USGA® GREEN SECTION

Record

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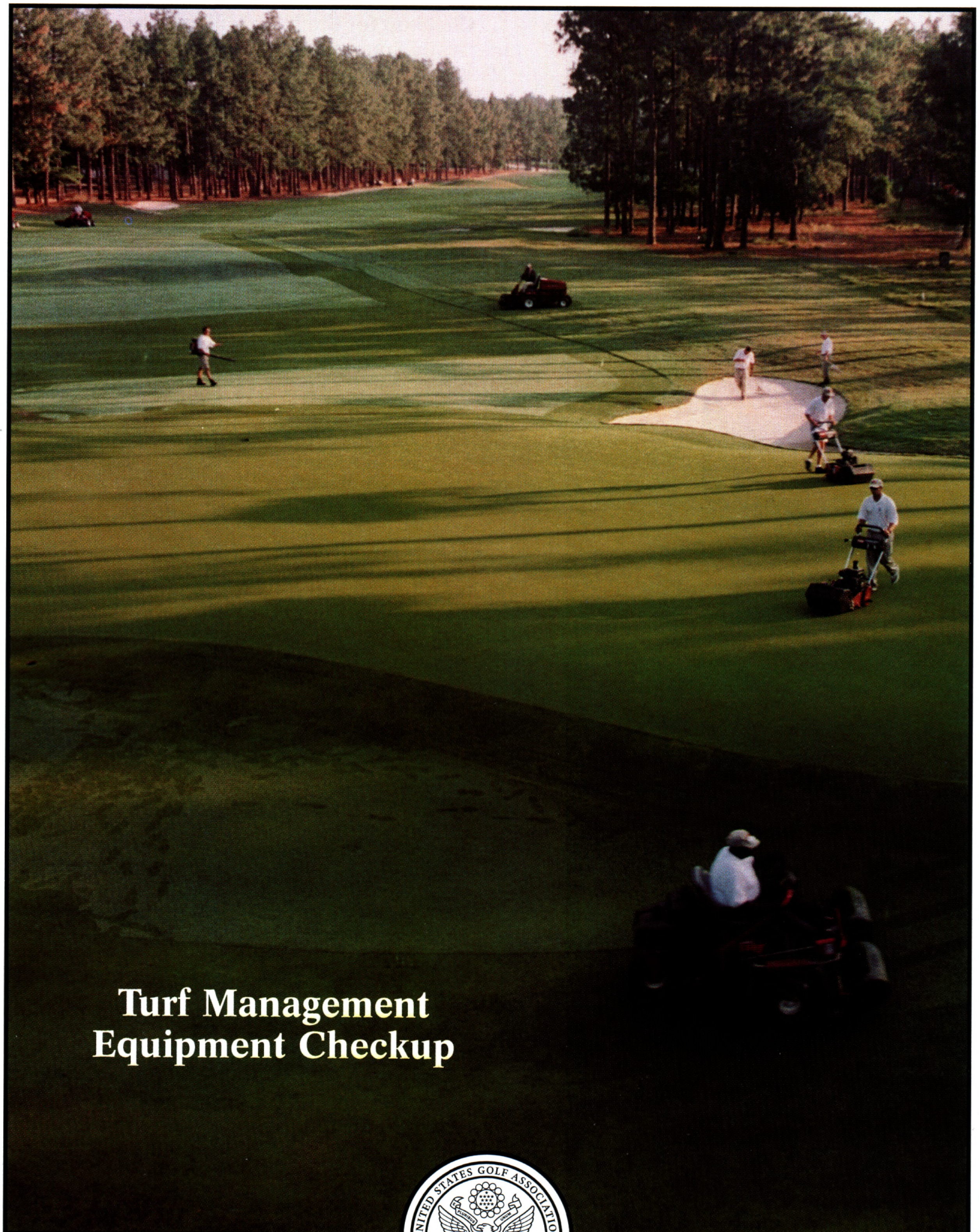

Turf Management Equipment Checkup

A PUBLICATION ON TURFGRASS MANAGEMENT BY THE UNITED STATES GOLF ASSOCIATION®

NOVEMBER/DECEMBER 2001
Volume 39, Number 6

*Cover Photo:
To provide the conditions that golfers expect today, turfgrass managers need more sophisticated equipment than ever before (Pinehurst No. 2, North Carolina).*

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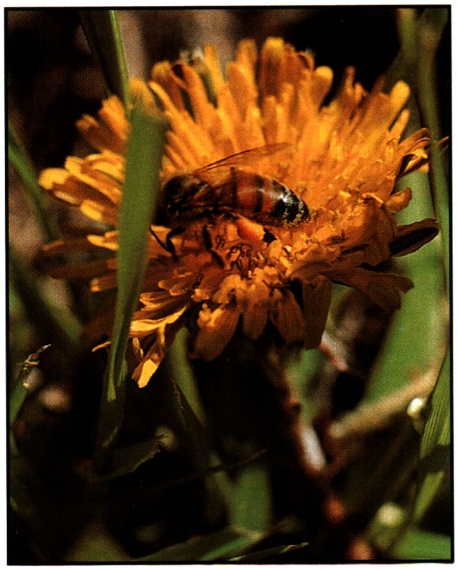
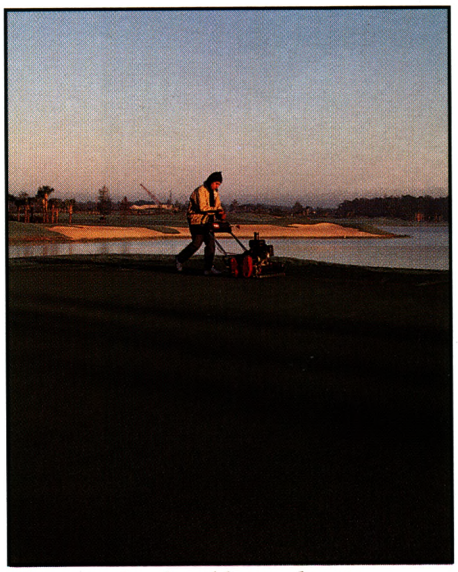


Preventive grub insecticides should pose little or no residual hazard to pollinators so long as residues are watered into the soil. See page 8.



The new ultradwarf bermudagrass cultivars can be managed to provide unprecedented putting speed, but special care must be taken. See page 14.

CHECKUP FOR THE NEW MILLENNIUM:
Does Your Equipment Fleet Make the Cut?

Meeting player expectations requires the right tools.

by MATT NELSON

IF YOU'RE A GOLF COURSE official or course owner who has been involved in purchasing golf course maintenance equipment, you might think that the Starship Enterprise is docked at the maintenance facility. The cost of golf course maintenance equipment is high, but when considering present maintenance standards and player expectations at many golf courses, the cost of various equipment items really is not so surprising. Putting greens commonly are mowed at ⅛ inch or below. Tees and fairways are being cut at ½ inch or lower. Bunkers (once known as hazards) are raked with unbelievable regularity, topdressing sand is applied every week or two at rates so light that golfers can't notice, specialized products are applied at rates of a few fluid ounces per acre or less, and cultivation is performed in a manner intended to minimize disruption to play. Has golf course conditioning gone haywire? Regardless, the cost of meeting today's player expectations is high, and if the course maintenance staff does not have the tools to get the job done, players should stop making unfounded comparisons to other golf courses.

There are several essential aspects of remaining competitive in the golf market. Customer service, location, golf course design, and conditioning likely top the list. Service and maintenance are the two that matter every day, and it is the latter that this article addresses. Proper conditioning of the golf course depends upon the skill and expertise of the golf course superintendent, a well-funded budget, and the necessary tools to get the job done (3). Given the exacting specifications of present-day playing standards, having the right tools for the task at hand separates the good, the bad, and the ugly (6). Following is a sample equipment inventory for an 18-hole golf course, designed to provide high quality playing conditions. This list may identify shortcomings in your equipment inventory that could be a major limiting factor in realizing the desired playing conditions at your golf course. Regional differences and special circumstances will necessitate some variation from this sample.

Quality aeration equipment is a must. Having the proper equipment allows the necessary practices to be completed in a short time and with the least amount of disruption to play.

Mowing Equipment

Mowing is the most routinely performed cultural practice on the golf course. The quality of cut clearly has a major influence on the playing surface, and it also can significantly affect the health of the turf. A dull mower can increase disease incidence, adversely affect the plant physiologically, and increase water use. Heavy mowing equipment imparts wear injury to the turf and causes soil compaction, both of which are commonly observed problems. Properly selected, dependable mowers are a must for good turf.

Greens: Six to eight walk-behind putting green mowers are most common. If you do not walk mow the putting greens – strike one. Walk mowing has consistently demonstrated the best playing conditions and the healthiest turf (5). Grooming units should be included to lightly vertical mow when conditions are favorable (16). At least two triplex mowers for greens are necessary for verticutting, weekend, or special occasion mowing, and for mowing following topdressing applications. Three or four triplex mowers are needed for the greens if you cannot walk mow.

Collars: Two walk-behind mowers for the collars should suffice. A distant second is mowing collars with a triplex mower that also can be used to mow tees and approaches. Fairway mowers should not be used to mow collars. Remember, the heavier the machine, the more the turf is damaged.

Tees: Two or three triplex putting green mowers should be part of the inventory for tee mowing. Tee mowers also are commonly used to mow approaches. This strategy prevents heavier fairway units from turning in this critical play area. Some of the best courses go one step further. Tees, collars, and approaches at these courses are walk mowed with wider walk-behind mowers, usually up to 26 inches

A dependable fleet of lightweight fairway mowers is needed for a good turf surface.

in width. Four to six of these walk mowers would be necessary.

Fairways: The advent of lightweight fairway mowers over the past 10 to 15 years truly revolutionized the management and playabilty of fairways at golf courses across the country. In fact, many golf courses with bentgrass fairways mow with triplex putting green mowers. More realistic, however, is an inventory of three or four fiveplex mowers. Within this class of mower, many different models are available to suit the specific conditions at your golf course – type of turfgrass, topography, soil conditions, etc. Your course has just one or two fairway mowers? Strike two. What happens when one unit breaks down and there is no backup? Can your crew stay ahead of the golfers? Pencil out the cost of these inefficiencies and it will be apparent that the cost of an additional unit can be recovered in a short time.

Roughs: Articulating rotary rough mowers with five to nine mower blades have significantly improved the mowing quality of turf in the roughs and streamlined maintenance efficiency. Smaller rotary and reel trim mowers allow mowing of areas that formerly could only be cut with walk-behind mowers or string trimmers. Significant scalping has all but disappeared at golf courses with an updated rough mowing fleet. Specific requirements depend largely on rough acreage and design, but generally one or two large rotary mowers and three to five trim mowers are needed. Don't forget that at least one machine will have to be set up to mow intermediate rough if this is a feature at the golf course. Advances in mower technology are, in fact, a huge reason that the roughs at many golf courses really aren't that rough anymore (17).

Cultivation Equipment

Proper cultivation cannot be overstated. High maintenance standards, traffic, poor construction, bad soil conditions, overseeding, renovation, and/or basic agronomic sense underscore the need for a good cultivation program. And, since golfers generally abhor most of the practices mentioned in this section, it is extremely helpful to have the proper equipment so that cultivation work can be completed in a short amount of time with the least amount of disruption to play as is possible.

Aerators: At least two walking putting green aerators are needed. Be sure that the machines have the necessary adapters to be equipped with tines of all sizes. The ability to perform specialized cultivation, including small-diameter solid-tine aeration, can make a big difference in plant health and overall success of greens. One or two tow-behind piston-driven aerators are necessary to aerate fairways and tees. No fairway aeration equipment in the fleet? Strike three. Next batter. Unless your course is located in a metropolitan area where contract aeration is available, the lack of fairway aeration equipment usually results in the development of agronomic problems and lousy playing quality. If rocks in the soil are a big problem, you may need to utilize a drum-type aerator in lieu of cam-driven units. The holes will not be as crisp or as deep, but at least gas exchange and water infiltration will be improved, soil compaction relieved somewhat, and an opportunity to overseed created.

Specialized aeration equipment, including deep-tine units and high-pressure water injectors, may also serve a useful niche, depending on soil conditions, water quality, and other factors. In many parts of the country, independent contractors perform this type of cultivation (14). Obviously, you will be limited by the schedule of the contractor. Timing problems and fickle weather conditions may warrant the purchase of such equipment. Seek the advice of a Green Section agronomist, university extension specialist, or other consultant to determine the best tool for the job and to justify the purchase.

Core Harvester: A core harvester certainly pays for itself fairly rapidly. The crew also will be glad to take another step away from the Stone Age.

Dethatching Machines: Once again, independent dethatching services have gained popularity in the turfgrass arena.

The development of new creeping bentgrass and bermudagrass cultivars for putting greens has prompted a refinement of management techniques, most importantly the control of organic matter deposition in the upper soil profile. If managing putting greens with the newer grasses, take a close look at available dethatching equipment.

Topdressing Applicators: Sand topdressing can be one of the most important practices used to improve agronomic conditions and playability. Soil modification with sand can improve compaction resistance and drainage. Sand applications help control thatch and smooth and firm the playing surface. One tow-behind drop spreading applicator is needed to fill holes completely following core aeration of putting greens. For light and frequent topdressing, however, a tow-behind rotary applicator greatly facilitates this practice. Many of the best golf courses lightly topdress putting greens on seven- to 14-day intervals throughout the growing season. Tow-behind rotary applicators enable superintendents to complete light topdressing of 18 greens in about two hours or less, at rates light enough that brushing or dragging is not required and golfers do not notice the practice has been done. And, if you are not topdressing the approaches, we've likely just retired the next batter.

In some areas of the country, fairway topdressing is performed to improve drainage and footing and reduce compaction effects. Have you ever seen earthworms on golf course fairways? Research conducted at Washington State University has shown sand topdressing to be the most promising (and legal!) means of reducing earthworm casting problems in fairway turf. Obviously, a large-volume materials handler is needed to perform this task. But these also are useful for many other tasks around the golf course, including bunker and cart path work and compost and fertilizer applications.

