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Tech Tak

Golf course superintendents share the technology they use to make courses shine, no matter the weather

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**Dollar spot, brown patch, anthracnose, gray leaf spot and snow mold were the five most common diseases according to a national survey among golf course superintendents.

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Keeping up with **The Jones**



"I couldn't help but quietly root for Mickelson ... Part of it was age: He showed the world that 50 shouldn't be considered old."

SETH JONES, Editor-in-Chief & Associate Publisher

A TOUCH OF GRAY

Old versus classic

have had many memorable interviews with professional golfers, and I always root for those people because they gave me some of their valuable time. Conversely, I have a few guys I tend to root against because when I see them, I'm reminded of times I crashed and burned. My two most epic fails are with guys who stole headlines at this year's PGA Championship: John Daly and Phil Mickelson.

Both Daly (age 55) and Mickelson (age 50) were in the spotlight at the beautiful Ocean Course at Kiawah Island Golf Resort. For Daly, first it was his new look, sporting a bushy beard. Then it was for his brief outright lead when he wedged out on his first hole of the tournament. Finally, it was when his golf cart got stuck in sand and needed to be unwedged by fans.

Then there was Mickelson who stole the whole show when he won the tournament, becoming the oldest player to ever win a major.

I root against both Lefty and Daly because they are undefeated in shooting me down for interviews, but my dislike for Phil has softened over the years because of his sense of humor and because he took



A photo of Mickelson with *Golfdom* Publisher Craig MacGregor helped soften Seth's icy take on the surprise 2021 PGA Championship winner.

time for a photo with *Golfdom* Publisher Craig MacGregor at a recent Wells Fargo Championship. Granted, I pushed Craig at Mickelson like a dad trying to use his son to secure his favorite Hall of Fame baseball player's autograph, but he smiled and took the photo, leading my friends to once again question how I could root against the affable pro.

Turns out, they're right. During the 2021 PGA Championship, I couldn't help but quietly root for Mickelson. Part of it was that he's been so good for so long, sustaining his level of play for the last three decades. And part of it was age: He showed the world that 50 shouldn't be considered old.

In this issue of *Golfdom*, we celebrate some oldies, or maybe classics. See Karl Danneberger's "old school" take on Qol fungicides on page 41 or Jim Kerns' research on *Pythium* resistance to fungicides on page FS10. In our regular department *Golfdom* Files (page 14), we celebrate the magazine's 94-year history by dusting off an article from our past.

We also look to the future with Managing Editor Sarah Webb's Tech Talk story on page 16, featuring superintendents talking in their own words about using new technologies. My story on the soon-to-be-released spring dead spot research from Virginia Tech is on page FS13. In the research section, we look at the GreenKeeper app and Deacon, two new technologies designed to make superintendents more efficient.

Despite my epic fails in getting interviews with Mickelson and Daly, I've learned to appreciate both of these golfers over the years. At least they still make for good stories when I'm talking professional golf with friends. Maybe it's my own old age showing, but I hardly root against anyone anymore. I just want to see a thrilling battle down the stretch.

Mickelson's win at the 2021 PGA Championship was a thrill, a historic win for the game and a reminder that there's a difference between being old and being classic. ③

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FERTILIZER PRICES ON THE RISE

BY SARAH WEBB // Managing Editor

It's no secret that the cost of fertilizer and other products, such as weed control and fungicide products, is increasing.

"The price increases we're seeing in finished good products is all driven on raw material costs," says Jeremy Bigler, landscape channel manager of Lebanon-Turf. "All of the three key raw materials that you typically see in fertilizers, urea, ammonium sulfate and potash have all increased significantly over the last year."

Bigler notes that urea is up 70 percent compared to last year, ammonium phosphate is up more than 80 percent and potash is up more than 50 percent. He notes that the industry is also seeing shortages of specialty materials in smaller granular sizes, commonly used in golf and sports turf.

"There are shortages, such that you

can't even buy them until the end of this year," he says. "There's been a lot of demand because of the pandemic and in the professional market and in the retail side of things. The other big piece of it is looking at indexes for crops like corn, wheat and soybeans. On all of those crops, the prices have gone up significantly over the last year. When those crops go up in price, it makes more sense for a farmer to apply more fertilizer to get a higher yield, so they're going to be more likely to use fertilizer, which is going to drive prices up because there's a high demand."

Shipping and securing raw materials is also taking a lot longer, Bigler says.

To help offset some of the cost, superintendents can try to take advantage of early order programs by forecasting *Continued on page 10*

//A SAD GOODBYE

REST IN PEACE MATT HENKEL

After a 13-year battle with brain cancer, superintendent Matt Henkel passed away surrounded by his family last month. He was the former superintendent and



general manager of PrairieView Golf Club in Byron, III., before cancer cut his career short. The father of three was 42.

The outpouring of emotion and support from the industry was tremendous. Thousands

Matt Henkel

of people shared memories of Henkel on his memorial page and on Twitter, and thousands made their support known when his wife announced the sad news. Before his passing, a GoFundMe account was created by industry friends that allowed the Henkel family to take Matt to see the ocean one last time. The account quickly grew to \$40,000. (The account is still open and contributions to support his family can be made here: https://gofund.me/1e4ca603)

Henkel and his battle with cancer were the subject of the May 2014 cover story of *Golfdom.* In that story, Henkel told *Golfdom,* "The luxury of my illness is I truly get to live each day like it's my last. It gives you that perspective to live life to its fullest."

/A NEW ROLE

CHALTAS JOINS AQUAFUSE

AquaFuse by CMF Global, a manufacturer of piping products that improve golf course performance and water efficiency, hired Dean Chaltas as director of sales and marketing.

He joins the company from being a senior product marketing manager at The Toro Co., where he was instrumental in driving sales in the ag business. Prior to this position, he was a corporate accounts manager, golf sales manager and western regional sales manager at Toro.

As the AquaFuse sales and marketing director, Chaltas will oversee the company's sales and marketing programs. He will develop and design strategic sales objectives. He will also establish sales quotas, manage budgets and evaluate sales performance.



//LIVE AND IN PERSON

Carolinas GCSA Conference to be in person

After missing a year because of the coronavirus pandemic, the Carolinas Golf Course Superintendents Association's (GCSA) annual Conference and Trade Show will return as an in-person event in Myrtle Beach, S.C., Nov. 15 to 17.

Booth sales open for exhibitors the week after Fourth of July, and seminar and attendee registration opens after Labor Day.

"We are so glad to be back on track," said Carolinas GCSA President Brian Stiehler, CGCS, MG from Highlands Country Club in Highlands, N.C. "The Conference and Show is the heartbeat of our association, not only financially, but also as a family. Getting together face to face after a long hot summer is when the brotherhood is truly celebrated and what makes this show so special."

For the first time, this year's conference will feature education seminars on Monday morning. Courses for this year's Carolinas GCSA Golf Championship will be the celebrated Mike Strantz designs at Caledonia Golf and Fish Club and True Blue Golf Club, and Tom Fazio's gem on the Waccamaw

River, Wachesaw Plantation. The golf championship, on Monday, offers medal play, four-ball and scramble formats. Monday also features the Carolinas GCSA Sporting Clays Championship at Back Woods Quail Club.

"I wouldn't be surprised if this show challenges attendance records," said Carolinas GCSA Executive Director Tim Kreger. "Our members are so ready to see each other again, and golf has been so busy during the pandemic that I hope every facility in the region is ready to reward their superintendent with a trip to our show. What better way to say thanks and invest in their superintendent's ongoing professional development?"

Kreger says the Carolinas GCSA will continue to monitor the pandemic and be ready to adapt as necessary. When the pandemic forced the cancellation of last year's in-person event, the Carolinas GCSA delivered a comprehensive slate of online education over 30 days, known as Conference Comes to You. Nearly 2,200 seminar seats were filled and \$40,000 given away in cash prizes.



The Carolinas GCSA's Conference and Trade Show will be held in person this year on Nov. 15-17 in Myrtle Beach, S.C.

//CONGRATS. JACK!

HARRELL JR. **RECEIVES LIFETIME** SERVICE AWARD

Harrell's CEO Jack Harrell Jr. recently received the Florida Golf Course Superintendents Association's Marie Roberts Lifetime Service Award. The award is presented



to individuals who have made significant contributions to the Florida **GCSA** and golf industry through participation, support and achievements in the industry. "It's an honor to

Jack Harrell Jr.

receive this award and be among the prestigious list of previous recipients," Harrell said. "I love this industry; I was raised into it from a young age, and it holds a special place in my heart, but I wouldn't be here today without the support and dedication of the Harrell's team. They make everything possible, every day, across all of our locations."

Harrell has been active for the golf community in Florida and throughout the GCSAA for many years. Harrell's has provided financial support, educational support for industry members and has represented the industry via government relations work.

//ON THE RIGHT COURSE

YOUTH ON COURSE AWARDS GRANTS

The nonprofit organization, Youth on Course, has unveiled the winners of its 2021 scholarship awards, granting \$296,000 to 20 deserving high school graduates. Since the inception of the scholarship program in 2008, 280 Youth on Course members have been awarded financial support totaling \$2 million, and recipients of the scholarship hold a 93 percent graduation rate.

The class of 2021 will be attending the country's most prestigious universities, including Dartmouth College, University of California - Berkeley and the United States Naval Academy, among others. The average GPA of this year's winners is 4.39, and six of the recipients will be playing college golf.

"Pursuing higher education, much like the game of golf, shouldn't hinge on the financial burdens it places on young people," said Michael Lowe, vice president of programs for Youth on Course. "These 20 students are among the brightest in the country and we ... are proud to help them continue to work toward their dreams on and off the golf course."



// A PRIME CANDIDATE

PRIME SOURCE ADDS ALLENBRAND

Prime Source, a division of Albaugh, hired April Allenbrand as its new marketing director



Allenbrand will also work on the U.S. Aq and Seed Treatment side with marketing and communication-related activities for the U.S business.

April Allenbrand

She brings a wealth of experience from the turf and ornamental industry from her eight years at PBI-Gordon in marketing and communications, as well as more than 10 years in the agency side of the business where she was involved in the FMC ag account for more than five years. She will be based out of Shawnee, Kan.



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//NATIONAL GOLF DAY = SUCCESS

MOMENTUM AND DIVERSITY FOR 2021 NATIONAL GOLF DAY

More than 300 leaders and representatives from a diverse cross section of the golf industry participated virtually in National Golf Day, which was focused on strengthening the ongoing collaboration needed to advance the game's appeal and increase its accessibility among those traditionally underrepresented in golf, while also building on the overall increased interest in the sport.

PGA of America CEO Seth Waugh, PGA Tour Commissioner Jay Monahan and LPGA Commissioner Mike Whan were keynote speakers during the virtual National Golf Day General Session. The leaders organized the industry last summer around addressing two critical opportunities: how to build on the momentum that golf has experienced since the pandemic began and how to bring greater diversity to the game.

As part of the same session, a panel including Sandy Cross of the PGA of America, Laura Diaz of the LPGA Foundation and Neera Shetty of the PGA Tour provided insights into the various working groups that have assembled over the last several months to further delve into industry diversity, equity and inclusion efforts in the areas of education and skill development, talent acquisition, procurement, human resources, youth and adult player development and marketing/communications. These work groups have brought together ideas and voices from all backgrounds and continue to grow in size and inclusivity.

Coordinated by a coalition of the game's leading associations and industry partners under the banner of We are Golf, National Golf Day, typically held in Washington, D.C., brings together more than 300 industry leaders from across the U.S. to support the game's \$84.1 billion economy, nearly \$4 billion annual charitable impact, close to 15,000 diverse businesses and 2 million jobs impacted.

