1999 Illinois Turfgrass Research Report

A COOPERATIVE EFFORT OF THE
University of Illinois, Southern Illinois University,
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Table of Contents

Greetings 5

1999 Golf Course Fairway, Turfgrass Cultivar, and Native Plant Research 6
Tom Voigt, Luke Cella, and Darin Lickfeldt

Precision Turfgrass Management 10
Tom Fermanian, Hye-Yun Jeong, and Mark Schmidt

Summary of Turfgrass Breeding Research 14
Andy Hamblin, Nicolle Hofmann, Amy Forbes, Dan Dinelli, Darin Lickfeldt, and Joyce Jones

Modern Turfgrass Diagnostic Services for Illinois 17
Henry T. Wilkinson

Weed Control and General Turfgrass Research 18
Bruce Branham, Hongfei Jiang, Joe Meyer, Dave Gardner, and Brian Horgan

Biological Management of Turfgrass Diseases 24
Henry T. Wilkinson

Turf Soils Research at Southern Illinois University-Carbondale 26
She-Kong Chong

Zoysiagrass for Central and Northern Illinois? 30
Kenneth L. Diesburg

Acknowledgments 32

Illinois Turfgrass Personnel 34

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 *1999 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, providing you with the latest in turf management techniques and technology.

If you have not seen the research report in the last few years, the format has also changed. Each participant conducts considerable research and education over the year. Oftentimes, the results of this research are preliminary or only describe 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 author's 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 our research and education possible. Without the **ITF**, it would be difficult to maintain the high-quality turfgrass research programs 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 page 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 *1999 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.

1999 Golf Course Fairway, Turfgrass Cultivar, and Native Plant Research

Tom Voigt, Luke Cella, and Darin Lickfeldt

During 1999, several studies were completed in our program. Results and recommendations are presented in this article.

Kentucky Bluegrass Fairway Evaluation

This project was planted in September, 1995, at the Landscape Horticulture Research Center, Urbana, IL, and the Purdue Agronomy Research Center in West Lafayette, IN. The objective of this study is to evaluate the morphological characteristics of twenty-five Kentucky bluegrasses to determine the suitability of each cultivar for use as a fairway turf. The Kentucky bluegrass cultivars were maintained under fairway conditions in Urbana (irrigation, 4#N/M/year, 0.875" mowing height) and West Lafayette, IN (irrigation, 4#N/M/year, 0.75" mowing height). In each case, the study has a randomized complete block design with three replications. From 1996 through 1998, the cultivars were evaluated for turfgrass quality (a combination of turf density, uniformity, color, etc.). In 1998 (Urbana only) and 1999 (Urbana and West Lafayette) the cultivars underwent extensive morphological measurements related to golf course fairway conditions, including shoot counts, leaf angle measurements, leaf texture, and thatch development (Tables 1 and 2).

Table 1. Kentucky bluegrass cultivar quality and tiller counts from Urbana, IL and West Lafayette, IN.

Cultivar	96-98 IL Quality	96-98 PU Quality	98 IL Tiller Count	99 IL Tiller Count	99 PU Tiller Count
Absolute	6	6.4	74.3 cd	60.7 b-f	102 g-i
Allure	5.6	5.9	72.7 bcd	59.0 b-e	84 b-e
America	5.7	6.8	73.4 b-d	61.7 b-g	104.9 hi
Award	5.4	6.1	77.1 c-e	69.6 e-g	88.4 d-g
Baron	4.7	5.5	73.7 b-d	68.4 d-g	76.6 b-d
Challenger	5.1	6	60.3 a	53.0 bc	72.3 a-c
Conni	5.6	6.2	114.7 g	89.7 ij	120.2 j
Eclipse	5.5	6.1	66.4 ab	50.9 a-c	81.7 b-e
Explorer	5.7	5.4	93.7 f	75.1 gh	100.6 f-i
Glade	5.3	5.8	74.6 cd	58.8 b-e	86.3 c-f
Kenblue	4	3.4	61.6 a	49.8 ab	60.4 a
Limousine	5.4	6.5	113.8 g	115.2 k	165.3 l
Midnight	5.5	6.3	72.9 b-d	55.2 b-d	91.9 e-h
North Star	6.3	6.1	116.8 g	98.2 j	143 k
NuGlade	5.9	5.8	80.2 de	61.3 b-g	105.4 h-j
Odyssey	5.8	5.9	69.7 bc	67.9 d-g	81.7 b-e
Princeton 105	5.6	6.1	79.4 de	63.8 c-g	80.7 b-e
Rambo	5.5	6.2	79 de	84.2 hi	109.8 ij
Raven	5.5	5.5	75.3 cd	62.2 b-g	88.9 d-g
Rugby II	5.9	5.9	79.6 de	73.0 f-h	88.3 d-g
Serene	5.4	5.9	78.3 de	68.4 d-g	100 f-i
SR 2000	6	5.3	58.7 a	38.8 a	70.7 ab
SR 2109	5.6	6.1	84.9 e	63.9 c-g	78.2 b-e
Total Eclipse	5.8	6	74.4 cd	62.6 b-g	80.9 b-e
Wildwood	5.5	5.9	95 f	73.1 f-h	102.1 g-i
LSD 0.05			7.8	14	15

Mean quality ratings are based on the average of three replications evaluated once per month during the growing season where 1 = dead turf, 5 = minimally acceptable turf quality, and 9 = perfect turf quality (Table 1). Mean quality ratings for 1996-98 are shown in columns 2 and 3 for Illinois and Purdue, respectively. Mean tiller counts also occur in Table 1 (columns 4, 5, and 6). These means represent counts of 3 plugs per replication and a plug size of 2 cm x 13 cm. There were significant density differences among cultivars at each rating. Mean density (tillers/26.0 cm^2) ranged from 38.8 ('SR 2000') at Illinois in 1999, to 165.3 ('Limousine') at Purdue in 1999. Because turf density is a highly desirable fairway characteristic, cultivars with the highest mean ranking were considered to be the most attractive. 'Limousine', 'North Star', 'Conni', 'Rambo', and 'America', ranked as the densest cultivars.

There were also significant differences in thatch depth at each of the three ratings (Table 2, columns 2, 3, and 4) when the thatch layers (mm) of three plugs per replication were measured. Because it supports the golf ball, improves wear tolerance, and is an indicator of turf growth rate, moderate thatch is a desirable fairway characteristic. Overall, cultivars that ranked highest in thatch measurements were 'North Star', 'America', 'Award', 'Princeton 105', and 'Eclipse' when all rankings were averaged. Those cultivars that produced the least amount of thatch were 'Midnight', 'Challenger', 'Wildwood', 'Glade' and 'Kenblue'.

Table 2. Kentucky bluegrass cultivar thatch depth and leaf angles from Urbana, IL and West Lafayette, IN.

Cultivar	98 IL Thatch Depth	99 IL Thatch Depth	99 PU Thatch Depth	98 IL Leaf 2 Angle	99 IL Leaf 2 Angle	99 Purdue Leaf 2 Angle
	mm			%		
Absolute	13 d-h	9.1 a-e	10.4 gh	52.2 c-e	49.3 b-e	58.5 b-f
Allure	13.2 e-i	12.2 e-i	7.1 a-d	49.4 a-d	35.7 a	55.9 b-d
America	13.3 e-i	12.1 e-i	13.7 i	66.5 g-i	55.1 c-g	68.9 g
Award	14 f-i	13.7 g-i	9.4 d-h	63.9 f-h	63.2 gh	61.9 b-g
Baron	11.2 b-d	14.0 hi	9 c-h	45.6 a-c	48.0 bc	60.5 b-g
Challenger	11.7 b-e	9.0 a-e	6.6 ab	69.4 h-j	60.1 f-h	67.9 fg
Conni	12.9 d-h	11.3 d-i	7.6 a-f	50.1 b-d	52.1 b-f	58.6 b-f
Eclipse	12.8 c-h	11.4 d-i	10.6 gh	57.0 d-f	54.1 b-g	60.5 b-g
Explorer	12.2 b-f	10.0 a-f	9.8 f-h	51.3 cd	47.6 bc	53.1 b
Glade	11.9 b-e	11.0 c-h	6.4 a	59.6 e-g	66.3 h	67.0 fg
Kenblue	7.9 a	8.2 a-d	9.6 e-h	42.2 ab	54.1 b-g	54.6 bc
Limousine	13.1 e-i	10.4 b-g	7 a-c	41.4 a	49.2 b-d	42.6 a
Midnight	10.6 b	7.0 a	7.7 a-f	67.5 g-i	59.0 e-h	63.7 c-g
North Star	17.9 j	14.7 i	9.1 c-h	44.8 a-c	51.5 b-f	55.1 b-d
NuGlade	12.8 c-h	9.1 a-e	10.3 gh	77.5 j	63.3 gh	63.6 c-g
Odyssey	13.3 e-i	12.9 f-i	7.4 a-f	72.7 ij	59.0 d-h	63.9 c-g
Princeton 105	14.9 i	12.1 e-i	7.7 a-f	63.6 f-h	59.7 f-h	64.7 d-g
Rambo	14.3 hi	7.8 a-c	9.8 f-h	57.5 d-f	55.0 c-g	56.7 b-e
Raven	11.2 b-d	10.0 a-f	9.2 c-h	45.1 a-c	52.1 b-f	66.8 fg
Rugby II	13.3 e-i	11.3 d-i	8.9 b-h	54.4 de	57.2 c-h	62.0 b-g
Serene	12.3 b-g	10.2 a-f	9 c-h	52.2 c-e	44.5 ab	60.1 b-g
SR 2000	14.1 g-i	11.9 e-i	7.2 a-e	68.8 hi	53.6 b-g	56.1 b-d
SR 2109	12.1 b-e	11.4 d-i	8.6 a-h	62.8 f-h	50.5 b-f	56.5 b-e
Total Eclipse	12.1 b-e	11.9 e-i	10.7 h	65.0 f-i	53.5 b-g	66.0 e-g
Wildwood	11 bc	7.6 ab	8.2 a-g	64.4 f-h	57.1 c-h	83.6 h
LSD 0.05	1.8	3.4	2.4	8.2	9.8	9.8

It is believed that narrow turfgrass leaf angles create more favorable fairway conditions than wide leaf angles because of an upright growth habit and an increased ability to support the golf ball. The angle of the 2nd leaf on eight tillers per replication was measured; mean leaf angles ranged from 35.7 degrees ('Allure') at Illinois in 1999, to 83.6 degrees ('Wildwood') at Purdue 1999 (Table 2, columns 5, 6, and 7). The cultivars with the narrowest leaf angle rankings were 'Limousine', 'Allure', 'Explorer', 'North Star', and 'Kenblue'.