Rollers: Rolling putting greens, when conducted with moderation, can improve playing conditions without jeopardizing the health of the turf. Rolling can be used to save a mowing and provide a little more leaf area without losing noticeable green speed. Rollers also can help prepare a seedbed and smooth newly laid sod. Select a type that best suits the needs at your course. Labor availability and operator expertise should be considered.

Slice Seeders: A slice seeder is a must for golf courses that overseed annually. A slice seeder also is very useful when renovation is needed following winterkill, vandalism, pest damage, etc. Turfgrass species conversion can be enhanced with a good slice seeder.

Spiker: A tow-behind spiker/tip seeder or spiking attachment for a triplex mower also is a useful component of the equipment fleet. Spiking is a good means of maintaining good gas exchange and improving water infiltration in the upper soil profile.

Sprayers and Spreaders

Advancement in sprayer technology has enabled application equipment to keep pace with product innovation. Many of the available products currently labeled for turfgrass use contain amazingly low amounts of active ingredient, requiring precise calibration to accurately apply mere ounces of product per acre. These applications must also be made over varied terrain, in closed or tight locations, and on windy sites. Coupled with the associated costs of the various products, the need for accurate application control is critical. Computerized control systems match flow with ground speed and/or pressure to maintain a uniform application rate. A dependable, modern sprayer makes economic, agronomic, and environmental sense.

Sprayers: A lightweight (approximately 150-gallon tank) sprayer with sophisticated control is a must for maintaining optimal putting green health and playing conditions. Foliar fertilization, plant growth regulator use, and accurate pest control applications are integral parts of many putting green management programs. A larger (300-gallon) sprayer for fairways and other large turf areas also should be included, along with two backpack sprayers and two hand-held sprayers for spot applications and edge applications.

Spreaders: Four to six walk-behind rotary fertilizer spreaders are needed at any golf course. Two drop spreaders (one small and one large) will also serve a useful purpose. One large-volume fertilizer spreader is also a necessity.

Specialized equipment, including large material handlers, can improve maintenance efficiency and make possible programs like fairway topdressing.

Utility Vehicles

Dependable transportation/work vehicles are needed to move employees around the course and complete tasks. On average, four to six heavy-duty vehicles and three to four light-duty vehicles should suffice. These numbers may need adjustments if the labor force is large.

Tractors and Trucks

The inventory should include at least two utility tractors with PTO, one loader with backhoe, one dump truck, and at least one pickup truck.

Miscellaneous Equipment

Most golf courses need one or two riding mechanical bunker rakes (even though hand raking is preferred). One or two sweepers, a tractor-mounted blower, a dump trailer, and a sod cutter should be on hand. Equipment including trenchers, chippers, stump grinders, and augers can usually be rented if use will be limited. An absolute must, however, are the proper grinding tools to grind both reels and bedknives and a hydraulic lift to service equipment (9). The shop also will require a steam cleaner, air compressors, a table saw, and a drill press.

Small Equipment

Plan on the need for five to seven walk-behind rotary mowers, five to seven string trimmers, at least two backpack blowers, two edgers, two chain saws, a pole saw, shovels, rakes, picks, cup cutters, sod knives, pitchforks, and any other necessary hand tools.

Protect the Investment

Based upon this list, the approximate inventory value based on initial purchase price could easily approach or exceed $1,000,000. Safeguarding this equipment would seem to be common sense, but all too often golf course equipment is improperly stored and protected. Various components degrade rapidly when left exposed to the weather. Preventative maintenance commonly is not performed on a regular basis. Machinery hours should be tracked so that regular maintenance can be performed. Failing to protect the equipment fleet diminishes its useful life span substantially, resulting in significant additional expense to the operation.

The value of the equipment fleet and its importance to a high quality golf course underscore the need for a full-time equipment manager. Mowers should be inspected on a daily basis (13). Preventative maintenance schedules need to be developed and followed (1, 10). A well-designed maintenance facility, with plenty of storage space and the proper work area for the equipment manager and technicians, is the cornerstone of well-run golf course maintenance operations.

Finally, operators should be thoroughly trained on every piece of equipment to prevent unnecessary wear and abuse, and they should be able to recognize the first sign of a problem so that the equipment manager can service the machine in a timely manner (2, 5).

Maintaining the Fleet: The Replacement Schedule

Maintaining an efficient, dependable, and current golf course equipment fleet requires a thorough and committed plan (7, 8). Without one, unwelcome surprises and a financial crisis are sure to arise (3). The golf course quality and competitive status may suffer for years as a result. Although there are no exact rules or formulas that can apply to all equipment or sites, there are some basic procedures and guidelines.

The golf course superintendent and equipment manager should review and update the status of each piece of equipment every year. This enables a prioritization of needed items during the budgeting process (3). Hours of operation and the total cost of repair, including parts and labor, should be tracked for every equipment item. Repair costs then can be compared to the replacement cost and current value of the equipment item to determine diminishing returns (15). Hours of operation missed due to breakdown, when the equipment item should have been on the golf course, should also be tracked to evaluate maintenance efficiency and any negative effects on playing quality.

Many golf courses that purchase their equipment allocate a figure for annual equipment replacement that represents approximately 10-15% of the total replacement value of the fleet. This is perhaps a useful beginning point, but fine tuning the budgeting process is only possible by tracking use and repairs as described above. Again, service, storage, and operation hugely impact the optimum replacement schedule.

While purchasing is usually the most cost-effective approach long-term, leasing is an attractive and effective method of managing equipment for many golf facilities (12). A shortage of capital is a compelling reason to consider a lease option. Clubs that have fallen significantly behind in equipment replacement may not be able to afford to catch up, but a lease could be an option that allows them to take advantage of modernization and dependability. Another advantage to leasing is the lack of turnover costs when items are due for replacement.

Any golf operation should work closely with an accountant to determine the best fit for equipment replacement (4). Tax advantages and disadvantages can be compared between purchasing, financing, and leasing. Golf course superintendents should provide details on the status of every equipment item and also present as many options as possible for replacement. When considering models from different manufacturers, be sure to include all cost factors, including the operational statistics, maintenance requirements, and any special benefits associated with each model (4). Available service should be considered strongly. You need to know that parts, answers, and/or backup items will be available when needed.

Conclusion

The intent of this article has been to outline the requirements of a golf course equipment fleet necessary to meet the demands of most golfers. Obviously, this proposed inventory is but a framework, and individual requirements will depend upon regional differences, expectations, and special circumstances. The other important message is that this fleet needs proper care, protection, and regular replacement to maintain efficiency and quality, and keep up with technological advances (11). A primary limitation of many golf operations is a lack of the necessary tools to get the job done. Too much money is spent on repairs, and the corresponding downtime results in reduced playing quality. Deficiencies in the equipment fleet will limit the attraction of new golfers or members and compromise competitiveness in the market. How does your course rate following this checkup?

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THE PERFECT LIE

Studying the lie of a golf ball on fairway turf with a Lie-N-Eye.

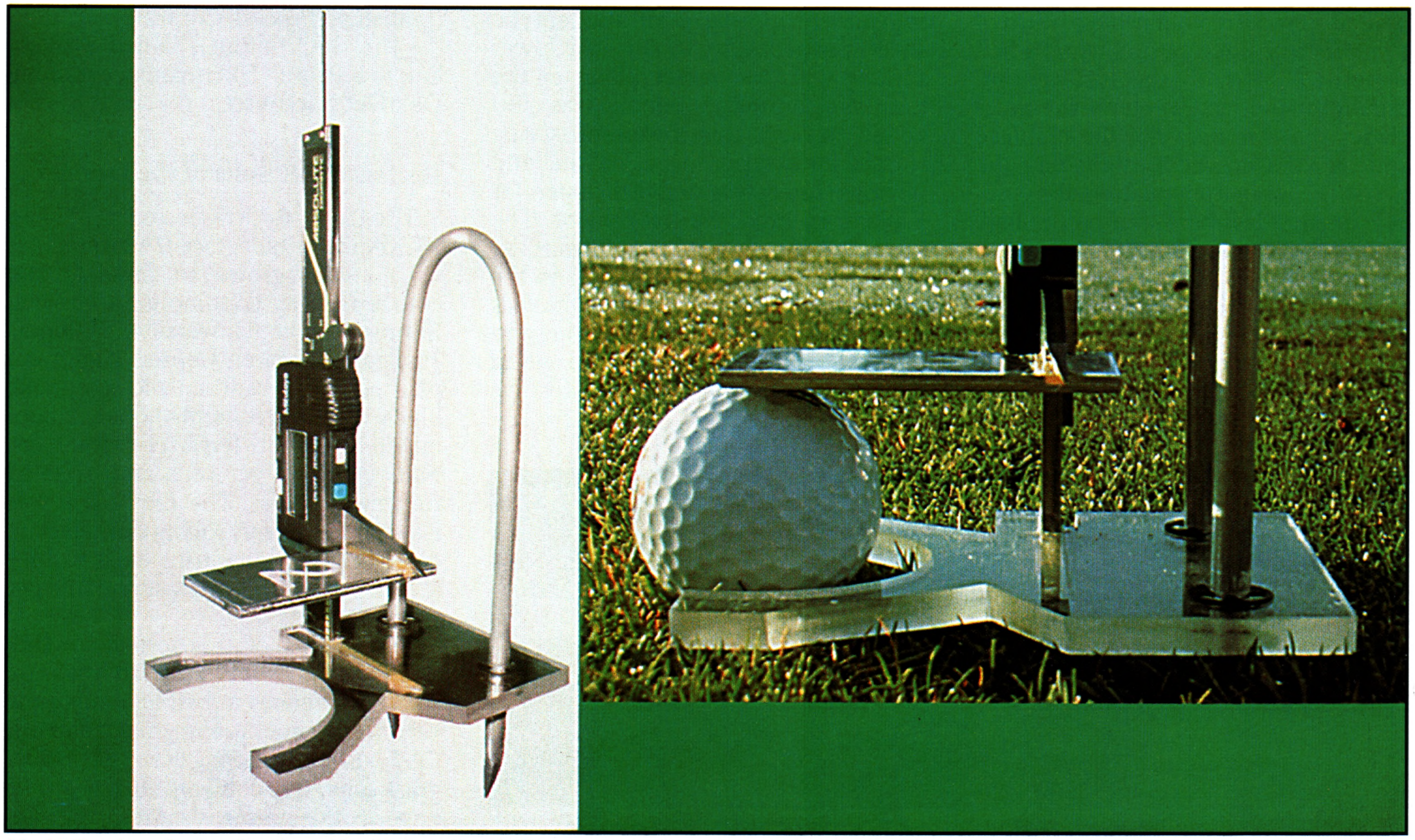
by LUKE CELLA, CGCS, and TOM VOIGT, Ph.D.

ALTHOUGH the Rules of Golf never mention the word *fairway*, everyone associated with golf knows that fairways are an integral part of most courses. The history of the golf course fairway is somewhat like most evolutions where humans are involved. There was a gap between the teeing and putting grounds and, over time, fairways filled that void.

Originally, golf course fairways were known as *fairgreens*. These were areas that golfers would try to reach from the teeing area to set up the next shot. These areas contained some managed turf and gave a clear shot to the green. No one is quite certain if the managed turf was more important than the clear shot to the green on these early fairways. It could be imagined that both attributes were important to the early golfer, especially when finding the ball could have been quite a challenge. In these early days, the function of the fairway was not completely clear, and the fairway's form followed the natural contour of the course.

Today, fairways make up the largest part of finely managed turf on most golf courses. A typical 18-hole golf course can have between 30 and 60 acres of intensively managed fairway turf. Newly constructed golf course fairways are shaped and graded with specialized equipment to form smooth, contoured surfaces. At one time, having irrigated fairways was unique enough to use as an advertising advantage; now, irrigated fairways are commonplace and expected in most areas. Advancements in mowing equipment and maintenance practices have led to closer and closer mowing of golf course fairways. The driving force behind the state of the golf course fairway today is that most golfers have come to expect a ball cleanly perched on a well-drained, uniform, verdant fairway.

Fairways have become very important on each golf course primarily because golfers know that they should always play the ball as it lies. This dictate comes into effect after one has hit the ball from the teeing ground and is playing from the area deemed through the green. *Through the green* is defined as the "whole area of the golf course except the teeing ground and the putting green of the hole being played and all hazards on the course." Golf course roughs, surrounds, aprons, native vegetation, forests, decorative plantings, and fairways fall under this definition. Since most of the game is played from these areas, the lie of the golf ball on the fairway is important because it provides a better lie than any other through-the-green area. The lie of the ball is produced by all of the turf species and/or cultivars and the management practices employed to maintain them.



Lie-N-Eye is a device developed by University of Illinois researchers to measure the ability of a turfgrass species to support a golf ball under a typical fairway setting.

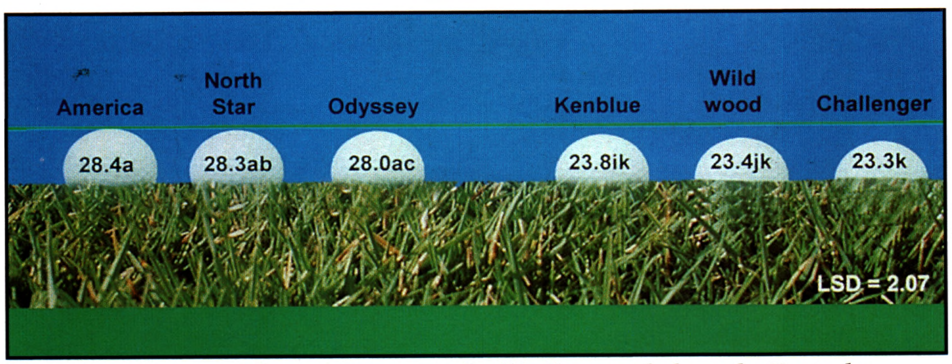
The importance of the golf ball lie (what we are referring to as the amount of a golf ball exposed above the canopy) can be expressed using simple physics. A golf ball in contact with a lofted club has two main types of force acting upon it, one normal (at a 90° angle) to the face of the club and one parallel (tangential) to it. The force normal to the club generally affects the velocity, while the tangential force rotates the ball. The rotation or spin (when a ball is hit correctly, backspin or under spin) placed upon the ball is necessary for proper lift and flight. The backspin imparted on the ball creates an upward force or lift, similar to an airplane wing.

