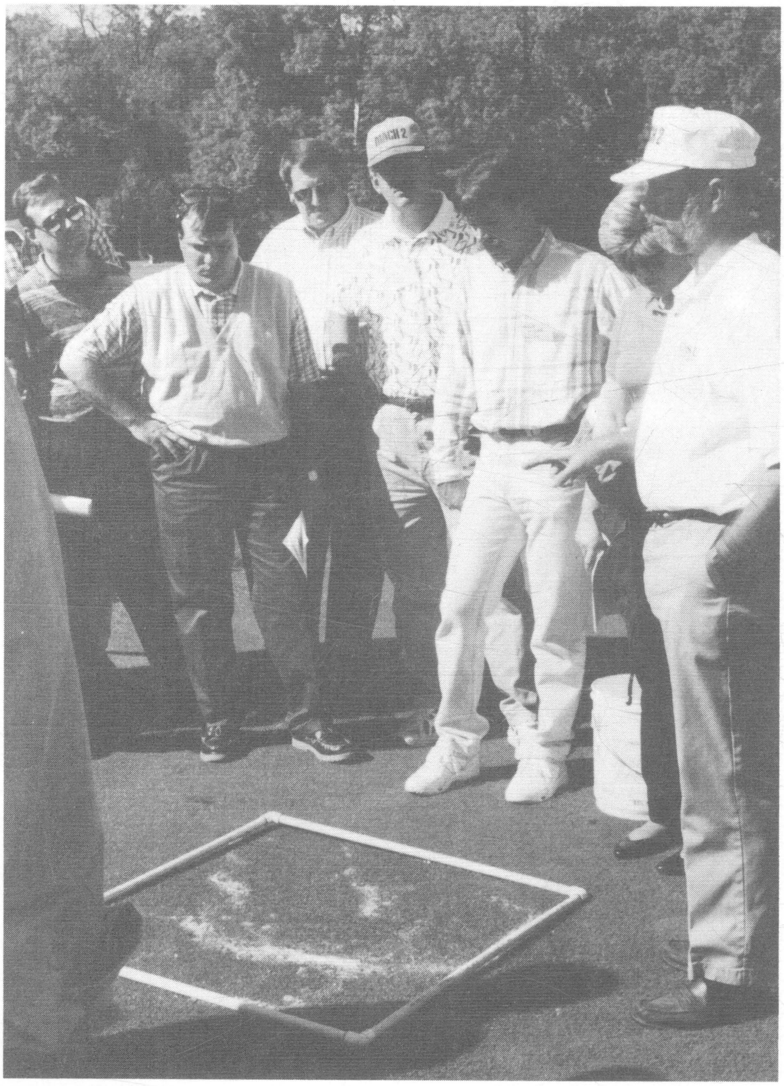
Turfgrass Research Report
1995



T·H·E OHIO STATE UNIVERSITY OARDC

T·H·E OHIO STATE UNIVERSITY EXTENSION

January 1997
Special Circular 153
Ohio Agricultural Research and Development Center
In Partnership With Ohio State University Extension

THE OHIO STATE UNIVERSITY
OARDC

Thomas L. Payne
Director

Ohio Agricultural Research and Development Center
1680 Madison Avenue
Wooster, Ohio 44691-4096
330-263-3700

Turfgrass Research Report
1995

Edited By
David Shetlar
Department of Entomology
Ohio State University Extension
Ohio Agricultural Research and Development Center
The Ohio State University

THE OHIO STATE UNIVERSITY
OARDC
THE OHIO STATE UNIVERSITY EXTENSION

January 1997
OARDC Special Circular 153
Ohio State University Extension
Ohio Agricultural Research and Development Center
College of Food, Agricultural, and Environmental Sciences

Salaries and research support were provided by state and federal funds appropriated to the Ohio Agricultural Research and Development Center and Ohio State University Extension of The Ohio State University's College of Food, Agricultural, and Environmental Sciences. Additional grant support was provided by the organizations and companies listed in the individual research reports.

Contents

Turfgrass Weed Control — 1

Postemergence Herbicide Efficacy on Crabgrass — 3
Preemergence Herbicide Efficacy on Crabgrass — 6
Preemergent Common Chickweed Weed Control Evaluation — 9
Preemergent Purple Dead Nettle Weed Control Evaluation — 11
General Turfgrass Broadleaf Weed Control Evaluation — 13
Finale/Roundup Herbicide Demonstration Evaluation — 17
Ground Ivy Control Evaluation — 19
Manage Yellow Nutsedge Control Evaluation — 21
Alternative Turflon Solvent Tolerance Evaluation — 23
Wild Violet Control Evaluation — 25

Turfgrass Disease Management — 27

Leaf Spot Study — 1995 — 29
Leaf Spot Control Study — Galena, Ohio — 30
Red Thread Control Study — 1995 — 31
Brown Patch Study — 1995 — 33
Brown Patch *(Rhizoctonia solani)* Curative Study — 39
Preventive Dollar Spot *(Sclerotinia homoeocarpa)* Control Study — 1995 — 40
Take-All Control Study — 44
Yellow Tuft Study — 1995 — 45
Summer Patch Control Study — 47
Sentinel and Daconil Ultrex Gallonage Study: Influence on Dollar Spot Control — 49
Pink Snow Mold Control Study, 1994 - 1995 — 50

Turfgrass Insect Control — 53

Control of Black Cutworm, *Agrotis ipsilon* (Hufnagel), and Sod Webworms (Pyralidae: Crambinae) on Short Cut Bentgrass, *Agrostis palustris* Hudson — 1995 — 55
Control of Black Cutworm, *Agrotis ipsilon* (Hufnagel), and Sod Webworms (Pyralidae: Crambinae) on Short Cut Bentgrass, *Agrostis palustris* Hudson Using Spinosad Formulations — 1995 — 57
Applications of Insecticides for Control of Second Generation Hairy Chinch Bugs in Turfgrass — 1995 — 59

Preventive Application of Insecticides for Control of Black Turfgrass Ataenius Larvae on Golf Course Fairways — 1995 61
Spring Application of Chemical and Biological Insecticides for Control of Overwintered White Grubs in Turfgrass —1995 63
Influence of Post-Treatment Irrigation on the Efficacy of RH 0345 and Merit Applied at the Time of Egg Hatch for Control of Japanese Beetle Larvae in Turf — 1995 65
Application of Various Insecticides for Preventive Control of Japanese Beetle Larvae in Turfgrass — 1995 67
Chemical and Biological Insecticides Applied for Control of White Grubs in Turfgrass — 1995 69

Turfgrass Fertility Studies 71

Nitrogen Source, Rate, and Timing Effect on Kentucky Bluegrass 73
Natural Organic Source Evaluation on a Kentucky Bluegrass-Perennial Ryegrass Mixture 86
Nitrogen Source, Rate, and Timing Effect on Kentucky Bluegrass 93
Polymer-Coated Nitrogen Source Effect on Kentucky Bluegrass 106

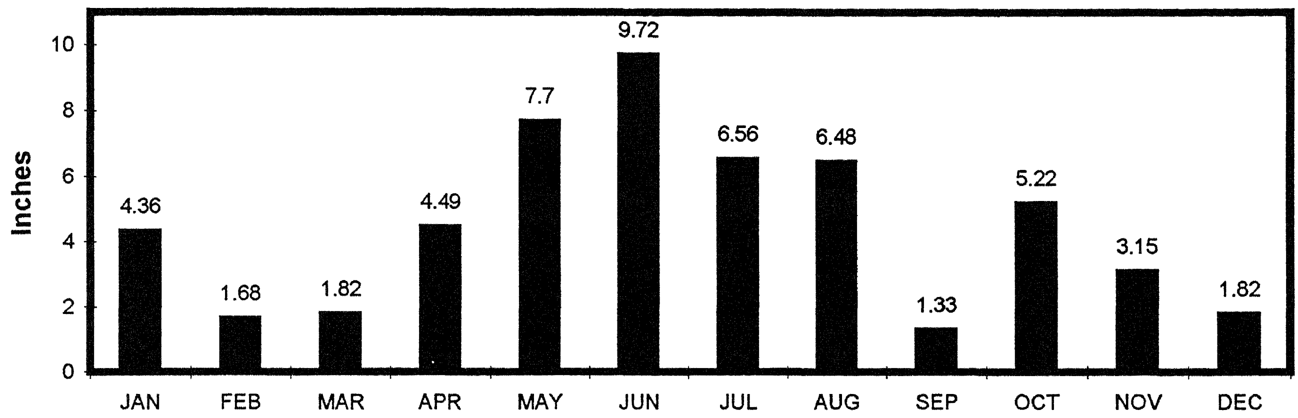
Turfgrass Species and Cultivar Evaluations 111

1993 NTEP Bentgrass Test (Fairway/Tee) 113
1993 NTEP Fineleaf Fescue Test 116
1994 NTEP Perennial Ryegrass Test 119

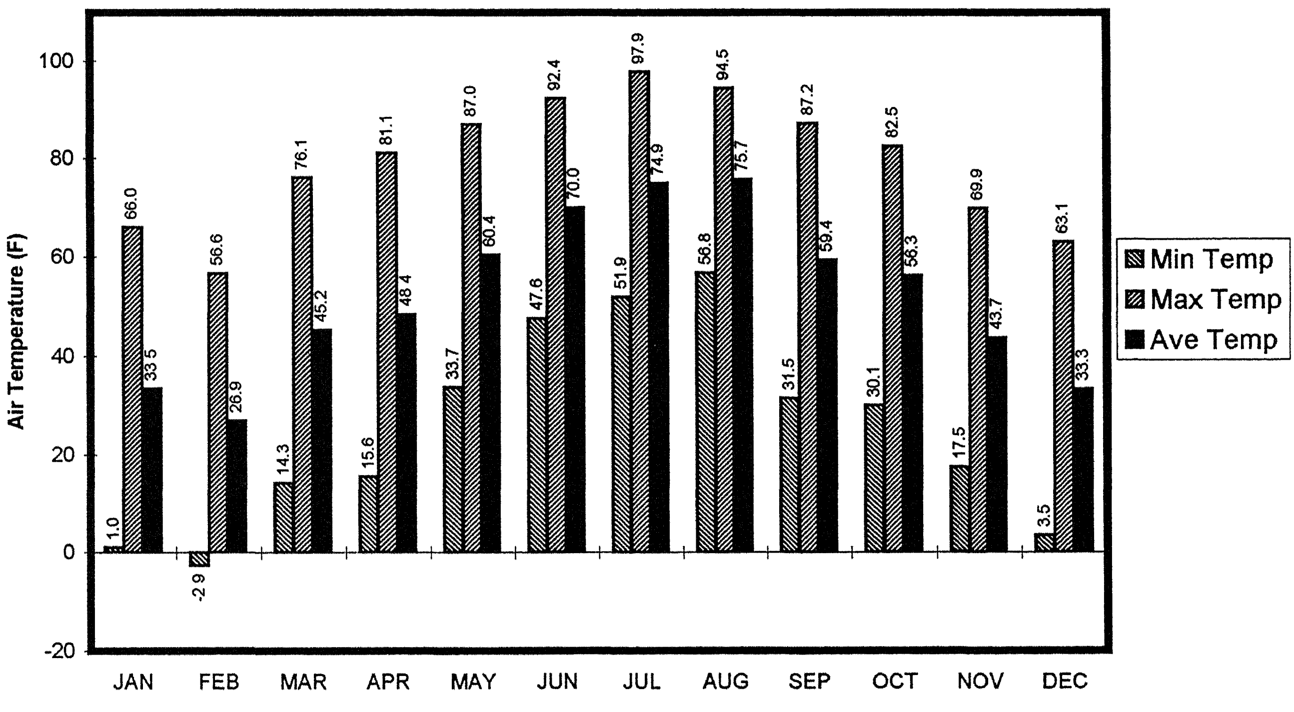
Turfgrass Culture, Management, and Biotechnology 123

'Primo' Growth Regulator Evaluation on Creeping Bentgrass 125
Bermudagrass Management Study 129
Electrophoretic Evaluation of Esterase Isozymes from Turfgrass Seed Blends and Mixtures 132
Computer Imaging of Electrophoretic Gels 134
Evaluation of Kentucky Bluegrass Blends Using Isoelectric Focusing and Computer Imaging 137
Identification of RAFLP Markers in Perennial Ryegrass 139
RAPD Analysis of Dry Turfgrass Seed 140

Monthly Rainfall Amounts, OSU Turfgrass Research Facility 1995



Monthly Temperatures, OSU Turfgrass Research Facility 1995



Turfgrass Weed Control

Postemergence Herbicide Efficacy on Crabgrass

John R. Street and Renee M. Stewart
Horticulture and Crop Science

Introduction

Postemergence crabgrass (*Digitaria* spp.) control for many years was primarily limited to the organic arsenicals (MSMA/DSMA). The organic arsenicals normally require repeat applications for effective postemergence crabgrass control and can cause some phytotoxicity/ injury to desirable turfgrasses, especially in hot weather. Acclaim has shown good to excellent efficacy for postemergence crabgrass control; however, some discoloration and stunting of Kentucky bluegrass may occur and efficacy drops under droughty (dry) soil conditions. A new isomer of Acclaim has been released that provides similar efficacy at significantly lower rates. Recently, some premix formulations of Acclaim with preemergence herbicides have become available. Dimension and Drive are the most recent postemergence crabgrass control herbicides with new chemistry under research evaluation.

Discussion/Summary

Various herbicides and rates were evaluated for postemergence crabgrass control on an established stand of Kentucky bluegrass (Table 1). Herbicides were applied to crabgrass at the 3–5 leaf to 1-tiller stages on July 7, 1995. All repeat and 1–2 tiller applications were made on July 28, 1995. Preemergence herbicide applications were made on April 28, 1995. All liquid applications were made with a CO_2-pressurized sprayer at 88 gpa. Irrigation was withheld for 48 hours after application. The postemergence area was verticut in two directions in mid-April and overseeded with one pound of crabgrass seed per 1,000 ft.^{2} The Kentucky bluegrass stand was maintained at a mowing height of 0.75 inches until two weeks prior to herbicide treatment. A mowing height of 1.75 inches was maintained for the remainder of the postemergence study. An annual total of three pounds of actual nitrogen per 1,000 ft.^{2} was applied during the growing season. Irrigation was provided several times per week prior to herbicide application to encourage crabgrass germination. Thereafter, irrigation was provided as needed to prevent wilt. Treatments were monitored for crabgrass control (percent crabgrass cover) at periodic intervals after herbicide application (Table 1).

Acclaim, in previous research at The Ohio State University, has exhibited good efficacy for postemergence crabgrass control. Acclaim efficacy on crabgrass has been good up to the 3–4 tiller stage where soil moisture is adequate. Efficacy drops dramatically under droughty (dry) soil conditions, sometimes causing erratic results and variability in the field. Acclaim efficacy also is significantly reduced when used in combination with phenoxy herbicides like 2,4-D. Adequate foliar coverage is essential for best results. This entails (1) mowing prior to treatment to open the turf canopy for maximum spray contact on crabgrass foliage, and (2) using sufficient spray volume to assure good foliar coverage. Some stunting and discoloration of Kentucky bluegrass may occur especially in the early season when bluegrass is growing rapidly.

Acclaim (1 EC) provided good postemergence crabgrass control at labeled rates in 1995 (Table 1). Escapes (crabgrass plants not controlled) were more prevalent in 1995 than in past years.

Environmental conditions following application in mid July were severe with high temperatures, high humidity, and above average rainfall. Sunlight intensity was also extreme during the post treatment application period. After August 12 (best efficacy rating date), there was additional crabgrass development from existing plants and/or additional germination. Acclaim rate of activity in our previous Ohio State University research has been described as moderate, killing crabgrass in two to three weeks. Crabgrass knockdown and kill were slightly slower this year, occurring in three to four weeks.

The new isomer of Acclaim (Acclaim Extra — an EW formulation) has provided good to excellent control of crabgrass in postemergence treatments at rates ranging from 0.06 to 0.125 lb. ai/A for the past several years. Acclaim Extra efficacy in 1995 (Table 1) at the 0.06 lb. ai/A rate was only fair when applied at the 3–5 leaf stage. This rate, of course, is on the lower end of the recommended range for this product and was obviously marginal under the 1995 environmental conditions. Acclaim Extra efficacy on 1–2 tiller crabgrass at the 0.088 lb. ai/A rate also was fair with rate of kill extended to four or five weeks.

AGRO 40500 (3.088 EC) is an American Cyanamid premix of Acclaim Extra and pendimethalin. AGRO 40500 worked best at a rate of 3.088 lb. ai/A. Lower rates of AGRO 40500 gave fair to good control. The AGRO 40500 premix (2.059 lb. ai/A rate) was similar to the Acclaim Extra alone (0.059 lb. ai/A rate) indicating no antagonism. Crabgrass development in the post-treatment period (i.e., 8-28 and 9-15) was significantly better with the premix compared to Acclaim and Acclaim Extra alone. Pendimethalin in the premix most likely eliminated additional crabgrass germination.

Dimension is a relatively new herbicide released into the marketplace that exhibits both preemergence and postemergence herbicide activity on crabgrass. Dimension has proven to be an excellent preemergence herbicide. In this trial, Dimension 1 EC applied preemergence at the 0.50 lb. ai/A rate provided excellent season-long crabgrass control. Postemergence activity of Dimension is slow with total kill typically ranging from three weeks (untillered crabgrass) to five weeks (early tillered crabgrass). Dimension does, however, stunt crabgrass in 10 to 14 days making its presence in the turfgrass canopy less noticeable. The crabgrass is initially hidden within the canopy and then eventually dies over a three- to four-week period. During the stunting phase, crabgrass initially turns yellow and then a purple color.

Combinations of Dimension with MSMA (Daconate) have been shown to enhance the rate of crabgrass kill and to improve efficacy. In previous Ohio State University research, Dimension 1 EC rates of 0.25, 0.38, and 0.50 lb. ai/A in combination with 1.0, 0.50, and 0.25 lb. ai/A rates of Daconate, respectively, have proved effective in enhancing the efficacy and rate of activity of Dimension. Dimension in combination with MSMA (Daconate) is not extremely effective beyond the three to four tiller stage. It will cause stunting of crabgrass, but kill may not occur.

In 1995, Dimension EC and FG, at rates ranging from 0.25 to 0.75 lb. ai/A, did not effectively control crabgrass postemergence. Higher rates of either formulations resulted in better efficacy, but control at all rates was unacceptable. Again, the environmental conditions in 1995 were very conducive to crabgrass growth and development, and very conducive to enhanced herbicide breakdown. The higher temperatures and excessive moisture may have resulted in rapid crabgrass maturation with plants more tolerant of Dimension herbicide. Dimension treatments at nine weeks after application exhibited crabgrass covers ranging from 32–60%.

Drive (quinclorac) has proven to be an excellent postemergence crabgrass herbicide. In previous Ohio State University research, Drive activity at rates ranging from 0.25 to 0.75 lb. ai/A has proven very rapid, typically killing crabgrass in seven to 10 days. Drive has also provided excellent efficacy on mature crabgrass at the 0.50 to 0.75 lb. ai/A rates. Drive efficacy does not appear to be as sensitive to soil moisture as Acclaim. In 1995, Drive provided good to excellent control of crabgrass at the 3–5 leaf stage within two to three weeks after herbicide application (Table 1). Drive has some pre-emergence activity resulting in no crabgrass reencroachment after initial knockdown. Drive efficacy at the 0.5 lb. ai/A rate was poor to fair with crabgrass in the 1-2 tiller stage under the summer conditions of 1995.

In general, all postemergence herbicides performed less effectively in 1995 compared to previous years.

Table 1. Efficacy of Postemergence Herbicides on Crabgrass (*Digitaria*).

Herbicide[b]	Formulation[c]	Rate (lbs. ai/A)	Stage	Crabgrass Cover (%)[a] 7-15	7-27	8-12	8-28	9-15
Pendulum	3.3 EC	2.0	Pre[d]	33	33	53	57	65
Dimension	1 EC	0.50	Pre[d]	1	3	4	5	8
Dimension	1 EC	0.25	3-5 leaf	70	63	57	53	55
Dimension	1 EC	0.38	3-5 leaf	70	57	43	40	45
Dimension	1 EC	0.50	3-5 leaf	70	47	30	28	33
Dimension AD 445	0.164 FG	0.25	3-5 leaf	70	70	70	57	60
Dimension AD 446	0.25 FG	0.38	3-5 leaf	70	67	67	57	60
Dimension AD 447	0.25 FG	0.50	3-5 leaf	70	67	53	37	40
Dimension AD 448	0.431 FG	0.75	3-5 leaf	70	60	40	32	32
AGRO 40500	3.088 EC	1.544	3-5 leaf	70	40	15	15	20
AGRO 40500	3.088 EC	2.059	3-5 leaf	70	40	12	12	12
AGRO 40500	3.088 EC	3.088	3-5 leaf	70	25	5	8	8
AGRO 40500	3.088 EC	1.544	3-5 leaf(repeat)	70	40	2	3	2
AGRO 40500	3.088 EC	2.059	3-5 leaf(repeat)	70	33	2	2	2
Acclaim Extra	0.57 EW	0.059	3-5 leaf	70	23	17	22	30
AGRO 40500	3.088 EC	3.088	1-2 tiller	70	72	53	17	20
Acclaim Extra	0.57 EC	0.088	1-2 tiller	70	70	50	12	20
Dimension	1 EC	0.50	1-2 tiller	70	70	60	37	40
Daconate	6 F	1.0	3-5 leaf	63	57	57	67	75
Daconate	6 F	2.0	3-5 leaf	63	53	50	67	70
Drive	50 DF	0.50	3-5 leaf	50	35	5	2	2
Drive	50 DF	0.50	1-2 tiller	70	30	20	30	37
Acclaim	1 EC	0.12	3-5 leaf	70	25	7	20	25
Acclaim	1 EC	0.18	3-5 leaf	70	70	15	18	24
Check	—	—	———	70	78	83	90	95
LSD(0.05)				6.5	7.0	10.5	12.0	9.4

[a] Crabgrass cover is reported as percent crabgrass cover per plot averaged over three replications.
[b] Initial postemergence herbicide application was made on July 7, 1995. Repeat and 1–2 tiller postemergence applications were made on July 28, 1995.
[c] Liquid applications were made at 2 gallons per 1,000 ft.^{2} using a CO_2-pressurized sprayer with a flat fan nozzle.
[d] Preemergence herbicide applications were made on April 28, 1995.

Preemergence Herbicide Efficacy on Crabgrass

John R. Street and Renee M. Stewart
Horticulture and Crop Science

Introduction

The evaluation of preemergence herbicides for crabgrass (*Digitaria* spp.) on established turfgrass is a continuing process. Crabgrass continues to be the No. 1 annual grassy weed target of the majority of herbicide control programs. Periodic evaluations are necessary to determine the suitability of new herbicides for use on various turfgrass species. Periodic evaluations are also helpful in observing and explaining variability in performance which occurs among preemergence herbicides and among years. Herbicide efficacy, reliability, and safety/phytotoxicity are all important in recommending a preemergence herbicide for use on various turfgrass species.

Discussion/Summary

Preemergence herbicides were monitored for crabgrass efficacy and safety/phytotoxicity on Kentucky bluegrass. All herbicides were initially applied on April 28, 1995. Sequential or split applications were made on June 29, 1995. Preemergence herbicides, application rates, and percent crabgrass cover are listed in Table 1. The Kentucky bluegrass stand had been maintained at a mowing height of 1.5 inches prior to initiation of herbicide treatments on April 28. The Kentucky bluegrass area was verticut lightly and overseeded with crabgrass at a rate of 1 lb. per 1,000 ft.^{2} one week prior to herbicide application. On May 11, 1995, the mowing height was lowered to 0.75 inches for the remainder of the study to encourage crabgrass pressure. An annual total of 3.0 lb. N/1,000 ft.^{2} was applied during the growing season. Irrigation was applied several times per week to maintain a moist seedbed for crabgrass germination. Granular herbicides were distributed by a hand-shaker technique. Liquid herbicide applications were made with a CO_2-pressurized sprayer at a volume of 88 gpa. Plots measured 3 ft. by 8 ft., and each treatment was replicated three times in a randomized complete-block design. Treatments were monitored for crabgrass infestation periodically throughout the growing season (see Table 1). No observable phytotoxicity symptoms were apparent from any of the herbicides, so ratings are not reported.

Dimension (dithiopyr) and Barricade (prodiamine) were monitored for a second year in a separate study for safety/phytotoxicity on 'Penncross' creeping bentgrass where PGR (Primo) interactive effects were examined. Dimension and Barricade rates of 0.5 and 1.0 lb. ai/A were used. Herbicide treatments were applied on April 28, 1995. Primo was applied in June, July, and August at a 0.25 fl. oz. rate per 1,000 square feet. Dimension and Barricade exhibited no negative effects on 'Penncross' creeping bentgrass quality throughout the 1995 growing season when applied alone or in combination with Primo. Bentgrass quality was actually enhanced (color and density) by Primo applications.

In the standard preemergence herbicide efficacy study on Kentucky bluegrass, the first crabgrass control ratings were made on June 1 (see Table 1). Crabgrass cover in the untreated plots averaged 12%. All herbicides and rates exhibited excellent efficacy on June 1.

On July 1, several herbicides and rates continued to exhibit good to excellent efficacy (Table 1). Herbicides/rates exhibiting a significant break in efficacy on July 1 were the Dow NAF experimentals (191-192-194) and Pendulum 3.3

EC. Crabgrass control by this latter group would have been considered unacceptable at this early date in the season. The lowest rates of Dimension and Barricade were still exhibiting excellent crabgrass efficacy on July 1.
On August 1, a number of herbicides/rates exhibited failure. All the Dow NAF formulations (191-195) exhibited fair to poor control. Crabgrass pressure was considered good with untreated plots on that date rating 50% or greater crabgrass cover. Barricade at the lowest rate (0.32 lb. ai/A) exhibited a significant break in control. Barricade at the 0.48 lb. ai/A rate also exhibited some crabgrass encroachment. Dimension at all the lower rates (0.06 and 0.09 multiple/sequential) exhibited a significant reduction in efficacy with crabgrass cover averaging 12-25%. Dimension at the single 0.125 lb. ai/A rate also showed signs of breakage. Surprisingly, Dimension at 0.25 and 0.38 lb. ai/A rates was still providing excellent crabgrass control at this time of the season. Pendimethalin at the single 1.5 lb. ai/A rate showed a significant reduction in efficacy by August 1. Pendimethalin (FG or WDG) at the 1.5 multiple/sequential rate continued to display excellent efficacy. Pendulum 3.3 EC exhibited major failure with crabgrass cover similar to the untreated plots.

On September 1, those latter herbicides/rates exhibiting previous breaks in efficacy/control, in general, continued to display increases in crabgrass encroachment. Dimension (EC and FG) at the 0.25 to 0.50 lb. ai/A rates provided excellent season-long control. Dimension at the 0.125 multiple/sequential rate also provided excellent control. Barricade at the 0.65 and 0.75 lb. ai/A rates provided excellent season-long control. Pendimethalin (FG and WDG) at the single 1.5 lb. ai/A rate showed a reduction in control about mid-season, whereas the multiple/sequential rate exhibited good to excellent season-long control. Team (FG) provided only fair season-long control. Pendimethalin efficacy was similar between the FG and WDG formulations. However, Dimension efficacy was always superior with the FG compared to the EC formulation at equivalent rates.

The 1995 growing season was a major year for crabgrass development throughout the state and the Midwest. Preemergence herbicide programs that traditionally have been successful in the majority of cases in previous years failed. Crabgrass populations and pressure were high for many reasons including a wet spring, a very hot summer, above average rainfall, many late afternoon–early evening rains, abundant soil moisture, high nighttime temperatures, and high day and night humidity, resulting in consistently moist canopies. These conditions were not only favorable for crabgrass germination and rapid growth, but also produced an overall stress on turfgrass and reduced its competitive ability. Preemergence herbicides like Pendimethalin required multiple applications for acceptable control. Preemergence herbicides, like Dimension and Barricade, required higher rates for control than reported in previous years. It was indeed the year for crabgrass.

Table 1. Efficacy of Various Preemergence Herbicides on Crabgrass (*Digitaria*), 1995.

Herbicide[b]	Formulation[c]	Rate (lbs. ai/A)	Crabgrass Cover (%)[a] 6-1	7-1	8-1	9-1
Barricade	65 WG	0.32	1	3	15	17
Barricade	65 WG	0.48	0	3	5	10
Barricade	65 WG	0.65	0	0	0	1
Barricade	65 WG	0.75	0	0	0	0
Team	1.25 FG	1.5 & 1.5 (8–10 weeks)	0	4	10	12
Dimension	0.172 FG	0.25	0	0	15	23
Barricade	0.22 FG	0.50	0	1	12	12
Dow NAF 191	0.57 FG	1.0	0	23	47	58
Dow NAF 191	0.57 FG	1.0 & 1.0 (8–10 weeks)	0	13	23	33
Dow NAF 192	0.86 FG	1.5	0	25	43	55
Dow NAF 192	0.86 FG	1.5 & 1.5 (8–10 weeks)	0	25	42	50
Dow NAF 193	1.15 FG	2.0	0	7	20	25
Dow NAF 194	1.72 FG	3.0	0	27	42	50
Dow NAF 195	3.44 FG	6.0	0	5	30	37
Pendimethalin	1.21 FG	1.0 & 1.0 (8–10 weeks)	0	3	22	27
Pendimethalin	1.21 FG	1.5	0	1	20	22
Pendimethalin	1.21 FG	1.5 & 1.5 (8–10 weeks)	0	0	2	4
Dimension	1 EC	0.125	0	0	15	22
Dimension AD 444	0.072 FG	0.125	0	2	8	10
Dimension	1 EC	0.25	0	0	0	2
Dimension AD 445	0.164 FG	0.25	0	0	0	0
Dimension	1 EC	0.38	0	0	0	0
Dimension AD 446	0.25 FG	0.38	0	0	0	0
Dimension	1 EC	0.50	0	0	0	0
Dimension AD 447	0.25 FG	0.50	0	0	0	0
Dimension	1 EC	0.06 & 0.06 (8–10 weeks)	0	2	25	30
Dimension AD 422	0.035 FG	0.06 & 0.06 (8–10 weeks)	0	1	13	17
Dimension	1 EC	0.09 & 0.09 (8–10 weeks)	0	0	25	30
Dimension AD 443	0.052 FG	0.09 & 0.09 (8–10 weeks)	0	2	12	15
Dimension	1 EC	0.125 & 0.125 (8–10 weeks)	0	0	8	13
Dimension AD 444	0.072 FG	0.125 & 0.125 (8–10 weeks)	0	0	2	2
Dimension	1 EC	0.25 & 0.125 (8–10 weeks)	0	0	0	0
Dimension AD 445 & 444	0.164 FG	0.25 & 0.125 (8–10 weeks) & 0.072	0	0	0	0
Dimension	1 EC	0.25 & 0.25 (8–10 weeks)	0	0	0	0
Dimension AD 445	0.164 FG	0.25 & 0.25 (8–10 weeks)	0	0	0	0
Pendimethalin	60 WDG	1.5			0	0
18	20					
Pendimethalin	60 WDG	1.5 & 1.5 (8–10 weeks)	0	0	4	4
Pendulum	3.0 EC		2	17	50	63
Check	——	———	12	22	47	63
LSD (0.05)			4.2	4.9	6.7	10.2

[a] Crabgrass cover is reported as percent crabgrass cover per plot averaged over three replications.
[b] Initial herbicide application made on April 28, 1995. Sequential herbicide application made on June 29, 1995.
[c] Liquid applications were applied at 2 gallons per 1,000 $ft.^2$ using a CO_2-pressurized sprayer with a flat fan nozzle.

Preemergent Common Chickweed Weed Control Evaluation

William Pound
Horticulture and Crop Science

Discussion/Summary

Common Chickweed (*Stellaria media*) is a winter annual broadleaf weed routinely found in turfgrass and landscape areas during the spring period in Ohio. The germination of Common Chickweed seed will begin as early as late September, with most of the germination and seedling establishment occurring in the mid to late fall. Rapid, extensive vegetative development then occurs during the late winter into mid-spring. The concerns from the presence of Common Chickweed, and other winter annual weeds in turfgrass, arise from the aesthetic issues associated with their presence from the time of germination (i.e., mid-fall), until postemergent broadleaf weed control treatments are applied the following spring. The purpose of this evaluation was to quantify the efficacy of both fall and spring treatments of various preemergent turfgrass herbicides on Common Chickweed in turfgrass.

The study was initiated on November 4, 1994, with applications of the fall herbicide treatments. The recommended turfgrass label use rates of the preemergent herbicides Barricade, Gallery, Pendimethalin, Dimension, and Team were evaluated. Barricade was also evaluated at reduced rates and in sequential Fall-Spring treatments. Additionally, two treatments in this evaluation were mixtures of Barricade + Gallery. Of the 17 herbicide treatments, eight were used in fall applications with the remaining nine left until the spring period. On April 11, 1995, the nine remaining treatments received spring applications. Two additional spring treatments of Barricade were applied to treatments No. 4 and 5. These applications represented the spring component of fall-spring sequential treatments.

On April 18, 1995, Common Chickweed plant counts were recorded. The data, expressed as "percent cover," were then statistically analyzed and are provided. Results of this evaluation show the fall applications of the five preemergent herbicides all provided statistically significant control. All fall herbicide applications provided 89–100% control of Common Chickweed. The spring applications of these preemergent herbicides did not provide statistically significant control. Understandably, none of the preemergent herbicides tested in this evaluation have been shown to possess postemergent properties on Common Chickweed. Since this weed, and the other winter annual broadleaf weed usually establish before the spring preemergent applications, these weeds will often persist in the turfgrass area until subsequent postemergent broadleaf herbicides are applied later in the season.

Results of this evaluation show a number of preemergent herbicides are highly efficacious on Common Chickweed, provided the timing of application is prior to the germination and establishment of this weed. Additional studies need to be conducted to determine if a single fall application of any of these preemergent herbicides can, in addition to providing control of at least some winter annual broadleaf weeds, also provide season-long control of the subsequent season's annual grass weeds. Based on the experiences of 1995, if any significant decline in soil herbicide concentration is incurred from a fall application during the late fall through early spring period, season long control of the following season's annual grass weeds would most likely not occur.

Table 1. Common Chickweed Control with Herbicides, 4/18/95.

Treatment	Rate lbs. ai/A	Timing	Common Chickweed % Plot Cover	% Control
1. Barricade	0.65	Fall	0.67	99.1
2. Barricade	0.65	Spring	55.00	10.8
3. Barricade	0.49	Spring	51.67	16.3
4. Barricade	0.49	Fall		
+ Barricade	0.49	Spring	5.00	91.9
5. Barricade	0.65	Fall		
+ Barricade	0.33	Spring	3.67	94.9
6. Gallery	0.75	Fall	0.67	99.1
7. Gallery	0.75	Spring	55.00	10.8
8. Barricade	0.65	Fall	0.00	100.0
+ Gallery	0.75	Fall		
9. Barricade	0.49	Spring	41.67	32.4
+ Gallery	0.38	Spring		
10. Pendimethalin	1.50	Fall	0.00	100.0
11. Pendimethalin	1.50	Spring	65.67	0.0
12. Dimension	0.50	Fall	0.33	99.5
13. Dimension	0.50	Spring	63.33	0.0
14. TEAM	2.00	Fall	7.67	89.4
15. TEAM	2.00	Spring	51.67	16.2
16. Barricade	0.75	Spring	54.33	11.9
17. Barricade	0.97	Spring	50.00	18.9
18. Check	--	Fall	72.33	----
19. Check	--	Spring	61.67	----
		LSD=0.05	29.03	

LOCATION: O.S.U. Howlett Hall Lawn Site
APPLICATION INFORMATION:

FALL APPLICATION

Date: Nov. 4, 1994 Time 9:00 P.M. Temperature: 66 F
Soil moisture: dry Wind speed:12 mph from S
Rain/irr. after app: 37 HAT/0.3"
Turfgrass species: Kentucky bluegrass, P.Rye Cultivar: Common
Height - 2.0" Density - 20-50% Condition - thin
Thatch - none Weed population - 40 - 60%
Testing on site previous year - none.
APPLICATION EQUIPMENT:
Liquid applications: 2.0 gal./1000 ft.^{2} at 35 psi. using Teejet 8002 nozzles
Granular applications (TEAM only) were applied using a shaker can at 2.3 lbs./1000 ft.^{2}
EXPERIMENTAL DESIGN: Randomized Complete-block Design
Plot size: 4.0 ft. by 6.0 ft. No. of reps.: 3 Size aisles: 0.5 ft.; 1.0 ft. between reps.

SPRING APPLICATION

Date - April 11, 1995 Time 9:00 pm. Temperature - 79 F
Soil moisture - field capacity Wind speed -10 mph from SW
Rain/irr. after app: 36 HAT/0.4";
Turfgrass species: KBG/P.Rye Cultivar: common

Preemergent Purple Dead Nettle Weed Control Evaluation

William Pound
Horticulture and Crop Science

Discussion/Summary

Purple Dead Nettle (*Lamium purpureum*) is one of a variety of winter annual broadleaf weeds which commonly invade turfgrass areas in Ohio. This weed is similar in appearance, and is often mistaken for, Henbit (*Lamium amplexicaule*), another winter annual species found in this region.

The germination of winter annual broadleaf weed seed generally begins in mid to late fall and, depending on weather conditions, may continue germinating until early spring. The concerns from the presence of winter annual weeds in turfgrass arise from the aesthetic issues associated with their presence from the time of germination (i.e., late fall) until postemergent broadleaf weed control treatments are applied the following spring. The purpose of this evaluation was to quantify the efficacy of both fall and spring treatments of various preemergent turfgrass herbicides on Purple Dead Nettle in turfgrass.

The study was initiated on November 3, 1994, with applications of the Fall herbicide treatments. The recommended turfgrass label use rates of the preemergent herbicides Barricade, Gallery, Pendimethalin, Dimension, and Team were evaluated. Barricade was also evaluated at reduced rates and in sequential Fall–Spring treatments. Additionally, two treatments in this evaluation were mixtures of Barricade + Gallery.

Of the 17 herbicide treatments, eight received Fall applications with the remaining nine left untreated until the spring period. On April 11, 1995, the nine remaining treatments received Spring applications. Two additional Spring treatments of Barricade were applied to treatments No. 4 and 5. These applications represented the spring component of Fall–Spring sequential treatments.

On April 12, 1995, Purple Dead Nettle plant counts were recorded. Statistical analyses were then conducted on these data and are provided. Results of this evaluation show the Fall applications of the five preemergent herbicides all provided statistically significant control. With the exception of the Team treatment, all Fall applications provided 94–100% control of Purple Dead Nettle. The Spring applications of these preemergent herbicides did not provide statistically significant control.

Understandably, none of the preemergent herbicides tested in this evaluation have been shown to possess postemergent properties on Purple Dead Nettle. Since this weed and the other winter annual broadleaf weeds usually establish before the spring preemergent applications, these weeds will often persist in the turfgrass area until subsequent postemergent broadleaf herbicides are applied later in the season.

Results of this evaluation show that a number of preemergent herbicides are highly efficacious on Purple Dead Nettle, provided the timing of application is prior to the germination and establishment of this weed. Additional studies need to be conducted to determine if a single Fall application of any of these preemergent herbicides can, in addition to providing control of at least some winter annual broadleaf weeds, also provide season-long control of the subsequent season's annual grass weeds. Based on the experiences of 1995, if any significant decline in soil herbicide concentration is incurred from a Fall application during the late Fall through early Spring period, season-long control of the following season's annual grass weeds would most likely not occur.

Table 1. Herbicidal Control of Purple Dead Nettle, 4/12/95.

Treatment	Rate lbs. ai/A	Timing	Purple Dead Nettle No. Plant /Tmt.	% Control
1. Barricade	0.65	Fall	0.33	98.0
2. Barricade	0.65	Spring	12.67	33.3
3. Barricade	0.49	Spring	0.67	54 .4
4. Barricade	0.49	Fall		
+Barricade	0.49	Spring	1.00	94.0
5. Barricade	0.65	Fall		
+Barricade	0.33	Spring	0.00	100.0
6. Gallery	0.75	Fall	0.00	100.0
7. Gallery	0.75	Spring	16.67	12.3
8. Barricade	0.65	Fall		
+ Gallery	0.75	Fall	0.00	100.0
9. Barricade	0.49	Spring		
+ Gallery	0.38	Spring	18.00	5.3
10. Pendimethalin	1.50	Fall	0.00	100.0
11. Pendimethalin	1.50	Spring	15.33	19.3
12. Dimension	0.50	Fall	0.00	100.0
13. Dimension	0.50	Spring	11.67	38.6
14. TEAM	2.00	Fall	6.00	64.0
15. TEAM	2.00	Spring	14.00	26.3
16. Check	--	Fall	16.67	--
17. Check	--	Spring	19.00	--
18. Barricade	0.75	Spring	11.67	38.6
19. Barricade	0.97	Spring	10.67	43.9
		LSD 0.05	10.30	

LOCATION: O.S.U. Turfgrass Research Center
APPLICATION INFORMATION:
FALL APPLICATION
Date: Nov. 3, 1994 Time: 1:30 P.M. Temperature: 67 F
Soil moisture: dry Wind speed: 10 mph from S
Rain/irr. after app: 56 HAT/0.3"
Turfgrass: Species Kent.Blue Cultivar: Improved Blend
Height - 1.0" Density - 25-40% Condition - Seedlings
Thatch - none Irrigation availability: Yes
Weed population: Mixed Testing on site previous year: None
APPLICATION EQUIPMENT:
Liquid applications: 2.0 gal./1000 ft.^{2} at 35 psi using Teejet 8002 nozzles; Technique Single Spray Wand
Granular applications: (TEAM only) were applied using shaker can at 2.3 lb./1000 ft.^{2}
EXPERIMENTAL DESIGN: Randomized Complete-block
Plot Size: 4.0 ft. by 6.0 ft. No. of reps: 3 Size aisles: 0.5 ft., 1.0 ft. between reps.

COMMENTS/CORRECTIONS: All applications were liquid sprays except the application of TEAM 2-G.
SPRING APPLICATION
Date: April 7, 1995 Time: 4:00 P.M. Temperature: 65 F
Soil moisture: field capacity Wind speed: 3 mph from W
Rain/irr. after app. 48 HAT/0.5"
Turfgrass: Species Kent.Bluegrass Cultivar: Improved Blend
Height - 1.0" Density - 10-40% Condition :Seedlings
Thatch - none Irrigation availability: Yes
Weed population: Mixed Testing on site previous year: none
APPLICATION EQUIPMENT:
same as Fall application

COMMENTS/CORRECTIONS:All applications were liquid sprays except the application of TEAM 2-G. Size aisles: 0.5 ft.; 1.0 ft. between reps.

General Turfgrass Broadleaf Weed Control Evaluation

William Pound
Horticulture and Crop Science

Discussion/Summary

The 1995 General Broadleaf Weed Control Evaluation was initiated on May 30, 1995, on a heavy weed-populated turfgrass area located in Worthington, Ohio. The broadleaf weed population consisted primarily of dandelion (*Taraxacum officinale*), buckhorn plantain (*Plantago lanceolata*), and white clover (*Trifolium repens*). Weather summaries for the two-week period prior to the initiation of this evaluation featured favorable daytime temperatures and adequate moisture to support plant growth, which resulted in active growth of all broadleaf weeds, as well as the desirable turfgrass, and provided ideal conditions under which to evaluate broadleaf weed control formulations critically. The weather summaries for the six-week period subsequent to the applications featured near normal temperatures and above normal precipitation at the test location.

