1998 Illinois Turfgrass Research Report

A COOPERATIVE EFFORT OF THE
University of Illinois, Southern Illinois University,
Illinois Turfgrass Foundation, and the Chicago District Golf Foundation.

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Greetings

The turf faculty, staff, and advisors at the University of Illinois, Southern Illinois University, and Chicago District Golf Association are pleased and proud to bring you the 1998 Illinois Turfgrass Research Report. This report contains brief summaries of programs conducted across the state of Illinois. We hope the report provides you with an insight into the diverse activities that are ongoing to provide you with the latest in turf management techniques and technology.

We have changed the publication timing of this report to late fall in order to provide more current information and so that you may also apply this knowledge in the coming season. We will provide this report prior to the North Central Turfgrass Exposition each year.

If you have not seen the research report in the last few years, the format has also changed. Considerable research and education is conducted by each participant over the year. Oftentimes, the results of this research is preliminary or only describes a response for a single growing season. To provide a more meaningful message, we have developed a summary format. Each brief article provides the highlights and impacts of the authors activities. With this format, we hope it is easier to draw a "take home" message from the activities that can be more directly applied to your turf management activities.

We sincerely thank the Illinois Turfgrass Foundation (ITF) for financing the production of this report. The ITF is a not-for-profit group dedicated to supporting turfgrass research and education in Illinois. The ITF sponsors many fund-raising activities that help make this research and education possible. Without the ITF, it would be difficult to maintain the high-quality turfgrass research findings and educational events turf managers in Illinois currently enjoy.

We also sincerely thank the many supporters and contributors to all of our programs. They are recognized in the acknowledgment section on pages 29-30. These individuals are committed to advancing the science of turfgrass management in Illinois by supporting educational activities for the betterment of the industry. They have been loyal supporters to our programs and are critical for our success.

In addition to this printed copy of the report, an electronic version was produced in its entirety and is available for viewing on the University of Illinois Turfgrass Program Web Site. You can view this site at www.turf.uiuc.edu. Along with the 1998 Illinois Turfgrass Research Report, research reports from previous years, back to 1989, are also available. We hope you find this information useful and wish you the best in the upcoming season

Tom Fermanian

Advances in Turfgrass Technology

Tom Fermanian

1998 has been excellent year for me, but certainly a different one. Many of my traditional activities continue. Service to the industry through distribution of articles and writings and troubleshooting turf problem is the primary activity. The difference, however, is a increasing focus on the development of new technologies to provide better communication and information to the turf industry in Illinois, across the U.S., and around the world. Newsweek magazine recently ranked Champaign-Urbana as one of the top 10 technology cities in the world. With this rich reserve of resources available, I feel it is appropriate to examine this technology to provide new tools for turfgrass managers. A focus of my program, therefore, continues to be the examination of a wide array of technologies to provide decision support for turf managers.

I. Precision Turfgrass Management

One of the newest technologies is "Precision Turfgrass Management". This technology encompasses the use of Global Positioning Systems (GPS) and Geographical Information Systems (GIS) to provide information and controlling mechanisms for uniquely defined areas of turf. These areas are defined by some measured attribute that differentiates it from other adjacent areas. Each area is precisely reference on a map for precise location and evaluation of collected data. Mapping is made possible by obtaining precise locations on the turf from a GPS instrument receiving signals from a group of satellites. The map information is then made available to a GIS system that both manages the map and provides a database to store and analyze any observed information.

The availability of precision turfgrass management systems requires development in three different areas. First, mechanisms for accurately scouting turfs to develop zones of management must be develop and verified. Initial research in the use of automated sensors to map zones of management is

Figure 1. Opening screen of Golf Course Management System (GCMS) a spatially referenced recordkeeping system.

underway at several institutions. Human judgment and observation systems should also be researched.

A second component of precision turf management is the GIS software system. The software needs to be both a repository for data collected from the site and a decision support system to assist the turf manager in selecting an appropriate management operation for each area. Over the past two years we have been developing a prototype for this type of system, Golf Course Management System (GCMS), Fig. 1. GCMS currently has the capacity for storing, manipulating, and retrieving data provided from a scouting system.

The third component of precision turf management is the hardware to precisely deliver management operations to each selected area in the same time frame as normal maintenance operations. Precision spraying equipment is being developed by several manufacturers. When this equipment becomes available, it should be evaluated under research conditions in order to establish its value and accuracy.

GCMS is a modification of the commercial software ArcView (ESRI, Inc.). Over 100 scripts written in the ArcView scripting language, Avenue, were developed to provide the GCMS database and mapping functionality. The system was designed for the management of pesticides on golf course fairways. He includes a database of pesticides commonly used on golf courses and appropriate pests. It also allows the user of the system to subjectively evaluate the severity of a pest infestation and track changes in the infestation over time. In the initial system, the targeted management unit was a fairway. Recently, greens have been added as an additional management unit.

The ultimate value of a system like GCMS, is being able to dynamically target sub-areas of either fairways or greens. While the current system does not include this capability, it does have a "small area calculator" to determine pesticide requirements for any size and shape area on the course. Either single small areas or a collection of multiple small areas can be evaluated for size and shape. The small area calculator provides the user with the quantity of material necessary to cover the entire small area and the quantity required for each sprayer tank load.

An additional strength of a system like GCMS is the capability of producing printed maps of the course at any magnification with great precision. These maps can serve as both instructional tools and accurate records. Any instructions or other annotations can also be added to the map.

In September 1997, GCMS was licensed to Integrated Pest Management Systems, Inc. in Monroe, North Carolina. It was the plan of IPM systems to incorporate GCMS as one component of their mapping service for golf courses across the U.S. Unfortunately, their marketing plan was not successful and the license was revoked in the fall of 1998. We are currently searching for a new licensee to make this software available to the turf industry.

The developers of GCMS are Claudio Golombek, a recently graduated Masters student and Paula Braga, a programmer still working in my lab. It was through their diligence and hard work that the program has evolved into its current state. As new precision turf management projects develop, GCMS will also be expanded to provide the necessary components for any new system.

Predicting Stress on Bentgrass Fairways

One of the most important activities in managing any golf course fairway turf is maintaining good plant health. Generally, any management activity directed towards fairway turf will respond most efficiently when the turf is in a healthy, actively growing state. Since it is usually easier to maintain plant health rather than resurrect it to healthy turf, early detection of plant stress is critical for efficient management.

By the time a turf becomes stressed enough to show visible signs of reduced quality some resurrection of overall plant health is generally required. If a golf course superintendent had the means to detect levels of general plant stress prior to any visible symptoms less drastic corrective measures might be taken.

Total Nonstructural Carbohydrate (TNC) levels in turfgrasses have long been considered a potential indirect indicator of plant stress and its ability to recover from injury. I have recently established an experiment at the Landscape Horticulture Research Facility to begin to evaluate the opportunity of using changes in TNC levels to potentially measure stress on a bentgrass fairway.

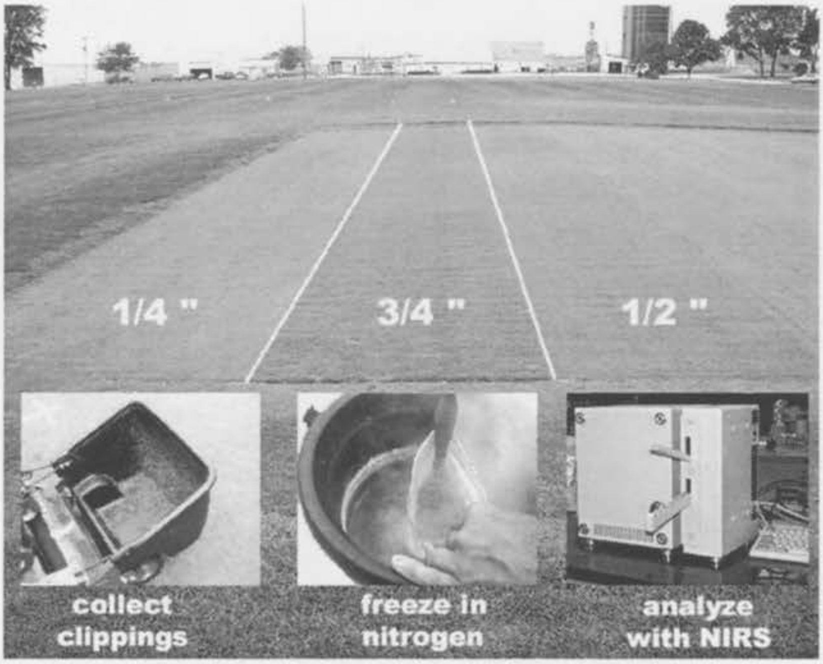

Figure 2. Bentgrass Stress Study at the Landscape Horticulture Research Center in Urbana, IL. Plots are mowed at 1/4, 1/2, or 3/4 inch to impose increasing levels of stress. Stress is evaluated by first collecting clippings, rapidly freezing them in liquid nitrogen, then analyzing them with near infrared spectrophotometer (NIRS).