There is another force acting between the ball and clubface known as friction. Increasing the roughness of the clubface increases the friction, allowing a rough clubface to grab the ball more than a smooth clubface would. This can increase the tangential force needed to spin the ball effectively. Ball spin greatly affects the flight path of the golf ball: sidespin results in a hooked or sliced ball, while topspin results in a ball with negative lift, creating a quickly diving path of flight. When there is an inadequate amount of the ball exposed above the turf canopy, there may not be enough friction to give the ball the desired spin. Most golfers have heard of a *flier lie* that often occurs when a ball is nestled down in the turf canopy, usually in the rough. Here, the grass blades that are between the clubface and ball are crushed, lubricating the two surfaces. In this situation, the clubface imparts less backspin on the ball, and ball flight and landing are less controlled.

Though the lie of the golf ball is relative to each particular golfer, the lie can still be quantified. This can be accomplished by accurately measuring the amount of golf ball exposed above the surface canopy of the fairway. A golf ball in accordance with the Rules of Golf must not be less than 1.680 inches in diameter. The greater the amount of ball above the canopy, the better the lie of the ball. A good lie allows the golfer to strike the ball cleanly with the club and impart the desired amount of backspin needed for proper shot control. With this in mind, we intended to create an instrument that would accurately measure golf ball lie on fairway turf, especially on higher-cut turf (0.75" to 1").

The Development of the Device

A device called a Lie-N-Eye is designed and constructed to measure the ability of a turfgrass species to support a golf ball under a typical fairway setting. The main component of the Lie-N-eye is a Mitutoyo Digimatic® Caliper. The caliper accurately measures an object by means of positioning the object between two jaws. In this project, the two jaws were adapted by adding necessary surfaces to measure ball position on golf course fairway turf. The first surface or plate was made from stainless steel and was added to the upper movable jaw. The lower measuring surface was added to the lower stationary jaw of the caliper and was constructed from sheet acrylic. The transparent property of the acrylic sheet was necessary to align the lower surface with the upper plane of the turfgrass canopy. A handle was also added through this lower measuring surface for two purposes. The first and obvious reason was to give the operator a place to hold the instrument. The second was to provide a means by which to place the instrument in the ground in a stable manner. This was achieved by grinding the opposing end of the handle to points and using them to position the instrument in the turf.



The numbers represent the mean amount of golf ball exposed above the Kentucky bluegrass canopy (measured in mm). The means followed by the same letter are not significantly different, according to Fisher's Protected LSD.

The operation of the Lie-N-Eye is very simple. After a golf ball has been uniformly rolled or dropped onto fairway turf, the user opens the jaw of the device past the target zone of measurement. The Lie-N-Eye is then placed alongside the ball and the lower surface of the acrylic sheet is lined up with the upper edge of the turfgrass canopy. The upper measuring surface of the Lie-N-Eye is then lowered onto the top of the ball and the measurement is shown on the liquid crystal display of the caliper and recorded.

A second, improved device, Lie-N-Eye II was developed to detect differences on shorter-cut fairway turf (0.375" to 0.625") and improve data collection. The basic operating principle of the Lie-N-Eye was used in the development of the Lie-N-Eye II, but the new device differed in several characteristics. Those characteristics were as follows:

- The lower measuring surface was machined to surround the golf ball on three sides.
- The upper measuring surface was resized and positioned to measure the ball perpendicular to the caliper.
- The handle was moved to the rear of the device.
- The Lie-N-Eye II used a Mitutoyo Digimatic® Absolute Caliper with SPC (Statistical Process Control) output.
- The SPC output enabled a direct link to a Palm™ IIIx organizer running DataGet™ software.

Testing and Results of the Devices

The Lie-N-Eye was tested in 1999 on 25 Kentucky bluegrass (*Poa pratensis* L.) cultivars grown to simulate golf course fairway conditions in Urbana, Illinois, at the University of Illinois Turfgrass Research Center. They were planted in a randomized complete block with three replications, maintained at 0.875", fertilized with 4 lbs. N/1,000 sq. ft. per year, and irrigated to prevent stress. The Lie-N-Eye was tested by uniformly rolling six balls onto each plot and measuring each ball for a total of 18 ball lie measurements per cultivar.

The results of this test show that the Lie-N-Eye was able to measure small differences in ball lie among the various Kentucky bluegrass cultivars. Obviously, if planting Kentucky bluegrass fairways, cultivars that not only have good pest resistance and appearance but also possess the ability to provide a good ball lie should be con-

Table 1

Cultivar	Lie Mean (mm)	Cultivar	Lie Mean (mm)
America	28.4a†	Conni	25.9dh
NorthStar	28.3ab	Serene	25.8di
Odyssey	28.0ac	Rambo	25.7di
Baron	27.8ad	Princeton105	25.7di
Limousine	27.5ae	Allure	25.6ei
Eclipse	27.6af	Raven	25.6ei
Absolute	27.4af	Midnight	25.4fj
Award	27.2ag	Explorer	25.2gk
SR2000	27.0ah	Glade	25.1hk
SR2109	26.6ah	Kenblue	23.8lk
NuGlade	26.5ah	Wildwood	23.4jk
TotalEclipse	26.2bh	Challenger	23.3K
RugbyII	26.1ch		
LSD			2.07

†Means followed by the same letter are not significantly different, according to Fisher's Protected LSD (0.05).

sidered. Conversely, cultivars that may offer a less desirable ball lie should be avoided.

The Lie-N-Eye II was tested in a similar fashion in 2000, but on six bentgrass (*Agrostis* spp.) fairway turfs. Three colonial bentgrass (*A. tenuis* Sibth.) and three creeping bentgrass (*A. palustris* Huds.) cultivars were tested at the University of Illinois Landscape Horticulture Research Center. The bentgrass cultivars were planted in a randomized complete block with three replications, maintained at 0.5", fertilized with 4 lbs. N/1,000 sq. ft. per year, and irrigated to prevent stress. The Lie-N-Eye II was tested by uniformly rolling six balls onto each plot and measuring each ball for a total of 18 ball lie measurements per cultivar. Results of these measurements indicate that the Lie-N-Eye II was able to identify small differences on the lower-cut bentgrass turf.

Future Use of the New Device

The results of these tests indicate that golf ball lie is determined, at least in part, by turfgrass species and/or cultivar. The reasons behind these differences have not been adequately studied; however, we can speculate that morphological characteristics (e.g., density or leaf width or angle) and/or physiology (e.g., cell wall constituents) play a role. What we do know now, due to the ability to measure ball lie, is that differences between turfs do exist.

The Lie-N-Eye and Lie-N-Eye II were designed to aid in the turfgrass selection process, as well as to judge the suitability of a turfgrass to support a golf ball in a fairway setting in an objective manner. The ability to measure and accurately quantify golf ball lie has interested others in this characteristic of golf course fairway turf. Studies are now being conducted on warm-season turfgrasses (bermudagrass) used for fairway turf to identify differences in the ball-lie ability of these turfs.

Other proposed work with the Lie-N-Eye II includes measuring the additional effects of turf species or cultivar selection and also management practices on golf ball lie. These may include the following:

- Management practices (fertilization, irrigation, cultivation, and mowing).
- Growth regulation.
- Turfgrass morphology.
- Traffic.
- Golfer/ball lie interaction.

Good golf ball lie is an important characteristic of a quality fairway. Anything that furthers the understanding and development of improving fairway ball lie will potentially make golf that much more enjoyable for golfers and turf managers alike.

Table 2

Cultivar	Type	Lie Mean (mm)
L-93	Creeping	40.7a†
Providence	Creeping	40.3ab
SR7100	Colonial	39.5bc
Pencross	Creeping	39.3bc
SRX7MOBB	Colonial	39.1c
Tiger	Colonial	38.7c
LSD		1.10

†Means followed by the same letter are not significantly different, according to Fisher's Protected LSD (0.05).

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Conserve Beneficial Insects on Your Golf Course

Natural enemies buffer turf against pest outbreaks.

by DANIEL A. POTTER

GOLF COURSE superintendents are constantly alert for insect pests, but it is doubtful that they think as often about the many beneficial insects and other small creatures inhabiting their turf. Some, such as tiny springtails and soil mites, aid in the breakdown of grass clippings and other plant litter, thus aiding nutrient recycling. Earthworms admittedly are a nuisance when they deposit their castings (soil and excrement) on closely mowed playing surfaces, but those sins must be weighed against the benefits they provide by aerifying and enriching the soil, enhancing water infiltration, and breaking down thatch (1).

Healthy turf also is hunting ground to diverse natural enemies such as predatory insects and spiders, as well as tiny wasps or flies that parasitize other insects. These so-called parasitoids lay eggs, *Alien*-style, in caterpillars or grubs, and the victim is then devoured by the developing parasitoid larva. Our long-term research has repeatedly shown the importance of natural enemies in buffering turf against pest outbreaks (2).

Golf courses also are frequented by honeybees and native pollinators, such as bumblebees, that forage on flowering weeds (e.g., white clover) in roughs and out-of-play areas. Habitat fragmentation, pesticide poisonings, diseases, and parasites such as tracheal mites are causing bees and other pollinators to disappear at alarming rates. This has prompted the U.S. Department of Agriculture to release warnings of an impending pollination crisis.

Honeybees, an introduced species, have been particularly hard hit. This decline places a greater importance on native pollinators. Golf courses can help to sustain insect pollinator populations by providing suitable habitat and nectar sources that may be deficient in surrounding subdivisions and urban areas.

After more than 22 years of studying turf insects, it is apparent to me that conserving beneficial species is among the keys to sustainable resource management for golf courses. This article summarizes some of our more recent USGA-funded research to evaluate the role of beneficial insects on golf courses and to develop tactics that allow superintendents to control pests without eliminating beneficial and non-target species.

Turfgrass Ants: Nuisance or Benefit?

Ants, which occur by the billions in roughs and elsewhere on golf courses, are voracious predators of the eggs and larvae of cutworms, grubs, and other turfgrass pests. These benefits, of course, must be weighed against the nuisance factor when ants build nests and mounds on putting greens and tees. We surveyed nuisance ants on golf courses in Kentucky and found that virtually all of the mounding problems involve just one species, *Lasius neoniger.* This same ant is found on golf courses throughout much of the United States.

Like all ants, *Lasius* is a social insect. Nests, consisting of shallow, interconnected chambers, occur in the upper 12 inches of soil. Each colony may contain hundreds of sterile female workers, but only one reproductive queen. A small mound of excavated soil particles tops each passage to the surface. The queen ant, with her eggs and larvae, remains underground and is fed and looked after by the workers.

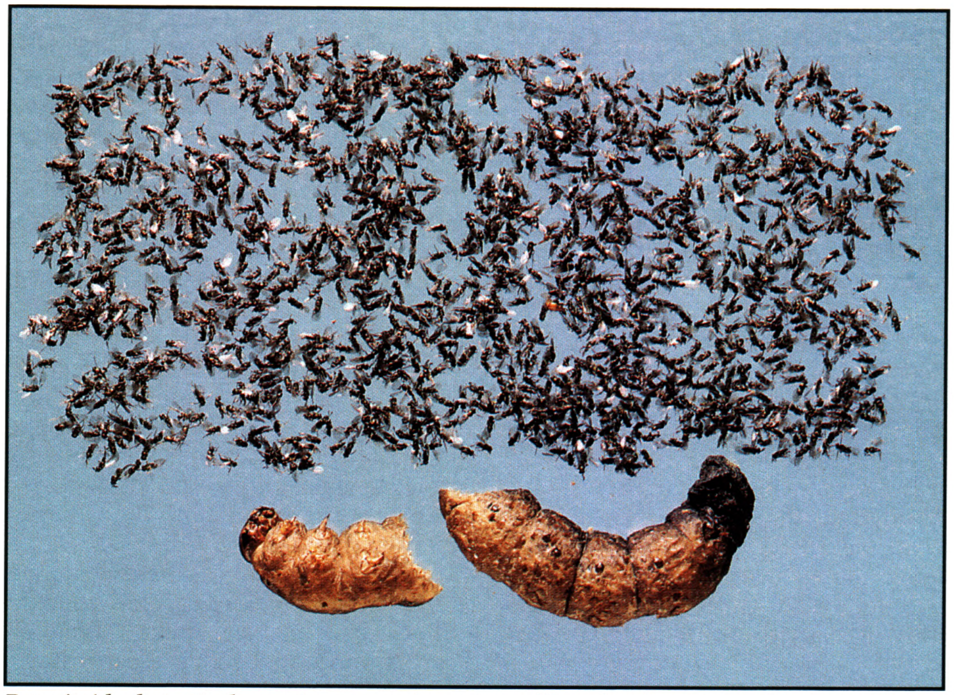
Turf-infesting ants are tough to control because conventional insecticides kill only a portion of surface-foraging workers, but usually fail to eliminate the queen. Thus, colonies may rebound soon after treatment. We tested a different approach: use of baits such as those used by pest control operators to eliminate ants from homes. Such baits contain a delayed-action insecticide formulated on sugary or protein-based food substances that attract the foraging ants. The workers carry the bait down into the nest and feed it to the queen and her brood. Once the queen is eliminated, the colony dies out and the mounds are not rebuilt.