The combined results of turf quality evaluations, along with the morphological measurements (tiller count, thatch depth, and leaf angle) leads us to speculate that of the 25 Kentucky bluegrasses cultivars evaluated, 'North Star', 'Limousine', 'Conni', 'Absolute', 'America', and 'Rambo' have the greatest potential for successful fairway use. Additional trials, however, will be conducted to evaluate characteristics such as ball position and recovery following divot creation prior to making recommendations. In addition, we intend to evaluate the effects of different management regimes such as mowing heights and the applications of growth regulating compounds and fertilizers.

Turfgrass Cultivar Research

During 1999, six National Turfgrass Evaluation Program (NTEP) studies were underway at the Landscape Horticulture Research Center in Urbana, IL, and a seventh at North Shore Country Club, Glenview, IL. Planted in Urbana are the high (102 cultivars) and low (21 cultivars) maintenance Kentucky bluegrass trials, bentgrass fairway (26 cultivars) and putting green (29 cultivars), and fine (79 cultivars) and tall (130 cultivars) fescue trials; in Glenview, a creeping bentgrass putting green trial (18 cultivars) is being evaluated.

In September, 1999, two NTEP perennial ryegrasses trials were planted. Both trials are comprised of 134 cultivars. The first, planted at the Landscape Horticulture Research Center in Urbana, will be maintained at athletic turf height. The second was planted on the twelfth fairway Blue at the U. of I. Golf Course in Savoy and will be used to evaluate gray leaf spot resistance.

Perennial Ryegrass Recommendations

Completed in Urbana in October, 1998, the 1994 NTEP Perennial Ryegrass Trial evaluated 98 cultivars. This trial was maintained at 1.75", irrigated to prevent stress, and received 3-4 pounds nitrogen per 1,000 ft.^{2} per year. The trial was also treated with pre- and postemergence herbicides to control annual grass and broadleaf weed invasions. Based on results of this evaluation, the following cultivars are recommended.

*Table 3. Recommended perennial ryegrasses following completion of the 1994 NTEP Perennial Ryegrass Trial.**

Academy	Buccaneer II	Montery	Quickstart	SR 4200
Accent	Calypso II	Palmer III	R2	SR 4400
Achiever	Dancer	Panther	Riviera II	Stallion Supreme
Assure	Edge	Passport	RPBD	Williamsburg
Blackhawk	Majesty	Precision	Sonata	Wind Star

*Recommended types have performed at the mean, or above the mean, in 20 of 27 ratings from April, 1995 through October, 1998.

These ryegrasses can be added to the list of previously recommended types.

Table 4. Recommended perennial ryegrasses prior to completion of the 1994 NTEP Perennial Ryegrass Trial.

Advent	Brenda	Diplomat	Omega II	Repell
Allaire	Caliente	Elka	Ovation	Repell II
APM	Citation II	Equal	Palmer	Rival
Barage++	Dandy	Express	Patriot	Runway
Barry	Dasher	Gator	Pennant	Seville
Birdie II	Delray	Gettysburg	Pinnacle	Tara
Blazer II	Derby	Goalie	Prelude	Target
		Manhattan II	Ranger	Yorktown III

Evaluation of Native Midwestern Plants for Use in the Golf Course Landscape

This project was finished at the conclusion of the 1999 growing season. Taking place at three Chicago area golf courses, Cantigny Golf Club, Wheaton; Olympia Fields Country Club, Olympia Fields, Illinois; and Skokie Country Club, Glencoe, Illinois, its primary objective was to evaluate native grasses, sedges, and forbs to determine their usefulness in unmowed areas of Midwestern golf courses. In addition, a data base of native Midwestern plant information is being developed.

During the summer of 1997, full sun and open shade areas were planted and established at each golf course. Thirty species were planted in full-sun areas and twenty-eight species were planted in partial-shade areas. Table 5 list plants that performed acceptably at least two of the sites during the study.

Table 5. Recommended native plants established in full-sun and partial-shade areas of three Chicago-area golf courses.

Full-Sun Entries (height in feet)	Partial-Shade Entries (height in feet)
Allium cernuum, Nodding Wild Onion (2-3)	*Allium cernuum,* Nodding Wild Onion (2.5)
Andropogon hallii cv. *U. I.,* U. of I. Sand Bluestem (4-7)	*Aster novae-angliae,* New England Aster (1-3)
Asclepias sp., Milkweed (4)	*Carex pensylvanica,* Common Oak Sedge (0.5-1)
Bouteloua curtipendula, Side-oats Grama (3)	*Carex radiata (rosea),* Straight-styled Wood Sedge (0.5-1)
Deschampsia caespitosa, Tufted Hair Grass (1.5-4)	*Deschampsia caespitosa,* Tufted Hair Grass (1.5-3)
Desmodium canadense, Showy Ticktrefoil (1-3)	*Dodecatheon meadia,* Shooting Star (1-1.5)
Eryngium yuccifolium, Rattlesnake Master (4-6)	*Hystrix patula,* Bottlebrush Grass (2-3)
Heliopsis helianthoides, False Sunflower (3-4)	*Iris virginica shrevei,* Wild Blue Iris (2-3)
Iris virgincia shrevei, Wild Blue Iris (2-3)	*Lobella siphilitica,* Great Blue Lobelia (2-3)
Liatris aspera, Rough Blazing Star (2-4)	*Phlox divaricata,* Blue Phlox (0.5-1)
Lythrum alatum, Winged Loosestrife (1-2)	*Rudbeckia triloba,* Brown-eyed Susan (3)
Monarda fistulosa, Wild Bergamot (3-4)	*Solidago flexicaulis,* Broad Leaved Goldenrod (1.5-3)
Penstemom digitalis, Foxglove Beard Tongue (3)	*Solidago ulmifolia,* Elm Leaved Goldenrod (2)
Pycnanthemum virginianum, Common Mountain Mint (3)	*Uniola latifolia,* Spike Grass (2-3)
Ratibida pinnata, Yellow Coneflower (3-5)	*Zizia aurea,* Golden Alexander (2-3)
Sanguisorba canadensis, American Burnet (2)	
Solidago rigida, Stiff Goldenrod (3-6)	
Vernonia fasciculata, Common Ironweed (3-4)	
Veronicastrum virginicum, Culver's Root (3)	

Precision Turfgrass Management

Tom Fermanian, Hye-Yun Jeong, and Mark Schmidt

1999 Activities

Graduate students in my program and I are focusing on the development of new technologies to provide better communication and information to the turfgrass industry and to assist you in safeguarding the environment. This technology development is occurring within three major projects. The development of a decision support tool for selecting turfgrass cultivars, evaluation of site-specific turfgrass management techniques, and the evaluation of total nonstructural carbohydrate (TNC) accumulation in bentgrass fairways are either new or ongoing projects in 1999.

Cultivar Selection Expert System

One of the simplest and most long-lasting methods of maintaining a healthy turf is the correct selection of plant materials for turf establishment or renovation. The United States Golf Association (USGA) research program, which began over 15 years ago, considered cultivar improvement as one of the most important research areas. They have since provided millions of dollars to turfgrass breeding efforts providing turfgrass cultivars that thrive in almost any situation.

Likewise, the National Turfgrass Evaluation Program (NTEP) has been active for an even longer period of time to provide unbiased evaluation of cultivar performance under various turf conditions. NTEP has supported turf evaluation trials for all of the major turfgrass species in almost every state in the U.S. Each species trial runs for a period of five years and then is replaced with a new set of cultivars. The results of NTEP investigations are summarized in both annual reports and in a five-year final report. The reports can be obtained directly from NTEP (Kevin Morris, Executive Director, National Turfgrass Evaluation Program, 10300 Baltimore Ave. Bldg. 002, Rm. 13, Beltsville Agricultural Research Center-West, Beltsville, Maryland 20705) or can be viewed on the Internet at www.ntep.org.

Interpreting the results of the NTEP reports can be a difficult task. Some cultivars do well at one site, but not so well at another. Not all the old cultivars are added to the replacement trial so there might be limited data on their performance. Following Tom Vogt's research, Miss Hye-yun Jeong (a Ph.D. student) is investigating the potential for developing a web-based software application to provide decision support in selecting Kentucky bluegrass cultivars. In essence, the tool would query a user for information pertaining to the management and conditions at an intended site of establishment or renovation and suggest a short list of Kentucky bluegrass cultivars that performed best under similar conditions. A program has been developed, called ML-tool to provide the initial cultivar performance analysis.

Even though this is relatively simple, it might be very helpful to a turf manager by conducting the cultivar performance analysis quickly and leaving the final selection to the manager. The development of this system is currently underway and should be completed by next year.

Precision Turfgrass Management

"Precision agriculture" has slowly moved into our vocabulary. Most of the major agricultural equipment manufacturers have active programs to expand their use of this technology. While there are several commonly used definitions, precision agriculture encompasses the use of global positioning systems (GPS) and geographical information systems (GIS) to provide information controlling mechanisms for uniquely defined areas of a production field. In theory, the smaller the uniquely defined areas, the greater the possible savings of inputs such as fertilizer and pest control.

Both John Deere and Toro companies are actively pursuing the same technology for application to turf. While the required precision might be greater, the ultimate goal is still the same. Precision turf systems are being developed to reduce input costs, gain greater turf quality and help to safeguard the environment. When and if these goals are reached is certainly a good question, currently without an answer.

The availability of precision turfgrass management systems requires development in three different, but connected, areas. First, mechanisms for accurately scouting turfs to develop zones of management must be developed and verified. Initial research in the use of automated sensors to map zones of management is 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. In the past we have been developing a prototype for this type of system, Golf Course Management System (GCMS). 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 application hardware to precisely deliver management operations to each selected area in the same time frame as normal maintenance operations. Several manufacturers are developing precision spraying equipment. When this equipment becomes available, it should be evaluated under research conditions in order to establish its value and accuracy.

