



Wisconsin TURFGRASS NEWS

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SPRING 2006

The New Soil Test Interpretations for Wisconsin Turfgrass

By Dr. Wayne Kussow and Steven Houlihan, Department of Soil Science, University of Wisconsin-Madison

The handwriting was on the wall by the year 2001. We were entering the era of regulation of fertilizer use on turfgrass based on soil tests. This has since become a reality for phosphorus use on home lawns in several communities in the state and for all of Dane County. On March 10, 2008, state-wide regulations will go into effect requiring that all turf areas of 5 or more acres under single ownership be fertilized according to soil tests in abeyance with the NR 151 Technical Standards currently being developed by a DNR-appointed committee. Note that the phrase "5 or more contiguous acres" has disappeared. This has interesting implications. For example, is a 5 or more acre housing development subject to these regulations until the homes are sold? Sod farms are exempt on the premise that they are agricultural enterprises.

The specter of regulation of fertilizer use based on soil tests was disconcerting to us. Soil test interpretations for turf used by state soil testing labs prior to 1994 were developed in the 1960's. They were based primarily on forage grass research. Turfgrass research at that time was still in its infancy. These were revised in 1994 using a very meager data base derived primarily from research conducted in other states. The changes were dramatic. For example, the optimum level of soil test P was reduced from 70 to 20 ppm for established

lawns. How valid was this dramatic change? We decided that it was vital to the state's turfgrass industry that our soil testing labs have interpretations whose validity and reliability had a solid scientific base and that this had to be done as quickly as possible.

Very few states, if any, have ever implemented a major research effort directed toward the development of comprehensive soil test interpretations for turfgrass. There are several reasons for this. The process is costly, time consuming, does not generate the refereed publications that junior researchers must write to get promoted, and is fraught with difficult decisions that have to be made. The first decision that has to be made is fundamental to the whole process. The starting point in soil test interpretation is determination of the relationship between soil test levels of nutrients and plant response. For field crops selection of an appropriate plant response is obvious. It's going to be yield in bushels per acre or whatever is appropriate for a particular crop. With turf, our goal is not that of maximizing clipping production, but maintaining acceptable quality. But there is a problem in using turf quality. Turf quality is a subjective rather than a quantitative property that is influenced by many factors other than nutrition. After giving the matter considerable thought, we decided that our plant parameter would be shoot nutrient concen-

tration. In other words, our task was to determine, for example, how turfgrass clipping P concentrations vary with increasing levels of soil test P. This decision was the driving force behind our collection of paired samples of turfgrass clippings and soil from the area where the clippings were collected. This had to be done for all major types of turf in the state and over a broad area.

Thanks to a grant from the Wisconsin Fertilizer Research Council, to having access to the WTA - funded W.R. Kussow Distinguished Graduate Fellowship, to a collaborative relationship with industry, and to the cooperation of many of you, over the period of 2003 to 2005 we were able to assemble a collection of 614 paired clipping and soil samples. The single largest set of samples, some 417, was collected from golf courses because this was where there were no pre-existing data. The remaining 197 pairs of samples came primarily from lawns, institutional grounds and athletic fields. The clippings were analyzed for all the essential nutrients of importance to the study. The soil samples were analyzed for pH, P, K, Ca, Mg, B, Fe, Mn, Cu, and Zn using several different methods because at that point we didn't know which methods would yield the most reliable results. Through this effort we generated a data base with nearly 25,000 entries.

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The Wisconsin Turfgrass News

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O.J. Noer Turfgrass
Research and
Educational Facility.

What's Eating Your Roots?

By Paul Koch, Turfgrass Diagnostic Lab/ Department of Plant Pathology, University of Wisconsin-Madison

With spring approaching and grass beginning to green up around the state, it is an exciting time for turfgrass managers. But while the grass on the surface can appear green and healthy, ectotrophic root infecting (ETRI) fungi could be setting your turf up for failure this summer. Many different diseases of cool season turfgrasses are caused by these ETRI fungi. Take-all patch (*Gaeumannomyces graminis* var. *avenae*), necrotic ring spot (*Ophiosphaerella korrae*), and summer patch (*Magnaporthe poae*) are the most common root pathogens of cool-season turfgrasses. All three of these fungi produce similar structures on the roots of turf (see Figure 1), but each one of them also is distinctive in its host, macroscopic symptoms, and/or active temperature.

Take-all patch is a common disease of newly planted creeping bentgrass stands that are associated with golf course construction or renovation. This is most likely due to the lack of competing organisms in the root zone, which can allow the take-all fungus free rein to inflict its damage. Symptoms can also be seen on older golf course stands, but damage is usually less severe and associated with other stresses such as root compaction and high soil pH levels (>7).

Symptoms include sunken, bronze colored patches a few inches to a few feet in diameter. Resistant grasses, such as annual bluegrass, may be seen repopulating the center of the patch. *G. graminis* var. *avenae* is most active in soils that are moist and have temperatures that range between 55 and 65°F. When soil temperatures fall out of this range, the fungus becomes dormant and does not inflict any further damage on the turfgrass plant. This means that in the heat of summer, when symptoms of take-all patch become most prevalent, the take-all fungus has most likely been dormant for several weeks and fungicide applications **will not affect the fungus**. For this reason, any chemical controls should be applied preventatively in either the spring or fall (or both) when soil temperatures have fallen into the optimum range for the fungus. Azoxystrobin and pyraclostrobin are effective chemical controls when watered in to the root zone with approximately 0.25 inches of water. Non-chemical controls include manganese applications (2 lb/A/year), decreasing soil pH, and improving overall root health with increased drainage and core aeration.

Necrotic ring spot mirrors take-all patch in many ways, except that it attacks the bluegrasses and fescues instead of the bentgrasses. It is the most common disease of home lawns we see at the Turfgrass Diagnostic Lab, and is especially troublesome on newly sodded lawns. Symptoms include circular or arc-like patches of yellow or tan grass that can vary greatly in size. Grass often fills in the center of these patches, giving the patch a "frog-eye" appearance



Fig. 1: Root infecting hyphae of take-all

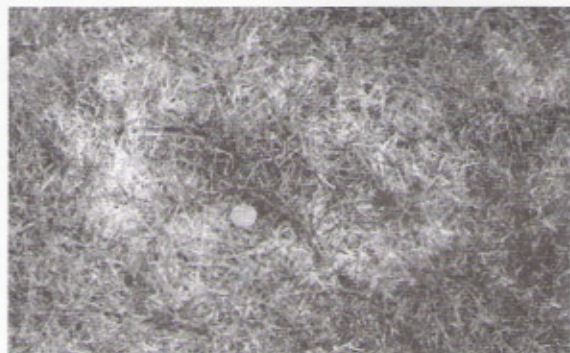


Fig. 2: Frog-eye appearance of NRS

(see Figure 2). Like take-all, necrotic ring spot infects the turfgrass roots in the spring when soil temperatures are between 55 and 65°F, but does not usually show symptoms until the heat and drought of summer expose the plant's reduced root system.

