# Turfgrass Research Report
# 1996

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July 1997
Special Circular 155
Ohio Agricultural Research and Development Center
In Partnership With Ohio State University Extension

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# Turfgrass Research Report
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# Preemergence Herbicide Efficacy on Crabgrass—1996

John Street and Renee 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 target weed for the majority of turfgrass weed control programs in the Midwest. 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 usage 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 29, 1996. Sequential or split applications were made on June 26. 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 29. The Kentucky bluegrass area was verticut lightly and overseeded with crabgrass at a rate of 1 lb. per 1,000 $ft^2$ at one week prior to herbicide applications. On May 10, 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 lbs nitrogen per 1,000 $ft^2$ was applied during the growing season. Irrigation was applied several times per week to maintain a moist soil and 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 x 8 feet, and each treatment was replicated three times in a randomized complete block design. Treatments were monitored for crabgrass infestation throughout the growing season (Table 1).

Crabgrass infestation is simply reported as percent crabgrass cover. No observable injury/phytotoxicity symptoms were apparent from any of the herbicides so ratings are not reported.

Dimension (dithiopyr) was monitored for safety/phytotoxicity on the 1994 creeping bentgrass NTEP cultivar trials. Dimension was applied across all cultivars at 0.5 lbs ai/A. Herbicide treatments were applied on May 5, 1996. Injury/phytotoxicity was monitored across all the bentgrass cultivars at approximately two-week intervals throughout the growing season. None of the bentgrass cultivars exhibited any negative or positive effects from the Dimension treatment at any rating date throughout the growing season.

In the standard preemergence herbicide efficacy study on Kentucky bluegrass, the first crabgrass control ratings were made on June 3 (Table 1).

Crabgrass infestation in the untreated plots averaged 18%. All herbicides and rates exhibited excellent efficacy on June 3.

On July 2, most herbicides and rates continued to provide excellent efficacy (i.e., <5% crabgrass). Herbicides/rates exhibiting a break in efficacy on July 2 were Dimension (AD 442) 0.06 + 0.06, Team 1.5, pendimethalin 0.86 FG 1.5 + 1.5, and Dimension 0.172 FG 0.25. Crabgrass cover in the untreated plots averaged 33 %. The lowest rates of Dimension and Barricade were still exhibiting excellent crabgrass efficacy on July 2.

On August 5, a number of herbicides/rates began to exhibit failure (Table 1). Significant crabgrass infestation/pressure had developed in the untreated plots (78%). All the Barricade WG treatments were still exhibiting excellent crabgrass control (i.e., <5% cover). All the pendimethalin formulations at 1.5 lbs ai/A began to exhibit some reduction in efficacy. The Pendulum 0.86 FG formulation at all rates also exhibited a significant reduction in efficacy (13 to 33% over). The Team 0.87 FG formulation also showed a significant drop in efficacy at both the 1.5 and 2.0 lbs ai/A rates. Both the Scotts Weedgrass Preventer and Scotts Fertilizer + Pre exhibited a significant break in crabgrass control. Pendimethalin 0.86 FG, Dimension 0.172 FG, and Barricade 0.22 FG formulations all exhibited a significant reduction in efficacy with crabgrass cover ranging from 11-25%. Dimension at all the lower rates (i.e., 0.06 and 0.09 lbs ai/A single and multiple/sequential) exhibited a significant drop in efficacy with crabgrass cover ranging from 15-32%. Lower rates of Dimension have not provided consistent, reliable season-long crabgrass control based on four years of research at The Ohio State University. Dimension 1 EC (0.25 lb ai/A) and Dimension 0.072 FG (0.125 lbs ai/A) both showed some degree of crabgrass encroachment (8-10%). The other Dimension formulations and rates continued to provide excellent crabgrass control.

On September 6 (final rating date), those latter herbicides/rates exhibiting previous breaks in efficacy/control, in general, continued to show increases in crabgrass infestation-cover. For example, the Dimension 1 EC (0.25 lbs ai/A) increased in crabgrass cover from 10 to 22% and Dimension AD 442-0.35 FG (0.06 + 0.06 lbs ai/A) increased in crabgrass cover from 25 to 37%. Pendimethalin (FG, G, and WDG) at the single 1.5 lbs ai/A rate all showed a significant reduction in crabgrass control about mid season. Pendulum 2 G at the 1.5 multiple and 3.0 lbs ai/A single rates continued to exhibit excellent season-long control. The Pendulum 0.86 FG formulation did not perform as well as Pendulum 2 G with the 1.5 multiple and 3.0 single lbs ai/A rates providing fair (17.7% cover) and poor control (33% cover); respectively. Barricade WG rates of 0.48 lbs ai/A and greater provided excellent season-long control. Dimension 1 EC efficacy was excellent at rates approaching 0.50 lbs ai/A. The Dimension 1 EC treatments of 0.25 and 0.38 lbs ai/A resulted in 22% and 15% crabgrass cover, respectively. In all of our Ohio testing, Dimension efficacy has always been superior with the FG formulations compared to the EC formulation at equivalent rates. Dimension FG provided good to excellent crabgrass control at rates of 0.25 lbs ai/A or greater.

**Table 1. Efficacy of various preemergence herbicides on crabgrass (*Digitaria*), 1996.**

| Herbicide[b] | Formulation[c] | Rate (lbs ai/A) | Crabgrass Cover (%)[a] 6/3 | 7/2 | 8/5 | 9/6 |
|---|---|---|---|---|---|---|
| Barricade | 65 WG | 0.32 | 0 | 0 | 3.33 | 7 |
| Barricade | 65 WG | 0.48 | 0 | 0.33 | 2 | 2 |
| Barricade | 65 WG | 0.65 | 0 | 0 | 0 | 0.33 |
| Barricade | 65 WG | 0.75 | 0 | 0 | 0 | 0 |
| Barricade | 65 WG | 0.50 & 0.25 (8-10 weeks) | 0 | 0.33 | 1.67 | 1.67 |
| Barricade | 65 WG | 0.65 & 0.32 (8-10 weeks) | 0 | 0 | 0.33 | 0.33 |
| Pre M | 60 WDG | 3.0 | 0 | 0 | 3.33 | 3.33 |
| Pre M | 60 WDG | 1.5 & 1.5 (8-10 weeks) | 0 | 0.33 | 4 | 10 |
| Dimension | 1 EC | 0.50 | 0 | 0 | 0.67 | 0.67 |
| Dimension | 1 EC | 0.25 & 0.25 (8-10 weeks) | 0 | 0 | 4 | 6.67 |
| Dimension | 1 EC | 0.25 | 0 | 0 | 10 | 21.67 |
| Dimension | 1 EC | 0.38 | 0 | 0 | 6.67 | 15 |
| Dimension | 1 EC | 0.125 & 0.125 (8-10 weeks) | 0 | 2 | 15 | 23.33 |
| Dimension | 1 EC | 0.250 & 0.125 (8-10 weeks) | 0 | 0 | 6.67 | 13.33 |
| Dimension (AD 444) | 0.072 FG | 0.125 | 0 | 0 | 8.33 | 16.67 |
| Dimension (AD 445) | 0.164 FG | 0.25 | 0 | 0 | 5 | 8.33 |
| Dimension (AD 446) | 0.250 FG | 0.38 | 0 | 0 | 0 | 0.33 |
| Dimension (AD 447) | 0.250 FG | 0.50 | 0 | 0 | 0 | 0.33 |
| Dimension (AD 442) | 0.035 FG | 0.06 & 0.06 (8-10 weeks) | 0 | 5.67 | 25 | 36.67 |
| Dimension (AD 442) | 0.035 FG | 0.09 & 0.09 (8-10 weeks) | 0 | 1.67 | 15 | 33.33 |
| Dimension (AD 442) | 0.035 FG | 0.06 | 1 | 5 | 31.67 | 56.67 |
| Dimension (AD 442) | 0.035 FG | 0.09 | 0 | 0.67 | 21.67 | 40 |
| Dimension (AD 444) | 0.072 FG | 0.125 & 0.125 (8-10 weeks) | 0 | 0 | 6.67 | 11.67 |
| Dimension (AD445&442) | 0.164 & 0.72 FG | 0.250 & 0.125 (8-10 weeks) | 0 | 0 | 4 | 4 |
| Pre M | 60 WDG | 1.5 | 0 | 0 | 8.33 | 25 |
| Pendulum | 2 G | 1.5 & 1.5 (8-10 weeks) | 0 | 0 | 2.33 | 2 |
| Pendulum | 2 G | 1.5 | 0.33 | 1.67 | 6.67 | 18.33 |
| Pendulum | 2 G | 3.0 | 0 | 0 | 0.33 | 0.67 |
| Pendulum | 0.86 FG | 1.5 & 1.5 (8-10 weeks) | 0.67 | 4.67 | 13.33 | 16.67 |
| Pendulum | 0.86 FG | 3.0 | 0 | 1.33 | 21.67 | 33.33 |
| Pendulum | 0.86 FG | 1.5 | 1 | 5.33 | 33.33 | 51.67 |
| Team | 0.87 FG | 1.5 | 2.33 | 8.33 | 40 | 65 |
| Team | 0.87 FG | 2.0 | 1 | 5 | 25 | 53.33 |
| Team | 0.87 FG | 1.5 & 1.5 (8-10 weeks) | 1 | 5 | 11.67 | 18.33 |
| Pendimethalin | 0.86 FG | 1.5 & 1.5 (8-10 weeks) | 1.33 | 6.67 | 13.33 | 16.67 |
| Dimension | 0.172 FG | 0.25 | 1.67 | 8.33 | 25 | 38.33 |
| Barricade | 0.22 FG | 0.50 | 0 | 0 | 11.67 | 28.33 |
| Scotts Weedgrass Preventer | 1.71 % G | 1.5 | 0 | 0.33 | 11.67 | 25 |
| Scotts Fert. + Pre | 0.75 % FG | 1.5 | 0 | 0.67 | 25 | 53.33 |
| Check | ------ | ------ | 18.33 | 33.33 | 78.33 | 95 |
| LSD (0.05) | | | 1.03 | 3.26 | 5.01 | 6.81 |

[a] Crabgrass cover is reported as percent crabgrass cover per plot averaged over three replications.
[b] Initial herbicide application was made on April 29, 1996. Sequential herbicide application was made on June 26, 1996.
[c] Liquid applications applied at 2 gallons per 1,000 ft.$^2$ using a $CO_2$-pressurized sprayer with a flat fan nozzle.

# Postemergence Herbicide Efficacy on Crabgrass—1996

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## Introduction

Postemergence crabgrass (*Digitaria* spp.) control for many years was primarily limited to organic arsenicals (MSMA, DSMA). The organic arsenicals 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 off under doughty (dry) soil conditions. A new isomer of Acclaim (Acclaim Extra) has been released that provides similar efficacy at significantly lower rates.

## Discussion/Summary

Various herbicides and rates were evaluated for postemergence crabgrass control on an established stand of Kentucky bluegrass. Herbicides were applied to crabgrass at the 3-5 leaf to 1-tiller stages on July 16, 1996 (Table 1). A late-postemergence application was made on August 2, with crabgrass in the 1- to 2-tiller stage. Preemergence herbicide applications (Dimension and Pendulum) were made on April 29, 1996. All liquid applications were made with a $CO_2$-pressurized sprayer at 88 gpa. Irrigation was withheld for 48 hours after postemergence applications. The postemergence area was verticut 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 three 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 throughout the season to encourage crabgrass germination and seedling development. Treatments were replicated three times in a randomized complete block design with plot size of 3 x 8 feet. Treatments were monitored for crabgrass control (percent crabgrass cover) at periodic intervals after herbicide application (Tables 1 and 2).

Acclaim in previous Ohio State University research 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 has been found to drop off dramatically under doughty (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 canopy for maximum contact of liquid spray with crabgrass foliage, and (2) spraying with sufficient water volume and proper nozzles to assure good foliar coverage. Some stunting and discoloration of Kentucky bluegrass may occur especially in the early season when bluegrass is rapidly growing. Iron and nitrogen will somewhat mask the discoloration symptom.

In 1996 Acclaim (1 EC) applied early postemergence (3-5 leaf to 1 tiller) provided only fair crabgrass control at the 0.12 ai/A rate (Table 1). Rain within 24 hours of the latter application may partially explain a somewhat lower than anticipated efficacy. Acclaim (1 EC) applied late postemergence (1-2 tillers) provided good to excellent crabgrass control at the 0.12 ai/A rate (Table 2).

The rate of Acclaim activity in our Ohio State University research is described as moderate with crabgrass kill typically occurring in two to three weeks. In 1996, crabgrass discoloration occurred within several days and crabgrass kill occurred within the typical 2- to 3-week period. There has been no noticeable difference observed in the rate of kill between the Acclaim (1 EC) and Acclaim Extra formulation in our research.

The new isomer formulation of Acclaim (Acclaim Extra) has also provided good to excellent control of crabgrass in postemergence treatments at rates ranging from 0.06 to 0.125 lbs ai/A for the past several years. In 1996, Acclaim Extra provided good to excellent efficacy of crabgrass for both early (Table 1) and late (Table 2) postemergence at the 0.06 and 0.09 lbs ai/A. The Acclaim Extra formulation outperformed the Acclaim 1 EC formulation in the early postemergence trial. It is possible that the Acclaim Extra formulation is more rain fast than the Acclaim 1 EC formulation.

Preclaim (3.09 EC) is an American Cyanamid premix formulation of Acclaim Extra and pendimethalin. In general, Preclaim has provided similar efficacy for postemergence crabgrass as Acclaim Extra alone. In 1996, Preclaim provided excellent efficacy on crabgrass in the early postemergence trial (Table 1) at the 2.06 and 3.09 lbs ai/A rates and only fair efficacy /control at the 1.545 lbs ai/A rate. In the late postemergence trial (Table 2), Preclaim provided good to excellent efficacy only at the 3.09 lbs ai/A rate. Preclaim did appear to prevent an increase in crabgrass population (% cover) later in the season when used early postemergence (Table 1). Pendimethalin in the premix most likely eliminated additional crabgrass germination.

Dimension (dithiopyr) is a relatively new herbicide released into the marketplace that exhibits both preemergence and postemergence herbicide activity on crabgrass. Dimension 1 EC applied preemergence at the 0.50 lb ai/A rate provided excellent season-long control of crabgrass (Table 1). Postemergence activity of Dimension is slow with total kill typically ranging from three (non-tillered crabgrass) to five weeks (early tillered crabgrass). Dimension does, however, stunt crabgrass in ten to fourteen days making its presence in the turfgrass canopy less noticeable. The stunted crabgrass is initially hidden within the canopy and then eventually dies over a 3- to 5-week period. During the stunting phase, crabgrass initially turns yellow and then a purple color.

Combinations of Dimension with MSMA (Daconate) in previous OSU research have been shown to enhance the rate of crabgrass kill and to improve efficacy. 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 proven effective in enhancing the efficacy and rate of Dimension activity. Dimension in combination with MSMA (Daconate) is not extremely effective beyond the three to four tiller stage. It may cause stunting of crabgrass, but kill may not occur.

Dimension EC and FG at rates ranging from 0.25 to 0.50 lb ai/A did not work effectively in controlling crabgrass postemergence in 1995. However, in 1996, the 0.5 lb ai/A rate provided excellent early postemergence control of crabgrass within a 3- to 4-week period (Table 1). Late postemergence control of crabgrass with Dimension at the 0.5 lb ai/A rate was poor. These efficacy results are consistent with efficacy results from past early and late postemergence trials at OSU. These results characterize

Dimension as a good to excellent early postemergence crabgrass herbicide and a poor late postemergence crabgrass herbicide. Dimension does widen the window for preemergence herbicide applications.

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 to be very rapid, typically killing crabgrass in seven to ten days. Drive has also provided excellent efficacy of 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 1996, Drive (BASF 514) was tested for efficacy at the 0.50 lb ai/A rate using eight different adjuvants. Some adjuvants appeared more effective than others (Tables 1 & 2). Several Drive - adjuvant combinations (i.e., BS 090, 092, 093, and 094) provided excellent postemergence crabgrass control in both the early (Table 1) and late postemergence trials with complete kill occurring within ten to twelve days following herbicide application. Although Drive is touted to have some preemergence activity, there was a noticeable increase in crabgrass in the early postemergence trial later in the season.

**Table 1. Effect of various postemergence herbicides on crabgrass (*Digitaria*) efficacy on Kentucky bluegrass (early postemergence).**

| | | | Crabgrass Cover[b] | | | | |
|---|---|---|---|---|---|---|---|
| Treatment[a] | Formulation | lb ai/Acre | 7-23-96 | 7-30-96 | 8-7-96 | 8-15-96 | 8-25-96 |
| BASF 514 BS 090 | 75 DF | 0.5 | 60 | 0 | 0 | 10 | 22 |
| BASF 514 BS 090 | 75 DF | 0.75 | 60 | 0 | 0 | 1 | 13 |
| BASF 514 BS 083 | 75 DF | 0.5 | 60 | 17 | 13 | 20 | 27 |
| BASF 514 BS 084 | 75 DF | 0.5 | 60 | 12 | 10 | 18 | 27 |
| BASF 514 BS 085 | 75 DF | 0.5 | 60 | 12 | 10 | 20 | 28 |
| BASF 514 BS 091 | 75 DF | 0.5 | 60 | 8 | 10 | 13 | 27 |
| BASF 514 BS 092 | 75 DF | 0.5 | 60 | 0 | 0 | 8 | 18 |
| BASF 514 BS 093 | 75 DF | 0.5 | 60 | 0 | 0 | 7 | 17 |
| BASF 514 BS 094 | 75 DF | 0.5 | 60 | 0 | 0 | 7 | 18 |
| Preclaim | 3.09 EC | 1.545 | 60 | 40 | 10 | 10 | 17 |
| Preclaim | 3.09 EC | 2.06 | 76 | 40 | 3 | 3 | 7 |
| Preclaim | 3.09 EC | 3.09 | 67 | 23 | 1 | 1 | 2 |
| Dimension | 1 EC | 0.5 | 63 | 60 | 10 | 0 | 0 |
| Dimension (Pre)[c] | 1 EC | 0.5 | 0 | 0 | 0 | 0 | 0 |
| Acclaim Extra | 0.57 EW | 0.09 | 60 | 16 | 4 | 8 | 13 |
| Acclaim Extra | 0.57 EW | 0.06 | 60 | 30 | 7 | 15 | 20 |
| Acclaim | 1 EC | 0.12 | 60 | 33 | 25 | 30 | 33 |
| Pendulum (Pre)[c] | 3.3 EC | 1.5 | 0 | 0 | 0 | 0 | 0 |
| Daconate 6 | 6 F | 2 | 63 | 33 | 20 | 30 | 33 |
| Untreated | ------ | --.--- | 63 | 68 | 80 | 87 | 87 |
| LSD (0.05) | | | 5.56 | 5.36 | 5.00 | 6.69 | 7.89 |

[a] Herbicides were applied on July 16, 1996, to crabgrass in the early postemergence stage (3- to 5-leaf to 1-tiller).

[b] Crabgrass ratings are based on percent crabgrass cover.

[c] Dimension and Pendulum were applied in post crabgrass area as preemergence treatments at 0.5 and 1.5 lb ai/Acre, respectively.

**Table 2. Effect of various postemergence herbicides applied late postemergent on crabgrass (*Digitaria*) in Kentucky Bluegrass.**

| | | | Crabgrass Cover[b] | | | |
|---|---|---|---|---|---|---|
| Treatment[a] | Formulation | lb ai/Acre | 8-12-96 | 8-20-96 | 8-30-96 | 9-10-96 |
| BASF 514 BS 090 | 75 DF | 0.5 | 2 | 3 | 6 | 7 |
| BASF 514 BS 090 | 75 DF | 0.75 | 0 | 0 | 0 | 0 |
| BASF 514 BS 083 | 75 DF | 0.5 | 8 | 10 | 15 | 17 |
| BASF 514 BS 084 | 75 DF | 0.5 | 10 | 10 | 12 | 13 |
| BASF 514 BS 085 | 75 DF | 0.5 | 10 | 10 | 8 | 10 |
| BASF 514 BS 091 | 75 DF | 0.5 | 0 | 2 | 2 | 7 |
| BASF 514 BS 092 | 75 DF | 0.5 | 0 | 0 | 0 | 0 |
| BASF 514 BS 093 | 75 DF | 0.5 | 0 | 0 | 0 | 0 |
| BASF 514 BS 094 | 75 DF | 0.5 | 2 | 2 | 4 | 5 |
| Preclaim | 3.09 EC | 1.545 | 60 | 30 | 12 | 15 |
| Preclaim | 3.09 EC | 2.06 | 60 | 20 | 10 | 10 |
| Preclaim | 3.09 EC | 3.09 | 60 | 20 | 7 | 5 |
| Dimension | 1 EC | 0.5 | 65 | 40 | 38 | 38 |
| Acclaim Extra | 0.57 EW | 0.09 | 53 | 13 | 2 | 5 |
| Acclaim Extra | 0.57 EW | 0.06 | 60 | 23 | 4 | 8 |
| Acclaim | 1 EC | 0.12 | 53 | 13 | 3 | 5 |
| Daconate 6 | 6 F | 2.0 | 75 | 73 | 75 | 80 |
| Untreated | ------ | -.-- | 75 | 78 | 88 | 93 |
| LSD (0.05) | | | 4.88 | 6.87 | 5.10 | 7.01 |

[a] Herbicides were applied on August 2, 1996, to late postemergent crabgrass (1- to 3-tiller stage).
[b] Crabgrass ratings are based on percent crabgrass cover.

# General Turfgrass Broadleaf Weed Control Evaluation

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## Discussion/Summary

The 1996 General Broadleaf Weed Control Evaluation was initiated on June 25, 1996, on a turfgrass area with a heavy weed population located on the grounds surrounding the maintenance facilities at The Ohio State University. The broadleaf weed population consisted primarily of dandelion (*Taraxacum officinale*), buckhorn plantain (*Plantago lanceolata*), white clover (*Trifolium repens*), common plantain (*Plantago rugelii*) and black medic (*Medicago lupulina*). 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 critically evaluate broadleaf weed control formulations. The weather summaries for the six-week period subsequent to the applications featured near normal temperatures and below normal precipitation at the test location.

Data were collected 2, 5 and 7 weeks after treatment (WAT). The formulations tested in this year's evaluation included six granular treatments provided by Riverdale Chemical Company and 28 spray treatments provided by Riverdale Chemical, DowElanco and FMC. 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 seven years in which these evaluations have been performed, herbicidal response attributable to the active ingredients were felt to have reached a maximum 6 to 7 WAT. Therefore, the 7 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 2 WAT in this year's trial showed a slightly faster initial response to the herbicide treatments compared to last year's 2 WAT data. The granular treatments were all applied to wet foliage. With the exception of the DTDA20, all Riverdale Chemical experimental granular treatments provided statistically similar, or better, control of broadleaf weeds than the Scotts Turf Builder+2 standard. This generalization applied across all five broadleaf weeds rated in this study.

A total of 28 spray treatments were included in this year's evaluation. Many of the Riverdale Chemical entries provided outstanding efficacy across all five broadleaf weeds in this evaluation. The best performing Riverdale Chemical treatments included Tri-Power, Tri-Power Plus, Triplet, Triplet Plus, MTDA, MTDE, MCDA, DTDA and DCDA. The RC252400 and RC715462 entries provided statistically less control and the RC1242520Y entry provided the least efficacious responses of the Riverdale Chemical entries.

DowElanco's Confront, Turflon Ester and the Turflon Ester + MCPP combination all provided excellent results on all the broadleaf weeds except Common Plantain. On this weed, the Turflon Ester + MCPP combination provided the best control of the DowElanco entries. This entry provided 65% control at 7 WAT.

The FMC entries (F-8426, MCPP and Sulfentrazone) generally failed to provide a level of broadleaf weed control desired by most turfgrass managers. The exception was on Black Medic where the F-8426 experimental, in combination with MCPP, provided good to excellent control. Of all the FMC treatments, the F-8426 + MCPP combinations generally provided the best herbicidal responses. Based on the data across all five broadleaf weeds (not accounting for differences in active ingredient rates), MCPP was the most efficacious of the FMC entries followed by F-8426, with Sulfentrazone providing the least herbicidal response.

For an applied assessment of efficacy of the individual treatments, consideration should be given to comparisons to industry standards. Several of these standards are included in this trial. 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 Classic (3.5 pt/A rate) was included in this evaluation. Also, Riverdale Chemical's Triplet possesses the same three-component combination. For turfgrass managers who desire a non-phenoxy alternative broadleaf weed control product, DowElanco's Confront is a viable option across many broadleaf weeds common in Ohio's turfgrass areas.

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

APPLICATION INFORMATION
LOCATION:Maintenance Facility Grounds - Ohio State University
Date: June 25, 1996 Time: 10:00 A. M. Temperature: 70 F
Soil Moisture: Field Capacity Wind Speed: 10 mph from N
Rain/Irr. After App.21 Days /0.40in
Turfgrass: Species KBG Blend Cultivar Common Types
Height 2.5 " Density < 50%
Condition: Fair Thatch: None
Irrigation availability: None Weed Population: 50 - 80 %
Testing on Site Previous Year: None
APPLICATION EQUIPMENT
Liquid Spray: Volume 2 gal/1000 $ft^2$ Pressure 35 psi
Nozzle Teejet 8002 Technique Single Spray Head
Granular Spreader/Setting N/A - Shaker Can
Rate/M Per Protocols

EXPERIMENTAL DESIGN: Randomized Complete Block Design Plot Size: 4.0 ' X 8.0 '; No. Of Reps.: 3
Aisle Between: Treatments 1.0 ' Replications 2.0 '
COMMENTS/CORRECTIONS: The weather conditions for June 25, 1996: 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 spray treatments were applied between 10:00 and 11:30 A.M. The granular treatments were applied between 7:00 and 9:00 P.M.

**Table 1. Broadleaf weed control on dandelion and buckhorn plantain.**

| | | | % Dandelion Control | | | % Buckhorn Plantain Control | | |
|---|---|---|---|---|---|---|---|---|
| Cooperator | Product | Rate | 7/09 | 7/30 | 8/13 | 7/09 | 7/30 | 8/13 |
| Riverdale | MTDA20 | 8.00 lb./M | 53 | 90 | 95 | 35 | 50 | 50 |
| Riverdale | MCDA20 | 8.00 lb./M | 63 | 83 | 95 | 50 | 75 | 85 |
| Riverdale | DCDA20 | 8.00 lb./M | 58 | 85 | 90 | 50 | 60 | 81 |
| Riverdale | DCDA30 | 8.00 lb./M | 57 | 90 | 96 | 50 | 82 | 90 |
| Riverdale | DTDA20 | 8.0 lb./M | 37 | 35 | 40 | 40 | 30 | 35 |
| Riverdale | TB+2 | 2.94 lb./M | 50 | 77 | 85 | 50 | 60 | 75 |
| Riverdale | Tri-Power | 3.00 pt./A | 78 | 95 | 98 | 72 | 87 | 92 |
| Riverdale | Tri-Power+ | 3.00 pt./A | 82 | 95 | 100 | 70 | 90 | 95 |
| Riverdale | Triplet | 3.00 pt./A | 80 | 93 | 100 | 73 | 85 | 95 |
| Riverdale | Triplet+ | 3.00 pt./A | 85 | 95 | 100 | 70 | 90 | 96 |
| Riverdale | MTDA | 3.00 pt./A | 83 | 93 | 96 | 68 | 82 | 93 |
| Riverdale | MTDE | 3.00 pt./A | 72 | 88 | 95 | 67 | 74 | 80 |
| Riverdale | MCDA | 3.00 pt./A | 82 | 95 | 100 | 80 | 90 | 90 |
| Riverdale | DTDA | 3.00 pt./A | 83 | 95 | 98 | 80 | 85 | 92 |
| Riverdale | DCDA | 3.00 pt./A | 87 | 95 | 100 | 74 | 87 | 96 |
| Riverdale | 252,400 | 3.60 pt./A | 92 | 75 | 70 | 78 | 70 | 65 |
| Riverdale | 1242520Y | 5.00 pt./A | 42 | 30 | 30 | 35 | 30 | 25 |
| Riverdale | 715416Z | 5.00 pt./A | 75 | 75 | 73 | 40 | 35 | 35 |
| DowElanco | Confront | 2.00 pt./A | 82 | 88 | 92 | 68 | 80 | 81 |
| DowElanco | Turfln Est | 2.00 pt./A | 74 | 88 | 90 | 64 | 73 | 80 |
| DowElanco | Turfln Est + | 1.00 pt./A | | | | | | |
| | MCPP | 2.50 pt./A | 85 | 93 | 98 | 80 | 92 | 95 |
| FMC | F-8426 | 0.03 lb./A | 58 | 15 | 20 | 40 | 20 | 15 |
| FMC | F-8426 | 0.06 lb./A | 70 | 20 | 20 | 45 | 20 | 15 |
| FMC | F-8426 | 0.13 lb./A | 73 | 23 | 20 | 45 | 15 | 12 |
| FMC | MCPP | 0.75 lb./A | 63 | 50 | 40 | 50 | 40 | 35 |
| FMC | MCPP | 1.50 lb./A | 72 | 60 | 55 | 52 | 48 | 50 |
| FMC | F-8426 + | 0.03 lb./A | | | | | | |
| | MCPP | 0.75 lb./A | 77 | 63 | 60 | 60 | 57 | 49 |
| FMC | F-8426 + | 0.03 lb./A | | | | | | |
| | MCPP | 1.50 lb./A | 82 | 75 | 70 | 62 | 55 | 52 |
| FMC | F-8426 + | 0.06 lb./A | | | | | | |
| | MCPP | 0.75 lb./A | 82 | 65 | 60 | 65 | 60 | 53 |
| FMC | F-8426 + | 0.06 lb./A | | | | | | |
| | MCPP | 1.50 lb./A | 79 | 65 | 65 | 70 | 62 | 56 |
| FMC | F-8426 + | 0.13 lb./A | | | | | | |
| | MCPP | 0.75 lb./A | 81 | 70 | 65 | 75 | 50 | 51 |
| FMC | F-8426 + | 0.13 lb./A | | | | | | |
| | MCPP | 1.50 lb./A | 80 | 75 | 75 | 73 | 60 | 54 |
| FMC | Sulfent. | 0.38 lb./A | 57 | 10 | 0 | 60 | 0 | 0 |
| Standard | Trimec | | | | | | | |
| | Classic | 3.50 pt./A | 83 | 97 | 100 | 73 | 85 | 92 |
| Check | Untreated | -.-- | 0 | 0 | 0 | 0 | 0 | 0 |
| LSD (0.05) | | | 5.17 | 5.93 | 4.12 | 8.31 | 6.24 | 6.82 |

**Table 2. Broadleaf weed control on white clover and common plantain.**

| Cooperator | Product | Rate | % White Clover Control 7/09 | 7/30 | 8/13 | % Common Plantain Control 7/09 | 7/30 | 8/13 |
|---|---|---|---|---|---|---|---|---|
| Riverdale | MTDA20 | 8.00 lb./M | 63 | 95 | 96 | 33 | 40 | 40 |
| Riverdale | MCDA20 | 8.00 lb./M | 68 | 95 | 98 | 40 | 35 | 40 |
| Riverdale | DCDA20 | 8.00 lb./M | 67 | 93 | 100 | 35 | 40 | 70 |
| Riverdale | DCDA30 | 8.00 lb./M | 72 | 95 | 100 | 43 | 50 | 85 |
| Riverdale | DTDA20 | 8.00 lb./M | 70 | 72 | 80 | 37 | 10 | 15 |
| Riverdale | TB+2 | 2.94 lb./M | 73 | 88 | 89 | 40 | 35 | 45 |
| Riverdale | Tri-Power | 3.00 pt./A | 85 | 97 | 100 | 60 | 70 | 75 |
| Riverdale | Tri-Power+ | 3.00 pt./A | 85 | 100 | 100 | 68 | 78 | 85 |
| Riverdale | Triplet | 3.00 pt./A | 85 | 95 | 95 | 65 | 75 | 85 |
| Riverdale | Triplet+ | 3.00 pt./A | 80 | 95 | 100 | 62 | 73 | 85 |
| Riverdale | MTDA | 3.00 pt./A | 83 | 95 | 98 | 55 | 73 | 80 |
| Riverdale | MTDE | 3.00 pt./A | 77 | 93 | 95 | 53 | 60 | 70 |
| Riverdale | MCDA | 3.00 pt./A | 85 | 99 | 100 | 62 | 70 | 85 |
| Riverdale | DTDA | 3.00 pt./A | 83 | 95 | 100 | 65 | 68 | 85 |
| Riverdale | DCDA | 3.00 pt./A | 88 | 100 | 100 | 65 | 78 | 87 |
| Riverdale | 252,400 | 3.60 pt./A | 95 | 95 | 95 | 83 | 80 | 70 |
| Riverdale | 1242520Y | 5.00 pt./A | 50 | 85 | 80 | 28 | 10 | 0 |
| Riverdale | 715416Z | 5.00 pt./A | 45 | 78 | 75 | 45 | 22 | 35 |
| DowElanco | Confront | 2.00 pt./A | 88 | 100 | 100 | 40 | 42 | 47 |
| DowElanco | Turfln Est | 2.00 pt./A | 82 | 88 | 93 | 42 | 35 | 30 |
| DowElanco | Turfln Est + | 1.00 pt./A | | | | | | |
| | MCPP | 2.50 pt./A | 87 | 100 | 100 | 72 | 60 | 65 |
| FMC | F-8426 | 0.03 lb./A | 52 | 20 | 15 | 68 | 0 | 0 |
| FMC | F-8426 | 0.06 lb./A | 65 | 30 | 25 | 65 | 0 | 0 |
| FMC | F-8426 | 0.13 lb./A | 67 | 40 | 35 | 73 | 0 | 0 |
| FMC | MCPP | 0.75 lb./A | 68 | 85 | 80 | 33 | 25 | 0 |
| FMC | MCPP | 1.50 lb./A | 73 | 90 | 80 | 50 | 20 | 0 |
| FMC | F-8426 + | 0.03 lb./A | | | | | | |
| | MCPP | 0.75 lb./A | 77 | 80 | 85 | 67 | 15 | 10 |
| FMC | F-8426 + | 0.03 lb./A | | | | | | |
| | MCPP | 1.50 lb./A | 80 | 93 | 92 | 62 | 40 | 28 |
| FMC | F-8426 + | 0.06 lb./A | | | | | | |
| | MCPP | 0.75 lb./A | 80 | 88 | 85 | 63 | 30 | 15 |
| FMC | F-8426 + | 0.06 lb./A | | | | | | |
| | MCPP | 1.50 lb./A | 82 | 95 | 95 | 63 | 25 | 30 |
| FMC | F-8426 + | 0.13 lb./A | | | | | | |
| | MCPP | 0.75 lb./A | 78 | 80 | 90 | 68 | 30 | 20 |
| FMC | F-8426 + | 0.13 lb./A | | | | | | |
| | MCPP | 1.50 lb./A | 80 | 90 | 98 | 70 | 30 | 25 |
| FMC | Sulfent. | 0.38 lb./A | 47 | 15 | 15 | 55 | 0 | 0 |
| Standard | Trimec | | | | | | | |
| | Classic | 3.50 pt./A | 83 | 95 | 100 | 70 | 73 | 75 |
| Check | Untreated | -.-- | 0 | 0 | 0 | 0 | 0 | 0 |
| LSD (0.05) | | | 4.32 | 3.72 | 2.68 | 6.37 | 6.57 | 4.94 |

**Table 3. Broadleaf weed control on black medic.**

| Cooperator | Product | Rate | % Black Medic Control 7/09 | 7/30 | 8/13 |
|---|---|---|---|---|---|
| Riverdale | MTDA20 | 8.00 lb./M | 75 | 95 | 100 |
| Riverdale | MCDA20 | 8.00 lb./M | 83 | 93 | 100 |
| Riverdale | DCDA20 | 8.00 lb./M | 85 | 93 | 100 |
| Riverdale | DCDA30 | 8.00 lb./M | 83 | 100 | 100 |
| Riverdale | DTDA20 | 8.00 lb./M | 50 | 50 | 60 |
| Riverdale | TB+2 | 2.94 lb./M | 80 | 95 | 97 |
| Riverdale | Tri-Power | 3.00 pt./A | 87 | 100 | 100 |
| Riverdale | Tri-Power+ | 3.00 pt./A | 90 | 100 | 100 |
| Riverdale | Triplet | 3.00 pt./A | 90 | 100 | 100 |
| Riverdale | Triplet+ | 3.00 pt./A | 90 | 100 | 100 |
| Riverdale | MTDA | 3.00 pt./A | 88 | 98 | 100 |
| Riverdale | MTDE | 3.00 pt./A | 87 | 96 | 100 |
| Riverdale | MCDA | 3.00 pt./A | 88 | 100 | 100 |
| Riverdale | DTDA | 3.00 pt./A | 88 | 100 | 100 |
| Riverdale | DCDA | 3.00 pt./A | 90 | 100 | 100 |
| Riverdale | 252,400 | 3.60 pt./A | 98 | 98 | 100 |
| Riverdale | 1242520Y | 5.00 pt./A | 78 | 85 | 80 |
| Riverdale | 715416Z | 5.00 pt./A | 80 | 80 | 90 |
| DowElanco | Confront | 2.00 pt./A | 93 | 100 | 100 |
| DowElanco | Turfln Est | 2.00 pt./A | 90 | 93 | 98 |
| DowElanco | Turfln Est + | 1.00 pt./A | | | |
| | MCPP | 2.50 pt./A | 93 | 100 | 100 |
| FMC | F-8426 | 0.03 lb./A | 40 | 38 | 35 |
| FMC | F-8426 | 0.06 lb./A | 62 | 40 | 35 |
| FMC | F-8426 | 0.13 lb./A | 70 | 42 | 45 |
| FMC | MCPP | 0.75 lb./A | 82 | 30 | 40 |
| FMC | MCPP | 1.50 lb./A | 80 | 72 | 65 |
| FMC | F-8426 + | 0.03 lb./A | | | |
| | MCPP | 0.75 lb./A | 85 | 85 | 90 |
| FMC | F-8426 + | 0.03 lb./A | | | |
| | MCPP | 1.50 lb./A | 90 | 95 | 95 |
| FMC | F-8426 + | 0.06 lb./A | | | |
| | MCPP | 0.75 lb./A | 87 | 85 | 90 |
| FMC | F-8426 + | 0.06 lb./A | | | |
| | MCPP | 1.50 lb./A | 88 | 90 | 95 |
| FMC | F-8426 + | 0.13 lb./A | | | |
| | MCPP | 0.75 lb./A | 90 | 92 | 90 |
| FMC | F-8426 + | 0.13 lb./A | | | |
| | MCPP | 1.50 lb./A | 90 | 95 | 95 |
| FMC | Sulfent. | 0.38 lb./A | 40 | 10 | 10 |
| Standard | Trimec Classic | 3.50 pt./A | 88 | 100 | 100 |
| Check | Untreated | -.-- | 0 | 0 | 0 |
| LSD (0.05) | | | 4.71 | 3.12 | 2.53 |

# Nonselective Herbicide Evaluation

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## Discussion/Summary

Nonselective herbicides are products used to control or suppress the growth and development of a broad spectrum of herbaceous plants. In turfgrass, these products are intended for use in areas where the manager desires the elimination of all herbaceous vegetation. The most important uses of these products in turfgrass management include, but are not limited to, the elimination of existing vegetation prior to renovation and vegetation control along fence rows, utility poles, sand traps, landscape plantings, etc. An additional need for nonselective herbicides exists where selective control alternatives are not available.

In recent years, a number of chemical companies featuring products for turfgrass and ornamentals have introduced new or reformulated nonselective herbicides with turfgrass-use labels. The product introductions include Finale™, Roundup Pro™ and Scythe™. These herbicides along with Zeneca's Reward™ are the primary nonselective herbicides currently being used in, and around, turfgrass areas. The purpose of this evaluation was to quantify the efficacy of nonselective herbicides on Kentucky bluegrass.

The study was initiated on June 13, 1996. Four commercial nonselective herbicide products were evaluated in this study and included the products Finale, Reward, Scythe and Roundup Pro. Treatments were applied using a 0.5 foot wide by 8.0 foot long plywood template. Kentucky bluegrass discoloration data were recorded 6 hours after treatment (HAT) and 1, 2, 3, 4, 5, 6, 7, 10, 14, 18, 21, 25, 28, 35, 38, 46, 49, 56, 63, 70, 77 and 84 days after treatment (DAT). Statistical analyses were performed on these data and are provided.

Results of this evaluation show the performance of the various herbicides is based on the mode-of-action of the active ingredients. Data were collected on turfgrass discoloration following herbicide treatments (Table 1). Herbicides with contact activity (Reward and Scythe) produced significant levels of discoloration on the Kentucky bluegrass within 6 HAT. After two to three mowings, much of the discolored blade tissue was removed and at 4-5 DAT significant greening was observed to be occurring in the treated areas.

Herbicides possessing systemic/translocative capabilities (Finale and Roundup Pro) required 6-10 DAT before 90% or greater levels of turfgrass discoloration were exhibited. These systemic herbicides maintained 90% or greater levels of discoloration for 35 (Finale) to 75 DAT (Roundup Pro).

Of special interest were the treatments containing combinations of a contact herbicide with the systemic herbicide Roundup Pro. Traditionally, the mixing of contacts and systemic herbicides has been discouraged due to the contact component reducing the activity of the systemic component. In both the Scythe + Roundup Pro and Reward + Roundup Pro treatments a high degree of discoloration (90% or greater) was achieved 1-2 DAT. Yet this same high degree of discoloration was maintained for 28 days in both treatments. The results of this evaluation show that mixing a contact with a systemic nonselective herbicide, delays the initial discoloration by one to two days, and these combinations will not produce high levels of discoloration as long as the systemic Roundup Pro is applied alone.

Data were collected to assess the movement of the nonselective herbicides into turfgrass along the treated areas (Table 2). At 28 DAT the width of the treated strip of turfgrass was measured at the 1, 2, 3, 4, 5, 6 and 7 foot marks along the 8-foot long plot. In general, no herbicide spread was observed following the Scythe or Reward treatments, and limited spread was observed from the Finale application. Moderate levels of herbicide spread were recorded in both the Scythe + Roundup Pro and Reward + Roundup Pro treatments. The greatest herbicide spread into turfgrass outside of the treated areas was observed from the Roundup Pro treatments.

The results of this evaluation show several nonselective herbicides are commercially available for use in turfgrass. When using these products for trimming and edging purposes the speed of initial discoloration, persistence of control and the movement of the herbicides into turfgrass outside of the treated areas are all important considerations to evaluate before making a purchasing decision.

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APPLICATION INFORMATION
LOCATION: OSU Turfgrass Research Center - South End of Range 13
Date: June 13, 1996 Time: 11:30 A.M. Temperature: 72 F
Soil Moisture: Field Capacity
Wind Speed: 5-8 mph from W Rain/Irr. After App. 28 hrs./Trace
Turfgrass: Species Kent.Blue Cultivar Improved Blend
Height 2.0 in.. Density High
Condition Excellent Thatch <0.25 inches
Irrigation availability: Yes Weed Population: N/A
Testing on Site Previous Year: None

APPLICATION EQUIPMENT
Liquid: X
Spray: Volume 2.0 gal./1000ft$^{-2}$
Pressure 35 psi
Nozzle Teejet 8002 Technique Single Head Wand
EXPERIMENTAL DESIGN:
Randomized Complete Block Design
Plot Size: 0.5 ft. X 8.0 ft. ; No. Of Reps.: 3
Aisle Between: Treatments: 2.5 ft. Replications 2.0 ft.
COMMENTS/CORRECTIONS: 35mm Slides were taken of treatments at 6 HAT, 1 DAT, 2 DAT, 3 DAT, 4 DAT, 5 DAT, 6 DAT and 7 DAT.

