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2005 builder excellence awards

GOLF COURSE NEWS

in conjunction with the Golf Course Builders Association of America

The awards recognize GCBAA builder members in three award categories:

- Creative Excellence Award for best new construction
- Heritage Excellence Award for best course renovation or reconstruction
- Environmental Excellence Award for best environmentally responsible course

The purpose of the awards are to:

- Advance and continuously improve the profession of golf course construction in agreement with the GCBAA mission statement
- Increase awareness of the contributions made by builders to the industry and the benefits of excellent course design and construction to the game

Special recognition for award winners includes:

- Awards presentation at the Golf Industry Show
- Profile of winners and winning projects in the March issue of *Golf Course News*
- Press releases to all major associations and local media for each winner

Contact John Walsh, editor of *Golf Course News*, at 800-456-0707 Ext. 239 for additional information.

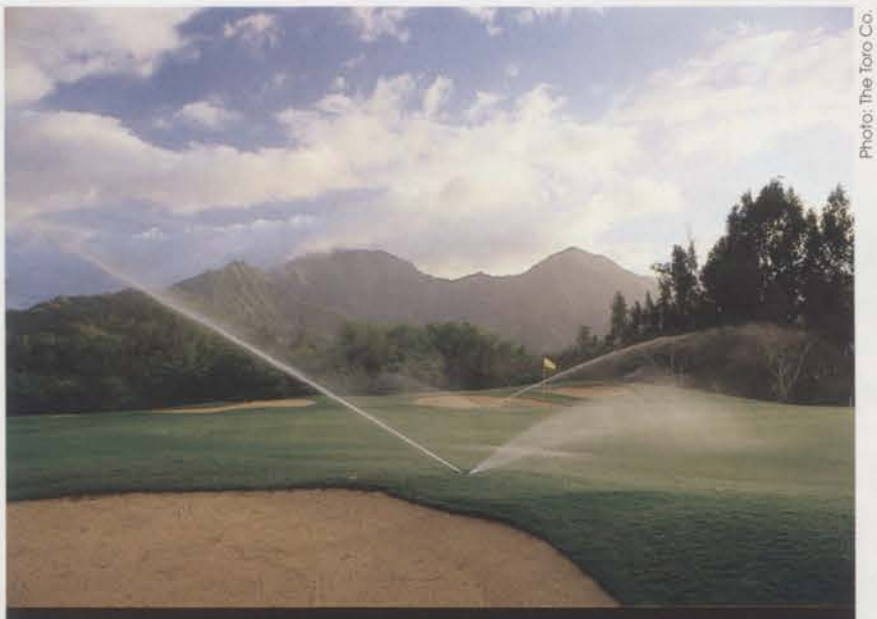

Photo: The Toro Co.

A positive aspect of a wireless irrigations system is the ability to upgrade a system without digging.

"You still have to have the communication wires in the central system to communicate to the satellites," he says.

Signature Control Systems has created the closest thing to a wireless communication system that's on the market, according to Holanda.

"I know their control box can communicate from satellite to satellite, so they took out the central," he says. "With that, you don't need the communication wires because everything is communicated by antennas on top of the control boxes. It's not completely wireless, but it is wireless communication."

Holanda says that next year Aronimink will install a new irrigation system to replace the current system, but he hasn't completely decided what manufacturer he plans to use. One thing that's certain is he's not ready to cut the cord.

"It's going to be a traditional system with all the communication wires and power wires," he says.

While Paul Jett, superintendent at Pinehurst No. 2 in North Carolina, has some interest in a completely wireless system, should one become available, he says he wouldn't install one just for the sake of having it.

"I'm sure we'd consider it, but I don't believe we'd put one in at the moment unless it was a new golf course construction," he says. "We've got systems in place already, and I don't believe that we'd up and close the course just to put one in because it's wireless."

Benefits of wireless

The positive aspects of wireless systems include not having to worry about lightning strikes taking out large portions of the irrigation system's hardware as well as the ability to upgrade a system without digging.

For Jett, having a partially wireless control system has been helpful. When it was installed, none of the old system had to be changed, and the software needed only three or four upgrades during that time.

"We still have all the wires going from the head to the box, but we use a radio frequency to control the whole thing, so it's still a manual thing," he says.

The system allows Jett to radio in from anywhere on the course to what he calls a "people finder" located in the office. The system in the office then relays the command to the individual satellites on the course, which Jett says saves him and his crew a lot of time and effort.

"It's a wonderful system, and it's obviously a whole lot more user-friendly than the old boxes that you had to go to with the manual dials and turn them off and on from the box there," he says. "It's a much more efficient system than that."

While a typical wireless system might be costly to install, superintendents will have to weigh the long-term benefits as well, Holanda says.

"No question about it – there's a place for the technology that's available out there, especially with the cost of wire and copper going so high in the past year or so, so there is a place out there for the system," he says. "You're talking about less wire out there and fewer people cutting through it."

Increased reliability

One of the questions that has arisen from the marriage between space-age technology and good old-fashioned agronomy is whether the technology is reliable enough to satisfy the average superintendent.

"The superintendent is by nature not an optimist," Holanda says. "They're always looking at the potential for the worst case. They love new technology that automates things for them, but they're conservative to know that they need a backup."

When wireless technology was first introduced to irrigation systems more than a decade ago, the control systems that were being rolled out at the time were light years ahead of their time, even if today they seem like relics. Systems that tell sprinklers not to operate in the rain have existed for several decades, but the hand-held remote control devices that allow superintendents to operate the systems wirelessly from around the course are relatively new and might take some getting used to, Davis says.

"As radio becomes more reliable, you can get away with radio only," he says. "We went radio only on lots of systems for a while, and a lot of our clients came to us and asked us to go back and put in the cable as a backup."