We rarely recommend chemical control to homeowners for this disease (or any other disease), and the best control option for homeowners dealing with necrotic ring spot is to maximize turfgrass root health in the first 6-10 years after sodding while the fungus gradually works its way through the lawn and competing organisms build up populations in the soil. You can maximize root health through proper fertilization (not before Memorial Day), proper irrigation (deep and infrequent), core aeration if excessive thatch is present (>1"), and also by planting cultivars of Kentucky bluegrass that are naturally more resistant to necrotic ring spot than others. Dr. Geunhwa Jung has done several years of research on cultivar resistance to necrotic ring spot, and a list of resistant and susceptible cultivars can be obtained from the TDL.

Summer patch is similar to necrotic ring spot in that it attacks primarily Kentucky bluegrass and annual bluegrass, but it is different from both necrotic ring spot and take-all patch in that it attacks turfgrass roots only in times of high temperature stress. Optimum conditions for summer patch are sustained temperatures above 85°F with periods of heavy rainfall. Symptoms of summer patch include circular or

arc-like patches of yellow or tan grass, much like necrotic ring spot, but these symptoms would only appear after the onset of hot and humid weather (see figure 3). Once this disease has infected the host tissue, it is extremely difficult to control for the rest of the summer season. For this reason, preventative fungicide applications are recommended if you have a high annual bluegrass population in your putting greens or a high-value area of Kentucky bluegrass. Effective chemical controls include azoxystrobin, pyraclostrobin, and propiconazole watered into the root zone when soil temperatures reach 65°F. Non-chemical controls are simply to promote good root health through proper irrigation, proper fertilization, and core aeration.

Being root diseases, it is difficult to assess the damage that these fungi can cause. But that is not to say that every decline of turfgrass in the summer can be blamed on one of these ETRI fungi. A host of other issues could be affecting turfgrass health, and the summer of 2005 was a prime example. Root compaction, excessive thatch, nematodes, juvenile plants as a result of winterkill, and plain old heat stress can all cause turfgrass to decline in the summer. But doing everything in your power as a turfgrass manager to reduce root stress and improve the growing environment of the turfgrass root system will increase the turf's ability to fend off ETRI fungi.

The plant pathology arm of the UW-Madison turfgrass program, under the guidance of Dr. Jung, will

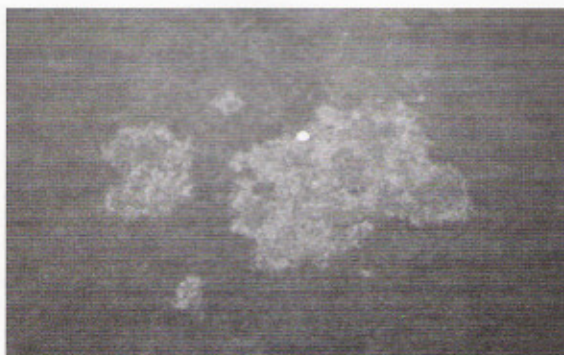


Fig. 3: Summer Patch in a bent/Poa putting green

be conducting two take-all patch studies this year, as well as one each of necrotic ring spot and summer patch. Do not hesitate to contact me (608-845-2535) or Dr. Jung if you have any questions regarding the outcomes of these studies. And of course, please contact the TDL or submit a sample if you start to see any of the symptoms discussed above. It would be a costly error to apply a couple tanks of Heritage to combat a simple root compaction problem!

References

- Abler, S. W., and Jung, G. 2005. Turf Diseases of the Great Lakes Region: Identification and control guide for golf courses, parks, and lawns. p 12, 18.
Smiley, R. W., Dernoeden, P. H., Clarke, B. B. 2005. Compendium of Turfgrass Diseases. Third Edition. p 88-105

President's Message WTA and the Future

By Rich Riggs, WTA President

As the weather slowly warms, our thoughts move towards getting out in the field again. Spring always brings thoughts of a new beginning. We have completed all of our off-season planning and can't wait to get out and begin the work.

It's also a new season for the WTA. In mid-March we held a two day strategic planning meeting to make decisions on the future of your organization. I would like to thank everyone who helped with the meeting for their time and effort in making this a success, especially Terry Kurth, a past president of WTA, who took the lead in organizing the meeting.

We set many goals for moving the organization forward. Next year will mark the 25th anniversary of the WTA. As we reviewed the hugely successful past there is much to be proud of, but we can not rest on our past. We need to review and understand our past and then make important plans to move forward.

One of our goals is to increase the membership. Currently we have 245 members and we would like to increase that by 10% annually for each of the

next 5 years. I think we can achieve that and more when you consider all the golf courses, athletic fields, municipal parks, sod farms, lawn care establishments, and landscaping companies in Wisconsin. I am challenging every member to recruit a new member.

Also, now is the time we are planning for Summer Field Day and the 2007 Turfgrass and Greenscape EXPO. If you have any ideas on topics or speakers that would have useful information for your industry, please talk to Audra at 608-845-6536, or a board member. Remember, this is your organization and your conferences. Get involved and become active. It will be a much better organization with everyone working to make Wisconsin's Green Industry the best in the nation.

If you have ideas, questions or concerns please talk with a board member. We can all strengthen our mission of improving turfgrass research and education in Wisconsin. Have a great spring and I look forward to seeing you throughout the season.



Noer Facility to Host International Turf Field Day

By Tom Schwab, O.J. Noer Turfgrass Research and Education Facility, University of Wisconsin-Madison

The O.J. Noer Turfgrass Research and Education Facility is in for an exciting event during the summer of 2007. The Turf Producers International (TPI) Summer Convention will convene in Madison on July 23 - 26, 2007, including a field day at O.J. Noer. The field day segment of the convention will be held in conjunction with the WTA and the Midwest Sod Council field days resulting in a potential 1,000 or more attendees from all around the globe visiting our turf research facility.

Two years ago, George Brandt of American Sod Corporation proposed hosting this international and combined field day at O.J. Noer. George is a lifetime member of WTA and will be the president of the TPI organization in 2007. When George brought the idea to our UW turfgroup, we agreed this would be a wonderful opportunity to bring together many organizations with the common interest of growing the best turfgrass.

TPI has members in over 40 countries, and they are very much like other turf organizations in the green industry. Their mission statement declares dedication to represent and advance the turfgrass sod industry worldwide through the promotion of improved practices and the professional development of members and the enhancement of the environment.

The third host of this combined field day is the Midwest Sod Council (MSC). Sod producers from seven Midwest states are served by MSC, and they traditionally hold a field day every other year, alternating between Illinois and Wisconsin. Rusty Stachlewitz is their executive director and he is very involved in organizing this combined field day. He coordinated many of the supplies of seed, fertilizer, chemicals, rock pickers, seeders, mowers, tractors, and irri-

gation equipment that we need to prepare for the event.

Preparations started last summer with establishing twenty new acres of turfgrass from three agricultural fields adjacent to the Noer Facility. The twenty acres consist of a twelve acre field to accommodate sod harvesting and mowing demonstrations and two other fields for parking.