Mark Schmidt, a Ph.D. student, has recently joined my program. Mr. Schmidt is the Program Manager of Precision Turf Care at John Deere. I will be taking sabbatical study for the next nine months and joining Mark in Moline, IL to focus on the development of the first two components of a precision turf system.

Carbohydrate Accumulation in Bentgrass Fairways

Most turf managers understand that plant stress from any source can lead to reduced turfgrass quality. Stress on the turf can come from the environment, management practices or pests. As stressful forces are imposed on the turf, they are generally detected by a visual reduction in turf quality or vigor. At this point, however, it may be difficult to restore the turf to a state of good health.

A tool that might revolutionize the way turfs are maintained is one that would allow the turf manager to "see" stress before it becomes "visible" as damage to the turf. A study was initiated in the fall of 1997 to evaluate the use of TNC or plant sugars as an indirect measure of impending turf stress.

The study was designed to look at the response of eight different bentgrass cultivars to an imposed stress. A stress that we can control to some degree is mowing stress. All plots were mowed at one of three different heights, 0.25, 0.50 or 0.75 in. (figure 2). This range of heights goes from well below normal fairway mowing heights to a height that is generally too high. In theory, the plots mowed at 0.25 in. should be under the greatest stress.

Near-infrared (NIR) technology is being used in many other areas examining biological objects. The dairy industry uses it to examine milk quality. It is used in many other industrial applications. NIR technology has been proposed in previous turfgrass research as a tool to measure turf stress. A NIR sensor can be used to evaluate the levels of plant sugars or TNC in the turf. Since carbohydrates are the byproduct of photosynthesis, their accumulation should indicate a healthy plant.

The use of sensing devices attached to mowers or sprayers is considered an important part of any precision turfgrass management system. The sensors will provide one stream of information among many to provide scouting data as input

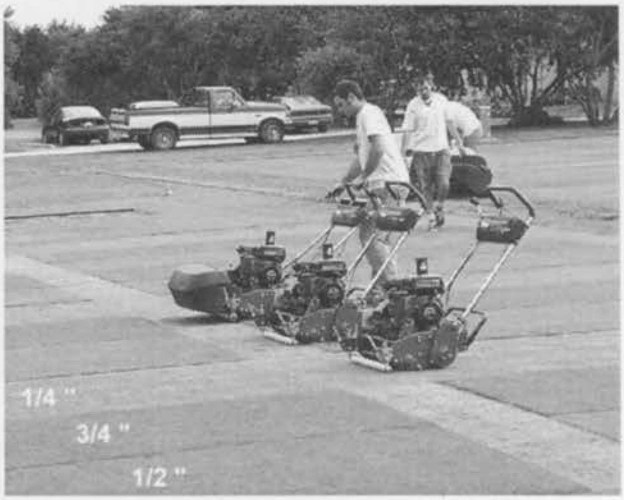


Figure 2. Creeping bentgrass fairway study at three mowing heights to impose different levels of stress. I wish to acknowledge the generous use of the Toro walking greens mowers shown in the figure from Modern Distributing, Inc.

to the turf manager. Both optical and near infrared sensors are being evaluated for their potential use on turf.

In order for this technique to be useful in a precision turf operation, we need to understand how the carbohydrates levels change across a season in a healthy bentgrass fairway. If a correlation can be established between turf stress and TNC levels, near infrared sensors have the potential to measure these compounds directly in the field.

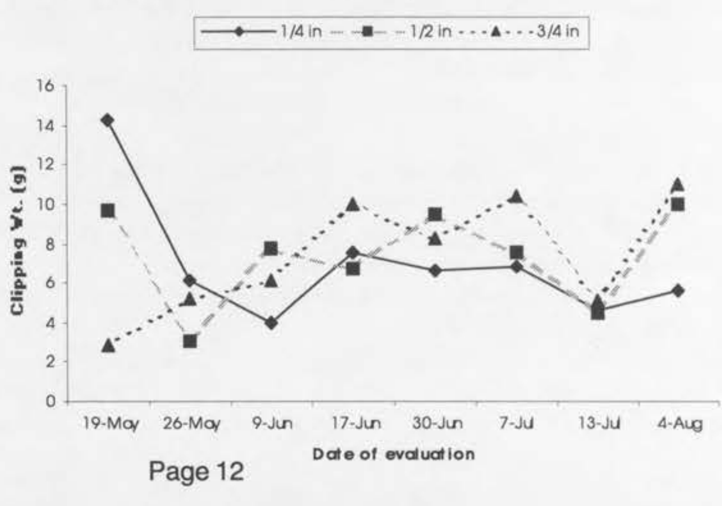
Preliminary Results

In the summer of 1998, TNC was evaluated on two days in August and one in September. Significant differences in TNC accumulation among the cultivars were observed for each date. For two of the dates, significant differences in TNC accumulation among the three mowing heights were also observed. The cultivars Penncross, Southshore and Crenshaw generally had the lowest percentage of TNC. Seaside II and L-93 generally had the greatest accumulation of TNC. The 0.25 and 0.50 in. mowing height plots accumulated more TNC than plots mowed at 0.75 in. These results are very early in the study and no trends should be assumed.

Additional clippings have been collected from the plots in 1999 for evaluation of TNC. The results of this evaluation will not be known until later in the year.

The dry weight of collected clippings was also measured throughout the summer. In order to understand TNC accumulation, it is important to compare TNC levels to the relative growth rate of the turf. Figure 3 presents the relative growth rate, averaged over all of the cultivars, at each mowing height from early May through August. There was one additional date of evaluation on Oct. 22, 1999 (not shown). Significant differences in mean clipping weights were observed at every date of evaluation, except for 7/14/99.

Figure 3. Clipping yield of bentgrass fairway at 3 mowing heights on 8 dates in 1999.



The data shows a gradual increase in growth until early July when a dramatic reduction growth is seen at all three mowing heights. Additionally, the lowest mowing height had the least growth as expected. What was unusual, however, was the reversal of this trend both early in the season (5/19/99) and late (10/22/99) where the greatest growth was observed at the 0.25 in. mowing height.

In early June 1999 the plots became infected with the disease, Dollor spot (*Sclerotina homoeocarpa*). This provided an excellent opportunity to evaluate the eight cultivars for their potential to resist Dollar spot infection (figure 4). Both Crenshaw and Penncross appeared to be relatively susceptible to Dollar spot.

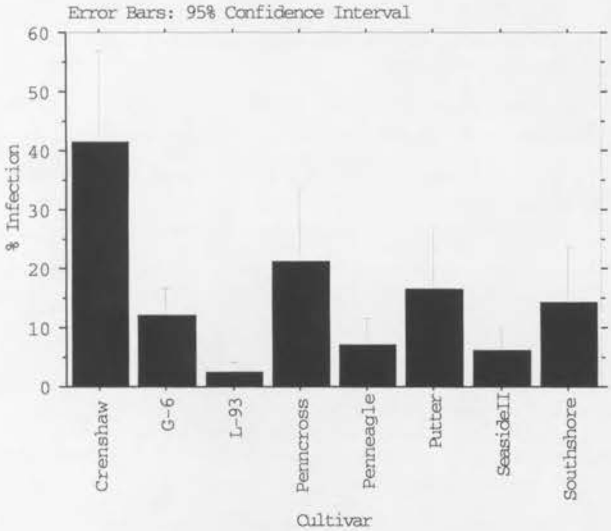


Figure 4. Percent of bentgrass plot area infected with the disease Dollar Spot on June 17, 1999. Each mean is the average of all three mowing heights.

Projected Activities for Next Year

As I presented in the 1998 Illinois Turfgrass Research Summary, the mechanism for obtaining samples of turf for TNC analysis is critical in this early work. Samples are taken directly from the mower basket, frozen in liquid nitrogen and held at freezing temperatures until they can be freeze-dried. This is a mechanism of removing all of the water from the sample without raising the temperature above freezing.

Our greatest limitation to processing the over 1200 samples we currently have in freezer storage is the unavailability of a freeze-drier. The facility used for the 1998 samples is currently not available. Due to the generous support of the ITF, I was able to persuade campus administrators to provide $34,000 to the project to purchase a large-scale freeze-drier. This apparatus will be able to process one month's worth of samples at a time. The drier will not be operational however, until after January 2000.

Due to the delay in processing of the 1999 samples, the spring and summer of 2000 will be very busy preparing, scanning, and analyzing samples. Therefore, the results of this study will not be available until late 2000 or early 2001. Even without the final results, we have learned a number of interesting and useful pieces of information from the study.

Information You Can Use

- The cultivars Crenshaw and Penncross were very susceptible to Dollar spot infestation, while the other cultivars in the study showed some degree of resistance to infection, especially L-93.
- Closer mowed turf grows fast this in spring and fall, while taller cut turf grows faster than the lower mowing height turf during midsummer.

Summary of Turfgrass Breeding Research

Andy Hamblin

Breeding for Gray Leaf Spot Resistance

Nicolle Hofmann and Andy Hamblin

Gray leaf spot is rapidly increasing in importance as a turf disease in Illinois and throughout the United States. Over the past two years gray leaf spot has caused near-epidemic devastation on perennial ryegrass in the Midwest and Mid Atlantic states. This is especially problematic when overseeding golf course fairways and roughs or athletic turfs with perennial ryegrass 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 short sighted to depend solely on fungicides for disease control, because of the possibility 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 from those currently available. No other private or public breeding program in the United States is actively isolating gray leaf spot resistance in perennial ryegrass, so the *University of Illinois* is especially well-positioned as the primary resource for resistance. The objectives of these studies are:

-Confirm the lack of resistance available in commercial varieties (Table 1)
-Compare the efficacy of greenhouse ratings with resistance in field plots.
-Identify resistant sources from worldwide collections of perennial ryegrass through greenhouse and field screening (Table 2).
-Determine the number of genes responsible for gray leaf spot resistance, identify how they are inherited, isolate genes using DNA methods, and identify how to efficiently move these genes into adapted germplasm.

Table 1. Commercial perennial ryegrass varieties included in our 1999-2002 gray leaf spot field evaluations.