Davis says that because of worst-case-scenario thinking the day might not come when a completely wireless system – one that includes wireless controllers that communicate directly with wireless rotors – is installed on a course.

"We're probably never going to be totally wireless because there's always an innate fear by a superintendent that they're losing control," he says. "It's what we call the fear factor. They're scared to death to lose the grass."

For wireless to really take off in the golf course industry, Davis says some of the fears about control and security will have to be as-

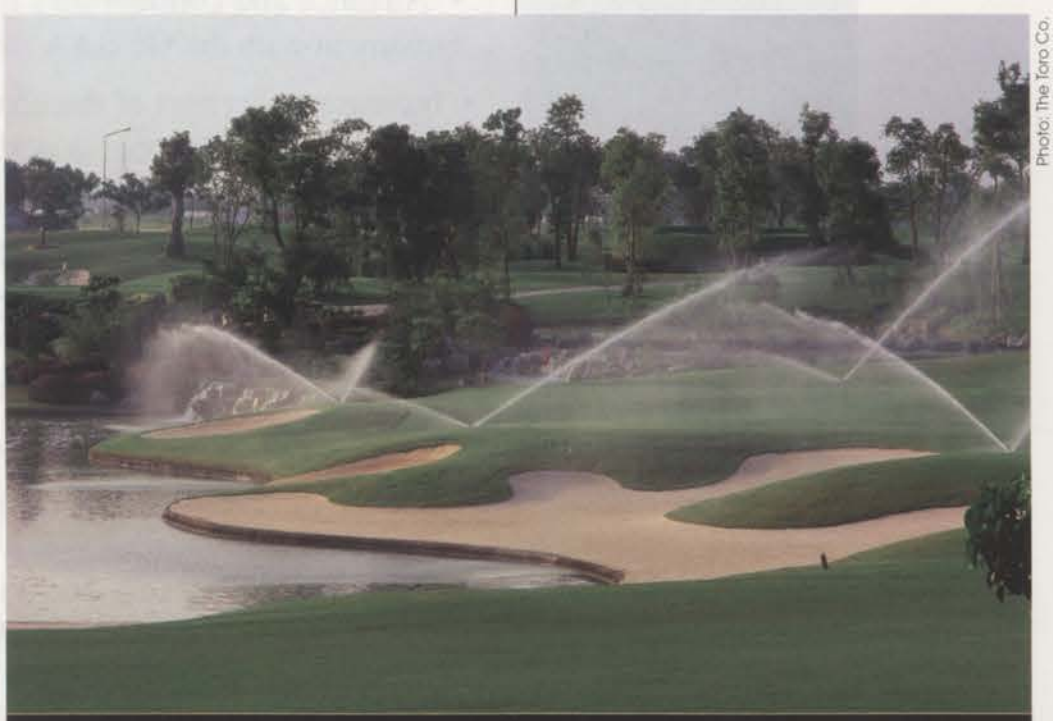

Photo: The Toro Co.

One of the biggest challenges of installing wireless heads is the potential for destruction that normal golf course maintenance can cause.

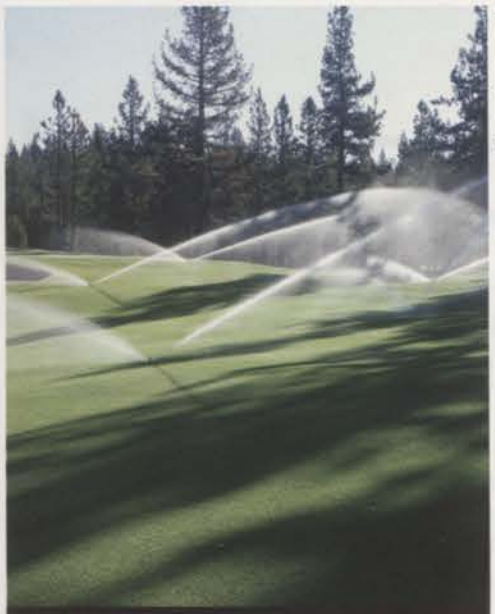

Photo: Hunter Golf

Wireless technology was first introduced to irrigation systems more than 10 years ago.

suaged, although there has been similar apprehension about new technologies in the past.

"I can remember in the old days, 15 or 20 years ago, when some of the central satellite systems were coming out, a fire truck driving by with its sirens on could turn on an irrigation system," he says.

Challenges of wireless

One of the biggest challenges of installing wireless heads is the potential for destruction that normal golf course maintenance can cause.

"A mower is the worst enemy of a sprinkler," Davis says. "And you can imagine that a radio transceiver sitting in the sprinkler or on the lid is going to be susceptible to getting chewed up by a mower."

Holanda says he would be concerned about what would result from a meeting between his heavy equipment and the wireless heads that include self-contained power supplies.

"With those heads that have the little solar panels on top of them, what happens when you go over them with the aerifiers?" he says. "Well, you're going to damage it."

For wireless rotors to come into more widespread use, manufacturers are going to have to come up with something that's almost bulletproof, according to Davis. However, he says there are situations in which using a wireless system is the only option.

"For example, if there's a golf course where there's a lot of concrete around and you can't bore through the concrete to get the cables in the ground, we have no problem suggesting that they go with wireless only," Davis says.

In those situations, he suggests stocking up on replacement parts.

"We tell them to have spare equipment on hand to replace whatever is going to take the biggest beating," he says.

A look to the future

Holanda says despite manufacturers' best intentions, he's not sure a completely wireless system will exist for some time.

"If you ask me what's a reasonable time frame, I don't think any time soon," he says. "Maybe four or five years from now … maybe. "I don't think they're going to have anything ready for the market anytime soon."

Davis agrees the technology isn't quite where it could or should be at this time to make a completely wireless irrigation system practical.