The hot and dry weather last summer was good for cultivating the agricultural acreage into sod fields. We were worried when the dry conditions continued into the fall after we seeded in mid September. Roberts Irrigation donated a Kifco water wheel to germinate the seed, but with our limited pump capacity, we barely got the turf established before winter. Much of the turf looked pretty spindly going into winter but it was protected under the December snow cover. Then it kept growing when the ground thawed during our record warm January, and the turf actually appeared mature by early February. It looked especially good in mid February, with nine inches of snow cover over it. March brought several large

rainstorms to store up good soil moisture reserves for this spring.

We still have a long way to go to prepare for this large event. The new fields are rough and need to be rolled, turf health and weeds need to be managed, the facility needs infrastructure changes for bus/truck parking and turn-around, and aesthetics need to be enhanced.

I attended the 2005 TPI Field Day in Salt Lake City last summer and the host site, Biograss Sod Farm, provided a very high standard for us to meet. The Noer Facility is poised to match those standards with all the support we have received thus far from Rusty, George, and many generous industry representatives.

We are honored to host this international and combined event at the UW. The field day will bring together turf experts from around the world and many ideas will be shared that cross all turf professions. The trade show segment will have every product and service that turf managers could ever want. And you don't even have to travel to attend. This international event will be held in our own backyard.



November 2005 aerial view of the international field day site to the left with Noer Facility pictured on the right.

How the turf looks in late March 2006 after being seeded in mid September 2005.



Wisconsin Influence Spreading to Texas

By Tom Schwab, O.J. Noer Turfgrass Research and Education Facility, University of Wisconsin-Madison

Many of you have listened to the personable and dynamic Kurt Steinke at WTA Summer Field Day. He has presented his research on phosphorus runoff, growing turf in the shade, increasing sod shelf life, and other pertinent issues to today's turf industry. Kurt won't be presenting to Wisconsin's turf industry anymore, except when he is invited back as a visiting turf professor.

This past January, Kurt finished his PhD work in the Department of Horticulture at the UW-Madison under Dr. John Stier. He will be taking what he learned at the UW to his new position of assistant professor at Texas A&M University in College Station, Texas. There he will embark on his new career in teaching and research of turfgrass ecology in their Department of Soil and Crop Sciences.

This new appointment is an important milestone of recent years. Kurt is the only student since the old guard of Bob Newman, Jim Love, Chuck Koval, Gayle Worf, and Wayne Kussow who received degrees from the UW-Madison and went on to become professors in turf education.

Kurt's research in Madison included runoff investigations of turf vs. native prairie systems, various projects to study shade, herbicide, and cold stresses to supina bluegrass, and use of different PGRs to increase shelf life of sod for transport.

He started his college life receiving a Bachelors Degree in soil science from UW-Stevens Point in 1999. In the summers he worked at both Hancock and Arlington Agricultural Research Stations doing studies with potatoes and other vegetable crops. From there he moved on to UW-Madison where he received a Master's Degree working with turfgrass in the Department of Horticulture under Dr. Stier's guidance. After graduation, he worked a year for Naturescape in Milwaukee before returning to Madison to receive his PhD of Horticulture in turfgrass studies.

Texas A&M will be quite the opportunity for a young professor. Presently A&M has between 100 and 110 undergraduate students in their turf program. And the turf industry is huge, as is everything else in Texas. As a comparison, the turf industry in Wisconsin is estimated to have a one billion dollar impact on the state's econ-



Dr. John Stier is proud of new professor Kurt Steinke who will be teaching turf in Texas.

omy. In Texas that number is eight billion dollars.

Kurt's appointment is 70% research and 30% teaching. Although he doesn't have any appointment to do extension work, I'm sure he will spend some time traveling around Texas, giving presentations to serve that huge turf industry.

That isn't the only big news in Kurt's life. He just became engaged to Beth, his girlfriend of three years and they already bought a new home in College Station. Things are looking bright for this ambitious new professor and we wish him the best. He answered many important turf questions during his time in Madison and will take this information south with him where he will continue to discover better ways to grow healthy turfgrass. 🍀

Mark your Calendars for a Fun and Educational Day

WTA Summer Field Day

O.J. Noer Turfgrass Research Facility

Tuesday August 1, 2006

608-845-6536

CALENDAR OF EVENTS

2006

April 24	WGCSA Monthly Meeting	Geneva National, Lake Geneva
May 16	NGLGCSA Monthly Meeting	Waupaca CC, Waupaca
May 31	WGCSA Monthly Meeting (Super/Pro)	Hawks View GC, Lake Geneva
June TBA	NGLGCSA Monthly Meeting	Portage Lakes GC, Houghton, MI
June 15	WSTMA Quarterly Meeting	UW-LaCrosse
June 19	WGCSA Monthly Meeting	Mee-Kwon Park GC, Mequon
July 18	WGCSA Monthly Meeting (People vs. Pro)	Lake Arrowhead GC, Nekoosa
July 18-21	TPI Summer Convention and Field Days	Memphis, Tennessee
Aug 1	Wisconsin Turfgrass Summer Field Day	O.J. Noer Facility, Verona
Aug TBA	NGLGCSA Monthly Meeting	Lakewoods Forest Ridges GC, Lake Nebagamon
Aug 15	WGCSA Monthly Meeting (Tournament)	Royal St. Patrick's GL, Wrightstown
Sept TBA	NGLGCSA Monthly Meeting (Crew Outing)	Eagle River GC, Eagle River
Sept 11	WGCSA Monthly Meeting (Supt/ Guest)	Ozaukee CC, Mequon
Sept 25	Wee One Foundation Fundraiser	Pine Hills CC, Sheboygan
Oct 6,7	WGCSA Dinner Dance	TBA
Oct TBA	WTA Golf Fundraiser	TBA
Nov 1-4	PLANET Green Industry Conference	Columbus, OH
Nov 28,29	Wisconsin Golf Turf Symposium	American Club

2007

Jan 9,10	WI Turfgrass and Greenscape EXPO 07	Marriott Madison West
Jan 17-19	Mid-Am Trade Show	Chicago, IL
Jan 17-21	STMA Annual Convention and Exhibition	San Antonio, TX
Feb 4-10	TPI Midwinter Conference	Gold Coast, Australia
Feb 19-24	GCSAA Conference & Golf Industry Show	Anaheim, CA

WTA Members — If you have an important date you'd like to share with other members, call 608-845-6895, fax 608-845-8162, or email tgschwab@wisc.edu to include it in the next calendar.

Contact Telephone Numbers

GCSAA/ GIS	GCSAA Conference & Golf Industry Show	800-472-7878
Mid-Am	Mid-America Horticultural Trade Show	www.midam.org
NGLGCSA	Northern Great Lakes Golf Course Superintendents Assoc.	630-443-1008
PLANET	Professional Landcare Network	800-395-2522
STMA	Sports Turf Managers Association	800-323-3875
Symposium	WI Golf Turf Symposium	414-786-4303
TPI	Turf Producers International Field Day	800-405-8873
Wee One	Wee One Foundation Fundraiser	920-458-6048
WGCSA	Wisconsin Golf Course Superintendents Association	414-786-4303
WGIF	Wisconsin Green Industry Federation Convention	414-529-4705
WSTMA	Wisconsin Sports Turf Manager Association	608-845-6895
WTA	Wisconsin Turfgrass Association	608-845-6536

Another Athletic Field Tool (DID I MENTION, IT'S FREE!)