This type of tool will only be useful, however, if a simple mechanism is developed for collecting, sampling, analyzing, and predicting TNC levels. The level of TNC must consistently correlate with general plant health. If this is true, a predictive model can be developed which will serve as a functional tool. This is a relatively ambitious project and will take several graduate student directed research efforts to accomplish.

During the summer of 1998, I focused on developing a consistent sampling technique, Fig. 2. Plant carbohydrates can rapidly change when plant tissue is removed. In order to prevent this change, we have examined the use of liquid nitrogen to rapidly freeze leaf tissue in the field. The collected samples are then freeze-dried in a process that is similar to food preservation used in some packaging in the grocery store. Finally, samples are ground into a fine powder and analyzed on a Karsten Turf Analyzer, a near-infrared spectrophotometer. This is the same machine that is currently being used for tissue nutritional analysis at a number of golf courses in the U.S.

In addition to refining this technique next summer, I will also examine the normal fluctuation of TNC levels in bentgrass clippings. This background level of TNC must be established in order to determine any rapid changes in the TNC level that might correspond to plant stress.

Developing in Internet Resource

The Internet, and particularly the World Wide Web, has grown tremendously in the past two years. Most universities have tried to establish at least some presence on the Web. This generally starts campus wide, but colleges, departments and individual programs have also developed Web sites. Developing a university web site makes a lot of sense. One of our major missions is to provide education and the Web can be an excellent conduit for that activity.

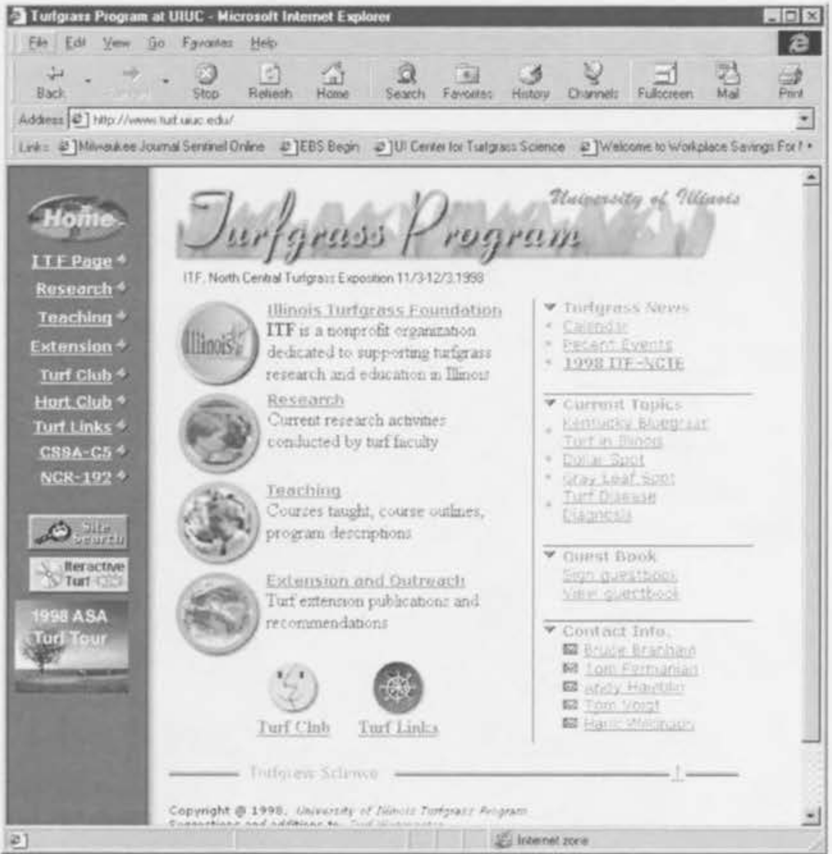

Figure 3. University Of Illinois Turfgrass Program web page. This page can be found at www.turf.uiuc.edu.

In late 1997, the University Of Illinois Turfgrass Program initiated the development of a World Wide Web site, Fig. 3 (www.turf.uiuc.edu). The main focus of this activity was to provide Illinois turfgrass managers with current information to assist them in their daily activities. From the start, we planned to add information on educational forums, current activities and contact information. The site was also considered an excellent area for making the old publications available that otherwise might not be accessed. Many of our turfgrass research summaries and past turfgrass conference proceedings are currently not available through libraries and are only referenced from databases like TGIF. One of the more popular areas on the turf web site is a listing of other turfgrass resources on the World Wide Web.

Data on the use of the turf program web site has been collected since July, 1998. Over the past five months, the site has been visited by over 5000 individuals. Over 15,000 pages have been viewed. These numbers only include visits from off campus. While most of the logged activity has stemmed from the state of Illinois, visitors from all over the world including countries like Saudi Arabia, Australia, South Africa, and Oman, have viewed our pages. The page that is most often downloaded is an article from the 1996 Illinois Turfgrass Research

Report. Traffic on the site has been very steady averaging about 35 visits per day. The site appears to be a tremendous resource for the future and should be continuously evaluated, modified and updated. The University of Illinois turfgrass site appears to be one more way in which pertinent management information can be communicated to those who can use it in their daily operations.

1998 Turfgrass Extension, Teaching, and Research Activities

Tom Voigt

During 1998, my program was involved in many new and exciting research, teaching, and extension activities. Major extension activities included outreach educational programs and turf information distribution, while turfgrass species and cultivar evaluations highlighted the 1998 research activities.

Extension and Teaching Highlights

- During early 1998, I participated in eight Pesticide Applicator Training Meetings on the topic of *Weed Control in Turf.*
- In February, 1998, we held the fifth annual *Indiana-Illinois Turfgrass Short Course* in Willowbrook, Illinois. The course sold out with 51 registrants.
- In August, I was involved in the 1998 University of Illinois Turf and landscape Field Day. More that 400 green industry professionals were in attendance.
- During the Fall, 1998, Semester, I initiated a new undergraduate class, *Landscape Uses for Native and Exotic Ornamental Grasses.* There were 18 undergraduate students enrolled along with, 2 "visiting" graduate students.
- In November, 1998, we held the second annual *University of Illinois-Central Illinois Golf Course Superintendents Association Education Seminar* in Peoria, Illinois. More than 115 golf turf personnel attended.
- During 1998, we began the process of surveying the Illinois turf industry in order to identify its economic value to the state.
- I published articles in *Golf Course Management, Crop Science, A.I. in Agriculture, Turfgrass Times, Turfgrass Tips, Home, Yard, and Garden Pest Newsletter,* and *On Course.*
- I made nineteen invited presentations in Illinois, Indiana, and California on topics including *Control Options for the Top Pests in Turf, Native Plants for Midwestern Golf Courses, Fall Lawn Care Activities,* and *Ornamental Grasses for the Midwest.*

Turfgrass Species and Cultivar Research

Many of our research activities involve studies sponsored by the National Turfgrass Evaluation Program (NTEP). Bentgrasses, Kentucky bluegrasses, tall and fine-leaf fescues, and perennial ryegrasses were studied in different evaluations. The objective of these studies is to determine the suitability of these turfgrasses for use in Illinois.

The 1993 NTEP fine-leaf fescue evaluation concluded with the end of the 1997 growing season. Grown in Urbana, these grasses were mowed at 1.75 - 2 inches, were not irrigated after establishment, and received 1 - 2 pounds of nitrogen per 1,000 square feet per year. Of the 59 entries in the trial, 19 performed acceptably during the 1994 - 97 growing seasons; Table 1 presents University of Illinois recommendations based on this study.

Table 1. Recommended fine-leaf fescue cultivars (type in parenthesis).