ASP 400	Cutter	Calypso II
ASP 410	Morningstar	Penguin
Precision	Brightstar II	SR 4330
Premier II	Navajo	Omni
BAR LP 895-1	Quickstart	SR 4200
Nighthawk PRG	Citation III	NJPR
Secretariat	Windstar	4PSU
Repel III	Stardance	4CCOR97
Prelude III	Omega 3	Allaire II
Palmer III	Brightstar	Caliente
Pick F3	Saturn II	Esquire
Sunshine	Catalina	WX3-93
Racer	PST-2CB	Vivid
Riveria II	Roadrunner (2ET)	Cathedral
Achiever	Chaparal (2DLM)	Seville
Blazer III	Sonata (2R3)	Midnight (kbg control)
Express	Manhattan III	

We are in the process of screening in the greenhouse USDA plant introductions, commercial sources, and backcrossed lines to identify resistance. This process has been continual since the Spring of 1999. We have identified some potential candidates for mapping studies and gene introgression. We have also space planted 200 USDA accessions in replicated field trials to correlate resistance found in the greenhouse. Commercial evaluations include two plots of standard and experimental entries, and an ancillary NTEP evaluation on a golf course in cooperation with Tom Voigt. From preliminary research, we do not expect to see gray leaf spot resistance present in commercial material. This emphasizes the need for new and different genetic materials in the search for resistance.

From a purely genetics standpoint, our study of gray leaf spot resistance will promote the development of genetic maps and may eventually lead to in-depth molecular studies to identify the function and expression of these genes. It will also allow comparative mapping to identify DNA sequence homologies with tall fescue, annual ryegrass, rice, and other cereal grasses. Our research puts us at the threshold of many exciting ventures that few have explored in turfgrass genetics. The successful accomplishment of this research will place the University of Illinois at the forefront of disease resistance genetics in turfgrasses and, ultimately, will enable the continued use of perennial ryegrass in the U.S. for years to come. Understanding perennial ryegrass genetics as a model system for cool season turfgrasses will provide additional insight into the genetics of other grasses as well.

Table 2. Mean percent disease severity of perennial ryegrass accessions to gray leaf spot following inoculation in the greenhouse.

Entry	Origin	Mean %	PI	Origin	Mean %
321681	France	21.70	170521	Turkey	41.70
303044	Belgium	23.30	303041	Netherlands	41.70
403849	Canada	25.00	418723	Luxembourg	42.22
420125	Japan	26.10	272121	Poland	42.80
422478	Germany	26.10	231605	Portugal	43.30
403848	Canada	29.40	198070	Sweden	43.90
403873	Canada	32.80	303025	Denmark	45.00
462339	New Zealand	32.80	182857	Czech	46.70
303015	Denmark	33.30	231572	Algeria	47.80
403870	Canada	33.90	223385	Iran	48.30
403839	Canada	34.40	418738	France	48.30
403853	Canada	35.60	311072	Romania	48.90
197270	Finland	36.10	306692	Poland	50.60
303019	Netherlands	36.70	220528	Afghanistan	51.70
303036	Denmark	37.20	303043	Belgium	52.80
418717	Italy	37.80	200322	Denmark	53.30
371952	Bulgaria	38.30	403861	Canada	56.67
284821	Australia	38.90	220178	Afghanistan	62.22
287850	Spain	39.40	311075	Romania	63.33
231565	Libya	41.00	220597	Afghanistan	72.80

LSD = 14.17

DNA Marker Diversity of Perennial Ryegrass

Amy Forbes and Andy Hamblin

Research was recently completed which focused on the study of genetic diversity in perennial ryegrass. Genetic diversity is the most fundamental concept in plant breeding. Without it, progress from plant selection is impossible. Therefore, we set out to answer several questions deemed essential to this process. Our test materials were the most diverse sources currently available, all coming from the National Plant Germplasm System of the USDA. These plant collections consist of worldwide resources representing every continent in the world, and virtually everywhere that perennial ryegrass is grown.

First we wanted to know how the genetic diversity *within* accessions compared to the variation *between* accessions based on DNA markers (specifically RAPDs, or Random Amplified Polymorphic DNA). A technique known as Analysis of Molecular Variance was used to test our hypotheses. We found that over 90% of the total variation was found *within* accessions, while only 8.6% of the variation occurred *between* accessions. This tells us that although DNA markers are different between plants from different collection sites throughout the world, considerable marker variation exists within a collection itself. This is due primarily to the outcrossing nature of perennial ryegrass.

Secondly, it was important for us to confirm evidence that states that perennial ryegrass originated close to the Mediterranean Sea. We bulked DNA from 12 individuals from 338 different USDA accessions to enhance the possibility of assessing *between* variation in worldwide collections. We used cluster analysis to distinguish differences between these collections. Basically, three large clusters were produced which were subdivided further into seven clusters. Clear trends were observed between DNA marker similarities and sampling locations. For instance, plants sampled from China generally fell within the same cluster. The ***most interesting*** feature of this clustering was that cluster 7, which is the most diverse cluster and is the least similar to the other clusters, contained mostly individuals from Algeria, Spain, Portugal, and Morocco. This clearly identifies the Mediterranean Sea as the point of origin for perennial ryegrass. As you move away from this area, you begin to lose markers (which we can assume are gene segments), hence decreasing genetic diversity.

In summary, progress from selection for most traits, given adequate natural and/or artificial selection pressure, will be effective when using USDA resources. However, when searching for rare genes that are not found elsewhere, it is then necessary to move closer to the point of origin. This phenomenon is apparent when considering the situation we have with gray leaf spot. The process of continual selection for turf-type characteristics in U.S. germplasm has led to a decrease in diversity and absence of genes necessary for gray leaf spot resistance. This situation requires searching outside of U.S. resources and delving into materials closer to the point of origin.

Blending Creeping Bentgrasses for Brown Patch Resistance

Andy Hamblin, Amy Forbes, and Dan Dinelli

We completed a study over the summer of 1999 to identify the relative proportion of 'Providence' and 'A-4' creeping bentgrass in a 50:50 blend using DNA fingerprinting. Dinelli observed that brown patch susceptibility in the blend was equal to the susceptible 'A-4' in monoculture. We found that this blend was unsuccessful in providing protection from brown patch because the composition was only 26% 'Providence', while 'A-4' made up the remaining 74%. This information will be submitted for publication toward the end of the year.

Aggressiveness of Kentucky Bluegrasses in Blends

Darin Lickfeldt, Joyce Jones, and Andy Hamblin

We recently identified DNA fingerprints to distinguish between six Kentucky bluegrass varieties commonly used in Illinois blends for seed distribution and sod production. Each of these varieties were planted in monoculture and in 2- and 3-way blends. We will evaluate these plots over several years using DNA methods to identify the varietal composition over time. We also sampled a golf course planted with three of these varieties to identify relative composition in a natural setting. We expect to use this information to determine the value of blending bluegrasses for commercial use.

Other Research Projects

-Evaluation of USDA perennial ryegrass resources (National Plant Germplasm Review Board).
-Low water requirements for turfgrass species (Scotts Company).
-Evaluation of grasses for low maintenance requirements (Summit Seed).

Modern Turfgrass Diagnostic Services for Illinois

Henry T. Wilkinson

"We Can Always Help You Manage Your Turf Problems"

Together, the Illinois Turfgrass Foundation (ITF) and Professor Henry T. Wilkinson have developed the best turf diagnostic service program in the country. Dr. Wilkinson is a world renown turfgrass pathologist and has used his knowledge and experience to solve turf disease problems from all corners of the globe. However, this service was developed specifically for the turf managers of Illinois. Through the development of a modern laboratory and communications system on the Urbana-Champaign campus, Professor Wilkinson can assist a turf manager in solving his problems. His program is staffed with an exceptional diagnostician, funded by the Mid-America Sod Producers. His modern service program uses state-of-the-art computer communications that allow the sending of digital pictures of problematic turf to his desk. His laboratory is fully equipped to evaluate the health of turf, identify the pathogens attacking it, and determine both the cause and solution for improving turf. Supported by the ITF, he has been able, through research, to develop DNA testing methods that more accurately and rapidly identify the pathogen attacking turf. In addition, soil can be analyzed for texture, toxins, organic matter, and nematodes.

How the Diagnostic Service Works

1. You bring the problem to Professor Wilkinson [217-244-3974; hwilkins@uiuc.edu]

2. Together, you and he will collect the necessary background information (pictures, history, your observations and turf samples).

3. Professor Wilkinson studies the information and conducts the necessary laboratory studies.

4. Professor Wilkinson contacts you to discuss both the cause of and solution for your problem.

This is a Free Service

This University of Illinois program has been free to turf managers for over 17 years. As Professor Wilkinson states, "I learn a great deal about turf management by solving problems. There are very few problems that we can not diagnose and solve, and I am always ready to meet a new challenge. What we learn from working with turf managers fully justifies not charging them for sharing their information with us."

Weed Control and General Turfgrass Research

Bruce Branham, Hongfei Jiang, Joe Meyer, Dave Gardner, and Brian Horgan

Introduction

The 1999 growing season was a trying one for all turfgrass managers. Heat and humidity in July took its toll and many turfgrass managers breathed a sigh of relief when August came in with lower than normal temperatures and humidity. Our research program was very active in 1999 with over 35 separate field studies conducted. This report will highlight some of those trials and discuss those funded by the Illinois Turfgrass Foundation during 1999. The focus of our research effort in 1999 was to continue to study the use of ethofumesate (trade name – Prograss) for annual bluegrass control in turf. We also studied the use of Beacon to control annual bluegrass; Embark, Proxy, and Prograss to control annual bluegrass seedheads; and we examined the use of Xpo, a biological annual bluegrass control.

Annual Bluegrass Seedhead Control

Two studies were conducted in 1998-99 to examine the use of plant growth regulators to control annual bluegrass seedheads under golf course fairway conditions. One study was established in the fall of 1998 and a second was established in the spring of 1999. The trial that began in the fall of 1998 was based upon a response we have observed from Prograss applications made in the fall.

Prograss is a herbicide that is labeled for fall applications to control annual bluegrass. We have observed that when Prograss is applied in the fall, the results are variable. Some years, Prograss applications will result in excellent annual bluegrass control while in other years little or no annual bluegrass control will be observed. When Prograss fails to control annual bluegrass, the surviving annual bluegrass is dark green in color and usually contains no seedheads. Most Prograss programs require 3-4 sequential application for annual bluegrass control. We wished to determine if one well-timed application in the spring or fall could control annual bluegrass seedheads without risk of injury or kill of annual bluegrass.

