stresses such as crown hydration and anoxia. Consequently, preparing for winter injury should be considered a year-long process that encompasses a number of different cultural practices to promote turfgrass health.

## GETTING WINTER READY

Winter hardiness of turfgrasses is achieved through the process of cold acclimation, which is induced by decreases in temperature and light during the fall. During this period of time, turfgrass plants undergo physiological and metabolic changes that allow them to become more tolerant to winter stresses. The process of cold acclimation is influenced by plant genetics (such as the species or cultivar) in combination with environmental conditions (such as temperature and moisture).

Along with cold acclimation, temperature fluctuations during winter and early spring months (deacclimation) can also influence the winter injury potential of the turfgrass. Largely, cold acclimation capacity and resistance to early cold deacclimation is controlled by genetics; however, there is potential to increase both of these factors through management strategies to ultimately reduce overall winter injury.

Because of the high degree of species variability that exists on putting greens, turfgrass species becomes the major factor influencing winter injury. For example, creeping bentgrass has excellent winter hardiness compared to annual bluegrass.

Research has shown that differences in winter injury potential between these two species is associated with enhanced cold acclimation capacity of creeping bentgrass along with increased susceptibility of annual bluegrass to early cold deacclimation (Thompkins et al., 2000, 2004; Hoffman et al., 2014). Therefore, one strategy to minimize winter damage would be to promote creeping bentgrass and reduce annual bluegrass populations.

**PHOTO 2**

Sod cutters are useful in opening up channels for water flow off putting surfaces prior to winter. Water will often back up at the green/collar interface, therefore extending these channels through the collar and into the green can be important.

PHOTO BY: SAM BAUER

In some situations this may not be an option. In addition, creeping bentgrass may still be susceptible to winter injury, depending on both plant and environmental factors. Consequently, management of annual bluegrass/creeping bentgrass golf greens should focus on promoting healthy turfgrass plants throughout the year while minimizing conditions that favor the potential for winter injury.

So let's look at a few of the major winter stresses, along with management strategies to prepare greens for winter.

## ICE, ICE, BABY

Crown hydration and damage from ice cover are two of the most devastating causes of winter injury on putting greens every year. Crown hydration occurs when temperatures increase, causing plants to absorb water, and results in winter injury if followed by subfreezing temperatures. As a consequence, cells rupture due to the formation of ice crystals and this is lethal for the plant. Damage may also be associated with ice formation outside of cells, causing water to move out of the cells and can cause severe dehydration and/or death of the turfgrass.

Ice cover can also be a contributor to crown hydration as ice melts and then refreezes. In addition, non-porous ice can cause anoxia and/or buildup of toxic gases, mainly $CO_2$, and has been shown to be more injurious to annual bluegrass compared to creeping bentgrass.

Tompkins et al. (2000, 2004) studied the impact of ice encasement, ice cover and snow cover on annual bluegrass in a growth chamber and in the field. Annual bluegrass plants did not survive 90 days of ice encasement in

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**PHOTO 3**

A five-inch auger bit being drilled three feet deep by staff at Medina (Minn.) G&CC to promote water infiltration in swales on native soil greens with no drainage. Channels are back-filled with pea gravel.

Continued from page 31

the growth chamber, whereas creeping bentgrass survived for 150 days. In the field, death of annual bluegrass plants was observed at 75 days of ice cover with damage to creeping bentgrass detected following 90 days of ice cover. These interspecific differences in winter injury associated with crown hydration and ice cover may primarily be associated with plant genetics; however, reducing overall moisture on greens prior and during winter may help reduce the incidence of both these stresses.

Golf courses dealing with extended periods of ice cover have lessened the damage by removing or melting the ice. A current study being conducted at the University of Minnesota and Michigan State University is evaluating the ice melting potential of several standard salts, specific ice melt products and solar absorption materials. The greatest melt followed the use of black solar absorption materials (Photo 1); black substances increased surface temperatures by up to seven degrees F. Products included in the solar absorption treatments were: Milorganite (6-2-0), Sustane (5-2-10), dyed black sand, Top Cut biosolids and BioDac (paper by-product). Phytotoxicity of these products to putting greens is also being evaluated. A more detailed explanation of this study can be found on the University of Minnesota's Turfgrass Science website (www.turf.umn.edu).

