longer than the nights of midsummer.

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