Prograss was applied on 10/31, 11/15, and 11/30/98 at rates of either 0.75 or 1.5 lbs ai/A. Prograss was also applied the following spring on 3/15, 4/1, and 4/15/99 at the same rates.

Results showed that excellent annual bluegrass seedhead control was obtained with late fall applications of Prograss, particularly at 1.5 lbs ai/A rate (Table 1). Seedhead control from the late fall applications started to decline with the 5/7/99 rating while seedhead control was starting to improve at this time with the early spring applications. In future research, we will combine a single late fall application with an early spring application to enhance seedhead control.

The effects of Prograss on turf quality were dramatic. The late fall applications reduced pre-green-up quality. Ratings taken in February and March showed significantly reduced turf quality from the fall-applied Prograss. Applications made earlier in the fall caused the most reduction in turf quality. The 12/1 application exhibited injury symptoms that were less severe than the earlier fall applications. The injury consisted of a bleaching of the foliar tissue, causing the annual bluegrass to resemble a dormant warm-season turfgrass. However, once green-up commenced, the Prograss-treated turf quickly recovered and then exhibited higher quality and a darker green color than the control. Applications made in the early spring significantly reduced turf quality and injured the annual bluegrass. Seedhead control from these early spring applications was largely ineffective with only the 3/30 treatment showing some reasonable seedhead control on the 5/7 rating date.

The level of seedhead control and turf quality that resulted from a single, late fall application of Prograss was impressive. Additional studies are underway to confirm and expand this potential management tool.

Table 1. Prograss PGR Activity on Seedhead Control and Turf Color

Treatment	RATE (lbs AI/A)	Timing	Seedheads 4/19*	5/4	5/7	Turf Quality 2/11	3/16	4/19	4/30	5/21
Prograss+	1.5	11/16	1.0	1.3	63.7	4.3	3.7	4.5	7.8	7.3
Prograss	1.5	12/1	1.0	1.7	89.7	6.2	5.5	7.8	8.3	7.0
Prograss	1.5	3/30	2.3	2.0	72.0	7.8	8.0	3.0	3.0	6.3
Prograss	1.5	10/30	1.0	2.5	142.3	3.2	4.0	5.3	6.8	6.2
Prograss	1.5	3/17	2.0	3.3	142.3	8.3	8.3	3.7	3.7	7.2
Prograss	0.75	11/16	1.3	3.7	124.0	4.5	4.7	5.7	6.2	5.8
Prograss	0.75	3/30	2.7	4.7	166.0	8.0	8.3	5.0	5.2	6.2
Prograss	0.75	12/1	1.7	4.7	91.7	6.7	5.7	6.5	7.0	5.2
Prograss	0.75	10/30	1.8	5.7	221.0	5.7	6.0	5.3	6.3	5.7
Prograss	1.5	4/22	6.3	7.2	277.0	8.2	8.3	5.7	5.3	3.3
Prograss	0.75	4/22	5.7	7.7	258.7	7.7	8.3	5.5	5.8	4.0
Prograss	0.75	3/17	3.3	7.7	170.7	8.7	8.3	5.0	6.5	5.5
Control			5.3	8.7	209.3	8.3	8.3	6.3	6.3	5.0
LSD (P=0.05)			**1.1**	**1.6**	**103**	**1.4**	**1.5**	**1.8**	**1.3**	**1.8**

+All Prograss treatments were applied with 17.1 lbs ammonium sulfate/100 gallons plus 0.5% v/v Activate Plus.

* Seedhead ratings on 4/19 and 5/4 were made on a 1-9 scale with 9= many seedheads and 1= no seedheads. The 5/7 seedhead rating was taken by counting the number of seedheads in 1 ft^2 of each plot. Color was rated on a scale of 1-9 with 9=dark green.

Conventional Annual Bluegrass Seedhead Control

A second study was conducted in 1999 to expand conventional plant growth regulators for their control of annual bluegrass seedheads. We looked not only at Embark but also at Chipco Proxy and Primo. Further, we included applications of Cascade, a wetting agent, based upon superintendent feedback that this product could control annual bluegrass seedheads. All treatments were applied on April 12, 1999 using a backpack sprayer. The 8 oz/M rate of Cascade was watered in immediately after treatment while the lower rates were allowed to dry on the leaf surface. Seedhead suppression and turf quality ratings were collected for 10 weeks following application.

Results were observed immediately following treatment. Cascade resulted in a decrease in turf quality at 1 day following application. This injury was temporary and recovery was quick with the 1 WAT rating showing a return to normal quality. Embark applications resulted in a slight decrease in turf quality for the first two weeks following application; however, the typical PGR response of Embark was exhibited in weeks 4 and 5 when turf quality exceeded that of the control (Table 2). Chipco Proxy caused no change in turf quality except for some minor turf discoloration at 1 and 4 days following application.

Table 2. Poa annua Quality ratings. Quality was rated on a 1-9 scale with 9=excellent quality and 1=poor quality.

Treatment	1 DAT	4 DAT	1WAT	2WAT	3WAT	4WAT	5WAT
Control	8.0	8.0	6.7	7.0	7.0	6.3	6.3
Chipco Proxy 3oz	6.3	6.3	6.3	7.2	7.0	6.3	6.5
Chipco Proxy 5oz	7.3	6.7	6.3	7.2	7.3	6.2	6.0
Chipco Proxy 10oz	7.3	7.0	6.3	7.5	7.2	6.0	6.3
Primo 0.5 oz	7.7	7.3	6.7	6.7	6.8	5.8	6.0
Embark 1.8 oz	7.0	7.7	5.7	6.3	6.5	7.0	7.8
Embark 1.4 oz	7.3	6.3	6.0	6.0	6.7	7.7	7.8
Embark 1.0 oz	7.3	7.3	5.7	6.2	6.8	7.2	7.7
Embark 1.8 oz + Sprint	7.0	5.3	5.3	5.7	6.8	8.0	7.7
Embark 1.4 oz + Sprint	7.7	6.0	4.8	6.2	7.0	7.7	7.3
Embark 1.0 oz + Sprint	7.7	7.7	6.7	6.5	6.8	7.7	7.3
Cascade 1 oz	7.7	5.3	7.0	7.2	7.3	6.0	5.8
Cascade 0.5 oz	6.7	5.7	6.3	7.2	7.2	5.8	6.2
Cascade 8 oz	6.3	5.0	6.0	6.7	6.8	6.0	6.7
Prograss 1.5 oz	7.0	5.3	5.7	6.3	7.0	7.0	6.7
LSD	0.7	1.0	1.2	1.0	0.4	1.0	0.7

Seedhead control was good during 1999 although the annual bluegrass appeared to produce seed for a longer period of time than normal during 1999. This caused some PGR's to lose effectiveness towards the end of the seed production period. Embark gave excellent seedhead suppression at 3 and 4 WAT but by 7 WAT, Embark was no longer providing much seedhead suppression. Chipco Proxy did not provide early seedhead control but, by 7 and 10 WAT, Chipco Proxy did reduce seedhead counts. However, by this time the peak of the seedhead production had passed (Table 3). Primo caused a slight reduction in seedheads at 3 WAT but then actually resulted in an increase in seedheads at 4 and 7 WAT. Cascade had little impact on seedhead production. There was a slight hint of reduction in seedhead production but nothing of significance at these rates or timings.

Table 3. Seedhead suppression of annual bluegrass by various PGRs. Data for weeks 2 and 3 were collected on a 1-9 scale with 9=many seedheads and 1=no seedheads. Data collected at weeks 4,7, and 10 represent the average of two random counts of the total seedheads in 1 ft².

Treatment	2WAT	3 WAT	4WAT	7WAT	10WAT
Control	6.0	9.0	190	84	79
Chipco Proxy 3oz	6.0	9.0	175	50	35
Chipco Proxy 5oz	6.3	7.7	154	48	33
Chipco Proxy 10oz	6.0	5.7	146	29	20
Primo 0.5oz	4.7	6.7	337	148	79
Embark 1.8 oz	5.0	1.0	44	89	80
Embark 1.4 oz	5.3	1.0	39	69	45
Embark 1.0 oz	6.3	1.2	34	74	35
Embark 1.8 oz + Sprint	5.7	2.0	90	105	48
Embark 1.4 oz + Sprint	6.7	1.7	68	85	49
Embark 1.0 oz + Sprint	6.7	3.3	116	104	36
Cascade 1 oz	7.0	8.7	139	109	84
Cascade 0.5 oz	5.3	9.0	187	97	68
Cascade 8 oz	6.7	7.7	182	108	62
Prograss 1.5 oz	5.3	4.2	126	108	67
LSD	ns	2.0	52	46	27

Summary of Seedhead Control Research

Prograss applied once as late in the fall as possible looks promising for seedhead control. On bentgrass, I would select a rate of 0.75 lbs ai/A although 1.5 lbs ai/A performed better. If using the 0.75 lbs ai/A rate, follow-up with another 0.75 lbs ai/A right after complete green-up the next spring. However, this approach is still experimental and should only be used on areas where you could afford injury or outright kill of turf until further research has validated this approach.

Currently, Embark is still the best PGR for seedhead control; however, the application window is narrow and some discoloration for 1-2 weeks following treatment should be expected.

Golf Turf Species Response to High Rates of Prograss

In a study definitely labeled "don't try this at home", we initiated a trial in 1999 to determine the response of four common golf turf species to single, high rates of Prograss. Prograss is typically applied in the fall, at relatively low rates, and with 3-4 sequential applications. In our continuing quest to understand more about the way Prograss works as a herbicide, we went back to square one and applied rates of Prograss of 0, 3, 6, 9, 12, 15, and 18 lbs ai/A (yes, you've read that correctly). We called this our "dead square" trial because we wished to determine the single application necessary to control each of the four species tested. Those species were annual bluegrass, creeping bentgrass, rough bluegrass and Kentucky bluegrass. The trial began on May 18, 1999 when the above rates were applied to the four species. The rough bluegrass, annual bluegrass, and creeping bentgrass were all maintained at a 0.5" height of cut while the Kentucky bluegrass was maintained at 2".