Continued from page 8

what their needs will be next year, ensuring spray equipment is calibrated properly and making sure crew members are properly trained so they're not wasting products when mixing or applying, according to Mike Caprio, regional business consultant for the Southeast Territory of Lawn Doctor.

"We're really going to have to wait and see about how much it goes up before it levels out, but my recommendation is to forecast accordingly, order your materials, and from a business model, take a look at your profit and loss statement and see where you can pick up some efficiencies somewhere else," Caprio says.

Bigler says courses can also aim to put down less product.

"Instead of putting down a pound of nitrogen, look at putting down three-quarters of a pound of nitrogen or maybe even as low as half a pound of nitrogen per application. That'll be a way to cut back on the material costs," he says. "It's difficult to say if prices will go down soon. Historically this time of year, we see prices start to drop off, but I haven't seen any indication of that yet, and this year is not shaping up as we expected in a lot of ways. It's difficult to judge with the pandemic, and then if we continue to see supply chain disruptions, that could also have an impact on this."

EDITOR'S NOTE: In last month's issue, Golfdom Research Editor Mike Kenna, Ph.D., wrote a column about two new turfgrasses coming to the market. We did not make mention that Kenna is a consultant to the seed company that will distribute those turfgrasses. In the future, we will acknowledge any such relationships when appropriate.

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//AND THE AWARD GOES TO ...

Coore and Crenshaw honored by ASGCA

Two-time Masters champion Ben Crenshaw and Bill Coore, ASGCA, have been chosen as the 2021 recipients of the American Society of Golf Course Architects (ASGCA) Donald Ross Award. Winners are chosen based on those making a significant contribution to the game of golf and the profession of golf course architecture.

Crenshaw's success as a professional golfer has resulted in him securing 19 PGA Tour victories. When Crenshaw was 16, a visit to Brookline Country Club in Massachusetts sparked an interest in golf course architecture that endures to this day. After serving as a player consultant on the design and construction of the TPC Course at Las Colinas, Texas, Crenshaw joined with Coore in 1985 to form the golf design firm that bears their names.

Coore graduated from Wake Forest



University and spent the first five years of his golf course architecture career with ASGCA Past Presidents Pete and Alice Dye. He formed his own design company in 1982.

Together, the pair has designed some of the world's most unique and well-respected golf courses, including Sand Hills Golf Club in Mullen, Neb.; Sheep Ranch Golf Course in Bandon, Ore.; Streamsong Resort Red Course in Fort Meade, Fla.; Friar's Head in Riverhead, N.Y.; and the new Te Arai Links, New Zealand.

#TurfTweetoftheMonth

Chad Price @CgcChad

President, Carolina Green Corp., Carolina Green Sod, GameOn Grass, Monroe, N.C.

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Chad Price

Had a legend on the farm last week, Dr Trey Rogers. Mentor to many, I really enjoyed our time talking turf and life in general.



Starter

Ask Thad By Thad Thompson Superintendent Terry Hills GC, Batavia, N.Y.

I understand New York doesn't allow a fertilizer application before April 1; is there a reason for this other than an April Fools' joke?

- Kennedy Ellis, @KennedyAnneTurf, Michigan

The New York State Dishwasher Detergent and Nutrient Runoff Law went into effect on August 14, 2010, after being signed by Governor Paterson. This essentially banned the use of phosphorus in New York without a soil test. The no-fertilizer provision from December 1 to April 1 went into law in 2012. This law went into effect as a way to reduce runoff, mainly from homeowners. It largely hasn't affected me unless we have an unusually warm stretch in the spring, like this year. I could have started earlier on a few greens that needed some attention due to our winter play but had to wait until it was legal to apply. This law doesn't affect agricultural applications.

Years of Audubon certifications, education and outreach ... how is our image getting better, and what should be done?

— Al Czervik, @AlCervik, Bushwood CC

We have come a long way from being the dirty, grease-covered people who work in the barn. Our image as the leaders in the golf industry, as well as stewards of the environment, has changed dramatically in the last 30 years. All the education, outreach and certifications are nice, but they really show our peers what we've accomplished. We have all heard that we should promote ourselves, and when you are building a resumé that is extremely important, why not promote yourself on a daily basis? Newsletters, blogs and social media are great ways to reach your golfers. Remember, your golf course is promoting their business, not their superintendent. That's up to you.

Got a question for Thad? Tweet to @Terry Hills Maint and @Golfdom or email Thad at thadthompson@terryhills.com

Talking Torrey, Part 2

More from *Golfdom*'s conversation between 2021 U.S. Open Torrey Pines Superintendent Rich McIntosh and 2008 Superintendent Mark Woodward, CGCS-Ret.

Mark Woodward: Tell me more about your turf types.

Rich McIntosh: We regrassed tees and approaches, kept them bermuda just for consistency and firmness. I went with Latitude 36, a little bit more tolerant to cool weather. We've seen great results, and it's an easier transition than the old 419. And still pure kikuyu fairways and kikuyu rough.

Woodward: Are you going to overseed fairways at all with a touch of rye?

McIntosh: No, that was one of my personal projects and focuses, after greens, to get fairways to a pure kikuyu stand. It's to the point now where we've dropped our overseed rates down to 400 pounds an acre, trying to reduce the effect of the base of the kikuyu. There have been years where we don't get a great catch on the fairways, but our kikuyu is so strong and dense that fairways are no longer a concern of mine. A lot of that is a pretty aggressive topdressing program. I have noticed, even when we strip kikuyu to let it come back, our fairways are the first to come back. That sand sitting in there allows it to warm up a little quicker.

Woodward: Our theory when I was there was let's try to get a monostand. I'm glad that theory is intact. What are some of the changes from the 2008 U.S. Open we'll notice on TV?



Eyes on the prize. Rich McIntosh, superintendent, Torrey Pines GC, keeps a close watch on turf conditions in the days leading up to the U.S. Open.

McIntosh: Some the tweaks from the renovation you'll have seen from the Farmers (Insurance Open). (Holes) 7, 10, 17 and 4 will have completely different looks than in '08. They've been there for two Farmers. I don't think much else will be different. The course will be set up similarly. I think we'll see some different tees from the Farmers, but overall, they were happy with the way the course played in 2008. It was a strong test and challenge. Hopefully, it'll be a little lighter shade of green than what we see in the winter.

You've definitely paved the way. I think the USGA having a contract with the city has created a lot of accountability and ownership to this event. I think everything you did in '08 and leading up ... saved us a lot of time, stress and worry. We're just trying to continue it and make things a little better and continue to elevate from where you left off.

Woodward: I appreciate you saying that. You know, it's a municipal golf course. When I got there, fairways were being mowed once a week, greens were being mowed three times a week, maybe. Cups weren't being changed very often. I'm proud of what we accomplished and listening to Rich, I'm really proud, and it sounds sustainable now. Torrey Pines is important to San Diego.

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The Golfdom

FROM THE ARCHIVE

Technology has come a long way since the world rang in the new millennium more than two decades ago, as is clear from this September 2000 article, where superintendents discuss elements they'd like to see incorporated into greens mowers — GPS sensors, disease-sensing monitors and more — elements that have since become common on a wide swath of golf course technology. Check out the cover story on p. 16 to find out just exactly how far technology and software have bounded ahead in the golf course world. To read the full article visit **golfdom. com/exclusive.**

To infinity and beyond

BY FRANK H. ANDORKA JR.

n a country where Buck Rodgers and Captain Kirk fueled expectations of what technological advances future centuries might hold, it's no surprise that superintendents expect greens mowers in the 21st century to follow a similar path.

Superintendents want future mowers to cut with lasers, be controlled by satellites and fix themselves. Heck, one superintendent even wants his greens mower to make coffee for him in the morning.

While the coffee idea might be a stretch, the rest of the high-tech gadgets superintendents expect to see on greens mowers might not be so pie in the sky.

Companies are conducting intense research into alternative power supplies, disease-sensing monitors and the possibility of integrating mower controls with the Global Positioning System (GPS).

Experts say the real question is not whether these innovations are possible, but when superintendents can start using them.

Helmut Ullrich, marketing manager for Toro's Greensmasters line of mowers, says one superintendent with whom he spoke described the perfect mower of the future.

"He said the perfect greens mower should be a solar-powered hovercraft



with a laser that will cut the grass to the ideal height to get the most speed on the greens," Ullrich says. "Were not quite to that point, but we're definitely making strides on a lot of fronts."

Ullrich says mowers in the new century will probably move from fixed cutting decks to flexible ones, and he said mowers will have narrower profiles as well. Those adjustments will help superintendents mow at lower heights because the machines will hug the contours of the greens more closely. It's the same theory that propels most razor innovations — the closer the blade hugs the surface, the closer the cut. Mowers will also become more operator friendly, a factor that's increasingly important in a world of frequent employee turnover, Ullrich says. "We want to create a mower where the operator can diagnose problems and fix them, possibly without a mechanic," Ullrich says.

Integrating mowers into GPS is something all companies are exploring. Chuck Greif, manager of worldwide golf and turf market development for John Deere Co., says such robotic mowers are about 10 years away, but it's not for a lack of trying. Computer technology will have a great impact on how mowers of the future will operate.

Not only will mowers cut grass without operators, but they will also have a feature called parallel tracking, which will guarantee straight lines on the greens, Greif says. It would allow superintendents to mow greens by remote late at night, knowing that they won't be destroyed in the process.

Mowers will also include sensors to track fungal development and nutrient levels on greens. Combined with the latest computer technology, these mowers will transmit such data to superintendents, allowing them to adjust pesticide and fertilization plans accordingly, Greif says.

Greif adds that the speed of the rollouts depends on how many industries can work together to develop new technologies. For example, alternative power sources that can also be applied to the auto industry will reach the market faster than optical disease sensors. "A lot of the technology to do these things exists now," Greif says.

"You have to balance the costs of how much it will take to bring a feature to market with how much the market will be willing to pay," Greif says. "Otherwise, your investment won't pay off." ^(c)

Musings from the Ledge



"The hope is that these searches are conducted above board by a reputable company or individual who is working in the best interest of all parties."

ALAN FITZGERALD, superintendent, LedgeRock GC, Mohnton, Pa.

Getting help with help wanted

ecently, there has been a lot of attention — and even two formal statements from the GCSAA — questioning the announced partnership between GGA Partners and the USGA Green Section to offer a golf course superintendent recruitment service. I would like to add my two cents to the mix.

This announcement came not long after a number of entertaining job postings hit the GCSAA job site. Thanks to the site's standards, those jobs were quickly removed. There was one with absolutely no information other than that it was a confidential hiring on a Caribbean Island. The most infamous ad had some very specific but questionable requirements, like an 11-foot Stimpmeter reading check with the GM every day at 2 p.m.

It is obvious with these job listings that some clubs are not equipped to host their own job search. Is it not better having a club recognize that, due to the complexity of a superintendent's position (especially at higher-end clubs), they need expert help to find and filter out the best candidates? This gap in the market traditionally has been filled by turf consultants, but, more recently, companies crossing over from GM executive searches have joined in, using agronomic experts as advisers. As such, I see GGAs Partners' recent announcement as fast-tracking its way into the market.

The main concerns are that it is a conflict of interest to have the governing body for the sport be involved with a search for a club and that using the Turf Advisory Service (TAS) will become a necessity to be considered for a position or that the TAS will become a requirement for the search and possibly even a method to get rid of superintendents. I will admit these are legitimate concerns; however, these could be a concern with any advisory service coming on site. Upon reflection, I am

ambivalent about having the sports governing body involved in recruitment searches as, although I could never see the GCSAA getting involved, the PGA of America offers a similar service and seems to be doing fine.