We tested a number of baits containing the active ingredients abamectin, fipronil, hydramethylnon, or spinosad in "taste tests" to determine palatability to *Lasius*, and then in field tests on golf courses. Several of the baits were effective. One in particular, Maxforce® granular ant bait containing hydramethylnon, seems to be well suited for use on closely mowed turf. Sprinkling a small amount around the mounds generally eliminated a colony within a few days. While not cost-effective for broadcasting, the bait method is practical for spot-treating putting greens and tees. Labeling for Maxforce permits its use on golf courses, including putting greens, except in California. Golf course superintendents may wish to experiment with this approach. The bait method is selective and non-hazardous to beneficial insects and wildlife.

We also found that broadcast applications of fipronil (the active ingredient in Chipco Choice) can provide season-long suppression of *Lasius* ants. Fipronil is effective at very low use rates, and it seems to have little impact on earthworms and predatory insects other than ants. The manufacturer has submitted a registration request for granular fipronil for ant control on golf courses. If granted, this will provide a powerful option for selective control of mound-building ants on greens and tees. It might be counterproductive, however, to treat fairways and roughs for *Lasius* because of the ants' importance in biological control of turfgrass pests.

We also documented a remarkable mutualism between *Lasius* ants and subterranean root aphids. The ants tend and protect the aphids, carrying them about in their mandibles and stroking them to obtain their sugary honeydew (a carbohydrate-rich, liquid fecal product), much as a farmer tends dairy cattle. These root aphids, which apparently do not harm the grass, are abundant in native soil surrounding putting greens, but apparently absent from sand-based greens. Perhaps the workers' "sweet tooth" (i.e., access to aphids) is why ant nests on putting greens often encroach from the edge. Possibly managing the aphids would help to suppress the ants. Despite its being so abundant on golf courses, ours is the first record of this aphid species, *Geoica setulosa*, from the eastern United States. With USDA collaborators, we are publishing the first descriptions, illustrations, and keys to this species – a case of golf courses enhancing knowledge of biodiversity!

Superintendents should bear in mind that "nuisance" ants such as *Lasius* are beneficial in fairways and roughs because they prey upon other pests. Several studies have shown how important this benefit can be. For example, we allowed black cutworm moths to lay eggs on turf cores, implanted the cores into fairways and roughs of two golf courses, and watched and videotaped the eggs' fate over the next 24 hours. Ants consumed up to 85% of the eggs in untreated roughs in a single night. In treated fairways where the ants were suppressed, much higher numbers of cutworm eggs survived to hatch.



Parasitoids that attack pest insects are important allies of turf managers. Tiny parasitic wasps killed and emerged from a black cutworm. Each of the more than 1,500 female wasps that emerged from this larva will seek out and parasitize additional cutworms.

Tiphia *wasps lay eggs on root-feeding white grubs; the wasp larva then feeds on the victim, killing it within a few weeks.*

Target-Selective Insecticides

The 1990s saw dramatic change in the types of insecticides used on golf courses. Traditional organophosphates (OPs) and carbamates were supplanted, in large part, by newer chemistry with more target-selective activity. Pyrethroids (e.g., bifenthrin, cyfluthrin, deltamethrin, lambdacyhalothrin, permethrin) and spinosad (Conserve®) came into use against surface-feeding pests, whereas two relatively persistent compounds, imidacloprid (Merit,® a chloronicotinyl) and halofenozide (MACH2,® a molt-accelerating compound), now dominate the grub control market. Fipronil (Chipco Choice®) provided a new option for mole cricket control.

Using target-selective insecticides is another means for integrating chemical and biological control in a more sustainable way. But are the newer insecticides really less toxic to beneficial species? To find out, we evaluated their potential impact on predatory insects, earthworms, and pollinators such as bumblebees that forage in weedy turf.

In a two-year field study, Kentucky bluegrass plots were treated with imidacloprid (Merit®) or halofenozide (MACH2®) in late May or June, followed by irrigation as is recommended for grub control. Other plots were treated with bendiocarb (Turcam), a broad-spectrum carbamate, or left untreated for comparison. We monitored the insecticides' impact on predator populations using pitfall traps, and also sampled earthworms and other beneficial soil fauna.

Every few weeks the plots were implanted with lab-reared eggs, larvae, or pupae of black cutworms, or eggs of Japanese beetles, and predation rates were determined. We wanted to see if any of the insecticides affected natural enemies enough to reduce predation on these pests. Finally, efficacy against the targeted pests was evaluated by sampling white grub populations in late summer. Other tests were done to compare the hazard to predators of irrigated versus non-irrigated spray residues.

We also have been evaluating potential hazards of insecticides to pollinators. Turf plots with flowering white clover were treated with preventive grub insecticides, with or without watering in, or with short-residual surface insecticides. Bumblebee hives were confined on the turf in large, screened cages after the residues had dried. The bees were allowed to forage for several weeks, and the hives then were sacrificed to evaluate hive health.

To determine if exposure to insecticide-treated plots disrupts bee behavior, foraging activity of workers, as well as their defensive response were evaluated. In one test, a researcher wearing a bee suit entered each cage and disturbed the hive by striking it with a stick in a consistent manner. The number of bees that issued forth to try to sting the intruder, and the speed of that response, were recorded. We also monitored native bumblebees' response to open turf plots with white clover to determine if bees avoid insecticide-treated areas.

New Chemistry is Promising

Halofenozide (MACH2®) had no measurable adverse effects on earthworms and other beneficial soil organisms, predators, or bumblebees in our tests. Nevertheless, our applications in late May provided excellent (>90%) residual control of Japanese beetle and masked chafer grubs. This demonstrates the product's selective toxicity to pest species, mainly white grubs and caterpillars.

Imidacloprid (Merit®) also gave excellent (>90%) residual control of white grubs. Granular or liquid applications followed by irrigation had relatively low impact on earthworms and predators, and no measurable adverse effects on bumblebees. Although imidacloprid is systemic, our results suggest that it is not translocated into pollen or nectar, or at least not at levels that are harmful to bees.

In contrast, exposure to non-irrigated imidacloprid spray residues resulted in paralysis, impaired walking, and other neurotoxic effects in predatory beetles, as well as decline of bumblebee colonies that were confined on treated plots. It is important to note that these adverse effects were substantially reduced or eliminated with timely post-treatment irrigation.

Broad-spectrum carbamates and OPs, by comparison, can have severe impact on beneficial species. Bendiocarb, for example, reduced earthworm populations by >90%, and it also caused high acute mortality of predators regardless of whether they were hit by spray droplets, crawled over dry residues, or consumed insecticide-contaminated food. Exposure to non-irrigated residues of bendiocarb or chlorpyrifos caused severe decline of bumblebee colonies foraging on flowering white clover that had been sprayed along with the grass.

Preserve Beneficial Organisms

Our studies indicate that the new, target-selective turf insecticides generally are compatible with conservation of beneficial invertebrates. Halofenozide and spinosad (Conserve®), in particular, seem to pose little or no hazard to earthworms, predators, parasitoids, or pollinators. Imidacloprid caused some suppression of earthworms, at least in our tests, but the reductions were short-lived and much less severe than those caused by bendiocarb, carbaryl, or certain organophosphates (e.g., ethoprop, fonofos).

Imidacloprid also seems to be compatible with predators and pollinators so long as the residues are watered in. Carbamates, organophosphates, and pyrethroids can adversely affect pollinators if residues are present on flowering weeds such as clover or dandelions. Mowing flower heads before treatment, using granular formulations, post-treatment irrigation, chemical weed control, or avoiding insecticide sprays when weeds are in bloom can reduce such hazards.

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Mound-building ants may warrant management on putting greens, but their predatory habits make them allies in suppressing other pests in fairways and roughs.

Rutgers University conducted a fungicide experiment on the third green at Charleston Springs North Golf Course (New Jersey). Field testing in real world situations can be an effective research strategy.

This Product Is So Good, It Didn't Need Any Research!

When choosing what's best for your golf course, rely upon scientific research rather than black magic.

by JAMES H. BAIRD, Ph.D.

"Take any common-place remedy, give it a mysterious origin, advertise it with extravagant claims, and it will be purchased by the [gullible]. At present, the crop of grass-growing [snake oils] appears to be above normal!" – Dr. Charles V. Piper and Dr. Russell A. Oakley, *The Bulletin of the USGA Green Section*, 1922.

SOME THINGS never change. Thankfully, neither has the commitment from the USGA Green Section and the scientific community to provide information for improving golf turf that is based upon scientific observation and experimentation. While it is true that science oftentimes seems dull and monotonous, it is factual. On the other hand, how many products, technologies, or services are you currently using that are based solely upon slick pitches from salespeople? Or maybe you've been persuaded by testimonials from leaders of the golf turf management profession. If they use it, it must be good, right? Or could it be that these people employ sound agronomic practices and excel at managerial skills in spite of using products that do nothing to improve their already pristine turf? Perhaps you are from the school of thought that these products can't hurt anything, so why not use them?

Although using snake oils may not harm your turf, what effects do they have on the professionalism that both you and the golf turf management industry have worked so hard to build? And more to the point, how much of your club's money is being spent on these products, and would you exercise they same blind faith if it were your money?

The primary purpose of this article is to provide the reader with a better understanding of the importance of research and the scientific method in the evaluation of products and technologies. Along the way, this article describes key elements for obtaining the most useful and unbiased information from a testing program on your golf course.

The Scientific Method

Research can be defined as an organized investigation into a subject to discover new facts or principles. The general procedure for research is called the *scientific method* and consists of:

- Formulating an hypothesis.
- Planning an experiment to test the hypothesis.
- Carefully observing and collecting data.
- Interpreting the results of the experiments.

To better illustrate the scientific method, let's say that you have been approached by a salesperson who claims that his product, we'll call it Thatch Away, will reduce thatch accumulation in your turf, thus reducing the need to cultivate. Because your golfers are up in arms about the holes that you regularly punch in the greens, you decide that this product is worth further investigation. What should you do next? First, ask the salesperson a lot of probing questions. How exactly does this product work? If the product works according to the claims, why isn't everyone using it and discarding their aerators, verticutting machines, and topdressers? Most important, is there any documented university research available that supports the claims for this product? Specifically, was the research conducted only in the laboratory or also in the field? Now, I am hopeful that most superintendents already know the likely answers to these questions and would graciously say, "Thanks but no thanks. I'll keep my cultivation equipment for the time being." However, in the back of your mind you may still be haunted by golfer distaste for cultivation and decide this product is at least worth a try on your golf course. Where do you go from here?

The Hypothesis

A hypothesis is often referred to as an educated guess or speculation in regard to the possible cause of a phenomenon. Any experiment and the interpretation of its results are only as good or bad as the hypothesis(es) or the objective(s) for performing it. In formulating your hypothesis, be specific about what you expect the outcome of the experiment to be. If Thatch Away reduces thatch by the smallest measurable increment, would this reduction result in any real benefit to the turf or significant change in your cultivation practices? The likely answer is no. So, if the concern about the disruptive effects of cultivation has led you to try this product, then a plausible hypothesis might be that *Thatch Away reduces thatch accumulation equivalent to or exceeding that of standard cultivation practices.*


Research can involve many different treatment combinations and especially when it involves evaluation of turfgrass germplasm.

Planning an Experiment to Test the Hypothesis

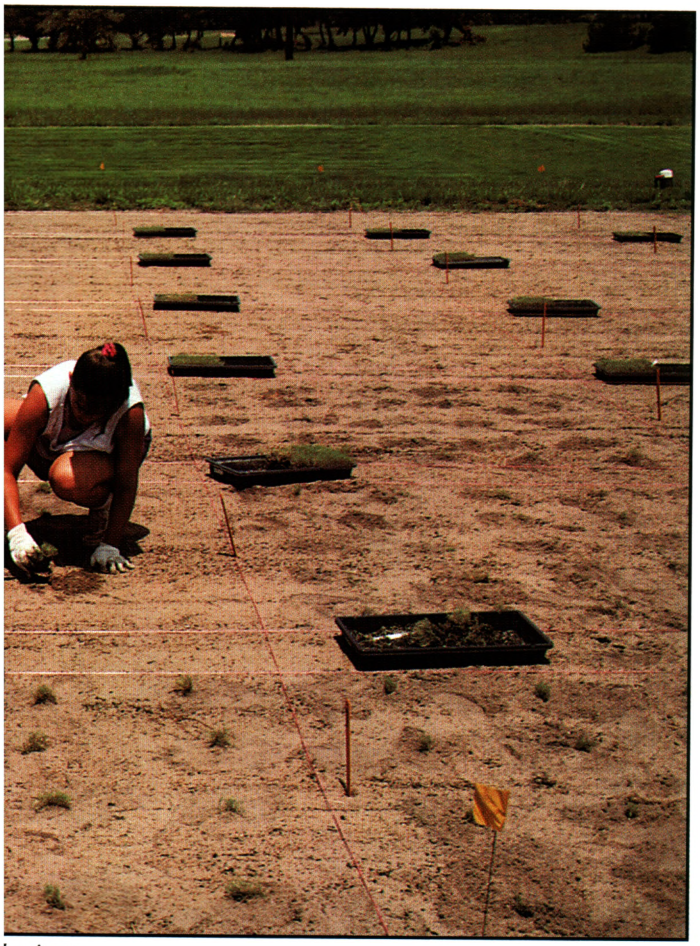
The two primary components of an experiment are the treatment and the experimental unit. A treatment is a dosage of material or a method that is to be tested in the experiment. The experimental unit refers to the unit of experimental material to which a treatment is applied. In our experiment, the treatments represent the Thatch Away product and cultivation practices, while the experimental unit is the turf in question, let's say the putting greens.

A major challenge in experimentation is that variability exists throughout nature. Differences due to genetics, soil, or the environment are especially apparent throughout the golf course. Have you ever attended a university turfgrass research field day and wondered why the greens are flat and have no trees surrounding them, unlike the conditions you face on the golf course? Even though variability still exists at the research facility, the idea is to minimize it as much as possible and to set up experiments that test treatment effects independent of unaccounted variability related to the experimental unit or its surrounding environment. In statistical science, unaccounted variability is called experimental error, and if we can design the experiment to provide an estimate of experimental error, then a more precise measure of the treatment effects can be made.