Injury ratings show an initial phytotoxicity for all species at 3 weeks following treatment (Figure 1). At 5 weeks after treatment, the effects of the different Prograss rates became more evident. By 7 weeks after treatment, the creeping bentgrass had recovered significantly at all application rates while the other three species were still severely injured from the highest rates tested (Figures 2 and 3).

Figure 1. Species Response to Prograss
3 Weeks After Treatment

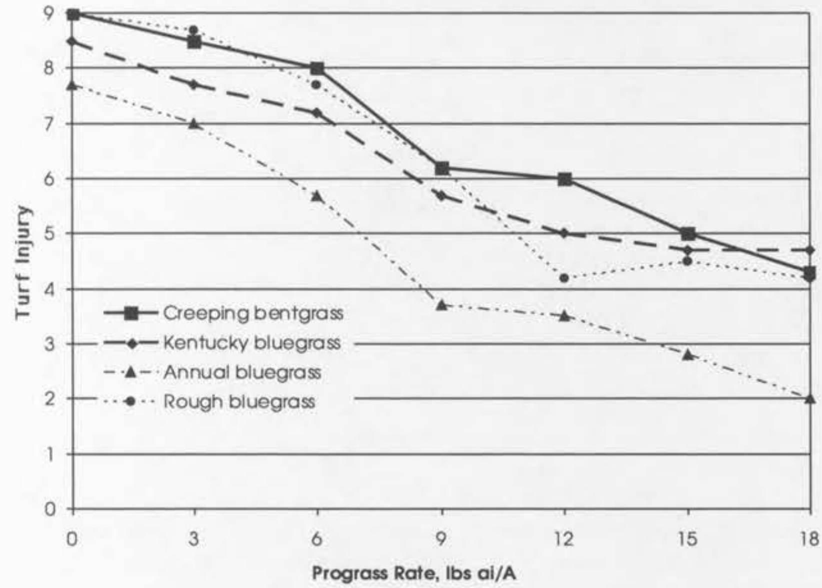
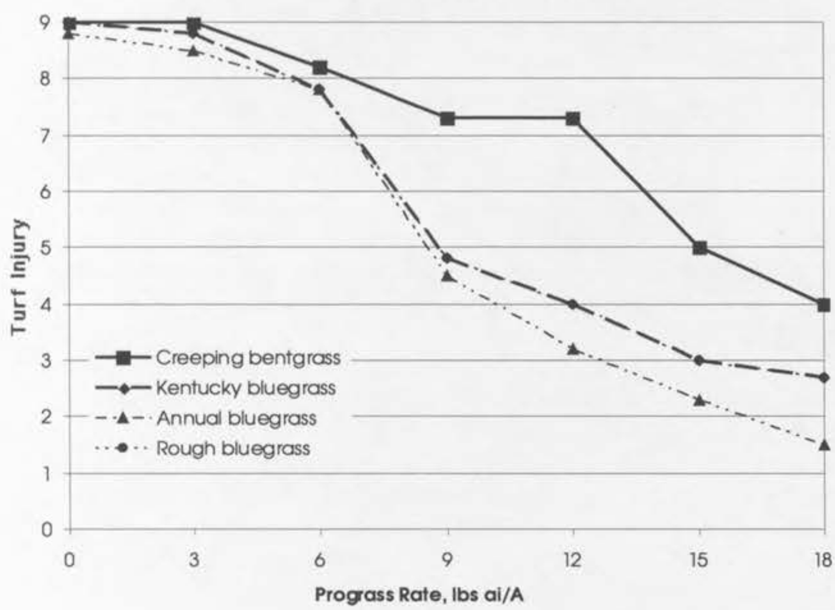


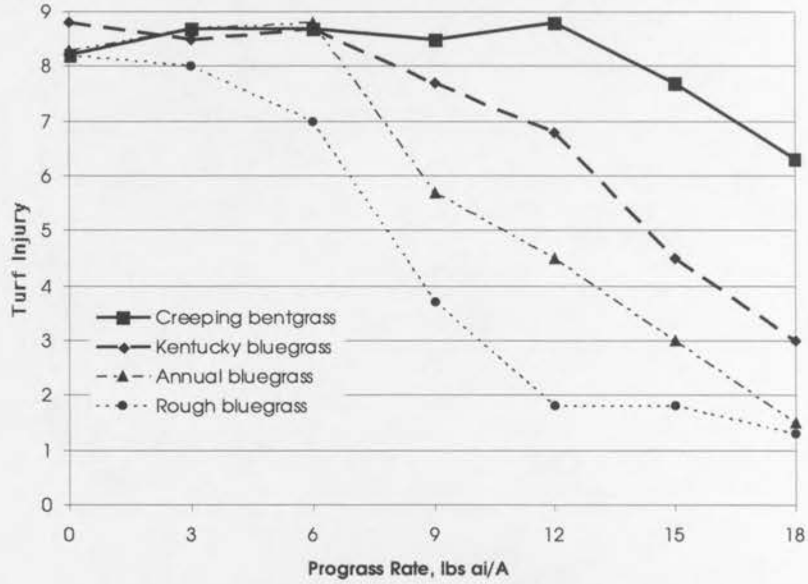
Figure 2. Species Response to Prograss
5 Weeks After Treatment



By 8 weeks after treatment, rough bluegrass was the most severely injured species. The 9 lb ai/A rate controlled 68 % of the rough bluegrass while rates of 12,15, or 18 lbs ai/A resulted in over 90 % control. Creeping bentgrass was injured by these rates but we only rated about 2 % turf loss at the 9 lb ai/A rate. Data at 7 WAT shows a clear separation of the species sensitivity to

Prograss. In order of decreasing sensitivity to Prograss the species can be ranked as rough bluegrass < annual bluegrass < Kentucky bluegrass < creeping bentgrass.

Figure 3. Species Response to Prograss 7 Weeks After Treatment



What practical value is there in this research? First, we understand more now regarding species sensitivity to Prograss. Second, we think the option of using a single high rate of Prograss is something the company should pursue. No selective herbicidal control is currently labeled for rough bluegrass. One high rate application of Prograss would give substantial control of rough bluegrass and annual bluegrass while leaving behind most or all of the creeping bentgrass. Thus, this option could be in lieu of a complete renovation but would require reseeding if a significant portion of annual bluegrass and rough bluegrass were present.

Xpo – A Biological Approach to Poa Control

Xpo is a novel approach to Poa annua control. Xpo is a bacterial disease that infects only annual bluegrass. EcoSoil Systems has been commercializing this product as a biological annual bluegrass control. The bacteria are sprayed onto turf and immediately mowed to promote wounding and infection of the annual bluegrass. The bacteria were applied on weekly basis to ensure infection. When environmental conditions are ripe for disease development; then the annual bluegrass dies. Or at least that is the way it is supposed to work.

We tested this idea at two sites in Champaign-Urbana during 1999. One trial was conducted at our research center in Urbana and a second trial was conducted at the Champaign Country Club, XPo bacteria were applied weekly beginning on May 14 in Urbana and June 18 at Champaign. The area to be treated with XPo was dragged to remove dew, the remaining wetness removed manually with towels, and the XPo was applied. Mowing immediately followed this procedure. Weekly applications were suspended on 8/6/99 in Champaign and Urbana.

Results to date have shown no observable activity from any of the XPo applications at either location (Table 4). At Champaign Country Club, the higher rates of Prograss provided good control of annual bluegrass. XPo alone showed no evidence of annual bluegrass control nor did partnering the XPo with Prograss result in improved annual bluegrass control. This biocontrol product offers the advantage of a non-pesticide approach, however, its use can't be recommended until the developer can ensure consistent, reliable results.

Treatment	Rate (oz prod/M)	6/16	7/9	8/6	8/13	8/20	10/7
		---------------- Annual bluegrass % ----------------					
1) Control		33.3	30.0	23.3	30.0	28.3	41.7
2) Prograss	3,1.5,1.5,1.5,3,3,3	31.7	30.0	21.7	21.7	16.7	8.3
3) Prograss	1.5,1.5,1.5,1.5,1.5,1.5,1.5	31.7	30.0	30.0	20.0	18.3	15.0
4) Prograss	1.5,0.75,0.75,0.75,1.5,1.5,1.5	26.7	25.0	25.0	31.7	28.3	28.3
5) XPo	1% v/v	25.0	20.0	28.3	26.7	26.7	36.7
6) XPo + Prograss	3,1.5,1.5,1.5,3,3,3 + 1% v/v	28.3	31.7	25.0	20.0	18.3	8.3
7) XPo + Prograss	1.5, 1.5, 1.5,1.5,1.5,1.5, 1.5,1.5 + 1% v/v	28.3	26.7	21.7	23.3	18.3	16.7
8) XPo + Prograss	1.5,0.75,0.75,0.75,1.5,1.5,1.5 + 1% v/v	30.0	26.7	21.7	28.3	18.3	13.3
LSD (p=0.05)		NS	9.6	7.7	NS	9.6	13.9

Table 4. Visual Percent Annual bluegrass estimates following treatment with Prograss, XPo, and Prograss plus XPo at Champaign Country Club. XPo treatments were applied weekly and Prograss treatments every 3 weeks at rates specified.

Information You Can Use.

1) Embark is currently the best PGR to control annual bluegrass seedheads.
2) Prograss shows considerable promise for effective and reliable annual bluegrass seedhead control.
3) Rough bluegrass is the most sensitive of the species tested to single applications of Prograss.
4) Xpo as currently formulated has not been effective as an annual bluegrass control agent.

Biological Management of Turfgrass Diseases

Henry T. Wilkinson

My goal is to make the use of biological organisms a significant and effective means of managing turf diseases, while reducing the use of fungicides.

If we are to continually strive to reduce the amount of pesticides we apply to our turf, the use of biological agents and better genetic resistance must be accomplished. All diseases are controlled biologically in nature. This is the fundamental principle which I have dedicated part of his time and resources to during the past 20 years. I have been able to find and demonstrate that natural bacteria can suppress turfgrass diseases. I am currently working with several Illinois companies on developing the methods and machinery to apply these antagonistic bacteria to turf for disease management. My studies will bridge the gap between technology and how to make it useful for the turf manager. My studies have repeatedly found that biological control is not a cure-all, but simply one effective way to reduce the severity of turfgrass diseases.