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**Table 1. Turfgrass discoloration following herbicide applications.**

| Treatment | Rate (% Solution) | Turfgrass Discoloration (% Discoloration Rated 1-100, where 100=100% Brown) 6 HAT | 1 DAT | 2 DAT | 3 DAT | 4 DAT | 5 DAT | 6 DAT | 7 DAT |
|---|---|---|---|---|---|---|---|---|---|
| Finale | 3.00 | 0.0 | 26.7 | 40.0 | 60.0 | 75.0 | 85.0 | 90.0 | 95.0 |
| Reward | 0.40 | 40.0 | 90.0 | 91.7 | 91.7 | 81.7 | 60.0 | 48.3 | 21.7 |
| Scythe | 7.50 | 91.7 | 100.0 | 100.0 | 97.7 | 94.3 | 85.0 | 78.3 | 63.3 |
| Scythe + | 3.00 | | | | | | | | |
| Roundup Pro | 1.00 | 73.0 | 93.0 | 95.0 | 96.3 | 95.0 | 95.0 | 95.0 | 95.0 |
| Reward + | 0.40 | | | | | | | | |
| Roundup Pro | 1.00 | 35.0 | 83.3 | 90.0 | 91.7 | 90.7 | 90.0 | 90.0 | 90.0 |
| Roundup Pro | 2.00 | 0.0 | 3.3 | 6.7 | 11.7 | 15.0 | 18.3 | 21.7 | 48.3 |
| Check | -.-- | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| LSD (0.05) | | 2.63 | 6.99 | 4.19 | 5.01 | 4.02 | 4.12 | 3.54 | 2.97 |

**Table 1. Turfgrass discoloration following herbicide applications.** (continued)

| | | 10 DAT | 14 DAT | 18 DAT | 21 DAT | 25 DAT | 28 DAT | 35 DAT | 38 DAT |
|---|---|---|---|---|---|---|---|---|---|
| Finale | 3.00 | 100.0 | 100.0 | 100.0 | 98.7 | 95.7 | 93.7 | 90.0 | 88.0 |
| Reward | 0.40 | 6.7 | 6.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Scythe | 7.50 | 21.7 | 18.3 | 5.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Scythe + | 3.00 | | | | | | | | |
| Roundup Pro | 1.00 | 98.0 | 97.7 | 99.0 | 99.0 | 96.0 | 94.3 | 86.7 | 84.3 |
| Reward + | 0.40 | | | | | | | | |
| Roundup Pro | 1.00 | 95.0 | 92.7 | 94.0 | 95.7 | 93.7 | 91.7 | 76.0 | 72.7 |
| Roundup Pro | 2.00 | 100.0 | 100.0 | 100.0 | 100.0 | 99.7 | 99.7 | 99.0 | 99.0 |
| Check | -.-- | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| LSD (0.05) | | 2.51 | 2.93 | 1.71 | 2.22 | 2.57 | 2.94 | 4.86 | 6.27 |

**Table 1. Turfgrass discoloration following herbicide applications.** (continued)

| | | 46 DAT | 49 DAT | 56 DAT | 63 DAT | 70 DAT | 77 DAT | 84 DAT |
|---|---|---|---|---|---|---|---|---|
| Finale | 3.00 | 81.7 | 76.7 | 73.3 | 65.0 | 60.0 | 48.3 | 33.3 |
| Reward | 0.40 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Scythe | 7.50 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Scythe + | 3.00 | | | | | | | |
| Roundup Pro | 1.00 | 78.3 | 71.7 | 63.3 | 56.7 | 50.0 | 41.7 | 28.3 |
| Reward + | 0.40 | | | | | | | |
| Roundup Pro | 1.00 | 63.3 | 58.3 | 45.0 | 35.0 | 28.3 | 21.7 | 13.3 |
| Roundup Pro | 2.00 | 96.7 | 96.0 | 95.7 | 91.7 | 91.7 | 90.0 | 78.3 |
| Check | -.-- | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| LSD (0.05) | | 8.60 | 10.36 | 11.71 | 11.35 | 13.63 | 14.89 | 13.02 |

DAT - Days After Treatment

**Table 2. Width of discolored turfgrass at 28 DAT.**

| Treatment | Rate (% Solution) | Width of Discolored Turfgrass (cm) 1.0 ft. | 2.0 ft. | 3.0 ft. | 4.0 ft. | 5.0 ft. | 6.0 ft. | 7.0 ft. |
|---|---|---|---|---|---|---|---|---|
| Finale | 3.00 | 16.0 | 15.7 | 15.7 | 15.7 | 15.7 | 15.3 | 16.3 |
| Reward | 0.40 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Scythe | 7.50 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Scythe + | 3.00 | | | | | | | |
| Roundup Pro | 1.00 | 16.7 | 17.3 | 16.7 | 17.7 | 17.7 | 17.3 | 16.3 |
| Reward + | 0.40 | | | | | | | |
| Roundup Pro | 1.00 | 15.3 | 15.3 | 16.0 | 16.7 | 17.0 | 15.7 | 16.3 |
| Roundup Pro | 2.00 | 18.3 | 19.0 | 19.0 | 19.0 | 19.3 | 19.3 | 19.7 |
| Check | -.-- | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| LSD (0.05) | | 1.15 | 1.73 | 0.57 | 1.10 | 1.12 | 1.35 | 1.35 |

DAT - Days After Treatment

# Postemergent Yellow Nutsedge Evaluation

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## 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, halosulfuron, for nutsedge control in turfgrass. This herbicide, named Manage™, was tested extensively at The Ohio State University in both 1994 and 1995 trials. In 1996 a protocol was developed to evaluate FMC's experimental herbicide, sulfentrazone, on yellow nutsedge in turfgrass. The purpose of this evaluation was to evaluate the activity of early postemergent liquid and granular applications of sulfentrazone on yellow nutsedge in turfgrass and compare its performance to, and in combination with, Monsanto's halosulfuron.

The study was initiated on July 29, 1996. Sulfentrazone was applied as single-application liquid (2 rates) treatments, single-application granular (2 rates) treatments, 30-day sequential liquid (3 rates) treatments, 30-day sequential granular (3 rates) treatments and in combination (3 rates) with halosulfuron. Two rates of single applications of Halosulfuron were included as the commercial standards. Yellow nutsedge control data were collected 7, 14, 28, 42, 56 and 70 days after treatment (DAT). Turfgrass injury data were collected 3, 8 and 14 DAT.

Results of this evaluation show applications of sulfentrazone to have the potential to be highly efficacious on yellow nutsedge (Table 1). Liquid-applied treatments provided much greater levels of control than comparable rates of the granular treatments. Of the 5 granular treatments, only one (0.25 lb. sequential) provided a level of control of 90% or greater. The remaining 4 granular treatments only provided 60% or less level of control. All 5 liquid-applied treatments provided 90%, or greater, yellow nutsedge control. In addition to the liquid-applied treatments providing high levels of control (as measured 0 - 10 weeks after application), these treatments also resulted in extensive initial discoloration of the yellow nutsedge (Table 1). At 7 DAT sulfentrazone treatments of 0.1875 lb. or higher provided 80% or higher levels of yellow nutsedge discoloration.

Previous studies with halosulfuron have historically shown this herbicide to provide low levels of initial discoloration on yellow nutsedge. In this trial, the addition of sulfentrazone to the halosulfuron resulted in excellent initial, and long term, discoloration and control of the yellow nutsedge. Injury/discoloration data on the desirable turfgrass were collected at 3, 8 and 14 DAT (Table 2). These data indicate sulfentrazone does have the potential to produce significant injury on the desirable turfgrass. All liquid-applied sulfentrazone treatments resulted in low to moderate levels of turfgrass discoloration within 14 DAT. None of the sulfentrazone granular, halosulfuron or sulfentrazone + halosulfuron treatments resulted in any observable discoloration on the desirable turfgrass within the first 14 DAT.

Additional research is recommended to further evaluate the sulfentrazone + halosulfuron mixtures. Particular detail should be made to confirm the response of both the excellent initial discoloration and long-term control of the yellow nutsedge without causing objectionable discoloration on the desirable turfgrass. The July 1996 evaluation summarized in this report indicates the mixture of these two active ingredients complements each other in providing outstanding yellow nutsedge control without jeopardizing the aesthetic attributes of the desirable turfgrass.

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LOCATION: O.S.U. Turfgrass Research Center - Range 14
APPLICATION INFORMATION
Date: July 29, 1996 Time: 10:00 A.M. Temperature: 74 F
Soil Moisture: Field Capacity
Wind Speed: 5-8 mph From S Rain/Irr. after App:.1.5 in./20 hr.
Turfgrass Species: Fine Fescue
Height: 2.0 in. Density: 50 - 75% Condition: Fair
Thatch: <0.50 inches
Irrigation availability: Yes
Weed Population: Yellow nutsedge density ranged from 15 - 30% Testing on Site Previous Year: None

APPLICATION EQUIPMENT
Liquid: X
Spray: Volume 4.0 gal./1000ft.$^2$ Pressure 40 psi
Nozzle Teejet 8004 Noz. Technique 2 Nozzle Boom
Granular: X Rate/M Per Protocol
EXPERIMENTAL DESIGN: Completely Randomized Design
Plot Size: 5.0 ft. X 5.0 ft.
Aisle Between: Treatments 1.0 ft.
COMMENTS/CORRECTIONS: All liquid treatments were applied with 0.5% Triton wetting agent. Sequential repeat treatments were applied on September 10, 1996.

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**Table 1. Yellow nutsedge discoloration and control following herbicide applications.**

| Treatment | Rate (lb ai/A) | Yellow Nutsedge Control (% Control Based on a 0 to 100 scale, where 0=no control and 100=complete control) 7 DAT | 14 DAT | 28 DAT | 42 DAT | 56 DAT | 70 DAT |
|---|---|---|---|---|---|---|---|
| Sulfentrazone 80 WP | 0.1875 | 80 | 80 | 80 | 88 | 90 | 95 |
| Sulfentrazone 80 WP | 0.25 | 90 | 95 | 98 | 98 | 98 | 98 |
| Sulfentrazone 80 WP& | 0.125 | | | | | | |
| Sulfentrazone 80 WP | 0.125 | 75 | 90 | 85 | 85 | 98 | 100 |
| Sulfentrazone 80 WP& | 0.1875 | | | | | | |
| Sulfentrazone 80 WP | 0.1875 | 85 | 95 | 98 | 98 | 100 | 100 |
| Sulfentrazone 80 WP& | 0.250 | | | | | | |
| Sulfentrazone 80 WP | 0.250 | 85 | 90 | 98 | 98 | 100 | 100 |
| Sulfentrazone 0.2 G | 0.1875 | 35 | 45 | 30 | 25 | 20 | 35 |
| Sulfentrazone 0.2 G | 0.25 | 35 | 35 | 20 | 20 | 20 | 50 |
| Sulfentrazone 0.2 G& | 0.125 | | | | | | |
| Sulfentrazone 0.2 G | 0.125 | 25 | 25 | 20 | 25 | 40 | 60 |
| Sulfentrazone 0.2 G& | 0.1875 | | | | | | |
| Sulfentrazone 0.2 G | 0.1875 | 35 | 35 | 20 | 20 | 35 | 60 |
| Sulfentrazone 0.2 G& | 0.250 | | | | | | |
| Sulfentrazone 0.2 G | 0.250 | 35 | 45 | 40 | 40 | 45 | 90 |
| Halosulfuron | 0.031 | 35 | 60 | 90 | 95 | 95 | 100 |
| Halosulfuron | 0.062 | 35 | 65 | 99 | 98 | 98 | 100 |
| Sulfentrazone 80 WP+ | 0.125 | | | | | | |
| Halosulfuron 75 WG | 0.031 | 75 | 85 | 99 | 95 | 98 | 98 |
| Sulfentrazone 80 WP+ | 0.125 | | | | | | |
| Halosulfuron 75 WG | 0.047 | 85 | 95 | 98 | 95 | 95 | 98 |
| Sulfentrazone 80 WP+ | 0.125 | | | | | | |
| Halosulfuron 75 WG | 0.062 | 85 | 90 | 99 | 99 | 98 | 98 |
| Check | -.--- | 0 | 0 | 0 | 0 | 0 | 0 |
| LSD (0.05) | | 6.99 | 6.19 | 5.01 | 4.02 | 4.72 | 3.54 |

DAT - Days After Treatment

**Table 2. Fine fescue discoloration following herbicide applications.**

| Treatment | Rate | Fine Fescue Injury (% Injury Rated 1-10, where 0=no injury and 10=complete turfgrass death) | | |
|---|---|---|---|---|
| | (lb. ai/A) | 3 DAT | 8 DAT | 14 DAT |
| Sulfentrazone 80 WP | 0.1875 | 1.0 | 1.0 | 0.5 |
| Sulfentrazone 80 WP | 0.252 | 2.0 | 1.0 | |
| Sulfentrazone 80 WP& | 0.125 | | | |
| Sulfentrazone 80 WP | 0.125 | 1.0 | 1.0 | 0.5 |
| Sulfentrazone 80 WP& | 0.1875 | | | |
| Sulfentrazone 80 WP | 0.1875 | 2.0 | 2.5 | 1.5 |
| Sulfentrazone 80 WP& | 0.250 | | | |
| Sulfentrazone 80 WP | 0.250 | 2.5 | 3.0 | 1.0 |
| Sulfentrazone 0.2 G | 0.1875 | 0.0 | 0.0 | 0.0 |
| Sulfentrazone 0.2 G | 0.250 | 0.0 | 0.0 | 0.0 |
| Sulfentrazone 0.2 G& | 0.125 | | | |
| Sulfentrazone 0.2 G | 0.125 | 0.0 | 0.0 | 0.0 |
| Sulfentrazone 0.2 G& | 0.1875 | | | |
| Sulfentrazone 0.2 G | 0.1875 | 0.0 | 0.0 | 0.0 |
| Sulfentrazone 0.2 G& | 0.250 | | | |
| Sulfentrazone 0.2 G | 0.250 | 0.0 | 0.0 | 0.0 |
| Halosulfuron | 0.031 | 0.0 | 0.0 | 0.0 |
| Halosulfuron | 0.062 | 0.0 | 0.0 | 0.0 |
| Sulfentrazone 80 WP+ | 0.125 | | | |
| Halosulfuron 75 WG | 0.031 | 0.0 | 0.0 | 0.0 |
| Sulfentrazone 80 WP+ | 0.125 | | | |
| Halosulfuron 75 WG | 0.047 | 0.0 | 0.0 | 0.0 |
| Sulfentrazone 80 WP+ | 0.125 | | | |
| Halosulfuron 75 WG | 0.062 | 0.0 | 0.0 | 0.0 |
| Check | -.-- | 0.0 | 0.0 | 0.0 |
| LSD (0.05) | | 0.21 | 0.36 | 0.17 |

DAT - Days After Treatment

# Preemergent Broadleaf Weed Control Evaluation

William Pound
Horticulture and Crop Science

## Discussion/Summary

One of the longstanding desires of managers of high quality turfgrass areas has been to identify an effective way to preemergently control broadleaf weeds. For many years now, the best approach to preventing the establishment of broadleaf weeds has been through the use of proper cultural and maintenance practices. Even though proper culture does significantly reduce the incidence of broadleaf weed establishment, some degree of weed invasion generally will occur. For this reason, more effective controls continue to be pursued. The purpose of this study was to evaluate the effectiveness of various commercial products and experimental treatments for preemergent broadleaf weed control in turfgrass.

### **Turfgrass Injury** - Table 1.

Ratings of turfgrass injury on the desirable turfgrass were conducted 3, 7 and 14 days after treatment (DAT). No turfgrass injury was detected 3 DAT. At 7 and 14 DAT a limited degree of discoloration was observed in 11 of the 28 treatments. Similarly at 14 DAT, 10 of the 28 treatments exhibited some degree of discoloration. The most significant discoloration was observed in plots treated with sulfentrazone in combination with the 1.00 lb. ai/acre rate of Barricade.

### **Broadleaf Weed Cover** - Table 2.

Once again in this single growing season assessment of the preemergent broadleaf weed control capabilities of turfgrass herbicides, a high degree of variability was present in the results. This is partially due to the random establishment of heavy prostrate spurge and yellow wood sorrel populations in July and the associated interference to the August and September ratings. In addition, the failure of the May 14 application of Trimec to remove existing broadleaf weed populations, particularly common plantain in the Pendulum treatments, also contributed to a high degree of variability.

In general, all applications of Gallery, sulfentrazone and the sulfentrazone + Barricade combinations provided statistically significant preemergent broadleaf weed control. With the exception of the 0.50 lb. and 0.50 lb./0.25 lb. ai/acre sequential treatment, all Barricade treatments provided significant preemergent control. The broadleaf weeds most commonly found encroaching back into the treated plots included, in order of presence, dandelion, common plantain, white clover and buckhorn plantain.

Results of this study reinforce the results of previous studies with Gallery which show this product to be an effective preemergent broadleaf weed control product. Barricade has been shown to exhibit effective preemergent broadleaf weed control on various winter annual broadleaf weeds. This study suggests, with proper application rates, some activity is also present on summer annuals and spring-germinating perennial broadleaf weeds. Lastly, the results of this study also show the experimental herbicide, sulfentrazone, to possess statistically significant preemergent broadleaf weed control capabilities as well.

**Table 1. Turfgrass injury following herbicide applications.**

| Treatment | Rate | Timing | Turfgrass Injury (Turfgrass Injury on a Scale of 1-10, where 10=100% Brown) | | |
|---|---|---|---|---|---|
| | | | 05/16 | 05/20 | 05/27 |
| Confront & | 2.0 pt. | 0 weeks | | | |
| Confront | 2.0 pt. | 4 weeks | 0.0 | 0.67 | 0.67 |
| Confront + Gallery & | 2.0 pt. + 0.75 lb. | 0 weeks | | | |
| Confront | 2.0 pt. | 4 weeks | 0.0 | 0.67 | 0.67 |
| Confront & | 2.0 pt. | 0 weeks | | | |
| Gallery + Confront & | 0.75 lb. + 2.0 pt. | 4 weeks | | | |
| Gallery | 0.75 lb. | Sept. | 0.0 | 0.67 | 0.67 |
| Trimec & | 3.5 pt. | 0 weeks | | | |
| Trimec | 3.5 pt. | 4 weeks | 0.0 | 0.0 | 0.0 |
| Gallery & | 0.75 lb. | 0 weeks | | | |
| Confront | 2.0 pt. | 4 weeks | 0.0 | 0.0 | 0.0 |
| Gallery & | 0.75 lb. | 0 weeks | | | |
| Trimec | 3.5 pt. | 4 weeks | 0.0 | 0.0 | 0.0 |
| Trimec | 3.5 pt. | 4 weeks | 0.0 | 0.0 | 0.0 |
| Barricade & | 0.50 lb. | 0 weeks | | | |
| Barricade | 0.25 lb. | 60 days | 0.0 | 0.33 | 0.67 |
| Barricade & | 0.65 lb. | 0 weeks | | | |
| Barricade | 0.32 lb. | 60 days | 0.0 | 0.33 | 0.33 |
| Barricade & | 0.75 lb. | 0 weeks | | | |
| Barricade | 0.38 lb. | 60 days | 0.0 | 0.33 | 0.67 |
| Barricade | 0.50 lb. | 0 weeks | 0.0 | 0.0 | 0.0 |
| Barricade | 0.65 lb. | 0 weeks | 0.0 | 0.0 | 0.0 |
| Barricade | 0.75 lb. | 0 weeks | 0.0 | 0.0 | 0.0 |
| Pendulum | 1.50 lb. | 0 weeks | 0.0 | 0.0 | 0.0 |
| Sulfentrazone | 0.125 lb. | 0 weeks | 0.0 | 0.0 | 0.0 |
| Sulfentrazone | 0.250 lb. | 0 weeks | 0.0 | 0.33 | 0.0 |
| Sulfentrazone | 0.375 lb. | 0 weeks | 0.0 | 0.0 | 0.0 |
| Barricade | 1.00 lb. | 0 weeks | 0.0 | 0.0 | 0.0 |
| Sulfentrazone + Barricade | 0.125 lb. + 0.50 lb. | 0 weeks | 0.0 | 0.0 | 0.0 |
| Sulfentrazone + Barricade | 0.125 lb. + 0.75 lb. | 0 weeks | 0.0 | 0.0 | 0.0 |
| Sulfentrazone + Barricade | 0.125 lb. + 1.00 lb. | 0 weeks | 0.0 | 0.67 | 1.0 |
| Sulfentrazone + Barricade | 0.250 lb. + 0.50 lb. | 0 weeks | 0.0 | 0.0 | 0.0 |
| Sulfentrazone + Barricade | 0.250 lb. + 0.75 lb. | 0 weeks | 0.0 | 0.33 | 0.67 |
| Sulfentrazone + Barricade | 0.250 lb. + 1.00 lb. | 0 weeks | 0.0 | 0.67 | 1.0 |
| Sulfentrazone + Barricade | 0.375 lb. + 0.50 lb. | 0 weeks | 0.0 | 0.0 | 0.0 |
| Sulfentrazone + Barricade | 0.375 lb. + 0.75 lb. | 0 weeks | 0.0 | 0.0 | 0.0 |
| Sulfentrazone + Barricade | 0.375 lb. + 1.00 lb. | 0 weeks | 0.0 | 1.0 | 1.0 |
| Check | ---- | ---- | 0.0 | 0.0 | 0.0 |
| LSD (0.05) | | | 0 | 0.653 | 0.851 |

**Table 2. Broadleaf weed cover following herbicide applications.**

| Treatment | Rate | Timing | Broadleaf Weed Cover (Percent Broadleaf Weed Cover on a Scale of 1-10, where 10=100% Cover) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 5/28 | 6/12 | 6/25 | 7/09 | 8/07 | 9/05 | 10/10 |
| Confront & | 2.0 pt. | 0 weeks | | | | | | | |
| Confront | 2.0 pt. | 4 weeks | 21.7 | 2.0 | 1.3 | 1.0 | 19.0 | 19.7 | 7.3 |
| Confront + Gallery & | 2.0 pt. + 0.75 lb. | 0 weeks | | | | | | | |
| Confront | 2.0 pt. | 4 weeks | 20.0 | 1.0 | 0.3 | 0.0 | 1.0 | 1.0 | 0.3 |
| Confront & | 2.0 pt. | 0 weeks | | | | | | | |
| Gallery + Confront & | 0.75 lb. + 2.0 pt. | 4 weeks | | | | | | | |
| Gallery | 2.0 pt. | Sept. | 20.0 | 2.3 | 0.3 | 0.3 | 1.0 | 2.3 | 0.3 |
| Trimec & | 3.5 pt. | 0 weeks | | | | | | | |
| Trimec | 3.5 pt. | 4 weeks | 25.0 | 3.3 | 2.0 | 1.7 | 1.7 | 2.7 | 1.3 |
| Gallery & | 0.75 lb. | 0 weeks | | | | | | | |
| Confront | 2.0 pt. | 4 weeks | 65.0 | 65.0 | 25.0 | 5.0 | 5.3 | 5.3 | 8.0 |
| Gallery & | 0.75 lb. | 0 weeks | | | | | | | |
| Trimec | 0.75 lb. | 4 weeks | 61.7 | 63.3 | 26.7 | 6.7 | 6.0 | 6.0 | 8.3 |
| Trimec | 3.5 pt. | 4 weeks | 65.0 | 68.3 | 28.3 | 8.3 | 10.0 | 12.0 | 19.3 |
| Barricade & | 0.50 lb. | 0 weeks | | | | | | | |
| Barricade | 0.25 lb. | 60 days | 26.7 | 8.3 | 6.3 | 6.7 | 9.3 | 11.3 | 12.3 |
| Barricade & | 0.65 lb. | 0 weeks | | | | | | | |
| Barricade | 0.32 lb. | 60 days | 23.3 | 7.7 | 6.7 | 6.3 | 7.3 | 7.3 | 7.3 |
| Barricade & | 0.75 lb. | 0 weeks | | | | | | | |
| Barricade | 0.38 lb. | 60 days | 30.0 | 5.3 | 4.3 | 3.7 | 5.7 | 7.0 | 5.0 |
| Barricade | 0.50 lb. | 0 weeks | 28.3 | 3.7 | 3.7 | 3.3 | 5.0 | 11.3 | 14.0 |
| Barricade | 0.65 lb. | 0 weeks | 26.7 | 4.0 | 2.7 | 2.7 | 4.7 | 5.0 | 5.7 |
| Barricade | 0.75 lb. | 0 weeks | 30.0 | 7.0 | 6.7 | 5.0 | 8.0 | 9.3 | 8.7 |
| Pendulum | 1.50 lb. | 0 weeks | 30.0 | 9.3 | 10.3 | 10.3 | 13.0 | 13.0 | 11.3 |
| Sulfentrazone | 0.125 lb. | 0 weeks | 23.3 | 5.0 | 5.0 | 4.3 | 8.3 | 10.4 | 5.3 |
| Sulfentrazone | 0.250 lb. | 0 weeks | 25.0 | 6.3 | 7.3 | 7.7 | 8.7 | 9.7 | 10.1 |
| Sulfentrazone | 0.375 lb. | 0 weeks | 21.7 | 2.3 | 2.0 | 2.0 | 4.7 | 6.7 | 5.3 |
| Barricade | 1.00 lb. | 0 weeks | 30.0 | 4.3 | 4.0 | 3.7 | 6.3 | 7.3 | 7.3 |
| Sulfentrazone + Barricade | 0.125 lb. + 0.50 lb. | 0 weeks | 25.0 | 3.3 | 3.3 | 3.3 | 6.0 | 9.0 | 8.7 |
| Sulfentrazone + Barricade | 0.125 lb. + 0.75 lb. | 0 weeks | 25.0 | 5.7 | 4.7 | 4.3 | 6.3 | 9.7 | 10.0 |
| Sulfentrazone + Barricade | 0.125 lb. + 1.00 lb. | 0 weeks | 25.0 | 5.3 | 5.7 | 5.7 | 9.0 | 10.3 | 9.7 |
| Sulfentrazone + Barricade | 0.250 lb. + 0.50 lb. | 0 weeks | 20.0 | 2.0 | 1.7 | 1.7 | 4.0 | 5.3 | 5.7 |
| Sulfentrazone + Barricade | 0.250 lb. + 0.75 lb. | 0 weeks | 21.7 | 3.0 | 3.0 | 3.0 | 5.3 | 7.0 | 8.7 |
| Sulfentrazone + Barricade | 0.250 lb. + 1.00 lb. | 0 weeks | 23.3 | 6.0 | 5.3 | 4.3 | 5.0 | 6.0 | 6.3 |
| Sulfentrazone + Barricade | 0.375 lb. + 0.50 lb. | 0 weeks | 20.0 | 2.0 | 1.3 | 1.0 | 2.7 | 3.7 | 3.7 |
| Sulfentrazone + Barricade | 0.375 lb. + 0.75 lb. | 0 weeks | 20.0 | 1.0 | 0.3 | 0.3 | 2.0 | 4.7 | 3.3 |
| Sulfentrazone + Barricade | 0.375 lb. + 1.00 lb. | 0 Weeks | 21.7 | 0.7 | 1.0 | 1.0 | 2.7 | 5.3 | 4.0 |
| Check | --- | --- | 66.7 | 68.3 | 68.3 | 70.0 | 71.7 | 63.3 | 60.0 |
| LSD (0.05) | | | 12.1 | 11.9 | 8.3 | 6.9 | 10.0 | 10.6 | 10.3 |

APPLICATION INFORMATION
LOCATION: OSU Maintenance Facilities
Date: May 13, 1996 Time: 4:00 P.M.
Temperature: 54 F Soil Moisture: Saturated
Wind Speed: 5-8 mph from NW
Rain/Irr. After App.: 1.00"+ /52 hr.
Turfgrass Species: Kent.Blue Cultivar: Common/Unknown
Height: 2.5" Density: Thin Condition: Fair
Thatch: None Irrigation availability: None
Weed Population: 50 - 65% Weed Coverage
Testing on Site Previous Year: None

APPLICATION EQUIPMENT
Liquid: X
Spray: Volume 2.0 gal./1000 ft$^2$ Pressure: 35 psi
Nozzle: Teejet 8002 w/ single head wand
EXPERIMENTAL DESIGN: Randomized Complete Block
Plot Size: 6.0 ft X 8.0 ft.; 3 Reps.
Aisles Between: Treatments 1.0 ft., Replications 2.0 ft.
COMMENTS/CORRECTIONS: With the exception of treatments 1, 2, 3, 5 and 6, all plots were treated with Trimec (3.5 pt./acre) on May 14, 1996. The 60 DAT Barricade sequential treatments were applied 7-10-96. September applications of Gallery were made on 9-5-96.

# *Turfgrass Insect Control*

# Control of Ant Mounds in Turfgrass—1996

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

## Methods and Materials

The experiment was located in fairway No. 10 of Crockett's Green Hills Golf Course at Clyde, Ohio. Treatments were applied May 2, to plots arranged in a randomized complete-block design replicated four times. Plots were 10 x 10 ft with 3 ft alleyways between plots and ranges. Granules were applied with a drop spreader and liquid applications with a $CO_2$ sprayer, 25 psi and XR8006VS Teejet nozzles which delivered a volume of 1 gal./1000ft$^2$. The area received no posttreatment irrigation.

Field conditions at the time of treatment were as follows:

(1) Ants—*Lasius neoniger* (Emery), ≈ 5 mounds/yd$^2$.
(2) Turf—50% Kentucky bluegrass and 50% Perennial ryegrass; height 1 in; no thatch.
(3) Soil—Moist, 48°F at 1 in. and 47°F at 3 in. deep, no soil analysis.
(4) Weather—misting to clearing, 54°F, wind gusting 0-7mph.

Efficacy data were obtained May 20, May 30, June 13, July 22, and August 26 (18, 28, 42, 81, 116 DAT) by counting the number of active mounds in two square yard areas in each plot. Analysis of variance was done on plot totals and means separated by LSD test ($P$=0.5).

## Results

At 18 DAT all treatments except three granular formulations, bifenthrin 0.5G, Merit 0.5G and Dursban 1% bait, reduced the mounds by at least one half. All liquid treatments except Merit 75WP and Dursban 6.6% RTS gave significant reductions.

All treatments at 28 DAT except Dursban 6.6% RTS and Merit 0.5G resulted in significant reduction of ant mounds. Merit 75WP, bifenthrin 0.5G, and Dursban 1% bait were showing increased reductions compared to the 18 DAT data. Merit 0.5G and Dursban 6.6% RTS still showed no efficacy.

The data at 42, 81, and 116 DAT failed to reveal any significant differences in any of the treatments. The counts from both Merit 75WP and Merit 0.5G at 81 and 116 DAT did suggest some effectiveness.

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

**Table 1. Season-long efficacy of insecticides for controlling the ant mounds of *Lassius neoniger* (Emery) on a golf course fairway Crockett's Green Hills Golf Course, Clyde, Ohio, 1996.**

| Treatment[a] | Rate lb.ai/A | $\bar{x}$ Active mounds/$yd^2$ and (% reduction)[c] 18 DAT | 28 DAT | 42 DAT | 81 DAT | 116 DAT |
|---|---|---|---|---|---|---|
| Check | -.-- | 2.6 ab | 4.2 a | 6.5 a | 2.6 a | 4.8 a |
| Talstar 0.66F | 0.10 | 0.5 cd (81) | 0.9 cd (79) | 3.5 a (46) | 1.1 a (57) | 3.0 a (37) |
| Talstar 0.66F | 0.20 | 0.0 d (100) | 0.3 d (94) | 2.4 a (63) | 2.3 a (14) | 4.4 a ( 8) |
| Talstar 0.66F[b] | 0.20(2X) | 0.6 cd (76) | 0.5 d (88) | 1.6 a (75) | 4.0 a ( 0) | 4.3 a (11) |
| binfenthrin 3ME | 0.05 | 0.8 cd (71) | 1.5 bcd (64) | 3.5 a (46) | 1.3 a (52) | 2.5 a (47) |
| bifenthrin 0.05G | 0.05 | 3.0 ab ( 0) | 1.6 bcd (61) | 4.9 a (25) | 1.8 a (33) | 2.6 a (45) |
| Talstar 0.2G | 0.20 | 1.4 bcd (48) | 1.6 bcd (61) | 3.0 a (54) | 2.3 a (14) | 2.9 a (39) |
| Talstar 0.2G | 0.40 | 0.3 cd (90) | 0.4 d (91) | 2.9 a (56) | 2.3 a (14) | 4.0 a (16) |
| Talstar 0.2G[b] | 0.20(2X) | 1.3 bcd (52) | 0.5 d (88) | 4.9 a (25) | 1.8 a (33) | 2.6 a (45) |
| diazinon 25% RTS | 4.00 | 0.4 cd (86) | 0.9 cd (79) | 6.4 a ( 2) | 2.1 a (19) | 3.3 a (32) |
| Dursban 6.6% RTS | 1.00 | 1.8 abcd (33) | 2.1 abcd (48) | 5.6 a (13) | 2.6 a ( 0) | 3.5 a (26) |
| RH 0345 101 2SC | 2.00 | 3.5 a ( 0) | 2.6 abc (36) | 6.6 a ( 0) | 1.5 a (43) | 2.4 a (50) |
| Merit 75WP | 0.30 | 1.8 abcd (33) | 1.5 bcd (64) | 2.1 a (67) | 0.5 a (81) | 1.1 a (76) |
| Merit 0.5G | 0.30 | 2.8 ab ( 0) | 3.5 ab (15) | 5.0 a (23) | 0.3 a (90) | 1.3 a (74) |
| Dursban 1% bait | 1.50 | 2.1 ab (19) | 1.5 bcd (64) | 2.6 a (60) | 1.0 a (62) | 3.5 a (26) |

[a] Treatments applied May 2, 1996, to plots 10 x 10 ft replicated 4x. No posttreatment irrigation.
[b] Treatment re-applied May 20, 1996.
[c] Data taken May 20, May 30, June 13, July 22, and August 26 based on 2, 1 $yd^2$ observations from each plot. ANOVA and LSD on plot totals. Means followed by the same letter are not significantly different.

# Control of Hairy Chinch Bugs in Turfgrass—1996

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

## Methods and Materials

Treatments were applied July 5, to plots 5 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 8010VS nozzles, and 35 psi. delivering 3 gal./1000ft$^2$. The granular formulations were applied using either a 2 foot Gandy drop spreader or a shaker Jar. Each plot treated with granules received 8 gallons (=¼ inch) posttreatment irrigation while the liquid treatments received none.

Field conditions during the treatments were as follows:

1) Chinch bugs—2% 1$^{st}$, 28% 2$^{nd}$, 26% 3$^{rd}$, 31% 4$^{th}$, and 12% 5$^{th}$ instar nymphs.
2) Turf—3 inch height, dry, 0.0-0.75 inch thatch depth.
3) Soil—moist; 79°F at 1 inch and 76°F at 3 inch deep.
4) Weather—mostly cloudy, 75°F; 0-5 mph wind.

Efficacy data were obtained July 15 (10 DAT) by counting the number of live chinch bugs floating to the surface within ten minutes in two flooded eight inch diameter cylinders in each plot. ANOVA was done by plot totals and plot sums transformed to log (X+1).

## Results

Due to the aggregated distribution of chinch bugs and limited degrees of freedom with three replicates, the data show no significant difference between any of the treatments. Resulting data indicate all insecticide treatments except the low rate of the Talsar formulations, 0.05 lb.ai/Acre, greatly reduced chinch bug counts. The combined fungicide treatment of Manicure and Fore did not enhance the population density as Manicure did alone in another evaluation study located nearby.

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

**Table 1. Efficacy of insecticides applied for control of hairy chinchbugs in turfgrass. North Fescue No. 1, OARDC Campus, Wooster, Ohio, 1996.**

| Treatment[a] | Rate/acre | Chinch bugs[b] $\bar{x}$/ft$^2$ | | % control |
|---|---|---|---|---|
| Talstar 0.66F | 0.05 lb.ai | 75 | a | 33 |
| Talstar 0.66F | 0.1 lb.ai | 18 | a | 84 |
| Talstar 0.66F | 0.2 lb.ai | 23 | a | 79 |
| Talstar 0.2G | 0.05 lb.ai | 53 | a | 53 |
| bifenthrin 0.3ME | 0.05 lb.ai | 10 | a | 91 |
| bifenthrin 0.05G | 0.05 lb.ai | 0 | a | 100 |
| Biflex 2TC | 0.1 lb.ai | 32 | a | 72 |
| diazinon 25% RTS | 4.0 lb.ai | 12 | a | 89 |
| Dursban 6.6% RTS | 1.0 lb.ai | 17 | a | 85 |
| Dursban 1G | 1.0 lb.ai | 5 | a | 95 |
| RH-0345 101 2SC | 2.0 lb.ai | 28 | a | 75 |
| Manicure 4.17F + | 12.5 fl.oz. | | | |
| Fore 80 | 17.4 oz. | 60 | a | 46 |
| Check | -.-- | 112 | a | |

[a] Applied July 5 to plots 5 x 10 ft replicated 3x.

[b] Data taken July 15 based on 2, 8 inch diameter samples in each plot. ANOVA ($f$ = 1.16), means are not significantly different.

# Preventive and Curative Insecticide Applications for Control of Hairy Chinch Bugs in Turfgrass—1996

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

## Materials and Methods

Treatments were applied May 22 and July 2 to plots 8 x 10 ft. arranged in a randomized complete-block design replicated three times. The experiment was located on a 100% fine fescue research area (South Fescue No. 1) at the Ohio Agricultural Research and Development Center, Wooster, Ohio. Liquid treatments were made with a $CO_2$ sprayer, Teejet 8010 nozzles, and 35 psi. delivering 2 gal./1000ft$^2$. The granular formulation was applied using a two-foot Gandy drop spreader. Each plot treated May 22 received 13 gallons (=¼) of posttreatment. The July applications were not irrigated.

Field conditions during the May 22 treatments were as follows:

(1) Chinch bugs—few adults, no pretreatment count taken.
(2) Turf—2.5 inch height, moist, 0.5-1.0 inch thatch depth.
(3) Soil—moist; 73 °F at 1 inch and 69 °F at 3 inch deep.
(4) Weather—sunny, 78 °F, 5-7 mph. wind.

Field conditions during the July 2 treatments were as follows:

(1) Chinch bugs—no adults. 23% 1st, 39% 2nd, 23% 3rd, 7% 4th, and 10% 5th instar nymphs.
(2) Turf—3 in. height, dry, 0.5-1.0 inch thatch depth.
(3) Soil—somewhat dry; 76 °F at 1 inch and 78 °F at 3 inch deep.
(4) Weather—mostly cloudy, 75 °F; no wind.

Efficacy data were obtained July 11 (50 & 9 DAT) by counting the number of live chinch bugs floating to the surface within ten minutes in two flooded eight inch diameter cylinders in each plot. ANOVA was based on plot totals.

## Results

Due to the aggregated distribution of chinch bugs and limited degrees of freedom with three replicates, the data show no significant difference between any of the treatments. While not statistically significant, the fungicide treated plots had nearly a twofold increase in the chinch bug population.

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

**Table 1. Efficacy of preventive and curative insecticide applications for control of hairy chinch bugs in turfgrass. OARDC South Fescue No. 1, 1996.**

| Treatment[a] | Rate/acre | Application Date | Chinch bugs[b] $\bar{x}/ft^2$ | % control |
|---|---|---|---|---|
| Merit 0.5G | 0.4 lb.ai | 5-22-96 | 7.2a | 61 |
| Merit on fertilizer | 0.4 lb.ai | 5-22-96 | 2.4a | 87 |
| Merit 75WP | 0.3 lb.ai | 7-2-96 | 9.1a | 50 |
| Merit 75WP | 0.4 lb.ai | 7-2-96 | 7.2a | 61 |
| Merit 75WP+ Tempo 10WP | 0.4 lb.ai+ 0.144 lb.ai | 7-2-96 | 4.8a | 74 |
| FCR 4545 20WP | 0.1 lb.ai | 7-2-96 | 18.1a | 0 |
| FCR 4545 125SC | 0.1 lb.ai | 7-2-96 | 7.2a | 61 |
| Tempo 20WP | 0.144 lb.ai | 7-2-96 | 24.3a | 0 |
| Manicure 4.16F | 24.0 oz. | 7-2-96 | 43.9a | 0 |
| Check | -.-- | | 18.1a | -- |

[a] Applied to plots 8 x 10 ft replicated 3x.

[b] Data taken July 11 based on chinch bugs surfacing following the flooding of two 8 inch diameter cylinders in each plot. ANOVA based on plot sum. There are no significant differences in any of the treatments ($f$ = 1.66)

# Quick Kill of Black Cutworm Larvae in Bentgrass—1996

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

## Materials and Methods

Treatments were applied the evening of July 30 to plots 6 ft. by 20 ft. arranged in a complete-randomized block design replicated four times. The site was in a practice fairway at Columbia Hills Country Club, Columbia Station, Ohio. Applications were made using a $CO_2$ sprayer with XR8006VS operated at 29 psi that delivered 1.0 gal./1000ft$^2$. The area received no irrigation between applications and final data acquisition. Thereafter, the fairway was irrigated to maintain turf quality.

Field conditions at time of treatments were as follows:

(1) Turf—100% creeping bentgrass; ½ inch height, level, no thatch.
(2) Soil—moist, 78°F at 1.0 inch, 79°F at 3.0 inch, no soil analysis.
(4) Weather—mostly cloudy, 80°F, 0 to 10 mph wind.

Treated plots were observed for dead cutworms on the surface recorded the following morning (approx. 12 hours posttreatment). Efficacy data taken August 1 (approx. 36 hours posttreatment) were based on the number of black cutworm larvae flushed to the surface in two 1 yd$^2$ areas in each plot using a soap irritant drench of 35 ml Joy dishwashing detergent in 2 gal. water. Analysis of variance was done on plot totals and the means were separated by the LSD test ($P$ = 0.5).

## Results

The number of cutworm carcasses the morning following treatment on the Tempo 20WP and Dursban Pro plots were significantly more than the other treatments. Dursban Pro had significantly more than the Tempo 20WP.

Efficacy of all treatments was significant 36 hours after treatment. The fewest cutworms (<1/yd$^2$) were in the Tempo 10WP and Dursban Pro treated plots.

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

**Table 1. Efficacy of insecticides applied for control of black cutworm larvae (BCW) and their surfacing response following treatment to turfgrass. Columbia Hills Country Club, Columbia Station, Ohio, 1996.**

| Treatment[a] | Rate lb.ai/A | Total dead BCW 12 hrs. posttreatment[b] | $\bar{x}$ live BCW per plot 36 hrs posttreatment[c] | % control |
|---|---|---|---|---|
| RH 0345 101 2SC | 0.50 | 1.0 c | 2.5b | 57 |
| RH 0345 101 2SC | 1.00 | 0.0 c | 2.0b | 66 |
| RH 0345 101 2SC | 1.50 | 3.0 c | 1.9b | 68 |
| Merit 75WP | 0.30 | 1.0 c | 2.6b | 55 |
| Tempo 20WP | 0.09 | 43.0 b | 0.5b | 91 |
| Dursban Pro 2EC | 1.00 | 66.0 c | 0.5b | 91 |
| Check | -.-- | 1.0 a | 5.9a | --- |

[a] Treatments applied July 30 to plots 6 x 20 ft. replicated 4x. No posttreatment irrigation.

[b] Data taken July 31 based on the total dead cutworms on the surface of each plot on the morning following applications. ANOVA based on plot sum. LSD at *P*=0.05. Means followed by the same letter are not significantly different.

[c] Data taken August 1, based on live cutworms surfacing following a soap solution drench in two 1 $yd^2$ areas in each plot. ANOVA based on plot sum. LSD at *P*=0.05. Means followed by the same letter are not significantly different.

# Control of Black Cutworm, *Agrotis ipsilon* (Hufnagel), and Sod Webworms (Pyralidae: Crambinae) in Creeping Bentgrass, *Agrostis palustris* Hudson, with Spinosad Formulations Columbus, Ohio, 1996

David J. Shetlar, Harry D. Niemczyk and Mark Belcher
Entomology

## Materials and Methods

The study was located on fairway No. 9 of the Scioto Country Club Golf Course, Columbus, Ohio. Pretreatment samples were taken from three 1.0 $yd^2$ areas in this range on July 6. Sod webworm larvae were small to medium (1.3/$yd^2$) and cutworms were medium to large (2.0/$yd^2$). Treatments were applied on Aug 6 to plots 4 x 8 ft arranged in a randomized complete-block design, replicated 4 times with the replicates separated by 3 ft alleys. Liquid treatments were applied using a pressurized $CO_2$ sprayer with TeeJet 8006VS nozzles using 26 psi pressure to deliver a volume of 1.0 gal/1000 $ft^2$. No immediate posttreatment irrigation was applied. The fairway was irrigated 16 hours after application. Thereafter, the fairway was irrigated as needed.

