1999 Turfgrass Research Report

Statement of Purpose

The purpose of the Turfgrass Science Team is to bring together faculty, staff, graduate students, industry, funding, and other resources in a way that is convenient to work together in mutual benefit of research, extension, and teaching.

Team Mission

The mission of the Turfgrass Science Team is to develop cultivars, cultural practices, curriculum, and outreach programs that conserve water, reduce pesticide use, minimize environmental impact and enhance the quality of life.

Turfgrass Science Team
University of Nebraska

Team Functions

Research

Extension

Education and Training

Outreach/Liaison

For more detailed information about the Turfgrass Science Team visit our Web page at: http://hort.unl.edu/turf

1999 Turfgrass Research Report

Report Coordinators: M.R. Vaitkus, R.C. Shearman and A.M. Streich

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Turfgrass Team Members
Faculty

Fred P. Baxendale

Research Emphasis:
- Investigate the biology, ecology and injury potential of turfgrass arthropods with the goal of developing effective sustainable and environmentally responsible Integrated Pest Management approaches for the insects and mites affecting Nebraska's turfgrasses.

Rhae A. Drijber

Research Emphasis:
- Enhance understanding of microbial ecology in managed grassland ecosystems, namely golf course putting greens.
- Identify relationships among microbial communities developed in putting greens in response to management history.
- Improve understanding of microbial community development in putting greens, leading to reduced inputs and disease pressure.

Loren J. Giesler

Research Emphasis:
- Diagnosis and management of ornamental plant diseases.
- Screening of experimental fungicides for disease control in ornamentals.

Roch E. Gaussoin

Research Emphasis:
- Improve turfgrass weed control practices through integrated turfgrass management practices.
- Enhance understanding of herbicide efficacy.
- Integrate approaches to buffalograss management.
- Study long-term effects of root zone mixes and grow-in on golf green characteristics.

Research Emphasis:
- Assess accurate pesticide application.
- Effects of sprayer calibration and nozzle arrangement on accurate and uniform applications.
- Reduce pesticide inputs.
- Reduce inputs to optimize economic returns.
- Use GPS / GIS technology for site-specific management.

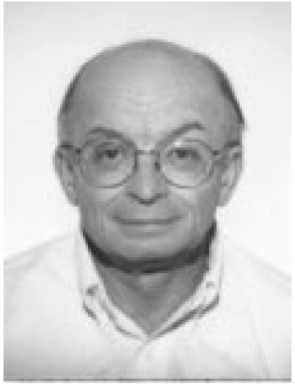
Robert (Bobby) D. Grisso

Garald L. Horst

Research Emphasis:
- Xenobiotic remediation by plants and plant-microorganism systems.
- Pesticide and nutrient fate in relationship to environmental and water quality.
- Turfgrass canopy environmental influence on microorganism ecology.
- Enhanced understanding of environmental quality and sustainability of resource systems.

Research Emphasis:
- Apply integrated pest management for vertebrate species, including moles, voles, ground squirrels, pocket gophers, deer and Canada geese.

Scott E. Hygnstrom

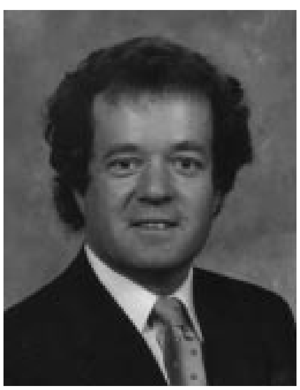


Robert V. Klucas

Research Emphasis:
- Enhance understanding of plant biochemistry with emphasis on nitrogen fixation, leghemoglobin and other plant responses.

Michael F. Kocher

Research Emphasis:
- Engineer systems to quantitatively assess turfgrass responses of interest, such as golf ball roll distance and uniformity, shear strength and traffic tolerance.

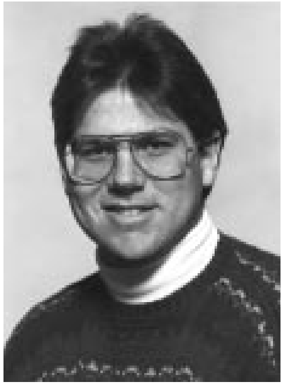


Dale T. Lindgren

Research Emphasis:
- Understand the interactions of wildflowers and warm-season turfgrass when planted in mixtures.
- Evaluate turfgrass cultivars and other turfgrass products for use in west central Nebraska.

Martin A. Massengale

Research Emphasis:
- Administrate and facilitate research activities related to the Center for Grassland Studies, including turfgrass development, evaluation and management and seed production practices.

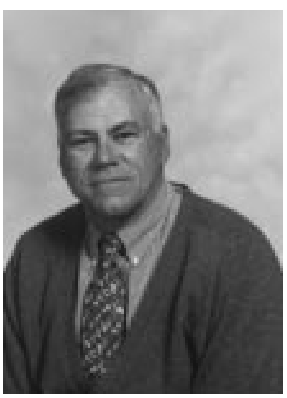


Robert A. Masters

Research Emphasis:
- Study systems approach to the establishment of native grasses and wildflowers, prairie restoration and management and herbicide efficacy evaluation.

Research Emphasis:
- Understand the long-term impacts of golf course putting green grow-in procedures on the soil physical properties associated with putting green performance and function.
- Determine water infiltration rate, air-filled porosity at 40 cm of suction head, total porosity, bulk density and pore size distribution.

William L. Powers



Terrance P. Riordan

Research Emphasis:
- Develop and evaluate improved buffalograss cultivars requiring less water, fertilizer, pesticides and mowing.
- Improve understanding of buffalograss breeding and genetics through traditional and molecular approaches.

Research Emphasis:
- Study integrated turfgrass management systems for sustainable function and performance, reducing chemical and energy inputs and water conservation.
- Improve understanding of turfgrass wear tolerance, water conservation, drought resistance, potassium nutrition and root growth and development.
- Study turfgrass species and cultivar evaluation for Nebraska and intensively used sites
- Study turfgrass and forage seed production for western Nebraska.

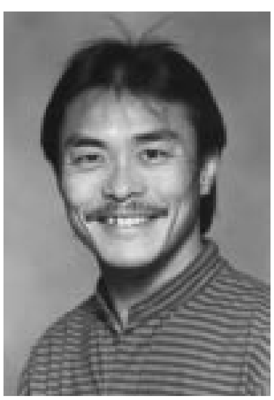
**Robert (Bob)
C. Shearman**

Donald H. Steinegger

Research Emphasis:
- Evaluate ornamental grasses and ground covers.
- Develop sustainable landscape systems.

Research Emphasis:
- Improve disease diagnosis and management.
- Establish disease management systems for dollar spot and brown patch.
- Screen experimental fungicides for turfgrass disease control.

John E. Watkins



Gary Y. Yuen

Research Emphasis:
- Identify microorganisms with potential for biological control of turfgrass diseases.
- Determine mechanisms of microbial effects on disease development.
- Understand environmental impacts on pathogenic fungi and applied antagonists, with emphasis on bacteria on leaf spot, brown patch and dollar spot.

Turfgrass Team Members

Support Staff

Leonard Wit	Unit Manager, JSA Turf and Ornamental Research Facility, ARDC
Usha Saran Bishnoi	Research Associate, Post-Doctorate, Buffalograss Transformation
Jane Christensen	Extension Assistant, Plant Pathology
Tom Eickhoff	Graduate Student, M.S., Buffalograss Entomology
Shuizhang Fei	Research Associate, Post-Doctorate, Buffalograss Transformation
Joel Ferdig	Technician, Ornamentals
Kevin Frank	Former Graduate Student, Ph.D.; currently, Turfgrass Extension Specialist, Michigan State University
Neil Heckman	Graduate Student, M.S., Turfgrass Physiology and Management
Tiffany Heng-Moss	Graduate Student ,Ph.D., Buffalograss Entomology
Christy Jochum	Research Technologist, Plant Pathology
Gopalakrishnan Krishnan	Post-doctorate, Agronomy, Xenobiotic Fate
Brian Lessman	Technician, Ornamentals
Amy Neigebauer	Graduate Student, M.S., Wildflower Establishment
Julie Schimelfening	Technician, Horticulture and Plant Pathology
Anne Streich	Extension Horticulturist, Outreach Programs
Milda Vaitkus	Research Technologist, Turfgrass Management and Physiology
Anthony Weinhold	Technician, Entomology; Graduate Student, M.S., Turfgrass Entomology
Steve Westerholt	Buffalograss Project Coordinator, Computer Support
Jeff Witkowski	Technician, Turfgrass Management

Turfgrass and Ornamental
Research Support

AgrEvo USA Co.
American Cyanamid
Arrow Seed
Aventis Environmental Science
Bailey Nurseries
Barenburg Research
BASF Corporation
Bayer Chemical Corporation
Big Bear Equipment
Bluebird Nursery Inc.
Campbell's Nursery
Cedar Chemical Company
Country Club of Lincoln
Deere & Company
Dow AgroSciences
EA Engineering Great Plains
Earl May Seed and Nursery, Limited Partnership
Ecogen
Exmark Mfg. Co. Inc.
Farmland Inc.
Fermenta Plant Protection
FMC Turf and Ornamentals
Garden America Inc.
Golf Course Supt. Assoc. of America
The Greenkeeper Company Inc.
Greenleaf Nursery Company
Griffin L.L.C.
Hartmann's Plantation Inc.
Hines Nurseries
Holmes Park Golf Course
Howard Johnson's Enterprises, Inc.
Jacklin Seed Co.
Jacobsen /Textron
John Deere Turf Care Inc.
Johnston Seed Co.
Lake County Nursery Inc.
Lesco
Lincoln Water Utilities
Loft's Pedigreed Seed
Mahoney Golf Course
Midwest Turf and Irrigation
Milorganite Company
Monsanto Corp.
Mount Arbor Nurseries
National Turfgrass Evaluation Program (NTEP)
NE Department of Environmental Quality
NE Golf Course Supt. Association (NGCSA)
NE Nursery and Landscape Association (NNLA)
NE Professional Lawn Care Assoc. (NPLCA)
NE Turfgrass Foundation (NTF)
North Star Gardens
Novartis
O.J. Noer Research Foundation
Organix Supply
Pickseed West Inc.
Pioneers Golf Course
Plains Tree Farm
Proprietary Seeds
Pure-Seed Testing
Quarry Oaks Golf Course
Reams Sprinkler and Supply
Rhone Poulenc Inc.
Rohm and Haas Co.
St. Gabriel Laboratories
J. Frank Schmidt and Sons Co.
The Scotts Company
Seed Research Inc.
Seeds West Inc.
Shadow Ridge Country Club
Stock Seed Company
Terra Industries Inc.
Todd Valley Farms Inc.
Tomen Agro Inc.
The Toro Company
Troy Biosciences
Turfgrass America, Inc.
Turf-Seed
United Horticulture Supply
United Seeds
United States Department of Agriculture
United States Environmental Protection Agency
United States Golf Association
UNL Water Center
Valent
Willamette Seed & Grain
Williams Lawn Seed
Zajac Performance Seeds
Zeneca Inc.

1999 Weather Summary for the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

M.R. Vaitkus

Weather conditions in 1999 at the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE were typical in terms of temperature, but fluctuated widely in precipitation. Average monthly temperatures followed the 14-year average quite closely, with the exception of February, July and November, when 1999 temperatures were above average (Figure 1). Record high temperatures were recorded during the second week in February and the last week of July and most of November were also unseasonably warm.

Precipitation was generally below average for most months (Figure 2). January through mid-March were below average in precipitation, while late March to mid-June were well above average, providing favorable early summer growing conditions. Below average precipitation was recorded for the rest of the year, especially in July, October, November and December. Below-average precipitation and above-average temperatures during July stressed turf and ornamentals.

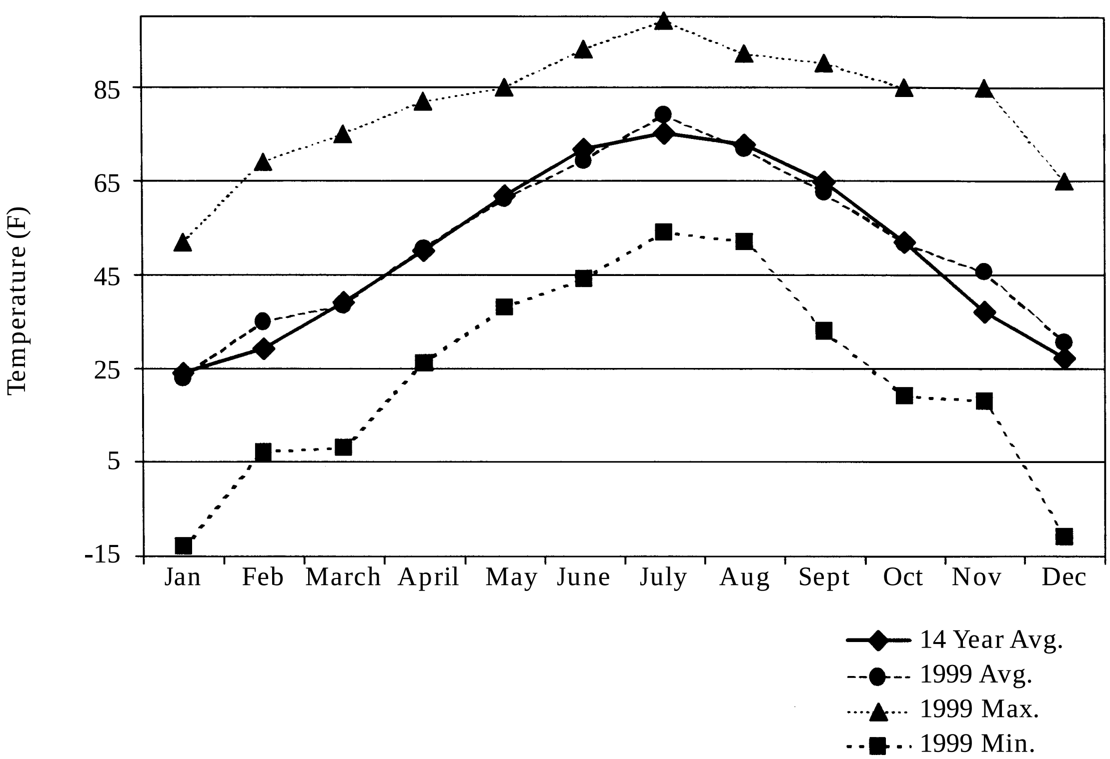


Figure 1. Monthly air temperatures (°F) at the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

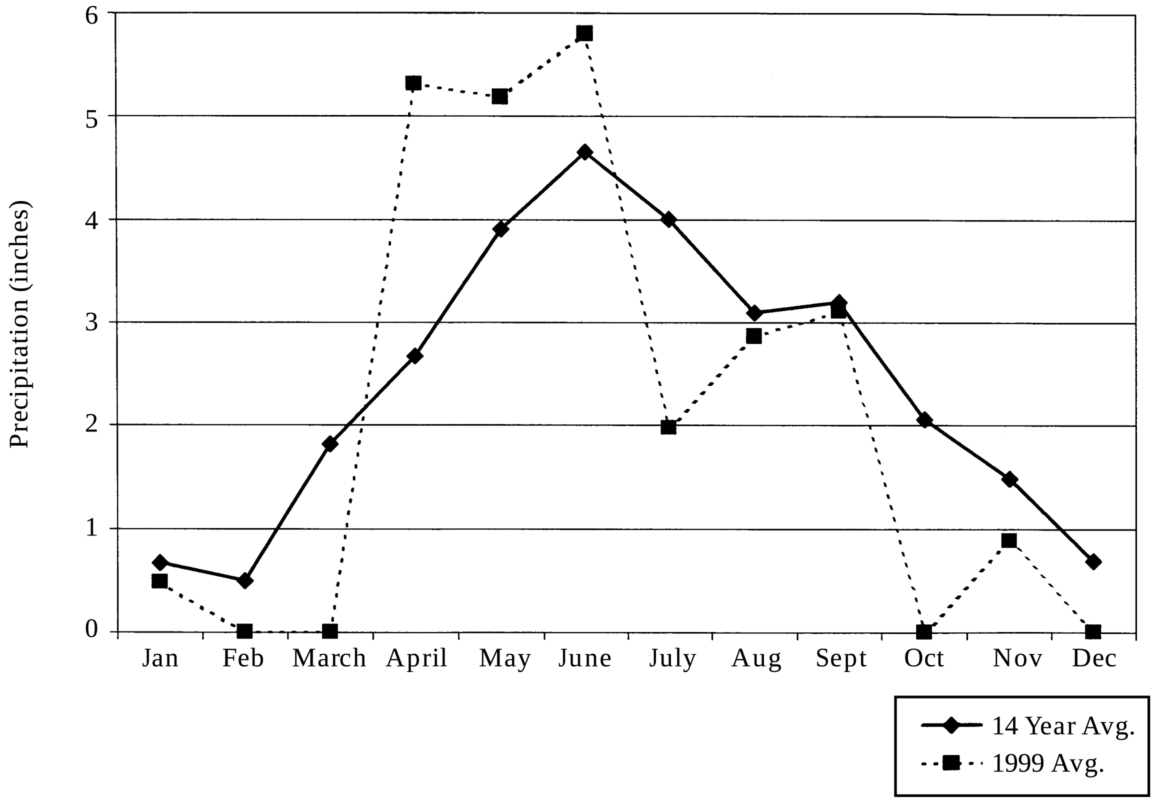


Figure 2. Monthly precipitation (inches) at the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

1999 Results from the 1995 National Kentucky Bluegrass High and Low Maintenance Trials

M.R. Vaitkus, R.C. Shearman and L.A. Wit

The High and Low Maintenance Kentucky Bluegrass trials were planted in late-September, 1995, at the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE. The seeding rate was 2 lbs/ $1000ft^2$. Cultivars were planted in a completely randomized block design with 3 replications and a plot size of 3 ft by 8 ft. Soil type was a Sharpsburg silty clay loam (fine, montmorillonitic, mesic Typic Argiudoll) with a pH of 7.2 and organic matter at 1.5% - 1.9%. A severe winter following planting caused extensive winter kill and both trials were interseeded in April 1996.

Medium/High Input Trial

This trial contains 103 entries. Turfs are mowed four to five times weekly at 5/8 inch. Nitrogen and potassium are applied at 4.0 lbs/1000 ft^2/ growing season. Phosphorous is applied at 1.0 lb /1000 ft^2/growing season. Irrigation is adjusted twice weekly to maintain an application rate of 80% ETp. Pendimethalin is applied annually at label-recommended rates for crabgrass control; postemergence herbicides are applied only as needed. No fungicides or insecticides are applied. Weekly traffic treatments are initiated in April and continued through October.

In 1999, spring greenup, genetic color, leaf texture and seasonal stand density, as well as monthly turfgrass quality, were evaluated. Cultivar performance reflected the relatively mild spring and summer growing conditions in 1999 (Table 1). Turfgrass densities were all well above the acceptable rating of 6.0 and remained high throughout the growing season. Mean turfgrass quality ranged from 3.3 to 7.4, with only 21 cultivars having overall mean quality ratings above 6.0 (a turfgrass quality rating of <6.0 is considered unacceptable quality).

Low Input Trial

The Low Input trial contains 21 cultivars. Turf height is maintained at three inches and turfs are mowed once each week. Fertilization is limited to the application of nitrogen at 1.0 lb /1000 ft^2 /growing season. Irrigation is adjusted twice weekly to maintain an application rate of 60% ETp. Pendimethalin is applied annually for crabgrass control at label-recommended rates. Post-emergence herbicides were applied in the Fall of 1997 and 1999. No other post-emergence herbicide applications made; no fungicides or insecticides applied. Weekly traffic treatments are initiated in early April and last through October.

Spring greenup, genetic color, leaf texture and seasonal stand density, as well as monthly turfgrass quality, were evaluated in 1999 (Table 2). Mean monthly cultivar densities were all consistently at 8 or above. Mean quality ratings were all low, with only two cultivars (Caliber and BAR VB 3115B) having acceptable (>6.0) ratings.

Table 1. 1995 Kentucky bluegrass NTEP trial - medium/high input - 1999 data summary. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	Greenup[†]	*Color*[‡]	*Texture*[§]	*Density*[¶]			*Quality*[#]							
Cultivar	*4/20*	*6/21*	*6/21*	*4/20*	*7/30*	*9/21*	*4/20*	*5/27*	*6/21*	*7/30*	*8/20*	*9/21*	*10/18*	*Mean*
NJ 1190	8.0	6.3	9.0	9.0	9.0	9.0	7.0	7.7	8.3	7.7	7.3	7.3	6.7	7.4
BLACKSBURG	7.0	7.7	8.3	8.7	9.0	9.0	6.0	7.0	7.0	8.0	7.3	7.3	6.7	7.0
J-1576	6.0	9.0	9.0	9.0	9.0	8.7	5.0	6.7	7.7	7.7	6.7	8.0	6.3	6.9
TCR-1738	7.0	9.0	8.7	8.7	9.0	9.0	5.7	7.0	7.7	7.3	7.0	7.3	5.7	6.8
ZPS-2572	6.3	8.7	8.3	9.0	9.0	9.0	5.7	6.7	8.0	6.7	6.3	7.7	7.0	6.8
J-1561	6.0	9.0	8.3	9.0	9.0	8.7	5.0	6.3	8.0	7.3	8.3	7.0	5.0	6.7
AWARD	7.0	9.0	9.0	9.0	9.0	9.0	4.7	7.3	7.0	7.3	7.0	7.0	5.7	6.6
PST-B2-42	6.3	7.7	8.7	9.0	9.0	9.0	5.3	7.0	7.3	6.0	7.0	7.7	5.3	6.5
J-1936	7.3	8.3	8.3	8.7	9.0	8.3	6.0	6.3	6.7	7.0	7.3	6.0	6.0	6.5
MED-18	7.7	9.0	9.0	9.0	8.7	8.3	5.3	6.3	7.7	7.0	7.3	6.0	5.3	6.4
NUGLADE	6.3	9.0	8.7	9.0	9.0	9.0	5.3	6.3	8.0	7.7	7.3	5.3	4.7	6.4
J-257	6.7	6.7	9.0	9.0	9.0	9.0	5.3	7.7	7.0	6.3	6.3	5.7	6.7	6.4
HV 130	5.0	7.0	8.7	8.3	9.0	8.7	4.7	6.7	7.3	7.7	6.3	5.3	6.3	6.3
PLATINI	6.7	7.0	9.0	9.0	9.0	9.0	6.3	6.3	6.3	6.3	6.3	6.3	6.0	6.3
BAR VB 233	7.3	7.7	8.3	9.0	9.0	9.0	6.3	6.0	6.3	5.7	7.3	6.0	6.0	6.3
ALLURE	6.3	6.3	8.0	8.7	9.0	8.7	6.0	7.7	7.0	5.7	6.0	5.7	5.7	6.2
COVENTRY	6.7	5.7	8.0	8.3	8.7	8.7	6.0	6.7	7.7	5.3	6.0	6.0	5.7	6.2
HV 242	6.7	7.0	8.7	8.7	9.0	9.0	5.0	6.3	6.0	5.7	7.3	6.3	6.0	6.1
PICK 8	6.3	8.0	8.0	8.7	9.0	9.0	5.0	5.3	5.7	7.0	7.0	6.3	6.3	6.1
SHAMROCK	7.7	5.7	8.7	8.7	8.3	9.0	6.0	6.0	6.3	5.0	6.0	7.0	6.3	6.1
AMERICA	6.3	6.7	8.0	8.3	9.0	8.7	5.3	5.3	6.7	6.3	6.0	7.0	6.0	6.1
SR 2109	5.7	7.0	9.0	8.0	8.7	9.0	4.7	6.3	6.3	6.0	7.0	6.0	6.0	6.0
BA 81-270	7.3	6.0	8.0	9.0	8.3	8.7	6.7	6.3	7.0	4.3	5.7	5.7	6.7	6.0
ZPS-2183	7.0	7.3	8.0	8.0	9.0	8.3	5.3	5.7	6.3	6.7	6.3	7.0	5.0	6.0
J-2582	6.7	7.0	9.0	8.7	9.0	9.0	5.3	5.7	7.3	6.7	6.0	5.7	5.3	6.0
PST-A7-245A	7.0	6.7	8.7	8.7	8.3	9.0	6.0	6.0	7.0	5.0	6.3	5.7	6.0	6.0
BAR VB 3115B	6.0	5.3	8.7	9.0	9.0	9.0	5.7	5.7	7.3	5.7	6.3	6.0	5.3	6.0
CHALLENGER	6.7	7.3	8.7	9.0	8.7	8.3	5.7	6.0	6.3	5.3	5.3	7.3	5.7	6.0
BARTITIA	6.0	7.7	8.7	8.3	9.0	9.0	4.7	6.3	6.0	6.7	7.0	5.7	5.7	6.0
J-1567	6.3	8.0	9.0	8.7	9.0	9.0	4.7	6.3	7.0	5.7	6.0	6.7	5.3	5.9
PST-B0-165	6.7	6.7	8.0	9.0	8.7	9.0	5.7	6.3	7.0	4.7	6.0	6.3	5.3	5.9
PST-BO-141	6.3	7.3	8.3	8.3	9.0	9.0	5.3	5.0	5.7	6.7	7.0	6.0	6.0	5.9
UNIQUE	6.3	7.0	8.7	8.7	9.0	9.0	5.3	5.3	5.7	6.7	6.3	5.7	6.3	5.9
PRINCETON 105	7.0	7.3	8.3	9.0	9.0	8.7	5.0	5.7	5.7	6.0	6.7	6.7	5.7	5.9
NJ-GD	8.0	6.0	8.7	8.7	9.0	9.0	6.7	6.3	5.3	5.3	5.7	6.3	5.7	5.9
MED-1497	6.7	8.3	8.7	8.7	8.3	8.0	5.7	7.3	7.0	6.0	5.0	5.3	5.0	5.9
NUSTAR	6.7	7.0	9.0	8.7	9.0	9.0	4.7	6.0	6.0	6.3	6.3	6.0	6.0	5.9
CHATEAU	7.0	6.3	8.3	9.0	8.7	9.0	5.3	6.3	6.3	5.3	6.0	5.3	6.3	5.9
CALIBER	7.0	7.0	7.7	8.3	9.0	8.7	5.3	5.7	5.7	6.3	6.3	6.0	5.7	5.8
PICK 3561	6.0	7.3	8.3	8.7	9.0	8.3	5.0	7.0	7.0	6.0	5.3	5.3	5.3	5.8
PST-638	6.7	8.3	8.7	8.7	9.0	8.0	5.0	6.0	6.0	6.3	5.7	6.0	5.7	5.8
MIDNIGHT	6.0	9.0	8.7	9.0	9.0	8.7	4.3	5.7	6.7	6.7	6.7	6.3	4.7	5.8
BAR VB 5649	6.3	6.3	8.7	8.7	8.7	8.7	5.7	6.3	5.7	5.7	5.3	6.3	5.7	5.8
RAVEN	6.3	7.3	8.7	8.0	9.0	8.3	4.7	6.3	6.3	6.3	6.7	5.7	4.7	5.8
PICK-855	6.0	6.3	8.7	8.3	9.0	9.0	5.0	6.3	6.0	6.3	5.7	5.3	6.0	5.8
BA 75-490	7.3	7.0	7.7	8.7	9.0	9.0	5.7	4.7	5.7	6.7	6.7	6.0	5.3	5.8
JEFFERSON	6.7	6.3	8.0	8.7	8.7	8.7	5.7	5.0	6.0	6.0	5.7	6.0	6.3	5.8
PST-B3-180	6.0	7.0	8.7	8.7	8.7	8.7	4.7	6.0	6.0	6.3	6.3	5.7	5.7	5.8
LIMOUSINE	5.7	6.3	9.0	9.0	8.7	8.0	5.3	7.3	7.3	5.3	5.0	4.7	5.3	5.8
NJ-54	5.7	6.0	8.7	8.7	9.0	8.7	5.0	5.0	5.7	7.0	6.0	5.7	6.0	5.8
GLADE	6.7	8.0	8.3	8.7	8.7	8.7	6.0	5.7	6.3	6.0	6.0	5.3	5.0	5.7
BA 77-702	6.0	7.0	8.0	8.3	9.0	9.0	4.7	6.0	6.0	6.0	6.0	5.7	5.3	5.7
BARONIE	5.3	6.3	7.7	9.0	9.0	8.7	4.7	5.7	6.0	6.0	5.7	5.7	6.0	5.7
BA 81-227	6.3	5.7	8.3	8.7	9.0	8.7	5.0	6.7	5.7	5.7	5.7	5.7	5.0	5.6
FORTUNA	6.0	7.3	8.0	8.0	9.0	9.0	4.7	5.3	5.3	6.3	6.3	5.7	5.7	5.6

Table 1. Continued.

Cultivar	*Greenup*† 4/20	*Color*‡ 6/21	*Texture*§ 6/21	*Density*¶ 4/20	7/30	9/21	*Quality*# 4/20	5/27	6/21	7/30	8/20	9/21	10/18	Mean
MED-1991	6.7	7.3	8.7	8.3	8.0	8.7	5.3	5.3	5.7	5.3	6.7	6.0	4.7	5.6
ECLIPSE	6.3	7.0	8.0	8.7	9.0	9.0	5.7	5.7	5.7	5.7	6.0	5.3	5.0	5.6
LIVINGSTON	5.7	5.7	8.3	8.3	9.0	9.0	5.0	5.3	6.0	5.7	6.0	5.7	5.3	5.6
HAGA	6.3	5.3	7.7	8.3	9.0	8.7	5.0	5.7	5.7	5.0	5.7	5.7	5.7	5.5
LPT-621	7.0	5.3	8.0	9.0	8.7	9.0	5.7	5.3	5.0	5.0	5.3	6.7	5.3	5.5
BA 75-173	7.0	6.7	8.0	8.3	9.0	8.7	5.3	5.7	5.7	5.7	5.7	5.3	5.0	5.5
BARON	5.7	7.3	8.0	8.3	8.7	8.7	5.0	6.0	5.0	5.3	6.0	5.7	5.0	5.4
SR 2000	7.0	8.0	7.0	8.3	8.7	8.3	5.0	5.0	5.0	6.0	5.7	6.3	5.0	5.4
BA 76-197	5.7	5.3	7.7	8.7	9.0	9.0	5.0	5.0	5.3	6.7	6.0	5.3	4.7	5.4
CONNI	5.3	7.3	8.3	8.7	8.7	9.0	4.7	6.3	5.7	5.7	5.0	5.0	5.7	5.4
CLASSIC	5.3	5.3	7.7	8.7	8.0	8.7	4.7	5.7	5.7	5.0	4.7	6.0	5.7	5.4
J-155	6.7	7.7	8.7	8.3	8.7	8.7	5.0	5.7	6.3	5.3	5.3	4.7	5.0	5.3
BA 73-373	6.0	7.0	7.7	8.0	8.3	8.3	5.0	5.7	5.3	5.3	5.3	5.7	4.7	5.3
BA 81-220	7.0	6.7	7.7	8.3	8.7	8.3	4.7	5.7	5.3	5.3	6.0	5.3	4.7	5.3
COMPACT	5.7	5.3	7.7	8.0	8.7	9.0	4.7	5.7	4.7	6.0	5.7	5.3	5.0	5.3
NIMBUS	5.7	5.7	8.7	8.3	9.0	8.3	4.3	5.7	5.7	6.3	5.0	5.7	4.3	5.3
MED 1580	5.7	7.0	8.3	8.7	8.3	8.7	4.7	5.0	5.0	6.0	5.3	5.3	5.3	5.2
SR 2109	6.3	6.7	8.3	8.3	8.3	8.7	4.7	5.0	5.7	5.0	6.7	5.0	4.7	5.2
PST-A7-60	4.7	8.3	8.3	8.7	8.7	8.7	3.7	5.0	5.7	5.3	5.7	6.0	5.3	5.2
ABBEY	7.0	6.3	7.7	8.0	8.0	9.0	4.7	5.0	5.3	5.7	5.3	5.3	5.0	5.2
CARDIFF	6.7	7.3	8.0	8.3	8.7	8.7	5.3	5.0	5.7	5.3	5.0	5.0	5.0	5.2
ASCOT	6.0	8.0	8.3	8.0	8.3	9.0	4.0	5.7	5.3	5.3	5.3	5.3	5.3	5.2
BA 87-102	6.3	7.7	7.3	8.0	9.0	8.3	4.3	5.0	5.0	5.7	5.7	5.7	5.0	5.2
PST-A418	7.7	8.7	7.7	8.3	9.0	8.3	5.3	5.3	5.7	5.7	4.3	5.0	4.7	5.2
ZPS-309	6.0	7.3	8.3	8.7	8.7	8.7	5.0	5.0	5.7	5.3	5.3	4.7	5.3	5.2
WILDWOOD	6.0	8.0	8.7	9.0	8.0	9.0	4.7	6.7	6.0	4.7	5.3	4.3	4.0	5.1
BA 70-060	6.0	6.7	7.7	8.0	9.0	8.7	4.3	5.0	5.0	5.7	5.7	5.7	4.3	5.1
PST-P46	5.3	8.3	8.3	8.3	8.3	8.0	4.7	5.3	5.7	5.3	4.7	5.0	5.0	5.1
LTP-620	7.3	5.7	8.3	8.0	8.3	8.0	5.7	5.0	4.7	4.7	5.3	5.3	5.0	5.1
LIPOA	6.7	8.0	8.3	8.3	9.0	8.3	5.0	5.0	3.7	6.3	5.3	5.7	4.3	5.0
BA 81-058	6.3	6.7	7.7	8.3	9.0	8.0	5.0	5.3	5.0	5.0	4.7	5.7	4.3	5.0
VB 16015	7.3	8.0	7.3	8.3	8.0	8.0	5.7	5.0	5.3	5.0	4.3	5.3	4.7	5.0
MARQUIS	5.0	7.0	8.0	8.3	8.7	8.7	4.3	4.7	5.3	5.0	6.3	4.7	4.7	5.0
SIDEKICK	5.7	7.0	7.3	8.0	8.0	8.3	4.0	5.0	5.3	5.0	5.7	5.3	4.3	5.0
BA 75-163	7.3	7.3	7.7	8.3	8.0	8.0	5.0	4.3	4.3	4.7	4.3	5.3	6.0	4.8
SR 2100	7.3	7.0	7.7	7.7	7.7	8.0	5.0	6.0	4.3	4.3	4.3	5.0	5.0	4.8
BAR VB 6820	6.3	8.0	8.0	8.0	8.3	8.0	4.7	5.7	6.3	4.0	3.7	3.7	5.0	4.7
BA 81-113	6.3	7.0	7.0	8.0	8.7	8.3	4.3	4.3	4.7	5.3	5.3	4.7	4.3	4.7
SODNET	6.0	8.3	7.3	8.0	7.7	8.0	4.7	5.0	5.3	4.3	4.3	4.3	4.0	4.6
H86-690	7.0	7.7	7.0	8.3	8.0	8.3	5.0	5.0	4.0	4.7	4.3	4.0	4.7	4.5
ZPS-429	7.0	5.7	7.0	8.0	7.3	8.0	5.0	4.3	4.0	4.7	4.7	4.7	4.0	4.5
A88-744	7.0	7.0	7.0	8.0	8.7	8.0	4.3	4.7	4.7	4.7	4.3	4.3	4.3	4.5
SRX 22O5	6.0	6.7	8.0	8.3	9.0	8.7	4.7	5.0	4.3	4.0	4.7	4.3	4.0	4.4
BA 76-372	5.7	7.0	7.7	8.0	7.3	7.7	4.3	4.7	4.3	4.0	4.0	4.3	4.0	4.2
BA 79-260	6.7	8.0	7.0	8.3	7.3	8.0	4.7	3.7	4.0	3.7	4.3	5.0	4.3	4.2
KENBLUE	6.3	5.3	9.0	7.7	8.0	8.7	4.0	4.0	3.7	4.0	4.7	4.0	4.3	4.1
BARUZO	6.0	7.7	7.7	7.7	8.0	7.3	3.0	4.0	4.0	4.0	4.0	3.3	3.7	3.7
DP 37-192	5.3	8.0	7.7	6.7	7.7	7.3	3.0	4.3	4.0	3.0	3.3	2.7	3.0	3.3
Mean	**6.4**	**7.1**	**8.2**	**8.5**	**8.7**	**8.6**	**5.1**	**5.7**	**5.9**	**5.7**	**5.8**	**5.7**	**5.3**	**5.6**
LSD ($p \leq 0.05$)	**1.3**	**0.8**	**1.0**	**0.8**	**0.7**	**0.7**	**1.3**	**1.4**	**1.5**	**1.2**	**1.3**	**1.5**	**1.6**	**0.8**

†Spring greenup rating scale 1-9, with 9=100% greenup.
‡Color rating scale 1-9, with 9=darkest color.
§Leaf texture rating scale 1-9, with 9=most desirable texture.
¶Turfgrass density 1-9 scale, with 9=greatest density.
#Turfgrass quality 1-9 scale, with 9=highest quality.

Table 2. 1995 Kentucky bluegrass NTEP trial - low input - 1999 data summary. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	Greenup†	*Color*‡	*Texture*§	*Density*¶			*Quality*#							
Cultivar	*4/20*	*6/21*	*6/21*	*4/20*	*7/30*	*9/21*	*4/20*	*5/27*	*6/21*	*7/30*	*8/20*	*9/21*	*10/18*	*Mean*
BAR VB 3115B	6.0	5.7	8.0	8.3	9.0	8.7	5.7	7.7	7.3	6.0	6.0	7.0	7.0	6.7
CALIBER	7.3	6.0	8.0	8.0	9.0	8.3	5.3	7.3	6.0	5.7	6.0	5.7	6.7	6.1
EAGLETON	6.3	5.3	7.7	8.3	8.3	8.7	5.3	6.0	6.0	5.7	5.7	5.3	6.3	5.8
KENBLUE	7.3	5.7	9.0	8.7	9.0	9.0	5.3	6.7	6.3	6.0	5.3	6.0	4.7	5.8
BAR VB 5649	6.3	7.0	6.7	8.3	8.7	8.7	5.0	6.3	6.0	5.0	5.7	5.3	6.3	5.7
BARONIE	5.3	5.3	7.3	8.7	8.0	8.3	5.3	5.7	5.3	5.0	5.7	5.3	6.3	5.5
ZPS-429	7.3	7.3	6.7	8.3	7.3	8.0	6.0	6.3	6.7	4.7	5.0	4.3	5.3	5.5
SOUTH DAKOTA	6.7	4.7	9.0	7.7	9.0	8.0	5.3	6.3	6.3	5.7	4.3	5.0	5.3	5.5
BARTITIA	6.3	7.3	7.7	8.3	8.0	8.0	5.7	6.0	5.3	5.3	5.7	5.3	4.7	5.4
LIPOA	8.0	6.7	7.3	7.7	8.0	8.7	5.7	5.3	5.3	4.3	5.7	5.7	5.3	5.4
CANTEBURY	5.3	6.3	7.3	8.3	8.3	7.7	5.3	5.3	5.3	4.7	4.7	4.7	5.3	5.1
BAR VB 233	6.7	7.3	7.3	7.3	8.0	8.0	4.7	5.3	5.3	4.3	5.7	4.3	5.7	5.0
BARON	6.7	8.0	7.0	8.3	8.3	7.7	5.0	5.3	4.7	4.7	5.0	4.3	5.3	4.9
BLUE STAR	7.0	7.0	7.0	8.0	8.0	7.7	5.3	6.0	4.7	4.7	4.7	4.0	4.7	4.9
BH 95-199	6.7	7.0	6.7	8.3	7.7	7.7	5.7	5.3	5.3	4.0	4.7	4.0	5.3	4.9
PST-B9-196	7.3	7.3	6.3	8.3	8.0	8.3	6.0	5.3	4.7	4.3	3.7	3.7	5.7	4.7
BARUZO	7.0	7.7	6.3	7.7	8.3	6.3	4.7	5.7	5.3	3.3	5.0	4.3	4.3	4.6
BAR VB 6820	6.0	6.7	7.0	7.7	8.3	8.3	4.0	4.7	4.0	4.7	4.3	3.3	5.3	4.3
PST-A7-60	5.0	8.7	8.0	7.7	7.0	7.3	4.3	4.0	3.7	4.0	4.0	4.7	5.3	4.3
MTT 683	6.7	7.0	7.7	7.0	8.3	7.7	4.0	4.3	4.7	4.7	3.7	4.0	4.0	4.2
VB 16015	7.7	8.7	6.0	8.0	7.0	6.7	5.3	5.0	4.3	4.0	3.3	3.0	4.0	4.1
Mean	**6.6**	**6.8**	**7.3**	**8.0**	**8.2**	**8.0**	**5.2**	**5.7**	**5.4**	**4.8**	**4.9**	**4.7**	**5.4**	**5.2**
LSD ($p \leq 0.05$)	**1.2**	**0.8**	**1.0**	**0.8**	**0.8**	**1.5**	**1.0**	**1.3**	**1.4**	**1.5**	**1.6**	**1.9**	**1.4**	**0.8**

†Spring greenup rating scale 1-9, with 9=100% greenup.
‡Color rating scale 1-9, with 9=darkest color.
§Leaf texture rating scale 1-9, with 9=most desirable texture.
¶Turfgrass density 1-9 scale, with 9=greatest density.
#Turfgrass quality 1-9 scale, with 9=highest quality.

1999 Results from the 1996 National Tall Fescue Trial

M. R. Vaitkus, R. C. Shearman, J. E. Watkins, and L. A. Wit

The National Tall Fescue trial was established in September, 1996 at the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE. The trial contains 130 cultivar entries planted in a completely randomized block design with 3 replications. Plot size is 4 ft by 5 ft and the seeding rate was 4.0 lbs / 1000 ft^2.

Soil type is a Sharpsburg silty clay loam (fine, montmorillonitic, mesic Typic Argiudoll) with a pH of 6.7 and 3.6% organic matter. Turf is maintained at a height of 1.5 inches and is mowed two times weekly. Nitrogen is applied at 4.0 lbs / 1000 ft^2 per year; phosphorous and potassium are applied according to soil test results. Irrigation is adjusted twice weekly to maintain an application rate of 60% ETp. Pendimethalin is applied annually at label-recommended rates for crabgrass control, while postemergence herbicides are applied only as needed. No fungicides or insecticides are applied.

In 1999, genetic color, leaf texture, turfgrass density and monthly turfgrass quality were evaluated. In late July, brown patch (*Rhizoctonia solani*) occurred and also was rated. Statistical analyses of monthly observations showed considerable variation among cultivars (Table 1). Most cultivars showed greater than 60% greenup (a rating of 6.0) by April 20; only six cultivars had greenup ratings below 6.0 (Arid, DLF-1, AV-1, JTTFA-96, DP 7952, and KY31 w / endo). Mean genetic color was relatively high (7.2) and only six cultivars (Titan 2, AV-1, JTTFA-96, Arid, DP 7952, and KY 31 w / endo) had unacceptable (<6.0) color ratings. Texture ratings also were relatively high, with a mean of 7.5; only six cultivars had ratings below 6.0 (DLF-1, PSII-TF-9, AV-1, Arid, DP 7952, and KY-31 w / endo). Density ratings throughout the season were high (between 7.0 and 9.0) for almost all cultivars, with the exception of KY-31 w / endo. Mean cultivar quality ratings ranged from 5.0 to 6.7, with 43 cultivars having unacceptable (<6.0) mean quality ratings. Highest mean monthly quality ratings were observed in June and September. Almost all the cultivars exhibited low to very low (i.e. severity ratings of <7.0) brown patch incidence ratings. Only the cultivar Bonsai, with a brown patch severity rating of 7.0, did not fit this category.

Table 1. 1996 NTEP tall fescue trial - 1999 data summary. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	Greenup†	*Color‡*	*Texture§*	*Density¶*			*Quality#*								*Brown Patch††*
Cultivar	*4/20*	*6/21*	*6/21*	*4/20*	*7/30*	*9/21*	*4/20*	*5/27*	*6/21*	*7/30*	*8/20*	*9/21*	*10/18*	*Mean*	*7/30*
Pennington-1901	7.3	8.3	8.3	8.7	9.0	9.0	6.7	6.7	8.7	5.7	7.7	8.0	6.7	7.0	5.0
ATF-182	6.3	6.3	7.3	8.7	8.7	9.0	6.0	7.7	6.3	5.0	6.7	6.3	7.0	6.7	5.7
CU9502T	7.3	7.0	8.7	9.0	9.0	8.3	7.0	7.3	7.3	6.0	6.0	6.7	7.7	6.7	4.0
AA-A91	7.3	8.0	8.0	8.3	9.0	8.7	6.3	7.7	7.7	5.3	6.0	6.3	6.0	6.7	6.0
Pick RT-95	7.7	7.7	9.0	9.0	9.0	9.0	6.7	6.3	8.0	5.3	6.3	8.3	7.3	6.7	4.3
Falcon II	7.3	7.3	7.7	9.0	8.7	8.3	7.0	6.7	6.0	5.0	5.7	7.3	7.0	6.6	5.0
Gazelle	7.7	7.3	8.0	9.0	9.0	9.0	8.0	6.7	8.0	4.7	6.0	7.0	7.0	6.6	5.7
Pick FA 15-92	7.7	7.7	8.3	8.0	9.0	8.7	5.7	7.7	7.3	5.0	5.0	6.0	6.0	6.5	6.0
WRS2	7.7	8.3	8.0	8.7	9.0	8.7	7.0	5.0	7.3	5.3	6.3	7.7	6.7	6.5	5.3
Renegade	6.0	7.0	7.0	8.3	8.7	8.7	6.0	6.7	7.0	6.0	5.3	6.3	6.3	6.5	4.0
Jaguar 3	7.7	7.0	8.7	9.0	9.0	9.0	8.0	6.0	7.7	5.0	7.0	8.3	7.7	6.5	5.7
Marksman	7.0	7.0	7.7	8.7	9.0	8.7	6.7	5.7	7.3	5.3	6.3	6.7	6.7	6.4	5.0
Southern Choice	8.0	7.0	7.3	9.0	9.0	9.0	7.0	6.7	7.3	5.7	5.7	6.7	7.0	6.4	4.7
ATF-196	7.0	7.0	8.3	8.7	9.0	9.0	6.7	7.0	7.7	5.0	5.7	7.7	7.0	6.4	5.7
J-98	8.3	8.0	8.3	8.3	9.0	9.0	6.7	7.7	8.3	5.3	5.7	6.3	6.7	6.4	5.0
MB 28	7.3	8.0	7.0	7.7	8.7	8.3	5.3	6.7	6.3	5.3	6.0	7.0	6.0	6.4	4.0
OFI-951	7.3	7.0	8.0	8.3	9.0	9.0	6.0	6.7	7.3	5.0	5.7	7.0	6.7	6.4	5.7
BAR Fa6 US3	8.0	8.0	8.7	8.3	8.7	8.7	6.7	6.3	7.3	5.0	5.7	7.0	6.0	6.4	5.0
MB 211	7.7	7.7	7.7	9.0	9.0	8.7	6.3	6.7	6.7	5.0	6.3	7.0	6.0	6.4	5.0

Table 1. Continued.

