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Perspectives on the Stimpmeter

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Cover Photo:
Testing the effect of slope on stimpmeter readings.

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The severe ridge in this green is difficult to maintain and limits hole locations when fast green speeds are required.

It's Time We Put the *Green* Back in Green Speed

by DAVID A. OATIS
Director, Northeastern Region, USGA Green Section

Editor's Note: This is the first of three articles concerning the stimpmeter appearing in this issue. Each was submitted independently, without knowledge of the others, and each takes a different approach to the topic. If you think this is overkill, consider that our 15 agronomists believe the misuse of the stimpmeter to be one of the most insidious problems of putting green turf in every part of the country.

FEW GOLF COURSE management topics attract greater attention or controversy than speed of greens. It is a constant source of debate, and Green Section agronomists are regularly bombarded with comments and questions about this volatile subject. Though some may feel the topic has been beaten to death, a good argument could be made that green speed is beating the game of golf to death. Too much emphasis is being placed on the importance of having ultra-fast greens, and many golfers fail to realize just how much green speed is related to subjectivity, perception, relativity, and reality.

Subjectivity

Thirteen years have passed since the stimpmeter was made available to golf course superintendents. The intentions behind its introduction were wonderful; essentially, the USGA wanted to have the ability to quantify green speed for the sake of consistency. There was a great demand among all interests in golf to know the relative speed of greens. To that end, the stimpmeter was used during 1976 and 1977 by USGA agronomists to gauge the relative speed of thousands of greens across the country. Data from this work formed the basis for the green speed charts found in the stimpmeter instruction manual. There has always been plenty of controversy about green speeds, but the introduction of the stimpmeter and the publication of quantitative data stimulated a new round of debate that has not subsided.

For anyone taking up golf, a great deal can be learned about the game just by asking questions, listening, and observing. It's a wonderful way to observe the interaction of golf with human nature. People who follow golf long enough usually come to the same conclusion: Golfers who are playing well tend to be happy and are generally complimentary of course conditioning. On the other hand, golfers who are playing poorly tend to be unhappy and are often critical of course conditioning. Tired or nervous golfers leave putts short or blast them by the hole, and green speed is often blamed for their poor performance. In general, golfers who negotiate the course with fewer than 25 putts love the greens, while those with putt totals over 34 feel the greens are inferior.

CONCLUSION: The condition of the golf course, in the subjective view of the golfer, is directly related to how well that golfer plays. This conclusion is further supported by my own golf career, when at age 17 I won a local junior golf tournament. The tournament was played in August on *Poa annua* greens that were 30-40% dead. (This happened every year.) After shooting a career round and winning the tournament, I deliberately sought out the superintendent and complimented him on the excellent condition of the course. "The golf course is in wonderful shape," I proclaimed.

The point is, course condition and green speed are very subjective in the mind's eye, and the stimpmeter was introduced to eliminate this subjectivity. The speed charts which were produced gave an accurate picture of relative green speeds at that time, but they did not (nor were they intended to) account for the many subtleties that should be considered when determining a green speed for a particular course.

There is a remarkably direct relationship between fast greens and dead grass, and most of the practices currently used to increase putting green speed are detrimental to the health of the turf if practiced to an extreme. The question is, how fast is fast, and how do we determine what is appropriate? Should we simply refer to the chart and pick a number for everyone to follow? "We want fast greens, so set them at 9′ 6″." No, this is absolutely the wrong way to look at the problem!

Scalping injury due to a low cutting height on a severely ridged green.

Perception

It is fascinating to consider just how often golfers playing the same course will have completely different views concerning the speed of the greens. A visit made several years ago to a course renowned for its fast greens provides a case in point. At the time, the membership was very unhappy about what they considered inferior green speed, even though the superintendent reported that it was 11′ 6″. After much discussion, a stimpmeter was produced and the whole group of committee people marched out to a putting green to measure its speed. The speed indeed measured at 11′ 6″, yet the committee was not impressed.

During the proceedings, a golfer who had played in the U.S. Open at a different site the previous week arrived to give his thoughts on the subject. "I don't care what that thing says," he said. "I just played in the U.S. Open and the greens were faster there than they are here." As a matter of record, the green speeds during that particular Open had been about 10′ 6″ throughout the championship.

Maybe it was the pressure or the status of playing in an Open that made the player think the greens were faster. After all, Open courses are well known for their firm, fast putting surfaces. Then again, it may have been the contours of the Open greens that made them seem so fast. In any event, the fact remains that the player was absolutely incorrect in his assessment of the green speed, and this is one of the reasons the stimpmeter was introduced.

The point is this: The best players in the world cannot determine green speed with a putter because touch and feel, no matter how finely tuned, are nothing more than senses. Though it is a simple instrument, the stimpmeter is very accurate and does not lie.

Relativity

Using the USGA green speed chart, whether for Regular or Championship play, does not always do justice to selecting a green speed range for a particular course. Severely contoured greens should not be maintained at very fast speeds because the skill factor is removed and is replaced with a luck

GREEN SPEED CHART
CHAMPIONSHIP PLAY

FAST	10′6″
MEDIUM FAST	9′6″
MEDIUM	8′6″
MEDIUM SLOW	7′6″
SLOW	6′6″

GREEN SPEED CHART
REGULAR MEMBERSHIP PLAY

FAST	8′6″
MEDIUM FAST	7′6″
MEDIUM	6′6″
MEDIUM SLOW	5′6″
SLOW	4′6″

Stimpmeter charts derived from surveying more than 1,500 greens in 36 states in 1976 and 1977.

Some fairways *roll 4-5 feet with the stimpmeter today!*

factor. Severely contoured greens combined with even reasonably fast green speeds (7′ 6″ to 8′ 6″ on the stimpmeter) give the golfer the perception that speeds are **very fast**. A good argument could be made that those stimpmeter readings are more than adequate for those particular greens, but the same stimpmeter readings on greens with less contour would be perceived by the same golfer as being quite slow.

Along the same lines, golfers playing in tournaments at other courses often return home with stories of "lightning fast" greens, and respond by putting even more pressure on their own superintendent to do the same. What the golfers fail to realize is that the tournament greens were more than likely peaked for that special event and were not kept that way for long. Carrying this one step further, visiting players are usually not as familiar with the greens as they are with their own, and this lack of local knowledge makes the greens seem faster.