Field conditions at time of treatments were as follows:

(1) Turf—90% creeping bentgrass and 10% annual bluegrass; mowed three times/week at 7/16 inch; level, dense, dry.
(2) Thatch—1/8 to ½ inch, dense, moist.
(3) Soil—moist, 87°F at 1 inch, 85°F at 3 inch, clay loam, no soil analysis performed.
(4) Weather—clear, 87°F, 0 to 3 mph wind.

Efficacy data taken 12 August (4DAT) were based on the number of black cutworm and sod webworm larvae flushed to the surface in two 1.0 $yd^2$ areas using a soap irritant drench consisting of 15 ml Joy™ dishwashing detergent in 2.0 gal water applied to each $yd^2$. All caterpillars from each plot were collected in KAAD preservative and identified. Plot totals were analyzed using standard ANOVA and means were separated by using the LSD test ($P$ = 0.5).

## Bioassay

Residual efficacy of the two spinosad formulations was performed by bioassay using 2nd and 3rd instar black cutworm larvae provided by DowElanco. On 14 August (8DAT) and 21 August (15DAT) ten 1.0 inch cores were pulled from each of the four replicates of NAF-85 (@12.0), NAF-127 (@12.0) and check plots. The cores were trimmed to include 1.0 inch of soil and roots with the turf. Each core was pushed into a shell vial and a single black cutworm larva (3rd or 4th instar) was placed inside. The vials were stoppered with a cotton plug. After three day's of exposure the cutworms were rated as living or dead.

## Results

Low numbers of small to large sod webworm larvae (2.1/yd$^2$ in checks) and low numbers of medium to large back cutworms (2.1/yd$^2$ in checks) surfaced at 7DAT. All products performed satisfactorily for sod webworm and cutworm control though the low numbers of larvae appeared to obscure any rate response to the NAF formulations. In the bioassay test, NAF-85 appeared to have little effect at the 8 and 15DAT trials. The NAF-127 residual was active at 8DAT but not at 15DAT.

**Table 1. Efficacy of two spinosad formulations for control of black cutworm and sod webworm larvae in turfgrass, Scioto Country Club Golf Course, Columbus, OH - 1995.**

| Treatment/ Formulation[a] | Rate oz. ai/Acre | $\bar{x}$ larvae/yd$^2$ 7 DAT (% control) BCW | | SWW | |
|---|---|---|---|---|---|
| NAF 85 4SC | 0.75 | 0.38 | 82 | 0.00 | 100 |
| 2NAF 85 4SC | 1.5 | 0.75 | 65 | 0.13 | 94 |
| NAF 85 4SC | 3.0 | 0.25 | 88 | 0.00 | 100 |
| NAF 85 4SC | 6.0 | 0.25 | 88 | 0.00 | 100 |
| NAF 85 4SC | 12.0 | 0.00 | 100 | 0.00 | 100 |
| NAF 127 80WG | 0.75 | 0.00 | 100 | 0.38 | 82 |
| NAF 127 80WG | 1.5 | 0.00 | 100 | 0.00 | 100 |
| NAF 127 80WG | 3.0 | 0.00 | 100 | 0.00 | 100 |
| NAF 127 80WG | 6.0 | 0.00 | 100 | 0.00 | 100 |
| NAF 127 80WG | 12.0 | 0.00 | 100 | 0.00 | 100 |
| Dursban Pro 2EC | 1.0 (lb.) | 0.00 | 100 | 0.13 | 94 |
| Check | -.-- | 2.13 | --- | 2.13 | --- |
| LSD *P* @ 0.05 = | | 0.51 | | 0.36 | |

[a] Applied Aug 6 to plots 4 X 8 ft, replicated 4x.
Data taken Aug 12 based on two 1.0 yd$^2$ soap flushed areas per plot. Analysis by ANOVA and LSD.

# Control of Black Cutworm, *Agrotis ipsilon* (Hufnagel), and Sod Webworms (Pyralidae: Crambinae) in Creeping Bentgrass, *Agrostis palustris* Hudson, with Observations on Black Turfgrass Ataenius Adults, *Ataenius spretulus* (Haldeman), Columbus, Ohio, 1996

David J. Shetlar, Harry D. Niemczyk and Mark Belcher
Entomology

## Materials and Methods

The study was located on the Ohio State University Turfgrass Research Facility, Range 8 North, Columbus, Ohio. Pretreatment samples were taken from three 1.0 $yd^2$ areas in this range on July 30. Sod webworm larvae were small to medium (1.3 $yd^2$) and cutworms were medium to large (2.0/$yd^2$).

Treatments were applied on August 2 to plots 4 x 8 ft arranged in a randomized complete-block design, replicated 3 times with the replicates separated by 3 ft alleys. Liquid treatments were applied using a pressurized $CO^2$ sprayer with TeeJet 8006VS nozzles using 15 psi pressure to deliver a volume of 1.0 gal./1000 $ft^2$. Granular treatments were applied using a shaker jar. Sprays were not irrigated and granulars received 1/4 inch of irrigation immediately after application. The ranges received approximately 0.2 inch of irrigation between 04:00 and 05:00 each day until efficacy data were taken.

Field conditions at time of treatments were as follows:

(1) Turf—100% creeping bentgrass, Pennway established June 1995; mowed two times/ week at inch; level, moderately dense, light dew present.
(2) Thatch—none.
(3) Soil—moist, 80 °F at 1 inch, 83 °F at 3 inch, clay loam, no soil analysis performed.
(4) Weather - partly cloudy, 81 °F, 3 to 8 mph wind.

Efficacy data were taken August 6 (4DAT) were 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 consisting of 15 ml Joy™ dishwashing detergent in 2.0 gal water. All caterpillars and black turfgrass ataenius adults, *Ataenius spretulus* (Haldeman), from each plot were collected in KAAD preservative and identified. Plot totals were analyzed using standard ANOVA and means were separated by using the LSD test ($P = 0.5$).

## Results

Moderate numbers of live medium to large sod webworm larvae (10/$yd^2$ in checks) and low numbers of medium to large back cutworms (2.67/$yd^2$ in checks) surfaced 4DAT. An average of 40.67 black turfgrass ataenius adults were found in the checks with considerable variation (2 to 103/$yd^2$) . Populations in the treated plots from 0 to 84/$yd^2$. Cutworms and/or sod webworm larvae were observed on the surface of most insecticide treated plots within two hours after treatment.

All products and rates performed satisfactorily for sod webworm and cutworm control. Because of the great variation in the black turfgrass ataenius data, no significant differences were detected in the data but the Bifenthrin 0.05G treatments seemed to greatly reduce the adult populations.

**Table 1. Efficacy of various chemical insecticides for control of black cutworm and sod webworm larvae in turfgrass, with observations on black turfgrass ataenius adults. Ohio State University Turfgrass Research Facility, Columbus, Ohio, 1995.**

| Treatment/ Formulation[a] | Rate lb AI/acre | $\bar{x}$ larvae/yd² 4 DAT (% control) BCW | | SWW | | BTA Adults 4DAT | % control |
|---|---|---|---|---|---|---|---|
| Talstar 0.66F | 0.0125 | 0.0 b | 100 | 1.3 b | 87 | 5.00 a | 88 |
| Talstar 0.66F | 0.025 | 0.3 b | 89 | 0.3 b | 97 | 7.33 a | 82 |
| Talstar 0.66F | 0.05 | 0.0 b | 100 | 0.0 b | 100 | 1.33 a | 97 |
| Biflex 2TC | 0.025 | 0.3 b | 89 | 0.7 b | 93 | 1.00 a | 98 |
| Bifenthrin 0.3ME | 0.05 | 0.0 b | 100 | 0.0 b | 100 | 2.33 a | 94 |
| Diazinon 25%RTS | 4.0 | 0.0 b | 100 | 0.0 b | 100 | 0.00 a | 100 |
| Talstar 0.2G | 0.1 | 0.0 b | 100 | 1.0 b | 90 | 0.00 a | 100 |
| Bifenthrin 0.05G | 0.05 | 0.3 b | 89 | 1.0 b | 90 | 28.33 a | 30 |
| Dursban 1G | 1.0 | 0.0 b | 100 | 0.0 b | 100 | 0.00 a | 100 |
| Dursban 6.6%RTS | 1.0 | 0.0 b | 100 | 0.0 b | 100 | 1.67 a | 96 |
| Sevin 2SL | 8.0 | 0.0 b | 100 | 0.3 b | 97 | 4.00 a | 90 |
| Sevin 2G | 8.0 | 0.0 b | 100 | 0.3 b | 97 | 0.33 a | 99 |
| FCR 4545 10WP | 0.05 | 0.0 b | 100 | 0.3 b | 97 | 1.33 a | 97 |
| FCR 4545 125SC | 0.05 | 0.0 b | 100 | 0.0 b | 100 | 1.33 a | 97 |
| Tempo 20WP | 0.1 | 0.0 b | 100 | 0.0 b | 100 | 7.00 a | 83 |
| Check | -.-- | 2.7 a | --- | 10.0 a | --- | 40.67 a | --- |
| LSD *P* @ 0.05 = | | 0.64 | | 3.11 | | n.s. | |

[a] Applied Aug 2 to plots 4 X 8 ft, replicated 3x.
Data taken Aug 6 based on one 1.0 yd² soap flushed area per plot. Analysis by ANOVA and LSD.

# Control of Black Cutworm, *Agrotis ipsilon* (Hufnagel), Sod Webworms (Pyralidae: Crambinae), and Black Turfgrass Ataenius Adults, *Ataenius spretulus* (Haldeman), in Creeping Bentgrass, *Agrostis palustris* Hudson, Columbus, Ohio, 1996

David J. Shetlar, Dr. Harry D. Niemczyk and Mark Belcher
Entomology

## Materials and Methods

The study was located on the Ohio State University Turfgrass Research Facility, Range 8 North, Columbus, Ohio. No pretreatment samples were taken because another plot in the same range had yielded adequate numbers of caterpillars during the previous week.

Treatments were applied on August 6 to plots 4 x 6 ft. arranged in a randomized complete-block design, replicated 4 times with the replicates separated by 2 ft alleys. Liquid treatments were applied using a pressurized $CO_2$ sprayer with TeeJet 8006VS nozzles using 26 psi pressure to deliver a volume of 2.0 gal./1000 $ft^2$. Entomopathogenic nematodes were applied in 2 gal. of water per plot using a sprinkling can. Spray treatments were not irrigated but the nematode treatments received 1/4 inch of irrigation immediately after application. The ranges received approximately 0.2 inch irrigation between 04:00 and 05:00 each day until efficacy data were taken.

Field conditions at time of treatments were as follows:

(1) Turf—100% creeping bentgrass, Pennway established June 1995; mowed two times/week at ½ inch; level, moderately dense, surface dry.
(2) Thatch—none.
(3) Soil—moist, 90°F at 1 inch, 88°F at 3 inch, clay loam, no soil analysis performed.
(4) Weather—partly cloudy, 90°F, 2 to 5 mph wind.

Efficacy data were taken August 12 (7DAT) were 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 and black turfgrass ataenius adults, *Ataenius spretulus* (Haldeman), from each plot were collected in KAAD preservative and identified. Plot totals were analyzed using standard ANOVA and means were separated by using the LSD test ($P = 0.5$).

## Results

Moderate numbers of live medium to large sod webworm larvae (7.5/$yd^2$ in checks) and low numbers of small to large black cutworms (2.0/$yd^2$ in checks) surfaced 7 DAT. An average of 42.75 black turfgrass ataenius adults were found in the checks with considerable (21 to 61/$yd^2$) variation. Populations in the treated plots varied from 0 to 148/$yd^2$. Cutworms and/or sod webworm larvae were observed on the surface of some of the Dursban treated plots within two hours of treatment.

All insecticide products and rates performed satisfactorily for sod webworm and cutworm control, and most treatments significantly reduced the BTA adult populations. The Condor and Crymax Bts gave satisfactory control of caterpillars but no control of BTA adults. Cruiser nematodes gave inadequate control of all insects, but the Savior nematodes gave satisfactory control of the caterpillar complex.

**Table 1. Efficacy of various chemical insecticides for control of black cutworm and sod webworm larvae, and black turfgrass ataenius adults in bentgrass. Ohio State University Turfgrass Research Facility, Columbus, Ohio, 1996.**

| Treatment/ Formulation[a] | Rate lb.ai/Acre | $\bar{x}$ larvae/yd$^2$ 7 DAT (% control) BCW | | SWW | | BTA Adults 4DAT | % control |
|---|---|---|---|---|---|---|---|
| Dursban Pro 2EC | 0.5 | 0.00 b | 100 | 0.25 c | 97 | 0.50 c | 99 |
| Dursban Pro 2EC | 1.0 | 0.00 b | 100 | 0.00 c | 100 | 0.50 c | 99 |
| Dursban Turf 4EC | 1.0 | 0.25 b | 86 | 0.25 c | 97 | 3.50 bc | 92 |
| NAF-259 0.14CS | 0.5 | 0.00 b | 100 | 0.00 c | 100 | 2.50 bc | 94 |
| NAF-39 2EC | 1.0 | 0.25 b | 86 | 0.00 c | 100 | 6.75 bc | 84 |
| NAF-264 2EC | 0.092 | 0.00 b | 100 | 0.25 c | 97 | 5.00 bc | 88 |
| Condor | 1.0 qt. | 0.00 b | 100 | 0.50 c | 93 | 46.50 ab | 0 |
| Crymax 15WDG | 0.5 lb form. | 0.50 b | 75 | 1.00 c | 87 | 63.25 a | 0 |
| Cruiser | 1.0x10$^9$ (nemas) | 1.50 a | 25 | 4.50 ab | 40 | 63.75 a | 0 |
| Savior | 1.0x10$^9$ (nemas) | 0.25 b | 86 | 0.75 c | 90 | 38.00 abc | 11 |
| Deltamethrin 1.0GL | 0.08 | 0.00 b | 100 | 1.25 bc | 83 | 15.50 bc | 63 |
| Check | --- | 2.00 a | --- | 7.50 a | --- | 42.75 abc | --- |
| LSD *P* @ 0.05 = | | 0.84 | | 3.28 | | 44.25 | |

[a] Applied Aug 6 to plots 4 X 6 ft, replicated 4x.
Data taken Aug 12 based on one 1.0 yd$^2$ soap flushed area per plot. Analysis by ANOVA and LSD.

# Control of Bluegrass Billbug, *Sphenophorus parvulus* Gyllenhal, Larvae in Lawn Turf, Wooster, Ohio, 1996

David J. Shetlar, Harry D. Niemczyk and Mark Belcher
Entomology

## Materials and Methods

The study was located on the Ohio State University Agricultural Technical Institute front lawn. Pretreatment samples indicated presence of medium and large billbug larvae. Insecticides and a biological control were applied on July 2 to plots 4 x 6 ft arranged in a randomized complete-block design, replicated four times with the replicates separated by 3 ft. Spray treatments were applied using a $CO_2$ sprayer with TeeJet 8004VS nozzles at 25 psi pressure that delivered a volume of 3.1 gal./1000 ft$^2$. Granular treatments were applied using a shaker jar. Entomopathogenic nematodes were applied in two gal. of water per plot using a sprinkling can. All treatments received 3/8 inch irrigation immediately after application.

Field conditions at time of treatments were as follows:

(1) Turf—slight slope, moderately dense, 3 inch height, surface dry, 80% Kentucky bluegrass and 20% perennial ryegrass.
(2) Thatch—none.
(3) Soil—dry, 85°F at 1 inch, 83°F at 3 inch, clay loam.
(4) Weather—partly cloudy, 83°F, 5-15 mph wind.

Efficacy data taken July 16 (14 DAT) were based on the number of bluegrass billbug larvae (BBL) and pupae extracted from four 4.25 inch diameter turf and soil cores pulled from each plot. Each core was pulled from a spot where a bluegrass billbug larval, frass-filled turf stem was detected. Plot totals were analyzed using standard ANOVA and means were separated by using the LSD test ($P = 0.05$).

## Results

Good populations of bluegrass billbug larvae and pupae were present in the plot with the checks averaging 29.8 larvae+pupae per ft$^2$. The best control was obtained with the Cruiser nematode while several other insecticides provided adequate control.

**Table 1. Efficacy of various insecticides and nematodes for control of bluegrass billbug larvae (BBL) in a lawn, ATI Campus, Wooster, Ohio, 1996.**

| Treatment/ Formulation[a] | Rate lb.ai/Acre | $\bar{x}$ BBL + pupae per ft$^2$ 14 DAT | % Control |
|---|---|---|---|
| Talstar 0.66F | 0.1 | 9.5 bc | 68 |
| Talstar 0.66F | 0.2 | 9.5 bc | 68 |
| Biflex 2TC | 0.2 | 13.3 bc | 55 |
| Bifenthrin 0.3ME | 0.05 | 7.6 bc | 74 |
| Astro 3.2EC | 0.4 | 9.6 bc | 72 |
| Astro 3.2EC | 0.8 | 18.4 ab | 38 |
| Diazinon 25%RTS | 4.0 | 10.8 bc | 64 |
| Talstar 0.2G | 0.1 | 6.4 c | 79 |
| Bifenthrin 0.5G | 0.05 | 19.0 ab | 36 |
| Dursban 6.6%RTS | 1.0 | 10.8 bc | 64 |
| Cruiser | $1.0 \times 10^9$ (nemas) | 4.4 c | 85 |
| Check | -.-- | 29.8 a | |
| LSD *P* @ 0.05 = | | 11.9 | |

[a] Applied July 2 to plots 4 X 6 ft, replicated 4x.
Data taken July 14 based on four 4.25 inch cores per plot. Analysis by ANOVA and LSD.

# Efficacy of Spinosad Applied Prior to Oviposition for Control of Bluegrass Billbug Larvae in Turfgrass—1996

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

## Methods and Materials

Treatments were applied May 15 to plots 10 x 10 ft. arranged in a randomized complete-block design replicated four times. The experiment was located on a turfgrass research plot at the Ohio Agricultural Research and Development Center campus in Wooster, Ohio. Liquid treatments were applied with a $CO_2$ sprayer, Teejet 8020 nozzles, and 80 psi. delivering 3.5 gal./1000ft$^2$. The experimental area received approximately 3/8 inch of irrigation after all treatments had been applied. There was no further supplemental irrigation applied to the area.

Field conditions at the time of the treatments were as follows:

(1) Billbugs—adults present, no pretreatment count.
(2) Turf—80 % Kentucky bluegrass, 10 % annual bluegrass, and 10 % weed species, 4 inch grass height, no thatch.
(3) Soil—moist; 54°F at 1 inch and 52°F at 3 inch deep.
(4) Weather—cloudy & light rain, 52°F., 2-18 mph wind.

Resulting larval data were obtained July 10 (56 DAT) by counting the number of live larvae in six 4.25 inch samples from each check plot. We believe predation is why pockets of larval frass were evident where no larvae or pupae were found. Therefore, the occurrences of frass pockets were recorded and combined with the incidence of larvae to obtain evidence of efficacy.

## Results

Low and erratic counts, possibly due to predation, confounded the results. There were no significant differences in any of the treatments.

The NAF formulations tank mixed well. They did produce a pungent odor in the vicinity of the experiment site.

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

**Table 1. Efficacy of spinosad applied prior to oviposition for control of bluegrass billbug larvae in turfgrass. OARDC Campus, Wooster, Ohio, 1996.**

| Material[a] | Rate lb.AI/acre | Total billbug larvae | Total frass count | $\bar{x}$ larvae[b] +frass/ft$^2$ | % Control |
|---|---|---|---|---|---|
| NAF - 85 | 0.125 | 0.0 | 2.0 | 0.9 | 80 |
| NAF - 85 | 0.250 | 6.0 | 6.0 | 5.1 | 0 |
| NAF - 85 | 0.500 | 5.0 | 2.0 | 3.0 | 30 |
| NAF - 85 | 1.000 | 5.0 | 7.0 | 5.1 | 0 |
| NAF - 85 | 2.000 | 1.0 | 2.0 | 1.3 | 70 |
| NAF - 127 | 0.125 | 4.0 | 10.0 | 5.9 | 0 |
| NAF - 127 | 0.250 | 3.0 | 6.0 | 3.8 | 10 |
| NAF - 127 | 0.500 | 4.0 | 5.0 | 3.8 | 10 |
| NAF - 127 | 1.000 | 2.0 | 6.0 | 3.4 | 20 |
| NAF - 127 | 2.000 | 0.0 | 2.0 | 0.9 | 80 |
| Dursban Pro 2EC | 1.000 | 8.0 | 6.0 | 5.9 | 0 |
| Dursban Pro 2EC | 2.000 | 3.0 | 5.0 | 3.4 | 20 |
| Check | -.-- | 2.0 | 8.0 | 4.2 | |
| Anova *F*-value | | 1.30 | 1.62 | 0.42 | |

[a] Applied to plots 10 x10 ft$^2$, replicated 4x.

[b] Data based on six 4.25 inch diameter samples from each plot. ANOVA on plot sums. No significant differences in any of the treatments.

# Efficacy of Insecticides Applied Prior to Oviposition for Control of Bluegrass Billbug Larvae in Turfgrass—1996

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

## Methods and Materials

Treatments were applied May 13 to plots 10 x 10 ft. arranged in a randomized complete-block design replicated four times. The experiment was located on a turfgrass research plot at the Ohio Agricultural Research and Development Center campus in Wooster, Ohio. Liquid treatments were applied with a $CO_2$ sprayer, Teejet 8015 nozzles, and 60 psi. delivering 3 gal./1000ft$^2$ and granules with a shaker jar. The experimental area received no posttreatment nor any supplemental irrigation.

Field conditions at the time of the treatments were as follows:

(1) Billbugs—adults present, no pretreatment count.
(2) Turf—60% Kentucky bluegrass, 30% annual bluegrass, and 10% weed species, 3.5 inch grass height, no thatch.
(3) Soil—moist; 55°F at 1 inch and 53°F at 3 inch deep, soil analysis.
(4) Weather—sunny, 60°F., 3-7 mph wind.

Resulting larval data were obtained July 9 (57 DAT) by counting the number of live larvae in six 4.25 inch samples from each check plot. We believe predation is why pockets of larval frass were evident where no larvae or pupae were found. Therefore, the occurrences of frass were recorded and combined with incidence of larvae to obtain evidence of efficacy.

## Results

All treatments suppressed the subsequent larval population but not all were significant. Low counts, possibly due to predation, resulted in erratic rate response data.

There were no signs of phytotoxicity at 7 and 14 days after treatments.

**Table 1. Efficacy of insecticides applied prior to oviposition for control of bluegrass billbug larvae in turfgrass. OARDC Campus, Wooster, Ohio, 1996.**

| Treatment[a] | Rate lb.AI/acre | Total billbug larvae | Total frass count | $\bar{x}$ larvae[b] +frass/ft$^2$ | % Control |
|---|---|---|---|---|---|
| Talstar 0.66F | 0.025 | 7 | 7 | 5.9 b | 48 |
| Talstar 0.66F | 0.050 | 10 | 11 | 8.9 ab | 22 |
| Talstar 0.66F | 0.100 | 10 | 7 | 7.2 ab | 37 |
| Talstar 0.2G | 0.100 | 2 | 2 | 1.7 b | 85 |
| bifenthrin 0.3ME | 0.100 | 5 | 7 | 5.1 b | 55 |
| bifenthrin 0.5G | 0.050 | 3 | 9 | 5.1 b | 55 |
| Biflex 2TC | 0.050 | 5 | 7 | 5.1 b | 55 |
| diazinon 25% RTS | 4.000 | 3 | 11 | 5.9 b | 48 |
| Dursban 6.6% RTS | 1.000 | 1 | 2 | 1.3 b | 89 |
| Dursban 1G | 1.000 | 3 | 12 | 6.3 b | 44 |
| Check | -.-- | 19 | 8 | 11.4 a | --- |

[a] Applied May 13 to plots 10 x 10 ft$^2$ replicated 4x. No posttreatment irrigation.
[b] Data taken July 9, based on six 4.25 inch diameter samples from each plot. Analysis on plot sums by ANOVA and LSD ($P$ = 0.1).

# Application of Insecticides to Kill Black Turfgrass Ataenius Adults Prior to Egg Laying on Golf Course Fairways—1996

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Entomology

## Materials and Methods

This experiment was initiated prior to oviposition. Treatments were applied May 7, to plots 5 x 15 ft. arranged in a completely randomized block design replicated four times. The site was in Fairway No. 2 of the north course at Westfield Country Club, Westfield, Ohio. Liquid applications were made using a $CO_2$ sprayer with XR8006VS operated at 29 psi that delivered 1.0 gal./1000ft$^2$. The granular treatments were applied with either a shaker jar or a Gandy two foot spreader. The entire experimental area received approximately 8 minutes irrigation after applications were made using the golf course system to wash the materials off the grass blades. Thereafter, the fairway was irrigated to maintain turf quality.

Field conditions at the time of treatment were as follows:

(1) BTA—adults present.
(2) Turf—60% bentgrass & 40% annual bluegrass, grass height 3/4 inch; thatch averaged 1 inch, very dense, and moist.
(3) Soil—moist, 50°F at 1 and 3 inch deep, no soil analysis.
(4) Weather—cloudy, 48°F, 3-15 mph wind.

All treatments except RH 0345 101 2SC reduced the adult population.

Efficacy data were obtained June 4 and 5 (28 and 29 DAT) by counting the number BTA adults flushed to the surface in three 1 ft$^2$ areas following a soap irritant drench of 30 ml Joy dishwashing detergent in 2.0 gal. water. Analysis of variance was based on plot totals and means separated by LSD test at $P = 0.05$.

## Results

Attempts were made to acquire adult efficacy data May 13 and again May 20 but the adults found in the untreated plots were insufficient. Although the adult population remained low June 4, replicates one and four revealed some trends. Adult counts were taken from the remaining replicates June 5. All treatments except Merit 75WP and RH 0345 101 significantly reduced the number of adults. Although the adult counts were low, the data indicate that pyrethroid insecticides are efficacious in an adult control program.

By July 15 the check plots had not produced adequate numbers of larvae, so there are no resulting larval data.

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

**Table 1. Efficacy of insecticides applied for control of black turfgrass ataenius (BTA) adults on a golf course fairway. Westfield Country Club, Westfield, Ohio, 1996.**

| Treatment[a] | Rate lb.ai/Acre | BTA adults[b] $\bar{x}$ /ft$^2$ | | % Control |
|---|---|---|---|---|
| Talstar 0.66F | 0.025 | 0.03 | c | 91 |
| Talstar 0.66F | 0.050 | 0.03 | c | 91 |
| Talstar 0.66F | 0.100 | 0.00 | c | 100 |
| bifenthrin 3ME | 0.050 | 0.17 | c | 82 |
| bifenthrin 0.05G | 0.050 | 0.08 | c | 91 |
| Talstar 0.2G | 0.100 | 0.00 | c | 100 |
| Dursban 6.6% SPG-96-55 | 1.000 | 0.00 | c | 100 |
| Dursban 1G SPG-96-57 | 1.000 | 0.00 | c | 100 |
| diazinon 25% SPG-96-56 | 4.000 | 0.25 | bc | 73 |
| diazinon 5G SPG- 96 58 | 4.360 | 0.25 | bc | 73 |
| RH 0345 101 2SC | 2.000 | 0.92 | a | 0 |
| Scimitar 10CS | 0.060 | 0.00 | c | 100 |
| Merit 75WP | 0.300 | 0.75 | ab | 18 |
| FCR 4545 10WP | 0.072 | 0.08 | c | 91 |
| FCR 4545 125CS | 0.072 | 0.33 | bc | 64 |
| Tempo 20WP | 0.144 | 0.33 | bc | 64 |
| Check | -.-- | 0.92 | a | --- |

[a] Treatments applied May 7 to plots 5 x 15 ft. replicated 4x, and with posttreatment syringing.

[b] Data taken June 4 & 5 based BTA surfacing following a soap solution drench in three 1 x 1 ft. areas in each plot. ANOVA based on plot sum. Means followed by the same letter are not significantly different using LSD @ $P = 0.05$.

# Preventive Applications for Control of Japanese Beetle Larvae in Turfgrass—1996

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

## Methods and Materials

Treatments were applied June 26 to plots 3 x 5 ft. arranged in a randomized complete-block design replicated four times. The experiment was located on a 100% Kentucky bluegrass lawn of the Ohio Agricultural Research and Development Center, Wooster, Ohio. Applications were made with a $CO_2$ sprayer, Teejet 8015 nozzles at 60 psi delivering 2 gal./1000ft$^2$. After all plots were treated. the entire area received approximately ½ inch of irrigation. No further supplemental irrigation was applied.

A week after treatments were applied three PVC cylinders eight inches inside diameter were inserted into each plot. On July 9, 30 beetles (measured volumetrically) 52% ♀ were caged in each cylinder and on July17, another 30 beetles 44%♀ were caged. Caged beetles were fed fresh apple slices dusted with brewers yeast every two days. Fifteen days after the initial caging the cylinders were removed. The area received no supplemental irrigation.

Field conditions at the time of treatment were as follows:

(1) Turf—100% Kentucky bluegrass, level, grass height 2 inch, no thatch.
(2) Soil—moist; 73°F at 1 inch and 71°F at 3 inch, no soil analysis.
(3) Weather—sunny, 76°F, 0-5 mph wind.

Efficacy data were obtained October 1 (96 DAT), by counting the number of live larvae in the 8 inch in diameter cylinder/cage locations in each plot. Analysis of variance was done by plot totals and means separated by LSD test at $P$ = 0.05.

## Results

Merit 75WP, EXP-61196 2.5EC at all rates, and EXP-61151 0.1G at the two high rates gave significant control of grubs. The 3.0 lb.ai/Acre rate of EXP-61196a and EXP-61151 essentially matched the control of the standard treatment Merit 75WP. None of the Talstar formulations or rates gave significant control.

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

**Table 1. Efficacy of preventive applied insecticides for control of Japanese beetle larvae produced by egg laying adults caged over treated plots. OARDC Campus, Wooster, Ohio. 1996.**

| Treatment[a] | Rate lb.ai/Acre | $\bar{x}$ larvae[b] per sq. ft.[2] | Percent control |
|---|---|---|---|
| Talstar 0.66F | 0.10 | 28.4 abc | 10 |
| Talstar 0.66F | 0.20 | 36.5 a | 0 |
| Talstar 0.5G | 0.20 | 30.1 ab | 4 |
| Talstar 0.2G | 0.40 | 22.2 abc | 30 |
| Merit 75WP | 0.30 | 0.0 d | 100 |
| Check | -.-- | 31.5 a | --- |

[a] Treatments applied June 26 to plots 3 x 5 ft. replicated 4x. Spray volume 3 gal./1000ft$^2$.

[b] Data taken October 1 (96 DAT) based on the number of larvae found in 3, 8 in. in diam. samples from each plot. Plot sums analyzed by AVOVA and LSD at $P = 0.05$. Means followed by the same letter are not significantly different.

# Influence of Application Date on the Efficacy of Insecticides Applied for Control of Japanese Beetle Larvae in Turfgrass—1996

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

## Methods and Materials

Treatments were applied June 6, July 16, and August 13, to plots 10 x 10 ft. arranged in a randomized complete-block design replicated four times. The experiment was located on Fairway 16 of Twin Lakes Golf Course, Ontario, Ohio. Liquid applications were made with a $CO_2$ sprayer with XR8006VS nozzles and 29 psi delivering 1 gallon of spray/$1000^2$. Each plot received 1/4 inch posttreatment irrigation. The site was an irrigated fairway and received regular supplemental irrigation.

Site conditions were as follows: 60% Kentucky bluegrass and 40% annual bluegrass, no thatch, mostly level.

Field conditions during the June 6 treatments were as follows:

(1) Japanese beetle—overwintered 3rd instars present.
(2) Turf—1.25 inch height.
(3) Soil—31.8% moisture; 60°F at 1 inch and 62°F at 3 inch deep.
(4) Weather—sun & clouds, 62°F.; 0-15 mph wind

Field conditions during the July 16 treatments were as follows:

(1) Japanese beetle—adult flight (fewer at this location than in previous years).
(2) Turf—1.25 inch height.
(3) Soil—25.7% moisture; 68°F at 1 inch and 62°F inch deep.
(4) Weather—cloudy, 72°F.; 0-10 mph wind.

Field conditions during the August 13, treatments were as follows:

(1) Japanese beetle—1st and 2nd instars present.
(2) Turf—1.25 inch height.
(3) Soil—22.2% moisture, 70°F at 1 and 3 inch deep.
(4) Weather—mostly sunny, 75°F; no wind.

Efficacy data were obtained October 1 (116, 76, & 43 DAT) by counting the number of live larvae in six samples 7 in. x 7 in. by approximately 3 in. deep from each plot. ANOVA was done on plot totals and means separated by LSD test at $P = 0.05$.

## Results

Results of the June applications show Merit gave good control 116 DAT although not significant.

The July applications of Merit and both RH 0345 formulations significantly controlled the grubs at 76 DAT. The F-5268 and F-6911 treatments showed some reduction in larvae but these results were not significantly different from either the check or most effective treatment.

At 43 DAT the August applications again show

Merit and the RH 0345 treatments gave significant control. The F-5268 and F-6911 treatments had no effect on the larval population.

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

**Table 1. Influence of application date on the efficacy of insecticides applied for control of Japanese beetle larvae on a golf course fairway. Twin Lakes Golf Course, Ontario, Ohio, 1996.**

| Treatment | Rate lb.ai/Acre | Application Date | DAT | $\bar{x}$ larvae/ft$^2$ | % control |
|---|---|---|---|---|---|
| RH 0345-101 2SC | 1.0 | 6-6-96 | 116 | 2.8 b | 35 |
| RH 0345- 102 2.5G | 1.0 | 6-6-96 | 116 | 7.8 a | 0 |
| Merit 75WP | 0.3 | 6-6-96 | 116 | 1.2 bcd | 72 |
| RH0345-101 2SC | 1.0 | 7-16-96 | 76 | 0.0 d | 100 |
| RH 0345-102 2.5G | 1.0 | 7-16-96 | 76 | 0.4 cd | 91 |
| Merit 75WP | 0.3 | 7-16-96 | 76 | 0.0 d | 100 |
| F - 5268 5F | 0.2 | 7-16-96 | 76 | 2.6 bcd | 40 |
| F - 6911 10F | 0.2 | 7-16-96 | 76 | 3.4 bcd | 21 |
| RH 0345-101 2SC | 1.0 | 8-13-96 | 43 | 0.1 d | 97 |
| RH 0345-102 2.5G | 1.0 | 8-13-96 | 43 | 0.1 d | 97 |
| MERIT 75WP | 0.3 | 8-13-96 | 43 | 0.0 d | 100 |
| F - 5268 5F | 0.2 | 8-13-96 | 43 | 4.3 abc | 0 |
| F - 6911 10F | 0.2 | 8-13-96 | 43 | 4.5 ab | 0 |
| CHECK | -.- | | | 4.3 abc | --- |

Plots 10 X 10 ft replicated 4x. Application volume 1 gal./1000ft$^2$. Posttreatment irrigation: 1/4 in. Data taken October 1 based on four 7 x 7 inch samples from each plot. ANOVA on plot sums and LSD at *P=0.05.* Means followed by the same letter are not significantly different.

# Application of Insecticides for Preventive Control of Japanese Beetle Larval Populations in Turfgrass—1996

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Entomology

## Methods and Materials

Treatments were applied July 16 to plots 10 x 10 ft. arranged in a randomized complete-block design replicated four times. The experiment was located on Fairway No. 15 of Twin Lakes Golf Course, Mansfield, Ohio. Liquid treatments were applied with a $CO_2$ sprayer, Teejet 8015 nozzles, and 60 psi delivering 1 gal./1000 $ft^2$. All RH 0345 granules were applied with a shaker jar and the others with a 2-foot wide Gandy drop spreader. The entire experimental area received 1/4 inch irrigation after all treatments were applied. Thereafter, irrigation was applied to maintain turf quality.

Field conditions at the time of treatment were as follows:

(1) Japanese beetles—adults actively feeding, yet not in the numbers observed at this location in previous years.
(2) Turf—50% Kentucky bluegrass and 50% annual bluegrass; grass height 1 inch; no thatch.
(3) Soil—moist; 65 °F at 1 and 3 inch deep, no soil analysis.
(4) Weather—sunny; 74 °F; 0-15 mph wind.

Efficacy data were obtained October 1 (45 DAT) by counting the number of live larvae in six 7 x 7 inch samples from each plot. Analysis of variance was done on plot totals and means separated by LSD test at $P = 0.05$.

## Results

The Japanese beetle adult population, much lower than observed in the previous four years, resulted in a low level larval population in the check plots. None the less, the data show all treatments gave significant control of the grubs.

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

**Table 1. Application of insecticides for preventive control of Japanese beetle larvae on a golf course fairway. Twin Lakes Golf Course, Ontario, Ohio, 1996.**

| Material[a] | Rate lb. AI/acre | $\bar{x}$ larvae/$ft^2$ | % Control |
|---|---|---|---|
| RH 0345-101 2SC | 0.5 | 0.0 c | 100 |
| RH 0345-101 2SC | 1.5 | 0.0 c | 100 |
| RH 0345-102 2.5G | 0.5 | 0.5 bc | 85 |
| RH 0345-102 2.5G | 1.5 | 0.0 c | 100 |
| RH 0345 0.86G[b] | 0.5 | 0.1 c | 96 |
| RH 0345 0.86G[b] | 1.5 | 0.0 c | 100 |
| RH 0345 0.67G[b] | 0.5 | 0.5 bc | 85 |
| RH 0345 0.67G[b] | 1.5 | 0.0 c | 100 |
| Dylox 6.2G | 8.0 | 1.6 b | 50 |
| Merit 0.5G | 0.3 | 0.2 c | 92 |
| Check | -.- | 3.2 a | --- |

[a] Applied July 16 to plots 10 x 10 ft replicated 4x. Spray volume 3 gal/1000$ft^2$. Posttreatment irrigation 1/4 inch. Data taken October 1 based on 6, 7 x 7 inch samples from each plot. ANOVA and LSD on plot sums. Means followed by the same letter are not significantly different.
[b] On fertilizer

# Application of *Bacillus thuringiensis* strain 'buibui' for Control of White Grubs in Turfgrass—1996

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Entomology

## Methods and Materials

Treatments were applied August 19 to plots 10 x 10 ft arranged in a randomized complete-block design replicated four times. The experiment was located in Fairway No. 6, Pleasant Hill Golf Course, Perrysville, Ohio. The granular treatments were applied using a shaker jar. Spray volume for the treatment was 2 gal./1000 $ft^2$ using Teejet XR8008VS nozzles and 35 psi. The entire experimental area received approximately 1/4 inch irrigation after all treatments were applied. The area received no further supplemental irrigation.

Field conditions at the time of treatment were as follows:

(1) White Grubs—100% Japanese beetles, 55% 1st and 45% 2nd instars.
(2) Turf—60% Kentucky bluegrass, 20 % fine fescue; dry, height 1.25 inch; no thatch.
(3) Soil—moist; 66°F at 1 and 3 inch deep, no soil analysis.
(4) Weather—sunny, 65°F, 5-8 mph wind.

Efficacy data were obtained October 1 (41 DAT) by counting the number of live larvae in six samples 7 x 7 inch from each plot. Analysis of variance was done on plot totals and means separated by LSD test at $P = 0.05$.

## Results

All treatments significantly reduced the grub population. The sprayable formulation of *B. thuringiensis*, MYX - 910 111F, gave excellent control and was equal to that of the chemical standard Dylox 6.2G. The grub population remaining in the plots treated with the *B. thuringiensis* granules ( MYX - 942 formulations) were at a level that could produce damage in persistant dry soil conditions.

There were no signs of phytotoxicity or differences in turf quality in any of the plots.

**Table 1. *Bacillus thuringiensis* applications for control of Japanese beetle larvae on a golf course fairway. Pleasant Hill Golf Course, Perrysville, Ohio, 1996.**

| Treatment | Rate per acre | $\bar{x}$ Larvae/$ft^2$ 41 DAT | % Control |
|---|---|---|---|
| MYX - 910 111F | 8.8 gal. | 1.2 c | 94 |
| MYX - 942 100G | 6.0 lb. | 8.2 bc | 62 |
| MYX - 942 104G | 6.0 lb. | 10.5 b | 51 |
| MYX - 942 106G | 6.0 lb. | 8.3 bc | 62 |
| Dylox 6.2G | 8.0 lb.ai | 1.6 c | 93 |
| CHECK | | 21.7 a | |

Applied August 19 to plots 10 x 10 ft replicated 4x. Spray volume 2 gal/1000$ft^2$. Posttreatment irrigation 1/4 inch. Data taken October 1 based on 6, 7 x 7 inch samples from each plot. ANOVA and LSD based on plot sum. Means followed by the same letter are not significantly different at $P = 0.05$.

# Curative Control of Masked Chafer Larvae in Turfgrass—1996

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Entomology

## Methods and Materials

Treatments were applied August 21 to plots 10 x 10 ft. arranged in a randomized complete-block design replicated four times. The experiment was located on the lawns of the Ohio Agricultural Research and Developmental Center, Wooster, Ohio. Liquid treatments were applied with a $CO_2$ sprayer, Teejet 8010VS nozzles, and 35 psi. delivering 3 gal./1000 ft$^2$ and granules were applied with a shaker jar. The entire experimental area received 1/2 inch irrigation after all treatments were applied. The area received no further supplemental irrigation.

Field conditions at the time of treatment were as follows:

(1) Northern Masked Chafer—100% 2nd instar larvae.
(2) Turf—60% Kentucky bluegrass, 30% annual bluegrass, 10% others; grass height 2.5 inch; no thatch.
(3) Soil—moist; 79°F at 1 inch and 77°F at 3 inch deep; no soil analysis.
(4) Weather—mostly sunny; 80°F; 0-5 mph wind.

Efficacy data were obtained October 1 (41 DAT) by counting the number of live larvae in six 7 x 7 inch samples from each plot. Analysis of variance was done on plot totals transformed to log (X+1) and means separated by LSD test at *P* = 0.05.

## Results

At the time of the October 1 sampling Japanese beetle larvae comprised 15% of the population. Triumph 4E and Dylox 6.2G were the only treatments that yielded significant reduced the white grubs population.

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

**Table 1. Application of insecticides for curative control of masked chafer larvae in turfgrass. OARDC Campus, Wooster, Ohio, 1996.**

| Material[a] | Rate lb. ai/Acre | $\bar{x}$ larvae/ft$^2$ | % Control |
|---|---|---|---|
| Triumph 4E | 2.0 | 0.1c | 99 |
| Pinpoint 15G | 5.0 | 17.1a | 0 |
| Orthene TTO | 5.0 | 12.1ab | 4 |
| Orthene TTO + | 5.0+ | | |
| Tame 2.4EC | 0.3 | 14.1a | 0 |
| Dylox 6.2G | 8.0 | 5.0b | 60 |
| Cruiser | 10.0$^9$/acre | 16.5a | 0 |
| Check | -.-- | 12.6a | --- |

[a] Applied August 21 to plots 10 x 10 ft replicated 4x. Spray volume 3 gal/1000ft$^2$. Posttreatment irrigation ½ inch. Data taken October 1 based on six 7 x 7 inch samples from each plot. Plot totals transformed to log(X=1) for ANOVA and LSD at *P* = 0.05. Means followed by the same letter are not significantly different.

# A Field Test of RH-0345 2SC and 2.5G at 2.0 lb.ai/Acre and Merit 75WP at 0.3 lb. ai/Acre for Control of Black Cutworm Larvae on Golf Course Greens

Harry D. Niemczyk
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## Study Objective

Determine the duration of efficacy for a single early spring application of RH-0345 2SC and 2.5G (halofenozide) at 2.0 lb ai/a and Merit 5W (imidacloprid) at 0.3 lb ai/a for control of black cutworm larvae in golf course greens.

Table 1 contains a list of the treatment sites and programs followed.