Let's say we decide to test Thatch Away by treating one of the greens on the golf course. Evaluating a practice on a single experimental unit (in this case one putting green) and then comparing this unit to one that is similar but untreated provides no measurement of experimental error and therefore is a poor measurement of whether or not differences in thatch accumulation were due to the product.

Three important principles of experimental design are replication, randomization, and local control. Replication of treatments on more than one experimental unit provides an estimate of experimental error and therefore a more precise measure of treatment effects. The number of replications is dependent upon the degree of precision desired and also the variability of the data to be collected. Measurement of thatch accumulation or reduction is likely to be more variable than measurement of weed control or fertilizer response. However, treatments in most field experiments are typically replicated three times.

Randomization is the assignment of treatments to experimental units so that all units have an equal chance of receiving a treatment. This ensures an



borious,

unbiased estimate of treatment means and experimental error. Randomization can be accomplished using a computer or random number table found in the appendix of most statistics textbooks. However, drawing numbers corresponding to treatments out of a hat is the simplest way of randomization in small experiments.

Local control is a restriction on randomization by grouping treatments in similar areas or blocks that are expected to perform differently. Let's say that you've decided to conduct a replicated experiment on one of your putting greens that is rather severely sloped from back to front and is lined with trees along the back side of the green. In order to account for the effects that slope and trees might have on thatch, all treatments would be randomized within each of three or however many blocks positioned from the back to the front of the green.

Hopefully, by now you have a better understanding of experimental design, but still we must select the treatments for our experiment. Here is where you refer back to the original hypothesis stating that *Thatch Away reduces thatch accumulation equivalent to or exceeding that of standard cultivation practices.* Therefore, one of the treatments would include Thatch Away applied without cultivation practices. Other treatments may include various rates or timing of application of this product, if deemed necessary. An important treatment to include in the experiment is the check or untreated control. In this scenario, the untreated control would include cultivation without Thatch Away. To carry this a step further, you could test whether or not your cultivation practices reduce thatch accumulation by including a treatment with no Thatch Away and no cultivation.

Careful Observation and Collection of Data

Measurement of thatch in the upper portion of the rootzone profile will be the main source of data collection in this experiment. The easiest way to do this without sending samples for laboratory analysis would be to measure thatch thickness from at least three subsamples of soil profiles taken from each plot throughout the experiment. Fortunately or unfortunately, thatch accumulation or reduction does not occur overnight, and an experiment like this may take several years to find measurable differences among treatments. Also, it would be a good idea to measure thatch thickness in the plots before application of treatments to serve as a baseline. In general, variability decreases as plot size increases, up to a point. This is advantageous on a golf course because equipment would not be available to treat small plot areas. However, by using large spray equipment you may need to treat individual putting greens as blocks, each containing one replication of all treatments in the experiment.

Interpretation of Results

Normally, data collected from an experiment is subjected to statistical analysis in order to provide evaluation of treatment differences according to tests of significance based on measuring uncontrolled variability. One test that most everyone should be familiar with from attending turf conferences, field days, or by reading experimental results such as the National Turfgrass Evaluation Program (NTEP) is the Least Significant Difference (LSD), usually at the 5% probability level. Thus, if the difference between two treatment means (e.g., 7.5 vs. 7.0, 7.5 − 7.0 = 0.5) is greater than the $LSD_{0.05}$ = 0.4, there is a 95% probability that the difference was due to treatment effects or a 5% probability that the difference was due to chance alone. Obviously, not many superintendents are going to subject their data to statistical analysis; however, it would be easy to calculate treatment means and to visually compare differences among treatment means. Conclusions should have as wide a range of validity as possible, meaning what works or does not work on your golf course should do the same at another golf course. The best way to ensure this is to conduct the experiment at more than one location and time. However, it is important to keep in mind that in any experiment there is always some degree of uncertainty as to the validity of the conclusions.

Conclusion

Research is a complex, time-consuming, and costly venture that is best left to the expertise of scientists. However, should the need or desire arise to test products on your golf course, remember that a well-planned experiment starts with a well-defined hypothesis or objective. And in order to distinguish real treatment effects from naturally occurring variability, treatments should be replicated, randomized, and grouped into blocks for local control, if necessary. Your state turfgrass extension specialist may be able to provide some assistance when planning a comparison of treatments at your golf course.

What's more important, let's hope this article sheds more light on the need for scientific research in your decision-making process when it comes to deciding what's best for your golf course. Don't underestimate your ability to grow good turf using sound agronomic practices that are firmly rooted in scientific research.

JIM BAIRD *is an agronomist in the USGA Green Section Northeast Region. Before joining the staff in 2000, he was an assistant professor of Turfgrass Research and Teaching at Michigan State University.*

Going Low with Ultradwarf Bermudagrass Putting Greens

While these new cultivars can tolerate very low mowing heights, there are numerous considerations for achieving long-term success.

by TOM COWAN

Two to three weeks after sprigging an ultradwarf bermudagrass putting surface, regular mowing is initiated. These new varieties tolerate heights of cut below those of standard bermudagrass cultivars.

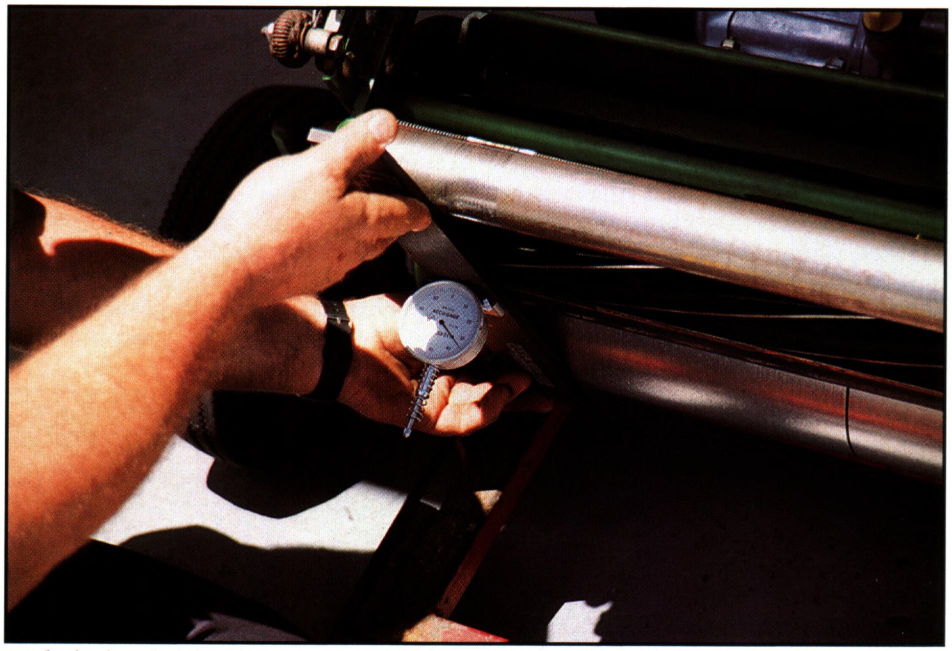
THE ARRIVAL of the "ultradwarf" bermudagrasses is challenging warm-season golf course superintendents to make changes in their cultural programs and maintenance practices for management of putting surfaces. With these ultradwarf bermuda cultivars being used frequently in new construction, and existing greens being renovated to "keep up with the Joneses," volumes will be written on the how-to's by superintendents, researchers, and associated industry professionals. The focus of this article will be to examine one of the most critical cultural practices in the maintenance of ultradwarf putting surfaces – mowing.

It is a well-known fact that grasses can be "dwarfed" by frequent low mowing. However, there are height-of-cut limits that must be respected to ensure turf survival. For Tifgreen and Tifdwarf bermudagrasses, the recommended low height-of-cut limits are 0.187" and 0.156", respectively. While lower mowing heights can be maintained for short periods of time, especially during periods of benign weather, these older cultivars can hit the wall and fail when pushed too far. Through selection and traditional turfgrass breeding efforts, we now have several bermudagrass cultivars that will tolerate much lower mowing heights. It is being recommended that the ultradwarf bermudas Champion, Floradwarf, MiniVerde, and TifEagle be maintained at a height of cut in the range of 0.120" to 0.140". When combined with their finer leaf texture and increased density, a smooth, true ball roll and fast to very fast putting speeds can be provided.

Beginning in the turf establishment phase, the ultradwarfs are being mowed at lower heights of cut. An initial height of cut of 0.187" is typical, and this height is reduced progressively with development of full turf coverage and a smooth surface condition. With optimum growing weather, full turf coverage is being achieved in as little as four to six weeks, and in a few cases the height of cut has been taken all the way down to 0.100".

There are several rules that must be followed to make this happen. First, make a test cut to be sure you are not disturbing the grade (plowing) or pulling out sprigs. Second, make sure that you mow in a different direction every time. Third, topdress and verticut routinely to help smooth the putting surface. Rolling of new greens is also a common surface-smoothing process, but it needs to be used with restraint. Assuming that adequate moisture and fertility are maintained throughout the grow-in process, decisions on height-of-cut changes should be made every five to ten days. As the height of cut is lowered, the turf surface will become smoother and show fewer scalp marks. As the scalp marks begin to disappear and the putting surface becomes uniform in color, the grooming phase of the grow-in can be implemented.

Just like fast cars and horses, these new bermudagrasses require special attention to keep them running fast. Thinner bedknives, more frequent grinding and back-lapping, less margin of error in reel setup, experimentation with roller types, frequent vertical mowing or grooming (in combination with topdressing) all present additional challenges for equipment technicians. Manufacturers are introducing mowers that will minimize scalping at heights of cut below 0.125". Modifications to existing mowers can also be required to help narrow the cutting plane by reducing the distance from the cutting edge to the front rollers. For example, with the Toro GR 800 or GR 1000 mowers, the front roller brackets can be reversed (left bracket becomes right bracket), which reduces the distance between the cutting edge and the front roller and in turn reduces scalping on undulating greens.



With the low height of cut required for the new bermudagrasses, there is no room for error in the setup of the mowing units. Equipment managers are constantly challenged to keep the equipment in top shape when dealing with ultradwarf putting greens.

A concern with the ultradwarf bermudas is their more aggressive growth rate and, in turn, increased rate of thatch accumulation. Excessive thatch or a mat layer negatively affects mowing results and in particular increases scalping damage. The importance of managing thatch in the upper rootzone cannot be overemphasized, and it should start in the establishment phase. Different types of vertical mowing knives are being introduced to reduce the amount of organic mat without raping the canopy. Fewer spacers between vertical knives (more blades per reel), carbon-tipped knives, and spiral reel configurations are other modifications that allow for easier movement through the canopy with less surface disruption and improved thatch control.

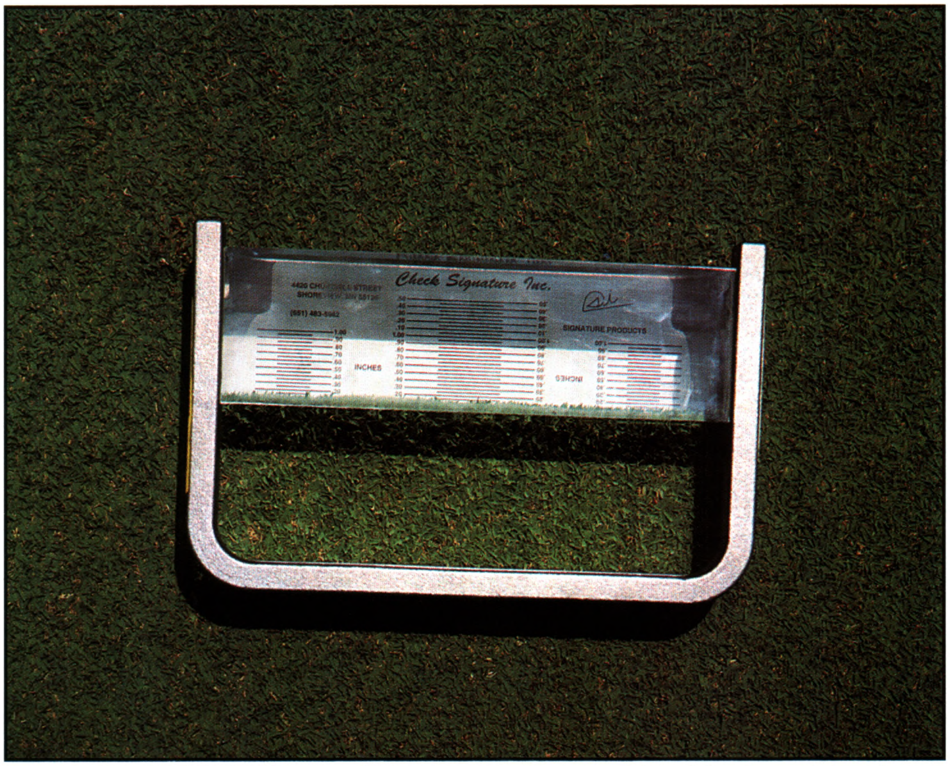
The aggressive ultradwarf growth habit results in a faster rate of thatch accumulation. Thatch must be controlled from the very beginning to ensure top quality mowing results and healthy turf growth.

Just as tolerances in high-performance engines get smaller to create higher speeds, when heights of cut are at 0.125" and below, the margin for error in mower setup is very low. Until technology allows us to laser cut our grass, we are restricted to the thickness of a bedknife and to the "lay of the land." I guess it is not inconceivable that someday we will have the technology to produce a flexible cutting head that will change form to adapt to changes in contours. But until then, the real challenge to every superintendent and head equipment technician is to find the threshold height of cut that provides the fastest ball roll with the greatest aesthetic appeal.