Weekly televised golf tournaments fuel the demand for fast greens, yet golfers fail to take into account that these events are prepared for weeks, months, or even years in advance. The U.S. Open Championship provides a classic example of selective viewing. Spectators and viewers do not see the course the week following the event, when the greens are usually fertilized, the cutting heights raised, and mowing postponed for a few days.

It should be noted that in 1976 and 1977, the years during which the stimpmeter was tested, the average speed across the country was 6′ 6″. Furthermore, anything over 7′ 6″ was considered excitingly fast by the Green Section agronomists doing the testing. These same speeds today would be considered very slow by some, and courses remaining at the same level occupied 13 years ago would have lost ground relative to most other courses.

Green speed is much like playing golf: The worse (slower) you are, the easier it is to improve (faster). It is also true that it is tougher for a good player to improve. Increasing the speed of greens from 7′ to 8′ is relatively easy, but taking it from 9′ to 10′ and beyond is progressively more difficult.

Essentially, some of the elite clubs that were once recognized for their fast greens have been caught or passed. But who says faster is better? The fastest three-lap average speed wins the pole position at the Indy 500, but consistently good speed, without mechanical failure, wins the race.

Many of the great old golf courses have a green or two which is so severely contoured that it has little usable cupping area, especially at faster green speeds. Some greens have mounds or ridges which cannot be mowed without scalping, and the comments and questions from the green committee in both scenarios are often the same: "What can we do? Should we rebuild the green? Can we raise the front or lower the back? Why don't we remove the mound?" The list goes on and on. Wonderful old courses by the late, great architects such as MacKenzie, Ross, Tillinghast, Banks, Flynn, and others have been completely changed or modified over the years for the sake of "modernization," and now they are being changed for the sake of green speed. Does this make sense? Is it right? Many would argue that it is not!

The value of fast green speeds is being greatly overemphasized. It should not be the only factor in determining changes in architecture. Within reason, architectural style should be an important consideration in determining green speed ranges on these courses. Having one or more severely contoured greens should be a factor in setting green speeds for the entire golf course, and a green should not necessarily be rebuilt or recontoured just to facilitate faster speeds. There are exceptions to every rule, and some of these severe greens may not be fair or reasonable even at relatively slow speeds. These greens may need adjustments, but great care should be taken not to confuse reasonable contours with excessive ones.

Reality

Maintaining very fast green speeds for a prolonged period of time can be detrimental to the health of the turf, and it greatly affects natural selection. Practices involving very close mowing, excessive verticutting, frequent grooming, low fertility, etc., leave the turf weak and subject to weed grass

(Left) Moss often accompanies the practices designed to increase green speed, including very close mowing, frequent grooming or verticutting, and low fertility.

(Above) The result of pressing for more speed on a soft, saturated green.

infestation. This effect is compounded by heavy play.

Weed grass invasion may come in the form of crabgrass and goosegrass, but their encroachment can usually be controlled with applications of preemergent herbicides. Unfortunately, these herbicides have their own detrimental side effects. The other weed grass which presents a problem is *Poa annua*, and this one is more difficult to control. The drawback to having *Poa annua* as a main constituent of greens is that it is an inconsistent grass when subjected to weather extremes.

It is no secret that moss and algae can be major problems at courses with fast greens. Low cutting heights and low fertility practices reduce the recuperative ability of the turf as well as its competitiveness. We've all heard that the best defense against weed grass invasion is to grow a healthy stand of turf, and this is true. The most effective way to control moss and keep it controlled is to increase fertility and raise cutting heights. In short, increase the vigor of the turf.

Weather has not yet been mentioned, yet this is surely the most significant variable superintendents must deal with. When rigorous cultural practices for improving speed are combined with extended periods of stressful weather, it can have a detrimental effect on the turf. The result can be loss of density, increased disease activity, or outright loss of turf.

Wet weather can completely change the character of a golf course by softening green surfaces and reducing green speed. When an extended period of wet weather occurs in an area, golf course superintendents have to be concerned about the health of the turf as well as the speed of the greens. Saturated soils and heavy play can cause root dieback and enhance disease activity, and the last thing the superintendent wants to hear is the members' requests for faster greens.

The geographic location of the golf course has much to do with how easy it is to develop fast green speeds. Maintenance practices which produce smooth, fast greens in cooler climates will likely produce dead turf in hotter, more humid areas. What can be done at one latitude or elevation cannot necessarily be done in another. How long is the stress period at your location? Is August normally the only bad weather month, or does your course experience three months or more of stress? How does your course come out of the winter? Is it healthy, or is winterkill a real problem? Sometimes we should just be thankful to have decent turf, let alone fast greens.

Turfgrass root systems play an important role in the turf's ability to withstand stress. Healthier, deeper roots translate to better stress tolerance. We have become more aware of the value of healthy roots in recent years, partly because unhealthy, weak-rooted turf is so often observed. The response has included innovations in aeration equipment and an increasing variety of fertilizers and growth-related products introduced to improve rooting and stress tolerance.

All of this is in direct response to a persistent trend in putting green management: The amount of stress being placed on putting greens increases every year. The stress comes in the form of heavier play and increased demand for faster green speeds. It is no wonder that two of the most commonly observed diseases on greens in many parts of the country in recent years have been anthracnose and summer patch, both stress-related diseases.

It is not hard to find fairway turf that measures more than 4′ 6″ on the stimpmeter today. Keep in mind that such speeds were not uncommon on some greens just a dozen years ago. Fairways have improved immeasurably because we have finally discovered how to reduce the amount of stress they receive. The trick has involved changing to lightweight mowers.

Why haven't we seen a similar response on the putting greens, where many clubs have gone back to using lighter, walk-behind mowers? The answer lies in the height of cut. There is little doubt the bentgrass existing in our greens would become more competitive if cutting heights were raised back to 3/16″ or ¼″. Speed would suffer, but the bentgrasses would begin crowding out the *Poa annua*. Wouldn't that be something!

Realistically, we all know this will not happen until tighter water restrictions or the loss of pesticides forces the issue. Nonetheless, proceeding with moderation as far as green speed is concerned will yield healthier turf.

Conclusion

There is a wonderful new trend in golf course architecture, especially with respect to some of our classic golf courses. That trend, or theme, is preservation. A new level of appreciation has emerged, and golfers are finally beginning to realize what some have known for a long time: The older courses are some of our best. Aided by computers and laser measuring devices, the contours of older courses are being measured and mapped with incredible accuracy. Our older courses are a part of the history and evolution of the game of golf in this country. As such, they should be treated with respect and they should be preserved. Changing anything but the most unreasonable contours for the sake of a few inches on a stimpmeter is a mistake.