Data were collected two, four, and seven weeks after treatment (WAT). The formulations tested in this year's evaluation included 10 granular treatments formulated by The Scotts Company and 23 spray treatments from DowElanco, Riverdale Chemical, and standard treatments. The spray formulations included a variety of active ingredients formulated in amine, ester, emulsifiable concentrate, and dry concentrate formulations. The data from all three reading dates were analyzed and are provided.

During the past six years in which these evaluations have been performed, herbicidal response attributable to the active ingredients was felt to have reached a maximum six to seven WAT. Therefore, the seven WAT data are generally the best data to use to assess overall efficacy and to make comparisons between treatments in the evaluation.

In general, the herbicidal response (i.e., epinasty) data collected two WAT in this year's trial showed a faster initial response to the herbicide treatments compared to last year's two WAT data. The granular treatments were most efficacious when applied to wet foliage. During the application of these granular products, an observation was made that the particles of the S-6272 formulation often deflected off the weed foliage, with less particle retention than that experienced with the S-6271 or S-2776 formulations. This is believed to partially explain the low levels of control achieved from the S-6272 treatments to dry foliage.

Twelve of the 23 spray-applied treatments were DowElanco products or experimental formulations. Two rates of each of four experimental formulations (NAF-99, 100, 101, and 102) were evaluated and compared to the commercial product Turflon Ester. These comparisons were performed as DowElanco is currently evaluating various solvent systems for a potential replacement for the current solvents used in the formulation of Turflon Ester. Both the 0.5 and 1.0 lb. ai/A rates of NAF-99, 100, 101, and 102 were evaluated and compared to the commercial Turflon Ester formulation.

In review of the seven WAT data, all NAF experimental formulations provided statistically similar control to comparable rates of the Turflon Ester formulation on dandelion, buckhorn plantain, and white clover. Even though the results show all formulations to be statistically the same, comparisons between the NAF formulations suggest the NAF-102 experimental, particularly the 0.5 lb./A, may be slightly less efficacious than the other three formulations. This conclusion is based on the seven WAT results of the 0.5 lb. rate of NAF-102 on both dandelion and buckhorn plantain. Additional testing of this formulation on other broadleaf weeds is suggested to confirm or refute the findings of this single evaluation. The addition of MCPP (1.25 lb./A) to Turflon Ester (0.5 lb./A) significantly increased the speed of control and the overall degree of efficacy.

As in previous studies, many of the Riverdale Chemical formulations provided some of the best performances in the evaluation. All Riverdale Chemical products and experimental formulations provided excellent control on dandelion, buckhorn plantain, and white clover.

For an applied assessment of efficacy of the individual treatments, consideration should be given to comparisons to industry standards. For many years now, many turfgrass managers have viewed the three-way combination products (2,4-D, MCPP + dicamba) as those standards. For individuals wishing to make such comparisons, PBI Gordon's Trimec (3.0 pt./A rate) was included in this evaluation. Also, Riverdale Chemical's Triplet possesses the same three-component combination. For turfgrass managers who wish to limit the use of dicamba in urban settings and desire the selection of an efficacious product, ISK Biotech's 2 Plus 2 product was included as a standard to allow that comparison. Lastly, for individuals who desire a non-phenoxy alternative broadleaf weed control product, DowElanco's Confront was included as a standard treatment in this year's trial.

Results of this evaluation show that a number of acceptable broadleaf weed control products are commercially available for use on turfgrass. An additional number of promising experimental formulations and combination products are currently under development.

Table 1. Broadleaf Weed Control on Dandelion and Buckhorn Plantain

			% Dandelion Control			% Plantain Control		
Cooperator	Product [a]	Rate	6/13	6/28	7/19	6/13	6/28	7/19
Scotts	S-6271(Dry)	2.75lb./M	43	58	67	40	38	47
Scotts	S-6271(Wet)	2.75lb./M	57	78	80	50	58	65
Scotts	S-6271(Dry)	3.17lb./M	47	63	65	45	48	55
Scotts	S-6271(Wet)	3.17lb./M	55	87	85	50	77	75
Scotts	S-6272(Dry)	2.66lb./M	22	47	60	25	32	45
Scotts	S-6272(Wet)	2.66lb./M	40	77	79	40	53	65
Scotts	S-6272(Dry)	3.06lb./M	30	43	63	32	42	50
Scotts	S-6272(Wet)	3.06lb./M	48	80	81	50	62	64
Scotts	S-2776(Dry)	2.86lb./M	27	55	57	25	52	52
Scotts	S-2776(Wet)	2.86lb./M	52	78	80	47	65	67
DowElanco	Turfln Est	0.50 lb./A	63	80	85	48	73	68
DowElanco	Turfln Est	1.00 lb./A	70	89	92	62	82	77
DowElanco	NAF- 99	0.50 lb./A	62	77	85	55	68	67
DowElanco	NAF- 99	1.00 lb./A	68	87	90	60	76	75
DowElanco	NAF-100	0.50 lb./A	57	80	83	50	70	64
DowElanco	NAF-100	1.00 lb./A	71	87	90	72	78	75
DowElanco	NAF-101	0.50 lb./A	58	83	83	55	65	63
DowElanco	NAF-101	1.00 lb./A	73	90	89	70	75	72
DowElanco	NAF-102	0.50 lb./A	58	76	77	52	60	60
DowElanco	NAF-102	1.00 lb./A	67	88	88	62	67	70
DowElanco	Turfln Est+ MCPP	0.50 lb./A 1.25 lb./A	80	96	95	75	92	92

Table 1 (Continued). Broadleaf Weed Control on Dandelion and Buckhorn Plantain

Cooperator	Product [a]	Rate	% Dandelion Control 6/13	6/28	7/19	% Plantain Control 6/13	6/28	7/19
Riverdale	Tri-Power Dry	2.32 lb./A	70	93	97	69	90	92
Riverdale	Tri-Power	48.0 oz./A	72	93	97	70	91	93
Riverdale	Dissolve	2.50 lb./A	77	95	95	73	92	93
Riverdale	Triplet WS	2.67 lb./A	78	93	95	77	90	92
Riverdale	Triplet WS	2.00 lb./A	75	90	94	72	87	87
Riverdale	Triplet	3.00 pt./A	75	89	95	77	87	89
Riverdale	RCATD11-95	37.0 oz./A	80	92	93	77	87	85
Riverdale	RCATD21-95	43.0 oz./A	77	92	95	73	87	88
Riverdale	RCATDE-95	43.0 oz./A	78	92	93	75	89	89
DowElanco	Confront	0.75 lb./A	77	91	92	73	83	84
Standard	Trimec	3.0 pt./A	78	93	96	73	89	91
Standard	2 Plus 2	3.0 qt./A	77	95	93	75	90	90
Check		----	0	0	0	0	0	0
	LSD Value =0.05		9.16	7.90	8.56	8.55	9.97	9.17

[a] "Dry" designation refers to dry foliage, "Wet" designation refers to wet foliage.

Table 2. Broadleaf Weed Control on White Clover

Cooperator	Product	Rate	% White Clover Control 6/13	6/28	7/19
Scotts	S-6271(Dry)	2.75lb./M	60	78	83
Scotts	S-6271(Wet)	2.75lb./M	72	92	92
Scotts	S-6271(Dry)	3.17lb./M	57	82	87
Scotts	S-6271(Wet)	3.17lb./M	68	93	95
Scotts	S-6272(Dry)	2.66lb./M	40	65	82
Scotts	S-6272(Wet)	2.66lb./M	60	90	93
Scotts	S-6272(Dry)	3.06lb./M	47	78	82
Scotts	S-6272(Wet)	3.06lb./M	58	94	95
Scotts	S-2776(Dry)	2.86lb./M	37	80	82
Scotts	S-2776(Wet)	2.86lb./M	60	92	92
DowElanco	Turfln Est	0.50 lb./A	80	93	96
DowElanco	Turfln Est	1.00 lb./A	87	95	98
DowElanco	NAF- 99	0.50 lb./A	80	91	92
DowElanco	NAF- 99	1.00 lb./A	87	93	95
DowElanco	NAF-100	0.50 lb./A	75	93	91
DowElanco	NAF-100	1.00 lb./A	88	98	98
DowElanco	NAF-101	0.50 lb./A	70	92	92
DowElanco	NAF-101	1.00 lb./A	85	98	98
DowElanco	NAF-102	0.50 lb./A	75	93	92
DowElanco	NAF-102	1.00 lb./A	82	95	97
DowElanco	Turfln Est+ MCPP	0.50 lb./A 1.25 lb./A	93	100	100

Table 2 (Continued). Broadleaf Weed Control on White Clover

Cooperator	Product	Rate	% White Clover Control 6/13	6/28	7/19
Riverdale	Tri-Power Dry	2.32 lb./A	90	100	100
Riverdale	Tri-Power	48.0 oz./A	89	100	100
Riverdale	Dissolve	2.50 lb./A	85	99	100
Riverdale	Triplet WS	2.67 lb./A	90	99	99
Riverdale	Triplet WS	2.00 lb./A	87	96	96
Riverdale	Triplet	3.00 pt./A	87	95	96
Riverdale	RCATD11-95	37.0 oz./A	87	96	95
Riverdale	RCATD21-95	43.0 oz./A	84	96	98
Riverdale	RCATDE-95	43.0 oz./A	84	98	99
DowElanco	Confront	0.75 lb./A	87	100	100
Standard	Trimec	3.0 pt./A	85	100	100
Standard	2 Plus 2	3.0 qt./A	85	100	99
Check	-----	----	0	0	0
LSD Value (@0.05)			9.80	8.13	6.41

LOCATION: United Methodist's Childrens Home - Worthington, Ohio
APPLICATION INFORMATION:
Date: May 30, 1995 Time: 4:00 P.M. Temperature: 70 F
Soil moisture: saturated Wind speed:< 5 mph from W
Rain/irr. after app: 40 hours/0.75 in.
Turfgrass: species KBG blend Cultivar: common types
Height - 2.5" Density - 85-95% Condition - excellent
Thatch - < 0.25 " Irrigation availability: none
Weed population: 40 - 60 %
Testing on site previous year: none
APPLICATION EQUIPMENT:
Liquid applications: 2 gpm at 35 psi using Teejet 8002 nozzles
Granular applications: Shaker can per protocols

EXPERIMENTAL DESIGN: Randomized Complete-block Design
Plot size: 4 ft. by 8 ft. No. of reps: 3; Aisle between: treatments 1 ft., replications 2 ft.

COMMENTS/CORRECTIONS: The weather conditions for May 30, 1995: heavy morning dew, bright sunshine with high temp. of 72 F. Plots receiving granular treatments were irrigated immediately prior to applications of the granular products. All granular treatments were applied between 4:30 and 5:30 P.M. The spray treatments were applied between 5:30 and 6:30 P.M.

Finale/Roundup Herbicide Demonstration Evaluation

William Pound
Horticulture and Crop Science

Discussion/Summary

In 1994, AgrEvo USA Company commercialized the compound glufosinate-ammonium, a new non-selective herbicide, under the trade name "Finale" in the turfgrass market. Since 1990, five years of evaluations have been conducted at The Ohio State University's Turfgrass Research Center quantifying the turfgrass uses and benefits of glufosinate-ammonium. The purpose of the 1995 evaluation was to compare the performance of glufosinate-ammonium to glyphosate (trade name Roundup) as a non-selective herbicide.

A study was initiated on August 2, 1995, comparing the performance of glufosinate-ammonium at a 4.0 oz./gallon rate to glyphosate at a 2.7 oz./gallon rate. Three separate applications were made on three separate sets of plots. The application dates were August 2, 11, and 14, 1995. This procedure allowed a static display to be featured at the 1995 Ohio State University Turfgrass Research Field Day on August 16, exhibiting the performance features of glufosinate-ammonium at two, five, and 14 DAT verses the activity of glyphosate under a similar treatment schedule.

Results of this evaluation showed similar trends as those observed in previous year's trials with the glufosinate-ammonium treatments providing faster turfgrass discoloration than glyphosate. Glufosinate-ammonium treatments consistently provided 90% discoloration at five DAT. However, glyphosate provided significantly faster turfgrass discoloration than in previous year's evaluations. In the 1995 trial, glyphosate applications consistently resulted in 70% discoloration at five DAT compared to 35–40% discoloration at five DAT in previous year's trials. The accelerated rate at which glyphosate applications resulted in turfgrass discoloration is presumably due to the abnormally high temperatures experienced during the trial period. Daytime temperatures consistently averaged 90–93 F, and nighttime lows were in the 70s during the August 2–16 period. These temperatures are presumably responsible for both faster translocation of the glyphosate to the underground plant parts and an accelerated rate of desiccation of the foliar portions of the plants following disruption in root function.

Glufosinate-ammonium continued to performed well in our trials as a trimmer/edger product. Line integrity continues to be a strong asset of this product. Due to this property, glufosinate-ammonium is fast becoming the preferred product option for edging along fences, around trees, ornamental beds, etc. Most other edger products on the market create rough, uneven lines which distract from the precision and aesthetics of the applications.

The results of this investigation show glufosinate-ammonium to be highly efficacious as a non-selective herbicide and to offer some unique herbicidal benefits in the manicuring of commercial and residential turfgrass areas.

Table 1. Percent of Turfgrass Discoloration (1-100, where 100=100% Brown)

Treatment	2 DAT[a] (48 HAT)	3 DAT (72 HAT)	5 DAT (120 HAT)	6 DAT (144 HAT)	8 DAT (192 HAT)	14 DAT (336 HAT)
Finale (4.0 oz./gal)	40	65	90	100	100	100
Roundup (2.7 oz./gal)	10	35	70	85	100	100
Check	0	0	0	0	0	0

DAT — Days After Treatment, HAT — Hours After Treatment

LOCATION: OSU Turfgrass Research Center-Range #9, North End
APPLICATION INFORMATION:
Application #1:
Date: Aug 2, 1995 Time: 8:30 P.M. Temperature: 85 F
Soil moisture: field capacity Wind Speed: 5 mph, from SE
Rain/irr. after app: 32 hours Relative humidity: 62%
Skies: partly cloudy
Application #2:
Date: Aug 11, 1995 Time: 5:00 P.M. Temperature: 90 F
Soil moisture: field capacity Wind speed: 5 mph, from NW
Rain/irr. after app: 32 hours Relative humidity: 58%
Skies: clear
Application #3:
Date: Aug 14, 1995 Time: 1:30 P.M. Temperature: 91 F
Soil moisture: field capacity Wind speed: 5 mph, from W
Rain/irr. after app: 16 hours Relative humidity: 57%
Skies: clear

Turfgrass species: KBG Cultivar: Improved Blend
Height - 2.5" Density - 100% Condition - Good
Thatch - < 0.5" Irrigation availability: Yes
Testing on site previous year: None
APPLICATION EQUIPMENT:
Liquid applications: 2 gal./1000 ft.^{2} at 35 psi using Teejet 8002
EXPERIMENTAL DESIGN: Not Applicable
Plot Size: 4 ft. by 6 ft.; No. of reps: 1; Size aisle: 1 ft., between replications - N/A
COMMENTS/CORRECTIONS: Turfgrass discoloration ratings collected August 16, 17 and 18, 1995.

Ground Ivy Control Evaluation

William Pound
Horticulture and Crop Science

Discussion/Summary

Ground ivy (*Glechoma hederacea*) is reported by Ohio's turfgrass managers to be one of the top eight most difficult broadleaf weeds to eradicate from turfgrass areas. Ground ivy is a perennial plant with aggressive creeping stems (stolons) that allow this weed to spread very quickly throughout cool season grass lawns. Even after ground ivy has been eliminated from a turfgrass area, reinvasion from ornamental beds, surrounding lawns, and other perimeter areas can occur very quickly.

For the past three years, numerous turfgrass managers in Ohio have expressed concerns regarding the inability of their broadleaf weed control programs to eliminate ground ivy. The majority of these concerns have been raised by lawn care personnel in the northeast region of Ohio. For this reason, a turfgrass area heavily invaded with ground ivy in Wooster, Ohio, was selected. The purpose of this evaluation was to quantify the efficacy of various commercial turfgrass broadleaf herbicides on ground ivy in turfgrass.

The study was initiated on June 15, 1995. Eight commercial broadleaf herbicide products were evaluated in this study and included the active ingredients 2,4-D, MCPP, 2,4-DP, Dicamba, Triclopyr, and Clopyralid. Ground ivy control data were recorded two, four, six, 10, and 22 weeks after treatment (WAT). Statistical analyses were performed on these data.

Results of this evaluation show a number of highly efficacious herbicides are commercially available to turfgrass managers. Data collected two weeks after treatment (2 WAT) show the herbicides Super Trimec, Dissolve, and 2 Plus 2 provided statistically similar levels of discoloration ranging from 80.0–85.0%. At four WAT, six of the eight herbicide treatments resulted in greater than 85% control of ground ivy.

Previous studies have shown the most accurate assessment of herbicide efficacy is recorded six to eight WAT. Data collected six WAT showed that seven of the eight herbicide treatments resulted in levels of control greater than 94%. The only herbicide treatment that did not provide a highly efficacious response was Dicamba. Initial epinasty recorded at two WAT did not progress to control of this weed as recorded six WAT.

Ground ivy, like many perennial turfgrass weeds, possesses vegetative structures that persist in development and encroachment in turfgrass areas. In this evaluation, none of the herbicides tested provided total eradication of the ground ivy within the treated plots following a single herbicide application. Aggressive stolon development then allowed the remaining plants to begin the reestablishment of a vast network of ground ivy plants and associated stolons. These stolons also allow reestablishment to occur from perimeter areas. Data collected 10 and 22 WAT show encroachment of the ground ivy from untreated aisles and border areas. The development of uncontrolled plants within the plots and from perimeter areas was limited at 10 WAT, but greater populations of ground ivy were observed within the treated plots at 22 WAT.

The results of this study show ground ivy to be a formidable opponent in the eradication of broadleaf weeds from turfgrass areas. Currently, no commercial products are available that can be expected to routinely provide 100% control on this weed following a single application. This is especially true in areas with high populations of this weed similar to the conditions of the area in which this evaluation was conducted. Turfgrass managers who desire selective control on ground ivy in turfgrass are encouraged to select products containing high levels of 2,4-D, MCPP, and/or Triclopyr. Although not tested in this evaluation, a repeat application four to six weeks after the initial application would be expected to further assist in the eradication of this weed. In addition to proper herbicide selection, proper spraying technique using low volume and fine droplets to coat the plants and minimize runoff will further assist turfgrass managers in the control of this weed.

Table 1. Ground Ivy Control
(Percent control rated 1-100 where 100 = 100% control)

Treatment	Rate (per acre)	2 WAT	4 WAT	6 WAT	10 WAT	22 WAT
2,4-D (Weedar 64)	4.0 pt.	71.7	89.7	94.3	92.7	86.0
2,4-D+ MCPP (2 Plus 2)	3.0 qt.	82.3	96.0	98.3	90.3	82.7
2,4-D+MCPP + 2,4-DP (Dissolve)	2.5 lb.	80.0	95.0	98.0	92.3	83.7
2,4-D+ MCPP + dicamba (Trimec)	4.0 pt.	72.7	86.7	94.7	91.3	76.3
Dicamba (Banvel)	1.0 pt.	3.3	6.7	0.0	0.0	0.0
2,4-D+ 2,4-DP + Dicamba (Super Trimec)	3.0 pt.	85.0	94.3	96.0	94.0	82.7
Triclopyr (Turflon Ester)	2.0 pt.	75.0	90.0	96.7	92.0	85.0
Triclopyr+ Clopyralid (Confront)	2.0 pt.	51.7	60.0	95.3	94.7	87.0
Check	----	0.0	0.0	0.0	0.0	0.0
LSD 0.05		5.9	8.1	3.7	5.7	4.9

LOCATION: Campus Grounds at OARDC - Wooster, Ohio
APPLICATION INFORMATION
Date: June 14, 1995 Time: 4:30 P.M. Temperature: 79 F
Soil moisture: field capacity Wind speed: 6 mph from W
Rain/irr. after app: 72 HAT/0.3"
Turfgrass species: KBG Cultivar: improved blend
Height - 2.5" Density - 70-80% Condition - Fair
Thatch - none Irrigation availability: No
Weed population: ground ivy population - 40-65% cover
Testing on site previous year - none
APPLICATION EQUIPMENT:
Liquid applications: 2.0 gal./1000 ft.^{2} at 35 psi using Teejet 8002 nozzles
EXPERIMENTAL DESIGN: Randomized Complete-block Design
Plot Size: 4.0 ft. by 7.0 ft.; No. of reps: 3; aisles between - treatments 1.0 ft., replications 1.0 ft.
COMMENTS/CORRECTIONS: All applications were liquid sprays.

Manage Yellow Nutsedge Control Evaluation

William Pound
Horticulture and Crop Sciences

Discussion/Summary

Yellow nutsedge (*Cyperus esculentus* L.) is a common weed in many high-quality cool-season turfgrass areas. This weed is a warm-season perennial plant characterized by an erect and triangular-shaped stem. The leaves are yellowish-green with a very waxy cuticle. Yellow nutsedge produces an extensive fibrous root system with many nut-like tubers. These tubers, combined with the ability to produce rhizomes, allows this perennial plant to spread within turfgrass areas. Because of the growth habit, color, and rapid growth rate above the normal maintenance height, it is a prominent distraction in the aesthetics of high-quality turfgrass. Few areas are immune to invasion from this weed as yellow nutsedge is common in home lawns, industrial sites, sod farms, athletic fields, and most golf course areas.

In 1995, Monsanto Chemical Company commercially introduced a new herbicide for nutsedge control in turfgrass. This herbicide, trade name Manage, was tested extensively throughout Ohio in 1994 under an EUP program. The purpose of this evaluation is to further quantify the efficacy of Manage on yellow nutsedge and compare the effectiveness with other commercial turfgrass yellow nutsedge control products.

The study was initiated on August 2, 1995. Manage was applied at four (0.5, 1.0, 2.0, and 4.0 oz. ai/acre) product rates. Also included in this evaluation were Basagran at a 1.0 pt./acre rate and Daconate 6 at 2.67 pt./acre. Yellow nutsedge discoloration data were collected five, seven, 15, 22, and 28 DAT. Statistical analyses were conducted on the data for all five reading dates and are provided.

Results of this evaluation show Manage to be highly efficacious on yellow nutsedge. At 28 DAT, all four rates provided statistically similar responses on yellow nutsedge with discoloration ranging from 96.0–100.0%. The primary difference between the Manage treatments was the speed of activity. The speed of activity increased as the rate of application increased up to 4.0 oz. ai/acre. In general, across the first four reading dates, the lowest rate (0.5 oz. ai/acre) provided the least discoloration of the four Manage treatments. Similarly, the highest rate (4.0 oz. ai/acre) provided the fastest discoloration response.

Basagran provided excellent initial discoloration and the highest degree of efficacy of any of the treatments at seven and 15 DAT. Daconate 6 provided intermediate initial discoloration and the lowest degree of efficacy (87.3%) of the treatments at 28 DAT. Turfgrass managers will find yellow nutsedge control with Manage to occur slower than with Basagran. Results of this evaluation indicate Manage treatments require three to four weeks for total control compared with one to two weeks with Basagran.

One of the promoted benefits of Manage is its alleged safety on high-quality turfgrass. Due to the sparse nature of the turfgrass at this test site, the tolerance feature vs. other commercial products could not be assessed. Additional testing is recommended to quantify the safety/tolerance of Manage on high-quality turfgrass as this attribute may be a significant performance feature of this product.

Table 1. Yellow Nutsedge Control
(Percent Yellow Nutsedge Discoloration rated 1-100 where 100=Total Brown)

Treatment	Rate (per acre)	8/07/95	8/09/95	8/17/95	8/24/95	8/30/95
Manage	0.5 oz. ai	13.3 D	28.3 C	65.0 D	90.7 D	96.0 A
Manage	1.0 oz. ai	20.0 C	38.3 B	66.7 D	94.0 C	100.0 A
Manage	2.0 oz. ai	21.7 C	38.3 B	71.7 C	97.0 B	100.0 A
Manage	4.0 oz. ai	31.7 B	41.7 B	80.0 B	99.3 AB	100.0 A
Basagran	2.00 pt.	68.3 A	90.0 A	98.3 A	100.0 A	100.0 A
Daconate 6	2.67 pt.	23.3 C	18.3 D	71.7 C	88.3 D	87.3 B
Check	----	0.0 E	0.0 E	0.0 E	0.0 E	0.0 C
LSD @ 0.05		4.2	4.7	4.8	2.7	4.7

APPLICATION INFORMATION:
LOCATION: OSU Turfgrass Research Center, Zone #9
Date: Aug. 2, 1995 Time: 7:30 P.M. Temperature: 85 F
Soil Moisture: Field Capacity Wind Speed: 5 mph from SE
Rain/irr. after app: 48 HAT/0.3"
Turfgrass apecies: KBG Cultivar: improved blend
Height - 2.5" Density - 70-80% Condition - good
Thatch - none Irrigation availability: No
Weed population: 30-60% yellow nutsedge and yellow foxtail
Testing on Site Previous Year: none

APPLICATION EQUIPMENT:
Liquid applications: 2.0 gal./1000 $ft.^2$ at 35 psi using Teejet 8002 nozzles
EXPERIMENTAL DESIGN: Randomized Complete-block Design
Plot Size: 4 ft. by 7 ft.; No. of reps: 3; aisles between- treatments 1 ft., replications 1 ft.
COMMENTS/CORRECTIONS: All applications were liquid sprays.

Alternative Turflon Solvent Tolerance Evaluation

William Pound
Horticulture and Crop Science

Discussion/Summary

The DowElanco product, Turflon Ester, is currently formulated in a solvent system containing petroleum distillates. A research effort is underway to evaluate alternative solvents that chemically preserve triclopyr's stability, yet maintain comparable efficacy and selective tolerance on the desirable turfgrasses.

In this year's research program at The Ohio State University, two alternative solvent system evaluations were conducted with the alternative solvent formulations. The first evaluation tested and compared the efficacy of two rates (0.5 and 1.0 lb. ai/A) of four alternative solvents (NAF-99, NAF-100, NAF-101, and NAF-102) to the current Turflon Ester commercial formulation on three common broadleaf weed species. In general, the results of that evaluation concluded that the experimental formulations provided comparable efficacy to the current Turflon Ester product on the weeds present.

On July 3, 1995, a second study was initiated on high-quality Kentucky bluegrass to quantify the injury/phytotoxicity potentials of the alternative solvent-based formulations on the desirable turfgrass. Turfgrass injury data were collected seven, 14, 21, 28, and 35 DAT.

Applications of triclopyr-containing products can have a significant impact on turfgrass quality. In comparison with the untreated check, the turfgrass injury data showed that varying degrees of phytotoxicity (expressed as reduced growth rates, discoloration, etc.) accompanied applications of both the 0.5 and 1.0 lb. ai/A rates of the Turflon Ester and all four alternative solvent experimentals. The highest incidence of statistically significant turfgrass injury was observed at the 1.0 lb. rates of Turflon Ester and the four experimental formulations. This injury was most severe 14–21 DAT with subtle injury still present 28 DAT. Significantly reduced injury was observed from only one formulation and on one reading date. Data collected seven DAT indicate that both the 0.5 and 1.0 lb. ai/A rates of NAF-101 resulted in significantly less injury than corresponding rates of any of the other formulations in this evaluation. However, during the peak period of turfgrass injury (14–21 DAT), no significant differences in turfgrass injury were observed between any of the treatments.

In summary, the results of this evaluation indicate, in comparison to the current formulation, that the alternative triclopyr solvent formulations do not negatively impact turfgrass quality. These results suggest applications of the NAF-101 formulation may result in slightly less initial (seven DAT) turfgrass injury levels when compared to similar rates of the current Turflon Ester formulation, but during the peak period of turfgrass injury, no significant reduction in injury can be anticipated.

Table 1. Percent Turfgrass Injury from Herbicide Application

Treatment	Rate (lb. ai/A)	(% Injury of 1-10, 10=100% Brown) 7/10	7/17	7/24	7/31	8/07
Turflon Ester	0.5	0.40	1.33	1.33	0.30	0.00
Turflon Ester	1.0	0.67	2.17	2.17	0.60	0.17
NAF-99	0.5	0.13	0.80	0.87	0.20	0.00
NAF-99	1.0	0.37	2.00	2.07	0.73	0.13
NAF-100	0.5	0.27	1.33	1.30	0.30	0.10
NAF-100	1.0	0.43	2.07	2.13	0.60	0.20
NAF-101	0.5	0.00	0.83	0.93	0.17	0.03
NAF-101	1.0	0.17	1.73	1.83	0.50	0.13
NAF-102	0.5	0.23	0.77	0.83	0.17	0.00
NAF-102	1.0	0.47	1.20	1.80	0.50	0.07
Turflon Ester	0.5	0.47	1.03	0.90	0.33	0.13
+ MCPP	1.25					
Check	----	0.03	0.17	0.17	0.00	0.00
LSD (0.05)	0.278	0.582	0.487	0.195	0.16	

APPLICATION INFORMATION
LOCATION: OSU Turfgrass Research Farm - Northeast Zone
Date: 7-03-95 Time: 4:00 P.M. Temperature: 73 F
Soil moisture: Field Capacity Wind seed: 7-9 mph fom N
Rain/ir. after app: 50 hr. - 0.03"
Turfgrass species: KBG Cultivar: Improved,Unknown
Height - 2.75" Density - 85-100% Condition - good
Thatch - <0.25 " Irrigation availability: Yes
Weed population: <10%
Testing on Site Previous Year: None

APPLICATION EQUIPMENT:
Liquid applications: 2.0 gpm at 35 psi using Teejet 8002 with hand spray wand

EXPERIMENTAL DESIGN: Randomized Complete-block Design
Plot Size: 3 ft. by 7 ft.; No. of reps: 3
Aisles between: treatments 0.5 ft. and replications 1 ft.

COMMENTS/CORRECTIONS: Area was well maintained with routine fertilizations and timely mowing prior to initiation of this evaluation.

Wild Violet Control Evaluation

William Pound
Horticulture and Crop Science

Discussion/Summary

Wild violet (*Viola* spp.) is a prevalent and persistent broadleaf weed found in many turfgrass areas in Ohio. Even though more than 100 different violet species have been identified east of the Mississippi River, most share many commonalities. Many of the species are perennial types exhibiting heart-shaped leaves with serrated (toothed) margins and purple flowers. The combination of vegetative structures (i.e., branching rootstock) and, in some species, stolons, allow these perennial types to persist indefinitely in turfgrass areas. Many violet species are best adapted to moderate shade environments but can also establish and persist in sunny areas as well. The purpose of this evaluation was to quantify the efficacy of various commercial turfgrass broadleaf herbicides on wild violet in turfgrass.

The study was initiated on June 16, 1995. Eight commercial broadleaf herbicide products were evaluated in this study and included the active ingredients 2,4-D, MCPP, 2,4-DP, Dicamba, Triclopyr, and Clopyralid. Wild violet control data were recorded one, two, three, four, five, six, and seven weeks after treatment (WAT). Statistical analyses were performed on these data and are provided.

Results of this evaluation show the product Turflon Ester (active ingredient Triclopyr) to possess the greatest efficacy of the products tested on wild violet. At seven WAT, from a single application of Turflon Ester (2 pt./acre), 81% of the wild violets were eliminated from the turfgrass area. The second best performing treatment in this evaluation was achieved with Confront (Triclopyr + Clopyralid) applied at a 2 pt./acre rate. This treatment provided 73% control seven WAT. None of the remaining six treatments in this evaluation provided greater than 30% wild violet control. The various phenoxy herbicides and phenoxy herbicide combinations provided 18–30% control at seven WAT. Dicamba (Banvel at 0.5 lb. ai/A), as a single treatment, provided only 11.7% control and was the least effective herbicide treatment in this evaluation. These results would suggest 2,4-D to be only slightly efficacious on wild violet. The active ingredients MCPP, 2,4-DP, and Dicamba failed to provide any additive or synergistic contributions in the control of this weed.

The results of this study show wild violet to be a formidable opponent in the eradication of broadleaf weeds from turfgrass areas. Currently, no commercial products are available that can be expected to routinely provide 100% control on this weed. Turfgrass managers who desire selective control on wild violet in turfgrass are encouraged to select products containing triclopyr (Turflon Ester and Confront) for the applications. The repeated use of triclopyr-containing herbicides can be expected to result in the eradication of wild violet. When herbicide programs are limited to the use of phenoxy-containing herbicides, single applications can be expected to provide only a limited degree of suppression of this weed. Wild violet eradication with phenoxy based herbicides, if possible, will most likely require numerous repeat applications over an extended period of time.

Table 1. Wild Violet Control
(Percent Control rated 1-100 where 100=100% Control)

Treatment	Rate (per acre)	1 WAT	2 WAT	3 WAT	4 WAT	5 WAT	6 WAT	7 WAT
2,4-D (Weedar 64)	4.0 pt	25.0	13.3	11.7	18.3	25.0	28.3	30.0
2,4-D+ MCPP (2 Plus 2)	3.0 qt	28.3	18.3	13.3	18.3	30.0	28.3	28.3
2,4-D+ MCPP+ 2,4-DP (Dissolve)	2.5 lb	33.3	23.3	11.7	16.7	25.0	20.0	18.3
2,4-D+ MCPP+ Dicamba (Trimec)	4.0 pt	30.0	20.0	13.3	20.0	25.0	16.7	20.0
Dicamba (Banvel)	1.0 pt	23.3	26.7	13.3	10.0	11.7	11.7	11.7
2,4-D+ 2,4-DP + Dicamba (Super Trimec)	3.0 pt	38.3	26.7	25.0	23.3	30.0	28.3	26.7
Triclopyr (Turflon Ester)	2.0 pt	80.0	76.7	81.7	81.7	83.3	86.0	81.7
Triclopyr+ Clopyralid (Confront)	2.0 pt	61.7	65.0	75.0	76.7	75.0	75.7	73.3
Check	----	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LSD 0.05		5.49	8.09	6.99	7.42	10.89	9.77	8.59

LOCATION: home lawn - Newark, Ohio
APPLICATION INFORMATION:
Date: June 15, 1995 Time: 11:00 am Temperature: 82 F
Soil moisture: field capacity Wind speed: 5 mph from W.
Rain/irr. after application: 56 HAT/0.2"
Turfgrass species: KBG Cultivar: common
Height - 2.5" Density - 80-90% Condition - fair
Thatch - none Weed population: Wild violet population: 40-70% Irrigation availability: no
Testing on site previous year: None
APPLICATION EQUIPMENT:
Liquid applications: 2.0 gal./1000 ft.^{2} at 35 psi using Teejet 8002 with single spray wand
EXPERIMENTAL DESIGN: Randomized Complete-block Design
Plot size: 3 ft. by 6 ft. No. of reps.: 3. Size aisles: 0.5 ft.; 1 ft. between reps.
COMMENTS/CORRECTIONS: All applications were liquid sprays.

Turfgrass Disease Management

Leaf Spot Study — 1995

Joe Rimelspach, Karl Danneberger, and Jill Taylor
Plant Pathology; Horticulture and Crop Science

Introduction

On May 1, 1995, a leaf spot (*Drechslera poae*) study was initiated on a common Kentucky bluegrass turf range at The Ohio State University Turfgrass Research Center in Columbus, Ohio. The turf had received a minimal amount of nitrogen during the spring. Fungicides were applied with a CO_2 sprayer with nozzle tips 8010 operating at 40 psi. All treatments were applied in randomized complete design and replicated three times. The plots measured 3 ft. by 8 ft. Percent leaf spot in each plot was measured.

The fungicide application schedule was as follows:

	Dates of Application			
Fungicides	**5/1**	**5/15**	**5/24**	**5/30**
IB 11521	X	X		X
Eagle 40W + Fore 80WP	X	X		X
Scotts FFII		X		X
RH-0611 62.2WP	X	X		X
Curalan DF	X			X
Daconil Ultrex	X	X		X
Curalan DF + Fore FLO	X		X	
Curalan DF + Fore FLO	X		X	
IB 11924				X

Results

Scotts FFII, IB11521, and IB11924 provided good to excellent leaf spot control in this study. Daconil Ultrex controlled leaf spot effectively, but the control period was less than 14 days. Curalan DF did not perform as well as in past years.

Table 1. Efficacy of Fungicides on Leaf Spot.

Treatment	Rate (oz./M)[a]	Interval (days)	Leaf Spot (%) 5/22	Leaf Spot (%) 6/6
IB 11521	2.75	14	3.3 a	5.0 a
Eagle 40W + Fore 80WP	0.6 + 4.5	14	5.0 a	10.0 ab
Scotts FFII	1X	21	6.7 a	0.0 a
RH-0611 62.2WP	6.0	14	8.3 ab	11.7 ab
Curalan DF	2.7 lbs. ai	21	11.7 abc	21.7 b
Daconil Ultrex	3.8	14	18.3 abcd	6.7 ab
Curalan DF + Fore FLO	1.35 + 4.0 lbs. ai	21	28.3 bcde	40.0 c
Curalan DF + Fore FLO	1.35 + 2.7 lbs. ai	21	41.7 e	18.3 b
IB 11924	2	75	14	--- 8.3
ab				
Control			30.0 cde	53.3 c
LSD			20.8	15.5

[a] M=1000 ft.²

Leaf Spot Control Study — Galena, Ohio

Joe Rimelspach, Karl Danneberger and Jill Taylor
Plant Pathology; Horticulture and Crop Science

Introduction

A leaf spot (*Drechslera poae*) was initiated on May 15, 1995, on a common Kentucky bluegrass homelawn in Galena, Ohio. The turf was mowed at 3-inch height of cut, irrigation was available but not used, and the thatch layer was less than 0.5 inches. The plot size measured 8 ft. by 3 ft., and each treatment was replicated three times in a randomized complete-block design. Treatments were made with a small-plot CO_2 sprayer with nozzle tips 6503 operating at 40 psi. Treatments were made initially curatively since disease was present at the time of first application. The 14-day treatments were applied on May 15, and May 30. The 21-day treatments were applied May 15 and June 7. Disease ratings were made on a scale of 0 to 10 with 0 = 0 % disease and 10 = 100 % disease.

Results

Fungicides that scored less than 2.5 performed well. For the most part, fungicide performance was consistent with the previous study done on leaf spot, with the noticeable exception of IB11521. In this study, IB11521 performed poorly. We have no explanation for this discrepancy at this time.

Table 1. Efficacy of Certain Fungicides on Leaf Spot.

Treatment	Rate (oz./M)[a]	Interval (days)	Leaf spot* 6/15	Leaf spot* 6/19
Scotts FFII	17.5 lbs.	21	2.0 a	1.3 a
Eagle 40W + Fore 80 WP	0.6+4.5	14	2.0 a	1.7 ab
RH-0611	6.0	14	2.3 ab	1.3 a
Daconil Ultrex	3.8	14	2.7 abc	1.0 a
Chipco 26019F	4.0	14	3.0 abcd	2.0 ab
Chipco 2601950WDG	2.0	14	3.0 abcd	2.0 ab
Heritage 50WDG	0.4	21	3.3 abcd	1.3 a
Control	--	--	3.7 abcd	4.3 c
Curalan DF + Clearys 3336	1.35 lb.+2.3	21	4.0 abcd	2.3 ab
Curalan DF + Clearys 3336	1.35 lb.+2.7	21	4.0 abcd	3.3 bc
Heritage 50WDG	0.2	21	4.3 bcd	2.7 abc
IB 11521	6.0	14	4.7 cd	4.3 c
Curalan DF	1.0	21	5.0 d	3.3 bc

* Disease ratings were made on a scale of 0 to 10 with 0 equaling 0 % disease and 10 equaling 100 % disease. Scores 2.5 or less were judged to give excellent control

[a] M=1000 $ft.^2$

Red Thread Control Study — 1995

Joe Rimelspach and Karl Danneberger
Plant Pathology; Horticulture and Crop Science

Introduction

A red thread (*Laetisaria fuciformis*) control study was conducted on a perennial ryegrass turf (cultivar unknown) located at The Ohio State University Turfgrass Research Center, Columbus. The turf was maintained at a two-inch height of cut. Fungicides were applied with a small-plot CO_2 sprayer with 6503 nozzle tips operated at 40 psi. The plot size was 6 ft. by 8 ft. with all treatments replicated three times. The plot design was a split plot randomized complete-block design. The split plot treatment was a fertilizer application. In half of the plot, a fungicide application alone was made. In the second half of the plot, the fungicide application was made along with a 1.0 pound per 1,000 sq. ft. nitrogen application (Lesco Elite 21-4-11). The plots that received a nitrogen treatment (Urea and Lesco Elite) received twice the nitrogen rate in the portion of the plots receiving a nitrogen treatment. Fungicide and fertilizer treatments were made May 19 and June 6 (14-day interval).

Results

Fungicide efficacy increased when combined with nitrogen (Table 2). However, the fertilizer treatments of urea and Lesco Elite contained more brown patch in those plots than the unfertilized.

Table 1. Efficacy of Certain Fungicides on Red Thread.

Treatment	Rate (oz./M)[a]	Interval (days)	Red thread (number of spots)* 6/5	6/13
Daconil'Ultrex	5.0	18	0.3 a	0.0 a
IB11521	6.0	18	1.7 ab	0.0 a
Heritage 50 WDG	0.4	18	2.3 abc	0.0 a
IB11925	2.75	18	3.0 abc	0.3 ab
Chipco 2601950WDG	2.0	18	3.3 abc	2.0 abcd
Urea	1 lb.	18	3.3 abc	0.7 ab
Sentinel 40 WG	0.25	18	5.0 abc	0.0 a
Touche 4F	2.0	18	5.0 abc	1.0 abc
Chipco 26019 F	4.0	18	5.3 abc	0.7 ab
Control	--	--	5.7 bc	4.3 d
Daconil Ultrex	3.8	18	6.3 bcd	2.3 abcd
Lesco Elite	1 lb.	18	7.3 cd	4.0 cd
Bayleton 25 WG	1.0	18	11.3 d	3.3 bcd
LSD (0.05)			5.3	3.2

* In a split plot design the number of red thread spots are based on a 4 ft. by 6 ft. plot
[a] M=1000 $ft.^2$

Table 2. Fungicide Plus Fertilizer Addition (Lesco elite 21-4-11 at 1 lb. N/1000 sq. ft.) on red thread control.

Treatment	Rate (oz/M)[a]	Interval (days)	Red thread (number of spots)** 6/5	6/13
IB11521	6.0	18	0.3	0.0 a
Daconil Ultrex	5.0	18	0.3	0.0 a
IB11925	2.75	18	0.7	0.0 a
Lesco Elite	1.0 lb*	18	1.0	0.3 a
Urea	1.0 lb*	18	1.3	0.0 a
Daconil Ultrex	3.8	18	1.3	1.0 a
Heritage 50 WDG	0.4	18	1.7	0.0 a
Sentinel 40 WG	0.25	18	2.3	0.0 a
Chipco 26019 50WDG	2.0	18	3.0	1.0 a
Chipco 26019 F	4.0	18	3.0	0.0 a
Touche 4F	2.0	18	4.7	0.7 a
Bayleton 25 WG	1.0	18	5.3	0.0 a
Control	--	--	5.7	4.3 b
LSD (0.05)			ns	1.7

* This rate is doubled with the addition of another increment of nitrogen.