"In all practicality, that probably is a few years off until it is reasonable enough to use," he says.

Rain Bird currently offers its Cyclik wireless control system, which is battery operated and consists of a control module and a field transmitter, as well as its Eagle wireless rotor series. In June, the company released its Freedom-Pad II hand-held remote control, which gives superintendents the ability to control irrigation systems in real-time through a map-based interface, using an HP iPAQ personal digital assistant.

Hunter Golf's Genesis III and Vista irrigation control systems have UHF radio connections from the central computer to the individual controllers in the field. Both systems offer two-way communications and can be used with any combination of hand-wired and radio controllers. The company also offers UHF portable radios that are equipped with a touch-tone keypad, allowing superintendents to address any controller on the course, as well as start-and-stop stations or entire programs.

Toro's entry into the wireless arena is with the SitePro Central Control System, which includes a T.Map interface that allows a superintendent to select irrigation functions, click on an individual sprinkler or a series of sprinklers and make adjustments directly from a map. SitePro also supports hybrid systems and its two-way communication provides the ability to read sensors from the field. When used with Flowtronex Pump Log or Wateronics Watervision software, SitePro provides pump station reflow alarm response.

Signature Controls' Aurora and Constellation product lines allow for remote control of irrigation systems, including global positioning satellite interoperability.

Because the majority of the nearly 17,000 golf courses in the United States don't use a wireless irrigation system, the market is open for manufacturers to roll out their technologies on a small scale for now, with expansion possible in the future, Davis says.

"Hunter, Rain Bird, Toro, they're all going to look at the wireless rotor, he says. "I don't think for widespread use – where every single rotor in the place is wireless – but if you had to add a sprinkler or something like that, and you just can't dig a trench and extend a wire from the controller out to the head, it's just not practical to do it," he says. "That's where the wireless rotors are going to end up for the time being." GCN

Derek Rice is a freelance writer and editor from Portland, Maine. He can be reached at 207/541-1928.

Disease control

KEEPING CURRENT WITH FUNGICIDES AND AGRONOMIC PROGRAMS HELPS CONTROL PATHOGENS AND MEET GOLFERS' EXPECTATIONS

by DOUG SAUNDERS

On a warm, sunny morning, superintendent Sam Samuelson, a certified golf course superintendent with Capital City Golf, a golf course management company based in Sacramento, Calif., starts his morning patrolling Haggin Oaks Golf Complex, a 36-hole public facility. During the hot summer months, daily tours are crucial. Like superintendents throughout the country at that time of year, Samuelson heads out to inspect his greens, check for dry and wet spots, and let his natural instincts take over as he looks for the subtle clues that might be warning signs.

Samuelson is looking for signs of outbreaks of pathogens such as brown patch, dollar spot or pythium, and he knows he must be diligent. The stakes are high because any major infestation that leads to the turf loss can lead to lost play, lost profits and possibly lost jobs.

Obviously, protecting turf from disease is every superintendent's goal and has been ever since the game began in earnest in this country a century ago. Every superintendent wants to present picture-perfect greens and fertile fairways to a more discerning public. As a result, chemical fungicides have become an important tool to control the natural ravages of pathogens, especially when golfer expectations are high, course competition is stiff and budgets are tight.