## LET IT DRAIN

While sometimes impossible to predict and manage, surface and subsurface drainage are important for reducing injury from crown hydration or ice cover. Surface drainage is based on the architecture of the green. Low-lying areas that hold water on the surface have the greatest potential for damage and moving water off of putting surfaces during the spring transition will have the biggest impact on survivability. As such, creating pathways and channels for water to travel is important for reducing damage (Photo 2). These areas should be established prior to winter to allow drainage as spring temperatures increase.

Swales on greens often drain poorly, which can result in excess surface moisture. Minimizing damage in these areas is much more difficult, but can be promoted by creating openings on the surface in these swales. Deep tine and core-aeration prior to winter help to alleviate damage by standing water in the spring, but the trade-off can be increased desiccation in winters that lack snow cover or in areas prone to drying.

Putting greens built on natural soils with minimal drainage will benefit from augering channels to improve water flow in these swales (Photo 3) and should be filled with pea gravel or other porous materials.

## MORE TO CONSIDER

Another important component in improving winter survivability is management of thatch and organic matter. On putting greens with thatch levels exceeding 0.25 inches, crowns may be exposed to fluctuating air temperatures during winter months. In comparison, crowns deeper in the soil profile are buffered against such rapid and sometimes extreme temperature changes. Excessive thatch and organic matter also hold moisture at the surface, leading to winter injury issues associated with crown hydration, ice cover and the snow mold pathogens.

Regular, frequent topdressing of sand-based root zones is required

PHOTO BY: ERIN MCMANUS

to reduce thatch and organic matter buildup. Sand chosen for topdressing should have a consistent particle size with the existing root zone to minimize layering. For native soil putting greens, it is practical to build up a profile of sand through several years of topdressing, and from a winter injury standpoint this is almost always an improvement.

Plant growth regulators, wetting agents and other specialty turf products all have their place when preparing putting greens for winter. Generally speaking, products that promote healthy turf throughout the growing season will also be beneficial for the plants during the cold acclimation process. No one program works for every superintendent due to site specifics and climatic variation. With that in mind, be sure to use only those products you are comfortable with and have proven successful for you in the past. Test strips are useful for evaluating new products, and untreated areas for justifying current ones.

Wetting agents are more commonly being applied in the late-fall prior to irrigation blowout. The benefits of this type of application have not yet been evaluated with research, but considering that a majority of our winter injury issues are moisture related, this is a topic worth investigating. Hydrophobic sands suffering from desiccation over winter months can potentially benefit from a late season wetting agent application, as will poorly infiltrating root zones. Adequate movement of the wetting agent into the root zone through irrigation or precipitation is necessary for this application to be successful. This research is ongoing and results will be available soon.

## A HOLISTIC APPROACH

A strong focus on the basics of putting green management is important for promoting survivability of both annual bluegrass and creeping bentgrass. Dr. James Beard may have said it best, "Cultural practices should ensure that the turf is healthy, disease-free, and well rooted as the winter season approaches," (Beard, 1973). We have learned a lot about the physiology of winter injury since then, but our recommendations remain the same. Balanced fertility, proper mowing heights, sharp reels and irrigation to promote rooting depth are just a handful of practices, in addition to what was already discussed, that need to become second nature in your management programs.

Winter injury of turfgrass is a complex issue that should be considered with a holistic approach. This article focused heavily on the types of damage that can occur over the winter months, as the specific type of winter injury will dictate management practices that should follow. No matter what type of winter injury you are dealing with, two main points hold true: 1) healthy turf is better able to withstand the stresses of winter, and 2) mother nature rules all. Remember these points as you prepare your putting greens for winter this year.