Bridgeport (chewings)	Medina (chewings)	SR5100 (chewings)
Brittany (chewings)	Nordic (hard)	Tiffany (chewings)
Dawson (slender creeper)	Reliant II (hard)	Treazure (chewings)
Eco (chewings)	Sandpiper (chewings)	Victory (E) (chewings)
Flyer II (strong creeper)	Seabreeze (slender creeper)	Victory II (chewings)
Jamestown II (chewings)	Shadow(E) (chewings)	
K-2 (chewings)	Shadow II (chewings)	

One of the most exciting and potentially useful NTEP trials is taking place at North Shore Country Club in Glenview, Illinois. Established in September, 1997, this study exemplifies cooperation; NTEP, the Golf Course Superintendents Association of America, the United States Golf Association, North Shore Country Club, and the University of Illinois have combined to make this evaluation a reality. Table 2 presents the final results of the 1998

Table 2. 1998 performance of eighteen bentgrass varieties in NTEP On-Site Bentgrass Trial at North Shore Country Club, Glenview, Illinois.[1]

	Mean Quality	Genetic Color	Density
Backspin	7.1	4.3 a	8.0 d-f
Cato	6.4	6.0 c	7.3 b-d
Century	7.3	5.0 ab	8.3 ef
Crenshaw	6.7	6.0 c	7.7 c-e
Imperial	6.8	5.3 bc	7.7 c-e
L-93.	7.1	5.3 bc	7.7 c-e
LCB-103	6.9	5.0 ab	8.0 d-f
Penn A-1	7.3	5.3 bc	8.0 d-f
Penn A-4.	7.6	5.0 ab	8.3 ef
Penn G-1	6.8	5.3 bc	8.7 f
Penn G-6	6.8	5.3 bc	7.7 c-e
Penncross	6.1	5.3 bc	6.0 a
Providence	6.5	6.0 c	7.7 c-e
Putter	6.4	5.0 ab	6.7 ab
SR 1020	6.8	5.3 bc	7.0 bc
SR 1119	7.0	6.0 c	7.3 b-d
Trueline	6.5	6.0 c	7.0 bc
Viper	6.4	6.0 c	7.7 c-e
LSD 0.05		1.0	0.9

[1]Mean quality is the average of monthly ratings of three replications. Quality is rated on a scale of 1 - 9 in which 1 = dead turf, 5 = minimally acceptable turf, and 9 = highest-quality turf. For color and density ratings, 1 = light green turf or open turf; 5 = turf of minimally acceptable color or density; and 9 = dark green or very dense turf.

At the Landscape Horticulture Research Center in Urbana, evaluations of two Kentucky bluegrass trials, planted in September, 1995, continued in 1998. A high-maintenance trial features 103 Kentucky bluegrasses maintained under golf course fairway conditions (7/8 inch mowing height, 4 pounds of N per 1,000 square feet per year, and irrigated). Some very obvious differences, particularly regarding turf color, disease resistance, density, and leaf texture, have developed since this trial was established. In a low-maintenance evaluation, twenty-one Kentucky bluegrasses are receiving very minimal management (1 pound of nitrogen per 1,000 square feet per year, no irrigation, mowed at 2.5 - 3 inches). Watch the *1999 Illinois Turfgrass Research Summary* for results and recommendations.

Ongoing evaluations of tall fescues and perennial ryegrasses were also components in the suite of NTEP studies. In the tall fescue study planted in 1996, 130 tall fescues cultivars are being evaluated under low-maintenance conditions (1 pound of nitrogen per 1,000 square feet per year, no irrigation, mowed at 2.5 - 3 inches). This year marks the conclusion of the 1994 NTEP perennial ryegrass trial. Here, ninety-eight perennial ryegrasses received irrigation, were mowed at 1.75 - 2 inches, and received 3 - 4 pounds of nitrogen per 1,000 square feet per year. Watch the *1999 Illinois Turfgrass Research Summary* for results and recommendations.

Tables 3 and 4 present final results for the top performing cultivars in each of the two 1993 NTEP bentgrass trials conducted in Urbana. Findings for

growing season for the 18 entries in the study.
fairway height bentgrasses (mowed at 0.5 inch) appear in Table 3 and putting green height bentgrasses (mowed at 0.125 - 0.25 inch) in Table 4. Both studies were conducted on native soils, were irrigated, and received 3 - 4 pounds of nitrogen per 1,000 square feet per year.

Table 3. Top performing (of twenty-one entries) bentgrass varieties in the 1993 NTEP Fairway Height Trial at Landscape Horticulture Research Center, Urbana, Illinois. 1994 - 97.[z]

Cultivar	1994 Mean Quality	1995 Mean Quality	1996 Mean Quality	1997 Mean Quality	Mean Quality 1994-1997
Penn G-6	5.27	6.46	6.96	5.94	6.16
Southshore	5.66	6.19	6.72	5.78	6.09
Seaside II (DF-1)	5.39	6.04	6.84	5.94	6.05
Penneagle	5.76	5.71	6.57	5.89	5.98
Cato	5.39	6.29	6.38	5.61	5.92
Providence	5.87	5.87	5.65	5.78	5.79
BAR Ws 42102	5.00	6.00	6.44	5.50	5.74
Crenshaw	5.76	5.67	6.06	5.39	5.72
Trueline	5.01	5.86	6.34	5.22	5.61
PRO/CUP	4.91	5.57	5.89	5.50	5.47
Penncross	5.04	5.19	6.07	5.39	5.42
Penn G-2	4.57	5.49	5.99	5.44	5.37
ISI-At-90162	5.16	5.34	5.89	4.89	5.32
Lopez	4.43	5.09	5.84	5.22	5.15
18th Green	4.43	5.13	5.67	4.78	5.00

Table 4. Top performing (of twenty-eight entries) bentgrass varieties in the 1993 NTEP Putting Green Height Trial at the Landscape Horticulture Research Center, Urbana, Illinois, 1994 - 1998.[z]

Cultivar	1994 Mean Quality	1995 Mean Quality	1996 Mean Quality	1997 Mean Quality	Mean Quality 1994-1997
Providence	5.86	5.14	6.90	5.45	5.84
Penn G-2	4.86	5.33	6.80	6.12	5.78
Penn A-1	5.33	5.13	6.90	5.50	5.72
Century (Syn 92-1-93)	5.10	5.30	6.33	5.62	5.59
Loft's L-93	5.30	5.39	6.67	4.95	5.58
Pennlinks	4.94	5.10	6.20	5.93	5.54
Southshore	4.86	5.43	6.47	5.12	5.47
Penn A-4	5.47	4.84	6.33	5.12	5.44
PRO/CUP	4.47	5.06	6.80	5.43	5.44
Penn G-6	4.81	4.77	6.57	5.55	5.43
Crenshaw	5.51	4.96	6.33	4.83	5.41
Cato	5.10	5.00	6.10	5.37	5.39
Lopez	4.29	5.19	6.43	5.22	5.28
Imperial (Syn 92-5-93)	5.14	5.01	6.23	4.62	5.25
SR 1020	4.80	5.00	5.80	5.35	5.24
Syn 92-2-93	4.51	4.93	6.23	5.02	5.17
BAR Ws 42102	4.63	4.96	5.90	5.10	5.15
Trueline	4.34	5.04	6.20	4.97	5.14
Penncross	4.71	4.77	6.00	5.00	5.12
MSUIEB	4.67	4.77	6.10	4.78	5.08
Mariner (Syn-1-88)	4.76	4.91	5.67	4.97	5.08
ISI-Ap-89150	4.76	4.66	5.43	5.23	5.02

[z]Values expressed are overall annual means. Ratings of three plots of each cultivar are made each month during the growing season and averaged to obtain a monthly mean. To obtain overall annual means, monthly means during a growing season were averaged. Quality ratings are based on scale of 1 - 9 in which 1 = dead turf, 5 = minimally acceptable turf quality, and 9 = perfect turf quality.

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Continuing Research Projects

In 1997, a low-maintenance study that combined grasses and legumes was established in Urbana at the University of Illinois Landscape Horticulture Research Center. This study, Low Input Sustainable Turf (LIST), was designed to identify the effects of white clover, birdsfoot trefoil, and red clover on the overall quality of minimally maintained tall and hard fescues. LIST is also being conducted at other Midwestern universities involved in the North Central Region 192 turf working group.

In another study taking place off campus, the 1998 growing season completed the second year of a three-year study of 54 native plant species at three Chicago-area golf courses, Cantigny Golf Club, Olympia Fields Country Club, and Skokie Country Club. Funded by the Midwest Association of Golf Course Superintendents, the Golf Course Superintendents Association of America, and the Illinois Turfgrass Foundation, this research seeks to identify species suited to unmowed, out-of-play areas in both full sun and light shade. Watch the *1999 Illinois Turfgrass Research Summary* for the findings of this study and recommendations for unmowed golf course, park, and other low-maintenance areas.