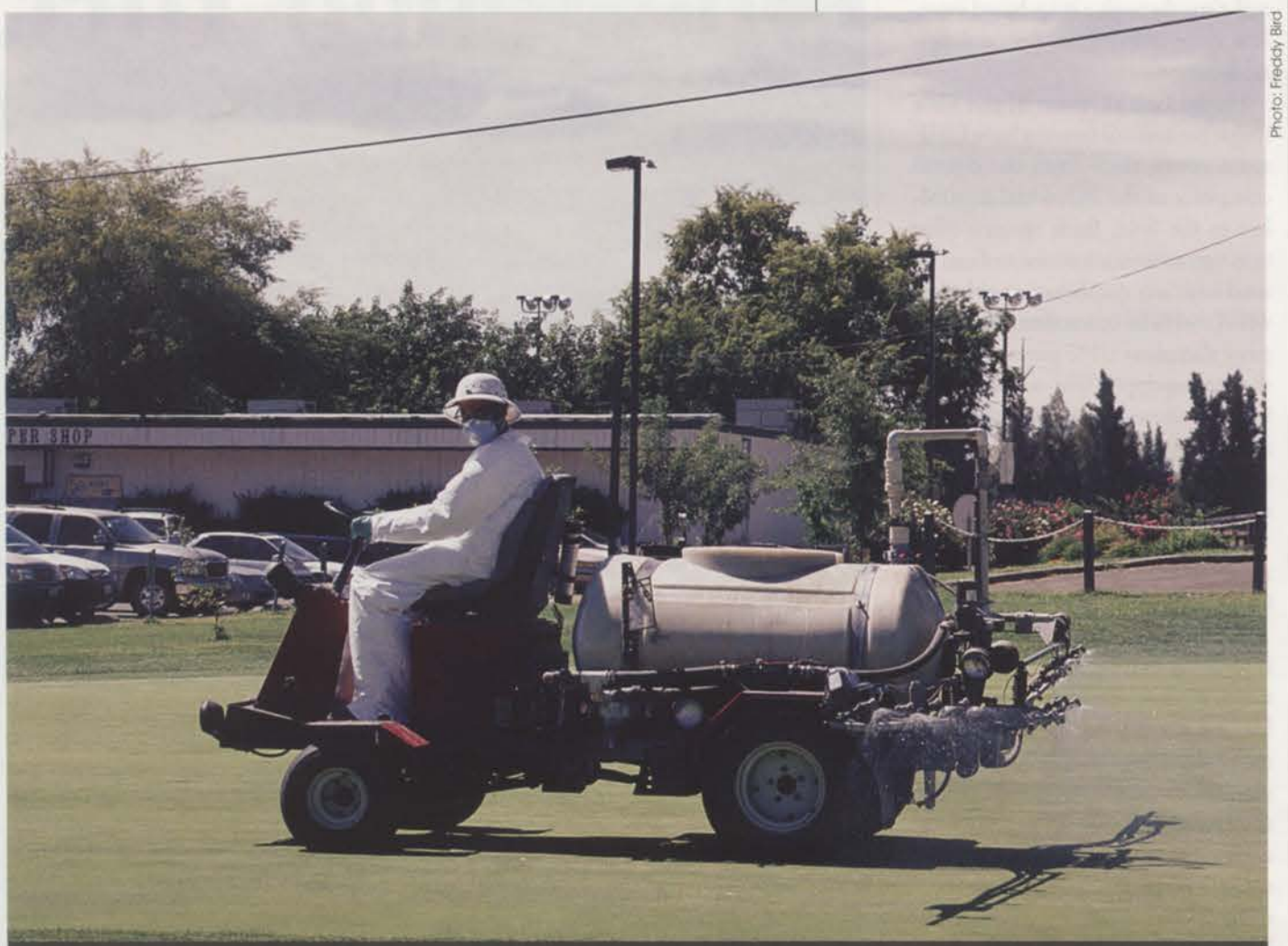

Photo: Freddy Bird

A protected worker sprays one of the greens at Haggin Oaks Golf Complex in California.

Chemical fungicides have experienced a phenomenal evolution since golf courses began using mercury salts in the 1920s to control pathogen growth. These heavy-metal toxins were effective but harmful and were replaced by synthetic compounds in the 1930s and 1940s.

Since then, the turf industry has seen the continuous advancement of materials, including the development of chlorothanyl (Daconyl) in the 1960s; the first synthetic systemics in the 1970s; sterile biosynthesis inhibitors in the 1980s; and the advent of broad-range strobilurins in the 1990s. Presently, there are eight major classes of chemical fungicides available to the golf course superintendent.

"We have a lot more tools available to us than we did 20 years ago, but just having more products doesn't mean that it has made my challenge with pathogens any easier," says Samuelson, who has been in the turf industry since 1968. "The golfing public has set higher standards that we are trying to meet. They want faster greens and fairways, but all superintendents understand that speed kills. As we have lowered mowing heights, we are putting more stress on the plants, which leaves them more susceptible to disease."

This has created the paradox of having to use more fungicides to protect turf while trying to control costs.

And this challenge only increases as mowing heights continue to lower. At the Haggin Oaks Golf Complex, Samuelson has seen mowing heights lowered from one inch on fairways and one-quarter inch on greens during the 1970s down to one-half inch on fairways and 5/32 of an inch on greens today.

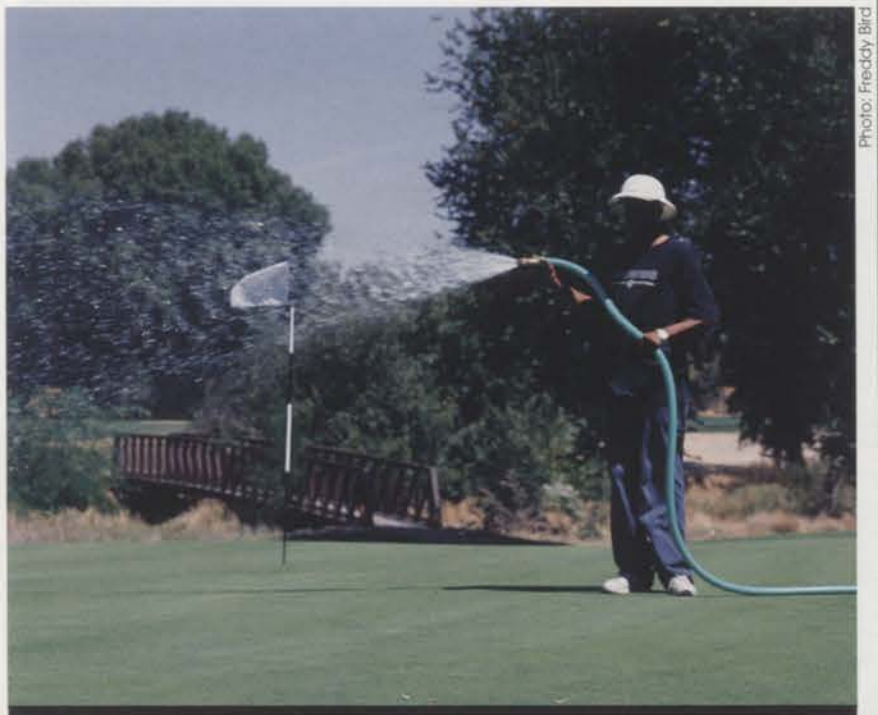

Photo: Freddy Bird

Spot watering is an important measure to control hot spots, which can lead to unhealthy turf.

On the whole, lower mowing heights have become a national trend as courses strive to remain competitive.

Pete Ramsey, superintendent at Range End Golf Club, an 18-hole daily-fee facility in Dillsburg, Pa., near Harrisburg, confirms the pressure to be competitive.

"There is no doubt that the golfing public has put more demands on us to provide a quality product," Ramsey says. "If my greens aren't what they want, then they will go play somewhere else. The challenge for me is to find ways to produce that quality while doing it within a limited budget. Fungicides are part of that equation, but the cost of the newer products forces me to look for other ways to combat pathogens."

Kyle Miller, senior technical specialist for BASF, says he understands the concerns superintendents have about fungicide costs.