Ultimately, each club must decide what green speed is reasonable and appropriate for its golf course. When warning signs appear (loss of density, shortened root systems, appearance of moss, scalped knolls, etc.), action should be taken. Increase fertility, raise the cutting height, eliminate verticutting and grooming, and switch to solid rollers. Some of the symptoms can be relieved through sound cultural practices, such as proper fertility, aerification, etc., but sometimes the towel should be thrown in as far as green speed is concerned. Agronomics and architecture must take precedence over green speed.

In short, too much emphasis is being placed on the value of extremely fast green speeds. The health of the turf is being compromised all too often, and this leads to turf failure or the risk of failure. Heavily contoured greens maintained at too great a speed reduce the amount of usable cupping area and leave some greens unplayable. Use the stimpmeter as it was intended: to measure speed and improve consistency between greens. Put the emphasis on consistency and smoothness, where it belongs. It's time we put the *green* back in green speed.

Beneficial Turfgrass Invertebrates

by **ROBERT C. VAVREK**
Agronomist, Great Lakes Region, USGA Green Section

PICK UP a trade magazine and thumb through the insecticide advertisements. Many contain claims such as "fast acting and long lasting," "reliable against 86 insects . . . ," "control for five full weeks . . . ," and "continuous protection that lasts." Other comments refer to broad-spectrum control of insect pest species found in turfgrass and ornamental plantings. One is led to believe that the best insecticide is the one that kills the most insects for the longest time.

A sound turfgrass maintenance program requires judicious use of insecticides from time to time. For a moment, though, consider the effects of these chemicals on the diverse group of organisms, other than cutworms and grubs, that live in a stand of turf. Scientists refer to these creatures as non-target organisms.

Sometimes predators are mistaken for the pests they control. For example, big-eyed bugs are easily confused with chich bugs, and ground beetles look much like black turfgrass ataenius adults. Accurate pest identification is the foundation of a sound turfgrass management program.

Most of these non-pest invertebrates are less than 1mm long and live in thatch or soil. Before they can be counted or studied, they must be removed from their habitat. A common method of extraction utilizes the Berlese funnel. A soil/thatch sample is placed on a screen which is attached to the inside walls of an open-ended funnel. A cover which contains a light bulb is placed over the top of the funnel, and a jar containing a small amount of alcohol seals the bottom of the funnel. The heat and light produced by the light bulb drive the invertebrates out of the sample, down the sides of the funnel, and into the alcohol, where they can easily be counted. The following are a few of the more common non-pest invertebrates found in turfgrass thatch and soil.

Mites

Anyone who has come into contact with chiggers has already had an itchy introduction to one of the mite species. Mites are often the most abundant organism extracted from soil and thatch. These tiny, eight-legged invertebrates are closely related to their much larger cousins, the ticks. Some are predaceous on other mites, insects, or insect eggs. Others are saprophytic and feed on dead or decaying plant material. Many feed on fungi, pollen, and spores. Some feed on living plant cell contents, but only the clover mite (*Bryobia praetiosa*), winter grain mite (*Penthaleus major*), and bermudagrass mite (*Eriophyes cynodoniensis*) are considered injurious to turfgrass.

Predatory mite populations are often reduced by applications of turfgrass insecticides.

Oribatid mites are commonly observed in thatchy turf and may aid in the decomposition process. Insecticides seem to have little effect on their populations.

Collembola

The next most abundant non-pests extracted from turfgrass soil and thatch are collembola. Only a few species are larger than 1mm, and most consume fungi or decaying plant material. They are often referred to as springtails because many utilize a small, forked appendage on the abdomen (furcula) to jump or spring about. Two groups can be easily recognized: the highly pigmented "globular" springtails that live near the soil surface, and the grey "elongate" type that are true inhabitants of the soil.

The role of collembolans in turfgrass is not known. They are known to be important in the decomposition of organic matter, though, in that their feeding habits regulate the growth of fungi that contribute to the degradation of complex plant residues, such as lignin and cellulose. Collembolan feeding has also been shown to rejuvenate senescent colonies of fungi by removing old hyphae and recycling important nutrients.

(Above) Big-eyed bugs prey on chinch bugs, an insect that causes considerable damage to cool- and warm-season turfgrass.

(Right) The pale, elongated collembolans live deeper in the soil. Notice the "springtail" near the end of the abdomen.

Enchytraeid Worms

Enchytraeid worms are tiny (1-3mm long), white segmented worms closely related to the more familiar earthworms or nightcrawlers. They are often observed in decomposing organic matter or thatchy turf, and are sometimes mistaken for nematodes. Nematodes are much smaller and can only be seen with the aid of a microscope.

Enchytraeid worms feed on bits of soil and organic matter, much like their larger relatives. Their role in the decomposition process was once thought to be limited to the initial processing of plant tissue, allowing microbes to more easily degrade plant residues. Recent research indicates that a few species have the enzymes necessary to actually break down complex plant molecules. Consequently, their role in the breakdown of organic matter, which accumulates in turfgrass as a thatch layer, may actually be quite important.

Rove Beetles

This is a very diverse family (Staphylinidae) of beetles, represented by more than 3,000 species identified in North America. They vary in size between 1mm and 25mm in length, but those extracted from thatch and soil samples are usually only a few millimeters long. Adults and larvae are very active predators and feed on a variety of organisms. They can be identified in the field by their short wing covers and their habit of raising the tip of the abdomen as they run.

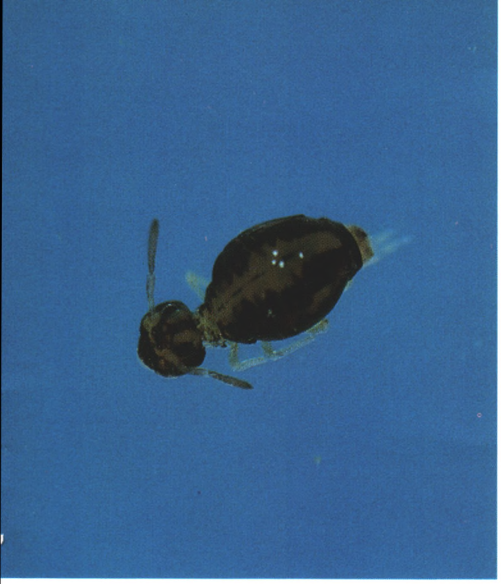
The role of predators in the turfgrass ecosystem was recently investigated. Dr. Dan Potter and co-workers at the University of Kentucky strongly suggest that ants, mites, rove beetles, and ground beetles have a role in the regulation of sod webworm populations. Ants are thought to be an especially important consumer of sod webworm eggs and, because of this, exert considerable natural control on these turf pests.