New Research Areas

In August, 1998, Mr. Darin Lickfeldt began studies toward a Ph. D in my program. He will be studying allelopathy (a chemical product produced by one plant that effects the growth of another plant) in fine fescues. The overall objectives of this work are to (1) identify naturally occurring products in fine fescues that may effect the growth of weeds and other turfgrasses, and to (2) determine if there are species and varietal differences among fine fescues regarding the production of allelopathic chemicals.

Also, in light of current disease problems with perennial ryegrass fairways due to gray leaf spot, Darin started selecting and characterizing Kentucky bluegrass cultivars suited to golf course fairway use. To conduct future studies, we planted two large-block areas of Kentucky bluegrass cultivars that appear to be suited to fairway use.

Three new NTEP evaluations were seeded during September, 1998. Fine fescue (79 entries), fairway height bentgrass (26 entries), and putting green height bentgrass (28 entries) evaluations were planted in Urbana. These studies will be ongoing for 3 to 5 years.

In a final study established in Urbana, eighteen fine fescues were planted in large blocks for evaluation when maintained with only a single annual spring or autumn mowing. Of interest is the long-termed performance of these grasses when used in unmowed rough areas, roadsides, parks, and other low maintenance areas. Ornamental characteristics and use suitability will be studied.

Thanks!

Thanks to supporters of my program activities! I am especially grateful to the University of Illinois Department of Natural Resources and Environmental Sciences and College of Agricultural, Consumer, and Environmental Sciences; the Midwest Association of Golf Course Superintendents; the Central Illinois Golf Course Superintendents Association; and the Illinois Turfgrass Foundation. Also, my thanks go out to Scott Witte of Cantigny Golf Club, Dan Dinelli of North Shore Country Club, Dave Ward of Olympia Fields Country Club, and Don Cross of Skokie Country Club for allowing me to conduct research at their facilities. Contributions from these groups, and several others, have enabled my program to move forward into new and exciting areas of study.

A New Turfgrass Growth Regulator

Kenneth Diesburg

Turfgrass growth regulators have been available since the 1960s. The road has been long and difficult to home and professional acceptance of the idea of regulating turfgrass growth instead of, or in combination with, mowing turfgrass. The most recent growth regulator released a few years ago is Primo. It has made inroads into professional acceptance beyond all previous products because of a combination of rapid effects, mild toxicity, and complete reliability on all turfgrass species.

We are researching a potential competitor to Primo. Its initial effects are about five days slower than those of Primo, but it has virtually no toxicity and its effects last close to three times longer than those of Primo. Its name is Proxy.

In 1997 we looked at the effects of Proxy on fairway bentgrass and *Poa annua*. Tables 1 to 4 show how Primo or Proxy alone performed, as well as combinations of Primo and Proxy. Their effects are compared to untreated and Cutless treated turf. The 3wk and 5wk treatments refer to Proxy applied to the same turf three weeks after Primo, and Primo applied to the same turf five weeks after Proxy. The '+' treatment is a tankmix of the two products.

You can study the numbers and pick out some advantages of both products. Considering long-term effects, Proxy at 2.0 oz was the best treatment for reducing *Poa annua* while not affecting bentgrass too strongly. Proxy at 5.0 oz was the best treatment for reducing growth of both bentgrass and *Poa annua* and bentgrass without reducing their turf quality.

In previous years we have found that Proxy works very well on all turfgrass species. Additionally, there is no delayed surge in turfgrass growth after its effects wear off, as occurs with Primo.

The use of turfgrass growth regulators for home and professional turf will continue to increase at a gradual rate. With the continued improvement of growth regulating chemicals, it is possible that we will be able to precisely control the duration and strength of growth restriction.

Table 1. Bentgrass quality in response to growth regulator treatments, Southern Illinois University, 1997.

		Date and Days After Initial Treatment					
Material	oz product 1000 sq ft	4/21 17	4/29 25	5/12 38	5/21 47	6/11 68	Avg
Proxy	5.0	7.0	8.3	7.0	7.7	7.3	7.47
Proxy, Primo 5 wk	4.0, .75	6.7	8.3	7.7	5.7	8.7	7.40
UTC		7.0	8.7	9.0	6.3	5.0	7.20
Proxy	2.0	6.3	7.7	8.0	7.0	7.0	7.20
Primo	.75	6.7	6.3	6.7	7.3	7.0	6.80
Primo+Proxy	.75+3.25	6.0	6.0	5.7	7.0	8.0	6.53
Primo	.375	6.3	5.3	5.3	7.0	5.0	5.80
Primo, Proxy 3 wk	.75, 4.0	5.7	4.3	5.0	7.3	6.0	5.67
Cutless	1.5	4.3	4.3	3.3	8.0	4.3	4.87
LSD 0.05		1.1	1.4	1.1	1.2	1.9	0.67

Table 2. Bentgrass clipping weight in response to growth regulator treatments, Southern Illinois University, 1997.

		Date and Days After Initial Treatment						
	oz product	4/18	5/12	5/23	5/29	6/5	6/19	
Material	1000 sq ft	14	38	49	55	62	76	Total
Primo+Proxy	.75+3.25	13.45	28.72	29.96	37.79	43.97	89.12	243.01
Proxy, Primo 5 wk	4.0, .75	45.45	78.88	28.44	21.19	23.68	59.70	257.34
Cutless	1.5	11.01	38.55	50.49	40.45	47.44	86.22	274.15
Proxy	5.0	32.49	43.89	30.02	40.64	47.45	95.36	289.84
Primo	.375	16.91	47.38	38.35	45.16	52.98	91.68	292.46
Proxy	2.0	15.08	74.45	41.13	42.05	49.12	74.70	296.53
Primo	.75	16.57	51.01	35.91	47.36	55.67	99.50	306.01
Primo, Proxy 3 wk	.75, 4.0	16.34	68.10	33.97	53.17	62.88	86.39	320.85
UTC		30.33	94.44	42.33	35.61	41.41	82.22	326.32
LSD 0.05		20.78	51.81	11.06	10.65	13.03	27.23	66.18

Table 3. Poa annua quality in response to growth regulator treatments, Southern Illinois University, 1997.

		Date and Days After Initial Treatment						
	oz product	4/9	4/21	4/29	5/12	5/21	6/11	
Material	1000 sq ft	11	23	31	44	53	74	Avg
UTC		8.0	8.3	6.3	6.0	5.0	5.0	6.4
Proxy	5.0	7.3	8.7	7.0	5.0	3.3	5.7	6.2
Proxy	2.0	4.7	6.7	6.3	7.7	5.3	3.3	5.7
Primo	.75	4.3	5.0	4.0	7.7	7.0	5.0	5.5
Proxy, Primo 5 wk	4.0, .75	6.7	7.3	6.7	3.0	3.3	3.3	5.1
Primo	.375	6.0	5.3	3.7	4.0	4.3	6.7	5.0
Primo+Proxy	.75+3.25	5.3	6.0	4.0	3.0	6.3	5.3	5.0
Primo, Proxy 3 wk	.75, 4.0	5.3	6.3	4.0	3.3	5.3	4.0	4.7
Cutless	1.5	3.0	3.3	1.3	2.0	7.3	3.0	3.3
LSD 0.05		1.7	1.5	1.6	2.3	2.2	1.5	0.7

Table 4. Poa annua clipping weight in response to growth regulator treatments, Southern Illinois University, 1997.