Questions and Answers for Guiding Turf Managers into Biological Management of Turf Diseases.

1. **How can bacteria control fungi that cause disease in your turf?**
Bacteria generally kill or suppress the growth of fungi by producing a toxin, i.e., a natural fungicide.

2. **How long can the bacteria survive on turf leaves and roots?**
Bacteria can live in the soil and on the roots for hours to days, but in order to survive for longer periods of time they must grow. Most bacteria that are applied to turf die within 24 hours.

3. **How does the new fermentor system work?**
The new fermentor (BioJect by EcoSoils) is a complicated machine, but well engineered. There are occasional mechanical difficulties with this system, but in general these are both infrequent and manageable. The use of fermentors like this on golf courses is new, and it will take several years to "work out the bugs."

4. **How do you determine how many bacteria are on your turf leaves?**
I have developed several methods to count the number of bacteria on leaves of turf. It requires specialized equipment and a laboratory. There are thousands of different types of bacteria that live on turf, and they are difficult to identify and count. However, in the case of the bacteria used by EcoSoils, the bacteria are marked in a very safe way which allows them to be identified.

5. **Do the new fermentors work?**
Yes, the BioJect fermentors work, but like any machine, they need care and attention. There is a lot more to using a system like BioJect than just the fermentors. First, there is the correct use and care for both the bacteria and their food. Next, the BioJect must run properly, but don't forget that it operates in temperatures that range from freezing to 100+ degrees F. Next, your irrigation system is complicated, and this presents a challenge to superintendents in terms of realizing how long they have to run the system to get good bacterial application. Even after the bacteria are delivered to the green, the challenges for the Bioject system are not over. Once applied to the grass, the bacteria face many variables such as heat, irradiation, traffic, other microorganisms, thatch, chemicals (fertilizers, pesticides, herbicides) and so on. In short, a biological control system requires a lot of coordination to work, but it is worth it.

6. What are the best bacteria to use?

Presently, the best bacteria to use are those currently offered by EcoSoils. The bacteria used in the Bioject system are all natural bacteria and are safe for our environment. I have tested these bacteria at the University of Illinois for two years, and they do suppress dollar spot and brown patch. My work is determining how to make them perform consistently. I also am testing and evaluating other natural bacteria, and in the near future different and more effective bacteria will be available. Remember, the bacteria are only part of the equation for successfully using biological control.

7. How can you integrate the use of bacteria with cultural and fungicide programs?

I have learned that bacteria, even when applied correctly, cannot support satisfactory disease management in the stressful periods of the growing season. The fungi are too powerful and the plant is just not growing fast enough in July-September for bacteria to maintain disease-free greens. This is not a fault or a weakness of the bacteria or the BioJect system, it is the way nature intended it to be. The best way to think about using these bacteria is to consider them as one tool in your arsenal of disease management weapons. For example, proper fertilization, stress management, proper irrigation, sufficient air circulation, and the use of fungicides are important tools, and they should be integrated with the use of biological controls. I am preparing specific recommendations that will allow you to predict when the biologicals are going to "fail" and when other practices, such as fungicides, should be used as a supplement.

8. What are the limitations of turf disease management using bacteria?

The limitations of using bacteria to control turf diseases stem from two weaknesses: i) the bacteria can only respond to so much disease pressure before they are overcome; and ii) we do not understand the science of how to optimize the effectiveness of the bacteria, i.e., we have a lot to learn.

9. Would you recommend continuing the use of a system like BioJect on a course, even if it did not save you money?

Without reservation, YES. As members of the green industry, we have an obligation to test, develop and use ecologically gentle methods to manage our turf. Simply put, no matter how beneficial turf is we cannot afford to continually load it up with toxic materials. Biologicals are gentle to the ecology. They will not be a cure-all or even replace fungicides, but we need to use them in an attempt to reduce our dependence on synthetic chemical controls. The benefit from using them may not be in dollars but in environmental health. We, as turf professionals, should embrace and seek to use this option for pest management. By supporting it, it will grow, develop and improve. In short, we cannot afford to ignore this science because it will cost us in the future.

10. How can I find out more about biological controls and get help using them?

I have studied the use of biological controls for over 20 years, and I am willing to help all of you with your questions and answers. If you have a question or problem concerning biological controls or a specific questions concerning the use of the BioJect system: CONTACT ME.

Biological Controls Hotline: (217) 333-8707 hwilkins@uiuc.edu

Turf Soils Research at Southern Illinois University-Carbondale

She-Kong Chong

Program Overview

I started my turf soils research program at Southern Illinois University Carbondale (SIUC) in the Fall of 1996. In the fall of 1998, Mr. Chang-Ho Ok completed his master degree at SIUC. He is my first graduate student majoring in turf soil research. Mr. Ok's thesis is entitled "*Physical and Chemical Properties of Rooting Mixtures Amended with Various Natural Organic Materials.*" In the summer of 1997, Mr. Richard Boniak joined us as a graduate student working on the crumb rubber project funded by the Illinois Department of Commerce and Community Affairs. Most of the field work was completed under Mr. Boniak's hard work and assistance. In the spring of 1999, in order to advance my knowledge, I took a sabbatical leave to visit several turf research programs at various universities including Dr. Paul Rieke's program at Michigan State University. The sabbatical leave was an invaluable experience for me not only assisting in my teaching, but also broadening my research in the turf soil area.

In the fall of 1999, a new course entitled "Golf Course Green Installation and Maintenance" was established and taught at SIUC. The main objective of this new 4-credit hour course is to provide students with a sound understanding of the rooting material which controls turf development and growth. The subjects covered in this course mainly focus on the selection, requirements, establishment, and maintenance of the rooting medium for putting greens and disturbed soils. Presently, we have ten students enrolled in this class.

I would like to take this opportunity to express my sincere thanks to the ITF for their support in my research. This is the first year I received research funding provided by the ITF.

Presently we have four projects working on various turf soil research. These projects are:

Research Highlights in 1999

1. Nitrate and Phosphorous Leaching Study

This project was designed to help the golf course industry understand the fate of nitrate and phosphorous applied to putting greens. Twenty-four lysimeters were installed in the newly established turf field at the Horticulture Research Center at SIUC. The rooting mixes used in the lysimeters included treated steer manure, reed sedge peat moss, and the combination of the two at various rates. Data collection will begin in the spring of 2000, if funding for this project is available.

2. Green Root Zone Mixes Amended with Various Amendments

The main objective of this study is to evaluate and compare some new materials which are economically feasible and environmentally safe for green root zone mixture amendments. This research is mainly focused on the physical properties of the mixes. Amendments selected in this study include:

1. Earthworm castings.
2. Treated steer manure.
3. Sphagnum peat moss.
4. Shamrock Irish peat moss.
5. Aged saw dust.
6. Profile.
7. Ecolite.
8. Dakota peat moss.

3. Turf Quality Established on Soils Amended With Crumb Rubber.

This study was funded by IDCCA and began June 1, 1997. The experimental plots were installed and completed in the summer of 1998. The objectives of this project are (1) to determine the optimal grade and amount of crumb rubber for the construction of optimal turf on native high clay content soils, and (2) to evaluate the quality and performance of turf established on rooting mixes amended with crumb rubber. Laboratory results indicated that regardless of the grade, mixtures with less than 15% crumb rubber in a fine-textured soil had little influence on their physical properties. Macro-porosity, hydraulic conductivity, and air permeability increased as the amount of crumb rubber amended in the mixture increased. However, total porosity of the mixture was inversely related to the amount of crumb rubber added into the soil. Preliminary field data indicated that root mass, surface hardness and soil moisture retention capacity decreased as the amount of crumb rubber amended in the mixture increased. Results also indicated that mixtures with 6.5 mm crumb rubber at a 20% amendment rate had the highest clipping yields and best turf quality.

4. Anaerobic Soils on the Golf Course Greens.

This research was not only examining the effect of oxygen content in root zone on turf quality, but also studied the effect of cultivation on the enhancement of oxygen content in the root zone. This is an on-range study. The experiment was started in late summer of 1998 at the Hickory Ridge golf course, Carbondale, IL. This project was co-investigated by Dr. She-Kong Chong, Dr. Sam Indorante (USDA-NRCS), Mr. David Buschschulte (formerly Hickory Golf Course Superintendent) and Richard Boniak (Graduate assistant). In the experiment, nine greens were randomly chosen for conducting the experiment. On each green, five small plots (1 m in diameter) were selected for the assessment of the relationship between turf and rooting medium quality. Parameters measured on each small plot included turf quality, CO_2 content in the root zone, profile water content, infiltration rate and soil macro-porosity. Preliminary results indicated that greens with high water content (Figure 1) and poor infiltration rate (figure 3) possessed the highest CO_2 content in the root zone. Turf quality declined when CO_2 in the root zone reached above 5% during the summer season. Cultivation of greens could initially increase oxygen in the root zone, but the benefits of aeration decreased with time (Figure 2). In addition, a large variation in CO_2 content, infiltration, and water retention capacity were observed within a green. It is believed that more research should be focused on the management of spatial variability within a green in the future.

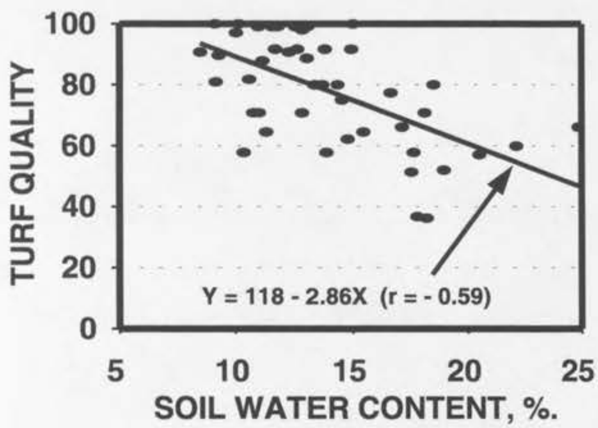


Figure 1. Relationship between turf quality and water content retained in the profile.

Figure 2. Relationship between CO_2 content and infiltration rate of the root zone.