	Greenup†	*Color*‡	*Texture*§	*Density*¶			*Quality*#								*Brown Patch*††
Cultivar	*4/20*	*6/21*	*6/21*	*4/20*	*7/30*	*9/21*	*4/20*	*5/27*	*6/21*	*7/30*	*8/20*	*9/21*	*10/18*	*Mean*	*7/30*
Crossfire II	8.0	7.3	8.7	8.7	9.0	8.7	7.0	5.7	8.7	6.0	6.7	7.3	6.3	6.4	3.7
AA-989	7.7	7.3	7.3	8.0	8.7	8.3	6.7	7.3	7.0	6.0	6.0	6.3	6.0	6.3	3.3
AA-983	7.3	7.3	7.7	8.3	9.0	9.0	6.0	6.0	7.3	5.3	7.7	6.7	6.7	6.3	4.3
CU9501T	8.0	7.3	8.7	8.7	8.7	9.0	7.3	6.3	8.0	6.0	6.0	6.7	7.0	6.3	4.7
Millennium	7.0	8.3	8.0	8.3	8.7	9.0	6.0	6.3	7.0	5.0	6.7	8.0	7.3	6.3	4.7
Anthem II	6.7	7.0	7.3	8.3	8.3	9.0	6.3	6.0	6.7	5.0	6.0	7.3	7.7	6.3	5.7
BAR FA 6D	7.3	7.7	8.7	8.3	9.0	8.3	6.3	5.7	8.3	4.7	5.3	5.7	6.0	6.3	6.0
Apache II	7.3	7.3	7.7	9.0	8.7	9.0	6.3	6.7	7.0	5.7	6.7	6.3	6.3	6.3	3.7
Pro 8430	6.3	7.0	7.0	8.0	9.0	8.7	5.3	7.3	7.0	5.0	5.3	7.0	6.3	6.3	5.3
ZPS-2PTF	7.0	7.7	8.3	8.7	9.0	8.7	6.7	7.3	7.0	5.0	5.3	6.7	6.7	6.3	5.3
ATF-022	7.0	6.3	8.0	8.7	9.0	9.0	6.7	6.3	6.7	5.7	5.7	6.3	7.0	6.3	5.3
Shortstop II	7.3	7.7	8.0	8.3	8.7	9.0	5.7	6.0	7.3	5.3	6.0	8.0	6.3	6.3	4.7
Safari	6.3	6.7	7.0	8.3	8.3	9.0	6.0	7.7	7.3	4.3	6.0	5.3	5.7	6.3	5.7
BAR Fa6 US2U	8.0	8.0	8.7	8.3	9.0	9.0	6.7	7.3	8.0	5.7	6.0	7.0	5.7	6.3	3.3
ATF-038	7.7	7.7	7.3	8.3	8.7	8.3	6.3	6.3	7.0	4.7	6.3	7.3	6.7	6.3	6.0
Pick FA UT-93	7.7	7.7	8.0	7.7	8.7	8.7	5.3	7.7	7.0	4.3	4.3	6.0	5.7	6.3	6.0
ATF-188	7.3	7.0	9.0	9.0	9.0	9.0	6.7	7.3	5.7	4.7	6.3	6.3	7.0	6.3	5.3
OFI-96-31	7.7	8.3	7.3	8.0	8.3	8.0	5.7	6.7	6.7	5.3	7.3	7.3	6.3	6.3	5.3
MB 210	7.3	7.3	7.0	8.3	9.0	8.7	6.0	6.0	6.7	4.3	6.7	7.7	6.3	6.3	4.3
MB 212	8.0	7.7	7.7	9.0	8.7	8.3	6.7	5.7	7.0	5.0	6.7	8.0	7.0	6.3	5.3
Tarheel	7.0	7.7	7.0	8.3	8.7	8.3	6.7	6.7	6.7	5.0	6.7	7.0	7.0	6.3	4.0
Coronado	7.3	7.3	7.3	8.3	8.7	8.0	6.0	7.3	6.7	5.0	5.3	6.7	6.7	6.3	5.7
Tulsa	7.3	6.3	8.7	9.0	9.0	8.7	6.7	6.3	7.3	4.7	5.0	6.7	6.7	6.2	5.7
Arid	5.7	5.0	5.3	8.7	8.0	7.7	6.0	6.0	5.7	4.3	5.3	5.7	5.7	6.2	5.0
LTP-4026 E+	7.7	7.7	8.7	9.0	9.0	9.0	6.7	6.3	7.0	5.7	8.0	8.7	7.0	6.2	4.0
MB 26	7.7	8.7	8.7	8.0	8.7	8.7	6.0	6.0	7.0	5.0	6.0	7.7	6.7	6.2	4.7
Coyote	7.0	7.7	8.3	8.7	8.7	8.7	6.3	7.0	6.7	4.3	6.0	6.7	7.3	6.2	5.7
Tomahawk-E	7.0	7.0	8.3	9.0	9.0	8.7	6.3	6.3	7.0	4.7	6.3	7.0	5.7	6.2	5.3
Sunpro	7.7	7.7	8.0	8.7	8.7	8.3	6.7	6.3	7.3	5.0	6.0	7.7	6.3	6.2	4.7
Shenandoah	6.3	6.7	7.0	9.0	8.7	8.7	6.7	7.0	7.3	5.7	5.7	6.3	6.7	6.2	4.0
BAR FA 6LV	7.3	7.7	8.7	8.3	9.0	9.0	5.7	6.3	7.7	4.3	5.3	5.7	5.7	6.2	6.3
Mustang II	6.3	7.3	8.7	9.0	9.0	8.7	6.3	6.7	6.7	5.0	6.3	6.0	6.7	6.2	5.3
TA-7	8.3	8.0	7.7	8.3	8.7	8.0	6.3	6.0	7.0	4.7	6.7	7.0	6.3	6.2	5.3
MB 29	7.7	8.7	7.0	8.0	9.0	8.7	5.3	4.7	7.0	5.3	6.7	6.7	6.3	6.2	4.7
MB 213	7.0	8.0	7.0	8.0	9.0	8.0	5.0	6.3	7.0	5.7	6.0	6.3	5.3	6.2	4.0
MB 214	7.7	8.3	8.0	8.7	9.0	8.3	6.3	6.7	6.7	4.7	6.3	7.3	6.3	6.2	5.7
ISI-TF11	7.0	6.3	6.0	7.7	8.3	8.3	5.7	5.3	5.7	5.7	5.3	6.0	6.3	6.2	4.0
OFI-FWY	7.3	7.3	8.3	8.7	8.7	8.7	6.3	7.3	7.0	4.7	5.3	5.7	6.3	6.2	5.3
BAR Fa6 US1	8.0	8.3	8.3	8.3	9.0	7.7	6.3	7.0	8.0	4.3	4.7	7.7	6.3	6.2	5.7
ATF-020	7.0	6.7	8.3	8.7	8.7	8.3	6.0	7.0	7.0	5.3	5.3	5.7	5.3	6.2	5.0
LTP-SD-TF	7.3	7.3	8.7	8.7	9.0	8.3	6.3	7.3	8.0	5.7	5.7	7.3	7.0	6.2	5.7
J-3	7.3	7.7	8.0	8.7	8.7	8.3	5.7	7.0	7.3	5.7	6.7	5.7	6.0	6.1	5.3
MB 215	8.0	8.3	7.3	8.0	8.7	8.0	6.0	6.3	7.7	5.0	5.7	6.7	6.0	6.1	4.0
PST-R5TK	7.0	7.3	7.3	9.0	9.0	8.3	6.7	6.3	6.7	5.7	6.3	6.7	7.0	6.1	4.3
MB 216	7.7	8.0	7.7	8.0	9.0	7.7	5.7	6.0	6.7	5.0	5.7	7.3	6.3	6.1	4.0
Titan 2	6.0	5.7	6.7	8.7	8.7	8.0	5.7	6.7	5.7	5.7	6.7	5.7	5.3	6.1	3.0
Pick FA 20-92	8.0	7.0	8.7	8.7	9.0	8.0	6.3	6.3	8.0	5.3	5.7	5.0	5.3	6.1	5.0
PST-523	6.3	6.7	7.3	9.0	9.0	9.0	6.0	7.3	6.7	6.7	6.3	7.0	6.7	6.1	3.7
Pick GA-96	7.3	7.3	7.3	8.3	9.0	9.0	5.7	6.0	6.7	4.3	6.0	6.7	6.0	6.1	5.7
ISI-TF10	8.0	7.7	6.3	7.7	8.3	8.0	5.0	6.3	5.7	4.7	5.0	5.7	5.3	6.1	5.3
Pick FA XK-95	7.7	7.7	7.7	8.0	8.7	8.7	5.7	6.0	7.0	4.7	5.3	6.3	6.7	6.1	6.0
Empress	7.3	6.7	7.7	9.0	9.0	9.0	6.3	6.0	6.7	6.0	5.7	6.0	7.0	6.1	5.0
Pick FA 6-91	8.3	8.7	7.7	8.3	8.0	8.3	6.3	6.0	7.0	4.7	5.3	5.3	5.3	6.0	5.7
WVPB-1B	6.7	7.3	7.0	8.0	8.3	9.0	5.0	5.3	6.3	5.0	5.7	6.0	5.7	6.0	6.0
PC-AO	6.7	7.7	7.3	8.0	8.7	8.0	5.3	6.3	7.0	5.3	7.0	7.3	7.3	6.0	4.3
JTTFC-96	6.0	6.0	6.3	8.0	8.3	8.3	6.0	6.7	5.7	5.3	6.0	5.7	5.3	6.0	5.0
SRX 8084	6.0	6.3	6.7	7.7	8.7	8.7	5.3	7.0	5.7	4.7	5.3	6.7	6.3	6.0	5.0
Regiment	6.7	6.0	7.0	8.7	9.0	8.7	6.0	7.0	5.3	4.7	6.0	7.0	6.0	6.0	5.3
Bonsai 2000	6.7	7.0	8.0	9.0	9.0	9.0	6.3	6.7	5.7	4.7	6.0	6.7	6.3	6.0	4.7
Pick FA B-93	7.3	7.0	8.3	8.7	9.0	9.0	6.3	6.7	7.3	4.7	5.3	7.0	7.0	6.0	4.7

Table 1. Continued.

	Greenup†	*Color*‡	*Texture*§	*Density*¶			*Quality*#								*Brown Patch*††
Cultivar	*4/20*	*6/21*	*6/21*	*4/20*	*7/30*	*9/21*	*4/20*	*5/27*	*6/21*	*7/30*	*8/20*	*9/21*	*10/18*	*Mean*	*7/30*
OFI-96-32	7.0	7.0	6.3	8.0	8.7	8.0	5.7	6.7	5.0	5.0	6.0	5.3	5.0	6.0	4.3
BAR Fa6D USA	7.7	8.7	8.3	8.3	8.7	9.0	6.3	6.3	7.0	5.7	6.0	6.3	5.7	6.0	5.3
ATF-257	6.7	6.7	7.3	8.7	9.0	9.0	6.3	6.3	6.3	5.3	5.7	6.3	6.3	6.0	5.0
RG-93	7.3	7.7	6.7	7.3	8.3	8.7	5.0	5.7	6.3	5.0	5.7	7.0	7.0	6.0	4.7
BAR FA6 US6F	7.7	7.7	7.7	8.3	9.0	9.0	6.3	6.7	6.7	5.0	6.3	6.3	6.3	6.0	4.3
PST-5TO	7.3	7.7	8.0	7.7	8.7	9.0	5.7	6.3	6.3	5.0	6.3	6.0	6.3	6.0	6.0
SRX 8500	7.7	7.7	8.3	8.3	8.7	9.0	6.3	5.7	8.0	4.7	5.7	7.7	6.7	6.0	6.3
PST-5RT	6.7	6.7	7.0	7.7	8.0	9.0	5.3	6.0	6.7	4.3	5.0	6.7	6.0	6.0	5.7
Duster	7.3	7.0	7.0	8.3	8.7	8.0	6.0	5.7	6.3	5.3	6.7	7.0	6.7	5.9	4.3
SR 8210	7.7	7.0	7.7	8.7	8.3	8.7	6.7	6.3	6.0	4.7	5.3	6.7	6.0	5.9	6.7
Monarch	6.0	6.7	6.3	8.0	8.3	9.0	5.3	6.0	6.0	5.0	6.0	5.7	6.3	5.9	5.7
R5AU	6.7	7.0	8.0	8.0	8.7	8.7	5.7	7.0	5.7	5.3	6.3	6.0	6.3	5.9	4.7
Twilight II	7.0	8.3	6.7	7.3	8.7	8.7	5.0	6.7	6.0	5.0	5.3	6.3	6.0	5.9	5.7
WX3-275	6.7	7.0	7.3	7.7	8.7	8.3	4.7	5.3	5.7	5.3	6.0	5.7	5.3	5.9	5.3
SS45DW	7.3	6.7	7.0	8.3	8.0	8.7	6.0	6.3	5.7	5.3	5.3	5.7	5.3	5.9	5.0
OFI-931	7.7	8.0	7.7	8.7	9.0	9.0	6.0	5.0	6.7	5.0	6.0	6.7	6.0	5.9	6.0
Alamo E+	7.7	7.0	7.7	8.0	9.0	8.3	5.3	5.0	6.7	5.0	5.3	6.0	6.0	5.9	5.0
WVPB-1D	6.7	6.3	7.3	8.3	8.7	8.7	5.7	6.0	5.7	4.3	6.0	6.3	6.3	5.9	5.3
Cochise II	7.0	6.7	7.3	8.3	8.7	8.3	5.7	7.0	6.0	4.7	5.3	6.0	6.3	5.9	4.7
JTTFA-96	5.3	5.3	6.3	8.3	9.0	8.7	5.7	5.7	6.0	5.3	5.0	7.3	6.0	5.9	5.3
PSII-TF-10	7.0	7.7	7.0	8.0	8.3	8.3	5.3	6.7	6.7	5.3	4.7	6.0	5.3	5.9	6.3
ISI-TF9	6.7	7.0	7.0	8.7	9.0	9.0	5.7	7.0	6.3	4.3	6.0	7.0	6.3	5.8	6.3
PST-5E5	6.7	8.3	7.0	9.0	8.7	9.0	6.0	6.3	6.7	5.7	5.7	6.0	6.7	5.8	4.0
PST-R5AE	7.3	7.3	7.3	8.7	8.3	8.7	7.0	6.3	6.7	4.7	6.0	7.0	6.0	5.8	5.0
PST-5M5	7.0	7.0	8.0	9.0	8.7	9.0	7.0	6.7	7.3	5.3	7.3	7.0	6.7	5.8	4.3
Bonsai	6.3	7.0	7.7	8.3	8.3	8.3	5.3	6.3	6.3	4.0	4.7	5.7	5.3	5.8	7.0
DP 50-9011	6.7	6.3	7.0	8.3	8.7	8.0	5.3	7.0	6.3	4.7	5.3	6.3	6.0	5.8	5.3
Lion	7.3	7.7	7.0	8.0	8.0	8.3	5.7	7.3	6.3	5.0	6.0	5.3	5.7	5.8	3.7
Equinox	6.3	6.7	6.3	7.0	8.0	8.7	4.3	6.0	5.7	4.3	5.7	5.3	5.7	5.7	5.3
JSC-1	6.0	7.3	7.0	8.0	8.7	9.0	5.3	6.0	6.3	5.0	6.3	6.3	5.7	5.7	4.7
Koos 96-14	7.0	7.0	7.3	8.3	8.3	8.3	5.3	7.3	5.0	4.3	5.0	4.7	5.0	5.7	5.3
Finelawn Petite	7.0	7.7	6.7	7.3	8.3	8.3	5.3	5.7	5.3	5.0	5.7	5.7	5.7	5.7	4.7
Genesis	7.3	7.0	7.0	8.3	9.0	8.7	6.0	6.0	6.0	5.0	5.3	7.0	6.3	5.7	4.7
ZPS-5LZ	7.3	8.0	7.7	8.3	9.0	7.0	6.7	6.0	6.3	4.7	5.7	6.7	6.0	5.7	5.3
Leprechaun	7.3	6.3	6.3	8.7	8.7	8.0	6.3	6.7	5.7	4.7	5.7	6.0	5.7	5.7	6.0
ATF-253	7.7	6.3	7.3	8.3	9.0	9.0	6.0	6.7	5.0	5.0	6.0	5.7	5.7	5.7	5.3
Aztec II	7.3	7.7	7.3	8.0	9.0	8.7	5.7	5.7	6.3	4.7	6.3	7.0	6.3	5.7	6.0
PSII-TF-9	6.7	6.0	5.3	7.7	8.3	8.0	5.0	7.3	5.3	4.7	5.0	6.0	5.7	5.7	4.7
J-101	7.3	8.7	8.0	8.0	9.0	8.7	5.3	5.7	7.7	4.7	6.7	7.3	6.0	5.6	6.0
Pick FA N-93	8.0	7.7	7.7	8.0	9.0	8.3	5.3	5.3	6.7	4.7	5.3	6.3	5.7	5.6	6.0
EA 41	7.0	7.3	7.3	8.0	8.3	8.3	5.0	5.7	5.3	4.7	5.0	6.0	5.3	5.6	5.3
DLF-1	5.7	6.3	5.7	7.3	8.0	8.0	5.0	6.7	5.0	4.3	5.0	5.7	5.3	5.5	5.7
EC-101	6.7	7.3	8.0	8.7	9.0	9.0	5.0	6.0	5.0	5.0	4.7	5.0	5.7	5.5	5.7
Pixie E+	6.7	7.3	7.3	8.3	9.0	9.0	5.7	5.7	6.7	5.3	6.7	6.3	6.0	5.5	5.0
WVPB-1C	7.0	7.0	7.3	7.7	8.0	9.0	5.0	7.0	4.0	4.3	4.7	4.7	4.3	5.5	5.3
ATF-192	6.3	6.7	6.0	7.0	8.3	8.0	4.7	6.3	5.0	4.3	5.3	6.0	5.3	5.5	5.7
J-5	7.7	7.7	7.7	7.7	8.3	9.0	5.0	5.7	6.3	4.7	6.3	6.0	5.7	5.4	5.3
AV-1	5.7	5.7	5.3	7.7	8.0	8.0	5.3	7.0	4.3	3.7	4.3	5.3	5.0	5.4	5.3
SSDE31	7.0	7.0	6.7	8.3	8.3	8.3	5.0	6.3	5.0	4.3	5.7	4.7	5.0	5.4	4.7
DP 7952	5.0	5.0	5.3	7.3	8.0	7.3	4.3	4.7	5.3	4.3	5.3	5.0	4.7	5.2	6.3
KY-31 w/endo	4.0	4.7	3.0	6.0	5.7	6.3	2.3	6.7	2.7	2.0	4.3	2.3	3.0	4.7	2.7
Mean	**7.1**	**7.2**	**7.5**	**8.3**	**8.7**	**8.6**	**5.9**	**6.4**	**6.6**	**5.0**	**5.9**	**6.5**	**6.2**	**6.1**	**5.1**
LSD (p<0.05)	**0.9**	**0.9**	**1.1**	**0.9**	**0.7**	**1.0**	**1.4**	**1.6**	**1.4**	**1.5**	**1.6**	**1.6**	**1.2**	**0.8**	**1.7**

†Spring greenup rating scale 1-9, with 9=100% greenup.
‡Color rating scale 1-9, with 9=darkest color.
§Leaf texture rating scale 1-9, with 9=most desirable texture.
¶Turfgrass density 1-9 scale, with 9=greatest density.
#Turfgrass quality 1-9 scale, with 9=highest quality.
††Brown patch rating 1-9, with 1= no disease and 9=greatest severity.

1999 Results from the 1998 National Fineleaf Fescue Trial

M.R. Vaitkus, R.C. Shearman and L.A. Wit

The 1998 National Fineleaf Fescue trial was planted in early September, 1998, at the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE. The trial contains 79 cultivar and experimental line entries planted in a completely randomized block design with 3 replications. Plot size is 4 ft by 5 ft and the seeding rate was 5.5 lbs / 1000 ft^2. The trial was established within a Scotch Pine plantation, with plots placed between rows of trees planted on a north / south orientation. The pH of the soil is 5.9, with organic matter at 5.8%.

Turf is maintained at a height of 3.0 inches and is mowed weekly. Nitrogen is applied in October at a rate of 1.0 lbs / 1000 ft^2 per year. Phosphorous and potassium are not applied. Irrigation of 1.0 inch is applied once each month during the growing season. Preemergence and postemergence herbicides are applied as needed to prevent stand loss from weed encroachment. No fungicides or insecticides are used.

In 1999, greenup, genetic color, turfgrass density and turfgrass quality were evaluated. Greenup ratings were low, with all cultivars except one (SR 6000) having ratings of 5.0 (Table 1). Mean turfgrass color was 6.7, with only four cultivars (Boreal, Shadow II, Common creeping red, and Sandpiper) having unacceptable ratings of <6.0. Mean densities were all above 6.0 throughout the growing season, although some individual cultivars started the growing season at a relatively low level and improved. In April, 18 cultivars had unacceptable (< 6.0) densities; in July, only 10; and by September, only 9. Mean quality ratings were low throughout the season (4.1 to 5.5) and only four cultivars (ASC 172, Dawson E+, ACF 083, and Treazure (E)) had acceptable (>6.0) ratings.

Table 1. 1998 NTEP fine fescue trial - 1999 data summary. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	Greenup†	*Color*‡	*Density*§			*Quality*¶							
Entry	*4/20*	*6/21*	*4/20*	*7/30*	*9/21*	*4/20*	*5/27*	*6/21*	*7/30*	*8/20*	*9/21*	*10/18*	*Mean*
ASC 172	5.0	7.0	5.0	6.3	6.7	3.0	3.0	4.3	3.3	4.7	4.3	5.7	6.2
Dawson E+	5.0	6.0	8.0	8.0	7.7	5.0	4.7	5.7	5.7	5.3	5.3	5.0	6.2
ACF 083	5.0	6.0	5.0	6.0	6.0	3.0	3.7	4.7	4.3	4.0	3.7	4.3	6.1
Treazure (E)	5.0	6.3	8.0	8.0	7.7	5.3	4.7	5.7	5.3	5.3	6.0	5.0	6.1
ACF 092	5.0	6.0	7.3	6.7	6.7	4.7	3.3	4.3	4.7	5.0	5.0	5.0	6.0
Shademaster II	5.0	6.0	5.3	5.3	6.3	3.3	3.3	4.3	3.7	4.0	4.7	4.7	6.0
Discovery	5.0	6.7	8.0	6.3	7.0	6.0	4.0	4.3	5.3	4.3	5.3	6.3	6.0
PST-4HM	5.0	6.0	3.3	3.0	3.0	2.3	1.3	1.7	2.0	2.0	2.3	2.7	6.0
Quatro	5.0	7.0	8.3	8.7	9.0	5.3	6.0	7.0	6.7	7.0	7.0	7.7	6.0
SRX 3961	5.0	7.0	7.7	6.3	6.7	5.0	3.7	5.0	4.7	5.0	4.7	5.7	6.0
Boreal	5.0	5.7	6.3	6.7	7.0	3.7	4.0	5.0	4.7	5.0	5.0	4.7	5.9
AHF 008	5.0	6.3	8.3	6.7	7.0	5.7	4.0	5.0	5.0	5.3	4.7	6.3	5.8
Minotaur	5.0	7.3	7.7	7.7	7.7	5.3	4.3	5.3	5.3	5.7	5.7	6.3	5.8
ASR 049	5.0	7.0	6.7	7.7	7.3	3.7	4.3	5.3	5.0	5.3	5.0	5.7	5.8
Attila E	5.0	6.7	8.0	7.7	7.7	5.7	4.3	5.3	5.3	5.3	5.0	5.7	5.8
Tiffany	5.0	6.7	4.3	5.0	5.7	3.3	2.7	3.7	3.7	3.7	4.7	4.3	5.7
AHF 009	5.0	6.3	8.0	6.7	7.3	5.7	4.7	5.0	5.3	4.7	5.7	6.0	5.7
Shadow lI	5.0	5.7	6.0	7.3	6.7	5.0	4.0	5.3	5.3	5.0	4.0	4.0	5.7
Bighorn	5.0	7.3	7.3	7.0	7.0	4.7	4.7	5.0	4.7	4.7	5.3	5.7	5.6
Longfellow II	5.0	6.7	4.3	6.3	7.0	3.0	3.7	5.0	5.3	5.3	5.7	5.3	5.6
Common creeping red	5.0	5.7	7.0	7.0	7.7	4.7	4.3	5.7	5.0	5.0	5.7	5.7	5.6
ASC 087	5.0	6.3	7.3	7.3	7.7	4.3	5.0	6.0	5.7	5.7	5.7	6.0	5.5
ISI Fl 11	5.0	7.0	8.0	8.3	8.7	6.0	4.3	5.3	6.0	6.0	6.0	6.3	5.5
ABT-HF-4	5.0	7.3	8.3	6.7	7.3	6.0	4.3	5.0	5.0	4.7	5.3	5.7	5.5

Table 1. Continued.

	Greenup†	Color‡	Density§			Quality¶							
Entry	*4/20*	*6/21*	*4/20*	*7/30*	*9/21*	*4/20*	*5/27*	*6/21*	*7/30*	*8/20*	*9/21*	*10/18*	*Mean*
Sandpiper	5.0	5.0	5.0	5.3	5.7	3.3	3.0	4.0	4.7	3.7	4.0	4.3	5.5
Florentine	5.0	6.3	5.7	6.0	6.0	3.3	3.0	4.0	4.7	4.7	4.7	5.0	5.4
PST-4MB	5.0	8.0	7.7	7.0	7.3	4.7	3.7	5.0	4.7	4.3	5.0	5.7	5.3
Jamestown II	5.0	6.3	7.0	8.0	8.0	5.0	4.7	5.7	6.0	5.0	5.7	5.0	5.3
ASC 082	5.0	6.3	6.0	6.7	7.3	3.7	3.0	4.0	4.0	4.7	5.3	6.3	5.3
ISI Fl 12	5.0	6.7	8.3	7.3	7.7	5.7	4.7	5.0	5.0	5.0	5.3	6.0	5.2
Reliant II	5.0	6.7	8.7	8.3	8.3	5.7	5.7	6.0	6.0	5.7	6.0	7.0	5.2
Rescue 911	5.0	7.0	6.7	6.3	6.3	5.0	4.0	4.7	4.0	4.3	4.3	5.7	5.1
Banner III	5.0	6.0	6.7	7.3	7.3	4.7	4.3	5.0	5.0	5.0	5.3	5.0	5.1
SR 3200	5.0	7.7	8.3	7.7	8.3	5.0	4.7	5.7	5.3	5.7	5.7	5.3	5.1
SR 6000	7.0	7.3	7.3	8.0	7.7	4.7	4.7	6.0	6.0	5.7	5.7	5.0	5.1
Culombra	5.0	6.7	6.3	6.0	6.0	4.0	3.3	4.3	4.3	4.0	3.7	3.7	5.0
SR 5100	5.0	6.3	7.7	8.7	9.0	5.7	6.0	7.7	6.3	5.7	6.7	6.7	5.0
MB-82	5.0	7.0	7.0	7.0	7.3	4.7	4.3	5.3	5.0	4.7	4.7	5.7	5.0
ABT-CHW-2	5.0	7.3	8.3	8.7	9.0	6.0	6.0	7.3	6.7	6.3	6.7	6.3	5.0
Salsa	5.0	6.3	7.0	8.3	8.7	4.7	4.3	5.7	6.0	6.3	6.3	6.7	4.9
ABT-HF1	5.0	7.3	8.7	7.7	8.0	6.0	3.3	5.0	5.3	6.0	5.7	6.0	4.9
PST-4FR	5.0	7.0	6.3	7.7	7.7	4.0	3.7	5.3	6.0	5.7	6.0	6.3	4.9
Heron	5.0	6.3	7.7	7.7	7.3	4.7	4.0	5.0	5.0	5.7	5.3	6.0	4.9
Pick Frc A-93	5.0	6.3	7.3	7.7	8.0	5.3	4.7	5.7	6.0	6.0	5.0	5.7	4.9
MB-63	5.0	7.0	7.0	7.0	7.7	5.0	3.0	5.0	4.7	5.0	5.7	5.7	4.9
SRX 52LAV	5.0	6.7	3.7	5.0	5.7	2.3	3.0	3.3	4.0	4.0	3.7	4.3	4.9
Bridgeport	5.0	6.3	7.3	7.7	8.0	5.3	4.7	6.0	5.7	5.7	6.3	6.0	4.8
ABT-CHW-1	5.0	6.7	5.0	6.3	6.0	3.3	2.7	4.7	4.3	4.3	5.0	4.0	4.8
BAR CF 8 FUS1	5.0	6.0	7.0	7.3	7.7	4.0	3.7	5.3	4.7	5.0	5.3	5.7	4.7
BAR SCF 8 FUS3	5.0	6.3	7.0	7.7	8.7	5.0	4.3	5.3	5.3	5.7	5.7	5.3	4.7
BAR HF 8 FUS	5.0	7.3	8.0	6.3	6.7	6.0	4.3	4.3	4.7	4.7	4.7	6.0	4.6
Magic	5.0	7.0	8.0	8.3	8.7	6.0	5.7	6.7	5.7	5.0	6.0	6.7	4.6
SRX 52961	5.0	6.3	5.7	6.0	6.3	4.0	4.0	4.3	4.7	5.3	5.3	4.7	4.6
Osprey	5.0	6.7	7.3	7.0	6.3	5.0	4.7	4.7	4.0	4.7	4.0	5.3	4.6
Pick FF A-97	5.0	6.7	6.7	6.7	6.7	4.3	3.7	4.0	3.7	4.7	4.3	5.7	4.6
ISI Frr 7	5.0	6.0	4.7	6.0	5.7	3.0	3.0	3.3	4.0	4.7	4.0	4.7	4.6
Nordic (E)	5.0	7.3	8.3	7.7	7.7	5.3	5.0	5.0	5.7	5.0	6.0	6.3	4.5
PST-47TCR	5.0	7.3	5.7	6.7	7.3	3.0	3.3	5.3	4.7	5.0	5.3	6.0	4.4
PST-EFL	5.0	6.7	6.0	6.7	7.7	3.7	4.0	4.7	5.0	5.0	5.7	6.0	4.4
ISI Frr 5	5.0	6.0	4.7	5.3	5.7	3.3	3.0	4.0	4.0	4.3	4.3	4.0	4.4
Oxford	5.0	6.7	7.7	6.7	6.7	5.3	4.0	4.3	4.0	4.7	5.0	5.7	4.2
Jasper lI	5.0	6.7	8.3	8.7	9.0	5.0	5.3	7.0	7.0	7.0	7.0	6.7	4.2
Intrigue	5.0	6.7	8.0	8.3	8.7	5.7	5.0	6.3	6.7	6.3	6.0	6.0	4.2
Scaldis	5.0	6.3	7.0	4.7	5.0	4.7	3.0	3.7	2.7	3.3	2.7	4.3	4.2
BAR CHF 8 FUS2	5.0	7.0	6.7	7.0	7.7	4.7	4.3	5.3	5.0	5.0	5.3	5.7	4.1
ABT-CR-3	5.0	7.0	6.3	7.7	7.7	3.7	3.7	5.7	5.7	5.7	5.0	5.3	4.1
Seabreeze	5.0	6.3	8.0	8.7	8.0	4.7	5.0	6.0	5.3	6.0	5.3	5.7	4.1
Pick Frc 4-92	5.0	6.7	5.0	5.7	5.7	3.3	3.7	4.7	4.7	4.3	4.0	4.3	4.0
Defiant	5.0	7.3	7.0	6.0	7.0	4.7	3.3	4.3	4.0	4.3	4.7	5.3	3.9
4001	5.0	7.3	5.7	4.7	4.3	3.7	2.3	3.0	2.7	3.0	3.3	5.0	3.9
ABT-HF-3	5.0	7.7	7.7	8.3	8.3	5.0	5.3	6.3	6.0	6.3	6.0	6.7	3.8
DGSC 94	5.0	6.7	6.7	7.0	7.7	3.3	3.3	4.7	4.7	5.0	5.3	6.3	3.7
ABT-HF-2	5.0	6.3	7.7	7.3	8.3	5.3	4.7	5.3	5.3	5.7	6.0	6.3	3.7
ABT-CHW-3	5.0	6.3	7.0	8.0	8.3	5.0	5.3	6.0	5.7	6.0	6.0	6.0	3.6
Ambassador	5.0	7.0	5.0	6.7	6.7	3.7	3.0	4.3	4.7	5.3	5.0	5.3	3.6
Shademark	5.0	7.0	7.0	6.7	7.3	4.7	3.7	4.7	4.0	5.0	5.3	6.3	3.5
ABT-CR-2	5.0	6.7	6.3	7.3	7.3	4.0	4.0	4.7	5.7	6.0	5.3	5.0	3.3
Brittany	5.0	7.3	7.3	8.0	7.7	5.0	4.7	5.3	6.0	5.3	5.3	5.7	3.3
Pathfinder	5.0	6.7	8.0	8.3	9.0	4.3	4.3	6.3	5.7	6.0	6.3	6.3	2.4
Mean	**5.0**	**6.7**	**6.9**	**7.0**	**7.2**	**4.6**	**4.1**	**5.1**	**5.0**	**5.1**	**5.2**	**5.5**	**4.9**
LSD (0.05)	**0.1**	**1.2**	**2.7**	**2.8**	**3.0**	**2.0**	**2.5**	**2.4**	**2.3**	**2.3**	**2.5**	**2.4**	**2.1**

†Spring greenup rating scale 1-9, with 9=100% greenup.
‡Color rating scale 1-9, with 9=darkest color.
§Turfgrass density 1-9 scale, with 9=greatest density.
¶Turfgrass Quality 1-9 scale, with 9=most desirable quality.

1999 Results from the 1998 National Bentgrass Fairway Trial

M.R. Vaitkus, R.C. Shearman and L.A. Wit

Turfgrass

The 1998 National Bentgrass Fairway trial was planted in early September, 1998, at the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE. The trial contains 26 cultivar entries planted in a completely randomized block design with 3 replications. Plot size is 5 ft by 10 ft and the seeding rate was 1.0 lbs/1000 ft^2. Soil type is a Sharpsburg silty clay loam (fine, montmorillonitic, mesic Typic Argiudoll) with a pH of 7.3 and organic matter at 2.4%. This trial will continue through the year 2003.

Turf is maintained at a height of 3/8 inches and is mowed four times weekly. Nitrogen and potassium are applied at 3.0 lbs/1000 ft^2 per year; phosphorous is applied according to soil test recommendations. Irrigation is adjusted twice weekly to maintain an application rate of 80% ETp. Pendimethalin is applied annually at label-recommended rates for crabgrass control, while postemergence herbicides are applied to control broadleaf weeds only as needed. Fungicides and insecticides will be applied as needed on a curative basis.

In 1999, genetic color, leaf texture, turfgrass density, as well as monthly turfgrass quality were evaluated. Greenup ratings were greater than 6.0 (60%) for almost all cultivars on 4/20 (Table 1). Only seven cultivars (Grand Prix, Backspin, Penn G-6, Princeville, Seaside II, Penneagle and Seaside) had unacceptable values less than 6.0. Mean genetic color was relatively high (6.7) and only one cultivar (Seaside) had an unacceptable (<6.0) color rating. Texture ratings ranged from 6.3 to 9.0. Mean density ratings increased throughout the growing season and ranged from 6.7 to 9.0 for all cultivars by September. Mean cultivar quality ratings ranged from 3.6 to 7.1. Only seven cultivars (Grand Prix, Imperial, Century, Trueline, Backspin, Penn G-6, and Princeville) had acceptable (>6.0) mean quality ratings. Monthly mean quality ratings ranged from 4.4 to 6.3, with the highest ratings occurring in August and September.

Table 1. 1998 NTEP bentgrass fairway trial - 1999 data summary. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

Cultivar	*Greenup*†	*Color*‡	*Texture*§	*Density*¶			*Quality*#							
	4/20	*6/21*	*6/21*	*4/20*	*7/30*	*9/21*	*4/20*	*5/27*	*6/21*	*7/30*	*8/20*	*9/21*	*10/18*	*Mean*
Grand Prix	5.7	6.7	8.7	8.3	9.0	9.0	6.0	6.7	7.0	7.0	8.0	8.0	7.3	7.1
Imperial	7.0	6.7	9.0	7.7	9.0	9.0	5.3	6.7	7.3	7.0	8.3	8.0	7.0	7.1
Century	6.7	7.0	8.7	7.7	8.7	9.0	5.3	6.0	6.3	6.7	8.3	8.3	7.0	6.9
Trueline	6.0	7.3	8.7	7.7	8.3	9.0	5.7	5.7	6.7	6.0	7.7	8.3	7.0	6.7
Backspin	5.3	7.0	8.0	8.0	9.0	9.0	5.0	5.3	6.0	6.7	7.3	8.3	6.7	6.5
Penn G-6	5.0	6.3	8.7	7.7	8.3	9.0	5.3	5.3	6.3	6.0	6.0	8.0	7.3	6.3
Princeville	5.7	6.0	8.3	7.3	8.3	9.0	4.7	6.3	6.0	6.3	6.7	6.7	6.7	6.2
PST-0VN	6.3	6.3	8.3	7.7	8.7	8.7	5.0	5.7	6.0	5.7	6.7	6.3	6.0	5.9
Providence	7.3	6.7	8.3	6.7	8.0	8.7	4.3	5.0	5.7	6.0	6.3	7.3	6.3	5.9
Penncross	6.0	6.3	8.3	7.3	8.7	9.0	4.7	5.3	6.3	5.7	7.0	6.3	5.7	5.9
L-93	7.0	6.7	8.7	6.7	8.3	8.7	4.3	5.0	5.7	5.7	6.7	6.7	6.3	5.8
SRX 1BPAA	7.3	7.7	8.3	7.0	7.7	9.0	4.3	4.7	5.7	6.0	6.0	6.7	6.3	5.7
Seaside II	5.7	6.3	8.3	7.0	8.0	9.0	4.3	5.0	5.7	5.7	6.0	6.3	6.0	5.6
SRX 7MOBB	6.7	7.7	8.0	6.7	7.3	8.7	5.0	5.0	5.3	5.0	5.3	6.7	5.7	5.4
PST-9HG	6.3	7.0	7.7	7.0	7.3	8.7	4.7	4.7	5.7	4.7	5.7	6.0	5.7	5.3
SR 1119	6.7	6.0	7.7	7.0	7.7	9.0	4.0	4.3	5.3	4.7	5.3	6.7	6.0	5.2
Penneagle	5.3	6.7	7.7	7.7	7.7	7.7	4.7	4.7	5.3	4.7	5.0	5.3	5.7	5.0
SRX 1120	6.0	7.0	8.0	6.0	7.3	8.7	3.3	4.0	4.7	5.0	5.3	6.3	5.3	4.9
SR 7100	6.7	6.0	7.7	6.3	7.0	8.3	4.3	4.7	5.3	4.3	5.0	5.3	5.0	4.8
GolfStar	6.7	7.3	7.7	6.7	7.0	7.7	4.0	4.3	5.3	5.0	5.0	5.3	4.3	4.7
SRX 7MODD	7.0	7.3	7.7	6.3	7.0	8.0	4.0	3.7	4.7	4.3	5.0	6.0	4.7	4.6
PST-9PM	6.7	7.0	7.3	6.3	7.0	7.7	4.3	3.7	5.0	4.3	4.7	4.3	4.7	4.4
Seaside	4.3	5.0	6.3	7.0	7.0	8.0	3.7	4.3	4.7	3.7	4.3	4.3	5.0	4.3
ISI At-5	7.0	6.7	7.7	6.3	6.7	7.7	3.7	3.3	4.0	4.0	5.0	5.0	4.3	4.2
ABT-Col-2	6.3	6.3	6.7	6.0	7.0	8.3	3.0	3.3	4.3	4.3	4.3	4.3	3.7	3.9
Tiger	7.7	8.3	7.0	5.3	6.7	6.7	2.3	3.7	4.0	3.7	4.7	3.7	3.0	3.6
Mean	**6.3**	**6.7**	**8.0**	**7.0**	**7.8**	**8.5**	**4.4**	**4.9**	**5.6**	**5.3**	**6.0**	**6.3**	**5.7**	**5.5**
LSD (0.05)	**1.6**	**1.3**	**1.4**	**ns**	**1.5**	**1.1**	**1.7**	**1.7**	**1.5**	**1.7**	**2.0**	**2.6**	**2.0**	**1.6**

†Spring greenup rating scale 1-9, with 9=100% greenup.
‡Color rating scale 1-9, with 9=darkest color.
§Leaf texture rating scale 1-9, with 9=most desirable texture.
¶Turfgrass density 1-9 scale, with 9=greatest density.
#Turfgrass quality 1-9 scale, with 9=highest quality.

1999 Results from the 1998 National Bentgrass Putting Green Trial

M.R. Vaitkus, R.C. Shearman and L.A. Wit

Turfgrass

The 1998 National Bentgrass Putting Green trial was planted in early April, 1999, at the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE. Inhospitable spring growing conditions resulted in poor establishment and the trial was interseeded on June 14, 1999. The trial contains 29 cultivar entries planted in a completely randomized block design with 3 replications. Plot size is 5 ft by 10 ft and the seeding rate was 1.0 lbs / 1000 ft^2. The trial was established on a sand substrate conforming to USGA Greens standards for texture. The pH is 6.6 and organic matter comprises 0.4% of the material.

Turf is maintained at a height of 0.125 inches and is mowed 6-7 times weekly. Nitrogen and potassium are applied at 6.0 lbs / 1000 ft^2 per year, divided into weekly applications of 0.125 lbs / 1000 ft^2. Phosphorous is applied in two treatments in mid-June and mid-July at a rate of 2.0 lbs / 1000 ft^2 per growing season. Irrigation is adjusted twice weekly to maintain an application rate of 80% ETp. The area is verticut and topdressed every 10-14 days, depending on growth rate. The north half of each plot receives preventive fungicide applications while the south is treated on a curative basis. Weeds and insects are controlled as needed.

In 1999, establishment, turfgrass density and turfgrass quality were evaluated. Mean establishment ratings were relatively high, with most cultivars above a rating of 7.0 and only one, Bavaria, below the acceptable rating of 6.0 (Table 1). Densities were all above 6.0, with most cultivars having ratings between 7.7 and 9.0. Mean quality ratings were relatively low, with only 13 cultivars having acceptable ($\geq$6.0) mean quality ratings.