** In a split plot design the number of red thread spots are based on a 4 ft. by 6 ft. plot

a M=1000 $ft.^2$

Brown Patch Study — 1995

Joe Rimelspach, Karl Danneberger, Joseph Vagnier, and Jill Taylor
Plant Pathology; Horticulture and Crop Science

Introduction

A preventative brown patch study (*Rhizoctonia solani*) was initiated on June 21, 1995, on short cut creeping bentgrass turf located at The Ohio State University Turfgrass Research Center. The creeping bentgrass cultivar was 'Penncross' maintained at 3/16th of an inch height of cut and irrigated when needed. The soil was clayey. All treatments were replicated three times in a randomized complete-block design. The plots measured 5 ft. by 6 ft., and liquid treatments were applied with a CO_2 sprayer with nozzle tips 8010 operating at 40 psi. Granular treatments were made by hand. The application dates for this study are given in Table 1.

Table 1. Treatment Dates

Date	Fungicide Treatment Interval 14 day	21 day	28 day
June 21	X	X	X
July 5	X		
July 12		X	
July 19	X		X
August 2	X	X	
August 16	X		X
August 23		X	
August 30	X		
September 13	X	X	X

Results

The summer of 1995 provided environmental conditions favorable for brown patch development. Relatively uniform disease pressure occurred beginning the third week of July and continued through August 19. All treatments were applied preventatively well before the onset of disease (two applications each of the 21- and 28-day treatments; and three applications of the 14-day treatments). In general, fungicides were more effective when applied preventatively than applied curatively (see Brown Patch Curative Study).

The data provided in Tables 2 through 4 represent various readings within the control period. For example, the July 26 reading was made seven days into the 14-day treatment period, 14 days into the 21-day treatment period, and seven days into the 28-day treatment period, while the July 31 evaluation was 12 days into the 14-day treatment period, 19 days into the 21-day treatment; and 12 days into the 28-day treatment period. The August 14 evaluation was made 12 days into the 14-day treatment period, 14 days into the 21-day treatment period, and 26 days into the 28-day treatment period.

In general, products having a rating of less than 2 gave excellent control. Generally, the contacts, chlorothalonils, and Fore gave good control, but 14-day control was not good. This year, control appeared to last only seven days. Sentinel at 0.25 oz./M gave better control than the lower rates of the product. Heritage in combination with Fore, Prostar, Eagle, and Chipco 26019 gave excellent control.

Table 2. Brown Patch Severity on July 26, 1995.

Treatment	Rate (oz/M)[a]	Interval (days)	Brown Patch* 7/26
EXP106082A	7.0	21	1.0 a
EXP106082A	3.5	21	1.0 a
Chipco 26019 WDG	2.0	21	1.0 a
Bayleton 25WDG + Fore 80WP	0.5+6.0	14	1.0 a
Sentinel 40 WG	0.167	14	1.0 a
Lynx 250 EW	28.4 ml	21	1.0 a
Bayleton 25 WDG + Ultrex	0.5+1.84	14	1.0 a
Lynx 25 DF + Prostar 50WP	1.0+2.0	21	1.0 a
Lynx 25 DF + Ultrex	0.5+1.84	14	1.0 a
Fore 80WP + Prostar 50WP	6.0+2.0	21	1.0 a
Fore 80WP + Chipco 26019 WP	6.0+2.0	21	1.0 a
Fore 80WP	6.0	14	1.0 a
S-4404	1X	14	1.0 a
Eagle + Heritage	0.6+0.2	21	1.0 a
Thalonil 90DF	3.5	14	1.0 a
Eagle + Prostar 50WP	0.6+2.0	21	1.0 a
Eagle + Chipco 26019 WP	0.6+2.0	21	1.0 a
RC01	0.15 ai	14	1.0 a
Sentinel 40WG	0.25	28	1.0 a
Sentinel 40WG	0.167	28	1.0 a
Banner 45WP + Ultrex	0.31+1.25	21	1.0 a
CGA64250 + Chipco 26019 WP	0.9+1.25	21	1.0 a
Fore 80WP + Heritage	6.0+2.0	21	1.0 a
IB11924	2.75	14	1.0 a
EXP10704A + Ultrex	4.0+4.0	14	1.0 a
Daconil 2787 F	6.0	14	1.0 a
Chipco 26019 F	4.0	14	1.0 a
EXP10704A + Chipco 26019 F	4.0+4.0	14	1.0 a
Chipco 26019 WP	3.0	21	1.0 a
EXP10704A	4.0	21	1.0 a
Fore WP + Bayleton WDG	6.0+1.0	21	1.0 a
CGA64250 + Pace +Sprint Fe	0.9+6.4+2.0	14	1.0 a
Banner GL + Chipco 26019 WP	0.3+2.0	21	1.0 a
IB10222	4.0	14	1.3 ab
Prostar 50WP	2.0	21	1.3 ab
Fore 80WP + Banner 1.1 EC	6.0+1.0	21	1.3 ab
Banner GL	0.3	21	1.3 ab
Eagle + Fore 80WP	0.6+4.5	21	1.3 ab
Ultrex	3.8	14	1.3 ab
Bayleton 25WDG + Prostar 50WP	0.5+2.5	28	1.3 ab
Eagle + Fore 80WP	0.6+6.0	21	1.3 ab
RH-0611 62.2 WP	6.0	21	1.3 ab
EXP 10702A	4.0	14	1.3 ab
ConSyst	3.0	14	1.3 ab
CGA64250	0.9	21	1.7 abc
EXP10704A + Dithane	4.0+8.0	14	1.7 abc
Eagle	0.6	21	1.7 abc

Table 2 (Continued). Brown Patch Severity on July 26, 1995.

Treatment	Rate (oz./M)[a]	Interval (days)	Brown Patch* 7/26
Banner 45WP	0.31	21	1.7 abc
Bayleton 25WDG + Daconil 2787 F	0.5+3.0	14	1.7 abc
Prostar 50WP	3.0	21	1.7 abc
Sentinel 40WG	0.167	21	1.7 abc
Banner 1.1E	1.0	21	2.0 abcd
Primo + Banner 1.1E	0.25+1.0	21	2.0 abcd
Aliette 80WDG + Fore FL + Latron AG	4.0+13+0.5	14	2.0 abcd
S-4404	2X	14	2.0 abcd
Thalonil 4L	6.0	14	2.0 abcd
CGA64250 +Daconil Ultrex	0.9+1.25	21	2.0 abcd
RC02	0.3 ai	14	2.7 bcde
Banner Granule	1.0	21	2.7 bcde
S-4404	2X	21	2.7 bcde
Bayleton 25 WDG	1.0	28	3.0 cde
Primo	0.25	21	3.3 de
Control	---		3.3 de
Control	---		4.0 e
LSD			1.3

* Brown patch severity is rated on a scale of 1 to 5 with 1 being no brown patch and 5 being severe brown patch present. Ratings below 2 are considered good controls.

[a] M=1000 ft.^{2}

Table 3. Brown Patch Severity on July 31, 1995.

Treatment	Rate (oz./M)[a]	Interval (days)	Brown Patch 7/31
Lynx 25 DF + Ultrex	0.5+1.84	14	1.0 a
RC01	0.15 ai	14	1.0 a
Sentinel 40WG	0.25	28	1.0 a
EXP10704A + Chipco 26019 F	4.0+4.0	14	1.0 a
Fore 80WP + Heritage	6.0+2.0	21	1.0 a
Lynx 250 EW	28.4 ml	21	1.0 a
Prostar 50WP	2.0	21	1.0 a
Lynx 25 DF + Prostar 50WP	1.0+2.0	21	1.0 a
Fore 80WP + Prostar 50WP	6.0+2.0	21	1.0 a
ConSyst	3.0	14	1.0 a

Table 3 (Continued). Brown Patch Severity on July 31, 1995.

Treatment	Rate (oz./M)[a]	Interval (days)	Brown Patch 7/31
Eagle + Heritage	0.6+0.2	21	1.0 a
Sentinel 40 WG	0.167	14	1.3 ab
EXP106082A	7.0	21	1.3 ab
EXP10704A + Ultrex	4.0+4.0	14	1.3 ab
Chipco 26019 F	4.0	14	1.3 ab
Bayleton 25WDG + Fore 80WP	0.5+6.0	14	1.3 ab
EXP 10702A	4.0	14	1.3 ab
Sentinel 40WG	0.167	28	1.3 ab
Eagle + Prostar 50WP	0.6+2.0	21	1.3 ab
Fore 80WP	. 6.0	14	1.3 ab
CGA64250 + Pace +Sprint Fe	0.9+6.4+2.0	14	1.3 ab
Bayleton 25 WDG + Ultrex	0.5+1.84	14	1.7 abc
Fore 80WP + Banner 1.1 EC	6.0+1.0	21	2.0 abcd
Banner 45WP + Ultrex	0.31+1.25	21	2.0 abcd
Chipco 26019 WDG	2.0	21	2.0 abcd
EXP10704A + Dithane	4.0+8.0	14	2.0 abcd
Fore 80WP + Chipco 26019 WP	6.0+2.0	21	2.0 abcd
Sentinel 40WG	0.167	21	2.0 abcd
Ultrex	3.8	14	2.0 abcd
Aliette 80WDG + Fore FL + Latron AG	4.0+13+0.5	14	2.0 abcd
Bayleton 25WDG + Daconil 2787 F	0.5+3.0	14	2.3 abcde
Bayleton 25WDG + Prostar 50WP	0.5+2.5	28	2.3 abcde
Banner GL	0.3	21	2.3 abcde
EXP106082A	3.5	21	2.3 abcde
Thalonil 90DF	3.5	14	2.3 abcde
IB11924	2.75	14	2.3 abcde
CGA64250 + Chipco 26019 WP	0.9+1.25	21	2.3 abcde
Fore WP + Bayleton WDG	6.0+1.0	21	2.3 abcde
Banner 45WP	0.31	21	2.3 abcde
Banner 1.1E	1.0	21	2.3 abcde
Primo + Banner 1.1E	0.25+1.0	21	2.3 abcde
Chipco 26019 WP	3.0	21	2.3 abcde
EXP10704A	4.0	21	2.3 abcde
Eagle + Chipco 26019 WP	0.6+2.0	21	2.7 abcde
S-4404	1X	14	2.7 abcde
Eagle + Fore 80WP	0.6+4.5	21	2.7 abcde
Eagle + Fore 80WP	0.6+6.0	21	2.7 abcde
Prostar 50WP	3.0	21	2.7 abcde
Daconil 2787 F	6.0	14	2.7 abcde
Thalonil 4L	6.0	14	2.7 abcde
Bayleton 25 WDG	1.0	28	3.0 abcdef
Banner GL + Chipco 26019 WP	0.3+2.0	21	3.0 abcdef
RC02	0.3 ai	14	3.3 bcdef
CGA64250	0.9	21	3.3 bcdef
Eagle	0.6	21	3.3 bcdef

Table 3 (Continued). Brown Patch Severity on July 31, 1995.

Treatment	Rate (oz./M)[a]	Interval (days)	Brown Patch 7/31
Banner Granule	1.0	21	3.3 bcdef
CGA64250			
+Daconil Ultrex	0.9+1.25	21	3.7 cdef
IB10222	4.0	14	3.7 cdef
RH-0611 62.2 WP	6.0	21	3.7 cdef
Primo	0.25	21	4.0 def
S-4404	2X	14	4.0 def
Control	---		4.3 ef
S-4404	2X	21	4.3 ef
Control	---		5.0 f
LSD			2.2

* Brown patch severity is rated on a scale of 1 to 5 with 1 being no brown patch and 5 being severe brown patch present. Ratings below 2 are considered good controls.

[a] M=1000 $ft.^2$

Table 4. Brown Patch Severity on August 14, 1995.

Treatment	Rate (oz./M)[a]	Interval (days)	Brown Patch 8/14
Fore 80WP + Heritage	6.0+2.0	21	1.0 a
Fore 80WP			
+ Prostar 50WP	6.0+2.0	21	1.0 a
EXP10704A			
+ Chipco 26019 F	4.0+4.0	14	1.0 a
Lynx 250 EW	28.4 ml	21	1.0 a
Eagle + Heritage	0.6+0.2	21	1.0 a
Sentinel 40WG	0.25	28	1.3 ab
Chipco 26019 F	4.0	14	1.3 ab
Eagle			
+ Chipco 26019 WP	0.6+2.0	21	1.7 abc
Lynx 25 DF + Ultrex	0.5+1.84	14	1.7 abc
Lynx 25 DF			
+ Prostar 50WP	1.0+2.0	21	1.7 abc
Ultrex	3.8	14	1.7 abc
RC01	0.15 ai	14	1.7 abc
Sentinel 40 WG	0.167	14	2.0 abcd
Sentinel 40WG	0.167	28	2.0 abcd
Thalonil 90DF	3.5	14	2.0 abcd
ConSyst	3.0	14	2.0 abcd
RH-0611 62.2 WP	6.0	21	2.0 abcd
Fore 80WP	6.0	14	2.0 abcd
Thalonil 4L	6.0	14	2.0 abcd
S-4404	1X	14	2.3 abcde
Eagle + Fore 80WP	0.6+4.5	21	2.3 abcde

Table 4 (Continued). Brown Patch Severity on August 14, 1995.

Treatment	Rate (oz./M)[a]	Interval (days)	Brown Patch 8/14
EXP10704A + Ultrex	4.0+4.0	14	2.3 abcde
Prostar 50WP	2.0	21	2.3 abcde
EXP10704A + Dithane	4.0+8.0	14	2.3 abcde
EXP 10702A	4.0	14	2.3 abcde
Banner 45WP	0.31	21	2.3 abcde
Eagle + Prostar 50WP	0.6+2.0	21	2.3 abcde
Fore 80WP+ Banner 1.1 EC	6.0+1.0	21	2.3 abcdef
Banner 45WP + Ultrex	0.31+1.25	21	2.7 abcdef
Prostar 50WP	3.0	21	2.7 abcdef
Fore 80WP + Chipco 26019 WP	6.0+2.0	21	2.7 abcdef
CGA64250 + Pace +Sprint Fe	0.9+6.4+2.0	14	2.7 abcdef
CGA64250 + Chipco 26019 WP	0.9+1.25	21	2.7 abcdef
Chipco 26019 WDG	2.0	21	3.0 abcdef
Banner GL	0.3	21	3.0 abcdef
Bayleton 25WDG + Fore 80WP	0.5+6.0	14	3.0 abcdef
CGA64250 +Daconil Ultrex	0.9+1.25	21	3.0 abcdef
Bayleton 25WDG + Prostar 50WP	0.5+2.5	28	3.0 abcdef
Chipco 26019 WP	3.0	21	3.0 abcdef
Primo + Banner 1.1E	0.25+1.0	21	3.0 abcdef
Eagle + Fore 80WP	0.6+6.0	21	3.3 abcdef
S-4404	2X	14	3.3 abcdef
Aliette 80WDG + Fore FL + Latron AG	4.0+13+0.5	14	3.3 abcdef
IB11924	2.75	14	3.3 abcdef
EXP10704A	4.0	21	3.3 abcdef
Fore WP + Bayleton WDG	6.0+1.0	21	3.3 abcdef
Banner GL + Chipco 26019 WP	0.3+2.0	21	3.3 abcdef
EXP106082A	7.0	21	3.7 bcdef
RC02	0.3 ai	14	3.7 bcdef
IB10222	4.0	14	3.7 bcdef
CGA64250	0.9	21	3.7 bcdef
Bayleton 25WDG + Daconil 2787 F	0.5+3.0	14	3.7 bcdef
Bayleton 25 WDG + Ultrex	0.5+1.84	14	3.7 bcdef
Banner 1.1E	1.0	21	3.7 bcdef
Daconil 2787 F	6.0	14	3.7 bcdef
Bayleton 25 WDG	1.0	28	4.0 cdef
Eagle	0.6	21	4.0 cdef
Sentinel 40WG	0.167	21	4.0 cdef
EXP106082A	3.5	21	4.0 cdef
Banner Granule	1.0	21	4.3 def
Primo	0.25	21	4.7 ef
Control	---		4.7 ef
Control	---		5.0 f
S-4404	2X	21	5.0 f
LSD			2.3

* Brown patch severity is rated on a scale of 1 to 5 with 1 being no brown patch and 5 being severe brown patch present. Ratings below 2 are considered good controls.

[a] M=1000 ft.^{2}

Brown Patch (*Rhizoctonia solani*) Curative Study

Joe Rimeslpach, Karl Danneberger, and Jill Taylor
Plant Pathology; Horticulture and Crop Science

Introduction

On August 3, 1995, 11 fungicide treatments that had given excellent to good brown patch control preventatively were applied curatively to a 'Penncross' creeping bentgrass putting green turf. The soil was a sandy mix established to USGA greens specifications. The putting green was maintained at 3/16th of an inch and irrigated when needed. Brown patch was uniformly dispersed throughout the test area (visual estimation). The treatments were applied with a small-plot CO_2 sprayer with nozzle tips 8010 at 40 psi. The plots measured 3 ft. by 5 ft., and all treatments were replicated three times in a completely randomized design.

Results

The contact fungicides were, in general, more effective as a curative treatment than the systemic fungicides. Daconil, Ultrex, Fore, and Fore WP + Heritage provided good curative control of brown patch. Chipco 26019 F and CGA + Pace + Sprint Fe also performed well.

Treatment	Rate (oz./M)[a]	Brown Patch Severity 8/9	Brown Patch Severity 8/14
Fore WP + Heritage	6.0 + 0.2	1.0 a	1.0 a
Fore WP	6.0	1.0 a	2.0 ab
Daconil Ultrex	3.8	2.3 ab	3.0 bcd
Chipco 26019 F	4.0	2.7 abc	3.7 bcde
CGA+Pace+Sprint Fe	0.9+6.4+2	2.7 abc	2.7 abc
Thalonil 90 DF	3.5	3.0 bcd	3.7 bcde
Prostar	2.0	3.0 bcd	2.7 abc
RCO1	0.15 oz/ai	4.3 cde	4.7 de
Control	---	4.3 cde	4.0 cde
Sentinel 40 WG	.25	4.7 de	3.3 bcde
Lynx 25 DF + Ultrex	0.5+1.84	5.0 e	4.7 de
Lynx 250 EW	28.4 ml	5.0 e	5.0 e
Control	---	5.0 e	5.0 e
LSD (0.05)		1.9	1.8

[a] M=1000 ft.^{2}

Preventive Dollar Spot (*Sclerotinia homoeocarpa*) Control Study — 1995

Joe Rimelspach, Karl Danneberger, Joseph Vagnier, and Jill Taylor
Plant Pathology; Horticulture and Crop Science

Introduction

A preventative dollar spot study (*Sclerotinia homoeocarpa*) was initiated on June 21, 1995, on short cut creeping bentgrass turf located at The Ohio State University Turfgrass Research Center. The creeping bentgrass cultivar was 'Penncross' maintained at 3/16th of an inch height of cut and irrigated when needed. The soil was clayey. All treatments were replicated three times in a randomized complete-block design. The plots measured 5 ft. by 6 ft. and liquid treatments were applied with a CO_2 sprayer with 8010 nozzles at 40 psi. Granular treatments were made by hand. The application dates for this study are given in Table 1. Readings were made on September 27 (14 days) and October 4 (21 days).

Table 1. Treatment Dates

Date	Fungicide Treatment Interval 14 days	21 days	28 days
June 21	X	X	X
July 5		X	
July 12		X	
July 19	X		X
August 2	X	X	
August 16	X		X
August 23		X	
August 30	X		
September 13	X	X	X

Results

Dollar spot pressure did not occur until later in the year (late September – early October). Although inoculum was introduced via infected grass clippings as in past years, disease pressure was not as strong. This may be in part due to the number of fungicide sprays that had been made preventatively (see Table 1). The data did show good control with a number of products under moderate dollar spot pressure.

Table 2. Dollar Spot Severity Rating on September 27, 1995.

Treatment	Rate (oz./M)[a]	Interval (days)	Dollar Spot (%) 9/27
EXP106082A	7.0	21	0.0 a
Chipco 26019 WDG	2.0	21	0.0 a
Bayleton 25WDG + Fore 80WP	0.5+6.0	14	0.0 a
Sentinel 40 WG	0.167	14	0.0 a
Lynx 250 EW	28.4 ml	21	0.0 a
Bayleton 25 WDG + Ultrex	0.5+1.84	14	0.0 a
Lynx 25 DF + Prostar 50WP	1.0+2.0	21	0.0 a
Lynx 25 DF + Ultrex	0.5+1.84	14	0.0 a
Fore 80WP + Chipco 26019 WP	6.0+2.0	21	0.0 a
Thalonil 90DF	3.5	14	0.0 a
Eagle + Prostar 50WP	0.6+2.0	21	0.0 a
Eagle + Chipco 26019 WP	0.6+2.0	21	0.0 a
RC01	0.15 ai	14	0.0 a
Sentinel 40WG	0.25	28	0.0 a
Sentinel 40WG	0.167	28	0.0 a
Banner 45WP + Ultrex	0.31+1.25	21	0.0 a
CGA64250 + Chipco 26019 WP	0.9+1.25	21	0.0 a
Chipco 26019 F	4.0	14	0.0 a
EXP10704A + Chipco 26019 F	4.0+4.0	14	0.0 a
Chipco 26019 WP	3.0	21	0.0 a
EXP10704A	4.0	21	0.0 a
Fore WP + Bayleton WDG	6.0+1.0	21	0.0 a
CGA64250+Pace+Sprint Fe	0.9+6.4+2.0	14	0.0 a
Fore 80WP + Banner 1.1 EC	6.0+1.0	21	0.0 a
Banner GL	0.3	21	0.0 a
Eagle + Fore 80WP	0.6+4.5	21	0.0 a
Ultrex	3.8	14	0.0 a
Bayleton 25WDG + Prostar 50WP	0.5+2.5	28	0.0 a
Eagle + Fore 80WP	0.6+6.0	21	0.0 a
RH-0611 62.2 WP	6.0	21	0.0 a
EXP 10702A	4.0	14	0.0 a
CGA64250	0.9	21	0.0 a
Eagle	0.6	21	0.0 a
Banner 45WP	0.31	21	0.0 a
Bayleton 25WDG + Daconil 2787 F	0.5+3.0	14	0.0 a
Sentinel 40WG	0.167	21	0.0 a
Banner 1.1E	1.0	21	0.0 a
Primo + Banner 1.1E	0.25+1.0	21	0.0 a
CGA64250+Daconil Ultrex	0.9+1.25	21	0.0 a
RC02	0.3 ai	14	0.0 a
S-4404	2X	21	0.0 a
Bayleton 25 WDG	1.0	28	0.0 a
Eagle + Heritage	0.6+0.2	21	0.7 a
EXP106082A	3.5	21	1.3 a
Daconil 2787 F	6.0	14	1.7 a
Banner GL + Chipco 26019 WP	0.3+2.0	21	1.7 a
Thalonil 4L	6.0	14	1.7 a
S-4404	2X	14	1.7 a

Table 2 (Continued). Dollar Spot Severity Rating on September 27, 1995.

Treatment	Rate (oz./M)[a]	Interval (days)	Dollar Spot (%) 9/27
S-4404	1X	14	1.7 a
ConSyst	3.0	14	2.3 ab
EXP10704A + Ultrex	4.0+4.0	14	3.3 ab
IB10222	4.0	14	5.0 ab
IB11924	2.75	14	8.3 b
Aliette 80WDG + Fore FL + Latron AG	4.0+13+0.5	14	18.3 c
Fore 80WP + Heritage	6.0+0.2	21	23.3 cd
Primo	0.25	21	23.3 cd
Prostar 50WP	2.0	21	23.3 cd
Banner Granule	1.0	21	25.0 de
Prostar 50WP	3.0	21	26.7 de
Control	---		30.0 e
Fore 80WP	6.0	14	40.0 f
EXP10704A + Dithane	4.0+8.0	14	43.3 fg
Control	---		45.0 fg
Fore 80WP + Prostar 50WP	6.0+2.0	21	46.7 g
LSD			6.7

[a] M=1000 ft.^{2}

Table 3. Dollar Spot Severity Rating on October 4, 1995.

Treatment	Rate (oz./M)[a]	Interval (days)	Dollar Spot (%) 10/04
EXP106082A	7.0	21	0.0 a
Bayleton 25WDG + Fore 80WP	0.5+6.0	14	0.0 a
Lynx 250 EW	28.4 ml	21	0.0 a
Bayleton 25 WDG + Ultrex	0.5+1.84	14	0.0 a
Lynx 25 DF + Prostar 50WP	1.0+2.0	21	0.0 a
Lynx 25 DF + Ultrex	0.5+1.84	14	0.0 a
Thalonil 90DF	3.5	14	0.0 a
Eagle + Prostar 50WP	0.6+2.0	21	0.0 a
Eagle + Chipco 26019 WP	0.6+2.0	21	0.0 a
RC01	0.15 ai	14	0.0 a
Sentinel 40WG	0.25	28	0.0 a
Banner 45WP + Ultrex	0.31+1.25	21	0.0 a
CGA64250 + Chipco 26019 WP	0.9+1.25	21	0.0 a
Chipco 26019 F	4.0	14	0.0 a
EXP10704A + Chipco 26019 F	4.0+4.0	14	0.0 a
Chipco 26019 WP	3.0	21	0.0 a
EXP10704A	4.0	21	0.0 a
Fore WP + Bayleton WDG	6.0+1.0	21	0.0 a

Table 3 (Continued). Dollar Spot Severity Rating on October 4, 1995.

Treatment	Rate (oz./M)[a]	Interval (days)	Dollar Spot (%) 10/04
CGA64250+Pace+Sprint Fe	0.9+6.4+2.0	14	0.0 a
Fore 80WP + Banner 1.1 EC	6.0+1.0	21	0.0 a
Banner GL	0.3	21	0.0 a
Eagle + Fore 80WP	0.6+4.5	21	0.0 a
Ultrex	3.8	14	0.0 a
Bayleton 25WDG + Prostar 50WP	0.5+2.5	28	0.0 a
Eagle + Fore 80WP	0.6+6.0	21	0.0 a
RH-0611 62.2 WP	6.0	21	0.0 a
EXP 10702A	4.0	14	0.0 a
Eagle	0.6	21	0.0 a
Banner 45WP	0.31	21	0.0 a
Bayleton 25WDG + Daconil 2787 F	0.5+3.0	14	0.0 a
Sentinel 40WG	0.167	21	0.0 a
Banner 1.1E	1.0	21	0.0 a
Primo + Banner 1.1E	0.25+1.0	21	0.0 a
CGA64250+Daconil Ultrex	0.9+1.25	21	0.0 a
RC02	0.3 ai	14	0.0 a
Bayleton 25 WDG	1.0	28	0.0 a
Eagle + Heritage	0.6+0.2	21	0.0 a
Banner GL + Chipco 26019 WP	0.3+2.0	21	0.0 a
Sentinel 40 WG	0.167	14	1.7 ab
Daconil 2787 F	6.0	14	1.7 ab
Chipco 26019 WDG	2.0	21	1.7 ab
Sentinel 40WG	0.167	28	1.7 ab
S-4404	2X	21	1.7 ab
ConSyst	3.0	14	3.3 abc
CGA64250	0.9	21	3.3 abc
S-4404	1X	14	3.3 abc
Fore 80WP + Chipco 26019 WP	6.0+2.0	21	3.3 abc
EXP106082A	3.5	21	5.0 abc
EXP10704A + Ultrex	4.0+4.0	14	5.7 abc
S-4404	2X	14	6.7 abc
IB10222	4.0	14	8.3 bc
IB11924	2.75	14	10.0 c
Thalonil 4L	6.0	14	10.0 c
Aliette 80WDG + Fore FL + Latron AG	4.0+13+0.5	14	20.0 d
Prostar 50WP	2.0	21	23.3 d
Primo	0.25	21	25.0 de
Banner Granule	1.0	21	26.7 def
Fore 80WP + Heritage	6.0+0.2	21	26.7 def
Prostar 50WP	3.0	21	31.7 fe
Control	---		33.3 f
EXP10704A + Dithane	4.0+8.0	14	43.3 g
Control	---		46.7 g
Fore 80WP + Prostar 50WP	6.0+2.0	21	50.0 g
Fore 80WP	6.0	14	50.0 g
LSD			7.5

[a] M=1000 $ft.^2$

Take-All Control Study

Joe Rimelspach and Karl Danneberger
Plant Pathology; Horticulture and Crop Science

Introduction

A take-all (*Gaeumannomyces graminis*) control study was initiated on June 12, 1995, at the Jefferson Country Club in Gahanna, Ohio. The test site was a 'Pennlinks' creeping bentgrass turf maintained at 0.5 inch height of cut. Take-all was present at the time of application. The plots measured 6 ft. by 20 ft. and liquid treatments were applied with a small-plot CO_2 sprayer with nozzle tips 6503 operating at 40 psi. All treatments were replicated four times in a completely randomized design.

Results

No fungicide effect for the control of take-all was observed in this study.

Table 1. Fungicide Effect on Take-All Patch.

Treatment	Rate (oz./M)[a]	Take-all present in plots at time of application	Take-all* (06/12)
Lynx	0.25	1.3 a	1.3
Bayleton 25 WP	2.0	2.0 a	1.3
Heritage 50 WDG	0.2	3.3 bc	1.5
Heritage 50 WDG	0.8	3.5 c	1.5
Bayleton 25 WP	4.0	2.3 ab	1.8
Heritage 50 WDG	0.4	4.3 c	2.3
Heritage 50 WDG	0.6	3.5 c	2.5
Control	--	4.0 c	2.5
Rubigan AS	4.0	4.0 c	2.8
LSD (0.05)		1.2	ns

* Disease rating is on a scale of 1 to 10 with 0 = no disease and 100 = 100% disease.
[a] M=1000 $ft.^2$

Yellow Tuft Study — 1995

Joe Rimelspach, Karl Danneberger, Joseph Vagnier, and Jill Taylor
Plant Pathology; Horticulture and Crop Science

Introduction

Yellow tuft (*Sclerophthora macrospora*) is a disease that can infect creeping bentgrass during the late summer and fall periods. No formal yellow tuft study was initiated in 1995; however, a severe infestation of yellow tuft occurred in the 1995 dollar spot study. Although most fungicide treatments used were ineffective for yellow tuft control, a reading was made from a selective list of fungicides.

The study was initiated on short cut creeping bentgrass turf located at The Ohio State University Turfgrass Research Center. The creeping bentgrass cultivar was 'Penncross' maintained at 3/16th of an inch height of cut and irrigated when needed. The soil was clayey. All treatments were replicated three times in a randomized complete-block design. The plots measured 5 ft. by 6 ft., and liquid treatments were applied with a CO_2 sprayer with 8010 nozzles at 40 psi. Granular treatments were made by hand. The application dates for this study are given in Table 1. Readings were made on September 27 (14 days) and October 4 (21 days).

Table 1. Treatment Dates

Date	Fungicide Treatment Interval 14 days	21 days	28 days
June 21	X	X	X
July 5	X		
July 12		X	
July 19	X		X
August 2	X	X	
August 16	X		X
August 23		X	
August 30	X		
September 13	X	X	X

Results

In past studies, Subdue and combinations of Subdue and Daconil 2787 have been effective for yellow tuft control. In this study, these treatments were not present, but results from this study showed that CGA64250 + Pace + Sprint Fe was the most effective yellow tuft control. This is probably due to the Pace component which contains Subdue.

The compounds IB11924, Fore 80WP + Heritage, Eagle + Fore 80WP, Aliette 80WDG + Fore FL + Latron AG, and Primo + Banner 1.1E gave marginal control.

Table 2. Yellow Tuft Infection in Fungicide-Treated Plots from the Dollar Spot Study, September 27, 1995.

Treatment	Rate (oz./M)[a]	Interval (days)	Yellow Tuft (%) (10/04)
CGA64250 + Pace _ Sprint Fe	0.0+6.4+2.0	14	0.0
IB11924	2.75	14	13.3
Fore 80WP + Heritage	6.0+0.2	21	13.3
Eagle + Fore 80WP	0.6+6.0	21	16.7
Aliette 80WDG + Fore FL + Latron AG	4.0+13+0.5	14	18.3
Primo + Banner 1.1E	0.25+1.0	21	18.3
EXP10704A + Dithane	4.0+8.0	14	20.0
EXP10704A + Ultrex	4.0+4.0	14	21.7
Fore 80WP + Chipco 26019 WP	6.0+2.0	21	23.3
EXP10704A + Chipco 26019 F	4.0+4.0	14	23.3
Fore WP + Bayleton WDG	6.0+1.0	21	23.3
Ultrex	3.8	14	23.3
Sentinel 40WG	0.167	21	23.3
Thalonil 4L	6.0	14	25.0
Eagle + Fore 80WP	0.6+4.5	21	26.7
Fore 80WP	6.0	14	28.3
Daconil 2787 F	6.0	14	30.0
IB10222	4.0	14	33.3
Eagle	0.6	21	36.7
Control	---	---	36.7
Control	---	---	43.3
LSD			13.6

[a] M=1000 ft.^{2}

Summer Patch Control Study

Rob Golembiewski, Joe Rimelspach and Karl Danneberger
Horticulture and Crop Science; Plant Pathology

Introduction

A summer patch (*Magnaporthe poae*) control study was conducted at theLittle Turtle Country Club in New Albany, Ohio. The treatments were applied to an annual bluegrass fairway that had a previous history of summer patch. Fungicide applications were made with a small-plot CO_2 sprayer operating at 40 psi with nozzle tips 8010. The plots were 6 ft. by 9 ft., and all treatments were replicated three times. The application dates are listed in Table 1.

Table 1. Dates and Number of Applications.

Date	14 days	21 days	28 days
May 26	X	X	X
June 9	X		
June 15		X	
June 23	X		X

Results

The amount (percent) of summer patch was evaluated on September 1. An extremely hot humid summer resulted in pythium activity within the plot area which affected the evaluation of summer patch control. The percent summer patch was relatively low and difficult to assess as a result of the pythium damage. No phytotoxicity was observed throughout the study; however, Sentinel applications resulted in the turf turning a dark green color.

Table 2. Evaluation of Fungicides for Control of Summer Patch.

Treatment	Rate (oz./M)[a]	Interval (days)	% Disease 09/01/95
Fluazinam	0.5	14	3.3 a
Banner GL + Turfex	0.6+5.0	28	5.0 ab
Banner GL	1.2	28	5.0 ab
Eagle 40W + Fore 80 WP	0.6+4.5	21	5.0 ab
Bayleton	4.0	28	6.7 ab
Sentinel	0.33	28	6.7 ab
IB11924	2.75	14	6.7 ab
Banner GL	0.9	28	8.3 ab
Banner GL + Turfex	0.9+5.0	28	8.3 ab
Fluazinam	1.0	14	8.3 ab
Sentinel	0.25	28	10.0 ab
Fore 80WP + Chipco 26019	4.0+2.0	21	10.0 ab
Eagle 40W	0.6	28	10.0 ab
Control	---		10.0 ab
Fore 80WP + Banner	4.0+2.0	21	11.7 b
LSD (0.05)			7.0

[a] M=1000 ft.^{2}

Sentinel and Daconil Ultrex Gallonage Study: Influence on Dollar Spot Control

Karl Danneberger and Jill Taylor
Horticulture and Crop Science

Introduction

A study was initiated on July 20, 1995, to evaluate dollar spot (*Sclerotinia homoeocarpa*) control using Sentinel and Daconil Ultrex in 0.5, 1.0, 2.0, and 4.0 gallons per 1,000 square feet. A creeping bentgrass turf mowed at 0.5 inch height of cut located at The Ohio State University Turfgrass Research Center was used for the study. The 0.5 and 1.0 gallons per 1,000 sq. ft. treatments were applied singularly to each plot using 8002 LP nozzle tips. The 2.0 and 4.0 gallonage treatments were applied with a small-plot CO_2 sprayer with 6503 nozzle tips operating at 40 psi. The treatments were applied to 3 ft. by 5 ft. plots with each treatment replicated three times.

Results

Gallonage appeared to have little effect on dollar spot control with either Sentinel or Ultrex. The control period with both products was expected (Ultrex 7- to 12-day control; Sentinel 28-day control). No difference in brown patch control was observed with gallonage amounts in this study. Further work is needed since gallonage delivered in controlled test studies may vary when practiced by the end user.

Table 1. Gallonage Effects on the Performance of Sentinel and Ultrex on Dollar Spot Control.

Fungicide	Rate (oz./M)	Gallonage per 1000 sq. ft.	Dollar Spot (%) 7/31	8/15
Sentinel	0.25	4.0	0.7 a	0.0 a
Sentinel	0.25	2.0	1.0 a	0.0 a
Sentinel	0.25	1.0	3.3 ab	0.0 a
Ultrex	3.8	1.0	3.7 ab	16.7 c
Sentinel	0.25	0.5	4.3 ab	3.3 ab
Ultrex	3.8	4.0	6.7 ab	15.0 c
Ultrex	3.8	2.0	8.3 ab	20.0 c
Ultrex	3.8	0.5	12.0 b	13.0 bc
Control	--	--	35.0 a	43.3 d
LSD (0.05)			10.1	9.7

Pink Snow Mold Control Study, 1994 – 1995

Jill Taylor, Joe Rimelspach, and Karl Danneberger
Horticulture and Crop Science; Plant Pathology

Introduction

A pink snow mold study (*Microdochium nivale*) was initiated December 16, 1994, at The Golf Club in New Albany, Ohio. The turfgrass was creeping bentgrass maintained at fairway height. The plots measured 9 ft. by 6 ft., and each treatment was replicated three times in a completely randomized design. Liquid applications were made with a CO_2 sprayer with 8004 nozzles at 40 psi. Dry applications were hand applied. Note: No pink snow mold was observed at the time of application.

A second pink snow mold study was initiated December 20, 1994, at Quail Hollow Golf Club and Resort in Painesville, Ohio. The turfgrass was a combination of creeping bentgrass and annual bluegrass maintained at fairway height (0.5 inches). The plots measured 9 ft. by 6 ft., and each treatment was replicated three times in a completely randomized design. Liquid applications were made with a CO_2 sprayer with 8004 nozzles at 40 psi. Dry applications were made by hand. Note: A slight amount of active (1 to 3%) pink snow mold was observed at time of treatment.

Results

Relatively high levels of pink snow mold were present in both studies. Product performance in general was consistent between the two sites. Overall, the PCNB products, especially Scotts FFII, performed well. In addition, the combination of Chipco 26019 and Daconil 2787, either as a flowable or as a granular, performed well.

Table 1. Pink Snow Mold Control Results from New Albany, Ohio, 1995.

Treatment	Rate (oz./M)	% Pink Snow Mold 2/22
R-P ExP 10452A	4	0.3 a
Scotts FFII	80	0.7 a
Turfcide 400 + Daconil 2787F	4 + 8	0.7 a
Chipco 26019 FLO + Daconil 2787F	4 + 8	1.0 a
Chipco 26019 + Lesco Revere 75DG + Daconil Ultrex	2+8+4.8	1.0 a
Chipco 26019 FLO + Daconil 2787F	8 + 8	1.0 a
Chipco 26019 WDG + Daconil Ultrex	2 + 4.8	1.7 ab
UBI 9250	80	2.3 ab
UBI 9249	120	2.7 ab
Banner EC	4	2.7 ab
Turfcide 400	12	2.7 ab
Banner 45 WP + Daconil 2787	.94g + 8	3.0 ab
Lesco 10-3-23 + PCNB G	6 lbs	3.0 ab
R-P EXP 10452A + Daconil Ultrex	8 + 8	3.0 ab
Chipco 26019 WDG + Daconil Ultrex	4 + 4.8	3.3 ab
Lesco Revere 75 DG	8	3.7 abc
Fore	4	4.0 abc
Sentinel 40 WG + Lesco Revere 75DG	0.3 + 8	4.7 abcd
Sentinel 40 WG + Chipco 26019 FLO	0.3 + 4	6.0 abcd
UBI 4044	120	9.7 abcde
Curalan	4	10.0 abcde
Bayleton	8	10.3 abcde
Terraneb SP	9	10.7 abcde
Sentinel 40WG	0.3	11.7 bcde
Control		31.0 f
LSD (P=0.05)		10.6

Table 2. Pink Snow Mold Control Results from Painesville, Ohio, 1995.

Treatment	Rate (oz./M)	% Pink Snow Mold (03/07/95)
Scotts FFII	101 8	4.3 a
UBI 9250	80	5.7 a
Chipco 26019 FLO + Daconil 2787F	4 + 8	5.7 a
UBI 9249	120	8.0 ab
Turfcide 400 + Daconil 2787F	4 + 8	8.0 ab
Chipco 26019 FLO + Daconil 2787F	8 + 8	8.3 ab
LESCO PCNB G (10-3-23)	6 lbs	8.3 ab
Chipco 26019 WDG + Lesco Revere 75DG + Daconil Ultrex	2 + 8 + 4.8	8.7 ab
Scotts FFII	80	9.0 ab
Turfcide 400	12	9.2 ab
Chipco 26019 WDG + Daconil Ultrex	4 + 4.8	10.3 ab
Scotts FFII	50.9	10.7 ab
EXP 10452A	4	14.3 abc
Sentinel 40 WG + LESCO Revere 75DG	0.3 + 8	15.0 abcd
Fore	4	15.0 abcd
EXP 10452A + Daconil Ultrex	4 + 4.8	15.7 abcd
Fluazinam F	1	17.3 abcd
UBI 4044	120	20.7 abcde
Chipco 26019 WDG + Daconil Ultrex	2 + 4.8	20.7 abcde
Sentinel 40 WG + Chipco 26019 FLO	0.3 + 4	21.7 abcde
Banner EC	4	21.7 abcde
LESCO Revere 75DG	8	23.0 abcde
Nature Safe (10-3-3)	1 lb	26.7 abcde
Bayleton	8	27.3 abcde
Curalan F	4	28.3 abcde
Sentinel 40 WG	0.3	35.0 bcde
Sustain 5-2-4 + Iron	3 lbs	36.7 bcde
Sustain 5-2-4 + Iron	2 lbs	41.7 cde
Control	---	41.7 cde
Terraneb SP	9	43.3 de
Control	---	46.7 e
Sustain 5-2-4 + Iron	1 lb	48.3 e

Means followed by the same letter are not significantly different (P=0.05) according to Duncan's Multiple Range test.

Turfgrass Insect Control

Control of Black Cutworm, *Agrotis ipsilon* (Hufnagel), and Sod Webworms (Pyralidae: Crambinae) on Short Cut Bentgrass, *Agrostis palustris* Hudson — 1995

David J. Shetlar, Harry D. Niemczyk and Kevin T. Power
Department of Entomology

Materials and Methods

The study was located on The Ohio State University Turfgrass Research Facility, Columbus, Ohio, on Ranges 3 and 4, north. Pretreatment samples were taken from three 1.0-yd.^{2} areas in this range August 28. Sod webworm larvae of small to medium size were present (9, 16, and 26 per yd.^{2}), but few small black cutworms were found (0, 2, and 3 per yd.^{2}).

Treatments were applied August 31 to plots 4 ft. by 5 ft. (larger plots were not used because of limited space, so 14 DAT data were not available). The plots were arranged in a randomized complete-block design replicated three times. The liquid treatments were applied with a pressurized CO_2 sprayer with TeeJet 8006VS nozzles using 19 psi to deliver a volume of 1.0 gal./1,000 ft.^{2} The granular formulations were applied with a two-foot Gandy drop spreader calibrated for each product. The sprays were not irrigated after application, while the granular treated plots received 3.0 gal. water per plot (= 1/4-inch of irrigation). The ranges received approximately 0.2 inch of irrigation each day between 4:00 and 5:00.