Effects of Insecticides on Non-Target Invertebrates

Turfgrass researchers are concerned that overuse of pesticides could lead to secondary outbreaks of insect pests. In other agricultural systems, insecticide use has sometimes had little effect on the target pests but great impact on their natural enemies. Reduced pressure from predators and parasites allows rapid resurgence of some of these pests. In other words, insect problems are increased after the application of insecticide.

The limited amount of research conducted indicates that predatory mites are quite susceptible to applications of chlorpyrifos (Dursban) and isofenphos (Oftanol), and to a lesser degree to trichlorfon (Proxol) and bendiocarb (Turcam). Little is known about the impact of other insecticides on predatory mite populations in turfgrass.

In a study conducted at the Ohio Agricultural Research and Develop-



(Above left) Sminthurid collembolans live near the soil surface and many feed on fungi or organic matter.

(Above) Enchytraeid worms are closely related to the more familiar earthworms and may have a similar role in the decomposition of organic litter.

(Left) Rove beetles are frequently extracted from soil and thatch samples. The role of these highly active predators in the turfgrass ecosystem has not been studied. (Photo courtesy of Dr. H. D. Niemczyk, the Ohio Agricultural Research and Development Center.)

ment Center, populations of predatory mites were reduced for six to 12 weeks following an application of isofenphos (Oftanol) to home lawns.

On the other hand, populations of oribatid mites, a common group of saprophytic mites in turfgrass, were unaffected by most insecticides. In fact, higher populations of these mites were observed in lawns treated with isofenphos (Oftanol) than those receiving no treatment. Perhaps reduced pressure from predators allows a buildup in their populations. Oribatids are considered important in the decomposition process of forest organic litter, especially under acidic conditions, but their role in the turfgrass ecosystem has not been studied.

Populations of collembolans are also reduced by applications of insecticides. Some scientists consider the presence or absence of collembolans an indicator of soil pollution. In one study, a two-pound rate of isofenphos (Oftanol) applied in late August to home lawns in Ohio reduced populations of these invertebrates, but they recovered by the following June.

Of the few insecticides tested, none were toxic to enchytraeid worms. However, insecticides such as chlordane, carbaryl (Sevin), and bendiocarb (Turcam), which are known to be toxic to large earthworms, may also affect their minute relatives. More enchytraeid worms were found in lawns treated with isofenphos (Oftanol) than those receiving no treatment, similar to the effect of this insecticide on oribatid mite populations.

Since collembolans, oribatid mites, and enchytraeid worms occupy a similar ecological niche, the elimination of one group may aid the survival and reproduction of the others. This may be one way nature recovers from the impact of pesticide applications.

In a study conducted in Kentucky, bendiocarb (Turcam) and trichlorfon (Proxol) applications reduced populations of rove beetles, but the effect lasted just a week. Isofenphos (Oftanol) and chlorpyrifos (Dursban) had a longer-lasting effect. A late-summer application of isofenphos (Oftanol) to home lawns reduced populations of these beetles for 43 weeks. Rove beetles seem to be affected by most soil insecticides, probably because they are very mobile and contact more insecticide as they seek prey.

Rove beetles have been identified as natural enemies of several important insect pests in agricultural systems. Their susceptibility to insecticides has resulted in less natural pest control and, consequently, more damage to some vegetable crops.

The contribution of mites, enchytraeid worms, and collembolans to the decomposition process in turfgrass has not been studied. However, if their role is similar to that reported from studies in forest ecosystems, reduced abundance may result in the inhibition of nutrient cycling. If this occurs, plant tissue residue, in the form of thatch, could be an undesirable side effect of pesticide applications. This, in turn, could lead to a myriad of thatch-related problems such as shallow rooting and pesticide adsorption.

Researchers are just beginning to understand the complex relationships between turfgrass pests and their natural predators and parasites, as well as the role of non-target invertebrates in the turfgrass ecosystem. Your support of the USGA Green Section makes funds available to universities for the continued investigation of these important interactions.

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Measuring Green Speed on Sloped Putting Greens

by A. DOUGLAS BREDE, Ph.D.
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I FIRST became impressed with some of the problems of measuring green speed 10 years ago when participating in a Master's thesis project with Clark Throssell, who is presently Associate Professor, Department of Agronomy, Purdue University. (Well, I suppose *participating* is not the best word for my involvement in his project — try *drafted.*) We found that one of the main problems in measuring green speed, as I'll explain, was slope. But first, let me describe how Clark's study got me involved in green speed research.

Clark Throssell was a first-year grad student at Penn State University, and I was an *experienced* fourth-year student. Stimping is easier with two people, and Clark needed someone to read measurements while he held the end of the stimpmeter. The story goes that Dr. Joe Duich, our mutual advisor, sent Clark and me on a week-long trip to Pittsburgh to assess differences in green speed among Pittsburgh's many fine golf courses as part of Clark's thesis project. With virtually no advanced planning and no roadmap, we trotted off in a rental car in search of some of Pennsylvania's most exclusive courses.

Getting permission to set foot on these courses was not always easy. Some superintendents were surprised to see two tired, tee-shirted students who wanted to check the speed of their

Figure 1. A formula (see text) was derived that corrects for slope in green speed readings. Here, the actual angles of inclination are checked before validation of the formula on the Stillwater (Oklahoma) Country Club.