Table 1. 1998 NTEP bentgrass putting green trial - 1999 data summary. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	Establishment†		*Density*‡	*Quality*§		
Cultivar	*7/30/99*	*8/27/99*	*10/8/99*	*10/8/99*	*10/18/99*	*Mean*
Penn A-4	8.3	8.3	9.0	8.0	7.7	7.8
BAR AS 8FUS2	9.0	9.0	8.7	7.0	7.3	7.2
Penn G-6	8.0	8.0	8.7	7.0	7.0	7.0
Penn A-1	8.0	8.0	9.0	6.7	7.0	6.8
ABT-CRB-1	8.7	8.0	8.7	6.0	7.0	6.5
Syn 96-2	8.3	8.3	9.0	6.0	7.0	6.5
Syn 96-3	8.3	8.3	8.7	6.0	7.0	6.5
Penn G-1	8.7	8.7	8.7	6.7	6.3	6.5
Penn A-2	8.7	8.7	8.7	6.3	6.7	6.5
SRX 1BPAA	8.3	8.3	8.7	6.3	6.3	6.3
Crenshaw	8.3	8.3	8.3	6.0	6.3	6.2
L-93	8.0	8.0	8.3	6.3	6.0	6.2
PST-A2E	8.0	8.0	8.0	6.3	5.7	6.0
ISI Ap-5	7.3	7.3	8.3	5.7	6.0	5.8
Syn 96-1	8.7	8.7	8.3	5.7	6.0	5.8
SRX 1120	8.0	8.0	8.3	6.0	5.7	5.8
Century	8.0	8.0	8.3	5.7	5.7	5.7
Pick CB 13-94	8.3	8.3	8.0	5.3	5.7	5.5
Providence	7.7	7.7	8.0	5.7	5.3	5.5
BAR CB 8US3	8.7	8.7	8.0	5.3	5.3	5.3
SR 1119	8.7	8.7	8.0	5.3	5.3	5.3
Imperial	8.3	8.3	7.7	4.7	5.3	5.0
SRX 1NJH	7.3	7.3	8.3	5.0	5.0	5.0
Pennlinks	7.3	7.3	8.3	5.0	5.0	5.0
Penncross	7.7	7.7	8.3	5.0	5.0	5.0
Backspin	8.3	7.7	7.7	4.7	5.0	4.8
Pick MVB	6.7	6.7	6.3	3.3	4.3	3.8
Bavaria	5.7	5.7	6.3	3.3	4.0	3.7
SR 7200	6.0	6.0	6.0	3.0	4.0	3.5
Mean	**8.0**	**7.9**	**8.2**	**5.6**	**5.9**	**5.8**
LSD ($p \leq 0.05$)	**1.3**	**1.3**	**1.1**	**1.4**	**1.3**	**1.2**

†Turfgrass establishment 1-9 scale, with 9=100% plant cover.
‡Turfgrass density 1-9 scale, with 9=greatest density.
§Turfgrass quality 1-9 scale, with 9=highest quality.

1999 Results from the 1999 National Perennial Ryegrass Trial

M.R. Vaitkus, R.C. Shearman and L.A. Wit

The 1999 National Perennial Ryegrass trial was planted in late August, 1999, at the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE. The trial contains 134 cultivar and experimental line entries planted in a completely randomized block design with 3 replications. Plot size is 4 ft by 5 ft and the seeding rate was 6 lbs / 1000 ft^2. The trial was established on a Sharpsburg silty clay loam. The pH of the soil is 6.8, with organic matter at 2.5%.

In the first full season of growth (2000), turf will be maintained at a height of 1 / 2 inch and mowed five times per week. Nitrogen and potassium will be applied at a rate of 6.0 lbs / 1000 ft^2 per year; phosphorous will be applied at 1.0 lb / 1000 ft^2 per year. Irrigation will be adjusted twice weekly to maintain an application rate of 80 percent ETp. Pendimethalin will be applied annually at label-recommended rates for crabgrass control and post-emergence herbicides will be applied as needed. No fungicides or insecticides will be used.

Initial establishment and turfgrass quality were evaluated in 1999. Establishment for most cultivars in this trial was good (Table 1) . The mean establishment was 6.8 and only 26 cultivars had means below 6.0, which is considered an acceptable rating. Mean quality for all cultivars was rather low (6.0) and 53 of the cultivars had unacceptable (<6.0) ratings.

Table 1. 1999 NTEP perennial ryegrass trial - 1999 data summary. Trial planted in late August at the J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	Establishment[†]	*Quality*[‡]
Cultivar	*9/21*	*10/1*
APR 1233	6.7	7.7
Pennington 11301	8.0	7.7
APR 776	7.7	7.7
Fiesta III	8.0	7.3
Pick PR1-94	7.7	7.3
Passport	6.7	7.3
Paragon	7.7	7.3
Koos R-71	8.0	7.3
Exacta	7.3	7.0
Affirmed	8.3	7.0
JR-187	7.7	7.0
SRX 4801	6.7	7.0
PST-2L96	6.0	7.0
SRX 4520	7.0	7.0
LPR 98-144	7.0	6.7
Pick EX2	7.0	6.7
APR 1234	6.3	6.7
WVPB-R-82	8.3	6.7
B1	6.3	6.7
Premier II	7.0	6.7
JR-128	7.7	6.7
PST-2A6B	6.3	6.7
Palmer III	8.3	6.7
Panther	8.3	6.7
SR 4500	7.0	6.7
ABT-99-4.724	5.7	6.7
ABT-99-4.753	8.7	6.7
Radiant	8.0	6.7
5-Iron	8.0	6.7
Racer	7.3	6.3
Headstart	8.3	6.3
LPR 98-143	8.0	6.3
YatsuGreen	8.3	6.3
Secretariat	8.0	6.3
Promise	6.3	6.3
Affinity	7.3	6.3
NJ-6401	7.7	6.3
LTP 98-501	7.7	6.3
CIS-PR-69	6.3	6.3
CIS-PR-84	6.0	6.3
R8000	7.0	6.3
Majesty	7.3	6.3

Table 1. Continued.

Cultivar	*Establishment*[†] 9/21	*Quality*[‡] 10/1
Ascend	7.0	6.3
Pleasure XL	7.0	6.3
APR 1235	6.3	6.3
Premier	7.7	6.3
JR-317	6.3	6.3
Pick MDR	7.3	6.3
Pick PRNGS	6.3	6.3
Catalina	7.0	6.3
ABT-99-4.464	6.3	6.3
Allsport	7.3	6.3
APR 777	6.7	6.3
MDP	7.0	6.3
ABT-99-4.709	6.7	6.3
ABT-99-4.965	5.0	6.3
ABT-99-4.633	8.0	6.3
Jet	7.7	6.3
BY100	9.0	6.3
5-Iron	8.0	6.3
Buccaneer	7.0	6.0
Pizzazz	6.3	6.0
WVPB-R-84	7.3	6.0
Nexus	7.0	6.0
Divine	7.0	6.0
APR 1237	7.0	6.0
Churchill	7.0	6.0
Pick PR B-97	6.0	6.0
PST-2RT	7.3	6.0
PST-2M4	6.3	6.0
PST-2SLX	6.0	6.0
PST-2CRL	6.0	6.0
Brightstar II	7.3	6.0
6011	7.0	6.0
AG-P981	7.0	6.0
APR 1232	6.3	6.0
SRX 4RHT	7.3	6.0
EP53	7.0	6.0
Skyhawk	5.3	6.0
MP103	5.7	6.0
ABT-99-4.625	5.0	6.0
ABT-99-4.960	6.0	6.0
PST-2JH	5.7	6.0
ABT-99-4.461	7.0	6.0
5-Iron	7.7	6.0
Calypso II	6.7	5.7
Pick RC2	5.7	5.7
Roberts 627	7.3	5.7
CIS-PR-75	5.7	5.7
CIS-PR-80	6.0	5.7
Barlennium	7.0	5.7
JR-151	6.0	5.7

Cultivar	*Establishment*[†] 9/21	*Quality*[‡] 10/1
Edge	6.7	5.7
PST-2CRR	5.7	5.7
PST-2BR	5.3	5.7
PST-CATS	5.0	5.7
Charger II	7.7	5.7
Phantom	8.0	5.7
ABT-99-4.721	6.7	5.7
Seville II	7.0	5.7
DP LP-1	6.3	5.7
Elfkin	7.3	5.7
MP58	5.7	5.7
CIS-PR-72	5.7	5.7
ABT-99-4.629	8.0	5.7
ABT-99-4.903	7.3	5.7
DLF-LDD	7.3	5.3
CIS-PR-78	5.3	5.3
CIS-PR-85	6.0	5.3
BAR 9 B2	6.7	5.3
Manhattan 3	6.3	5.3
ABT-99-4.339	6.0	5.3
ABT-99-4.600	6.3	5.3
Cathedral II	8.3	5.3
Line Drive	8.0	5.3
APR 1231	6.3	5.3
SRX 4120	6.7	5.3
MP107	5.0	5.3
MEPY	4.7	5.3
ABT-99-4.560	5.7	5.3
5-Iron	7.7	5.3
APR 1236	5.7	5.0
Pick PR QH-97	5.3	5.0
PST-2LA	5.7	5.0
ABT-99-4.834	6.0	5.0
Pennant II	6.3	5.0
DP 17-9496	6.7	5.0
DP 17-9069	5.7	5.0
DP 17-9391	7.0	5.0
Wilmington	5.7	5.0
CAS-LP84	6.0	5.0
EPD	6.3	5.0
ABT-99-4.115	6.0	5.0
Linn	8.7	4.7
PST-2SBE	5.0	4.3
ABT-99-4.815	5.3	4.3
EP57	5.7	4.3
LTP-ME	3.7	4.0
LSD ($p \leq 0.05$)	**1.6**	**1.6**
Coef. of Variation (%)	**15.1**	**16.5**

[†]Turfgrass establishment 1-9 scale, with 9= 100%plant cover
[‡]Turfgrass Quality 1-9 scale, with 9=most desirable quality.

1999 Results from the 1996 National Buffalograss Trial

S.R. Westerholt and T.P. Riordan

Turfgrass

The 1996 buffalograss test was planted at 11 sites around the country, including the John Seaton Anderson Turfgrass and Ornamental Facility near Mead, NE. This trail was established as part of a national program to evaluate adaptability of cultivars and experimental lines of buffalograss.

Three replications of 12 vegetative and 5 seeded cultivars of buffalograss were established in turf plots in 1996. Plots were maintained at 2.5 inches and mowed 1 to 2 times per month. Fertilizer was applied in May and July at 1 lb. N / 1000 sq.ft. / application; no supplemental irrigation was applied. Weed control consisted of applications of pendimethalin in April and June. Data collection was initiated in 1997 and continued through 1999. Color, quality, spring greenup and fall color were evaluated annually. Color ratings were rated on a scale of 1 to 9, with 9 as the darkest green. Quality was rated on a scale of 1 to 9 with 9 as the highest quality.

The top performers in the Nebraska trial were 91-118 and 'Legacy' (86-61) (Tables 1 & 2). 'Bonnie-Brae' ranked intermediate but was the best overall of the non-Nebraska derived cultivars. Southern-adapted types, especially diploids such as 'Stampede' and UCR-95, did not survive the 1996-97 winter and most of theses plots were replanted to 'Texoka' to maintain a uniform turf area. Cultivar '609' also winter killed in 1996-97 and was reestablished by plugs from a nearby turf area. It has continued to winter kill to some degree, but reestablishes from surviving plant material. Its quality ratings reflect this cycle of injury and recovery.

Except for the common type variety 'Texoka', the seeded varieties have shown little differentiation in this study (Tables 1 & 2). The improved seeded types like 'Tatanka', 'Cody', 'Bam-1000', and 'Bison' have acceptable color and quality. They continue to demonstrate significant improvements over 'Texoka'.

Table 1. Quality ratings from the National Turfgrass Evaluation Programs 1996 Buffalograss Evaluation Trial for 1999. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		Quality‡						
Cultivar	*Estab.*	*5/15/99*	*6/17/99*	*7/15/99*	*8/12/99*	*9/13/99*	*10/5/99*	*Mean*
91-118	Veg	6.7	6.3	8.0	9.0	8.7	8.0	7.8
86-61	Veg	7.0	7.0	8.0	7.7	7.0	6.7	7.2
93-181	Veg	5.3	5.7	8.0	7.0	7.3	7.0	6.7
86-120	Veg	6.7	6.3	6.7	7.0	7.0	6.7	6.7
'378'	Veg	6.3	6.3	6.3	6.7	6.3	6.3	6.4
Bonnie-Brae	Veg	5.3	5.7	6.7	7.0	7.0	6.7	6.4
91-181	Veg	6.0	6.0	6.7	7.0	6.3	6.0	6.3
93-170	Veg	5.3	5.0	5.7	6.0	5.3	5.3	5.4
Midget	Veg	4.0	4.0	5.0	5.3	6.0	6.0	5.1
'609'	Veg	1.0	2.0	3.0	5.7	6.3	6.3	4.1
UCR-95	Veg	.	.	.	.	.	.	.
Stampede	Veg	.	.	.	.	.	.	.
Mean	**5.2**	**5.2**	**6.2**	**6.6**	**6.4**	**6.1**	**6.0**	
LSD (.05)	**1.5**	**1.5**	**0.9**	**1.0**	**0.7**	**0.9**	**0.7**	
Tatanka	Seed	6.0	5.7	6.3	6.7	6.3	6.0	6.2
Cody	Seed	6.0	5.7	6.3	6.3	6.0	6.0	6.1
BAM-1000	Seed	5.3	5.7	5.7	6.0	6.0	5.7	5.7
Bison	Seed	5.3	5.7	5.7	5.3	5.7	5.7	5.6
Texoka	Seed	4.3	5.0	4.7	4.7	5.3	5.0	4.8
Mean	**5.4**	**5.5**	**5.7**	**5.8**	**5.9**	**5.7**	**5.7**	
LSD (.05)	**0.8**	**1.3**	**1.2**	**1.0**	**0.9**	**1.1**	**0.5**	
Mean All Entries	**5.4**	**5.5**	**6.2**	**6.5**	**6.4**	**6.2**	**6.0**	
LSD (.05)	**1.3**	**1.4**	**0.9**	**1.0**	**0.7**	**0.9**	**0.7**	

Cultivars developed at the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE.
‡Quality rating on a 1 to 9 scale, with 9 as the highest quality.

Table 2. Quality ratings from the National Turfgrass Evaluation Programs 1993 Buffalograss Evaluation Trial for 1999. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		Percent Greenup	*Color‡*					*% Fall Color*	
Cultivar	*Estab.*	*5/3/99*	*5/15/99*	*6/17/99*	*7/15/99*	*8/12/99*	*9/13/99*	*10/5/99*	*Mean*
86-61	Veg	3.0	7.0	7.0	8.0	8.0	7.3	4.7	7.5
86-120	Veg	2.3	6.3	6.3	7.0	7.0	7.0	2.0	6.7
'378'	Veg	4.3	6.7	6.3	6.7	6.7	6.7	2.7	6.6
'609'	Veg	1.0	6.0	5.7	7.0	7.0	6.3	8.7	6.4
91-181	Veg	3.0	5.7	6.3	7.0	7.0	6.0	2.3	6.4
93-170	Veg	5.3	6.0	6.0	6.7	6.3	6.7	3.0	6.3
Bonnie-Brae	Veg	2.7	5.3	6.0	7.0	6.7	6.3	2.7	6.3
91-118	Veg	1.3	5.7	5.7	6.0	6.0	5.7	6.7	5.8
Midget	Veg	2.3	5.0	5.3	5.0	5.0	6.0	3.7	5.3
93-181	Veg	4.7	5.0	4.3	5.0	5.3	5.7	3.3	5.1
UCR-95	Veg	.	.	.	.	.	.	.	.
Stampede	Veg	.	.	.	.	.	.	.	.
Mean		**3.4**	**5.7**	**5.7**	**6.4**	**6.3**	**6.2**	**3.8**	**6.1**
LSD (.05)		**2.4**	**1.5**	**1.6**	**0.6**	**0.7**	**1.0**	**1.3**	**0.9**
Tatanka	Seed	2.3	6.0	6.0	6.3	6.7	6.3	4.3	6.3
Bison	Seed	3.0	5.3	6.3	6.0	6.7	6.0	4.0	6.1
Cody	Seed	2.3	6.0	6.0	6.7	5.7	6.0	3.0	6.1
BAM-1000	Seed	2.7	5.3	5.7	5.7	5.7	5.7	2.7	5.6
Texoka	Seed	3.0	4.3	5.3	5.3	5.3	5.3	2.7	5.1
Mean		**2.7**	**5.4**	**5.9**	**6.0**	**6.0**	**5.9**	**3.3**	**5.8**
LSD (.05)		**1.3**	**0.8**	**0.9**	**0.8**	**0.9**	**0.9**	**0.9**	**0.5**
Trial Mean		**2.9**	**5.7**	**5.9**	**6.4**	**6.3**	**6.2**	**3.8**	**6.1**
LSD (.05)		**2.0**	**1.3**	**1.4**	**0.7**	**0.8**	**0.9**	**1.1**	**0.8**

Cultivars developed at John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE.
‡Color rated on a scale of 1 to 9, with 9 as the darkest green.

Nodal Culture of Buffalograss and Evaluation of Its Application for Particle Bombardment

S. Fei, T. Yu, T. Clemente and T.P. Riordan

Turfgrass

Buffalograss *(Buchloe dactyloides (Nutt) Engelm.)*, an alternative turfgrass species, has recently gained renewed interest because of its excellent drought tolerance and other low maintenance characteristics. Development of herbicide-resistant buffalograss may greatly reduce potential environmental pollution by using safer herbicides in turfgrass management. Microprojectile bombardment is a major tool in genetic transformation of monocots, including most turfgrass species. Nodal explants of buffalograss with multiple meristems may be used as alternative targets for bombardment. In this study, we investigated the effects of naphthaleneacetic acid (NAA), 6-benzyladenine (BA) and their combinations, preculture and cutting position on the production of axillary buds. The effect of shooting parameters on gold particle penetration also was investigated.

Plant materials and tissue culture: Stolons from a female genotype, '609', were harvested from greenhouse-grown plants. After dipping in 70% ethanol for 1 minute, stolons were sterilized with 15% bleach plus Tween-20 for 15 minutes followed by rinsing three times with autoclaved distilled water. Stolons then were cut into segments so that each contained one node for subsequent culture. In the first experiment, preexisting axillary buds were immediately removed to enhance *de novo* shoot regeneration on MS medium containing 0.1, 0.5, 1.0 or 2.0 mg BA/l combined with 0, 0.1 or 0.5 mg NAA/l. In other experiments, preexisting buds were allowed to elongate on MS medium containing 0.5, 1.0, 3.0 or 5.0 mg BA/l for a week (preculture). Elongated preexisting buds were then removed at either high or low positions relative to the node to promote growth of new axillary buds. Materials subjected to preculture were used for bombardment. Cultures were placed at 24°C under light with 16h light/day and a light intensity of approximately 60 µmol/m^{2}s.

Microprojectile bombardment: Seven to 10 days after preculture, top portions of the node sections with multiple buds were removed to expose apical meristems, which were bombarded with gold particles (average size 1.0 µm) coated with a construct containing β-glucuronidase (GUS) gene. Bombardment was carried out with a PDS-1000/He Biolistic device. Gap distance and vacuum pressure were fixed at 1/4 inch and 27 mm Hg, respectively. Various levels of rupture disk pressures and particle travel distance were used to evaluate their effects on gold particle penetration.

Histological analysis: After bombardment, nodal explants were immediately fixed for 2h in 3.7% formaldehyde in Phosphate buffer saline (PBS) (pH 7.4) and washed three times in PBS (20 minutes each). Samples were embedded in O.C.T., an embedding medium for frozen tissue specimens (Sakura Finetek U.SA., Torrance,CA, USA) and frozen longitudinal sections (~8µm thick) were cut using a CM1900 Cryostat (Leica Inc.). Propidium iodide (emission at 598 nm) was used for nuclear counter staining. Up to 20 serial sections, with five areas from each section, were surveyed for each treatment. Results were pooled and represented as means (± S.D.).

The effect of NAA combining with BA on shoot regeneration with the complete removal of preexisting axillary buds: The highest average number of new shoots per explant emerged from the site where the preexisting buds were removed, with treatments of 0.1 mg NAA/l plus 0.1 mg BA/l, and 0.1 mg NAA plus 0.5 mg BA /l. Some explants produced an average as high as 6 shoots per explant. Shoots obtained through this pathway resembled *de novo* shoot regeneration; therefore, this pathway may be ideal for microprojectile bombardment by providing an accessible target area if the regeneration efficiency is significantly improved.

The effect of preculture and cutting position on axillary bud proliferation: The average number of visible shoots after a preculture of nodal explants with preexisting buds for one week in the presence of BA at 0.5, 1, 3 or 5 mg/l was recorded. BA at 1,3 or 5 mg/l induced more shoots than BA at 0.5 mg/l. There was only a slight difference among 1, 3 or 5 mg BA/l. The average number of shoots developed per explant one week after the removal of the visible axillary buds at different positions was also recorded. Overall, more shoots were induced when buds were removed at a higher position relative to the node than at a lower position, and when axillary buds were immediately removed without preculture. After two weeks, more than 20 shoots could be obtained from each explant when cultured on a medium containing 1mg BA/l or above. BA at 1 mg/l was optimal for shoot induction.

The effect of rupture disk pressure and particle travel distance on gold particle penetration: Table 1 shows that various combinations of different levels of rupture disk pressures (1350 psi, 1500 psi, 1800 psi) and different target travel distances (6 cm and 9 cm) had no significant impact on gold particle penetration. Delivery of the DNA-coated particles was limited to cells at or near the cutting surface, still far from the meristem. Although cutting at a lower position may expose the meristems, the regeneration efficiency was significantly reduced. We suggest that it would be very difficult for DNA-coated particles to be delivered into meristematic tissues under current circumstances because of the hard nature of the plant tissue and the small amount of meristematic tissues that are deeply embedded within the leaf cluster.

In conclusion:

The complete removal of the preexisting buds facilitated the shoot regeneration that resembled *de novo* shoot regeneration. The site where preexisting buds were removed and where new shoots emerged provides a more accessible area for microprojectile bombardment if the regeneration efficiency is significantly improved.

Preculture and cutting position had a great influence on the number of shoots developed from each nodal explant, with cutting at a higher position yielding more shoots than cutting at a lower position. Preculture enhanced shoot proliferation.

Bombardment of nodal explants subjected to preculture and subsequent removal of the visible buds resulted in poor penetration of the gold particles, regardless of the various rupture disk pressures and different particle travel distances. Further tissue manipulations or adjustments of the shooting parameters are needed to ensure a successful delivery of DNA into target tissues. Bombardment of embryogenic calli to develop herbicide tolerant buffalograss is making progress.

Table 1. The effect of rupture disk pressure and particle travel distance on gold particle penetration in buffalograss shoots. Nodal Culture of Buffalograss and Evaluation of Its Application for Particle Bombardment.

Treatment		*Gold particle penetration (mm)*
Particle travel distance (cm)	*Rupture disk (psi)*	*(Mean ± SE)*
6.0	1350	8.71 ± 0.12
6.0	1550	8.96 ± 0.24
6.0	1800	9.06 ± 0.06
9.0	1350	8.86 ± 0.15
9.0	1550	8.97 ± 0.20
9.0	1800	8.99 ± 0.06

Mature Caryopsis Culture and Plant Regeneration from Immature Inflorescence-derived Callus

U.S. Bishnoi, S.Fei and T.P. Riordan

Turfgrass

Buffalograss has received renewed attention as a desirable home lawn turfgrass because of its excellent drought resistance. Biotechnologies such as plant regeneration and genetic transformation have increasingly become valuable tools for crop improvement. Although the use of immature embryo has been an excellent explant in *in vitro* regeneration in cereal crops, in buffalograss it is not feasible. Because the time of flowering is not synchronized, the optimal developmental stage of immature embryos for explanting by counting the number of days since anthesis cannot be easily determined in buffalograss. In addition, the number of immature embryos produced per plant is very limited. Although immature inflorescences have proved to be suitable explants for regeneration, the limited availability of immature inflorescences and the fact that growth conditions of stock plants significantly affect the embryogenic callus induction of buffalograss pose serious challenges.

Mature caryopses can provide year-round availability for buffalograss tissue culture and plant regeneration using them has been achieved with a number of important grass species. The objectives of this research were to: (1) generate embryogenic callus through buffalograss mature caryopses culture, and (2) optimize regeneration for dry type callus that were derived from immature inflorescence culture. Here we report some preliminary results.

Callus induction from mature caryopsis culture

Mature caryopses from the cultivar 'Cody' and a genotype of 96-118 were used for our experiments. Culture medium was composed of MS basal medium supplemented with 2 mg 2,4-D/l unless noted otherwise. Caryopses were sterilized with soapy water for 20 minutes, then rinsed thoroughly with tap water. Caryopses were then soaked in undiluted commercial bleach (Clorox) plus 0.1% Tween-80 for 30 minutes, followed by rinsing with sterilized distilled water. Nine caryopses were placed on each Petri plate (100mmx15mm).

Treatments were: (1) removal of coleoptiles 7 days after germination vs. no removal; (2) different combinations of 2,4-D at 0.5, 1.0, 1.5 mg / 1 and picloram at 1.0, 2.0, 3.0 mg /1; (3) addition of 500 mg casein hydrolysate/l (MSD2CH) vs. 2 gram proline (MSD2Pro2).

A high percentage of caryopses started to form calluses that appeared smooth, loose, watery and non-embryogenic. The cultivar 'Cody' showed better response in terms of germination and callus formation as compared to 96-118 and the MSD2Pro2 medium was found better for callus formation. No marked differences were observed between the treatment with coleoptiles removed and the treatment with intact mature embryos. Embryogenic callus formation also was observed after an extended culture period.

A new sterilization procedure was compared with the standard procedure described in the previous materials and methods section. The new procedure involved soaking seeds in 70% ethanol for 1 minute and treating with 10% Chlorox for 15 minutes, followed by washing with sterilized distilled water. We found that this new sterilization procedure worked better in terms of callus formation than the one used in the previous two experiments.

Another approach was taken to isolate the embryonic axis for use as explant. Seeds were allowed to imbibe for three hours before the embryogenic axis was excised and cultured on medium. Both wet and non-embryogenic calluses were obtained from these cultures. This type of explant showed response after the second day of culture and the callusing response was comparatively higher than in the previous two experiments.

Plant Regeneration From Immature Inflorescence-derived Callus

Dry and friable calli induced from immature inflorescences were used for this regeneration experiment. A 4 x 4 factorial design with three replications was employed using Benzyladeninepurine (BAP) at 0, 0.1, 0.5, 1.0 mg / 1 and Kinetin (Kn) at 0, 0.1, 0.5, 1.0 mg / 1 as treatments. About 0.1 gram of callus (divided into 9 pieces) was placed in each plate.

Preliminary results indicate that callus started showing pigmentation after the second day of culture and greenish coloration became clear after the third day. On the seventh day, shoot emergence was observed accompanied by the formation of some hairy structures. Shoots showed gradual increase in length and pigmentation and greenish coloration (green sectors) became more prominent as the culture continued.

Among 16 combinations of two cytokinins (BAP and Kn), treatments of 1.0 mg Kn/l alone, 0.1 mg BAP/l plus 0.5 mg Kn/l, 0.5 mg BAP/l plus 0,0.1,0.5 or 1.0 mg/l Kn 0.1 or 1.0 mg BAP/l plus 0.1 mg Kn/l showed better response than the others. Some callus pieces turned brown after a certain period, whereas others continued growth without showing any signs of regeneration. Though there were still many green sectors the response began to decrease and data after 8 weeks will confirm any plant recovery.

In conclusion:

Mature caryopsis may provide another viable embryogenic callus source for genetic transformation. However, further studies are needed to examine techniques to convert nonembryogenic callus to embryogenic callus. At this point, the rate of conversion of nonembryogenic callus to embryogenic callus is still very low and plant regeneration from dry friable callus is still much lower than from soft friable callus. Further work aimed at improving the regeneration efficiency would certainly pave the road for utilization of this callus type for particle bombardment.

Differential Tolerance of Cool- and Warm-Season Grasses to TNT in Soil

G. Krishnan, G.L. Horst, and P.J. Shea

Turfgrass

Plants can be used for effective and economical remediation of soil provided they are tolerant or resistant to contaminants. Greenhouse experiments were conducted to determine the tolerance of the cool-season grasses: smooth bromegrass (*Bromus inermis* Leyss) and tall fescue (*Festuca arundinacea* Schreb), and the warm-season grasses: big bluestem (*Andropogon gerardii* Vitman) and switchgrass (*Panicum virgatum* L.) to TNT (2,4,6-trinitrotoluene) in soil.

High concentrations of 2,4,6-trinitrotoluene (TNT) and other contaminants are commonly found in soil due to explosives loading, handling and packing at former munitions facilities such as the Nebraska Ordnance Plant (NOP) near Mead, NE. As an alternative to the expensive and energy-intensive incineration process, phytoremediation holds promise for low-cost remediation.

Grasses have fibrous root systems with larger surface area per unit volume of soil than plants with tap roots. This may increase microbial populations, enhancing bioremediation potential. Grass species are highly desirable for phytoremediation in Nebraska because their high evapotranspiration rates promote retention of solutes near the soil surface. Smooth bromegrass has been the predominant species growing on the NOP site for the past 50 years. Thus, most of the soil at this site contains munitions residues at sufficiently low concentration to establish and grow some plant species. At some locations within sites, however, the TNT is present at concentrations toxic to plants and, thus, the effectiveness of phytoremediation is reduced. Tall fescue root growth was reduced by more than 90% at TNT concentrations above 30 mg TNT L^{-1}. In contaminated soil, smooth bromegrass and tall fescue did not tolerate concentrations of TNT in soil solutions that were greater than 31 mg L^{-1}.

TNT-contaminated soil was collected from a ditch at the NOP site where packing line washings were drained at least forty years ago. Plants were grown in contaminated and uncontaminated soil mixed at different ratios (dilutions) to obtain a range of TNT concentrations. Uncontaminated soils with and without plants were included as controls.

Cone-tainers™ were filled with 135 g of each soil mix and the soil mix was saturated by placing the cone-tainers in distilled deionized water for 2 days. The lower 75% of each cone-tainer was suspended in an insulated cooler with a 7-cm thick lid. Coolers were placed in a greenhouse where temperature was maintained inside the cooler at 20 and 25°C for the cool- and warm-season grasses, respectively, by circulating temperature-controlled water. Daylight was extended to 14 hours using sodium vapor lamps and the day/night temperature in the greenhouse was 23/17°C, respectively. A 250 mL amber glass bottle was placed under each cone-tainer within the coolers to collect leachate.

Ten seeds of smooth bromegrass, tall fescue, big bluestem, or switchgrass were planted in each cone-tainer and covered with a 2 to 3 mm layer of uncontaminated soil. Cone-tainers were initially covered with clear polyethylene wrap to facilitate germination and later misted with water to avoid disturbing the seeds. Grasses were thinned to 4 per cone-tainer 13 days after initiation (DAI). After thinning, moisture was maintained in the planting mix by adding 10 mL of distilled deionized water to each cone-tainer daily and fertilizing once a week with 20:10:20 (NPK) fertilizer. Treatments were replicated six times and the experiment was conducted twice.

Germination was recorded daily and thinning and grass shoot height were determined by measuring length from the plant base to the longest leaf tip. Leachate samples from bottles were collected at 20 and 40 DAI. Grasses were harvested 8 weeks after planting, and shoot and root dry weight, root length and root surface area were recorded. Shoots and roots were separated and adhering soil was removed by washing. Root length was measured from the root/shoot junction to the root tip. Root surface area measurements were determined.

Concentrations of TNT from the soil mixtures were high, even after diluting with uncontaminated soil. The germination of all species decreased with increasing TNT concentration (Figure 1) and was not significantly different within the cool- or warm-season grasses. Shoot heights of all species decreased with increasing concentrations of water-extractable TNT (Figure 2A), and were at least 60% less than the controls. At lower concentrations, TNT had a smaller effect on tall fescue shoot height than big bluestem, switchgrass or smooth bromegrass. The shoot biomass of all species decreased with increasing TNT concentration in soil (Figure 2B). There was no difference in sensitivity to increasing TNT concentrations within the warm-season grasses. Although tall fescue shoot biomass decreased sharply at lower TNT concentrations, the shoot biomass was greater at high TNT concentrations than for smooth bromegrass. Although seeds of smooth bromegrass and tall fescue germinated at water-extractable TNT concentrations greater than 150 and 220 mg TNT kg^{-1}, respectively, no growth was observed. At 86 mg TNT kg^{-1}, shoot biomasses of the warm-season grasses were 80% of those obtained in uncontaminated soil control.

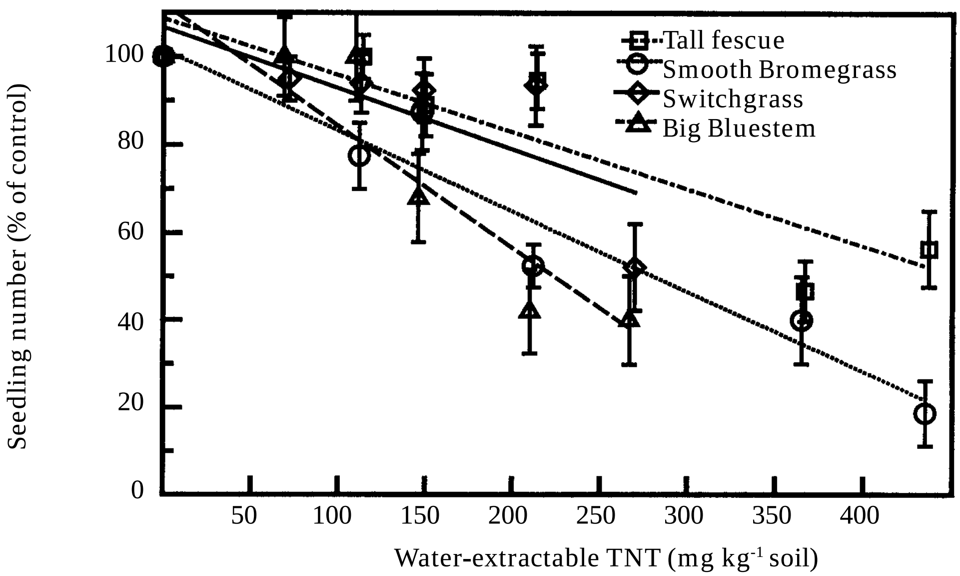


Figure 1. Germination (seedling number 15 days after initiation) of four grass species as influenced by water-extractable TNT concentrations in mixtures of TNT-contaminated soils with uncontaminated soils. Bars on symbols represent standard errors of the mean; where absent, bars fall within symbols.

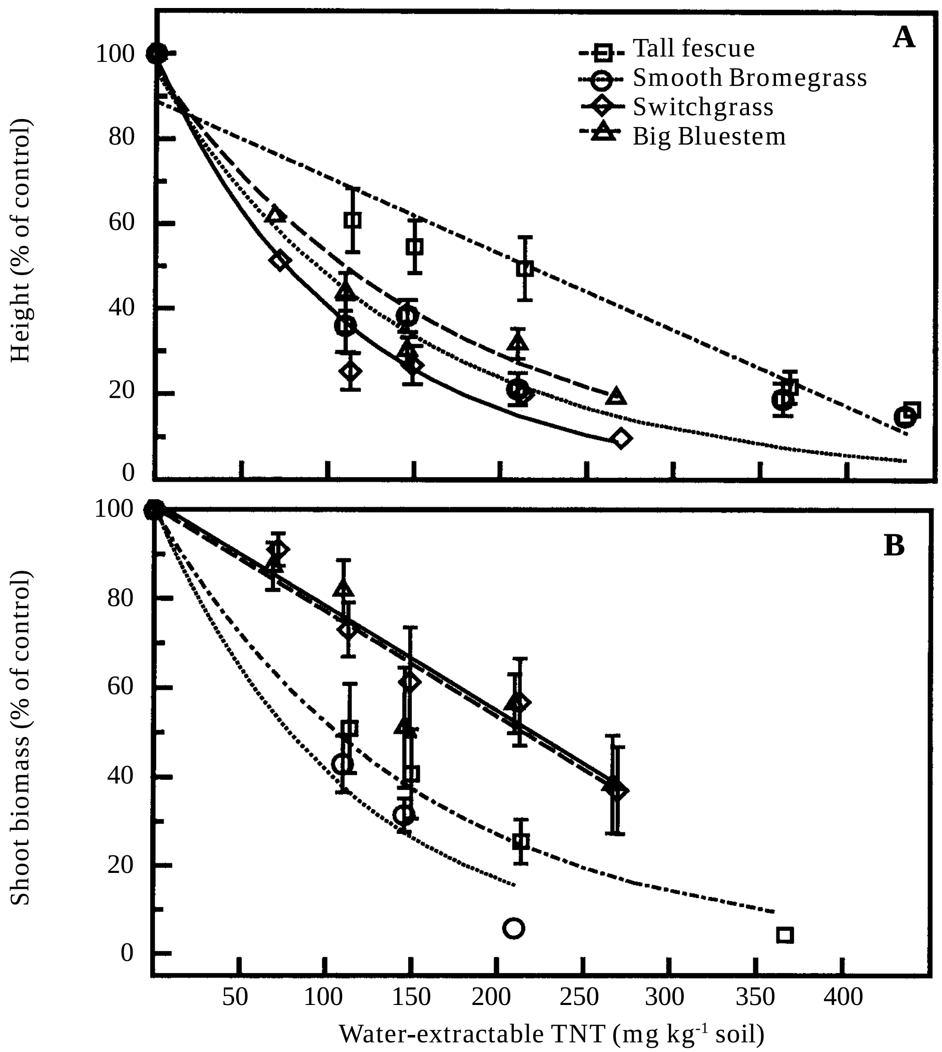


Figure 2. Top growth height (A) and shoot biomass (B) of four grass species as influenced by water-extractable TNT concentrations in mixtures of TNT-contaminated soils with uncontaminated soils. Shoot height (cm) measured 25 days after initiation and dry weight (g) measured 56 days after initiation. Bars on symbols represent standard errors of the mean; where absent, bars fall within symbols.

A significant reduction in root biomass was observed in all species with increasing TNT concentrations (Figure 3A). There were no differences in sensitivity to increasing TNT concentration within the cool-season and warm-season grasses. Root biomass of cool-season grasses decreased significantly at lower TNT concentrations compared to warm-season grasses. Cool-season grasses did not produce any roots at TNT concentrations greater than 370 mg TNT kg^{-1} soil. At 73 mg TNT kg^{-1}, root biomasses of the warm-season grasses were 80% of those in the controls.

Increasing TNT concentrations in mix soils resulted in decreasing root area in all species (Figure 3B). No significant differences in root area were observed within the warm-season grasses. Root area of cool-season grasses decreased significantly at lower TNT concentrations compared to warm-season grasses. At 72 and 89 mg TNT kg^{-1}, root biomass of big bluestem and switchgrass were 80% of the control.

Although the mechanism of action for TNT phytotoxicity is unknown, it affects root and shoot growth. Roots of seedlings which germinated close to the cone-tainer wall were able to grow between the soil and the sides of the cone-tainer at higher TNT concentrations than roots of seedlings established in the middle of the cone-tainers. Roots growing along the cone-tainer sides were probably exposed to less TNT.

A significant reduction of shoot and root growth was observed in cool-season grasses at lower concentrations compared to warm-season grasses in the soil mixtures. Although the shoot and root growth of warm-season grasses decreased with increasing TNT concentrations, warm-season grasses were less sensitive than cool-season grasses at TNT concentrations included in this study. Grass response to TNT concentrations at less than 71 mg TNT kg^{-1} were not evaluated in this study due to difficulties in mixing uncontaminated and contaminated soil at dilution ratios exceeding 500:1. Results indicated that warm-season grasses can tolerate TNT concentrations at less than 86 mg TNT kg^{-1} (based on 80% of growth in uncontaminated soil). Establishment of these plants can decrease TNT leaching in soil and can also be used to stabilize contaminated sites prior to remediation or where other remedial action is not taken.

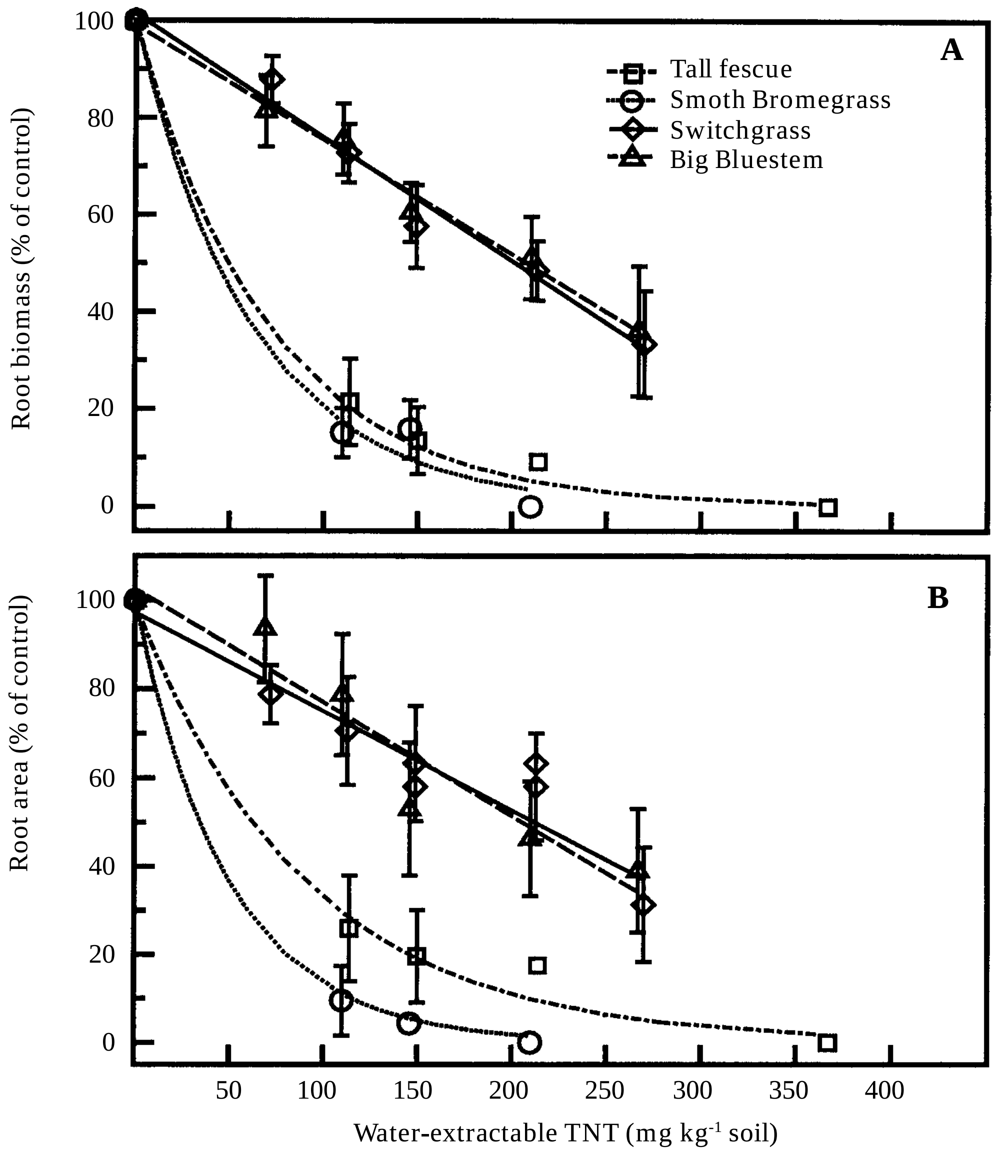


Figure 3. Root biomass (A) and root area (B) of four grass species as influenced by water-extractable TNT concentration in mixtures of TNT-contaminated soils with uncontaminated soils. Dry weight (g) and root area (cm^2) measured 56 days after initiation. Bars on symbols represent standard errors of the mean; where absent, bars fall within symbols.

Sprig Establishment of Buffalograss

S.R. Westerholt

Turfgrass

This preliminary study investigated different establishment techniques and their effectiveness in establishing new stands of buffalograss. We examined the use of pre-rooted versus non pre-rooted stolons, as well as the use of a mulch. In addition, incorporation versus non-incorporation of stolons was also studied. The idea of pre-rooting sprigs was intended to extend the storage life of stolons and expedite the pegging of roots, while providing cover mulch to prevent desiccation. Pre-rooting consisted of mixing sprigs with rooting material prior to planting in order to have actively growing roots at planting time.

A bare soil area at the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE was used to establish two vegetative cultivars of buffalograss, 86-118 and 86-61, using plugs and sprigs. Treatments consisting of sprigs incorporated into the top 2 cm, non-incorporated sprigs, pre-rooted (premixed with potting soil 24 hours prior to planting and incorporated in the top 2 cm) sprigs, non-incorporated sprigs with straw mulch, chop sod (sod strips chopped up into 2 – 3 cm pieces and incorporated in the top 2 cm), and vegetative plugs (planted on 30 cm (12") centers) were planted June 24, 1999 in 2 m^{-2} plots. Simazine herbicide was applied for preemergence weed control and escapes were hand weeded. To maintain optimum soil moisture conditions during pegging, water was applied twice daily for the first two weeks.

Coverage ratings were collected every two weeks until at least one treatment was 100 percent covered.

Initial sprig establishment was observed as early as one week after planting. Pre-rooted sprigs, incorporated sprigs, and chopped sod treatments were first to root and initiate growth (Table 1). However, the pre-rooted sprigs had a greater coverage than the chopped sod after six weeks. Surface-applied sprigs with no incorporation failed to root, despite good soil moisture conditions. The straw mulch treatments were slightly better than the nonmulched surface-applied treatments. There were no significant differences between incorporated sprigs and plug treatments.

Pre-rooted sprigs were clearly the best treatment overall, with a 2 –3 week coverage advantage over other treatments. This study demonstrated that sprigs could be used to establish buffalograss turf complete coverage within 12 weeks.