**Sam Bauer, Brain Horgan, Ph.D., and Lindsey Hoffman, Ph.D., are at the University of Minnesota where Bauer is a turfgrass extension specialist, Horgan is an associate professor of turfgrass science and Hoffman is a postdoctoral turfgrass research scientist. Bauer can be contacted at sjbauer@umn.edu for more information.**

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//HEALTHY COMPETITION

# Pursuing *Poa annua*-free cool-season fairways

## *Overseeding and post-seeding herbicides*

*By Zac Reicher, Ph.D.*

All golf courses, regardless of budget, struggle to minimize *Poa annua* in fairways. Thinning or complete death of *Poa annua* in summer or winter, plus additional damage to the desired species inevitably leads to reseeding the desired turf.

However, *Poa annua* quickly germinates when favorable weather returns and it aggressively out-competes seedlings of the desired turf. Often the end result is higher populations of *Poa annua* than were originally present (Fig. 1). This cycle may repeat itself annually in areas of the country with consistently difficult summers and/or difficult winters. However, new thinking with modern herbicides may help stop this cycle.

FIGURE 1

*Poa annua* filling in between lines of perennial ryegrass overseeded in early September in Nebraska. The *Poa annua* will out-compete the perennial ryegrass over the winter, likely resulting in more *Poa annua* present than in the previous year.

### TIMING OF OVERSEEDING

Seeding summer-thinned areas usually starts near Labor Day with the return of cooler temperatures. Though this is an ideal time to seed cool-season grasses, the majority of *Poa annua* seed in the soil will also start to germinate in mid-September (Kaminski and Dernoeden, 2007). The desired grass and *Poa annua* will be germinating at almost the same time and *Poa annua* will always outcompete desired turf. Therefore, seeding earlier in the summer is preferred to allow germination and maximum maturity prior to *Poa annua* seed germination.

Our work at Purdue showed that seeding creeping bentgrass in mid-August resulted in 19 percent cover of annual bluegrass by the following June (with no control interventions), whereas seeding only a month later resulted in 43 percent cover of annual bluegrass. Furthermore, Henry et al. (2005) showed overseeding creeping bentgrass into an existing *Poa annua* green in July resulted in greater than 70 percent coverage of creeping bentgrass two years later, whereas August seedings resulted in 17 percent or less coverage and September seedings resulted in eight percent or less coverage of creeping bentgrass (Fig. 2).

Our current work at the University of Nebraska is also evaluating seeding in mid-summer, almost as a preventative seeding in areas that perennially thin during the summer stress. This three-year study will wrap up soon, but early results indicate early summer seeding is more effective than late summer seeding for long-term success, especially when overseeding with creeping bentgrass. More important, our work is showing that following up seeding with herbicides for *Poa annua* control limits competition and further improves successful establishment of desired seedlings.

In other studies, we are evaluating ratios of Kentucky bluegrass/perennial ryegrass, for short-term cover (golfer satisfaction) as well as aiming to maximize Kentucky bluegrass in the stand. This study also includes aggressive use of post-seeding herbicides to minimize *Poa annua*. Early results suggest that regardless of the Kentucky bluegrass/perennial

PHOTO BY: ZAC REICHER

ryegrass ratio used in seeding, the most important aspect is aggressive use of post-seeding *Poa annua* control herbicides (Fig. 3).

## HERBICIDES FOR *POA ANNUA* CONTROL

Controlling established annual bluegrass is difficult and a task that the industry has struggled with for generations. However, control is much easier on annual bluegrass that is thinning due to summer stress or when it is a newly-germinated seedling. Even though there is some risk that seedling damage may occur with aggressive herbicide use, it can be quickly compensated for with reduced competition from annual bluegrass.