Field conditions at the time of treatments were as follows:

- Turf — 100% creeping bentgrass; mowed three times per week at 3/16 inch (5 mm); level; moderately dense; light dew present.
- Thatch — loose, moist, and 1/4 inch or less.
- Soil — moist; 78°F at 1.0 inch, 74°F at 3.0 inch; clay-loam; no soil analysis performed.
- Weather — mostly sunny; 84 to 88°F; 0 to 12 mph wind.

Treated plots were observed for approximately two hours after application of all the insecticides to determine if any black cutworm or sod webworm came to the surface. Efficacy data were taken September 7 (7 DAT) based on the number of black cutworm and sod webworm larvae flushed to the surface in a 1.0 yd.^{2} area using a soap irritant drench of 15 ml Joy dishwashing detergent in 2.0 gal. water. All caterpillars were collected in KAAD preservative for each plot and identified in the laboratory. Plot totals were analyzed using standard ANOVA, and the means were separated by using the LSD test (@ $P = 0.5$).

Results

Large- to medium-sized black cutworm larvae surfaced for all the insecticide treated plots within two hours after application. Generally, one to three cutworms surfaced.

All the products and rates performed satisfactorily, although the lower rates of Talstar 0.66F and Bifenthrin 1EC did not eliminate all the sod webworms. The Scimitar formulations provided complete control as did the standard, Dursban.

There were no signs of phytotoxicity from any of the treatments.

Table 1. Efficacy of Various Chemical Insecticides for Control of Black Cutworm and Sod Webworm Larvae in Turfgrass. The Ohio State University Turfgrass Research Facility — 1995.

Treatment[a]	Rate lb. (AI)/acre	x larvae/yd.^{2} @ 7DAT BCW	SWW
Sevin 3.5G	8.0	0.0 c	0.3 b
Sevin 4SL	8.0	0.0 c	0.0 b
Sevin 7G	8.0	0.3 c	0.0 b
Talstar 0.66F	0.0125	0.3 c	0.0 b
Talstar 0.66F	0.00625	0.0 c	2.7 b
Talstar 0.66F	0.00313	1.3 b	4.3 b
Bifenthrin 1EC	0.0125	0.0 c	0.0 b
Bifenthrin 1EC	0.00625	0.0 c	1.0 b
Bifenthrin 1EC	0.00313	0.3 c	2.0 b
Scimitar 10CS	0.0288	0.0 c	0.0 b
Scimitar 10CS	0.0576	0.0 c	0.0 b
Scimitar 10WP	0.0288	0.0 c	0.0 b
Scimitar 10WP	0.0576	0.0 c	0.0 b
Dursban TI 4EC	1.0	0.0 c	0.0 b
Check	---	4.3 a	14.7 a
LSD ($P<0.05$)		0.8	5.1

[a] Applied August 31 to plots 4 ft. by 5 ft. replicated three times.
Data taken September 7 based on one 1.0 yd.^{2} soap flushed area per plot. Analysis by ANOVA and LSD.

Control of Black Cutworm, *Agrotis ipsilon* (Hufnagel), and Sod Webworms (Pyralidae: Crambinae) on Short Cut Bentgrass, *Agrostis palustris* Hudson Using Spinosad Formulations — 1995

David J. Shetlar, Harry D. Niemczyk, and Kevin T. Power
Department of Entomology

Materials and Methods

The study was located on The Ohio State University Turfgrass Research Facility, Columbus, Ohio, on Ranges 3 and 4, north. Pretreatment samples were taken from three 1.0-yd.^{2} areas in this range August 28. Sod webworm larvae of small to medium size were present (9, 16, and 26 per yd.^{2}), but few small black cutworms were found (0, 2 , and 3 per yd.^{2}).

Treatments were applied August 31 to plots 4 ft. by 8 ft., arranged in a randomized complete-block design replicated three times. Replicates were separated by 2-ft. alleys. The liquid treatments were applied with a pressurized CO_2 sprayer with TeeJet 8006VS nozzles using 19 psi to deliver a volume of 1.0 gal./1,000 ft.^{2} The sprays were not irrigated after application. The ranges received approximately 0.2 inch of irrigation each day between 4:00 and 5:00.

Field conditions at the time of treatments were as follows:

- Turf — 100% creeping bentgrass; mowed three times per week at 3/16 inch (5 mm); level; moderately dense; light dew present.
- Thatch — loose, moist, and 1/4 inch or less.
- Soil — moist; 78°F at 1.0 inch; 74°F at 3.0 inch; clay-loam; no soil analysis performed.
- Weather — mostly sunny; 84 to 88°F; 0 to 12 mph wind.

Treated plots were observed for approximately two hours after application of all the insecticides to determine if any black cutworms or sod webworms came to the surface. Efficacy data were taken Sept ember 7(7 DAT) and September 14 (14 DAT), based on the number of black cutworm and sod webworm larvae flushed to the surface in a 1.0 yd.^{2} area using a soap irritant drench of 15 ml Joy dishwashing detergent in 2.0 gal. water. All caterpillars were collected in KAAD preservative for each plot and identified in the laboratory. Plot totals were analyzed using standard ANOVA and the means were separated by using the LSD test (@ $P = 0.5$).

Results

No larvae were observed to surface in any of the NAF treated plots. One black cutworm larva in each of two Dursban treated plots surfaced within two hours after treatment.

All the products and rates provided satisfactory control since no visible damage was detected in the plots. However, the lower rates of NAF and the NAF-144 formulation allowed considerable survival of sod webworms.

There were no signs of phytotoxicity from any of the treatments. The NAF-144 formulation was very difficult to get into solution, and this formulation had a strong "earthy" odor that was not objectionable but noticeable.

Table 1. Efficacy of Various Spinosad Formulations for Control of Black Cutworm and Sod Webworm Larvae in Turfgrass. The Ohio State University Turfgrass Research Facility — 1995.

Treatment[a]	Rate lb. ai/A	x larvae/yd.^{2} BCW	@ 7DAT SWW	x larvae/yd.^{2} BCW	@ 14DAT SWW
NAF-85 4SC	1.4000	0.0 b	0.3 c	0.0 c	0.0 d
NAF-85 4SC	0.7000	0.3 b	0.0 c	1.0 bc	0.0 d
NAF-85 4SC	0.350	0.7 b	1.3 c	0.0 c	0.3 cd
NAF-85 4SC	0.1750	0.3 b	0.0 c	0.0 c	2.0 cd
NAF-85 4SC	0.0875	0.7 b	3.7 c	1.3 b	4.0 c
NAF-127 80WG	1.4000	0.3 b	0.0 c	0.0 c	0.7 cd
NAF-127 80WG	0.3500	0.7 b	0.0 c	0.7 bc	0.0 d
NAF-127 80WG	0.1750	0.7 b	2.0 c	0.7 bc	1.0 cd
NAF-127 80WG	0.0875	0.7 b	1.0 c	0.7 bc	2.7 cd
NAF-144 2.2WP	0.7000	0.3 b	0.0 c	1.0 bc	0.7 cd
NAF-144 2.2WP	0.3750	0.0 b	1.3 c	0.3 bc	2.0 cd
NAF-144 2.2WP	0.1750	1.0 b	3.3 c	0.7 bc	2.7 cd
NAF-144 2.2WP	0.0875	1.0 b	15.0 b	1.0 bc	9.7 b
Dursban 2EC	1.0	0.3 b	0.0 c	0.0 c	0.0 d
Check	---	5.7 a	34.3 a	6.3 a	29.0a
LSD P<0.05)		1.59	8.58	1.08	3.99

[a] Applied August 31 to plots 4 ft. by 5 ft. replicated three times.
Data taken September 7 and September 14 based on one 1.0 yd.^{2} soap flushed area per plot. Analysis by ANOVA and LSD.

Applications of Insecticides for Control of Second Generation Hairy Chinch Bugs in Turfgrass — 1995

David J. Shetlar, Harry D. Niemczyk, and Kevin T. Power
Department of Entomology

Introduction

The objective of this trial was twofold — first, a quick knockdown of a chinch bug population, and second, longer term control. Thus, two application dates were chosen to acquire such data.

Methods and Materials

Treatments were applied July 24 and August 10, to plots 8 ft. by 10 ft., arranged in a randomized complete-block design replicated three times. The experiment was located on a 100% fine fescue research area (North Fescue No. 1) at the Ohio Agricultural Research and Development Center, Wooster, Ohio. Liquid treatments were made with a CO_2 sprayer, TeeJet 8015 nozzles, and 60 psi. delivering 3 gal./1,000 ft.^{2} The granular formulations were applied using a shaker jar. On each application date, the site received approximately 1/4 in. irrigation one hour after the treatments were applied.

Field conditions during the July 24 treatments were as follows:

- Chinch bugs — second generation egg hatch; few adults; no pretreatment count taken.
- Turf — 3 in. height; dry; 3/4 in. thatch depth.
- Soil — moist; 85°F at 1 in. and 81°F at 3 in. deep.
- Weather — partly sunny; 80°F; 3 mph. wind.

Field conditions during the August 10, treatments were as follows:

- Chinch bugs — 80% first and second instar nymphs.
- Turf — 3 in. height; dry; 3/4 in. thatch depth.
- Soil — moist; 84°F at 1 in. and 81°F at 3 in. deep.
- Weather — mostly cloudy; 83°F; 0-3 mph. wind.

Two samples, 4.25 inches in diameter, were taken from each plot August 10, and insects extracted in Burlese funnels equipped with 25 watt bulbs.

Efficacy data were obtained August 17, (24 and 7 DAT) by counting the number of live chinch bugs floating to the surface within five minutes in two flooded eight-inch diameter cylinders in each plot. ANOVA was done by plot totals transformed to log (X+1) and means separated by Duncan's multiple range test at p=0.05.

Results

Samples taken August 10 and extracted in Burlese were an attempt to determine whether the systemic and/or contact toxicity properties of MERIT controlled early nymphs. Though the data in Table 1 are variable, they show that, except for the 0.5G at 0.4 lb. ai/A, no control was evident 17 DAT.

As is often the case with chinch bug, the population at the test site was "clumped" and extremely low in replicate 3. It is our view that despite the fact that there was no significant difference between the treatments, the percent control shown in Table 2 more adequately reflects the results.

There were no signs of phytotoxicity from any of the treatments.

Table 1. Efficacy of Merit for Control of Second Generation Chinch Bug (CB) Populations in Turfgrass. OARDC Campus, Wooster, Ohio. 1995

Treatment[a]	Rate lb. ai/A	Chinch Bugs/ft.^{2} 17 DAT[b] 1st stage	2nd stage	Adults	% Control
Merit 75WP	0.3	14	3	41	0
Merit 75WP	0.4	36	19	0	0
Merit 0.5G	0.3	27	22	0	0
Merit 0.5G	0.4	8	0	0	72
Check	-.-	19	10	0	

[a] Applied July 24 to plots 8 ft. by 10 ft. replicated three times. Posttreatment irrigation 1/4 in.

[b] Data taken August 10 based on two samples 4.25 inches in diameter from each plot. Insects were extracted in burlese funnels using 25 watt bulb.

Preventive Application of Insecticides for Control of Black Turfgrass Ataenius Larvae on Golf Course Fairways — 1995

David J. Shetlar, Harry D. Niemczyk, and Kevin T. Power
Department of Entomology

Methods and Materials

Treatments replicated four times were applied May 15, at onset of bloom of Vanhoutte Spirea, to Fairway No. 3 of the north course of Westfield Country Club, Westfield, Ohio. Plots were 6 ft. by the width of the fairway (≥ 65 ft.). Liquid applications were made using a CO_2 sprayer with XR8006VS operated at 35 psi that delivered 1.0 gal./1,000 $ft.^2$ The granular treatment was applied with a two-foot spreader. The entire experimental area received approximately 1/4 inch irrigation one hour after applications were made using the golf course system. Following the day of treatment, the fairway was irrigated. Thereafter the fairway was irrigated to maintain turf quality.

Field conditions at the time of treatment were as follows:

- BTA — ovipositing adults present.
- Turf — 60% annual bluegrass and 40% bentgrass; grass height 3/4 inches; thatch -1 in. depth, very dense.
- Soil — moist; 60°F at 1 and 3 inches deep; no soil analysis.
- Weather — sunny; 64°F; 0-8 mph wind.

Efficacy data were obtained July 10 (56 days post-treatment) by counting the number of live BTA larvae and pupae in 10 samples 4-1/4 inches in diameter by two-inches deep from each plot. Totals per plot were transformed to log (X+1) for analysis of variance and means separated by Duncan's multiple range test at p=0.05.

Results

All treatments provided a significant reduction in larval counts. The Pyrethrin treatments were the most efficacious as was FCR 4545. The standard Dursban at 2.0 lb. ai/A (applied once) gave acceptable results.

There were no signs of phytotoxicity from any of the treatments.

Table 1. Effectiveness of Insecticide Applications Directed at Ovipositing Black Turfgrass Ataenius Adults to Prevent Infestations of Larvae. Westfield Country Club, Westfield, Ohio — 1995

Treatment[a]	Formulation	Rate lb. ai/A	BTA larvae 58 DAT	% Control
Talstar	0.66F	0.100	0.0 d	100
PL95-124	1.0EC	0.100	0.0 d	100
PL 95-076	0.25EC	0.100	1.5 cd	94
Talstar	0.2G	0.100	0.3 cd	99
Dursban	4EC	2.000	8.4 b	66
Tempo	20WP	0.144	0.5 cd	98
FCR 4545	10WP	0.070	2.0 c	92
Check	---		24.6 a	---

[a] Application May 15,1995, to plots 6 ft. by the width of the fairway replicated four times. Spray volume 1 gal./1,000 ft.^{2}

[b] Data taken July 12, based on 12 random samples (4.25 in. diam.) from each plot. Data transformed to log (X+1) for analysis. Means followed by the same letter are not significantly different according to Duncan's new multiple range test at p=0.05.

Spring Application of Chemical and Biological Insecticides for Control of Overwintered White Grubs in Turfgrass —1995

David J. Shetlar, Harry D. Niemczyk, and Kevin T. Power
Department of Entomology

Methods and Materials

Treatments were applied May 3 to plots 5 ft. by 10 ft. arranged in a randomized complete-block design replicated three times. The experiment was located in the rough of Valley Fairway No. 4 at Valley View Golf Course, Akron, Ohio. Spray volume for the treatments was 3 gal./ 1,000 $ft.^2$ using TeeJet XR8010 nozzles and 30 psi. The granular treatment was applied with a two-foot wide Gandy drop spreader. The entire experimental area received approximately one-half inch irrigation after all treatments were applied. The area received no further supplemental irrigation.

Field conditions at the time of treatment were as follows:

- White Grubs — ca:15/$ft.^2$, 3^{rd} instars; 60% masked chafers; and 40% Japanese beetle.
- Turf — 50% bentgrass, 30% annual bluegrass, and 20% Kentucky bluegrass; grass height 1 – 2 inches; no thatch.
- Soil — moist; 50° F at 1 and 3 inches deep; no soil analysis.
- Weather — sunny; 47°F; no wind.

Efficacy data were obtained May 30 (27 DAT) by counting the number of live larvae in four samples 7 in. by 7 in. from each plot. Analysis of variance was done on transformed log (X+1) and means separated by Duncan's new multiple range test at p=0.05.

Results

Triumph, Dylox, and Diazinon gave good control. The MYX - 910 at the high rate (26 gal. product/acre) reduced the population although not significantly due to high numbers of grubs in one replicate. The remaining treatments failed to yield acceptable control.

There were no signs of phytotoxicity from any of the treatments.

Table 1. Spring Application of Insecticides for Control of Overwintered Third Instar Japanese Beetle Larvae. Valley View Golf Course, Akron, Ohio — 1995.

Treatment	Rate	Larvae/ft.^{2} 27 DAT	% Control
Crusade 5G	4.0 lb. ai/A	8.6 a	59
Dylox 80S	8.0 lb. ai/A	3.2 bc	85
Triumph 4E	2.0 lb. ai/A	0.3 c	99
Diazinon 4E	5.5 lb. ai/A	2.5 bc	88
MYX - 915	5.5 gal./A	17.6 a	15
MYX - 915	11.0 gal./A	12.9 a	38
MYX - 910	13.0 gal./A	13.7 a	34
MYX - 910	26.0 gal./A	5.8 ab	72
SCIMITAR 10CS	0.06 lb. ai/A	15.0 a	27
CHECK		20.8 a	

[a] Applied May 3 to plots 5 ft. by 10 ft. replicated four times. Spray volume 3 gal./1000 ft.^{2} Post-treatment irrigation 1/4 in.

[b] Data taken May 26 based on 4, 7 in. by 7 in. samples from each plot. Data transformed to log (X=1) for analysis. Means followed by the same letter are not significantly different according to Duncan's new multiple range test at p=0.05.

Influence of Post-Treatment Irrigation on the Efficacy of RH 0345 and Merit Applied at the Time of Egg Hatch for Control of Japanese Beetle Larvae in Turf — 1995

David J. Shetlar, Harry D. Niemczyk, and Kevin T. Power
Department of Entomology

Methods and Materials

Treatments were applied August 3, to plots 8 ft. by 10 ft., arranged in a randomized complete-block design replicated four times. The experiment was located in Fairway No. 15 of Twin Lakes Golf Course, Mansfield, Ohio. Spray volume for the treatments was 3 gal./1,000 ft.^{2} using TeeJet 8015 nozzles and 60 psi. The granular treatments were applied with a two-foot wide Gandy drop spreader.

Four different post-treatment irrigation regimes were employed — immediately after sprays were applied, after sprays dried, after granules were applied, and no post-treatment irrigation. Irrigation was applied with a sprinkling can at 12.5 gal./plot which is approximately equal to 1/4 in. Two days following the treatment date, the fairway was irrigated. Thereafter, the fairway was irrigated regularly to maintain turf quality.

Field conditions at the time of treatment were as follows:

- Japanese beetle — adults and 1st instar larvae present.
- Turf — 50% Kentucky bluegrass and 50% annual bluegrass; grass height 1 in.; no thatch.
- Soil — moist; 75° F at 1 in. and 74° F at 3 in. deep; no soil analysis.
- Weather — sunny; 88°F; 0-8 mph wind.

Efficacy data were obtained September 26 (43 DAT) by counting the number of live larvae in six samples 7 in. by 7 in. from each plot. Analysis of Variance was done on transformed log (X+1) data and means separated by Duncan's new multiple range test at p=0.05.

Results

The 2SC and 2.5G formulations of RH 0345 and MERIT gave excellent control regardless of the irrigation regime.

There were no signs of phytotoxicity from any of the treatments.

Table 1. Influence of Post-Treatment Irrigation Timing upon RH0345 Applications to Control Japanese Beetle Larvae in Turfgrass. Twin Lakes Golf Course, Mansfield, Ohio. 1995.

Treatment[a]	Formulation	Rate lb. ai/A	Larvae/ft.² Irrigation[b]	43 DAT[c]	% control
RH 0345-101	2SC	1.0	None	0.5 b	96
RH 0345-101	2SC	2.0	None	0.2 b	98
RH 0345-101	2SC	1.0	After drying	0.5 b	96
RH 0345-101	2SC	2.0	After drying	0.0 b	100
RH 0345-101	2SC	1.0	Immediate	0.2 b	98
RH 0345-101	2SC	2.0	Immediate	0.1 b	99
RH 0345-102	2.5G	1.0	None	0.1 b	99
RH 0345-102	2.5G	2.0	None	0.2 b	98
RH 0345-102	2.5G	1.0	After appl.	0.1 b	99
RH 0345-102	2.5G	2.0	After appl.	0.0 b	100
MERIT	75WP	0.3	None	1.8 b	85
MERIT	75WP	0.3	After drying	0.2 b	98
CHECK			None	12.5 a	

[a] Applied August 3 to plots 8 ft. by 10 ft. replicated four times. Spray volume 3 gal./1000 ft.^{2}

[b] Post-treatment irrigation 1/4 in.

[c] Data taken September 26 based on 6, 7 in. by 7 in. samples from each plot. Data transformed to log (X+1) for analysis. Means followed by the same letter are not significantly different according to Duncan's new multiple range test at p=0.05.

Application of Various Insecticides for Preventive Control of Japanese Beetle Larvae in Turfgrass — 1995

David J. Shetlar, Harry D. Niemczyk and Kevin T. Power
Department of Entomology

Methods and Materials

Treatments were applied August 14, to plots 10 ft. by 10 ft., arranged in a randomized complete-block design replicated four times. The experiment was located in Fairway No. 16 of Twin Lakes Golf Course, Mansfield, Ohio. Liquid treatments were applied with a CO_2 sprayer, TeeJet XR8006VS nozzles, and 25 psi. delivering 1 gal./1000 ft.^{2} The granules were applied with a shaker jar. The entire experimental area received 1/4 inch irrigation after all treatments were applied. Two days following the treatment date, the fairway was irrigated. Thereafter, irrigation was applied to maintain turf quality.

Field conditions at the time of treatment were as follows:

- Japanese beetles — Adults actively feeding; eggs present.
- Turf — 50% Kentucky bluegrass and 50% annual bluegrass; grass height 1-1/4 in.; no thatch.
- Soil — moist; 77°F at 1 in. and 76°F at 3 in. deep; no soil analysis.
- Weather — sunny; 78°F; 0-5 mph wind.

Efficacy data were obtained September 26 (43 DAT) by counting the number of live larvae in six 7 in. by 7 in. samples from each plot. Analysis of Variance was done on plot totals transformed to log (X+1) and means separated by Duncan's new Multiple Range Test at p=0.05.

Results

All formulations and rates of RH 0345 gave excellent and significant reductions in the developing larval populations as did Merit and Triumph. The microencapsulated formulation of isazofos (Triumph CS) gave a slight but not significant reduction.

Table 1. Efficacy of Insecticides Applied After Japanese Beetle Egg Hatch to Control Larvae. Twin Lakes Golf Course, Mansfield, Ohio. 1995.

Treatment[a]	Formulation	Rate lb. ai/A	Larvae/ft.^{2} 43 DAT[b]	% control
RH 0345-101	2SC	1.5	0.2 bc	99
RH 0345-101	2SC	2.0	0.1 c	99
RH 0345-102	2.5G	1.0	0.6 bc	97
RH 0345-102	2.5G	1.5	1.4 bc	92
RH 0345-102	2.5G	2.0	1.2 bc	93
RH 0345-103	5G	1.0	2.0 b	89
RH 0345-103	5G	1.5	0.9 bc	95
RH 0345-103	5G	2.0	2.0 b	89
Merit	75WP	0.3	0.2 bc	99
Triumph	4E	2.0	2.3 bc	87
Triumph	500CS	2.0	10.2 a	42
CHECK			17.5 a	

[a] Applied August 14 to plots 10 ft. by 10 ft. replicated four times. Spray volume 1 gal./1000 ft.^{2} Post-treatment irrigation 1/4 in.

[b] Data taken September 26 based on 6, 7 in. by 7 in. samples from each plot. Data transformed to log (X+1) for analysis. Means followed by the same letter are not significantly different according to Duncan's new multiple range test at p=0.05.

Chemical and Biological Insecticides Applied for Control of White Grubs in Turfgrass — 1995

David J. Shetlar, Harry D. Niemczyk, and Kevin T. Power
Department of Entomology

Materials and Methods

Treatments were applied August 24, to plots 8 ft. by 10 ft., arranged in a randomized complete-block design replicated four times. The experiment was located in the rough of Fairway No. 4 on Valley View Golf Course, Akron, Ohio. The liquid treatments were applied with a pressurized CO_2 sprayer, 8015 TeeJet nozzles, and 60 psi at 3 gal./1,000 ft.^{2} Granules were applied with a two-foot Gandy drop spreader. The entire experimental area received 1/4 in. irrigation using the golf course system after all treatments were applied. The area received no further supplemental irrigation.

Field conditions at the time of treatment were as follows:

- White grubs — ca. 20/ft.^{2}; 60% Japanese beetle (JB), 20% 1st, 70% 2nd, and 10% 3rd instars; 40% Masked chafers (MC), 20% 2nd and 80% 3rd instar larvae.
- Turf — 50% Kentucky bluegrass, 25% bentgrass, and 25% annual bluegrass; 2-1/4 in. height; no thatch.
- Soil — moist; 72°F. at 1 inch and 3 inches deep. No soil analysis.
- Weather — sunny; 75°F.; 0-2 mph wind.

Efficacy data were obtained September 27 (30 DAT) by counting the number of live larvae in six samples 7 in. by 7 in. by approximately 3 inches deep. Plot totals were transformed to log (X+1) for ANOVA and means separated by LSD test (p=0.5).

Results

All formulations of Sevin provided adequate control of JB and MC. Turcam was better but not significantly so. MYX 915 provided inadequate control of both pests. Control with MYX 910 was also inadequate and less than previously experienced.

There were no signs of phytotoxicity from any of the treatments.

Table 1. Efficacy of Various Chemical Insecticides and a *Bacillus thuringiensis* Strain for Control of White Grubs in Turfgrass. Valley View Golf, Akron, Ohio — 1995.

		Japanese Beetle(JB) & Masked Chafer (MC) larvae 30 DAT[b]					
Treatment[a]	Rate	JB/ft.^{2}	% JB control	MC/ft.^{2}	% MC control	MC+JB/ft.^{2}	% JB&MC control
Sevin 4SL	8.0 lb. ai/A	5.2 abcd	71	0.9 bc	82	6.0 abc	73
Sevin 3.5G	8.0 lb. ai/A	5.2 abcd	71	1.2 bc	74	6.4 abc	72
Sevin 7G	8.0 lb. ai/A	3.4 bcd	81	1.3 bc	72	4.8 abc	79
Turcam 2.5G	2.0 lb. ai/A	2.6 cd	86	0.4 c	92	2.9 c	87
Sevin 4SL +	4.0 lb. ai/A						
Diazinon AG500	2.0 lb. ai/A	2.4 d	86	0.6 bc	87	3.0 bc	86
MYX - 915	5.5 gal/A	7.8 abcd	56	2.1 abc	56	9.9 abc	56
MYX - 915	11.0 gal/A	12.2 ab	31	7.3 a	0	19.5 a	13
MYX - 910	13.0 gal/A	8.0 abc	55	2.1 abc	56	10.1 ab	55
MYX - 910	26.0 gal/A	5.4 abcd	70	2.4 abc	49	7.8 abc	65
Check		17.8 a		4.8 ab		22.6 a	

[a] Applied August 24 to plots 8 ft. by 10 ft. replicated four times. Post-treatment irrigation 1/4 in.

[b] Data taken September 4 based on 6, 7 in. by 7 in. samples from each plot. Analysis log(X+1) ANOVA & DMRT p=0.05.

Turfgrass Fertility Studies

Nitrogen Source, Rate, and Timing Effect on Kentucky Bluegrass

John R. Street and Renee M. Stewart
Horticulture and Crop Science

Introduction

Good turfgrass growth is dependent on an adequate supply of all the essential nutrients as well as other environmental and cultural factors. Of the essential nutrients, nitrogen is the element that receives the most attention in turfgrass fertilization programs. One reason for emphasis on nitrogen is that turfgrasses give a good color and growth response to nitrogen. The color and growth responses from nitrogen are usually more dominant than any other element. The behavior of nitrogen, in both the plant and the soil, places it in the unique position of being the "growth control" element. Supplies of other nutrients are kept at adequate levels, and the turfgrass manager regulates growth and color by adding or withholding nitrogen. Thus, fertilization strategies for turfgrass are primarily designed around nitrogen.

A key strategy in fertilization of turfgrasses is to produce as uniform and slow a growth throughout the growing season as needed to provide the necessary color, growth, and recuperative potential for each management situation. Uniform growth is desired, and rapid fluctuations in growth or surge growth (peak and valley feeding) are undesirable. Uniform growth strategies involve proper fertilization timing, proper selection of nitrogen sources, multiple seasonal applications, and proper nitrogen application rates. Many slow-release nitrogen sources are available today with unique chemistries and release characteristics to assist in nitrogen programming and uniform growth patterns.

A unique timing strategy, late-season fertilization, has become a widely recommended practice for cool-season grasses. Several advantages to late-season fertilization include enhanced late fall, winter, and/or spring quality; reduced mowing requirements; more uniform spring and early summer growth; improved plant carbohydrate balance; deeper and more prolific rooting; and enhanced overall stress tolerance. Late-season fertilization is timed in the late fall when top growth of cool-season turfgrasses has ceased or stopped. Soil temperatures at this time of year are relatively cold. The most efficient nitrogen sources in late season are those relatively independent of temperature for nitrogen release. The nitrogen sources available today differ significantly in their nitrogen release characteristics based on temperature.

A number of nitrogen-containing fertilizers are presently available in the marketplace for turfgrass fertilization. For the purpose of simplicity, they can be grouped into two major categories — water-soluble or quickly available, and water-insoluble or slowly available. These nitrogen sources vary considerably in their chemical and physical properties. Slowly available sources such as ureaformaldehyde (UF), milorganite, isobutylidene diurea (IBDU), methylene ureas, and sulfur-coated ureas have been available for years.

Many new processed and composed natural organic fertilizers have emerged into the marketplace in the last few years. Several new slowly-available sources have more recently emerged into the marketplace. These are the polymer-coated ureas and polymer-coated, sulfur-coated ureas. Polymer-coated urea is by definition a coated slow-release fertilizer consisting of fertilizer urea particles coated with a polymer plastic resin. The polymer-coated, sulfur-coated ureas are sulfur-coated urea particles coated with a polymer-plastic (resin). Coating thickness of the sulfur and/or plastic (resin) plays a major role in the release characteristics of these latter sources.

The main purpose of this research is to evaluate various nitrogen sources, especially those in the latter categories (polymers), for performance in seasonal and late-season fertilization strategies.

Discussion/Summary

The effects of several nitrogen sources, nitrogen rates, and application timings were evaluated on turfgrass quality and yield/growth of Kentucky bluegrass throughout the growing season. Specific application timing and rates are provided in Table 1 for November 1994 through November 1995.

The ESN polymer-coated urea sources (ESNs 2002, 2003, and 2004) have correspondingly heavier coatings, providing estimated nitrogen release patterns of 60 days, 90 days, and 120 days, respectively. The ESN polymer-coat is based on elastomer polymer technology. ESN 2002 was applied at ESN to urea ratios of 100/0, 60/40, 40/60, and 20/80. ESN 2003 and ESN 2004 were applied at higher rates and less frequently than the other nitrogen sources. The remaining nitrogen sources were all applied at a 1.5 lb. N/1,000 ft.^{2} rate in the late-season application (November 7, 1994, and October 30, 1995) and at the 1.0 lb. N/1,000 ft.^{2} rate for all other applications (Table 1).

All nitrogen sources were programmed to provided a total of 4.5 lb. N/1,000 ft.^{2} per growing season. Each treatment was replicated three times in a completely randomized block design using 3 ft. by 10 ft. plots. Nitrogen fertilizer applications were made by hand onto a six-screen mesh fertilizer distribution flow box to ensure uniform application. Mowing was performed at a two-inch height, and clippings were collected on a 10- to 12-day interval schedule throughout the growing season (Tables 5–6). Clipping yield was based on one complete swath across the center of each plot with a 22-inch Lawn Boy rotary mower. Clippings were bagged, dried at 60 degrees C for 72 hours, and then weighed to provide dry matter yields. Turfgrass quality ratings were taken on a scale of one through nine, with one representing poorest and nine representing best (Tables 2–4). Irrigation was performed as needed to prevent wilt.

Turfgrass Quality

Fall Color Retention (1994)

This study was initiated with a late-season fertilization on November 7, 1994. Quality ratings (fall color retention and spring greenup/residual) from this application are provided in Table 2. Unfertilized plots consistently showed poorer quality than all fertilized turfgrass throughout the fall, winter, and spring periods. Color/quality of nonfertilized late-season turf was exceptionally low during the winter months. In the one to nine rating scheme, six is considered marginally acceptable, and anything below six is considered unacceptable.

Urea provided the best quality responses from the late-season fertilization in the fall and early winter. The fall and early winter of 1994–1995 were extremely mild. As late as January 12, 1995, turfgrass quality responses from urea were considered very acceptable (i.e., 6.5–7.5). Fair quality responses were obtained with NBN, Coron, both Poly Plus blends, and the ESN blends containing the most water-soluble nitrogen (urea) (i.e., ESN 2002 40/60 and ESN 2002 20/80). ESN 2002 20/80 and Poly Plus 25/75 were the only slow-release nitrogen sources to provide an acceptable response into January 1995. Nutralene, Nature Pure, and ESN 2002 100/0 performance in the fall were very marginal. IBDU response in the fall was unsatisfactory. This may be partially explained due to the two- to three-week delay in nitrogen response from coarse IBDU particles.

The ESN 2002 100/0 did not produce a good late-season response when applied alone. Each incremental increase in urea in the ESN/urea ratio resulted in significantly better late-season responses. ESN 2002 20/80 provided the best late-season (fall) response of the ESN 2002 fertilizers. ESN 2002 40/60 also provided a fair to good response (i.e., quality ratings of 6.0–6.8 through 12-27). ESN 2002 40/60 performance was slightly better than ESN 2002 60/40. The ESN 2003 and ESN 2004 (each 100/0) provided a poor late-season response, clearly indicating that heavier-coated polymer-coated ureas will not provide a significant agronomic response at this time of year. This is further substantiated by the poor late-season (fall) response of Polyon 44-0-0 (4% coating).

Spring Greenup (1995)

Color/quality increases were noticeable starting in early April 1995. However, no fertilizer produced an acceptable quality response on or before April 12, 1995. Many of the fertilizer sources reached an acceptable quality level (i.e., ≥ 6.0) by April 19. NBN, urea, Polyon, ESN 2002 20/80, and ESN 2002 40/60 produced the best spring greenup responses by April 19 (i.e., ≥ 7.0). All fertilizers showed significantly better quality than the untreated turf.

Initial spring greenup responses were better from urea and those ESN 2002 fertilizers containing higher percentages of urea. In contrast, spring residual responses were better from those ESN 2002 fertilizers containing more polymer-coated urea. For example, ESN 2002 100/0 provided the best residual quality responses among the ESN 2002 fertilizers. Overall, a general conclusion is that ESN 2002 40/60 provided the best late-season fertilization performance (i.e., fall color retention, initial spring greenup, and residual color/quality) among the ESN 2002 fertilizers.

ESN 2003 and 2004 provided a slightly slower greenup response in the early spring compared to the ESN 2002 fertilizers. However, overall spring color/quality was superior from ESN 2003 and 2004 compared to any other fertilizer in late April, May, and early June. Residual color/quality responses from ESN 2004 were good to excellent in May, June, and early July from a single late-season fertilizer application (i.e., 2.5 lb. N/1,000 ft.^{2} on November 7, 1994). Also residual color/quality responses from ESN 2003 were quite acceptable through its reapplication on June 7 (i.e., 6.5–7.0). Clearly, ESN 2003 and ESN 2004, at the rates applied in the late-season application, provided superior spring color/quality compared to urea and the other nitrogen sources. Polyon performance in the spring from the late-season application was considered superior to most of the other fertilizers. This information suggests the possible utilization of heavier-coated polymer-coated ureas in late-season fertilization programs, where high spring color/quality is important and where elimination of traditional spring fertilization operations are desirable, or both. Fertilizer-preemergence combos may also be desirable in this type of late-season programming scheme.

Spring-Summer Performance (1995)

Color/quality ratings from the May 15, June 7, and July 15 fertilizer applications will be discussed in this section (Table 3). Color/quality responses from the ESN blends were initially higher from those blends containing higher percentages of urea following both the May 15 and July 15 applications. ESN 2002 100/0 exhibited a slight lag in initial response.

Color/quality responses from urea were always better than any of the other nitrogen sources during the first several weeks after application. As expected, the ESN 2002 20/80 provided the best initial responses among the ESN 2002 fertilizers. All the ESN 2002 fertilizers outperformed urea during the intermediate and residual response periods (i.e., beyond four to five weeks). The ESN 2002 blends of 60/40 and 40/60 provided better intermediate and residual color/quality responses than ESN 2002 20/80. ESN 2003 provided excellent color/quality during June, July, and August before dropping to an unacceptable level on 8-25. ESN 2003 fell somewhat short of the predicted 90-day residual with color/quality ratings reported as unacceptable on 8-25, 9-5, and 9-14 (approximately 10-week residual).

ESN 2004 provided good to excellent color/quality throughout the summer with only a slight drop in color/quality in mid July prior to reapplication (7-15). At no time during the summer period did ESN 2004 drop below an unacceptable color/quality level. The ESN blends of 60/40 and 40/60 provided good, consistent summer color/quality and similar performance, although ESN 60/40 color/quality was slightly higher than ESN 40/60 on a few rating dates. The main advantage to ESN 2002 100/0 in the summer was a slightly better residual than the ESN 60/40 and 40/60 blends.

Polyon performance during this same time period was good to excellent, with fairly consistent ratings of 7.5–8.0. Color/quality ratings from Polyon exceeded that of ESN 2002 100/0 on several rating dates. Nature Pure, Lesco SCU, NBN, and Poly S all provided good to excellent summer performance with color/quality ratings consistently in the range of 7–8. Good performance was also provided by Poly Plus, IBDU, Nutralene, and Coron.

Fall-Late Season Performance (1995)

All treatments received a one-pound application of nitrogen per 1,000 square feet on September 15 except for ESN 2004. In addition, all treatments received a late-season fertilization on October 30 (Table 4). All nitrogen sources were providing acceptable color/quality prior to the September 15 application except for ESN 2003. All nitrogen sources provided acceptable color/quality ratings following the September 15 application. Urea provided the best initial color/quality responses. Initial color/quality responses were also good to excellent from ESN 2002 20/80, Poly Plus, and Poly S.

Best initial color/quality responses among the ESN 2002 fertilizers occurred from those with the highest percentage or ratio of urea. Intermediate and residual responses were better from ESN 2002 100/0 than the other ESN blends. ESN 2003 provided only a fair response to the fall-applied fertilizer. Polyon and IBDU performance was slightly better than ESN 2003 from the fall (September 15) application. ESN 2004 color/quality dissipated to an unacceptable level after 10-19 (i.e., response from a 2.0 lb. N/1,000 ft.^{2} application on July 15). ESN 2004 provided an approximate residual of 10 weeks from the latter application. High temperatures and excessive rainfall in the summer of 1995 most likely played a major role in reducing the anticipated residuals of the polymer-coated urea fertilizers. There were no striking differences among the nitrogen sources in intermediate and residual responses from the September 15 application. All fertilizers except ESN 2004 provided similar color/quality ratings (i.e., 6.5–7.0) prior to the late-season fertilization on October 30. Air temperatures in October were unseasonably cool. This typically minimizes differences in nitrogen source responses at this time of year.

Late-season fertilization responses were disappointing in 1995 (Table 4). Air temperatures in November and early December averaged 20 degrees F below normal in central Ohio. As a result, no fertilizer source provided a significant response from the late-season (October 30) application. Urea did not even provide a color/quality increase by the 11-15 rating date. By 12-3, all fertilizer sources provided color/quality ratings below an acceptable level. There were essentially no differences in residual or fall color retention among nitrogen sources at this date (12-3).

Acceptability ratings for the various nitrogen sources for the fall (1994)–spring (1995) and summer (1995) periods are provided in Tables 7 and 8, respectively. The acceptability ratings give some indication of the overall performance of a nitrogen source during the designated rating period. However, it does not provide specifics on initial, intermediate, or residual color/quality responses.

Spring greenup and spring color/quality ratings will be made in 1996. Treatments will also be maintained through the 1996 growing season so as to obtain two years of data.

Growth/Clipping Yield

Fall 1994-Spring 1995

Growth/yield responses from the late-season fertilization in the late fall of 1994 (November 7, 1994) were minimal. Even though color/quality differences among nitrogen sources were significant in the late fall and winter of 1994, there were no major differences in growth/yield among the nitrogen sources. As a result, only one yield harvest was made (12-20-1994). Late-season fertilization was timed properly since no growth was stimulated, but color/quality was enhanced by several nitrogen sources (Table 2).

Growth initiation in the spring from late-season fertilization closely coincided with increases in the color/quality ratings (i.e., 4-19). All nitrogen sources significantly out-yielded the untreated turf in the spring. Urea initially produced the highest yield among nitrogen sources.

In general, growth/yield was correlated with color/quality responses. Growth/yield responses from the late-season application in the spring typically exhibited a lag of one to two weeks relative to initial color/quality responses. Growth/yield was somewhat higher for those ESN 2002 fertilizers containing higher percentages of polymer-coated urea (i.e., yields through 5-16). Surprisingly, growth/yield responses from ESN 2003 and 2004 were not significantly higher than the ESN 2002 fertilizers even though color/quality responses were much higher. These responses reflect an enhancement in residual greening (color/quality) in the spring without excessive top growth from the ESN fertilizers relative to urea. Polyon 44-0-0 exhibited a similar trend.

Summer 1995

All nitrogen sources produced a significantly higher growth/yield response than untreated turf (Tables 5 and 6). Urea initially produced the highest growth/yield among the nitrogen sources from the 5-15 fertilizer application. There was a general trend for nitrogen sources higher in water-soluble nitrogen to produce greater growth/yield responses. For example, the ESN 2002 fertilizer blends produced greater growth/yield than ESN 2002 100/0. NBN and Coron also produced an initial growth surge similar to urea.

The polymer-coated urea sources (i.e., ESN 2002, ESN 2003, ESN 2004, Polyon, Poly Plus, and Poly S) also do not exhibit as dramatic a drop in growth and quality in the intermediate to residual response periods as urea. Most of the other slow-release nitrogen sources display this latter trend as well. There was essentially no difference in growth/yield among the ESN 2002 blended fertilizers except a consistent trend for ESN 2002 100/0 to produce a slightly higher yield in the intermediate to residual response periods. Growth/yield from ESN 2003 and 2004 were moderate and very consistent (i.e., no major fluctuations) through the summer. ESN 2004 provided consistent growth/yield compared to the other nitrogen sources with corresponding high quality through reapplication on 7-15.

There were also good correlations between moderate consistent growth/yield and high color/quality for Polyon 44-0-0, Nature Pure, and Lesco SCU. Nitrogen sources containing higher water-soluble nitrogen, in general, produced greater initial growth/yield following the 7-15 reapplication. Growth/yield was similar among nitrogen sources two to three weeks after the 7-15 application. Polyon 40-0-0 and ESN 2004 consistently exhibited slightly higher yields during August and early September which coincides with color/quality.

Fall-Late Fall 1995

Temperature plays a major role in top growth regulation during the fall and late fall period on cool-season grasses. Slower growth and less fertilizer growth (yield) responses are typically apparent when compared to growth responses from spring and summer nitrogen applications. The fall and late fall of 1995 was no exception. Cold temperatures (below normal) in October and November generally reduced growth/yield and color/quality responses (Table 4 and 6). Growth/yield was typically initially higher from those nitrogen sources containing higher amounts of water-soluble nitrogen. The ESN 2002 blends provided slightly better growth/yield than ESN 2002 100/0. ESN 2004 showed a significant drop in growth/yield after October 1. This coincided with a dramatic drop in color/quality as well.

In general, growth yield of the polymer-coated urea nitrogen sources (i.e., ESN 2002, ESN 2003, Polyon, and Poly S) dropped substantially, but color/quality was maintained through mid

November. This might suggest that higher application rates of polymer-coated ureas somewhat earlier in the fall may provide a more acceptable late-season (fall) response.