		Date and Days After Initial Treatment								
Material	oz product 1000 sq ft	4/11 13	5/2 34	5/13 45	5/22 54	5/29 61	6/6 69	6/20 83	6/27 90	Total
Proxy	2.0	3.74	14.36	68.63	49.74	37.51	40.61	60.59	37.28	312.46
Primo+Proxy	.75+3.25	5.17	10.04	39.45	63.16	54.64	52.72	106.63	41.32	373.14
Primo	.375	8.27	28.39	48.21	48.61	47.84	57.47	90.39	47.29	376.47
Cutless	1.5	2.05	6.16	32.35	91.82	55.83	63.29	104.97	39.21	395.68
Proxy, Primo 5 wk	4.0, .75	2.99	44.26	27.31	104.51	47.06	39.28	80.40	54.38	400.19
Primo, Proxy 3 wk	.75, 4.0	4.62	42.20	74.32	71.52	66.15	47.60	75.37	38.22	420.00
Primo	.75	2.58	7.23	87.41	106.63	45.40	55.78	94.34	39.28	438.64
Proxy	5.0	51.79	66.12	88.47	73.37	41.52	45.52	78.75	53.42	498.96
UTC		61.73	134.28	133.63	79.51	45.55	41.31	96.40	31.34	623.75
LSD 0.05		11.76	16.75	15.49	30.40	10.20	12.93	20.82	8.05	67.75

Validity of Qualitative Ratings for Rust Resistance

Andy Hamblin, Amy Forbes, Nicolle Hofmann

We are fortunate in the turfgrass industry to have information on varietal performance that is recent and has nationwide cooperation. One such resource is the National Turfgrass Evaluation Program (NTEP). Performance information on quality, green color, density, disease resistance, and many other traits are collected on a multitude of varieties that are currently available to consumers. Statistical designs to quantify differences between varieties are very similar for every trait evaluated. A standard randomized complete block design with three replications and generally one rater are commonplace. Unfortunately, this type of design is not always applicable to all traits that are measured. Some experiments would be better analyzed with more replications and other experimental designs would reduce the effects of environmental variation. Also, individual raters at different locations often have different "mental" scales that are used in their rating scheme. For example, if a "7" score out of nine was given for a plot by one particular rater, a different rater may give the same plot a "5" or "6". This lack of uniformity is not monumental if these rating differences are accounted for on the same plot. However, these rater differences usually occur over different locations which can create problems with rater by environment interactions. The objective of this study was to identify the validity of such information and assemble a model that accounts for errors in the design.

Materials and Methods

In this study, we used rust severity as the trait of interest. It is a relatively easy trait to measure because of distinct color differences between varieties, and the epidemiology of rust infection provides for relatively uniform inoculation. The plots were the NTEP high maintenance Kentucky bluegrass trial which includes 105 varieties in three replications. Plots were rated on a 1 to 9 scale where 1 represents maximum rust severity and 9 represents a plot with no apparent rust infection. Plots were rated during a one week period in October 1998 by two raters, one rater being moderately experienced and the other a novice. Each rater evaluated plots two times each for a combined total of four ratings. Various models were used in the experiment where combinations of factors were tested. Factors included replication, rater, replication by rater, rating within rater, entry (or variety), entry by replication, entry by rater, and entry by replication by rater. Random effects included replication and interactions with replication. Sufficiency of the mixed model was assumed when the F-value for the model was high, the R-square value was high, the coefficient of variation was low, and the root error mean square was low.

Results

The standard output using a single rater and single rating [similar to what is presented in the NTEP reports] is presented in Table 1. The effects of replication and entries were both significant at P=0.0001. The pooled error term is essentially the interaction between replications and entries. The difference between using the pooled error term and replication by entry is insignificant (data not shown).

Using the full model with various levels of interactions, much of the design error is exposed (Table 2). The effect of replication is no longer significant, which is quite a difference from what was seen with the standard model. Rater differences are not significant, and neither are the effects of replication by rater and rating within rater. Both entry and entry by replication by rater effects are highly significant.

The comparison between the two models are given in Table 3. The F-value increases from the single rater model to the full, optimized model. The R-square value is greatly improved with the full model and explains 80% of the variation as opposed to 63% of the variation explained by the single rater model. The coefficient of variation and root error mean square both drop significantly with the full model. A major improvement in the F-value occurs for the entry effect going from 3.20 for the single rater to 7.39 for the full model. Most significantly for reporting purposes, the LSD value goes from 2.29 for the single rater to 0.89 with the full model. This changes the number of T-groupings from 19 for the single rater to 32 for the optimized model. Further studies will identify the optimum number of replications for this research and the efficiency of the randomized complete block design.

Conculsions

From this study, we can clearly see the benefit from using better models in our evaluation of qualitative data. Because of the weakness of the experimental designs used in most evaluations (like NTEP trials), true differences between varieties cannot be justified. We have shown here that a much greater distinction between varieties can be seen with reduced error and improved efficiency. In addition, we can also identify possible sources of error by using improved models which account for a greater amount of the experimental variation. If replications, raters, or ratings are significantly different, we can isolate and account for these discrepancies. Previous suggestions by researchers about the value of multiple raters and ratings are largely unfounded. We show here that multiple raters and ratings are necessary and provide much better information. Many would complain that this would drastically increase the time they spend on plot evaluations. Realistically, it basically increases a 30 minute rating to 60 minutes, and the addition of a couple of ratings by a graduate student or temporary helper is not only cost efficient but largely unbiased.

- **Multiple raters and ratings provide for better information on varietal performance.**
- **Better experimental design and analysis allows us to troubleshoot and optimize the results of evaluations.**
- **Increasing raters and ratings is a cost efficient method of getting more out of our data.**

Table 1. Standard model applied to rust severity ratings[a] on NTEP high maintenance Kentucky bluegrass trial in Urbana, IL, October 1998.

Source	Degrees of Freedom	Mean Square	F-value	Pr > F
Rep	2	24.29	11.97	0.0001
Entry	104	6.50	3.20	0.0001
Pooled error	208	2.03		

[a]Rust severity ratings based on a 1 to 9 scale where 1=maximum rust and 9=no rust.

Table 2. Full model applied to rust severity ratings[a] on NTEP high maintenance Kentucky bluegrass trial in Urbana, IL, October 1998.

Source	Degrees of Freedom	Mean Square	F-value	Pr > F
Rep[b]	2	26.63	5.12	0.1635
Rater	1	6.39	5.07	0.1283
Rep × rater[b]	2	5.21	2.27	0.1043
Rating (rater)	2	2.41	1.97	0.1409
Entry	104	16.94	7.39	0.0001
Entry × rep × rater[b]	520	2.29	1.87	0.0001
Pooled error	628	1.23		

[a]Rust severity ratings based on a 1 to 9 scale where 1=maximum rust and 9=no rust.
[b]Random effects in the model.

Table 3. Comparison of single rater parameters versus the optimized model[a] applied to rust severity ratings[b] on NTEP high maintenance Kentucky bluegrass trial in Urbana, IL, October 1998.

Source	Single Rater	Optimized Model
F-value (full model)	3.37	3.94
R-square	0.63	0.80
Coefficient of variation	22.54	18.17
Root error mean square	1.42	1.11
F-value (entry)	3.20	7.39
Least significant difference	2.29	0.89
Number of T-groupings	19	32

[a]Optimized model includes: rust = mean + [rep] + rater + [rep×rater] + rating(rater) + entry + [entry×rep×rater] + pooled error. Factors enclosed by [brackets] represent random effects in the model.

[b]Rust severity ratings based on a 1 to 9 scale where 1=maximum rust and 9=no rust.

Genetic Diversity of Perennial Ryegrass

Plant breeders are continually concerned with the lack of genetic variability present in germplasm collections. As we continually select for specific traits, large segments of DNA are being whittled away and sometimes lost forever. So how can we regain this genetic variability? We can go to original sources of plant species, from Germany, Italy, Korea, or elsewhere, and cross them with adapted US cultivars. *But how do we identify where the greatest variability exists for a particular trait?* Not an easy question, especially if you were to try to identify variability based on morphological traits alone. Imagine trying to identify differences based on leaf width, plant vigor, spreading habit, genetic color, etc. Instead, we propose to identify differences in plant genotypes using modern DNA biotechnological methods.

This is being approached in two ways. First, because of the outcrossing behavior of perennial ryegrass, it is very hard to say that cultivars are genetically similar, or homogeneous. In other words, genes aren't fixed in any one plant but vary greatly, even within one particular cultivar. So, instead of only looking at differences ***between*** cultivars, it is first necessary to identify differences ***within*** cultivars. Then we can statistically calculate the variation that exists. Second, we will look at a much larger collection of plants to determine differences between cultivars. Using this information, in combination with information on various traits collected by the University of Wisconsin, will enable us to get a clearer picture on the amount of diversity that exists.

The questions we hope to answer through this research are:

1. *How much diversity exists in available germplasm?*
2. *How can we eliminate within variety variation to identify between variety variation?*
3. *What countries or locations have the greatest variation for a particular trait?*
4. *Can DNA methods be useful for future studies on genetic variation in turfgrasses?*

The implications for this research are numerous. Without genetic variation, breeding programs are ineffective and will show little progress. If we can find variation for rust resistance in Romania, for example, it would be a good idea to obtain plant materials from that country as a source of resistance. Then we can cross this resistance into varieties that we are already using in the United States. Even further, what if a breeding company is accused of stealing germplasm from another company? Can we use this technology to solves such disputes? Certainly, if you've read anything about paternity suits and other such issues with human populations. Have you ever planted a blend of Kentucky bluegrass and wondered what has happened to the costly variety that you included. Is it still there? Was it worth it? What if we could identify the percentage of that variety based on its DNA? There are really no barriers to this type of research. It will greatly enhance our ability to breed better grasses for Illinois and elsewhere.