"We hear about the cost issue, but the reality is that Environmental Protection Agency requirements are more stringent," Miller says. "It's difficult to get newer products licensed in several markets, and there are fewer companies that are producing products.

"At BASF, we produce products for the agricultural market and the golf market. While the golf sector is only about 5 percent of our total business, the liability involved in golf is greater due to a higher probability of human contact and the cost of golf turf versus open fields. These factors all contribute to the reasons that fungicides for the golf sector are more expensive than the agricultural equivalent."

Joseph DiPaola, golf market manager for Syngenta Professional Products, says developing a new control agent for the turf and ornamental market can cost as much as $100 million.

"The size of the investment will probably curtail the introduction of new agents in the future," DiPaola says.

Maintenance matters

Of course, fungicides aren't the only turf treatment option. Observation and other maintenance practices play an important role in disease-free turf.

Ramsey stresses the importance of sound maintenance practices on his course. Sound maintenance saves on his treatment costs. Because treating a pathogen outbreak with a fungicide on only one hole of a course might wipe out 25 percent of his annual budget, Ramsey uses his resources to develop strong fertility levels, monitor watering and carefully watch for the developing environmental conditions that cause pathogens to appear.

But this approach doesn't eliminate his fungicide use.

"I spray as a preventive measure," Ramsey says. "I have been at Range End for eight years, so I know areas of my course where problems may first appear. These are my monitors. Constant observation and developing a real knowledge of your course's environment are crucial."

Still, deciding on the right treatment is tough. The balancing act between turf protection and cost effectiveness adds up to a difficult decision for most superintendents.

The modern fungicides on the market offer several obvious advantages – namely lower rates and longer protection. Older contact fungicides (chlorothanyl) were effective at a rate of 4 to 8 ounces per 1,000 square feet and provided a seven- to 10-day rate of effectiveness. The first systemics that worked directly on a plant were effective at a rate of 2 to 4 ounces per 1,000 square feet and provided a 14- to 21-day rate of effectiveness. The newer, broad-spectrum fungicides are effective at a rate of 0.13 to 1 ounce per 1,000 square feet and provide a 21- to 28-day rate of effectiveness.

The main drawback of these modern products are their higher price tags. There's also the issue of resistance, which adds another dimension to this complex aspect of golf course maintenance.

Dr. Frank Wong is an urban pathologist at the University of California at Riverside and conducts extensive research about fungicides and their effectiveness in the golf industry.

"The new materials are more powerful than the chemistry in the past, but they have to be looked at as a double-edged sword," Wong says. "We have seen how pathogens develop resistance to these new products quicker than in the past."

While Wong acknowledges advantages of the new products, he cautions superintendents to use them as labeled.

"The slogan in the old days was: 'Paint it white and sleep at night' with the contact fungicides, but those days are over," Wong says. "The new products allow for a lower application rate, and their ability to bond to the plant are beneficial in reducing run-off concerns. But it is imperative to follow the guidelines for their use."

Others say not to expect a silver-bullet solution. Paul Miller, certified golf course superintendent of Nashawtuk Country Club in Concord, Mass., is one. Nashawtuk, a private club, hosts an annual Champions PGA Tour event, so the need to be in peak condition has led Miller to use all tools available. Unlike a smaller daily-fee course, he has access to a large budget, which gives him more options.

"The development of the new products has been very beneficial, but it has to be stressed that they are not a silver bullet," Paul Miller says. "The problem of resistance is there, and it is important to rotate the different classes of fungicides through the course rather than relying on one type of fungicide."

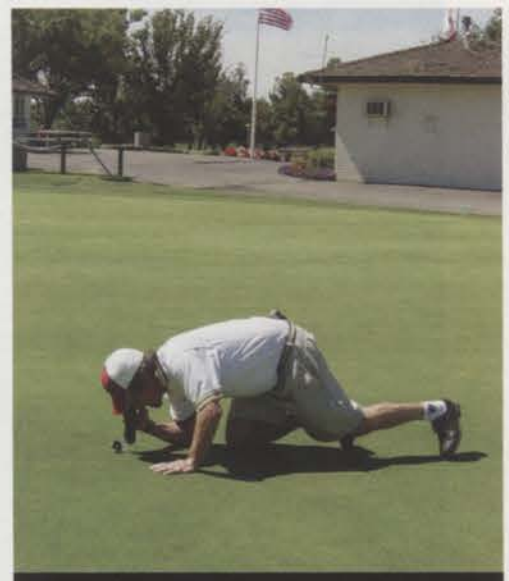

Photo: Freddy Bird

Sam Samuelson carefully scopes a green for signs of pathogens.

Paul Miller approaches the challenge by taking in all considerations, such as maintaining the course in the condition that members expect, doing it within the budget available and in a way that's environmentally compatible.

"There are two kinds of superintendents: ones who have lost turf and ones who will," he says. "This reality just means that we have to develop a creative balancing act between science and art to protect our golf courses

as best as we can. We need to develop sound knowledge of the use and application of the various chemical products that are available to us and blend that with the natural agronomy practices that we can use to produce healthy turf."

DiPaola says superintendents need to educate themselves about fungicides to help use them more effectively.

"We have made many advances through the newer classes of control agents, but the reality is that resistance to these agents will always be a serious concern," DiPaola says. "It is important that superintendents educate themselves about the various classes of fungicides to understand the chemistry as they develop a program for rotation at their particular course."

> "The challenge for me is to find ways to produce that quality while doing it within a limited budget. Fungicides are part of that equation ... "— PETE RAMSEY

In the meantime, product advances in the pipeline could simplify use. One advance that will be seen in the near future, according to DiPaola, is a color-coded packaging and labeling system making it easier to identify different classes of control agents.

"Hopefully, this concept could become an industrywide standard in the future to help make defining products easier for those who are using them," he says.