There were essentially no growth/yield responses from any of the nitrogen sources from the late-season application (October 30, 1995)(Table 6).

Growth/yield responses will be monitored through the 1996 growing season to provide additional data and two years of data.

Table 1. Nitrogen Fertilizer Sources with Rates and Application Dates.

Fertilizer Source	Analysis	Ratio w/ Urea	Application Dates					
			11-7-94	5-15-95	6-7-95	7-15-95	9-15-95	10-30-95
ESN 2002	41-0-0	100/0	1.5[a]	1.0		1.0	1.0	1.5
ESN 2002	43-0-0	60/40	1.5	1.0		1.0	1.0	1.5
ESN 2002	44-0-0	40/60	1.5	1.0		1.0	1.0	1.5
ESN 2002	45-0-0	20/80	1.5	1.0		1.0	1.0	1.5
ESN 2003	41-0-0	100/0	2.0[b]		1.5		1.0	2.0
ESN 2004	41-0-0	100/0	2.5[b]		2.0		2.5	
Poly Plus	32-5-7	25/75	1.5	1.0		1.0	1.0	1.5
Poly Plus	32-5-7	50/50	1.5	1.0		1.0	1.0	1.5
Urea	46-0-0	100	1.5	1.0		1.0	1.0	1.5
Polyon	44-0-0	100	1.5	1.0		1.0	1.0	1.5
Poly S	40-0-0	100	1.5	1.0		1.0	1.0	1.5
IBDU	31-0-0	100	1.5	1.0		1.0	1.0	1.5
Nature Pure	3-5-3	100	1.5	1.0		1.0	1.0	1.5
Lesco SCU	37-0-0	100	1.5	1.0		1.0	1.0	1.5
Nutralene	40-0-0	100	1.5	1.0		1.0	1.0	1.5
NBN	30-0-0	100	1.5	1.0		1.0	1.0	1.5
Coron	28-0-0	100	1.5	1.0		1.0	1.0	1.5
Check		------	------					

[a] Values represent pounds of actual nitrogen applied per 1,000 square feet.
[b] Note that ESN 2003 and 2004 received only three and two nitrogen applications per year, respectively.
[c] Note that all fertilizers received a total of 4.5 lbs. N/1,000 ft.^{2} per growing season.

Table 2. The Effect of Various Nitrogen Sources, Rates, and Timings on Seasonal Color Quality of Kentucky Bluegrass.

Fertilizer[b] Source	Analysis	Ratio w/ Urea	Turfgrass Quality Rating[a] 11-17	12-1	12-11	12-27	1-12	4-1	4-12	4-19	5-1	5-14
ESN 2002	41-0-0	100/0	5.5	6.0	6.0	5.0	4.3	3.5	4.0	6.3	7.0	7.0
ESN 2002	43-0-0	60/40	6.0	6.5	6.7	6.0	5.0	4.0	5.0	6.5	7.0	6.5
ESN 2002	44-0-0	40/60	6.5	6.8	6.8	6.0	5.0	4.0	5.0	7.0	7.0	6.5
ESN 2002	45-0-0	20/80	7.0	7.0	7.0	6.5	6.0	4.5	5.0	7.0	6.7	6.0
ESN 2003	41-0-0	100/0	4.0	4.0	4.2	3.3	3.0	3.3	4.0	6.0	7.5	8.0
ESN 2004	41-0-0	100/0	4.0	4.0	4.3	3.3	3.0	3.3	4.0	6.0	7.5	8.5
Poly Plus	32-5-7	25/75	6.8	6.8	6.8	6.2	6.0	3.5	4.0	6.0	6.0	6.0
Poly Plus	32-5-7	50/50	6.7	6.7	6.5	6.0	5.2	3.8	4.8	6.5	6.5	6.5
Urea	46-0-0	100	7.5	7.5	7.5	7.0	6.5	4.5	5.5	7.3	7.0	6.0
Polyon	44-0-0	100	4.0	4.7	4.5	4.0	3.3	4.0	5.0	7.0	7.5	7.5
Poly S	39-0-0	100	6.3	6.5	6.5	5.5	5.2	4.0	4.8	6.5	7.0	7.0
IBDU	31-0-0	100	4.0	5.0	5.5	5.0	5.0	3.8	5.0	6.5	6.5	6.5
Nature Pure	3-5-3	100	4.3	5.0	5.0	5.0	4.3	3.5	4.3	6.0	6.5	6.5
Lesco SCU	37-0-0	100	5.5	6.0	5.5	5.0	4.3	3.5	4.0	5.7	7.0	7.0
Nutralene	40-0-0	100	6.0	6.3	6.0	5.2	4.7	3.3	4.0	5.7	6.0	6.5
NBN	30-0-0	100	7.0	7.0	7.0	6.0	5.5	4.0	4.8	7.0	7.0	6.5
Coron	28-0-0	100	7.0	7.0	7.0	6.0	5.5	4.0	4.5	6.5	7.0	6.5
Check	------	-----	3.2	3.2	3.0	2.3	2.0	1.5	2.0	3.0	3.0	3.8
LSD (0.05)			0.25	0.27	0.25	0.41	0.42	0.24	0.22	0.23	0.12	0.12

[a] Quality ratings were taken on a scale of 1 to 9, with 9 representing best and 1 representing poorest.

[b] Fertilizer applications were made on November 7, 1994, and May 15, June 7, July 15, and September 15, 1995. Note that ESN 2003 and 2004 received only three and two applications per year, respectively. See Table 1 for specific application rates and dates.

Table 3. The Effect of Various Nitrogen Sources, Rates, and Timings on Seasonal Color/Quality of Kentucky Bluegrass.

Fertilizer[b] Source	Analysis	Ratio w/ Urea	Turfgrass Quality Rating[a] 5-25	6-4	6-15	6-24	7-2	7-11	7-16	8-2	8-14	8-25	9-5	9-14
ESN 2002	41-0-0	100/0	6.5	7.5	8.0	7.5	7.7	7.3	6.5	7.0	7.5	7.5	6.5	7.0
ESN 2002	43-0-0	60/40	7.0	7.5	7.5	7.5	7.7	7.0	6.5	7.5	7.5	7.5	6.5	6.5
ESN 2002	44-0-0	40/60	7.5	8.0	7.5	7.5	7.5	6.7	6.5	7.5	7.5	7.0	6.5	6.2
ESN 2002	45-0-0	20/80	8.0	8.5	7.5	7.0	7.0	6.5	5.5	8.0	8.0	7.0	6.5	6.0
ESN 2003	41-0-0	100/0	6.5	7.0	8.5	9.0	9.0	8.5	8.5	7.5	7.0	5.8	5.8	5.5
ESN 2004	41-0-0	100/0	7.0	8.0	8.0	7.5	7.7	7.0	6.0	8.5	8.5	8.5	8.0	8.0
Poly Plus	32-5-7	25/75	7.5	8.0	7.5	7.0	7.0	6.5	6.0	7.5	7.5	7.0	6.5	6.0
Poly Plus	32-5-7	50/50	6.5	8.0	7.5	7.5	7.5	7.0	6.5	8.0	7.5	7.5	6.7	7.0
Urea	46-0-0	100	8.0	8.5	7.5	6.5	6.5	6.3	5.3	8.5	8.0	7.0	6.0	6.0
Polyon	44-0-0	100	6.5	7.5	8.5	8.2	8.0	7.5	6.5	7.5	8.0	7.8	7.5	7.3
Poly S	40-0-0	100	7.5	8.0	7.7	7.5	7.5	7.0	6.5	8.0	7.5	7.5	6.5	7.2
IBDU	31-0-0	100	6.5	7.0	7.0	7.0	7.0	7.3	7.0	7.0	7.0	7.3	6.7	7.0
Nature Pure	3-5-3	100	7.0	8.3	8.0	8.0	8.0	7.3	7.0	7.5	7.5	7.2	6.5	7.2
Lesco SCU	37-0-0	100	7.0	8.0	7.7	8.0	8.0	7.7	6.8	8.0	8.0	7.5	7.0	7.3
Nutralene	40-0-0	100	6.5	7.0	7.0	7.0	7.0	7.0	6.5	7.7	7.5	7.5	7.0	7.2
NBN	30-0-0	100	7.5	8.0	7.5	7.5	7.5	7.0	6.5	8.0	8.0	7.5	7.0	7.2
Coron	28-0-0	100	7.0	8.0	7.5	7.3	7.2	6.5	6.0	8.0	8.0	7.5	6.5	7.2
Check	------	------	3.0	3.0	3.0	3.3	3.0	3.0	3.3	3.7	3.7	3.7	3.3	4.3
LSD (0.05)			0.02	0.12	0.17	0.27	0.20	0.26	0.28	0.25	0.23	0.29	0.30	0.37

[a] Quality ratings were taken on a scale of 1 to 9, with 9 representing best and 1 representing poorest.

[b] Fertilizer applications were made on November 7, 1994, and May 15, June 7, July 15, and September 15, 1995. Note that ESN 2003 and 2004 received only three and two applications per year, respectively. See Table 1 for specific application rates and dates.

Table 4. The Effect of Various Nitrogen Sources, Rates, and Timings on the Seasonal Color/ Quality of Kentucky Bluegrass.

Fertilizer[b] Source	Analysis	Ratio w/ Urea	Turfgrass Quality Rating[a]					
			9-24	10-7	10-19	10-28	11-15	12-3
ESN 2002	41-0-0	100/0	7.0	7.0	7.5	7.0	7.0	5.5
ESN 2002	43-0-0	60/40	7.5	7.5	7.0	6.5	6.5	5.0
ESN 2002	44-0-0	40/60	7.5	7.8	7.0	6.5	6.5	5.0
ESN 2002	45-0-0	20/80	8.0	8.0	7.5	6.5	6.0	5.2
ESN 2003	41-0-0	100/0	6.5	6.5	7.0	7.0	6.8	5.0
ESN 2004	41-0-0	100/0	7.3	6.5	6.0	5.5	5.0	4.0
Poly Plus	32-5-7	25/75	8.0	8.0	7.5	6.5	6.0	5.0
Poly Plus	32-5-7	50/50	8.0	8.0	7.5	6.7	6.5	5.0
Urea	46-0-0	100	8.5	8.5	8.0	6.5	6.5	5.5
Polyon	44-0-0	100	7.0	7.0	7.0	6.5	6.5	5.0
Poly S	40-0-0	100	8.0	8.0	7.5	7.0	6.5	5.0
IBDU	31-0-0	100	7.0	7.0	7.0	6.5	6.5	5.5
Nature Pure	3-5-3	100	7.5	7.5	7.5	6.8	6.3	5.0
Lesco SCU	37-0-0	100	7.5	7.5	7.5	7.0	6.5	4.3
Nutralene	40-0-0	100	7.5	7.5	7.0	6.5	6.0	4.7
NBN	30-0-0	100	7.5	8.0	7.7	7.0	6.5	5.0
Coron	28-0-0	100	7.5	8.0	7.5	7.0	6.2	5.0
Check	------	------	4.3	3.7	4.0	3.7	3.7	2.0
LSD (0.05)			0.26	0.26	0.12	0.28	0.30	0.35

[a] Quality ratings were taken on a scale of 1 to 9, with 9 representing best and 1 representing poorest.
[b] Fertilizer applications were made on November 7, 1994, and May 15, June 7, July 15, and September 15, 1995. Note that ESN 2003 and 2004 received only three and two applications per year, respectively. See Table 1 for specific application rates and dates.

Table 5. The Effect of Various Nitrogen Sources, Rates, and Timings on Seasonal Clipping Yield of Kentucky Bluegrass.

Fertilizer[b] Source	Analysis	Ratio w/urea	Clipping Yield (grams)[a] 12-20	4-19	5-3	5-16	5-26	6-7	6-11	6-30	7-13	7-25
ESN 2002	41-0-0	100/0	2.0	4.0	18.7	43.3	40.0	50.0	41.0	34.7	26.0	35.3
ESN 2002	43-0-0	60/40	2.0	7.3	30.0	48.0	49.0	54.0	39.0	32.7	23.3	38.0
ESN 2002	44-0-0	40/60	2.7	6.0	22.7	40.0	48.0	56.0	36.0	29.3	22.0	35.3
ESN 2002	45-0-0	20/80	2.7	5.3	18.7	31.3	44.3	54.0	37.0	30.0	22.0	40.0
ESN 2003	41-0-0	100/0	2.7	2.0	14.0	32.7	33.3	38.7	42.0	60.0	50.0	49.3
ESN 2004	41-0-0	100/0	2.0	2.0	13.3	40.0	39.3	43.3	35.3	29.3	24.7	32.7
Lesco ESN Poly Plus	32-5-7	25/75	2.7	4.0	19.3	29.3	42.7	50.7	38.0	29.3	27.3	42.0
ESN Poly Plus	32-5-7	50/50	4.0	6.0	22.7	37.3	45.3	49.3	35.3	28.7	24.7	43.3
Urea	46-0-0	100	5.3	12.0	26.7	37.3	54.7	57.3	34.7	24.7	18.7	38.7
Pursell	44-0-0	100	2.0	4.0	18.7	37.3	35.3	42.7	41.3	34.0	26.0	27.3
Poly S	39-0-0	100	2.0	6.7	24.7	41.3	43.3	50.7	38.0	28.0	24.0	34.0
IBDU	31-0-0	100	2.0	2.0	4.7	13.3	22.0	26.0	21.0	19.3	20.7	24.7
Nature Pure	3-5-3	100	2.0	2.0	8.7	18.7	30.0	48.0	42.0	36.7	28.7	34.7
Lesco SCU	37-0-0	100	2.0	2.7	13.3	26.0	29.3	40.0	34.0	28.7	24.7	34.7
Nutralene	40-0-0	100	2.0	3.3	10.7	22.7	28.7	32.0	22.0	24.7	18.0	30.0
NBN	30-0-0	100	4.0	9.3	26.0	36.7	51.3	52.7	35.3	26.7	20.7	44.7
Coron	28-0-0	100	2.7	6.0	22.0	37.3	51.3	50.7	34.0	27.3	17.3	42.0
Check	------	------	2.0	2.0	3.3	6.7	14.7	8.7	6.7	7.3	8.0	12.7
LSD (0.05)			1.9	3.8	11.3	14.3	10.0	5.9	4.9	6.3	5.3	6.6

[a] Quality ratings were taken on a scale of 1 to 9, with 9 representing best and 1 representing poorest.
[b] Fertilizer applications were made on November 7, 1994, and May 15, June 7, July 15, and September 15, 1995. Note that ESN 2003 and 2004 received only three and two applications per year, respectively. See Table 1 for specific application rates and dates.

Table 6. The Effect of Various Nitrogen Sources, Rates, and Timings on Seasonal Clipping Yield of Kentucky Bluegrass.

Fertilizer[b] Source	Analysis	Ratio w/urea	Clipping Yield (grams)[a]								
			8-7	8-17	8-28	9-7	9-28	10-9	10-19	10-30	11-17
ESN 2002	41-0-0	100/0	52.0	33.3	30.0	25.3	30.0	14.7	10.0	2.7	1.3
ESN 2002	43-0-0	60/40	51.3	30.7	28.0	25.3	34.0	18.7	11.3	4.0	2.3
ESN 2002	44-0-0	40/60	50.7	30.0	26.7	25.3	40.0	22.0	13.3	2.7	1.7
ESN 2002	45-0-0	20/80	54.0	32.0	28.0	22.7	40.7	23.3	12.7	5.3	2.7
ESN 2003	41-0-0	100/0	44.7	28.0	27.3	22.7	24.7	14.0	10.0	4.0	2.0
ESN 2004	41-0-0	100/0	54.7	40.7	45.3	38.0	30.0	12.7	6.7	2.0	1.3
Lesco ESN Poly Plus	32-5-7	25/75	60.7	31.3	29.3	23.3	37.3	22.0	14.7	2.7	2.0
ESN Poly Plus	32-5-7	50/50	54.7	28.0	26.7	23.3	39.3	22.7	14.0	6.0	2.0
Urea	46-0-0	100	53.3	26.7	22.7	21.3	37.3	23.3	13.3	2.7	1.3
Pursell	44-0-0	100	44.7	40.0	36.0	30.0	22.0	11.3	7.3	2.7	1.0
Poly S	39-0-0	100	47.3	33.3	31.3	26.0	35.3	16.0	11.3	2.0	2.3
IBDU	31-0-0	100	34.0	24.7	24.0	22.0	22.7	8.7	7.3	2.7	1.3
Nature Pure	3-5-3	100	44.0	24.7	26.7	21.3	34.0	22.7	12.7	3.3	2.3
Lesco SCU	37-0-0	100	46.7	29.3	27.3	25.3	30.0	17.3	13.3	2.7	2.0
Nutralene	40-0-0	100	45.3	28.0	28.7	23.3	30.7	16.0	10.0	2.7	1.7
NBN	30-0-0	100	59.3	34.7	28.7	24.0	38.0	28.7	17.3	2.7	1.7
Coron	28-0-0	100	54.7	31.3	27.3	24.0	34.7	25.3	14.0	7.3	3.0
Check	------	-----	20.0	14.7	16.7	22.0	16.0	4.0	2.0	2.0	1.0
LSD (0.05)			7.5	6.1	5.3	5.0	6.4	5.4	3.0	2.1	0.9

[a] Clipping yields were made by taking a swath down the center of each plot with a Lawn Boy rotary mower.

[b] Fertilizer applications were made on November 7, 1994, and May 15, June 7, July 15, and September 15, 1995. Note that ESN 2003 and 2004 received only three and two applications per year, respectively. See Table 1 for specific application rates and dates.

Table 7. Acceptability Ratings for Various Nitrogen Sources During the Fall (1994) and Spring (1995)[a].

Fertilizer Source	Analysis	Ratio w/ Urea	Acceptability Rate[b]					
			≥6.0	≥6.5	≥7.0	≥7.5	≥8.0	Total
ESN 2002	41-0-0	100/0	5	2	2	0	0	9
ESN 2002	43-0-0	60/40	7	5	1	0	0	13
ESN 2002	44-0-0	40/60	7	6	2	0	0	15
ESN 2002	45-0-0	20/80	8	6	4	0	0	18
ESN 2003	41-0-0	100/0	3	2	2	2	2	11
ESN 2004	41-0-0	100/0	3	2	2	2	2	11
Poly Plus	32-5-7	25/75	8	5	1	0	0	15
Poly Plus	32-5-7	50/50	7	6	0	0	0	13
Urea	46-0-0	100	8	7	6	3	0	24
Polyon	44-0-0	100	3	3	3	2	0	11
Poly S	40-0-0	100	6	5	2	0	0	13
IBDU	31-0-0	100	3	3	0	0	0	6
Nature Pure	3-5-3	100	5	2	0	0	0	5
Lesco SCU	37-0-0	100	3	2	2	0	0	7
Nutralene	40-0-0	100	5	1	0	0	0	6
NBN	30-0-0	100	7	6	5	0	0	18
Coron	28-0-0	100	7	6	4	0	0	17
Check	------	------	0	0	0	0	0	0

[a] Fall (1994) and spring (1995) periods include rating dates from 11-17 (1994) to 5-14 (1995).

[b] Acceptability ratings are the number of times a nitrogen source is rated greater than or equal to a rating value during the fall (1994) and spring (1995).

Table 8. Acceptability Ratings for Various Nitrogen Sources During the Summer[a].

Fertilizer Source	Analysis	Ratio w/Urea	Acceptability Rate[b]						
			≥6.0	≥6.5	≥7.0	≥7.5	Total	≥8.0	Total
ESN 2002	41-0-0	100/0	12	12	9	6	39	14	40
ESN 2002	43-0-0	60/40	12	12	9	7	40	0	40
ESN 2002	44-0-0	40/60	12	11	8	7	38	1	39
ESN 2002	45-0-0	20/80	11	10	8	5	34	4	38
ESN 2003	41-0-0	100/0	9	9	8	6	32	5	37
ESN 2004	41-0-0	100/0	12	11	11	9	43	7	50
Poly Plus	32-5-7	25/75	12	10	8	5	35	1	36
Poly Plus	32-5-7	50/50	12	12	8	7	39	2	41
Urea	46-0-0	100	11	8	6	5	30	4	34
Polyon	44-0-0	100	12	12	10	9	43	4	47
Poly S	40-0-0	100	12	12	10	8	42	2	44
IBDU	31-0-0	100	12	12	10	0	34	0	34
Nature Pure	3-5-3	100	12	12	11	6	41	4	45
Lesco SCU	37-0-0	100	12	12	11	8	43	5	48
Nutralene	40-0-0	100	12	12	10	3	37	0	37
NBN	30-0-0	100	12	12	11	8	43	3	46
Coron	28-0-0	100	12	11	9	5	37	3	40
Check	--------	-----	0	0	0	0	0	0	0

[a] Summer period includes rating dates from 5-25 to 9-14 (Table 3).
[b] Acceptability ratings are the number of times a nitrogen source is rated greater than or equal to a rating value during the summer.

Natural Organic Source Evaluation on a Kentucky Bluegrass-Perennial Ryegrass Mixture

John R. Street and Renee M. Stewart
Horticulture and Crop Science

Introduction

Good turfgrass growth is dependent on an adeqûate supply of all the essential nutrients as well as on other environmental and cultural factors. Of the essential nutrients, nitrogen is the element that receives the most attention in turfgrass fertilization programs. One reason for emphasis on nitrogen is that turfgrasses give a good color and growth response to nitrogen. The color and growth response from nitrogen is usually more dominant than any other element. The behavior of nitrogen, in both the plant and the soil, places it in the unique position of being the "growth control" element. Supplies of other nutrients are kept at adequate levels and the manager regulates growth and color by adding or withholding nitrogen. Thus, fertilization strategies for turfgrass are primarily designed around nitrogen.

A number of nitrogen-containing fertilizers are presently available in the marketplace for turfgrass fertilization — water soluble or quickly available and water insoluble or slowly available. These nitrogen fertilizers vary considerably in their chemical and physical properties. Slowly available sources such as ureaformaldehyde (UF), milorganite, isobutylidene diurea (IBDU), methylene ureas, and sulfur-coated ureas have been available for years. Several new slowly available nitrogen sources have more recently emerged into the turfgrass marketplace. These are the polymer-coated ureas and polymer-coated, sulfur-coated ureas. Evaluation of these latter sources is provided in several other research reports available from the authors. More recently an interest has developed in the use of natural organic and natural organic-based fertilizers for turfgrass fertilization programs. The purpose of this research investigation is to evaluate the performance of a number of these latter nitrogen sources.

Discussion/Summary

Several organic and natural organic-based nitrogen fertilizers at various application rates were compared for color/quality responses (Table 1) and clipping yield (Table 2) for a 16-week period after initial fertilizer application. The nitrogen fertilizer sources were applied on May 11, 1995. One (1N) and two (2N) pounds of nitrogen per 1,000 $ft.^2$ were applied with each fertilizer source. Nitrogen fertilizer applications were made by hand onto a six-screen mesh fertilizer distribution flow box. Each treatment was replicated three times in a randomized complete block design using 3 ft. by 10 ft. plots. Mowing was perfo.med at a two-inch height and clippings were collected throughout the season. Clipping yield was based on one complete swath across the center of each plot with a 22-inch Lawn Boy rotary mower. Clippings were bagged, dried at 60°C for 72 hours, and then weighed to provide dry matter yields. Turfgrass color/quality ratings were taken at 10- to 12-day intervals and based on a scale of one to nine with one representing poorest and nine representing best. Irrigation was performed as needed to prevent wilt.

Seasonal performance rankings are provided in Figures 1–3. Performance rankings are simply the number of times a fertilizer source scores a color/quality rating over the 16-week evaluation above the designated rating value (i.e., ≥6.0 and ≥7.0).

Turfgrass Quality

Nitrogen fertilizer applications were made on May 11, 1995. Unfertilized turfgrass consistently showed poorer color/quality than the fertilized turfgrass throughout most of the rating period (Table 1). Urea provided significantly better initial color/quality responses than any of the other nitrogen fertilizer sources. Turf Plex V and Turf Plex VI were the only two natural organic-based nitrogen sources to provide acceptable color/quality responses (i.e., ≥6.0) at the 1 N rate within two weeks after fertilizer application. Color/quality responses from all the nitrogen sources, except urea, can be characterized as relatively slow at a traditional 1 lb. N rate per 1,000 $ft.^2$ At the 2N rate, initial color quality responses were significantly better with several nitrogen fertilizer sources.

Turfgrass color/quality ratings throughout the spring and summer rating period were similar among the better performing nitrogen fertilizer sources at the 1N rate. These nitrogen sources exhibited a slow initial response, fair intermediate response, and a fair to poor residual response. Turfgrass color/quality ratings at the 1N rate for all the nitrogen sources, except urea, never exceeded a color/quality rating much above marginally acceptable (i.e., all ratings <7.0). Turf Plex VI, Nature Pure, and urea performed best at the 1N rate based on seasonal performance rankings (Figure 1). Com-til, Nutriganics, and Natural Organic I provided unacceptable color/quality throughout the rating period at the 1N rate. Best residual color/quality responses were obtained with Scotts All Natural, Turf Plex VI, Nature Pure, and Nutralene at the 1N rate (8–9 weeks residual). Urea's residual quality at the 1N rate was less than most of the nitrogen fertilizer sources. The higher nitrogen rate (2N) consistently outperformed the lower nitrogen rate (1N) across all nitrogen fertilizer sources throughout the rating period (Table 1 and Figures 1–3). Urea and Turf Plex V provided the best initial color/quality responses at the 2N rate. Residual color/quality responses from urea and Turf Plex V, however, were significantly less than many of the other nitrogen fertilizer sources. Scotts All Natural, Turf Plex VI, and Nature Pure provided the best overall performance among all the nitrogen fertilizer sources at the 2N rate. Scotts All Natural, Turf Plex VI, Nature Pure, Nature Safe, and Nutralene all provided the best residual color/quality responses (i.e., 6.0–6.5) for 12 to 13 weeks. The wet, hot summer most likely favored efficient breakdown and release of nitrogen from the natural organic sources. Seasonal performance rankings (Figure 2) indicated Scotts All Natural, Turf Plex VI, Nature Pure, and Nutralene providing best performance at the 2N rate. Seasonal performance rankings (Figure 3) further indicate the overall best performance among the nitrogen fertilizer sources based on color/quality as Nature Pure, Turf Plex VI, and Scotts All Natural. Many of the natural organics outperformed urea based on overall seasonal performance at the 2N rate.

Growth/Clipping Yield

Growth/clipping yields taken at 10- to 12-day intervals throughout the rating period are provided in Table 2. The unfertilized turfgrass consistently provided the lowest growth/clipping yield when compared to all the nitrogen fertilizer sources and rates throughout the first 10 to 11 weeks of the rating period (i.e., 8-3). Urea produced the greatest initial growth/clipping yields in the first one to two weeks after fertilizer application. Growth/clipping yields were also somewhat higher in the first few weeks after application from Scotts All Natural, Turf Plex V, Turf Plex VI, and Nature Pure. Those nitrogen fertilizer sources exhibiting better color/quality in the intermediate response period generally provided slightly higher growth/clipping yield. Growth/clipping yield from Nutriganics and Com-til was seldom better than the untreated turfgrass. There were no major differences in growth/clipping yield beyond 10 to 11 weeks even though several nitrogen fertilizer sources provided slightly better residuals for 12 to 13 weeks. Many of the nitrogen fertilizer sources provided better growth/clipping yield than urea during the intermediate response period at the 2N rate.

Table 1. The Effect of Various Natural Organic Fertilizers on Perennial Ryegrass Quality.

Fertilizer[b] Source	Analysis	Rate[c] (lb. N/M)	Turfgrass Quality Rating[a] 5-18	5-24	6-2	6-12	6-23	7-8	7-19	8-2	8-14	8-24	9-10
Nutriganics	10-3-1	1	3.0	4.0	4.0	5.0	5.0	5.0	5.0	5.2	5.2	5.2	5.0
		2	4.0	5.0	5.0	6.2	6.0	6.2	6.0	6.0	6.0	5.7	5.0
Scotts All Natural	11-2-4	1	5.5	5.7	6.5	6.5	6.5	6.5	6.0	5.5	5.3	5.2	5.0
Turf Builder		2	7.5	7.5	8.0	7.5	7.5	7.5	7.0	6.5	6.5	6.0	5.5
Turf Plex VI	12-3-9	1	5.5	6.0	6.5	6.5	6.5	6.5	6.5	5.5	5.5	5.5	5.0
Bio Pro		2	7.0	7.7	8.0	7.5	7.5	7.5	7.5	6.5	6.5	6.0	5.0
Turf Plex V	22-2-3	1	5.7	6.5	6.5	6.2	6.0	6.0	5.5	5.0	5.0	5.0	5.0
Bio Pro		2	8.0	8.5	8.3	7.2	7.0	6.5	6.5	6.0	5.5	5.2	5.3
Nature Pure	3-5-3	1	5.0	5.5	6.5	6.8	6.5	6.5	6.5	6.0	5.7	5.5	5.0
		2	6.8	7.7	8.3	8.0	8.0	7.5	7.5	7.0	6.5	6.0	5.5
Sustane	5-2-4	1	5.2	5.8	6.0	6.0	6.2	6.0	6.0	5.3	5.0	5.0	5.0
		2	6.5	7.0	7.3	7.0	7.2	7.0	7.0	6.2	6.0	5.5	5.0
Nature Safe	10-3-3	1	4.0	5.2	6.2	6.5	6.5	6.5	6.0	5.5	5.5	5.5	5.0
		2	5.0	6.3	8.0	8.0	7.8	7.5	7.0	6.5	6.5	6.0	5.2
Ringer	10-2-6	1	4.0	5.5	6.5	6.3	6.3	6.3	6.0	5.5	5.5	5.0	5.0
		2	5.0	6.7	8.0	7.8	7.8	7.5	7.0	6.5	6.0	5.5	5.0
ReVita Lawn	8-3-3	1	3.4	5.0	6.0	6.0	6.0	6.0	5.8	5.5	5.2	5.0	5.0
		2	4.7	6.0	7.0	7.0	7.0	7.0	6.8	6.0	6.0	5.5	5.0
Natural Organic 1	3-4-3	1	4.5	5.0	4.8	5.0	5.0	5.3	5.0	5.0	5.0	5.0	5.0
		2	5.5	6.0	6.0	6.0	6.0	6.2	6.0	5.7	5.5	5.5	5.0
Nutralene	40-0-0	1	5.2	5.5	6.5	6.5	6.5	6.5	6.5	5.5	5.5	5.3	5.0
		2	6.2	6.5	7.5	7.5	7.5	7.5	7.5	6.5	6.5	6.0	5.3
Urea	46-0-0	1	7.5	7.5	7.5	7.0	6.5	6.0	5.2	5.0	6.0	5.0	5.0
		2	8.5	9.0	9.0	8.0	7.5	6.8	6.2	5.2	5.2	5.0	5.0
Com-til	2-3-0	1	3.0	4.0	4.3	3.7	3.7	5.3	4.3	5.0	4.7	5.0	5.0
		2	4.5	5.0	5.3	4.7	4.3	6.0	5.0	5.0	4.7	5.0	5.5
Check	------	--	3.0	3.0	3.0	3.0	3.0	4.0	4.2	5.0	4.7	5.0	5.0
		--	3.0	3.0	3.0	3.0	3.0	4.0	4.2	5.0	4.3	5.0	5.0
LSD (0.05)			0.40	0.33	0.75	0.31	0.43	0.21	0.39	0.20	0.45	0.20	0.16

[a] Quality ratings were taken on a scale of 1 to 9 with 9 representing best and 1 representing poorest. A rating of 6.0 is considered marginally acceptable.

[b] Fertilizer applications were made on May 11, 1995.

[c] lb. N/M represents pounds of nitrogen per 1,000 ft.^{2}

Table 2. The Effect of Various Natural Organic Fertilizers on Perennial Ryegrass Seasonal Clipping Yield.

Fertilizer[b] Source	Analysis	Rate[c] (lb. N/M)	Clipping Yield (grams)[a] 5-23	6-2	6-13	6-28	7-11	7-25	8-3	8-14	8-25
Nutriganics	10-3-1	1	13	12	11	9	14	16	16	25	25
		2	11	13	9	7	16	19	15	27	24
Scotts All Natural	11-2-4	1	26	23	18	13	22	20	14	24	21
Turf Builder		2	40	39	31	18	26	24	17	28	24
Turf Plex VI	12-3-9	1	28	25	18	12	27	22	13	25	22
Bio Pro		2	40	47	39	28	31	26	16	27	26
Turf Plex V	22-2-3	1	30	25	17	8	15	14	10	19	22
Bio Pro		2	49	45	32	16	20	16	14	25	26
Nature Pure	3-5-3	1	24	26	18	10	19	15	16	24	24
		2	47	56	36	22	27	23	17	30	30
Sustane	5-2-4	1	28	25	15	12	22	16	14	26	24
		2	38	38	27	16	24	19	16	23	23
Nature Safe	10-3-3	1	22	22	16	12	19	18	11	26	27
		2	32	36	34	23	25	21	16	29	33
Ringer	10-2-6	1	16	15	13	9	17	18	16	24	25
		2	29	35	26	16	23	20	14	26	23
ReVita Lawn	8-3-3	1	15	14	12	9	16	19	11	23	25
		2	17	23	19	12	21	22	15	26	26
Natural Organic 1	3-4-3	1	14	11	7	5	14	16	11	22	20
		2	22	18	14	13	19	18	13	23	24
Nutralene	40-0-0	1	18	20	12	9	18	18	13	25	25
		2	29	28	16	12	22	19	15	25	25
Urea	46-0-0	1	35	29	19	12	22	17	13	25	24
		2	68	57	28	20	22	23	15	25	24
Com-til	2-3-0	1	16	12	7	7	14	14	11	22	24
		2	26	18	9	9	16	16	12	24	23
Check	------	---	13	9	6	6	13	15	13	27	27
		---	13	10	8	6	16	16	14	25	26
LSD (0.05)			9.5	6.5	5.8	7.1	7.1	7.5	7.1	4.7	7.7

[a] Clipping yields were made by taking a swath down the center of each plot with a Lawn Boy rotary mower.
[b] Fertilizer applications were made on May 11, 1995.
[c] lb. N/M represents pounds of nitrogen per 1,000 ft.^{2}

Figure 1. Seasonal Performance Ranking of Various Natural Organic Fertilizers @ 1.0 lb N/M

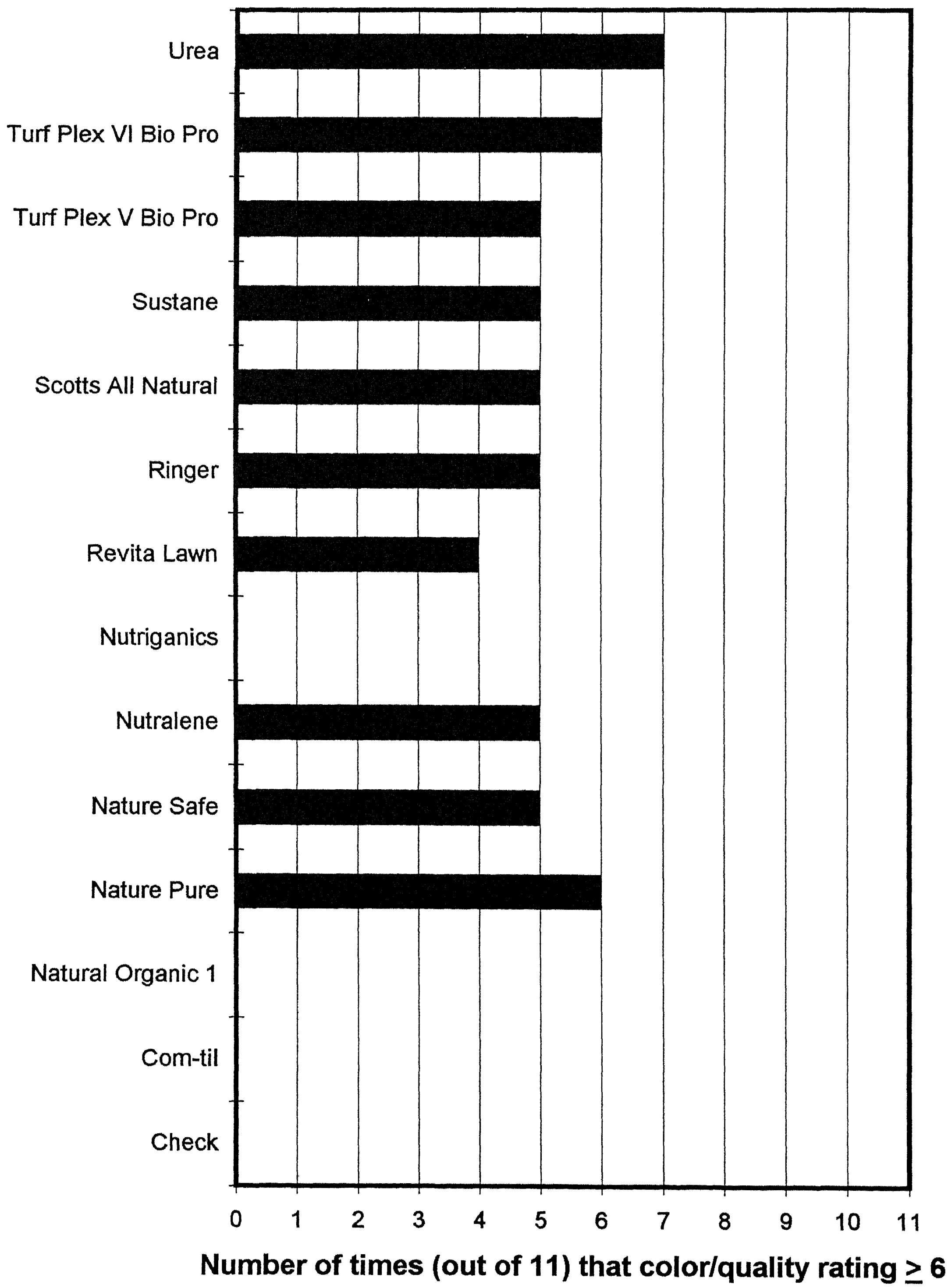


Figure 2. Seasonal Performance Ranking of Various Natural Organic Fertilizers @ 2.0 lb N/M

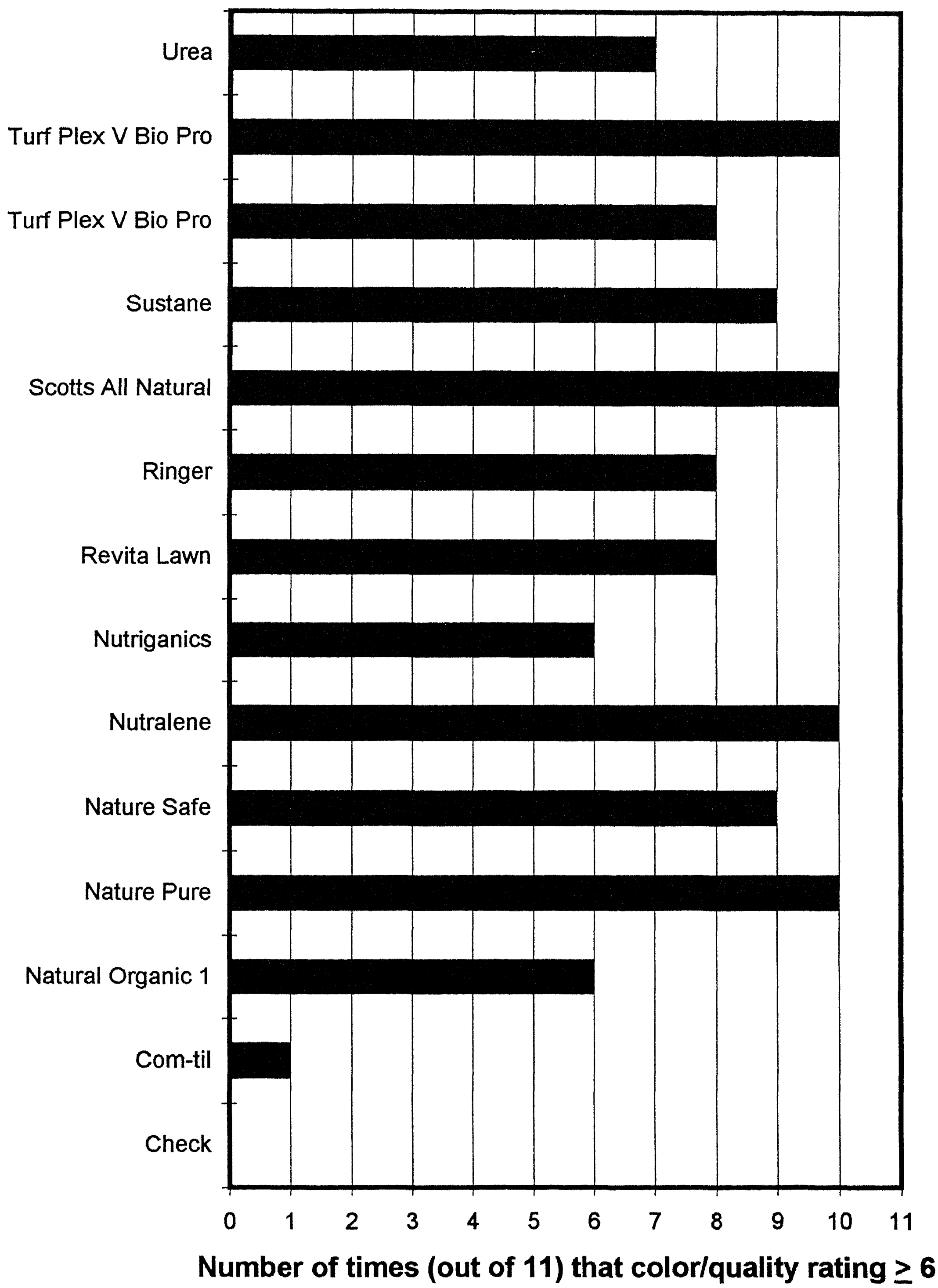
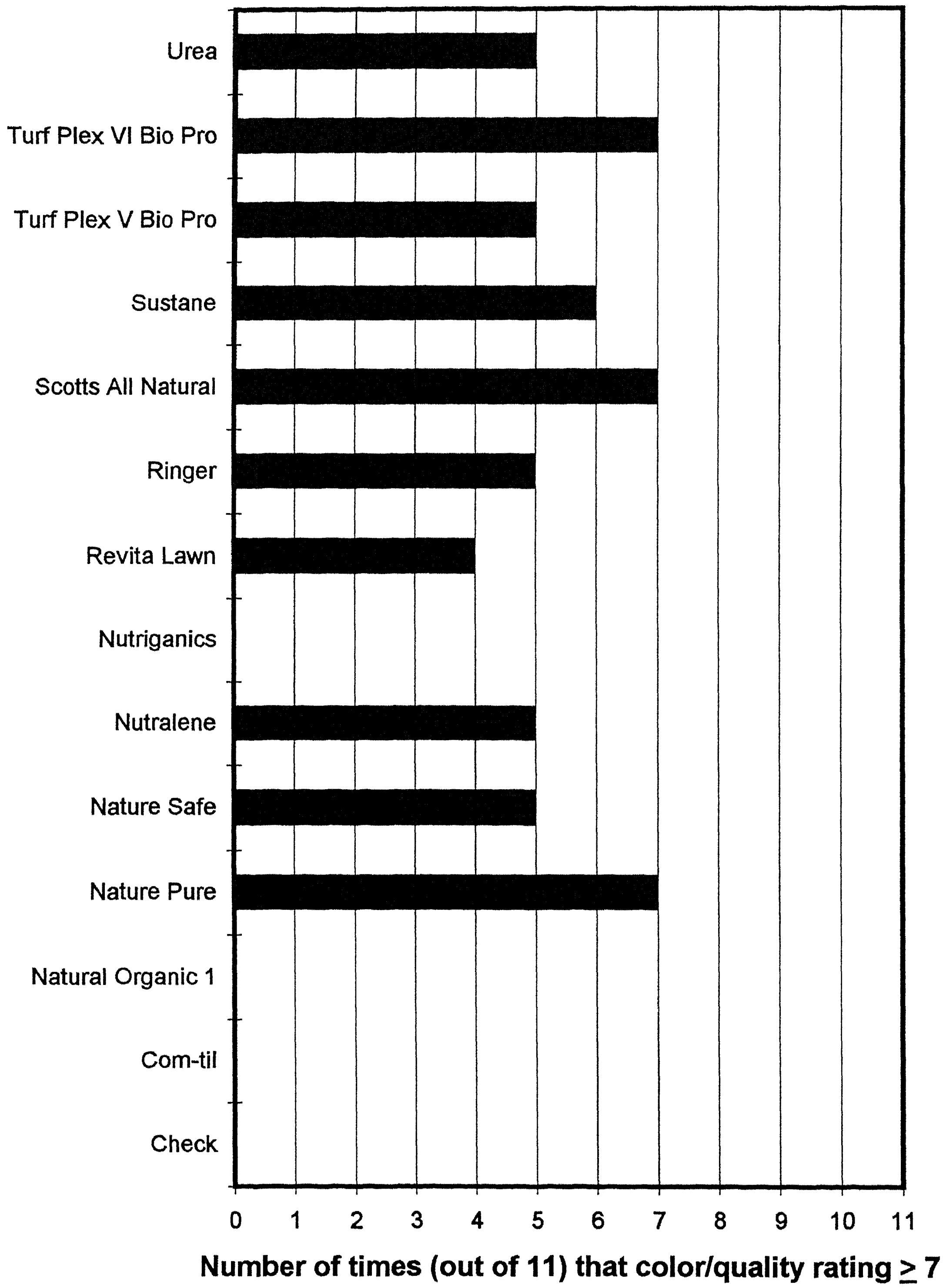


Figure 3. Seasonal Performance Ranking of Various Natural Organic Fertilizers @ 2.0 lb N/M



Nitrogen Source, Rate, and Timing Effect on Kentucky Bluegrass

John R. Street and Renee M. Stewart
Horticulture and Crop Science

Introduction

Good turfgrass growth is dependent on an adequate supply of all the essential nutrients as well as on other environmental and cultural factors. Of the essential nutrients, nitrogen is the element that receives the most attention in turfgrass fertilization programs. One reason for emphasis on nitrogen is that turfgrasses give a good color and growth responses to nitrogen. The color and growth responses from nitrogen are usually more dominant than any other element. The behavior of nitrogen, in both the plant and soil, places it in the unique position of being the "growth control" element. Supplies of other nutrients are kept at adequate levels and the turfgrass manager regulates growth and color by adding or withholding nitrogen. Thus, fertilization strategies for turfgrass are primarily designed around nitrogen.