Breeding for Gray Leaf Spot Resistance

Gray leaf spot is rapidly increasing in importance in Illinois and throughout the United States. Over the past two years in Illinois, gray leaf spot has caused near-epidemic devastation on perennial ryegrass. This is especially problematic when overseeding golf course fairways and roughs or athletic turfs during late Summer. Conditions which favor this disease are hot temperatures during the day (mid-80's), night temperatures greater than 70°F, and greater than 10 hours of leaf wetness over several days. Excess available nitrogen and predisposing factors such as compaction, drought stress, and herbicide injury can contribute to infection. Currently, a few select fungicides are available which control this disease. In the long-term, however, it would be extremely short sighted to depend solely on fungicides because of the possible build up of resistance to these chemicals. The use of host resistance through breeding will provide the most environmentally amenable method of control. Preliminary studies have yet to find resistant varieties that are currently available. No other private or public breeding program in the United States is studying this problem on perennial ryegrass, so the *University of Illinois* is especially well-positioned as the primary resource for gray leaf spot resistance. The objectives of these studies are:

- Confirm the lack of resistance available in commercial varieties.
- Identify variation in resistance across various environments in Illinois.
- Compare the efficacy of greenhouse ratings with resistance in field plots.
- Identify how many genes are involved in resistance and how they are expressed.
- Select resistant varieties from a large USDA collection of perennial ryegrass.

It is expected that we will provide both information and genetic materials that will allow for the efficient breeding of gray leaf spot resistant varieties in the near future. Further studies will focus on isolation of genes conferring gray leaf spot resistance in both perennial ryegrass and tall fescue. This will be followed by DNA marker-assisted methods of identifying resistant germplasm and backcrossing resistance into adapted varieties.

1998 Turfgrass Research Summary

Bruce Branham, Hongfei Jiang, Dave Gardner, Eric Kohler, and Brian Horgan

The 1998 growing season was an eventful one with enough heat, humidity, and rain to challenge even the most skillful turf manager. The central region of Illinois was struck by a disease of epidemic proportions that literally killed all the perennial ryegrass on high maintenance turf that was not on a fungicide program.

Our research program made significant progress in 1998. Eric Kohler completed his MS degree research on the uptake, metabolism, and translocation of ethofumesate (Prograss) in three turfgrass species. Dave Gardner is a Ph.D. candidate funded by a grant from the United States Golf Association Green Section Research Committee. His project examines the impact of turfgrass surface organic matter on pesticide fate. Brian Horgan is also supported by the USGA Green Section Research Committee and his project focuses on the loss of nitrogen from fertilized turfgrass stands. We suspect that volatile losses of nitrogen occur from fertilized turfs, but so far no one has been able to show that volatile losses account for a significant portion of the N loss from turf. Hongfei Jiang is responsible for all the general turfgrass management and weed control research being conducted under my direction.

Research Highlights in 1998

I. **Poa annua control**

We have attacked the issue of annual bluegrass control from two different angles in 1997-98. We examined the potential of various sulfonylurea herbicides to selectively control annual bluegrass during 1998. These trials were inconclusive with some positive results with primisulfuron (Beacon) but little success with other herbicides from this herbicidal family. Our focus on the sulfonylureas was diverted by the success of our research with ethofumesate. Eric Kohler's thesis research sought to answer some of the basic questions on the herbicidal characteristics of ethofumesate, the only herbicide labeled and shown to provide some selective control of annual bluegrass in other cool-season turfgrasses. During the course of his research, he observed that ethofumesate was slightly volatile. This led Eric to ask the question, can the reduced activity of ethofumesate in the summertime be due to volatility? The follow-up question was can that activity be increased by raising the rates? Eric investigated this idea by applying 1, 2, 3, 4, and 5 lbs AI/A of ethofumesate to a mixed stand of 80% annual bluegrass and 20% tall fescue on July 4, 1997. Some reduction in annual bluegrass turf quality was observed but no outright kill was achieved. So Eric continued to apply ethofumesate at those same rates in August, September, and October of 1997. The results observed in 1998 were astounding. Single applications of ethofumesate up to 5 lbs AI/A had no effect on annual bluegrass, but multiple applications at rates of 3, 4 or 5 lbs AI/A per application yielded good to excellent control (Table 1). These results were extremely promising since ethofumesate applications in the fall have given variable and inconsistent results. Can ethofumesate applications in the growing season give more consistent results? We set out to answer this question during 1998.

We found out several interesting pieces of information in 1998. First single applications of ethofumesate, up to 8 lbs AI/A, caused no observable injury to Penncross creeping bentgrass. Repeated applications of 2 or 4 lbs AI/A also caused no injury to creeping bentgrass. Second, the herbicidal activity of ethofumesate is greatly increased by tank-mixing with a nitrogen source. Steve Davis of AgroEvo USA had told us that urea was effective as a tank mix and this is true. We also saw increased herbicidal activity with tank-mixing with ammonium sulfate, AMS, a common additive in agricultural commodities. By using a nitrogen source, urea or AMS, and a wetting agent, the herbicidal activity of ethofumesate can be significantly enhanced so that annual bluegrass control in the growing season can be obtained at normal use rates.

Table 1. Effect of single and multiple applications of ethofumesate to a mixed stand of tall fescue and annual bluegrass turf.

Ethofumesate Rate (lbs AI/A)	Timing	Percent Annual Bluegrass
5	Jul, Aug, Sep, Oct	11* a
4	Jul, Aug, Sep, Oct	19 a
3	Jul, Aug, Sep, Oct	29 a
2	Jul, Aug, Sep, Oct	57 b
4	Jul	73 bc
1	Jul, Aug, Sep, Oct	74 bc
2	Jul	75 bc
3	Jul	81 c
Control		85 c
5	Jul	86 c
1	Jul	88 c

*Means with the same letter are significantly different by Fishers protected LSD at P=0.05.

Looking Ahead

One of the problems turf managers encountered when using ethofumesate in the past was the unpredictable results. One year ethofumesate would work great, the next year, following the same program, it wouldn't work at all. We believe much of this variability was caused by the application timing, i.e. the late fall. Thus all we knew about ethofumesate is being thrown out the window. In a sense, we are starting over in our understanding of the use of ethofumesate to control annual bluegrass.

So, 1999 is a key year. We plan to study the tolerance of the various species and cultivars that are commonly used where annual bluegrass is a problem. We will study single and sequential application programs, the effects of N sources and wetting agents on ethofumesate activity, and rates and timings of applications needed to achieve a gradual transition from mixed stands containing annual bluegrass to stands that contain minimal amounts of annual bluegrass.

Other Research Conducted in 1998

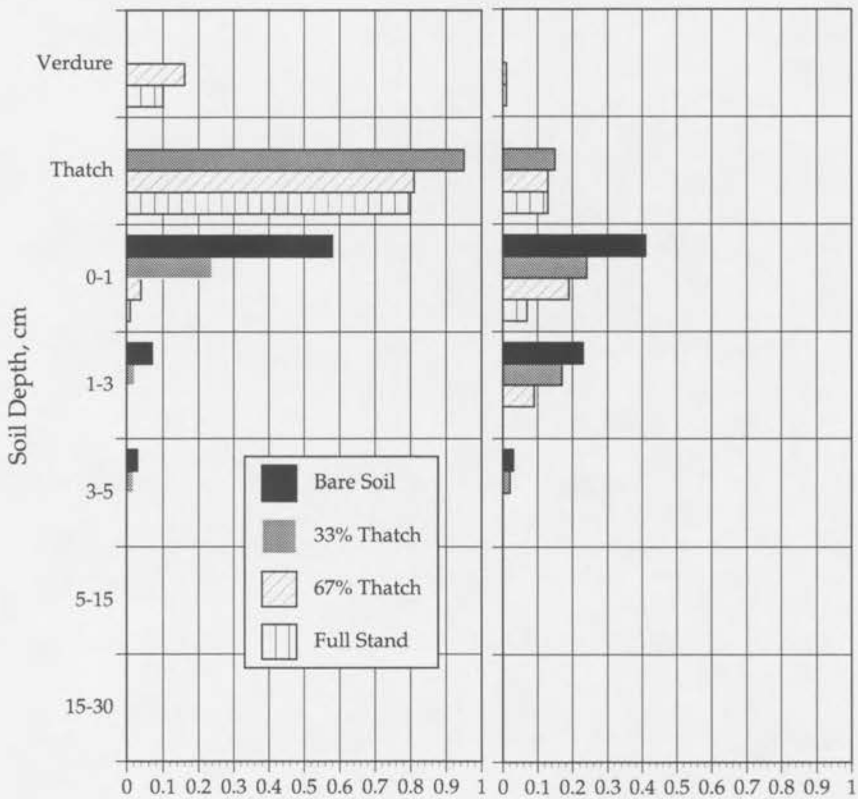
II. Dissip..