Table 1. Sprig establishment coverage ratings with five sprigging methods and two cultivars of buffalograss. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		Coverage†					
Cultivar	*Treatments*	*07/02/99*	*07/16/99*	*07/29/99*	*08/10/99*	*08/25/99*	*09/07/99*
86-118	Pre-Rooted&Incorporated	2.0	3.0	4.0	5.3	6.7	8.3
86-118	Chop Sod & Incorporated	2.0	2.0	2.7	3.0	5.3	6.0
86-118	Incorporated	0.7	1.3	2.3	3.7	5.0	5.3
86-118	Plugs	1.0	1.0	2.0	3.0	4.0	4.7
86-118	Mulch	0.3	0.3	0.3	1.0	1.7	2.0
86-118	No Incorporation	0.0	0.0	0.3	0.7	1.0	1.0
86-61	Pre-Rooted&Incorporated	1.7	2.7	4.0	5.3	7.0	7.7
86-61	Chop Sod & Incorporated	1.0	1.0	1.3	1.3	2.7	4.0
86-61	Incorporated	1.0	1.0	2.0	2.0	3.0	3.3
86-61	Plugs	1.0	1.0	2.0	2.7	4.3	4.7
86-61	Mulch	0.3	0.3	0.7	1.0	1.7	1.7
86-61	No Incorporation	0.0	0.0	0.7	1.0	1.0	1.3
Mean		**0.9**	**1.1**	**1.9**	**2.5**	**3.6**	**4.2**
LSD ($p \leq 0.05$)		**0.6**	**0.8**	**1.0**	**1.3**	**1.3**	**1.6**

†Coverage ratings 1=0-10% 9=90-100% plot coverage.

Turfgrass

The Effect of Age and Temperature on Sprig Rooting in Buffalograss

S.R. Westerholt

Vegetative propagation has been a very important means of establishing stands of buffalograss by increasing vegetative female cultivars. Buffalograss growth habits make it well adapted to many methods of vegetative propagation. The propagation of buffalograss using sprigs was used as early as the 1920s and four types of vegetative propagation are commonly used for the establishment of buffalograss: transplanting runners or stolons, broadcasting sod, spot sodding and plugging. Under field conditions for forage use, sprigging has not been considered practical due to lack of water for establishment, the amount of labor required and lack of equipment for harvesting runners. However, use of buffalograss in home lawns and golf courses has made sprigging a practical alternative.

Developing techniques for sprig establishment will allow for rapid expansion of buffalograss material and potentially reduce establishment costs. Expected gains from sprigging establishment include better uniformity of stands, quicker establishment, and more effective weed control. This study evaluated the physical conditions that influence sprig root development in buffalograss. Sprig development was evaluated for the effects of age and temperature on the rate of root development.

Runners from 91-118 were collected from plants grown under greenhouse conditions. Individual sprigs, consisting of 6 nodes per runner, were clipped from the main plant and separated according to age, with the youngest node coming from the end of the runner and the oldest closest to the mother plant. Individual nodes were placed in labeled petri dishes on an agar medium. Treatments consisting of internodes of varying ages and two temperature regimes (21° C and 5° C) were replicated 3 times. Stolons were examined every 12 hours for developing roots and root length was measured. The experiment was ended after 60 hours, when it was evident that no further rooting would occur. This experiment was repeated once with similar results.

First signs of rooting were noted as early as 6 hours after placing the sprigs in the agar medium. Sprigs maintained at 21°C were quicker in rooting than sprigs at 5°C (Table 1). Overall, the sprig growth patterns were similar for both temperatures, although at 5°C the growth rate was slower. The fifth and sixth nodes were the quickest to root and rooting declined as stolon age increased.

The data indicate that as age increases, stolons gradually lose their ability to set roots. In addition, results suggest that root growth is accelerated by higher temperatures, although roots were able to form at temperatures as low as 5°C.

Table 1. Root length in (mm) of 91-118 buffalograss nodes at two temperatures. The Effect of Age and Temperature on Sprig Rooting in Buffalograss.

		Root length in (mm)						
Exp # 1	*Temp*	*12hr*	*24hr*	*36hr*	*48hr*	*60hr*	*72hr*	*Mean*
Node 1†	21C	0.0a‡	0.0a	0.0a	0.0a	0.0a	0.0a	0.0
Node 2	21C	0.0a	0.0a	0.0a	0.0a	0.3a	1.0a	0.2
Node 3	21C	0.3ab	1.7ab	3.3b	5.0b	7.3b	9.3b	4.5
Node 4	21C	0.7b	2.0b	3.3b	4.7b	6.3b	7.0b	4.0
Node 5	21C	1.3b	3.0b	4.7b	7.3b	9.0b	10.0b	5.9
Node 6	21C	1.0b	2.0b	3.3b	6.7b	8.0b	8.7b	4.9
Mean		**0.6**	**1.4**	**2.4**	**3.9**	**5.2**	**6.0**	**3.3**
LSD ($p \leq 0.05$)		**0.6**	**1.9**	**2.1**	**4.2**	**4.2**	**4.5**	
Node 1	5C	0.0a	0.0a	0.0a	0.0a	0.0a	0.0a	0.0
Node 2	5C	0.0a	0.0a	0.3a	0.7a	1.0ab	1.0ab	0.5
Node 3	5C	0.0a	0.0a	0.7ab	1.0a	1.7abc	2.0b	0.9
Node 4	5C	0.0a	0.0a	1.0ab	1.3ab	2.3bcd	2.7b	1.2
Node 5	5C	0.0a	0.5a	2.0b	3.5b	4.5e	5.0c	2.6
Node 6	5C	0.0a	0.0a	1.0ab	2.0ab	3.0cde	3.0b	1.5
Mean		**0.0**	**0.1**	**0.8**	**1.4**	**2.1**	**2.3**	**1.1**
LSD ($p \leq 0.05$)		**ns**	**ns**	**1.3**	**2.3**	**1.9**	**1.7**	
Mean		**0.4**	**0.9**	**1.5**	**2.2**	**3.1**	**3.7**	
LSD ($p \leq 0.05$)		**0.3**	**0.6**	**0.9**	**1.2**	**1.3**	**2.1**	

†Node numbering system 1-6, with 1= youngest node and 6= oldest node.
‡Data with similar letters are non-significantly different at 0.05 level.

Terra GoldCote Fertilizer Efficacy Trial

R.C. Shearman and M.R. Vaitkus

This study evaluated the performance of six Terra fertilizers on Kentucky bluegrass turf. Specifically, the goal of this research was to determine the efficacy of Terra's GoldCote line of fertilizers as a slow-release fertilizer for turf.

The study was conducted in the summer of 1999 at the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE. Fertilizer performance was evaluated on a five-year-old stand of Kentucky bluegrass growing on a Sharpsburg silty clay loam soil. Treatment plots were 3 ft by 6 ft and the experimental design was a randomized complete block with treatments replicated three times. Treatments (Table 1) were applied by hand on June 7, 1999 and watered in with an irrigation of 0.5 inches. The study area was maintained at a mowing height of 2.5 inches with clippings removed. Irrigation was applied at 80% ETp; application rates were adjusted every three to four days.

Turfgrass color, quality and density were rated visually on a weekly basis using standard National Turfgrass Evaluation Program (NTEP) procedures. Turfgrass color was evaluated on a scale of 1 to 9, with 1= straw-colored and 9= dark green. Turfgrass quality ratings were based on a 1 to 9 scale, with 1=lowest, 9=highest, and 6= acceptable quality. Density ratings were also evaluated on a 1 to 9 scale, with 1= 0-10% ground cover and 9= 90-100% cover. Clipping yields were taken about every three weeks for 18 weeks. Clippings were harvested with an 18 inch reel mower set at 2.25 inches. One mower pass through the center portion of each plot was made; clippings were bagged, dried for 24 hours at 70°C and then weighed. These tissue samples were then sent to Ag Analytical in Elida, Ohio, for chemical analysis.

Most treatments showed consistently higher color rating than the control throughout the trial (Table 2). There were no significant differences between other treatments on most observation dates. The exception was treatment 18-3-18 (Country Club), which was not different from the control on seven of the observation dates. There were no significant differences between treatments in quality evaluations (Table 3). Most treatments were greater than the control on all observation dates. On five observation dates, the 18-3-18 (Country Club) treatment was equal to the untreated control (check).

Table 1. Terra Inc. GoldCote Products and their rate of application in this study. Terra GoldCote Fertilizer Efficacy Trial on Kentucky bluegrass, conducted at the J. S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE, during the 1999 growing season.

	Rate	
Treatment	*lbs N/1000 ft²*	*lbs Product/1000 ft²*
16-4-20 GoldCote (Putters Pride) TRA-0219	1.0	6.25
12-0-42 GoldCote (Putters Pride) TRA-0217 + 46-0-0 (Urea) TRA-0169	0.5 + 0.5 (Urea)	4.16 + 1.09 (Urea)
18-3-18 GoldCote (Drivers Edge) TRA-0261	1.0	5.56
46-0-0 (Urea) TRA-0169	1.0	2.17
32-2-10 (SCU base, Magic Carpet) TRA-0170	1.0	3.13
18-3-18 (Country Club) TRA-0175	1.0	5.56
Check	0	0

Table 2. Turfgrass color evaluations for the Terra GoldCote Fertilizer Efficacy Trial on Kentucky bluegrass conducted at the J. S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE during the 1999 growing season.

	Color[†]																	
	Weeks after Treatment																	
Treatment	*0*	*1*	*2*	*3*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*
16-4-20 (Putters Pride)	6	7.5ab[‡]	8.5a	7.5a	7.8ab	8.0a	7.5a	7.8ab	7.8a	8.0a	8.0a	8.0a	7.0a	7.0	7.0a	7.3a	8.0a	8.0a
12-0-42 (Putters Pride)																		
+ 46-0-0 (Urea)	6	7.3abc	8.3a	7.5a	7.5abc	7.8a	7.0ab	7.0cd	8.0a	8.0a	7.8a	7.8a	7.0a	7.0	7.0a	7.0ab	8.0a	8.0a
18-3-18 (Drivers Edge)	6	6.5cd	7.0b	7.3ab	7.0cd	7.8a	7.3ab	7.5abc	8.0a	8.0a	8.0a	8.0a	7.0a	6.5	7.0a	7.0ab	8.0a	8.0a
46-0-0 (Urea)	6	7.8a	8.5a	7.8a	7.3bcd	8.0a	7.3ab	7.3bcd	7.8a	7.8ab	7.5ab	7.5ab	7.0a	7.0	7.0a	7.0ab	7.8ab	7.8a
32-2-10 (SCU base,																		
Magic Carpet	6	7.5ab	8.0a	7.8a	8.0a	8.0a	7.5a	8.0a	8.0a	8.0a	8.0a	8.0a	7.0a	7.0	7.0a	7.0ab	8.0a	8.0a
18-3-18 (Country Club)	6	6.8bcd	7.0b	6.5b	6.8d	7.0b	6.5b	6.8d	6.8b	7.3bc	7.0b	7.0b	6.5b	6.8	6.8a	6.8b	7.0bc	6.8b
Check	6	6.0d	5.5c	5.3c	5.0e	6.0c	5.0c	6.0e	6.5b	6.8c	6.3c	6.3c	6.3b	6.5	6.0b	6.0c	6.8c	7.0b
LSD (0.05)	**ns**	**0.8**	**0.8**	**0.8**	**0.5**	**0.6**	**0.8**	**0.6**	**0.6**	**0.7**	**0.6**	**0.6**	**0.4**	**ns**	**0.3**	**0.4**	**0.8**	**0.6**

[‡]Turfgrass color evaluated on a scale of 1 to 9, with 1 equal to straw-colored and 9 equal to dark green.
[‡]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Table 3. Turfgrass quality evaluations for Terra GoldCote Fertilizer Efficacy Trial on Kentucky bluegrass conducted at the J. S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE during the 1999 growing season.

	Quality[†]																	
	Weeks after Treatment																	
Treatment	*0*	*1*	*2*	*3*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*
16-4-20 (Putters Pride)	6	7.5ab[‡]	7.8a	7.5ab	7.8a	8.0a	7.0ab	7.8a	7.8a	7.8ab	8.0a	8.0a	8.0a	8.0	7.8a	7.8a	8.5a	8.0a
12-0-42 (Putters Pride)																		
+ 46-0-0 (Urea)	6	7.3ab	7.5a	7.8ab	7.5ab	7.8a	7.0ab	7.3ab	7.8a	8.0a	7.8ab	7.8ab	8.0a	8.0	7.8a	7.5ab	8.0a	7.8a
18-3-18 (Drivers Edge)	6	7.0b	7.0a	7.5ab	7.0ab	7.8a	6.8ab	7.3ab	7.8a	8.0a	8.0a	8.0a	7.8a	6.5	7.8a	7.5ab	8.3a	8.0a
46-0-0 (Urea)	6	7.8a	7.8a	8.0a	7.3ab	8.0a	7.3a	7.3ab	7.5a	7.5ab	7.3bc	7.3bc	7.5a	7.3	7.3ab	7.3ab	8.0a	7.8a
32-2-10 (SCU base,																		
Magic Carpet)	6	7.8a	7.5a	7.8ab	7.8a	8.0a	7.3a	7.8a	7.5a	8.0a	8.0a	8.0a	7.5a	7.8	7.5ab	7.0b	8.0a	7.8a
18-3-18 (Country Club)	6	7.0b	7.0a	7.0b	6.8b	7.0b	6.5bc	6.5b	6.8b	7.3b	7.0c	6.8c	6.0b	7.0	6.5bc	7.0b	7.3b	6.8a
Check	6	6.0c	5.8b	5.5c	5.5c	5.8c	6.0c	5.5c	6.0c	6.3c	6.0d	5.8d	6.0b	6.5	5.5c	6.3c	6.8b	5.8c
LSD (0.05)	**ns**	**0.7**	**0.9**	**1.0**	**0.8**	**0.6**	**0.7**	**0.8**	**0.7**	**0.6**	**0.5**	**0.6**	**0.9**	**ns**	**1.0**	**0.7**	**0.6**	**0.6**

[†]Turfgrass quality evaluated on a scale of 1 to 9, with 1= poorest quality and 9= highest quality.
[‡]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

The same trend was observed in the density evaluations (Table 4). Overall densities of all treatments were high on all observation dates (75 to >90% cover) and were not different from each other, although they were greater than the control. Treatment 18-3-18 (Country Club) showed densities similar to the control on eight observation dates. A one-week interval between harvests proved to be insufficient to allow for regrowth and the schedule for turfgrass dry weight determinations was adjusted to compensate. Treatment 18-3-18 (Country Club) had the lowest dry weight values over all observation dates (Table 5). Treatment 18-3-18 (Driver's Edge) had initially low dry weights, then showed among the highest dry weight yield by 12 and 14 weeks after treatment.

The study area was uniformly managed before initiation of this study. Before treatment, the plots appeared uniform in color, quality, and density (Tables 2-4). Despite this appearance, plant tissue analysis made

Table 4. Turfgrass density evaluations for the Terra GoldCote Fertilizer Efficacy Trial on Kentucky bluegrass conducted at the J. S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE during the 1999 growing season.

	Density[†]																	
	Weeks after Treatment																	
Treatment	*0*	*1*	*2*	*3*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*
16-4-20 (Putters Pride)	8	8.0	8.5ab[‡]	8.5a	8.5a	8.8ab	8.0a	8.0ab	8.0a	8.0a	8.0a	8.0a	8.8a	8.8	9.0a	8.0a	9.0a	9.0a
12-0-42 (Putters Pride) + 46-0-0 (Urea)	8	8.0	8.3abc	8.8a	8.5a	8.8ab	8.0a	8.0ab	8.0a	8.0a	8.0a	8.0a	7.5ab	9.0	8.5ab	8.0a	9.0a	8.8a
18-3-18 (Drivers Edge)	8	8.0	8.0bc	8.5a	8.2ab	8.5ab	7.8ab	7.8b	8.0a	8.0a	8.0a	8.0a	8.0bc	7.8	8.5ab	8.0a	9.0a	9.0a
46-0-0 (Urea)	8	8.0	8.8a	8.8a	8.5a	8.8ab	8.0a	8.0ab	8.0a	7.8a	8.0a	8.0a	8.3ab	8.3	8.3ab	8.0a	8.8a	8.8a
32-2-10 (SCU base, Magic Carpet)	8	8.0	8.3abc	8.8a	8.8a	9.0a	8.3a	8.3a	8.0a	8.0a	8.0a	8.0a	8.0bc	9.0	8.8a	8.0a	9.0a	9.0a
18-3-18 (Country Club)	8	7.8	7.8c	8.3ab	7.8bc	8.0bc	7.8ab	7.8b	7.8a	8.0a	7.8a	7.8a	7.5cd	8.3	7.8bc	7.5b	7.8b	7.8b
Check	8	7.5	7.0d	7.8b	7.3c	7.5c	7.3b	7.0c	7.0b	7.3b	7.0b	7.0b	7.3d	7.8	7.3c	7.0c	7.8b	7.3b
LSD (0.05)	**ns**	**ns**	**0.7**	**0.6**	**0.6**	**0.8**	**0.5**	**0.4**	**0.3**	**0.4**	**0.3**	**0.3**	**0.7**	**ns**	**0.8**	**0.3**	**0.7**	**0.7**

[‡]Turfgrass density evaluated on a scale of 1 to 9, with 1= 0-10% plant cover and 9= 90-100% cover.
[‡]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Table 5. Turfgrass clipping yields (g/m² dry weight) for the Terra GoldCote Fertilizer Efficacy Trial on Kentucky bluegrass conducted at the J. S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE during the 1999 growing season.

	Clipping Yields (g/m² Dry Weight)							
	Weeks after Treatment							
Treatment	*2*	*3*	*5*	*6*	*9*	*12*	*14*	*18*
16-4-20 (Putters Pride)	4.5ab [†]	15.4a	12.4a	18.8a	39.4a	48.3abc	39.8ab	32.7
12-0-42 (Putters Pride) + 46-0-0 (Urea)	6.1a	14.4a	11.7ab	17.7ab	42.5a	53.7ab	46.8a	30.3
18-3-18 (Drivers Edge)	1.5bcd	3.8bc	4.1c	12.3ac	40.7a	58.3a	44.1ab	34.5
46-0-0 (Urea)	3.9abc	10.3ab	6.4bc	14.7ab	35.7ab	41.0bc	26.3cd	30.7
32-2-10 (SCU base, Magic Carpet)	3.5a-d	12.1a	10.8ab	19.6a	47.2a	55.2ab	30.7bc	34.7
18-3-18 (Country Club)	1.1cd	2.9bc	1.9c	8.6cd	25.3b	32.2c	16.7de	26.8
Check	0.6d	1.0c	0.9c	3.2d	8.4c	14.1d	7.7e	16.6
LSD (0.05)	**3.1**	**7.6**	**5.7**	**5.5**	**13.4**	**16.2**	**13.5**	**ns**

[†]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

immediately before treatment indicated differences in tissue nutrient levels among the various nutrients tested (Table 6). These tissue nutrient results support the presence of inherent spatial variation among soil nutrients, a fact that would be expected when conducting a field trial such as this. With this in mind, tissue analysis data were subjected to covariate analysis.

Tissue nutrient analysis measurements were made 3, 6, 9, 12, 15, and 18 weeks after treatment (WAT). All treatments provided significantly higher N-levels than the check through 6 WAT (Table 6). There were no differences in tissue N-levels among treatments by 12 WAT. Tissue N-levels for the check and Country Club (18-318) treatments declined similarly over time. Tissue K-levels varied among treatments (Table 6). Responses were more variable than with nitrogen.

This variability likely reflects the frequency of application and the high soil K levels in the study area. The Putters Pride (16-4-20) treatment maintained the highest tissue K-levels throughout the 18-week study. Phosphorus analysis among treatments was relatively low when compared to N and K analyses. The highest P_2O_5 level among the treatments tested was 4% (Table 1). Tissue contents for P were quite variable, reflecting primarily the high soil P levels found in the test site. Plant tissue contents of S, Ca, Mg, Na, B, Zn, Mn, and Cu also differed by treatment, while Fe and Al levels did not.

Table 6. Plant tissue analyses from the Terra GoldCote Fertilizer Efficacy Trial on Kentucky bluegrass conducted at the J. S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE during the 1999 growing season. Data are from pre-treatment (i.e. prior to fertilizer application) and 3 to 18 weeks after treatment.

	Pre-Treatment												
Treatment	*Al*	*N*	*S*	*P*	*K*	*Mg*	*Ca*	*Na*	*B*	*Zn*	*Mn*	*Fe*	*Cu*
	ppm	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm
16-4-20 (Putters Pride)	125a[†]	2.8a	0.33b	0.28b	1.69ab	0.23ab	0.71c	0.03a	33.5f	11.2a	30b	137e	7.01e
12-0-42 (Putters Pride) + 46-0-0 (Urea)	125a	2.6d	0.35a	0.29b	1.71a	0.23ab	0.75ab	0.03a	38.2a	8.1b	30b	145c	7.4b
18-3-18 (Drivers Edge)	115b	2.7c	0.34ab	0.32a	1.69b	0.24a	0.75ab	0.03a	37.3d	7.8c	31a	138d	7.8a
46-0-0 (Urea)	92f	2.7c	0.33b	0.29b	1.66c	0.23ab	0.70cd	0.03a	34.1e	5.2f	29c	152b	7.4b
32-2-10 (SCU base, Magic Carpet)	112c	2.8a	0.34ab	0.29b	1.63d	0.24a	0.76a	0.02b	37.5c	5.7d	29c	134f	7.1d
18-3-18 (Country Club)	102d	2.7b	0.34ab	0.29b	1.66c	0.24a	0.74b	0.02b	37.7b	5.3e	30b	175a	7.3c
Check	102e	2.6e	0.33b	0.28b	1.55e	0.22b	0.69d	0.02b	34.1e	4.2g	26d	127g	7.1d
LSD (0.05)	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**

[†]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

	3 Weeks After Treatment												
Treatment	*Al*	*N*	*S*	*P*	*K*	*Mg*	*Ca*	*Na*	*B*	*Zn*	*Mn*	*Fe*	*Cu*
	ppm	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm
16-4-20 (Putters Pride)	96	4.3a[†]	0.29bc	0.22b	1.96a	0.16b	0.31c	0.012ab	11.6a	27.7b	23.8b	76	11.0ab
12-0-42 (Putters Pride) + 46-0-0 (Urea)	66	4.2a	0.29c	0.23b	1.96ab	0.16b	0.32bc	0.013a	7.7cd	24.7bc	22.0bc	72	10.2bc
18-3-18 (Drivers Edge)	62	3.9b	0.28c	0.29a	1.73c	0.16b	0.42b	0.013a	9.8b	32.3a	20.2c	71	9.3c
46-0-0 (Urea)	61	4.1a	0.31b	0.26ab	1.85b	0.16b	0.42b	0.013a	8.2cd	24.9bc	21.1bc	72	11.9a
32-2-10 (SCU base, Magic Carpet)	52	4.2a	0.28c	0.23b	1.87ab	0.15b	0.28c	0.011b	6.9d	21.0d	21.3bc	68	10.0bc
18-3-18 (Country Club)	59	3.9b	0.32a	0.31a	1.84b	0.16b	0.42b	0.012ab	9.0bc	21.9cd	22.2bc	73	8.6c
Check	61	4.3a	0.25d	0.31a	1.92ab	0.23a	0.73a	0.012ab	12.5a	25.5b	29.2a	76	9.1c
LSD (0.05)	**ns**	**0.2**	**0.01**	**0.07**	**0.09**	**0.01**	**0.11**	**0.001**	**1.4**	**3.4**	**3.2**	**ns**	**1.6**

	6 Weeks After Treatment												
Treatment	*Al*	*N*	*S*	*P*	*K*	*Mg*	*Ca*	*Na*	*B*	*Zn*	*Mn*	*Fe*	*Cu*
	ppm	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm
16-4-20 (Putters Pride)	54	3.7ab[†]	0.31c	0.30d	1.81a	0.17bc	0.36f	0.02b	20b	20bc	20	79	8.2b
12-0-42 (Putters Pride) + 46-0-0 (Urea)	67	3.6ab	0.30c	0.30d	1.79ab	0.17bc	0.38e	0.02b	17c	20bc	20	77	7.8bc
18-3-18 (Drivers Edge)	63	3.6ab	0.31c	0.32c	1.70bc	0.18b	0.41b	0.02b	21b	21abc	20	81	7.4c
46-0-0 (Urea)	67	3.5bc	0.31c	0.30d	1.67c	0.17bc	0.41bc	0.02b	18c	19c	19	74	7.8bc
32-2-10 (SCU base, Magic Carpet)	135	3.7a	0.30c	0.31cd	1.77ab	0.16c	0.39de	0.02b	17c	22a	20	79	9.1a
18-3-18 (Country Club)	201	3.4c	0.34b	0.34b	1.72abc	0.18b	0.40cd	0.02b	20b	20bc	20	80	8.2b
Check	66	3.1d	0.36a	0.38a	1.58d	0.21a	0.53	0.03a	26a	21ab	20	76	6.5d
LSD (0.05)	**ns**	**0.1**	**0.01**	**0.01**	**0.09**	**0.01**	**0.01**	**0.01**	**2.3**	**1.6**	**ns**	**ns**	**0.7**

[†]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Table 6. Continued.

Treatment	9 Weeks After Treatment												
	Al	*N*	*S*	*P*	*K*	*Mg*	*Ca*	*Na*	*B*	*Zn*	*Mn*	*Fe*	*Cu*
	ppm	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm
16-4-20 (Putters Pride)	51	3.8a[†]	0.45	0.44	2.3	0.24	0.59	0.031	84	61	30	93	13
12-0-42 (Putters Pride) + 46-0-0 (Urea)39	39	3.7ab	0.34	0.34	1.8	0.19	0.46	0.02	13	31	100	55	10
18-3-18 (Drivers Edge)	36	3.8a	0.34	0.36	1.9	0.20	0.46	0.02	14	28	85	103	10
46-0-0 (Urea)	41	3.7ab	0.36	0.37	1.7	0.20	0.50	0.02	14	32	103	64	10
32-2-10 (SCU base, Magic Carpet)	37	3.7a	0.34	0.36	1.8	0.19	0.48	0.02	13	29	103	59	10
18-3-18 (Country Club)	36	3.6bc	0.38	0.40	1.8	0.21	0.47	0.02	14	28	91	53	9
Check	35	3.5c	0.37	0.41	1.8	0.22	0.56	0.03	15	35	98	39	9
LSD (0.05)	**ns**	**0.16**	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**	**ns**

Treatment	12 Weeks After Treatment												
	Al	*N*	*S*	*P*	*K*	*Mg*	*Ca*	*Na*	*B*	*Zn*	*Mn*	*Fe*	*Cu*
	ppm	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm
16-4-20 (Putters Pride)	43	3.6	0.40d[†]	0.43bc	1.96a	0.24c	0.56d	0.01	18.6c	27.3a	32	73ab	7.0a
12-0-42 (Putters Pride) + 46-0-0 (Urea)	39	3.5	0.37e	0.41c	1.89abc	0.24c	0.56d	0.01	16.8d	26.2bcd	32	67d	6.5bcd
18-3-18 (Drivers Edge)	41	2.8	0.37e	0.43bc	1.87bc	0.24c	0.56d	0.01	17.0d	26.8ab	31	68cd	6.6abc
46-0-0 (Urea)	40	3.5	0.41c	0.47ab	1.82c	0.25bc	0.61b	0.01	19.3bc	25.1d	31	69bcd	6.3cd
32-2-10 (SCU base, Magic Carpet)	51	3.6	0.41cd	0.46ab	1.91ab	0.25b	0.62b	0.011	9.7bc	26.6abc	32	75a	6.9ab
18-3-18 (Country Club)	47	3.4	0.43b	0.49a	1.81c	0.26b	0.58c	0.01	20.4b	26.2bc	32	70bcd	6.1d
Check	57	3.3	0.45a	0.50a	1.71d	0.29a	0.66a	0.01	22.9a	25.6cd	31	72abc	5.6e
LSD (0.05)	**ns**	**ns**	**0.01**	**0.05**	**0.08**	**0.01**	**0.01**	**ns**	**1.4**	**1.0**	**ns**	**4.2**	**0.4**

[†]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Treatment	15 Weeks After Treatment												
	Al	*N*	*S*	*P*	*K*	*Mg*	*Ca*	*Na*	*B*	*Zn*	*Mn*	*Fe*	*Cu*
	ppm	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm
16-4-20 (Putters Pride)	47	3.1	0.35c[†]	0.42d	1.7a	0.19c	0.55b	0.027c	16.8b	17	25	109	13
12-0-42 (Putters Pride) + 46-0-0 (Urea)	43	3.1	0.33de	0.40e	1.8a	0.19c	0.55b	0.032b	15.3bc	11	23	76	9
18-3-18 (Drivers Edge)	52	3.1	0.32e	0.40e	1.7a	1.20bc	0.56b	0.025c	14.5c	12	22	62	9
46-0-0 (Urea)	53	3.0	0.37b	0.45c	1.6ab	1.21b	0.59b	0.032b	16.1b	10	21	61	8
32-2-10 (SCU base, Magic Carpet)46	46	3.1	0.34cd	0.43d	1.5b	1.20bc	0.57b	0.032b	15.4bc	8	20	58	8
18-3-18 (Country Club)	54	2.9	0.38a	0.48a	1.5b	0.23a	0.61b	0.037a	18.4a	12	23	60	7
Check	60	3.0	0.38ab	0.47b	1.6ab	0.24a	0.68a	0.037a	19.4a	12	23	61	8
LSD (0.05)	**ns**	**ns**	**0.01**	**0.01**	**0.2**	**0.01**	**0.07**	**0.005**	**1.5**	**ns**	**ns**	**ns**	**ns**

Treatment	18 Weeks After Treatment												
	Al	*N*	*S*	*P*	*K*	*Mg*	*Ca*	*Na*	*B*	*Zn*	*Mn*	*Fe*	*Cu*
	ppm	%	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm
16-4-20 (Putters Pride)	69abc[†]	3.1	0.36ab	0.37ab	1.6	0.22ab	0.70bc	0.055abc	24.7ab	19	19.5abc	57	8
12-0-42 (Putters Pride) + 46-0-0 (Urea)	53c	3.1	0.30c	0.30c	1.3	0.18b	0.61c	0.045c	19.6c	18	16.8c	37	7
18-3-18 (Drivers Edge)	56bc	3.1	0.30c	0.31bc	1.4	0.19b	0.62c	0.045c	19.2c	17	16.8c	50	7
46-0-0 (Urea)	64abc	3.0	0.34bc	0.37ab	1.4	0.21ab	0.69bc	0.050bc	21.9bc	19	19.3bc	52	7
32-2-10 (SCU base, Magic Carpet)	77ab	3.0	0.34bs	0.36abc	1.4	0.21ab	0.67bc	0.050bc	22.6bc	18	18.5bc	71	7
18-3-18 (Country Club)	85a	2.9	0.39a	0.42a	1.5	0.24a	0.78ab	0.063ab	27.9a	20	22.8a	71	7
Check	82a	2.9	0.37ab	0.41a	1.5	0.25a	0.84a	0.067a	27.9a	21	20.8ab	67	7
LSD (0.05)	**23**	**ns**	**0.8**	**0.07**	**ns**	**0.05**	**0.12**	**0.015**	**4.6**	**ns**	**3.3**	**ns**	**ns**

[†]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Terra GoldCote Slow Release Fertilizer Trial

M.R. Vaitkus and R.C. Shearman

Turfgrass

The goal of this research was to determine the nitrogen release rate of three formulations of GoldCote slow release nitrogen fertilizers under field conditions.

The study was conducted in the summer of 1999 at the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE. Fertilizer performance was evaluated on a 5-year-old stand of Kentucky bluegrass growing on a Sharpsburg silty clay loam soil. Treatment plots were 2 ft by 2 ft and the experimental design was a randomized complete block with treatments replicated three times. The study area was maintained at a mowing height of 2.5 inches with clippings removed. Irrigation was applied at 80% ETp; application rates were adjusted every three to four days

Replicated samples of three formulations of GoldCote slow release nitrogen fertilizer, sulfur-coated urea and urea were placed in the soil at a depth of 10cm below the surface on June 14, 1999. A four-inch cupcutter was used to remove a block of sod and soil from the center of each plot. After placing the sample at the appropriate depth, the block of soil and sod was replaced. The fertilizer samples were sealed within two bags — one constructed of large mesh plastic coated nylon screen and one of a coarse weave 100% nylon fabric. These bags permitted full biotic and environmental interactions between the soil and fertilizer prills, while allowing retrieval of the prills for determination of N release. The treatment plots received no other fertilizer application other than the buried sample.

Fertilizer samples were weighed prior to placement in the soil. Samples were removed from the soil at 30, 60, 90, 120, 150 and 180 days after placement. The fertilizer prills were separated from the enclosing mesh bags, dried for 24 hours at 45°F and weighed. Turfgrass color, quality and density were evaluated on adjacent surface-treated plots at 30, 60, 90 and 120 days after placement.

Weight change in fertilizer granules showed an interaction between treatments and number of days after placement (Table 1). Lower weight changes at 150 and 180 days after placement may have been due to wet soil conditions during sample removal, resulting in poor separation of soil and plant roots from prills. Turfgrass color evaluation likewise showed an interaction between treatments and number of days after placement (Table 2). At 30 and 60 days after placement, the urea treatment had significantly lower color ratings than most other treatments. Turfgrass quality was greater for Putter's Pride (16-4-20) than for Drivers Edge (18-3-18), Magic Carpet, S-coated Urea (32-2-10) and Urea (46-0-0) (Table 3). Density evaluations did not differ between treatments. Quality and density were highest at 120 days after placement (Table 4).

Table 1. Percent (%) Weight Change (g) in fertilizer granules as affected by the interaction of Treatments and Days after Placement for the Terra GoldCote Slow Release Nitrogen Trial conducted at the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE, during the 1999 growing season.

	% Weight Change (g)					
	Days after placement					
Treatments	*30*	*60*	*90*	*120*	*150*	*180*
GoldCote Drivers Edge (18-3-18)	50	59	60	74	56	65
GoldCote Putters Pride (16-4-20)	68	76	76	74	71	78
GoldCote Putters Pride+ (12-0-42)	67	83	86	93	89	90
Magic Carpet, S-coated Urea (32-2-10)	85	94	95	100	93	94
Urea (46-0-0)	100	100	100	100	100	100

LSD_1 ($p \leq 0.05$) within rows = 8
LSD_2 ($p \leq 0.05$) within columns = 6

Table 2. Turfgrass color evaluations as affected by the interaction of Treatments and Days after Placement for the Terra GoldCote Slow Release Nitrogen Trial conducted at the J. S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE, during the 1999 growing season.

	Color†			
	Days after placement			
Treatments	*30*	*60*	*90*	*120*
GoldCote Drivers Edge (18-3-18)	7.0	8.1	7.0	8.1
GoldCote Putters Pride (16-4-20)	8.0	8.1	7.0	8.1
GoldCote Putters Pride+ (12-0-42)	7.7	8.1	7.0	8.1
Magic Carpet, S-coated Urea (32-2-10)	8.0	8.0	7.0	8.1
Urea (46-0-0)	7.3	7.7	7.0	8.2

LSD_1 ($p \leq 0.05$) within rows = 0.41
LSD_2 ($p \leq 0.05$) within columns = 0.40
†Turfgrass color evaluated on a scale of 1 to 9, with 1 = straw-colored and 9 = dark green.

Table 3. Turfgrass quality and density evaluations for the Terra GoldCote Slow Release Nitrogen Trial conducted at the J. S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE, during the 1999 growing season.

Treatments	*Quality*†	*Density*‡
GoldCote Drivers Edge (18-3-18)	7.6bc§	8.4
GoldCote Putters Pride (16-4-20)	8.1a	8.6
GoldCote Putters Pride+ (12-0-42)	7.9ab	8.5
Magic Carpet, S-coated Urea (32-2-10)	7.7bc	8.5
Urea (46-0-0)	7.5c	8.5
LSD (p<0.05)	**0.4**	**ns**

†Turfgrass quality evaluated on a scale of 1 to 9, with 1= poorest quality and 9= highest quality.
‡Turfgrass density evaluated on a scale of 1 to 9, with 1= 0-10% plant cover and 9= 90-100% cover.
§Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Table 4. Turfgrass quality and density evaluations for the Terra GoldCote Slow Release Nitrogen Trial conducted at the J. S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE, during the 1999 growing season.

Days after placement	*Quality*†	*Density*‡
30	7.5b§	8.7b
60	7.7b	8.0d
90	7.7b	8.3c
120	8.1a	9.0a
LSD (p<0.05)	**0.3**	**0.2**

†Turfgrass quality evaluated on a scale of 1 to 9, with 1= poorest quality and 9= highest quality.
‡Turfgrass density evaluated on a scale of 1 to 9, with 1= 0-10% plant cover and 9= 90-100% cover.
§Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Howard Johnson's Fertilizer Trial

R.C. Shearman and M.R. Vaitkus

Turfgrass

This study evaluated the performance of four Howard Johnson's fertilizers on Kentucky bluegrass turf. The goal of this research was to determine the performance of these materials on turfgrass color, quality and clipping yields.

The study was conducted in the summer of 1999 at the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE. Fertilizer performance was evaluated on a 5-year-old stand of Kentucky Bluegrass growing on a Sharpsburg silty clay loam soil. Soil chemical characteristics are noted in Table 1. Treatment plots were 3 ft by 6 ft and the experimental design was a randomized complete block, with treatments replicated three times.

Treatments were applied by hand on June 7, 1999 and watered in with an irrigation of 0.5 inches. The study area was maintained at a mowing height of 2.5 inches with clippings removed. Irrigation was applied at 80% ETp; application rates were adjusted every three to four days.

Turfgrass color and quality were rated visually on a weekly basis using standard National Turfgrass Evaluation Program (NTEP) procedures. Turfgrass color was evaluated on a scale of 1 to 9, with 1= straw-colored and 9= dark green. Turfgrass quality ratings were based on a 1 to 9 scale, with 1=lowest, 9=highest, and 6= acceptable quality.

Clipping yields were taken about every three weeks for 18 weeks. Clippings were harvested with an 18-inch reel mower set at 2 1/4 inches. One mower pass through the center portion of each plot was made; clippings were bagged, dried for 24 hours at 70°C and then weighed.

Most treatments showed consistently higher color rating than the control throughout the trial (Table 2). Treatments having the highest color values on at least 11 of the observation dates were HJCT Coated N (44-0-0), Scott's Poly S (38-0-0) and Scott's Fairway (22-0-22), all at the 1.5 lb/M rate.

The same trend was observed in the quality evaluations (Table 3). Overall quality of all treatments ranged from 6.0 to 8.0 throughout the trial. Scott's Poly S (38-0-0) at the 1.5 lbs/M rate had the highest mean quality rating. HJCT Coated N (44-0-0), Scott's Poly S (38-0-0) and Scott's Fairway (22-0-22), all at the 1.5 lb/M rate, had the highest quality values on at least 9 of the observation dates.

The schedule for turfgrass dry weight determinations was adjusted to compensate for slow plant growth (Table 4). Dry weight yields of most fertilizer treatments were significantly greater than the untreated control during July and August harvests. HJCT Coated N (44-0-0), 1 lb/M, had the lowest dry weights during this period; they also did not differ significantly from the untreated control. Highest dry weights were recorded for the Scott's Poly S (38-0-0), 1.5 lb/M, treatment during this period. In September and October, dry weight yields were relatively low and did not differ significantly among treatments or from the untreated control.

Table 1. Pretreatment soil chemical properties during the 1999 growing season for the Howard Johnson's Fertilizer Trial site at the J. S. Anderson Turfgrass and Ornamental Research Facility located near Mead, NE.

pH	*Soluble Salts mmho/c*	*O.M. %*	*N ppm*	*P ppm*	*K ppm*	*S ppm*	*Zn ppm*	*Fe ppm*	*Mn ppm*
7.3	0.44	2.5	1.4	18	401	19	1.33	30.2	28

	Cu ppm	*Ca ppm*	*Mg ppm*	*Na ppm*	*B ppm*	*CEC*	*K %sat*	*Ca %sat*	*Mg %sat*
	1.68	3529	662	63	0.7	24.5	4	72	23

Table 2. Color evaluations during the 1999 growing season for the Howard Johnson's Fertilizer Trial located at the J. S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	Rate	*Color*†																
Treatment	*lb/M*	*6/7*	*6/14*	*6/21*	*6/28*	*7/12*	*7/19*	*7/26*	*8/2*	*8/9*	*8/16*	*8/23*	*8/30*	*9/7*	*9/14*	*9/21*	*9/28*	*10/5*
HJCT Coated N (44-0-0)	1	6.0‡	6.5	6.3bc	6.0b	6.3cd	6.5d	5.5cd	5.8cd	6.3cd	7.0bc	6.8	6.8	7.0ab	7.0ab	6.8bc	6.8	7.3b
HJCT Coated N (44-0-0)	1.5	6.0	6.5	6.8b	7.0a	7.0ab	7.3abc	6.5b	6.8ab	7.0ab	7.3b	7.3	7.0	7.3a	7.5a	7.5ab	7.3	8.0a
HJCT Coated N (44-0-0) + HJCT Coated K (0-0-58)	1 + 1	6.0	6.3	6.3bc	6.0b	6.5bcd	7.0bcd	5.3d	5.8cd	6.0de	7.0bc	7.0	7.3	7.0ab	7.0ab	7.3ab	7.0	7.3b
HJCT Coated N (44-0-0) + HJCT Coated K (0-0-58)	1.5 + 1.5	6.0	6.8	6.8b	6.8a	6.8abc	7.0bcd	6.0bc	6.3bc	6.5bcd	7.0bc	7.0	7.0	7.0ab	7.3a	7.3ab	7.0	7.0b
Scott's Poly S (38-0-0)	1	6.0	6.5	6.5bc	6.8a	6.8abc	7.3abc	6.5b	6.5b	6.8bc	7.3b	7.3	7.3	6.8b	7.0ab	6.8bc	6.8	7.3b
Scott's Poly S (38-0-0)	1.5	6.0	7.3	7.5a	7.0a	7.3a	7.8a	7.5a	7.3a	7.5a	7.8a	7.5	7.5	7.0ab	7.5a	7.8a	7.0	7.3b
Scott's Fairway (22-0-22)	1	6.0	6.3	6.8b	6.8a	6.5bcd	6.8cd	5.5cd	5.5de	6.0de	6.8c	6.8	6.8	7.0ab	7.0ab	6.8bc	6.8	6.8bc
Scott's Fairway (22-0-22)	1.5	6.0	7.0	7.5a	7.0a	7.0ab	7.5ab	6.5b	6.8ab	7.0ab	7.0bc	7.0	7.0	7.0ab	7.3a	7.5ab	6.8	7.3b
Untreated Control		6.0	6.3	6.0c	5.3c	6.0d	6.5d	5.3d	5.0e	5.5e	7.0bc	6.5	7.0	6.3c	6.5b	6.3c	6.3	6.3c
LSD (0.05)		**ns**	**ns**	**0.7**	**0.7**	**0.5**	**0.7**	**0.7**	**0.7**	**0.7**	**0.5**	**ns**	**ns**	**0.4**	**0.6**	**0.8**	**ns**	**0.7**

†Color rated on a scale of 1 to 9, with 1 equal to straw brown and 9 equal to darkest color.
‡Values in a column followed by the same letter are not significantly ($p \leq 0.05$) different based on the Least Significant Difference (LSD) multiple means technique.

Table 3. Quality evaluations during the 1999 growing season for the Howard Johnson's Fertilizer Trial located at the J. S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	Rate	*Quality*†																
Treatment	*lb/M*	*6/7*	*6/14*	*6/21*	*6/28*	*7/12*	*7/19*	*7/26*	*8/2*	*8/9*	*8/16*	*8/23*	*8/30*	*9/7*	*9/14*	*9/21*	*9/28*	*10/5*	*Mean*
HJCT Coated N (44-0-0)	1	6.0	6.3bc‡	6.3bc	6.5c	6.3bc	6.3ef	5.3de	6.0bc	6.3bcd	6.5c	6.8	6.5	7.0ab	7.0	7.0ab	7.0	7.0b	6.5c
HJCT Coated N (44-0-0)	1.5	6.0	6.3bc	6.8ab	6.8bc	6.5abc	6.8cde	6.0bc	6.5ab	7.3a	6.8bc	7.0	6.8	7.5a	7.3	7.3a	7.0	8.0a	6.9b
HJCT Coated N (44-0-0) + HJCT Coated K (0-0-58)	1 + 1	6.0	6.3bc	6.3bc	6.8bc	6.3bc	6.8cde	5.5cde	5.5cd	6.0cd	6.8bc	6.8	7.0	6.8b	7.0	7.0ab	7.0	7.3b	6.5c
HJCT Coated N (44-0-0) + HJCT Coated K (0-0-58)	1.5 + 1.5	6.0	6.5abc	6.5abc	7.0ab	6.5abc	7.0bcd	5.5cde	6.5ab	7.0ab	6.8bc	7.0	7.0	6.8b	7.0	7.0ab	7.0	7.0b	6.7bc
Scott's Poly S (38-0-0)	1	6.0	6.5abc	6.5abc	6.8bc	6.8ab	7.3abc	5.8cd	6.5ab	6.8abc	6.8bc	7.0	7.0	6.8b	6.8	6.5b	6.8	7.0b	6.7bc
Scott's Poly S (38-0-0)	1.5	6.0	7.0a	7.0a	7.3a	7.0a	7.8a	7.0a	7.0a	7.3a	7.8a	7.3	7.3	7.3ab	7.5	7.3a	7.3	7.3b	7.2a
Scott's Fairway (22-0-22)	1	6.0	6.3bc	6.5abc	6.8bc	6.3bc	6.5def	5.8cd	6.0bc	6.3bcd	6.8bc	6.5	6.8	7.0ab	7.0	7.0ab	6.8	7.3b	6.6c
Scott's Fairway (22-0-22)	1.5	6.0	6.8ab	7.0a	7.0ab	6.8ab	7.5ab	6.5ab	6.8a	7.0ab	7.0b	7.0	7.0	6.8b	7.0	7.0ab	6.8	7.3b	6.9b
Untreated Control		6.0	6.0c	6.0c	6.0d	6.0c	6.0f	5.0e	5.3d	5.5d	6.8bc	6.5	6.5	6.0c	6.5	5.8c	6.3	6.7b	6.1d
LSD (0.05)		**ns**	**0.5**	**0.6**	**0.5**	**0.6**	**0.6**	**0.6**	**0.7**	**0.8**	**0.5**	**ns**	**ns**	**0.6**	**ns**	**0.6**	**ns**	**0.6**	**0.3**

†Quality rated on a scale of 1 to 9, with 9 equal to most desirable quality.
‡Values in a column followed by the same letter are not significantly ($p \leq 0.05$) different based on the Least Significant Difference (LSD) multiple means technique.