A key strategy in fertilization of turfgrasses is to produce as uniform and slow a growth throughout the growing season as needed to provide the necessary color, growth, and recuperative potential for each management situation. Uniform growth is desired and rapid fluctuations in growth or surge growth (peak and valley feeding) are undesirable. Uniform growth strategies involve proper fertilization timing, proper selection of nitrogen sources, multiple seasonal applications, and proper nitrogen application rates. Many slow-release nitrogen sources are available today with unique chemistries and release characteristics to assist in nitrogen programming and uniform growth patterns.

A unique timing strategy, late-season fertilization, has become a widely recommended practice for cool-season grasses. Several advantages to late-season fertilization include enhanced late fall, winter, and/or spring quality; reduced mowing requirements; more uniform spring and early summer growth; improved plant carbohydrate balance; deeper and more prolific rooting; and enhance overall stress tolerance. Late-season fertilization is timed in the late fall when top growth of cool-season turfgrasses has ceased or stopped. Soil temperatures at this time of year are relatively cold. The most efficient nitrogen sources in late season are those relatively independent of temperature for nitrogen release. The nitrogen sources available today differ significantly in their nitrogen release characteristics based on temperature.

A number of nitrogen-containing fertilizers are presently available in the marketplace for turfgrass fertilization. For simplicity purposes, they can be grouped into two major categories—water-soluble or quickly available and water-insoluble or slowly available. These nitrogen sources vary considerably in their chemical and physical properties. Slowly available sources such as ureaformaldehyde (UF), milorganite, isobutylidene diurea (IBDU), methylene ureas, and sulfur-coated ureas have been available for years. Many new processed and composed natural organic fertilizers have emerged into the marketplace in the last few years. Several new slowly available sources have more recently emerged into the market place. These are the polymer-coated ureas and polymer-coated, sulfur-coated ureas. Polymer-coated urea is by definition a coated slow-release fertilizer consisting of fertilizer urea particles coated with a polymer plastic resin. The polymer-coated, sulfur-coated ureas are sulfur-coated urea particles coated with a polymer-plastic (resin). Coating thickness of the sulfur and/or plastic (resin) plays a major role in the release characteristics of these latter sources.

The main purpose of this research is to evaluate various nitrogen sources, especially those in the latter categories (polymers), for performance in seasonal and late-season fertilization strategies.

Discussion/Summary

The effects of several nitrogen sources, nitrogen rates, and application timings were evaluated on turfgrass quality and yield/growth of Kentucky bluegrass throughout the growing season. Specific application timing and rates are provided in Table 1 for November 1994 through November 1995.

The ESN polymer-coated urea sources (ESNs 2002, 2003, and 2004) have correspondingly heavier coatings, providing estimated nitrogen release patterns of 60-days, 90-days, and 120-days, respectively. The ESN polymer-coat is based on elastomer polymer technology. ESN 2002 was applied at ESN to urea ratios of 100/0, 60/40, 40/60, and 20/80. ESN 2003 and ESN 2004 were applied at higher rates and less frequently than the other nitrogen sources. The remaining nitrogen sources were all applied at a 1.5 lb. N/1000 ft.^{2} rate in the late-season application (November 7, 1994, and October 30, 1995) and at the 1.0 lb. N/1000 ft.^{2} rate for all other applications (Table 1).

All nitrogen sources were programmed to provided a total of 4.5 lb. N/1000 ft.^{2} per growing season. Each treatment was replicated three times in a completely randomized block design using 3 ft. by 10 ft. plots. Nitrogen fertilizer applications were made by hand onto a six-screen mesh fertilizer distribution flow box to ensure uniform application. Mowing was performed at a two-inch height, and clippings were collected on a 10- to 12-day interval schedule throughout the growing season (Tables 5–6). Clipping yield was based on one complete swath across the center of each plot with a 22-inch Lawn Boy rotary mower. Clippings were bagged, dried at 60 degrees C for 72 hours, and then weighed to provide dry matter yields. Turfgrass quality ratings were taken on a scale of one through nine, with one representing poorest and nine representing best (Tables 2–4). Irrigation was performed as needed to prevent wilt.

Turfgrass Quality

Fall Color Retention (1994)

This study was initiated with a late-season fertilization on November 7, 1994. Quality ratings (fall color retention and spring greenup/residual) from this application are provided in Table 2. Unfertilized plots consistently showed poorer quality than all fertilized turfgrass throughout the fall, winter, and spring periods. Color/quality of nonfertilized late-season turf was exceptionally low during the winter months. In the one to nine rating scheme, six is considered marginally acceptable, and anything below six is considered unacceptable.

Urea provided the best quality responses from the late-season fertilization in the fall and early winter. The fall and early winter of 1994–1995 were extremely mild. As late as January 12, 1995, turfgrass quality responses from urea were considered very acceptable (i.e., 6.5–7.5). Fair quality responses were obtained with NBN, Coron, both Poly Plus blends, and the ESN blends containing the most water-soluble nitrogen (urea) (i.e., ESN 2002 40/60 and ESN 2002 20/80). ESN 2002 20/80 and Poly Plus 25/75 were the only slow-release nitrogen sources to provide an acceptable response into January 1995. Nutralene, Nature Pure, and ESN 2002 100/0 performance in the fall were very marginal. IBDU response in the fall was unsatisfactory. This may be partially explained due to the two- to three-week delay in nitrogen response from coarse IBDU particles.

The ESN 2002 100/0 did not produce a good late-season response when applied alone. Each incremental increase in urea in the ESN/urea ratio resulted in significantly better late-season responses. ESN 2002 20/80 provided the best late-season (fall) response of the ESN 2002 fertilizers. ESN 2002 40/60 also provided a fair to good response (i.e., quality ratings of 6.0–6.8 through 12-27). ESN 2002 40/60 performance was slightly better than ESN 2002 60/40. The ESN 2003 and ESN 2004 (each 100/0) provided a poor late-season response clearly indicating that heavier coated polymer-coated ureas will not provide a significant agronomic response at this time of year. This is further substantiated by the poor late-season (fall) response of Polyon 44-0-0 (4% coating).

Spring Greenup (1995)

Color/quality increases were noticeable starting in early April 1995. However, no fertilizer produced an acceptable quality response on or before April 12, 1995. Many of the fertilizer sources reached an acceptable quality level (i.e., ≥ 6.0) by April 19. NBN, urea, Polyon, ESN 2002 20/80, and ESN 2002 40/60 produced the best spring greenup responses by April 19 (i.e., ≥ 7.0). All fertilizers showed significantly better quality than the untreated turf. Initial spring greenup responses were better from urea and those ESN 2002 fertilizers containing higher percentages of urea. In contrast, spring residual responses were better from those ESN 2002 fertilizers containing more polymer-coated urea. For example, ESN 2002 100/0 provided the best residual quality responses among the ESN 2002 fertilizers. Overall, a general conclusion is that ESN 2002 40/60 provided the best late-season fertilization performance (i.e., fall color retention, initial spring greenup, and residual color/quality) among the ESN 2002 fertilizers.

ESN 2003 and 2004 provided a slightly slower greenup response in the early spring compared to the ESN 2002 fertilizers. However, overall spring color/quality was superior from ESN 2003 and 2004 compared to any other fertilizer in late April, May, and early June. Residual color/quality responses from ESN 2004 were good to excellent in May, June, and early July from a single late-season fertilizer application (i.e., 2.5 lb. N/1000 ft.^{2} on November 7, 1994). Also residual color/quality responses from ESN 2003 were quite acceptable through its reapplication on June 7 (i.e., 6.5–7.0). Clearly, ESN 2003 and ESN 2004 at the rates applied in the late-season application provided superior spring color/quality compared to urea and the other nitrogen sources. Polyon performance in the spring from the late-season application was considered superior to most of the other fertilizers. This information suggests the possible utilization of heavier-coated polymer-coated ureas in late-season fertilization programs, where high spring color/quality is important and/or elimination of traditional spring fertilization operations are desirable. Fertilizer-preemergence combos may also be desirable in this type of late-season programming scheme.

Spring-Summer Performance (1995)

Color/quality ratings from the May 15, June 7, and July 15 fertilizer applications will be discussed in this section (Table 3). Color/quality responses from the ESN blends were initially higher from those blends containing higher percentages of urea following both the May 15 and July 15 applications. ESN 2002 100/0 exhibited a slight lag in initial response. Color/quality responses from urea were always better than any of the other nitrogen sources during the first several weeks after application.

As expected, the ESN 2002 20/80 provided the best initial responses among the ESN 2002 fertilizers. All the ESN 2002 fertilizers outperformed urea during the intermediate and residual response periods (i.e., beyond four to five weeks). The ESN 2002 blends of 60/40 and 40/60 provided better intermediate and residual color/quality responses than ESN 2002 20/80. ESN 2003 provided excellent color/quality during June, July, and August before dropping to an unacceptable level on 8-25. ESN 2003 fell somewhat short of the predicted 90-day residual with color/quality ratings reported as unacceptable on 8-25, 9-5, and 9-14 (approx. 10-week residual). ESN 2004 provided good to excellent color/quality throughout the summer with only a slight drop in color/quality in mid July prior to reapplication (7-15). At no time during the summer period did ESN 2004 drop below an unacceptable color/quality level. The ESN blends of 60/40 and 40/60 provided good, consistent summer color/quality and similar performance, although ESN 60/40 color/quality was slightly higher than ESN 40/60 on a few rating dates. The main advantage to ESN 2002 100/0 in the summer was a slightly better residual than the ESN 60/40 and 40/60 blends.

Polyon performance during this same time period was good to excellent with fairly consistent ratings of 7.5–8.0. Color/quality ratings from Polyon exceeded that of ESN 2002 100/0 on several rating dates. Nature Pure, Lesco SCU, NBN, and Poly S all provided good to excellent summer performance with color/quality ratings consistently in the range of seven to eight. Good performance was also provided by Poly Plus, IBDU, Nutralene, and Coron.

Fall-Late Season Performance (1995)

All treatments received a one-pound application of nitrogen per 1,000 square feet on September 15 except for ESN 2004. In addition, all treatments received a late-season fertilization on October 30 (Table 4). All nitrogen sources were providing acceptable color/quality prior to the September 15 application except for ESN 2003. All nitrogen sources provided acceptable color/quality ratings following the September 15 application. Urea provided the best initial color/quality responses. Initial color/quality responses were also good to excellent from ESN 2002 20/80, Poly Plus, and Poly S.

Best initial color/quality responses among the ESN 2002 fertilizers occurred from those with the highest percentage or ratio of urea. Intermediate and residual responses were better from ESN 2002 100/0 than the other ESN blends. ESN 2003 provided only a fair response to the fall-applied fertilizer. Polyon and IBDU performance was slightly better than ESN 2003 from the fall (September 15) application. ESN 2004 color/quality dissipated to an unacceptable level after 10-19 (i.e., response from a 2.0 lb. N/1000 ft.^{2} application on July 15). ESN 2004 provided an approximate residual of 10 weeks from the latter application. High temperatures and excessive rainfall in the summer of 1995 most likely played a major role in reducing the anticipated residuals of the polymer-coated urea fertilizers. There were no striking differences among the nitrogen sources in intermediate and residual responses from the September 15 application. All fertilizers except ESN 2004 provided similar color/quality ratings (i.e., 6.5–7.0) prior to the late-season fertilization on October 30. Air temperatures in October were unseasonable cool. This typically minimizes differences in nitrogen source responses at this time of year.

Late-season fertilization responses were disappointing in 1995 (Table 4). Air temperatures in November and early December averaged 20 degrees F below normal in central Ohio. As a result, no fertilizer source provided a significant response from the late-season (October 30) application. Urea did not even provide a color/quality increase by the 11-15 rating date. By 12-3, all fertilizer sources provided color/quality ratings below an acceptable level. There were essentially no differences in residual or fall color retention among nitrogen sources at this date (12-3).

Acceptability ratings for the various nitrogen sources for the fall (1994)-spring (1995) and summer (1995) periods are provided in Tables 7 and 8, respectively. The acceptability ratings give some indication of the overall performance of a nitrogen source during the designated rating period. However, it does not provide specifics on initial, intermediate, or residual color/quality responses.

Spring greenup and spring color/quality ratings will be made in 1996. Treatments will also be maintained through the 1996 growing season so as to obtain two years of data.

Growth/Clipping Yield

Fall 1994–Spring 1995

Growth/yield responses from the late-season fertilization in the late fall of 1994 (November 7, 1994) were minimal. Even though color/quality differences among nitrogen sources were significant in the late fall and winter of 1994, there were no major differences in growth/yield among the nitrogen sources. As result, only one yield harvest was made (12-20-1994). Late-season fertilization was timed properly since no growth was stimulated but color/ quality was enhanced by several nitrogen sources (Table 2).

Growth initiation in the spring from late-season fertilization closely coincided with increases in the color/quality ratings (i.e., 4-19). All nitrogen sources significantly out yielded the untreated turf in the spring. Urea initially produced the highest yield among nitrogen sources. In general, growth/yield was correlated with color/ quality responses. Growth/yield responses from the late-season application in the spring typically exhibited a lag of one to two weeks relative to initial color/quality responses. Growth/yield was somewhat higher for those ESN 2002 fertilizers containing higher percentages of polymer-coated urea (i.e., yields through 5-16). Surprisingly, growth/yield responses from ESN 2003 and 2004 were not significantly higher than the ESN 2002 fertilizers even though color/quality responses were much higher. These responses reflect an enhancement in residual greening (color/quality) in the spring without excessive top growth from the ESN fertilizers relative to urea. Polyon 44-0-0 exhibited a similar trend.

Summer 1995

All nitrogen sources produced a significantly higher growth/yield response than untreated turf (Tables 5 and 6). Urea initially produced the highest growth/yield among the nitrogen sources from the 5-15 fertilizer application. There was a general trend for nitrogen sources higher in water-soluble nitrogen to produce greater growth/yield responses. For example, the ESN 2002 fertilizer blends produced greater growth/yield than ESN 2002 100/0. NBN and Coron also produced an initial growth surge similar to urea. The polymer-coated urea sources (i.e., ESN 2002, ESN 2003, ESN 2004, Polyon, Poly Plus, and Poly S) also do not exhibit as dramatic a drop in growth and quality in the intermediate to residual response periods as urea. Most of the other slow-release nitrogen sources display this latter trend as well. There was essentially no difference in growth/yield among the ESN 2002 blended fertilizers except a consistent trend for ESN 2002 100/0 to produce a slightly higher yield in the intermediate to residual response periods. Growth/yield from ESN 2003 and 2004 were moderate and very consistent (i.e., no major fluctuations) through the summer. ESN 2004 provided consistent growth/yield compared to the other nitrogen sources with corresponding high quality through reapplication on 7-15. There were also good correlations between moderately consistent growth/yield and high color/quality for Polyon 44-0-0, Nature Pure, and Lesco SCU. Nitrogen sources containing higher water-soluble nitrogen, in general, produced greater initial growth/yield following the 7-15 reapplication. Growth/yield was similar among nitrogen sources two to three weeks after the 7-15 application. Polyon 40-0-0 and ESN 2004 consistently exhibited slightly higher yields during August and early September, which coincides with color/quality.

Fall-Late Fall 1995

Temperature plays a major role in top growth regulation during the fall and late fall period on cool-season grasses. Slower growth and less fertilizer growth (yield) responses are typically apparent when compared to growth responses from spring and summer nitrogen applications. The fall and late fall of 1995 was no exception. Cold temperatures (below normal) in October and November generally reduced growth/yield and color/quality responses (Table 4 and 6). Growth/yield was typically initially higher from those nitrogen sources containing higher amounts of water-soluble nitrogen. The ESN 2002 blends provided slightly better growth/ yield than ESN 2002 100/0. ESN 2004 showed a significant drop in growth/yield after October 1. This coincided with a dramatic drop in color/ quality as well. In general, growth yield of the polymer-coated urea nitrogen sources (i.e., ESN 2002, ESN 2003, Polyon, and Poly S) dropped substantially, but color/quality was maintained through mid November. This might suggest higher application rates of polymer-coated ureas somewhat earlier in the fall may provided a more acceptable late-season (fall) response.

There were essentially no growth/yield responses from any of the nitrogen sources from the late-season application (October 30, 1995)(Table 6).

Growth/yield responses will be monitored through the 1996 growing season to provide additional data and two years of data.

Table 1. Nitrogen Fertilizer Sources with Rates and Application Dates.

			Application Dates					
Fertilizer Source	**Analysis**	**Ratio w/ Urea**	**11--94**	**5-15-95**	**6-7-95**	**7-15-95**	**9-15-95**	**10-30-95**
ESN 2002	41-0-0	100/0	1.5[a]	1.0		1.0	1.0	1.5
ESN 2002	43-0-0	60/40	1.5	1.0		1.0	1.0	1.5
ESN 2002	44-0-0	40/60	1.5	1.0		1.0	1.0	1.5
ESN 2002	45-0-0	20/80	1.5	1.0		1.0	1.0	1.5
ESN 2003	41-0-0	100/0	2.0[b]	1.5		1.0	2.0	
ESN 2004	41-0-0	100/0	2.5[b]	2.0		2.5		
Poly Plus	32-5-7	25/75	1.5	1.0		1.0	1.0	1.5
Poly Plus	32-5-7	50/50	1.5	1.0		1.0	1.0	1.5
Urea	46-0-0	100	1.5	1.0		1.0	1.0	1.5
Polyon	44-0-0	100	1.5	1.0		1.0	1.0	1.5
Poly S	40-0-0	100	1.5	1.0		1.0	1.0	1.5
IBDU	31-0-0	100	1.5	1.0		1.0	1.0	1.5
Nature Pure	3-5-3	100	1.5	1.0		1.0	1.0	1.5
Lesco SCU	37-0-0	100	1.5	1.0		1.0	1.0	1.5
Nutralene	40-0-0	100	1.5	1.0		1.0	1.0	1.5
NBN	30-0-0	100	1.5	1.0		1.0	1.0	1.5
Coron	28-0-0	100	1.5	1.0		1.0	1.0	1.5
Check	----	----						

[a] Values represent pounds of actual nitrogen applied per 1,000 ft.^{2}
[b] Note that ESN 2003 and 2004 received only three and two nitrogen applications per year, respectively.
[c] Note that all fertilizers received a total of 4.5 lbs. N/1,000 ft.^{2} per growing season.

Table 2. The Effect of Various Nitrogen Sources, Rates, and Timings on Seasonal Color Quality of Kentucky Bluegrass.

			Turfgrass Quality Rating[a]									
Fertilizer[b] Source	Analysis	Ratio w/Urea	11-17	12-1	12-11	12-27	1-12	4-1	4-12	4-19	5-1	5-14
ESN 2002	41-0-0	100/0	5.5	6.0	6.0	5.0	4.3	3.5	4.0	6.3	7.0	7.0
ESN 2002	43-0-0	60/40	6.0	6.5	6.7	6.0	5.0	4.0	5.0	6.5	7.0	6.5
ESN 2002	44-0-0	40/60	6.5	6.8	6.8	6.0	5.0	4.0	5.0	7.0	7.0	6.5
ESN 2002	45-0-0	20/80	7.0	7.0	7.0	6.5	6.0	4.5	5.0	7.0	6.7	6.0
ESN 2003	41-0-0	100/0	4.0	4.0	4.2	3.3	3.0	3.3	4.0	6.0	7.5	8.0
ESN 2004	41-0-0	100/0	4.0	4.0	4.3	3.3	3.0	3.3	4.0	6.0	7.5	8.5
Poly Plus	32-5-7	25/75	6.8	6.8	6.8	6.2	6.0	3.5	4.0	6.0	6.0	6.0
Poly Plus	32-5-7	50/50	6.7	6.7	6.5	6.0	5.2	3.8	4.8	6.5	6.5	6.5
Urea	46-0-0	100	7.5	7.5	7.5	7.0	6.5	4.5	5.5	7.3	7.0	6.0
Polyon	44-0-0	100	4.0	4.7	4.5	4.0	3.3	4.0	5.0	7.0	7.5	7.5
Poly S	39-0-0	100	6.3	6.5	6.5	5.5	5.2	4.0	4.8	6.5	7.0	7.0
IBDU	31-0-0	100	4.0	5.0	5.5	5.0	5.0	3.8	5.0	6.5	6.5	6.5
Nature Pure	3-5-3	100	4.3	5.0	5.0	5.0	4.3	3.5	4.3	6.0	6.5	6.5
Lesco SCU	37-0-0	100	5.5	6.0	5.5	5.0	4.3	3.5	4.0	5.7	7.0	7.0
Nutralene	40-0-0	100	6.0	6.3	6.0	5.2	4.7	3.3	4.0	5.7	6.0	6.5
NBN	30-0-0	100	7.0	7.0	7.0	6.0	5.5	4.0	4.8	7.0	7.0	6.5
Coron	28-0-0	100	7.0	7.0	7.0	6.0	5.5	4.0	4.5	6.5	7.0	6.5
Check	------	-----	3.2	3.2	3.0	2.3	2.0	1.5	2.0	3.0	3.0	3.8
LSD (0.05)			0.25	0.27	0.25	0.41	0.42	0.24	0.22	0.23	0.12	0.12

[a] Quality ratings were taken on a scale of 1 to 9 with 9 representing best and 1 representing poorest.

[b] Fertilizer applications were made on November 7, 1994, and May 15, June 7, July 15, and September 15, 1995. Note that ESN 2003 and 2004 received only three and two applications per year, respectively. See Table 1 for specific application rates and dates.

Table 3. The Effect of Various Nitrogen Sources, Rates, and Timings on Seasonal Color/ Quality of Kentucky Bluegrass.

Fertilizer[b] Source	Analysis	Ratio w/Urea	Turfgrass Quality Rating[a] 5-25	6-4	6-15	6-24	7-2	7-11	7-16	8-2	8-14	8-25	9-5	9-14
ESN 2002	41-0-0	100/0	6.5	7.5	8.0	7.5	7.7	7.3	6.5	7.0	7.5	7.5	6.5	7.0
ESN 2002	43-0-0	60/40	7.0	7.5	7.5	7.5	7.7	7.0	6.5	7.5	7.5	7.5	6.5	6.5
ESN 2002	44-0-0	40/60	7.5	8.0	7.5	7.5	7.5	6.7	6.5	7.5	7.5	7.0	6.5	6.2
ESN 2002	45-0-0	20/80	8.0	8.5	7.5	7.0	7.0	6.5	5.5	8.0	8.0	7.0	6.5	6.0
ESN 2003	41-0-0	100/0	6.5	7.0	8.5	9.0	9.0	8.5	8.5	7.5	7.0	5.8	5.8	5.5
ESN 2004	41-0-0	100/0	7.0	8.0	8.0	7.5	7.7	7.0	6.0	8.5	8.5	8.5	8.0	8.0
Poly Plus	32-5-7	25/75	7.5	8.0	7.5	7.0	7.0	6.5	6.0	7.5	7.5	7.0	6.5	6.0
Poly Plus	32-5-7	50/50	6.5	8.0	7.5	7.5	7.5	7.0	6.5	8.0	7.5	7.5	6.7	7.0
Urea	46-0-0	100	8.0	8.5	7.5	6.5	6.5	6.3	5.3	8.5	8.0	7.0	6.0	6.0
Polyon	44-0-0	100	6.5	7.5	8.5	8.2	8.0	7.5	6.5	7.5	8.0	7.8	7.5	7.3
Poly S	40-0-0	100	7.5	8.0	7.7	7.5	7.5	7.0	6.5	8.0	7.5	7.5	6.5	7.2
IBDU	31-0-0	100	6.5	7.0	7.0	7.0	7.0	7.3	7.0	7.0	7.0	7.3	6.7	7.0
Nature Pure	3-5-3	100	7.0	8.3	8.0	8.0	8.0	7.3	7.0	7.5	7.5	7.2	6.5	7.2
Lesco SCU	37-0-0	100	7.0	8.0	7.7	8.0	8.0	7.7	6.8	8.0	8.0	7.5	7.0	7.3
Nutralene	40-0-0	100	6.5	7.0	7.0	7.0	7.0	7.0	6.5	7.7	7.5	7.5	7.0	7.2
NBN	30-0-0	100	7.5	8.0	7.5	7.5	7.5	7.0	6.5	8.0	8.0	7.5	7.0	7.2
Coron	28-0-0	100	7.0	8.0	7.5	7.3	7.2	6.5	6.0	8.0	8.0	7.5	6.5	7.2
Check	------	------	3.0	3.0	3.0	3.3	3.0	3.0	3.3	3.7	3.7	3.7	3.3	4.3
LSD (0.05)			0.02	0.12	0.17	0.27	0.20	0.26	0.28	0.25	0.23	0.29	0.30	0.37

[a] Quality ratings were taken on a scale of 1 to 9 with 9 representing best and 1 representing poorest.

[b] Fertilizer applications were made on November 7, 1994, and May 15, June 7, July 15, and September 15, 1995. Note that ESN 2003 and 2004 received only three and two applications per year, respectively. See Table 1 for specific application rates and dates.

Table 4. The Effect of Various Nitrogen Sources, Rates, and Timings on the Seasonal Color/ Quality of Kentucky Bluegrass.

Fertilizer[b] Source	Analysis	Ratio w/Urea	Turfgrass Quality Rating[a] 9-24	10-7	10-19	10-28	11-15	12-3
ESN 2002	41-0-0	100/0	7.0	7.0	7.5	7.0	7.0	5.5
ESN 2002	43-0-0	60/40	7.5	7.5	7.0	6.5	6.5	5.0
ESN 2002	44-0-0	40/60	7.5	7.8	7.0	6.5	6.5	5.0
ESN 2002	45-0-0	20/80	8.0	8.0	7.5	6.5	6.0	5.2
ESN 2003	41-0-0	100/0	6.5	6.5	7.0	7.0	6.8	5.0
ESN 2004	41-0-0	100/0	7.3	6.5	6.0	5.5	5.0	4.0
Poly Plus	32-5-7	25/75	8.0	8.0	7.5	6.5	6.0	5.0
Poly Plus	32-5-7	50/50	8.0	8.0	7.5	6.7	6.5	5.0
Urea	46-0-0	100	8.5	8.5	8.0	6.5	6.5	5.5
Polyon	44-0-0	100	7.0	7.0	7.0	6.5	6.5	5.0
Poly S	40-0-0	100	8.0	8.0	7.5	7.0	6.5	5.0
IBDU	31-0-0	100	7.0	7.0	7.0	6.5	6.5	5.5
Nature Pure	3-5-3	100	7.5	7.5	7.5	6.8	6.3	5.0
Lesco SCU	37-0-0	100	7.5	7.5	7.5	7.0	6.5	4.3
Nutralene	40-0-0	100	7.5	7.5	7.0	6.5	6.0	4.7
NBN	30-0-0	100	7.5	8.0	7.7	7.0	6.5	5.0
Coron	28-0-0	100	7.5	8.0	7.5	7.0	6.2	5.0
Check	------	------	4.3	3.7	4.0	3.7	3.7	2.0
LSD (0.05)			0.26	0.26	0.12	0.28	0.30	0.35

[a] Quality ratings were taken on a scale of 1 to 9 with 9 representing best and 1 representing poorest.

[b] Fertilizer applications were made on November 7, 1994, and May 15, June 7, July 15, and September 15, 1995. Note that ESN 2003 and 2004 received only three and two applications per year, respectively. See Table 1 for specific application rates and dates.

Table 5. The Effect of Various Nitrogen Sources, Rates, and Timings on Seasonal Clipping Yield of Kentucky Bluegrass.

			Clipping Yield (grams)[a]									
Fertilizer[b] Source	**Analysis**	**Ratio w/Urea**	**12-20**	**4-19**	**5-3**	**5-16**	**5-26**	**6-7**	**6-11**	**6-30**	**7-13**	**7-25**
ESN 2002	41-0-0	100/0	2.0	4.0	18.7	43.3	40.0	50.0	41.0	34.7	26.0	35.3
ESN 2002	43-0-0	60/40	2.0	7.3	30.0	48.0	49.0	54.0	39.0	32.7	23.3	38.0
ESN 2002	44-0-0	40/60	2.7	6.0	22.7	40.0	48.0	56.0	36.0	29.3	22.0	35.3
ESN 2002	45-0-0	20/80	2.7	5.3	18.7	31.3	44.3	54.0	37.0	30.0	22.0	40.0
ESN 2003	41-0-0	100/0	2.7	2.0	14.0	32.7	33.3	38.7	42.0	60.0	50.0	49.3
ESN 2004	41-0-0	100/0	2.0	2.0	13.3	40.0	39.3	43.3	35.3	29.3	24.7	32.7
Lesco ESN Poly+	32-5-7	25/75	2.7	4.0	19.3	29.3	42.7	50.7	38.0	29.3	27.3	42.0
ESN Poly Plus	32-5-7	50/50	4.0	6.0	22.7	37.3	45.3	49.3	35.3	28.7	24.7	43.3
Urea	46-0-0	100	5.3	12.0	26.7	37.3	54.7	57.3	34.7	24.7	18.7	38.7
Pursell	44-0-0	100	2.0	4.0	18.7	37.3	35.3	42.7	41.3	34.0	26.0	27.3
Poly S	39-0-0	100	2.0	6.7	24.7	41.3	43.3	50.7	38.0	28.0	24.0	34.0
IBDU	31-0-0	100	2.0	2.0	4.7	13.3	22.0	26.0	21.0	19.3	20.7	24.7
Nature Pure	3-5-3	100	2.0	2.0	8.7	18.7	30.0	48.0	42.0	36.7	28.7	34.7
Lesco SCU	37-0-0	100	2.0	2.7	13.3	26.0	29.3	40.0	34.0	28.7	24.7	34.7
Nutralene	40-0-0	100	2.0	3.3	10.7	22.7	28.7	32.0	22.0	24.7	18.0	30.0
NBN	30-0-0	100	4.0	9.3	26.0	36.7	51.3	52.7	35.3	26.7	20.7	44.7
Coron	28-0-0	100	2.7	6.0	22.0	37.3	51.3	50.7	34.0	27.3	17.3	42.0
Check	------	-----	2.0	2.0	3.3	6.7	14.7	8.7	6.7	7.3	8.0	12.7
LSD (0.05)			1.9	3.8	11.3	14.3	10.0	5.9	4.9	6.3	5.3	6.6

[a] Clipping yields were made by taking a swath down the center of each plot with a Lawn Boy rotary mower.
[b] Fertilizer applications were made on November 7, 1994, and May 15, June 7, July 15, and September 15, 1995. Note that ESN 2003 and 2004 received only three and two applications per year, respectively. See Table 1 for specific application rates and dates.

Table 6. The Effect of Various Nitrogen Sources, Rates, and Timings on Seasonal Clipping Yield of Kentucky Bluegrass.

			Clipping Yield (grams)[a]								
Fertilizer[b] Source	Analysis	Ratio w/Urea	8-7	8-17	8-28	9-7	9-28	10-9	10-19	10-30	11-17
ESN 2002	41-0-0	100/0	52.0	33.3	30.0	25.3	30.0	14.7	10.0	2.7	1.3
ESN 2002	43-0-0	60/40	51.3	30.7	28.0	25.3	34.0	18.7	11.3	4.0	2.3
ESN 2002	44-0-0	40/60	50.7	30.0	26.7	25.3	40.0	22.0	13.3	2.7	1.7
ESN 2002	45-0-0	20/80	54.0	32.0	28.0	22.7	40.7	23.3	12.7	5.3	2.7
ESN 2003	41-0-0	100/0	44.7	28.0	27.3	22.7	24.7	14.0	10.0	4.0	2.0
ESN 2004	41-0-0	100/0	54.7	40.7	45.3	38.0	30.0	12.7	6.7	2.0	1.3
Lesco ESN Poly+	32-5-7	25/75	60.7	31.3	29.3	23.3	37.3	22.0	14.7	2.7	2.0
ESN Poly Plus	32-5-7	50/50	54.7	28.0	26.7	23.3	39.3	22.7	14.0	6.0	2.0
Urea	46-0-0	100	53.3	26.7	22.7	21.3	37.3	23.3	13.3	2.7	1.3
Pursell	44-0-0	100	44.7	40.0	36.0	30.0	22.0	11.3	7.3	2.7	1.0
Poly S	39-0-0	100	47.3	33.3	31.3	26.0	35.3	16.0	11.3	2.0	2.3
IBDU	31-0-0	100	34.0	24.7	24.0	22.0	22.7	8.7	7.3	2.7	1.3
Nature Pure	3-5-3	100	44.0	24.7	26.7	21.3	34.0	22.7	12.7	3.3	2.3
Lesco SCU	37-0-0	100	46.7	29.3	27.3	25.3	30.0	17.3	13.3	2.7	2.0
Nutralene	40-0-0	100	45.3	28.0	28.7	23.3	30.7	16.0	10.0	2.7	1.7
NBN	30-0-0	100	59.3	34.7	28.7	24.0	38.0	28.7	17.3	2.7	1.7
Coron	28-0-0	100	54.7	31.3	27.3	24.0	34.7	25.3	14.0	7.3	3.0
Check	------	-----	20.0	14.7	16.7	22.0	16.0	4.0	2.0	2.0	1.0
LSD (0.05)			7.5	6.1	5.3	5.0	6.4	5.4	3.0	2.1	0.9

[a] Clipping yields were made by taking a swath down the center of each plot with a Lawn Boy rotary mower.
[b] Fertilizer applications were made on November 7, 1994, and May 15, June 7, July 15, and September 15, 1995. Note that ESN 2003 and 2004 received only three and two applications per year, respectively. See Table 1 for specific application rates and dates.

Table 7. Acceptability Ratings for Various Nitrogen Sources During the Fall (1994) and Spring (1995)[a].

Fertilizer Source	Analysis	Ratio w/ Urea	Acceptability Rate[b] ≥6.0	≥6.5	≥7.0	≥7.5	≥8.0	Total
ESN 2002	41-0-0	100/0	5	2	2	0	0	9
ESN 2002	43-0-0	60/40	7	5	1	0	0	13
ESN 2002	44-0-0	40/60	7	6	2	0	0	15
ESN 2002	45-0-0	20/80	8	6	4	0	0	18
ESN 2003	41-0-0	100/0	3	2	2	2	2	11
ESN 2004	41-0-0	100/0	3	2	2	2	2	11
Poly Plus	32-5-7	25/75	8	5	1	0	0	15
Poly Plus	32-5-7	50/50	7	6	0	0	0	13
Urea	46-0-0	100	8	7	6	3	0	24
Polyon	44-0-0	100	3	3	3	2	0	11
Poly S	40-0-0	100	6	5	2	0	0	13
IBDU	31-0-0	100	3	3	0	0	0	6
Nature Pure	3-5-3	100	5	2	0	0	0	5
Lesco SCU	37-0-0	100	3	2	2	0	0	7
Nutralene	40-0-0	100	5	1	0	0	0	6
NBN	30-0-0	100	7	6	5	0	0	18
Coron	28-0-0	100	7	6	4	0	0	17
Check	------	------	0	0	0	0	0	0

[a] Fall (1994) and spring (1995) periods include rating dates from 11-17 (1994) to 5-14 (1995).

[b] Acceptability ratings are number of times a nitrogen source rated greater than or equal to a rating value during the fall (1994) and spring (1995).

Table 8. Acceptability Ratings for Various Nitrogen Sources During the Summer[a].

Fertilizer Source	Analysis	Ratio w/Urea	Acceptability Rate[b]						
			≥6.0	≥6.5	≥7.0	≥7.5	Total	≥8.0	Total
ESN 2002	41-0-0	100/0	12	12	9	6	39	14	40
ESN 2002	43-0-0	60/40	12	12	9	7	40	0	40
ESN 2002	44-0-0	40/60	12	11	8	7	38	1	39
ESN 2002	45-0-0	20/80	11	10	8	5	34	4	38
ESN 2003	41-0-0	100/0	9	9	8	6	32	5	37
ESN 2004	41-0-0	100/0	12	11	11	9	43	7	50
Poly Plus	32-5-7	25/75	12	10	8	5	35	1	36
Poly Plus	32-5-7	50/50	12	12	8	7	39	2	41
Urea	46-0-0	100	11	8	6	5	30	4	34
Polyon	44-0-0	100	12	12	10	9	43	4	47
Poly S	40-0-0	100	12	12	10	8	42	2	44
IBDU	31-0-0	100	12	12	10	0	34	0	34
Nature Pure	3-5-3	100	12	12	11	6	41	4	45
Lesco SCU	37-0-0	100	12	12	11	8	43	5	48
Nutralene	40-0-0	100	12	12	10	3	37	0	37
NBN	30-0-0	100	12	12	11	8	43	3	46
Coron	28-0-0	100	12	11	9	5	37	3	40
Check	--------	-----	0	0	0	0	0	0	0

[a] Summer period includes rating dates from 5-25 to 9-14 (Table 3).

[b] Acceptability ratings are number of times a nitrogen source rated greater than or equal to a rating value during the summer.

Polymer-Coated Nitrogen Source Effect on Kentucky Bluegrass

John R. Street and Renee M. Stewart
Horticulture and Crop Science

Introduction

Good turfgrass growth is dependent on an adequate supply of all the essential nutrients as well as on other environmental and cultural factors. Of the essential nutrients, nitrogen is the element that receives the most attentiôn in turfgrass fertilization programs. One reason for emphasis on nitrogen is that turfgrasses give a good color and growth response to nitrogen. The color and growth responses from nitrogen are usually more dominant than any other element. The behavior of nitrogen, in both the plant and soil, places it in the unique position of being the "growth control" element. Supplies of other nutrients are kept at adequate levels and the turfgrass manager regulates growth and color by adding or withholding nitrogen. Thus, fertilization strategies for turfgrass are primarily designed around nitrogen.

A key strategy in fertilization of turfgrasses is to produce as uniform and slow a growth throughout the growing season as needed to provide the necessary color, growth, and recuperative potential for each management situation.Uniform growth is desired and rapid fluctuations in growth or surge growth (peak and valley feeding) are undesirable. Uniform growth strategies involve proper fertilization timing, proper selection of nitrogen sources, multiple seasonal applications, and proper nitrogen application rates. Many slow-release nitrogen sources are available today with unique chemistries and release characteristics to assist in nitrogen programming and uniform growth patterns.

A number of nitrogen-containing fertilizers are presently available in the marketplace for turfgrass fertilization. For simplicity purposes, they can be grouped into two major categories—water-soluble or quickly available and water-insoluble or slowly available. These nitrogen sources vary considerably in their chemical and physical properties. Slowly available sources such as ureaformaldehyde (UF), milorganite, isobutylidene diurea (IBDU), methylene ureas, and sulfur-coated ureas have been available for years. Many new processed and composed natural organic fertilizers have emerged into the marketplace in the last few years. Several new slowly available sources have more recently emerged into the marketplace. These are the polymer-coated ureas and polymer-coated, sulfur-coated ureas. Polymer-coated urea is by definition a coated slow-release fertilizer consisting of fertilizer urea particles coated with a polymer plastic resin. The polymer-coated sulfur-coated ureas are sulfur-coated urea particles coated with a polymer-plastic (resin). Coating thickness of the sulfur and/or plastic (resin) plays a major role in the release characteristics of these latter sources.

The main purpose ot this research is to compare various nitrogen sources, especially those in the latter categories (polymers), for performance in seasonal fertilization strategies.

Discussion/Summary

The effect of several nitrogen sources and rates (Tables 1–3) on turfgrass quality and growth/clipping yield were compared throughout the 1995 growing season. All the one- and two-pound nitrogen rates per 1,000 ft.[2] were applied on May 19 and September 22, 1995. Each treatment was replicated three times in a completely randomized block design using 3 ft. by 10 ft. plots. Nitrogen fertilizer applications were made by hand onto a six-screen mesh fertilizer distribution flow box to ensure uniform application. Mowing was performed at a two-inch height and clippings were collected on a 10- to 12-day interval schedule throughout the growing season (Table 3). Clipping yield was based on one complete swath across the center of each plot with a 22-inch Lawn Boy rotary mower. Clippings were bagged, dried at 60° C for 72 hours, and then weighed to provide dry matter yields. Turfgrass quality ratings were taken on a scale of one through nine with one representing poorest and nine representing best (Tables 1–2). Irrigation was performed as needed to prevent wilt. Spring green-up and spring color/quality will be monitored in 1996 to evaluate residual responses from the September 1995 application.