Herbicide choice depends on the overseeded turf species. Velocity (byspiribac-sodium) can be used as early as two weeks after emergence of creeping bentgrass or perennial ryegrass according to the label. Tenacity (mesotrione) is highly effective when used

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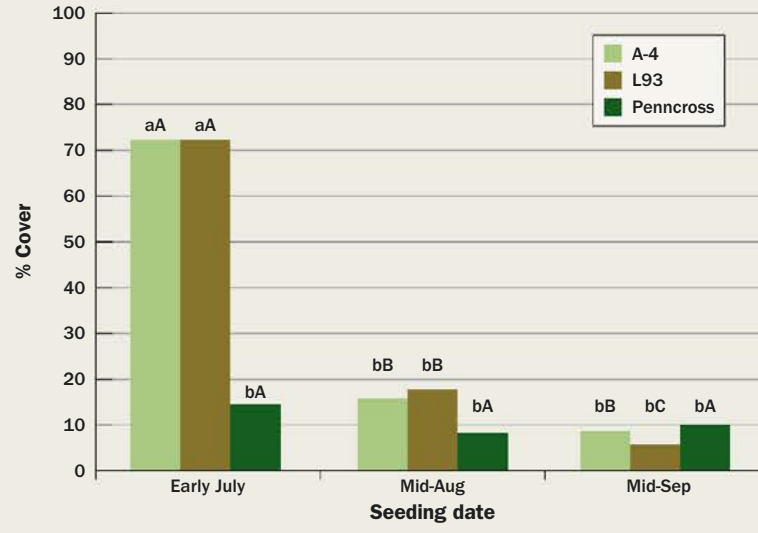
**FIGURE 2**

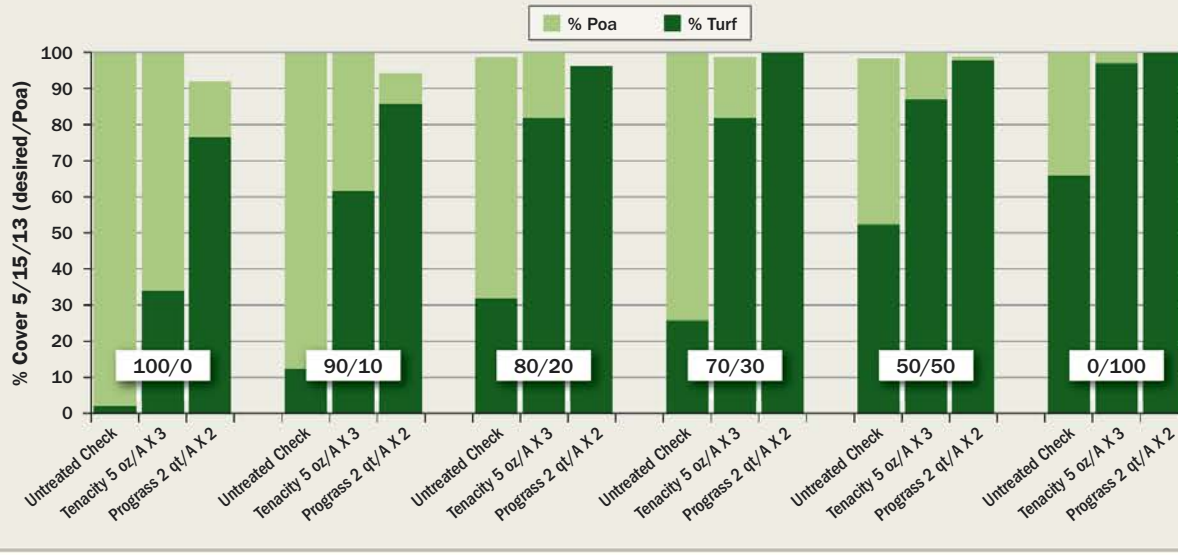
**Effect of seeding date on creeping bentgrass overseeding into Petersons creeping bluegrass (*Poa annua* L. spp. *reptans*) green rated in July, two years after seeding.**




Seeding earlier in the summer results in improved establishment of creeping bentgrass in the short term, which continues to spread in future years. This is especially true with the newer, more aggressive creeping bentgrasses. Bars with a different lower case letter within a seeding date are different at P≤0.05 and bars with a different uppercase letter within a cultivar are different at P≤0.05 (Henry et al, 2005).