Table 4. Dry weight (g/m^2) of harvested plant tissue during the 1999 growing season for the Howard Johnson's Fertilizer Trial located at the J. S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	Rate	*Dry Weight (g/m^2)*				
Treatment	*lb/M*	*7/19*	*8/9*	*8/30*	*9/21*	*10/13*
HJCT Coated N (44-0-0)	1	13.8de†	27.7de	29.7bc	23.8	27.9
HJCT Coated N (44-0-0)	1.5	28.7bcd	45.2bc	41.0b	23.4	29.4
HJCT Coated N (44-0-0) + HJCT Coated K (0-0-58)	1 + 1	17.4cde	32.6cd	35.2b	26.8	28.3
HJCT Coated N (44-0-0) + HJCT Coated K (0-0-58)	1.5 + 1.5	23.6bcd	40.9bcd	30.6b	24.5	27.6
Scott's Poly S (38-0-0)	1	33.9b	49.0b	38.5b	25.8	28.8
Scott's Poly S (38-0-0)	1.5	68.6a	77.8a	58.6a	32.5	39.4
Scott's Fairway (22-0-22)	1	31.8bc	40.8bcd	40.1b	28.8	24.9
Scott's Fairway (22-0-22)	1.5	58.6a	52.8b	41.4b	28.9	32.2
Untreated Control		7.6e	15.2e	17.3c	19.7	12.1
LSD (0.05)		**15.0**	**13.6**	**12.9**	**ns**	**ns**

†Values in a column followed by the same letter are not significantly ($p \leq 0.05$) different based on the Least Significant Difference (LSD) multiple means technique.

Effects of Primo on Kentucky Bluegrass Sod Storage and Handling

N.L. Heckman, G.L. Horst, and R.E. Gaussoin

Turfgrass

Kentucky bluegrass (*Poa pratensis* L.) is the most predominant cool-season grass used in North American sod production. In the sod industry, it is important to have adequate sod quality, which consists of both sod tensile strength and the ability to regrow. Heat accumulation within the sod pallet when it is stored is one of the most serious negative influences on sod quality. This can result in a less-dense sod that may require netting to avoid tearing during transplanting. Heat accumulation in the pallet can also lead to plant death and unusable sod.

Kentucky bluegrass sod with a blend of America, Apex, Eclipse, and Midnight cultivars was grown at Todd Valley Farms near Mead, NE on a Sharpsburg silty clay loam soil. On May 24, 1998, 26-month-old sod was treated with 0.6 oz Primo / 1000 ft^2 (0.23 kg trinexapac-ethyl ha^{-1}). Sod was harvested on June 2 with a mechanical sod cutter into 20 by 40 inch (51 by 102 cm) sections that were 0.75 inches (1.9 cm) thick. Sod was immediately stacked on pallets. Each stack had 40 rows of sod, with each row consisting of two sections of sod forming a 40 inch by 40 inch (102 cm by 102 cm) square. Nine pallets contained grass treated with Primo and nine pallets with untreated grass were used as controls. Thermocouples were placed in six treated and six control pallets during the stacking of the sod. These thermocouples were inserted at depths of 12 and 36 inches (30.5 and 91.5 cm) from the bottom of the stack along a vertical shaft placed directly in the center of the pallet. A horizontal shaft was placed at row 20 and housed thermocouples at 1, 4, 8, and 12 inches (2.5, 10.2, 20.3 and 30.5 cm) from the center of the stack. The thermocouples were connected to a data logger and hourly temperature readings were recorded.

Sod tensile strength was measured 24, 48 and 72 hours after harvest from the center of each stack. Sections of sod approximately 13.5 by 20 inches (34 by 51 cm) were placed on the sod table and strapped securely with nylon bands. Half of each sod section was on a stationary grate, while the other half was on a mobile grate. The grates were pulled apart until the sod tore and the maximum force recorded. Three replicates were tested from each pallet.

The experiment was repeated in 1999. Twenty-month-old sod that was treated with 0.6 oz Primo / 1000 ft^2 (0.23 kg trinexapac-ethyl ha^{-1}) May 25 and harvested June 8 using the same techniques described in the 1998 experiment. At 12, 24 and 48 hours after harvest, sod from the center three rows was transplanted and sod tensile strength was measured. Visual color and quality ratings were measured 2, 4 and 6 weeks after the last sod sections were transplanted in 1999. Color ratings were taken on the turf that survived the temperatures in the pallet. A color or quality rating of < 6 was unacceptable, 6 was acceptable for home lawn use, and 9 was the best color and quality.

Regression analysis was used to analyze the sod temperature data, and Student's pair *t*-test used to detect differences in sod tensile strength. Color and quality ratings were analyzed using analysis of variance.

Sod pallet temperatures at all thermocouple placements were significantly lower in sod stacks treated with Primo than in untreated sod after 10 hours in 1998 (Figure 1). In 1999, pallet temperatures were significantly lower in sod stacks treated with Primo than in untreated sod after 20 hours (Figure 2). Greater heat accumulation also was found in the center of the pallet compared to thermocouples placed farther from the center. At 24 hours after harvest, sod tensile strength was greater for sod treated with Primo than for untreated sod in 1998 (Table 1). Visual color ratings of the sod treated with Primo were greater than untreated controls four weeks after transplanting (Table 2). Quality ratings of Primo-treated sod were higher than untreated sod two weeks after transplanting.

A single application of Primo, 10 to 14 days before harvest of Kentucky bluegrass sod, has been shown to reduce heat accumulation within sod during storage. Other effects may also result, such as improved tensile strength and better transplant color and quality.

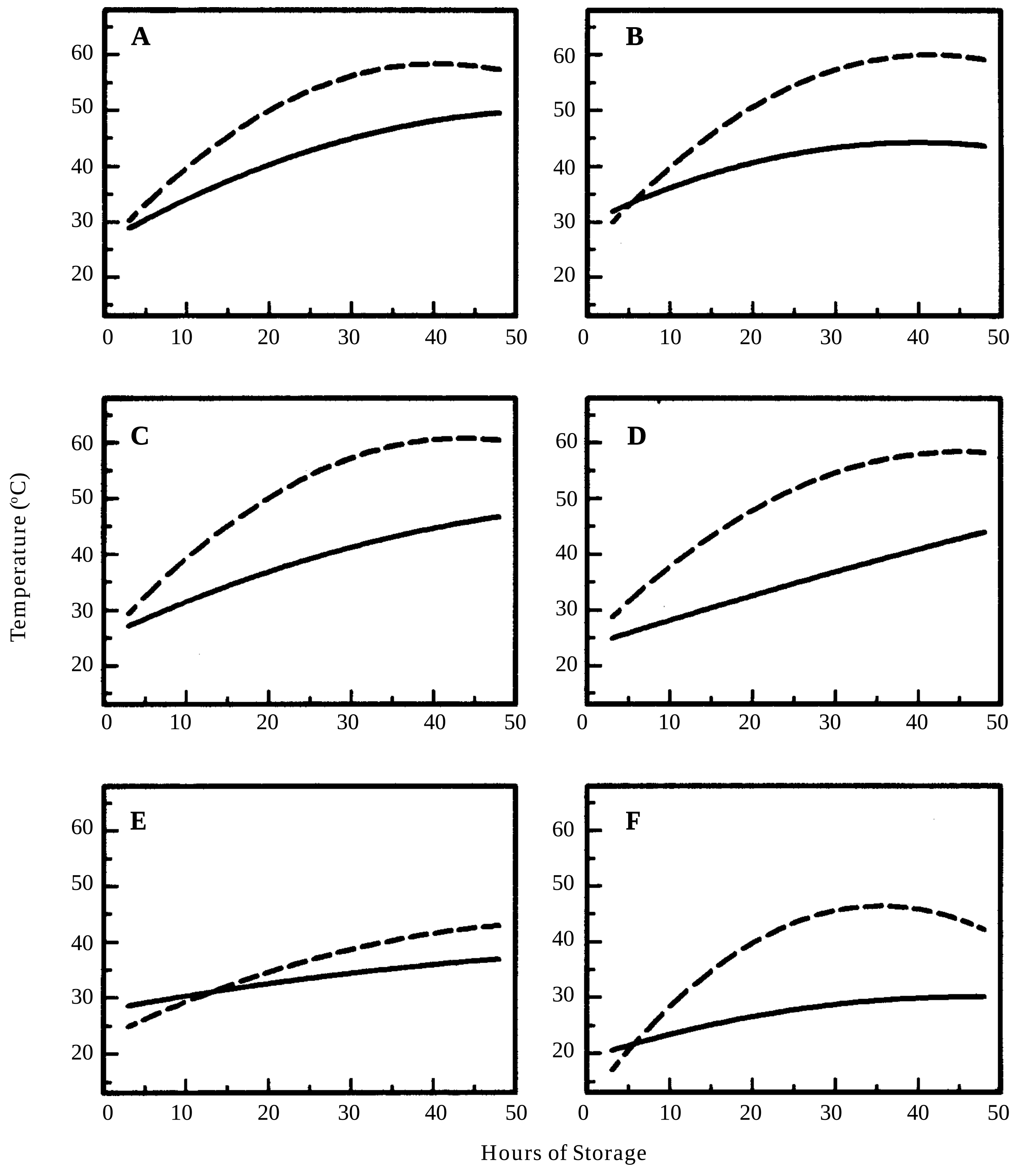


Figure 1. Comparison of Primo-treated (————) and untreated (– – – –) sod stack temperatures from 3 to 48 hours after harvest in 1998. (A) Measurements taken 1 inch horizontally from the center of the sod stacks. (B) Measurements taken at 4 inches horizontally from the center of the sod stacks. (C) Measurements taken 8 inches horizontally from the center of the sod stacks. (D) Measurements taken 12 inches horizontally from the center of the sod stacks. (E) Measurements taken 12 inches vertically from the bottom of the sod stacks. (F) Measurements taken 36 inches vertically from the bottom of the sod stacks.

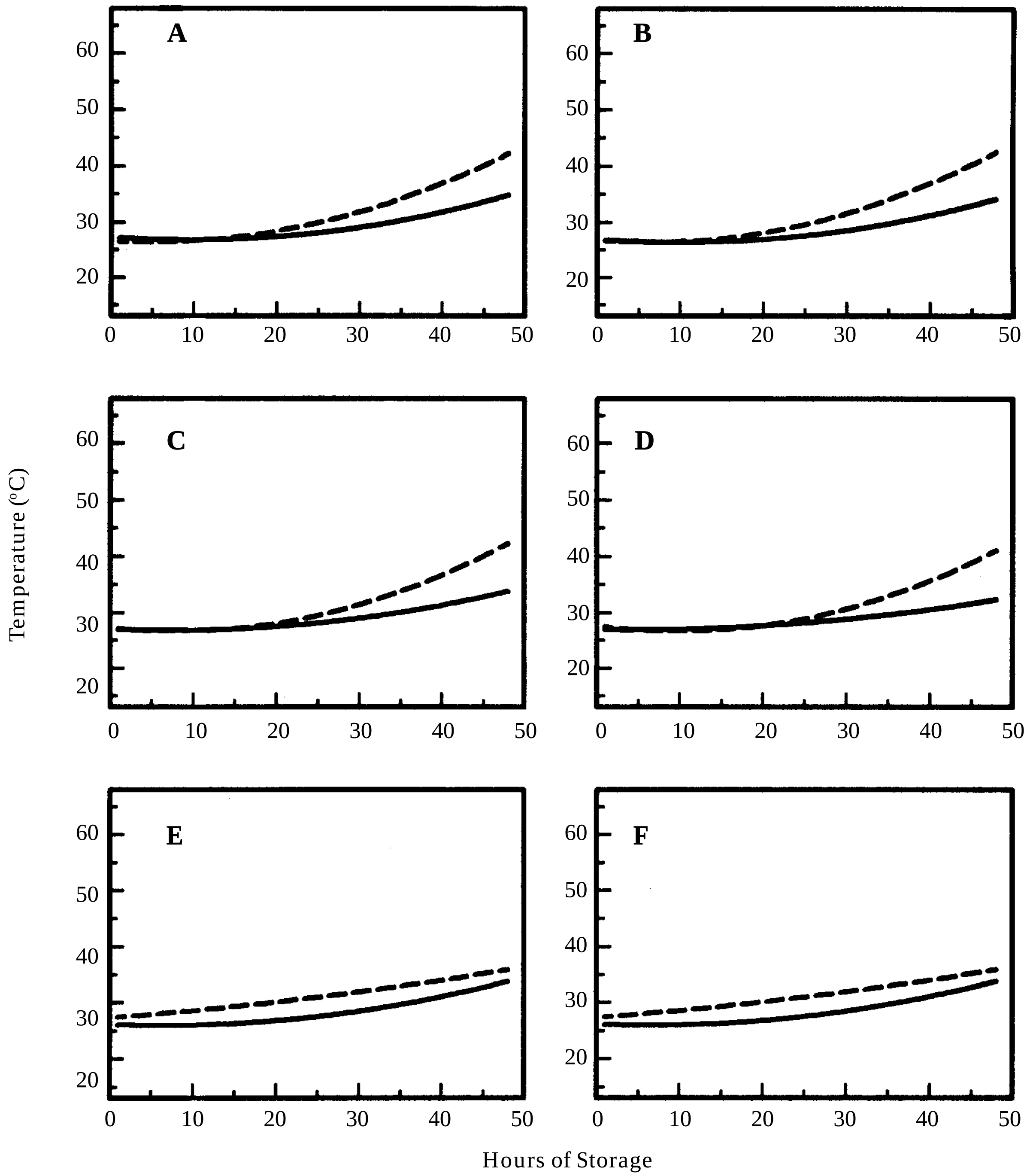


Figure 2. Comparison of Primo-treated (————) and untreated (– – – –) sod stack temperatures from one to 72 hours after harvest in 1999. (A) Measurements taken at 1 inch horizontally from the center of the sod stacks. (B) Measurements taken at 4 inches horizontally from the center of the sod stacks. (C) Measurements taken 8 inches horizontally from the center of the sod stacks. (D) Measurements taken 12 inches horizontally from the center of the sod stacks. (E) Measurements taken 12 inches vertically from the bottom of the sod stacks. (F) Measurements taken 36 inches vertically from the bottom of the sod stacks.

Table 1. Effects of 0.6 oz Primo/1000 ft^2 on Kentucky bluegrass sod tensile strength after storage. Effects of Primo on Kentucky Bluegrass Sod Storage and Handling. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	June 1998			*June 1999*		
	Hours After Harvest					
Treatment	*24*	*48*	*72*	*12*	*24*	*48*
	lbs					
Primo	144.6†	67.1	12.4	55.8	44.1	22.9
Control	110.8	44.2	25.9	49.6	37.7	19.2
LSD (0.05)	**28.9**	**ns**	**ns**	**ns**	**ns**	**ns**

†Data are expressed as mean resistance of sod to longitudinal stress measured by the minimum amount of longitudinal stress required to separate the sod.

Table 2. Influence of 0.6 oz Primo/1000 ft^2 on the color and quality of Kentucky bluegrass sod following storage on a pallet. Effects of Primo on Kentucky Bluegrass Sod Storage and Handling. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	Color†			*Quality‡*		
	Weeks After Transplanting					
Treatment	*2*	*4*	*6*	*2*	*4*	*6*
Primo	6.9	7.4	6.9	6.6	7.2	6.8
Control	6.1	6.3	6.9	5.6	6.4	6.6
LSD (0.05)	**ns**	**0.9**	**ns**	**0.9**	**ns**	**ns**

†Sod color ratings were based on a 1 to 9 scale, where < 6 unacceptable; 6 was acceptable for home lawn use; 9 was best.
‡Sod quality ratings were based on a 1 to 9 scale, where < 6 unacceptable; 6 was acceptable for home lawn use; 9 was best.

Heat Tolerance of Kentucky Bluegrass as Affected by Primo

N.L. Heckman, G.L. Horst, and R.E. Gaussoin

Heat tolerance of cool-season grasses is of major importance in the turf industry because of the increased use of these grasses in the transition zone and in other areas to which they are not adapted. Primo is a turfgrass plant growth regulator that is used to reduce clipping yield and improve stress tolerance. Golf course superintendents have reported that frequent applications of low rates of Primo enhance turfgrass quality during the summer months. Research was conducted in 1999 to evaluate the effect of Primo on the heat tolerance of two cultivars of Kentucky bluegrass (*Poa pratensis* L.).

Kentucky bluegrass cultivars ‘Midnight’ and ‘Huntsville’ were vegetatively propagated from established stands at the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE in October 1998. Plants were grown in 6-inch pots in the greenhouse, where temperatures fluctuated between 15° and 30°C. The growth medium was sand, and plants were irrigated daily and fertilized on a weekly basis.

The first experiment was initiated in June 1999. Three replications of 3 leaf sprigs from each cultivar were transplanted into 0.75 inch diameter pots and irrigated daily with distilled water. Sprigs were grown in a controlled growth chamber with a 14 hr photoperiod and temperatures of 22°C day / 19°C night. Seven days after being placed in the growth chamber, sprigs were treated with 0.6 oz Primo / 1000 ft^2 or left as untreated controls. Ten days after Primo application plants were placed in a temperature gradient block. The temperature gradient block contained 55 chamber wells arranged as 11 rows at different temperatures with five samples per row. Samples underwent the chronic heat treatment for 4 days at temperatures ranging from 33° to 40°C. Plants then were placed back into the same growth chamber, and sprigs were allowed to regrow for 14 days. They then were evaluated for survival, with plants showing regrowth considered living and plants showing no regrowth considered nonliving. The temperatures needed to killed 20% (Lt_{20}), 50% (Lt_{50}), and 80% (Lt_{80}) of the grass were derived and separated using standard errors (P = 0.05). The experiment was repeated in September 1999.

The Lt_{50} for Kentucky bluegrass exposed to chronic heat stress for 4 days was between 35.4° and 36.3°C for grass treated with Primo and untreated controls (Table 1). Kentucky bluegrass sprigs treated with a single application of Primo had lower heat tolerance than untreated sprigs. The Lt_{20}, Lt_{50}, and Lt_{80} of Kentucky bluegrass sprigs treated with Primo at 0.6 oz / 1000 ft^2 were significantly lower than those of untreated controls (Figure 1).

The effects on heat tolerance of multiple applications of Primo are not certain and need to be researched. Because Primo is in the same chemical family as some grass herbicides, some herbicidal effects on the treated plants may occur.

Table 1. Lethal temperatures for two cultivars of Kentucky bluegrass treated with 0.6 oz Primo/1000 ft^2 and untreated controls 10 days prior to chronic heat stress treatment. Data represents the mean Lt_{20}, Lt_{50}, and Lt_{80} for two experiments.

		Lethal Temperatures		
Cultivar	*Treatment*	Lt_{20}	Lt_{50}	Lt_{80}
		°C		
Midnight	Primo	34.9	35.7	36.4
Midnight	Control	35.5	36.3	37.1
Huntsville	Primo	34.5	35.4	36.3
Huntsville	Control	34.7	35.8	36.8

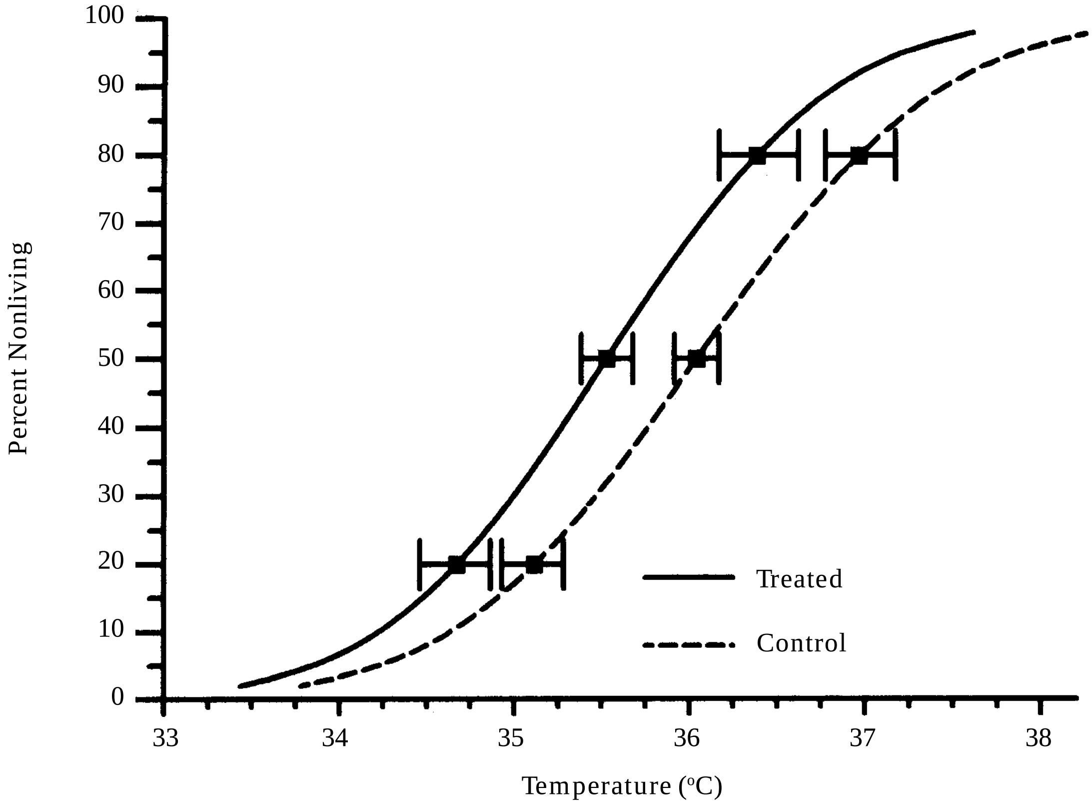


Figure 1. Lethal temperature curves of Kentucky bluegrass treated with 0.6 oz Primo/1000 ft² and untreated controls 10 days prior to chronic heat stress treatment. Data points (■) represent the mean Lt_{20}, Lt_{50}, and Lt_{80} ± standard error for two experiments.

Grow-in and Cultural Impacts on USGA Putting Greens and their Microbial Communities

R.E. Gaussoin, R. Drijber, W. Powers, R.C. Shearman, M. Aslan, M.R. Vaitkus, and L.A. Wit

The overall goal of this project is to develop a better understanding of the impact of grow-in procedures on putting green establishment and performance. Impacts on the physical, chemical and microbiological factors associated with the USGA root zones and rhizosphere are emphasized in the project. The project is being conducted at the University of Nebraska's John Seaton Anderson Turfgrass Research Facility located near Mead, NE. The 5-year project is composed of three phases: Construction and Grow-in, Microbial Community Assessments and Grow-in Procedure Impacts on the Long-term performance of the Putting Green. Phases one and two span three-year periods, while phase three will involve experiments repeated over the five years of the project.

Two separate USGA-specification root zone mixtures — one composed of sand and peat (80/20 ratio) and one a combination of sand, peat, and soil (80/15/5 ratio) — were developed in 1996. Materials used for construction complied with USGA Greens recommendations for physical characteristics and organic matter content. First year greens were constructed in late summer of 1996, allowed to settle over the winter, and were seeded with Providence creeping bentgrass (1.5 lbs/1000ft^2) in the spring (May 30) of 1997. Year two greens were constructed in 1997. They were allowed to settle over the winter and were seeded in the spring (May 27) of 1998. Year-three greens were constructed in 1998, allowed to settle over the winter and seeded in May 1999. Year-four greens were constructed in 1999 and will be allowed to settle over the winter. They will be seeded in the spring of 2000. Accelerated and controlled grow-in treatments were applied prior to and after seeding of the three greens according to the treatment schedule outlined in Table 1.

Table 1. Establishment and grow-in treatments for GCSAA/USGA greens construction project. All rates are in pounds per 1000ft^2 unless noted. J. S. Anderson Turfgrass and Ornamental Research Facility, Mead, NE.

	Accelerated				*Controlled*			
		N	*P*	*K*		*N*	*P*	*K*
Preplant Treatments								
STEP (83113)	16	—	—	—	11	—	—	—
Started (16-25-12)	12	2	3	1.4	6	1	1.5	.7
15-0-29 (8845)	9	1.35	0	2.6	4.5	.7	0	1.3
38-0-0 (8820)	7.25	2.75	0	0	3.6	1.34	0	0
Totals	6.1	3	4		3.04	1.5	2	
Postplant Treatments								
Starter (16-25-12)	Full rate - Weekly				Half Rate - Every 2 weeks			
STEP	100#/A				60#/A			
	(45/90 days post planting)							
Mowing	3/8' to 3/16'							
Verticutting	Canopy only (7-10 days)							
Topdressing	Light, frequent (7-10 days)							
Rolling	1X weekly				1X every 2 weeks			
Disease Control	Preventative							
Insect Control	Preventative							
Weed Control	Preemergence; Preventative							

Table 2. Cover and quality means for USGA/GCSAA greens construction project. J. S. Anderson Turfgrass and Ornamental Research Facility, Mead, NE.

	%Cover[†]		*Quality*[‡]								
Root Zone Mix	*1997*	*1998*	*1997*	*1998 Results*			*1999 Results*				
1997 Greens	*7/3*	*6/15*	*8/1*	*7/14*	*9/1*	*9/15*					
sand / peat	68.3	66.7[§]	5.2	5.8	6.5	6.8					
sand / peat / soil	78.3	70.8	6.2	6.0	6.5	6.3					
1998 Greens							5 / 27				
sand / peat							6.0				
sand / peat / soil							6.0				
1999 Greens								*7/27*	*8/26*	*9/22*	*10/26*
sand / peat								4.5	6.7	5.8	5.8
sand / peat / soil								4.5	7.3	6.3	6.7

	%Cover[†]		*Quality*[‡]								
Grow-in Treatment	*1997 Results*	*1998 Results*	*1997 Results*	*1998 Results*			*1999 Results*				
1997 Greens	*7/3*	*6/15*	*8/1*	*7/14*	*9/1*	*9/15*					
Accelerated	84.2[§]	69.2	3.0[§]	5.7	6.2	6.3					
Controlled	62.5	68.3	8.3	6.2	6.8	6.8					
1998 Greens							*5/27*				
Accelerated							6.0				
Controlled							6.0				
1999 Greens								*7/27*	*8/26*	*9/22*	*10/26*
Accelerated								3.0[§]	7.2	5.0[§]	5.2[§]
Controlled								6.0	6.8	7.2	7.2

[†]Turfgrass cover evaluated on a 0 to 100% scale.
[‡]Turfgrass quality evaluated on a 1 to 9 scale, with 1= poorest and 9= highest quality turf.
[§]Denotes significant ($p \leq 0.05$) differences between treatment means within years.

Data collected on year one through year three greens were: (1) color, (2) quality, (3) ball roll distance (Stimpmeter), and (4) surface hardness (Clegg).

Soil physical properties were examined annually, in October. Infiltration rates were measured in the field using a 6" single-ring infiltrometer. Soil cores were sampled and analyzed for water retention and total porosity using pressure plate techniques. Soil chemical properties were analyzed annually, in the spring, prior to treatment and in the fall. Samples for microbial characterization also were collected in the spring and fall.

1997 Greens

(1) Early season (6 / 15) vegetative cover was greater for root zone mix plots containing soil than those without soil; 71% versus 67%, respectively (Table 2). There was no effect of grow-in treatment. Quality and color were unaffected by differences in the root zone mix (Tables 2 and 3).

(2) High humidity and little precipitation in July of 1998 resulted in evidence of *Pythium* sp., as well as direct high temperature injury. Pythium damage was evaluated in mid-July on a scale of 1-9, with 9 indicating greatest damage. The accelerated treatment exhibited greater decline than the controlled grow-in (7.5 vs. 3.0) (Table 3). There was no effect of root zone mix and quality was not adversely affected. No quality or color differences were observed from data collected in 1998 and 1999.

(3) A significant interaction between treatments was found for ball roll distance on June 15, 1998 (Table 4). The soil-less root zone mix with accelerated grow-in treatments had longer ball roll than the controlled or soil-containing mix. Root zone mix had no effect on ball roll. On most observation dates, grow-in treatment also had no effect on ball roll; differences between accelerated (7 ft) and controlled (6.5 ft) grow-in treatments were observed Sept. 24, 1998.

The soil-containing root zone mixture had higher surface hardness than the soil-less mix on all observation dates in 1997, 1998 and 1999 (Table 5).

Table 3. Decline, pythium damage, injury, and color means for USGA/GCSAA greens construction project. J. S. Anderson Turfgrass and Ornamental Research Facility, Mead, NE.

	Decline†	*Pythium Damage‡*	*Injury§*	*Color¶*					
Root Zone Mix	*1997 Results*	*1998 Results*	*1999 Results*	*1997 Results*	*1998 Results*	*1999 Results*			
1997 Greens	*8/1*	*7/14*		*8/15*	*9/1*				
sand / peat	5.2	5.3		7.2	7.2				
sand / peat / soil	4.7	5.2		7.2	7.7				
1998 Greens						*5/27*			
sand / peat						6.8			
sand / peat / soil						7.0			
1999 Greens			*6/22*				*7/27*	*8/26*	*10/26*
sand / peat			6.3				6.5	5.0	7.3
sand / peat / soil			4.5				6.3	5.0	7.7

	Decline	*Pythium Damage*	*Injury*	*Color*					
Grow-In Treatment	*1997 Results*	*1998 Results*	*1999 Results*	*1997 Results*	*1998 Results*	*1999 Results*			
1997 Greens	*8/1*	*7/14*		*8/15*	*9/1*				
Accelerated	4.7	7.5#		7.2	8.7#				
Controlled	5.2	3.0		7.2	6.2				
1998 Greens						*5/27*			
Accelerated						7.2			
Controlled						6.7			
1999 Greens			*6/22*				*7/27*	*8/26*	*10/26*
Accelerated			6.8				6.2	3.7#	7.3
Controlled			4.0				6.7	6.3	7.7

†Decline evaluated on a scale of 1 to 9, with 1= no decline and 9= complete decline.
‡Pythium damage evaluated on a scale of 1 to 9, with 1= no damage and 9= greatest damage.
§Turfgrass injury evaluated on a scale of 1 to 9, with 1= no injury and 9= greatest injury.
¶Turfgrass color evaluated on a scale of 1 to 9, with 9= darkest color.
#Denotes significant ($p \leq 0.05$) differences between treatment means within years.

1999 Greens	*Color† 9/22*	
Treatment	*Accelerated*	*Controlled*
sand / peat	7.3	7.7
sand / peat / soil	6.3	8.3

LSD (0.05)= 1.5

†Turfgrass color evaluated on a scale of 1 to 9, with 9= darkest color.

Surface hardness was not affected by grow-in treatment. In 1998 the soil-less media had a lower bulk density than the soil-containing treatment (Table 7).

(4) Soil infiltration rates in 1997, 1998 and 1999 were not significantly different between root zone mixes. In 1999 the accelerated grow-in treatment had infiltration rates faster than the controlled (Table 6).

(5) There appears to be a trend toward a greater change in microbial biomass over time for the soil-less than the soil-containing root zone mix (Table 8).

1998 Greens

(1) No quality or color differences were observed among treatments in 1998 or 1999 (Tables 2 and 3).

(2) Ball roll distance was greater in controlled (6.3 ft) versus accelerated (5 ft) greens in October 1998, while root zone mix had no effect (Table 4).

Table 4. Ball roll distance in feet (Stimpmeter) for USGA/GCSAA greens construction project. J. S. Anderson Turfgrass and Ornamental Research Facility, Mead, NE.

Root Zone Mix	*1997 Results*			*1998 Results*					*1999 Results*			
1997 Greens	*8/4*	*9/16*	*10/22*	*5/21*	*7/14*	*8/14*	*9/24*	*10/14*	*5/27*	*6/22*	*7/27*	*8/26*
sand / peat	2.6	2.1	2.4†	6.3	8.1	8.7	6.9	6.1	6.9	7.1	8.5	7.5
sand / peat / soil	2.6	2.1	2.6	6.3	8.3	8.7	6.7	6.4	6.9	7.1	8.8	7.6
1998 Greens												
sand / peat							6.3	5.6	7.7	6.5	8.5	7.6
sand / peat / soil							6.2	5.7	7.6	6.5	8.5	7.6

†Denotes significant ($p \leq 0.05$) differences between treatment means within years.

Grow-In Treatment	*1997 Results*			*1998 Results*					*1999 Results*			
1997 Greens	*8/4*	*9/16*	*10/22*	*5/21*	*7/14*	*8/14*	*9/24*	*10/14*	*5/27*	*6/22*	*7/27*	*8/26*
Accelerated	2.5	2.1	2.3†	6.1	8.2	8.7	7.0†	6.1	6.9	7.0	8.6	7.5
Controlled	2.6	2.2	2.7	6.4	8.2	8.7	6.5	6.4	7.0	7.2	8.6	7.6
1998 Greens												
Accelerated							6.0	5.0†	7.8	6.7	8.4	7.4
Controlled							6.5	6.3	7.6	6.4	8.6	7.8

†Denotes significant ($p \leq 0.05$) differences between treatment means within years.

1997 Greens	*Ball Roll Distance (6/15/98)*	
Treatment	*Accelerated*	*Controlled*
sand / peat	8.2	8.4
sand / peat / soil	8.6	8.0

LSD (0.05)=0.3

(3) Surface hardness was greater in the root mix containing soil than in the soil-less mix in 1998 and 1999 (Table 5). Grow-in treatments did not have any effect on surface hardness.

(4) Soil infiltration rates were not significantly different between root zone mixes or grow-in treatments in 1998 or 1999 (Table 6).

(5) As was seen for the 1997 greens, there appears to be a trend toward a greater change in microbial biomass over time for the soil-less than the soil-containing root zone mix (Table 8).

1999 Greens

(1) Accelerated treatments had significantly lower quality on three of four evaluation dates in 1999, primarily due to stand loss from environmental injury (Table 2).

(2) An observed trend toward higher stress injury was similar to results for greens constructed in 1997 and 1998 (Table 3).

(3) Similar to results from the 1997 and 1998 greens, the soil-containing root zone had greater surface hardness (Table 5).

(4) Infiltration was not affected by grow-in or root zone treatments (Table 6).

Microbial biomass was not affected by root-zone mix or grow-in procedure on plots established in 1997. Microbial biomass increased over 200% from spring to fall and decreased 40-60% as sampling depth increased. There appears to be a trend toward a greater change in microbial biomass over time for the soil-less than the soil-containing root zone mix.

Water infiltration measurements from treatments established in 1997, 1998 or 1999 did not differ in establishment or subsequent years.

Establishment results were similar in greens established in 1997, 1998 or 1999. For three consecutive years it was found that higher inputs initially will increase cover during grow-in. This increase may not translate to earlier opening for play if environmental stress conditions occur that result in damage to lush, immature turf.

Table 5. Surface hardness (clegg, gravities (G)) for USGA/GCSAA greens construction project. J. S. Anderson Turfgrass and Ornamental Research Facility, Mead, NE.

Root Zone Mix	*1997 Results*			*1998 Results*						*1999 Results*					
1997 Greens	*8/4*	*9/16*	*10/22*	*5/21*	*6/15*	*7/14*	*8/14*	*9/24*	*10/14*	*5/27*	*6/22*	*7/27*	*8/26*	*9/22*	*10/18*
sand / peat	47.9[†]	56.4[†]	56.1[†]	53.0[†]	54.8[†]	57.8[†]	60.8[†]	57.4[†]	64.2[†]	52.3[†]	57.8	58.2[†]	58.4[†]	56.4[†]	61.9[†]
sand / peat / soil	60.3	68.3	68.1	60.8	64.0	70.2	71.1	65.2	75.1	57.9	58.2	65.6	64.5	60.8	67.6
1998 Greens															
sand / peat								67.1	78.9[†]	60.4	64.0[†]	66.9[†]	65.8[†]	64.9	69.6[†]
sand / peat / soil								74.3	91.3	62.8	68.8	74.0	72.4	69.7	76.9
1999 Greens															
sand / peat													64.1[†]	65.7[†]	67.1[†]
sand / peat / soil													74.5	70.7	75.1

[†]Denotes significant ($p \leq 0.05$) differences between treatment means within years.

Grow-in Treatment	*1997 Results*			*1998 Results*						*1999 Results*					
1997 Greens	*8/4*	*9/16*	*10/22*	*5/21*	*6/15*	*7/14*	*8/14*	*9/24*	*10/14*	*5/27*	*6/22*	*7/27*	*8/26*	*9/22*	*10/18*
Accelerated	53.0	61.2	61.7	56.8	59.2	64.9	63.3	61.9	70.3	54.9	57	62.4	61.6	58.2	65.5
Controlled	55.2	63.5	62.4	57.0	59.6	63.2	68.6	60.7	68.9	55.2	59	61.3	61.3	59.0	64.0
1998 Greens															
Accelerated								70.3	85.9	61.7	65.3	70.3	69.8	68.6	73.3
Controlled								71.1	84.3	61.4	67.6	70.6	68.5	66.1	73.2
1999 Greens															
Accelerated													69.6	68.6	71.1
Controlled													68.9	67.8	71.1

Table 6. Infiltration at 2 inch soil depth (inch/hour) for USGA/GCSAA greens construction project. J. S. Anderson Turfgrass and Ornamental Research Facility, Mead, NE.

Root Zone Mix	*1997 Results*	*1998 Results*	*1999 Results*
1997 Greens	*10/20*	*10/17*	*10/18*
sand / peat	21.6	23.8	24.9
sand / peat / soil	20.3	19.8	22.9
1998 Greens			
sand / peat		20.9	19.9
sand / peat / soil		19.2	20.5
1999 Greens			
sand / peat			20.1
sand / peat / soil			18.4

Grow-In Treatment	*1997 Results*	*1998 Results*	*1999 Results*
1997 Greens	*10/20*	*10/17*	*10/18*
Accelerated	20.4	21.9	26.1[†]
Controlled	21.4	22.8	22.0
1998 Greens			
Accelerated		22.7	20.0
Controlled		17.9	20.3
1999 Greens			
Accelerated			21.2
Controlled			17.5

[†]Denotes significant ($p \leq 0.05$) differences between treatment means within years.

Table 7. Soil physical characteristics for USGA/GCSAA greens construction project. J. S. Anderson Turfgrass and Ornamental Research Facility, Mead, NE.

Root Zone Mix	*1997 Results*					*1998 Results*				
			Porosity (%)					*Porosity (%)*		
1997 Greens	*Bulk Density g/cm³*	λ[†]	*Total*	*Air filled*	*Water-filled*	*Bulk Density g/cm³*	λ	*Total*	*Air-filled*	*Water-filled*
sand / peat	1.46	1.33	45	30	16[‡]	1.36[‡]	1.06	49[‡]	27	20
sand / peat / soil	1.49	1.39	44	31	13	1.42	1.04	47	26	19
1998 Greens										
sand / peat						1.43	1.3	46	26	20
sand / peat / soil						1.47	1.2	45	26	19

[†]Pore size distribution index (slope of water release curve)
[‡]Denotes significant ($p \leq 0.05$) differences between treatment means within years.

Grow-In Treatment	*1997 Results*					*1998 Results*				
			Porosity (%)					*Porosity (%)*		
1997 Greens	*Bulk Density g/cm³*	λ	*Total*	*Air-filled*	*Water-filled*	*Bulk Density g/cm³*	λ	*Total*	*Air-filled*	*Water-filled*
Accelerated	1.48	1.35	44	29	15[‡]	1.39	1.00	48	26	20
Controlled	1.47	1.37	45	31	14	1.39	1.11	48	28	19
1998 Greens										
Accelerated						1.46	1.3	45	25	20
Controlled						1.43	1.2	46	27	19

[†]Pore size distribution index (slope of water release curve)
[‡]Denotes significant ($p \leq 0.05$) differences between treatment means within years.

Table 8. Lipid P values (nmol/g) for USGA/GCSAA greens construction project. J. S. Anderson Turfgrass and Ornamental Research Facility, Mead, NE.

Root Zone Mix	*1997 Results*				*1998 Results*					
1997 Greens	*Spring 0-6"*	*Fall 0-3"*	*Fall 3-6"*	*Change 0-6"*	*Summer 0-3"*	*Summer 0-3"*	*Fall 3-6"*	*Fall 0-3"*	*Change 3-6"*	*Change*
sand / peat	10.4[†]	20.0	14.4	6.7	23.9	11.8	27.7	17.9	3.8	6.1
sand / peat / soil	7.7	20.2	13.0	9.0	23.7	9.3	31.2	13.8	7.5	4.5
1998 Greens					*Spring 0-6"*		*Fall 0-3"*	*Fall 3-6"*		*Change 0-6"*
sand / peat					13.9		20.9	18.5		5.7
sand / peat / soil					16.3		22.8	18.3		4.2

[†]Denotes significant ($p \leq 0.05$) differences between treatment means within years.

Grow-In Treatment	*1997 Results*				*1998 Results*					
1997 Greens	*Spring 0-6"*	*Fall 0-3"*	*Fall 3-6"*	*Change 0-6"*	*Summer 0-3"*	*Summer 0-3"*	*Fall 0-3"*	*Fall 0-3"*	*Change 3-6"*	*Change*
Accelerated	8.1	21.2	13.5	9.2	24.4	11.5	30.0	14.7	5.6	3.3
Controlled	10.0	19.0	13.9	6.5	23.1	9.7	28.8	17.0	5.7	7.3
1998 Greens					*Spring 0-6"*		*Fall 0-3"*	*Fall 3-6"*		*Change 0-6"*
Accelerated					15.6		19.5[†]	17.6		2.9
Controlled					14.7		24.3	19.1		7.1

Seed Priming Kentucky Bluegrass

W. K. Cecil, R. C. Shearman, L. A. Witt

Turfgrass

Emergence of Kentucky bluegrass (*Poa pratensis* L.) seedlings can take up to four weeks. There are several situations, however, where it is beneficial to get Kentucky bluegrass established more rapidly. Competition from other species in the mixture, below optimum soil temperatures, forecast of adverse weather conditions, and quick establishment for immediate use require alternative methods to be incorporated into the planting system. Under such conditions seed priming may be beneficial. Seed priming starts the metabolic activity of seed germination by partially hydrating the seed, and then stopping this process prior to emergence of the radicle. This study examined the effectiveness of solid matrix primed Kentucky bluegrass when compared to unprimed seed. Primed and unprimed treatments were evaluated for emergence and stand establishment.

The study was seeded on Aug. 23, 1999 at the John Seaton Anderson Turfgrass Research Facility, near Mead, NE. Two treatments, primed and unprimed, were arranged in a completely randomized design and replicated six times. The seed was a Kentucky bluegrass blend consisting of equal parts of Absolute, Blue Moon, Rambo and Nu Glade.

The primed and unprimed seed was provided by United Seed of Omaha, NE. The seed priming technique used was solid matrix, developed by Kamterter Inc., Lincoln, NE. In this relatively new method, seed is mixed with high water-holding capacity solid materials and water. The physical and chemical characteristics of these materials control water imbibition. Seed was treated with Apron fungicide to control seedling diseases, then drop seeded into a firm seedbed, and culti-packed to ensure seed-soil contact. Starter fertilizer (12-25-10) was applied over the seedbed. Herbicide was applied at the labeled rate for post-emergence, broadleaf control. Three-tenths of an inch of water was applied daily until emergence.

Following emergence, visual ratings of emergence and stand establishment were made weekly using a 1 to 9 scale, where 9 is equal to 90-100% ground cover. Data were analyzed using MSTAT ANOVA technique. There were no significant differences between the primed and unprimed seed treatments in emergence and stand establishment, and variance within treatments was high. Visually there appeared to be variation in the study plots, although ratings for weeks two and five were equal (Figure 1). The third, sixth and seventh weeks following planting showed a slight increase in visual ratings of the primed seed treatment over the unprimed treatments. This is unusual in that the literature indicates that the primed treatments should show markedly higher ratings earlier and then equal out over time with the unprimed seed. Here we saw an inverse effect.

A number of factors may have contributed to these results. There may have been a decrease in the priming effectiveness due to handling and storage procedures. The seed was held about a month at 35-40°F before it was planted and it was not stored in an airtight container. This may have diminished the priming effectiveness. The seed was also not tested prior to planting to determine germination. There was a high common purslane (*Portulaca oleracea* L.) population competing with the turfgrass establishment. The purslane was not uniformly distributed across the study area; therefore, incorporating stress disproportionally and adding to plot variability. The environmental conditions did not favor the priming technology over the untreated seed. During late August to early September eastern Nebraska experienced unusually warm and dry conditions. Seed priming is preferable when unseasonably cold weather is forecast.

This study was conducted only once in one location. Further data needs to be collected. This will enable conclusive decisions to be established on the reliability and feasibility of seed priming using the solid matrix priming technique. Under field conditions in this study solid matrix priming effects might have been masked. Conditions were very good for the establishment of both primed and unprimed seed.