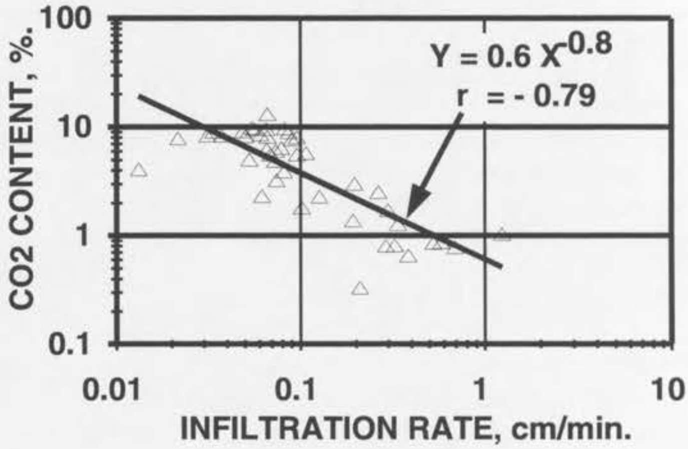


Figure 3. Relationship between turf quality and CO_2 content in the root zone. Results indicated that turf quality decreased in the summer when CO_2 increased above 5%.

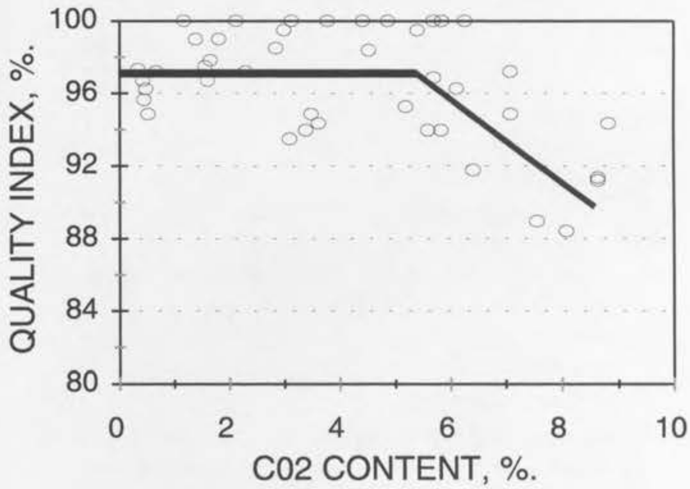
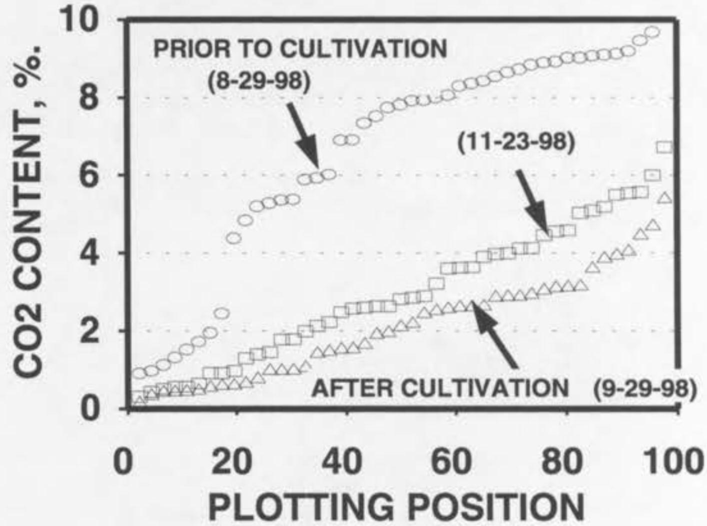


Figure 4. Changes in CO_2 content in the profile after cultivation by a 10-cm hollow tine.



For more information on this study, feel free to contact Dr. She-Kong Chong at (618) 453-1793, Fax (618) 453-7457, or e-mail: skchong@siu.edu

Zoysiagrass for Central and Northern Illinois?

Kenneth L. Diesburg

When the opportunity to begin this project occurred in 1997, I was thinking that there would be little to no support for it from northern Illinois. But members of the Illinois Turfgrass Foundation Board, many of whom are superintendents, claim that there is a lot of interest in having a new species of turfgrass that could offer beautiful and tough turf during the summer stress period. The trick is to develop a zoysiagrass that would also be beautiful during the cooler times of year.

The opportunity is in the form of a very large source of germplasm in the Jack Murray collection. A friend of the Murray family, David Doguet, has been able to purchase the collection of seed progenies that are part of Jack Murray's legacy to turf. In a cooperative research effort with David, I have the opportunity to continue Jack's legacy toward the development of superior seeded zoysiagrass cultivars.

Zoysiagrass is a species that has potential for considerable improvement for turf. Presently there are several vegetatively propagated cultivars that offer excellent turf quality. However, sod is expensive, plugs are slow to fill in, and many of the cultivars are not winter-hardy. There is a need for a seeded, finely textured, vigorously spreading, winter-hardy zoysiagrass with good color. Today's best seeded variety is not a whole lot better in quality than common zoysiagrass, being coarsely textured with moderate leaf density and poor color.

In 1998, we planted 900 plants in the first batch of progenies from the Murray collection. My graduate student, Tim Murray, collected data regarding crown diameter, maximum stolon length, number of stolons, density of spread, winter hardiness, texture, and rust resistance. The table below shows the range in expression of the traits that were measured.

Using Tim's data and my own visual screening for agronomic acceptability for turf and seed production, I formed four germplasm pools in 1999: 1. vigorously spreading, 2. high seed yield, 3. elite turf-type, and 4. I don't know yet. In 1999 we planted another 600 plants in the second batch of progenies. This process of planting, evaluating, and selecting will continue indefinitely in the search for high numbers of superior plants to become parents for future seeded cultivars. During the year 2000, I plan to perform the first matings of superior parents to determine if their progenies will provide superior turf. This alone would be an achievement not yet attained by anyone. It is not known whether zoysiagrasses can be made to intermate readily. Many strongly vegetative, long-lived species like zoysiagrass have lost their ability to intermate readily.

In the future, I hope to keep you updated with many exciting and factual stories about the performance of progenies in this project. Several stories are beginning to unfold now, but I must wait to see how much I can report as fact. Please, stay tuned.

My most sincere thanks goes to the ITF for its continuing support of turfgrass research at SIU. It is for the betterment of Illinois turf which I consider to be my mission in service.

	Maximum	Minimum	Average
Crown Diameter (cm)	26	1	11.7
Maximum Stolon Length (cm)	130	0	49.2
Number of Stolons	31	0	11.1
Density Rating (9=ideal)	8.5	0.5	3.7
Winter Hardiness Rating (9=hardy)	9.0	0	6.5
Texture Rating (9=most fine)	9	1	5.4

Table 1. Spreading and quality traits of 900 plants within 50 families, SIU Carbondale, Il, 1998.

Acknowledgments

We wish to thank the following companies and organizations for their support of our turfgrass research programs during 1998. Much of our success depends on the generous support of industry through contributions of time, materials, or funding. If your organization provided support in 1998 and was not listed, please contact Carol Preston at 217-333-7738.

ABT Seeds
AgrEvo, USA
AgriLife Products, Inc.
American Cyanimid
Aquatrols
Aspen Ridge Golf Course
BASF Corp.
Bayer Corp.
Belleville Seed House
Bladerunner Farms, Inc.
CEBECO International Seeds, Inc.
Cantigny Golf Club
Carillon Golf Club L.L.C.
Central Illinois Golf Course Superintendents Association
Century Rain Aid
Chicago Botanic Gardens
Chicago District Golf Association
Club Car, Inc.
Cushman-Ryan
DFL Trifolium
Desert King International
Dow Agro Sciences
E-Z Go
Eagle Ridge Resort
Eco-Green Technologies, Inc.
Eco Soils
Effingham Country Club
Forbes Seed Co.
Golf Course Superintendents Association of America
Golf Links, Inc.
Griffin Industries
H & E Sod Nursery, Inc.
Hickory Ridge Golf Course
Hunter Irrigation
Illinois Council for Food and Agricultural Research
Illinois Department of Commerce and Community Affairs
Illinois Lawn Equipment, Inc.
Illinois Turfgrass Foundation
International Seeds, Inc.
Jacklin Seed Co.
Jackson Country Club
Jacobsen Div. Textron Co.
Kellogg, Inc. Seed & Supplies
Kokopelli Golf Course
Lange-Stegmann, Co.
LESCO Inc.
Lebanon Chemical Corp.
Legacy by Hunter
Lewis Seed Co.
Lincolnshire Fields Country Club
Lofts Seed, Inc.
Medalist America

Mid America Sod Producers
Association
Midwest Association of Golf
Course Superintendents
Milorganite
Modern Distributing, Inc.
Modern Equipment
Monsanto Co.
Morton Arboretum
Mueller Mist Irrigation
National Grass Variety Review Board
National Turfgrass Evaluation
Program
Nettle Creek Country Club
North Shore Country Club
Northwest Illinois Golf Course
Superintendents Assoc.
Novartis
O.M. Scott & Sons Co.
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Olympia Fields Country Club
PBI Gordon
Pickseed West, Inc.
Piper Glen Golf Courses
Pontiac Elks Club
Professional Turf Specialties, Inc.
Profile Products, Inc.
Purdue University Turf Program
Pure Seed Testing, Inc.
Rend Lake Golf Course
Rhone-Poulenc Ag. Co.
Riverside Golf Club
Rohm & Haas Company
St. Charles Country Club
Seed Research of Oregon, Inc.
Southern Illinois University Grounds
Maintenance Assoc.
Skokie Country Club
Spraying Systems Co.
Stone Creek Golf Course
Summit Seed Company
Supreme Turf Products, Inc.
TMI Seeds
Tee-2-Green Corp.
Terra International
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U. of I., Div. of Campus Recreation
Wisconsin Sod Association
Zajac Performance Seed
Zeneca Incorporated

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Andy Schall
Brandon Smith
Andy Stephens
Jason Straehlein
Dr. Brad Taylor
Todd Thomas
Randy Williams

Illinois Turfgrass Calendar of Events

Indiana-Illinois Turfgrass Short Course .... February 28 - March 3, 2000

2000Turfgrass and Landscape Field Day .... August 3, 2000

2000 North Central Turfgrass Exposition .... November 27 - 30, 2000

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

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