Because of the need for speed, "drivers" of these new dwarfs must pay attention to every indicator of mechanical breakdown. The same rules that apply to growing the older dwarf bermudas apply to the ultradwarfs. At very low cuts, these cousins to Tifdwarf are subject to failure if driven to the brink. Shade is most definitely an enemy. Also, the very dense turf cover and faster rate of thatch accumulation is resulting in localized dry spots (LDS) being a common occurrence. Fertility levels present as many debates as there are growers of the new cultivars. But if there is one cultural practice that has tempted superintendents into pushing the envelope, and one that requires daily scrutiny, it is mowing!

If you are at the wheel of an ultradwarf, test drive it daily behind your mowers. Hit a few putts to get an idea of how fast and how true your surfaces are. Startling discoveries can be made. When you are living on the edge, you really have to pay attention. It is just as important that your head mechanic check the mowers daily. Even if a mower leaves the shop perfectly adjusted, banging around in transport can knock it out of adjustment. If triplex mowers are used, it is a good idea to train your operators to take the smoothest, safest route from hole to hole. With walk mowers, carefully loading and unloading from the trailer are critical to keeping it in adjustment. Securing the mower to the trailer is also important.

If you are new to the ultradwarfs, it's possible that changes in mowing equipment are required. If triplex mowers have been used in the past, it may be necessary to go to a fixed-head walk mower. It also needs to be remembered that several factors affect the actual height of cut. Total unit weight, weight distribution, bedknife attitude, and front roller setup are a few of the variables. Two mowers with the exact same bench height-of-cut adjustment can produce different actual heights in the field. Before making a decision, it would be wise to demo competitive models and consult other growers. Equipment technicians also are constantly challenged to keep a sharp reel and bedknife.



What is the effective height of cut? Prism gauges are a useful tool for determining the actual mowing height.


As with standard bermudagrasses, the ultradwarf cultivars lack shade tolerance.

Drivers' education (or walkers' education) is not a degree course for your operators. Greens mowing is continuing education. If your machines leave the shop perfectly tuned and ready for the race, the driver must be up to the task. You can train your team to perform to your standards, but once on the course, they assume control. No two greens are alike. No two operators are alike. Special instructions, such as direction of cut for the day or when and where to skip a perimeter pass need to be issued. Emptying baskets frequently enough to prevent excessive weight buildup or simply removing any loose impediments before mowing are other instructions that need to be repeated and can mean the difference between a good and poor-quality cut.

Just as golf is a humbling game, so too is the profession of growing and maintaining the turf on the courses where the game is played. New technology, new grasses, and greater pressure to compete in a market flooded with new courses place additional pressures on today's golf course superintendents. In a world where fast seems to pay dividends, it seems that the greatest dividend will be paid to managers of the ultradwarfs who can pursue speed with caution. Height of cut should not become a contest among your peers. The real prize should be given to the turf manager who can achieve the greatest speed at the highest height of cut. The racecar driver who finishes the most races may indeed have the longest career. The golf course superintendent who manages his speed properly may never hit the wall.

TOM COWAN *grew up in the turfgrass maintenance business, working at several courses in central and south Florida. He was a superintendent for more than 15 years before moving over to fertilizer, turf, and equipment sales. Tom is also a USGA Green Section Committee member in Florida.*

PESTICIDES: ARE GOLFERS SAFE?

University of Florida studies suggest that pesticides do not pose any significant health threat to golfers.

by GEORGE H. SNYDER, JOHN L. CISAR, and CHRISTOPHER J. BORGERT

ARTICLES about pesticide usage on golf courses and the dangers to which golfers are exposed because of these pesticides often appear in the popular press. These articles make good press with eye-catching headlines, but they often raise concern by citing potential hazards without providing any scientifically based analyses. In order to provide data that can be analyzed scientifically, the United States Golf Association has provided grants totaling millions of dollars to university scientists to conduct research into the fate of pesticides applied to golf turf and to assess the associated risks to golfers.

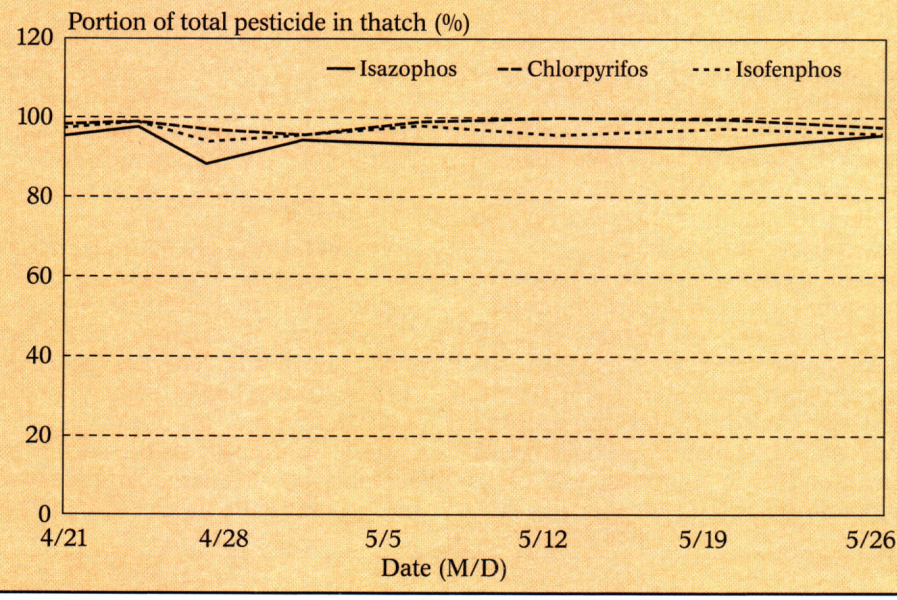
While no single university study has provided all the answers to this complex issue, each has made headway in answering specific components of the puzzle. For example, our work has focused on pesticide leaching, pesticide removal in clippings, pesticide dislodgeability from turf surfaces, and pesticide losses by volatilization. Because dislodgeability and volatilization can result in direct golfer exposure to pesticides, we have conducted assessments of the risks to golfers posed by such pesticide losses. We concentrated our studies on the class of pesticides known as organophosphates (OP) because of their widespread use, effectiveness as insecticides and nematicides, and because they are known to be toxic to humans at certain levels of exposure.

Table 1
Pesticide leached following application at labeled rates to a USGA green, expressed as a percent of the amount applied*

Pesticide	Application Date	Amount Leached *% of applied*
Chlorpyrifos	Jan. 27, 1992	0.15
	April 21, 1992	0.38
Fonophos	Nov. 13, 1991	<0.01
	Jan. 27, 1992	0.02
Isazophos	April 21, 1992	0.09
	Sept. 17, 1992	0.02
Isofenphos	April 21, 2001	0.02
	Sept. 17, 1992	0.01
Ethoprop	Sept. 17, 1992	0.07

*Data extracted from Cisar and Snyder (7)

Figure 1
Following application of three organophosphate pesticides, most of the pesticide that was observed in the thatch and soil was located in the thatch portion

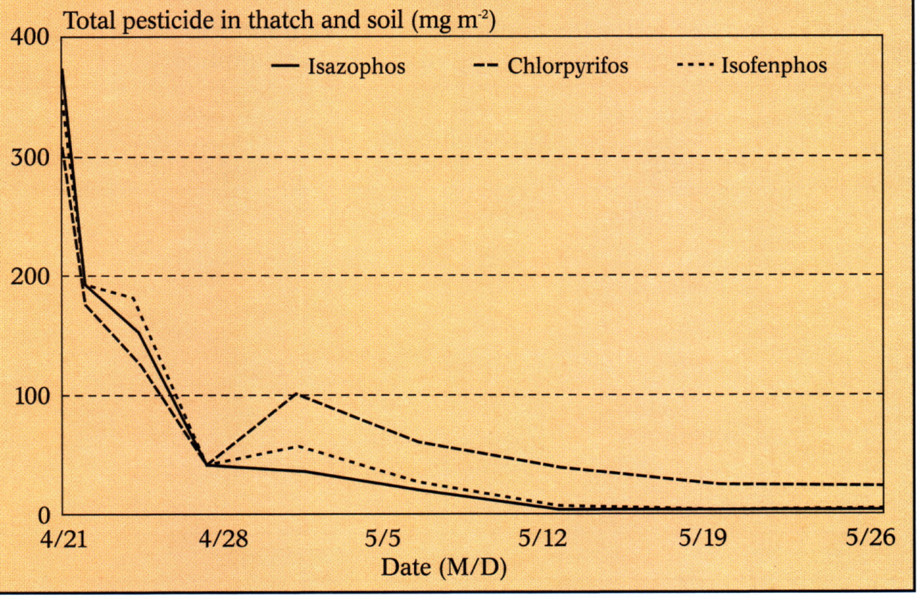


Pesticide Leaching

Following application at labeled rates, we measured pesticide in thatch, soil, and in percolate. The field work was conducted at the University of Florida/IFAS St. Lauderdale Research and Education Center using a special facility that has stainless-steel lysimeters installed in a research golf green ('Tifdwarf' bermudagrass) patterned after USGA specifications for putting green construction (2). The lysimeters were used to collect percolate water from the golf green for several months after pesticide application. The pesticides generally were applied as liquid sprays. With one exception, which will be discussed later, less than 1% of the applied pesticide was found in the percolate water (Table 1).

There are two reasons why so little pesticide was recovered in percolate water. First, the pesticides were strongly adsorbed by and retained in the thatch layer (Figure 1). For most of the OP pesticides studied, very little pesticide actually made it through the thatch and into the soil. Secondly, the pesticides were degraded by microorganisms that essentially use the pesticides as a food source. Consequently, the concentration of pesticide in the thatch/soil decreased rapidly with time (Figure 2).

Figure 2
Three organophosphate pesticides rapidly disappeared from thatch and soil following application to a USGA green due to microbial degradation



The exception that we found to the generalization that OP pesticides are strongly adsorbed in the thatch layer, and therefore undergo little leaching, was for the nematicide fenamiphos (Nemacur), and particularly for its metabolites (breakdown products), which also can be toxic. Following an application of fenamiphos, of the total metabolites in the 0-15 cm (0-6 inch) layer, we observed only 20% being in the thatch (7). Nearly 18% of the applied fenamiphos was observed as metabolite in the leachate.

It has been established that following fenamiphos applications, microbial populations that can readily degrade the pesticide rapidly increase in the soil and remain there for years (6). Therefore, when additional fenamiphos applications are made, microbial breakdown of the fenamiphos and of its metabolites can be very rapid. In agreement with this, when we applied fenamiphos a second time, only 1.1% of that applied was detected in percolate water in the form of metabolites. Nevertheless, this is considerably more than was found for other OP pesticides. For this reason, we developed a sand-sized soil amendment (patent pending, University of Florida) that absorbs fenamiphos and its metabolites without reducing the rate of water percolation (8).

Grass Clippings

Organophosphate pesticide removal in grass clippings for several weeks after application also amounted to less than 1% of that applied, in most of the trials, when the pesticides were applied as sprays. In some cases, somewhat more was recovered in clippings when granules were used as the carrier, presumably because some granules were picked up by the mower (3). For both liquid and granular application, pesticide removal in clippings generally declined quite rapidly with time.

Table 2
Pesticide dislodged by vigorously wiping the turf surface with damp cheesecloth at various intervals following pesticide application*

Time After Application	Pesticide		
	Fenamiphos	Isazofos	Chlorpyrifos
	----- % of applied -----		
15 minutes	2.89	1.40	1.12
3 hours (irrigated)	0.10	0.08	0.06
20 hours	0.00	0.02	0.01

*Data from R. H. Snyder (9)

Dislodged Pesticides

From our studies with OP pesticides, it appears that most of the pesticides dissipate rapidly, and there is little loss in clippings or percolate. These loss mechanisms should pose little hazard to golfers or to the environment. However, there are two pesticide loss pathways by which direct golfer exposure can occur: dislodging from the turf surface directly or indirectly to a golfer's skin and inhalation of pesticides volatilized from the turf. We have investigated both of these loss pathways and have estimated potential risks for several scenarios under which golfers might be exposed to pesticides.