Studies are needed to examine the influences of fungicide treatments. The use of fungicides may create a priming effect by breaking down the dormancy of the seed coat or minimizing exudates. These chemical interactions have not been thoroughly studied for turfgrass species. Studies also are needed on specific planting methods and on various species of turfgrasses. Seed priming may prove very beneficial with such species as velvet bentgrass (*Agrostis canina* L.), which has been difficult to establish.

Finally, seed priming may show more promise with green seed that is harvested and then immediately planted the same year. Seed priming may break down some of the inherent dormancy traits in the seed. Seed priming from this preliminary experiment shows no benefits, but more work in this field needs to be done to determine where and how seed priming will be most effective.

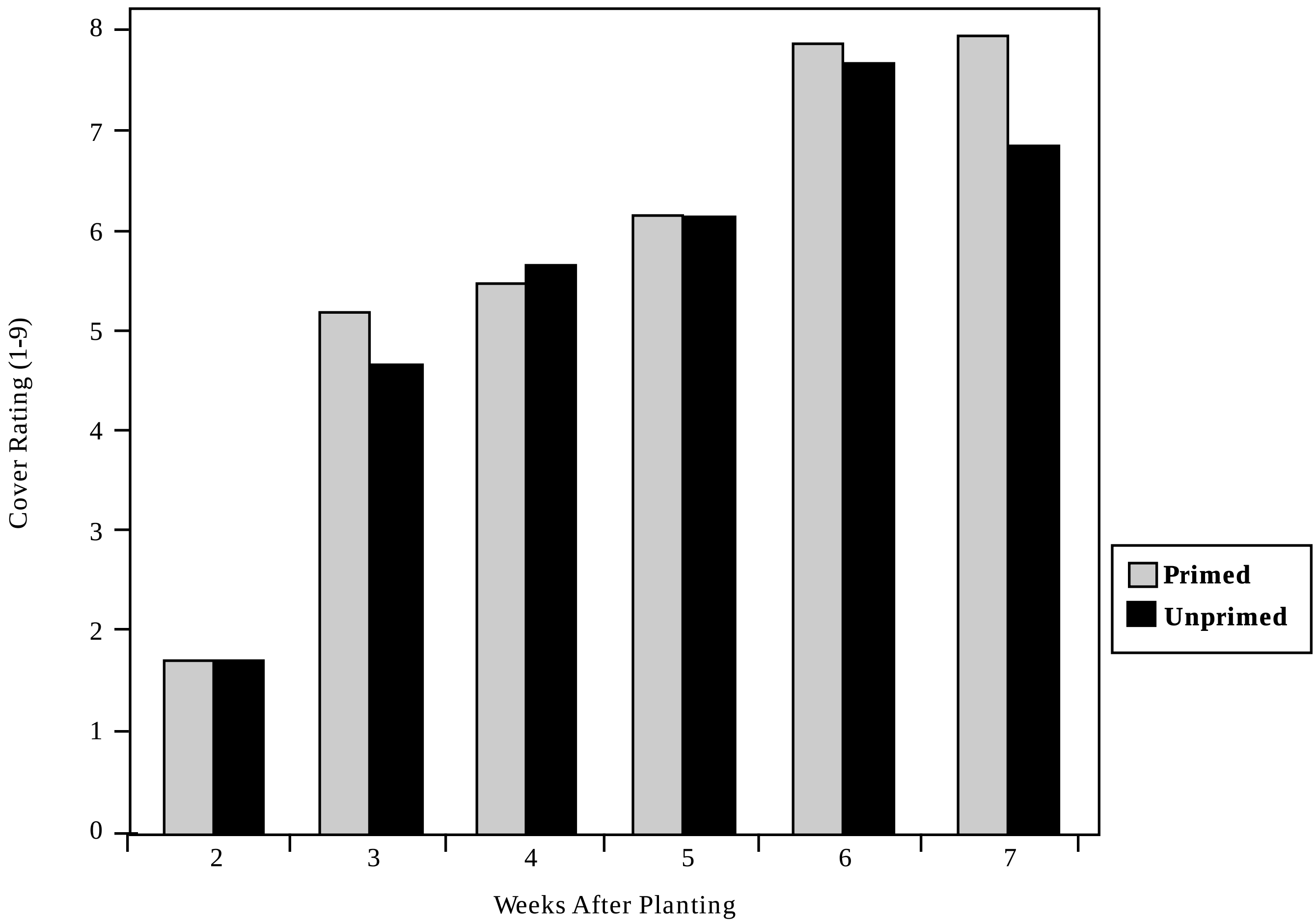


Figure 1. Establishment and cover rating (1-9) of Kentucky bluegrass primed and unprimed seeds over time in the fall of 1999 growing season. J. S. Anderson Turfgrass Research Facility near Mead, NE.

Shiner Products in Turf — Broadcast Applications

M.R. Vaitkus and R.E. Gaussoin

Research was conducted in 1999 to evaluate the efficacy of a research-numbered compound in combination with Roundup Pro in turf and to determine the burndown activity of the product in combination with Roundup.

The experimental area was an eight year old year old blend of Kentucky bluegrass (Merit, Baron, Touchdown, Adelphi), maintained at a 2.5 inch mowing height and irrigated as needed to prevent stress. Prevalent weed species were dandelion (*Taraxacum officinale*) and ground ivy (*Glechoma microcarpa*). Soil type was a Sharpsburg silty clay loam (fine, montmorillonitic, mesic Typic Argiudoll), with 2.2% organic matter, a bulk density of 1.38 g/cm^3 and a pH of 7.2. Plot size was 3 ft by 6 ft. The experimental design was a randomized complete block with 3 replications, comprised of 14 herbicide treatments and an untreated control.

Treatments in the following tables were applied July 13, 1999. Weather during application was sunny, 84^{o}F, 57%RH, with a moderate (13 mph) south wind; soil temperature at 4 inches depth was 74^{o}F. Treatments were applied with a CO_2-driven backpack sprayer equipped with a single 8002V flat fan nozzle and calibrated to deliver 40 gal/A at 30 psi. Turf injury and weed control of individual species (0-100% scale) were visually evaluated at 1 (weed control only), 3, 6, 14, 30 and 60 days after treatment (DAT). Data were analyzed using MSTAT statistical analysis software.

Turf injury was highest at 3 and 6 DAT for the Scythe treatment (Table 1). Scythe showed burndown in as little as 30 minutes after application. Finale also showed significant turf injury at 3 and 6 DAT. At 14 DAT all treatments, except Scythe and Finale, showed significant turf injury (40 to 90%). Turf in the Scythe, Finale and Roundup Pro (1.5 lb AE/A) treatments had recovered by 30 DAT and were no different from the control; other treatments showed injury values ranging from 23.3 to 66.7%. By 60 DAT, no significant turf injury was observed in any of the treatments.

At 1 DAT, dandelion control in the Scythe treatment was 100% (Table 2). Roundup Pro (3 lb AE/A) plus MON 46710 (0.0009 lb A/A) also showed significant control. All treatments, except Roundup Pro (1.5 and 3 lb AE/A), showed significant control at 3 and 6 DAT, with many treatments having values greater than 80%. At 30 DAT, post-control germination and grow-in from plot edges accounted for lower percentage control values (16.7 to 35%). There was no significant dandelion control in any treatment at 60 DAT.

As with dandelion control, the Scythe treatment showed the highest initial ground ivy control at 1 and 3 DAT (Table 3). Roundup Pro (1.5 and 3 lb AE/A) plus MON 46710 (0.0071 lb A/A) showed significant control at 1 DAT also. At 3 DAT, many treatments showed control levels greater than 30% and continued showing significant control up to 30 DAT. At 30 DAT, ground ivy control was significant for only five treatments. Post-control germination and grow-in from plot edges contributed to non-significant ground ivy control by any of the treatments at 60 DAT.

Table 1. Percent turf injury in 1999. Shiner Products in Turf — Broadcast Applications. J. S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		%Injury[†]				
Treatment	*Rate*	*3DAT*	*6DAT*	*14DAT*	*30DAT*	*60DAT*
Roundup Pro MON 46710	1.5 lb AE / A 0.0009 lb A / A	5.0cd[‡]	10.0cd	66.7ab	40.0bc	14.7
Roundup Pro MON 46710	1.5 lb AE / A 0.0018 lb A / A	6.7c	10.0cd	66.7ab	30.0cd	26.0
Roundup Pro MON 46710	1.5 lb AE / A 0.0036 lb A / A	5.0cd	11.7cd	73.3a	30.0cd	18.7
Roundup Pro MON 46710	1.5 lb AE / A 0.0054 lb A / A	5.0cd	10.0cd	63.3ab	23.3cde	26.0
Roundup Pro MON 46710	1.5 lb AE / A 0.0071 lb A / A	8.3c	8.3cd	63.3ab	36.7cd	7.3
Roundup Pro MON 46710	3 lb AE / A 0.0009 lb A / A	3.3cd	8.3cd	90.0a	66.7a	16.3
Roundup Pro MON 46710	3 lb AE / A 0.0018 lb A / A	6.7c	8.3cd	86.7a	60.0ab	42.7
Roundup Pro MON 46710	3 lb AE / A 0.0036 lb A / A	6.7c	8.3cd	90.0a	66.7a	42.7
Roundup Pro MON 46710	3 lb AE / A 0.0054 lb A / A	3.3cd	6.7cd	86.7a	60.0ab	34.3
Roundup Pro MON 46710	3 lb AE / A 0.0071 lb A / A	5.0cd	11.7cd	86.7a	60.0ab	26.0
Roundup Pro	1.5 lb AE / A	3.3cd	3.3cd	40.0bc	15.0def	26.0
Roundup Pro	3 lb AE / A	6.7c	18.3bc	63.3ab	66.7a	42.7
Scythe	5 % V / V	100.0a	70.0a	10.0d	0.0f	26.0
Finale	4 qt / A	26.7b	33.3b	20.0cd	6.7ef	34.3
Untreated Control		0.0d	0.0d	0.0d	0.0f	0.0
LSD ($p \leq 0.05$)		**6.4**	**15.6**	**29.2**	**23.3**	**ns**

[†]Turfgrass injury visually estimated on a 0-100% scale, with 1= no injury and 100= 100% injury.
[‡]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Table 2. Percent dandelion control in 1999. Shiner Products in Turf — Broadcast Applications. J. S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		% Control[†]					
Treatment	*Rate*	*1DAT*	*3DAT*	*6DAT*	*14DAT*	*30DAT*	*60DAT*
Roundup Pro MON 46710	1.5 lb AE / A 0.0009 lb A / A	60.0ab[‡]	93.3ab	80.0ab	50.0cd	21.7abc	25.0
Roundup Pro MON 46710	1.5 lb AE / A 0.0018 lb A / A	46.7bc	100.0a	83.3ab	63.3abc	21.7abc	16.7
Roundup Pro MON 46710	1.5 lb AE / A 0.0036 lb A / A	31.7bc	93.3ab	66.7bc	83.3abc	16.7bcd	16.7
Roundup Pro MON 46710	1.5 lb AE / A 0.0054 lb A / A	33.3bc	100.0a	90.0ab	43.3cd	18.3bcd	16.7
Roundup Pro MON 46710	1.5 lb AE / A 0.0071 lb A / A	43.3bc	100.0a	93.3ab	83.3abc	16.7bcd	0.0
Roundup Pro MON 46710	3 lb AE / A 0.0009 lb A / A	50.0b	100.0a	93.3ab	96.7a	6.7de	33.3
Roundup Pro MON 46710	3 lb AE / A 0.0018 lb A / A	56.7ab	100.0a	100.0a	93.3ab	11.7cde	33.3
Roundup Pro MON 46710	3 lb AE / A 0.0036 lb A / A	40.0bc	90.0b	96.7ab	73.3abc	10.0cde	25.0
Roundup Pro MON 46710	3 lb AE / A 0.0054 lb A / A	26.7bc	100.0a	93.3ab	76.7abc	26.7ab	0.0
Roundup Pro MON 46710	3 lb AE / A 0.0071 lb A / A	26.7bc	100.0a	96.7ab	93.3ab	13.3b-e	16.7
Roundup Pro	1.5 lb AE / A	0.0c	0.0d	0.0e	13.3de	35.0a	0.0
Roundup Pro	3 lb AE / A	0.0c	0.0d	6.7de	20.0de	23.3abc	0.0
Scythe	5 % V / V	100.0a	100.0a	80.0ab	16.7de	13.3b-e	33.3
Finale	4 qt / A	0.0c	20.0c	36.7cd	52.7bcd	20.0bcd	0.0
Untreated Check		0.0c	0.0d	0.0e	0.0e	0.0e	0.0
LSD ($p \leq 0.05$)		**48.9**	**7.1**	**30.4**	**41.4**	**13.6**	**ns**

[†]Weed control visually estimated on a 0-100% scale, with 0= no control and 100= 100% control.
[‡]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Table 3. Percent ground ivy control in 1999. Shiner Products in Turf — Broadcast Applications. J. S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		% Control[†]					
Treatment	*Rate*	*1DAT*	*3DAT*	*6DAT*	*14DAT*	*30DAT*	*60DAT*
Roundup Pro MON 46710	1.5 lb AE / A 0.0009 lb A / A	6.7bc[‡]	40.0c-f	43.3a-d	66.7ab	3.3de	35.0
Roundup Pro MON 46710	1.5 lb AE / A 0.0018 lb A / A	1.7cd	60.0bc	66.7ab	66.7ab	16.7bcd	37.3
Roundup Pro MON 46710	1.5 lb AE / A 0.0036 lb A / A	0.0d	26.7d-g	30.0b-e	56.7bc	21.7bc	16.0
Roundup Pro MON 46710	1.5 lb AE / A 0.0054 lb A / A	1.7cd	40.0c-f	53.3abc	58.3bc	18.3bcd	29.7
Roundup Pro MON 46710	1.5 lb AE / A 0.0071 lb A / A	10.0b	73.3ab	60.0ab	78.3ab	8.3cde	31.3
Roundup Pro MON 46710	3 lb AE / A 0.0009 lb A / A	3.3cd	50.0b-e	33.3b-e	73.3ab	11.7cde	45.0
Roundup Pro MON 46710	3 lb AE / A 0.0018 lb A / A	1.7cd	33.3c-f	60.0ab	73.3ab	13.3b-e	28.3
Roundup Pro MON 46710	3 lb AE / A 0.0036 lb A / A	5.0bcd	23.3efg	60.0ab	80.0ab	11.7cde	28.3
Roundup Pro MON 46710	3 lb AE / A 0.0054 lb A / A	3.3cd	33.3c-f	43.3a-d	86.7ab	3.3de	61.7
Roundup Pro MON 46710	3 lb AE / A 0.0071 lb A / A	6.7bc	53.3bcd	80.0a	90.0a	3.3de	36.3
Roundup Pro	1.5 lb AE / A	0.0d	0.0g	0.0e	33.3c	28.3ab	19.3
Roundup Pro	3 lb AE / A	0.0d	0.0g	13.3de	66.7ab	6.7cde	24.7
Scythe	5 % V / V	100.0a	100.0a	80.0a	60.0abc	20.0bc	25.3
Finale	4 qt / A	0.0d	20.0fg	20.0cde	30.0cd	38.3a	0.0
Untreated Check		0.0d	0.0g	0.0e	0.0d	0.0e	0.0
LSD ($p \leq 0.05$)		**5.0**	**28.2**	**37.8**	**31.6**	**15.4**	**ns**

[†]Weed control visually estimated on a 0-100% scale, with 0= no control and 100= 100%control.
[‡]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Alternate High Load Glyphosate Formulations for Turf — Broadcast Applications

Turfgrass

M.R. Vaitkus and R.E. Gaussoin

Research was conducted in 1999 to determine whether alternate higher acid equivalent-loaded glyphosate formulations give better efficacy than Roundup Pro in turf.

The experimental area was an 8-year-old blend of Kentucky bluegrass (Merit, Baron, Touchdown, Adelphi), maintained at a 2.5-inch mowing height and irrigated as needed to prevent stress. Prevalent weed species were dandelion (*Taraxacum officinale*), white clover (*Trifolium repens*) and ground ivy (*Glechoma microcarpa*). The soil type was a Sharpsburg silty clay loam (fine, montmorillonitic, mesic Typic Argiudoll), with 2.2% organic matter, a bulk density of 1.38 g/cm^3 and a pH of 7.2. Plot size was 3 ft by 6 ft. The experimental design was a randomized complete block with three replications, comprised of six herbicide treatments and an untreated control.

Treatments in the following tables were applied July 13, 1999. Weather during application was sunny, 80°F, 63%RH, with a moderate (12 mph) south, southwest wind; soil temperature at a 4-inch depth was 72°F. Treatments were applied with a CO_2-driven backpack sprayer equipped with a single 8002V flat fan nozzle and calibrated to deliver 40 gal/A at 30 psi. Turf injury and weed control of individual species (0-100% scale) were evaluated at 6, 15, 30 and 60 days after treatment (DAT). Data were analyzed using MSTAT statistical analysis software.

Percent turf injury was greatest for Roundup Pro (3 lbs AE/A), MON 788112 (3 lbs AE/A) and MON 78063 (3lbs AE/A) treatments on all observation dates (Table 1). Other treatments applied at a rate of 1.5 lbs AE/A were not significantly different from the untreated control.

Variability in the distribution of individual weed species within the plots appears to have resulted in few significant differences between treatments in percentage control of dandelion, white clover and ground ivy on all observation dates (Tables 2 through 4). Treatments that did show significant dandelion control were Roundup Pro and MON 788112 at the 3 lbs AE/A rates at 15 DAT (Table 2). Roundup Pro at both rates, and MON 788112 and MON 78063 at 3 lbs AE/A showed significant ground ivy control at 15 DAT (Table 4).

Table 1. Percent turf injury in 1999. Alternate High Load Glyphosate Formulations for Turf — Broadcast Applications. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		% Injury[†]			
Treatment	*Rate (lb AE/A)*	*6 DAT*	*15 DAT*	*30 DAT*	*60 DAT*
Roundup Pro	1.5	8.3ab[‡]	23.3bc	30.0b	3.3b
Roundup Pro	3	13.3a	86.7a	90.0a	70.0a
MON 788112	1.5	1.7cd	11.7c	0.0b	0.0b
MON 788112	3	10.0ab	63.3a	76.7a	58.3a
MON 78063	1.5	5.0bcd	13.3c	13.3b	3.3b
MON 78063	3	6.7bc	60.0ab	75.0a	65.0a
Untreated		0.0d	0.0c	0.0b	0.0b
LSD ($p \leq 0.05$)		**6.5**	**39.7**	**37.1**	**44.3**

[†]Turfgrass injury visually estimated on a 0-100% scale, with 0= no injury and 100= 100% injury.
[‡]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Table 2. Percent dandelion control in 1999. Alternate High Load Glyphosate Formulations for Turf — Broadcast Applications. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		% Control†			
Treatment	*Rate (lb AE/A)*	*6 DAT*	*15 DAT*	*30 DAT*	*60 DAT*
Roundup Pro	1.5	0	33.3ab‡	16.7	22.3
Roundup Pro	3	0	53.3a	33.3	30.7
MON 788112	1.5	0	3.3b	16.7	22.3
MON 788112	3	0	70.0a	58.3	66.7
MON 78063	1.5	3.3	3.3b	16.7	44.3
MON 78063	3	30	66.7a	50.0	44.3
Untreated		0	0.0b	0.0	0.0
LSD (p≤0.05)		**ns**	**42.9**	**ns**	**ns**

†Dandelion control visually estimated on a 0-100% scale, with 0= no control and 100= 100% control.
‡Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Table 3. Percent white clover control. Alternate High Load Glyphosate Formulations for Turf — Broadcast Applications. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		% Control†			
Treatment	*Rate (lb AE/A)*	*6 DAT*	*15 DAT*	*30 DAT*	*60 DAT*
Roundup Pro	1.5	0.0	6.7	0.0	0.0
Roundup Pro	3	3.3	40.0	33.3	43.3
MON 788112	1.5	0.0	0.0	16.7	16.7
MON 788112	3	0.0	23.3	16.7	0.0
MON 78063	1.5	0.0	0.0	0.0	0.0
MON 78063	3	3.3	16.7	16.7	16.7
Untreated		0.0	0.0	0.0	0.0
LSD (p≤0.05)		**ns**	**ns**	**ns**	**ns**

†Dandelion control visually estimated on a 0-100% scale, with 0= no control and 100= 100% control.

Table 4. Percent ground ivy control. Alternate High Load Glyphosate Formulations for Turf — Broadcast Applications. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		% Control†			
Treatment	*Rate (lb AE/A)*	*6 DAT*	*15 DAT*	*30 DAT*	*60 DAT*
Roundup Pro	1.5	3.3	33.3bc‡	33.3	14.0
Roundup Pro	3	10.0	70.0a	67.0	39.0
MON 788112	1.5	0.0	10.0d	11.0	17.0
MON 788112	3	0.0	50.0ab	56.0	25.3
MON 78063	1.5	3.3	16.7cd	42.7	39.3
MON 78063	3	3.3	53.3ab	31.3	22.3
Untreated		0.0	0.0d	0.0	0.0
LSD (p≤0.05)		**ns**	**20.1**	**ns**	**ns**

†Ground ivy control visually estimated on a 0-100% scale, with 0= no control and 100= 100% control.
‡Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Alternate High Load Glyphosate Formulations for Turf — Spray to Wet, Trim & Edge

M.R. Vaitkus and R.E. Gaussoin

Research was conducted in 1999 to determine whether alternate higher acid equivalent-loaded glyphosate formulations give better efficacy than Roundup Pro in turf.

The experimental area was an 8-year-old blend of Kentucky bluegrass (Merit, Baron, Touchdown, Adelphi), maintained at a 2.5-inch mowing height and irrigated as needed to prevent stress. Prevalent weed species were dandelion (*Taraxacum officinale*), white clover (*Trifolium repens*), and ground ivy (*Glechoma microcarpa*). Soil type was a Sharpsburg silty clay loam (fine, montmorillonitic, mesic Typic Argiudoll), with 2.2% organic matter, a bulk density of 1.38 g/cm^3, and a pH of 7.2. Plot size was 0.5 ft by 10 ft. The experimental design was a randomized complete block with 3 replications, comprised of 10 herbicide treatments and an untreated control.

Treatments in the following table were applied July 13, 1999. Weather during application was sunny, 73°F, 71%RH, with a moderate (11 mph) south, southwest wind; soil temperature at 4 inches depth was 71°F. Treatments were applied with a CO_2-driven backpack sprayer equipped with a single 8002V flat fan nozzle and calibrated to deliver 40 gal / A at 30 psi. Turf injury and weed control of individual species (0-100% scale) were visually evaluated at 6, 14, 30, and 60 days after treatment (DAT). Data were analyzed using MSTAT statistical analysis software.

At 6 DAT, visual observation indicated no treatment differences. All plots showed approximately 15% grass injury and slight yellowing of dandelion. Ground ivy and white clover control were 0%. At 14 DAT, grass injury was 100% and control in all treatments was 100% for ground ivy and white clover and from 95-98% for dandelion (Table 1). Roundup Pro at 2 %V / V, MON 788112 at all rates, and MON 78063 at 1%V / V showed significant (67-100%) ground ivy control at 60 DAT.

Table 1. Percent dandelion and ground ivy control in 1999. Alternate High Load Glyphosate Formulations for Turf — Spray to Wet, Trim & Edge. J. S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		% Control[†]		
		Dandelion		*Ground Ivy*
Treatment	*Rate (%V/V)*	*14 DAT*	*60 DAT*[‡]	*60 DAT*
Roundup Pro	1	95a[§]	67	28bcd
Roundup Pro	2	97a	50	100a
MON 788112	1	97a	33	76abc
MON 788112	2	97a	33	94a
MON 788112	0.81	97a	42	67abc
MON 788112	1.62	98a	42	94a
MON 78063	1	95a	33	89ab
MON 78063	2	95a	42	61a-d
MON 78063	0.81	98a	67	42a-d
MON 78063	1.62	97a	50	17cd
Untreated		0b	0	0d
LSD ($p \leq 0.05$)		**6**	**ns**	**64**

[†]Visually estimated on a 0-100% scale, with 0= no control and 100= 100% control.
[‡]At 60 DAT, % dandelion control was hard to evaluate due to post-control germination and grow-in from plot edges.
[§]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Fast Burndown Product TM with Roundup Pro — Spray to Wet Trial

M.R. Vaitkus and R.E. Gaussoin

Research was conducted in 1999 to evaluate the efficacy of a research-numbered compound in combination with Roundup Pro in turf and to determine the burndown activity of the product, alone and in combination with Roundup.

The experimental area was an 8-year-old blend of Kentucky bluegrass (Merit, Baron, Touchdown, Adelphi), maintained at a 2.5-inch mowing height and irrigated as needed to prevent stress. Prevalent weed species were dandelion (*Taraxacum officinale*), white clover (*Trifolium repens*) and ground ivy (*Glechoma microcarpa*). Soil type was a Sharpsburg silty clay loam (fine, montmorillonitic, mesic Typic Argiudoll), with 2.2% organic matter, a bulk density of 1.38 g/cm^3 and a pH of 7.2. Plot size was 1 ft by 10 ft. The experimental design was a randomized complete block with three replications, composed of 37 herbicide treatments and an untreated control.

Treatments in the following tables were applied July 13, 1999. Weather during application was sunny, 84°F, 57%RH, with a moderate (13 mph) south wind; soil temperature at 4 inches depth was 74°F. Treatments were applied with a CO_2-driven backpack sprayer equipped with a single 8002V flat fan nozzle and calibrated to deliver 40 gal/A at 30 psi. Turf injury and weed control of individual species (0-100% scale) were visually evaluated at 1 (weed control only), 3, 6, 14, 30 and 60 days after treatment (DAT). Data were analyzed using MSTAT statistical analysis software.

Turf injury was greatest (> 90%) for Scythe (5 %V/V), Roundup Pro (1% V/V) plus Scythe (3 %V/V), Roundup Pro (1 %V/V) plus MON 59120 (10 %V/V) and Roundup Pro (2 %V/V) plus MON 59120 (10 %V/V) treatments at 3 and 6 DAT (Table 1). At 14 DAT, almost all treatments, with the exception of MON 46501 (0.8 % V/V) and Aim (0.8 % V/V), had significant turf injury. Many treatments showed 100% turf injury on this observation date. At 30 DAT, all treatments showed significant turf injury. Scythe (5 %V/V), Roundup Pro (2 % V/V) plus Aim (0.8 % V/V), MON 46501 (0.8 %V/V) and Resource (0.2 %V/V) treatments were the only treatments without significant injury values at 60 DAT.

Scythe (5 %V/V), Roundup Pro (1% V/V) plus Scythe (3 %V/V), Roundup Pro (1 %V/V) plus MON 59120 (10 %V/V) and Roundup Pro (2 %V/V) plus MON 59120 (10 %V/V) showed greatest initial dandelion control at 1 DAT (Table 2). By 3 DAT, all treatments, except Roundup Pro (2 %V/V) plus MON 59120 (0.8 %V/V) and Roundup Pro Dry (1.3 %W/W), showed significant control. Aim (0.8 % V/V) was the only treatment not to show significant control at 6 and 14 DAT. At 30 DAT, all products showed significant dandelion control, many in excess of 90%. By 60 DAT, post-control germination and grow-in from plot edges resulted in greater plot variability and fewer treatments showed significant dandelion control.

Scythe (5 %V/V), Roundup Pro (1 %V/V) plus MON 59120 (10 %V/V) and Roundup Pro (2 %V/V) plus MON 59120 (10 %V/V) were the only treatments that showed white clover control at 1 DAT (Table 3). At 3 DAT, more products were showing significant control and many had control values greater than 80% by 6 DAT. At 14 and 30 DAT, only Aim (0.8 % V/V) didn't show significant control. At 60 DAT, all treatments were showing significant control of white clover.

Table 1. Percent turf injury in 1999. Fast Burndown Product TM with Roundup Pro — Spray to Wet Trial. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		% Injury[†]				
Treatment	*Rate*	*3 DAT*	*6 DAT*	*14 DAT*	*30 DAT*	*60 DAT*
Roundup Pro MON 46501	1 %V / V 0.1 %V / V	6.7def[‡]	10.0de	96.7a	100.0a	100.0a
Roundup Pro MON 46501	1 %V / V 0.2 %V / V	8.3c-f	13.3de	100.0a	100.0a	100.0a
Roundup Pro MON 46501	1 %V / V 0.4 %V / V	6.7def	10.0de	100.0a	100.0a	100.0a
Roundup Pro MON 46501	1 %V / V 0.8 %V / V	5.0def	10.0de	100.0a	100.0a	100.0a
Roundup Pro MON 46501	1 %V / V 1.6 %V / V	8.3c-f	10.0de	100.0a	100.0a	100.0a
Roundup Pro MON 46501	2 %V / V 0.1 %V / V	8.3c-f	10.0de	100.0a	100.0a	100.0a
Roundup Pro MON 46501	2 %V / V 0.2 %V / V	8.3c-f	11.7de	100.0a	100.0a	100.0a
Roundup Pro MON 46501	2 %V / V 0.4 %V / V	3.3ef	13.3de	100.0a	100.0a	100.0a
Roundup Pro MON 46501	2 %V / V 0.8 %V / V	8.3c-f	10.0de	100.0a	100.0a	76.7a
Roundup Pro	1 %V / V	6.7def	11.7de	100.0a	100.0a	100.0a
Roundup Pro	2 %V / V	3.3ef	10.0de	100.0a	100.0a	100.0a
Scythe	5% V / V	100.0a	80.0b	46.7c	23.3d	1.7d
Finale	1 %V / V	60.0b	73.3b	76.7b	91.7a	41.7b
Roundup Pro Scythe	2 %V / V 3% V / V	100.0a	96.7a	100.0a	100.0a	96.7a
Roundup Pro MON 59120	1 %V / V 2.5% V / V	10.0c-f	10.0de	100.0a	100.0a	100.0a
Roundup Pro MON 59120	1 %V / V 5% V / V	16.7cd	16.7d	100.0a	100.0a	100.0a
Roundup Pro MON 59120	1 %V / V 10% V / V	96.7a	96.7a	100.0a	100.0a	100.0a
Roundup Pro MON 59120	2 %V / V 2.5% V / V	15.0cde	16.7d	100.0a	100.0a	100.0a
Roundup Pro MON 59120	2 %V / V 10% V / V	91.7a	96.7a	100.0a	100.0a	100.0a
Roundup Pro Dry MON 59120	1.3 %W / W 0.2 % V / V	8.3c-f	11.7de	100.0a	100.0a	100.0a
Roundup Pro Dry MON 59120	1.3 %W / W 0.4 % V / V	5.0def	11.7de	100.0a	100.0a	100.0a
Roundup Pro Dry MON 59120	1.3 %W / W 0.8 % V / V	5.0def	10.0de	100.0a	100.0a	100.0a
Roundup Pro Aim	2 %V / V 0.2 % V / V	6.7def	15.0de	100.0a	100.0a	100.0a
Roundup Pro Aim	2 %V / V 0.4 % V / V	6.7def	11.7de	100.0a	100.0a	100.0a

Table 1. Continued.

Treatment	*Rate*	*% Injury*† 3 DAT	6 DAT	14 DAT	30 DAT	60 DAT
Roundup Pro Aim	2 %V / V 0.8 %V / V	3.3ef	8.3de	53.3c	53.3b	11.7cd
Roundup Pro Dry Aim	1.3 %W / W 0.2 %V / V	8.3c-f	13.3de	100.0a	100.0a	100.0a
Roundup Pro Dry Aim	1.3 %W / W 0.4 %V / V	10.0c-f	13.3de	100.0a	100.0a	100.0a
Roundup Pro Dry Aim	1.3 %W / W 0.8 %V / V	8.3c-f	15.0de	100.0a	100.0a	100.0a
Roundup Pro Resource	2 %V / V 0.1 %V / V	8.3c-f	33.3c	100.0a	100.0a	100.0a
Roundup Pro Resource	2 %V / V 0.2 %V / V	3.3ef	13.3de	100.0a	100.0a	100.0a
Roundup Pro Dry Resource	1.3 %W / W 0.1 %V / V	11.7c-f	15.0de	100.0a	100.0a	100.0a
Roundup Pro Dry Resource	1.3 %W / W 0.2 %V / V	6.7def	10.0de	100.0a	100.0a	100.0a
Roundup Pro Dry	1.3 %W / W	8.3c-f	13.3de	100.0a	100.0a	100.0a
Roundup Pro Dry	4 %W / W	20.0c	11.7de	100.0a	100.0a	100.0a
Roundup Pro	5 %V / V	11.7c-f	13.3de	100.0a	100.0a	100.0a
MON 46501	0.8 %V / V	3.3ef	1.7de	8.3e	20.0d	1.7d
Aim	0.8 %V / V	0.0f	5.0de	5.0e	13.3d	33.3bc
Resource	0.2 %V / V	5.0def	3.3de	28.3d	40.0c	10.0cd
Untreated Check		0.0f	0.0e	0.0e	0.0e	0.0d
LSD ($p \leq 0.05$)		**12.0**	**15.8**	**15.2**	**10.5**	**23.5**

†Visually estimated on a 0-100% scale, with 0= no injury and 100= 100% injury.
‡Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Table 2. Percent dandelion control in 1999. Fast Burndown Product TM with Roundup Pro — Spray to Wet Trial. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		% Control[†]					
Treatment	*Rate*	*1 DAT*	*3 DAT*	*6 DAT*	*14 DAT*	*30 DAT*	*60 DAT*
Roundup Pro MON 46501	1 %V/V 0.1 %V/V	0.0d[‡]	96.7ab	96.7a	96.7a	100.0a	51.7a-d
Roundup Pro MON 46501	1 %V/V 0.2 %V/V	6.7cd	93.3abc	93.3ab	100.0a	91.7ab	6.7de
Roundup Pro MON 46501	1 %V/V 0.4 %V/V	3.3d	93.3abc	96.7a	100.0a	91.7ab	50.0a-e
Roundup Pro MON 46501	1 %V/V 0.8 %V/V	0.0d	100.0a	100.0a	100.0a	100.0a	30.0b-e
Roundup Pro MON 46501	1 %V/V 1.6 %V/V	0.0d	100.0a	100.0a	70.0b	100.0a	20.0cde
Roundup Pro MON 46501	2 %V/V 0.1 %V/V	0.0d	76.7a-e	76.7a-d	98.3a	100.0a	20.0cde
Roundup Pro MON 46501	2 %V/V 0.2 %V/V	0.0d	66.7a-e	76.7a-d	98.3a	100.0a	46.7a-e
Roundup Pro MON 46501	2 %V/V 0.4 %V/V	3.3d	65.0a-e	70.0a-d	100.0a	100.0a	71.7ab
Roundup Pro MON 46501	2 %V/V 0.8 %V/V	0.0d	10.0g	53.3bcd	100.0a	100.0a	63.3abc
Roundup Pro	1 %V/V	0.0d	63.3b-e	86.7abc	100.0a	100.0a	46.7a-e
Roundup Pro	2 %V/V	0.0d	80.0a-e	86.7abc	100.0a	91.7ab	60.0abc
Scythe	5% V/V	100.0a	100.0a	93.3ab	86.7ab	50.0d	6.7de
Finale	1 %V/V	0.0d	46.7ef	100.0a	100.0a	91.7ab	6.7de
Roundup Pro Scythe	2 %V/V 3% V/V	100.0a	100.0a	100.0a	70.0b	91.7ab	0.0e
Roundup Pro MON 59120	1 %V/V 2.5% V/V	0.0d	60.0cde	46.7cd	93.3ab	100.0a	58.3abc
Roundup Pro MON 59120	1 %V/V 5% V/V	0.0d	86.7a-d	96.7a	100.0a	100.0a	46.7a-e
Roundup Pro MON 59120	1 %V/V 10% V/V	90.0abc	95.0abc	96.7a	100.0a	100.0a	73.3ab
Roundup Pro MON 59120	2 %V/V 2.5% V/V	3.3d	83.3a-d	60.0a-d	98.3a	100.0a	58.3abc
Roundup Pro MON 59120	2 %V/V 10% V/V	93.3ab	93.3abc	96.7a	100.0a	100.0a	76.7ab
Roundup Pro Dry MON 59120	1.3 %W/W 0.2 % V/V	6.7cd	96.7ab	100.0a	100.0a	100.0a	71.7ab
Roundup Pro Dry MON 59120	1.3 %W/W 0.4 % V/V	10.0bcd	93.3abc	100.0a	100.0a	100.0a	50.0a-e
Roundup Pro Dry MON 59120	1.3 %W/V 0.8 % V/V	13.3bcd	100.0a	100.0a	100.0a	100.0a	38.3b-e
Roundup Pro Aim	2 %V/V 0.2 % V/V	6.7cd	100.0a	100.0a	100.0a	100.0a	33.3b-e
Roundup Pro Aim	2 %V/V 0.4 % V/V	6.7cd	100.0a	100.0a	100.0a	100.0a	33.3b-e

Table 2. Continued.

		% Control[†]					
Treatment	*Rate*	*1 DAT*	*3 DAT*	*6 DAT*	*14 DAT*	*30 DAT*	*60 DAT*
Roundup Pro Aim	2 %V / V 0.8 %V / V	10.0bcd	100.0a	100.0a	93.3ab	61.7cd	6.7de
Roundup Pro Dry Aim	1.3 %W / W 0.2 %V / V	10.0bcd	70.0a-e	100.0a	100.0a	100.0a	40.0b-e
Roundup Pro Dry Aim	1.3 %W / W 0.4 %V / V	3.3d	100.0a	100.0a	100.0a	100.0a	20.0cde
Roundup Pro Dry Aim	1.3 %W / W 0.8 %V / V	6.7cd	100.0a	100.0a	100.0a	100.0a	46.7a-e
Roundup Pro Resource	2 %V / V 0.1 %V / V	6.7cd	100.0a	100.0a	100.0a	100.0a	38.3b-e
Roundup Pro Resource	2 %V / V 0.2 %V / V	3.3d	100.0a	100.0a	100.0a	91.7ab	45.0a-e
Roundup Pro Dry Resource	1.3 %W / W 0.1 %V / V	6.7cd	96.7ab	100.0a	100.0a	91.7ab	46.7a-e
Roundup Pro Dry Resource	1.3 %W / W 0.2 %V / V	0.0d	100.0a	70.0a-d	100.0a	91.7ab	71.7ab
Roundup Pro Dry	1.3 %W / W	0.0d	16.7fg	70.0a-d	100.0a	100.0a	93.3a
Roundup Pro Dry	4 %W / W	0.0d	60.0cde	83.3abc	100.0a	100.0a	80.0ab
Roundup Pro	5 %V / V	0.0d	73.3a-e	100.0a	100.0a	100.0a	60.0abc
MON 46501	0.8 %V / V	0.0d	93.3abc	66.7a-d	68.3b	75.0bc	60.0abc
Aim	0.8 %V / V	3.3d	56.7de	40.0de	0.0d	28.3e	33.3b-e
Resource	0.2 %V / V	6.7cd	93.3abc	66.7a-d	36.7c	48.3d	20.0cde
Untreated Check		0.0d	0.0g	0.0e	0.0d	0.0f	0.0e
LSD (p≤0.05)		**85.9**	**36.4**	**40.5**	**25.2**	**19.0**	**50.2**

[†]Visually estimated on a 0-100% scale, with 0= no control and 100= 100% control.
[‡]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Table 3. Percent white clover control in 1999. Fast Burndown Product TM with Roundup Pro — Spray to Wet Trial. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		% Control†					
Treatment	*Rate*	*1 DAT*	*3 DAT*	*6 DAT*	*14 DAT*	*30 DAT*	*60 DAT*
Roundup Pro MON 46501	1 %V / V 0.1 %V / V	0.0c‡	6.7ghi	66.7a-f	90.0a	100.0a	86.7ab
Roundup Pro MON 46501	1 %V / V 0.2 %V / V	0.0c	6.7ghi	36.7f-i	93.3a	100.0a	86.7ab
Roundup Pro MON 46501	1 %V / V 0.4 %V / V	0.0c	10.0hgi	60.0b-f	98.3a	100.0a	100.0a
Roundup Pro MON 46501	1 %V / V 0.8 %V / V	0.0c	16.7f-i	40.0f-i	96.7a	100.0a	100.0a
Roundup Pro MON 46501	1 %V / V 1.6 %V / V	0.0c	26.7e-i	76.7a-e	100.0a	100.0a	86.7ab
Roundup Pro MON 46501	2 %V / V 0.1 %V / V	0.0c	10.0ghi	70.0a-f	100.0a	100.0a	93.3ab
Roundup Pro MON 46501	2 %V / V 0.2 %V / V	0.0c	36.7c-g	66.7a-f	100.0a	100.0a	100.0a
Roundup Pro MON 46501	2 %V / V 0.4 %V / V	0.0c	10.0ghi	70.0a-f	100.0a	100.0a	100.0a
Roundup Pro MON 46501	2 %V / V 0.8 %V / V	0.0c	8.3ghi	43.3e-h	100.0a	100.0a	66.7ab
Roundup Pro	1 %V / V	0.0c	6.7ghi	53.3d-g	100.0a	100.0a	100.0a
Roundup Pro	2 %V / V	0.0c	6.7ghi	70.0a-f	100.0a	66.7b	100.0a
Scythe	5% V / V	33.3b	100.0a	63.3b-f	43.3b	86.7ab	73.3ab
Finale	1 %V / V	0.0c	63.3bcd	100.0a	98.3a	100.0a	86.7ab
Roundup Pro Scythe	2 %V / V 3% V / V	0.0c	100.0a	93.3ab	100.0a	100.0a	100.0a
Roundup Pro MON 59120	1 %V / V 2.5% V / V	0.0c	10.0ghi	20.0b-j	96.7a	100.0a	66.7ab
Roundup Pro MON 59120	1 %V / V 5% V / V	6.7c	46.7c-f	90.0abc	100.0a	100.0a	100.0a
Roundup Pro MON 59120	1 %V / V 10% V / V	96.7a	100.0a	100.0a	100.0a	100.0a	93.3ab
Roundup Pro MON 59120	2 %V / V 2.5% V / V	0.0c	31.7d-e	70.0a-f	100.0a	100.0a	100.0a
Roundup Pro MON 59120	2 %V / V 10% V / V	100.0a	100.0a	100.0a	100.0a	100.0a	96.7a
Roundup Pro Dry MON 59120	1.3 %W / W 0.2 % V / V	0.0c	33.3d-h	63.3b-f	100.0a	100.0a	100.0a
Roundup Pro Dry MON 59120	1.3 %W / W 0.4 % V / V	0.0c	23.3e-i	83.3a-d	100.0a	100.0a	100.0a
Roundup Pro Dry MON 59120	1.3 %W / W 0.8 % V / V	0.0c	16.7f-i	93.3ab	100.0a	100.0a	100.0a
Roundup Pro Aim	2 %V / V 0.2 % V / V	0.0c	20.0e-i	86.7a-d	100.0a	100.0a	100.0a
Roundup Pro Aim	2 %V / V 0.4 % V / V	0.0c	20.0e-i	80.0a-d	100.0a	100.0a	100.0a

Table 3. Continued.

Treatment	Rate	% Control†					
		1 DAT	3 DAT	6 DAT	14 DAT	30 DAT	60 DAT
Roundup Pro Aim	2 %V/V 0.8 %V/V	0.0c	50.0cde	93.3ab	100.0a	66.7b	100.0a
Roundup Pro Dry Aim	1.3 %W/W 0.2 %V/V	0.0c	43.3c-f	93.3ab	100.0a	100.0a	100.0a
Roundup Pro Dry Aim	1.3 %W/W 0.4 %V/V	0.0c	66.7bc	93.3ab	100.0a	100.0a	100.0a
Roundup Pro Dry Aim	1.3 %W/W 0.8 %V/V	0.0c	83.3ab	90.0abc	100.0a	100.0a	100.0a
Roundup Pro Resource	2 %V/V 0.1 %V/V	0.0c	25.0e-i	56.7c-f	96.7a	100.0a	100.0a
Roundup Pro Resource	2 %V/V 0.2 %V/V	0.0c	8.3ghi	90.0abc	100.0a	100.0a	100.0a
Roundup Pro Dry Resource	1.3 %W/W 0.1 %V/V	0.0c	36.7c-g	90.0abc	100.0a	100.0a	100.0a
Roundup Pro Dry Resource	1.3 %W/W 0.2 %V/V	0.0c	26.7e-i	80.0a-d	100.0a	100.0a	100.0a
Roundup Pro Dry	1.3 %W/W	0.0c	23.3e-i	80.0a-d	100.0a	100.0a	100.0a
Roundup Pro Dry	4 %W/W	0.0c	63.3bcd	83.3a-d	100.0a	100.0a	100.0a
Roundup Pro	5 %V/V	0.0c	30.0e-i	63.3b-f	100.0a	100.0a	100.0a
MON 46501	0.8 %V/V	0.0c	3.3hi	6.7ij	45.0b	33.3c	60.0b
Aim	0.8 %V/V	0.0c	0.0i	6.7ij	16.7c	0.0d	80.0ab
Resource	0.2 %V/V	0.0c	6.7ghi	13.3hij	46.7b	33.3c	66.7ab
Untreated Check		0.0c	0.0i	0.0j	0.0c	0.0d	0.0c
LSD ($p \leq 0.05$)		**15.4**	**32.1**	**35.3**	**19.7**	**29.9**	**34.1**

†Visually estimated on a 0-100% scale, with 0= no control and 100= 100% control.