Fungicide guidelines

The experiences of Samuelson, Ramsey and Paul Miller show that the pressures and challenges of preventing pathogens from developing are similar from coast to coast. Also, several common themes emerge in course maintenance and fungicide use.

1. Observe diligently. Samuelson walks his greens twice a day during the summer and includes regular soil and turf samplings and careful monitoring of mowing heights. Ramsey gets drawn in many directions at his course in the summer, and he relies on his staff to help keep a watchful eye on the turf during the busy season. The lesson: Learn which environmental conditions are unique to a course and watch for early warning signs to use fungicides preventively.

2. Develop a sound agronomic program. Rather than worrying about what one can't control with Mother Nature, Paul Miller suggests superintendents use their knowledge of the things they can control, such fertility levels, water monitoring and foot traffic. This also means proper crew training to watch for dry spots, hand-water correctly and cultivate a team effort toward a goal of growing healthy turf.

3. Educate about fungicides. Because of the wide variety of products available, it's imperative to know about all the classes of fungicides to be able to decide what type of chemistry will work in any green situation.

Education also requires knowing how to use fungicides properly.

"These products are effective but also powerful," Wong says. "I have seen problems where someone may overuse a product to try to pound out a problem, or where someone might try to stretch them out by not applying at the right strength."

4. Rotate fungicides. This is key to proper use, no matter where a course is located. Constant use of the same product can lead to resistance from pathogens the fungicide is trying to control. By rotating various products through spraying cycles, this problem can be managed. Education and observation play vital roles in this process.

Uncontrollable variables

The steps above are factors superintendents can control. Another variable is increasing expectations by the public or course membership about golf course conditions. This isn't something a superintendent can control completely. Golfers might have unrealistic expectations to start because they see a PGA Tour event on TV on a Sunday and want to see this at the course they play on Monday.

Luckily, advances in golf course construction techniques throughout the past 10 years have provided daily-fee golfers better conditions. And they expect those conditions wherever they play.

"The level of acceptability has increased dramatically over the last 15 years, which has lead to more spraying," says Ray Viera, golf course superintendent of The Members Club at Four Streams, a private club in Beallsville, Md. "I can accept some signs of aesthetic pathogens, but members might not. I just take pride in knowing that I am doing everything possible to provide the best conditions, but I wonder where are we taking conditions and how do I pay for it?"

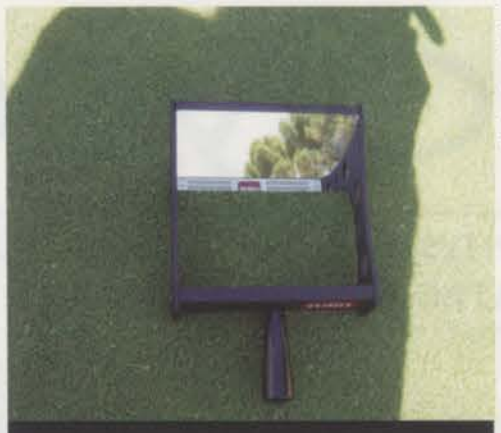

Photo: Freddy Bird

Low mowing heights increase stress on turf and make it more susceptible to disease.

While superintendents understands what it takes to bring a golf course to PGA-Tour quality, the average golfer is unaware of the price to produce these conditions. As a result, developing some form of communication between a golf club's membership or the course general manager becomes crucial to set thresholds of acceptability for a particular facility. These thresholds should address course cost, environmental effects and how this translates into green fees.

"We are all being challenged to get a bigger bang for the buck, so developing the communication with management is essential," Paul Miller says. GCN

Doug Saunders is a freelance writer based in Truckee, Calif. He can be reached at dougs@sierra.net.

Photo: Nashawtuk Country Club

Paul Miller, superintendent at Nashawtuk Country Club, uses chemicals and natural agronomy practices to produce healthy turf.

Analyze this

ASSESSING SOIL PHYSICAL PROPERTIES HELPS DETERMINE STRATEGIES FOR IMPROVING GREENS

by DR. NORMAN HUMMEL

Excess soil moisture at the exclusion of soil air can be devastating to a green. After the summer of 2004, superintendents in the eastern half of the United States know this all too well. Knowing and understanding the physical properties of the soil in greens might help superintendents develop a strategy to improve them. In some cases, soil physical test results might provide the information needed to convince membership or owners to take more drastic steps to improve greens, including reconstruction.

The physical properties of soils encompass many things, including those related to the solid, liquid and gaseous phases in the soil. The properties normally related to greens performance include drainage (soil permeability), aeration, water retention and factors that affect these, such as particle size and soil density (compaction).

Soil drainage is measured in the lab by determining how fast water moves through the soil under saturated conditions. Called the saturated hydraulic conductivity or infiltration rate, it's probably the property of which most people relate. If the infiltration rate is low in a lab test, chances are good drainage will be a problem in the green.