**Table 1. List of treatment programs and cooperators in evaluation of RH-0345 and Merit.**

| Treatment Program | Cooperators | Total Test Area $ft^2$ | Untreated Check Areas |
|---|---|---|---|
| RH-0345 - 2.5G PREVENTIVE | Tom Walker, CGCS, Supt.<br>Inverness Club<br>Toledo, OH 43651 | 35,000-RH0345<br>46,900-MERIT | 25,000 $ft^2$ (nursery & chipping green) |
| RH-0345 - 2SC CURATIVE | Phil Williams, Supt.<br>College of Wooster Golf Course<br>College of Wooster Stadium<br>Wooster, OH 44691 | 33,000-RH-0345 | 4,000 $ft^2$ (pitching green + No. 9 green) |
| RH-0345 - 2SC PREVENTIVE | Steve Numbers, Supt.<br>"New Course" Westfield Country Club<br>Westfield Center, OH 44251 | 100,000-RH-0345<br>100,000-MERIT | 5,000 $ft^2$ (nursery + No. 3 tee) |
| RH-0345 - 2SC PREVENTATIVE | John Laake, CGCS, Supt.<br>Hyde Park Country Club<br>Cincinnati, OH 45208 | 75,000-RH0345<br>75,000-MERIT | 4,000 $ft^2$ (chipping greens) |
| RH-0345 - 2SC PREVENTATIVE | Brian Chalifoux<br>Fort Wayne Country Club<br>Fort Wayne, IN 46815-5351 | 48,000-RH-0345<br>40,000-MERIT | 5,500 (3 chipping greens) |

## Overview of the Test Program

RH-0345 was to be applied to at least nine course greens and Merit to nine greens, plus whatever adjacent turf surfaces are normally treated for cutworm-bird damage control. A single treatment was to be applied. The cooperating superintendent inspected the treated greens from time to time to evaluate and record the status of cutworm presence, damage and/or bird activity.

If, at any time, the superintendent believed that the treatment was not providing adequate control of damage, a decision was made as to whether to retreat or differ treatment. If further treatment was made, the program was discontinued, and the superintendent was free to apply whatever materials he deemed necessary.

## Results & Discussion

Results of the field test program in this report are presented as individual reports on each cooperating golf course. Presented for each is: general information about the course and cooperating superintendent; a table summarizing the record of treatment application and damage ratings; a general summary, overview and opinion are given at the end of the total report.

### Inverness Golf Club, Toledo, Ohio

The Inverness Golf Club is a private 18-hole course that hosted the PGA tournament in 1986 and U.S. OPEN in 1993. The superintendent, Tom Walker, CGCS, has high standards for the course and has been superintendent since 1980. Mr. Walker is a careful and thorough observer, environmentally conscientious, and employs IPM principles, applying insecticides to the greens only when necessary. Generally, four to five applications are needed to control sod webworm, cutworm and bird damage. Damage from overwintered sod webworm larvae is the primary spring problem on the greens of this course. The record of treatments and damage ratings are presented in Table 2.

**Table 2. Record of treatment applications and damage rating. The Inverness Golf Club, Toledo, Ohio, 1996.**

| Damage Rating[a] | | | Rating | Treatment | Application |
|---|---|---|---|---|---|
| Merit | RH-0345 | Check | Date | Applied | Date |
| 0 | 0 | 0 | 5/1/96 | | |
| | | | | MERIT 75WP | 5/2/96 |
| 1SWW | | | 5/8/96 | | |
| 2SWW | 3SWW | 3SWW | 5/20/96 | RH-0345 2.5G | 5/20/96 |
| 2SWW | 3SWW | | 5/22/96 | | |
| 3SWW | 3SW | | 5/30/96 | | |
| 1SWW | 1SWW | | 6/7/96 | | |
| 1SWW | 1SWW | 1SWW | 6/15/96 | | |
| 1SWW | 2SWW | 1SWW | 7/1/96 | | |
| 3SWW | 3SWW | 3SWW | 7/15/96 | CRUSADE® 5G | 7/15/96 |
| 1CW | 1CW | 2CW | 7/25/96 | | |
| 1CW | 1CW | 4CW | 8/10/96 | | |

[a] Cutworm (CW)/ sod webworm (SWW)/ bird (B) damage rating: 0 = none; 1 = little; 2 = some; 3 = moderate; 4 = significant; 5 = severe.

**Summary.** Nine greens were treated May 2 with Merit 75WP. Due to a delay in receiving product, the remaining nine test greens were not treated with RH-0345 2.5G until May 20. At that time, there was no evidence of CW activity on any of the greens, but SWW damage was evident, especially on the greens that were to be treated with RH-0345. Merit provided some degree of SWW control thru July 1. There was no evidence of similar control from RH-0345 ten days after application. By June 15, SWW damage diminished in the check areas and all test greens. SWW damage reoccurred on all greens July 15 and Crusade was applied. This treatment apparently controlled the SWW infestation. The first evidence of CW damage appeared July 25.

No dead BTA adults occurred on the check area surfaces throughout the test but live adults (1-3/$ft^2$) were commonly recorded. Dead BTA adults (2/$ft^2$) were common thrrough May on greens treated May 2 with Merit. Similar numbers (2-3/$ft^2$) were recorded through May 30 after the May 20 application of RH-0345.

**Conclusion.** The May 2 application of Merit provided an acceptable level of SWW control. There was no evidence of SWW control following the May 20 application of RH-0345. No conclusions regarding CW control are possible.

The presence of dead BTA adults following treatments indicated both Merit and RH-0345 2.5 caused significant adult mortality.

## Westfield Country Club "New Course," Westfield Center, Ohio

The "New Course" is one of two private 18-hole courses of the Westfield Country Club, located 20 miles north of Wooster. Both courses are owned by the Westfield Insurance Companies. Steve Numbers has been superintendent since the "New Course" was built in 1989. Normally, two applications of insecticide (Dursban), one in late June - early July, and one in late summer when greens are aerified, are needed to control cutworm/bird damage.

The record of treatments and damage ratings are presented in Table 3.

**Table 3. Record of treatment applications and damage rating. "New Course," Westfield Country Club, Westfield Center, Ohio, 1996.**

| Damage Rating[a] | | | Rating | Treatment | Application |
|---|---|---|---|---|---|
| Merit | RH-0345 | Check | Date | Applied | Date |
| 0 | 0 | 0 | 5/8/96 | MERIT 75WP & RH0345 2SC | 5/8/96 |
| 0 | 0 | 0 | 5/15/96 | | |
| 0 | 0 | 0 | 5/31/96 | | |
| 0 | 0 | 1 | 6/10/96 | | |
| 0 | 0 | 3CW,B | 6/17/96 | | |
| 0 | 0 | 4 | 6/20/96 | | |
| 3CW | 2CW | | 7/22/96 | | |
| 4CW | 4CW | | 7/24/96 | | |
| 4CW | 4CW | | 7/28/96 | TEMPO | 7/28/96 |

[a] Cutworm (CW)/bird (B) damage rating: 0 = none; 1 = little; 2 = some; 3 = moderate; 4 = significant; 5 = severe.

**Summary.** Nine greens were treated May 8 with RH-0345 and nine with Merit. No CW or B damage was evident at that time. All tees except No. 3, which was used as the check in this test, were treated May 23 with Merit 75WP. These treated tees required retreatment June 16 to stop further CW damage. CW damage on the untreated tee (No. 3) began to appear June 10 and intensified thru June. The treated greens showed no damage until July 22. Tempo was applied July 28 to prevent further damage to the test greens.

The superintendent reported no evidence of living or dead black turfgrass ataenius (BTA) adults on the test or check areas.

**Conclusion.** The test clearly showed RH=0345 and Merit protected the treated greens from the mid June CW infestation that developed on the tees treated May 23 with Merit. This experience also indicated that the May 23 application of Merit was "too late." Merit and RH-0345 provided CW control until late July in this test.

Though there was no clear evidence of BTA adult mortality on the treated greens, none developed an infestation of BTA larvae. All fairways are (and were) treated in May with Dursban to protect against a larval infestation that will occur if treatment is not applied.

**Hyde Park Country Club, Cincinnati, Ohio**

Hyde Park Country Club is an 18-hole private golf course within the city of Cincinnati. The superintendent, John Laake, CGCS, was a GCSAA director and past president of the Ohio Turfgrass Foundation. He has been superintendent at Hyde Park for five years. Mr. Laake demands high quality on the golf course, especially greens. Levels of cutworm damage considered tolerable on other courses are considered unacceptable at Hyde Park.

Generally, the Cincinnati area annually experiences significant infestations of black cutworm larvae on greens and bentgrass fairways. Two, and sometimes three or four, applications of insecticides are used to control damage from birds and/or cutworms.

**Table 4. Record of treatment applications and damage rating. Hyde Park Country Club, Cincinnati, Ohio, 1996.**

| Damage Rating[a] | | | Rating | Treatment | Application |
|---|---|---|---|---|---|
| Merit | RH-0345 | Check | Date | Applied | Date |
| 0 | 0 | 0 | 5/6/96 | Merit 75WP & RH-0345 2SC | 5/6/96 |
| 0 | 0 | 0 | 5/15/96 | | |
| 0 | 0 | 0 | 5/31/96 | | |
| 0 | 0 | 0 | 6/7/96 | | |
| 2 | 0 | 0 | 6/8/96 | | |
| 1CW | 1CW | 0 | 6/10/96 | | |
| 3CW | 2CW | 0 | 6/13/96 | | |
| 4CW | 3CW | 0 | 6/17/96 | | |
| 4CW | 3CW | 0 | 6/30/96 | | |
| 5CW | 3CW | 0 | 7/1/96 | Dursban Pro | 7/1/96 |

[a] Cutworm (CW)/bird (B) damage rating: 0 = none; 1 = little; 2 = some; 3 = moderate; 4 = significant; 5 = severe.

**Summary.** Nine greens were treated May 6 with RH0345 and nine with Merit. No bird or CW damage was observed at that time. CW damage began appearing on all test greens June 10. Damage on the Merit treated greens intensified throughout June and probably should have been treated by June 7 (according to the superintendent). Damage on the RH-0345 treated greens stabilized to a tolerable level through June. The superintendent reported that "the RH-0345 greens looked better than Merit greens for all of June." Damage to the RH-0345 greens was still tolerable July 1, but intolerable on those treated with Merit. All test greens were treated with Dursban July 1. No damage occurred to the test greens.

The superintendent reported no evidence of living or dead black turfgrass ataenius (BTA) adults on the test or check greens.

**Conclusion.** Both treatments provided cutworm control thru the last of May and early June when cutworm damage usually occurs in Cincinnati. However, RH-0345 provided control through June and Merit did not.

No conclusion regarding BTA adult control is possible, however, none of the treated greens experienced a BTA larval infestation.

**Fort Wayne Country Club, Fort Wayne, Indiana**

The Fort Wayne Country Club is a private 18-hole course. Brian Chalifoux, CGCS, superintendent since 1985, must maintain high course standards. In addition to May application of Dursban for control of Black Turfgrass Ataenius adults, two additional applications of insecticide are annually applied to greens and tees for control of cutworm and other insects. The Fort Wayne Country Club ranks among the top clubs in Indiana.

**Summary.** Nine greens were treated April 25 with RH-0345 2SC and nine with MERIT 75WP. Unfortunately, all test greens were overtreated with Dursban Pro May 24. This treatment terminated the evaluation. Observations made between April 24 and May 24 showed neither evidence of CW damage, nor living or dead BTA adults on the treated or check greens.

**Conclusion.** Test canceled.

# *Turfgrass Disease Control*

# Dollar Spot Control Study—1996

Karl Danneberger, Joseph Rimelspach, Michael Boehm, and Jill Taylor
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## Introduction

On July 1, 1996, a dollar spot (*Sclerotinia homoeocarpa*) control study was initiated at the Ohio State Turfgrass Research Center, Columbus, Ohio. The turf was "Penncross" creeping bentgrass maintained at 3/16-inch height and mowed daily with a walk-behind greens mower. The turf was grown on Brookston silty-clay loam, modified with off-site fill with little thatch present. The treatments were applied with a hand held $CO_2$ pressurized sprayer with two 8010 nozzle tips, spaced 18 inches apart, at 40 psi. The treatments were replicated three times. The plots measured 3 x 6 ft with an untreated 6-inch border between each plot. The treatment schedule was the following:

| | Fungicide Treatment Interval | | | |
|---|---|---|---|---|
| Date | 7 day | 14 day | 21 day | 28 day |
| July 1 | X | X | X | X |
| July 8 | X | | | |
| July 15 | X | X | | |
| July 22 | X | | X | |
| July 29 | X | X | | X |
| August 5 | X | | | |
| August 13 | X | X | X | |
| August 19 | X | | | X |
| August 26 | X | X | | |

## Results

Due to the cooler summer, dollar spot occurred earlier in the year than normally in our studies. Three ratings during the course of the year were made for dollar spot. The first two ratings consisted of counting the dollar spot symptoms per plot while the last rating was based on percent infected area. The readings were taken when disease was present. The following table represents the days after treatment (DAT) and the accumulated number of sprays up to that date.

| Fungicide Interval (days) | Days after Treatment (DAT) | | | Accumulated no. of sprays | | |
|---|---|---|---|---|---|---|
| | 7/23 | 8/1 | 8/26 | 7/23 | 8/1 | 8/26 |
| 7 | 1 | 2 | 7 | 4 | 5 | 8 |
| 14 | 8 | 2 | 14 | 2 | 3 | 4 |
| 21 | 1 | 9 | 14 | 2 | 2 | 3 |
| 28 | 22 | 2 | 7 | 1 | 2 | 3 |

The fungicide ranking in Table 1 is based on the August 26 rating. Variability in control among products may have occurred because of the varying DAT rating dates. In general, a number of products and combinations of products worked well for dollar spot control.

**Table 1. Evaluation of fungicides for the control of dollar spot on "Penncross" creeping bentgrass turf maintained at 3/16-inch.**

| Treatment | Rate (oz/M) | Application Interval | Number of Dollar Spots 7/23 | Number of Dollar Spots 8/1 | Infected Area (%) 8/26 |
|---|---|---|---|---|---|
| Sentinel 40WG | 0.167 | 14 (alternate) | 0.0 | 0.0 | 0.0 |
| Daconil Ultrex | 3.8 | | | | |
| EXP10682(4STG-122) | 3.4 | 14 | 0.0 | 3.0 | 0.0 |
| Chipco 26019 FLO+ Banner Maxx | 2.0+0.5 | 14 | 0.0 | 0.0 | 0.0 |
| Banner Maxx | 2.0 | 14 | 0.0 | 0.0 | 0.0 |
| CGA-BMP | 0.56 | 14 | 0.0 | 0.0 | 0.0 |
| CGA-BMP | 1.14 | 14 | 0.0 | 0.0 | 0.0 |
| Chipco 26019 FLO+ Cleary 33336 | 2.0+0.5 | 14 | 0.0 | 0.0 | 0.0 |
| EXP 10673A | 6.0 | 14 | 0.0 | 1.0 | 0.0 |
| EXP 10673A | 12.0 | 14 | 0.0 | 0.0 | 0.0 |
| Eagle 40 WP | 0.6 | 14 | 0.0 | 0.0 | 0.0 |
| Eagle 40 WP | 1.2 | 14 | 0.0 | 0.0 | 0.0 |
| Thalonil 4L + Eagle 40 WP | 6.0+0.6 | 14 | 0.0 | 0.0 | 0.0 |
| Thalonil 90 DF + Eagle 40 WP | 3.5+0.6 | 14 | 0.0 | 0.0 | 0.0 |
| Thalonil 90 DF + Banner Maxx | 6.0+2.0 | 21 | 0.0 | 0.0 | 0.0 |
| Thalonil 4L + Bayleton 25DF | 6.0+1.0 | 21 | 0.0 | 0.0 | 0.0 |
| Banner Maxx | 1.0 | 21 | 3.0 | 0.0 | 0.0 |
| Eagle 40 WP | 0.6 | 28 | 3.3 | 0.0 | 0.0 |
| CGA-BMP | 0.56 | 21 | 3.3 | 0.0 | 0.0 |
| Thalonil 4L + Lynx 25 DF | 6+0.75 | 21 | 0.0 | 0.0 | 0.0 |
| Bayleton 25 WG | 1.0 | 21 | 0.0 | 15.0 | 0.0 |
| Eminent SL | 0.7 | 14 | 0.0 | 0.0 | 0.0 |
| Sentinel 40WG + Rizolex | 0.167+2.5 | 21 | 1.3 | 0.0 | 0.0 |
| Chipco 26019 FLO + Bayleton 25 WG | 2.0+0.5 | 14 | 0.0 | 0.3 | 0.0 |
| Daconil Ultrex | 3.8 | 7 | 0.3 | 0.0 | 0.0 |
| Daconil ZN | 6.0 | 7 | 0.0 | 2.0 | 0.0 |
| Sentinel 40WG | 0.167 | 21 | 1.7 | 0.0 | 0.0 |
| Lynx 25 DF | 0.5 | 21 | 10.7 | 7.3 | 0.0 |
| Lynx 25 DF | 0.75 | 21 | 16.3 | 2.0 | 0.0 |
| Lynx 25 DF | 1.0 | 21 | 6.7 | 5.3 | 0.0 |
| Lynx 250 EW | 0.721 | 21 | 24.3 | 0.0 | 0.0 |
| Daconil Ultrex + | 3.8 | 14(alternate) | 4.7 | 2.7 | 0.0 |
| Sentinel 40WG | 0.167 | | | | |
| Bayleton 25 WG + Prostar 50WP | 1.0+2.0 | 28 | 0.0 | 2.7 | 0.0 |
| Bayleton 25 WG | 1.0 | 28 | 17.7 | 10.7 | 0.0 |
| Bayleton 25 WG + Heritage 50WG | 1.0+0.2 | 28 | 74.3 | 66.7 | 0.0 |

**Table 1 (continued). Evaluation of fungicides for the control of dollar spot on "Penncross" creeping bentgrass turf maintained at 3/16-inch.**

| Treatment | Rate (oz/M) | Application Interval | Number of Dollar Spots 7/23 | Number of Dollar Spots 8/1 | Infected Area (%) 8/26 |
|---|---|---|---|---|---|
| EXP10715A + EXP10702A (8/13) | 4.0+4.0 | 14 | --.- | --.- | 0.0 |
| Chipco 26019 FLO | 4.0 | 14 | 0.0 | 0.0 | 0.7 |
| Bayleton 25 WG + Thalonil 90DF | 0.5+1.67 | 14 | 0.7 | 1.7 | 0.7 |
| Banner Maxx + Daconil Ultrex | 1.0+3.8 | 14 | 0.0 | 0.0 | 0.7 |
| EXP10682(4STG-124) | 3.4 | 14 | 2.3 | 17.0 | 1.7 |
| EXP10715A + EXP10702A | 4.0<br>4.0 | 14(alternate) | 6.3 | 24.0 | 1.7 |
| IB11924 | 2.75 | 7 | 2.7 | 0.0 | 1.7 |
| Chipco 26019 FLO + Daconil Ultrex | 2.0+3.0 | 14 | 4.3 | 30.7 | 1.7 |
| EXP10682(4STG-123) | 1.7 | 14 | 41.0 | 34.3 | 1.7 |
| Chipco 26019 FLO | 3.0 | 14 | 0.7 | 29.0 | 2.3 |
| ConSyst WDG | 4.0 | 14 | 0.0 | 1.7 | 3.3 |
| Chipco 26019 FLO+ Heritage | 2.0+0.2 | 14 | 14.3 | 33.0 | 4.7 |
| Chipco 26019 WDG | 2.0 | 14 | 0.0 | 0.0 | 5.0 |
| Echo 75WDG | 8.5 | 14 | 0.0 | 0.0 | 5.0 |
| Chipco 26019 WDG | 1.5 | 14 | 4.0 | 10.0 | 5.0 |
| EXP10682(4STG-123) | 3.4 | 14 | 14.0 | 20.3 | 5.0 |
| Eagle 40 WP | 1.2 | 28 | 60.0 | 60.0 | 6.7 |
| EXP10682(4STG-122) | 1.7 | 14 | 24.0 | 58.7 | 8.3 |
| EXP10682(4STG-124) | 1.7 | 14 | 26.0 | 30.0 | 8.3 |
| Sentinel 40WG + Daconil Ultrex | 0.167<br>3.8 | 21(alternate) | 7.3 | 9.7 | 10.0 |
| Aliette WDG + Fore WP | 4.0+8.0 | 14 | 95.0 | 97.0 | 11.7 |
| Fore 80 WP | 6.0 | 7 | 29.0 | 72.3 | 11.7 |
| Thalonil 4L | 6.0 | 14 | 42.0 | 43.3 | 15.0 |
| Daconil 2787 F | 6.0 | 14 | 58.0 | 80.0 | 16.7 |
| SysTec 1998 WDG | 1.0 | 21 | 1.3 | 21.0 | 16.7 |
| CGA 329351 + Daconil 2787 F | 1.0+6.5 | 14 | 52.3 | 16.3 | 16.7 |
| Chipco 26019 FLO | 2.0 | 14 | 27.7 | 55.7 | 18.3 |
| Heritage 50 WG | 0.2 | 28 | 88.3 | 140.0 | 21.7 |
| EXP10702A + Aliette WDG | 4.0<br>4.0 | 14(alternate) | 47.0 | 48.3 | 21.7 |
| Thalonil 90 DF | 3.5 | 14 | 116.0 | 143.3 | 21.7 |
| Prostar | 2.0 | 14 | 89.3 | 163.3 | 21.7 |
| EXP10715A | 4.0 | 14 | 92.7 | 124.7 | 25.0 |
| Echo 720F | 8.0 | 14 | 2.0 | 25.7 | 25.0 |
| IB11924 | 2.75 | 14 | 38.0 | 32.7 | 28.3 |
| EXP10715A+ Dithane | 8.0+8.0 | 14 | 107.3 | 127.0 | 28.3 |
| CGA 173506 | 0.5 | 14 | 38.7 | 57.3 | 28.3 |
| Heritage 50 WG | 0.2 | 21 | 77.0 | 134.7 | 33.3 |

**Table 1 (continued). Evaluation of fungicides for the control of dollar spot on "Penncross" creeping bentgrass turf maintained at 3/16-inch.**

| Treatment | Rate (oz/M) | Application Interval | Number of Dollar Spots 7/23 | 8/1 | Infected Area (%) 8/26 |
|---|---|---|---|---|---|
| EXP10715A+ Dithane | 4.0+4.0 | 14 | 71.0 | 153.3 | 35.0 |
| Thalonil 4L + Aliette 80 WDG | 6.0+4.0 | 14 | 52.3 | 49.3 | 35.0 |
| Control | --.- | --- | 131.7 | 180.0 | 37.3 |
| Daconil Ultrex + EXP10715A | 3.0+4.0 | 14(alternate) | 86.0 | 70.3 | 40.0 |
| EXP10715A | 8.0 | 14 | 107.0 | 163.3 | 40.0 |
| Rizolex 75 WP | 2.5 | 21 | 57.7 | 123.3 | 40.0 |
| EXP10704A+ Dithane | 4.0+4.0 | 14 | 94.0 | 113.3 | 41.7 |
| Prostar | 3.0 | 21 | 135.7 | 168.3 | 43.3 |
| Control | --.- | --- | 89.0 | 170.0 | 45.0 |
| Prostar 50 WP | 2.0 | 28 | 138.0 | 180.0 | 46.7 |
| Daconil ZN | 6.0 | 14 | 40.0 | 43.3 | 46.7 |
| Prostar Plus | 2.5 | 21 | 63.7 | 120.7 | 50.0 |
| Control | --.- | --- | 140.0 | 180.3 | 50.0 |
| Daconil Ultrex | 3.8 | 14 | 61.0 | 81.7 | 53.3 |
| CGA 173506 | 0.25 | 7 | 88.7 | 110.7 | 53.3 |
| LSD (0.05) | | | 55.6 | 62.5 | 20.0 |

# Quality Ratings for Various Fungicide Treatments on Creeping Bentgrass Putting Green Turf

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## Introduction

In conjunction with the dollar spot control study, evaluation for the presence of any phytotoxicity or turfgrass decline was taken. On July 1, 1996, a dollar spot (*Sclerotinia homoeocarpa*) control study was initiated at the Ohio State Turfgrass Research Center, Columbus, Ohio. The turf was "Penncross" creeping bentgrass maintained at 3/16-inch height of cut. The turf was mowed daily with a walk-behind greens mower. The turf was grown on Brookston silty-clay loam modified with off-site fill, and little thatch was present. The treatments were applied with a hand-held $CO_2$ pressurized sprayer with two 8010 nozzle tips, spaced 18 inches apart, at 40 psi. The treatments were replicated three times. The plots measured 3 x 6 ft with an untreated 6-inch border between each plot. The treatment schedule was the following:

**Fungicide Treatment Interval**

| Date | 7 day | 14 day | 21 day | 28 day |
|---|---|---|---|---|
| July 1 | X | X | X | X |
| July 8 | X | | | |
| July 15 | X | X | | |
| July 22 | X | | X | |
| July 29 | X | X | | X |
| August 5 | X | | | |
| August 13 | X | X | X | |
| August 19 | X | | | X |
| August 26 | X | X | | |

Quality ratings were made to determine if any detrimental or phytotoxic effects occurred with fungicide applications. The quality ratings do not reflect the amount of disease that may be in the plot. No phytotoxic effects were observed with any of the fungicide treatments. EXP 10673 caused a short-term yellowing of the turf after application. The effect lasted less than three days. At the end of the study (8/26) reading date, a bluish turf color was observed with some of the fungicide treatments (denoted by a reading of 7). No density decrease was noted, just a change in the color.

**Table 1. Phytotoxicity ratings for the various fungicides tested for dollar spot control.**

| Treatment | Rate (oz/M) | Application Interval | Quality (1 to 9; 9=highest quality) 7/23 | 8/1 | 8/26 |
|---|---|---|---|---|---|
| Aliette WDG + Fore WP | 4.0+8.0 | 14 | 8.0 | 8.0 | 8.7 |
| Banner Maxx | 2.0 | 14 | 8.3 | 9.0 | 7.0 |
| Banner Maxx+Daconil Ultrex | 1.0+3.8 | 14 | 8.0 | 8.3 | 8.7 |
| Banner Maxx | 1.0 | 21 | 8.0 | 8.7 | 8.7 |
| Bayleton 25 WG + Prostar 50WP | 1.0+2.0 | 28 | 7.7 | 8.0 | 8.7 |
| Bayleton 25 WG + Heritage 50WG | 1.0+ 0.2 | 28 | 8.0 | 8.0 | 8.7 |
| Bayleton 25 WG | 1.0 | 28 | 8.0 | 8.3 | 8.7 |
| Bayleton 25 WG | 1.0 | 21 | 8.3 | 8.3 | 8.7 |
| Bayleton 25 WG + Thalonil 90DF | 0.5+1.67 | 14 | 8.3 | 8.0 | 8.7 |
| CGA-BMP | 0.56 | 21 | 8.3 | 8.3 | 8.7 |
| CGA-BMP | 0.56 | 14 | 8.3 | 9.0 | 7.0 |
| CGA-BMP | 1.14 | 14 | 8.3 | 8.7 | 7.0 |
| CGA 173506 | 0.25 | 7 | 8.3 | 8.0 | 8.7 |
| CGA 173506 | 0.5 | 14 | 8.0 | 8.0 | 8.7 |
| CGA 329351+ Daconil 2787F | 1.0+ 6.5 | 14 | 7.7 | 8.0 | 8.7 |
| Chipco 26019 FLO | 4.0 | 14 | 8.3 | 8.0 | 8.7 |
| Chipco 26019 FLO | 3.0 | 14 | 8.7 | 8.0 | 8.7 |
| Chipco 26019 FLO | 2.0 | 14 | 8.0 | 8.0 | 8.7 |
| Chipco 26019 FLO+ Banner Maxx | 2.0+0.5 | 14 | 8.0 | 8.0 | 8.7 |
| Chipco 26019 FLO+ Bayleton 25 WG | 2.0+0.5 | 14 | 8.7 | 8.0 | 8.7 |
| Chipco 26019 FLO + Cleary 3336 | 2.0+0.5 | 14 | 8.7 | 8.0 | 8.7 |
| Chipco 26019 FLO+ Heritage | 2.0+0.2 | 14 | 8.3 | 8.0 | 8.7 |
| Chipco 26019 FLO+ Daconil Ultrex | 2.0+3.0 | 14 | 8.3 | 8.7 | 8.7 |
| Chipco 26019 WDG | 1.5 | 14 | 8.0 | 8.0 | 8.7 |
| Chipco 26019 WDG | 2.0 | 14 | 8.0 | 8.0 | 8.7 |
| ConSyst WDG | 4.0 | 14 | 8.0 | 8.0 | 8.7 |
| Daconil 2787 F | 6.0 | 14 | 8.0 | 8.0 | 8.7 |
| Daconil Ultrex | 3.8 | 7 | 7.7 | 8.3 | 8.7 |
| Daconil Ultrex | 3.8 | 14 | 8.3 | 8.0 | 8.7 |
| Daconil ZN | 6.0 | 7 | 8.0 | 8.0 | 8.7 |
| Daconil ZN | 6.0 | 14 | 7.3 | 8.0 | 8.7 |
| Daconil Ultrex + Sentinel 40WG | 3.8 0.167 | 14(alternate) | 7.7 | 8.8 | 8.7 |
| Daconil Ultrex + EXP10715A | 3.0 4.0 | 14(alternate) | 7.3 | 8.0 | 8.7 |
| Eagle 40 WP | 0.6 | 14 | 8.3 | 8.0 | 8.7 |
| Eagle 40 WP | 0.6 | 28 | 8.7 | 8.0 | 8.7 |
| Eagle 40 WP | 1.2 | 14 | 8.7 | 8.0 | 8.7 |
| Eagle 40 WP | 1.2 | 28 | 8.0 | 8.0 | 8.7 |
| Echo 720F | 8.0 | 14 | 8.3 | 8.3 | 8.7 |

**Table 1 (continued). Phytotoxicity ratings for the various fungicides tested for dollar spot control.**

| Treatment | Rate (oz/M) | Application Interval | Quality (1 to 9; 9=highest quality) 7/23 | 8/1 | 8/26 |
|---|---|---|---|---|---|
| Echo 75WDG | 8.5 | 14 | 8.7 | 8.0 | 8.7 |
| Eminent SL | 0.7 | 14 | 8.7 | 8.0 | 8.7 |
| EXP10715A+Dithane | 4.0+4.0 | 14 | 8.0 | 8.0 | 8.7 |
| EXP10715A+Dithane | 8.0+8.0 | 14 | 8.0 | 8.0 | 8.7 |
| EXP10704A+Dithane | 4.0+4.0 | 14 | 8.3 | 8.0 | 8.7 |
| EXP10715A | 8.0 | 14 | 8.0 | 8.0 | 8.7 |
| EXP10702A | 4.0 | 14(alternate) | 7.7 | 8.0 | 7.0 |
| Aliette WDG | 4.0 | | | | |
| EXP10715A | 4.0 | 14(alternate) | 7.7 | 8.0 | 8.7 |
| EXP10702A | 4.0 | | | | |
| EXP10715A | 4.0 | 14 | 7.7 | 8.0 | 8.7 |
| EXP10682(4STG-122) | 1.7 | 14 | 8.3 | 8.0 | 8.7 |
| EXP10682(4STG-122) | 3.4 | 14 | 8.3 | 8.0 | 8.7 |
| EXP10682(4STG-123) | 1.7 | 14 | 8.0 | 8.0 | 8.7 |
| EXP10682(4STG-123) | 3.4 | 14 | 7.3 | 8.0 | 8.7 |
| EXP10682(4STG-124) | 1.7 | 14 | 8.0 | 8.0 | 8.7 |
| EXP10682(4STG-124) | 3.4 | 14 | 8.0 | 8.0 | 8.7 |
| EXP 10673A | 6.0 | 14 | 8.3 | 8.0 | 8.7 |
| EXP 10673A | 12.0 | 14 | 8.0 | 8.0 | 8.7 |
| Fore 80 WP | 6.0 | 7 | 8.0 | 8.3 | 8.7 |
| Heritage 50 WG | 0.2 | 21 | 8.0 | 8.0 | 8.7 |
| Heritage 50 WG | 0.2 | 28 | 8.0 | 8.0 | 8.7 |
| IB11924 | 2.75 | 7 | 8.0 | 8.0 | 8.7 |
| IB11924 | 2.75 | 14 | 8.3 | 8.0 | 8.7 |
| Lynx 25 DF | 0.5 | 21 | 8.3 | 8.0 | 8.7 |
| Lynx 25 DF | 0.75 | 21 | 8.3 | 8.0 | 8.7 |
| Lynx 25 DF | 1.0 | 21 | 8.3 | 8.3 | 8.7 |
| Lynx 250 EW | 0.721 | 21 | 8.3 | 8.0 | 8.7 |
| Prostar 50 WP | 2.0 | 28 | 7.0 | 8.0 | 8.7 |
| Prostar | 2.0 | 14 | 7.7 | 8.0 | 8.7 |
| Prostar | 3.0 | 21 | 7.7 | 8.0 | 8.7 |
| Prostar Plus | 2.5 | 21 | 7.3 | 8.0 | 8.7 |
| Rizolex 75 WP | 2.5 | 21 | 7.7 | 8.0 | 8.7 |
| Sentinel 40WG | 0.167 | 14 (alternate) | 8.7 | 8.3 | 8.7 |
| Daconil Ultrex | 3.8 | | | | |
| Sentinel 40WG | 0.167 | 21 | 8.0 | 8.7 | 7.0 |
| Sentinel 40WG + Rizolex | 0.167+2.5 | 21 | 8.7 | 8.7 | 7.0 |
| Sentinel 40WG + Daconil Ultrex | 0.167+ 3.8 | 21(alternate) | 8.7 | 8.0 | 8.7 |
| SysTec 1998 WDG | 1.0 | 21 | 8.3 | 8.0 | 8.7 |
| Thalonil 4L | 6.0 | 14 | 8.0 | 8.0 | 8.7 |
| Thalonil 90 DF | 3.5 | 14 | 7.7 | 8.0 | 8.7 |
| Thalonil 4L+ Aliette 80 WDG | 6.0+4.0 | 14 | 7.7 | 8.3 | 8.7 |
| Thalonil 4L + Eagle 40 WP | 6.0+0.6 | 14 | 8.7 | 8.3 | 8.7 |
| Thalonil 90 DF+ Eagle 40 WP | 3.5+0.6 | 14 | 8.3 | 8.3 | 8.7 |
| Thalonil 90 DF+ Banner Maxx | 6.0+2.0 | 21 | 8.7 | 8.3 | 8.7 |

**Table 1 (continued). Phytotoxicity ratings for the various fungicides tested for dollar spot control.**

| Treatment | Rate (oz/M) | Application Interval | Quality (1 to 9; 9=highest quality) 7/23 | 8/1 | 8/26 |
|---|---|---|---|---|---|
| Thalonil 4L+ Bayleton 25 DF | 6.0+1.0 | 21 | 8.0 | 8.0 | 8.7 |
| Thalonil 4L + Lynx 25 DF | 6.0+ 0.75 | 21 | 8.7 | 8.0 | 8.7 |
| Control | --.- | --- | 7.7 | 8.0 | 8.7 |
| Control | --.- | --- | 7.7 | 8.0 | 8.7 |
| Control | --.- | --- | 7.7 | 8.0 | 8.7 |
| LSD (0.05) | | | | 0.8 | ns |

# Brown Patch Control Study on Creeping Bentgrass Turf—1996

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## Introduction

On July 1, 1996, a brown patch (*Rhizoctonia solani*) control study was initiated at the Ohio State Turfgrass Research Center, Columbus, Ohio. The turf was "Penncross" creeping bentgrass maintained at 3/16-inch height of cut. The turf was mowed daily with a walk-behind greens mower. The turf was grown on Brookston silty-clay loam modified with off-site fill and little thatch was present. The treatments were applied with a hand-held $CO_2$ pressurized sprayer with two 8010 nozzle tips, spaced 18 inches apart, at 40 psi. The treatments were replicated three times. The plots measured 3 x 6 ft with an untreated 6-inch border between each plot. The treatment schedule was the following:

| Date | Fungicide Treatment Interval 7 day | 14 day | 21 day | 28 day |
|---|---|---|---|---|
| July 1 | X | X | X | X |
| July 8 | X | | | |
| July 15 | X | X | | |
| July 22 | X | | X | |
| July 29 | X | X | | X |
| August 5 | X | | | |
| August 13 | X | X | X | |
| August 19 | X | | | X |

After the treatments were initiated, the plot area was irrigated four times a day to keep the turf wet. Given the cooler than normal temperatures, the increased moisture tended to increase the severity of brown patch, especially during the August 8 and 12 reading dates.

## Results

Four ratings during the course of the year were made for brown patch. The rating was based on a scale of 1 to 5 (1 being no brown patch and 5 being severe). As a general rule, a rating of 2.0 or less is acceptable control for putting green turf. The readings were taken when disease was present. The following table represents the days after treatment (DAT) and the accumulated number of sprays up to that date.

| Fungicide Interval (days) | Days after Treatment (DAT) 7/30 | 8/8 | 8/12 | 8/22 | Accumulated no. of sprays 7/30 | 8/8 | 8/12 | 8/26 |
|---|---|---|---|---|---|---|---|---|
| 7 | 1 | 3 | 7 | 3 | 5 | 5 | 6 | 7 |
| 14 | 1 | 9 | 14 | 9 | 3 | 3 | 3 | 4 |
| 21 | 8 | 16 | 21 | 9 | 2 | 2 | 2 | 3 |
| 28 | 1 | 9 | 14 | 3 | 2 | 2 | 2 | 3 |

The brown patch that occurred in our study was from a natural infection of *Rhizoctonia solani*. We did detect in two of the readings a block effect, which was caused by one block not having the brown patch pressure observed in other two blocks. Variation in product performance was attributed, in a large part, to the DAT. As a preventative program, a number of fungicides showed good control of brown patch. The new compounds, Heritage, CGA-BMP, CGA173506, Lynx, chlorothalonil products, and Chipco 26019, all performed well at the proper rate.

**Table 1. Brown patch severity on "Penncross" creeping bentgrass turf maintained at 3/16-inch.**

| Treatment | Rate (oz/M) | Application Interval | Brown Patch Severity[a] 7/30 | 8/8 | 8/12 | 8/22 |
|---|---|---|---|---|---|---|
| Heritage 50 WG | 0.2 | 28 | 1.0 | 1.0 | 1.0 | 1.0 |
| Sentinel 40WG | 0.167 | 14 (alternate) | 1.0 | 1.3 | 1.0 | 1.0 |
| Daconil Ultrex | 3.8 | | | | | |
| Bayleton 25 WG+ Heritage 50WG | 1.0+0.2 | 28 | 1.0 | 1.7 | 1.7 | 1.0 |
| CGA-BMP | 1.14 | 14 | 1.0 | 1.0 | 1.0 | 1.0 |
| CGA 173506 | 0.25 | 7 | 1.0 | 1.0 | 1.0 | 1.0 |
| Chipco 26019 FLO+ Heritage | 2.0+0.2 | 14 | 1.0 | 1.0 | 1.0 | 1.0 |
| Chipco 26019 WDG | 2.0 | 14 | 1.0 | 1.0 | 1.0 | 1.0 |
| Lynx 250 EW | 0.721 | 21 | 1.0 | 1.0 | 1.0 | 1.0 |
| EXP 10673A | 12.0 | 14 | 1.0 | 1.0 | 1.0 | 1.3 |
| Sentinel 40WG | 0.167 | 21 | 1.0 | 1.0 | 1.3 | 1.0 |
| Sentinel 40WG + Rizolex | 0.167+2.5 | 21 | 1.0 | 1.0 | 1.3 | 1.0 |
| Lynx 25 DF | 0.75 | 21 | 1.0 | 1.0 | 1.7 | 1.0 |
| Prostar | 2.0 | 14 | 1.0 | 1.0 | 1.3 | 1.7 |
| Prostar | 3.0 | 21 | 1.0 | 1.0 | 1.0 | 1.0 |
| Prostar Plus | 2.5 | 21 | 1.0 | 1.0 | 1.3 | 1.0 |
| EXP10682 (4STG-124) | 1.7 | 14 | 1.0 | 1.0 | 2.0 | 1.0 |
| Thalonil 4L + Eagle 40 WP | 6.0+0.6 | 14 | 1.0 | 1.3 | 1.3 | 1.0 |
| Prostar 50 WP | 2.0 | 28 | 1.0 | 1.3 | 1.0 | 1.0 |
| Sentinel 40WG | 0.167 | 21(alternate) | 1.0 | 1.7 | 2.0 | 2.3 |
| Daconil Ultrex | 3.8 | | | | | |
| EXP10715A | 4.0 | 14(alternate) | 1.0 | 2.3 | 3.7 | 2.7 |
| EXP10702A | 4.0 | | | | | |
| Thalonil 4L + Lynx 25 DF | 6.0+0.75 | 21 | 1.0 | 1.0 | 1.3 | 1.0 |
| EXP10682(4STG-122) | 3.4 | 14 | 1.0 | 1.7 | 1.0 | 1.3 |
| Eminent SL | 0.7 | 14 | 1.0 | 1.0 | 1.3 | 1.3 |
| EXP10715A | 8.8 | 14 | 1.0 | 1.7 | 3.3 | 3.3 |
| Thalonil 90 DF + Eagle 40 WP | 3.5+0.6 | 14 | 1.0 | 2.3 | 3.3 | 1.3 |
| Thalonil 90 DF + Banner Maxx | 6.0+2.0 | 21 | 1.0 | 2.0 | 2.3 | 1.0 |
| Daconil ZN | 6.0 | 14 | 1.0 | 1.3 | 1.0 | 2.0 |
| EXP10702A + Aliette WDG | 4.0 / 4.0 | 14(alternate) | 1.0 | 1.0 | 1.7 | 3.0 |
| Chipco 26019 WDG | 1.5 | 14 | 1.0 | 1.3 | 2.0 | 3.0 |
| Bayleton 25 WG + Thalonil 90DF | 0.5+1.67 | 14 | 1.0 | 1.3 | 2.7 | 2.0 |
| Echo 75WDG | 8.5 | 14 | 1.0 | 2.3 | 1.3 | 1.3 |
| EXP10715A + EXP10702A | 4.0+4.0 | 14 | -.- | -.- | -.- | 1.0 |
| Fore 80 WP | 6.0 | 7 | 1.3 | 1.0 | 1.7 | 1.0 |
| Bayleton 25 WG + Prostar 40 WP | 1.0+2 | 28 | 1.3 | 1.7 | 1.3 | 1.3 |
| EXP10682(4STG-122) | 1.7 | 14 | 1.3 | 1.3 | 2.0 | 1.0 |

**Table 1 (continued). Brown patch severity on "Penncross" creeping bentgrass turf maintained at 3/16-inch.**

| Treatment | Rate (oz/M) | Application Interval | Brown Patch Severity[a] 7/30 | 8/8 | 8/12 | 8/22 |
|---|---|---|---|---|---|---|
| Rizolex 75 WP | 2.5 | 21 | 1.3 | 2.0 | 2.0 | 1.0 |
| Thalonil 4L+ Bayleton 25DF | 6.0+1.0 | 21 | 1.3 | 2.0 | 2.0 | 1.3 |
| Lynx 25 DF | 1.0 | 21 | 1.3 | 1.0 | 1.0 | 1.0 |
| Bayleton 25 WG | 1.0 | 21 | 1.3 | 2.3 | 1.7 | 1.7 |
| ConSyst WDG | 4.0 | 14 | 1.3 | 1.7 | 1.7 | 2.3 |
| EXP10682(4STG-124) | 3.4 | 14 | 1.3 | 2.7 | 3.0 | 3.7 |
| EXP10715A | 4.0 | 14 | 1.3 | 2.3 | 3.7 | 3.0 |
| Chipco 26019 FLO+ Cleary 3336 | 2.0+0.5 | 14 | 1.3 | 1.7 | 4.0 | 3.7 |
| Chipco 26019 FLO+ Daconil Ultrex | 2.0+3.0 | 14 | 1.3 | 3.3 | 4.0 | 2.3 |
| Heritage 50 WG | 0.2 | 21 | 1.7 | 1.0 | 1.0 | 1.0 |
| Daconil Ultrex | 3.8 | 14(alternate) | 1.7 | 1.3 | 1.0 | 1.0 |
| Sentinel 40WG | 0.167 | | | | | |
| Lynx 25 DF | 0.5 | 21 | 1.7 | 1.0 | 1.3 | 1.0 |
| Chipco 26019 FLO | 4.0 | 14 | 1.7 | 1.0 | 1.0 | 1.0 |
| EXP10715A+Dithane | 8.0+8.0 | 14 | 1.7 | 1.3 | 1.3 | 1.7 |
| Daconil ZN | 6.0 | 7 | 1.7 | 2.3 | 1.3 | 1.0 |
| EXP10704A+Dithane | 4.0+4.0 | 14 | 1.7 | 2.3 | 4.3 | 2.7 |
| Aliette WDG + Fore WP | 4.0+8.0 | 14 | 1.7 | 2.0 | 1.7 | 1.3 |
| EXP 10673A | 6.0 | 14 | 1.7 | 2.3 | 3.0 | 2.3 |
| Eagle 40 WP | 0.6 | 28 | 1.7 | 2.3 | 2.3 | 1.7 |
| Eagle 40 WP | 1.2 | 28 | 1.7 | 1.7 | 2.7 | 2.0. |
| Chipco 26019 FLO | 3.0 | 14 | 1.7 | 2.7 | 3.7 | 3.7 |
| CGA 173506 | 0.5 | 14 | 2.0 | 1.3 | 1.0 | 1.0 |
| Echo 720F | 8.0 | 14 | 2.0 | 1.3 | 1.3 | 1.3 |
| Daconil Ultrex | 3.8 | 14 | 2.0 | 2.3 | 1.3 | 2.0 |
| Thalonil 4L | 6.0 | 14 | 2.0 | 3.3 | 3.7 | 2.0 |
| Daconil 2787 F | 6.0 | 14 | 2.0 | 1.0 | 2.0 | 1.0 |
| CGA-BMP | 0.56 | 21 | 2.0 | 2.7 | 2.3 | 2.3 |
| Banner Maxx + Daconil Ultrex | 1.0+3.8 | 14 | 2.0 | 2.3 | 2.3 | 2.7 |
| Eagle 40 WP | 1.2 | 14 | 2.0 | 1.3 | 1.7 | 2.0 |
| CGA-BMP | 0.56 | 14 | 2.0 | 2.3 | 3.0 | 2.0 |
| EXP10715A+Dithane | 4.0+4.0 | 14 | 2.3 | 1.0 | 1.3 | 1.3 |
| SysTec 1998 WDG | 1.0 | 21 | 2.3 | 2.0 | 2.3 | 1.7 |
| Banner Maxx | 2.0 | 14 | 2.3 | 2.3 | 2.7 | 2.0 |
| Chipco 26019 FLO + Bayleton 25WG | 2.0+0.5 | 14 | 2.3 | 3.7 | 4.0 | 2.3 |
| EXP10682(4STG-123) | 3.4 | 14 | 2.3 | 2.3 | 3.0 | 1.3 |
| IB11924 | 2.75 | 14 | 2.3 | 2.7 | 1.3 | 1.0 |
| Daconil Ultrex | 3.8 | 7 | 2.3 | 1.3 | 1.7 | 1.0 |
| Chipco 26019 FLO+ Banner Maxx | 2.0+0.5 | 14 | 2.3 | 3.7 | 4.0 | 4.0 |
| Banner Maxx | 1.0 | 21 | 2.3 | 4.7 | 4.7 | 4.0 |
| CGA 329351 + Daconil 2787 F | 1.0+6.5 | 14 | 2.3 | 1.7 | 2.0 | 2.0 |
| Thalonil 90 DF | 3.5 | 14 | 2.3 | 1.3 | 1.7 | 1.0 |

**Table 1 (continued). Brown patch severity on "Penncross" creeping bentgrass turf maintained at 3/16-inch.**

| Treatment | Rate (oz/M) | Application Interval | Brown Patch Severity[a] 7/30 | 8/8 | 8/12 | 8/22 |
|---|---|---|---|---|---|---|
| Rizolex 75 WP | 2.5 | 21 | 1.3 | 2.0 | 2.0 | 1.0 |
| Eagle 40 WP | 0.6 | 14 | 2.3 | 3.3 | 2.7 | 1.7 |
| Thalonil 4L + Aliette 80 WDG | 6.0+4.0 | 14 | 2.7 | 1.7 | 1.3 | 1.3 |
| Daconil Ultrex | 3.0 | 14(alternate) | 2.7 | 1.7 | 3.0 | 2.3 |
| EXP10715A | 4.0 | | | | | |
| EXP10682 (4STG-123) | 1.7 | 14 | 2.7 | 3.7 | 3.7 | 3.7 |
| Control | --.- | - | 2.7 | 4.3 | 4.7 | 3.3 |
| IB11924 | 2.75 | 7 | 3.0 | 2.7 | 2.3 | 1.7 |
| Chipco 26019 FLO | 2.0 | 14 | 3.3 | 3.0 | 4.0 | 3.3 |
| Control | --.- | - | 3.0 | 4.0 | 3.7 | 3.3 |
| Bayleton 25 WG | 1.0 | 28 | 3.7 | 3.7 | 3.0 | 2.3 |
| Control | --.- | - | 4.0 | 3.0 | 4.0 | 3.3 |
| | | LSD (0.05) | 1.6 | 1.8 | 1.8 | 1.9 |

[a] The brown patch rating is based on a scale of 1 to 5 with 1= no brown patch, and 5 = high levels of brown patch present. In general 1 = 0 infection, 2 = 5 to 10% infection, 3 = 11-20% infection, 4 = 21 to 40 % infection, 5 = > 40 % infection.