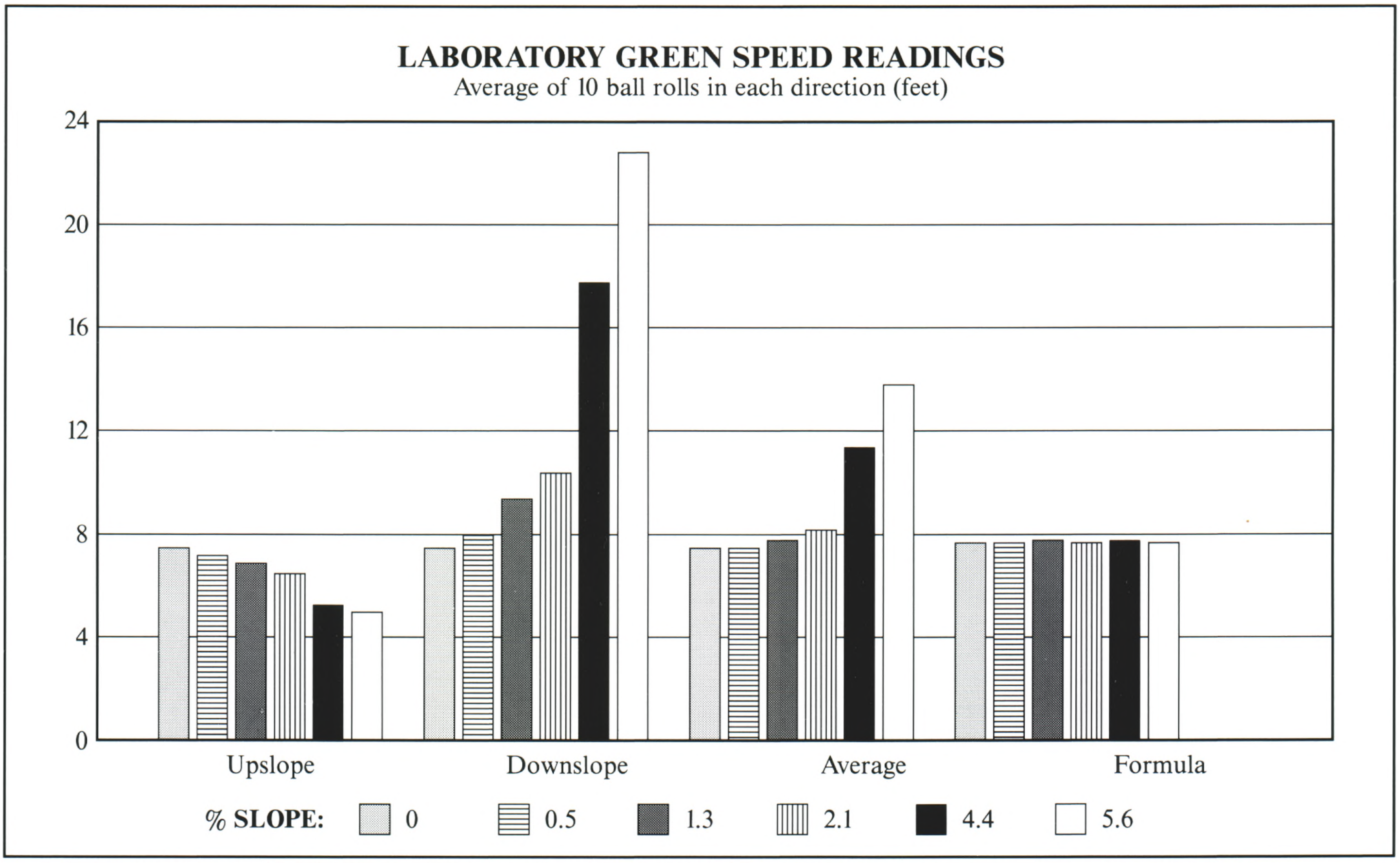


Figure 2. As the slope of the laboratory runway apparatus was increased from 0 to 5.6%, error from gravitational acceleration was reflected in the average stimpmeter speed. The formula (see text) compensated for gravity and gave a uniform green speed reading regardless of slope.

greens. Others were afraid we'd publicize how slow their greens were. "You should have been here last week before the rains hit," they'd say.

But those problems paled in comparison to the one we encountered when we took our measurements. The U.S. Golf Association Green Section booklet on the stimpmeter explains that readings must be taken on a reasonably level area. To our dismay, we had one heck of a time trying to locate representative level areas on which to take our green speed readings. Whole greens had to be bypassed because they just weren't flat. This problem seemed to be worse at the finer courses, the ones with challenging green architecture and lightning fast speeds. Staying within the six-inch deviation between forward and reverse readings recommended in the USGA booklet was nearly impossible. Furthermore, we were skipping large portions of the golf course because of sloped greens.

Mathematics to the Rescue

Necessity is the mother of invention. The problem of sloped greens bugged me for several years after our Pittsburgh study. One day, though, I sat down and figured out a mathematical solution to the problem. The solution came too late for Clark, though. He'd since graduated with his degree in Stimpmeter Science and was off to Kansas for his Ph.D. I also graduated shortly thereafter and was off to a faculty position at Oklahoma State. It was there at Oklahoma State that I was able to do the field validation work on the devised formula. Ron Hostick, one of my undergraduate students, was drafted to hold the stimpmeter while I took readings.

Deriving a formula for correcting green speed readings on a slope was not as complicated as it sounds. I had some help from Sir Isaac Newton. After Newton recovered from his apple-induced head injuries, he penned some of the basic theories of motion physics. These basic theories were the foundation of my formula for correcting green speed readings for slope. Who knows? If a stray hook shot instead of an apple had beaned him, Newton might have claimed the fame for this new formula instead of me!

Newton described the motion of apples (or any other object) moving down a slope in mathematical terms. By merging his equations for up- and down-slope movement into one equation, the following formula was born:

$$\text{green speed corrected for slope} = \frac{2 \times S\uparrow \times S\downarrow}{S\uparrow + S\downarrow}$$

where $S\uparrow$ is the stimpmeter reading taken in the uphill direction, and $S\downarrow$ is the reading taken downhill.

As simple as the formula looks, it actually works to remove the effect of slope from green speed readings. In fact, when using a calculator for the math, computing green speed is no more complicated than with the traditional two-direction averaging method the USGA presently recommends. Here's how to use the formula:

1. Locate a spot on the green with a uniform surface. The surface can be on a slope or on a flat area; the formula works in either case. Try to avoid areas with concave or convex surfaces, just as you would when reading traditional stimpmeter speed. Also, avoid shooting crossways on a slope, as the ball will curl downhill (Figure 3).

2. Roll three balls in the downhill direction. Average the three rolls. Then, roll three in the uphill direction, averaging these. Plug the downhill average into **Sz** in the formula and the uphill average into Sz. The formula will provide a green speed reading as if the sloped green were tilted into an upright, level position.

Validating the Formula

Mathematical theories are of no use unless they're validated with actual data. Checking the formula on golf course putting greens was only part of the validation. One problem arises when testing green speed on putting greens: Stimpmeter speeds can change from location to location on a golf course, confounding the ability to validate the formula. For example, comparing a rough-surfaced slope with a smooth-surfaced level area would be like comparing apples and oranges.