Soil bulk density is a property routinely measured that has a profound affect on other physical properties. The density is the dry weight per unit volume of soil and is an indicator of soil compaction. The higher the num-

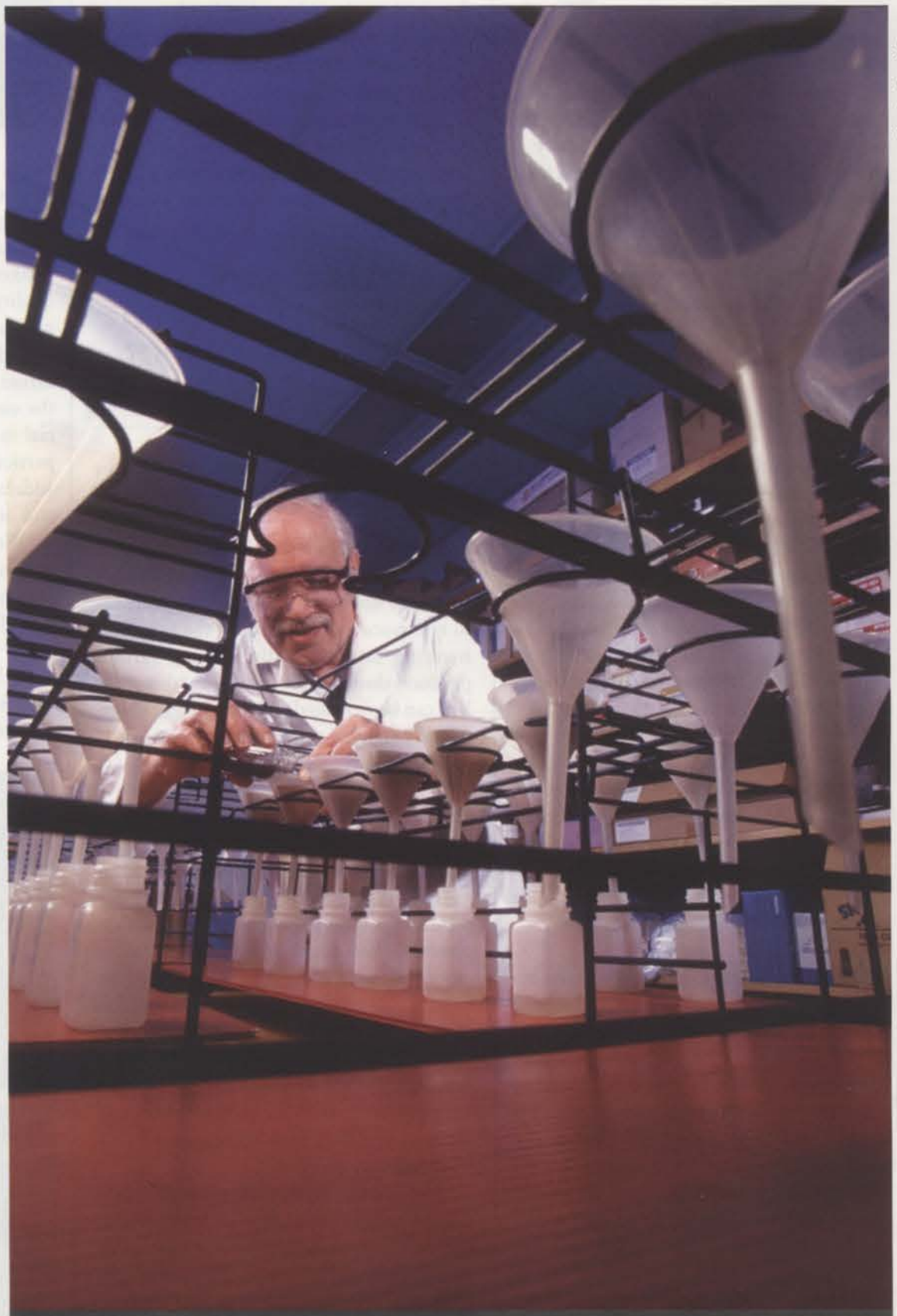

Photo: Scott Bauer

Soil physical test results can provide information needed to convince memberships or owners to take more drastic measures to improve greens.

Photo: Hummel & Co.

Soil physical properties include the relationship of solid, liquid and gaseous phases in the soil.

THE GLOVES ARE OFF.

Because of activists, extremists and misinformed politicians, consumers are questioning whether the products and resources (such as water) used to care for their lawns, landscapes and other green spaces are a waste—or a harm to the environment. Yes, legislation and regulations have been throwing the green industry some rough punches. And we're about to start fighting back.

Project EverGreen is an alliance of green industry associations, companies and professionals dedicated to educate the public, protect the green industry and grow our business. It was created in response to unfavorable regulations in many parts of the United States and Canada. If the services our industry professionals offer are restricted, regulated or made illegal, everyone will lose revenue and customers.

Help Project EverGreen educate consumers on the environmental, economic and lifestyle benefits of green spaces. To make a contribution, volunteer your time or find out more information, call **1-877-758-4835** or visit **www.projectevergreen.com**.

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USE READER SERVICE #32

Soil properties – three case studies

Case study	Sample depth (In.)	SOIL SEPARATE Sand (%)	Silt (%)	Clay (%)	PHYSICAL PROPERTIES Infiltration rate (in./hr.)	Aeration porosity (%)	Capillary porosity (%)	Organic matter (%)
1. Native soil green	**0–3"**	92.5	4.2	3.0	5.6	27.5	25.6	3.74
	4–7"	27.4	36.2	35.0	0.0	8.2	29.9	1.92
2. Sand based green	**0–3"**	96.5	1.4	1.6	3.7	8.8	35.6	2.09
	4–7"	97.3	0.9	0.9	13.7	22.9	19.7	0.56
3. Old USGA green	**0–3"**	85.2	7.1	5.1	0.3	5.0	51.9	10.03
	4–7"	85.7	5.9	4.9	2.5	4.6	27.4	0.91

ber, the more compacted the soil will be and the less favorable the other physical properties are likely to be. Greens can be built with the perfect topsoil or sand-based mix, but they will perform poorly if compacted.

Related to bulk density is the total porosity, which is the total void space that exists between sand and soil particles. It's directly influenced by the soil density. The higher the density, the lower the total porosity. Organic matter content also will influence the total porosity – increasing with increasing organic matter in the soil.