Several years ago, I was in a class on hiring and retaining good employees. We were told that the best hires came from recommendations from other staff, peers or friends. Most people do not want to look bad, so they are not willing to recommend someone who might let them down. Over the years, I have found that those recommendations are infrequent; however, the ones that were recommended have been exceptional employees. As such, nepotism plays a part in our everyday lives. Maybe it is a member

who knows a superintendent, maybe it is an agronomist or consultant, maybe it is the recruitment agency, or it could even be a superintendent recommending another for a job that he or she is leaving.

A recommendation may get you in the door, but at the end of the day, it is the person who impresses the hiring committee the most who gets the job. A bad hire does no one favors, so along with recommendations, advertising the position to make sure there is a pool of qualified candidates is essential to maintaining a reputable service.

A site visit is a vital part of writing a superintendent job description — how else will someone hiring know what the requirements of the actual position are and what kind of qualifications they are looking for? The TAS is a ready-built version of this. I would have an issue if the USGA says you need to follow its precise agronomic guidance after you are hired or recommends a superintendent's dismissal if their philosophies differ (assuming the superintendent is performing well), and I would feel the same about anyone in this situation overexerting their influence because then, these searches lose their impartiality. The hope is that these searches are conducted above board by a reputable company or individual, who is working in the best interest of all the parties something the Green Section has been doing for years. G

Alan FitzGerald (alan@ledgerockgolf. com) is superintendent at LedgeRock GC in Mohnton, Pa.



Golf course superintendent share the technology they use to make courses shine, no matter the weather

Golf course superintendents no matter the weather

As told to Sarah Webb

Turf Cloud

TurfCloud is a digital golf course management system, a product of GreenSight and powered by GreenSight's automated drone technology platform.

Golf course superintendents no longer have to worry about snippets of data floating around in the clouds, because it's all there with Turf Cloud's data platform and automated drone technology. User Ryan Walsh, superintendent at Woods Hole Golf Club in Woods Hole, Mass., explains how.

I've been at this club for four years, and I'm on my fifth season now. I've used Turf Cloud since 2017, my first season here, and drone technology since 2018.

I've known (founder) Jason van Buskirk since he was a superintendent. He was always a big turf geek and always had the latest and greatest and most detailed spreadsheets. A few people got in his ear saying, "Man, you should sell some of these spreadsheets." From there, Turf Cloud was developed.

The job board aspect of it is phenomenal. Getting away from

the whiteboard and dry erase markers and being able to set up jobs no matter where you are has been very helpful. Staffwide, having my assistants understand what everybody's doing keeps everybody on the same page. It's also about being able to show where your labor is going. A lot of golf courses' labor consists of probably 60 to 65 percent of their total annual budget, so being able to show your members or your owners where that time and money is going is so important nowadays.

We've also used Turf Cloud's drone imagery, and that has translated to instant savings, water savings, electrical savings. From 2017 to 2020, we had a 31 percent water reduction from 2013 through 2016. That's a lot of gallons of water, a lot of electricity. Water savings is going to be a huge problem down the road. Anything that we can do to help and reduce consumption is a feather in our cap.

It can be so overwhelming when you have close to 2,000 individual sprinklers positioned throughout the entire property. In the spring, we're really trying to fine-tune things and make sure



we eliminate any issues, and we do a lot of our troubleshooting to get ready for the busy summer season. To be able to see your entire golf course right on your computer screen in real time as far as your water dispersion and uniformity, it's a huge time-saver. It really makes us more efficient in creating a priority list of areas to address.

We've also got a new addition this year of the drone imagery that's created with Turf Cloud: We've got some underground sensors that monitor moisture levels. They tell us what soil temperatures are. Not only are we seeing what's going on with the golf course from what we see in our eyes, but we're also measuring from the air and underneath the ground, too. It's getting a whole lot of data and fine-tuning our irrigation philosophies.

There's also updated mapping through this imagery with a drone. I use a lot of it for training my staff, showing them the areas of the golf course that I want them to work or the tasks associated with certain locations. I can describe and show them pictures rather than driving out there and pointing it out.

To set up the drone technology, The Turf Cloud team comes in and assesses the property. They figure out your fly zones and any aviation restrictions, and they'll help you if you need an individualized permit to fly there.

Overall, Turf Cloud gives you a great amount of information, but not an overwhelming amount. You can certainly peel back the layers and dive into it as much as you'd like, but there's just phenomenal information right on your desktop or on your phone. *Continued on page 18*

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// TECHNOLOGY & AGRONOMY

Continued from page 17

Frost

Frost's Ninja GPS Spray technology controls spray at each nozzle, maintains application rate at any speed and has two nozzles at each position on the boom for a wider speed range while spraying.

Jesse Trcka, superintendent at Wayzata Country Club in Wayzata, Minn., relies on Frost's Ninja GPS technology on the Outcross sprayer to keep track of how much product is being put down, where it's applied and what adjustments can be made for the future.

This will be our ninth season since we had our first Frost GPS sprayer on the property. It was something that the ag industry has been doing for a long time, and I felt we could find efficiencies from the GPS side of things and even have items as basic as the individual nozzle control on



Frost's GPS sprayer technology can help golf courses save money by promoting efficiency when spraying.

the sprayers.

We can pull data off the sprayers and be able to look at what my applicators

have done. From there, I'm able to coach staff through making improvements on *Continued on page 35*







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A Supplement to **Golfdom**

FOCUS ON FUNGICIDES

INSIDE

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FOCUS ON FUNGICIDES

// A Word From Our Sponsor

The PBI-Gordon fungicide pipeline process

By Brian A. Aynardi, Ph.D., and Jeffrey W. Marvin, Ph.D.

Disclaimer: This article does not discuss every step in the regulatory and registration process.

ur fellow turf pros often have questions about a new fungicide, but the most common question about a new product is "How long did it take to come up with that?" It's a fair question, but the answer is typically more complex than one may expect. In this article, we'll offer more insight on how an idea becomes a product ready for the shelves and turf.

Since 1947, PBI-Gordon Corp. has been a premier formulator of herbicides, beginning with Trimec® family of products, now an industry favorite for more than 50 years. As a specialized formulation and development company, PBI-Gordon has partnerships with companies all over the world that provide us with the opportunity to evaluate assets from their pipeline. Supply partners come to PBI-Gordon because we know turf, we know formulation technology and we provide a turnkey opportunity for suppliers entering the turfgrass and ornamental market.



BRIAN AYNARDI

Working with our global partners, PBI-Gordon has added five fungicides to our line, including Segway[®] Fungicide SC, Kabuto[®] Fungicide SC, Tekken[®] Broad Spectrum Fungicide, Pedigree Fungicide SC and Union[™] Fungicide SC.

The process of launching a fungicide product begins with a partnership agreement to evaluate the active ingredient. With that agreement, evaluation usually begins with background information on the range of pathogens a particular compound may have efficacy in controlling across various species of grasses, but turfgrass is a unique commodity, so the compound being evaluated may not control the same species from one commodity to another. For instance, the pathogen that causes gray leaf spot in turf is a major pathogen of rice. We have seen candidates provide strong control of that pathogen on rice, but when it gets to turf, there is little, if any, control.

So, how do we find out if a product will provide control or is a candidate to move forward? We typically *Continued on page FS4*

FOCUS ON FUNGICIDES

Continued from page FS3 focus on a core group of pathogens representing the two types of fungi, basidiomycetes and ascomycetes, along with fungal-like organisms called oomycetes.

We often test rates "outside the box," and, depending on the mode of action of a fungicide, we may immediately look at premix partners. The key is to find out how much of an active ingredient is needed for acceptable control of at least two primary pathogens.

Once a required amount of a product is defined, it's time for the PBI-Gordon regulatory department or our supply partner to set allowances on use rates. Allowances are determined by ecotoxicology testing, soil dissipation studies and other key metrics. The more that is known about an active ingredient, the shorter the time required to develop and register it.

When the rate required for key pathogen control is acceptable with PBI-Gordon regulatory department or our supply partner, it's time to find out what else a fungicide does or does not do. Turfgrass safety is always a key concern but often, is less of a development hurdle with fungicides than herbicides, as fungicides typically have little to no off-target effects on other plants. It is important to know how



JEFFREY MARVIN

safe an active ingredient is on all turf species, particularly those that have a transition period from dormancy to fully green and in the event of misapplication by an end user.

All the aforementioned efficacy testing is well on its way within the first two years at PBI-Gordon and usually means our research team has enough information by this time to make a recommendation about the continuation or termination of an evaluation.

Expanded testing with cooperators on primary pathogens of interest continues into the third year, as well as the evaluation of tertiary pathogens of interest and potential premix partners. A timeline for registration is also in the works at this period, and significant coordination is occurring among various units within PBI-Gordon and in conjunction with the supplier. this point in the process.

While the learning

process never ends on

a product, future field

efficacy evaluations are

conducted primarily to afford end users to see

the product firsthand at

field day events hosted

cooperators. If we've

internally or by university

done our jobs right, the

new product overdeliv-

ers in pathogen control

it may seem like we're

we've been evaluating the next generation of

active ingredients in the

pipeline throughout this

time, too.

done with our work,

expectations. And, while

From here, the timeline of a product reaching a shelf depends primarily on the type of registration and any additional toxicological studies that are required. If it is a new active ingredient to the United States, the whole process will take six years or longer and several million dollars. If an active ingredient is already registered with the Environmental Protection Agency, the product is likely submitted for registration at

Brian A. Aynardi, Ph.D., is the Northeast research scientist for PBI-Gordon. Aynardi is a turfgrass pathologist that has an extensive background in field efficacy testing with fungicides for the control of various diseases of turfgrass. He completed his Ph.D at Penn State University. You can reach him at baynardi@pbigordon.com for more information.

· W. Min

Jeffrey W. Marvin, Ph.D., is senior director of field research & development for PBI-Gordon. Marvin leads the field research team in the development of next generation products that support innovation in the turfgrass and ornamental industry. He earned his Ph.D. in plant and environmental science at Clemson University. You can reach him at jmarvin@pbigordon.com for more information.



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OCUS ON FUNGICIDES

Safe shelter from Pythium

By Chris Lewis

Shelter Harbor Golf Club in Rhode Island overcomes extreme weather, delivers exceptional conditions ocated in Charlestown, R.I., in the southwestern portion of the state, Shelter Harbor GC is a member-owned private equity club situated on roughly 400 acres. The club has a temperate oceanic climate, leading to a variety of temperature extremes, from very mild to very hot in the summertime, and mild to very warm in the winter, resulting in a decline in snowstorms, compared to other areas in the Northeast. The weather is so extreme, in fact, that nighttime temperatures often surpass 70 degrees F during the summer.

As a result of the extreme weather, the club's 27-hole facility encounters a wide array of turfgrass diseases every year, including brown patch, fairy ring, summer patch and various forms of *Pythium*, such as blight and root rot.

"Shelter Harbor's disease definitely varies by season too," says Superinten-

dent Michael Dachowski. "Some years, pressure is low with dry conditions, while other years, it can be high with moisture and humidity instead."

To help overcome this extreme variation in weather conditions, along with the conse-

quent types of *Pythium* diseases he encounters every year, Dachowski

decided to invest in PBI-Gordon's Union Fungicide SC.

Intended for usage on the club's 7,006yard, 18-hole Michael Hurzdan- and Dana Fry-designed championship layout, Dachowski — and his summertime crew of nearly 30 employees, 11 of whom have turf degrees — decided to apply the premix fungicide on the club's par-27, 1,206-yard par-3 course as well.