It was necessary, therefore, to construct a test runway in the laboratory that could be tilted at various angles and still have the same uniform surface. This was accomplished by building a solid wooden runway, 24 feet long, covered with patio grass carpet. Those of you who've putted on this stuff know that it stimps about 8 or 9 feet, similar to many putting greens. We tilted the runway at six different angles from 0 to 5.6% slope and tested the stimpmeter speed as we changed slope (Figure 2). Up-slope readings slowly declined with increasing slope, while down-slope readings began to really take off at slopes above 1 or 2%.

As a result, the traditional averaging method of computing stimpmeter speed began to incur error as slope increased. Using the formula, however, corrected speeds were equal, regardless of slope.

In our tests on actual golf courses, the formula provided the same correction factor as in the laboratory. We tested it on slopes up to 6% and still it yielded accurate results.

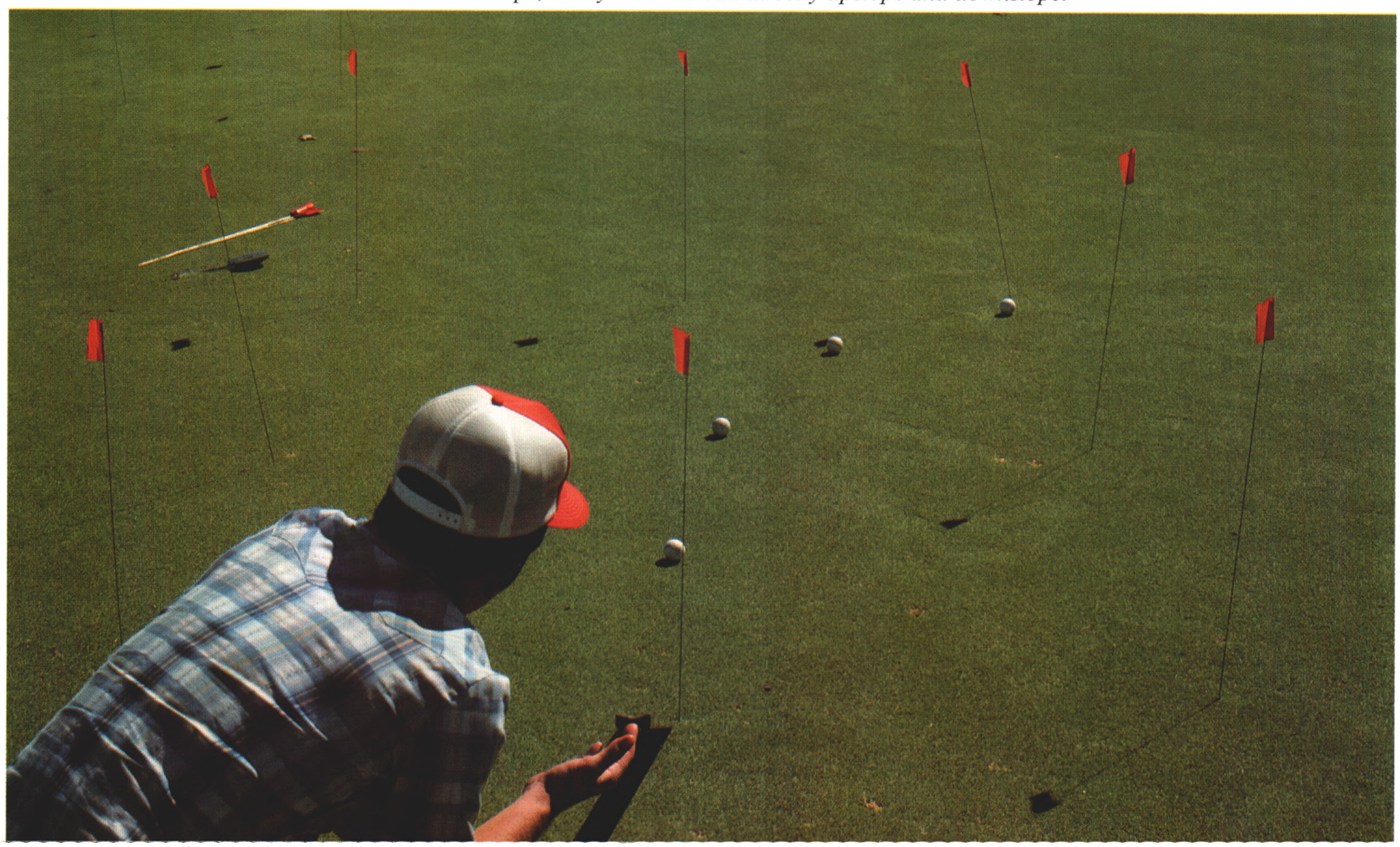
"Eyeballing" the amount of slope — or lack of it — on a golf course is a tricky task, even for professional golfers. After all, golf course architects design greens with an optical illusion that makes slope difficult to judge. I took several students out to a green where I'd placed pairs of flags on various slopes. Most were unable to distinguish a 2.2% slope from level. Thus, don't rely on your sight to tell you if you're on a level area. You'll know you're on a level surface when the forward and reverse stimpmeter readings differ by no more than six inches. If not, use the formula instead.

When to Use It and When Not to

If you're fortunate to have level greens, stick with the traditional averaging method of calculating green speed — the formula will give you no better results than the method you're presently using. But if you have sloping greens, or sloping spots you'd love to check for green speed, try the formula. You'll probably agree that the traditional forward-reverse averaging method is still handier. But for those sloped areas, the formula will give you accurate green speed readings that were previously impossible to obtain.

*This article is a **progress report**, highlighting results of a study that has been submitted to a scientific journal for peer review.*

Figure 3. Checking stimpmeter speed by rolling crossways across a slope (shown here) distorts readings, whether you're using the formula or the traditional forward-reverse averaging method of calculation. When using the formula to compute green speed on a slope, always roll the ball directly upslope and downslope.



An example of severe surface contamination.

Controlling the Battle of Bermudagrass

by JOHN H. FOY
Director, State of Florida Region, USGA Green Section

THERE'S A BATTLE between bermudagrasses taking place on many greens in the South that most people aren't familiar with. Someone might take for granted that after various bermudagrass strains are planted on greens, fairways, and surrounds, the job is done and there they stay. Once established, however, these grasses begin a long-term competition that results in certain cultivars or strains laying claim to much larger territories than they were originally intended to occupy.