# Brown Patch Control on Tall Fescue

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## Introduction

On July 12, 1996, a study was initiated to evaluate a selected group of fungicides for brown patch (*Rhizoctonia solani*) control on tall fescue. The location of the study was at the Ohio State University Turfgrass Research Center, Columbus, Ohio. The site had been treated with methyl bromide in the fall of 1995 and seeded with a blend of Duke, Carefree, and Heritage tall fescue. The turf is mowed at 2.5 inches and irrigated when needed. At the time of treatment brown patch was not present. Treatments were made with a $CO_2$ sprayer with nozzle tips 8010 operating at 40 psi (1.4 gal./1000 $ft^2$). All treatments were applied in a randomized complete-block design and replicated three times. The plots measured 5 x 6 ft. Percent brown patch was evaluated on a visual basis.

The treatment schedule was as following:

| | Treatment Interval | | | |
|---|---|---|---|---|
| Date | 7 day | 14 day | 21 day | 28 day |
| July 12 | X | X | X | X |
| July 19 | X | | | |
| July 26 | X | X | | |
| Aug. 2 | X | | | X |
| Aug. 9 | X | X | | |
| Aug. 16 | X | | | X |
| Aug. 23 | X | X | X | |

## Results

Data were collected on August 9, 1996. Although various levels of brown patch were present, levels within the checks were not high except for August 9. Variability between blocks was present. The variability may be in part due to the natural infections, and the methyl bromide treatment during establishment during the fall of 1995. Caution should be exercised when evaluating the data. Only one reading was taken on this study. The fungicides Fore, Heritage, Chipco 26019, Daconil Ultrex, CGA 173506, Prostar, Lynx, Banner and Thalonil worked well as a preventive application.

**Table 1. Brown patch (*Rhizoctonia solani*) severity on tall fescue.**

| Treatment | Rate (oz/M) | Interval (days) | % Brown Patch (8/9) |
|---|---|---|---|
| Fore 80 WP | 6.0 | 7 | 0.0 |
| Daconil Ultrex | 3.8 | 14 | 0.0 |
| CGA-BMP (46.5WP) | 0.56 | 21 | 0.0 |
| Aliette WDG + Fore WP | 4.0+8.0 | 14 | 0.0 |
| CGA 173506 50 WP | 0.5 | 14 | 0.0 |
| Prostar | 2.0 | 14 | 1.7 |
| Prostar | 3.0 | 21 | 1.7 |
| Sentinel 40 WG | 0.167 | 21 | 1.7 |
| Chipco 26019 FLO | 4.0 | 14 | 1.7 |
| Chipco 26019 FLO + Heritage | 2.0+0.2 | 14 | 1.7 |
| Banner Maxx + Ultrex | 1.0+3.8 | 14 | 1.7 |
| Daconil Ultrex | 3.8 | 7 | 1.7 |
| Daconil 2787 | 6.0 | 14 | 1.7 |
| Heritage 50 WG | 0.2 | 21 | 1.7 |
| EXP10715A | 4 | 14 | 3.3 |
| Chipco 26019 FLO | 2 | 14 | 3.3 |
| Prostar Plus | 2.5 | 21 | 3.3 |
| Chipco 26019 WDG | 2.0 | 14 | 3.3 |
| Lynx 25DF | 0.5 | 21 | 3.3 |
| Lynx 25DF | 0.5 | 21 | 3.3 |
| Thalonil 90DF | 3.5 | 14 | 5.0 |
| Bayleton 25 WG | 0.75 | 21 | 5.0 |
| Rizolex 75 WP | 2.5 | 21 | 5.0 |
| Banner Maxx | 1.0 | 14 | 5.0 |
| Eagle 40 WP | 0.6 | 21 | 5.0 |
| Chipco 26019 FLO + Daconil 2787 | 2.0+3.0 | 14 | 5.3 |
| EXP10715A + Dithane | 4.0+4.0 | 14 | 6.7 |
| Banner Maxx | 2.0 | 14 | 8.3 |
| Thalonil 4L | 6.0 | 14 | 11.7 |
| Daconil ZN | 6.0 | 14 | 13.3 |
| CGA329351 2ME + Daconil 2787 | 1.0+6.5 | 14 | 18.3 |
| IB11924 | 2.75 | 14 | 20.0 |
| Urea | | | 23.3 |
| ConSyst WDG | 4.0 | 14 | 25.0 |
| Control | -.- | --- | 33.0 |
| Control | -.- | --- | 40.0 |
| LSD (0.05) | | | 15.9 |

# Yellow Tuft Study—1996

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## Introduction

On July 1, 1996, a yellow tuft (*Scleropthora macrospora*) control study was initiated at the Ohio State Turfgrass Research Center, Columbus, Ohio. The turf was "Penncross" creeping bentgrass maintained at 3/16-inch height of cut. The turf was mowed daily with a walk-behind greens mower. The turf was grown on Brookston silty-clay loam, modified with off-site fill, and little thatch was present. The treatments were applied with a hand-held $CO_2$ pressurized sprayer with two 8010 nozzle tips, spaced 18 inches apart, at 40 psi. The treatments were replicated three times. The plots measured 3 x 6 ft. with an untreated 6-inch border between each plot. The treatment schedule was the following:

| | **Fungicide Treatment Interval** | | | |
|---|---|---|---|---|
| Date | 7 day | 14 day | 21 day | 28 day |
| July 1 | X | X | X | X |
| July 8 | X | | | |
| July 15 | X | X | | |
| July 22 | X | | X | |
| July 29 | X | X | | X |
| August 5 | X | | | |

## Results

Results were variable as indicated by the relatively large LSD value. However, CGA 173506 and CGA 329351 (Subdue Maxx) + Daconil 2787 performed well, as did EXP10715A + Dithane.

**Table 1. Yellow tuft control study conducted on creeping bentgrass maintained at 3/16-inch.**

| Treatment | Rate (oz/M) | Application Interval | % Yellow Tuft 8/12 |
|---|---|---|---|
| EXP10715A + Dithane | 4.0+4.0 | 14 | 0.0 |
| CGA 173506 | 0.25 | 7 | 1.7 |
| CGA 173506 | 0.5 | 14 | 1.7 |
| CGA 329351 + Daconil 2787F | 1.0+6.5 | 14 | 3.3 |
| EXP10715A + Dithane | 8.0+8.0 | 14 | 3.3 |
| Thalonil 4L + Aliette 80 WDG | 6.0+4.0 | 14 | 3.3 |
| Aliette WDG + Fore WP | 4.0+8.0 | 14 | 5.0 |
| EXP10715A | 8.0 | 14 | 6.7 |
| EXP10715A | 4.0 | 14 | 6.7 |
| IB11924 | 2.75 | 7 | 6.7 |
| Daconil ZN | 6.0 | 7 | 6.7 |
| Sentinel 40WG + Rizolex | 0.167+2.5 | 21 | 8.3 |
| Prostar | 2.0 | 14 | 8.3 |
| Fore 80 WP | 6.0 | 7 | 8.3 |
| Daconil Ultrex | 3.8 | 7 | 8.3 |
| CGA-BMP | 1.14 | 14 | 10.0 |
| Daconil ZN | 6.0 | 14 | 10.0 |
| Daconil Ultrex | 3.0 | 14(alternate) | 13.3 |
| EXP10715A | 4.0 | | |
| Chipco 26019 FLO + Daconil Ultrex | 2.0+3.0 | 14 | 13.3 |
| IB11924 | 2.75 | 14 | 13.3 |
| Sentinel 40WG | 0.167 | 21 | 13.3 |
| Sentinel 40WG | 0.167 | 21(alternate) | 13.3 |
| Daconil Ultrex | 3.8 | | |
| Lynx 25 DF | 0.5 | 21 | 13.3 |
| Chipco 26019 FLO + Heritage | 2.0+0.2 | 14 | 15.0 |
| Daconil Ultrex | 3.8 | 14 (alternate) | 16.7 |
| Sentinel 40WG | 0.167 | | |
| Prostar Plus | 2.5 | 21 | 18.3 |
| EXP10704A+Dithane | 4.0+4 | 14 | 18.3 |
| EXP10702A | 4.0 | 14 (alternate) | 18.3 |
| Aliette WDG | 4.0 | | |
| CGA-BMP | 0.56 | 21 | 18.3 |
| Lynx 25 DF | 0.75 | 21 | 18.3 |
| Lynx 25 DF | 1.0 | 21 | 18.3 |
| Heritage 50 WG | 0.2 | 21 | 18.3 |
| Control | -.- | — | 18.7 |
| Control | -.- | — | 19.3 |
| EXP10715A | 4.0 | 14 (alternate) | 20.0 |
| EXP10702A | 4.0 | | |
| Sentinel 40WG | 0.167 | 14 (alternate) | 20.0 |
| Daconil Ultrex | 3.8 | | |
| Daconil Ultrex | 3.8 | 14 | 20.0 |
| Chipco 26019 FLO | 4.0 | 14 | 23.3 |
| CGA-BMP | 0.56 | 14 | 23.3 |
| Chipco 26019 FLO + Banner Maxx | 2.0+0.5 | 14 | 25.0 |
| Prostar | 3.0 | 21 | 25.0 |
| Heritage 50 WG | 0.2 | 28 | 25.0 |
| Control | -.- | — | 25.7 |
| LSD (0.05) | | | 16.5 |

# Creeping Bentgrass Melting-Out Study

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## Introduction

A melting-out (*Drechslera poae*) study was initiated on May 6, 1996, on a creeping bentgrass golf course fairway at Muirfield Village Golf Club. The fairway was maintained at 0.5 inch height of cut at the time of initial application. The turf was comprised of roughly 70 percent creeping bentgrass and 30 percent *Poa annua*. The plot size measured 5 x 6 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 8010 operating at 40 psi. The 14-day treatments were made May 6 and 20 and the 21-day treatments were May 6 and May 24. At the time of initial treatment, leaf spot was present. Disease ratings were based upon the percentage of infected plot (50 leaves were assessed per plot).

## Results

A significant reduction in melting-out was observed with all fungicide treatments. Primo did not enhance or decrease the amount of disease present.

**Table 1. The effect of various fungicides on melting-out of creeping bentgrass**

| Treatment | Application Rate (oz/m) | Interval (days) | Melting-out (%) 5/14 | 5/20 |
|---|---|---|---|---|
| CGA 173506 | 0.25 | 21 | 10.0 | 0.0 |
| Chipco 26019 FLO | 3.0 | 21 | 11.7 | 0.7 |
| Daconil Ultrex | 3.8 | 14 | 13.3 | 0.0 |
| Primo + CGA 173506 | 0.3+0.25 | 21 | 13.3 | 0.0 |
| Fore 75 DG | 8.0 | 14 | 15.0 | 0.0 |
| Fore 80 WP | 8.0 | 14 | 18.3 | 0.0 |
| IB11924 | 2.75 | 14 | 18.3 | 1.7 |
| Daconil ZN | 6.0 | 14 | no reading | 0.0 |
| Primo | 0.3 | 21 | 36.7 | 6.0 |
| Control | -.- | --- | 51.7 | 12.3 |
| LSD (0.05) | | | 20.0 | 1.9 |

# Kentucky Bluegrass Melting-Out Study

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## Introduction

A Helminthosporium melting-out (*Drechslera poae*) study was initiated on May 17, 1996, on a common Kentucky bluegrass turf at the Ohio State Turfgrass Research Center, Columbus, Ohio. The turf was maintained at 2-inch height of cut at the time of initial application. The plot size measured 5 x 6 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 8010 operating at 40 psi (1.4 gal/10 $ft^2$). At the time of initial treatment, melting-out was present. Disease ratings were made on a percent of infected plot (50 leaves were assessed per plot).

## Results

Melting-out was significantly reduced with applications of Fore and Daconil initially. Effective control of melting-out with Chipco 26019, IB11924, and CGA 173506 occurred later.

**Table 1. Evaluation of fungicides for melting-out control on Kentucky bluegrass.**

| Treatment | Application Rate (oz/m) | Interval (days) | Melting-Out (%) 5/23 | Melting-Out (%) 5/30 |
|---|---|---|---|---|
| Fore 80 WP | 6.0 | 14 | 1.7 | 0.7 |
| Fore 75 DG | 8.0 | 14 | 3.3 | 0.0 |
| Fore 80 WP | 8.0 | 14 | 3.3 | 3.0 |
| Fore 75 DG | 6.0 | 14 | 3.3 | 3.0 |
| Daconil Ultrex | 3.8 | 14 | 6.7 | 2.3 |
| RH-0611 | 8.0 | 14 | 6.7 | 8.3 |
| Daconil ZN | 6.0 | 14 | 10.0 | 4.3 |
| Daconil 2787 | 6.0 | 14 | 10.0 | 3.3 |
| CGA 173506 | 0.25 | 21 | 10.0 | 4.0 |
| RH-0611 | 10.0 | 14 | 13.3 | 6.7 |
| Eagle 40 WP | 0.6 | 21 | 15.0 | 11.7 |
| IB11924 | 2.75 | 14 | 16.7 | 6.7 |
| Chipco 26019 | 3.0 | 21 | 18.3 | 3.0 |
| Eagle 40 WP | 1.2 | 21 | 18.3 | 9.7 |
| Primo | 0.3 | 21 | 25.0 | 21.0 |
| Primo+CGA 173506 | 0.3+0.25 | 21 | 25.0 | 11.3 |
| Control | --.- | --- | 30.0 | 21.7 |
| LSD (0.05) | | | 14.3 | 7.9 |

# Red Thread Control Study on Perennial Ryegrass

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## Introduction

A red thread (*Laetisaria fuciformis*) study was initiated on May 18, 1996, at The Ohio State University Turfgrass Research Center, Columbus, Ohio. The turfgrass was an established stand of perennial ryegrass (cultivar unknown) maintained at 2.5 inches. The area received minimal maintenance with no fertilization or irrigation during the past year. The condition of the stand was fair with poor color and rather low density. No thatch was present. Liquid treatments were made with a $CO_2$ small plot sprayer with nozzle tips 8004 operating at 40 psi (2.5 gal/1000 $ft^2$). Dry treatments were made by hand. The plots measured 6 x 10 ft and were replicated 3 times in a randomized complete block design. At the time of application the disease was active and 30-40% of the surface of each plot was diseased. Spring conditions in Columbus were unusually wet and cool, resulting in elevated activity of red thread.

### Results

Initial reduction in red thread was most evident with Heritage and Prostar Plus. Other materials that showed a initial reduction included Lynx, Chipco 26019 WDG, Sentinel and the chlorothalonil products. Primo treatments initially had no effect on red thread activity. However, by the end of the study, considerable disease was present in the Primo plots. The likely reason was the reduction in recovery of the turf from the Primo application.

**Table 1. Evaluation of various fungicides for the control of red thread on perennial ryegrass.**

| Treatment | Rate (oz/m) | Percent Red Thread 6/5 (3 WAT) | 6/12 (4 WAT) |
|---|---|---|---|
| Heritage + Primo | 0.4 + 0.2 | 5.0 | 6.7 |
| Prostar Plus | 22.3 gram/2 litre | 5.7 | 5.0 |
| Heritage 50 WG | 0.2 | 11.7 | 6.7 |
| Heritage 50 WG | 0.4 | 11.7 | 5.3 |
| Lynx 25 DF | 0.75 | 13.3 | 8.3 |
| Heritage 50 WG | 0.14 | 14.0 | 10.0 |
| Chipco 50 WDG | 2.0 | 15.0 | 21.7 |
| Sentinel | 0.25 | 15.0 | 6.7 |
| IB 11924 | 2.75 | 16.7 | 15.0 |
| Daconil ZN | 6.0 | 16.7 | 23.3 |
| Lynx 25 WG | 1.0 | 18.3 | 13.3 |
| Thalonil 90 DF | 3.5 | 20.0 | 18.3 |
| Bayleton 50 WG | 0.5 | 20.0 | 12.3 |
| Daconil Ultrex | 3.8 | 20.0 | 18.3 |
| Chipco FLO | 4.0 | 21.7 | 10.0 |
| Eagle 40 WP | 1.2 | 25.0 | 25.0 |
| Banner Maxx | 1.0 | 26.7 | 20.0 |
| Banner Maxx | 2.0 | 28.3 | 30.0 |
| Lynx 25 DF | 0.5 | 29.0 | 13.3 |
| Banner Maxx + Primo | 2.0 + 0.3 | 30.0 | 18.3 |
| Fertilizer (18-5-9) | 1.0 lb. N | 40.0 | 23.3 |
| Urea (46-0-0) | 1.0 lb. N | 40.0 | 26.7 |
| Primo | 0.3 | 55.0 | 43.3 |
| Control | --.- | 61.7 | 55.0 |
| LSD (0.05) | | 20.4 | 13.4 |

WAT = weeks after treatment.

# Red Thread Control Study on Kentucky Bluegrass

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## Introduction

A red thread (*Laetisaria fuciformis*) study was initiated on May 29, 1996, at The Ohio State University Turfgrass Research Center, Columbus, Ohio. The turfgrass was an established stand of Kentucky bluegrass (cultivar common) maintained at 2.5 inches. The area received minimal maintenance during the past year. The condition of the stand was fair with good color and medium density. Liquid treatments were made with a $CO_2$ small plot sprayer with nozzle tips 8004 operating at 40 psi (2.5 gal/1000 ft$^2$). Dry treatments were made by hand. The plots measured 6 x 10 ft and were replicated 3 times in a randomized complete block design. At time of application the disease was active and 30-40% of the surface of each plot was diseased. Spring conditions in Columbus were unusually wet and cool. Red thread activity was very active.

## Results

Readings were taken 2 and 3 weeks after application. Outstanding control was achieved with Heritage, Chipco 26019 WDG, Chipco FLO, Sentinel and Lynx.

**Table 1. Evaluation of various fungicides for the control of red thread on Kentucky bluegrass**

| Treatment | Rate (oz/m) | Number of Red Thread Patches 6/12 | 6/20 |
|---|---|---|---|
| Heritage 50 WG | 0.4 | 0.7 | 0.0 |
| Heritage 50 WG + Chipco WDG | 0.4 + 2.0 | 0.7 | 0.3 |
| Heritage 50 WG | 0.2 | 1.3 | 0.3 |
| Prostar Plus | 22.3 gram/2litre | 2.3 | 0.3 |
| IB 11924 | 2.75 | 2.7 | 3.3 |
| Chipco 26019 WDG | 2.0 | 4.0 | 4.3 |
| Chipco FLO | 4.0 | 4.7 | 4.0 |
| Lynx 25 DF | 0.75 | 6.0 | 3.0 |
| Sentinel + Ultrex | 0.25 + 2.0 | 6.3 | 1.3 |
| Banner Maxx | 1.0 | 6.3 | 13.3 |
| Fertilizer (18-5-9) | 1 lb. of N | 8.0 | 15.3 |
| Daconil Ultrex | 3.8 | 8.7 | 30.7 |
| Eagle | 1.2 | 11.3 | 24.7 |
| Sentinel | 0.25 | 11.7 | 2.0 |
| Bayleton 50 WG | 0.5 | 14.0 | 9.0 |
| Bayleton G | 3.0 lbs | 25.7 | 27.7 |
| Scotts FFII | 29.18 lbs/5.5 M | 32.7 | 20.0 |
| Control | | 38.3 | 54.0 |
| LSD (0.05) | | 12.7 | 20.3 |

# Evaluation of Fungicides for the Control of Red Thread in Kentucky Bluegrass, 1996

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## Introduction

The test was conducted at the TruGreen-ChemLawn Technical Center, Delaware, Ohio, on a four-year-old stand of Kentucky bluegrass (*Poa pratensis* L.) consisting of the following cultivars 'Julia,' 'Merit,' 'Schamrock,' and 'Touchdown' at 25% each. The soil is a Blount silt loam with a pH of 6.2. The turfgrass was maintained at 2.25 inch cutting height, clippings returned, and irrigated as needed to avoid water stress. The condition of the stand was good with good color, medium density, and less than 0.5 in of thatch. The 6 x 10 ft plots were in a randomized complete block design with three replications. Water soluble fungicide treatments for red thread [*Laetisaria fuciformis* (McAlpine) Burdsall], were applied with a hand-held $CO_2$ -powered boom sprayer, with 8004 Teejet nozzles at 40 psi, (water equivalent to 2.5 gal water/1000 $ft^2$). Granular materials were applied by hand. All treatments were made on May 29. The average high and low air temperatures and rainfall for each month were: May 69.8 °F, 49.7 °F, 7.3 inch; Jun, 80.2 °F, 58.4 °F, 4.1 inch, respectively. Spring environmental conditions were unusually wet and cool, and favorable for red thread development. The disease was active at the time of applications and present across the evaluation area. Readings of the number of red thread patches were taken at approximately two and three weeks after applications.

## Results

Outstanding control was achieved with Heritage and ProStar. Sentinel showed excellent results over time; however, initial control was slow. Chipco 26019 50WDG and 2F provided good management of the disease. Daconil provided good short-term reduction of the disease, but since this is a contact fungicide, repeat applications would be needed. Granular treatments did not provide adequate control. Fertilizer applications were not adequate to manage the disease.

**Table 1. Mean number of red thread patches.**[a]

| Treatment | Rate / 1000 $ft^2$ | June 12 | June 20 |
|---|---|---|---|
| Heritage 50WG | 0.4oz. | 0.7 | 0.0 |
| Heritage 50WG + Chipco 26019 50WDG | 0.4 oz + 2.0 oz | 0.7 | 0.3 |
| Heritage 50WG | 0.2 oz. | 1.3 | 0.3 |
| Prostar 50WP | 7.4 oz. | 2.3 | 0.3 |
| IB 11924 | 2.75 oz. | 2.7 | 3.3 |
| Chipco 26019 50WDG | 2.0 oz. | 4.0 | 4.3 |
| Chipco 26019 2F | 4.0 oz | 4.7 | 4.0 |
| Lynx 25DF | 0.75 oz. | 6.0 | 3.0 |
| Sentinel 40WG + Daconil Ultrex 82.5 WDG | 0.25 oz + 2.0 oz | 6.3 | 1.3 |
| Banner Maxx 1.1 MC | 1.0 oz. | 6.3 | 13.3 |
| Fertilizer (18-5-9) | 34.8 oz. | 8.0 | 15.3 |
| Daconil Ultrex 82.5WDG | 3.8 oz. | 8.7 | 30.7 |
| Eagle 40WP | 1.2 oz | 1.3 | 24.7 |
| Sentinel 40WG | 0.25 oz. | 11.7 | 2.0 |
| Bayleton 50WG | 0.5 oz. | 4.0 | 9.0 |
| Bayleton 10G | 48.0 oz. | 25.7 | 27.7 |
| Proturf (14-3-3) FFII | 101.8 oz. | 32.7 | 20.0 |
| Control | -.- | 38.3 | 54.0 |
| LSD (0.05) | | 12.7 | 20.3 |

[a] Patches counted were 2 inches in diameter or larger.

# Evaluation of Fungicides for the Control of Red Thread in Perennial Ryegrass, 1996

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## Introduction

The test was conducted at The Ohio State University Turfgrass Research Center, in Columbus, on an established stand of perennial ryegrass (*Lolium perenne* L., cultivar unknown). Mowing height was 2.5 inches with clippings returned, and received no irrigation or fertilizer. The condition of the sward was fair, with poor color, no thatch and low density. The soil was clay, pH 7.3. Individual plots 6 x 10 ft were in a randomized complete-block design with three replications. Water soluble fungicide treatments were applied with a hand-held $CO_2$ powered boom sprayer, with 8004 Teejet nozzles at 40 psi (water equivalent to 2.5 gal/1000 $ft^2$). Granular materials were applied by hand. All treatments were made on May 18. The average high and low air temperatures and rainfall for each month were: May 69.9°F, 50.5°F, 10.0 inch; Jun 82.2°F, 61.3°F, 8.2 inch, respectively.

## Discussion/Summary

Spring environmental conditions were favorable for red thread development [*Laetisaria fuciformis* (McAlpine) Burdsall], and the disease was active at the time treatments were initiated. Relatively uniform disease pressure occurred over the evaluation area and continued until late June. Initial reduction in red thread was most evident when treated with Heritage. Other materials that showed an initial reduction included Lynx, Chipco 26019 WDG, Sentinel, and the chlorothalonil products. Primo, a plant growth regulator, initially had no effect on the disease activity. By the end of the study, considerable levels of red thread and dollar spot was present in the Primo plots. The reduced growth in the Primo plots (a plant growth regulator), most likely was the reason for higher disease ratings. Fertilizer alone was not adequate for disease management.

**Table 1. Mean number of red thread patches.**

| Treatment | Rate / 1000 ft$^2$ | % Red Thread 5 June | 12 June |
|---|---|---|---|
| Heritage 50WG + Primo 12.0EC | 0.4 oz + 0.3 oz. | 5.0 | 6.7 |
| Heritage 50WG | 0.2 oz | 11.7 | 6.7 |
| Heritage 50WG | 0.4 oz | 11.7 | 5.3 |
| Lynx 25DF | 0.75 oz | 3.3 | 8.3 |
| Heritage 50WG | 0.14 oz. | 14.0 | 10.0 |
| Chipco 26019 50WDG | 2.0 oz. | 15.0 | 21.7 |
| Sentinel 40WG | 0.25 oz. | 15.0 | 6.7 |
| IB 11924 | 2.75 oz. | 16.7 | 15.0 |
| Daconil ZN | 6.0 oz. | 16.7 | 23.3 |
| Lynx 25WG | 1.0 oz.. | 18.3 | 13.3 |
| Thalonil 90DF | 3.5 oz. | 20.0 | 18.3 |
| Bayleton 50WG | 0.5 oz | 20.0 | 12.3 |
| Daconil Ultrex 82.5WDG | 3.8 oz. | 20.0 | 18.3 |
| Chipco 26019 2F | 4.0 oz. | 21.7 | 10.0 |
| Eagle 40WP | 1.2 oz.. | 25.0 | 25.0 |
| Banner Maxx 1.1MC | 1.0 oz.. | 26.7 | 20.0 |
| Banner Maxx 1.1MC | 2.0 oz. | 28.3 | 30.0 |
| Lynx 25DF | 0.5 oz.. | 29.0 | 13.3 |
| Banner Maxx 1.1MC+ Primo 12.0EC | 2.0 oz + 0.3 | 30.0 | 18.3 |
| Fertilizer (18-5-9) | 34.8 oz. | 40.0 | 23.3 |
| Urea (46-0-0) | 88.9 oz. | 40.0 | 26.7 |
| Primo 12.0EC | 0.3 oz. | 55.0 | 43.3 |
| Control | --.- | 61.7 | 55.0 |
| | LSD (0.05) | 20.4 | 13.4 |

Disease severity was associated with a scale of 0 to 100% with 100 being equal to complete coverage of the plot ($n$ = 3).

# Pink Snow Mold Control Study—1995-1996

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## Introduction

A pink snow mold study (*Microdochium nivale*) was initiated November 29, 1995, 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 feet by 6 feet and each treatment was replicated three times in a randomized complete block design. Liquid applications were made with a small-plot $CO_2$ sprayer with nozzle tips 8004 operating at 40 psi. Dry applications were made by hand. At time of application, the plot area was saturated, 0.5 inch of thatch, with ambient temperatures around 35°F. No pink snow mold was present at time of application. The treatments were evaluated on May 27, 1996. The number of pink snow mold patches (approximately 6 inches in diameter) were counted.

## Results

At Quail Hollow a light amount of pink snow mold was present in our study for 1995-1996. Given this, we did see a number of products perform well under light infection. Heavier infection would probably have given a better separation. Some observations include:

* Aliette 80 WDG + Fore 4F exhibited some tank compatibility problems. This combination was difficult to spray even with the addition of Latron.

* The PCNB products worked well alone and in combination with other fungicides.

* Chipco 26019 + Daconil treatments performed well.

**Table 5. Evaluation of fungicides for pink snow mold on March 27, 1996.**

| Treatment | Rate (oz/1000 ft$^{2}$) | Number of pink snow mold patches |
|---|---|---|
| Chipco 26019 2F + Daconil 2787 4.17F | 4.0 + 8.0 | 0.0 |
| Chipco 26019 2F + Daconil 2787 4.17F | 8.0 + 8.0 | 0.0 |
| Chipco 26019 2F + Terraclor 75 WP | 4.0 + 8.0 | 0.0 |
| Chipco 26019 2F + Terraclor 75 WP + Daconil 2787 4.17F | 4.0 + 4.0 + 8.0 | 0.0 |
| Aliette 80 WDG + Fore 4F | 4.0 + 8.0 | 0.0 |
| Aliette 80 WDG + Fore 4F + Daconil Ultrex 82.5 | 4.0 + 8.0 + 4.8 | 0.0 |
| Eagle 40 WSP + Fore 80 WP | 0.6 + 6.0 | 0.0 |
| Eagle 40 WSP | 1.2 | 0.0 |
| Eagle 40 WSP | 1.8 | 0.0 |
| Eagle 40 WSP + Fore 80 WP | 1.8 + 6.0 | 0.0 |
| Turfcide 400 4F | 12.0 | 0.0 |
| Turfcide 10G | 160.0 | 0.0 |
| Scotts FFII 15.4G | 104.0 | 0.0 |
| Turfcide 400 4F | 8.0 | 0.0 |
| Turfcide 400 4F + Daconil 2787 4.17F | 8.0 + 8.0 | 0.0 |
| Turfcide 400 4F + Spotrete 75 WDG | 8.0 + 6.0 | 0.0 |
| Turfcide 400 4F + Prostar 50 WP | 8.0 + 4.0 | 0.0 |
| Turfcide 400 4F + Heritage 50 WDG | 8.0 + 0.7 | 0.0 |
| Daconil WS + Terraclor 75 WP | 6.0 + 4.0 | 0.0 |
| Fluazinam 500 + Terraclor 75 WP | 1.5 + 4.0 | 0.0 |
| Scotts FFII 15.4G | 80.0 | 0.0 |
| Heritage 50 WDG | 0.8 | 0.0 |
| Lesco PCNB 10G | 6.0 lbs | 0.0 |
| Banner MAXX | 4.0 | 0.0 |
| Banner MAXX + Terraclor 75 WP | 4.0 + 6.0 | 0.0 |
| Banner MAXX + Medallion 50 WP | 4.0 + 0.5 | 0.0 |
| Scotts FFII 15.4G | 160.0 | 0.0 |
| Scotts FFII 15.4G | 51.0 | 0.3 |
| IB1152 + Chipco 26019 2F | 8.0 + 4.0 | 0.3 |
| IB11924 | 8.0 | 0.3 |
| IB10222 + Chipco 26019 2F | 6.0 + 4.0 | 0.3 |
| Eagle 40 WSP + Fore 80 WP | 1.2 + 6.0 | 0.3 |
| UBI 4121 10G | 160.0 | 0.3 |
| Chipco 26019 2F + Daconil Ultrex 82.5 G | 8.0 + 4.0 | 0.3 |
| Fore 80 WP | 8.0 | 0.7 |
| Eagle 40 WSP | 0.6 | 0.7 |
| Aliette 80 WDG + Fore 4F | 4.0 + 8.0 | 0.7 |
| RH-0611 | 8.0 | 1.0 |
| Fluazinam 500 | 1.0 | 1.3 |
| Chipco 26019 2F + Prostar 50 WP | 4.0 + 6.0 | 1.7 |
| UBI 4118 15G | 107.0 | 2.3 |
| Urea 46-0-0 | 1.0 lb N | 2.3 |
| Control | -.- | 2.3 |
| Control | -.- | 5.0 |
| LSD (0.05) | | 1.6 |

# Primo & Sentinel Applications on *Poa Annua* Quality

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## Introduction

A study was initiated to evaluate the effects of Primo and Sentinel alone and in combination on *Poa annua* L. and creeping bentgrass (*Agrostis palustris*) turf quality. The study was conducted on a practice chipping green at Muirfield Village Golf Club in Dublin, Ohio. The green was constructed to USGA greens specification and maintained under putting green management conditions. The turf consisted of roughly 50 percent creeping bentgrass and 50 percent *Poa annua*.

The treatments were initiated on April 24, 1996. All treatments were replicated three times in a randomized complete block design. The plots measured 5 x 6 ft and treatments were applied with a $CO_2$ sprayer with nozzle tips 8010 operating at 40 psi. Additional treatments were made on an approximately 14-day schedule (April 24, May 6th, May 20th, June 4th). Plots were evaluated for *Poa annua* seedhead suppression, phytotoxicity, turf quality, and disease present.

## Results

During the course of this study, we observed no decrease in *Poa annua* populations or a reduction in seed head production with any of the treatments. We did observe a significant change in turf color with the repeated applications of Sentinel. The Sentinel treatments appeared a bluish wilt color, but no density loss was observed. By the middle of July the coloration had disappeared.

**Table 1. Treatment evaluation for May 6, 1996.**

| Treatment | Rate (oz/m) | Seed Head Suppression(%) | Phyto-toxicity(%) | Turf Quality(%)[a] | Disease |
|---|---|---|---|---|---|
| Sentinel | 0.25 | 0.0 | 0.0 | 8.0 | 0.0 |
| Primo | 0.125 | 0.0 | 0.0 | 8.0 | 0.0 |
| Sentinel+ | 0.25 | 0.0 | 0.0 | 8.0 | 0.0 |
| Primo | 0.125 | | | | |
| Control | -.-- | 0.0 | 0.0 | 8.0 | 0.0 |
| LSD (0.05) | | ns | ns | ns | ns |

[a] Turf Quality - 1 = dead; 9 = highest turf quality

**Table 2. Treatment evaluation for May 14, 1996 (8 days after 2nd application).**

| Treatment | Rate (oz/m) | Seed Head Suppression(%) | Phyto- toxicity (%) | Turf Quality | Disease Pink SM (# spots) |
|---|---|---|---|---|---|
| Sentinel | 0.25 | 0.0 | 0.0 | 8.0 | 0.0 |
| Primo | 0.125 | 0.0 | 0.0 | 8.0 | 3.0 |
| Sentinel+ | 0.25 | 0.0 | 0.0 | 8.0 | 0.0 |
| Primo | 0.125 | | | | |
| Control | | 0.0 | 0.0 | 8.0 | 3.3 |
| LSD (0.05) | | ns | ns | ns | ns |

Comments: On May 14th, a slight darkening of color is detected in the Primo plots.

**Table 3. Treatment evaluation for June 4, 1996 (during 4th application).**

| Treatment | Rate (oz/m) | Seedhead Suppression(%) | Phyto- toxicity (%) | Turf Quality | Disease Pink SM(# spots) |
|---|---|---|---|---|---|
| Sentinel | 0.25 | 0.0 | 0.0 | 8.0 | 0.0 |
| Primo | 0.125 | 0.0 | 0.0 | 8.0 | 0.0 |
| Sentinel+ | 0.25 | 0.0 | 0.0 | 8.0 | 0.0 |
| Primo | 0.125 | | | | |
| Control | -.-- | 0.0 | 0.0 | 8.0 | 0.0 |
| LSD (0.05) | | ns | ns | ns | ns |

The plots containing Primo appeared bluish in color. However, in all treatments the density was similar.

**Table 4. Treatment evaluation for June 19, 1996.**

| Treatment | Rate (oz/m) | Seedhead Suppression(%) | Phyto- toxicity (%) | Turf Quality | Dissease Pink SM(# spots) |
|---|---|---|---|---|---|
| Sentinel | 0.25 | 0.0 | 0.0 | 6.0 | 0.0 |
| Primo | 0.125 | 0.0 | 0.0 | 8.0 | 0.0 |
| Sentinel+ | 0.25 | 0.0 | 0.0 | 5.0 | 0.0 |
| Primo | 0.125 | | | | |
| Control | | 0.0 | 0.0 | 8.0 | 0.0 |
| LSD (0.05) | | ns | ns | ns | ns |

On July 18th, the Sentinel and Sentinel and Primo continued to show a bluish tint but at a lesser degree than on June 19th.

# *Turfgrass Fertility*

# Nitrogen Source, Rate, and Timing Effect on Kentucky Bluegrass—1996

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## 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 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 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 urea-formaldehyde (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. This is the second year of a two-year research project with initial treatments made in the fall of 1994.

## Discussion/Summary

In 1996, 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 1995 through November 1996. The ESN polymer-coated urea sources (ESN 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 November 4, 1996) 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 x 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 ten- to twelve-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 1 through 9 with 1 representing poorest and 9 representing best. Irrigation was provided as needed to prevent wilt.

## Turfgrass Quality

**Late-Season Performance (1995):** Late-season fertilization in 1995 was made on October 30. Specific turfgrass quality and yield responses from the late season application for the remainder of 1995 have been reported in previous research reports (*see* Turfgrass Research Report 1995, OARDC Special Circular 155). Late-season fertilization responses were disappointing in 1995. Air temperatures in November and early December averaged 20°F below normal in central Ohio. As a result, no fertilizer source provided a significant response from the October 30 application. Urea (1.5 lbs N/1000 $ft^2$) did not provide a color/quality increase by November 15. By December 3, all fertilizer sources exhibited color/quality ratings below an acceptable level. There were no differences in residual or fall color retention among the nitrogen sources at this date.

**Spring Greenup (1996):** Turfgrass quality rating (spring greenup/residual) from the 1995 late-season fertilization are provided in Table 2. Unfertilized turfgrass consistently showed poorer quality than all fertilized turfgrass throughout the spring period. Color/quality increases were noticeable starting in early April 1996. However, no fertilizer produced an acceptable turfgrass quality response until the April 20, 1996, rating date. Those fertilizer sources reaching an acceptable quality level (i.e., ≥ 6.0) by the April 20 rating date were ESN 2003, Urea, Polyon, Poly S, NBN, and Coron. There was a significant increase in turfgrass quality from all nitrogen sources by May 1 with all nitrogen sources providing an acceptable quality level.

Among the ESN 2002 sources, initial greenup responses were somewhat better from those ESN 2002 fertilizers containing higher percentages or ratios of urea (i.e., ESN 2002 40/60 and ESN 2002 20/80). In contrast, spring residual quality responses were better from those ESN 2002 fertilizers containing a higher percentage of the polymer-coated urea. As in 1995, the ESN 2002 40/60 fertilizer provided the best spring greenup and spring residual quality responses among the ESN 2002 fertilizers. The ESN 2002 20/80 fertilizer decreased in quality to an unacceptable level prior to the first fertilization of 1996 on May 23 (Table 1).

ESN 2003 and ESN 2004 surprisingly provided similar greenup responses to the ESN 2002 fertilizers. In 1995, initial greenup responses from ESN 2003 and ESN 2004 were slower than the ESN 2002 fertilizers. The extremely cold fall of 1995 and winter of 1996 may have played a role in these latter yearly variations compared to the 1994/1995 period.