Comprised of 5.84 percent cyazofamid, a quinone inside inhibitor that is actually the same active ingredient that Segway Fungicide SC uses to control every type of *Pythium* disease, Union Fungicide SC also has one other active ingredient: azoxystrobin (encompassing 3.25 percent of the fungicide overall), a quinone outside inhibitor that provides broadspectrum disease control.

Due to its inclusion of cyazofamid, which received registration by the EPA

> in 2004, the fungicide is able to disrupt the electron transport chain at the inside binding site of complex III of the cytochrome B, which is the key to its ability to control *Pythium* diseases in a timely, long-lasting fashion.

Additionally, as a result of its inclusion of azoxystrobin, Union Fungicide





SC can control 21 of the most common turfgrass diseases, including anthracnose, brown patch, cool-weather brown patch, fairy ring, gray leaf spot, leaf and sheath spot and yellow patch. Not to mention, the addition of azoxystrobin to cyazofamid ensures superintendents also have a second mode of action to control the pathogens that cause the various *Pythium* diseases. "As superintendents apply Segway,

As superintendents apply Segway, which is a phenomenal *Pythium* control product for the turf industry, or Union premix, as a form of resistance management for controlling *Pythium* pathogens, they must remember that both products contain cyazofamid," says Brian Aynardi, Ph.D., Northeast research scientist, PBI-Gordon. "As a result, no more than two consecutive applications of Union or Segway (or a combination thereof) should be applied without transitioning to an active ingredient — from a different mode of action — before reapplying them."

THE INFLUENCE OF UNION FUNGICIDE SC

Depending on the type of *Pythium* disease that superintendents are striving to control — blight, damping-off, root rot or root dysfunction — along with other factors such as weather, Union Fungicide SC's use rates and application intervals vary.

For example, to better control *Pythium* blight and *Pythium* damping-off, superintendents should apply the fungicide at a rate of 2.9 to 5.75 fluid ounces per 1,000 square feet and at an application interval of 14 to 28 days, but to control *Pythium* root rot, the application interval is a bit shorter (14 to 21 days), and the use rate remains unchanged. To control *Pythium* root dysfunction, Union Fungicide SC must be applied Shelter Harbor GC in Rhode Island is situated in an area with temperature extremes, which can result in a multitude of turfgrass diseases.

at a rate of 5.75 fluid ounces per 1,000 square feet and at an application interval that ranges from 21 to 28 days.

Dachowski was primarily interested in controlling *Pythium* blight and root rot, so he applied the fungicide at a rate of 3.0 ounces per 1,000 square feet. The application was only necessary once — during a two-week stretch of very humid weather in August 2020.

"The product was so effective that there was no need to apply it to the fairways or the greens after that first application," Dachowski explains. "I was very pleased with the almost immediate results I noticed, as Shelter Harbor's noticeable *Pythium* diseases were soon minimized at a time of year in which *Continued on page FS8*

FOCUS ON FUNGICIDES

Continued from page FS7 the course is usually most vulnerable to its spread."

Union Fungicide SC is labeled for usage on all types of cool-season and warm-season turfgrasses. Dachowski applied it to Shelter Harbor Golf Club's championship course's and par-3 course's Velvet bentgrass greens and creeping bentgrass tees and fairways.

"We didn't conduct any trials, so when I first applied Union Fungicide SC on all 27 holes' fairways and greens, I wasn't sure how else I could use the product," he says. "I was just focused on targeting my two main problem areas when it came to *Pythium*: greens and fairways. I wanted to respond to the issue as quickly as possible and control it as fast as I could." He continues, "We were simply replacing another strobilurin and *Pythium* product we had already used in our program, as Union Fungicide SC made more sense to us, especially considering the combination — of cyazofamid and azoxystrobin — it provided. Now that we have witnessed the results of the fungicide firsthand, especially its speed and duration of effectiveness, we will be looking into other areas we can apply it in the future."

MAINTAINING SHELTER HARBOR'S VIBRANT APPEARANCES

Alongside the Hurzdan and Fry 18hole championship course and the par-3, nine-hole course that's located near



Shelter Harbor GC Superintendent Michael Dachowski and his team have depended on an array of PBI-Gordon products to keep the course looking vibrant.

it, Shelter Harbor Golf Club also has a 22-acre practice facility that features six tees, five target greens, two short game areas, a practice putting green and a private tee for professional instruction. This entire practice facility was also treated with Union Fungicide SC last summer (and will be treated yet again this summer) as a means to further enhance guests' experiences while they sharpen their games.

Dachowski and his team have also relied on PBI-Gordon's other products, including Segway Fungicide SC, Brushmaster Herbicide, Super Trimec Broadleaf Herbicide, Tupersan Herbicide Wettable Powder, TZone SE Broadleaf Herbicide for Tough Weeds and Vexis Herbicide Granular.

"By using all of these products, weeds are controlled as they actively grow, so they can be completely eliminated with lower rates of products, leading to cost and time savings because my team is able to focus on other aspects of their jobs, rather than weed treatment," Dachowski says. "And, of equal importance, Union Fungicide SC's premixed formulation — with two distinct, powerful, active ingredients — also saves us money and time because we don't have to buy and spray two products (one with cyazofamid and one with azoxystrobin) anymore."

The result is high praise from Shelter Harbor Golf Club's membership, which has been impressed with the golf courses' consistently healthy, vibrant appearances, despite the unpredictable weather.

"PBI-Gordon products have been wonderful, with their long-term efficacy, their ease of use, the impact they've had on the courses' appearances and, in turn, members' responses," Dachowski says. "I'm looking forward to using these products for years to come."

THE PBI-GORDON FUNCTION OF INNOVATION



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OCUS ON FUNGICIDES

Preventive control of Pythium Root Dysfunction

By Jim Kerns, Ph.D.

Analyzing the sensitivity of Pythium volutum to fungicides

Editor's note: This article is an adaption of "Preventative control of Pythium Root Dysfunction in creeping bentgrass putting greens and sensitivity of Pythium volutum to fungicides" by Jim Kerns, Ph.D. It originally appeared in the December 2009 issue of Plant Disease, a publication of the American Phytopathological Society. It is presented with permission from the author. reeping bentgrass, a cool-season turfgrass, is ideal for greens because it tolerates extremely close mowing and produces a uniform playing surface. However, most of the Southeast U.S. is in the Transition Zone for cool- and warm-season turfgrasses and the hot, humid summers often result in reduced turf vigor and increased susceptibility to diseases.

Pythium root dysfunction of creeping bentgrass was first described by C.F. Hodges and L.W. Coleman in 1985. They observed that newly established, high-sand-content putting greens were wilting in irregular patterns that eventually progressed to foliar decline. In 2007, J.P. Kerns and L.P. Tredway confirmed that *P. volutum* was the cause of *Pythium* root dysfunction (PRD) in samples from North Carolina, South Carolina, Georgia and Virginia.

In North Carolina, symptoms of PRD typically develop during the summer months, when creeping bentgrass is subjected to heat and drought stress. Symptoms initially develop as wilt or chlorosis then progress to foliar decline, which is likely due to rapid dieback of roots. Based on our current understanding of PRD epidemiology, fungicide applications during the time of pathogen activity may provide more effective disease control.

Tredway and E.L. Butler tested fungicides for early and late curative control of PRD in an A-1 creeping bentgrass putting green. All treatments and programs that included pyraclostrobin were nearly free of disease symptoms during late June and early July. Suppression of disease symptoms were not observed with any of the standard *Pythium* spp. fungicides, which included mefenoxam, *fosetyl- Al*, propamocarb and ethazole. As the heat and drought stress increased through late July and early August, no treatments or programs significantly suppressed PRD symptoms compared with the untreated controls. Research was needed to determine whether preventive applications, when the pathogen is actively infecting roots, are more effective for the management of PRD.

Pyraclostrobin belongs to the strobilurin group of the class of fungicides known as the quinone outside inhibitors (QoIs). The QoIs are used on a broad range of crops for suppression of all major fungal pathogen groups, as well as oomycetes. These fungicides inhibit mitochondrial respiration by binding to the Qo center of cytochrome *b*, thereby blocking the electron transport chain. As a result, the production of ATP is terminated and fungal growth is inhibited. Because of this biochemical mode of action, the QoIs are most effective as a prophylactic treatment.

To improve the management of PRD, research was needed to determine the basis of the activity of pyraclostrobin and to evaluate fungicides for preventative control of PRD. The specific objectives of this study were to (i) evaluate fungicides for preventive control of PRD in field experiments, (ii) determine the in vitro sensitivity of *P. volutum* to fungicides and (iii) evaluate the effects of pyraclostrobin applications on creeping bentgrass foliar growth rate.

MATERIALS AND METHODS

Preventive control of PRD: A three-year field experiment was conducted at the Pinehurst Golf Resort in Pinehurst, N.C., on a G-2 creeping bentgrass putting green that was severely affected with PRD. Isolations from the affected area revealed that *P. volutum* was the causal agent of PRD in this location. The putting green was constructed in 1993 according to USGA specifications with a root zone mix of 85 percent sand and 15 percent sphagnum peat moss by volume. In 2005, the site was fertilized with nitrogen at 171 kg ha⁻¹ and was mowed daily at 3.2 mm throughout the year. In 2006 and 2007, the putting green received 195 kg ha⁻¹ year–1 and was mowed daily at 3.2 mm during the fall and spring and at 3.5 mm during the summer months. The study site was irrigated as needed to prevent drought stress.

Fungicide treatments and application dates are shown in Table 1 and were initiated in September 2004 and continued in the fall of 2005 and 2006.

TABLE 1. Treatments, rates andpost-application treatment forpreventive control of Pythium rootdysfunction in 2004 through 2007

Fungicide	Rate (product at g or ml m ⁻²) ^y	Watered in ^z
Control		-
Menfenoxam	0.31 ml	+
Propamocarb	2.44 g	+
Fosetyl-Al	1.3 ml	-
Ethazole	1.22 g	+
Azoxystrobin	0.12 g	+
Pyraclostrobin	0.28 g	+
Trifloxystrobin	0.076 g	+
Cyazofamid	288 ml	+

^y Treatments were applied in H2O at 81.5 ml m⁻².
^z Treatments did (+) or did not (-) receive 6.4 ml of

irrigation immediately after application.

FIGURE 1. Area under the disease progress curve values (AUDPC) in response to preventive fungicide applications in 2005. Treatments were applied on 9-22-04, 10-20-04, 3-29-05, 4-19-05 and 5-26-05. AUDPC values were calculated from disease severity data collected three times on a weekly interval. Bars followed by the same letter are not significantly different according to Waller-Duncan *k*-ratio *t* test (k = 100).



Fall applications were initiated when soil temperatures declined to 24 degrees C, and spring applications were initiated when soil temperatures increased to 12 degrees C. Treatments were applied with a CO2-powered boom sprayer at 276 kPa using flat fan nozzles calibrated to deliver H2O at 81.5 ml –2m. All treatments except fosetyl-Al were watered in immediately after application. Plots were 4.6 m² and were arranged in a randomized complete block design with four replications. Treatments were applied to the same experimental area in all three years.

Disease severity was evaluated biweekly during the summer months using a modified Horsfall-Barratt (HB) scale (11 = 100 percent, 6 = 50 to 75 percent,and 0 = 0 percent). The scale data were converted to the geometric mean of the percentage range corresponding to the scale number in order to calculate the area under the disease progress curve (AUDPC) values. Three ratings were used to calculate AUDPC values. Turf quality was assessed visually by estimating the overall uniformity, density and color within each plot before every fungicide application and during each disease severity rating. Turfgrass quality was quantified using a 1 to 9 scale (9 = best, 5 = minimally acceptable, and 1 = bare ground). AUDPC values were subjected to analysis of variance and mean separations using the Waller-Duncan *k*-ratio *t* test (k = 100) in SAS.