For golfers, the competition doesn't matter so much until inferior or unwanted strains gain a significant foothold on greens. Then, putting green quality and consistency can really suffer.

Golf course superintendents throughout the Sunbelt know how difficult it is to prevent or control bermudagrass encroachment in greens. During the summer months, aggressive rhizome and stolon growth can result in significant lateral spread of hybrid and common bermuda from surrounding areas into existing putting green turf.

Bermudagrass encroachment into bentgrass greens has received a fair amount of attention over the years, and recent research work appears to have developed strategies for minimizing this problem. Various chemical treatments are used to prevent or suppress bermuda encroachment into bentgrass turf.

The situation is more difficult, however, when one bermudagrass encroaches on another. Such is the case when Tifway (419) bermuda encroaches into Tifdwarf and Tifgreen (328) bermudagrass putting greens. It was originally thought that Tifway encroachment into bermuda greens would not be a problem because it could not tolerate close mowing heights and competition from the putting green quality bermudas. As it turns out, Tifway can survive and spread into

Tifway encroachment into Tifgreen bermuda green.

greens maintained at 5/32- to 1/8-inch without much difficulty. In the South Florida area, more than two feet of encroachment can occur in a year's time. Unfortunately, though Tifway bermuda can survive at putting green height, it does not provide an acceptable playing surface, and selective chemical control of one bermudagrass strain that infests another is simply not possible today.

The development of off-type strains in existing bermuda greens is another major problem southern superintendents must deal with over periods of time. The occurrence of these different strains, or mutants, in hybrid bermuda greens was first reported in the early 1960s. Everything from bermudagrass mites, disease activity, and environmental and mechanical stress, to the introduction of material from the outside and genetic mutation of the original turf, was being examined to explain the patches of different grasses. The actual cause of surface contamination/mutation is still being debated today.

Surface contamination/mutation is a problem because many of these off-type strains vary in texture, growth habit, and tolerance to routine green management practices. As surface contamination increases, it is more and more difficult to maintain consistently good quality appearance and playability. Many of these off-type strains react very poorly to routine verticutting operations, particularly during the mid-to-late summer when environmental stresses build up. Typically, after 30% to 40% of the green surface is contaminated, management practices cannot be adjusted sufficiently to overcome the negative impact of the contaminants.

Winter overseeding of bermuda greens masks the presence of strains that arise from encroachment and surface contamination, but because it is not possible to see the areas of off-type material, spread of these strains occurs with routine changing of hole locations and the sod plugs. Furthermore, given the trend toward the use of lower overseeding rates and finer-textured overseeding grasses such as *Poa trivialis* and bentgrasses, consistent overseeding results are much more difficult to achieve with highly contaminated putting surfaces.

The problems with fairway bermuda encroachment and surface contamination/mutation of bermudgrass greens in Florida have been so pronounced that the replanting of greens every 10 years has been a common practice. In some cases it has been necessary to regrass greens in six to eight years. These expectations have made it even more difficult to justify the long-term benefits of proper putting green construction techniques.

The cost of reestablishing a monostand turf cover (a minimum of $40,000 to $60,000 to replant 18 greens) and the inconveniences that must be tolerated by the membership when it is necessary to close a course for three or four months surely justify efforts to prevent and control encroachment and contamination problems before they become unmanageable. Following is a review of various practices that can be utilized to accomplish this objective.

Planting Strategies

At the time of planting or regrassing of bermudagrass greens, soil sterilization and planting operations should be extended a minimum of 10 to 15 feet beyond the putting surface proper. This practice creates a buffer strip that significantly reduces the rate of encroachment of fairway bermudagrass into the green surface. This planting scheme can also reduce the amount of foreign material tracked into the putting surfaces by golfers and equipment.

A variation on this planting strategy being tried on a few courses in South Florida involves establishing a buffer strip between the putting surface and the fairway bermudagrasses using different turf selections. It is generally accepted that Tifdwarf is the best adapted hybrid bermudagrass available for use on putting greens in Florida. Unfortunately, the less-aggressive growth habit of Tifdwarf makes it more susceptible to encroachment problems. On the other hand, Tifgreen bermuda produces a more consistent surface at higher heights and can compete better against invasion from Tifway. Thus, these courses are using Tifgreen bermuda to create a buffer strip between their putting green and fairway bermudas. The width of the buffer strip varies from a couple of yards to the entire green surround. To date, satisfactory results have been experienced. Earlier attempts using zoysiagrass in similar buffer strip plantings did not work well.

Mechanical and Chemical Control

Maintaining a band of separation 4 to 6 inches wide between greens and surrounds with glyphosate would probably work quite well, but it would hardly be acceptable to most golfers. However, non-selective chemical control of encroachment and surface contamination is strongly recommended during the establishment of new or renovated greens. During this time, when a dense turf cover is not present, fairway ber-

A replanted green being chemically edged.

mudagrasses are quickly able to encroach into greens. Maintaining a band of separation with glyphosate, therefore, should be a standard practice when establishing bermuda greens. Furthermore, during the grow-in stage, chemically roguing any off-type strains detected in the putting surfaces will help insure the purity of the base turf.

When bentgrass greens were first established in the South, it was recommended that a thin-bladed edger be used around the perimeter of the greens, followed by a band application of siduron. This program was conducted each spring and fall to help control encroachment. It was also found that mechanical edgings during the summer months, in conjunction with hand pulling of bermuda runners, was of great benefit.

While applications of siduron, or other selective herbicides, are not effective with bermuda greens, mechanical edging has a place. Ideally, the same grass used for the greens should be established on the collars. Mechanically edging the outside perimeter of the collars once or twice per month during active growth and hand pulling any runners that have encroached are definitely worthwhile.

Encroachment barriers and mechanical barriers.

Barrier Materials

Through the years a variety of permanent barrier materials have been installed around greens to physically inhibit bermudagrass encroachment. These materials have run the gamut from plastic and galvanized steel edging to concrete walls buried below the soil surface. One of the problems with this approach to encroachment control was highlighted at this year's PGA Championship at Shoal Creek Country Club in Birmingham, Alabama. One competitor's approach shot hit the barrier material and careened widely away from the green. While the probability of this occurring on a regular basis is low, the negative impact on course playability and appearance cannot be overlooked.

Recently, two new plastic barrier materials have been introduced. Because both of these barriers were specifically developed to combat encroachment problems, their benefits and acceptance will undoubtedly be better. A key to success with both of these barriers, however, is following through with an edging program on a regular basis. Several courses that have installed these barriers are reporting satisfactory results.