Overall, spring color/quality was superior from the ESN 2003 and ESN 2004 compared to any other fertilizer in May and early June. However, it is important to recognize that the late-season fertilization rates from ESN 2003 and ESN 2004 were 2.0 and 2.5 lbs N/1000 $ft^2$, respectively. 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 lbs N/ 1000 $ft^2$ on October 30, 1995). Also, residual color quality responses from ESN 2003 were excellent in May and acceptable in June until reapplication on June 17. Spring residual color/quality responses were better during the late residual period for both ESN 2003 and ESN 2004 in 1995 compared to 1996. The turfgrass quality results from both years, however, do support good residual quality responses from ESN 2003 and ESN 2004 into the spring and early summer from late-season fertilization. Polyon, Poly S, and Lesco SCU performance in the spring from the late-season application were also considered superior to most of the other fertilizer sources and certainly superior to urea. This information further supports the conclusion presented in 1995 for 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 (1996):** Color/quality ratings from the May 23, June 17, and July 27 fertilizer applications will be discussed in this section (Table 2). All fertilizers except ESN 2003 and ESN 2004 were applied at 1.0 lb/1000 $ft^2$ on both May 23 and July 27 (Table 1). ESN 2003 and ESN 2004 were applied at 1.5 and 2.0 lbs. N/1000 $ft^2$ on June 17 and July 27, respectively. Color/quality responses from the ESN 2002 blends were initially higher from those blends containing higher percentages or ratios of urea following both the May 23 and July 27 applications. ESN 2002 100/0 exhibited a good, uniform response throughout the summer period (i.e., turfgrass quality ratings of ≥ 7.0). Color/ quality responses from urea were always better than the other nitrogen sources during the first few weeks after application. However, intermediate and residual responses were poorer and more variable from urea. All the ESN 2002 fertilizers outperformed urea during the intermediate and residual response periods (i.e., beyond 4-5 weeks) resulting in significantly more uniform responses from the slow-release sources during the summer season. NBN, Coron, and ESN 2002 20/80 also produced excellent initial color/quality responses and somewhat better residual responses than urea alone. However, these three latter sources showed a significant drop in color/quality to below an acceptable level by the July 30 rating date. The ESN 2002 blends of 60/40 and 40/60 provided significantly better intermediate and residual color/quality responses than ESN 2002 20/80. ESN 2003 provided acceptable quality during June from the late-season fertilization. The ESN 2003 also provided exceptional quality from the June 17 application (i.e., 1.5 lbs N/1000 $ft^2$) before dropping off to an unacceptable level on the September 3 rating date. As in 1995, ESN 2003 fell somewhat short of the predicted 90-day residual with color/quality ratings reported as unacceptable on September 3, 9 and 23 (approximate residual of 10-weeks). ESN 2004 provided good to excellent color/quality throughout the summer with only a slight drop in color/quality in late July prior to reapplication (July 27). Color/quality responses from ESN 2004 were significantly higher than any other nitrogen source during late August and the entire month of September. 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 with ESN 60/40 providing slightly better color/quality on a few rating dates. ESN 2002 100/0 and ESN 60/40 performed very similarly during June and July.

The performance of Polyon and Lesco SCU during this same period was good to excellent with fairly consistent ratings of 7.0-8.5. Color/quality of Polyon exceeded that of ESN 2002 100/0 on several rating dates.

**Fall-Late Season Performance (1996):** All treatments received a one pound application of nitrogen per 1,000 $ft^2$ on September 20, 1996 except for ESN 2004. In addition, all treatments received a late-season fertilization on November 4, 1996 (Table 1). All fertilizers provided acceptable color/quality ratings following the September 20 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, Poly S, Lesco SCU, NBN, and Coron.

Best initial color/quality responses among the ESN 2002 fertilizers occurred among those containing the highest percentage or ratio of urea (i.e., 20/80, 40/60, 60/40). All the ESN 2002 fertilizers provided good color/quality to fall-applied fertilization (September 20). Turfgrass quality responses among the ESN fertilizers were best from ESN 2002 20/80 and ESN 2002 40/60. ESN 2003 exhibited a significant drop in quality prior to September 20 and only a minimal response from the fall application. ESN 2004 performance in July and August was excellent with good color/quality extending up through the late-season fertilization. The residual color/quality response from ESN 2004 applied on July 27 was acceptable for over 14 weeks. Except for ESN 2003, all the fertilizers provided good to excellent color/quality responses from the fall-applied nitrogen. All fertilizers, except ESN 2003 and 2004, provided similar color/quality ratings on November 4, prior to the late-season fertilization.

Late-season fertilization was applied on November 4 (Table 1). Among the ESN 2002 fertilizers, best color/quality responses were obtained from those fertilizers containing higher percentages or ratios of urea. ESN 2003 and ESN 2004 continued to exhibit a decline in color/quality and essentially provided no response from late-season fertilization. The poor color/quality response from heavier coated polymer-coated ureas in late-season fertilization is consistent with our previous results (i.e., late-season 1994). Urea and ESN 2002 20/80 provided the best late-season fertilization responses. ESN 2002 40/60 and ESN 2002 60/40 were intermediate in their late-season response. NBN and Coron also provided above average color/quality responses from late-season fertilization. All fertilizer sources, however, declined below an acceptable level by the December 20 rating. In general, under traditional late-season fertilization target dates, those nitrogen fertilizers containing higher percentages of urea or quick-release nitrogen consistently perform better in late-season fertilization programs with traditional application dates.

## Growth-Clipping Yield

**Spring 1996:** Growth/yield initiation in the spring from late-season fertilization closely coincided with increases in the color/quality ratings. All nitrogen sources significantly out yielded the untreated turf in the spring. Growth/yield responses among the nitrogen sources were initially very similar (May 2 sampling rate). Growth/yield responses in the spring typically exhibited a lag of 1-2 weeks relative to initial color/quality responses. There was little difference in growth/yield among the ESN 2002 fertilizers prior to the first spring fertilization (May 24). In general, ESN 2003 and 2004 provided higher growth/yield than the ESN 2002 fertilizers through May 24. Growth/yield from ESN 2003, ESN 2004, and Polyon were slightly higher than the other nitrogen sources in the spring. Growth/yields from urea were surprisingly similar to most of the slow-release sources through the spring (May 24 sampling date). Slightly higher growth/yields in May from the polymer-coated and sulfur-coated urea nitrogen sources was reflected in slightly higher color/quality ratings from these sources in May compared to urea.

**Summer 1996:** All fertilizer sources except ESN 2003 and ESN 2004 were applied at 1.0 pounds of nitrogen per 1,000 $ft^2$ on May 24 and July 27. ESN 2003 was applied for the first time in 1996 on June 17 at 1.5 pounds of nitrogen per 1,000 $ft^2$. ESN 2004 was not applied in 1996 until July 27 at 2.0 pounds of nitrogen per 1,000 $ft^2$.

All nitrogen sources produced significantly higher growth/yield responses than the untreated turf throughout the summer (Table 3). Urea initially produced the highest growth/yield among the nitrogen sources from the May 24 fertilizer application. There was a general trend for nitrogen sources higher in water-soluble nitrogen to produce greater growth/yield responses for several weeks after fertilizer application. For example, the ESN 2002 fertilizer blends produced slightly greater growth/yield than ESN 2002 100/0. Typically, during the intermediate and residual response periods (i.e., greater than 3-4 weeks after fertilizer application) the slow-release nitrogen sources consistently exhibit slightly higher growth/yield responses than urea. The polymer-coated urea sources (i.e., ESN 2002, ESN 2003, ESN 2004, Polyon, and Poly S) also do not exhibit as dramatic a drop in growth/yield and color/quality in the intermediate and residual response periods as urea. Most of the other slow-release nitrogen sources display a similar trend as well.

ESN 2003 provided excellent color/quality and relatively high growth/yield through the beginning of September. Growth/yield dropped dramatically in early September with corresponding unacceptable color/quality ratings. ESN 2004 growth/yield dropped significantly in late July/early August with a corresponding decline in color/quality. However, color/quality for ESN 2004 during this period never dropped below an unacceptable level. ESN 2004 reapplication on July 27 resulted in a significant increase in growth/yield and outstanding color/quality ratings in August and September. The ESN 2004 application on July 27 resulted in acceptable color/quality ratings until the late-season application in November.

**Fall-Late Fall 1996:** Temperature plays a major role in top growth regulation of cool-season grasses during the fall and late fall periods. Slower growth and less fertilizer growth/yield responses are typically apparent when compared to growth/yield responses from similar spring and summer nitrogen applications. The fall and late fall of 1996 were no exception even though temperatures in Ohio were near normal. Growth/yield was initially greater from those nitrogen sources containing higher amounts of water-soluble nitrogen. The ESN 2002 blends provided slightly better growth/yield than the ESN 2002 100/0. ESN 2004 provided some growth/yield through October 17. This growth/yield response was most likely from July 27 carryover nitrogen. Growth/yield from ESN 2003 was minimal. In general, those nitrogen sources providing better growth/yield responses resulted in corresponding higher color/quality. Growth/yield responses were lowest from ESN 2002, ESN 2003, Polyon, IBDU, and Nature Pure. Very modest growth/yield, however, still resulted in some very acceptable color/quality responses. In general, growth/yield of the polymer-coated urea sources dropped substantially but acceptable color/quality was maintained through late November to early December. As suggested previously, higher application rates of polymer-coated urea somewhat earlier in the fall may provide more acceptable fall and late-season responses.

There were essentially no growth/yield responses from any of the nitrogen sources from the late-season fertilization (November 4). There were no visual signs of growth after October 28 so growth/yield for 1996 was terminated.

Growth/yield responses well be monitored through the 1997 spring growing season to monitor residual late-season fertilization responses.

**Table 1. Nitrogen sources with rates and application dates.**

| Fertilizer Source | Analysis | Ratio W/ Urea | Application Dates 11-95 | 5-23-96 | 6-17-96 | 7-27-96 | 9-20-96 | 11-4-96 |
|---|---|---|---|---|---|---|---|---|
| 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 appplied 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/1000 ft.$^2$ per growing season.

**Table 2. The effect of various nitrogen sources, rates, and timings on quality of Kentucky bluegrass.**

| Fertilizer[b] Source | Analysis | Ratio w/ Urea | Turfgrass Quality[a] 3-29 | 4-10 | 4-20 | 5-1 | 5-15 | 5-23 | 6-4 | 6-17 | 7-5 | 7-23 | 7-30 | 8-12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ESN 2002 | 41-0-0 | 100/0 | 2.5 | 3.0 | 5.0 | 6.5 | 7.0 | 7.0 | 7.0 | 7.5 | 7.5 | 7.0 | 6.5 | 7.0 |
| ESN 2002 | 43-0-0 | 60/40 | 2.5 | 3.0 | 5.0 | 6.5 | 7.0 | 6.5 | 7.5 | 7.5 | 7.5 | 7.0 | 6.5 | 7.5 |
| ESN 2002 | 44-0-0 | 40/60 | 2.5 | 3.0 | 5.5 | 6.5 | 7.5 | 6.5 | 7.5 | 7.5 | 7.0 | 6.5 | 6.0 | 7.5 |
| ESN 2002 | 45-0-0 | 20/80 | 2.3 | 4.0 | 5.5 | 6.5 | 7.5 | 5.5 | 8.3 | 8.0 | 6.5 | 5.7 | 5.0 | 8.0 |
| ESN 2003 | 41-0-0 | 100/0 | 2.5 | 4.0 | 6.2 | 7.0 | 8.5 | 8.0 | 6.0 | 6.3 | 9.0 | 9.0 | 8.5 | 7.0 |
| ESN 2004 | 41-0-0 | 100/0 | 2.2 | 3.0 | 5.0 | 6.5 | 8.0 | 8.5 | 6.5 | 7.0 | 7.0 | 6.0 | 6.0 | 7.5 |
| Poly Plus | 32-5-7 | 25/75 | 2.3 | 3.0 | 5.5 | 6.5 | 7.0 | 5.5 | 7.5 | 7.5 | 6.7 | 6.3 | 5.5 | 7.5 |
| Poly Plus | 32-5-7 | 50/50 | 2.2 | 3.0 | 5.5 | 7.0 | 7.5 | 6.5 | 7.0 | 7.5 | 7.3 | 7.0 | 6.5 | 8.0 |
| Urea | 46-0-0 | 100 | 3.0 | 4.0 | 6.0 | 7.5 | 7.5 | 6.0 | 8.5 | 8.2 | 6.0 | 5.0 | 5.0 | 8.0 |
| Polyon | 44-0-0 | 100 | 2.5 | 3.5 | 6.5 | 7.5 | 8.0 | 7.0 | 6.5 | 8.5 | 8.0 | 7.0 | 6.5 | 7.5 |
| Poly S | 40-0-0 | 100 | 2.2 | 3.2 | 6.0 | 7.0 | 8.0 | 6.5 | 7.5 | 7.5 | 7.5 | 6.5 | 5.8 | 8.0 |
| IBDU | 31-0-0 | 100 | 2.3 | 3.0 | 5.0 | 6.0 | 7.0 | 7.0 | 6.0 | 6.5 | 7.5 | 7.0 | 6.2 | 7.0 |
| Nature Pure | 3-5-3 | 100 | 2.3 | 3.0 | 5.0 | 6.0 | 7.0 | 6.5 | 7.0 | 7.5 | 7.5 | 7.0 | 6.5 | 7.0 |
| Lesco SCU | 37-0-0 | 100 | 2.3 | 3.0 | 5.5 | 7.0 | 8.0 | 7.0 | 7.5 | 8.0 | 8.0 | 7.2 | 7.0 | 8.0 |
| Nutralene | 40-0-0 | 100 | 2.3 | 3.0 | 5.0 | 6.5 | 7.0 | 6.5 | 7.0 | 7.0 | 7.5 | 6.7 | 6.5 | 7.0 |
| NBN | 30-0-0 | 100 | 2.2 | 4.0 | 6.5 | 7.5 | 7.5 | 6.0 | 8.0 | 7.5 | 7.0 | 6.0 | 5.5 | 8.0 |
| Coron | 28-0-0 | 100 | 3.0 | 4.0 | 6.5 | 7.5 | 7.5 | 6.5 | 8.5 | 8.0 | 7.5 | 6.5 | 5.5 | 8.0 |
| Check | ---- | --- | 1.5 | 1.5 | 2.0 | 2.2 | 3.2 | 3.2 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 2.8 |
| LSD (0.05) | | | 0.37 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.16 | 0.16 | 0.22 | 0.16 | 0.12 |

[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 October 30, 1995, and May 23, June 17, July 27, September 20, and November 4, 1996. 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 2 (continued). The effect of various nitrogen sources, rates, and timings on quality of Kentucky bluegrass.**

| Fertilizer[b] Source | Analysis | Ratio w/ Urea | Turfgrass Quality[a] 8-22 | 9-3 | 9-13 | 9-23 | 10-3 | 10-17 | 10-28 | 11-4 | 11-18 | 12-2 | 12-20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ESN 2002 | 41-0-0 | 100/0 | 7.0 | 7.0 | 7.5 | 7.5 | 6.5 | 7.5 | 7.5 | 7.0 | 6.5 | 6.0 | 4.5 |
| ESN 2002 | 43-0-0 | 60/40 | 7.5 | 7.0 | 7.0 | 7.0 | 7.0 | 8.0 | 7.5 | 7.0 | 6.5 | 6.5 | 5.0 |
| ESN 2002 | 44-0-0 | 40/60 | 7.5 | 7.0 | 7.0 | 7.0 | 7.5 | 8.0 | 7.7 | 7.0 | 6.5 | 6.5 | 5.0 |
| ESN 2002 | 45-0-0 | 20/80 | 7.5 | 6.5 | 6.5 | 6.5 | 7.5 | 8.5 | 8.0 | 7.0 | 7.0 | 7.0 | 5.0 |
| ESN 2003 | 41-0-0 | 100/0 | 6.5 | 5.7 | 5.5 | 5.5 | 5.2 | 6.0 | 6.0 | 5.5 | 4.0 | 4.0 | 2.5 |
| ESN 2004 | 41-0-0 | 100/0 | 8.3 | 9.0 | 8.5 | 8.0 | 7.0 | 6.7 | 7.0 | 6.0 | 4.5 | 4.5 | 2.5 |
| Poly Plus | 32-5-7 | 25/75 | 7.0 | 6.5 | 6.5 | 6.5 | 7.5 | 8.0 | 8.0 | 7.0 | 6.5 | 6.5 | 5.0 |
| Poly Plus | 32-5-7 | 50/50 | 7.5 | 7.0 | 7.3 | 7.2 | 7.5 | 8.0 | 7.5 | 7.0 | 6.7 | 6.5 | 5.0 |
| Urea | 46-0-0 | 100 | 7.5 | 6.5 | 6.5 | 6.5 | 8.0 | 8.3 | 8.0 | 7.0 | 7.0 | 7.0 | 5.5 |
| Polyon | 44-0-0 | 100 | 8.0 | 7.7 | 7.5 | 7.0 | 6.0 | 7.0 | 7.5 | 7.0 | 6.5 | 5.5 | 4.0 |
| Poly S | 40-0-0 | 100 | 7.8 | 7.3 | 7.5 | 7.5 | 8.0 | 8.5 | 8.0 | 7.0 | 6.5 | 6.5 | 5.0 |
| IBDU | 31-0-0 | 100 | 7.0 | 7.2 | 7.5 | 7.5 | 7.0 | 7.5 | 7.5 | 7.0 | 6.5 | 6.5 | 5.0 |
| Nature Pure | 3-5-3 | 100 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.5 | 7.5 | 6.3 | 6.2 | 6.0 | 4.0 |
| Lesco SCU | 37-0-0 | 100 | 8.0 | 7.7 | 7.5 | 7.5 | 7.7 | 8.0 | 8.0 | 7.3 | 6.5 | 6.3 | 4.0 |
| Nutralene | 40-0-0 | 100 | 7.2 | 7.0 | 7.0 | 7.2 | 7.0 | 7.5 | 7.5 | 7.0 | 6.5 | 6.0 | 4.0 |
| NBN | 30-0-0 | 100 | 7.5 | 7.0 | 7.0 | 7.0 | 8.0 | 8.5 | 8.0 | 7.0 | 7.0 | 6.5 | 5.0 |
| Coron | 28-0-0 | 100 | 7.5 | 7.0 | 7.2 | 7.0 | 7.5 | 8.0 | 8.0 | 7.0 | 7.0 | 6.5 | 5.0 |
| Check | ----- | --- | 3.0 | 2.8 | 4.0 | 4.0 | 3.0 | 2.8 | 3.0 | 3.0 | 2.7 | 2.0 | 1.7 |
| LSD (0.05) | | | 0.20 | 0.28 | 0.16 | 0.16 | 0.16 | 0.20 | 0.12 | 0.17 | 0.27 | 0.12 | 0.12 |

[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 October 30, 1995, and May 23, June 17, July 27, September 20, and November 4, 1996. 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 clipping yield of Kentucky bluegrass.**

| Fertilizer[b] Source | Analysis | Ratio w/ Urea | Turfgrass Clipping Yield (grams)[a] 5-2 | 5-13 | 5-24 | 6-5 | 6-17 | 6-27 | 7-10 | 7-22 | 8-1 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ESN 2002 | 41-0-0 | 100/0 | 18.7 | 47.3 | 56 | 48 | 54.7 | 34 | 30.7 | 19.3 | 16.7 |
| ESN 2002 | 43-0-0 | 60/40 | 22.7 | 50.7 | 54 | 53.3 | 60.7 | 32 | 26.7 | 18 | 15.3 |
| ESN 2002 | 44-0-0 | 40/60 | 25.3 | 50 | 54 | 58.7 | 62.7 | 34 | 26.7 | 15.3 | 15.3 |
| ESN 2002 | 45-0-0 | 20/80 | 27.3 | 50 | 51.3 | 56.7 | 66 | 29.3 | 28 | 18 | 17.3 |
| ESN 2003 | 41-0-0 | 100/0 | 28 | 63.3 | 68.7 | 50.7 | 48.7 | 32 | 54 | 52 | 33.3 |
| ESN 2004 | 41-0-0 | 100/0 | 17.3 | 46.7 | 60.7 | 44 | 46.7 | 26.7 | 27.3 | 16 | 15.3 |
| Poly Plus | 32-5-7 | 25/75 | 21.3 | 40.7 | 43.3 | 52 | 58 | 26 | 27.3 | 18 | 16.7 |
| Poly Plus | 32-5-7 | 50/50 | 22.7 | 44.7 | 47.3 | 53.3 | 56 | 26.7 | 26 | 18.7 | 18 |
| Urea | 46-0-0 | 100 | 20.7 | 44.7 | 46.7 | 60.7 | 64 | 27.3 | 20 | 10.7 | 12.7 |
| Polyon | 44-0-0 | 100 | 30 | 62 | 59.3 | 41.3 | 58.7 | 38.7 | 32 | 18 | 13.3 |
| Poly S | 40-0-0 | 100 | 28 | 53.3 | 53.3 | 51.3 | 55.3 | 30.7 | 28.7 | 20.7 | 15.3 |
| IBDU | 31-0-0 | 100 | 4 | 17.3 | 30 | 23.3 | 33.3 | 26 | 24.7 | 20 | 12.7 |
| Nature Pure | 3-5-3 | 100 | 11.3 | 34 | 41.3 | 44 | 60 | 36 | 35.3 | 27.3 | 19.3 |
| Lesco SCU | 37-0-0 | 100 | 19.3 | 48 | 51.3 | 50.7 | 56.7 | 34 | 36 | 26.7 | 22 |
| Nutralene | 40-0-0 | 100 | 9.3 | 33.3 | 40 | 40 | 44.7 | 24 | 29.3 | 21.3 | 20.7 |
| NBN | 30-0-0 | 100 | 39.3 | 60 | 55.3 | 56.7 | 57.3 | 26.7 | 24 | 17.3 | 16.7 |
| Coron | 28-0-0 | 100 | 24.7 | 48.7 | 52.7 | 55.3 | 60 | 30.7 | 24 | 15.3 | 17.3 |
| Check | ----- | ---- | 2 | 2 | 4 | 5.3 | 2.7 | 2 | 2 | 2 | 2 |
| LSD (0.05) | | | 9.04 | 11.46 | 9.53 | 8.91 | 8.87 | 4.48 | 6.01 | 6.55 | 4.74 |

[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 October 30, 1995, and May 23, June 17, July 27, September 20, and November 4, 1996. 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 (continued). The effect of various nitrogen sources, rates, and timings on seasonal clipping yield of Kentucky bluegrass.**

| Fertilizer[b] Source | Analysis | Ratio w/ Urea | 8-13 | 8-23 | 9-3 | 9-13 | 9-24 | 10-4 | 10-17 | 10-28 |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Turfgrass Clipping Yield (grams)[a] | | | | | | | |
| ESN 2002 | 41-0-0 | 100/0 | 36.7 | 28.7 | 24.7 | 16.7 | 15.3 | 9.3 | 8.0 | 2.0 |
| ESN 2002 | 43-0-0 | 60/40 | 40.7 | 30.7 | 26.0 | 14.7 | 12.0 | 16.7 | 10.0 | 3.3 |
| ESN 2002 | 44-0-0 | 40/60 | 44.0 | 31.3 | 25.3 | 14.7 | 13.3 | 16.0 | 12.0 | 2.0 |
| ESN 2002 | 45-0-0 | 20/80 | 51.3 | 32.7 | 22.7 | 12.0 | 12.7 | 17.3 | 12.7 | 4.0 |
| ESN 2003 | 41-0-0 | 100/0 | 38.7 | 24.0 | 19.3 | 11.3 | 10.7 | 8.0 | 4.0 | 2.0 |
| ESN 2004 | 41-0-0 | 100/0 | 39.3 | 45.3 | 40.7 | 32.0 | 22.0 | 13.3 | 7.3 | 2.0 |
| Poly Plus | 32-5-7 | 25/75 | 48.7 | 32.0 | 21.3 | 14.0 | 14.0 | 18.7 | 14.7 | 3.3 |
| Poly Plus | 32-5-7 | 50/50 | 46.7 | 34.7 | 26.7 | 16.7 | 16.7 | 16.7 | 14.7 | 2.7 |
| Urea | 46-0-0 | 100 | 44.7 | 28.0 | 22.7 | 12.0 | 14.7 | 22.0 | 15.3 | 4.7 |
| Polyon | 44-0-0 | 100 | 33.3 | 33.3 | 28.7 | 19.3 | 11.3 | 7.3 | 6.0 | 3.3 |
| Poly S | 40-0-0 | 100 | 36.7 | 30.7 | 25.3 | 14.0 | 11.3 | 15.3 | 10.7 | 2.7 |
| IBDU | 31-0-0 | 100 | 24.0 | 20.7 | 20.7 | 15.3 | 10.0 | 6.7 | 4.0 | 2.7 |
| Nature Pure | 3-5-3 | 100 | 36.7 | 28.7 | 23.3 | 14.7 | 12.7 | 8.7 | 6.7 | 2.0 |
| Lesco SCU | 37-0-0 | 100 | 44.7 | 38.7 | 29.3 | 20.0 | 14.7 | 15.3 | 11.3 | 4.7 |
| Nutralene | 40-0-0 | 100 | 38.0 | 28.0 | 22.0 | 14.7 | 14.7 | 13.3 | 7.3 | 2.0 |
| NBN | 30-0-0 | 100 | 50.7 | 33.3 | 24.7 | 16.0 | 18.0 | 22.0 | 16.7 | 4.0 |
| Coron | 28-0-0 | 100 | 42.7 | 31.3 | 24.0 | 16.7 | 18.0 | 19.3 | 12.7 | 2.7 |
| Check | ----- | ---- | 5.3 | 4.7 | 3.3 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| LSD (0.05) | | | 6.63 | 5.18 | 4.67 | 5.03 | 4.45 | 4.04 | 3.25 | 2.13 |

[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 October 30, 1995, and May 23, June 17, July 27, September 20, and November 4, 1996. Note that ESN 2003 and 2004 received only three and two applications per year, respectively. See Table 1 for specific application rates and dates.

# Natural Organic Source Evaluation on a Kentucky Bluegrass-Perennial Ryegrass Mixture—1996

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## 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 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 urea-formaldehyde (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 yields (Table 2) for a 16-week period after initial fertilizer application. This fertilizer trial is the second year evaluation of a two-year study initiated in 1995. The nitrogen fertilizer sources were applied on May 23, 1996. One (1 N) and two (2 N) lbs. of nitrogen per 1,000 $ft^2$ (M) 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 x 10 ft plots. Mowing was performed 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 1 to 9 with one representing poorest and 9 representing best. Irrigation was performed as needed to prevent wilt.

Seasonal performance rankings are provided in Figures 1 to 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 & ≥7.0).

## Turfgrass Quality

Nitrogen fertilizer applications were made on May 23, 1996. 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 Scotts All Natural were the only two natural organic-based nitrogen sources to provide acceptable color/quality responses (i.e., ≥6.0) at the 1 N/M rate within one week after fertilizer application (May 30). As in 1995, color/quality responses from all the nitrogen sources at the 1 N/M rate can be characterized as relatively slow initially compared to urea. Several of the natural organic nitrogen sources did provide acceptable color/quality responses at the 1 N/M rate at two weeks after application. At the 2 N/M rate, initial color quality responses were significantly better with the majority of nitrogen sources.

Turfgrass color/quality ratings throughout the spring and summer rating periods were similar among the better performing natural organic nitrogen sources at the 1 N/M rate. These natural organic nitrogen sources, in general, exhibited a slow initial response, fair intermediate response, and a fair to poor residual response.

Turfgrass color/quality ratings at the 1 N/M rate were not much above marginally acceptable level (i.e., all ratings of ≤ 7.0). In fact, only urea and Nature Pure provided color/quality ratings of 7.0 at certain rating dates during the season at the 1 N/M rate. Nature Pure, Turf Plex VI, and Nutralene performed best at the 1 N/M rate based on seasonal performance ratings (Figure 1). Com-til, Nutriganics, and Natural Organic 1 provided unacceptable color/quality throughout the rating period at the 1 N/M rate. Scotts All Natural, Turf Plex VI, and Nature Pure provided the best residual responses at the 1 N/M rate (August 9 weeks residual). These latter color/quality responses were similar to those reported in 1995. Urea performance in 1996 was, however, significantly lower than in 1995. Intermediate and residual color/quality responses from urea were unacceptable at the 1 N/M rate.

The higher nitrogen rate (2 N/M) consistently outperformed the lower nitrogen rate across all nitrogen fertilizer sources throughout the rating period (Table 1 and Figures 2-3). Urea, Turf Plex V, Nature Pure, and Scotts All Natural provided the best overall performance among all the nitrogen fertilizer sources at the 2 N/M rate. Scotts All Natural, Nature Pure, Nature Safe, and Nutralene all provided the best residual color/quality responses (residual rating of 6.0-6.5) for 12 to 13 weeks. These latter four nitrogen sources provided similar residual color/quality responses to those in 1995. Seasonal performance ranking (Figures 2, 3) indicate that Scotts All Natural, Turf Plex VI, Nature Pure, Nature Safe, and Nutralene providing the best performance at the 2 N/M rate. Nature Pure clearly provided the best overall color/quality performance among the nitrogen sources at the 2 N/M rate. Nutriganics, Natural Organic 1, and Com-til seldom provided an acceptable response even at the 2 N/M rate. Many of the natural organic sources outperformed urea based on overall seasonal performance at the 2 N/M 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 sources and rates. Generally, there was a trend throughout the rating period for higher growth/clipping yields for the 2 N/M rate compared to the 1 N/M rate. These latter rate differences were more dramatic in the first four to six weeks after fertilizer application. Urea produced the highest initial growth/clipping yields in the first one to two weeks after fertilizer application (i.e., May 31). Growth/clipping yields were also somewhat higher in the first few weeks after fertilizer application from Scotts All Natural, Turf Plex V, Turf Plex VI, and Nature Pure. Those nitrogen sources exhibiting better color/quality in the intermediate response period generally provided slightly higher growth/clipping yields. Also, those nitrogen sources providing better growth/clipping yield consistently out yielded urea during the intermediate and residual periods at both nitrogen rates. Growth/clipping yields from Nutriganics, Natural Organic 1, and Com-til was seldom better than the untreated turfgrass.

**Table 1. The effect of various natural organic nitrogen fertilizers on quality of a Kentucky bluegrass-perennial ryegrass mixture.**

| Fertilizer[b] Source | Analysis | Rate[c] (lb N/M) | Turfgrass Quality[a] 5-30 | 6-10 | 6-28 | 7-15 | 7-25 | 8-5 | 8-16 | 8-28 | 9-9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nutiganics | 10-3-1 | 1 | 3.0 | 3.0 | 3.3 | 4.3 | 4.0 | 4.3 | 4.0 | 4.0 | 4.0 |
| | | 2 | 4.0 | 4.0 | 5.2 | 5.3 | 5.0 | 5.0 | 5.0 | 5.0 | 4.3 |
| Scotts All Natural Turf Builder | 11-2-4 | 1 | 6.0 | 6.7 | 6.5 | 6.5 | 6.5 | 6.0 | 5.2 | 5.0 | 4.5 |
| | | 2 | 8.0 | 8.2 | 7.5 | 7.5 | 7.5 | 7.0 | 6.0 | 6.0 | 5.5 |
| Turf Plex VI Bio Pro | 12-3-9 | 1 | 5.0 | 6.5 | 6.5 | 6.5 | 6.5 | 6.0 | 5.0 | 4.7 | 4.0 |
| | | 2 | 7.0 | 7.5 | 7.5 | 7.5 | 7.5 | 7.0 | 6.0 | 5.8 | 4.8 |
| Turf Plex V Bio Pro | 22-2-3 | 1 | 6.0 | 6.5 | 6.0 | 6.0 | 5.3 | 4.3 | 4.7 | 4.3 | 4.2 |
| | | 2 | 7.8 | 8.0 | 7.3 | 7.0 | 6.3 | 5.3 | 5.3 | 4.7 | 4.8 |
| Nature Pure | 3-5-3 | 1 | 5.0 | 7.0 | 7.0 | 7.0 | 7.0 | 6.0 | 5.5 | 5.0 | 4.8 |
| | | 2 | 7.5 | 8.5 | 8.0 | 8.0 | 8.0 | 7.0 | 6.5 | 6.3 | 5.8 |
| Sustane | 5-2-4 | 1 | 4.0 | 5.8 | 6.0 | 5.5 | 5.7 | 5.0 | 5.0 | 5.0 | 4.3 |
| | | 2 | 5.0 | 6.8 | 7.0 | 6.5 | 6.3 | 6.0 | 6.0 | 5.5 | 5.2 |
| Nature Safe | 10-3-3 | 1 | 4.0 | 6.2 | 6.5 | 6.0 | 5.7 | 5.7 | 5.2 | 4.7 | 4.5 |
| | | 2 | 5.0 | 8.0 | 7.5 | 7.0 | 7.0 | 6.5 | 6.5 | 6.0 | 5.5 |
| Ringer | 10-2-6 | 1 | 3.3 | 5.7 | 6.5 | 6.5 | 6.5 | 5.8 | 5.3 | 4.7 | 4.0 |
| | | 2 | 5.2 | 7.3 | 7.5 | 7.5 | 7.3 | 6.8 | 6.2 | 5.3 | 4.7 |
| ReVita Lawn | 8-3-3 | 1 | 3.0 | 5.0 | 6.3 | 5.0 | 4.7 | 4.3 | 5.0 | 4.7 | 4.3 |
| | | 2 | 4.0 | 7.0 | 7.3 | 6.0 | 6.0 | 5.3 | 6.0 | 5.7 | 4.8 |
| Natural Organic 1 | 3-4-3 | 1 | 3.0 | 3.3 | 3.3 | 3.7 | 3.7 | 4.0 | 4.0 | 4.0 | 4.0 |
| | | 2 | 4.0 | 6.2 | 4.7 | 4.7 | 4.5 | 5.0 | 5.0 | 5.0 | 4.7 |
| Nutralene | 40-0-0 | 1 | 4.0 | 6.5 | 6.5 | 6.5 | 6.0 | 5.8 | 5.5 | 5.0 | 4.7 |
| | | 2 | 6.0 | 7.5 | 7.5 | 7.5 | 7.0 | 6.8 | 6.5 | 6.0 | 5.8 |
| Urea | 46-0-0 | 1 | 7.0 | 7.0 | 5.8 | 5.3 | 4.0 | 4.0 | 4.3 | 4.3 | 4.2 |
| | | 2 | 9.0 | 9.0 | 7.2 | 6.5 | 6.0 | 5.0 | 5.5 | 5.2 | 4.8 |
| Comtil | 3.8- | 1 | 2.0 | 3.0 | 3.0 | 3.3 | 3.0 | 4.0 | 4.0 | 4.0 | 3.3 |
| | | 2 | 3.0 | 3.7 | 4.0 | 4.3 | 4.0 | 4.0 | 4.5 | 4.3 | 4.0 |
| Untreated | --- | --- | 2.0 | 3.0 | 3.7 | 4.0 | 4.3 | 4.0 | 4.0 | 4.0 | 3.0 |
| LSD (0.05) | | | 0.22 | 0.37 | 0.43 | 0.14 | 0.42 | 0.45 | 0.27 | 0.56 | 0.45 |

[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 23, 1996.
[c] lb N/M represents pounds of nitrogen per 1,000 ft.$^2$

**Table 2. The effect of various natural organic nitrogen fertilizers on growth/clipping yield of a Kentucky bluegrass-perennial ryegrass mixture.**

| Fertilizer[b] | | Rate[c] | Turfgrass Clipping Yields (grams)[a] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Source | Analysis | (lb N/M) | 5-31 | 6-12 | 6-25 | 7-5 | 7-16 | 7-26 | 8-6 | 8-19 | 8-29 | 9-10 |
| Nutiganics | 10-3-1 | 1 | 9 | 7 | 8 | 7 | 3 | 7 | 23 | 17 | 10 | 6 |
| | | 2 | 15 | 19 | 14 | 9 | 6 | 10 | 23 | 20 | 9 | 14 |
| Scotts All Natural Turf Builder | 11-2-4 | 1 | 22 | 29 | 21 | 13 | 12 | 17 | 32 | 27 | 16 | 21 |
| | | 2 | 39 | 54 | 41 | 22 | 12 | 20 | 34 | 26 | 15 | 19 |
| Turf Plex VI Bio Pro | 12-3-9 | 1 | 24 | 25 | 21 | 13 | 8 | 14 | 29 | 23 | 14 | 14 |
| | | 2 | 33 | 49 | 45 | 24 | 10 | 15 | 31 | 25 | 16 | 16 |
| Turf Plex V Bio Pro | 22-2-3 | 1 | 22 | 25 | 18 | 8 | 4 | 8 | 19 | 16 | 8 | 9 |
| | | 2 | 36 | 52 | 37 | 17 | 9 | 12 | 21 | 18 | 12 | 11 |
| Nature Pure | 3-5-3 | 1 | 19 | 25 | 22 | 14 | 10 | 11 | 24 | 22 | 12 | 12 |
| | | 2 | 37 | 60 | 56 | 29 | 22 | 20 | 36 | 27 | 16 | 19 |
| Sustane | 5-2-4 | 1 | 12 | 17 | 18 | 10 | 7 | 10 | 22 | 17 | 11 | 14 |
| | | 2 | 19 | 33 | 38 | 18 | 11 | 12 | 25 | 22 | 13 | 16 |
| Nature Safe | 10-3-3 | 1 | 16 | 20 | 21 | 10 | 5 | 10 | 18 | 14 | 10 | 16 |
| | | 2 | 21 | 38 | 39 | 22 | 11 | 16 | 28 | 22 | 14 | 21 |
| Ringer | 10-2-6 | 1 | 8 | 15 | 12 | 9 | 8 | 14 | 29 | 20 | 10 | 9 |
| | | 2 | 11 | 29 | 30 | 15 | 11 | 15 | 31 | 22 | 10 | 13 |
| ReVita Lawn | 8-3-3 | 1 | 10 | 11 | 13 | 8 | 5 | 10 | 23 | 16 | 10 | 13 |
| | | 2 | 14 | 27 | 30 | 14 | 6 | 14 | 27 | 22 | 12 | 19 |
| Natural Organic 1 | 3-4-3 | 1 | 8 | 10 | 9 | 7 | 3 | 8 | 16 | 11 | 7 | 7 |
| | | 2 | 13 | 20 | 17 | 9 | 7 | 11 | 23 | 15 | 10 | 10 |
| Nutralene | 40-0-0 | 1 | 15 | 17 | 12 | 8 | 7 | 11 | 22 | 20 | 10 | 13 |
| | | 2 | 25 | 32 | 25 | 18 | 14 | 16 | 28 | 27 | 12 | 13 |
| Urea | 46-0-0 | 1 | 27 | 27 | 23 | 11 | 4 | 9 | 17 | 16 | 10 | 10 |
| | | 2 | 50 | 65 | 47 | 19 | 12 | 12 | 24 | 18 | 11 | 12 |
| Comtil | 3.8- | 1 | 13 | 11 | 7 | 8 | 3 | 5 | 13 | 13 | 8 | 9 |
| | | 2 | 15 | 15 | 14 | 7 | 3 | 7 | 17 | 13 | 8 | 9 |
| Untreated | --- | --- | 10 | 9 | 6 | 6 | 5 | 10 | 17 | 19 | 14 | 20 |
| LSD (0.05) | | | 12.27 | 15.55 | 14.12 | 8.53 | 8.69 | 8.79 | 9.88 | 10.78 | 8.98 | 17.97 |

[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 23, 1996.
[c] lb N/M represents pounds of nitrogen per 1,000 ft.$^2$.