IN VITRO SENSITIVITY OF P. VOLUTUM TO FUNGICIDES

The sensitivity of 11 *P. volutum* isolates and one *P. aphanidermatum* isolate to pyraclostrobin, azoxystrobin, mefenoxam, cyazofamid, propamocarb, fluopicolide and fluoxastrobin was determined in mycelial growth assays. *P. aphanidermatum* was included in the sensitivity assay as a standard for comparison. Hyphal plugs (4 mm) from the edge of actively growing colonies on clarified V8 juice agar were placed in the center of petri dishes containing potato dextrose agar (PDA) amended with six *Continued on page FS12*

FOCUS ON FUNGICIDES

FIGURE 2. Impact of preventive fungicide applications on turfgrass quality in 2005, 2006 and 2007. Turf quality was visually estimated on a scale of 1 to 9 (1 = bare ground 5 = minimally acceptable and 9 = best). Bars represent the average of three turf quality rating dates. Dotted line represents acceptable turfgrass quality. Applications were made on 9-22-04, 10-20-04, 3-29-05, 4-19-05, 5-26-05, 9-4-05, 10-4-05, 3-15-06, 4-17-06, 5-17-06, 9-13-06, 10-12-06, 3-14-07, 4-12-07 and 5-16-07.



Continued from page FS11

concentrations (0, 0.0001, 0.001, 0.01, 0.1, 1 and 10 μ g/ml) of commercially formulated pyraclostrobin (Insignia 20WG; BASF), azoxystrobin (Heritage 50WDG, Syngenta Professional Products), mefenoxam (Subdue MAXX 2ME; Syngenta Professional Products), propamocarb (Banol 6SL; Bayer Environmental Science), fluoxastrobin (Disarm 480SC; Arysta Life Science) or cyazofamid (Segway 3.33SC; FMC). Technical-grade fluopicolide was used because of the lack of commercially formulated product for the turf and ornamentals market and was provided by Valent Professional Products. Salicylhydroxamic acid (SHAM, 100 µg/ml) was added to all pyraclostrobin, fluoxastrobin and azoxystrobin concentrations to inhibit the alternative oxidase pathway, and a PDA + SHAM control was also included. Fungicide and SHAM solutions were added to autoclaved PDA that was cooled to approximately 55 degrees C.

RESULTS

Preventive control of PRD. In 2005, 2006 and 2007, foliar symptoms were not present in the experimental area during the fall and spring application periods, and treatments did not impact turfgrass quality during this time. In 2005, PRD symptoms developed during the beginning of July, immediately following a heavy sand topdressing event and the USGA U.S. Open. During 2005, only applications of cyazofamid, trifloxystrobin, azoxystrobin and pyraclostrobin significantly reduced PRD severity compared with the untreated control (Fig. 2). These treatments also maintained acceptable turf quality throughout the summer (Fig. 3). Symptoms of PRD developed in the beginning of July of 2006 as well, but, in general, the symptoms were not as severe as in 2005. In 2006, only pyraclostrobin provided suppression of disease symptoms when compared with the untreated control. Differences in turf quality were minimal in 2006, with the untreated control demonstrating acceptable turf

quality (Fig. 3). Symptom development occurred in early July 2007, yet the symptoms were minor at this time. However, by 9 August 2007, the symptoms had become severe in the untreated controls due to extremely hot, dry conditions. Fosetyl-Al-, ethazole-, trifloxystrobin-, cyazofamid-, azoxystrobin- and pyraclostrobin-treated plots provided significant suppression of PRD compared with the untreated control. However, acceptable turf quality was only observed in plots treated with pyraclostrobin, azoxystrobin and cyazofamid (Fig. 3).

Sensitivity of P. volutum to fungicides. Variation of EC50 values between the two experiments was not significant and data from the two experiments were combined for analysis. P. volutum was highly sensitive to pyraclostrobin (EC50 = 0.005), cyazofamid (EC50 = 0.004) and fluoxastrobin (EC50 = 0.010); moderately sensitive to azoxystrobin (ED50 = 0.052); and the least sensitive to mefenoxam (EC50 = 0.139). For the tested fungicide concentrations, a dose response to propamocarb or fluopicolide was not detected for most isolates of P. volutum. In contrast, the single P. aphanidermatum isolate was most sensitive to pyraclostrobin, cyazofamid and mefenoxam; moderately sensitive to azoxystrobin and fluopicolide; and the least sensitive to fluoxastrobin. This particular isolate of P. aphanidermatum was not sensitive to propamocarb.

Impact of pyraclostrobin on creeping bentgrass growth. ANOVA detected no significant differences among experiments; therefore, data presented are the average of the two experiments. Regardless of rate, pyraclostrobin did not significantly (P > 0.05) impact creeping bentgrass foliar growth. Increasing nitrogen rates caused an expected increase in clipping yield but a significant interaction between nitrogen and pyraclostrobin treatments was not detected. **G**

Right time, right spot

endell Hutchens, a Ph.D. candidate at Virginia Tech, is in the final year of his education. It's an exciting time, not just because his days as a student are coming to an end, but also because the results of the research he has been conducting alongside David McCall, Ph.D., are also coming to a conclusion.

"We're in the final year of results for a lot of these field trials. so a lot of information is coming in," he says, adding that 2021 is turning into a banner year for spring dead spot. "The disease pressure has been much higher than last

year, so there's more disease this spring than last year. We've seen all around the state that the pressure has been higher."

Hutchens has focused his studies on spring dead spot for multiple reasons. For one, he has studied under McCall for several years, and McCall is also keyed in on the disease. Another reason is he studied summer patch and fungicide movement for his master's thesis, so he was already interested in the soil-borne crown and root infecting pathogens.

"I wanted to dive deeper," Hutchens says. "I also like studying soil-borne pathogens because they're kind of a pain to work with, but usually, any results you get are very helpful to superintendents and athletic field managers because they're major problems."

While some of the results are still com-

ing in, other research is under review. Most of it will be formally released over the next year. In the meantime, Hutchens and McCall took time to report on what their test plots are showing them thus far.

A DEEPER DIVE

Five years ago, McCall did a survey of Virginia superintendents and asked them

what turf nuisance was

trending upward for them.

He learned that 85 percent

of them were growing bermudagrass, almost all of

them were battling spring

dead spot and a majority

of them were using fungi-

cides to combat it.



DAVID McCALL

"That was a clear indication that we needed to spend more time on it," McCall says. "Spring dead spot is the biggest emphasis we have in our program."

Their research is headquartered at the Virginia Tech campus in Blacksburg but also includes five other locations around the state and one spot in Maryland. McCall has a couple students studying spring dead spot. One student, Caleb Henderson, is studying the best methods for computer-automated detection of the disease. Hutchens is doing a deeper dive into the management and the epidemiology of spring dead spot.

"We are evaluating everything from optimizing the delivery and timing of applications, which we have learned is a bit different than we thought, to tracking Continued on page FS14

By Seth Jones



concluding intense spring dollar spot research



Wendell Hutchens, Ph.D. candidate, studies test plots in Blacksburg, Va.



FOCUS ON FUNGICIDES

Continued from page FS13

the causal species distribution to learning how each species responds to fungicides," McCall says. "Not just around the state but the region and around the country."

THE RESULTS

In the past, McCall has advised superintendents to wait until soil temperatures drop to 70 degrees F to make their first fungicide application. Now, McCall has adjusted that to apply fungicides when soil temperatures are between 72 and 75 degrees F. Also, he advises tightening the window for the second application. Don't wait a month, he says, but instead apply again two to three weeks after the first application.

"Much to our surprise, most of the growth of the spring dead spot pathogen occurs in that 70- to 80-degree (range,)" McCall says. "Another key point we found is that there is essentially no pathogen



growth once you get below 60 degrees F. You can still apply a fungicide at 55 degrees F, but you probably won't get the best bang for your buck."

Hutchens said that last year, in a light spring dead spot pressure season, a lot of fungicides worked on the disease, three to five "really worked" and one or two



While spring dead spot pressure was light in 2020, this year, the disease is much more prolific. Bad for superintendents, but good for analysis.

were "the best."

"Last year, DMIs did OK, 50 percent to 70 percent suppression for most of them. SDHIs generally are the best from what we've seen," he says. "Last year with low disease pressure, things like tebuconazole, propiconazole and pyraclostrobin were doing OK, with 50 to 70 percent suppression. This year, with more pressure, they didn't touch it — that's a problem. But, you still had those top tier fungicides, and in that top tier, (PBI-Gordon's) Kabuto is consistently the top performer."

Hutchens says there were a few different fungicides that competed with Kabuto from site to site, but overall, it was Kabuto that stood out across all sites, with more than 90 percent control at all locations.

"That was shocking. It's the only one that's steady regardless of the pathogen, the species, regardless of the location, the management strategy of the golf course," Hutchens says. "You can pick out the Kabuto plots, we'll just say that."

THAT LIGHTBULB MOMENT

Over the last 10 to 15 years, Virginia has seen more and more courses transition to cold-tolerant bermudagrasses varieties. Being in the Transition Zone means spring dead spot is an annual occurrence.



It's the desire of McCall and Hutchens to not just find the right fungicide, timing and methods, but also to create overall best management practices for courses of large and small budgets. They are working to find ways to map pests and diseases so fewer fungicides are needed. They also want to find and alleviate the underlying issues in the trouble areas.

"We want to show a way to maintain exceptional quality playing surfaces, yet still go out and use that right product, something like Kabuto, in the place where it needs to be, at the right time," McCall says. "A lot of these products can be very expensive, and a lot of places can't afford to spray 30, 40 acres of fairway. I just spoke to a superintendent, and he said he has 55 acres of fairways. He can't spray something that's \$300 an acre everywhere, but if we can say here's the 10 percent of the area that needs it the most, then he can make a targeted application in those areas."

Hutchens figures he will be studying

spring dead spot for a long time, because he says on bermudagrass in the Transition Zone, spring dead spot is the most problematic disease out there.

"It's ubiquitous throughout the Transition Zone," he says. "Once the infection takes place in the fall, the symptoms and damage occur from frost events and freezing events over the wintertime, and green-up is when you see the symptoms. You can't spray a fungicide in the spring. It can help it recover a little bit, but it's not like a dollar spot application. You're pretty much looking at it until it grows back in. From a playability standpoint, it's a huge issue because it causes pitted, sunken patches."

McCall is happy to see three years of research rounding into shape, but he says the most rewarding thing is seeing students finding success that, in turn, gives turf managers in the state success.

"It's a blast when you come across something new that was unexpected," McCall says. "Wendell and all my students have done an excellent job with



Als, number of applications and timing all play a role in the efficacy of products, according to McCall.

all of this work. It's really rewarding to me when the student comes in, and they're excited about something — like when they come in and Kabuto is doing much better than expected or they see a shift in when the applications should be made. When that lightbulb moment hits and the student realizes they're on to something groundbreaking that will help the end user, that's the most satisfying thing."



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TECHNOLOGY & AGRONOMY

Continued from page 18 how they're making applications.

It's also that recordkeeping bit, so when and if somebody wants to see exactly where we're making an application, I have that data.

The other part of it is we've been doing prescription applications here for the last five or six seasons now. Using normalized difference vegetation index imagery, we can generate maps on the golf course. That allows us to be able to go through and determine what areas of the golf course we've done with fungicides.