By Tom Schwab, O.J. Noer Turfgrass Research and Education Facility, University of Wisconsin-Madison

There is one more tool now available to Wisconsin's sports field managers. The tool is information. The WSTMA and University of Wisconsin-Madison created an "electronic discussion group" for local field managers, University turfgrass researchers, and athletic field sales representatives to share information among themselves. The service is called Noersportsnet and it's free, thanks to the UW-Madison.

There is a similar electronic discussion group called Noernet, created by the Wisconsin Turfgrass Association and the UW-Madison, that has been successful for almost ten years. Noernet has members from the sod, golf, lawn care, landscaping, and sports field industries, but this new discussion group is exclusively for the sports field industry.

The way it works is any Noersportsnet subscriber may write a question, concern, or comment to the Noersportsnet email address. Everyone who is a subscriber will receive that message in the form of an email. They will then have the choice to just read the email or to send a reply back to Noersportsnet. All subscribers will see that reply and may email additional information to the group that everyone will again see.

Discussions over Noersportsnet will include field renovation and establishment tips, turfgrass species and cultivar selection, innovative solutions to wear problems, reporting pest outbreaks, selecting sports field management tools, reporting turfgrass educational meetings, field construction recommendations, sale of used equipment, and other topics.

Noersportsnet is meant for local use and concerns. There are many national discussion groups but Noersportsnet will be kept private, for local sports turf professionals in Wisconsin and neighboring states. We are better able to voice concerns unique to our upper Midwest region by keeping it local. Likewise, there is plenty of local expertise right here to answer questions posed by other subscribers.

If you believe sharing of information is an important tool for sports field management, then Noersportsnet is one more tool available to you. Let other peers know about this service if you feel they could benefit from it. Some subscribers will be extremely active and respond to every message. Other people will never write. They will only use Noersportsnet to monitor what is happening around the region. Most subscribers will keep track of messages and respond occasionally. You can participate as much or as little as you like.

You must first sign up if you want to participate in

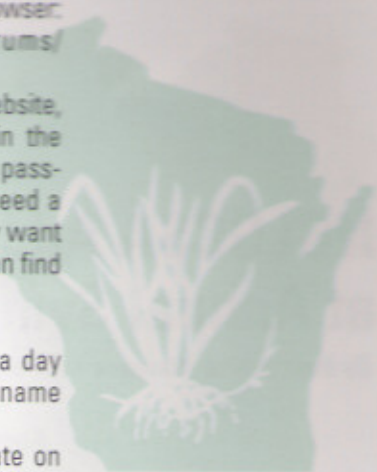
this discussion group. Below are the instructions for subscribing. This is a web-based discussion group but you may participate either in the web format or, more simply, through the way you normally send and receive emails. There are a few more features by participating in the web format, like archiving, postponing, and optional ways to receive your Noersportsnet emails. You will be sent a welcome message after you join that describes the added features along with how to normally send and receive messages. You may write or call me if you have any questions or problems with Noersportsnet at tgschwab@wisc.edu or 608-845-6895.

Follow these steps to subscribe to Noersportsnet:

1. Log onto this Noersportsnet website in Netscape, Internet Explorer, or similar browser:
https://lists.wisc.edu/read/all_forums/subscribe?name=noersportsnet
2. Once you get to the Noersportsnet website, enter your email address, and name in the blanks provided. You may also enter a password but that is optional. (You do not need a password, so enter one only if you really want one. If you forget your password, you can find it again through the website.)
3. Next hit the subscribe button.
4. Since this is a private list, it may take a day before the administrator posts your name after you subscribe — so be patient.

There are two different ways to participate on Noersportsnet after you are subscribed

1. The easiest way to participate is to write and receive your Noersportsnet emails just like you normally send and receive emails. When you want to post a message to the Noersportsnet group, you send an email to Noersportsnet@lists.wisc.edu. The discussion group computer will distribute your message to all other subscribers. You will receive messages from the group the way you normally receive emails. Emails will come to the computer which you used to subscribe to Noersportsnet.
2. The second way to participate on Noersportsnet is more complicated. You may go to the Noersportsnet website and write and receive your email message from there. You will have more options to change settings and do other features from the website. The Noersportsnet website is: <https://lists.wisc.edu/read/?forum=noersportsnet>
 - a. Once you get to the website, enter your email address and password (if you



have a password, but I recommended not having one unless you really want to), then click the OK button.

- b. Next, click the "create new message" button. Write your email to Noersportsnet, and be sure to write something on the subject line, and then hit send when you've finished your message.

There are some extra features to customize your subscription that are only available from the Noersportsnet website mentioned in the previous paragraph. I'll describe some features here:

1. You may quit your subscription from the website. If you change your email address, then please quit your old email address before you sign up a new address. Noersportsnet will become cluttered if you don't quit your old email addresses.
2. If you are on vacation or otherwise out of the office, you may want to postpone your subscription for that period. You may postpone receiving mail from the main website after you log onto it by choosing the following from the Status button — NoMail: Receive No Mail From This Mailing List.
3. When you return to the office, reset the Status button to — Mail: Receive Messages As They Are Contributed.

4. Noersportsnet has an archived messages section. You may view 180 days of past entries but since this is brand new there will be no old messages for awhile. You may retrieve old messages by clicking the View Messages button on the main website page.

The University of Wisconsin-Madison sponsors this discussion group. They have set an appropriate use policy for electronic discussion groups:

1. You may not use Noersportsnet for uses that are forbidden by the University of Wisconsin campus telephone or paper mail system.
2. Noersportsnet is not intended to be used for personal purposes or gain.
3. Do not send abusive, vulgar, harassing or bigoted messages.
4. It is the policy of the University of Wisconsin-Madison Board of Regents that Noersportsnet be used primarily for purposes of fulfilling the University's mission of teaching, research and public service.
5. Content of all postings are that of the contributing author and not necessarily of the Noersportsnet list owner, moderator, or of the University of Wisconsin-Madison Division of Information Technology. 🍌

NGLGCSA Addresses Winter Turf Loss and Recovery at Annual Symposium

By Brett Grams, Waupaca Sand and Solutions

Approximately 90 attendees gathered for the Northern Great Lakes Golf Course Superintendents Associations 17th Annual Turf Symposium in Wausau on March 1, 2006. Winter Turf Injury and Turf Loss was the theme of this year's symposium and certainly was a timely topic of concern for this time of year. The lineup of quality speakers was fantastic and ended with

the popular panel discussion of real life experiences of the local superintendents.

Current NGLGCSA President Jay Pritzl of Timber Ridge GC in Minocqua welcomed the attendees and started the presentations. Mr. Bryce Gartner of the GCSAA headquarters staff was the first speaker. He is the Managing Director of Marketing and Web Site Publications for the

national association. Mr. Gartner's presentation was on the future of the Golf Course Superintendent. His message was interactive with many questions and comments about the GCSAA mission, current focus, and future ideas. Several attendees voiced their concerns and offered suggestions that Mr. Gartner promised to take back to the GCSAA headquarters in Kansas.