Contamination Removal and Replacement

The previously described strategies were directed toward preventing encroachment of fairway bermuda into collar and putting green surfaces. What about putting surface contamination/mutation control? At this time, the only good approach is a program of spot removal and replacement.

All of the greens should be closely examined during the summer months and off-type selections should be identified. These areas should then be treated with two or three applications of glyphosate on a seven-day schedule. The dead turf can then be cut or plugged out, and clean sod can be installed. The appearance and playability of the areas being worked on is unquestionably affected, but this is an acceptable consequence for the sake of maintaining surface purity and extending the life expectancy of the greens. Furthermore, even when a good encroachment control program is practiced, a similar spot removal program through collar areas will be required from time to time. To practice an effective and economical spot removal program, a good turf nursery must be available as a source of replacement material.

Some may question whether the effort to prevent and control encroachment and surface contamination is justifiable. The best argument for establishing and maintaining an aggressive control program is that surface purity can be maintained for 25 years or longer. There is a course located on the lower southeast coast of Florida where the superintendent has actively pursued controlling surface contamination. The greens on this course are as clean as any newly planted green.

In the future, research work may provide alternative control strategies, such as genetic tolerance to herbicides within similar turf varieties, so that selective control is possible. Until that day comes, however, diligence and the application of regular control programs will be necessary to maintain a pure stand of grass on bermuda putting greens.

ALL THINGS CONSIDERED

Say No to Posting

by JAMES CONNOLLY
Agronomist, Northeastern Region, USGA Green Section

"DO YOU USE a stumpmeter?"

"A what?"

"A stumpmeter. You know, the thing used to see how fast your greens are."

"You mean a stimpmeter?"

"Yeah, a stumpmeter. I was at Old Moss Country Club the other day and they were posting stumpmeter readings at the first tee. We should do that too! By the way, what do our greens roll?"

"Well, about . . . ."

"Theirs rolled 27 feet!"

"Really? That's pretty fast."

"You should post our speeds."

Good grief, not again! Another club official has succumbed to the dangerous temptation to place too much importance on green speed by publicly posting green speed readings on a daily basis.

Several superintendents have contacted me recently concerning the practice of posting green speeds. It seems other clubs in their area are doing this and some of their own members think it is a good idea. This is ridiculous, and here's why:

1. Grass grows and other conditions change during the course of a day. Speeds at 6:00 a.m. could be different at 10:00 a.m. or 4:00 p.m. There is no doubt that readings can be deceptive.

2. What difference does it make, anyway? Whose putting game is so great that he could stand on the first green and putt differently because the posting sheet says 8′ 6″ today versus 8′ 0″ yesterday?

3. Posting green speeds forces golf course superintendents to take unnecessary risks with the health of the turf during weather extremes for the sake of maintaining someone else's unrealistic green speed standards. There are too many variables involved to expect green speeds to remain constant throughout the season, much less from day to day. Grass is lost and superintendents lose jobs when they are forced to abuse the turf to post a double-digit green speed at the first tee.

4. Posting creates unhealthy comparisons between clubs and can generate strife among superintendents. There are enough unjustified comparisons between clubs now; let's not add another.

Needless to say, I feel it is truly absurd to post stimpmeter readings. I hope that clubs do not gauge the success of their superintendent or the quality of the greens solely by what the stimpmeter says. This useful device is not some infallible benchmark of turf or putting quality. Like a doctor's thermometer, it provides a small piece of information that can be incorporated into the larger management picture.

Let's use it wisely. Note how the turf responds to your efforts to increase green speeds at various times during the season. You may be able to associate certain turf problems with these practices and improve your management techniques.

Follow good agronomic practices and let *that* be your guide to speed. Consistency is the key. Giving the golfer good uniformity on 18 holes is part of good management. The stimpmeter can help you do that. Don't succumb to the pressure to post; let's have a "POST-FREE GOLF COURSE"!

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I certify that the statements made by me are correct and complete.

Robert Sommers, Managing Editor

TURF TWISTERS

WHICH SHOULD I CHOOSE?

Question: The temperature of the water in our irrigation pond reaches 86 degrees on hot summer days. There is also a well on our property where the water temperature goes no higher than 68 degrees. Should I consider pumping water from the well to syringe and cool our bentgrass greens during the summer? (South Carolina)

Answer: A gram of 86-degree pond water absorbs 580 calories of energy, while a gram of 68-degree well water absorbs 586 calories. Since the difference is only 6 calories of energy, don't spend extra money to extract water from the well. As far as water temperature is concerned, it makes no difference where you get the water for syringing purposes.

GYPSUM OR SULFUR

Question: My course is located in the state of Arizona where high sodium levels in the soil are a problem. In surveying area superintendents, there seem to be two popular responses to this problem. Some apply gypsum (calcium sulfate) to add calcium to the soil, and others apply sulfur to lower the pH. Both the gypsum and sulfur are reported to lower the sodium buildup. Can you shed some light on this topic? (Arizona)

Answer: You are correct in stating that both the gypsum and sulfur applications help reduce sodium buildup. The choice in any particular location would depend on the soil chemistry of the site. Gypsum is prescribed when the soil has a neutral pH reading and the amount of measurable calcium is low in relation to magnesium and sodium. When sulfur is prescribed, the soil generally has a high pH reading and will release calcium when neutralized with an acid solution. In both cases the calcium level is raised, which reduces the sodium adsorption ratio (SAR).

FOR TOP-NOTCH TEES

Question: We are in the early stages of building a new course, and the grassing specs call for Tifgreen (328) bermuda to be used on the tees. What are the pros and cons of this grassing scheme? (Florida)

Answer: Tifgreen (328) bermuda has been used instead of Tifway (419) on tees at several courses in the South over the past few years. The primary reason for its use is that it can tolerate a mowing height of about ¼ inch. While this characteristic makes it possible to provide top-quality teeing surfaces, Tifgreen does require a different maintenance regime. First of all, Tifgreen bermuda is less aggressive and has a lighter color than Tifway, and extra fertilization is required to maintain uniform color and a dense turf cover when subjected to heavy play. A second consideration is that Tifgreen tees have experienced some surface contamination after a period of time. Though most golfers never notice this situation, the presence of two bermuda types does complicate management (herbicide) programs to some degree. Thus, while Tifgreen bermuda can produce top-quality tees, it is not necessarily superior to Tifway bermuda.