Figure 1. Seasonal Performance Ranking of Various Natural Organic Fertilizers

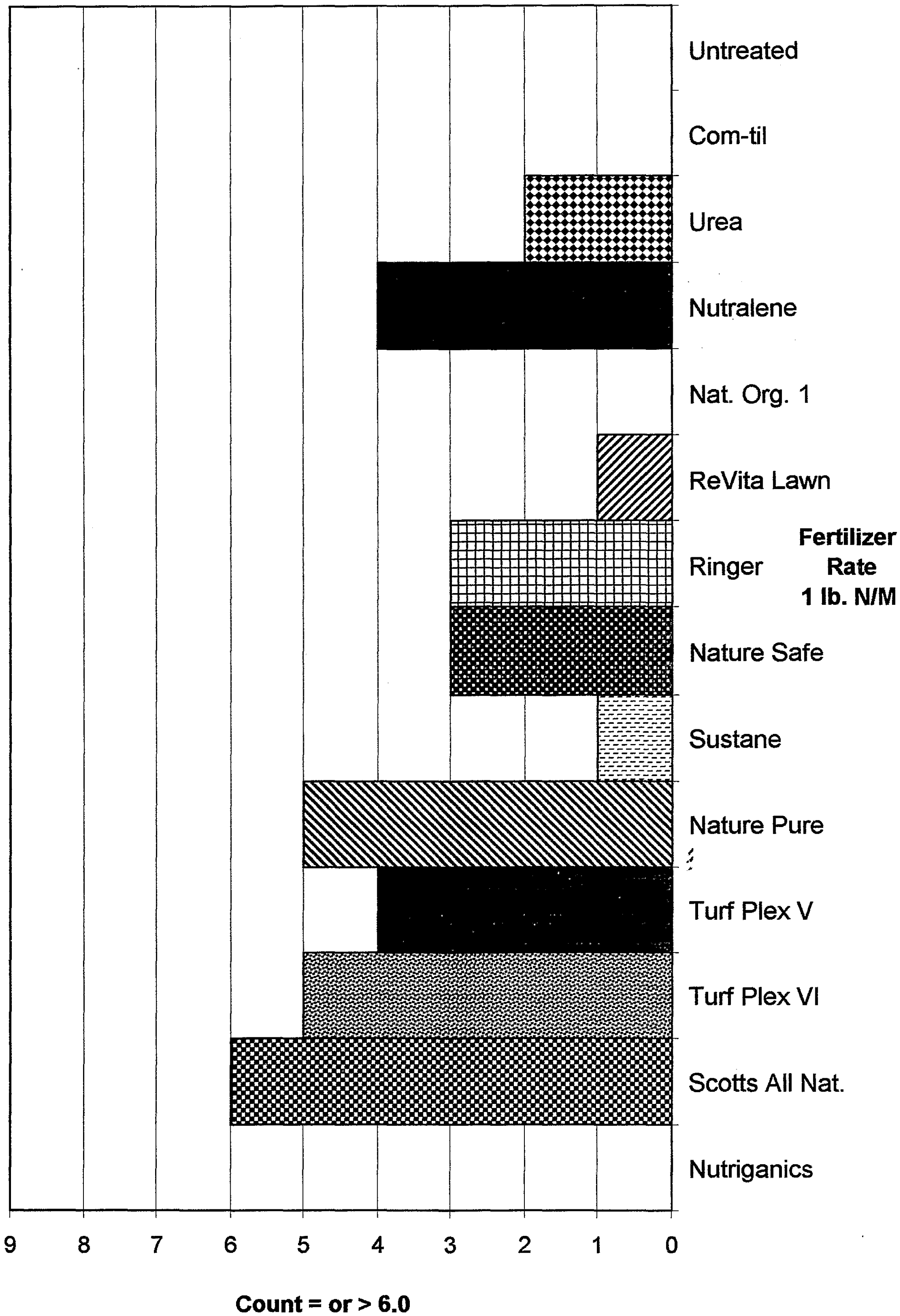


Figure 2. Seasonal Performance Ranking of Various Natural Organic Fertilizers

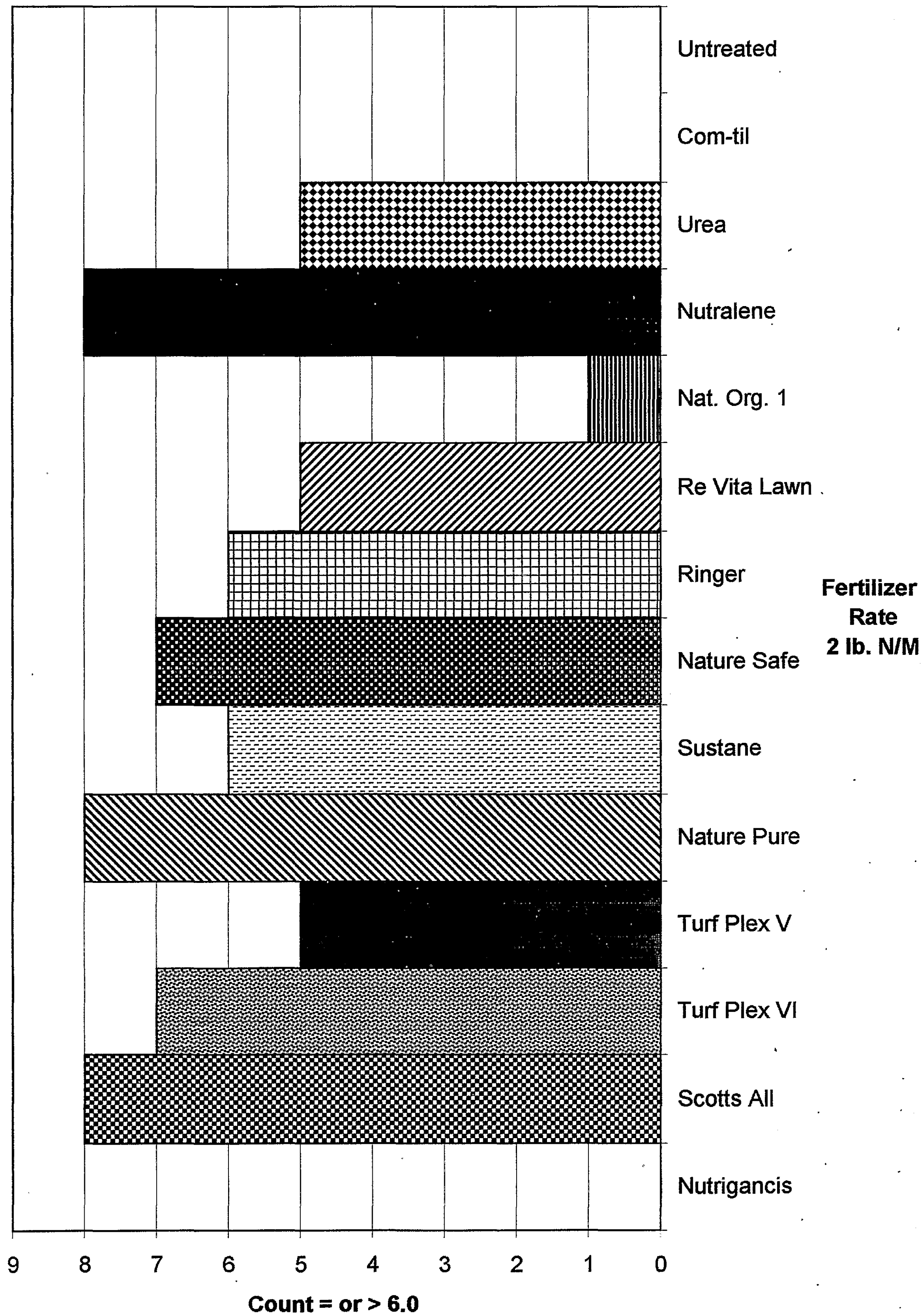
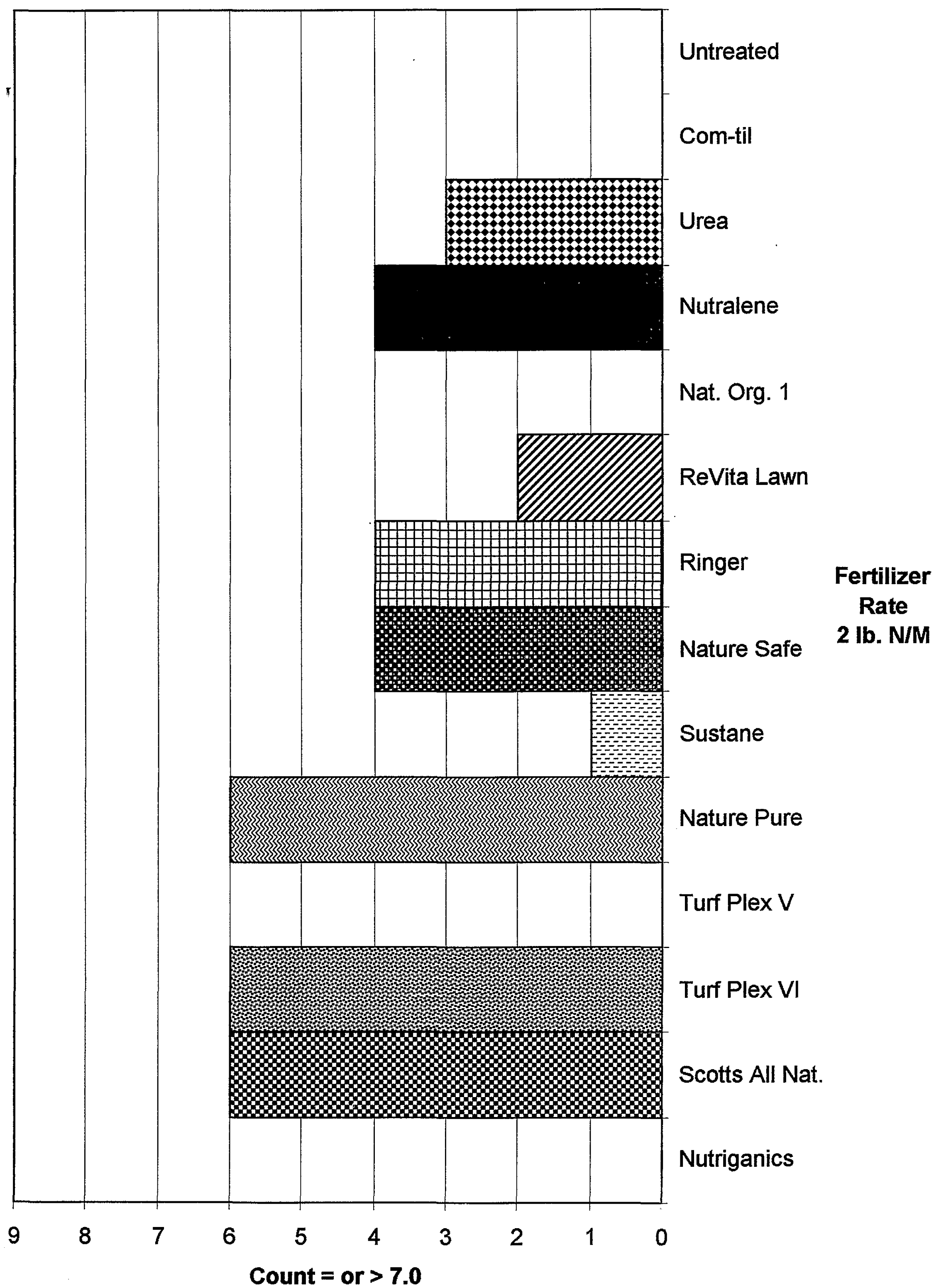


Figure 3. Seasonal Performance Ranking of Various Natural Organic Fertilizers



# Polymer-Coated Urea Source and Rate Effect on Kentucky Bluegrass

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## 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 response from nitrogen is 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 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 sources vary considerably in their chemical and physical properties. Slowly available sources such as ureaformaldehyde (UF), methylene ureas (MUs), milogranite, isobutylidene diurea (IBDU), and sulfur-coated ureas have been available for years. Several slowly available sources have more recently emerged into the marketplace. These are the polymer-coated ureas and polymer-coated sulfur-coated ureas. The polymer-coated sulfur-coated ureas are sulfur-coated urea particles coated with a polymer plastic (resin). The polymer coatings SCU granules have typically ranged from 1-2%. Our research at The Ohio State University comparing similar non-coated and polymer-coated sulfur-coated ureas have shown limited differences. Polymer-coated urea by definition is a coated slow-release fertilizer consisting of fertilizer urea particles coated with a polymer plastic resin. Coating thickness and chemistry of the polymer coating both play significant roles in the release characteristics of nitrogen, from these polymer-coated urea (PCU) fertilizers.

## Materials/Methods

The effects of several polymer-coated urea sources and rates (Tables 1 through 4) on turfgrass quality and clipping yield were compared throughout the 1996 growing season. Each PCU fertilizer was applied at rates of 1, 2, and 4 lb. of actual nitrogen/1,000 ft$^2$ (N/M) on June 5, 1996. Plot size was 3 x 10 ft. in a completely randomized block design. Nitrogen fertilizer applications were made by hand onto a six-screen mesh fertilizer distribution flow box to ensure uniform granule distribution. Mowing was performed at a 2-inch height and clippings were collected on a 10- to 12-day interval schedule throughout the growing season (Tables 3, 4). 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 1 through 9 with 1 representing poorest and 9 representing best (Tables 1, 2). A quality rating of 6.0 was considered to be the lower limit for minimal acceptable quality. Quality ratings below 6.0 were considered unacceptable. Irrigation was performed as needed to prevent wilt.

## Turfgrass Quality

This study was initiated with a single season fertilization of 1, 2, or 4 N/M on June 5, 1996. Turfgrass quality ratings for the various polymer-coated urea nitrogen sources are provided in Tables 1 and 2. Urea (46-0-0) was used as a standard source for comparison. In the 1 to 9 rating scheme, 6.0 was considered marginally acceptable and anything below 6.0 was unacceptable. Unfertilized turfgrass consistently showed poorer quality than the fertilized turfgrass throughout the growing season. Urea provided the best initial quality during the first few weeks after fertilizer application.

All polymer-coated urea (PCU) nitrogen sources exhibited a delay in initial turfgrass response for one to two weeks after fertilizer application. Vicote (75-d) provided the fastest initial response among the PCU nitrogen sources. The initial turfgrass response rate was slower from those PCU fertilizers having a predicted longer residual response (i.e., Polyon 42-0-0 > Polyon 43-0-0 > Polyon 44-0-0). Higher nitrogen rates within a specific PCU nitrogen source resulted in more rapid initial turfgrass quality responses.

Turfgrass quality responses during the evaluation period from all the PCU nitrogen sources seldom exceeded an average turfgrass quality rating of 6.5 at the 1x nitrogen rate. The PCU nitrogen sources at the 1x rate did, however, provide a significantly longer residual response compared to urea. Urea provided an acceptable residual response for only 6 to 7 weeks after fertilization; whereas, the PCU nitrogen sources provided 9 to 10 weeks of acceptable residual response at the 1 N/M rate [e.g., Vicote (75-d) provided a $\geq$ 6.0 rating until September 10]. The average quality responses from the lower rate of even the shorter residual (i.e., thinner coated) PCU fertilizers indicates that dosage or rate is important in designing nitrogen fertilization strategies with PCU nitrogen sources.

Turfgrass quality ratings from longer residual PCU nitrogen sources (e.g., Meister 100-d and 150-d, Polyon 42-0-0, and Vicote 43.5-0-0) typically resulted in slower initial responses but better intermediate and residual responses. Every PCU nitrogen source showed a significant increase in turfgrass quality as the nitrogen dosage or rate was increase from one to four lbs N/M. For example, Polyon 44-0-0 provided an acceptable residual response of 9 weeks, 10 to 11 weeks, and 14 to 15 weeks at the 1,2, and 4 lb. N/M rates, respectively. Shorter residual PCU nitrogen sources (e.g., Vicote 44-0-0) provided better initial turfgrass quality responses than longer residual PCU nitrogen sources (e.g., Vicote 43.5-0-0).

The longer residual PCU nitrogen sources, even though providing poorer initial quality, provided excellent intermediate and residual quality. These longer residual PCU nitrogen sources (i.e., Vicote 43.5-0-0, ESN 2004, Polyon 42-0-0, and Meister 150-d) at the 4 lb. N/M rate provided acceptable turfgrass quality for a considerable portion of the growing season (i.e., 18-20 weeks). Intermediate responses from the longer residual materials at the 4 lb. N/M rate were excellent. Shifts in the intensity of initial, intermediate and residual responses are influenced by the longevity characteristics of the various PCU nitrogen sources. An excellent example of this is the change in turfgrass quality response intensity among the rates and sources of Polyon 44-0-0, 43-0-0, and 42-0-0.

## Turfgrass Clipping Yield

Turfgrass clipping yield taken at 10- and 12-day intervals throughout the growing season are provided in Tables 3 and 4. In general, dry matter yield trends reflect trends in turfgrass quality. The unfertilized turfgrass consistently provided the lowest yields throughout the growing season. Urea clipping yields were higher than the PCU nitrogen sources when compared at equivalent rates in the first several weeks after fertilizer application. PCU nitrogen source yields were initially higher for the shorter residual PCU nitrogen sources relative to the longer residual PCU sources. Shifts in the magnitude of clipping yield are reflected by the longevity characteristics of the PCU nitrogen sources. PCU nitrogen sources significantly extended the magnitude of growth longer into the growing season compared to urea.

**Table 1. The effect of polymer-coated ureas on seasonal quality of Kentucky bluegrass.**

| Fertilizer[b] Source | Analysis | Rate[c] (lb N/M) | Turfgrass Quality[a] 6/13 | 6/18 | 7/5 | 7/23 | 8/5 | 8/16 | 8/30 | 9/10 | 9/20 | 10/1 | 10/12 | 10/25 | 11/15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Polyon | 44-0-0 | 1 | 5.3 | 6.0 | 6.5 | 6.5 | 6.5 | 6.0 | 6.0 | 5.0 | 4.0 | 4.0 | 4.0 | 3.5 | 3.0 |
| Polyon | 44-0-0 | 2 | 5.8 | 6.5 | 7.5 | 7.0 | 7.0 | 7.0 | 7.0 | 6.0 | 5.0 | 5.0 | 4.3 | 4.0 | 3.0 |
| Polyon | 44-0-0 | 4 | 6.3 | 7.5 | 9.0 | 9.0 | 9.0 | 9.0 | 8.5 | 7.5 | 6.0 | 5.5 | 5.5 | 4.5 | 3.5 |
| Polyon | 43-0-0 | 1 | 4.0 | 4.5 | 6.0 | 6.5 | 6.5 | 6.5 | 6.5 | 5.5 | 5.0 | 4.5 | 4.0 | 3.5 | 3.0 |
| Polyon | 43-0-0 | 2 | 4.5 | 5.5 | 7.5 | 7.5 | 8.0 | 8.0 | 7.5 | 6.5 | 5.5 | 5.0 | 4.8 | 3.8 | 3.5 |
| Polyon | 43-0-0 | 4 | 6.5 | 7.5 | 9.0 | 9.0 | 9.0 | 9.0 | 8.5 | 7.5 | 6.5 | 5.5 | 5.5 | 4.5 | 3.5 |
| Polyon | 42-0-0 | 1 | 4.0 | 4.0 | 5.3 | 6.5 | 6.5 | 6.5 | 6.5 | 6.0 | 5.0 | 5.0 | 4.5 | 3.3 | 3.0 |
| Polyon | 42-0-0 | 2 | 4.3 | 5.0 | 7.0 | 7.5 | 7.5 | 7.5 | 7.5 | 7.0 | 6.0 | 5.5 | 5.0 | 4.0 | 3.5 |
| Polyon | 42-0-0 | 4 | 4.5 | 5.3 | 8.8 | 9.0 | 9.0 | 9.0 | 9.0 | 8.5 | 7.0 | 6.5 | 6.0 | 4.8 | 4.3 |
| Meister Ty5 (50-d) | 40-0-0 | 1 | 4.0 | 5.0 | 6.5 | 6.5 | 6.5 | 6.5 | 6.5 | 5.5 | 5.0 | 4.8 | 4.0 | 3.3 | 3.0 |
| Meister Ty5 (50-d) | 40-0-0 | 2 | 4.5 | 6.0 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 6.5 | 5.5 | 5.3 | 4.5 | 4.0 | 3.5 |
| Meister Ty5 (50-d) | 40-0-0 | 4 | 5.0 | 7.5 | 9.0 | 9.0 | 9.0 | 9.0 | 8.5 | 7.5 | 6.5 | 5.8 | 5.5 | 4.5 | 4.0 |
| Meister Ty10 (100-d) | 40-0-0 | 1 | 4.0 | 4.0 | 6.0 | 6.5 | 7.0 | 7.0 | 6.5 | 6.0 | 5.0 | 4.5 | 4.5 | 4.0 | 3.5 |
| Meister Ty10 (100-d) | 40-0-0 | 2 | 4.5 | 5.3 | 7.0 | 7.5 | 8.0 | 8.0 | 7.5 | 7.0 | 6.0 | 5.3 | 5.0 | 4.5 | 3.5 |
| Meister Ty10 (100-d) | 40-0-0 | 4 | 4.5 | 5.5 | 9.0 | 9.0 | 9.0 | 9.0 | 8.5 | 8.5 | 7.0 | 6.5 | 6.5 | 5.5 | 4.5 |
| Meister Ty15 (150-d) | 40-0-0 | 1 | 4.0 | 4.5 | 5.5 | 6.5 | 7.0 | 7.0 | 7.0 | 6.0 | 5.3 | 4.3 | 4.0 | 4.0 | 3.0 |
| Meister Ty15 (150-d) | 40-0-0 | 2 | 4.0 | 4.5 | 6.8 | 7.5 | 8.0 | 8.0 | 8.0 | 7.5 | 6.5 | 5.5 | 4.8 | 4.5 | 3.5 |
| Meister Ty15 (150-d) | 40-0-0 | 4 | 4.5 | 5.3 | 8.3 | 8.8 | 9.0 | 9.0 | 9.0 | 8.8 | 7.5 | 7.0 | 6.3 | 6.0 | 5.0 |
| Check | ------ | --- | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 3.0 | 3.0 | 2.3 |
| LSD (0.05) | | | 0.31 | 0.31 | 0.22 | 0.26 | 0.00 | 0.20 | 0.22 | 0.11 | 0.20 | 0.40 | 0.42 | 0.29 | 0.20 |

[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 June 5, 1996.
[c] lb N/M represents pounds of nitrogen per 1,000 square feet.

**Table 2. The effect of polymer-coated ureas on seasonal quality of Kentucky bluegrass.**

| Fertilizer[b] Source | Analysis | Ratio[c] (lb N/M) | Turfgrass Quality[a] 6/13 | 6/18 | 7/5 | 7/23 | 8/5 | 8/16 | 8/30 | 9/10 | 9/20 | 10/1 | 10/12 | 10/25 | 11/15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vicote (75-d) | 44-0-0 | 1 | 5.3 | 6.3 | 6.5 | 6.5 | 6.5 | 6.5 | 6.3 | 6.0 | 5.0 | 4.5 | 4.5 | 4.0 | 3.5 |
| Vicote (75-d) | 44-0-0 | 2 | 6.0 | 7.0 | 7.0 | 7.3 | 7.5 | 7.5 | 7.5 | 7.0 | 5.8 | 5.5 | 5.0 | 4.5 | 3.5 |
| Vicote (75-d) | 44-0-0 | 4 | 7.0 | 8.3 | 8.5 | 8.8 | 8.5 | 8.5 | 8.5 | 8.0 | 7.0 | 7.0 | 6.3 | 5.5 | 4.8 |
| ESN 2002 (60-d) | 41-0-0 | 1 | 4.5 | 5.0 | 6.0 | 6.3 | 6.5 | 6.0 | 6.5 | 5.5 | 5.0 | 4.0 | 4.0 | 3.3 | 3.0 |
| ESN 2002 (60-d) | 41-0-0 | 2 | 5.0 | 6.0 | 7.0 | 7.0 | 7.5 | 7.5 | 7.3 | 6.5 | 5.5 | 5.0 | 4.5 | 3.5 | 3.0 |
| ESN 2002 (60-d) | 41-0-0 | 4 | 6.5 | 7.8 | 9.0 | 8.8 | 9.0 | 9.0 | 8.8 | 7.5 | 6.5 | 5.5 | 5.0 | 4.0 | 4.0 |
| ESN 2003 (90-d) | 41-0-0 | 1 | 4.0 | 5.0 | 6.0 | 6.0 | 6.5 | 7.0 | 7.0 | 6.0 | 5.0 | 5.0 | 4.3 | 4.0 | 3.5 |
| ESN 2003 (90-d) | 41-0-0 | 2 | 5.0 | 6.0 | 7.0 | 7.0 | 7.5 | 8.0 | 8.0 | 7.0 | 6.0 | 5.5 | 5.0 | 4.5 | 3.5 |
| ESN 2003 (90-d) | 41-0-0 | 4 | 6.0 | 7.5 | 8.0 | 8.5 | 9.0 | 9.0 | 9.0 | 8.0 | 7.0 | 6.5 | 6.0 | 5.0 | 4.5 |
| ESN 2004 (120-d) | 41-0-0 | 1 | 4.0 | 4.5 | 5.5 | 6.0 | 6.5 | 6.5 | 7.0 | 6.5 | 5.5 | 4.5 | 4.5 | 3.5 | 3.0 |
| ESN 2004 (120-d) | 41-0-0 | 2 | 4.5 | 5.5 | 7.0 | 7.5 | 8.0 | 8.0 | 8.0 | 7.5 | 6.5 | 5.5 | 5.0 | 4.3 | 3.5 |
| ESN 2004 (120-d) | 41-0-0 | 4 | 5.3 | 6.5 | 8.0 | 8.5 | 9.0 | 9.0 | 9.0 | 8.5 | 7.5 | 7.0 | 6.5 | 6.0 | 5.0 |
| Vicote Urea | 43.5-0-0 | 1 | 4.0 | 4.5 | 6.0 | 6.0 | 6.0 | 6.0 | 7.0 | 5.5 | 4.8 | 4.5 | 4.3 | 3.5 | 3.0 |
| Vicote Urea | 43.5-0-0 | 2 | 4.5 | 5.3 | 6.5 | 6.5 | 7.0 | 7.0 | 8.0 | 6.5 | 6.0 | 5.5 | 5.3 | 4.0 | 3.5 |
| Vicote Urea | 43.5-0-0 | 4 | 5.0 | 6.5 | 7.5 | 7.5 | 8.0 | 8.0 | 9.0 | 8.0 | 7.0 | 7.0 | 6.5 | 6.0 | 5.0 |
| Urea | 46-0-0 | 1 | 6.5 | 7.0 | 6.5 | 6.5 | 5.5 | 5.3 | 5.0 | 4.5 | 4.0 | 4.0 | 3.5 | 3.0 | 3.0 |
| Urea | 46-0-0 | 2 | 7.5 | 8.0 | 7.5 | 7.5 | 6.5 | 6.3 | 6.0 | 5.0 | 4.5 | 4.3 | 3.5 | 3.0 | 3.0 |
| Urea | 46-0-0 | 4 | 8.3 | 9.0 | 9.0 | 8.5 | 7.5 | 7.3 | 6.8 | 5.5 | 5.0 | 4.8 | 4.0 | 3.5 | 4.0 |
| Check | ------ | --- | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 3.0 | 3.0 | 2.3 |
| LSD (0.05) | | | 0.31 | 0.31 | 0.22 | 0.26 | 0.00 | 0.20 | 0.22 | 0.11 | 0.20 | 0.40 | 0.42 | 0.29 | 0.20 |

[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 June 5, 1996.
[c] lb N/M represents pounds of nitrogen per 1,000 square feet.

**Table 3. The effect of polymer-coated ureas on seasonal clipping yield of Kentucky bluegrass.**

| Fertilizer[b] | | Rate[c] | Turfgrass Clipping Yield (grams)[a] | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Source | Analysis | (lb N/M) | 6/19 | 7/1 | 7/11 | 7/24 | 8/6 | 8/20 | 8/30 | 9/11 | 9/20 | 10/1 | 10/15 |
| Polyon | 44-0-0 | 1 | 56 | 35 | 26 | 18 | 27 | 21 | 15 | 17 | 3 | 5 | 3 |
| Polyon | 44-0-0 | 2 | 45 | 58 | 27 | 35 | 55 | 26 | 17 | 14 | 4 | 6 | 3 |
| Polyon | 44-0-0 | 4 | 26 | 82 | 63 | 94 | 53 | 51 | 28 | 18 | 7 | 7 | 4 |
| Polyon | 43-0-0 | 1 | 26 | 28 | 18 | 28 | 25 | 29 | 21 | 15 | 5 | 7 | 3 |
| Polyon | 43-0-0 | 2 | 26 | 35 | 31 | 45 | 45 | 38 | 25 | 20 | 7 | 7 | 4 |
| Polyon | 43-0-0 | 4 | 63 | 108 | 74 | 104 | 72 | 53 | 31 | 24 | 8 | 8 | 4 |
| Polyon | 42-0-0 | 1 | 24 | 27 | 21 | 26 | 28 | 24 | 19 | 18 | 7 | 5 | 4 |
| Polyon | 42-0-0 | 2 | 29 | 51 | 39 | 55 | 53 | 42 | 31 | 24 | 8 | 9 | 5 |
| Polyon | 42-0-0 | 4 | 25 | 50 | 53 | 110 | 90 | 74 | 49 | 38 | 11 | 10 | 5 |
| Meister Ty5 (50-d) | 40-0-0 | 1 | 28 | 30 | 18 | 25 | 40 | 27 | 24 | 19 | 9 | 7 | 6 |
| Meister Ty5 (50-d) | 40-0-0 | 2 | 29 | 54 | 34 | 45 | 36 | 35 | 28 | 24 | 7 | 6 | 4 |
| Meister Ty5 (50-d) | 40-0-0 | 4 | 42 | 97 | 67 | 98 | 86 | 60 | 36 | 27 | 9 | 9 | 5 |
| Meister Ty10 (100-d) | 40-0-0 | 1 | 21 | 20 | 17 | 30 | 36 | 35 | 31 | 26 | 6 | 7 | 4 |
| Meister Ty10 (100-d) | 40-0-0 | 2 | 31 | 38 | 34 | 62 | 57 | 55 | 39 | 34 | 9 | 9 | 7 |
| Meister Ty10 (100-d) | 40-0-0 | 4 | 32 | 52 | 57 | 113 | 92 | 71 | 46 | 34 | 14 | 10 | 6 |
| Meister Ty15 (150-d) | 40-0-0 | 1 | 18 | 14 | 10 | 20 | 30 | 27 | 21 | 24 | 11 | 5 | 5 |
| Meister Ty15 (150-d) | 40-0-0 | 2 | 16 | 21 | 19 | 51 | 56 | 54 | 38 | 33 | 11 | 10 | 7 |
| Meister Ty15 (150-d) | 40-0-0 | 4 | 25 | 37 | 46 | 113 | 104 | 91 | 58 | 44 | 16 | 14 | 6 |
| Check | ------ | --- | 34 | 17 | 9 | 12 | 15 | 16 | 17 | 17 | 7 | 5 | 5 |
| LSD (0.05) | | | 18.46 | 17.68 | 12.91 | 18.16 | 19.22 | 14.99 | 13.11 | 14.43 | 6.03 | 4.6 | 3.79 |

[a] Clipping yields were made by taking a swath down the center of each plot with a Lawn Boy rotary mower.
[b] Fertilizer application was made on June 5, 1996.
[c] lb N/M represents pounds of nitrogen per 1,000 square feet.

**Table 4. The effect of polymer-coated ureas on seasonal clipping yield of Kentucky bluegrass.**

| Fertilizer[b] Source | Analysis | Ratio[c] (lb N/M) | Turfgrass Clipping Yield (grams)[a] 6/19 | 7/1 | 7/11 | 7/24 | 8/6 | 8/20 | 8/30 | 9/11 | 9/20 | 10/1 | 10/15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vicote (75-d) | 44-0-0 | 1 | 38 | 29 | 15 | 22 | 27 | 25 | 23 | 20 | 10 | 9 | 6 |
| Vicote (75-d) | 44-0-0 | 2 | 44 | 40 | 19 | 23 | 29 | 32 | 24 | 20 | 10 | 10 | 5 |
| Vicote (75-d) | 44-0-0 | 4 | 88 | 79 | 36 | 51 | 54 | 45 | 36 | 36 | 17 | 12 | 12 |
| ESN 2002 (60-d) | 41-0-0 | 1 | 32 | 30 | 15 | 22 | 31 | 27 | 21 | 21 | 8 | 7 | 4 |
| ESN 2002 (60-d) | 41-0-0 | 2 | 45 | 38 | 20 | 31 | 36 | 32 | 27 | 25 | 7 | 8 | 5 |
| ESN 2002 (60-d) | 41-0-0 | 4 | 65 | 85 | 54 | 79 | 71 | 61 | 38 | 31 | 10 | 6 | 4 |
| ESN 2003 (90-d) | 41-0-0 | 1 | 35 | 34 | 16 | 25 | 34 | 36 | 26 | 27 | 8 | 10 | 5 |
| ESN 2003 (90-d) | 41-0-0 | 2 | 44 | 39 | 21 | 36 | 47 | 49 | 35 | 31 | 14 | 12 | 7 |
| ESN 2003 (90-d) | 41-0-0 | 4 | 67 | 76 | 40 | 67 | 71 | 73 | 54 | 43 | 18 | 16 | 7 |
| ESN 2004 (120-d) | 41-0-0 | 1 | 31 | 23 | 11 | 17 | 25 | 28 | 27 | 24 | 13 | 8 | 5 |
| ESN 2004 (120-d) | 41-0-0 | 2 | 42 | 36 | 21 | 39 | 42 | 47 | 36 | 32 | 11 | 8 | 4 |
| ESN 2004 (120-d) | 41-0-0 | 4 | 42 | 49 | 31 | 52 | 55 | 59 | 45 | 39 | 12 | 9 | 8 |
| Vicote Urea | 43.5-0-0 | 1 | 28 | 20 | 11 | 15 | 20 | 20 | 18 | 14 | 7 | 5 | 3 |
| Vicote Urea | 43.5-0-0 | 2 | 34 | 28 | 14 | 22 | 27 | 29 | 25 | 27 | 10 | 6 | 7 |
| Vicote Urea | 43.5-0-0 | 4 | 40 | 42 | 19 | 32 | 38 | 35 | 25 | 28 | 17 | 10 | 9 |
| Urea | 46-0-0 | 1 | 66 | 37 | 12 | 18 | 21 | 23 | 16 | 17 | 7 | 4 | 5 |
| Urea | 46-0-0 | 2 | 85 | 48 | 16 | 17 | 20 | 18 | 16 | 10 | 3 | 2 | 4 |
| Urea | 46-0-0 | 4 | 113 | 92 | 43 | 46 | 36 | 27 | 19 | 17 | 8 | 3 | 3 |
| Check | ------ | --- | 34 | 17 | 9 | 12 | 15 | 16 | 17 | 17 | 7 | 5 | 5 |
| LSD (0.05) | | | 18.46 | 17.68 | 12.91 | 18.16 | 19.22 | 14.99 | 13.11 | 14.43 | 6.03 | 4.6 | 3.79 |

[a] Clipping yields were made by taking a swath down the center of each plot with a Lawn Boy rotary mower.
[b] Fertilizer application was made on June 5, 1996.
[c] lb N/M represents pounds of nitrogen per 1,000 ft$^2$.

# Polymer-Coated Urea and IBDU Fertilizer Performance on Kentucky Bluegrass

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## 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 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.

Today's nitrogen sources 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. Polymer-coated urea is by definition a coated slow-release nitrogen fertilizer consisting of fertilizer urea particles coated with a polymer or plastic resin. Coating thickness of the polymer plastic/resin or coating chemistry play a major role in the release characteristics of these latter sources.

The main purpose of this research was to evaluate a new polymer-coated urea (V-Cote) fertilizer alone and in combination with a traditional slow-release nitrogen source (IBDU) for performance (turfgrass quality and clipping yield) on Kentucky bluegrass.

## Materials and Methods

The effects of V-Cote (polymer-coated urea), IBDU, and 24-4-12 (50% IBDU/50% Urea) alone and in various combinations were evaluated for turfgrass quality and yield/growth responses of Kentucky bluegrass for a 16-week period (Table 1). Each nitrogen source and/or combination were applied both at 1 and 2 pound nitrogen rate per 1,000 $ft^2$ (lb. N/M). Fertilizer applications were made on May 24, 1995. Each treatment was replicated three times in a randomized complete block design using 3 x 10 ft plots. Mowing was performed at a two-inch height and clippings were collected throughout the experimental period on a 10- to 12-day interval schedule (Table 2). Clipping yield was based on one complete swath across the center of each plot with a 22-inch Lawn Boy rotary mower. Clippings were immediately bagged, dried at 60°C for 72 hours, and then weighed to provide dry matter yields (Table 2). Turfgrass quality ratings were taken at approximately 10- to 12-day intervals using a rating scale of one through nine, with one representing poorest and nine representing best (Table 1). A turfgrass quality rating below six was considered unacceptable. Irrigation was performed as needed to prevent wilt. Analysis of variance was performed on both the turfgrass quality and clipping yield data. Duncan's multiple range test was used to determine the least significant difference (LSD) values among means. These LSD values are provided at the bottom of Table 1 and Table 2.

## Summary/Conclusions

All fertilizers consistently performed better than the untreated plots at every rating date throughout the 16-week evaluation period. IBDU alone provided the slowest initial turfgrass quality response. All the IBDU/PCU combinations provided a better initial response than IBDU alone. The Par Ex 24-4-12 fertilizer provided the best initial turf response. IBDU/PCU combinations containing 50% or more PCU (V-Cote) or PCU (V-Cote) alone provided better intermediate turf quality responses than IBDU alone, especially at the higher nitrogen rate (i.e., 2 lb. N/M). All fertilizer treatments provided acceptable turf quality (i.e., $\geq$ 6.0) throughout the 16-week period at the 2 lb. N/M rate. IBDU alone provided slightly better residual turfgrass quality than the other fertilizer treatments at 12 to 14 weeks after application. In general, the PCU (V-Cote) fertilizer provided a uniform, slow-release turfgrass response through the initial, intermediate, and early residual response periods. The major contribution of PCU fertilizers in this and other research at The Ohio State University is their better intermediate and early residual phase responses compared to other slow-release fertilizers.

| Table 1. The effect of IBDU and PCU on Kentucky bluegrass quality. | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Turfgrass Quality Rating[a] | | | | | | | | | | |
| Fertilizer[b] Source | Ratio | Analysis | Rate[c] (lbs N/M) | 6-2 | 6-9 | 6-15 | 6-26 | 7-6 | 7-18 | 7-29 | 8-7 | 8-19 | 9-2 | 9-12 |
| IBDU Coarse | 100 | 31-0-0 | 1 | 5 | 5.5 | 6.0 | 6.3 | 7.0 | 7.0 | 7.5 | 7.5 | 6.5 | 5.5 | 5.5 |
| IBDU Coarse | 100 | 31-0-0 | 2 | 6.0 | 6.5 | 7.0 | 7.0 | 8.2 | 8.0 | 8.5 | 9.0 | 8.0 | 6.0 | 6.0 |
| IBDU/PCU | 75/25 | 31-0-0/44-0-0 | 1 | 6.0 | 6.0 | 6.5 | 6.5 | 7.0 | 7.0 | 7.0 | 7.0 | 6.5 | 5.5 | 5.5 |
| IBDU/PCU | 75/25 | 31-0-0/44-0-0 | 2 | 6.5 | 7.0 | 7.5 | 7.5 | 8.2 | 8.0 | 8.0 | 8.5 | 7.5 | 6.0 | 6.0 |
| IBDU/PCU | 50/50 | 31-0-0/44-0-0 | 1 | 6.0 | 6.5 | 7.0 | 7.0 | 7.3 | 7.0 | 7.5 | 7.5 | 6.0 | 5.5 | 5.5 |
| IBDU/PCU | 50/50 | 31-0-0/44-0-0 | 2 | 7.0 | 7.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 7.5 | 6.0 | 6.0 |
| IBDU/PCU | 25/75 | 31-0-0/44-0-0 | 1 | 6.0 | 6.7 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 6.0 | 5.5 | 5.5 |
| IBDU/PCU | 25/75 | 31-0-0/44-0-0 | 2 | 7.5 | 8.0 | 8.7 | 9.0 | 8.5 | 8.5 | 8.7 | 8.5 | 7.5 | 6.0 | 6.0 |
| PCU | 100 | 44-0-0 | 1 | 6.5 | 7.0 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 6.0 | 5.5 | 5.5 |
| PCU | 100 | 44-0-0 | 2 | 7.5 | 8.0 | 9.0 | 9.0 | 8.5 | 8.5 | 8.5 | 8.5 | 7.5 | 6.0 | 6.0 |
| Par Ex | 100 | 24-4-12 | 1 | 7.0 | 6.5 | 7.0 | 7.0 | 7.0 | 7.5 | 7.0 | 7.0 | 6.0 | 5.5 | 5.5 |
| Par Ex | 100 | 24-4-12 | 2 | 8.0 | 8.0 | 8.0 | 8.0 | 8.2 | 8.5 | 8.5 | 8.5 | 7.5 | 6.0 | 6.0 |
| Check | --- | --- | -- | 4.7 | 4.3 | 4.7 | 4.0 | 4.0 | 3.8 | 4.0 | 3.8 | 4.8 | 3.8 | 4.7 |
| LSD (0.05) | | | | 0.27 | 0.29 | 0.30 | 0.13 | 0.24 | 0.13 | 0.13 | 0.13 | 0.14 | 0.13 | 0.27 |

[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 24, 1995.
[c] lb. N/M represents pounds of Nitrogen per 1,000 ft.[2]

**Table 2. The effect of IBDU and PCU on Kentucky bluegrass growth (yield).**

| Fertilizer[b] Source | Ratio | Analysis | Rate[c] (lbs N/M) | Clipping Yield (grams) [a] 6-6 | 6-16 | 6-30 | 7-11 | 7-21 | 7-31 | 8-10 | 8-23 | 9-5 | 9-15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IBDU Coarse | 100 | 31-0-0 | 1 | 7.3 | 8.7 | 6.7 | 10.0 | 6.7 | 16.7 | 26.7 | 33.3 | 20.0 | 16.0 |
| IBDU Coarse | 100 | 31-0-0 | 2 | 7.3 | 6.7 | 11.3 | 15.3 | 15.3 | 24.7 | 33.3 | 40.7 | 24.0 | 22.7 |
| IBDU/PCU | 75/25 | 31-0-0/44-0-0 | 1 | 8.0 | 10.0 | 6.7 | 11.3 | 7.3 | 14.7 | 24.7 | 31.3 | 19.3 | 20.7 |
| IBDU/PCU | 75/25 | 31-0-0/44-0-0 | 2 | 11.3 | 15.3 | 16.0 | 17.3 | 15.3 | 24.7 | 34.7 | 43.3 | 30.0 | 22.0 |
| IBDU/PCU | 50/50 | 31-0-0/44-0-0 | 1 | 10.7 | 10.7 | 10.0 | 10.7 | 8.0 | 12.0 | 25.3 | 35.3 | 21.3 | 16.7 |
| IBDU/PCU | 50/50 | 31-0-0/44-0-0 | 2 | 19.3 | 22.0 | 22.7 | 24.0 | 18.0 | 24.0 | 36.7 | 49.3 | 30.7 | 21.3 |
| IBDU/PCU | 25/75 | 31-0-0/44-0-0 | 1 | 8.0 | 12.0 | 10.0 | 11.3 | 10.7 | 16.7 | 28.7 | 32.7 | 17.3 | 18.7 |
| IBDU/PCU | 25/75 | 31-0-0/44-0-0 | 2 | 16.7 | 24.0 | 22.7 | 22.0 | 18.0 | 28.0 | 35.3 | 41.3 | 24.0 | 24.0 |
| PCU | 100 | 44-0-0 | 1 | 10.7 | 15.3 | 14.7 | 12.7 | 9.3 | 15.3 | 28.0 | 34.0 | 20.7 | 20.7 |
| PCU | 100 | 44-0-0 | 2 | 15.3 | 25.3 | 24.0 | 23.3 | 16.7 | 24.0 | 34.7 | 40.0 | 24.0 | 24.0 |
| Par Ex | 100 | 24-4-12 | 1 | 12.0 | 14.0 | 9.0 | 11.0 | 8.0 | 16.0 | 27.0 | 35.0 | 23.0 | 21.0 |
| Par Ex | 100 | 24-4-12 | 2 | 37.0 | 40.0 | 33.0 | 38.0 | 25.0 | 30.0 | 41.0 | 43.0 | 29.0 | 22.0 |
| Check | --- | --- | -- | 16.0 | 12.0 | 9.0 | 9.0 | 10.0 | 12.0 | 24.0 | 28.0 | 17.0 | 14.0 |
| LSD (0.05) | | | | 9.7 | 8.3 | 6.0 | 6.1 | 6.0 | 6.1 | 5.3 | 8.6 | 8.7 | 8.0 |

[a] Clipping yields were made by taking a swath down the center of each plot with a Lawn Boy rotary mower.
[b] Fertilizer application was made on May 24, 1995.
[c] lb. N/M represents pounds of Nitrogen per 1,000 $ft.^2$

# *Turfgrass Species, Culture and Management*

# 1993 NTEP Bentgrass (Fairway/Tee) Cultivar Evaluation

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## Introduction

The 1993 NTEP Bentgrass Test (Fairway/Tee) cultivar evaluation trial was established in September 1993 at the Ohio State University Turfgrass Research Facility in Columbus. Twenty-one entries were hand-seeded at 6 grams/24 $ft^2$ (0.55 lb/1000 $ft^2$) in a randomized complete block design with three replications. Five colonial bentgrasses are included in the test.

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 is 2.75 lb./1000 $ft^2$ per year.

## Discussion/Summary

A list of the entries and 1996 ratings appears in Table 1.

All entries had good first-year cover, ranging from 45-78% six weeks after seeding. 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. However, these seedlings did not survive the severe winter of 1993/94. The trial was then chemically killed and reseeded in May 1994.

Genetic color ratings are based on a scale of 1-9, with 9 = darkest green color and 1 = absence of green color. Entries that had the darkest green genetic color (rating 8.0 or higher) are Providence, Cato, Penncross, G-2 G-6, BAR Ws 42102, Exeter, PRO/CUP, Southshore, DF-1 and Tendez (Table 1).

Quality ratings are based on a scale of 1-9, with 9=best quality and 1=poorest quality. Entries rating highest in summer 1996 mean quality (rating 7.0 or higher) are BAR Ws 42102, Providence, Cato, Southshore, DF-1, G-2, and Penneagle and PRO/CUP (Table 1).

A percent dollar spot (*Sclerotinia homoeocarpa)* infection rating was taken in July 1996 (Table 1). All entries were affected. Those entries showing most resistance to dollar spot (20% or less visible infection) are BAR As 493, Seaside, DF-1 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. 1993 NTEP bentgrass trial—quality, color and percent dollar spot ratings for 1996.**

| Entry | Quality | | | | | % Dollar spot | Genetic color |
|---|---|---|---|---|---|---|---|
| | May | June | July | Aug | Mean | | |
| 18th Green | 5.0[1] | 6.3 | 6.3 | 6.3 | 6.0 | 71.7[2] | 7.7[3] |
| Bar As 493 | 5.0 | 7.3 | 7.3 | 7.3 | 6.7 | 18.3 | 7.3 |
| BAR Ws 42102 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 28.3 | 8.0 |
| Trueline | 6.3 | 6.7 | 6.7 | 6.7 | 6.6 | 68.3 | 7.7 |
| Providence | 7.0 | 7.3 | 7.3 | 7.3 | 7.2 | 28.3 | 8.0 |
| Seaside | 5.3 | 7.3 | 7.3 | 7.3 | 6.8 | 16.7 | 7.3 |
| Cato | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 38.3 | 8.0 |
| Exeter | 5.3 | 6.0 | 6.0 | 6.0 | 5.8 | 33.3 | 8.0 |
| PRO/CUP | 6.0 | 7.3 | 7.3 | 7.3 | 7.0 | 55.0 | 8.0 |
| Crenshaw | 6.0 | 7.0 | 7.0 | 7.0 | 6.8 | 50.0 | 7.7 |
| Southshore | 6.7 | 7.3 | 7.3 | 7.3 | 7.1 | 26.7 | 8.0 |
| SR 7100 | 5.0 | 6.0 | 6.0 | 6.0 | 5.8 | 26.7 | 7.7 |
| Penncross | 6.0 | 6.7 | 6.7 | 6.7 | 6.5 | 38.3 | 8.0 |
| DF-1 | 6.7 | 8.0 | 8.0 | 8.0 | 7.7 | 20.0 | 8.0 |
| G-2 | 7.0 | 7.7 | 7.7 | 7.7 | 7.5 | 25.0 | 8.0 |
| G-6 | 7.0 | 6.7 | 6.7 | 6.7 | 6.8 | 15.0 | 8.0 |
| Penneagle | 7.0 | 7.3 | 7.3 | 7.3 | 7.2 | 25.0 | 7.7 |
| Lopez | 5.7 | 6.7 | 6.7 | 6.7 | 6.5 | 35.0 | 7.7 |
| Tendez | 5.3 | 6.0 | 6.0 | 6.0 | 5.8 | 21.7 | 8.0 |
| ISI-At-90162 | 4.7 | 6.0 | 6.0 | 6.0 | 5.7 | 36.7 | 7.3 |
| OM-At-90163 6.0 | 7.0 | 7.0 | 7.0 | 6.8 | 6.9 | 83.3 | 7.7 |

[1] Mean quality ratings 1-9 with 9=best quality and 1= poorest quality.
[2] Mean percent dollar spot ratings 1-100, with 0=no visible infection and 100=complete plot infection.
[3] Mean genetic color ratings 1-9, with 9=darkest green and 1=complete absence of green color.