NGL BOD- L to R, Joe Deschler, Steve Spears, Linc Lautenbach, Randy Swonger, Ed Hoover, Glen Rochester, Charles Gentz, and Jay Pritzl.



Current NGLGCSA President Jay Pritzl of Timber Ridge CC in Minocqua, WI.

The always popular and entertaining Dr. David Minner of Iowa State University talked about his research on winter injury to creeping bentgrass and annual bluegrass putting greens. His research centered on low temperature injury, ice accumulation, snow cover, and the effects of using various covers.

After lunch our own Dr. John Stier spoke about the winterkill of turfgrasses. His presentation described the various kinds of injuries and how they can weaken and kill turf in the winter and early spring. He also described the differences of various turf types and their ability to survive tough winters.

Mr. Bob Vavrek, our regional USGA Agronomist, gave an enlightening presentation of winterkill injury and prevention. His travels have allowed him to see many different strategies and practices that superinten-

dents are utilizing to keep turf alive during the varied winters of our region.

Mr. Vavrek also moderated the panel discussion which included three superintendents: Mr. Ed Hoover, of The Woods Golf Course in Green Bay, Mr. Kurt Stromquist, of the Oak Crest Golf Club in Norway, Michigan, and Mr. Mike Jaeger, of the Minocqua County Club. All have different types of courses and experienced varying types and forms of damage in spring 2005. The panel was informative and enlightening to all.

The day ended with the silent auction results and door prize give away. All proceeds from the day are used for turf research in our region. 🌱



Dr. Stier from the UW-Madison



GCSAA's Bryce Gartner



Dr. David Minner from Iowa State University



Mr. Bob Vavrek from the USGA Green Section



Panel, L to R, Ed Hoover, Kurt Stromquist, Mike Jaeger, and Bob Vavrek

MEET THE UW-MADISON TURF PROGRAM GRADUATE STUDENT

Rain Gardens & Shaded Putting Greens

By Jacob Schneider, University of Wisconsin-Madison, Department of Horticulture

For my first day of work at North Shore Golf Club, Scott Schaller had me hauling rolls of Kentucky bluegrass sod to him for twelve hours. Needless to say, it was a lot of work for a five-foot-nothing fifteen year old, but it was then that I began to develop my passion for working in turf management on golf courses. After thoroughly enjoying my three years of work at North Shore, it only seemed natural to pursue an education in turfgrass management at the collegiate level. This past May, I completed my Bachelor's degree under the guidance of Wisconsin's very own "Turf Doc", Dr. Wayne Kussow. Besides gaining invaluable academic knowledge as an undergraduate, I worked for two more years at North Shore and completed an internship with Monroe Miller at Blackhawk Country Club, where I continue to work when time allows.

With the retirement of Dr. Kussow, I approached Dr. John Stier in the Horticulture Department about continuing on to graduate studies at the UW-Madison. After being graciously

offered a position by Dr. Stier and funding through the newly developed Terry and Kathleen Kurth Fellowship, I began the construction of my graduate research projects at the O.J. Noer Turfgrass Research Facility this past summer.

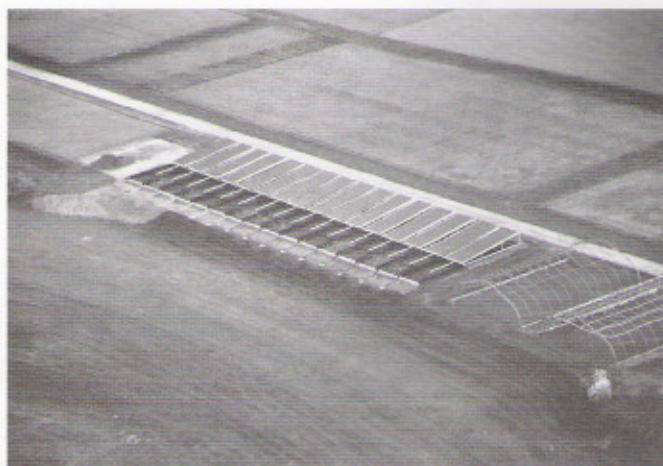
My main project will be an investigation into the use of rain gardens to mitigate urban runoff and its associated contaminants from entering surface and ground water. Rain gardens are bermed areas that trap water coming from rooftop downspouts and allow this water to filter through the soil, rather than immediately going to another impervious surface. The objectives of this project are to determine the controlling factor(s) behind rain garden effectiveness. Rain gardens have been constructed both with and without berms and with either turfgrass or "native" plantings. With water quality issues becoming more and more prevalent in urban settings, the need for such a study has never been greater, and its results have the potential to substantially affect the quantity and quality of urban runoff.

With my background and future in turf management on golf courses, I have a vested interest in conducting research that will provide solid answers to agronomic issues that superintendents face on a daily basis. Accordingly, my second research project will be looking at the maintenance of shaded putting greens. The objective of this study will be to determine the best grass cultivar for shaded greens based on two cultivars each of velvet and creeping bentgrass. This study will also attempt to determine the most appropriate level of nitrogen fertilization on the aforementioned turfgrass cultivars. It is my hope that this project will provide superintendents with more answers to one of their worst enemies-shade.

From urban water-quality issues to agronomic difficulties on golf courses, there is no doubt that there are plenty of issues to be answered in the world of turfgrass research. I look forward to the challenge of attempting to answer some of these questions through my graduate research at UW-Madison. 🌱



Jacob Schneider pictured in front of his rain garden Masters Degree investigation.



Aerial view of Jake's 16 simulated roof tops to be used in the rain garden study.

EXPO 2006 "A Crowd Pleaser"

By Tom Schwab, O.J. Noer Turfgrass Research and Education Facility, University of Wisconsin-Madison

Midwest turf managers got a treat on January 10th and 11th, when they attended the revamped Wisconsin Turfgrass and Greenscape EXPO. Attendance numbered 268 individuals from all walks of turf management. Local speakers provided the majority of education, along with several experts from Minnesota, Illinois, and Rhode Island who all gave enlightening presentations. The weather was even a treat as attendees enjoyed some rare blue skies and temperatures in the 40s.

The EXPO committee can't take the credit for the good weather but they can be credited for finding excellent education. They decided to incorporate more local speakers into this year's show because of all the lessons learned in Wisconsin from last year's brutal year of ice damage in the spring and drought conditions during the summer. Jerry Kershasky from Westmoor Country Club described the round-table portion of the golf section best. He said it was similar to the Wisconsin Golf Turf Symposium where one subject is chosen and intensely discussed to find all the answers. The panel of local experts in the round-table included Mike Handrich from

Racine CC, Rod Johnson from Sheboygan Pine Hills, Gary Tanko of Sentry World, and Pat Sisk of Milwaukee CC.

Local expertise was also evident by the roster of UW-Madison turf professors who talked about everything from mowing heights, to changing the makeup of rootzones, and controlling prominent insect and disease problems. Additionally, UW professors talked about tree health, remote sensing tools, and the new NR151 technical standard that will soon affect everyone who manages more than 5 acres of turf.