Being able to limit the amount of fungicides that go down on turf that is healthier as determined by the satellite imagery, we've been able to lessen the total amount of product that goes out by as much as a third for a fungicide application.

As far as the fungicide product, we'll save anywhere between 25 percent to 33 percent on our prescription applications when we do those. On tee boxes, because of that individual nozzle control, we save probably 15 percent to 20 percent because we're able to more accurately apply it to the surface.

I've talked to a number of different

superintendents when we were a relatively early adopter of this, and the biggest thing is to be patient and accept the learning curve. You're going to have to learn how it's going to best fit your methodology, your applications and your golf course. You're going to realize those savings and those efficiencies as long as you don't just have some expectation that the minute you drive out the door, it's going to be seamless.

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Turf Nutrition Tool

The Andersons' Turf Nutrition Tool (TNT) provides a model for nutrient release over time.

For Patrick Murphy, golf course superintendent at The River Club in North Augusta, S.C., tracking the amount of fertilizer he needs is no longer a guessing game, thanks to The Anderson's Turf Nutrition Tool.

I first used The Andersons' Turf Nutrition Tool in February of 2020. It was something The Andersons had come out with, and I've used Andersons' products in the past, and I wanted to give it a shot.

It allowed me to see how many bags of fertilizer it would take for me to do an application and what my cost would be. I was able to plug in different fertilizer scenarios, so I could analyze and see what would be the best fit for the course.

I've used the TNT mainly for greens applications, so I can look and see the different Andersons products, the different contents, and see a price and how much I would need right there in front of my face. I don't have to get the calculator out and try to figure everything out.

Sometimes, when we've got to sit down with a pencil and paper, we get distracted at different times, so we may end up going with what we've always gone with, but with this app, I'm able to look at it and see different scenarios and play around with it, like with percentages of nitrogen and see what best fits us. It saves me time, and I can look up rates and everything pretty quickly.

Everyone is going to be different with how they use it. Guys that are using it for more than just greens, using it for tees, fairways and all that, they would have a bigger advantage than I do because they can look at a broader range of acreage.

For other superintendents who don't already use it, I would recommend they log on and give it a shot. Try it out and see.

Continued on page 36



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// TECHNOLOGY & AGRONOMY

Continued from page 35

GreenKeeper App

The GreenKeeper App automatically keeps track of product efficacy, including PGR breakdown with growing degree day models, records fertilizer applications and monitor changes in soil and tissue test results over time, uses hyper-local weather data to help predict pest outbreaks and more.

Eric Johnson, director of agronomy at Chambers Bay Golf Course in University Place, Wash., explains how his course went from Excel sheets to the GreenKeeper app.

We started using it in 2018. We already had everything in Excel, and to me, this looked like a good chance to put everything together in one place and make it easier and sharable with our general manager and other guys on the staff.

The assistants and superintendents

can bring it up and add data themselves. If you were managing multiple courses, it would be pretty easy to see what's going on a hundred miles away at the other course. You can keep track of what's going on there without being on-site. Before, if I had a spreadsheet with Stimpmeter readings, I had to fill that out and then email it to whoever wants it. Now, we can bring up that page in the app.

We track all of our inputs besides irrigation, so fertilizer, any chemicals, wetting agents. We use the pest report feature where, say, if you find a spot of disease on the 12th green, you can drop a pin on it in the app. Also, we enter clipping volume, soil moisture, green speed, firmness, soil temperature into the performance tracker of the GreenKeeper app.

With the product tracking feature, for example, if you want to put out ammonium sulfate or some fertilizer, you plug it into



your application sheet, and if you don't have enough, the GreenKeeper app will give you a red flag so that you know you're out or that you need to adjust.

A newer item is keeping track of cultivation, like aeration and topdressing. We've just started tracking that on the Green-Keeper app, so I'm excited to see what

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we get over the summer with all of our cultivation practices.

The dashboard is nice for everyone, especially for the maintenance department. With how the app keeps track of product efficacy, it'll show you how much time you have left before the next application based on growing degree days. Any product that The GreenKeeper app's technology helps keep Chambers Bay GC in University Place, Wash., in pristine condition.

has an expiration date — fungicides and growth regulators — you can keep track of without having to dive deep into it.

The nice thing about this is that Green-Keeper app team is pretty open to suggestions. We've emailed back and forth over the years with ideas. It is always evolving. There is another change upcoming. **G**

Editor's Note: Bill Kreuser, Ph.D., developer of the GreenKeeper app has left the University of Nebraska — Lincoln and will be working on the Greenkeeper App full time.



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More than a golf course

Michigan's Golf Club at Harbor Shores uplifts a community

he Golf Club at Harbor Shores in southwest Michigan is a massive property encompassing 500 acres. The course spreads out over four diverse terrains: dunes, woodlands, river wetlands and inland terrain. Thirty acres of hiking trails and a 10-acre beach on Lake Michigan are additional elements of the large property. Every other year, the course proudly hosts the Senior PGA Championship.

The course was scheduled to host the event in 2020 until the pandemic forced the cancellation of the tournament. Now, the crew members, led by Nate Herman, superintendent, have their sights set on 2022.

"With everything that was going on, I wouldn't have wanted to host the tournament (in 2020)," Herman reflects. "We changed gears pretty quick. You take it and roll with it, and now we have two years to prepare for the tournament."

Harbor Shores was in the process of staffing up in preparation for the Senior PGA and then froze hiring in the wake of COVID-19. The course normally

opens in mid-April, but postponed opening last year by a few weeks to be in accordance with Michigan state laws. Once the course opened, it saw a 15 percent uptick in golfer traffic.

"Those first two weeks, there were no carts," Herman recalls. "It was interesting to see everybody walking around."

Infinite options

Combine the massive property size at Harbor Shores with the shortage in labor and the challenges of COVID, and 2020 could have become a nightmare of a season, but Herman and Equipment Technician Scott Brock look back and realize it was a success story, in part, because of their reliance on John Deere equipment and JW Turf.

Scott Wilkinson is the account manager for JW Turf and calls on



Harbor Shores. He has a great perspective on the course because previously, he was the assistant superintendent there. He says the course uses John Deere 180 E-Cuts with groomers on greens; for fairways, 7500A E-Cut

Nate Herman

Hybrids with groomers and rear roller brushes; and roughs are maintained with new 7400As.

"We rarely ever double-cut greens," Herman says. "With time constraints with COVID and labor, we're able to get the product on the Stimpmeter for our guests and members, as opposed to sending twice as many greens mowers out to put a double-cut out." "The greens are very undulated (at Harbor Shores)," Wilkinson says. "They've made their own tweaks (to the 180 E-Cuts), but they follow the contours spectacularly. Same with the fairway mowers — they've got 7500A E-Cuts, outfitted with fairway turf conditioners and out-front brushes. Those are two of the main factors related to Deere that help them do a great job taking care of the course."

Brock, a native of the area who has worked as an equipment technician at the course since 2015, says he enjoys maintaining the Deere equipment because of the flexibility of the machines.

"I feel like Deere has given us a lot of options to make their equipment operate as well as it needs to," Brock says. "You have infinite adjustments between rollers settings, bedknife angles and different bedknife options. They've done a good job in their research and development. We have had really good success with communication with John Deere service and parts, as well as sales."

Prideful work

Wilkinson still gets a call from Herman from time to time, asking for a historical perspective from his days as an assistant at the course, but Wilkinson laughs; after seven years, things get hazy.

"They do an awesome job," Wilkinson says of the crew. "They've got a nice groove on setting up their reels and what works for them. Nate is one of the smartest superintendents I've come in touch with ... in terms of managing the crew, the science of turfgrass, budgets ... he's very intense, but in a good way. He lives and breathes turfgrass." The next Senior PGA Championship for the course is still another year away, but Herman and Brock enjoy making the entire Harbor Shores property shine for the local community and the area's many tourists.

"It's more than a golf course and a beach. Restaurants, homes, businesses have all developed because of this (course)," Herman says. "We're the central core of the revitalization of Benton Harbor."

"Growing up in this area and seeing what this area was like prior to the golf course being built, the change in the landscape and the economic development," Brock adds, "what the course has done for the area is really prideful."





Hosted by Mike Kenna, Ph.D. | mpkenna@gmail.com

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// USGA DEACON

DEFER TO DATA

By Mike Kenna, Ph.D.

he USGA recently released Deacon, a program to help make data-driven decisions on resource consumption, the pace of play or guidance for renovations. I am excited about the potential the program has on the game of golf.

Why would Deacon be something you should check out? Here are three areas of focus the program addresses:

Golfer experience: You want every golfer to walk off the final green eager to return. Deacon helps deliver high-quality putting green surfaces. With the GPS service, you can identify course bottlenecks that slow play.

Resource prioritization: Deacon helps use resources efficiently in the areas that come into play more and significantly impact the playing experience. There are



The new Deacon tool to improve the golfer experience honors Deacon Palmer (left), the father of legendary golfer Arnold Palmer.

several features providing insight into maintenance spending. Data-driven decisions help provide better playing conditions more efficiently.

Easy to use: Deacon's visualization platform makes the data easy to enter, see and understand. There are customizable maps, charts and dashboards providing a synoptic view of the course. Both desktop and mobile interfaces allow you to monitor data in real time or analyze historical trends.

Deacon works by pulling together data from several sources.

• Surface management allows you to easily track daily putting green inputs and view trends to make data-driven decisions.

• Sensor integration allows you to connect to soil moisture, temperature and salinity data from in-ground wireless sensors.

• Hole location allows you to track the quality of hole locations and their impact on the golfer experience, as well as print championship-quality hole location sheets.

• Advanced weather allows you to track how weather conditions and various maintenance variables impact playing conditions.

To ensure your success, the USGA Green Section is available for help. It offers one-to-one onboarding and an easy setup process to get you up and running. Deacon bundles well with the Course Consulting Service, so an agronomist can help you get the most out of the features available.

To learn more about USGA Deacon, go to https://gsshop. usga.org/pages/deacon. G



This project was funded in part by the USGA Green Section.

NEWS UPDATES

SYNGENTA'S ASCERNITY **REGISTERED IN CALIFORNIA**

Ascernity fungicide from Syngenta has been registered for use on turf and golf courses in California. According to the company, the fungicide will help superintendents control anthracnose, large patch, gray leaf spot and more.

"It's exciting to finally receive the registration of Ascernity in California after several years of testing on turf," said Dean

scern Fungicide

Mosdell. Ph.D., technical services

manager for Syngenta. "Ascernity adds a powerful tool to our disease control programs for cool- and warm-season turf in California."

Ascernity combines succinate dehydrogenase inhibitor Solatenol technology (benzovindiflupyr) with difenoconazole, the proven cooling demethylation inhibitor, to bring broadspectrum disease control into focus.

Ascernity offers superintendents control of diseases like anthracnose, large patch, summer patch, brown ring patch, gray leaf spot, microdochium patch, dollar spot and more; suppresses rapid blight under a 2(ee) label; and provides turf safety with no heat restrictions, even in the summer when disease pressure is high.

OUR LAB HAS BEEN **CREATING MODELS TO** PREDICT THE DURATION AND PERFORMANCE OF PGRS USING GROWING DEGREE DAY MODELS."

William C. Kreuser, Ph.D. (see story on page 42)



"In designing and implementing management programs, we use products and practices that have been around for decades ..."

KARL DANNEBERGER, PH.D., Science Editor

A classic fungicide

Id school is a term used to describe people who do the same thing the way it always has been done. Old school and, more specifically, old things that were popular years ago and ended on the scrap heap of history have seen a resurrection in demand and popularity among current generations, especially the millennial generation. A commonality of old school items, as a group, is that they predate today's digital world.