Turfgrass Quality

Turfgrass color/quality ratings for the 1995 growing season are provided in Tables 1–2. Unfertilized turfgrass consistently exhibited poorer color/quality than the fertilized turfgrass throughout the growing season. In the one to nine rating scheme, six is considered marginally acceptable. Spring green-up from fall-applied nitrogen was best with UHS 2003 25-5-10, UHS 2004 25-5-10, CIL-SCU, Polyon, UHS 2002, UHS 2003, and UHS 2004 at the 2 lb. N rate. UHS 2004 provided the best initial spring green-up among the nitrogen sources at the 2 lb. N rate. None of the nitrogen sources provided acceptable color/quality in early spring prior to the May fertilizer application at the 1 lb. N rate. Dosage obviously plays a major role in residual carryover of fall-applied nitrogen from coated-urea nitrogen sources.

Urea provided the best initial color/quality responses from both the May and September fertilizer applications. NBN and Coron also provided good initial color/quality responses in spring and fall. Polyon (42-0-0, 8%) provided the slowest initial color/quality responses among the slow-release nitrogen sources. The UHS 25-5-10 fertilizers (resin coated) slightly masked the response delay compared to the UHS 2002, 2003, and 2004 sources since a portion of each of the former fertilizers blends contain free urea and ammonium nitrogen. UHS 2004 exhibited a slower initial color/quality response in both May and September compared to UHS 2002 and 2003. UHS 2004 has a thicker polymer coat (resin). Initial color/quality responses among the remaining nitrogen sources were slightly better with Poly S, CIL-SCU, and Poly S.

Intermediate and residual color/quality responses were consistently better from the UHS polymer-coated ureas fertilizers compared to urea during the summer. In general, intermediate and residual color/quality responses among the nitrogen sources were somewhat better from Polyon and UHS fertilizers during the summer. Polyon and UHS 2004 clearly provided significantly better intermediate and residual color/quality than the other nitrogen sources at the 2 lb. N rate. Sulfur Kote II, Poly S, and Poly Plus responses were similar on the majority of dates. Positive differences in the magnitude of color/quality responses of the polymer-coated urea nitrogen sources compared to the other slow-release nitrogen sources occurred more frequently at the higher nitrogen rate or dosage.

Urea provided the best color/quality responses from the September 22 fertilizer application. Highest color/quality responses among all the nitrogen sources occurred at the 2 lb. N rate. Most of the slow-release nitrogen sources provided an acceptable color/quality response from fall-applied nitrogen at both the 1 and 2 lb. N rates. Polyon provided the poorest color/quality response from the fall-applied nitrogen. Better fall-applied color/quality responses among the UHS fertilizers occurred with the thinner-coated polymer-coated ureas. The intermediate to heavier coated polymer-coated urea UHS fertilizers may provide good fall color and fall color retention with the added or enhanced benefit of enough residual nitrogen for early spring green-up and spring color retention.

Turfgrass Growth/Clipping Yield

Growth/clipping yields at 10- to 12-day intervals throughout the growing season are provided in Table 3. The unfertilized turfgrass consistently provided the lowest growth/

clipping yield throughout the growing season. In general, all the slow-release nitrogen sources showed a slower initial growth/clipping yield response than urea. Those nitrogen sources containing a higher percentage of water-soluble nitrogen, like NBN, Coron, and Poly Plus, provided higher initial growth/clipping yield responses. Growth/clipping yield, in general, was slightly better in the intermediate and residual response periods from the slow-release nitrogen sources compared to urea. The polymer-coated urea sources exhibited better growth than most other slow-release nitrogen sources in the intermediate to residual response periods. Growth/clipping yield differences from fall-applied nitrogen were much less than in the spring and summer.

Table 1. Kentucky Bluegrass Quality as Effected by Various Nitrogen Fertilizers.

Fertilizer[b]		Rate[c]	Turfgrass Quality Rating[a]										
Source	Analysis	(lbs. N/M)	4-21	5-5	5-26	6-8	6-19	6-30	7-13	7-24	8-7	8-20	9-1
UHS 2002	25-5-10	1	4.5	4.0	5.5	6.5	6.5	7.0	7.0	7.0	6.5	6.0	5.0
		2	5.5	5.0	6.5	8.0	7.5	8.0	8.0	8.0	7.5	6.5	5.5
UHS 2003	25-5-10	1	4.8	4.0	5.0	6.5	6.5	7.0	7.0	7.3	7.0	6.3	5.0
		2	6.0	5.5	6.0	7.5	7.5	8.5	8.5	8.5	8.0	7.0	5.5
UHS 2004	25-5-10	1	5.0	5.0	5.0	5.5	6.5	6.5	7.0	7.3	7.5	6.7	5.3
		2	6.3	6.0	6.0	7.3	7.5	8.5	8.5	8.5	8.5	7.5	6.0
Urea	46-0-0	1	4.0	4.0	7.0	7.2	7.0	6.7	6.5	6.5	6.0	6.0	5.0
		2	5.2	5.2	8.5	8.5	8.0	7.7	7.5	7.5	7.0	6.5	5.0
Nutralene	40-0-0	1	4.2	4.0	5.0	6.0	6.5	7.0	7.0	7.0	6.5	6.5	5.2
		2	4.8	5.5	6.5	7.8	7.5	8.0	8.0	8.0	7.5	7.5	6.0
Sulfur Kote II[d]	39-0-0	1	4.2	4.0	5.5	6.7	6.5	7.0	7.0	7.0	6.5	6.5	5.0
		2	5.5	5.5	6.8	8.3	7.5	8.0	8.0	8.0	7.5	7.5	5.7
Poly Plus[d]	39-0-0	1	4.3	4.0	6.0	6.5	6.7	7.0	7.0	7.5	7.0	6.5	5.0
		2	5.5	5.5	7.5	8.3	7.7	8.5	8.5	8.5	8.0	7.5	6.0
CIL-SCU	37-0-0	1	5.0	4.8	6.0	6.5	6.5	7.0	7.0	7.5	7.0	6.5	5.2
		2	6.2	6.0	7.3	8.5	7.5	8.0	8.0	8.5	8.0	7.5	6.0
Poly S[d]	40-0-0	1	4.3	4.0	6.0	6.5	6.5	7.0	6.5	7.2	6.5	6.0	5.2
		2	5.0	5.0	7.3	8.5	7.5	8.0	7.5	8.2	7.5	6.8	6.0
Polyon	42-0-0	1	4.5	4.2	4.0	5.0	6.3	7.0	7.0	7.5	7.5	7.0	5.5
		2	6.0	6.0	5.0	5.5	7.3	8.5	8.5	9.0	8.5	8.0	6.5
Nature Pure	3-5-3	1	4.0	3.3	4.0	5.8	6.5	6.5	6.5	6.5	6.3	6.0	5.0
		2	5.2	4.8	5.2	8.3	7.5	7.5	7.5	7.5	7.3	7.0	6.0
UHS 2002	41-0-0	1	4.8	5.0	5.0	5.8	6.5	7.2	7.5	7.5	7.0	6.5	5.5
		2	6.5	6.0	6.0	7.5	7.5	9.0	8.5	9.0	8.5	7.5	6.0
UHS 2003	41-0-0	1	5.2	5.0	5.0	5.5	6.5	7.0	7.5	7.5	7.0	6.5	5.5
		2	6.5	6.0	6.0	7.2	7.5	8.5	8.5	9.0	8.5	7.5	6.0
UHS 2004	41-0-0	1	5.5	5.5	5.0	5.5	6.5	7.0	7.5	7.5	7.5	7.0	5.5
		2	7.0	6.5	6.0	6.7	7.5	8.5	8.5	9.0	9.0	8.0	6.2
Morral NBN	30-0-0	1	4.2	4.0	6.5	7.0	6.5	7.0	7.0	7.0	6.5	6.0	5.0
		2	5.2	5.0	7.5	8.5	7.5	8.0	8.0	8.0	7.3	6.5	5.5
Coron	28-0-0	1	4.0	4.0	6.5	7.0	6.5	7.0	7.0	7.0	6.0	6.0	5.0
		2	5.0	5.0	7.5	8.5	7.5	8.0	8.0	8.0	7.2	6.5	5.5
Check	------	---	2.0	3.0	3.0	3.0	3.0	3.3	3.3	3.3	3.3	4.7	3.7
		---	2.5	3.0	3.0	3.0	3.0	3.3	3.3	3.3	3.3	4.7	3.7
LSD (0.05)			0.52	0.27	0.16	0.46	0.15	0.27	0.22	0.28	0.28	0.26	0.30

[a] Quality ratings were taken on a scale of 1 to 9 with 9 representing best and 1 representing poorest.
[b] Fertilizer application was made on May 19, 1995.
[c] lbs. N/M represents pounds of nitrogen per 1,000 $ft.^2$
[d] These nitrogen sources are plastic-coated, sulfur-coated ureas.

Table 2. Kentucky Bluegrass Quality as Effected by Various Nitrogen Fertilizers.

Fertilizer[b] Source	Analysis	Rate[c] (lbs. N/M)	Turfgrass Quality Rating[a]				
			10-1	10-16	10-31	11-15	11-25
UHS 2002	25-5-10	1	7.0	7.0	7.0	6.0	5.0
		2	8.0	8.5	8.5	7.0	6.0
UHS 2003	25-5-10	1	6.5	6.5	7.0	6.0	5.0
		2	7.5	8.0	8.0	7.0	6.0
UHS 2004	25-5-10	1	6.5	6.5	7.0	6.0	5.0
		2	7.5	8.0	8.0	7.0	6.0
Urea	46-0-0	1	8.0	8.0	7.5	6.2	5.0
		2	9.0	9.0	8.5	7.3	6.0
Nutralene	40-0-0	1	7.0	7.0	7.0	5.7	5.0
		2	8.5	8.5	8.0	6.7	5.7
Sulfur Kote II[d]	39-0-0	1	6.5	7.0	7.0	6.0	5.0
		2	7.5	8.5	8.5	7.5	6.3
Poly Plus[d]	39-0-0	1	7.5	7.2	7.0	6.0	5.0
		2	8.5	8.7	8.5	7.0	6.0
CIL-SCU	37-0-0	1	7.0	7.0	7.0	6.0	5.0
		2	8.5	8.5	8.5	7.0	6.0
Poly S[d]	40-0-0	1	7.5	7.5	7.0	6.0	5.0
		2	7.5	7.5	7.0	6.0	5.0
Polyon	42-0-0	1	5.7	5.5	6.0	5.3	4.7
		2	6.7	6.5	7.0	6.5	5.7
Nature Safe	10-3-3	1	5.8	6.2	6.5	5.7	4.8
		2	6.8	8.0	8.0	7.0	6.0
UHS 2002	41-0-0	1	7.0	7.0	7.0	6.0	5.0
		2	8.0	8.5	8.5	7.0	6.2
UHS 2003	41-0-0	1	6.5	6.5	7.0	5.5	4.7
		2	7.5	8.0	8.2	7.0	6.0
UHS 2004	41-0-0	1	6.5	6.5	6.5	5.3	4.5
		2	7.5	7.5	7.5	6.5	5.5
Morral NBN	30-0-0	1	7.5	7.5	7.0	6.0	5.0
		2	8.5	8.5	8.5	7.0	6.0
Coron	28-0-0	1	7.5	7.5	7.0	6.0	5.0
		2	8.5	8.5	8.5	7.0	6.0
Check	------	---	3.7	3.7	3.7	3.3	3.0
		---	3.7	3.7	3.7	3.3	3.0
LSD (0.05)			0.28	0.26	0.24	0.29	0.21

[a] Quality ratings were taken on a scale of 1 to 9 with 9 representing best and 1 representing poorest.
[b] Fertilizer application was made on September 22, 1995.
lbs. N/M represents pounds of nitrogen per 1,000 ft.^{2}
[d] These nitrogen sources are plastic-coated, sulfur-coated ureas.

Table 3. Kentucky Bluegrass Clipping Yields as Effected by Various Nitrogen Fertilizers.

Fertilizer[b] Source	Analysis	Rate[c] (lbs. N/M)	Clipping Yield (grams)[a] 4-25	5-11	5-31	6-12	6-22	7-2	7-12	7-26	8-9	8-21	9-1	10-4	10-16	11-2
UHS 2002	25-5-10	1	16	28	42	43	20	15	10	24	45	27	18	22	16	5
		2	28	36	57	66	30	25	13	31	50	24	15	31	26	9
UHS 2003	25-5-10	1	17	26	39	31	16	12	11	22	46	22	16	21	12	4
		2	41	47	54	64	30	32	19	36	55	26	15	27	21	6
UHS 2004	25-5-10	1	19	29	37	28	12	13	11	24	46	28	17	23	12	5
		2	37	52	59	58	30	32	22	37	62	34	20	31	23	7
Urea	46-0-0	1	11	16	50	40	15	10	8	16	41	24	16	28	22	6
		2	18	29	77	76	28	18	14	23	46	25	20	40	43	13
Nutralene	40-0-0	1	14	20	42	31	13	9	8	21	47	33	24	34	16	4
		2	24	34	61	66	25	22	13	31	59	40	32	41	36	9
Sulfur	39-0-0	1	11	19	42	40	9	9	8	18	39	25	18	19	14	6
Kote II[d]		2	27	40	66	71	24	20	11	25	45	27	18	24	28	7
Poly	39-0-0	1	21	27	46	42	15	13	10	22	42	26	23	30	18	5
Plus[d]		2	33	44	71	81	31	24	14	32	53	32	24	41	32	10
CIL-SCU	37-0-0	1	18	29	47	37	16	10	82	54	62	9	22	28	18	7
		2	33	49	62	64	24	22	16	29	47	22	11	24	30	12
Poly S[d]	40-0-0	1	15	26	43	39	14	10	8	19	37	21	14	21	16	4
		2	29	38	57	68	26	22	15	25	49	24	19	31	35	15
Polyon	42-0-0	1	18	24	38	22	15	15	11	23	46	27	17	18	9	2
		2	37	49	43	31	23	37	25	41	66	35	18	20	9	2
Nature	10-3-3	1	10	18	31	27	13	8	7	17	38	24	16	19	12	5
Safe		2	14	35	44	65	27	26	16	28	52	31	20	19	16	8
UHS 2002	41-0-0	1	15	30	38	24	16	16	10	22	48	27	19	21	14	6
		2	45	58	51	46	32	36	22	40	66	37	26	30	28	10
UHS 2003	41-0-0	1	17	26	42	31	17	11	11	23	47	30	21	22	11	5
		2	38	46	49	51	30	29	20	40	63	49	33	22	17	4
UHS 2004	41-0-0	1	20	28	38	29	12	10	11	22	47	29	23	19	14	3
		2	52	60	55	47	25	27	19	36	57	32	23	24	23	4
Morral	30-0-0	1	22	24	44	41	17	14	11	26	48	28	19	25	21	8
NBN		2	33	47	73	83	29	21	13	27	40	21	12	24	35	11
Coron	28-0-0	1	20	28	45	42	16	10	14	23	38	25	23	30	29	7
		2	22	33	82	96	35	21	14	27	42	25	14	40	42	17
Check	------	---	7	5	26	10	5	2	3	12	32	25	18	16	5	2
		---	6	10	25	10	6	2	2	12	34	27	21	15	8	2
LSD (0.05)			15.8	13.9	15.7	15.9	8.4	8.7	5.2	8.4	11.1	10.3	10.7	10.4	12.7	5.7

[a] Clipping yields were made by taking a swath down the center of each plot with a Lawn Boy rotary mower.
[b] Fertilizer applications were made on May 19 and September 22, 1995.
[c] lb. N/M represents pounds of nitrogen per 1,000 ft.^{2}
[d] These nitrogen sources are plastic-coated, sulfur-coated ureas.

Turfgrass Species and Cultivar Evaluations

1993 NTEP Bentgrass Test (Fairway/Tee)

Jill A. Taylor
Horticulture and Crop Science

Introduction

The 1993 NTEP Bentgrass Test (Fairway/Tee) was established September 23, 1993, at The Ohio State University Turfgrass Research Center in Columbus. Twenty-one entries were hand-seeded at 6 grams/24 ft.^{2} (0.55 pounds/ 1,000 ft.^{2}) in a randomized complete-block design with three replications.

Five colonial bentgrasses are included in the test. They are Exeter, SR 7100, Tendez, ISI-At-90162, and OM-At-90163.

The site is in full sun on natural clay loam and is maintained at one-half inch height of cut to simulate fairway/tee conditions. Actual nitrogen applied in 1995 was 2.75 pounds/1,000 ft.^{2}

Discussion/Summary

In 1993, percent cover ranged from 45–78% six weeks after seeding. However, these seedlings did not survive the severe winter of 1993–1994. These plots were then chemically killed and reseeded in May 1994.

All entries had excellent first-year cover. Entries that were more aggressive initially were 18th Green, BAR Ws 42102, Cato, PRO/CUP, Crenshaw, Southshore, Penncross, DF-1, G-2 and G-6.

Entries that had the darkest green color in the 1995 ratings were Providence, Cato, Penncross, G-2 and G-6. Entries rating highest in annual mean quality are BAR Ws 42102, Providence, Cato, Crenshaw, Southshore, DF-1, G-2, G-6 and Penneagle (Table 1).

A percent dollar spot (*Sclerotinia homoeocarpa*) infection rating was taken in June prior to any fungicide control (Table 2). All entries were affected. Those entries showing most resistance to dollar spot were Providence, Seaside, DF-1, G-6, Penneagle, Lopez, Tendez, BAR WS 42102, SR 7100, and ISI-At-90162.

A brown patch (*Rhizoctonia solani*) infection rating was taken in August (Table 2). All entries were affected. Those entries showing most resistance to brown patch were Providence, Cato, Crenshaw, Southshore, G-2 and G-6.

Monthly data from this three-year NTEP Test is submitted annually to the NTEP and appears as Ohio data in the *NTEP National Test Report*. Annual data includes color, quality, texture, and genetic color.

Table 1. 1995 Mean Quality Ratings--1993 NTEP Bentgrass Test (Fairway).

Entry	May	June	July	Aug	Sept	Oct	Mean
G-6	8.0[a]	8.0	8.7	8.0	8.3	7.0	8.0
Cato	7.7	8.7	8.0	8.3	8.0	6.7	7.9
Providence	8.0	8.0	8.7	8.3	7.7	7.0	7.9
Southshore	8.0	8.0	8.7	8.3	7.7	7.0	7.9
G-2	7.7	8.0	8.3	8.0	8.0	7.0	7.8
Penneagle	7.7	8.0	8.3	8.0	8.0	6.7	7.8
BAR WS 42102	7.7	8.3	8.0	8.0	7.3	7.0	7.7
DF-1	6.7	8.0	8.7	7.7	8.0	7.0	7.7
18th Green	8.0	7.3	8.0	7.3	7.7	7.0	7.6
PRO/CUP	8.0	7.7	8.3	7.0	7.3	7.0	7.6
Crenshaw	7.7	7.0	8.0	8.0	7.3	7.0	7.5
Trueline	8.0	6.0	8.3	7.3	7.3	6.7	7.3
Penncross	7.3	6.7	7.7	6.7	7.0	6.3	6.9
Lopez	7.3	7.0	7.0	6.0	7.3	5.7	6.7
BAR AS 492	6.7	6.0	7.0	6.7	7.3	5.7	6.6
OM-AT-90163	7.0	5.0	8.0	6.7	7.0	5.7	6.6
Seaside	6.3	5.7	7.7	7.0	6.7	5.7	6.5
SR 7100	7.0	5.7	6.7	6.0	7.0	5.0	6.2
ISI-AT-90162	7.0	5.3	6.7	5.7	7.0	4.7	6.1
Tendez	7.7	4.3	6.7	4.7	6.3	5.0	5.8
Exeter	4.3	3.7	6.7	6.3	5.7	4.3	5.2
LSD Value	0.8	1.1	1.3	2.5	0.9	1.1	0.6

[a] Quality ratings 1-9, with 9 = best quality, 6 = marginal quality, and 1 = poorest quality.

Table 2. 1995 Disease Ratings--1993 NTEP Bentgrass Test (Fairway).

Entry	Dollarspot	Brown Patch
G-6	8.0[a]	7.3[b]
Cato	6.0	7.3
Providence	8.0	7.3
Southshore	6.7	7.0
G-2	7.3	7.7
Penneagle	8.0	5.7
BAR WS 42102	8.0	6.7
DF-1	7.7	5.3
18th Green	4.0	5.0
PRO/CUP	5.7	5.7
Crenshaw	5.7	7.7
Trueline	6.3	4.7
Penncross	6.7	5.3
Lopez	6.7	6.3
BAR AS 492	7.7	4.7
OM-AT-90163	7.0	5.0
Seaside	7.7	2.7
SR 7100	8.0	2.0
ISI-At-90162	8.0	2.0
Tendez	7.7	1.7
Exeter	7.0	6.7
LSD	3.1	5.0

[a] Dollar Spot ratings 1-9, 9 = resistant, 1 = totally susceptible.
[b] Brown Patch ratings 1-9, 9 = resistant, 1 = totally susceptible.

1993 NTEP Fineleaf Fescue Test

Jill Taylor
Horticulture and Crop Science

Introduction

The 1993 NTEP Fineleaf Fescue Test was established September 1993 in full sun at The Ohio State University Turfgrass Research Center. Sixty entries were hand seeded at 50 grams/25 $ft.^2$ (4.4 pounds/1,000 $ft.^2$) in a randomized complete-block design with three replications.

The site is in full sun on silt loam and is maintained at 1.5 inches height of cut. Actual nitrogen applied in 1995 was 1.75 pounds/1,000 $ft.^2$

Fineleaf fescues represented in this trial are chewings, strong creeping, hard, and sheep fescues.

Discussion/Summary

The test was seeded in September 1993. Initial plot density six weeks after seeding ranged from 25–50 percent. This data, based on varietal comparisons, did not reveal any seedling vigor consistency of one fineleaf fescue species over another.

Cover by June 1994 was excellent, ranging from 86–98 percent. Some of the species slower to achieve full plot density were of the chewings and strong creeping varieties.

A decimating infestation of brown patch disease (*Rhizotonia solani*) occured in July 1994, causing loss of cover for all species. A curative fungicide was applied. Plot density improved monthly but had not fully recovered by the end of 1994. Varieties with good recovery (75%+ cover) by this time were:

Strong creeping varieties: Aruba, PST-4ST, Shademaster II, Jasper, and Flyer.
Sheep varieties: FO 143.
Hard varieties: SR 3100, Spartan, MED 32, MB 83-93, Discovery, Pamela, Brigade, Reliant II, Scaldis, and Ecostar.
Chewings varieties: none

Some chewings varieties showed better recovery than others. Those with 40–60% recovery were Brittany, MB 61-93, Jamestown II, Pick 4-91W, Bridgeport, and SR 5100.

Varieties with slow recovery (40% or less cover) by 11/94 were:

Strong creeping varieties: BAR Frr 4ZBD, WX3-FFG6, Bar UR 204, and common creeping.
Sheep varieties: 67135
Hard varieties: none
Chewings varieties: PRO 92/20, Shadow (E), NJ F-93, Cascade and MB 63-93.

Chewings varieties with less than 10% cover were Victory (E), MB 66-93, Molinda, Darwin, Medina, MB 65-93, Tiffany, Jamestown, ISI-FC-62, and PST-44D.

Various other ratings were taken throughout 1994, including quality, color, and disease. After the 1994 brown patch infestation, quality ratings taken of the remaining live grass indicated that the hard fescues were the only species in the acceptable quality range. (See: *1994 Turfgrass Research Report, The Ohio State University, Ohio Agricultural Research and Development Center, Special Circular 148.*)

Table 1 gives some of the 1995 quality, texture, and genetic color ratings. Entries rating highest in quality (7.0–7.9) in August 1995 are NJ F-93, Brigade, Jasper, Nordic, Discovery, Spartan, MB 61-93, MB 81-93, MB 82-93, MB 83-93, Reliant II, Aurora, and MED 32. Entries rating finest in texture (9.0) are Dawson, Scaldis, Brigade, Seabreeze, Discovery, Jamestown, FO 143, MB 66-93, MB 81-93, MB 82-93, SR 3100, Reliant II, ISI-FC-62, TMI-3CE, and MED 32. Entries rating highest in genetic color (8.5–8.6) are Jasper, MB 61-93, MB 63-93, and Reliant II.

Monthly data from this three-year NTEP trial is submitted annually to the NTEP and appears as Ohio data in the *NTEP National Test Report*. Annual data includes color, quality, texture, and genetic color.

Table 1. 1995 Quality Ratings — 1993 NTEP Fineleaf Fescue Test.

Entry	Species	May	June	July	Aug	Sep	Oct	Mean
NJ F-93	chewings	7.5	7.5	8.0	7.0	8.0	6.0	7.5
Dawson	slender crping	7.5	8.0	8.0	5.0	6.0	4.0	7.2
Scaldis	hard	7.0	7.3	7.3	5.7	5.7	5.0	6.3
Ecostar	hard	8.0	8.0	7.7	7.0	7.3	6.0	7.3
Rondo	strong crping	7.3	7.0	7.0	5.0	4.5	1.5	5.8
Pamela	hard	8.0	7.7	7.7	7.0	7.3	6.3	7.3
Medina	chewings	7.0	7.0	7.0	4.0	4.0	3.0	5.3
WVPB-STCR-101	strong crping	7.0	7.0	7.0	4.5	5.0	4.0	6.3
Brigade	hard	7.3	7.3	8.3	7.3	7.7	6.3	7.4
Molinda	chewings	8.0	7.5	7.0	6.0	6.5	4.5	6.6
BAR Frr 4ZBD	strong crping	7.3	7.0	7.0	4.0	5.0	3.5	6.2
BAR UR 204	strong crping	7.0	7.0	6.7	4.0	4.7	3.0	5.7
Jasper (E)	strong crping	7.0	7.0	7.3	7.3	7.7	5.7	7.0
Victory (E)	chewings	7.0	7.0	7.0	7.0	7.0	NR	7.0
Pick 4-91W	chewings	7.7	7.7	7.7	5.3	7.3	6.0	6.9
Bridgeport	chewings	7.3	7.7	7.7	6.0	7.3	4.7	6.8
Nordic	hard	7.3	7.7	8.3	8.0	7.3	6.7	7.6
ZPS-MG (Treasure)	chewings	8.0	8.0	7.0	7.0	7.0	6.0	7.2
Seabreeze	slender crping	7.3	7.3	7.0	4.7	5.5	3.0	6.2
PST-4VB Endo.	strong crping	7.7	7.7	7.3	6.0	7.0	5.5	6.9
PST-4DT	strong crping	7.0	7.3	7.7	6.3	7.7	5.3	6.9
Shademaster II	strong crping	7.3	7.7	7.7	5.0	6.7	5.7	6.7
Shadow (E)	chewings	7.7	7.3	6.7	7.0	6.5	4.5	6.8
Discovery	hard	7.3	7.3	8.0	7.7	8.0	6.7	7.5
Tiffany	chewings	7.5	7.5	6.5	5.0	5.5	4.0	6.0
PST-4ST	strong crping	7.7	7.3	7.7	5.7	6.3	6.0	6.8
PST-44D	chewings	7.0	7.3	7.0	5.0	5.3	3.7	5.9
Flyer	strong crping	7.3	7.3	7.3	5.0	5.3	4.7	6.2
Jamestown II	chewings	7.0	7.0	7.0	6.0	7.0	3.5	6.6
Jamestown	chewings	7.0	7.0	8.0	5.5	6.0	4.0	6.3
Aruba	strong crping	7.3	7.3	7.0	4.7	5.0	5.0	6.1
WX3-FFG6	strong crping	7.0	7.0	7.3	5.7	6.5	6.0	6.6
WX3-FF54	chewings	7.7	7.7	7.3	6.7	6.3	5.0	6.8
Brittany	chewings	8.0	8.0	7.5	6.0	7.5	6.0	7.2

Table 1 (Continued). 1995 Quality Ratings — 1993 NTEP Fineleaf Fescue Test.

Entry	Species	May	June	July	Aug	Sep	Oct	Mean
Spartan	hard	7.7	7.7	8.0	7.7	7.7	7.0	7.6
Banner II	chewings	7.3	7.3	7.3	6.3	7.0	4.7	6.7
MB 61-93	chewings	7.7	7.7	8.0	7.3	7.7	5.3	7.3
MB 63-93	chewings	7.3	7.3	7.0	6.5	6.0	4.0	6.7
MB 64-93	chewings	7.3	7.3	7.3	6.0	6.3	4.3	6.4
MB 65-93	chewings	7.0	7.7	7.0	5.0	5.5	3.0	6.3
MB 66-93	chewings	7.0	7.0	7.0	4.0	5.0	3.0	6.3
MB 81-93	hard	7.3	7.3	8.3	7.3	7.3	6.3	7.3
MB 82-93	hard	8.0	8.0	8.0	7.7	8.0	6.3	7.7
MB 83-93	hard	7.7	7.7	8.0	7.3	7.3	6.0	7.3
SR 3100	hard	8.0	8.0	8.0	7.0	7.3	6.3	7.4
SR 5100	chewings	7.3	7.7	7.7	6.7	7.0	6.0	7.1
PRO 92/20	chewings	7.0	7.3	7.3	6.0	6.3	5.0	6.5
PRO 92/24	hard	7.3	7.3	8.0	6.7	6.7	5.7	6.9
Reliant II	hard	7.7	7.7	8.0	7.7	7.7	6.3	7.5
CAS-FR13	strong crping	7.3	7.3	7.0	5.5	6.0	5.5	6.7
ISI-FC-62	chewings	7.5	7.5	6.5	4.0	6.0	3.0	6.3
TMI-3CE	chewings	7.7	7.7	7.0	6.7	7.0	6.0	7.0
Aurora w/endo.	hard	7.7	7.7	8.3	8.0	7.0	6.0	7.4
ZPS-4BN	strong crping	7.3	7.3	7.0	4.7	5.7	4.3	6.1
Cascade	chewings	7.0	7.0	7.0	6.0	7.0	5.0	6.8
common creeping	strong crping	7.3	7.3	7.0	4.7	5.0	4.0	6.1
Entry 60	hard	8.0	7.3	8.0	8.0	8.0	6.7	7.7

[a] Quality ratings 1-9, with 9 = highest quality, 6 = marginally acceptable, 1 = poorest quality.
NR = not rated due to lack of cover.

1994 NTEP Perennial Ryegrass Test

Jill Taylor
Horticulture and Crop Science

Introduction

The 1994 NTEP Perennial Ryegrass Test was established Aug. 31, 1994, at The Ohio State University Turfgrass Research Center.

Ninety-six entries were hand-seeded at 60 grams/25 ft.^{2} (5.2 pounds/1,000 ft.^{2}) in a randomized complete-block design with three replications.

The site is on irrigated, natural soil in full sun and is maintained at 2.5 inches height of cut with a rotary mower. Actual nitrogen applied in 1995 was 1.5 pounds.

Discussion/Summary

A list of the entries and 1995 monthly quality ratings are listed in Table 1.

Mean quality ratings are on a nine point scale, with 9 = best possible quality, 6 = marginally acceptable quality, 5–1 = poor quality, and 1 = poorest quality, brown or dead.

Entries rated highest (8.0 or higher from the total mean quality column) were:

Laredo, PST-2M3, PST-2ET, Navajo, PST-2FF, ISI-R2, Top Hat, Pick 928, SRX 4400, LRF-94-MPRH, MB 44, MB 46, and MB 47.

Monthly data from this three-year NTEP trial are submitted annually to the NTEP and appears as Ohio Data in the *NTEP National Test Report*.

Annual data include color, quality, texture, and genetic color.

Table 1. 1995 Quality Ratings — 1994 NTEP Perennial Ryegrass Test.

Entry	Jun	July	Aug	Sep	Oct	Nov	Mean
1. Elf	7.7	8.0	8.7	8.0	6.7	7.7	7.8
2. Dancer	8.0	8.0	8.0	8.0	7.3	7.3	7.8
3. BAR Er 5813	7.3	8.0	8.3	8.0	7.3	7.0	7.7
4. DSV NA 9401	7.7	8.0	7.3	7.0	6.3	6.7	7.2
5. DSV NA 9402	7.7	8.0	8.0	7.7	6.7	7.0	7.5
6. Achiever	8.0	8.0	8.7	8.0	7.0	7.3	7.8
7. APR 066	7.7	7.7	8.0	8.0	6.7	7.0	7.5
8. APR 106	8.3	8.0	8.7	8.0	7.3	7.0	7.9
9. APR 124	8.0	8.0	8.3	8.0	7.0	7.7	7.8
10. APR 131	8.7	8.0	9.0	8.0	7.0	7.0	7.9
11. Precision	7.7	8.0	8.3	8.0	7.0	7.3	7.7
12. Calypso II	7.7	8.0	8.3	8.0	7.3	7.3	7.8
13. Laredo	8.0	8.0	9.0	8.0	7.7	8.0	8.1

Table 1 (Continued). 1995 Quality Ratings — 1994 NTEP Perennial Ryegrass Test.

Entry		Jun	July	Aug	Sep	Oct	Nov	Mean
14.	Accent	7.7	8.0	8.0	8.3	7.3	7.0	7.7
15.	MED 5071	7.7	8.0	8.3	8.3	7.7	7.3	7.9
16.	J-1703	7.3	8.0	8.7	8.0	7.0	7.3	7.7
17.	J-1706	7.7	8.0	8.7	8.0	7.3	7.0	7.8
18.	Edge	7.7	8.0	8.0	8.0	7.3	7.0	7.7
19.	Cutter	7.7	8.0	8.7	8.3	7.3	7.3	7.9
20.	Express	7.3	7.7	8.7	8.0	7.0	7.0	7.6
21.	Esquire	8.3	8.0	8.7	8.0	7.3	7.0	7.9
22.	Vivid	7.7	8.0	9.0	8.0	7.3	7.0	7.8
23.	WX3-91	7.7	8.0	9.0	8.0	7.7	7.3	7.9
24.	WX3-93	7.7	8.0	8.0	8.3	7.3	7.0	7.7
25.	PST-2FE	8.0	8.0	8.3	8.0	8.0	7.3	7.9
26.	PST-2R3	8.0	8.0	8.3	8.0	7.3	7.7	7.9
27.	PST-2DLM	7.7	7.7	8.3	8.0	7.7	7.3	7.8
28.	PST-GH-94	8.0	8.0	8.3	8.0	7.7	7.3	7.9
29.	PST-2DGR	8.0	7.7	8.0	7.7	7.7	7.3	7.7
30.	PST-2M3	8.3	8.0	8.7	8.0	8.0	8.3	8.2
31.	PST-28M	7.3	8.0	7.7	8.0	7.3	6.7	7.5
32.	PST-2ET	8.0	8.0	8.3	8.0	8.0	7.7	8.0
33.	Manhattan III	7.3	8.0	8.0	8.0	8.0	7.3	7.8
34.	Prizm	7.7	8.0	8.3	8.0	7.7	7.0	7.8
35.	Navajo	8.3	8.0	8.7	8.3	7.7	7.3	8.1
36.	ZPS-2ST	7.3	8.0	8.7	8.0	7.3	7.3	7.8
37.	ZPS-2DR-94	7.7	7.7	8.7	8.0	7.3	7.3	7.8
38.	PSI-E-1	7.3	8.0	8.3	8.0	7.7	7.3	7.8
39.	WVPB-93-KFK	7.0	8.0	8.3	8.0	7.3	7.3	7.7
40.	WVPB-PR-C-2	7.3	8.0	8.3	8.0	7.0	7.3	7.7
41.	MVF-4-1	7.7	7.7	9.0	8.0	7.3	7.0	7.8
42.	PC-93-1	8.0	8.0	8.0	8.0	7.3	7.0	7.7
43.	PST-2FF	8.3	8.0	8.7	8.0	7.7	7.3	8.0
44.	Quickstart	7.7	8.0	9.0	8.0	7.7	7.0	7.9
45.	ZPS-2NV	7.7	8.0	7.7	7.7	7.0	7.3	7.6
46.	Brightstar	7.7	8.0	8.7	8.0	7.0	7.7	7.8
47.	ISI-MHB	8.3	8.0	8.7	8.0	7.7	7.0	7.9
48.	ISI-R2	8.0	8.0	9.0	8.3	7.3	7.3	8.0
49.	Top Hat	8.3	8.0	8.7	8.3	7.7	7.7	8.1
50.	LRF-94-C8	7.3	8.0	8.0	8.3	7.7	7.7	7.8
51.	LRF-94-C7	7.3	8.0	8.3	8.3	7.3	7.7	7.8
52.	LRF-94-B6	7.0	8.0	8.0	8.0	7.0	7.7	7.6
53.	Pick PR 84-91	7.7	8.0	8.3	8.0	7.0	7.0	7.7
54.	Pick 928	7.7	8.0	8.7	8.0	8.0	7.7	8.0
55.	Assure	8.0	8.0	8.3	7.7	7.0	7.3	7.7
56.	Advantage	7.3	8.0	7.7	8.3	7.3	7.0	7.6
57.	LESCO-TWF	7.3	8.0	7.7	8.0	7.3	7.0	7.6
58.	Williamsburg	8.3	8.0	8.7	8.0	7.7	7.0	7.9
59.	Riviera II	7.3	8.0	8.7	8.0	7.3	7.3	7.8
60.	BAR USA 94-II	8.0	8.0	8.0	8.0	7.7	7.7	7.9
61.	Koos 93-3	8.0	8.0	8.7	8.0	7.0	7.3	7.8
62.	Linn	7.3	7.0	6.3	6.0	5.7	7.0	6.6

Table 1 (Continued). 1995 Quality Ratings — 1994 NTEP Perennial Ryegrass Test.

Entry		Jun	July	Aug	Sep	Oct	Nov	Mean
63.	Stallion Slct.	7.7	8.0	8.0	8.0	7.3	7.0	7.7
64.	ZPS-PR1	8.0	8.0	9.0	7.7	7.3	7.0	7.8
65.	Figaro	8.0	8.0	7.7	7.3	6.0	7.0	7.3
66.	DLP 1305	8.7	8.0	7.7	7.7	7.0	7.0	7.7
67.	Nine-O-One	7.3	7.7	8.7	8.0	7.0	7.7	7.7
68.	SRX 4010	7.3	8.0	9.0	8.0	7.7	7.7	7.9
69.	SR 4200	7.0	8.0	8.3	8.0	7.3	7.7	7.7
70.	SRX 4400	8.0	8.0	9.0	8.0	8.0	7.3	8.1
71.	Omni	7.3	7.3	8.7	8.0	7.0	7.0	7.6
72.	Night Hawk	8.3	7.7	8.7	8.0	7.0	7.7	7.9
73.	WVPB 92-4	8.0	8.0	8.7	8.0	7.0	7.0	7.8
74.	Koos 93-6	7.7	7.7	8.3	8.0	7.7	7.3	7.8
75.	PS-D-9	8.0	8.3	8.3	8.0	7.3	7.0	7.8
76.	LRF-94-MPRH	8.0	8.0	8.0	8.3	8.0	7.7	8.0
77.	Pick Lp 102-92	8.3	8.0	8.0	8.0	7.3	7.0	7.8
78.	CAS-LP23	7.3	8.0	8.0	8.0	6.7	7.3	7.6
79.	RPBD	8.0	8.3	8.7	8.0	7.3	7.3	7.9
80.	PST-2CB	8.0	8.0	8.7	8.3	7.0	7.3	7.9
81.	Pennfine	7.7	8.0	8.7	8.0	6.7	7.0	7.7
82.	Morning Star	7.7	8.0	8.3	8.0	7.3	7.0	7.7
83.	Saturn	8.0	8.0	8.3	8.3	7.3	7.0	7.8
84.	Imagine	8.0	7.7	8.0	8.0	7.3	7.7	7.8
85.	Pegasus	8.0	8.0	9.0	8.0	7.0	7.3	7.9
86.	TMI-EXFLP94	7.7	8.0	8.7	8.0	7.0	7.0	7.7
87.	Nobility	7.3	8.0	8.3	8.0	7.7	7.7	7.8
88.	Divine	8.0	8.0	8.3	8.0	7.3	7.3	7.8
89.	MB 1-5	8.3	8.0	8.0	8.0	7.3	7.3	7.8
90.	MB 41	8.7	7.7	8.0	8.3	7.7	7.3	7.9
91.	MB 42	8.0	8.0	8.7	8.0	7.3	7.7	7.9
92.	MB 43	7.7	8.0	9.0	8.0	7.7	7.3	7.9
93.	MB 44	8.0	8.0	8.7	8.0	7.7	8.0	8.1
94.	MB 45	8.0	8.0	8.0	8.0	7.7	7.7	7.9
95.	MB 46	8.0	8.0	8.7	8.3	7.3	8.0	8.1
96.	MB 47	8.0	8.0	9.0	8.0	7.7	8.0	8.1

Quality ratings 1–9, 9 = best possible quality, 1 = poorest quality.

Turfgrass Culture, Management, and Biotechnology

'Primo' Growth Regulator Evaluation on Creeping Bentgrass

William Pound
Horticulture and Crop Sciences

Discussion/Summary

The growth regulator Primo is the latest growth regulator product introduced into the turfgrass market for use on high maintenance turfgrass. Studies conducted at The Ohio State University from 1991–1993 quantified the benefits this growth regulator offers when used on highly maintained Kentucky bluegrass. Evaluations conducted in 1993–1994 further showed significant benefits could also be achieved from the use of Primo on creeping bentgrass. The purpose of the 1995 study was to quantify, through a second year's evaluation, color and growth reduction benefits that accompany the use of Primo on fairway-height creeping bentgrass.

The study was initiated on April 21, 1995. Beginning with the late April application, treatments were repeated every 30–35 days and concluded with the September 28, 1995, treatment. Data were collected every six to nine days and included creeping bentgrass coloration data (Table 1), creeping bentgrass fresh weight data (Table 2), and creeping bentgrass discoloration.

Results of this investigation show the addition of low rates of Primo (0.125–0.25 fl. oz./1,000 ft.^{2}) in combination with nitrogen (0.50–1.00 lb./1,000 ft.^{2}) to significantly enhance creeping bentgrass coloration. The addition of 0.125 fl. oz. of Primo to 0.5 lb. of nitrogen improved the average monthly creeping bentgrass color ratings by 0.44–1.82 units greater than the standard 0.5 lb. nitrogen treatment (Table 3). The use of the higher Primo rate (0.25 fl. oz.) further enhanced this coloration by resulting in improved monthly color ratings of 0.75–2.08 units on the 0.50 lb. nitrogen treatments and 0.50–2.08 units on the 1.0 lb. nitrogen treatments (Table 3).

Turfgrass discoloration was observed following only one application of the fertilizer/Primo treatments. The applications on 8/19/95 resulted in substantial discoloration and injury on the creeping bentgrass in only the treatments containing the 1.0 lb./1,000 ft.^{2} rate of nitrogen (Table 4). This discoloration consistently ranged from 40.0–46.7% per plot area for the next four reading dates and subsequently resulted in the partial loss of the creeping bentgrass. The damaged areas were overseeded with 'Penncross' creeping bentgrass in mid-September. Establishment of the overseedings combined with encroachment of the creeping bentgrass into damaged areas has resulted in 90% + recovery as of early November. The addition of Primo did not influence the level of discoloration or loss of creeping bentgrass. No discoloration was observed from any of the Primo-only or 0.5 lb. N/1,000 ft.^{2} treatments following any of the six applications.