Sports field managers benefited from the local expertise of Raechal Volkening from the Milwaukee Brewers organization, Chris Brindley from UW-Stevens Point, Dan Wyatt from UW-Madison, Alan Johnson from the Packers, and several state high school field managers. They talked about managing fields with budgets that are shrinking, maintaining the new increasingly popular infill artificial turf surfaces, and developing creative internship and volunteer programs.

Lawn and landscape professionals learned about immigration laws, invasive species, woody ornamental and perennial

flower care, and much more. EXPO had something for everyone that works with turf including taking care of the other plants we are responsible for.

Turf equipment technicians greatly benefited from EXPO '06, with the very popular Turf Equipment Technician's Workshop. Nearly 30 mechanics attended to learn everything about reel mowers including maintenance, rebuilding, grinding, setup, and problem diagnosis.

Last but not least was the trade show, which was reworked this year to add more punch. It took place over fewer hours than in past years, but those hours were more productive for both the exhibitors and attendees. The trade show was only held on the first day and it was strictly trade-show-only hours for the entire time it was open. This allowed exhibitors undistracted time to display and talk about their wares without conflicts from educational presentations. A listing of the 37 EXPO exhibitors is included here as a reference. They help to bring you the great education of EXPO, so please return the favor by giving them a chance for your 2006 business.

The exhibitors likewise helped sponsor the exciting



A flurry of activity and important discussions took place during the trade show period.



Many customers found the answers they needed in the Reinders booth.



Doug DeVries is handed the \$1,000 travel voucher by Bruce Schweiger in the vendor sponsored EXPO raffle.



Field managers Alan Johnson from the Green Bay Packers and Dan Wyatt from UW-Madison gave important information on managing the new infill system athletic fields to the sports field audience.

raffle that was part of EXPO. Just ask Doug DeVries from Reid Municipal Golf Course how exciting it was. Doug won the Grand Prize \$1,000 travel voucher. Other prizes included a pair of Badger men's basketball tickets donated by John Powless, a Home Depot Gift Card from UAP, four Chicago Blackhawks hockey tickets from Cleary Chemical, an Al Harris autographed Packers' jersey from Reinders, and a pair of Packers' tickets for next season donated by the Packers.

Many other awards were presented during EXPO. The luncheon banquet afforded time for the WTA to accept several donations to the Wisconsin Distinguished Graduate Fellowship. The Fellowship is a program that guarantees funds to conduct important Wisconsin turf research into the future. Many UW-Madison turf students likewise received awards that were important to their more immediate future of paying for books and tuition. The list of 2006

scholarship recipients and donors is listed below. The turf industry is stronger for the contributions from all these individuals.

The industry is likewise stronger because of all the great education of EXPO. Thanks go to all the presenters, trade show participants, and attendees that continue to make EXPO one of the best turf meetings available. Everyone involved was especially pleased with this year's show.

2006 Wisconsin Turfgrass and Greenscape EXPO Research and Scholarship Recipients

Scholarship Donor

WGCSA/James R. Love Scholarship
Chalet Nursery Scholarship
J.W. Turf John Buck Scholarship
Bayer Environmental Scholarship
Spring Valley Turf Products Scholarship
WTA Scholarship
WTA Scholarship
WTA Scholarship
WTA Scholarship
David Mergatroyd Memorial Scholarship

Recipient

Dan Lloyd
Dan Lloyd
William Kreuser
Adam Moeller
Shannon Barstow
Steve Sartorius
Brad DeBels
Michael Boettcher
Patrick Bastron
Paul Nelson

Amount

\$1,500
\$500
\$1,000
\$1,000
\$600
\$600
\$600
\$600
\$600
\$500

Turf Research Donor

DHD Tree Products
Horst/ Aquatrols
WI Turf
Reinders/ Daconil

Recipient

Distinguished Graduate Fellowship
Distinguished Graduate Fellowship
Distinguished Graduate Fellowship
Distinguished Graduate Fellowship

Amount

\$1,000
\$1,700
\$1,250
\$4,650

2006 Wisconsin Turfgrass and Greenscape EXPO Exhibitors

The Andersons

David Louttit 219-662-1014
Fertilizers, fertilizer combination products, spreaders.

BASF

David Oberle 651-681-8050

Badger Turf & Grounds Club

Bayer

Kerry Anderson 847-910-3130

Cleary Chemical

Tim Keating 630-885-3130
Turf & ornamental plant protectants.

Contree Sprayer & Equipment Co

Kevin White 920-356-0121
Custom built sprayers, parts and service.

DHD Tree Products

Dan Quast 920-386-9000
Fertilizer, plant protectants, tree supplies, greens roller.

Dow AgroSciences

Beth Whitehouse 608-216-5066
Ornamental and technical products. Offers high-quality insecticides, herbicides and fungicides to professionals in lawn care, golf course and nursery business.

Ero-Tex

Scott Bordeau 262-387-1934
Erosion control & turf reinforcement mats, bunker liners, winter green protection system.

Gempler's

Kim Karls 608-662-3301
Handpicked commercial grade supplies direct to your dock or doorstep.

Herfort Norby G C Architects

Kevin Norby 952-942-0266
Golf course design, practice facilities, irrigation, renovations, restorations.

Horst Distributing

Grant Mortimer 920-849-2341
Turf maintenance equipment and supplies.

Lesco

Robert Wasser 262-206-0775
Fertilizer, seed, control products, equipment and golf accessories.

Midwest Turf Products

Cubby O'Brien 630-742-5124
Plant protectants, fertilizers & accessories for the turf professional.

Milorganite

Jaime Staufenbeil 414-221-6816
Organic nitrogen fertilizer.

National Golf Graphics

Peter Meyer 608-222-9363
Golf course signage, accessories, flags & on course drinking water systems.

National Seed

Dan Biddick 208-890-4453
Seed, fertilizer, mulch, erosion blankets.

North Pacific Ag Products

Darren MacFarlane 800-461-3477

Olds Seed Solutions

Chris Wendorf 608-249-9291
Seed and custom seed blends.

Paul's Turf & Tree Nursery

Paul Huggett 608-655-3600
Sod and tree needs.

Pendelton Turf Supply

Ed Witkowski 262-534-3334
Seed, fertilizer, pesticides, tee and green supplies.

ProGreen Plus

Mike Akin 414-751-1113
Fertilizers, aquatic supplies, seed and chemicals.

ProSource One

Conrad Stynchula 608-249-8500
Distributor of plant protectants, fertilizer and seed to the turfgrass market.

Rain Now

Paul Roessler 608-850-7246
Above ground watering systems

Reinders

Dean Musbach 262-786-3300
Distributor of commercial turf equipment, fertilizer, grass seed, herbicides, fungicides, irrigation products, landscape supplies and ice control salt.

Riesterer & Schnell / Green Image

Deanna Boldrey 920-751-8787
John Deere turf equipment and One Source supplies.

Sports Turf Specialists

Terry Donahoe 651-775-0002

Syngenta

Steve Abler 920-860-6374
A complete portfolio of turf care products.

Tiziani Xcite

Mike Schaefer 262-370-5208
Turf, commercial and rough utility vehicles.

UAP Professional Products

Shawn Hilliard 608-516-4006
Pesticides, fertilizers and seed.