Old school is defined in actions or items like vinyl records that have had a rebirth in our current culture. In a music world of streaming and highquality digital delivery methods, vinyl records, which basically died out in the late 1980s and early 1990s, have seen a revival among young listeners. A few of the reasons given for vinyl popularity include the facts that you can hold it in your hands and that other options don't produce a perfect sound. Old school stuff tends to be viewed as unique and nonconforming.

In golf, we see trends in the business, but those are associated with new advancements in the profession. When looking for the next best practice or product, we tend to not look back at old-school ways. However, in designing and implementing management programs, we use products and practices that have been around for decades that have not lost a significant amount of popularity. For example, fungicide programs are continually evolving on a yearly basis. New modes of action or fungicide combinations are inserted into the program, replacing older products based on factors like efficiency and efficacy. Intermixed with newer fungicides are older ones. These older products are not old school in the sense they never lost favor due to a new trend but have achieved the status of traditional or classic components of a program.

For example, strobilurin fungicides are broad-spectrum fungicides that are important in the control of certain turf diseases. Strobilurins are effective on some of the root-infecting pathogens that cause patch diseases. Prior to the arrival of the strobilurin, controlling patch diseases with available fungicides was not very effective, and control with some patch diseases was dependent on cultural practices.

The original strobilurin was discovered by scientists in 1977. Named initially strobilurin A, this fungal antibiotic was produced by the pine cone fungus *Strobilurus tenacellus*. It's believed that this wood-rotting fungus, and similar fungi, produced strobilurin to help protect it from microbes present in the wood. In 1997, the strobilurin — an azoxystrobin — came to market.

Over the years, researchers enhanced the natural strobilurin synthetically, leading to the class of fungicides known as strobilurins. Strobilurins are more properly referred to as QoI fungicides. The Qo is part of the Q cycle found in mitochondria respiration. QoI fungicides inhibit fungal respiration by attacking the site Qo, which is part of the Q cycle in the mitochondria cytochrome system. The effect is that energy in the form of adenosine triphosphate (ATP) is not produced.

The QoI fungicides' mode of action is specific. Fungal resistance can occur with a single-site mutation. The first reported case of resistance globally occurred one to two years after the commercial release of azoxystrobin. Although QoI fungicides have a similar mode of action, they do differ in regard to the molecule itself, leaf absorption and transportation within the plant and diseases controlled. When applied correctly, they are extremely effective and remain an integral part of fungicide programs.

For more than 26 years, the QoI fungicides have been used professionally and properly to maintain turfgrass diseases on both cool- and warm-season turfgrasses. Over this period, the QoI fungicides have never lost favor in the industry or been subjected to the ups and downs of trends. This is one of the fungicide groups that will go down in the history of golf course management as a classic. **G**

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

//LOOK TO THE MODELS

Guiding PGR applications by growing degree days

By William C. Kreuser, Ph.D

t the University of Nebraska, our lab has been creating models to predict the duration and performance of plant growth regulators (PGRs) using growing degree day (GDD) models. We have more than 570 different models specific to grass species, the active ingredient, application rate and even mowing height.

We developed a web-based decisionsupport tool called GreenKeeper (**GreenKeeperApp.com**). The goal was to house and drive the various PGR-GDD models with automated weather data retrieval. Users select the PGR, and GreenKeeper tells them how it is working at their golf course.

With support from the USGA, we created a new model that guides managers with the correct partial PGR application rate when making a follow-up application before the ideal reapplication interval. The model will limit the stacking effect and intensification of growth suppression documented in previous research.

"The goal was to house and drive the various PGR-GDD models with automated weather data retrieval. Users select the PGR, and GreenKeeper tells them how it's working at their golf course."



The impact of different PGR reapplication models on the relative clipping yield suppression of a creeping bentgrass fairway mowed at 0.400 inch.

We started the experiment on a creeping bentgrass golf fairway mowed at 0.4 inch. The 10 treatments included a nontreated control for normalization and a 3-by-3 factorial of Primo (trinexapac-ethyl), Trimmit (paclobutrazol) and Anuew (prohexadione-Ca) applied weekly at either the standard rate or two different fractions



of the standard rate depending on growing degree day accumulation.

We based the equation used to estimate PGR degradation on the half-life:

Replacement PGR rate (ounce/acre) = Full PGR rate – Full PGR rate × 0.5 [Laff-life in GDD]

The Primo, Trimmit and Anuew full rates were 7, 16 and 11 ounces per acre, respectively. The tight and long estimated half-lives for Primo, Trimmit and Anuew were 116/175 GDD, 160/240 GDD and 140/210 GDD. We collected clippings several times each week to determine if clipping LOOK TO THE MODELS // USGA

yield suppression was static or intensifying over time.

After four weeks, we stopped this experiment because clipping yield suppression intensified over the three applications for all treatments except for Primo with the 175 GDD half-life (Figure 1). Strong phytotoxicity (Figure 2) and greater than 80 percent clipping yield suppression for all other treatments relative to the nontreated control resulted. Future research will evaluate other degradation models (i.e., linear) and different proposed half-life coefficients. This research will help with variable rate sprayers and minimize PGR-induced collar decline.

We created a refined PGR-GDD model based on the clipping yield results from the PGR study above and a DMI fungicide/PGR combination trial collected from a creeping bentgrass putting green during fall 2019. This model accounts for individual PGR application performance and generates a predicted "cumulative clipping yield suppression" value from the combination of the various PGR and DMI applications. The model uses segmented nonlinear regression with a breakpoint at 23.1 percent clipping yield suppression. It has an R² value of 0.763.

We tested the performance of this new PGR Model on a 007 creeping bentgrass putting green during the summer of 2020. This research green was built to USGA recommendations for putting green construction and irrigated to prevent wilt.

Treatments included a factorial of four PGR treatments (nontreated, Primo at 5.5 ounces/A, Primo at 33 ounces/A, and Primo (5.5 ounces/A) + Trimmit (16 ounces/A) by two N fertilization rates (0.15 or 0.30 pound N per 1,000 feet²) and two different mowing heights (0.12 and 0.08 inch).

We applied the PGRs at 200 GDD for Primo alone or 280 GDD when Primo was mixed with Trimmit. Data were collected every two weeks from



The impact of different PGR reapplication models on the turfgrass quality of a creeping bentgrass fairway mowed at 0.4 inch.



The PGR program's influence on average clipping yield production from a creeping bentgrass putting green at 0.12-inch or 0.08-inch height of cut.

June through July. Measurements included green speed before and after clipping yield collection, turfgrass quality and color from a Holland Scientific Rapid Scan active sensor.

Turf maintained at the lower height of cut (HOC) and higher N rate had an increased clipping yield. When averaged across the entire season, the grass mowed at 0.08 inch grew 45 percent faster than grass cut at 0.12 inch. The accelerated growth rate increased nutrient removal and carbohydrate depletion during mowing. As a result, the higher N rate was required to **Continued on page 44**



creeping bentgrass putting green receiving 0.15 or 0.30 lb. N ft-² every two weeks.

Research Takeaways

- We tested a model to estimate the amount of PGR remaining in the plant when the PGRs were applied before their ideal reapplication interval. A half-life approach model was used to schedule the PGR application rate. The model tested resulted in an intensification of clipping yield suppression and increase phytotoxicity over time. The results indicate the models were too aggressive.
- A new PGR-GDD model accounts for the clipping yield suppression of multiple PGR and DMI fungicide applications. The model was developed from a combination of various datasets and had an R² value of 0.763.
- In 2020, the new PGR model was used to evaluate putting green performance when PGR ingredients were mixed. Mixing Primo with Trimmit increased green speed by 8.4 inches compared to the nontreated control. This mixture combined with higher levels of nitrogen fertilizer sustained high putting green stand density and acceptable color. We are replicating this experiment in 2021.



Continued from page 43

sustain acceptable turfgrass quality at the lower height of cut.

The Primo treatments (one-time or six-time label rates) had the best turfgrass quality at each HOC and N treatment. There was never phytotoxicity from the high rate of Primo applied alone. Total clipping yield suppression from that high rate of Primo was more significant than the one-time rate. Still, it was less than Primo and Trimmit used together at the maximum labeled rates for bentgrass putting greens (Figure 3).

Both the six-time rate of Primo and combination treatment with Trimmit prevented enhanced clipping yield from the high N rate at both HOCs (Figure 4). The one-time rate of Primo was unable to offset the clipping yield increase that resulted from the higher N application rate.

The PGR combination of Primo and Trimmit enhanced ball roll distance by 8.4 inches. The Primo treatments applied alone only enhanced ball roll distance by 3 to 4 inches — a distance that golfers would not perceive. Increasing the N rate from 0.15 to 0.30 lb. N per 1000 feet² did not influence ball roll distance, and the lower HOC only enhanced ball roll distance by 4.8 inches.

William C. Kreuser, Ph.D., is assistant professor, Extension turfgrass specialist, at the University of Nebraska. If you would like to learn more about PGR models or the GreenKeeper application, you can reach Dr. Kreuser at wkreuser2@unl.edu.



"USGA Deacon and similar decision tools or software are just the beginning of the big-data technology revolution for the game of golf."

MIKE KENNA, PH.D., Research Editor

From Lotus 1-2-3 on

o think how fast computer technology has progressed is staggering. Managing the resources on golf courses will benefit from each innovation. Technology already guides scheduling tasks for your crew, irrigation or product applications. USGA Deacon and other software like it are beginning a revolution to put it all together in one dashboard.

The name is a tribute to Deacon Palmer's 50-year stewardship of Latrobe Country Club. Latrobe is where Deacon taught his son, Arnold, to play the game on his way to becoming a beloved sports figure.

At the turn of the 20th century, golf course agronomy was more art than science. There is more science at the turn of the 21st century, but art is still there. We have data, sometimes too much, to help with the decisions made. How are we going to manage big data?

I remember attending the Texas Turfgrass Conference in December 1985. In a golf course session, Jim Moore, a new USGA agronomist, talked about using Lotus 1-2-3 to monitor green speed. This early spreadsheet program was popular in the 1980s. It contributed to the success of IBM PC-compatibles. I am not sure how many superintendents had a PC or used Lotus 1-2-3, but Moore made a strong case with the new technology.

Moore never lost his desire to use computers to help with golf course decisions. He tried for years to convince members or owners that it was time to conserve resources in out-of-play areas. There was a litany of names for these areas — low maintenance, wildlife habitat, environmentally sensitive or native areas, to name a few.

There were hurdles preventing decision-makers at the course from getting on board. How many acres? Do they impact the golfer? Will it save money? Good questions that were difficult to answer without more information.

Aerial images of an individual golf course were not available or expensive to get. The release of Google Earth in 2001 helped Moore address the amount of acreage. With Google Earth, Moore provided accurate estimates of greens, tees, fairways and rough, but how would low-maintenance native areas impact the pace of play?

In 2012, the USGA's effort to understand the pace of play revealed the answer. GPS data loggers given to golfers provided pace-of-play information and showed areas where golfers never enter. Moore now had the data to assign lower-maintenance areas using Google Earth. The superintendent could manage 10 to 30 acres with fewer resources. So, what are the potential savings?

Moore now had accurate measurements for all parts of the golf course facility: greens, tees, fairways, bunkers and rough. He designated four levels of rough from closest to the fairway (R1) to rough no one hits into (R4). From R1 to R4, there were decreasing amounts of resources used for maintenance. Getting back to Moore's prowess with spreadsheets, he created several "whatif scenarios" to compare changes in management or resource usage.