‡Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Broadleaf Weed Control with Finale

R. E. Gaussoin and M.R. Vaitkus

Turfgrass

Research was conducted in 1999 to evaluate the efficacy of Finale herbicide on broadleaf landscape weeds. This trial was performed on a weedy 3-year-old stand of Kentucky bluegrass at the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE. The experimental area was maintained at a 2.5-inch mowing height and irrigated as needed to prevent stress. Soil type was a Sharpsburg silty clay loam (fine, montmorillonitic, mesic Typic Argiudoll). Soil had 3.4% organic matter, a bulk density of 1.38 g/cm^3, and a pH of 6.8. Plots were 3 ft by 6 ft. The experimental design was a randomized complete block, comprised of 3 herbicide treatments and an untreated control, with three replications.

Treatments were applied April 28, 1999. Weather during application was cloudy, 53ºF, 90%RH, with a moderate (9 mph) wind from the north / northeast; soil temperature was 53ºF. Treatments were applied with a CO_2-driven backpack sprayer equipped with a single 8002VS flat fan nozzle and calibrated to deliver 40 gal / A of product at 30 psi. Weed density data were collected April 28 (pretreatment), April 30 (2 days after treatment (DAT)), May 6 (7 DAT), May 12 (14 DAT), May 26 (4 weeks after treatment (WAT)), June 22 (8 WAT) and July 21 (12 WAT). Weed density was estimated visually on a scale from 0 to 100%, with 100 equal to 100% weed cover. The density data then were transformed to percent control within each replication for each corresponding date. Percent control data were analyzed using ARM (Agriculture Research Manager) software.

Total stand weed density prior to treatment ranged from 75 to 95%. Dominant weed species were ground ivy (*Glechoma microcarpa*), dandelion (*Taraxacum officinale*) and white clover (*Trifolium repens*), in approximately equal proportions. Total weed control in excess of 90% was exhibited by all treatments at 14 DAT (Table 1). Initial control (at 2 and 7 DAT) was greatest in the Finale + Reward treatment. In all treatments grass was totally eliminated, resulting in higher than pretreatment total weed density at 12 WAT (negative % control values).

Percent ground ivy control was greatest with Finale + Reward at 2 and 7 DAT (Table 2). At 14 DAT, all treatments showed over 86% control. Regrowth of ground ivy was variable, with some plots still showing control at 12 WAT, while others showed an increase in white clover. At 8 and 12 WAT, none of the treatments differed from the control.

Control of dandelion was greatest with the Finale + Reward treatment at 2 DAT(Table 3). The other treatments ‘caught up’ by 7 DAT, with greater than 50% control by all treatments. The Finale treatment continued to show significant control at 8 and 12 WAT.

As with the other weed species, the Finale + Reward treatment showed the greatest initial control of white clover at 2 DAT (Table 4). From 7 DAT to 4 WAT, all treatments showed control at greater than 75%. Control at 8 WAT and 12 WAT was variable. In some plots, white clover was covered by ground ivy and not easily evaluated. The variability in white clover control data at 8 and 12 WAT reflect this, with no treatment varying significantly from the untreated control.

In summary, the Finale + Reward (2 + 0.5 oz / gal) treatment showed the greatest initial control of ground ivy, dandelion and white clover at 2 DAT. By 14 DAT, control by all treatments was similar and greater than 80%. Regrowth at 8 and 12 WAT was variable, with only dandelion control by Finale (4 oz / gal) being significantly different from the control at 12 WAT (Table 3). Total removal of grass by all treatments resulted in increased weed density (negative % control values) in many individual plots by the end of the trail (12 WAT).

Table 1. Percent (%) total weed control in 1999 following application of Finale. Broadleaf Weed Control with Finale. J. S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		% Total Weed Control[†]					
Treatment	*Rate (oz/gal)*	*2 DAT*	*7 DAT*	*14 DAT*	*4 WAT*	*8 WAT*	*12 WAT*
FINALE	4	0.0b[‡]	0.0b	96.5a	89.3a	10.4a	-1.9a
FINALE + RoundUp Pro	1.5 + 1.5	2.0b	2.0b	94.7a	91.1a	15.4a	-9.8a
FINALE + Reward	2 + 0.5	63.3a	63.3a	90.5a	55.9b	-1.9a[§]	-1.7a
Untreated		0.0b	0.0b	0.0b	0.0a	0.0a	-2.4a
LSD (p=0.05)		**15.5**	**15.5**	**11.0**	**11.9**	**32.8**	**17.7**

[†]Visually estimated on a 0-100% scale, with 0= no control and 100= 100% control.
[‡]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.
[§]Negative numbers denote an increase in weed density, indicating regrowth.

Table 2. Percent (%) ground ivy control in 1999 following application of Finale. Broadleaf Weed Control with Finale. J. S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		% Ground Ivy Control[†]					
Treatment	*Rate (oz/gal)*	*2 DAT*	*7 DAT*	*14 DAT*	*4 WAT*	*8 WAT*	*12 WAT*
FINALE	4	0.0b[‡]	44.4a	96.3a	70.4a	-44.4a[§]	-25.9a
FINALE + RoundUp Pro	1.5 + 1.5	0.0b	16.7bc	86.1a	69.4a	17.8a	21.1a
FINALE + Reward	2 + 0.5	58.3a	90.3a	86.1a	15.3ab	-63.9a	-72.2a
Untreated		0.0b	0.0c	0.0b	0.0b	0.0a	0.0a
LSD (p=0.05)		**22.0**	**33.2**	**19.2**	**47.6**	**76.3**	**85.3**

[†]Visually estimated on a 0-100% scale, with 0= no control and 100= 100% control.
[‡]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.
[§]Negative numbers denote an increase in weed density, indicating regrowth.

Table 3. Percent (%) dandelion control in 1999 following application of Finale. Broadleaf Weed Control with Finale. J. S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		% Dandelion Control†					
Treatment	*Rate (oz/gal)*	*2 DAT*	*7 DAT*	*14 DAT*	*4 WAT*	*8 WAT*	*12 WAT*
FINALE	4	0.0b‡	50.0a	95.8a	100.0a	83.3a	75.0a
FINALE + RoundUp Pro	1.5 + 1.5	6.7b	58.5a	96.3a	100.0a	31.9b	21.5b
FINALE + Reward	2 + 0.5	56.2a	74.3a	100.0a	83.8b	27.6b	39.0ab
Untreated		0.0b	0.0b	0.0b	0.0c	0.0b	0.0b
LSD (p=0.05)		**22.1**	**23.3**	**7.9**	**3.3**	**28.4**	**39.0**

†Visually estimated on a 0-100% scale, with 0= no control and 100= 100% control.
‡Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Table 4. Percent (%) white clover control in 1999 following application of Finale. Broadleaf Weed Control with Finale. J. S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		% White Clover Control†					
Treatment	*Rate (oz/gal)*	*2 DAT*	*7 DAT*	*14 DAT*	*4 WAT*	*8 WAT*	*12 WAT*
FINALE	4	0.0b‡	80.6a	100.0a	95.8a	73.6a	80.0a
FINALE + RoundUp Pro	1.5 + 1.5	0.0b	46.0a	100.0a	83.3a	3.2a	11.1a
FINALE + Reward	2 + 0.5	80.6a	86.1a	83.3a	75.0a	-25.0a§	69.4a
Untreated		0.0b	0.0b	0.0b	0.0b	-8.3a	0.0a
LSD (p=0.05)		**17.3**	**44.6**	**16.6**	**31.4**	**100.2**	**102.2**

†Visually estimated on a 0-100% scale, with 0= no control and 100= 100% control.
‡Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.
§Negative numbers denote an increase in weed density, indicating regrowth.

Monsanto Roundup Rainfast Trial

M.R. Vaitkus and R.E. Gaussoin

Research was conducted in 1999 to determine if time of irrigation following application of various forms of Roundup has an impact on product efficacy.

The experimental area was an 8-year-old mixture of Kentucky bluegrass (America) and perennial ryegrass (Palmer) maintained at a 2.5-inch mowing height. Pre-treatment irrigation was applied as needed to prevent stress. Soil type was a Sharpsburg silty clay loam (fine, montmorillonitic, mesic Typic Argiudoll), with 2.2% organic matter, a bulk density of 1.38 g / cm^3, and a pH of 7.2. Plot size was 0.5 ft by 10 ft. The experimental design was a randomized complete block with three replications, composed of three herbicide treatments and an untreated control.

Treatments in the following tables were applied on Oct. 19, 1999. Weather during application was partly sunny, 45°F, 58%RH, with a moderate (13 mph) north wind; soil temperature at 4 inches depth was 49°F. Treatments were applied with a CO_2-driven backpack sprayer equipped with a single 8002V flat fan nozzle and calibrated to deliver 40 gal / A at 30 psi. Turf injury (0-100% scale) was visually evaluated at 2, 3 and 4 weeks after treatment (WAT). Data were analyzed using MSTAT statistical analysis software.

At 2 WAT, treatments irrigated 15 minutes after application showed the greatest turf injury (Table 1). By 3 WAT, there were no differences in turf injury based on irrigation timing. Percent turf injury was significant at 2 and 3 WAT, but did not differ between herbicide treatments (Table 2). Subsequent observations at 4 WAT showed all treated plots at 95-100% turf injury and indistinguishable from each other.

Table 1. Percent turf injury as influenced by time to irrigation. Monsanto Roundup Rainfast Trial, conducted at the J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE, in 1999.

	% Turf Injury[†]		
Time Period	*2 WAT*	*3 WAT*	*4 WAT*
No irrigation	45.8c[‡]	56.7	73.4
90 Minutes to irrigation	53.3ab	57.5	73.8
60 minutes to irrigation	50.0bc	59.2	74.6
30 minutes to irrigation	49.2bc	56.7	73.4
15 minutes to irrigation	57.5a	59.2	74.6
LSD ($p \leq 0.05$)	**5.8**	**ns**	**ns**

[†]Visually estimated on a 0-100% scale, with 0= no injury and 100= 100% injury.
[‡]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Table 2. Percent turf injury as influenced by herbicide treatment. Monsanto Roundup Rainfast Trial, conducted at the J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE, in 1999.

	% Turf Injury [†]		
Herbicide Treatment	*2 WAT*	*3 WAT*	*4 WAT*
Roundup Pro Liquid	68.0a[‡]	78.0a	99.1a
Roundup Original	68.0a	75.3a	97.7a
Roundup Pro Dry	68.7a	78.0a	99.1a
Control	0.0b	0.0b	0.0b
LSD ($p \leq 0.05$)	**5.2**	**3.4**	**1.7**

[†]Visually estimated on a 0-100% scale, with 0= no injury and 100= 100% injury.
[‡]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Fast Burndown Product TM with Roundup Pro

M.R. Vaitkus and R.E. Gaussoin

Turfgrass

Research was conducted in 1999 to evaluate the efficacy of MON 46501 in combination with Roundup Pro in turf and to determine the burndown activity of MON 46501 plus Roundup Pro.

The experimental area was an 8-year-old blend of Kentucky bluegrass (Merit, Baron, Touchdown, Adelphi), maintained at a 2.5-inch mowing height and irrigated as needed to prevent stress. Prevalent weed species were dandelion (*Taraxacum officinale*), white clover (*Trifolium repens*) and ground ivy (*Glechoma microcarpa*). Soil type was a Sharpsburg silty clay loam (fine, montmorillonitic, mesic Typic Argiudoll), with 2.2% organic matter, a bulk density of 1.38 g/cm^3 and a pH of 7.2. Plot size was 3 ft by 6 ft. The experimental design was a randomized complete block with three replications, composed of 20 herbicide treatments and an untreated control.

Treatments in the following tables were applied July 13, 1999. Weather during application was sunny, 76°F, 67%RH, with a moderate (12 mph) south, southwest wind; soil temperature at 4 inches depth was 72°F. Treatments were applied with a CO_2-driven backpack sprayer equipped with a single 8002V flat fan nozzle and calibrated to deliver 40 gal/A at 30 psi. Turf injury and weed control of individual species (0-100% scale) were visually evaluated at 1 (weed control only), 3, 6, 14, 30 and 60 days after treatment (DAT). Data were analyzed using MSTAT statistical analysis software.

As plots were being treated, some plots began to show grass injury and/or broadleaf control within 15 minutes of application. The Scythe treatment (5% V/V) exhibited burndown of both grass and broadleaves during this time period. Roundup Pro (1.5 lbs AE/A) plus Scythe (3% V/V) exhibited burndown of grass only. At 3 and 6 DAT, the Scythe 5%V/V, Roundup Pro (1.5 lbs AE/A) plus Scythe (3%V/V) and Roundup Pro (3 lbs AE/A) plus MON 59120 (10%/V) treatments showed significant turf injury (Table 1). By 14 and 30 DAT, the Scythe 5% V/V plots had begun to recover, while all other treatments exhibited significant turf injury. At 60 DAT, a dozen treatments still showed significant injury; Roundup Pro (3 lbs AE/A) plus MON 59120 (2.5% V/V) and Roundup Pro (3 lbs AE/A) plus MON 59120 (10% V/V) had injury levels exceeding 94%.

At 1 DAT, only Scythe (5% V/V), Roundup Pro (1.5 lbs AE/A) plus Scythe (3% V/V), and Roundup Pro (3 lbs AE/A) plus MON 59120 (10% V/V) treatments showed significant dandelion control (Table 2). At 3 and 6 DAT, many treatments showed control greater than 90%. At 14 DAT, only Roundup Pro (1.5 lbs AE/A) plus MON 46501 (0.0071 lbs AE/A) did not control dandelion better than the untreated control. At 30 and 60 DAT, % dandelion control was difficult to evaluate due to post-control germination and grow-in from plot edges.

As with dandelion control, products that provided greatest initial (1 to 6 DAT) white clover control were Scythe (5% V/V) and Roundup Pro (1.5 lbs AE/A) plus Scythe (3% V/V) (Table 3). Roundup Pro (3 lbs AE/A) plus MON 59120 (10% V/V) showed greater than 40% control starting at 3 DAT and continuing through 30 DAT. At 14 and 30 DAT, most treatments had % control values greater than 50%. Post-control germination and grow-in from plot edges made evaluations of white clover control at 60 DAT difficult.

Percent control of ground ivy was greatest at 1 and 3 DAT in the Scythe (5% V/V), Roundup Pro (1.5 lbs AE/A) plus Scythe (3% V/V) and Roundup Pro (3 lbs AE/A) plus MON 59120 (10% V/V) treatments (Table 4). At 14 DAT, many treatments had control values greater than 45%. As with the other weed species, at 30 and 60 DAT, % control was difficult to evaluate due to post-control germination and grow-in from plot edges.

Table 1. Percent turf injury in 1999. Fast Burndown Product TM with Roundup Pro. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		% Injury[†]				
Treatment	*Rate*	*3DAT*	*6 DAT*	*14 DAT*	*30 DAT*	*60 DAT*
Roundup Pro MON 46501	1.5 lbs AE / A 0.0071 lbs A / A	5.0c[‡]	6.7de	50.0de	33.3ef	29.7efg
Roundup Pro MON 46501	1.5 lbs AE / A 0.0142 lbs A / A	5.0c	5.0de	60.0b-e	50.0de	34.0d-g
Roundup Pro MON 46501	1.5 lbs AE / A 0.0284 lbs A / A	3.3c	3.3de	53.3de	83.3abc	24.7efg
Roundup Pro MON 46501	1.5 lbs AE / A 0.0568 lbs A / A	5.0c	5.0de	56.7cde	73.3bc	11.0fg
Roundup Pro MON 46501	1.5 lbs AE / A 0.12 lbs A / A	3.3c	5.0de	60.0b-e	66.7cd	24.0efg
Roundup Pro MON 46501	3 lbs AE / A 0.0071 lbs A / A	6.7c	8.3de	93.3a	88.3ab	73.0abc
Roundup Pro MON 46501	3 lbs AE / A 0.0142 lbs A / A	6.7c	8.3de	90.0a	93.3a	69.0a-d
Roundup Pro MON 46501	3 lbs AE / A 0.0284 lbs A / A	3.3c	6.7de	76.7a-d	83.3abc	54.7b-e
Roundup Pro MON 46501	3 lbs AE / A 0.0568 lbs A / A	5.0c	10.0de	93.3a	91.7a	76.0ab
Roundup Pro	1.5 lbs AE / A	1.7c	8.3de	56.7cde	33.3ef	39.3c-f
Roundup Pro	3 lbs AE / A	3.3c	10.0de	86.7ab	90.0ab	54.3b-e
Scythe	5% V / V	70.0a	80.0a	10.0fg	0.0g	6.7fg
Finale	3QT / A	26.7b	50.0b	33.3ef	18.3f	0.0g
Roundup Pro Scythe	1.5 lbs AE / A 3% V / V	66.7a	73.3a	76.7a-d	73.3bc	33.0efg
Roundup Pro MON 59120	1.5 lbs AE / A 2.5% V / V	5.0c	10.0de	83.3abc	86.7ab	71.0abc
Roundup Pro MON 59120	1.5 lbs AE / A 5% V / V	5.0c	15.0d	83.3abc	93.3a	74.7abc
Roundup Pro MON 59120	1.5 lbs AE / A 10% V / V	26.7b	33.3c	86.7ab	93.3a	74.3abc
Roundup Pro MON 59120	3 lbs AE / A 2.5% V / V	10.0bc	13.3d	96.7a	100.0a	94.7a
Roundup Pro MON 59120	3 lbs AE / A 5% V / V	6.7c	13.3d	83.3abc	95.0a	78.0ab
Roundup Pro MON 59120	3 lbs AE / A 10% V / V	53.3a	70.0a	96.7a	98.3a	96.7a
Untreated Check		0.0c	0.0e	0.0g	0.0g	0.0g
LSD ($p \leq 0.05$)		**16.9**	**12.8**	**27.1**	**18.0**	**35.7**

[†]Visually estimated on a 0-100% scale, with 0= no injury and 100= 100% injury.
[‡]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Table 2. Percent dandelion control in 1999. Fast Burndown Product TM with Roundup Pro. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		% Control[†]					
Treatment	*Rate*	*1DAT*	*3 DAT*	*6 DAT*	*14 DAT*	*30 DAT*[‡]	*60 DAT*
Roundup Pro MON 46501	1.5 lbs AE / A 0.0071 lbs A / A	0.0c[§]	46.7bcd	43.3def	26.7de	0.0	0.0
Roundup Pro MON 46501	1.5 lbs AE / A 0.0142 lbs A / A	3.3c	56.7a-d	53.3b-e	46.7cd	0.0	0.0
Roundup Pro MON 46501	1.5 lbs AE / A 0.0284 lbs A / A	0.0c	76.7abc	100.0a	93.3ab	0.0	0.0
Roundup Pro MON 46501	1.5 lbs AE / A 0.0568 lbs A / A	18.3bc	96.7a	96.7a	90.0ab	66.7	16.7
Roundup Pro MON 46501	1.5 lbs AE / A 0.12 lbs A / A	5.0c	93.3a	93.3ab	90.0ab	0.0	0.0
Roundup Pro MON 46501	3 lbs AE / A 0.0071 lbs A / A	1.7c	56.7a-d	90.0abc	95.0ab	0.0	0.0
Roundup Pro MON 46501	3 lbs AE / A 0.0142 lbs A / A	0.0c	93.3a	93.3ab	96.7a	16.7	33.3
Roundup Pro MON 46501	3 lbs AE / A 0.0284 lbs A / A	1.7c	86.7ab	96.7a	93.3ab	16.7	0.0
Roundup Pro MON 46501	3 lbs AE / A 0.0568 lbs A / A	13.3bc	96.7a	100.0a	93.3ab	25.0	0.0
Roundup Pro	1.5 lbs AE / A	0.0c	3.3ef	0.0g	66.7a-d	33.3	8.3
Roundup Pro	3 lbs AE / A	0.0c	0.0f	6.7fg	53.3bcd	33.3	8.3
Scythe	5% V / V	70.0a	70.0abc	36.7d-g	56.3a-d	36.7	25.0
Finale	3QT / A	0.0c	43.3cde	70.0a-d	73.3abc	58.3	58.3
Roundup Pro Scythe	1.5 lbs AE / A 3% V / V	70.0a	66.7abc	66.7a-d	78.3abc	16.7	0.0
Roundup Pro MON 59120	1.5 lbs AE / A 2.5% V / V	0.0c	1.7f	6.7fg	66.7a-d	25.0	8.3
Roundup Pro MON 59120	1.5 lbs AE / A 5% V / V	3.3c	3.3ef	33.3d-g	86.7abc	25.0	16.7
Roundup Pro MON 59120	1.5 lbs AE / A 10% V / V	16.7bc	20.0def	40.0d-g	65.0a-d	33.3	0.0
Roundup Pro MON 59120	3 lbs AE / A 2.5% V / V	0.0c	5.0ef	13.3efg	86.7abc	58.3	33.3
Roundup Pro MON 59120	3 lbs AE / A 5% V / V	1.7c	0.0f	33.3d-g	70.0abc	66.7	16.7
Roundup Pro MON 59120	3 lbs AE / A 10% V / V	26.7b	36.7c-f	50.0cde	78.3abc	58.3	0.0
Untreated Check		0.0c	0.0f	0.0g	0.0e	0.0	0.0
LSD (0.05)		**20.2**	**41.6**	**41.5**	**42.1**	**ns**	**ns**

[†]Visually estimated on a 0-100% scale, with 0= no control and 100= 100% control.
[‡]At 30 and 60 DAT, % dandelion control was difficult to evaluate due to post-control germination and grow-in from plot edges.
[§]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Table 3. Percent white clover control in 1999. Fast Burndown Product TM with Roundup Pro. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

Treatment	*Rate*	*% Control*[†]					
		1 DAT	*3 DAT*	*6 DAT*	*14 DAT*	*30 DAT*	*60 DAT*[‡]
Roundup Pro MON 46501	1.5 lbs AE / A 0.0071 lbs A / A	0.0d[§]	0.0d	0.0c	10.0ef	0.0c	0.0
Roundup Pro MON 46501	1.5 lbs AE / A 0.0142 lbs A / A	0.0d	0.0d	0.0c	23.3c-f	33.3bc	0.0
Roundup Pro MON 46501	1.5 lbs AE / A 0.0284 lbs A / A	0.0d	0.0d	13.3bc	16.7def	33.3bc	0.0
Roundup Pro MON 46501	1.5 lbs AE / A 0.0568 lbs A / A	0.0d	13.3cd	16.7abc	60.0a-d	100.0a	0.0
Roundup Pro MON 46501	1.5 lbs AE / A 0.12 lbs A / A	0.0d	3.3d	3.3bc	90.0a	50.0abc	16.7
Roundup Pro MON 46501	3 lbs AE / A 0.0071 lbs A / A	0.0d	0.0d	0.0c	73.3ab	66.7ab	16.7
Roundup Pro MON 46501	3 lbs AE / A 0.0142 lbs A / A	0.0d	0.0d	0.0c	90.0a	100.0a	33.3
Roundup Pro MON 46501	3 lbs AE / A 0.0284 lbs A / A	0.0d	0.0d	10.0bc	46.7a-f	66.7ab	33.3
Roundup Pro MON 46501	3 lbs AE / A 0.0568 lbs A / A	0.0d	3.3d	6.7bc	68.3abc	83.3ab	0.0
Roundup Pro	1.5 lbs AE / A	0.0d	0.0d	0.0c	16.7def	41.7abc	0.0
Roundup Pro	3 lbs AE / A	0.0d	0.0d	3.3bc	56.7a-e	33.3bc	33.3
Scythe	5% V / V	80.0a	66.7a	30.0ab	50.0a-e	100.0a	66.7
Finale	3QT / A	0.0d	13.3cd	16.7abc	76.7ab	66.7ab	33.3
Roundup Pro Scythe	1.5 lbs AE / A 3% V / V	60.0ab	46.7ab	6.7bc	90.0a	100.0a	16.7
Roundup Pro MON 59120	1.5 lbs AE / A 2.5% V / V	0.0d	1.7d	0.0c	50.0a-e	100.0a	66.7
Roundup Pro MON 59120	1.5 lbs AE / A 5% V / V	3.3d	0.0d	6.7bc	63.3a-d	100.0a	33.3
Roundup Pro MON 59120	1.5 lbs AE / A 10% V / V	38.3bc	15.0bcd	13.3bc	30.0b-f	58.3abc	33.3
Roundup Pro MON 59120	3 lbs AE / A 2.5% V / V	0.0d	0.0d	6.7bc	73.3ab	83.3ab	0.0
Roundup Pro MON 59120	3 lbs AE / A 5% V / V	1.7d	1.7d	3.3bc	35.0b-f	75.0ab	66.7
Roundup Pro MON 59120	3 lbs AE / A 10% V / V	20.0cd	40.0abc	43.3a	76.7ab	83.3ab	0.0
Untreated Check		0.0d	0.0d	0.0c	0.0f	0.0c	0.0
LSD (0.05)		**22.5**	**32.2**	**29.2**	**47.2**	**59.5**	**ns**

[†]Visually estimated on a 0-100% scale, with 0= no control and 100= 100% control.
[‡]At 60 DAT, % white clover control was difficult to evaluate due to post-control germination and grow-in from plot edges.
[§]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Table 4. Percent ground ivy control in 1999. Fast Burndown Product TM with Roundup Pro. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		% Control[†]					
Treatment	*Rate*	*1 DAT*	*3 DAT*	*6 DAT*	*14 DAT*	*30 DAT*	*60 DAT*[‡]
Roundup Pro MON 46501	1.5 lbs AE / A 0.0071 lbs A / A	0.0d[§]	0.0d	0.0	13.3gh	33.3	62.7
Roundup Pro MON 46501	1.5 lbs AE / A 0.0142 lbs A / A	0.0d	1.7cd	6.7	36.7e-h	33.3	36.7
Roundup Pro MON 46501	1.5 lbs AE / A 0.0284 lbs A / A	0.0d	0.0d	13.3	33.3fgh	48.7	58.3
Roundup Pro MON 46501	1.5 lbs AE / A 0.0568 lbs A / A	1.7d	10.0cd	13.3	36.7e-h	48.7	52.7
Roundup Pro MON 46501	1.5 lbs AE / A 0.12 lbs A / A	5.0d	30.0bcd	20.0	70.0a-f	70.3	22.3
Roundup Pro MON 46501	3 lbs AE / A 0.0071 lbs A / A	0.0d	0.0d	16.7	70.0a-f	71.0	19.3
Roundup Pro MON 46501	3 lbs AE / A 0.0142 lbs A / A	0.0d	5.0cd	13.3	76.7a-e	51.3	11.0
Roundup Pro MON 46501	3 lbs AE / A 0.0284 lbs A / A	0.0d	6.7cd	26.7	76.7a-e	71.0	25.0
Roundup Pro MON 46501	3 lbs AE / A 0.0568 lbs A / A	0.0d	23.3bcd	10.0	98.3a	100.0	83.3
Roundup Pro	1.5 lbs AE / A	0.0d	0.0d	10.0	40.0d-h	8.3	22.3
Roundup Pro	3 lbs AE / A	0.0d	0.0d	10.0	70.0a-f	58.0	29.3
Scythe	5% V / V	86.7a	73.3a	43.3	73.3a-f	74.7	33.3
Finale	3 QT / A	0.0d	16.7bcd	23.3	36.7e-h	77.7	66.7
Roundup Pro Scythe	1.5 lbs AE / A 3% V / V	63.3b	73.3a	46.7	80.0a-d	40.3	33.3
Roundup Pro MON 59120	1.5 lbs AE / A 2.5% V / V	0.0d	1.7cd	10.0	56.7b-f	41.7	30.7
Roundup Pro MON 59120	1.5 lbs AE / A 5% V / V	8.3d	35.0bc	23.3	76.7a-e	71.0	47.3
Roundup Pro MON 59120	1.5 lbs AE / A 10% V / V	30.0c	30.0bcd	30.0	50.0b-g	61.0	47.3
Roundup Pro MON 59120	3 lbs AE / A 2.5% V / V	1.7d	6.7cd	26.7	83.3abc	86.0	41.7
Roundup Pro MON 59120	3 lbs AE / A 5% V / V	1.7d	13.3bcd	23.3	46.7c-g	89.0	47.3
Roundup Pro MON 59120	3 lbs AE / A 10% V / V	36.7c	46.7ab	43.3	90.0ab	64.0	82.0
Untreated Check		0.0d	0.0d	0.0	0.0h	0.0	0.0
LSD (0.05)		**17.1**	**33.3**	**ns**	**40.9**	**ns**	**ns**

[†]Visually estimated on a 0-100% scale, with 0= no control and 100= 100% control.
[‡]At 30 and 60 DAT, % ground ivy control was difficult to evaluate due to post-control germination and grow-in from plot edges.
[§]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Biocontrol of Brown Patch with *Stenotrophomonas maltophilia* Strain C3

G.Y. Yuen and Z. Zhang

Stenotrophomonas maltophilia strain C3 is a chitinolytic bacterium isolated from Kentucky bluegrass foliage. It was shown to have little efficacy against brown patch in previous field experiments when the bacterium was applied as cells grown on agar media suspended in buffer. In this study, we evaluated the benefits of applying whole cultures of strain C3 grown in a broth medium having chitin as the carbon source. Experiments were conducted on established swards of tall fescue (*Festuca arundinacea* 'Kentucky-31') and perennial ryegrass (*Lolium perenne* 'Manhattan') at the University of Nebraska John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE. The plots were maintained under low fertility (around 50 kg N / ha annually), irrigated twice per week, and mowed at a height of 8 cm. Urea (50 kg / ha) was applied to the experimental areas about two weeks before treatments were applied. Brown patch activity was preexistent in both areas, but to ensure inoculum uniformity, 40 g of seed inoculum, containing two Nebraska isolates of *R. solani* AG1-IA, were added to each plot Aug. 11. In both experiments, there were four 1.5-m x 1.5-m replicate plots per treatment arranged in a block design. Treatments were: 1) C3 cells from tryptic soy agar suspended in phosphate buffer; 2) whole 7-day-old cultures of C3 in chitin broth, diluted 1:1 with water; 3) diluted (1:1, v / v), filter-sterilized fluid from C3 chitin broth cultures; and 4) nontreated control. C3 treatments contained about $5X10^8$ CFU / ml. The three liquid treatments were amended with 0.25% (v / v) Soydex as a spreader-sticker. Each treatment was applied twice (14 Aug and 20 Aug) at 500 ml per plot each time. On 1 Sept, all plots were rated for brown patch severity (1 to 5 scale: 1 = no disease, 5 = >80% of turf area blighted) and for quality (1 to 10 scale: 1 = lowest, 10 = highest).

Disease levels in nontreated plots in both grass species were moderate to high (Table 1). All of the treatments reduced brown patch severity and improved turf quality in comparison to the nontreated control. Cell-free culture fluid was as effective as C3 suspended in phosphate buffer. The C3 chitin broth culture treatment was most effective in suppressing brown patch in both experiments.

Table 1. Effects of *Stenotrophomonas maltophilia* strain C3 and chitin broth culture fluid on brown patch severity and turf quality.

Treatment	*Tall fescue*		*Perennial ryegrass*	
	Disease †	*Quality*‡	*Disease*	*Quality*
C3 in phosphate buffer	2.8	6.0	2.5	6.5
C3 chitin broth culture	1.5	8.2	1.5	7.8
Fluid from C3 broth culture	2.2	7.0	2.8	6.2
Nontreated control	3.8	5.0	3.8	4.0
LSD(0.05)	**1.0**	**1.3**	**0.8**	**1.4**

†Disease rated on a 1 to 5 scale: 1 = no disease, 5 = >80% of turf area blighted.
‡Turfgrass quality rated on a 1 to 10 scale: 1 = lowest, 10 = highest.

Managing Dollar Spot on a Creeping Bentgrass Fairway

J.E. Watkins, R.C. Shearman, R.E. Gaussoin, M.R. Vaitkus and L.A. Wit

This research seeks to determine the interactive effects of cultivar, irrigation, nitrogen nutrition and fungicide application frequency on bentgrass fairway quality and disease incidence. Little research information is available regarding management systems requirements for bentgrass use as a fairway turf. There is research information about specific management practices, but there is very little information that assesses the interactive impacts of a systems approach to turf management. Thus, the overall objective of this research was to identify a management system(s) that maintains desired turfgrass quality and playability and minimizes disease injury, while more efficiently using nitrogen nutrition, fungicide treatments and irrigation practices.

Plots of Penneagle and SR1020 creeping bentgrass were arranged in a 2x2x3x5 factorial design with treatments replicated three times. Main plots consisted of irrigation treatments of 100% ETp or 60/80% ETp and subplots consisted of the cultivars Penneagle and SR1020. Fungicide treatment interval and nitrogen nutrition level were the sub-subplots and sub-sub-subplots, respectively.

Plots were initially seeded May 22, 1997 on a Sharpsburg silty clay loam site. Cropping history of the area was bentgrass that was killed with glyphosate and the turf removed. Routine fertilizer, fungicide and irrigation treatments were applied in 1997 to allow the Penneagle and SR1020 turfs to establish. Research treatments were initiated in the 1998 growing season.

For the 1999 growing season, Trimec herbicide was applied at a rate of 3 lbs per acre in 60 gallons of water per acre March 31 to control knotweed. Pre-emergent treatments with Pendulum 3.3EC at 1.5 lbs per acre were applied April 6 and again June 8. Grubs were controlled with Dursban (44.9%) applied at 3 fl oz per 1000 ft^2 July 13 and again Aug. 5. Prograss (19%) was applied Sept. 9 at a rate of 0.75 lbs ai per acre to control annual bluegrass (*Poa annua* L.).

The turf was mowed at 3/8 inch, three to four times weekly. Clippings were removed. The plot area was aerified on April 26, 1999 with the cores being removed. It was aerified again Aug. 31, 1999 with the cores chopped and returned. Following the August aerification the cores were left until the turf on the plugs had died to avoid contamination between cultivars. The plot area was trafficked weekly from mid-June to early August using four passes with the traffic machine per plot. To promote spring growth, 0.25 lbs of a 20-20-20 water soluble fertilizer were applied May 13, 1999 and again on May 18. Based on soil test analyses phosphorus (P) was applied to replicates 1 and 2 June 13, 1999. A water soluble potassium (0-0-62) fertilizer was applied with the urea treatments (Table 2) at a rate of 0.43 lbs per 1000 ft^2, for a total of 3 lbs P per season.

Plots were inoculated on June 23, 1999 with *Sclerotinia homeocarpa*, cause of dollar spot, cultured on autoclaved tall fescue seed. Inoculum was applied with a 2.5 foot Gandy drop spreader calibrated to deliver 1.5 lbs of inoculum per 1000 ft^2.

Nitrogen nutrition treatments consisted of 1.5, 3 or 6 lbs of nitrogen per 1000 ft^2 per season applied on the following schedule (Table 1).

Sulfur-coated urea was applied for the initial nitrogen treatment in 1998; however, liquid urea (46-0-0) was used for all subsequent treatments in 1998 and 1999 to obtain more uniform distribution. The urea was bulked into a 2.5 gallon tank that was pressurized with CO_2 and applied at 30 psi with a Spray Hawk sprayer fitted with a T-jet 80015 flat fan nozzle.

In 1998 fungicide treatments consisted of a tank mix of Chipco Aliette Signature (4 oz/1000 ft^2) and Daconil Ultrex (1.8 oz/1000 ft^2). To avoid potential pathogen resistance in 1999, a tank mix of Heritage (0.4 oz/1000 ft^2) and Daconil Ultrex (1.8 oz/1000 ft^2) was applied to plots on a 7-, 14-, 21- or 28-day schedule using the Spray Hawk sprayer with a T-jet 8002

Table 1. Nitrogen application schedule and rates for the 1998 and 1999 growing seasons. Managing Dollar Spot on a Creeping Bentgrass Fairway. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	Rate of N (lbs)/application						
lbs N /1000 ft²/season	*May*	*June*	*July*	*August*	*September*	*October*	*November*
1.5	0.21	0.21	0.21	0.21	0.21	0.21	0.21
3.0	0.43	0.43	0.43	0.43	0.43	0.43	0.43
6.0	0.86	0.86	0.86	0.86	0.86	0.86	0.86

flat fan nozzle. Fungicide treatments were initiated June 23, 1999 and terminated August 18, 1999.

Dollar spot severity was rated every two weeks from July 1 to Sept. 1 in 1998, and July 30 to Aug. 27 in 1999. Turf quality was rated monthly in both years. Disease prevalence was rated on a scale of 0-10 as an estimate of the percent of the plot area showing symptoms. A 1 rating would be about 10% of the plot showing disease injury symptoms, a 5 about 50% injury, and a 10 about 100% injury. Ratings are the means of three replications. Quality was rated on a scale of 1 (lowest quality) to 9 (highest quality). Chlorosis was also rated on a 1-9 scale with 1 being approximately 1-10% of the plot area chlorotic and 9 being approximately 90-100% of the plot area chlorotic.

In general, the irrigation and cultivar treatments did not influence turfgrass quality or dollar spot prevalence; therefore, the results and discussion will focus on turfgrass quality and dollar spot prevalence as influenced by nitrogen nutrition level and fungicide treatment interval. The irrigation treatments were essentially masked because high rainfall in spring and early summer resulted in all plots receiving similar amounts of moisture.

Data from both growing seasons are summarized in Tables 2-12. Turfgrass quality was influenced by both fungicide application frequency and nitrogen nutrition level (Tables 2-6). As fungicide frequency decreased from every 7 days to every 28 days, there was a significant decrease in turfgrass quality in 1998 (Table 2). However, in 1999 there was little difference in quality between the 7-, 14- and 21-day treatment intervals (Table 3).

In both years N nutrition level alone did not significantly influence turfgrass quality (Tables 4 and 5). However, within the Aug. 27, 1999 ratings there was a significant nitrogen nutrition level by fungicide treatment interval interaction (Table 6). In general, the highest quality occurred at the 6 lb N level with a 7- or 14-day fungicide treatment interval.

Many of the plots were chlorotic when quality and disease ratings were taken on Aug. 27, 1999. The chlorosis was thought to be induced by the rapid growth rate of the bentgrass due to recovery from dollar spot in the fungicide treated plots. Plots receiving 6 lb N were less chlorotic but the differences between N rates were not significant (Table 5).

Dollar spot developed slowly during June and early July, becoming moderately severe by late July. As expected during both years, dollar spot prevalence was reduced by fungicide treatment. In 1998, when treated every 7 or 4 days, dollar spot prevalence was

Table 2. Quality in 1998 as influenced by fungicide treatment interval. Managing Dollar Spot on a Creeping Bentgrass Fairway. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	Quality†		
Treatment interval (days)	*7/1/98*	*7/29/98*	*8/26/98*
0	4.3bc‡	4.0d	2.5e
7	4.0c	6.4a	73.a
14	4.5ab	6.1a	6.6b
21	4.5ab	5.7b	5.0c
28	4.8a	5.1c	5.0d
LSD ($p \leq 0.05$)	**0.3**	**0.3**	**0.3**

†Quality evaluated on a 1 to 9 scale, with 1 equal to poorest and 9 equal to highest quality.
‡Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Table 3. Quality and chlorosis in 1999 as influenced by fungicide treatment interval. Managing Dollar Spot on a Creeping Bentgrass Fairway. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	Quality†		*Chlorosis*‡
Treatment interval (days)	*7/30/99*	*8/27/99*§	*8/27/99*
0	3.9b¶	3.1	4.3a
7	6.7a	7.8	1.5c
14	7.1a	7.9	2.0c
21	7.2a	7.1	3.1b
28	6.7a	6.2	4.7a
LSD ($p \leq 0.05$)	**0.6**		**0.7**

†Quality evaluated on a 1 to 9 scale, with 1 equal to poorest and 9 equal to highest quality
‡Chlorosis evaluated on a 1 to 9 scale, with 1 equal to 1-10% of the plot area chlorotic and 9 equal to 90-100% of the plot area chlorotic.
§Main effect significant; fungicide treatment interval X nitrogen level interaction also significant (Table 5).
¶Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Table 4. Quality in 1998 as influenced by nitrogen nutrition level. Managing Dollar Spot on a Creeping Bentgrass Fairway. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		Quality†	
N nutrition level (#N/M/S)	*7/1/98*	*7/29/98*	*8/26/98*
1.5	4.3b‡	5.4	5.1
3.0	4.2b	5.5	5.1
6.0	4.7a	5.5	5.0
LSD ($p \leq 0.05$)	**0.3**	**ns**	**ns**

†Quality evaluated on a 1 to 9 scale, with 1 equal to poorest and 9 equal to highest quality.
‡Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Table 5. Quality and chlorosis in 1999 as influenced by nitrogen nutrition level. Managing Dollar Spot on a Creeping Bentgrass Fairway. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	Quality†		*Chlorosis*‡
N nutrition level (#N/M/S)	*7/30/99*	*8/27/99*§	*8/27/99*
1.5	6.2	6.1	3.4
3.0	6.4	6.3	3.1
6.0	6.4	6.8	2.9
LSD ($p \leq 0.05$)	**ns**		**ns**

†Quality evaluated on a 1 to 9 scale, with 1 equal to poorest and 9 equal to highest quality.
‡Chlorosis evaluated on a 1 to 9 scale, with 1 equal to 1-10% of the plot area chlorotic and 9 equal to 90-100% of the plot area chlorotic.
§Main effect significant; fungicide treatment interval X nitrogen level interaction also significant (Table 6).

Table 6. Quality (Aug. 27, 1999) as influenced by the interaction of treatment interval and nitrogen nutrition level. Managing Dollar Spot on a Creeping Bentgrass Fairway. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	N nutrition level (#N/M/S)		
Treatment interval (days)	*1.5*	*3.0*	*6.0*
0	2.7	2.6	4.0
7	7.4	7.9	8.0
14	7.6	7.9	8.1
21	7.0	6.8	7.4
28	5.8	6.3	6.5

LSD_1 ($p \leq 0.05$) within rows 0.6
LSD_2 ($p \leq 0.05$) with columns = 0.7

Table 7. Dollar spot prevalence in 1998 as influenced by fungicide treatment interval. Managing Dollar Spot on a Creeping Bentgrass Fairway. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	Dollar spot[†]			
Treatment interval (days)	*7/1/98*	*7/15/98*	*7/29/98*	*8/26/98*
0	1.1	3.9a[‡]	5.9a	7.8a
7	1.1	1.6c	1.1c	1.6e
14	1.1	1.6c	1.5c	2.7d
21	1.1	2.8b	1.7c	5.2c
28	1.0	3.0b	3.4b	6.5b
LSD ($p \leq 0.05$)	**ns**	**0.6**	**0.6**	**0.5**

[†]Dollar spot evaluated on a scale of 0 to 10 as an estimate of the percent of the plot area showing symptoms.
[‡]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Table 8. Dollar spot prevalence in 1999 as influenced by fungicide treatment interval. Managing Dollar Spot on a Creeping Bentgrass Fairway. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	Dollar spot[†]		
Treatment interval (days)	*7/30/99*[‡]	*8/16/99*	*8/27/99* [‡]
0	7.1	6.8a[§]	7.4
7	1.0	1.2c	1.1
14	1.0	1.2c	1.0
21	1.0	1.8c	1.2
28	1.5	4.5b	1.8
LSD ($p \leq 0.05$)		**0.7**	

[†]Dollar spot evaluated on a scale of 0 to 10 as an estimate of the percent of the plot area showing symptoms.
[‡]Main effect significant; fungicide treatment interval X nitrogen nutrition level interaction also significant (Tables 11 and 12).
[§]Means within columns followed by different letters are significantly different based on the Least Significant Difference (LSD) multiple means technique.

Table 9. Dollar spot prevalence in 1998 as influenced by nitrogen nutrition level. Managing Dollar Spot on a Creeping Bentgrass Fairway. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	Dollar spot[†]			
N nutrition level (#N/M/S)	*7/1/98*	*7/15/98*	*7/29/98*	*8/26/98*
1.5	1.1	2.8	2.9	4.8
3.0	1.1	2.5	2.9	4.7
6.0	1.0	2.4	2.5	4.8
LSD ($p \leq 0.05$)	**ns**	**ns**	**ns**	**ns**

[†]Dollar spot evaluated on a scale of 0 to 10 as an estimate of the percent of the plot area showing symptoms.

Table 10. Dollar spot as influenced by nitrogen nutrition level. Managing Dollar Spot on a Creeping Bentgrass Fairway. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	Dollar spot[†]		
N nutrition level (#N/M/S)	*7/30/99*[‡]	*8/27/99*	*8/27/99*[§]
1.5	2.4	3.1	2.8
3.0	2.4	3.2	2.7
6.0	2.2	3.1	2.1
LSD ($p \leq 0.05$)		**ns**	

[†]Dollar spot evaluated on a scale of 0 to 10 as an estimate of the percent of the plot area showing symptoms.
[‡]Fungicide treatment interval X nitrogen nutrition level interaction significant.
[§]Main effect significant; fungicide treatment interval X nitrogen nutrition level interaction also significant (Tables 11 and 12).

held to less than 20%, except for the 14-day treatment interval evaluated on Aug. 26 (Table 7). This was reflected in the corresponding high quality ratings for these plots. A disease prevalence level below 20% is barely detectable visually and is well above the acceptable level for quality bentgrass fairway turf.

A similar trend was noted in 1999, with the difference being that the 21-day treatment interval was equally as effective as the 7- and 14-day treatment intervals (Table 8).

Dollar spot prevalence was not influenced by N nutrition level in 1998 (Table 9), but in 1999 it was influenced by a significant fungicide treatment interval X N nutrition level interaction (Tables 10-12).