Waugata Sand & Solutions

Brett Grams 715-258-8566
Supplier of quality topdressings, sand mixes, decorative stone, compost to sports fields and golf courses for over 25 years.

Wisconsin Turf Equipment

Gary Huenerberg 608-752-8766
Full line of turf maintenance equipment and supplies featuring, Jacobsen, Smithco, Turfco, National, Jacklin Seed, Lebanon fertilizer & Pro's Choice. Contract deep-tine aerification.

Wisconsin Sports Turf Managers

Brett Grams 715-258-8566
Committed to enhancing the professionalism of athletic field managers in Wisconsin.

Wisconsin Turfgrass Association

Audra Anderson 608-845-6536
Dedicated to better turf through research and education.

Wolosek Landscaping

Dan Wolosek 715-423-3909
Manufacturing golf course topdressing sand.

Yamaha Golf Car

Anne Kloss 608-527-4348
Golf Car Sales

The use made of this large data base was to meet the objective of determining which of the various soil test methods used performed best for turfgrass. Soil test performance is judged according to the strength of the relationship between soil analyses and plant response. The stronger the relationship, the greater the assurance that the test extracts from soil only those forms of nutrients truly available to plants. We found these relationships to be very weak, statistically insignificant, and of little value in deciding whether one test method performed better than another. More intensive inspection of our data revealed why this was the case. We were being confronted with one of the unique features of turfgrass as compared to field crops. Nitrogen application rates on field crops are set at non-growth limiting levels because this results in maximum economic returns for the crop. We determined through field experiments that in our climate it takes at least 16 lb N/1,000 ft²/yr⁻¹ to maximize clipping production on a Kentucky bluegrass lawn and in excess of 3.8 lb N/1,000 ft²/mo⁻¹ on a bentgrass fairway (Fig. 1). Because no one fertilizes at much more than 1/4 these rates, N is almost always growth limiting. From this we surmised that it is N that drives clipping production and, in so doing,

drives turfgrass uptake of all the other essential nutrients. This phenomenon is vividly illustrated in Figure 2 for P and K. What this figure indicates is that turfgrass clipping P and K concentrations are much more dependent on fertilizer N rate than soil supplies of P and K. For example, two stands of Kentucky bluegrass growing on soils with exactly the same amounts of soil test P could have very different concentrations of P in the clippings depending on how much N was being applied. As you might imagine, this complicated subsequent attempts to establish relationships between soil test levels of nutrients and their tissue concentrations. Such relationships provide the basis for defining critical soil test levels of the nutrients, the levels above which plants do not respond to further increases in test levels.

Before attacking the task of circumventing the N influence on nutrient uptake, we addressed a concern with the so-called Bray-1 method for extracting soil P and K. This is the method currently being used by all soil testing laboratories in the state. The method was developed for use on acid soils and does not function well for soils with significant amounts of carbonates. In Wisconsin, many golf putting greens and some athletic fields have been constructed with calcareous sands and wherever turf has

been irrigated for some time with ground water that has filtered through limestone, soil pH values approach and even exceed 7.6 after a few years of watering. This is the pH where we begin to find carbonates in soil. Thus, the possibility existed that the Bray-1 soil test method was not appropriate for all turf soils. To examine this potential problem, we compared the amounts of soil P and K extracted by the Bray-1 method to the amounts extracted by a method held to function effectively across a wide range in soil pH. This comparison indicated that for our 614 soil samples with pH ranging from 4.25 to 7.9 the Bray-1 procedure functioned with equal effectiveness and there is no reason not to use it for turf soils. Minnesota research has shown that failure of the Bray-1 test to adequately extract P and K from soils does not occur until soils contain 12 % or more carbonates. Chances of encountering a turf soil in Wisconsin with carbonates levels this high are close to zero.

A statement sometimes made is that UW research has shown that the P measured by soil tests in calcareous soils is unreliable because what's measured is not truly plant available. We could not find any evidence of this in our research.

When we plotted turfgrass clipping nutrient concentration

Figure 1a. Bentgrass N Response Curve

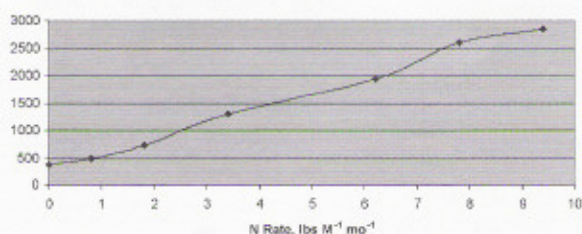


Figure 1b. Bluegrass N Response Curve

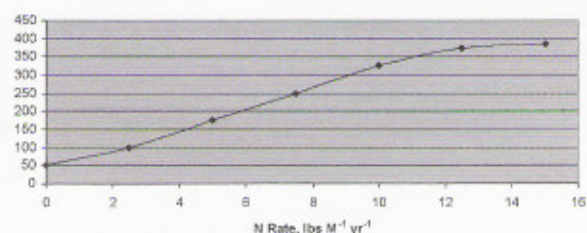
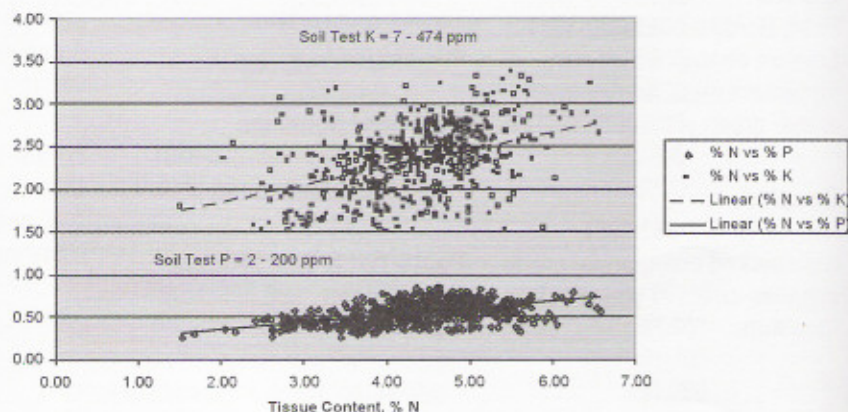