Moore also applied this technique to irrigation zones. For example, tee compounds often have a few large-radius irrigation heads. Golfers do not hit shots from tee surrounds comprising 90 percent of the irrigated area. We could save water by focusing on the tees with smaller radius irrigation heads.

Moore had a modest budget for a software company to develop the resource management tool. Then, the USGA's Research, Science and Innovation, led by Matt Pringle, Ph.D., got involved. Agronomists, engineers and programmers worked together on a helpful decision tool.

The USGA acquired GPS shape files used for yardage estimates on smartphones and other devices. Regional surveys to gauge labor, fuel and water costs provided a starting point for each course. By 2015, the components needed for the tool were in place, with several refinements along the way. USGA Deacon provides data-driven facility management decisions that help make the game more affordable and enjoyable.

USGA Deacon and similar decision tools or software are just the beginning of the big-data technology revolution for the game of golf. As the song goes, the best is yet to come! **G**

Mike Kenna, Ph.D., is the retired director of research, USGA Green Section. Contact him at mpkenna@gmail.com.

SuperScience // EXPERTS' INSIGHTS



Crabgrass germinates when mean soil temperatures are at about 55 degrees F.

Stop crabgrass in its tracks

FOR CRABGRASS CONTROL, THINK EARLY APPLICATIONS OF BOTH PRE- AND POSTEMERGENT HERBICIDES

Crabgrass is emerging earlier in the spring due to a warming climate. So, it's critical for golf course superintendents to make applications in the late winter or early spring, depending on location. Crabgrass germinates when the 24-hour mean soil temperature average is about 53-55 degrees F for a few days. Fred Yelverton, Ph.D., professor and Extension specialist in turfgrass weed science at North Carolina State University, says cool soil temperatures help extend the shelf life of early applications.

"Here's the beauty in applying it earlier," he says. "Preemergent herbicides are primarily degraded in the soil by the soil microbes. It's a pretty safe thing to say apply them earlier. There really isn't a penalty for applying them earlier because microbial activity gets really up and going when soil temperatures are up in the 60s."

Excessive water will also degrade some preemergent herbicides. If your area had a wet winter, you may need to

go back in with a second application. Yelverton says you still have time if your initial application was made before germination. You'll likely see crabgrass germination due to herbicide degradation in July and August.

"Make a repeat application of the preemergent herbicide if you experienced excessively wet soils," he says. "If your soils stayed saturated for extended periods after preemergent application, your yearly herbicide rate may need to be a bit higher than normal due to anaerobic degradation of the herbicide."

And, if you start to see crabgrass emerging, don't wait too long to use a postemergent herbicide. Treat the weed at the two- to three-leaf stage.

"There are several effective postemergent crabgrass herbicides available," he says. "You have to be careful and choose the right product and the right rate for your turfgrass."

FMC Professional Solutions

TINA BOND, PH.D.

Technical service manager

Large and smooth are the two prominent crabgrasses in the U.S. Both have a toothed, membranous ligule, seed heads with three to five spikes and branched stems that root at the



nodes. Large crabgrass has hairy leaves, and smooth crabgrass is smooth. Preemergent applications should be targeted before crabgrass begins to germinate. Germination occurs when soil temperatures reach 55 degrees F for four or more days. Postemergent applications are most effective on younger, pretiller crabgrass. Most labels will tell you how well the herbicide works on certain tiller stages of crabgrass. Rainfall or irrigation is necessary after a preemergent application to achieve the most effective control. Avoid going out with rates that are too low. Always use the recommended label rate for the best results. A healthy stand of turfgrass is always the best defense against weeds.

PBI-Gordon Corp.

ERIC REASOR, PH.D. Southeast research scientist

There are several species of crabgrasses that are problematic weeds in all golf



course situations, including greens and roughs. Most crabgrasses are summer annual grassy weeds that germinate in spring when soil temperatures warm to 55 degrees F for several days. Maintaining an actively growing turfgrass through proper cultural practices comprises most of crabgrass management. For example, mowing too low allows more light into the turfgrass canopy, facilitating more crabgrass germination. Preemergent herbicides are typically highly effective at controlling crabgrass. Make initial applications prior to germination and then a second application two months later for best results. Rotate herbicide modes of action to prevent resistance from developing. Some crabgrass breakthrough is inevitable, so there are also several postemergent options available.

Corteva Agriscience

JARED HOYLE. PH.D.

Turf and ornamental territory manager

Crabgrass loves growing in quality turf superintendents

are striving to create and protect. The best defense is maintaining healthy turfgrass, which often includes using herbicides. There are many options for pre- and postemergent herbicides, and application timing can vary by region. Effective control is achieved by using a preemergent in the spring when soil temperatures are consistently 50 to 55 degrees F. If crabgrass has emerged, impacting course aesthetics and playability, postemergent herbicide applications are recommended. Products containing dithiopyr can be a game-changer. Herbicides with dithiopyr provide preemergent and early postemergent control of crabgrass — up to the five-leaf stage. It also provides continued preemergent control for the entire season.

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Fire away

HOW TO KEEP FIRE ANTS AT BAY

By Sarah Webb

ire ants can be easily identified by the mounds they build — a useful piece of information to avoid getting too close to the female fire ants, which can sting.

"They typically like building their mounds in areas that are disturbed, such as where two different types of turf come together or along curbs and the edging of golf cart paths," says Janis Reed, Ph.D., board-certified entomologist and technical services manager for the pest control division at Control Solutions Inc. "Most people know they have encountered fire ants because they got stung by one."

For those who dare to take a closer look, fire ants typically sport a reddish/brown color. They have two nodes between the thorax and gaster, 10-segmented antennae and a two-segment club at the end of each antenna.

The pests mostly dwell in southern states and are most active after rain. During the winter, they reside deeper in the soil, but because they mostly thrive in warm-weather states, fire ants are active all year long.

The damage fire ants cause is twopronged, Reed says.

"There's an aesthetic damage up through the turf due to their mounding activities," she says. "There's also the damage to a worker or a golfer who may reach down to pick up a ball and instead get five or six fire ants on them and be stung."

To help keep fire ants under control, Reed recommends putting out fire ant baits both at the beginning and end of the season.



Unlike many other ant species, fire ants can be identified by the mounds they build.

"They are easy to apply and don't take any specialized equipment," she says. "The most effective time for bait applications is in the fall because you're attacking those fire ants when they're going into the lean winter months. If you can knock down numbers at that time of year, you can get the best control."

Reed says the main cultural practice to help control fire ants is to keep the turf healthy, but on golf courses, there is a lot of disturbance — golf cart paths, cup cutting, golfers inflicting divots into the grass — so it's important to address both play and nonplay areas.

"You can cover a large area without a lot of product," Reed says. "It pays to manage fire ants over time rather than just when they become a problem." **G**





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ne 5 // MUST-HAVE NEW PRODUCTS



Foley 653 Accu-Master 1

With automated in-feed grind cycles for both the spin and relief grind process, the FOLEY 653 Accu-Master only takes two minutes to spin grind when distinguishing technician time from grind time. It features Hands-Free Relief Grind, the automation of in-feeds and the patented Autoindex. Finally, the Automatic Placement feature allows the Accu-Reel Selector and Cylinder Height Stop system to automatically locate the reel for a fast and easy placement to spin and relief grind in one setup.

FoleyCo.com

2 Adidas SP0010 Eyewear

The ADIDAS SP0010 sunglasses are made with impact-resistant and ultralightweight TR90 injection molding with a 12-hole ventilation system, keeping the frames comfortable on the user's face all day long, free from sweat and resistant to fogging up. With the Kolor Up scratch-resistant lenses, users will have an easier time noticing the green's break due to the high contrast and colorenhancing filter.

Adidas.com

3 GolfBoard Pro

The electronically controlled **GOLFBOARD** Pro will never spin or lock its wheels, according to the company. It features four true turf tires and comes in at about one-fourth of the weight of a standard golf cart. Additionally, the product is designed so that compaction and wear patterns aren't an issue. GolfBoard.com

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5



4 PowerDrive Golf Car Solar Panel

To get the most value from a batterypowered golf car, superintendents need a portable means of charging and maintaining batteries. **POWERFILM SOLAR**'s PowerDrive Golf Car Solar Panel is a 150W solar panel that improves electric golf cars by maximizing battery lifetime, increasing overall driving distance, reducing charging costs and offsetting carbon emissions. PowerDrive Panels are designed, engineered and assembled in the United States.

PowerFilmSolar.com

5 Express Dual 5500 grinding machine

Bernhard's Express Dual 5500 is a fast and automated reel mower sharpener. It now features a laser reel surveying system for correction and precision conditioning and a direct cylinder drive with fast setup. New radio-frequency identification technology allows recall of previous setups, while the wireless handset increases ease of use and flexibility. The new 10.5-inch touchscreen features an intuitive and responsive interface, and the enclosed cabinet doors allow users to operate the grinder safely. Bernhard.co.uk

6 GreenSight platform

The **GREENSIGHT** Platform includes a suite of autonomous drone hardware and sensors for remote sensing and mapping, as well as software for data processing, visualization and assessment. Superintendents can capture multiple types of data in a single autonomous drone flight and make smart choices using the company's data analysis software tools. GreenSight has an FAA Section 333 exemption and multiple complex Part 107 waivers for commercial drone operations and beyond visual line of sight flying. The company has more than a dozen Part 107 licensed drone operators on staff to support a variety of flight operations. GreenSightTag.com

The 19th 10cc

Brandon Razo

SUPERINTENDENT // Cross Creek Golf Club, Decatur, Ind.



Tell me about Cross Creek.

What are you drinking?

An ice-cold Miller Lite.

Cross Creek is a 27-hole public facility. We have an 18-hole course and a ninehole course. The nine-hole is sort of an executive course. It's neat. If it's not busy, you can zoom around and be done in an hour.

Tell me about your family. My wife's name is Miranda, and we've been married for almost three years. I have three



teenage stepdaughters: Lauren, Lexi and Ayneira. I jumped right into that. I love every minute of it, all the time I get to spend with them when I'm not at work. My

middle daughter, Lexi, is a senior on the softball team, and I volunteer as a coach.

What's your favorite tool to get the

job done? Our Green Sweeper brush. There's just something that is satisfying when you're brushing the sand in after a topdressing or aerifying. It's relaxing to me.

What teams do you root for? The Chicago Cubs. Indiana University, it doesn't matter what sport. And I've been a Dallas Cowboys fan my whole life.

Who or what is your archenemy?

My irrigation system. Last year, we had to get the motor rebuilt. We had to get the turbine pump rebuilt because it was hit by lightning. That blew my motor up right in the hottest part of the summer. We got it fixed, but I'm still having issues. It's always something — once something gets fixed, something else happens somewhere else on the course. It's a real old system. From when I start it up to when I blow it out, it's a headache.

If I'm in Decatur, where are we

going to go eat? When my sales guys come in town and they want to go out for lunch, we always go to Soul Pig BBQ. It's

a spot in downtown Decatur that is great. They have pulled pork, brisket, good Southern sides, and they always have awesome specials with a crazy sandwich or a burger of the day.



When you're playing golf, do you keep score, or is it just for fun? Most of the time, just for fun. I live on the course, so in the evenings, I'll go out and play three or four holes. I do play in the men's league on Monday nights, and we have a bunch of association events throughout the year, and I play in all of those. When it counts, I'm keeping

As interviewed by Seth Jones, May 17, 2021.

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score, but the score is ugly.



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LATE.' THAT'S INSTILLED IN ME."





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