Creeping bentgrass is becoming more widely used as a fairway turf in the central USA. Many of the cultivars being grown in fairways are susceptible to diseases such as dollar spot. In fact, in the golf course industry today, there are more dollars spent to control dollar spot than any other disease. This is reflected in the general concern among golf course superintendents that bentgrass fairways require more inputs to avoid disease problems and maintain quality and playability compared to other turfgrass species. Our project was designed to determine the interactive effects of cultivar, irrigation, nitrogen nutrition and fungicide treatment interval on bentgrass fairway quality and dollar spot prevalence.

Our research has shown that under the conditions of this study, irrigation regime and cultivar generally did not significantly influence quality or dollar spot prevalence. Although there was some significant interaction between fungicide treatment interval and N nitrogen level on both quality and dollar spot prevalence, the factor that most influenced these was fungicide treatment interval.

Table 11. Dollar spot (July 30, 1999) as influenced by the interaction of fungicide treatment interval and nitrogen nutrition level. Managing Dollar Spot on a Creeping Bentgrass Fairway. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	N nutrition level (#N/M/S)		
Treatment interval (days)	*1.5*	*3.0*	*6.0*
0	7.4	7.3	6.4
7	1.0	1.0	1.0
14	1.0	1.0	1.0
21	1.0	1.0	1.1
28	1.4	1.4	1.7

LSD_1 ($p \leq 0.05$) within rows 0.6
LSD_2 ($p \leq 0.05$) with columns = 0.7

Table 12. Dollar spot (August 27, 1999) as influenced by the interaction of fungicide treatment interval and nitrogen nutrition level. Managing Dollar Spot on a Creeping Bentgrass Fairway. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	N nutrition level (#N/M/S)		
Treatment interval (days)	*1.5*	*3.0*	*6.0*
0	8.2	7.9	6.2
7	1.2	1.2	1.0
14	1.0	1.0	1.1
21	1.3	1.3	1.1
28	2.3	1.9	1.3

LSD_1 ($p \leq 0.05$) within rows 0.6
LSD_2 ($p \leq 0.05$) with columns = 0.7

With a total seasonal nutritional level of 6 lb N, we were able to effectively control dollar spot and maintain turfgrass quality with a 21-day fungicide treatment interval using the Heritage / Daconil Ultrex tank mix. A higher N rate, when combined with an effective fungicide program, promoted rapid turfgrass recovery from injury due to disease. The more rapid recovery results in higher turfgrass quality and better playability. Superintendents should be able to effectively manage diseases on bentgrass fairways with a 21-day fungicide treatment schedule using a tank mix of a broad spectrum fungicide with a systemic fungicide effective against dollar spot, brown patch and Pythium blight. In this study the Heritage / Daconil Ultrex tank mix treatment provided effective dollar spot control. Even at the higher 6 lb N rate, Pythium blight and brown patch did not occur. This approach provides a sustainable aspect to bentgrass fairway management while minimizing fungicide inputs. The course realizes a savings in dollars while reducing the impact on the environment through reduced fungicide use by extending the treatment interval to 21 days.

Efficacy of Selected Insecticides Against Second Generation Chinch Bugs on Buffalograss Turf in 1999

T.M. Heng-Moss, F.P. Baxendale, and T.P. Riordan

Insecticides were evaluated for control of chinch bugs on plots located at the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE. The turf (100% buffalograss) was maintained at a height of 3 inches and thatch accumulation (finger compressed) in the plot area was less than 0.125 inches. Field conditions at the study site were: soil type, silty clay loam; soil organic matter, 3-5%; soil pH, 6-7; water pH, 7.0. Environmental conditions at the time of treatment were: soil moisture, 14%; air temperature, 87°F; soil temperature, 82°F; relative humidity, 49%; wind direction and velocity, 176° at 13 mph. Plots were 4 ft x 4 ft and the experimental design was a randomized complete block with four replications. Insecticide treatments were applied Sept. 3, 1999 using a hand shaker. Post-treatment irrigation was 0.125 inches and a total of 2.99 inches of rain accumulated during the post-treatment period. Treatments were evaluated Sept. 11, 21 and 28 (11, 18 and 25 days after treatment (DAT)) by removing from each plot three, 4.25 inch diameter turf-soil cores (0.3 ft^2 total area) to a depth of 2 inches. Cores were placed in Berlese funnels and extracted chinch bugs were counted after 48 hours. The pre-treatment estimate of insect activity was 80 chinch bugs per ft^2.

All treatments, except InterCept-H&G evaluated at 25 DAT, provided statistically significant reductions in chinch bug numbers when compared to the untreated control (Table 1). By the end of the study, most treatments had achieved greater than 90% control, with the exception of S8728 and InterCept-H&G, which provided 86.8% and 42.1% control, respectively. No phytotoxicity was observed.

Table 1. Mean chinch bug (CB) numbers and percent control following applications of selected insecticides. Efficacy of Selected Insecticides Against Second Generation Chinch Bugs on Buffalograss Turf in 1999. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

			11 DAT[†]		*18 DAT*		*25 DAT*	
	Formulation	*Rate (lbs ai/A)*	*Mean CB/1.05 ft²*	*% Control*[‡]	*Mean CB/1.05 ft²*	*% Control*	*Mean CB/1.05 ft²*	*% Control*
Spectracide Soil & Turf Insect Control	5.0 GR	4.36	0.0a[§]	100.0	0.3a	98.6	0.0a	100.0
SPG99-001	0.09 GR	0.1	0.0a	100.0	0.3a	98.6	0.5a	94.7
Scotts Lawn Insect Control	4.54 GR	4.0	0.0a	100.0	0.0a	100.0	0.0a	100.0
Dursban	1.0 GR	1.0	0.5a	97.9	0.0a	100.0	0.3a	97.4
Scotts Turf Builder with Insect Control	3.2 GR	4.0	0.5a	97.9	2.0a	88.7	0.3a	97.4
Sta-Green Lawn Insect Control	3.34 GR	4.36	1.3ab	94.7	0.5	97.2	0.8a	92.1
Spectracide Lawn & Garden Insect Control 7000	1.0 GR	1.09	2.8abc	88.4	0.3a	98.6	0.5a	94.7
S8728	0.086 GR	0.1	3.0abc	87.4	0.3a	98.6	1.3a	86.8
InterCept-Home & Garden	0.1 GR	0.13	7.5abc	68.4	0.8a	95.8	5.5ab	42.1
Spectracide 3X Insect Control	0.25 GR	0.33	10.8 bc	54.7	3.8a	78.9	0.5a	94.7
S8727	0.09 GR	0.1	11.8 c	50.5	3.5a	80.3	0.5a	94.7
Untreated Control			23.8 d	0.0	17.8 b	0.0	9.5 b	0.0
LSD ($p<0.05$)		**ns**	**9.76**	**ns**	**7.34**	**ns**	**5.83**	**ns**

[†]DAT = Days after treatment.

[‡]Evaluated on a scale of 0-100%, with 0 = no control and 100% = total control.

[§]Means in a column followed by the same letter are not significantly different based on the Least Significant Difference (LSD) multiple comparison technique.

Efficacy of Diazinon and Bifenthrin Insecticides for Control of Adult Bluegrass Billbugs in 1999

A.P. Weinhold, F.P. Baxendale, and R.D. Grisso

Insecticide formulations containing either diazinon (Scotts Turf Builder with Insect Control, Scotts Lawn Insect Control, Sta-Green Lawn Insect Control,) or bifenthrin (SPG99-001, S-8727, S-8728) with a chloropyrifos (Dursban) standard were evaluated for control of adult billbugs on plots located at the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE. The turf (100% Kentucky bluegrass) was maintained at a height of 3 inches and thatch accumulation (finger compressed) in the plot area was 0.5 inches. Field conditions at the study site were: soil type, silty clay loam; soil organic matter, 3-5%; soil pH, 6-7; water pH, 7.0. Environmental conditions at the time of treatment were: soil moisture, 23%; air temperature, 72°F; soil temperature, 70°F; relative humidity, 42%; wind direction and velocity, 214° at 7 mph. Plots were 6 ft x 10 ft and the experimental design was a randomized complete block with 4 replications. Insecticide treatments were applied May 18, 1999 using a hand shaker. Post-treatment irrigation was 0.125 inches and a total of 8.35 inches of rain accumulated during the post-treatment period. Treatments applied to adult billbugs were evaluated July 7 (48 days after treatment) by removing from each plot three, 8 inch diameter turf-soil cores (2.10 ft^2 total area) to a depth of 3 inches and counting the number of surviving larvae. The pre-treatment estimate of insect activity was approximately 1 billbug adult per ft^2.

Of the products tested, only the diazinon treatments provided statistically significant reductions in billbug larval numbers when compared to the untreated control. No phytotoxicity was observed (Table 1).

Table 1. Percent (%) bluegrass billbug (BB) control 48 days after application of selected insecticides. Efficacy of Diazinon and Bifenthrin Insecticides for Control of Adult Bluegrass Billbugs in 1999. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

Treatment	*Formulation*	*Rate lb (ai)/A*	*Mean BB/ 2.10 ft^2*	*% Control*†
Scotts Turf Builder with Insect Control	3.2 GR	4.0	0.5 a ‡	92.3
Sta-Green Lawn Insect Control	3.34 GR	4.36	0.8 ab	88.5
Scotts Lawn Insect Control	4.54 GR	4.0	1.5 abc	76.9
S-8728	0.086 GR	0.1	4.8 bcd	26.9
Dursban	1.0 GR	1.0	5.0 cd	23.1
SPG99-001	0.09 GR	0.1	6.0 d	7.7
S-8727	0.09 GR	0.1	7.3 d	0.0
Untreated Control			6.5 d	0.0
LSD ($p \leq 0.05$)			**4.17**	**ns**

†Evaluated on a scale of 0-100%, with 0 = no control and 100% = total control.
‡Means in a column followed by the same letter are not significantly different based on the Least Significant Difference (LSD) multiple comparison technique.

Evaluation of Mach 2 Formulations Applied on Two Dates for Control of Bluegrass Billbugs in 1999

F.P. Baxendale and A.P. Weinhold

Three formulations of Mach 2 insecticide applied on two dates (in May and June) were evaluated for control of bluegrass billbugs in plots located at the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE. The turf (100% Kentucky bluegrass) was maintained at a height of 3 inches and thatch accumulation (finger compressed) in the plot area was 0.5 inches. Field conditions at the study site were: soil type, silty clay loam; soil organic matter, 3-5%; soil pH, 6-7; water pH, 7.0. Environmental conditions at the time of treatment were: soil moisture, 24% on both dates; air temperature, 63°F and 59°F, respectively; soil temperature, 65°F and 62°F; relative humidity, 63% and 75%; wind direction and velocity, 339° at 16 mph and 43° at 7 mph. Plots were 6 ft x 10 ft and the experimental design was a randomized complete block with 4 replications. Insecticide treatments were applied on May 24 and June 16, 1999 using a CO_2 sprayer with a TeeJet® 8002 nozzle at 30 psi and delivering 87 gallons per acre formulation. Post treatment irrigation was 0.125 inches and a total of 7.0 inches of rain accumulated during the post treatment period. Treatments were evaluated July 8 (45 and 22 days after treatment) by removing from each plot three, 8 inch diameter turf-soil cores (2.10 ft^2 total area) to a depth of 3 inches and counting the number of surviving larvae. The pre-treatment estimate of insect activity was approximately 1 billbug adult per ft^2.

All treatments provided statistically significant reductions in the number of billbug larvae, regardless of formulation and application timing when compared to the untreated control (Table 1). Although not significant, there was a general trend toward better control with the 0.86FG formulation applied on the June application date. No phytotoxicity was observed.

Table 1. Effect of application timing on control on mean bluegrass billbug (BB) numbers and percent control using Mach 2 insecticide 45 days after treatment. J.S. Anderson Turfgrass and Research Facility near Mead, NE.

Treatment	*Formulation*	*Rate lb (ai)/A*	*Application Date*	*Mean BB/ 2.10 ft^2*	*% Control*[†]
Mach 2	0.86 FG	1.5	16 Jun	1.8a[‡]	84.8
Mach 2	2 SC	1.5	16 Jun	3.5a	69.6
Mach 2	0.86 FG	1.5	24 May	3.8a	67.4
Mach 2	0.57 FG	1.5	16 Jun	5.0a	56.5
Mach 2	0.57 FG	1.5	24 May	5.5a	52.2
Mach 2	2 SC	1.5	24 May	5.8a	50.0
Untreated Control				11.5b	0.0
LSD ($p \leq 0.05$)				**4.3**	**ns**

[†]Evaluated on a scale of 0-100%, with 0 = no control and 100% = total control.
[‡]Means in a column followed by the same letter are not significantly different based on the Least Significant Difference (LSD) multiple comparison technique.

1999 Fungicide Evaluation Trial for the Control of Brown Patch on Perennial Ryegrass

J.E. Watkins and L.A. Wit

Brown patch, caused by the fungus *Rhizoctonia solani*, is an endemic problem affecting golf course greens, tees and fairways. Outbreaks of the disease are closely tied to high maintenance, warm temperatures and high humidities. To provide information on cost-effective chemical control of this serious disease, fungicides are annually evaluated for efficacy in field trials.

Plots were located on a blend of perennial ryegrasses at the John Seaton Anderson Turf and Ornamental Research Facility near Mead, NE. Plots were mowed three times weekly at a height of 1.5 in. and irrigated to maintain an application rate of 100% ETp. Preemergence weed control was with Tupersan at 8 lbs / acre applied in early May. The experimental area was inoculated in early July and again in mid-July with *Rhizoctonia solani* cultured on sterilized tall fescue seed. The inoculum was applied with a 4-ft Gandy drop spreader calibrated to deliver 2 lbs tall fescue inoculum per 1,000 sq ft. After inoculation the area was covered with Seed Guard (A.M. Leonard, Inc., Piqua, OH) for 48 hours to encourage disease development. Seed Guard is a white spun-bound polypropylene material used in turfgrass establishment to increase seed germination. Preventive fungicide treatments were applied to 25 sq ft plots using a CO_2 pressurized (30 psi) backpack sprayer with a flat fan nozzle. The sprayer was calibrated to deliver 5 gallons of spray solution per 1,000 sq ft. Three replications per treatment were arranged in a randomized complete block design. Precipitation was above normal in April and May and below normal from June to September. Temperatures were above normal during July, with an intermittent cool period in early August. Soil type at this site is a Sharpsburg silty clay loam with a pH of 7.2. Sulfur-coated urea (32-0-0) was applied in mid-June at 1 lb N / 1000 sq ft.

Brown patch was moderately severe during July and moderate during August (Table 1). Initial fungicide treatments were applied prior to the onset of brown patch symptoms. Several treatments had significantly less brown patch than the untreated check. Compass 50WG applied on a 21-day schedule was not as effective as the other products tested on a 14-day treatment interval. The performance of Heritage 50WG, ProStar 70WP, Bayleton 50DF, Chipco 26GT, Eagle 40W and Banner MAXX were similar for both evaluation dates.

Table 1. Fungicides evaluated for control of brown patch on a perennial ryegrass turf. 1999 Fungicide Evaluation Trial for the Control of Brown Patch on Perennial Ryegrass at the J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

Treatment & rate (product/1,000sq ft)	*Treatment interval (days)‡*	*Brown patch prevalence†* 28 July	*Brown patch prevalence†* 16 August
Heritage 50WG, 0.2 oz	14	3.7	2.7
Heritage 50WG, 0.4 oz	28	3.3	1.7
ProStar 70WP, 2.25 oz	14	2.3	1.7
Daconil Ultrex 82.5 WDG, 1.8 oz	14	6.0	5.7
Bayleton 50DF, 0.25 oz	14	2.3	1.0
Chipco 26GT 2SC, 4 fl oz	14	3.3	2.3
Eagle 40W, 0.6 oz	14	3.7	2.7
Banner MAXX 1.24 MEC, 0.5 fl oz	14	4.7	2.3
Compass 50WG, 0.15 oz	21	7.0	4.0
Compass 50WG, 0.15 oz + Primo MAXX 1ME, 0.25 fl oz	21	7.7	5.0
Untreated check	—	7.0	6.0
Mean		4.6	3.4
LSD ($P \leq 0.05$)		**1.9**	**1.6**

†Disease prevalence is rated on a scale of 0-10 as an estimate of the percent of the plot area showing symptoms. A 1 rating would be approximately 10% of the plot showing disease injury symptoms; a 5 approximately 50% injury and a 10 approximately 100% injury. Ratings are the means of three replications.
‡Treatments were initiated July 7, and the final treatments applied August 4.

Turfgrass

1999 Fungicide Evaluation Trial for the Control of Gray Leaf Spot on Perennial Ryegrass

J.E. Watkins and L.A. Wit

Gray leaf spot was epidemic in the central plains states of Nebraska, Kansas and Iowa in 1998. The disease had never been reported in Nebraska prior to 1998. It developed during August and devastated many perennial ryegrass fairways in eastern Nebraska. The purpose of this 1999 gray leaf spot evaluation trial was to determine which products provided effective control of this disease.

Plots were located on a blend of perennial ryegrasses at the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE. Plots were mowed weekly at a height of 1.0 in. and irrigated to maintain an application rate of 100% ETp. Preemergence weed control was with Tupersan at 8 lbs / acre applied in early May. The plot area was overseeded in late June with a perennial ryegrass blend and was inoculated in early July and again in mid-July with *Pyricularia grisea* cultured on sterilized tall fescue seed. Preventive fungicide treatments were applied to 25 sq ft plots using a CO_2 pressurized (30 psi) backpack sprayer with a flat fan nozzle. The sprayer was calibrated to deliver 5 gallons of spray solution per 1,000 sq ft. Three replications per treatment were arranged in a randomized complete block design. Precipitation was above normal in April and May, and below normal from June to September. Temperatures were above normal during July, with an intermittent cool period in early August. Temperatures were moderate during the first half of September. Soil type at this site is a Sharpsburg silty clay loam with a pH of 7.2. Sulfur-coated urea (32-0-0) was applied in mid-June at 1 lb N / 1000 sq ft.

Gray leaf spot prevalence was moderate during August and moderately severe during early September (Table 1). All treatments had significantly less gray leaf spot than the untreated check. There were no significant differences between treatments. Heritage 50WG applied on a 21-day treatment interval was slightly less effective than on a 14-day treatment interval. Similar results were noted for Eagle 40W on a 28-day treatment interval as compared to the 14-day treatment interval. The differences in gray leaf spot prevalence between treatment intervals for both products, however, was not significant. Junction at 8 oz / 1000 sq ft and Pentathlon 4F at 12.8 fl oz / 1000 sq ft were slightly more effective than the respective products at 4 or 6 oz and 9.6 fl oz, but the differences were not significant. No phytotoxicity was observed with any of the products applied.

Table 1. Fungicide efficacy for the control of gray leaf spot on perennial ryegrass. 1999 Fungicide Evaluation Trial for the Control of Gray Leaf Spot on Perennial Ryegrass at the J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

		Gray leaf spot prevalence[†]			
Treatment & rate (product/1000 sq ft)	*Treatment interval (days)*[‡]	*16 Aug*	*25 Aug*	*1 Sept*	*15 Sept*
Heritage 50WG, 0.2 oz	14	1.3	1.7	1.0	1.5
Heritage 50WG, 0.4 oz	21	1.7	1.7	1.7	1.4
Banner MAXX 1.24 MEC, 0.5 fl oz	14	2.3	1.7	1.7	2.3
Daconil Ultrex 82.5 WDG, 1.8 oz	7	1.0	1.3	1.3	1.0
Eagle 40W, 0.6 oz	14	1.3	0.7	0.7	1.3
Eagle 40W, 1.2 oz	28	1.7	2.3	2.3	1.7
Fore 80W, 8 oz	14	1.3	1.3	1.0	1.3
Junction 61.1 WDG, 4 oz	7	1.7	1.3	1.0	1.3
Junction 61.1 WDG, 6 oz	7	1.7	1.0	1.3	1.7
Junction 61.1 WDG, 8 oz	7	1.0	0.3	1.0	1.7
Pentathlon 4F, 9.6 fl oz	7	1.3	1.3	1.3	1.3
Pentathlon 4F, 12.8 fl oz	7	1.0	0.3	0.7	1.0
Untreated check		5.0	5.7	6.7	5.0
Mean		1.7	1.7	1.8	1.7
LSD ($P \leq 0.05$)		**1.1**	**1.2**	**1.0**	**0.9**

[†]Disease prevalence is rated on a scale of 0-10 as an estimate of the percent of the plot area showing symptoms. A 1 rating would be approximately 10% of the plot showing disease injury symptoms; a 5 approximately 50% injury and a 10 approximately 100% injury. Ratings are the means of three replications.
[‡]Treatments were initiated July 14 and the final treatments applied August 25.

Shoot and Root Characterization of Black-eyed Susan Mowed at Different Heights

A.L. Neigebauer, G.L. Davis, G.L. Horst, and D.H. Steinegger

Wildflower sod has been researched since 1978 and was patented in 1990, but the reasoning behind the production system methods is not clear. One parameter of wildflower sod production that has been debated is the height at which plants should be maintained. Shoot growth is managed to reduce damage to plants when undercut and to allow for ease of shipping. Previous research treated several species of wildflowers with three growth regulators to control shoot height; however, the effects were not significant. The reduction of shoots by mowing is a more dependable alternative to growth regulators, but optimal mowing height is unknown. Growers typically use a height of about 7.6 cm because this is the maximum height allowed by many mowers. Clipping the shoots of perennial rangeland grasses causes root biomass to decrease and wildflowers may be influenced in the same manner. This research determined the influence of mowing height on wildflower sod production.

Black-eyed Susan (*Rudbeckia hirta L.*) was used as a representative wildflower species and seeded at a rate of 0.01 g Pure Live Seed (PLS) into 10.2 cm diameter polyvinyl chloride (PVC) tubes. Seeds were sown at triple the recommended rate to ensure a dense planting. Tubes were 76 cm deep, and coarse gravel (15 cm layer) was added to the bottom of each tube to simulate field conditions. A layer of landscape fabric was placed on the top to prevent roots from growing into the rocks. Masonry-washed fill sand, particle size 0.4 to 3.2 mm, was used as the growing medium (60 cm layer). A 1 cm space was left as a lip at the top of the tube. A pH range of 6.0-7.0 was maintained by adding aluminum sulfate when pH levels were above 7.0. Seeds were germinated and tubes removed from the mist when seedlings produced their first set of true leaves. Daytime temperatures in the greenhouse ranged from 24 to 27 ºC, and nighttime temperatures ranged from 18 to 24ºC. Metal halide lights were used to maintain a light level of approximately 450 to 700 $mmol.m^{-2}.s^{-1}$ at 1400 HR for a 14-hour daylength. Minimum critical daylength for black-eyed susan. is 12-14.5 hours. During weeks 2 to 4, plants were fertilized with N at 100 $mg.L^{-1}$ [(20N-4.4P-16.6K) + miconutrients] and 200 $mg.L^{-1}$ during weeks 5 to 13. Plants were either not mowed (control) or hand-clipped to simulate mowing. When initial heights of 7.6, 11.4 and 15.2 cm were reached, plants were mowed to 5.1, 7.6, and 10.2 cm, respectively (1/3 of shoot growth removed). After initial mowing, plants were mowed at approximately 7-day intervals (seven mowings). Shoots were harvested after each mowing, dried at 65ºC for 48 hours, and weighed. Root dry weight was measured at depths of 0.0-2.5 cm, 2.5-21.7 cm, 21.7-40.8 cm, and 40.8-60.0 cm at the end of the study. Depth of longest root, number of root laterals in the top 2.5 cm, and root:shoot ratios were also determined at this time. The experimental design was a randomized complete block with four replications. Data were analyzed with the Mixed Models procedure in order to account for two sources of variability.

Mowing black-eyed susan plants had a significant influence on plant growth. Plants that were not mowed had deeper roots as compared to plants that were mowed (Figure 1A). Plants that were mowed to 5.1 cm had significantly lower rooting depths than plants mowed to 7.6 and 10.2 cm ($P \leq 0.05$). As mowing height increased, the depth of longest root increased linearly ($y=4.75x + 41.9$; $r^2=0.49$). Plants not mowed or plants mowed to 10.2 cm produced significantly more root laterals ($P \leq 0.05$) in the top 2.5 cm of sand than mowing heights of 5.1 cm or 7.6 cm (Fig 1B). As mowing height increased, the number of root laterals in the top 2.5 cm increased linearly ($y=5.31x + 4.98$; $r^2=0.36$).

Unmowed plants had higher root:shoot ratios at time of harvest than mowed plants (Figure 1C). The plants that were not mowed had a higher root than shoot biomass, while mowed plants had a higher shoot than root biomass. Root dry weight in the top 2.5 cm, which is the segment used for wildflower sod, was considerably higher in unmowed plants as compared to mowed plants (Figure 2). A similar trend was observed in the deeper root segments. No significant differences were found between the mowed plants. Comparing the total root dry weight of all segments indicated that mowing significantly reduced root biomass (Figure 1D).

Increasing the mowing height of black-eyed susan sod would produce more root laterals, creating a more dense sod. However, the increased mowing height may increase damage to shoots from shipping. If damage can be kept at a minimum, a 10.2 cm mowing height would increase the stability of wildflower sod for shipping and transplant handling.

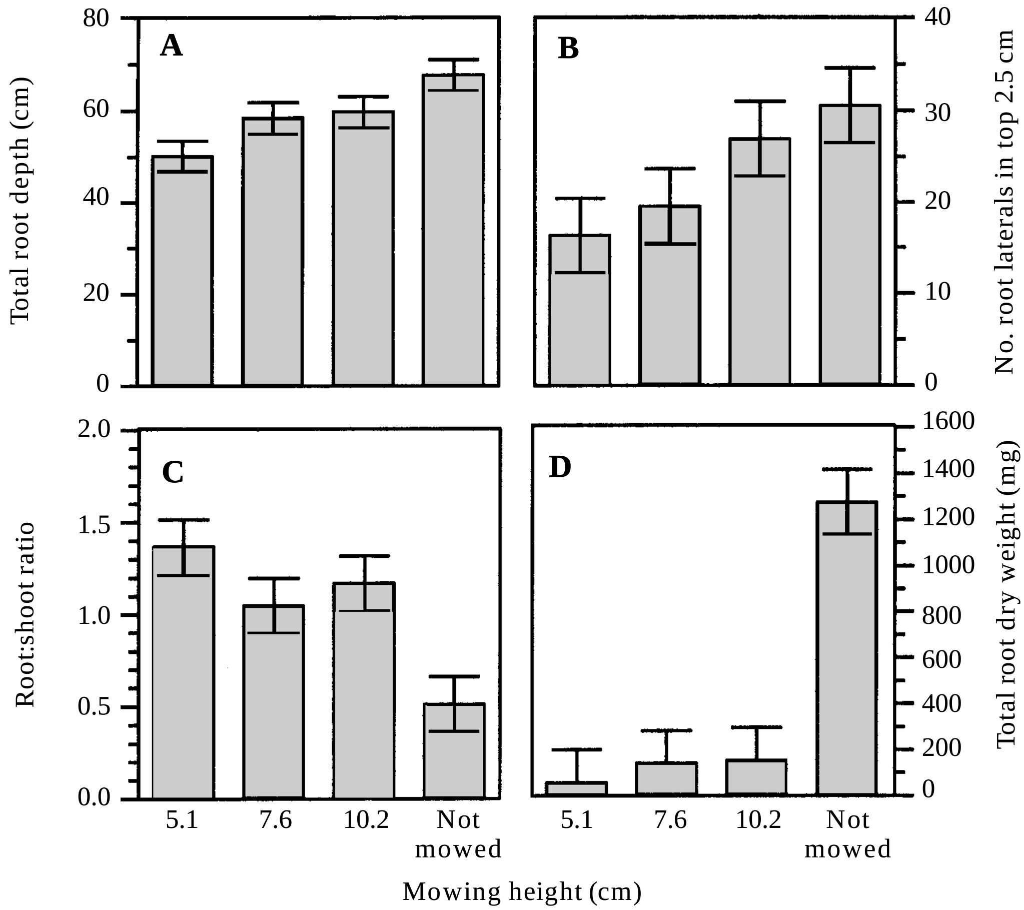


Figure 1. Mowing height effects on (A) total root depth, (B) number of root laterals in top 2.5 cm of sand, (C) root:shoot ratio, and (D) total root dry weight of black-eyed susan (*Rudbeckia hirta* L.) in a wildflower sod production system. Means ± SE are shown.

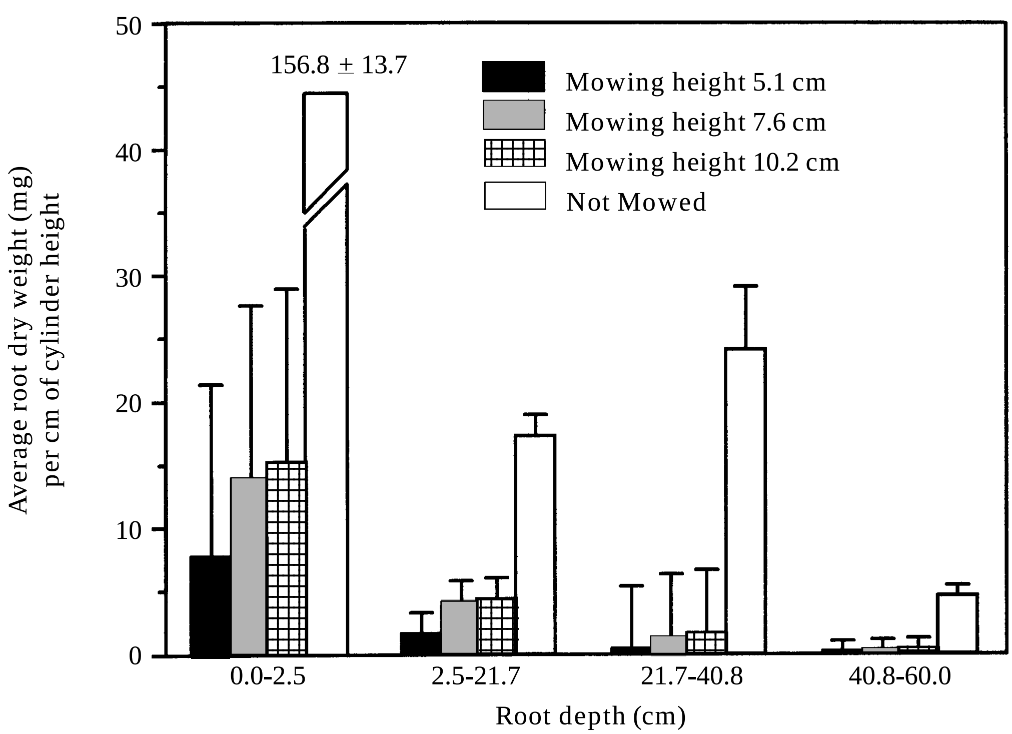


Figure 2. Root dry weight for different mowing heights at depths of 0.0-2.5 cm, 2.5-21.7 cm, 21.7-40.8 cm, and 40.8-60.0 cm. Means ± SE are shown.

Turfgrass

Evaluation of Fungicides for the Control of Foliar Diseases on Geranium and Black-eyed Susan

A.M. Streich, J.E. Watkins, D.H. Steinegger, L.J. Giesler

Fungicides were evaluated on geranium (*Pelargonium x hortum* 'Orbit Red') and black-eyed susan (*Rudbeckia fulgida* 'Goldsturm') for the control of foliar diseases at the John Seaton Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

On June 8, 1999, geranium and black-eyed susan plugs were planted in two separate blocks. Plants were fertilized with 1 lb of nitrogen on June 16. The first fungicide application was on July 16. Nine treatments were applied to the geraniums and black-eyed susans. Three replications per treatment with 8 plants in each 3 ft by 5 ft plot were arranged in a randomized complete block design. No disease was present and plant quality was similar at the time of the first spray application. Treatments, except Aliette, were applied every 14 days, ending Aug. 27, with a CO_2 driven backpack sprayer equipped with a single flat fan nozzle. Aliette was applied every 28 days. Treatments were applied in a spray volume of 100 gal per acre. Plant quality (1-9, 9=best) and disease severity (0-10, 0=no disease and 10=100% diseased) were rated weekly. Starting July 30 and running through the duration of the trial, a brief overhead irrigation was applied two times each night to increase disease pressure.

Disease pressure was low in June and July. In late July, a bacterial leaf spot (*Xanthomonas* sp.) caused severe damage to geraniums in all of the treatments, and plant quality declined (Table 1). However, treatment effects throughout the trial on plant quality were not significantly greater than the untreated control. No fungal diseases were found on the geraniums from June through September.

Small amounts of leaf spot (*Septoria* sp.) appeared on the black-eyed susans beginning on Aug. 23 and continuing through September (Table 2). No other foliar diseases occurred. The four Heritage treatments and the EXP001 treatment effectively controlled foliar disease throughout the trial. The only treatment that did not significantly reduce disease incidence better than the untreated control at anytime during the trial was Aliette. Treatment effects on plant quality were not significantly different from the untreated control at anytime during the trial.

Table 1. The effects of fungicide applications on foliar disease control on geranium (*Pelargonium x hortum* 'Orbit Red') in 1999 at the J. S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	Geranium quality†							
Treatment	*7/23*	*7/30*	*8/6*	*8/13*	*8/20*	*8/27*	*9/3*	*9/10*
Untreated control	5.0a‡	5.0a	6.0ab	5.7ab	5.3ab	5.7a	6.0ab	4.7ab
Heritage 50 WG 1 oz	5.0a	5.0a	5.7ab	5.7ab	6.3ab	7.0a	8.0a	6.7ab
Heritage 50 WG 2 oz	5.0a	5.0a	6.0ab	4.3b	5.7ab	5.7a	6.7ab	4.7ab
Heritage 50 WG 4 oz	5.0a	4.3b	3.7b	3.3b	4.3b	5.0a	5.3b	4.0a
Heritage 50 WG 8 oz	5.0a	5.0a	5.7ab	5.3ab	6.0ab	6.3a	6.7ab	6.3ab
Daconil Ultrex 82.5 WDG 1.4 lbs	5.0a	5.0a	5.3ab	4.0b	5.3ab	5.3a	6.7ab	6.3ab
EXP 0001 50 WG 1.5 oz	4.7b	4.0b	5.0ab	4.3b	4.7b	6.0a	7.3ab	6.7ab
Bayleton 25 DF 2.7 oz	5.0a	5.0a	7.3a	6.0ab	5.7ab	7.0a	7.0ab	6.0ab
Aliette 80 WP 1.25 lbs	5.0a	5.0a	7.0a	7.3a	7.7a	7.3a	7.7a	7.3a
Eagle 40 W 4 oz	5.0a	5.0a	5.0ab	5.3ab	5.3ab	6.3a	6.7ab	5.3ab

†Visual estimate of plant quality; rated 1-9, 9=best.
‡Column means with a letter in common are not significantly different based on LSD (P=0.05).

Table 2. The effects of fungicide applications on foliar disease control on black-eyed susan (*Rudbeckia fulgida* 'Goldsturm') in 1999 at the J. S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	Black-eyed Susan quality†								*Leaf spot severity*‡		
Treatment	*7/23*	*7/30*	*8/6*	*8/13*	*8/20*	*8/27*	*9/3*	*9/10*	*8/27*	*9/3*	*9/10*
Untreated control	4.7a§	5.0a	4.7ab	5.0ab	4.7ab	4.7ab	5.0abc	6.3abc	1.0a	2.3a	1.7ab
Heritage 50 WG 1 oz	5.0a	5.0a	4.0b	5.3ab	5.3ab	4.3ab	4.7abc	6.0abc	0.0b	0.0b	0.0d
Heritage 50 WG 2 oz.	5.0a	4.7a	4.7ab	5.0ab	5.0ab	5.3ab	4.7abc	6.3abc	0.0b	0.0b	0.0d
Heritage 50 WG 4 oz.	5.0a	5.7a	6.0a	6.0a	6.3a	6.0a	6.3a	7.7a	0.0b	0.0b	0.0d
Heritage 50 WG 8 oz.	4.7a	5.0a	4.7ab	4.3ab	4.0ab	4.3ab	4.0bc	4.3c	0.0b	0.0b	0.0d
Daconil Ultrex 82.5 WDG 1.4lbs	4.7a	4.7a	4.7ab	5.0ab	4.7ab	4.7ab	4.7abc	5.3abc	0.3ab	0.7b	0.3cd
EXP 0001 50 WG 1.5 oz	5.0a	5.7a	6.0a	6.0a	5.3ab	6.0a	5.7abc	6.7abc	0.0b	0.0b	0.0d
Bayleton 25 DF 2.7 oz	5.0a	4.7a	4.7ab	5.0ab	4.0ab	5.0ab	4.3abc	4.7bc	0.0b	0.7b	1.0bc
Aliette 80 WP 1.25 lbs	4.7a	4.7a	4.0b	4.0b	3.3b	4.0b	3.7c	4.7bc	0.3ab	1.7a	2.0a
Eagle 40 W 4 oz	5.0a	5.0a	5.3ab	5.7ab	4.7ab	6.0a	6.0ab	7.0ab	0.0b	0.0b	0.0a

†Visual estimate of plant quality; rated 1-9, 9=best.
‡Visual estimate of plant disease (Septoria sp.) severity; rated 0-10, 0=no disease and 10= completely diseased.
§Column means with a letter in common are not significantly different based on LSD (P = 0.05).

1999 Ornamental Grass Evaluation

D.H. Steinegger and A.M. Streich

Several ornamental grasses have been evaluated throughout Nebraska for plant quality. The characteristic of foliage color (summer and fall), form, inflorescence attractiveness and consistent timing of inflorescence bloom are characteristics important for ornamental grasses in Nebraska. The following ornamental grasses were rated 8.5 or better on a plant quality scale of 1 to 10, 10 = best.

Calamgrostis acutiflora 'Karl Foerster' (Feather reedgrass)
- 3 1/2 - 4 1/2 feet tall
- full sun, will lodge in shade
- tolerates heavy soils and wet conditions
- good vertical accent, remains upright all winter
- broad adaptation
- better than species in places that have low night temperatures

Carex morrowii 'Ice Dance' (Variegated Japanese sedge)
- 1 foot tall
- partial shade, protect from afternoon sun
- moist rich soil
- likes high nitrogen soils
- a new attractive white variegated cultivar; strong visual appearance

Leymus arenarius (Blue lyme grass)
- 1 – 1 1/2 feet tall
- full sun
- well drained soil
- best adapted to sandy soils; does not spread as quickly in silty-clay soils
- invasive – contain or use where containment isn't necessary
- clear, pure blue foliage
- leaves fold without moisture
- mow occasionally to maintain young foliage and restore fresh blue color to plant

Helictotrichon sempervirens (Blue oatgrass)
- 1 1/2 feet tall
- full sun with good air movement
- needs well drained soils to prevent root rot
- attractive fine-leafed blue foliage grass
- tolerates hot dry sites
- clump former
- good alternative to *Festuca glauca* (Blue fescue)

Miscanthus cultivars (Japanese silver grass)
- full sun
- well-drained soils

'Bitsy Ben'
- 4-5 feet tall
- great abundance of silver-white inflorescence

'Blondo'
- 7 feet tall
- golden yellow inflorescence
- yellow foliage summer through fall
- very hardy, adaptable plant

'Juli'
- 6-7 feet tall
- red inflorescence

'Grosse Fontane'
- 7-8 feet tall
- cascading form, maintains vase shape through winter
- red inflorescence maturing to silver

'Malepartus'
- 7-8 feet tall
- purplish pink inflorescence
- ostrich bloom
- yellow to orangish red fall foliage

'Strictus'
- 6 feet tall
- upright form
- yellow banded variegation
- hardier than Zebragrass, more upright and does not flop
- better, similar cultivars are available if they can be found, 'Punktchen'

Miscanthus purpurascens (Flame grass)
- 4-5 feet tall
- very hardy
- silvery inflorescence
- great orange-red fall foliage

Pennisetum alopecuroides 'Hameln' (Fountain grass)
- 2 1/2 -3 feet tall
- full sun
- dark green textured foliage
- compact whitish inflorescence

Rhynchelytrum neriglume (Rubygrass)
- 2 1/2 feet tall
- spectacular dark pink inflorescence, shimmers in sunlight
- annual

Schizachyrium scoparium 'The Blues' (Little Bluestem)
- 2-3 feet tall
- blue summer foliage
- orange-cranberry fall foliage persists into winter

Spodiopogon sibericus (Frost grass)
- 1 1/2 feet tall
- part shade, protect from afternoon sun
- red fall foliage
- slow to mature
- stiff bamboo-like form

Sporobolus heterolepis (Prairie dropseed)
- 1 foot tall
- takes dry soil
- attractive delicate fragrance
- naturalizes, large scale groundcover
- inflorescence held above foliage

Panicum virgatum 'Northwind' (Switchgrass)
- 5 feet tall
- erect habit, holds form
- orange-red fall foliage
- red inflorescence

Evaluation of Variations in Prairie Wildflower and Native Grass Plantings

G. L. Davis and J. Schimelfenig

The composition of wildflower plantings does not remain static over time. The intention of this study was to monitor the variation encountered when establishing a prairie wildflower planting over a three-year period.

The field study was conducted at the John Seaton Anderson Turfgrass and Ornamental Research facility near Mead, NE. The experimental design was a split plot in time and space, with 4 replications. Three "groups" of wildflowers, annuals (*A*), perennials (*P*) and Prairie grasses (*G*), were seeded at the same rate within the following mixtures:

1. *AP* Annuals and Perennials
2. *P* Perennials alone
3. *A* Annuals alone
4. *APG* Annuals, Perennials, Prairie Grasses
5. *PG* Perennials, Prairie Grasses
6. *AG* Annuals, Prairie Grasses

The plantings were weeded by hand in 1997; however, weeding was not necessary in 1998 or 1999. The plots were irrigated to replace 80% ETp. These 6 mixtures were evaluated for plant density, plant height and flower number seven times from 1997 through 1999.

Table 1 shows the density of annuals, perennials and the combination of annuals, perennials and grasses for the six mixtures over 1997, 1998 and 1999. The density of annuals is shown in columns 1-3 of Table 1. Annuals had a significantly higher density in 1997, 1998 and 1999 when only annuals were present, than when annuals, perennials and grasses were present in various mixtures. Therefore, even though the seeding rate of annuals remained fixed among mixtures, the annuals did not compete as well with perennials or grasses and their densities were lower in these mixtures. In addition, the density of annuals in the establishment year was greater in mixtures of annuals alone or annuals in combination with grasses than when perennials were present. These results suggest that annuals experienced interference from perennials during the first year of establishment. By the second year the density of annuals was significantly lower than all other mixtures when in combination with perennials and grasses (APG). Evidently in the second year, the higher densities of non-annual plants lowered the density of annuals.

The density of perennials is shown in columns 4-6 of Table 1. The density of perennials was significantly greater in mixtures of perennials alone or perennial / annuals than when in mixtures of perennials / grasses or annuals / perennials / grasses in 1997 or 1998. This suggests that the establishment of perennials may be decreased by the presence of prairie grasses during the first two years of establishment. Perennial density in 1999 was significantly lower when in mixtures of annuals / perennials / grasses than in any other mixture. This is similar to the response seen in annuals in 1998.

The overall density of annuals, perennials and grasses is shown in column 7-9 of Table 1. The overall density was significantly greater in mixtures of annuals alone or annuals / perennials than perennials alone or mixtures of annuals / perennials / grasses in 1997. The overall density was significantly greater in mixtures of annuals than annuals / perennials. Both these mixtures were significantly denser than all other mixtures of annuals, perennials or grasses by 1998; however, this trend changed in 1999. The average overall density was significantly lower in mixtures of annuals alone or annuals / grasses than in mixtures of annuals / perennials, perennials alone or perennials / grasses by 1999.

Although there were some significant specific species responses in plant height and flower density to wildflower composition, overall there did not appear to be any significant trend in these parameters. Apparently, annuals and perennials experience interference differently during establishment. Our results suggest that annuals experienced interference mostly from perennials during the first year of establishment, whereas perennials experienced interference mostly from prairie grasses during the first two years of establishment.

Both annuals and perennials experienced significantly lower densities in 1998 and 1999, respectively, in annuals / perennials / grasses mixtures than in all other mixtures. It is possible that, following establishment, prairie grasses interfere with the persistence of annuals and perennials in these mixtures. Although overall average plant density was greatest for annuals alone in 1998, by 1999 plant density appeared to be lowest for annuals alone or annual / grass mixtures. These results suggest that over time the density of annuals decreases more than the density of perennials or grasses. It appears that, within species, plant height and flower density were somewhat fixed per plant; they did not appear to vary significantly in response to mixture composition.

Table 1. Plant density of annuals, perennials and perennials, annuals, grasses for different planting mixtures, for 1997, 1998 and 1999. J.S. Anderson Turfgrass and Ornamental Research Facility near Mead, NE.

	Total Plant Density /m²								
	Annuals			*Perennials*			*Annuals/Perennials/Grasses*		
Planting Mixtures†	*1997*	*1998*	*1999*	*1997*	*1998*	*1999*	*1997*	*1998*	*1999*
AP	23	157	53	41	242	805	65	398	857
P	0	0	0	50	254	668	50	254	668
A	64	714	289	0	0	0	64	714	289
APG	23	59	41	17	61	336	47	199	429
PG	0	0	0	21	134	670	42	211	697
AG	46	229	89	0	0	02	52	303	144
LSD ($p \leq 0.05$)	**16**	**86**	**72**	**18**	**92**	**329**	**16**	**95**	**309**

†Planting mixtures consisting of *A* = annuals, *P* = perennials, or *G* = grasses.

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