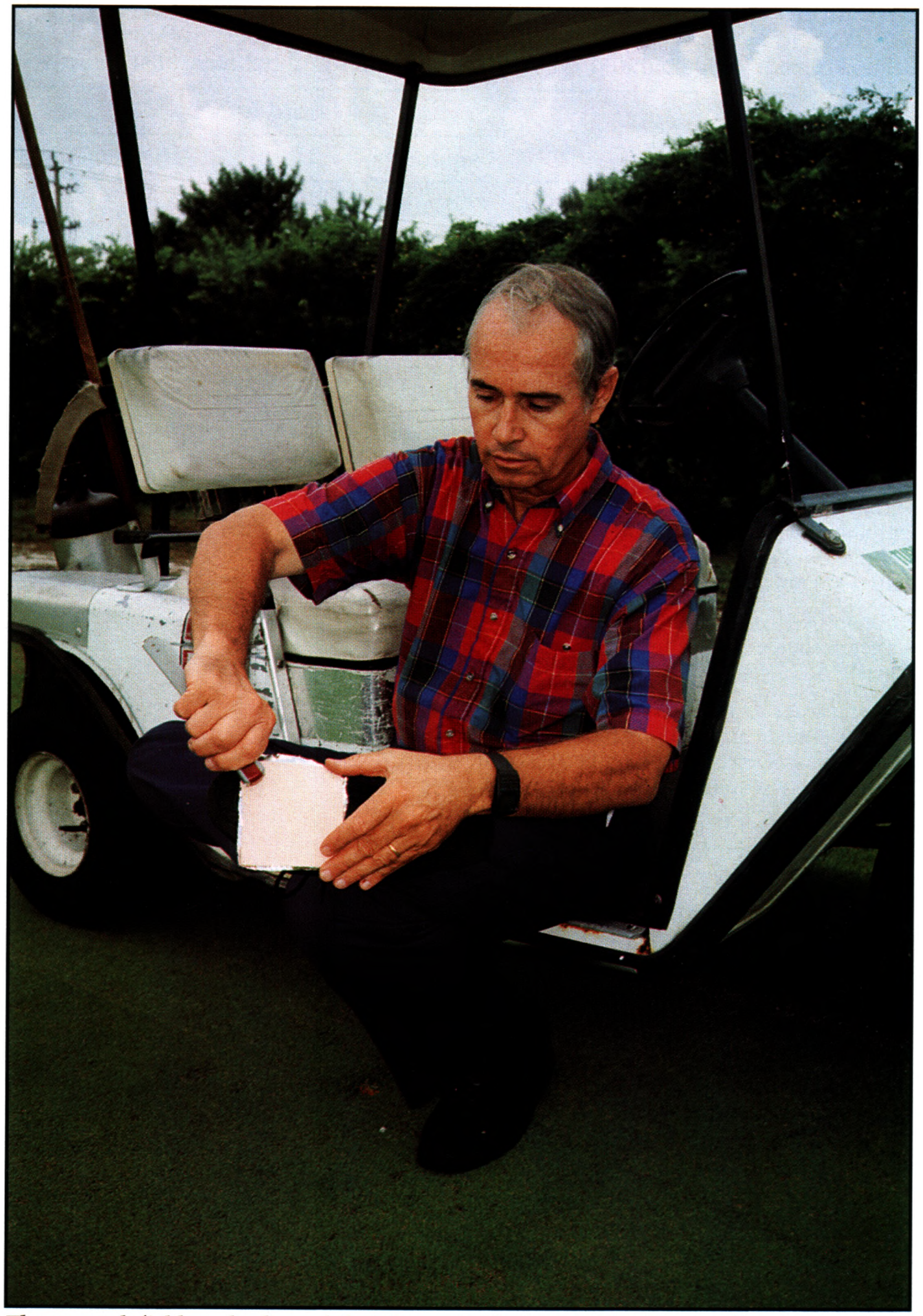
All chemicals can be toxic to some organisms at some dose. The question to be determined in our studies was whether a golfer is likely to receive a toxic dose as a result of exposure to pesticides applied to maintain golf turf. Toxicity may be immediate or may occur only after many years of exposure. The U.S. Environmental Protection Agency (USEPA) provides values that can be used for assessing the risk of exposure to various pesticides (10). Pesticides sprayed on turf surfaces may contact golfers directly when a player touches the turf or indirectly when the golfer touches various items (club heads, golf balls, etc.) that have come in contact with the turf. In an extreme case, the golfer may have oral contact with certain of these items and thereby ingest some pesticide.

A series of studies was conducted by University of Florida graduate student Raymond H. Snyder to evaluate the risks to golfers from pesticide doses associated with these exposures. These studies measured the amount of pesticide that could be dislodged by various means. For example, after applying a pesticide at the labeled rate, moist cheesecloth was rubbed vigorously over the turf surface. This procedure was assumed to estimate, and probably greatly overestimated, the maximum amount of pesticide that might be dislodged by touching the turfgrass. Golf grips were placed on the turf and rolled around, and a golf ball was putted across the surface twice. Following an application of pesticide to turf several inches tall, a club head was swung through the grass to simulate chipping out of a rough. The amount of pesticide on the golf grips, golf ball, and club face was measured to estimate the amount of pesticide that could be dislodged by these methods and potentially be transferred to a golfer's skin.

Wiping the turf surface with damp cheesecloth dislodged considerably more pesticide than any of the other methods. But even for this method, less than 3% of the applied pesticide could be dislodged only minutes after application. Several hours later, following irrigation, no more than 0.1% was dislodged even by this very aggressive method (Table 2).

Using the dislodgeability data, some of the golfer behaviors that could lead to contact with pesticides were investigated. They included a) placing a hand on the turf surface following an application of pesticide, b) handling golf grips that had been placed on the turf surface, c) handling a golf ball that had been putted twice across a pesticide-treated green, d) touching a club face and back following chipping onto a green, e) kissing or licking a golf ball that had been putted on a treated green. Since the studies did not involve human subjects, pesticide was dislodged from the turf and the golf equipment by means that no doubt were far more thorough in dislodging pesticide than by casual touch. Therefore, the studies added an extra margin of safety above that margin incorporated into the USEPA figure used to calculate risks (generally 10- to 10,000-fold).

Because very little scientific information exists about the behaviors that expose golfers to pesticides, a theoretical golfer was created to simulate both high and worst-case estimates of dermal and oral exposure. For purposes of the study, this theoretical golfer was assumed to exhibit behavior that exceeds what any real golfer would reasonably do. It was assumed that on each hole of golf the theoretical golfer did each of the five previously listed behaviors that could lead to contact with pesticide that had been applied to turfgrass. Since none of the pesticides studied have shown any carcinogenic effects, risk was assessed using the hazard index approach to assess potential non-cancer effects. This approach compares the average daily intake (dermal and oral) of each pesticide to a published acceptable level of daily intake for chronic or subchronic exposure (RfD) (1). If the resulting hazard index is less than or equal to 1.0, the chemicals are considered unlikely to represent a risk to human health. If the hazard index is greater than one, a potential risk to human health may exist (4).



The research field study showed that the pesticide dose received by a golfer very much depended on the time period and irrigation cycle after a pesticide application.

The field study showed that the pesticide dose received by the theoretical golfer very much depended on the time period after application, and on irrigation following pesticide application. Increasing either factor reduced the golfer's estimated dose of pesticide. Thus, the golfer's risk also depended on these two factors (Table 3). For behaviors leading to hazard indexes greater than 1.0, some level of risk might exist. These behaviors range from the absurd, such as playing 18 greens 30 minutes after pesticide application every day for a lifetime of 70 years, thereby resulting in an unacceptable risk from some pesticides, to more reasonable, although still unlikely, scenarios producing no measurable risk (hazard index of less than 1.0).

The calculated indexes also are very dependent on the pesticide studied. Considering three contrasting pesticides, for example, the calculated risks are much higher for fenamiphos than for chlorpyrifos (Table 3). But even for fenamiphos, the chances of any of the behaviors leading to hazard indexes

Table 3
Hazard indexes calculated for various pesticides and behavioral scenarios[1]

Behavior	Hazard Index[2] Fenamiphos	Isazofos	Chlorpyrifos
Golfer plays on 18 greens 30 minutes after pesticide application every day for a lifetime (70 years)	152.00	55.12	0.31
Golfer plays on one green 30 minutes after pesticide application and on the remaining 17 greens after pesticide application and irrigation every day for a lifetime	17.05	6.80	0.04
Golfer plays on 18 greens after pesticide application and irrigation every day for a lifetime	9.08	3.95	0.02
Golfer plays on 18 greens the day after application and irrigation every day for a lifetime	0.84	1.30	0.01
Golfer plays on 18 greens 30 minutes after pesticide application two times a week for 35 years	21.65	7.86	0.04
Golfer plays on one green 30 minutes after pesticide application and on the remaining 17 greens after application and irrigation two times a week for 35 years	2.43	0.97	0.01
Golfer plays on 18 greens after application and irrigation two times a week for 35 years	1.29	0.56	0.003
Golfer plays on 18 greens the day after application and irrigation two times a week for 35 years	0.12	0.19	0.002

[1]Data from R. H. Snyder (9) [2]Hazard risk less than 1.0 produces no measurable risk

greater than 1.0 are minuscule, because fenamiphos cannot be used legally more than twice per year on any one area.

Furthermore, there are behaviors a golfer can easily avoid to further reduce the risk posed by pesticides. For example, it is known that a much higher proportion of pesticide is absorbed into the body following oral versus dermal exposure (2.5% of the pesticide that reaches a golfer's skin is assumed to be adsorbed into the body, but 100% of the pesticide ingested by oral exposure is assumed to be adsorbed). Therefore, simply avoiding the "kissing or licking the golf ball" behavior is a good way to reduce whatever dose of pesticide might be received.

Pesticide Volatilization

A portion of the pesticide applied to golf turf is volatilized into the atmosphere. Inhalation of volatilized pesticides represents another way that pesticide can enter the body. We and others (5) have observed that more pesticide may be lost from turf by volatilization than by leaching or dislodging. For example, we have observed losses by volatilization, measured only during daylight hours, ranging from 2.5% to 13.6% of that applied (Table 4), which are greater losses than we observed due to leaching, dislodging, or clipping removal for some of the same pesticides.

Table 4
Pesticide volatilized over a three-day period, excluding nighttime periods, expressed as a percent of the amount applied

Pesticide	Study Year 1999	2000
Ethoprop	11.3%	13.6%
Fonofos	7.2%	—
Chlorpyrifos	—	6.0%
Isophenfos	2.5%	2.8%

Risks associated with inhalation of volatilized pesticides also can be calculated when USEPA chronic reference dose (RfD) data are available. The average daily inhaled dose of pesticide for a 70 kg adult (154 pounds) playing a 4-hour round of golf can be estimated as (5):

$$D = (C^*R^*4h)/70\text{ kg} \quad \text{(Equation 1)}$$

where D = daily inhaled dose of pesticide (micrograms kg^{-1}), C = measured air concentration of pesticide (micrograms m^{-3}), and R = adult breathing rate during moderate activity (2.5 $m^3\ h^{-1}$).

For chlorpyrifos, the USEPA chronic reference dose (RfD) is 3.0 micrograms $kg^{-1}\ d^{-1}$. Using Equation 1 and assuming that all inhaled pesticide is absorbed by the body, it can be calculated that the concentration (C) of chlorpyrifos in air that provides a daily inhaled dose (D) equal to the RfD is 21 micrograms $kg^{-1}\ m^{-3}$. This value was not exceeded in either of the two studies we have conducted (Table 5), indicating that golfer exposure to volatile losses of chlorpyrifos poses little health hazard.

However, it should be noted that the RfD for chlorpyrifos is rather high compared to certain other organophosphate pesticides, so the lack of a health hazard for chlorpyrifos should not be taken as a generalized lack of health hazard for other pesticides. For example, fenamiphos has a RfD of only 0.25 micrograms $kg^{-1}\ d^{-1}$. Based on Equation 1, C is only 1.75. However, this value was exceeded for only a short time in one of two studies conducted on fenamiphos volatilization (Table 5). Of course, the calculations assume exposure to the corresponding concentration of pesticide for an entire round of golf every day for a lifetime, which will not occur based on the data from our study (Table 5) and the regulatory requirement that fenamiphos be used no more than twice per year.

Conclusions

No single study can answer all the questions that have been raised about the fate of pesticides applied to golf turf and the risks they pose to golfers. We can only hope that our work provides a piece of the scientific information needed to make a comprehensive assessment of pesticide risks to golfers. However, working with a selection of OP pesticides, we generally have observed relatively small losses by clipping removal or by leaching because of the strong adsorbing ability of the thatch layer of the turf. Furthermore, under most reasonable golfing scenarios, for the pesticides we studied, we find little reason to anticipate that golfers are incurring any serious risk due to dislodged or volatilized pesticides used for maintaining turfgrass on golf courses.

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Table 5
Concentration of chlorpyrifos and fenamiphos in air following application to bermudagrass turf

Sample Time Following Application		Chlorpyrifos		Fenamiphos	
Study 1	Study 2	Study 1	Study 2	Study 1	Study 2
--- (hours) ---		------- ($g\ m^{-3}$) -------			
0 - 2	0 - 1	4.24	6.39	0.39	3.15
2 - 4	1 - 2	1.02	6.48	0.00	0.04
4 - 6	2 - 3	1.22	5.27	0.09	0.02
6 - 18	3 - 4	0.32	3.52	0.00	0.02
18 - 24	4 - 5	0.19	3.18	0.00	0.02
24 - 27	5 - 19	0.08	0.51	0.01	0.01

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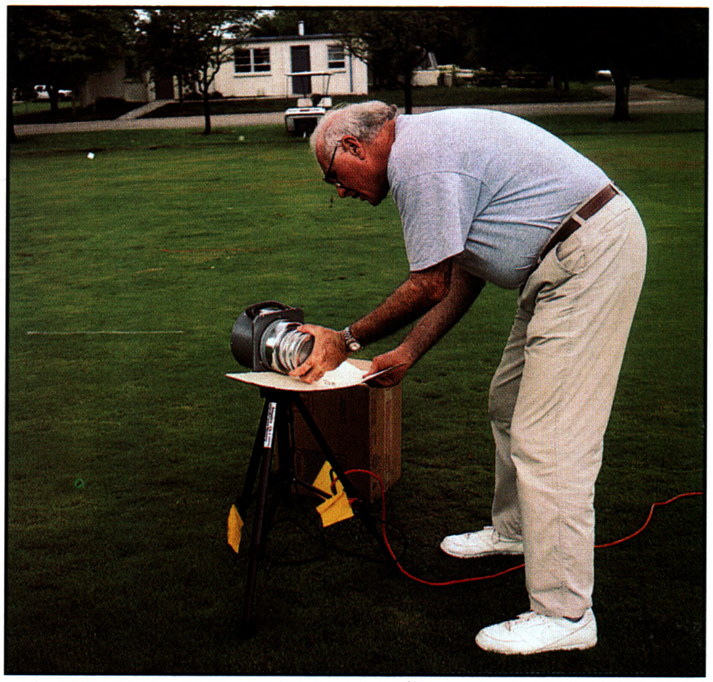


(Left) The University of Florida has conducted research to measure direct golfer exposure to pesticides used on the golf course. For purposes of this research, their theoretical golfer was exposed to situations created to simulate a worst case of exposure. (Right) A pesticide-adsorbing resin in the air sampler was used to measure the pesticide concentration in the air following its application to the turf.

Transforming The Lakes

Improving wildlife habitat and water quality with lake bank buffer zones.

by BOB MARSHALL

IGM AT THE HABITAT, an 18-hole municipal course in Malabar, Florida, has more than 31 acres of lakes. Prior to 1998, all of the lake banks were maintained right down to the water's edge. This clean edge did not allow for any naturalized areas to develop along the lake banks.