We have two projects focused on the environmental aspects of turf management. One project focuses on pesticide degradation and the second focuses on nitrogen fate in turf. The nitrogen fate project is just getting started so I'll save that story until we have a more complete picture. The pesticide fate study has reached the midway point of the project and is developing some excellent information.

Three pesticide dissipation trials have been initiated, one is completely finished, one is 80% completed, and the third was just initiated in the late summer of 1998. One trial which has been completed examined the dissipation of cyproconazole in turf versus bare soil. The purpose of the study was to attempt to quantify the effect of turfgrass on pesticide fate. We started with a creeping bentgrass turf and removed 33, 67, and 100% of the surface organic matter (turfgrass plus thatch). Thus, we had "treatments" of 100, 67, 33, and 0% turf to which was applied cyproconazole (Sentinel) fungicide at the rate of 0.33 ounces product/1000 ft^2. Intact soil cores were collected at 0, 4, 8, 16, 32, 64, and 128 days after treatment. Each core was sectioned into verdure, thatch and 0-1, 1-3, 3-5, 5-15, and 15-30 cm soil layers.

The results were dramatic. Any amount of turfgrass thatch enhanced the rate of degradation and reduced the leaching of cyproconazole. Cyproconazole half-life (the time in days to reduce soil concentration by 1/2), decreased from 129 days in bare soil to between 8 to 15 days for 33 to 100% turf cover. The effects of turf on movement and dissipation of cyproconazole is clear in the accompanying figure showing the distribution of cyproconazole at 4 and 32 DAT. Note how the quantity of cyproconazole in the thatch drops by about 75% in all three turf-conditioning treatments from 4 to 32 DAT. The bare soil drops only by about 30% in the 0-1 cm layer but the concentration in the 1-3 cm layer rises substantially. The thatch and other organic matter associated with turf provide an environment conducive to the sorption and degradation of pesticides.

Figure 1. Distribution of cyproconazole residues at 4 and 32 days after treatment.



Plant Growth Regulators and Disease Management on Creeping Bentgrass

H.T. Wilkinson, J.M. McMeans, and T.W. Fermanian

Brief Summary

In this report, we look at the potential for plant growth regulators (PGRs) (Primo and Cutless) to interact with dollar spot, brown patch and Pythium blight. This research was conducted at the turfgrass research center in Urbana using three approaches: laboratory, greenhouse, and field. The project required three years of study, and the results should be useful for all turf managers who use or have contemplated using PGR products to inhibit the growth of turf. We will describe why PGRs are suspected of interacting with turf diseases, and then summarize useful information that can be applied to turf management programs.

Plant Growth Regulators

PGRs are chemicals that affect the growth and/or the development of plants. The effect can be to increase rates of growth or development, or more commonly, to inhibit growth and/or development. PGRs can act by interfering with the meristems of a grass plant. Meristems are found in the crowns, rhizomes, and stolons. Growth is the increase in cell number or size; development is the process leading to the formation of tissues, such as leaves, shoots, rhizomes. There are two classes of PGRs: Type I and Type II. Type I PGRs inhibit both growth and development of the turfgrass plant and, in general, are more phytotoxic to grass plants. There are three different groups of Type I PGRs. Type II PGRs inhibit only growth. The subject of our report is the activity of the Type II PGRs Cutless and Primo. However, there are differences in these two PGRs. Most Type II PGRs are absorbed or taken into the plant via the roots. This is the case for Cutless, but not for Primo. Primo is taken into the plant by absorption into the leaf tissue, i.e., foliar absorption. We specifically selected these Type I PGRs because they have several important differences in addition to their point of absorption.

Cutless (fluprimidol) is a pyrimidine. You might recall another important pyrimidine that is used by turf managers, Rubigan (fenarimol). Rubigan has both growth inhibition and fungicidal properties. This has not gone unnoticed by turfgrass scientists. We wanted know if a PGR that is related to known fungicides could be acting as both a PGR and a fungicide in turf. Primo (trinexapac-ethyl) belongs to the cyclohexanetriones, and is not chemically related to the pyrimidines. In fact, we have no knowledge that this chemistry has any fungicidal activity, but it does represent a more recent PGR chemistry. Therefore, we believed that studying these two PGRs would provide better insight for turf managers into the potential non-target effects from using a PGR in their turf management program.

It is very important to you, the turf manager, to understand how a PGR could affect your disease management program. Keep in mind that PGRs have been around for over 40 years, and no major devastating disease has been attributed to their use. However, it is important to understand PGRs and how they could interact with turf diseases for two reasons. First, there is evidence that some of the newer PGRs have been observed, by both managers and scientists, to change turf disease severity. Secondly, new PGRs are being developed, and each time a new chemistry is developed for turf management it is important to understand how it will impact other aspects of your management program, including disease management.

Most of the important diseases in turf are caused by fungi. PGRs generally affect leaf or shoot growth (above ground turf parts). Generally, the most frequent and important fungi that attack the leaves and shoots are those which cause dollar spot, brown patch and Pythium blight. These fungi live in the soil and thatch of your turf. When conditions are favorable for them (not you or the turf), they grow up and onto the crowns, shoots and leaves, infecting them and producing lesions. Lesions are areas of the leaf that die as a result of fungal infection. Thus, you (and your customer) see sick (off-color) or dead grass. So the growth of and infection by the fungi lead to disease. Simply put, the fungicides that you use to control turf diseases block the fungi from attacking and causing lesions. But that is only half the battle for the turf manager. The simple, but unfortunate, truth about diseased crowns, shoots and leaves is: they do not recover. The only way to remove unsightly diseased plant tissue in a turf is to mow it off and replace it with new, healthy tissue. Keep this in mind: managing disease is a combination of slowing down the infection process and growing new turf. With this simple model for managing disease in mind, let us describe the objectives of the research reported here.

Research Objectives

1. To determine if Cutless or Primo can act like a fungicide by inhibiting the infection of turfgrass.
2. To determine if Cutless or Primo prolong the time you see disease symptoms because the grass is slower at growing new leaves.
3. To determine if it is beneficial to use fungicides with a PGR program.

What Did We Discover?

1. Pythium blight on creeping bentgrass—

   (Laboratory studies)
   A. Primo did not reduce growth of the *Pythium* fungus.
   B. Cutless did not reduce growth of the *Pythium* fungus.
   (Greenhouse studies)
   C. Primo did not reduce Pythium blight severity.
   D. Cutless did not reduce Pythium blight severity.

2. Dollar spot on creeping bentgrass—

   (Laboratory studies)
   A. Primo inhibited growth of the dollar spot fungus.
   B. Cutless inhibited growth of the dollar spot fungus.
   (Greenhouse studies)
   C. Primo did not reduce the severity of dollar spot.
   D. Cutless dramatically reduced the severity of dollar spot.
   (Field studies)
   E. Primo reduced dollar spot disease severity in the field.

   F. Cutless reduced dollar spot disease severity in the field.

3. Brown patch on creeping bentgrass—

   (Laboratory studies)
   A. Primo inhibited growth of the brown patch fungus but the inhibition was reduced after 48 hr.
   B. Cutless inhibited growth of the brown patch fungus.
   (Greenhouse studies)
   E. Primo did not reduce brown patch disease severity.
   F. Cutless did not reduce brown patch disease severity.
   (Field studies)
   G. Primo-treated turf had less severe brown patch.
   H. Cutless-treated turf had more severe brown patch

Summary statements for the interaction of Primo and Cutless with Pythium blight, on creeping bentgrass:

1. Neither PGR reduced the growth of by *Pythium*.
2. Neither PGR reduced the disease severity of Pythium blight on creeping bentgrass.
3. We did not determine if use of either PGR would retard the recovery of grass that developed Pythium blight.
4. The control of severe Pythium blight still requires the use of fungicides in a management program using PGRs.