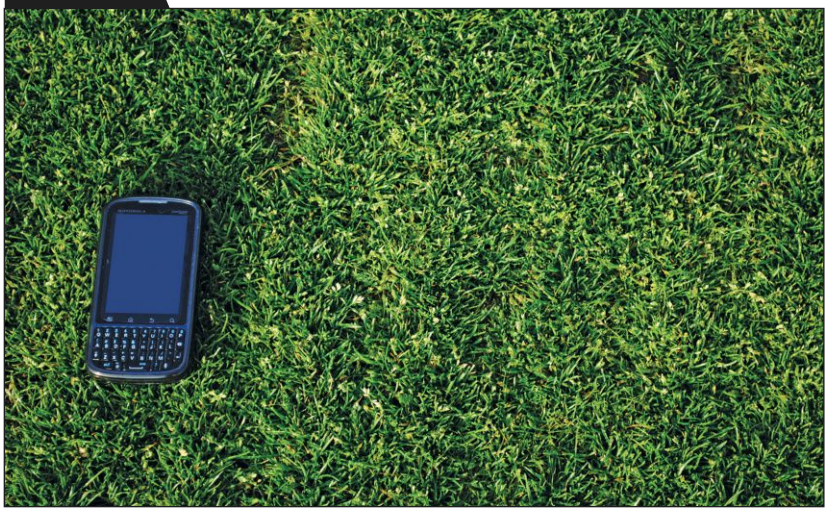
**FIGURE 3**

**Effect of seeding ratio of Kentucky bluegrass/perennial ryegrass (in white box in each set of bars) and post-seeding herbicides on percent cover of desired turf or *Poa annua* rated in May following seeding.**




Areas were killed with glyphosate, power raked in two directions, seeded in September 2012, herbicide applications began in mid-October 2012 and were made on two week intervals. Regardless of seeding ratio, this preliminary data suggests following-up seeding with aggressive *Poa annua* control herbicides will reduce *Poa annua* and increase desired turf.

**FIGURE 4**



A fall seeding of perennial ryegrass with no follow-up *Poa annua* control herbicide application results in turf that is over 50 percent *Poa annua* the following spring.

**FIGURE 5**

A fall seeding of perennial ryegrass with aggressive Tenacity use following seeding. *Poa annua* cover is essentially zero percent the following spring and ryegrass can fill in with no competition.

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in the seedbed of Kentucky bluegrass or perennial ryegrass to control *Poa annua* before it germinates. Tenacity can also be used postemergence within four weeks after seedling emergence (Fig. 4 and Fig. 5). Tenacity applied as recommended on the label at 8 oz./A in the seedbed followed by 8 oz./A at four weeks after seedling emergence is highly effective, as are three 5.3 oz./A applications with the first application applied to the seedbed and the second and third applications made four and six weeks after seedling emergence. Though Tenacity is safe on seedlings of Kentucky bluegrass and perennial ryegrass and on established Kentucky bluegrass, damage is occasionally seen when applied to established perennial ryegrass.

Though not as commonly used, Prograss (ethofumesate) is also labeled and effective for *Poa annua* control when applied to seedlings of perennial ryegrass (Fig. 3). Dimension or Dithiopyr (dithiopyr) has the most flexible label among the preemergence herbicides for use over seedlings. Dithiopyr can be applied shortly after the second mowing of the seedlings to help limit *Poa annua* germinating later in the fall and/or early spring. However, this herbicide cannot be used on fairways mowed below 0.5 inch.

Regardless of the situation on each golf course, it is crucial to follow up seeding with aggressive control of *Poa annua*. Furthermore, if seeding in the spring following winterkill, additional controls will likely be needed for crabgrass and broadleaf weeds. Tenacity, Tupersan (siduron), Drive and other quinclorac-containing products, Quicksilver (carfentrazone) and SquareOne (carfentrazone plus quinclorac) have some of the most flexible labels for use in seedling cool-season grasses for controlling crabgrass and/or broadleaf weeds.

## REGRASSING WITHOUT CLOSING FAIRWAYS?

The expense and inconvenience of closing fairways often raises questions about successful regrassing from annual bluegrass without closing. Historical research suggests it is virtually impossible when converting to Kentucky bluegrass (Kraft et al., 2004) since it is not aggressive as a seedling.