In addition to the enhancement in coloration, the addition of Primo reduced clipping production of the creeping bentgrass. Both the 0.125 and 0.25 fl. oz. rates, in combination with 0.5 lb. of nitrogen, reduced clipping yields. These reductions ranged from 12.06–19.43% when compared with the 0.5 lb. nitrogen check. Less fresh weight reductions were realized when those same Primo rates (0.125 and 0.25 fl. oz.) were applied in combination with the 1.0 lb. rate of nitrogen. These yield reductions ranged from 9.52% (0.125 fl .oz.) to 15.7% (0.25 fl. oz.). The greatest fresh weight yield reductions were realized in the Primo-only treatments in comparison with the untreated check. These yield reductions ranged from 18.39% (0.125 fl. oz.) up to 28.33% (0.25 fl. oz.). Previous studies on

Kentucky bluegrass showed the growth suppression benefits of the growth regulator could be diminished with the addition of nitrogen. Presumably, the addition of nitrogen can override the growth reduction capabilities of Primo on creeping bentgrass as well.

In summary, the addition of Primo to nitrogen applications on creeping bentgrass will result in a dramatic enhancement in turfgrass coloration. The application of Primo will also result in reduced growth rates on the creeping bentgrass with the addition of nitrogen exhibiting the ability to override growth regulation.

Table 1. Turfgrass Color Ratings on Creeping Bentgrass.

	Turfgrass Color Ratings (1–10, 10 = best)														
Treatment	**4/21**	**4/25**	**5/01**	**5/08**	**5/15**	**5/22**	**5/30**	**6/05**	**6/12**	**6/19**	**6/27**	**7/05**	**7/11**	**7/18**	**7/25**
Fert.0.5 lb.	4.7	5.0	6.1	6.4	5.8	5.8	6.2	6.1	5.8	5.7	6.3	6.0	5.8	5.6	6.5
Fert.1.0 lb.	5.5	5.5	7.1	7.3	6.8	6.2	7.2	7.0	6.5	6.4	7.1	6.9	6.5	6.4	6.7
Fert.0.5 lb.+Prımo 0.125 oz.	5.3	5.5	6.2	6.4	6.3	6.5	7.1	7.6	7.7	7.5	8.0	8.0	7.4	7.2	7.9
Fert.0.5 lb.+Primo0.25 oz.	5.5	5.7	6.5	6.4	6.3	6.5	7.0	7.6	7.9	7.9	8.3	8.3	8.1	7.7	8.0
Fert.1.0 lb.+Primo 0.125 oz.	6.0	6.0	7.2	7.6	7.4	7.3	7.9	8.1	7.8	8.1	8.7	8.6	7.9	7.5	8.4
Fert.1.0 lb.+Primo 0.25 oz.	6.0	6.0	7.3	7.8	7.5	7.6	8.2	8.5	8.5	8.5	9.2	9.2	8.5	8.0	9.0
Primo.125 oz.	5.2	5.2	5.3	6.0	6.1	6.1	6.1	6.3	6.5	6.7	6.7	6.6	6.6	6.4	6.4
Primo.25 oz.	5.0	5.0	5.1	6.1	6.0	6.3	6.6	6.7	6.9	7.1	7.1	7.1	7.2	6.8	6.8
Untreated Check	5.0	5.0	5.2	5.6	5.4	5.2	5.0	5.7	5.1	5.2	5.2	5.2	5.1	5.3	5.4
LSD 0.05	0.26	0.36	0.38	0.27	0.30	0.24	0.25	0.21	0.21	0.26	0.15	0.23	0.24	0.20	0.18

Table 1 (Continued). Turfgrass Color Ratings on Creeping Bentgrass

	Turfgrass Color Ratings (1–10, 10 = best)												
Treatment	**8/01**	**8/09**	**8/17**	**8/24**	**8/30**	**9/07**	**9/14**	**9/21**	**9/28**	**10/09**	**10/16**	**10/25**	**11/02**
Fert.0.5 lb.	6.3	6.0	5.8	6.2	6.3	6.4	6.0	5.7	5.5	6.4	6.4	6.6	6.7
Fert.1.0 lb.	6.7	6.9	6.5	6.6	6.6	6.9	6.6	6.3	6.1	7.2	7.0	7.2	7.3
Fert.0.5 lb.+Primo 0.125 oz.	8.0	8.1	7.8	7.9	7.9	7.8	7.7	7.2	6.9	8.1	8.1	8.2	8.2
Fert.0.5 lb.+Primo 0.25 oz.	8.4	8.4	8.0	8.1	8.1	8.0	7.9	7.6	7.1	8.2	8.5	8.6	8.8
Fert.1.0 lb.+Primo 0.125 oz.	8.6	8.8	8.1	8.3	8.4	8.4	8.2	8.0	7.5	8.5	8.5	8.6	9.1
Fert.1.0 lb.+Primo 0.25 oz.	9.3	9.2	8.4	8.4	8.4	8.4	8.4	8.2	7.9	8.8	9.0	9.0	9.3
Primo 0.125 oz.	6.4	6.5	6.6	6.6	6.5	6.5	6.6	6.5	6.4	6.2	6.5	6.6	6.7
Primo 0.25 oz.	6.6	6.9	6.9	6.9	6.8	7.0	7.0	7.0	6.9	6.8	6.9	7.0	7.2
Untreated Check	5.3	5.4	5.4	5.5	5.4	5.4	5.4	5.5	5.4	5.4	5.3	5.5	5.5
LSD 0.05	0.23	0.28	0.28	0.27	0.15	0.29	0.23	0.21	0.25	0.21	0.12	0.12	0.16

Table 2. Fresh Weight Yields on Creeping Bentgrass.

Treatment	Fresh Weights Collections (grams)														
	5/01	5/08	5/15	5/22	5/30	6/06	6/13	6/20	6/28	7/05	7/12	7/19	7/26	8/02	8/10
Fert.0.5 lb	96	131	121	97	128	139	96	103	132	171	140	122	201	130	125
Fert.1.0 lb	157	230	203	161	171	226	177	140	238	250	197	172	238	143	140
Fert.0.5 lb.+Primo 0.125 oz.	98	103	109	87	85	94	99	113	120	143	141	126	133	94	130
Fert.0.5 lb.+Primo 0.25 oz.	89	101	90	86	67	87	99	115	105	122	139	120	110	76	120
Fert.1.0 lb.+Primo 0.125 oz.	152	195	182	151	157	199	157	147	185	239	195	183	199	135	133
Fert.1.0 lb.+Primo 0.25 oz.	137	163	151	143	142	198	171	158	173	232	201	155	173	112	119
Primo 0.125 oz	77	83	77	55	49	59	66	99	68	76	94	89	73	51	95
Primo 0.25 oz	70	68	57	46	43	47	67	88	66	67	87	85	66	36	75
Untreated Check	100	118	98	74	77	79	77	105	98	90	79	79	111	69	133
LSD 0.05	11.1	6.9	10.9	8.1	11.1	14.6	7.3	9.3	15.9	11.0	11.6	12.6	16.4	8.0	24.3

Table 2 (Continued). Fresh Weight Yields on Creeping Bentgrass

Treatment	Fresh Weight Collections (grams)										Totals	% Reduction vs. Same Fert. Checks	
	8/17	8/24	8/31	9/07	9/14	9/21	9/28	10/09	10/16	10/23			
Fert.0.5 lb.	139	148	109	140	147	123	73	165	119	55	3150	Check	---
Fert.1.0 lb.	179	191	177	161	151	145	103	242	189	72	4453	---	Check
Fert.0.5 lb.+Primo 0.125 oz.	148	133	89	130	140	112	65	128	105	45	2770	12.06	---
Fert.0.5 lb.+Primo 0.25 oz.	129	120	83	121	123	134	72	92	87	51	2538	19.43	---
Fert.1.0 lb.+Primo 0.125 oz.	170	175	156	134	148	139	75	173	176	74	4029	---	9.52%
Fert.1.0 lb.+Primo 0.25 oz	157	162	147	117	131	127	97	144	173	72	3755	---	15.67%
Primo 0.125 oz.	98	67	43	81	77	91	38	34	33	18	1691	18.39%	---
Primo 0.25 oz.	106	59	27	79	67	77	31	29	26	16	1485	---	28.33%
Untreated Check	94	97	53	85	99	84	51	45	45	32	2072	Check	---
LSD 0.05	13.8	16.4	10.1	20.0	27.6	34.0	9.3	22.2	18.9	5.8			

Table 3. Average Monthly Turfgrass Color Ratings on Creeping Bentgrass.

Treatment	Average Monthly Turfgrass Color Ratings (Turfgrass Color Ratings 1–10, where 10 = Best)						
	Apr.	May	June	July	Aug.	Sept.	Oct./Nov.
Fert. 0.5 lb.	4.85	6.06	5.98	5.98	6.12	5.90	6.53
Fert. 1.0 lb.	5.50	6.92	6.75	6.63	6.66	6.48	7.18
Fert. 0.5 lb.+Primo 0.125 oz.	5.40	6.50	7.70	7.63	7.94	7.40	8.15
Fert. 0.5 lb.+Primo 0.25 oz.	5.60	6.54	7.93	8.03	8.20	7.65	8.53
Fert. 1.0 lb.+Primo 0.125 oz.	6.00	7.48	8.18	8.10	8.44	8.03	8.68
Fert. 1.0 lb.+Primo 0.25 oz.	6.00	7.68	8.68	8.68	8.74	8.23	9.03
Primo 0.125 oz.	5.20	5.92	6.55	6.50	6.52	6.50	6.50
Primo 0.25 oz.	5.00	6.02	6.95	6.98	6.82	6.98	6.98
Untreated Check	5.00	5.28	5.23	5.25	5.40	5.43	5.43

Table 4. Creeping Bentgrass Discoloration

Treatment	Creeping Bentgrass Discoloration (1–10, where 10 = 100% Brown)			
	8/24	8/30	9/07	9/14
Fert. 0.5 lb.	0.00	0.00	0.00	0.00
Fert. 1.0 lb.	4.33	4.33	4.00	3.33
Fert. 0.5 lb.+Primo 0.125 oz.	0.00	0.00	0.00	0.00
Fert. 0.5 lb.+Primo 0.25 oz.	0.00	0.00	0.00	0.00
Fert. 1.0 lb.+Primo 0.125 oz.	4.33	4.67	4.67	4.33
Fert. 1.0 lb.+Primo 0.25 oz.	4.33	4.33	4.67	4.67
Primo 0.125 oz.	0.00	0.00	0.00	0.00
Primo 0.25 oz.	0.00	0.00	0.00	0.00
Untreated Check	0.00	0.00	0.00	0.00

APPLICATION INFORMATION:
LOCATION: OSU Turfgrass Research Center-Range #1, North End

Application #1:
Date: April 21, 1995 Time: 5:00 P.M. Temperature: 73 F
Soil moisture: saturated Wind speed: 12 mph, from W
Rain/irr. after app: 15 hours - 0.20" Relative humidity: 44%
Skies: Partly Cloudy

Application #2:
Date: May 19, 1995 Time: 3:00 P.M. Temperature: 69 F
Soil moisture: field capacity Wind speed: 8 mph, from N
Rain/irr. after app: 140 hours - 0.70" Relative humidity: 42%
Skies: clear - sunny

Application #3:
Date: June 18, 1995 Time: 8:00 P.M. Temperature: 80 F
Soil moisture: field capacity Wind speed: < 5 mph, from W
Rain/irr. after app: 32 hours - 0.25" Relative humidity. 54%
Skies: clear - sunny

Application #4:
Date: July 19, 1995 Time: 6:00 P.M. Temperature: 83 F
Soil moisture: field capacity Wind speed: 7 mph, from W
Rain/irr. after app: 34 hours - trace Relative humidity: 41%
Skies: clear - sunny

Application #5:
Date: Aug.18, 1995 Time: 4:00 P.M. Temperature: 83 F
Soil moisture: saturated Wind speed: 8 mph, from SE
Rain/irr. after app 11 hours - 0.25" Relative humidity: 80 %
Skies: partly cloudy

Application #6:
Date: Sept. 28, 1995 Time: 5:00 P.M. Temperature: 80 F
Soil moisture: moderate Wind speed: 5 mph, from SE
Rain/irr. after app: 12 hours - 0.25" Relative humidity: 33%
Skies: clear - sunny

Turfgrass Species: Creep Bent Cultivar: "Penncross"
Height - 0.5" Density - 100% Condition - Good
Thatch - 0.5" Irrigation availability: Yes
Testing on site previous year: Growth Regulator Evaluation

APPLICATION EQUIPMENT:
Liquid formulations: 2 gal/1000 $ft.^2$ at 35 psi using Teejet 8002 with single hand wand.

EXPERIMENTAL DESIGN: Randomized Complete-block Design
Plot Size: 3 ft. by 20 ft.; No of reps - 3; Aisle between treatments - 0 and replications - 0

COMMENTS/CORRECTIONS: Turfgrass Color, Phytotoxicity and Fresh Weight collections to be taken weekly

Bermudagrass Management Study

John Street and Jill Taylor
Horticulture and Crop Science

Introduction

Bermudagrass is a warm-season turfgrass species touted for its excellent heat and drought tolerance. It also forms a dense, durable sod due to high tillering and an extensive stolon and rhizome system. The major limitation to bermudagrass use in the north is a lack of winter/cold hardiness. Several cultivars of bermudagrass have been developed more recently with improved (claimed) winter hardiness. 'Sundevil' bermudagrass (Medalist America) has been observed to survive winters as far north as Chicago, Illinois.

Discussion/Summary

The objectives of this research were to evaluate 'Sundevil' bermudagrass for quality and winter survival as influenced by nitrogen and potassium fertilization. Bermudagrass was seeded on June 6, 1993, at 1.5 pounds per 1,000 ft.^{2} Mowing height was initiated at 1.5 inches with a Jacobson triplex reel mower. On July 29, 1993, the mowing height was lowered to a 1-inch maintenance height using a Cushman front line rotary mower. Mowing was performed twice weekly during the growing season. Nitrogen treatments were 0, 2, and 4 pounds per 1,000 ft.^{2} Potassium treatments were 0, 4, and 8 pounds of K_2O per 1,000 ft.^{2} The experimental design was a randomized complete split plot design, resulting in all combinations of nitrogen and potassium rates. Nitrogen and potassium rates were split into four equal applications. Fertilizer applications were initially applied on September, 15, 1993. In 1994, treatments were applied on May 2, June 17, August 3, and September 9. Nutralene (40-0-0) and muriate of potash (0-0-61) were used as the nitrogen and potassium sources, respectively. Color ratings were at approximately two-week intervals throughout the growing season until dormancy occurred in the fall. Color ratings were based on a scale of one to nine, with one representing poorest (brown, dormant), six representing marginally acceptable, and nine representing best (greenest). Percent cover ratings were taken at periodic intervals throughout the growing season in 1994 and 1995 (see Table 1). At the end of the 1993 season, the entire bermudagrass area exhibited 90%+ cover.

Bermudagrass color/quality ratings are provided in Table 2. The initial nitrogen and potassium fertilizations occurred on September 15, 1993. Color/quality of bermudagrass increased with increasing nitrogen fertilization. The addition of potassium (0 compared to 4 and 8 lbs.) provided enhanced color/quality on some dates. There appeared to be minimal difference, if any, in color/quality between the 4 and 8 lb. K_2O per 1,000 ft.^{2} rates.

Bermudagrass winter survival is measured by percent cover ratings during the 1994 and 1995 growing season (see Table 1). Prior to dormancy in 1993, bermudagrass cover in all treatments was 90% +. Nitrogen fertilization alone had no effect on winter survival of bermudagrass. Nitrogen fertilization did enhance the recovery rate of bermudagrass. There was a corresponding increase in bermudagrass survival with increasing potassium rates. This is well illustrated by the percent mean cover ratings in May and June. There also appeared to be a positive nitrogen-potassium interaction on bermudagrass winter survival.

Table 1. Bermudagrass Percent Cover as Influenced by Nitrogen and Potassium Fertilization

	Mean Percent Cover 1994[a]								
Fertility Level[b]	**5/10**	**5/25**	**6/9**	**6/22**	**7/6**	**7/20**	**8/8**	**8/22**	**9/8**
0 K, 0 N	4	5	7	27	33	33	30	30	30
0 K, 2 N	1	4	10	23	27	27	37	60	60
0 K, 4 N	2	8	10	25	33	33	40	48	48
4 K, 0 N	6	18	45	60	62	62	68	58	58
4 K, 2 N	7	23	43	55	62	62	57	82	82
4 K, 4 N	15	42	55	68	70	70	85	83	83
8 K, 0 N	42	42	65	82	80	80	80	83	83
8 K, 2 N	40	47	83	88	83	83	93	95	95
8 K, 4 N	65	75	87	89	93	93	98	93	93

	Mean Percent Cover 1995[a]						
Fertility Level[b]	**5/5**	**5/23**	**6/5**	**6/13**	**6/20**	**7/10**	**9/1**
0 K, 0 N	35	40	40	48	52	37	88
0 K, 2 N	50	68	68	77	80	78	93
0 K, 4 N	57	65	65	72	75	75	88
4 K, 0 N	47	45	45	71	65	63	85
4 K, 2 N	70	83	83	88	88	87	92
4 K, 4 N	73	88	88	96	94	93	87
8 K, 0 N	50	67	67	77	75	83	91
8 K, 2 N	73	90	90	95	96	90	92
8 K, 4 N	70	88	88	95	93	95	89

[a] Mean Percent Cover 1–100. Percent cover was 90% + in 1993.
[b] Fertility level in pounds/1,000 ft.^{2}/ year in four timely applications.

Table 2. Bermudagrass Color as Influenced by Nitrogen and Potassium Fertilization.

	Mean Color 1993[a]				
Fertility Level	9/22	10/6	10/20	11/4	11/18
0 K, 0 N[b]	6.3	5.0	6.1	5.0	1.0
0 K, 2 N	6.8	5.6	6.6	6.3	1.0
0 K, 4 N	7.3	6.5	7.0	6.9	1.0
4 K, 0 N	6.3	4.7	6.0	5.4	1.0
4 K, 2 N	7.2	6.7	6.7	6.3	1.0
4 K, 4 N	7.8	6.5	7.1	7.3	1.0
8 K, 0 N	6.3	5.7	6.1	5.0	1.0
8 K, 2 N	7.2	6.5	6.3	6.1	1.0
8 K, 4 N	8.0	6.5	7.0	7.2	1.0

	Mean Color 1994[a]							
Fertility Level	8/8	9/8	9/19	10/15	10/26	11/10	11/23	12/14
0 K, 0 N[b]	6.2	7.0	6.8	5.7	3.7	1.7	1.3	1.0
0 K, 2 N	7.0	7.2	7.7	6.3	6.3	3.3	2.5	1.0
0 K, 4 N	7.2	7.5	8.0	7.5	6.3	5.0	3.8	1.0
4 K, 0 N	6.0	6.6	7.7	5.0	3.0	2.7	2.0	1.0
4 K, 2 N	7.4	7.5	7.0	7.0	6.8	3.7	2.8	1.0
4 K, 4 N	7.8	7.8	8.0	8.0	7.0	4.2	3.2	1.0
8 K, 0 N	6.2	6.8	6.9	5.3	4.7	4.3	3.2	1.0
8 K, 2 N	7.2	7.7	8.0	7.0	6.3	5.0	3.8	1.0
8 K, 4 N	8.0	8.1	8.0	8.0	7.3	6.0	4.5	1.0

	Mean Color 1995[a]							
Fertility Level	5/23	6/5	6/27	7/18	7/27	8/9	10/23	11/13
0 K, 0 N[b]	7.0	7.0	5.7	7.3	7.3	7.3	1.5	1.0
0 K, 2 N	7.6	7.6	7.5	7.8	7.8	8.0	2.0	1.0
0 K, 4 N	8.3	8.3	8.5	8.1	8.1	9.0	3.0	1.0
4 K, 0 N	6.3	6.3	5.5	7.2	7.2	7.3	2.0	1.0
4 K, 2 N	7.9	7.9	8.0	7.8	7.8	8.0	3.0	1.0
4 K, 4 N	9.0	9.0	8.8	8.0	8.0	9.0	4.3	1.0
8 K, 0 N	6.1	6.1	6.2	7.8	7.8	7.3	2.7	1.0
8 K, 2 N	8.1	8.1	7.8	8.0	8.0	8.2	4.7	1.0
8 K, 4 N	8.3	8.3	9.0	8.0	8.0	9.0	6.3	1.0

[a] Mean color 1–9, with 9 = greenest; 6 = some green color, marginally acceptable; 5–1 = poor color; 1 = poorest color, brown, dormant or dead.
[b] Fertility level in pounds/1,000 ft.^{2}/year in four timely applications.

Electrophoretic Evaluation of Esterase Isozymes from Turfgrass Seed Blends and Mixtures

G.E. Bell, M.B. McDonald, Jr., and T.K. Danneberger
Horticulture and Crop Science

Introduction

Turfgrass seeds are commonly blended to improve performance. However, once physically blended, no fast, reliable technique is available to identify the cultivars and the proportion of each cultivar in the blend. The objective of this study was to isolate specific species and cultivars in seed blends or mixtures through examination of esterase banding patterns on electrophoretic gels and to compare band intensities unique to each cultivar or species when blended in increasing or decreasing proportions.

Two cultivars of Kentucky bluegrass (*Poa pratensis* L.) were blended by weight in proportions ranging from 0 to 100%. Protein was extracted, separated on isoelectric focusing gels (pH gradient 3 to 9) and stained for esterase activity. Mixtures of fine fescue (*Festuca* spp.) species only and mixtures of both fine fescue species and Kentucky bluegrass cultivars were prepared in the same manner. Gels were visually analyzed for the presence of characteristic bands unique to each cultivar or species and for intensities of characteristic bands when cultivar proportions were varied within a seed blend or mixture.

The results indicated that visual discriminations could be made between cultivars and species in turfgrass blends or mixtures and that bands unique to a cultivar or species varied in intensity with their concentration in a blend or mixture. These findings have importance to seed companies and consumers interested in monitoring the composition of seed blends and mixtures subsequent to physical mixing.

Discussion/Summary

Cultivar Identification and Selection

Visual examination of three electrophoretic gels resolving esterase isozymes from seven different Kentucky bluegrass cultivars revealed distinctive banding patterns unique to each cultivar. Most cultivars were identified by bands characteristic of that cultivar and others by visual discrimination of band intensities. These results confirmed those of previous electrophoretic studies. The banding patterns of all cultivars and all seed lots were consistent and repeatable from gel to gel, suggesting that the esterase isozymes used for discrimination were indeed a part of the chemical composition of the seed and indicative of the cultivar.

Evaluation of Blends and Mixtures

Two Kentucky bluegrass cultivars, 'Glade' and 'NuStar,' were chosen for blend analysis based on their respective banding patterns. NuStar contained a unique band at pI 7.2 not present in Glade. Glade contained a unique band at pI 8.5 not present in NuStar. The optical intensity of the characteristic bands unique to each cultivar increased as the proportion of the cultivar increased in the blend. These early results suggested that it was possible to visually assess the proportion of individual cultivars in turfgrass blends. Gel resolution, however, was poor and greater resolution desired.

To improve band resolution, the seed to extract buffer ratio was increased to concentrate the supernatant. This process, however, failed to increase band resolution. It was believed the seed inflorescence (lemma and palea) absorbed most of the enzyme extract buffer used for analysis. As a result, the seed was scarified to remove these seed parts and cleaned in a seed blower. A substantial improvement in gel resolution was achieved by this process. The increase or decrease in intensity of electrophoretic bands from one side of the gel to the other was apparent and consistent among the samples. Bands unique to the cultivars were visible in proportions as low as 10%. Visual comparison of these blends with cultivars of 100% intensity could be used for general estimates of the actual proportion of each cultivar in a blend. The bands unique to each cultivar were present in each blend.

Evaluation of Seed Mixtures

Similar studies were conducted with mixtures of hard and chewings fescue. Unique bands were identified in both species at concentrations as low as 10%. As with Kentucky bluegrass, visual assessments indicated that lower concentrations of a particular species in the mixture resulted in characteristic bands of less intensity; higher concentrations resulted in characteristic bands of greater intensity. These results suggested that more complex mixtures could also be evaluated.

Four-component seed mixtures of NuStar, Glade, Longfellow chewings fescue, and Brigade hard fescue were prepared in proportions common to commercial preparations for shaded sites. Bands unique to NuStar and Glade at pI 7.2 and pI 8.5, respectively, were identified as well as bands unique to chewings fescue at pI 9.1 and hard fescue at pI 7.4. The characteristic band of interest for each species or cultivar, except Glade, was present in the mixture, but with less intensity than in lanes of 100% concentration. The band characteristic of Glade was also present, but at very low intensity, and thus more difficult to resolve. A darkening of lanes, believed to be scattered isozymes, present in chewings fescue at pI 8.5, combined with the low concentration (15%) of the low intensity Glade band, resulted in a masking of the band. Therefore, a higher concentration of Glade in the mixture would be needed to reveal its presence.

These results demonstrate that isoelectric focusing can resolve individual components of turfgrass blends or mixtures. Removal of the outer seed inflorescence during seed preparation enhanced electrophoretic band resolution. Characteristic bands unique to a turfgrass cultivar or species could be identified at concentrations as low as 10%. Visual assessment suggested that the density of electrophoretic bands unique to a cultivar or species was proportional to its concentration in either turfgrass blends or mixtures and further suggested that appropriate quantitative measurements of these bands might be used to determine the actual proportion of components in those blends or mixtures.

An electrophoretic system provides a rapid, reliable means for identification and quantification of components in a seed blend or mixture. Such a system would be a useful quality control tool for the turfgrass seed industry. Sod producers may also use such a system for determining the components of their seed blends before planting.

Computer Imaging of Electrophoretic Gels

G.E. Bell, M.B. McDonald Jr., T.K. Danneberger and S. K. St. Martin
Horticulture and Crop Science

Introduction

Electrophoresis is commonly used in agricultural sciences and industries to evaluate protein constituents of plant and animal tissue and for cultivar identification. Visual analysis of polymorphic bands is effective, but analysis of electrophoretic banding patterns containing common bands of unique optical densities is difficult and can be subjective. A simple, reliable means of objective evaluation is necessary for these analyses and is not currently available.

The purpose of this study was to test the effectiveness of computer-aided image analysis for quantitative evaluation of electrophoretic bands. Seed protein was extracted from mixtures and blends of turfgrass species and cultivars, separated on isoelectric focusing gels, and stained for esterase activity. Banding patterns were scanned, their images stored in computer memory, and densitometric evaluation of band densities performed. Statistical evaluation of repetitive scans of varying band densities revealed that computer-aided image analysis is an effective, reliable method for quantitative evaluation of individual electrophoretic gels.

Discussion/Summary

Evaluation of Gray Paper Gradients

An analysis of gray paper gradients demonstrated the effectiveness of computer imaging when optical densities were known. This test was important because optical densities of electrophoretic bands are varied and unknown and cannot alone establish the effectiveness of the procedures tested. Statistical analysis of gray paper gradients resulted in no significant variation among scanned positions within the sample ($P=0.05$). The imaging system, therefore, accurately determined optical densities within scans throughout its physical scanning range.

Optical density values assigned to each marker box were valid and mathematical calculations (e.g., Marker 2 - Marker 1 = UOD) performed with those values were also valid. The imaging system was tested using areas of optical density differing in intensity by as much as 400% (Marker 4 compared to Marker 1) without loss of accuracy. Significant varation was found among scans of the same gradients (test of scans = blocks at $P = 0.05$). Scanned results, however, accurately compared the optical density of gradient levels within each scan, suggesting that the scanning device was automatically recalibrating before each scan. Consequently, comparative results within scans were accurate. The results of these preliminary tests using known optical densities suggested that the imaging system could be effective for evaluation of electrophoretic gels where optical densities of bands were varied and unknown.

Evaluation of Electrophoretic Gels

Bands unique to a turfgrass cultivar or species vary in optical density in relation to their proportion in a blend or mixture. The imaging system, therefore, was expected to provide a quantitative evaluation of differences in optical density of bands unique to a cultivar or species applied in varying proportions. Each electrophoretic gel in set one contained cultivar or species proportions of 100%, 90%, 10%, and 0%. In some cases, it was difficult to visually discriminate between bands of proportions differing by only 10%, such as 0% Glade and 10% Glade (not shown) or 90% chewings fescue and 100% chewings fescue. The imaging system, however, was effective for this purpose. Of 80 observations made, the imaging system assigned a greater percent optical density value to the larger cultivar or species proportion in 78 cases. These observations demonstrate that the use of the imaging system enabled the discrimination of even minor differences in band density. Such findings suggested that this system could be effective for cultivar and species identification and the discrimination of turfgrass components within blends or mixtures where varying densities of common bands exist.

Data for tests of electrophoretic gels were obtained by comparing band density to the density of the lane in which the band was found. When using this method, the denominator (total lane density) varied with the proportion of cultivars or species applied to lanes. The numerator (total band density) also varied in the same manner. This variation of lane density was undesirable, but had little effect on the calculated results. The magnitude of the denominator exceeded that of the numerator in each test by a factor of at least 100. A small change in both numerator and denominator, therefore, had little effect on the final outcome. Tests of total lane variation in Gel Set 1 indicated significant variation in total lane density among lanes containing the same protein extracts ($P = 0.05$). Tests of the pipet used for gel loading also suggested significant variation ($P = 0.05$) in the amount of supernatant applied to each lane. Because of these effects, it was necessary to compare band densities to lane densities in order to improve precision. Tests of bands differing in proportion by only 10% indicated that this procedure was effective. In addition, POD values were effective for determination of relative cultivar proportions in seed blends using band densities as indicators.

Evaluation of electrophoretic banding patterns is a respected scientific technique for biological analyses. Analyses of variance performed for treatment factors among gels and among scans within gels resulted in components of variance suggesting that the imaging system was more precise than the electrophoretic gels it evaluated. The components of variance among gels containing identical cultivar components prepared from identical protein extracts (Set 1 and Set 2) exceeded that of scans within gels in each test, suggesting that, in each case, error introduced by electrophoresis was of greater significance than error resulting from computer-aided image analysis.

Although continued improvement is needed, these findings support the accuracy of the imaging system for present-day quantitative evaluation of electrophoretic gels. The results, however, emphasized that image analysis is of value only when comparing banding patterns on a single gel and within a single scan. F-tests revealed that significant variation existed among gels and among scans within gels for all tests ($P=0.05$). The variance component for seed samples in Set 3, however, was exceptionally high (69% of total variation detected), suggesting that biological differences may be the greatest contributor of variation in electrophoretic tests. These results support the use of electrophoresis for analysis of biological markers.

Optical densities of position fields containing lanes of identical cultivar or species proportions were expected to have little variation among gels. In fact, field variation was insignificant for all tests ($P = 0.05$), indicating that POD values for field 1, when averaged over all gels tested, were not significantly different from average POD values for fields two, three, four, and so on. Components of variance for gel x field interaction, however, indicated that variation among fields existed within gels. F-tests for this interaction were significant for each analysis. This variation was not attributed to the imaging system because the analysis of gray paper gradients had indicated no variation among scanned positions.

As expected, field variation was inherent within gels as opposed to scans of those gels. A graphic representation of average field POD as a function of field positions within scans explained this phenomenon. Each scan of a particular gel had its own identity. Each field within a scan and gel also had its own identity, but variation among scans had little, if any, effect on variation among fields. Fields held their positions according to relative magnitude among scans. A field that was comparatively light or dark on one scan proved to be comparatively light or dark on all other scans of the same gel.

Furthermore, little interaction was observed between scans within gels and position fields. Components of variance indicated that less than 0.25% of total variation could be attributed to field x scan (gel) interaction, indicating that variation among scanned images was independent of variation among fields. Protein extracts therefore segregated and resolved somewhat differently with respect to their positions on the gel, and the imaging system accurately discriminated this variation. This consideration of gel x field interaction, significant for all tests ($P = 0.05$), suggested that the most dense (or least dense) bands seldom occurred at the same position on different gels. It was, therefore, determined that an average of band density in lanes positioned across a gel was the most accurate means of quantitative electrophoretic evaluation using image analysis.

In summary, variation among scans, although significant, was minimal relative to variation observed among gels and was attributed to the automatic recalibration of the scanning instrument prior to each scan. Biological variation, however, between seed samples obtained from the same commercial seed lots exceeded variation among gels by a factor of 3.28 suggesting that electrophoresis accurately discriminates biological anomalies. Components of variance for field x gel interaction illustrated that the contribution of position variation within electrophoretic gels was a factor of concern for quantitative analysis. Comparisons then, could be made between optical densities of individual bands within electrophoretic gels; more accuracy, however, could be obtained by comparing means of multiple identical bands within the same gel, as was done for tests of optical density for concentrations differing by only 10%. Using these techniques, accurate comparisons can be made.

It is concluded that computer-aided image analysis is a fast, reliable system for quantitative evaluation of electrophoretic bands. Electrophoretic bands result in varying optical densities regardless of electorphoretic technique used, staining system employed, or biological species tested. Computer imaging, therefore, may be applicable wherever quantitative electrophoretic analysis is desired. This system could be useful for such diverse applications as cultivar identification in plants, evaluation of host-protective antigens in livestock, or human hemoglobin analysis.

Evaluation of Kentucky Bluegrass Blends Using Isoelectric Focusing and Computer Imaging

Gregory E. Bell, Miller B. McDonald Jr., and T. Karl Danneberger
Horticulture and Crop Science

Introduction

Seeds of turfgrass cultivars are commonly blended to improve performance. Once physically blended, however, no fast, reliable technique is available to identify the proportions of cultivars present. The objective of this study was to test the effectiveness of computer imaging of electrophoretic gels for determining the relative proportions of two Kentucky bluegrass (*Poa pratensis* L.) cultivars in seed blends based on optical densities of electrophoretic bands unique to each cultivar.

Blends of the two cultivars, 'NuStar' and 'Glade,' ranging from 0 to 100%, were prepared by weight, protein extracted, and separated on isoelectric focusing gels stained for esterase activity. The gels were electronically scanned and their electrophoretic images analyzed using a computer software program to determine the proportion of each cultivar present in 27 blends. The results indicated that this technique accurately quantified the percentages of cultivars in seed blends to within ±8.6% with 95% consistency. Based on this study, the combination of isoelectric focusing and computer imaging was an effective method for determining cultivar proportions in turfgrass seed blends.

Discussion/Summary

In some cases (NuStar 20% and 80%), little variation was observed among the error values associated with replications of the same blended proportions. In most cases, however, substantial (greater than 9.0%) variation occurred among these replications. In addition, linear regression analysis indicated no correlation between cultivar proportions and their associated error values ($r = 0.035$). Such findings suggest that error was not related to the proportion of cultivars included in a blend, but was randomly distributed among gels. Collectively, according to the Lilliefors test for goodness of fit at $P = 0.05$, the error values observed resulted in a normal statistical curve. A graphic comparison of data expected (standard normal statistical curve) with data observed supported this observation. The error ranged from +13.8% to -14.7% with a mean of 1.6% and a standard deviation of 7.4%. Consequently, based on the empirical rule, the analysis of any individual experiment using data observed from a single gel can be expected to fall within ±7.4% of the actual blended proportions 68% of the time and within ±14.8% of the actual blended proportions 95% of the time.

More accurate results, however, were obtained by averaging multiple replications of gels of the same cultivars and blended proportions. The average error for three replicates of gels containing identical blended proportions ranged from +9.7% to -8.5%, with a standard error of 4.3%. Based on this study, error values using three gel replicates can be expected to fall within ±8.6% with 95% consistency as opposed to ±14.8% using a single gel analysis. These findings suggest that further increases in the number of gels analyzed results in greater accuracy.

A study of computer-aided image analysis demonstrated that most of the error observed during this process could be attributed to the electrophoretic procedures (extraction, electrophoresis, and staining). Consequently, it is possible that this accuracy may further be improved by closely regulating protein extraction and electrophoresis procedures.

This study has demonstrated that the relative proportions of individual cultivars in seed blends can be determined by comparison of polymorphic bands unique to each cultivar. Using similar techniques, it may also be possible to make these determinations by evaluating optical densities of bands common to more than one cultivar, by determining total lane density of individual cultivars, or by examining portions of lanes that differ among cultivars. Potentially, statistical methods could be used to compare all bands, both common and unique, represented on a gel. Computer imaging techniques, therefore, are quite flexible. These techniques could be effective for evaluating blends containing more that two cultivars.

According to reports, protein extractions from blends of three to five Kentucky bluegrass cultivars consistently resulted in unique banding patterns on electrophoretic gels. Statistical comparisons of these banding patterns using computer-imaging techniques may result in reliable estimations of cultivar proportions included in these more complicated blends. Electrophoresis, however, contains some inherent variability. It is possible, therefore, that evaluation of many bands on a gel, each being somewhat variable, would increase error and consequently require several replications to improve accuracy. These comments, however, are quite speculative and encourage more formal study.

The process described can be used to evaluate a seed blend and ensure that the components and component proportions listed on the seed tag are accurate. Turfgrass seed companies can employ this technique as a fast, reliable quality control measure. Sod producers and other large turfgrass seed consumers can determine the components and proportions of turfgrass seed blends before planting. This is important because it has been suggested that substitution of cultivars exists in the turfgrass seed industry, indicating a need for discriminatory quality control techniques. A fast, reliable method for quantification of turfgrass cultivars in seed blends as described here protects and benefits both the consumer and the seed supplier and results in the marketing of a superior product.

Identification of RAFLP Markers in Perennial Ryegrass

Patricia M. Sweeney and Karl Danneberger
Horticulture and Crop Science

Preliminary work with *Poa annua* showed the generation of restriction amplification fragment length polymorphic (RAFLP) markers to be feasible. These molecular markers are similar to random amplified DNA (RAPD) markers in that they are easy to generate, require only small amounts of tissue for analysis, and do not require previous knowledge of DNA sequences of genes. They have the added advantage of being co-dominant. Each genotype is easily identified, which makes them more valuable in genetic studies.

Although RAFLP markers are theoretically co-dominant, this has not been verified in genetic studies. Our work with a population of *Poa annua* identified several RAFLP markers that occurred in unexpected portions for a diploid species. *Poa annua* is actually an allotetraploid — it contains the chromosome sets of two different progenitor species, (2X (14 chromosomes from parent No. 1) + 2X (14 chromosomes from parent No. 2) = 4X (28 chromosomes for *Poa annua*) — but in previous genetic studies has behaved as a diploid (2X). We expected *Poa annua* to behave as a diploid for RAFLP markers, but suspect that it was behaving like a tetraploid (4X) for some markers. Since studies to verify co-dominant gene action of RAFLP markers are based on the assumption that a species is diploid, the tetraploid-like behavior of some RAFLP markers would seriously confound our studies to verify the co-dominance of RAFLP markers. We, therefore, switched to perennial ryegrass, a diploid species, to continue our research.

We initially began looking for restriction loci using those primers that gave good results in our studies with Poa annua, but soon found that primers that worked well for one species did not necessarily work well in the other. Therefore, we re-screened 180 primers and selected 88 that gave desirable amplification. Using these primers with the five restriction enzymes (*Hind* III, *Kpn* I, *Pst* I, *Apa* I, and *Sma* I) that worked well in our previous study, we identified 64 restriction loci. Fourteen of these restriction loci were polymorphic and, hence, identified as RAFLP markers. Replication of amplification and restriction digestion produced identical results for these RAFLP markers.

Unlike our experiments with *Poa annua*, where more than half of the RAFLP markers occurred in proportions that were not as predicted for a diploid, all the RAFLP markers identified in perennial ryegrass occurred in proportions expected for a diploid species. Therefore, we concluded that the occurrence of unusual proportions of RAFLP markers in *Poa annua* was due to its genetic history as a tetraploid and was not a phenomenon that is inherent to RAFLP markers.

We have vernalized plants of the perennial ryegrass genotypes that were used to identify RAFLP markers. When these plants flower, crosses will be made and progeny tested. Those RAFLP markers that exhibit Mendelian genetic (segregate 1:2:1) and co-dominance should be useful for genetic studies. Since RAFLP markers can be used to get direct estimates of gene frequencies, they will be especially useful in monitoring gene flow between populations, identifying genetic shifts in cultivars and populations, and verifying crosses.

RAPD Analysis of Dry Turfgrass Seed

Patricia Sweeney, Robert Golembiewski, and Karl Danneberger
Horticulture and Crop Science

The need for improved methods of variety identification of turfgrass species is increasing due to the large number of varieties released each year. Recent advances in technology have shown that amplification of DNA using arbitrary primers can generate an almost infinite number of polymorphisms called RAPD markers. These markers have been used to distinguish varieties of zoysiagrass, centipedegrass, and perennial ryegrass and should prove useful for identifying varieties in other turfgrass species.

Unlike most agronomic species, which are sold as uniform pure line varieties or hybrids, most cool season turfgrass species are marketed as synthetic varieties. Hence, turfgrass varieties are often composed of a large number of unique, but related, genotypes, and differences between some varieties may be due solely to gene frequencies. Therefore, it may be necessary to analyze single seeds and determine frequencies of RAPD markers to distinguish these varieties. Therefore, the ability to extract DNA from a single seed may be an important factor in variety identification procedures.

In previous studies, DNA from leaf tissue was used for amplification. The requirement of using leaf tissue hinders the use of RAPD analysis in a routine seed testing laboratory where variety identification is practiced since the time required to grow tissue may exceed seven days. A procedure for extracting DNA from dry seed of maize, cotton, soybean, peanut, wheat, and red clover for amplification with arbitrary primers has been reported, but currently, amplification of turfgrass seed DNA has not been tested. The objectives of our study were to determine if the amplification procedure that was successful for other species was suitable for turfgrass seed and if DNA extracted from a single turfgrass seed could be amplified.

One gram samples of common bermudagrass, 'Koket' and 'Banner' fine fescue, *Poa annua*, 'Supra' *Poa supina*, 'Cobra' creeping bentgrass, 'America' and 'Bronco' Kentucky bluegrass, 'Caravelle' and 'Accolade' perennial ryegrass, and 'Arid' and 'Finelawn 1' tall fescue were scarified for two minutes then transferred to a vacuum blower for two minutes to remove remaining chaff. For each scarified sample, DNA was extracted from a 20 mg. bulk sample and a single seed using a simple procedure. After mixing ground dry seed in a buffer, samples were centrifuged. Isopropanol was used to precipitate DNA from the supernatant. The resulting pellet, isolated by certification, was dried in a vacuum desiccator then suspended in buffer.

Estimates of DNA concentrations of extracts from the bulk samples ranged from 6 to 31 μg ml^{-1}. Bulk DNA extractions were diluted with to 2 to 5 μg ml^{-1} for amplification. Concentrations of DNA extracts from single seeds were too low to quantify, so 1 μl extract was used for the amplification. Amplification was repeated for each extraction. After the DNA was amplified, agarose gels containing ethidium bromide were used to separate amplification products. Amplification products were detected under ultraviolet light and photographed.

In all species evaluated, DNA extracted from both bulk and single seed samples was successfully amplified. Amplification was identical for replicate samples of each extraction. Turfgrass DNA extracted from single dry seeds and bulk samples was suitable for amplification. Although strength of the amplification fragments varied among the species, the single primer tested gave reproducible results for all the species evaluated. With an almost infinite number of primers available, finding primers that produce obvious bands to identify varieties should be possible for most turfgrass species.

The Ohio State University
College of Food, Agricultural, and Environmental Sciences
Ohio Agricultural Research and Development Center
1680 Madison Avenue
Wooster, Ohio 44691-4096
330-263-3700

In Partnership With
Ohio State University Extension

Ohio Agricultural Research and Development Center
In Partnership With
Ohio State University Extension
College of Food, Agricultural, and Environmental Sciences