Summary statements for the interaction of Primo and Cutless with dollar spot, on creeping bentgrass:

1. Cutless, but not Primo, has fungicidal activity against growth of the dollar spot fungus.
2. Cutless, but not Primo, reduced dollar spot severity in the greenhouse.
3. Both PGRs reduced dollar spot severity in the field, but this may be limited to seasons with low dollar spot disease pressure.
4. The use of Cutless or Primo does not appear to cause severe dollar spot.
5. It would appear that while these PGRs do slightly reduce dollar spot, the continued use of cultural and fungicidal programs are necessary when using a PGR program.

Summary statements for the interaction of Primo and Cutless with brown patch, on creeping bentgrass:

1. Both PGRs appear to have some fungicidal activity.
2. Neither PGR appears to be capable of reducing infection.
3. Primo-treated turf had slightly less brown patch, and Cutless-treated turf slightly more.
4. Fungicides for the control of brown patch are still necessary when the disease severity is high and unmanageable with cultural practices.

The Take-Home Message from the Research

Primo and Cutless can inhibit fungal growth, suppress disease, and also change the severity of diseases in turf, but this research indicates that most of the effects are slight. However, it is clear from this research that each new PGR should be studied separately, in order to characterize how it could affect disease management.

What Do Other Researchers Say?

In the only other study similar to the University of Illinois project, researchers in Georgia found that growth of the dollar spot fungus was inhibited greater by Cutless than Primo (our findings agree). In the field, Cutless was more effective than Primo in reducing the severity of dollar spot (our findings agree). However, they found Primo more effective in reducing disease severity than did we.

Turf Soils Research at Southern Illinois University-Carbondale

She-Kong Chong

Searching for a New Solution for an Old Problem

Southern Illinois University at Carbondale (SIUC) initiated their turf rooting medium research in the Fall of 1996. The first research project was working on adding amendments to sand based rooting medium to improve both chemical and physical properties of the root zone for turf growth. The amendments selected in the study were mainly focused on the materials which are locally available, economically feasible and environmentally safe for the golf course industry. This research was conducted by Mr. Chang-ho Ok, a graduate student co-advised by Dr. She-Kong Chong and Dr. Ken Diesburg, for his Master degree thesis. The amendments selected for his study included earthworm castings and treated steer manure. Since peat moss is one of the most commonly used organic materials in the root zone mix, the sphagnum peat moss was included for comparison. Results indicated that peat moss had a very low pH and CEC as compared to the earthworm castings and steer manure (Table 1). Both earthworm castings and steer manure possessed almost neutral pH. The CECs of earthworm castings and steer manure were about 5 and 21 times, respectively, higher than that of the peat moss. Table 1 also reveals that treated steer manure had a very high sodium content. Even though the fertility of earthworm castings was between the peat moss and treated steer manure, in general, the nutrient content of the earthworm castings were inconsistent depending upon the materials used in the feeding.

Physical properties indicated that total porosity and air-filled porosity of all the rooting mixtures amended with the three materials were within the range recommended by the USGA.. Hydraulic conductivity of the mixtures amended with earthworm castings and steer manure showed a similar trend but they were about twice as high as that of the mixture amended with peat moss. Results also revealed that hydraulic conductivity of the mixture amended with the three materials remained almost unchanged when the amendment rates reached 3%. Due to the lack of air-filled porosity, peat moss mixtures amended higher than 3% had a very low hydraulic conductivity and air permeability. The air permeability in mixtures amended with steer manure and the earthworm castings were almost the same and were about 2.5 times higher than that of the peat moss mixture. Results indicated that each organic material has its strengths and weaknesses to be used as an amendment alone. Therefore, it is suggested that the mixture should be prepared by mixing the amendments together at a proper rate so that a healthy rooting media can be established.

In addition to the steer manure and earthworm castings, aged saw dust, shamrock peat moss and Dakota peat moss have presently been adding to our study list. Since most of the nutrient contents of these materials are available in the literature, our research will mainly focus on the physical properties of the mixtures.

The lysimeter is On

Twenty four lysimeters were installed at the newly established turf field at the Horticulture Research Center at SIUC. These lysimeters were constructed mainly for a leaching study. All the construction work have been completed. The experimental plots, including 24 micro-plots with treatments similar to that of the lysimetes were seeded in the Fall of 1998. The purpose of this study was to examine the potential of chemical contamination in the putting green area. The rooting mixtures used for the rooting medium in the lysimeters included treated steer manure, sphagnum peat moss and the combination of the two at various rates. The leaching experiment will be started in 1999.

Turf on the Crumb Rubber

II,

A research project to evaluate the quality of turf growing on soil amended with crumb rubber was funded by the Illinois Department of Commerce and Community Affairs (IDCCA) in the summer of 1997. The main objective of this project was to evaluate the use of crumb rubber as an amendment for the amelioration of physical properties of the rooting medium for turf growth. The experimental plots were installed and completed in the summer of 1998. The experiment was conducted at two different locations. The first experiment was installed on one of the athletic fields at Southern Illinois University-Edwardsville (SIUE) campus. A similar experiment was conducted at the Horticulture Research Center at the Southern Illinois University-Carbondale (SIUC) campus. The experiment was a randomized complete block design with 11 treatments and each treatment was replicated four times. Three different sizes of crumb rubber were used in this experiment. The sizes used were 5-10 mesh, 1/4-inch and 3/8-inch. The application rates for each grade were 0 (as a check), 20, 30 and 40% by weight. Crumb rubber was roto-tilled into the soil to a depth of 6 inches. In addition, a treatment of 0% with topdressing was also included for comparison. Totally, forty-four plots were established at each location. A mixture of tall fescue and Kentucky bluegrass was used in the experiment. Presently, all the installation work have been completed.

The plot size (for each treatment) at the Horticulture Research Center (SIUC) was 2 m by 4 m. All the plots were facilitated with drainage and irrigation systems. It is our intention that in the spring of 1999 one-half of each plot will be topdressed with the 1/4-inch crumb rubber. The main reason for doing this is to examine the effect on turfgrass quality under topdress and non-topdress conditions. Presently, Mr. Richard Boniak is the graduate research assistant working on this project. For more information on this study, please contact Dr. She-Kong Chong at (618) 453-1793 or by e-mail: skchong@siu.edu, Dr. Ken Diesburg at (618) 453-1787 or Mr. Richard Boniak at (618) 453-2496.

A New Course will be Added to the Turf Curriculum at SIUC

A new course (PLSS 474) entitled "Golf Course Green Installation and Maintenance" has been approved and added to the curriculum of the turf program at SIUC. This course will be offered for the first time in the Fall of 1999 by Dr. She-Kong Chong. The objective of this new course is to provide students with a sound understanding of the rooting media related to turfgrass development and growth. The material covered in this course will mainly focus on the requirements, establishment, care and maintenance of the rooting media, particularly, of golf course putting green and turfgrass established on disturbed soils. For further information, please contact Dr. S.-K. Chong at (618) 453-1793, Fax (618) 453-7457, or by e-mail: skchong@siu.edu

Table 1. Nutrient content and chemical properties of peat moss, earthworm castings and steer manure

Properties	Peat Moss	Earthworm Castings	Steer Manure
pH	3.6	7.1	7.0
CEC, meq/100g	7	37	146
		Macro-nutrient, ppm	
P1	5	33	96
K	28,530	157	65
		Secondary nutrient, ppm	
Ca	220	6,110	10,590
S	60	60	27
Mg	110	700	2,430
		Micro-nutrient, ppm	
Zn	2	3	25
Fe	14	366	20
Mn	3	2	25
Cu	ND*	1	2
B	0.5	0.6	0.6
		Heavy metals, ppm	
Ni	1.5	1.5	1
Pb	9	8	1.1
Cd	ND	ND	ND
Na	8	22	2230
		Based-saturation, %	
Ca	16.2	83.1	36.2
Mg	13.5	15.9	13.9
K	2.5	1.1	50.0
H	67.8	ND	ND

*ND: Denotes not detectable.

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Illinois Turfgrass Calendar of Events

Indiana-Illinois Turfgrass Short Course .... February 22-26, 1999

1999 Turfgrass and Landscape Field Day .... August 5, 1999

1999 North Central Turfgrass Exposition .... November 29 - December 2, 1999

For information about these events, or to obtain additional copies of this report, contact:

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