Converting fairways to perennial ryegrass may be more successful since it is more aggressive as a seedling. Most success is seen with regular overseeding with creeping bentgrass to convert the fairways (Reicher and Hardebeck, 2002). However, most success is currently seen when overseeding at high rates over many years and when combined with scalping, growth regulators and/or other strategies that favor the overseeded grass (Figure 4). Our previously mentioned research is re-evaluating some of these strategies using newer herbicides after seeding.

**FIGURE 6**

Converting fairways to a new species is difficult without an application of glyphosate and closing. However, three years of seeding creeping bentgrass at high rates is starting to have an effect in this study on an Indiana golf course.

## TAKE HOME MESSAGE

Unfortunately, many golf courses are faced with repairing summer- or winter-damaged areas of *Poa annua*. The easiest and quickest fix is to overseed a fast-germinating species plus allow the *Poa annua* to germinate and fill back in.

However, this is only a short-term fix and damage will likely reoccur with the next harsh summer or winter. Rethinking the situation, fixing the cultural issues, choosing to overseed a better-performing species at a potentially better time than used in the past and following up with *Poa annua* controls should help limit future problems.

**Zac Reicher, Ph.D., is a professor of turfgrass science at the University of Nebraska-Lincoln. Reicher can be contacted at zreicher2@unl.edu for more information.**

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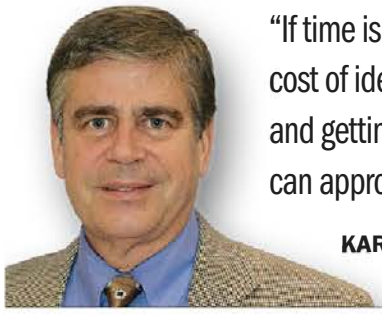

"If time is money, the combination of the sheer cost of identifying a new compound, testing and getting it through government regulations... can approach or exceed $50 million."

**KARL DANNEBERGER, PH.D.,** *Science Editor*

# Patent laws need to change

Basel, Switzerland is a beautiful city that sits on the Swiss, French and German borders. It has a population just under 200,000 and has been around since 374 A.D. Basel has been home to chemical and pharmaceutical companies for centuries.

In 1758 the origins of a company was started in Basel. Johann Geigy, a merchant, started a dye business that evolved into a chemical company. Like Johann Geigy's company, many of the early chemical and pharmaceutical companies had their roots in dye processing. Johann originally used natural products to dye silk ribbons. Through generations, the Geigy business grew and expanded into chemicals and pharmaceuticals through advances in chemistry.

In 1970 J.R. Geigy merged with Ciba AG to form Ciba-Geigy, shortened to Ciba in 1992. In 1996 Ciba merged with Sandoz (another Swiss chemical company) to form Novartis. Novartis remained as the pharmaceutical company, but the agricultural division, which includes turf and ornamental, became Syngenta.

At the same time of Geigy's evolution, new innovation became increasingly more costly and time-wise, longer to bring products to market. In the 1960s the chances that a research chemist's idea would lead to a commercial product was 1/11,000.

Now those odds are 1/100,000.

After optimizing, screening and developing that chemical compound into a product, along with trying to get it through the maze of toxicology and environmental reviews and regulations, you are looking at well over eight years to bring a product to market.

If you hit snags in government reviews the product can be delayed even longer. If time is money, the combination of just the sheer cost of identifying a new compound, testing and getting it through government regulations... it does not take long to see why a product's development from conception to market can approach or exceed $50 million.

I'm not at all promoting the idea that we need less regulation. I want to know that a product that could potentially be widely used, does not impact the local or global environment negatively. I am wondering, however, if the current patent laws should be revised.

Early in the discovery phase of developing a chemical, a patent is often sought. From the date that patent is granted, the company is given 17 years of product protection. The longer a product takes to get to the market, the less time you have to recoup your investment and make a profit.

When chemicals were released in the 1960s the period from discovery to commercial release was quicker, allowing for a longer period of time for the product to remain commercially under patent protection. Now it takes longer to bring a product to market, along with being more costly.

But patent protection remains 17 years. If the world is changing, I think this is one law that should change as well.