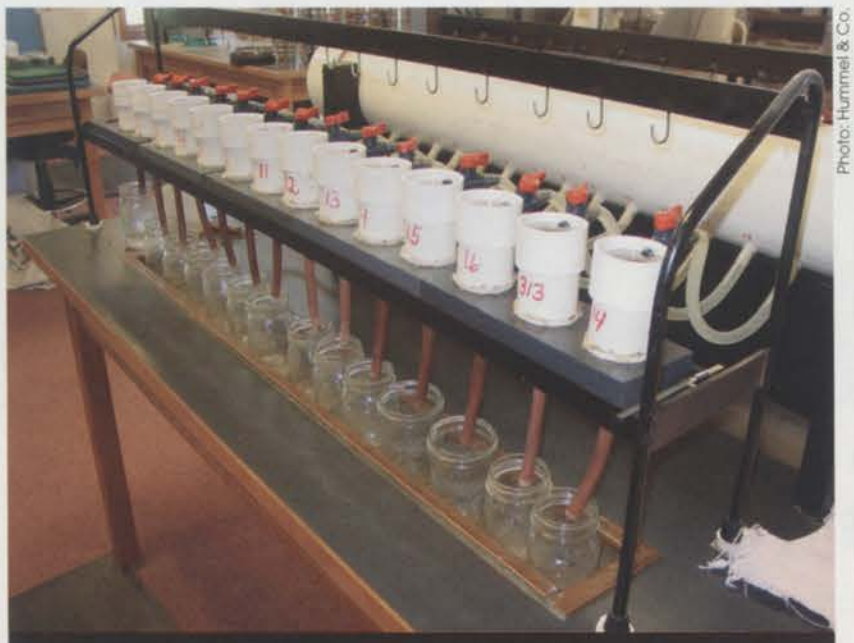

Photo: Hummel & Co.

Loose soil samples from existing greens aren't useful to assess soil physical properties such as infiltration rate and porosity.

The pores or voids that exist in the soil vary in size. Larger diameter pores tend to conduct water downward under saturated conditions. When they're drained, they tend to be occupied with air, providing the plant roots with needed oxygen. These pores are called macropores or collectively, the aeration porosity. The smaller diameter pores tend to retain water against the force of gravity because of stronger capillary forces. A portion of this water will be available for plant use. These pores are micropores or collectively, the capillary porosity.

When soils or sand-based mixes from greens are tested, it's important that the distribution of air and water filled pores are determined because they also relate to soil health.

Sampling

If a new green was built, a loose sample of mix would be sent to the lab, where the mix would be evaluated on laboratory-compacted samples. One shouldn't send loose samples from existing greens to labs to assess soil physical properties such as infiltration rate and porosity. Doing so won't provide any pertinent information about the greens because the sample won't be tested at the density it exists in the green. A good assessment of soils from existing greens should be done on undisturbed samples.

Using special sampling equipment or techniques, samples are removed from greens as cores that are shipped to the lab intact. This enables the lab to test the samples with the soil or mix as it exists in the field, providing a better evaluation of the physical properties.

While there's special equipment available for pulling undisturbed soil samples, these generally aren't cost effective for superintendents to purchase and involve some technique to pull a good sample. Instead, there's been good experience having samples pulled with PVC pipe, which should be beveled on the forward edge so that soil is displaced to the outside as the pipe is driven into the ground. Drilling holes in the top to insert a metal rod assists in pulling the sample out.

Once in the lab, the pipes are cut into sections. Then the soil properties are evaluated in one to several depths in the profile.

Why soil properties change

Throughout the life of a green, soil physical properties will change because of several factors. Nature brings about changes: freeze-thaw cycles, micro and macroorganisms, and the dead and decaying turfgrass plants. Management practices such as topdressing, aerification and watering have a profound impact on soil physical properties as well.

The following three cases show how soil physical properties change, the problems created and possible solutions to the problems.

Case study 1: Native soil green with topdressing cap

This case is a common scenario seen in older, native soil greens. The green was originally constructed with a fine textured soil. A sandy layer about 3-inches thick has accumulated from years of topdressing applications. (See the top-left photo on page 63.) From 3-inches to about 6-inches deep, the soil was a fine textured soil that was determined to be a clay loam. Below six inches was a lighter-colored subsoil.

Selected data from this case are included in the table above. Looking at the infiltration rate, one can notice how good it is three inches in the surface. The results on the aeration and capillary porosity are good as well. The benefits of years of topdressing are well documented by this data.

Unfortunately, below three inches, the soil is impermeable. Hopefully, this green was designed with good surface drainage. Back when the green was built, the fact that the soil was slowly permeable might not have been a concern. Excess water from rainfall and snow melt would simply run off. Now the top three inches has been modified and is quite permeable, so water will move through it. Unfortunately, without internal drainage the water has no where to go. Common symptoms of this scenario are wet greens surfaces and shallow rooting, especially during wet years.

There are a number or options to improve this. Considering how impermeable the subsoil is, an intervention like a drill and fill or deep-tine aerification wouldn't be of much help.

The most definitive option would be to reconstruct the green to contemporary standards, such as USGA greens. Short of re-

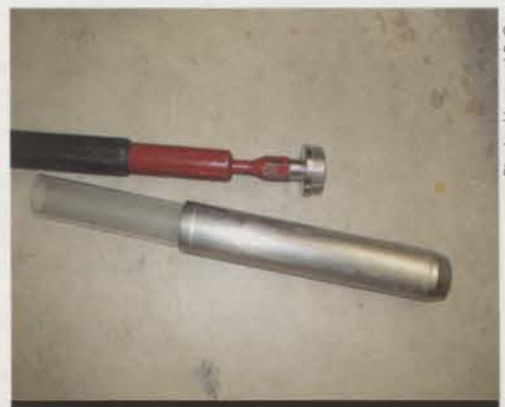

Photo: Hummel & Co.

Special equipment can be used to pull undisturbed soil samples from greens.