Figure 2. Clipping N vs Clipping P and K



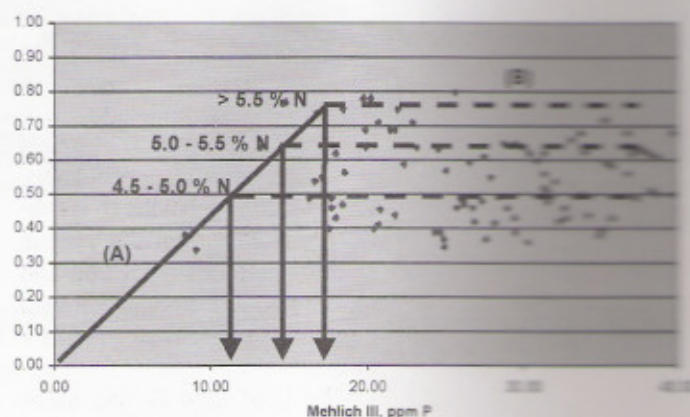
against soil nutrient content to identify critical soil test values, the result was a literal mess. The data plotted in Figure 3 for our 417 golf putting greens illustrate what we're talking about. While it's obvious from the figure that above a certain soil test level of P there is no change in clipping P concentration, it's equally clear that clipping P can range from 0.3 to 0.8 % at a single level of soil test P. To put this in perspective, 0.3 % P in bentgrass clippings is considered by turfgrass researchers to be low and 0.8 % P is excessive. We surmised that this situation reflects the fact that, as shown in Figure 2, N supply controls how much soil P turfgrass takes up. This prompted sorting of the samples into clipping % N ranges and computing for each range the relationship between clipping and soil P. The result of this exercise is shown in Figure 3. By drawing in the appropriate lines, this figure tells us that what might be established as a critical soil test value actually varies with clipping N concentration; the higher the clipping N, the greater the critical soil test value. To some, this might suggest that soil tests cannot be reliably interpreted without knowledge of clipping N concentrations. We took the stance that it is unrealistic to require that turf soil samples submitted to labs for analysis be accompanied by clipping samples. Our approach to this problem was to define critical soil test values at what we viewed as reasonable and realistic clipping nutrient concentrations. For P in putting greens, we chose 0.6 %. One reason is that this concentration is at the upper end of what is considered to be the sufficiency range for P in bentgrass. What this decision did was ignore clippings with % N above about 5.5. In essence, we were deciding that more than 5.5 % N is excessive and arose either from inappropriate use of N or a temporary condition that might exist shortly after fertilizer

N application. The other reason for selecting the 0.6 % P tissue concentration has to do with the fact that grass clipping P concentrations are considerably lower during periods when low air temperatures restrict growth. In view of the strong influence of turfgrass growth rate on nutrient uptake, this temperature effect is understandable. After consulting turfgrass literature, we became confident that if bentgrass has a mid-season clipping P concentration of 0.6 %, the % P will most likely never drop below a potentially growth restricting level of 0.35 % during cold weather. Similar considerations went into the selection of critical soil test values for other types of turf.

Yet another problem we encountered in the project was the fact that among all the samples there were few instances where soil and tissue P and K concentrations were below optimum levels. Over 79 % had soil test levels of P and K so high that their data were of no value when it came to identifying critical soil test values. No golf putting greens or tees had very low or low soil tests. To overcome this deficiency in our data base, we had to reconstruct a putting green, deliberately creating deficiency levels of soil P and K. Having a range of increasing soil test values over which tissue nutrient concentrations increased accordingly was vital to the establishment of critical soil test values. This relationship results in the line "A" in Figure 3. Where it is drawn determines the point of intersection with line "B," the critical soil test value. Therefore, having data to define line "A" has a lot to do with the reliability of the soil test calibrations.

Having worked through all of the above processes and making rational judgments regarding what we would use as "target" clipping nutrient concentrations, the next step was to establish critical soil test val-

Figure 3. Critical Mehlich III P Concentrations for Different Tissue N Ranges



ues. It was at this point that we focused our attention on the data for the different types of turf we were dealing with to see if there was a justifiable need to calibrate soil tests differently for each of these different turf types. What became obvious to us is that bentgrass putting greens and tees are distinctively different from fairways, lawns and athletic fields. The main reason for this separation is the consistently higher N concentrations in bentgrass than in Kentucky bluegrass and, therefore, bentgrass has higher P and K requirements. With our data base, we could not justify separate soil test calibrations for fairways, lawns or athletic fields. Collection of more data might provide justification for separation of bentgrass fairways from lawns, athletic fields and bluegrass or fine fescue fairways for the purpose of soil test calibration.

We attempted two different approaches for determination of critical soil test values. One was a mathematical method in which a curvilinear response curve is generated for soil test values below the critical value and a flat, straight line computed for those soil test values above which there is no change in tissue nutrient concentrations. The intersection of the two lines defines the critical soil test value. We had to abandon this

approach because we simply did not have enough data points to reliably compute the curvilinear portion of the response curve for samples testing less than the optimum. This led to use of a graphical approach that has been used extensively for field crops and has a statistical basis. We used the technique to identify critical values for the various soil test methods employed and for the two turf groups; golf tees + greens and fairways + lawns + athletic fields.

The final step in this study was to develop soil test interpretations. This is a simple process once the critical soil test values have been determined. It involves dividing the range in soil test from zero up to the critical value into several segments. The number of segments depends on the nutrient, is a matter of personal preference, and is commonly either 4 or 5 for nutrients such as P and K. Each range in soil test values is then assigned an interpretation such as *very low*, *low*, *medium*, and so on. Here again, the terms used reflect personal preference. We elected to go with 5 divisions for P and K and interpretations of *very low*, *low*, *medium*, *optimum*, and *high* with the critical soil test being at approximately the mid-

point of the optimum range. An example of these soil test interpretations is shown in Figure 4 for golf tees and greens and the Mehlich III test P. In the case of micronutrients, soil tests are not as reliable as for P, K, Ca, Mg, and S and the range of values tends to be very narrow. In this case, soil test values below the critical level are declared deficient or insufficient and those above the critical value are termed sufficient or adequate.

Although not a part of this study, fertilizer recommendations had to be developed as a final step for completion of what constitutes a complete soil testing program. It is this complete package that is required by soil testing laboratories. The amounts of fertilizer recommended are those deemed to be necessary to take any soil from its current soil test level to the optimum level as defined by its critical value. Ideally, these recommendations are based on research that has determined for different soils what rate of application of a particular nutrient is equivalent to a single unit increase in soil test. We are very fortunate because these relationships already exist for P and K for soils of different textures and origins in the state.

These relationships are referred to as nutrient buffering capacities and are what were used to develop fertilizer recommendations for P and K based on our new soil test interpretations for turfgrass. If and when customers request fertilizer recommendations for the secondary and micronutrients, more creativity will be required to create them because buffering capacities of these nutrients have never been established.

We're pleased to report that our new interpretations for the Bray-1 tests for soil P and K and corresponding fertilizer recommendations have already been adopted by the University of Wisconsin soil testing labs in Madison and Marshfield and made available to all soil testing labs in the state that are certified by the Wisconsin Department of Agriculture and Consumer Protection. Furthermore, our soil test interpretations and fertilizer recommendations are being written into the DNR technical standards for regulations on fertilizer use on 5-acre or more turf areas under single ownership that are scheduled to go into effect in 2008. Thus, we have met the original intent of this research project, which was to develop reliable, state-based soil test interpretations for turfgrass before they became the basis for regulation of fertilizer use.

So this is it - probably more than you ever wanted to know about the rationale and science behind Wisconsin's new soil test interpretations and fertilizer recommendations for turfgrass. We hope it alleviates some of your concerns about being mandated to fertilize your turf according to soil test.

Editor's note: Wayne Kussow is Emeritus Professor of Soil Science. Steve Houlihan, the second recipient of the Wisconsin Turfgrass Association W.R. Kussow Distinguished Graduate Fellowship is now Assistant Superintendent, Merrill Hills Country Club.

Figure 4. Mehlich III P Calibrations For Golf Greens and Tees