Everyone likes cheaper products, and in the chemical and pharmaceutical sphere that is in the form of post-patent products or generics. But I also know that if there is not some protection for companies that create new chemistries and compounds, innovation will slow to a snail's pace. And in all likelihood managing my own health, let alone turfgrass pests, will become more difficult.

It seems hard to defend chemical and pharmaceutical companies that may be making hundreds of millions, if not billions of dollars (also spending hundreds of millions of dollars on science). But if the trend continues, as it has for the last 40 years, the cost of development will continue to skyrocket. I think it is worth an additional year or two or three on patent protection to keep companies like BASF, Bayer, FMC, Syngenta and the other companies around Basel making our life better both professionally and personally.

**Karl Danneberger, Ph.D., *Golfdom*'s science editor and a professor at The Ohio State University, can be reached at danneberger.1@osu.edu.**

## Sit back and wait.

No, that's not your style. Your turf is your livelihood so you anticipate problems and take the initiative to solve them before they appear. But the environment has become less predictable, and the pressure to do more with less means your resources are not what they once were. Now you need a different plan of attack to make things happen. **What are you waiting for?**

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# A day with club managers

Guess who isn't a big fan of committees to manage a golf club? Club managers. Or at least, the 40-plus club managers I had the pleasure of spending a couple of days with at a golf community in West Palm Beach, Fla. They are not big fans of committees who manage the affairs of the club and golf course.

More accurately, the complaint about committees was that they got lost in the details of small items and never tackled the big issues.

A club manager discussing committees and management of clubs jokingly, and with a little frustration in his voice, said that after many years of attending green committee meetings the hot topic of discussion was still whether bunker rakes should be placed inside or outside of the bunkers.

Let me back up a little and set the stage. It was my privilege to teach basic turfgrass management to the club managers at a weeklong education event sponsored by the Club Managers Association of America. The event was entirely focused on golf and included a full day of education on turf management.

My impressions from the event were that club mangers have a great respect for superintendents and the job that they do. While they are interested in turf management and would like to know why a certain practice is carried out, the club managers I was with had no desire to be a superintendent or tell the superintendent what to do.

I don't think the group questioned what a superintendent has done; they just would like to understand why it was done so they can be informed when golfers ask questions about things they have seen on the golf course.

A quick example to illustrate my point was a discussion we had on verticutting.

Several attendees had a limited knowledge of verticutting and more importantly, why verticutting is used to maintain greens. I described verticutting and its many variations and the situations where a specific type of verticutting might be used. The club mangers asked many good questions and seemed pleased to have one of the many maintenance practices that superintendents take for granted explained to them.

I also heard about a great experience on how to grow the game of golf.

During a panel discussion on growing the game of golf a co-director of golf at a local facility was asked about his efforts to grow the game. His response illustrated the challenge of growing the game and the personal touch necessary in many cases to attract new golfers to the game.

The co-director of golf said that Mr. Jones was a regular golfer and that while Mr. Jones played golf, Mrs. Jones and her friends would relax by the pool. The co-director of golf took the initiative to introduce himself to Mrs. Jones and her friends and began to build a friendship. For the first six months he never mentioned golf to Mrs. Jones, all he wanted to do was create an atmosphere where Mrs. Jones was comfortable.

Sometime later, he told Mrs. Jones that if she were ever interested in trying golf he would be glad to help her.

About a year after first meeting Mrs. Jones, she told the co-director that she would like to give golf a try. Now Mrs. Jones is a regular golfer along with several of her friends, all new to the game.

The co-director of golf said the key in the process was getting to know Mrs. Jones first and develop a level of comfort where she felt at ease asking about golf.

While challenging, lead the green committee to the big items. After all, they look to you to lead the way.

**A CLUB MANAGER... SAID THAT AFTER MANY YEARS OF ATTENDING GREEN COMMITTEE MEETINGS THE HOT TOPIC OF DISCUSSION WAS STILL WHETHER BUNKER RAKES SHOULD BE PLACED INSIDE OR OUTSIDE OF THE BUNKERS.**


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