After joining the Audubon Cooperative Sanctuary Program (ACSP) and learning the benefits of buffer zones, we decided to let the naturalized plants take priority. It has been more than two years since we stopped using weed-eaters on the lake banks, and the results are tremendous. The plant community has flourished, resulting in more food sources and shelter for wildlife, which is now plentiful. By transforming our lakes, we're living up to our name in a whole new way.

Lake buffers enabled IGM at The Habitat to achieve its goals:

- Enhanced local biodiversity by encouraging natural plant growth.
- Improved the water quality and reduced chemical applications.
- Provided additional habitat for wildlife.

Implementation and Maintenance

Before embarking on such a significant transformation, a communication and education strategy was in order. We educated our crew and clubhouse staff about the goals and plans of the project. Signage was erected on the golf course to try to keep golfers out of the new habitat areas. Information was added to our ACSP display to show the benefits of the buffer zones.

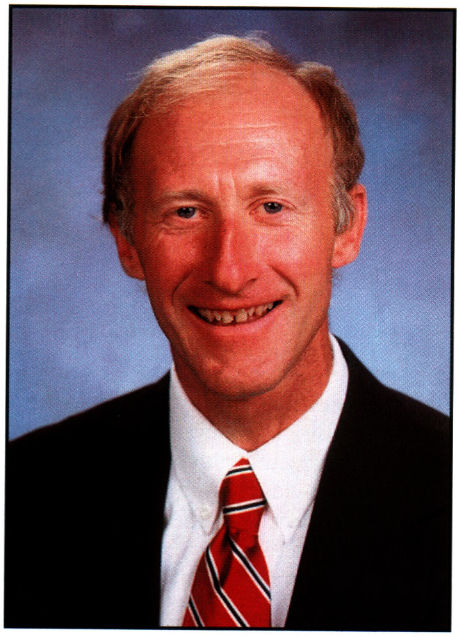
From there we let Mother Nature take her course – and the results were dramatic. We added four to five acres of habitat and have seen an increase in the diversity of wildlife in and around our lakes. Countless hours of labor-intensive maintenance have been saved. Our crew goes in once a year, or when necessary, to eliminate invasive exotic plants by hand. The amount of chemicals used in and around the lakes has also been reduced.

At first – and still on occasion – golfers complain about losing balls. We always make sure to trim plants that have grown too high so they do not block golf balls. After experiencing the positive effect that the native areas have had on our wildlife and the added interest to the game of golf, golfers have come to respect what has been achieved. Our lakes are now more beautiful and diverse – they're better for wildlife, better for the environment, and better for golf.

BOB MARSHALL *is the former superintendent at IGM at The Habitat and the current superintendent at IGM at Pelican Bay in Daytona Beach, Florida. He is available to answer questions regarding this project and can be reached at pelicanbay@-igminc.net.*

Adding buffers to the water features on the golf course has resulted in more wildlife on the property. A nesting pair of great blue herons fledged two young for the first time in 2000. The project involved very little cost and actually saved the staff countless hours of labor.

David Wienecke Joins Green Section



The USGA Green Section Southwest Region is proud to announce the addition of a new agronomist to its staff. David Wienecke joined the Santa Ana, California, office to work with Pat Gross, director in the region. He replaces Mike Huck, who left the staff in June.

Dave's introduction to golf came as an irrigation technician, which eventually evolved into assistant superintendent and superintendent positions. He holds an M.S. degree in horticulture, specializing in turfgrass science, from Oregon State University. Most recently, he consulted with golf courses in IPM and certification in the Audubon Cooperative Sanctuary Program while working as an assistant superintendent at Oswego Lake Country Club, in Lake Oswego, Oregon. In addition to spending several years as assistant superintendent at various golf courses, Dave taught at several colleges. He has been active in the Oregon Golf Course Superintendent's Association and the Northwest Turfgrass Association, most recently participating in development of the publication *Best Management Practices for Golf Courses*.

Dave's responsibilities will include making Turf Advisory Service visits throughout Arizona, California, Utah, Colorado, and Nevada. The USGA Green Section welcomes Dave to the staff.

Physical Soil Testing Laboratories*

The following laboratories are accredited by the American Association for Laboratory Accreditation (A2LA), having demonstrated ongoing competency in testing materials specified in the USGA's Recommendations for Putting Green Construction. The USGA recommends that only A2LA-accredited laboratories be used for testing and analyzing materials for building greens according to our guidelines.

BROOKSIDE LABORATORIES, INC.
308 S. Main Street, New Knoxville, OH 45871
Attn: Mark Flock
(419) 753-2448 • (419) 753-2949 FAX

EUROPEAN TURFGRASS LABORATORIES LIMITED
Unit 58, Stirling Enterprise Park
Stirling FK7 7RP Scotland
Attn: John Souter
(44) 1786-449195 • (44) 1786-449688 FAX

N. W. HUMMEL & CO.
35 King Street, P.O. Box 606
Trumansburg, NY 14886
Attn: Norm Hummel
(607) 387-5694 • (607) 387-9499 FAX

ISTRC NEW MIX LAB, LLC
1530 Kansas City Road, Suite 110
Olathe, KS 66061
Attn: Bob Oppold
(800) 362-8873 • (913) 829-8873
(913) 829-4013 FAX
e-mail: istrcNewMixLab@worldnet.att.net

THOMAS TURF SERVICES, INC.
2151 Harvey Mitchell Parkway South, Suite 302
College Station, TX 77840-5247
Attn: Bob Yzaguirre / Jim Thomas
(979) 764-2050 • (979) 764-2152 FAX
e-mail: soiltest@thomasturf.com

TIFTON PHYSICAL SOIL TESTING LABORATORY, INC.
1412 Murray Avenue, Tifton, GA 31794
Attn: Powell Gaines
(912) 382-7292 • (912) 382-7992 FAX
pgaines@surfsouth.com

TURF DIAGNOSTICS AND DESIGN, INC.
310-A North Winchester Street
Olathe, KS 66062
Attn: Sam Ferro
(913) 780-6725 • (913) 780-6759 FAX

*Revised September 2001. Please contact the USGA Green Section (908-234-2300) for an updated list of accredited laboratories.

STATEMENT OF OWNERSHIP, MANAGEMENT, AND CIRCULATION

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JAMES T. SNOW, Editor

A STEP-BY-STEP GUIDE TO CONSISTENT BUNKERS

Follow the rules and you can achieve consistency, but are you sure you want to?

by CHRIS HARTWIGER

BUNKERS are one of the most popular topics discussed during Green Section Turf Advisory Visits. These hazards, as defined in The Rules of Golf, are often criticized for being too hard, too soft, too wet, or contaminated with sediment. Bunker discussions almost always end with the familiar refrain: "All we want are consistent bunkers!" For those of you who share in this desire, I have good news for you. It can be done.

Having been down the long, winding road to bunker consistency with golfers before, the first step is to weed out a few of the pretenders from those who are ready to get down to business. This short survey will do the trick:

How would you rate bunker consistency at your golf course:

1. The bunkers are fine just the way they are.
2. The bunkers are not consistent, but I am not willing to pay any money out of my own pocket to improve them.
3. The bunkers are not consistent and I am willing to pay up to $500 to improve them.
4. The bunkers are not consistent and I am ready to pay whatever it takes to improve them.

For those of you who selected 1, 2, or 3, you have permission to stop reading and go directly to the "Turf Twisters" on the back of this issue. For those of you who selected 4, read on.

For years golf course superintendents have tried to maintain all the bunkers with the same riding machine or hand raking technique. In the quest for consistency, this approach was doomed to fail because of the many factors that influence bunker performance. The shape of the subgrade, the runoff of surface water, the spacing of the drain lines, the amount of irrigation coverage, and the position of the bunkers in relation to the prevailing wind are a few of the factors that make each bunker unique. The same maintenance program does not produce consistent bunkers.

The first step in our quest for consistency is complete reconstruction. Purchase the best sand in your area and use the most technologically advanced construction technique. Here is where things get a little sticky. If we really want consistent bunkers, it is imperative to make each bunker the same size and shape. After all, it would be inconsistent to have a sloped subgrade on one bunker and a flat bottom on another. Come to think of it, this will make construction even easier.

The next step does require me to break a little bad news to you. If we want consistent bunkers, and we do, we had better go ahead and make each green identical to avoid any inconsistencies in the way the shot should be played. For example, a bunker shot to a green sloping away from the player is going to perform differently than a shot to a green sloping toward the player. This would represent inconsistency.

Hang in there – the last two changes are almost painless. Every approach shot on par 3s, par 4s, and par 5s should be the same length. Change the length of the holes as needed to meet this requirement. Although our sand is perfect, I have a feeling that a ball hit high with a pitching wedge into a bunker will have a different lie than the lie of a ball in the bunker hit with a low screaming 3 iron. Again, different lies would result in inconsistent bunkers.

Finally, we must do something about the variety of sand wedges that are available. Some sand wedges are great for firm sand, while others are better for softer sand. If we want consistency in our bunkers, we cannot stand for different equipment. Each club can specify which wedge their players must use. To offer a little variety, maybe a different wedge could be specified for different days of the week.

There you have it – consistent bunkers. Although I have offered great recommendations, I hope no one follows them. Now I will tell you why. (Caution: The next few statements may infuriate some of you.) First, most people who complain about the bunkers being inconsistent are really saying that they are not getting the ball up and down as frequently as they think they should. Second, who ever said bunkers are supposed to be consistent? Every bunker is different and, therefore, bunkers are inherently inconsistent.

If you do not take anything else from this article, remember that golf is a game of inconsistencies. A player must make adjustments for yardage, the lie of the ball, the direction and speed of the wind, the slope of the putting green, and on and on and on. What is consistent about playing the game? Nothing. And that is precisely why it is fun to try to get that little ball into the hole in as few strokes as possible.

If the bunkers at your golf course frustrate the daylights out of you, take a lesson from a golf professional. Become a better course manager and avoid them. But above all else, do not allow the condition of a hazard to take the fun out of the game.

CHRIS HARTWIGER *shares innovative ideas as agronomist for the USGA Green Section Southeast Region, based in Birmingham, Alabama.*

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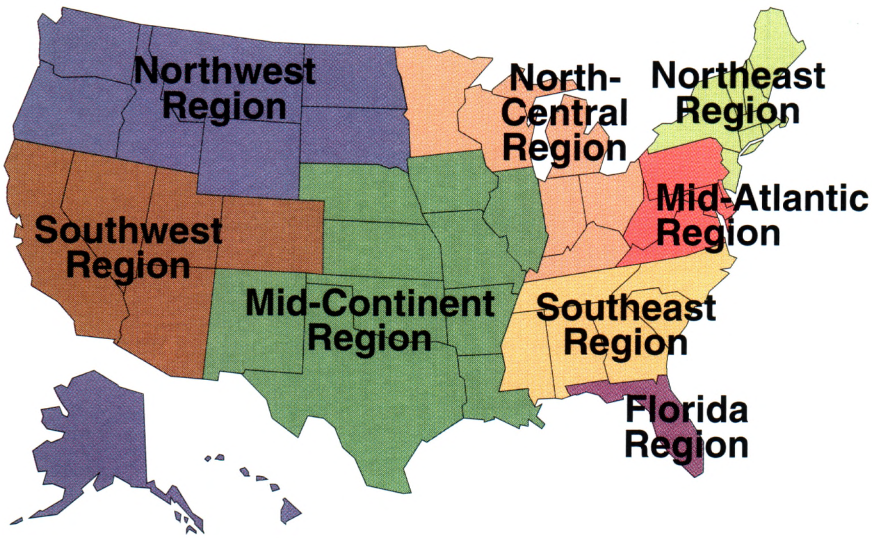

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TURF TWISTERS

COMMIT TO

Question: We are considering a number of projects on our course over the coming years and are debating whether to try to do the work in-house with our existing crew or to hire outside contractors. The two largest projects are rebuilding our bunkers and extending our cart path system. Do many courses attempt such projects on their own?

Answer: Many do, and many wish they had not by the time the projects are finished. Few courses are adequately staffed to take on such labor-intensive projects without sacrificing many of the daily necessities of keeping the course in good condition. Golfers often have the idea that the work can all be accomplished in the winter, since they think the crews are not busy then anyway. Actually, most golf course crews are extremely busy in the winter overhauling equipment, caring for trees, and completing many smaller-scale projects. It is also important to remember that winter weather often plays major havoc with major projects, greatly extending the time necessary to complete the work. A good compromise on major projects is to combine the expertise, equipment, and manpower of an outside contractor with some labor being contributed by the course's own staff.

BRUSHING UP ON

Question: We have tried many different raking strategies in our bunkers. I have heard that brushes can be used and that they can be fitted to mechanical bunker rakes. Is this true? (Pennsylvania)

Answer: Yes, as a matter of fact, there are several manufacturers that supply brushes that can be retrofitted to bunker maintenance equipment. However, the machine operator is essential to the success of the technique. A mechanical rake fitted with brushes requires the operator to carefully govern the speed with which the sand is groomed. Excessive ground speed promotes unevenness, with ridges of sand being one of the negative side effects. As with any procedure, practice makes perfect!

THE RULES OF GOLF

Question: I've recently been impressed with the need to improve my knowledge of course marking and the Rules of Golf. While I have taken a GCSAA seminar on this subject in the past, I would like to pursue a higher level. Do you have any suggestions? (Indiana)

Answer: Each year the USGA and PGA co-sponsor multiple Rules of Golf workshops around the country. These typically include three days of reviewing the Rules in detail, followed by a comprehensive test. Attending a USGA/PGA Rules of Golf workshop, including he exam, will improve your knowledge. Workshop locations can be determined by calling either association or checking their respective websites. Be sure to plan ahead; space is limited and the workshops fill quickly.