# 1993 NTEP Fineleaf Fescue Cultivar Evaluation

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## Introduction

The 1993 NTEP Fineleaf Fescue Cultivar Evaluation was established September 1993 at the Ohio State University Turfgrass Research Facility in Columbus. Sixty entries were hand seeded at 50 grams/25 $ft^2$ (4.4 lb./1000 $ft^2$) in a randomized complete block design with three replications.

The site is on irrigated silt loam soil in full sun and is maintained at 1.5 inches height of cut with a reel mower. Actual nitrogen applied is 1.75 lb./1000 $ft^2$ per year. Fineleaf fescues represented in this trial are chewings, strong creeping, hard and sheep fescues.

Initial percent cover ranged from 25-50 percent. Some of the species slower to achieve full plot density in 1994 were of the chewings and strong creeping varieties. A decimating infestation of brown patch disease (*Rhizoctonia solani*) occured in July 1994, causing loss of cover for all species. A curative fungicide was applied. Plot density during recovery improved monthly but had not fully recovered by the end of 1994. At this time, quality ratings taken of the entries indicate the hard fescues were the only species in the acceptable quality range. (See *The Ohio State University 1994 Turfgrass Research Report, Special Circular 148.*)

Since 1994, when some of the entries lost 1-3 replications to brown patch, ratings only include surviving entries of the original trial. The unreported entries lost to brown patch are listed in Table 1.

**Table 1. Fineleaf fescue NTEP entries lost to brown patch since initial establishment.**

| Chewings | Strong creeping | Sheep | Hard | Slender Creeping |
|---|---|---|---|---|
| NJ F-93 | Rondo | 67135 | MB 81-93 | Dawson |
| Medina | WVPB-STCR-101 | | | |
| Victory (E) | BAR UR 204 | | | |
| ZPS-MG | WX3-FFG6 | | | |
| Tiffany | CAS-FR13 | | | |
| Jamestown II | common | | | |
| Jamestown | | | | |
| Darwin | | | | |
| Brittany | | | | |
| MB 63-93 | | | | |
| MB 65-93 | | | | |
| Molinda | | | | |
| MB 66-93 | | | | |
| ISI-FC-62 | | | | |
| Cascade | | | | |
| WX3-FF54 | | | | |

**Discussion/Summary**

A list of the entries and 1996 ratings appears in Table 2.

Quality ratings are based on a scale of 1-9 with 9=best quality and 1=poorest qualtiy. Entries rating highest in mean quality (7.0 or higher) in Summer 1996 are Ecostar, Pamela, Brigade, Nordic, PST-4ST, Spartan, MB 82-93, SR 3100, Aurora w/endo and MED 32 (Table 1).

Genetic color ratings are based on a scale of 1-9 with 9=darkest green color and 1=abscence of green color. All entries are rated between 7.7 and 8.6 in Summer 1996 (Table 1).

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 2. 1993 NTEP fine fescue—ratings for 1996.**

| | | Quality | | | | |
|---|---|---|---|---|---|---|
| Entry | Species | June | July | Aug | Mean | Genetic Color |
| Scaldis | hard | 6.0[1] | 6.7 | 6.7 | 6.2 | 7.9[2] |
| Ecostar | hard | 6.7 | 7.0 | 7.3 | 7.0 | 8.0 |
| Pamela | hard | 7.0 | 7.0 | 7.0 | 7.0 | 8.2 |
| Brigade | hard | 7.0 | 7.3 | 7.0 | 7.1 | 7.7 |
| BAR Frr 4ZBD | strong creeping | 3.3 | 4.3 | 5.7 | 4.4 | 8.0 |
| Jasper (E) | strong creeping | 6.7 | 7.0 | 7.0 | 6.9 | 8.6 |
| Pick 4-91W | chewings | 6.0 | 6.7 | 7.0 | 6.6 | 8.1 |
| Bridgeport | chewings | 4.7 | 7.0 | 6.7 | 6.1 | 7.8 |
| Nordic | hard | 7.3 | 7.5 | 7.0 | 7.3 | 8.1 |
| Seabreeze | slender creeping | 3.0 | 4.7 | 6.3 | 4.7 | 7.8 |
| PST-54VB Endo | strong creeping | 6.0 | 6.7 | 7.0 | 6.6 | 8.2 |
| PST-4DT | strong creeping | 6.3 | 7.0 | 7.0 | 6.8 | 8.4 |
| Shademaster II | strong creeping | 6.7 | 7.0 | 6.7 | 6.8 | 8.2 |
| Shadow (E) | chewings | 4.0 | 4.0 | 5.7 | 4.6 | 8.1 |
| Discovery | hard | 7.0 | 7.0 | 6.3 | 6.8 | 8.1 |
| PST-4ST | strong creeping | 7.3 | 7.3 | 7.3 | 7.3 | 8.1 |
| PST-44d | chewings | 2.5 | 5.0 | 6.0 | 4.5 | 7.9 |
| Flyer | strong creeping | 5.0 | 5.3 | 6.3 | 5.5 | 8.3 |
| FO 143 | sheep | 6.3 | 7.3 | 7.0 | 6.9 | 8.3 |
| Aruba | strong creeping | 4.3 | 6.0 | 6.7 | 5.7 | 8.4 |
| Spartan | hard | 8.0 | 8.0 | 7.3 | 7.8 | 8.3 |
| Banner II | chewings | 4.3 | 5.0 | 6.3 | 5.2 | 8.3 |
| MB 61-93 | chewing | 5.7 | 6.3 | 6.7 | 6.2 | 8.5 |
| MB 64-93 | chewings | 4.3 | 5.7 | 6.3 | 5.4 | 8.3 |
| MB 82-93 | hard | 7.3 | 7.0 | 6.7 | 7.0 | 8.3 |
| MB 83-93 | hard | 7.0 | 6.7 | 6.3 | 6.7 | 8.3 |
| SR 3100 | hard | 7.7 | 7.0 | 6.3 | 7.0 | 8.3 |
| SR 5100 | chewings | 6.3 | 7.3 | 7.0 | 6.9 | 7.9 |
| PRO 92/20 | chewings | 4.5 | 5.3 | 6.3 | 5.4 | 8.2 |
| PRO 92/24 | hard | 7.0 | 4.3 | 5.5 | 5.6 | 7.8 |
| Reliant II | hard | 6.7 | 7.3 | 6.7 | 6.9 | 8.5 |
| TMI-3CE | chewings | 5.3 | 5.0 | 6.0 | 5.4 | 8.2 |

**Table 2 (continued). 1993 NTEP fine fescue—ratings for 1996.**

| Entry | Species | Quality June | July | Aug | Mean | Genetic Color |
|---|---|---|---|---|---|---|
| Aurora w/endo | hard | 7.0 | 7.3 | 6.7 | 7.0 | 8.4 |
| ZBS-4BN | strong creeping | 3.5 | 5.3 | 6.3 | 5.0 | 8.2 |
| MED 32 | hard | 7.0 | 7.7 | 7.0 | 7.2 | 8.3 |

[1] Mean quality ratings 1-9, with 9=best quality and 1=poorest quality.
[2] Mean genetic color ratings 1-9, with 9=darkest green and 1=complete absence of green color.

# 1994 NTEP Perennial Ryegrass Cultivar Evaluation

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## Introduction

The 1994 NTEP Perennial Ryegrass cultivar evaluation trial was established in August 1994 at the Ohio State University Turfgrass Research Facility in Columbus, Ohio. Ninety-six entries were hand seeded at 60 grams/25 $ft^2$ (5.2 lb/1000 $ft^2$) 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 and 1996 was 1 lb. per year.

## Discussion/Summary

A list of the entries and 1996 ratings appears in Table 1.

Quality ratings are based on a scale of 1-9 with 9=best quality and 1=poorest quality. Entries rating highest in mean quality (7.8 or higher) in Summer 1996 are Laredo, WX3-91, PST-2R3, Manhattan III, WVPB-93-KFK, PST 2FF, ISI-MHB, Pick 928, Williamsburg, ZPS-PR1, SRX 4010, SR 4200, SRX 4400, Saturn, Nobility, and MB 42.

Genetic color ratings are based on a scale of 1-9, with 9 = darkest green color and 1 = absence of green color. Entries rating highest in genetic color (rating 8.0 or higher ) are J-1706, WX3-93, PST-GH-94, PST-2DGR, PST-2M3, LRF-94-C8, LRF-94-C7, LRF-94-B6, LESCO-TWF, BAR USA 94-11, Imagine, MB 1-5, MB 42, MB 43, MB 44, MB 45, MB 46 and MB 47.

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. 1994 NTEP ryegrass—ratings for 1996.**

| | Quality | | | | Genetic |
|---|---|---|---|---|---|
| Entry | June | July | Aug | Mean | Color |
| Elf | 7.7[1] | 6.7 | 6.7 | 7.0 | 7.7[2] |
| Dancer | 8.0 | 7.0 | 7.0 | 7.3 | 7.7 |
| BAR ER 5813 | 8.0 | 7.7 | 6.3 | 7.1 | 7.3 |
| DSV NA 9401 | 8.7 | 6.7 | 6.3 | 7.2 | 7.0 |
| DSV NA 9402 | 7.7 | 6.7 | 6.3 | 6.9 | 7.7 |
| Achiever | 8.0 | 7.3 | 7.3 | 7.5 | 7.3 |
| APR 066 | 8.0 | 7.0 | 7.0 | 7.3 | 7.0 |
| APR 106 | 8.0 | 7.7 | 7.3 | 7.7 | 7.0 |
| APR 124 | 8.0 | 7.0 | 6.7 | 7.2 | 7.3 |
| APR 131 | 8.3 | 7.0 | 7.3 | 7.5 | 7.0 |
| Precision | 8.3 | 7.3 | 6.7 | 7.4 | 7.0 |
| Calypso II | 8.0 | 7.0 | 7.0 | 7.3 | 7.7 |
| Laredo | 8.3 | 7.3 | 7.7 | 7.8 | 7.7 |
| Accent | 7.7 | 7.3 | 7.0 | 7.3 | 7.3 |
| MED 5071 | 8.0 | 7.3 | 7.3 | 7.5 | 7.7 |
| J-1703 | 8.3 | 6.7 | 6.7 | 7.2 | 7.0 |
| J-1706 | 8.3 | 7.0 | 7.0 | 7.4 | 8.0 |
| Edge | 8.7 | 7.0 | 7.0 | 7.6 | 7.0 |
| Cutter | 8.3 | 6.7 | 7.0 | 7.3 | 7.7 |
| Express | 8.0 | 7.3 | 7.0 | 7.4 | 7.0 |
| Esquire | 8.7 | 7.0 | 7.3 | 7.7 | 7.3 |
| Vivid | 8.0 | 6.7 | 7.0 | 7.2 | 7.3 |
| WX3-91 | 8.7 | 7.7 | 7.7 | 8.0 | 7.3 |

**Table 1 (cont'd). 1994 ryegrass—ratings for 1996.**

| Entry | Quality June | July | Aug | Mean | Genetic Color |
|---|---|---|---|---|---|
| WX3-93 | 7.7 | 6.7 | 6.3 | 6.9 | 8.0 |
| PST-2FE | 8.0 | 7.3 | 7.3 | 7.5 | 7.3 |
| PST-2R3 | 8.7 | 7.7 | 7.3 | 7.9 | 7.7 |
| PST -2DLM | 7.7 | 6.7 | 7.3 | 7.2 | 7.7 |
| PST-GH-94 | 8.0 | 7.3 | 7.7 | 7.7 | 8.0 |
| PST-2DGR | 7.7 | 7.0 | 6.3 | 7.0 | 8.0 |
| PST-2M3 | 8.3 | 7.0 | 7.7 | 7.7 | 8.7 |
| PST-28M | 8.0 | 6.7 | 7.0 | 7.2 | 7.3 |
| PST-2ET | 7.3 | 7.0 | 6.7 | 7.0 | 7.0 |
| Manhattan III | 8.0 | 8.0 | 7.7 | 7.9 | 7.7 |
| Prizm | 8.0 | 6.7 | 7.3 | 7.3 | 7.3 |
| Navajo | 8.7 | 7.0 | 7.0 | 7.6 | 7.0 |
| ZPS-2ST | 8.0 | 6.7 | 7.3 | 7.3 | 7.3 |
| ZPS-2DR-94 | 8.0 | 7.3 | 7.0 | 7.4 | 7.7 |
| PSI-E-I | 7.7 | 7.0 | 7.3 | 7.2 | 6.7 |
| WVPB-93-KFK | 8.3 | 7.3 | 7.7 | 7.8 | 7.0 |
| WVPB-PR-C-2 | 8.0 | 6.3 | 6.7 | 7.0 | 7.0 |
| MVF-4-1 | 8.3 | 7.3 | 7.3 | 7.7 | 7.7 |
| PC-93-1 | 8.0 | 7.3 | 7.0 | 7.4 | 7.3 |
| PST-2FF | 8.7 | 7.7 | 7.7 | 8.0 | 7.7 |
| Quickstart | 8.3 | 7.3 | 7.0 | 7.5 | 7.0 |
| ZPS-2NV | 8.0 | 6.3 | 6.7 | 7.4 | 7.7 |
| Brightstar | 8.0 | 6.3 | 6.7 | 7.0 | 7.7 |
| ISI-MHB | 8.3 | 7.7 | 7.3 | 7.8 | 7.3 |
| ISI-R2 | 8.0 | 7.7 | 7.3 | 7.7 | 7.3 |
| Top Hat | 8.0 | 7.0 | 7.0 | 7.3 | 7.3 |
| LRF-94-C8 | 8.3 | 7.0 | 7.0 | 7.4 | 8.3 |
| LRF-94-C7 | 7.7 | 6.7 | 6.3 | 6.9 | 8.3 |
| LRF-94-B6 | 7.7 | 6.3 | 6.7 | 6.9 | 8.0 |
| Pick PR 84-91 | 8.0 | 7.3 | 7.0 | 7.4 | 7.3 |
| Pick 928 | 9.0 | 7.7 | 7.7 | 8.1 | 7.3 |
| Assure | 7.7 | 7.0 | 7.3 | 7.3 | 7.0 |
| Advantage | 8.0 | 6.7 | 6.7 | 7.1 | 7.7 |
| LESCO-TWF | 8.3 | 7.0 | 7.0 | 7.4 | 8.0 |
| Williamsburg | 8.3 | 7.7 | 7.3 | 7.8 | 7.0 |
| Riviera II | 8.0 | 6.3 | 6.7 | 7.0 | 7.3 |
| BAR USA 94-11 | 7.7 | 6.7 | 7.0 | 7.1 | 8.0 |
| Koos 93-3 | 8.0 | 7.0 | 7.0 | 7.3 | 7.3 |
| Linn | 6.0 | 5.3 | 4.7 | 5.3 | 6.0 |
| Stallion Slct. | 8.0 | 7.0 | 7.0 | 7.3 | 7.0 |
| ZPS-PR1 | 8.0 | 7.7 | 7.7 | 7.8 | 7.7 |
| Figaro | 8.0 | 7.0 | 6.3 | 7.2 | 7.3 |
| DLP 1305 | 8.0 | 6.7 | 7.0 | 7.2 | 7.0 |
| Nine-O-One | 8.0 | 7.0 | 6.7 | 7.2 | 7.3 |
| SRX 4010 | 8.3 | 7.3 | 7.7 | 7.8 | 7.7 |
| SR 4200 | 8.0 | 7.3 | 8.0 | 7.8 | 7.3 |
| SRX 4400 | 8.3 | 8.0 | 7.3 | 7.9 | 7.0 |
| Omni | 8.3 | 7.3 | 7.0 | 7.5 | 7.3 |

**Table 1 (cont'd). 1994 ryegrass—ratings for 1996.**

| Entry | Quality June | July | Aug | Mean | Genetic Color |
|---|---|---|---|---|---|
| Night Hawk | 8.7 | 7.0 | 7.3 | 7.7 | 7.7 |
| WVPB 92-4 | 8.0 | 7.3 | 7.3 | 7.5 | 6.7 |
| Koos 93-6 | 8.0 | 7.0 | 7.3 | 7.4 | 7.0 |
| PS-D-9 | 8.3 | 7.3 | 7.3 | 7.6 | 7.0 |
| LRF94-MPRH | 8.3 | 7.0 | 7.3 | 7.5 | 7.7 |
| PickLp 102-92 | 8.0 | 6.3 | 7.0 | 7.1 | 7.7 |
| CAS-LP23 | 7.3 | 6.3 | 6.0 | 6.5 | 7.3 |
| RPBD | 8.0 | 7.3 | 7.0 | 7.5 | 7.7 |
| PST-2CB | 8.3 | 7.0 | 7.0 | 7.4 | 7.0 |
| Pennfine | 8.7 | 7.3 | 6.7 | 7.6 | 6.7 |
| Morning Star | 7.7 | 7.3 | 7.0 | 7.3 | 7.0 |
| Saturn | 8.3 | 7.7 | 7.3 | 7.8 | 7.7 |
| Imagine | 7.7 | 5.6 | 6.3 | 6.5 | 8.3 |
| Pegasus | 7.7 | 6.3 | 6.3 | 6.8 | 7.3 |
| TMI-EXFLP94 | 8.3 | 7.0 | 6.7 | 7.3 | 7.0 |
| Nobility | 8.3 | 8.0 | 7.3 | 7.9 | 7.0 |
| Divine | 8.0 | 7.0 | 6.7 | 7.2 | 7.7 |
| MB 1-5 | 8.0 | 6.7 | 7.0 | 7.2 | 9.0 |
| MB 41 | 8.3 | 7.0 | 6.7 | 7.3 | 7.3 |
| MB 42 | 8.7 | 7.3 | 7.7 | 7.9 | 8.3 |
| MB 43 | 8.0 | 6.3 | 7.0 | 7.1 | 8.0 |
| MB 44 | 8.3 | 7.0 | 7.0 | 7.4 | 8.7 |
| MB 45 | 8.3 | 6.77 | 6.7 | 7.2 | 8.3 |
| MB 46 | 8.3 | 7.0 | 7.0 | 7.4 | 8.7 |
| MB 47 | 8.7 | 7.0 | 7.3 | 7.7 | 8.0 |

[1] Mean quality ratings 1-9, with 9=best quality and 1=poorest quality.

[2] Mean genetic color ratings 1-9, with 9=darkest green and 1=complete abscence of green color.

# 1995 Kentucky Bluegrass (Medium/High Input) Cultivar Evaluation

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## Introduction

The 1995 Kentucky Bluegrass (Medium/High Input) Cultivar Evaluation was established in September 1995 at the Ohio State University Turfgrass Research Facility in Columbus, Ohio. One hundred and three entries were hand seeded at 25 grams/25 $ft^2$ (2.2 lb/1000 $ft^2$ ) in a randomized complete block design with three replications.

The site is on irrigated, natural soil in full sun and is maintained with a rotary mower.

Medium/high input management requirements for the trial are as follows: mowing height at 2 inches; short mowing frequency of twice weekly; high nutrition rate of 3 lb. nitrogen per 1000 $ft^2$ per year; irrigation (after establishment) regularly applied to prevent stress; and pest management control applied only as necessary.

## Discussion/Summary

A list of the entries and 1996 ratings appears in Table 1.

Initial cover ratings taken in May 1996 ranged from poor to good. Entries with poor initial cover (50% cover or less) are A88-744, BAR VB 233, BAR VB 5649, BAR VB 6820, LTP-621, MED-1991, NuStar, ZPS-2572, SR 2000, SR 2100, Ascot, Sidedick, Sodnet, LTP-620, PST-BO-165, PST-A7-245A, PST-A418, Fortuna, and Baruzo.

Quality ratings are based on a scale of 1-9, with 9=best quality and 1=poorest quality. Mean quality ratings ranged from good to excellent across the entries. Entries rating highest in summer mean quality (rating 7.9 or higher) are Princeton 105, Shamrock , Haga, MED-1580, J-1555, J-2579, J-2582, Limousine, NJ 1190, ZPS-2183, Platini, Livingston, Jefferson, and PST-B3-180.

Genetic color ratings are based on a scale of 1-9, with 9 = darkest green color and 1 = absence of green color. Mean genetic color ratings are very good across the entries. Entries rating highest (9.0) are Princeton 105, J-1561, NuGlade, Limousine, Coventry, Ba 81-270, PST-B2-42, NJ 1190, ZPS-2183, Conni, Baronie, and Bartitia.

Monthly data from this five-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 NTEP Kentucky bluegrass (medium/high input)—ratings for 1996.**

| Entry | Quality June | Quality July | Quality Aug | Mean | Gen. Color | % Cover |
|---|---|---|---|---|---|---|
| Princeton 105 | 7.7[1] | 8.3 | 7.7 | 7.9 | 9.0[2] | 63.3[3] |
| Baron | 7.3 | 7.7 | 6.3 | 7.1 | 8.0 | 63.3 |
| A88-744 | 6.7 | 7.7 | 6.0 | 6.8 | 7.3 | 43.3 |
| Shamrock | 7.7 | 9.0 | 7.3 | 8.0 | 8.7 | 63.3 |
| Wildwood | 7.3 | 8.0 | 6.7 | 7.3 | 8.3 | 60.0 |
| LKB-95 | 7.3 | 7.7 | 7.0 | 7.3 | 8.0 | 61.7 |
| Chateau | 7.0 | 8.0 | 6.7 | 7.2 | 8.0 | 63.3 |
| DP 37-192 | 6.0 | 7.7 | 6.7 | 6.8 | 7.7 | 51.7 |
| Lipoa | 6.7 | 7.3 | 5.7 | 6.6 | 8.0 | 60.0 |
| America | 8.0 | 8.3 | 6.0 | 7.4 | 8.3 | 68.3 |
| Haga | 8.3 | 8.7 | 7.0 | 8.0 | 8.0 | 73.3 |
| BAR VB 233 | 6.7 | 8.0 | 6.0 | 6.9 | 7.3 | 46.7 |
| BAR VB 3115B | 7.7 | 8.7 | 7.3 | 7.9 | 8.0 | 60.0 |
| BAR VB 5649 | 7.0 | 7.7 | 6.3 | 7.0 | 8.7 | 43.3 |
| BAR VB 6820 | 7.0 | 8.0 | 5.0 | 6.7 | 6.3 | 48.3 |
| Ba 75-163 | 7.7 | 8.0 | 6.7 | 7.5 | 8.7 | 61.7 |
| Ba 77-702 | 5.7 | 7.7 | 6.0 | 6.5 | 8.3 | 61.7 |
| NJ-GD | 7.7 | 8.0 | 6.3 | 7.3 | 7.7 | 63.3 |
| LTP-621 | 6.7 | 8.0 | 6.3 | 7.0 | 7.7 | 50.0 |
| Marquis | 8.0 | 8.3 | 7.0 | 7.8 | 8.7 | 68.3 |
| HV 130 | 7.0 | 8.0 | 6.7 | 7.2 | 8.3 | 55.0 |
| HV 242 | 7.0 | 7.7 | 7.3 | 7.3 | 8.3 | 63.3 |
| Raven | 7.0 | 8.3 | 7.0 | 7.4 | 8.7 | 60.0 |
| Pick 8 | 7.3 | 8.0 | 7.0 | 7.4 | 8.7 | 63.3 |
| MED-18 | 7.0 | 7.7 | 6.7 | 7.1 | 8.0 | 61.7 |
| MED-1497 | 7.3 | 8.0 | 6.7 | 7.3 | 8.7 | 61.7 |
| MED-1580 | 7.7 | 8.7 | 7.3 | 7.9 | 8.3 | 63.3 |
| MED-1991 | 5.7 | 7.0 | 5.0 | 5.9 | 7.3 | 41.7 |
| Classic | 7.3 | 8.3 | 6.7 | 7.4 | 8.7 | 73.3 |
| Caliber | 7.7 | 8.7 | 7.0 | 7.8 | 7.7 | 75.0 |
| J-1555 | 7.7 | 8.3 | 7.6 | 7.9 | 8.3 | 63.3 |
| J-1561 | 7.3 | 8.0 | 7.0 | 7.4 | 9.0 | 60.0 |
| Eclipse | 7.7 | 8.0 | 7.3 | 7.7 | 8.7 | 68.3 |
| NuStar | 6.3 | 7.3 | 5.0 | 6.2 | 7.0 | 45.0 |
| Award | 7.3 | 8.3 | 7.0 | 7.5 | 8.7 | 55.0 |
| NuGlade | 7.0 | 8.0 | 7.3 | 7.4 | 9.0 | 63.3 |
| J-1576 | 7.0 | 8.0 | 6.3 | 7.1 | 8.0 | 60.0 |
| TCR-1738 | 7.0 | 7.3 | 6.0 | 6.8 | 8.0 | 50.0 |
| J-1936 | 7.0 | 8.0 | 7.0 | 7.3 | 8.3 | 55.0 |
| J-2579 | 7.3 | 8.3 | 7.3 | 7.6 | 9.0 | 58.3 |
| J-2582 | 7.7 | 8.7 | 7.3 | 7.9 | 8.0 | 65.0 |
| J-1567 | 7.0 | 7.7 | 6.3 | 7.0 | 7.0 | 71.7 |
| Limousine | 8.0 | 8.7 | 7.3 | 8.0 | 9.0 | 76.7 |
| Pick-3561 | 7.3 | 8.3 | 6.7 | 7.4 | 8.3 | 66.7 |
| ZPS-2572 | 7.0 | 7.7 | 6.7 | 7.1 | 8.0 | 50.0 |
| Pick-855 | 6.7 | 7.7 | 7.0 | 7.1 | 8.0 | 58.3 |
| SR 2000 | 6.7 | 7.3 | 6.3 | 6.8 | 8.3 | 46.7 |
| SR 2100 | 6.7 | 8.3 | 6.7 | 7.2 | 7.3 | 50.0 |
| SR 2109 | 7.3 | 8.0 | 6.7 | 7.3 | 8.3 | 63.3 |
| SRX 2205 | 7.0 | 8.0 | 6.7 | 7.2 | 8.7 | 70.0 |
| Abbey | 7.0 | 7.7 | 6.3 | 7.0 | 8.7 | 60.0 |
| Ascot | 4.7 | 7.3 | 5.0 | 5.7 | 7.3 | 40.0 |
| Coventry | 7.0 | 8.3 | 6.7 | 7.3 | 9.0 | 58.3 |
| Sidekick | 6.3 | 7.0 | 5.3 | 6.2 | 7.0 | 43.3 |
| Ba 70-060 | 7.0 | 8.7 | 7.0 | 7.6 | 8.3 | 63.3 |
| Ba 73-373 | 7.3 | 8.3 | 7.3 | 7.6 | 8.7 | 68.3 |
| Ba 75-173 | 6.7 | 8.0 | 6.7 | 7.1 | 7.3 | 55.0 |
| Ba 75-490 | 7.3 | 8.3 | 7.0 | 7.5 | 8.0 | 61.7 |
| Ba 76-197 | 6.3 | 7.7 | 6.0 | 6.7 | 8.0 | 51.7 |
| Ba 76-372 | 6.3 | 7.7 | 5.7 | 6.6 | 7.7 | 56.7 |
| Ba 79-260 | 7.3 | 8.0 | 7.0 | 7.4 | 8.7 | 71.7 |
| Ba 81-058 | 6.7 | 7.3 | 6.7 | 6.9 | 7.3 | 53.3 |
| Ba 81-113 | 7.3 | 7.7 | 6.3 | 7.1 | 7.7 | 65.0 |
| Ba 81-220 | 7.0 | 8.0 | 6.3 | 7.1 | 8.7 | 65.0 |
| Ba 81-227 | 6.7 | 7.3 | 6.3 | 6.8 | 8.0 | 53.3 |
| Ba 81-270 | 7.0 | 7.7 | 6.7 | 7.1 | 9.0 | 56.7 |
| Ba 87-102 | 7.7 | 8.7 | 6.7 | 7.7 | 8.0 | 61.7 |
| H86-690 | 7.0 | 8.0 | 6.7 | 7.2 | 7.7 | 53.3 |
| Sodnet | 6.7 | 7.3 | 6.7 | 6.9 | 7.7 | 43.3 |
| LTP-620 | 6.3 | 7.0 | 5.3 | 6.2 | 8.0 | 43.3 |
| PST-P46 | 7.3 | 8.7 | 7.7 | 7.9 | 8.7 | 56.7 |
| PST-BO-165 | 5.7 | 7.0 | 5.0 | 5.9 | 7.0 | 46.7 |
| PST-638 | 7.3 | 7.3 | 6.3 | 7.0 | 7.7 | 56.7 |
| PST-B2-42 | 7.3 | 8.0 | 6.7 | 7.3 | 9.0 | 66.7 |
| PST-A7-60 | 7.0 | 8.3 | 6.3 | 7.2 | 8.7 | 75.0 |
| PST-A7-245A | 6.3 | 7.3 | 6.3 | 6.6 | 7.7 | 40.0 |
| PST-A418 | 6.7 | 8.0 | 6.3 | 7.0 | 8.3 | 50.0 |
| PST-BO-141 | 7.7 | 8.3 | 6.7 | 7.6 | 8.7 | 70.0 |
| NJ 1190 | 7.7 | 9.0 | 7.7 | 8.1 | 9.0 | 73.3 |
| Challenger | 8.0 | 8.0 | 6.7 | 7.6 | 8.0 | 61.7 |
| Blacksburg | 7.7 | 8.0 | 7.0 | 7.6 | 8.7 | 75.0 |
| Unique | 7.7 | 8.3 | 6.3 | 7.4 | 8.3 | 71.7 |
| Midnight | 7.3 | 8.3 | 7.7 | 7.8 | 8.3 | 66.7 |
| ZPS-309 | 7.0 | 8.0 | 6.7 | 7.2 | 8.7 | 70.0 |
| ZPS-429 | 6.7 | 7.0 | 6.3 | 6.7 | 8.3 | 56.7 |
| ZPS-2183 | 7.7 | 8.7 | 7.7 | 8.0 | 9.0 | 68.3 |
| Glade | 7.7 | 8.7 | 7.0 | 7.8 | 8.3 | 71.7 |
| Kenblue | 7.7 | 8.3 | 6.3 | 7.4 | 7.7 | 63.3 |
| Compact | 5.7 | 7.7 | 6.3 | 6.6 | 8.0 | 51.7 |
| Conni | 7.0 | 8.3 | 6.3 | 7.2 | 9.0 | 65.0 |
| Platini | 7.3 | 8.7 | 7.7 | 7.9 | 8.3 | 66.7 |
| Livingston | 7.3 | 8.7 | 7.7 | 7.9 | 7.3 | 68.3 |
| Jefferson | 7.7 | 8.7 | 7.3 | 7.9 | 7.7 | 65.0 |
| Nimbus | 8.0 | 9.0 | 7.3 | 5.9 | 8.0 | 76.7 |
| Allure | 7.7 | 8.3 | 6.7 | 7.6 | 8.3 | 63.3 |
| Cardiff | 7.0 | 7.3 | 6.0 | 6.8 | 7.7 | 60.0 |
| Fortuna | 6.7 | 7.7 | 6.0 | 6.8 | 7.3 | 48.3 |
| VB 16015 | 6.7 | 7.7 | 6.7 | 7.0 | 8.0 | 55.0 |
| Baronie | 7.7 | 8.3 | 7.0 | 7.7 | 9.0 | 75.0 |
| Bartitia | 7.3 | 8.7 | 6.7 | 7.6 | 9.0 | 71.7 |
| Baruzo | 6.3 | 7.3 | 6.0 | 6.5 | 7.3 | 43.3 |
| NJ-54 | 7.3 | 8.0 | 7.0 | 7.4 | 8.0 | 51.7 |
| PST-B3-180 | 7.7 | 8.7 | 7.3 | 7.9 | 8.7 | 65.0 |

[1] Mean quality ratings 1-9, with 9 = best quality and 1 = poorest quality.

[2] Mean genetic color ratings 1-9, with 9 = darkest green and 1 = complete absence of green color.

[3] Mean initial percent cover ratings 1-100, with 10 = complete plot coverage and 1 = no existing grass plants.

# 1995 NTEP Kentucky Bluegrass (Low Input) Cultivar Evaluation

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## Introduction

The 1995 NTEP Kentucky Bluegrass (Low Input) cultivar evaluation trial was established in September 1995 at the Ohio State University Turfgrass Research Facility in Columbus. Twenty-one entries were hand seeded at 25 grams/25 $ft^2$ (2.2 lb./1000 $ft^2$) in a randomized complete block design with three replications.

The site is on irrigated, natural soil in full sun and is maintained with a rotary mower.

Low input management requirements for the trial are as follows: high mowing height of 3.0 inches; long mowing frequency of once every two weeks; low nutrition rate of 1.0 lb. nitrogen per 1000 $ft^2$ per year; irrigation (after establishment) only to prevent stand loss due to drought stress; and broadleaf weed control applied as necessary to maintain the stand.

## Discussion/Summary

A list of the entries and 1996 ratings appears in Table 1.

Initial cover ratings taken in May 1996 ranged from poor to good. Entries with poor initial cover (50% cover or less) were BAR VB 3115B, BAR VB 6820, BH 95-199, Bluestar, PST-B9-196, and S. Dakota.

Quality ratings are based on a scale of 1-9, with 9=best quality and 1=poorest quality. Mean quality ratings ranged from poor to very good across the entries. Entries rating highest in summer mean quality (rating 7.5 or higher) are Eagleton, BAR VB 233, BAR VB 5694, Caliber, Kenblue, Baronie and Bartitia.

Genetic color ratings are based on a scale of 1-9, with 9 = darkest green color and 1 = absence of green color. Mean genetic color ratings were very good across the entries. Two entries, BAR VB 6820 and BH 95-199, have lowest but still acceptable color.

Monthly data from this five-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 NTEP Kentucky bluegrass (low input)—ratings for 1996.**

| Entry | Quality June | Quality July | Quality Aug | Mean | Gen. Color | % Cover |
|---|---|---|---|---|---|---|
| Eagleton | 8.3[1] | 9.0 | 8.7 | 8.7 | 8.7[2] | 81.7[3] |
| Lipoa | 5.7 | 6.3 | 6.7 | 6.2 | 8.0 | 65.0 |
| BAR VB 233 | 8.0 | 8.3 | 7.3 | 7.9 | 8.7 | 81.7 |
| BAR VB 3115B | 7.0 | 7.7 | 6.7 | 7.1 | 8.3 | 50.0 |
| BAR VB 5694 | 7.3 | 7.7 | 8.0 | 7.7 | 8.7 | 63.3 |
| BAR VB 6820 | 4.7 | 5.0 | 5.0 | 4.9 | 7.3 | 45.0 |
| Caliber | 7.3 | 7.3 | 8.0 | 7.5 | 8.7 | 60.0 |
| BH 95-199 | 5.7 | 6.0 | 5.7 | 5.8 | 7.3 | 33.3 |
| ZPS-429 | 6.7 | 7.3 | 6.7 | 6.9 | 8.7 | 53.0 |
| BlueStar | 5.3 | 5.7 | 6.0 | 5.7 | 8.0 | 40.0 |
| PST-B9-196 | 5.0 | 5.3 | 5.0 | 5.1 | 8.0 | 35.0 |
| PST-A7-60 | 6.3 | 6.7 | 6.7 | 6.6 | 8.0 | 65.0 |
| Baron | 6.3 | 6.7 | 7.0 | 6.7 | 8.3 | 61.7 |
| Kenblue | 7.3 | 8.3 | 7.3 | 7.6 | 8.3 | 78.3 |
| S.Dakota | 5.7 | 5.7 | 6.3 | 5.9 | 8.0 | 38.3 |
| Canterbury | 7.0 | 7.3 | 7.7 | 7.3 | 8.3 | 58.3 |
| VB 16015 | 6.7 | 6.7 | 6.3 | 6.6 | 8.7 | 51.7 |
| MTT 683 | 6.3 | 6.3 | 7.0 | 6.5 | 8.3 | 53.3 |
| Baronie | 8.3 | 8.7 | 8.3 | 8.4 | 8.7 | 81.7 |
| Bartitia | 7.7 | 7.7 | 7.7 | 7.5 | 8.7 | 73.3 |
| Baruzo | 6.0 | 6.7 | 6.0 | 6.2 | 8.7 | 51.7 |

[1] Mean quality ratings 1-9 with 9 = best quality and 1 = poorest quality.
[2] Mean genetic color ratings 1-9, with 9 = darkest green and 1 = complete absence of green color.
[3] Mean initial percent cover ratings 1-100, with 100 = complete plot coverage and 1 = no existing grass plants.

# Controlling Annual Bluegrass and Rough Bluegrass in Creeping Bentgrass Fairways: A Nutritional Approach

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## Introduction

Annual bluegrass and rough bluegrass are important grass weeds on golf course fairways in temperate regions. Creeping bentgrass, a common turfgrass chosen for golf course fairways, must compete with these grassy weeds. Attempts to control annual bluegrass and rough bluegrass in creeping bentgrass fairways have met with limited success. It is believed that applications of plant growth regulators such as flurprimidol and trinexapac-ethyl tend to favor the competitive ability of creeping bentgrass over these weeds (Shoop, et al. 1986). Selective herbicides such as ethofumesate have been somewhat successful for controlling annual bluegrass in fairway situations (Branham 1990). Used correctly, preemergent herbicides can be used to control annual varieties of annual bluegrass (Callahan and Shepard 1991; Callahan and McDonald 1997) but have no effect on rough bluegrass. It is also believed that regulating irrigation can affect annual bluegrass and rough bluegrass less favorably than creeping bentgrass (Sprague and Burton 1937).

Little research has been attempted with rough bluegrass in fairway conditions, but several studies have tested the ecology of mixed stands of creeping bentgrass and annual bluegrass treated with various nutritional inputs (Waddington, et al. 1978; Eggens and Wright 1985; Dest and Guillard 1987). Annual bluegrass and rough bluegrass are more yellow than creeping bentgrass. This suggests either a higher concentration of accessory pigments in these two weeds or a lower concentration of chlorophyll. Annual bluegrass is believed to be more photosynthetically efficient than creeping bentgrass (Vargas 1996). Rough bluegrass, because of its propensity to proliferate in shaded environments, may also be considered more photosynthetically efficient. These variations in photosynthetic efficiency could provide a means for controlling these weed species in creeping bentgrass turf. Increases in atomic iron are known to stimulate pigment synthesis and may result in increased chlorophyll concentrations when combined with increases in atomic magnesium. Increasing pigment concentrations above normal levels in plants with efficient photosynthetic potential may increase light energy consumption to critical levels. High energy levels result in photoinhibition of photosynthesis (Barenyi and Krause 1985; Critchley 1988; Long, et al. 1994), increased photorespiration (Watschke, et al. 1972), and lipid oxidation (Fuerst 1991). Annual bluegrass and rough bluegrass decline rapidly during summer periods. Although this decline has been linked to poor heat tolerance or disease (Vargas and Detweiler 1985), some decline may be due to photodegredation. By increasing leaf concentrations of magnesium and iron, this decline may be accelerated. Creeping bentgrass, because it already contains high concentrations of chlorophyll, is unlikely to be severely affected by additional pigment increases. The objective of this study was to compare creeping bentgrass, annual bluegrass, and rough bluegrass when subjected to common weed control practices and foliar applications of iron and magnesium.

## Materials and Methods

A research site was selected in an area of Kentucky bluegrass rough at the Country Club at Muirfield Village, Dublin, Ohio. The site was stripped of Kentucky bluegrass sod, cultivated with a rototiller, raked, and seeded with a mixture of creeping bentgrass ('Crenshaw,' 'Pro Cup,' 'Providence,' 'Penncross,' 'Southshore,' 'SR 1020'), annual bluegrass (a 1990 seed source and a 1994 seed source collected as weed seed), and rough bluegrass ('Laser' and 'Polder') in September 1995. Creeping bentgrass was sown at 97.6 kg $ha^{-1}$ ( 2.0 lb/1000 $ft^2$), annual bluegrass at 16.6 kg $ha^{-1}$ (0.34 lb/1000 $ft^2$), and rough bluegrass at 16.6 kg $ha^{-1}$ (0.34 lb/1000 $ft^2$). The soil at the site was clay loam, and slope at the site was adequate to provide drainage. The research site was maintained by the golf course green crew and provided the same level of care as the golf course fairways. Pesticides were applied as needed, and nitrogen was applied at 195.3 kg $ha^{-1}$ $yr^{-1}$ (4 lb/1000 $ft^2$) with adequate levels of phosphorus and potassium. The site was mowed at 12.7 mm (½ inches) three times each week. Preemergent herbicides, plant growth regulators, and irrigation were applied only as treatments.

The site was divided into 10 main plots, five randomly selected to receive deficit irrigation at 50% evapotranspiration (ET) and five randomly selected for deficit irrigation at 100% ET. Irrigation was applied three times each week (Monday, Wednesday, Friday) and adjusted for natural rainfall. In 1996 no irrigation was applied unless ET exceeded natural rainfall for the week preceding the date of irrigation.

Each main plot was randomly divided into seven subplots, including a control. Subplots measured 2.16 $M^2$ (3 x 8 ft). Each subplot received one of the following treatments:

1) trinexapac-ethyl (Primo™) at 0.26 L $ha^{-1}$ (0.5 oz/1000 $ft^2$) applied monthly;
2) ethofumesate (Prograss™) applied in mid-March, early-May, early September and early-October at 0.78 L $ha^{-1}$ (1.5 oz/1000 $ft^2$);
3) bensulide (Bensumec™ 4E) applied at 3.13 L $ha^{-1}$ (6.0 oz/1000 $ft^2$) in mid-March, early-May, and early-September of each year;
4) foliar magnesium ($MgSO_4 \cdot 7H_2O$) at 1.68 kg $ha^{-1}$ (1.5 lb/A) applied monthly;
5) foliar iron ($FeSO_4 \cdot 2H_2O$) at 1.68 kg $ha^{-1}$ (1.5 lb/A) applied monthly;
6) a mixture of foliar magnesium and foliar iron (foliar Mg/Fe) applied at previous rates monthly; or
7) no additional input (control).

Monthly applications were made on the first of each month beginning in April and ending in October of each year. Subplots treated with trinexapac-ethyl also received a single treatment of bensulide at 3.13 L $ha^{-1}$ (6.0 oz/1000 $ft^2$) in mid-March to help control crabgrass and other grass weeds. Foliar treatments (magnesium, iron, Mg/Fe, Primo) were applied using SS8002 spray nozzles. Remaining treatments were applied using SS8010 spray nozzles. Visual ratings for color on a 1 through 9 scale (1 = brown; 5 = yellow-green; 9 = blue-green) and density by percentage (density = % of maximum potential density) were taken on the 15th day of each month during the same periods.

Data were analyzed using analysis of variance for a split plot design and multiple comparisons were made using LSD (least significant difference). Results were considered significant if probability of a type I error was less than 0.05%.

## Results and Discussion

The three species seeded, creeping bentgrass, annual bluegrass, and rough bluegrass exhibited differential seedling survival. The fall seeding in 1995 produced a dense stand of young turf by spring 1996. All three species were present, and other species comprised less than 1% of the turfgrass stand. Species survival was not rated in spring 1996 because segregation had not occurred, and individual ratings were difficult. In November 1996, subplots receiving no additional input (control) averaged 62.2% creeping bentgrass, 33.9% annual bluegrass and 3.9% rough bluegrass. Laboratory germination tests using AASA (American Association of Seed Analysts) protocol revealed a 95% germination rate for creeping bentgrass and annual bluegrass and a 65% germination rate for rough bluegrass, accounting for the poor representation of rough bluegrass at the site.

Creeping bentgrass proportion declined, and annual bluegrass proportion increased in plots irrigated at 100% ET in 1996, but these results did not vary significantly. Surprisingly, rough bluegrass proportions were significantly greater in plots treated to 50% ET irrigation compared with plots treated to 100% ET irrigation. All subplot treatments resulted in a greater proportion of creeping bentgrass in relation to control subplots, but only foliar iron treatments (19.3% greater) and foliar Mg/Fe treatments (40.2% greater) indicated a significant response in 1996 (Figure 1). Trinexapac-ethyl treatments (7.0% greater) may have provided a significant increase in creeping bentgrass if the proportion of rough bluegrass in the subplots had been higher (Figure 1). Foliar iron (30.0% reduction for annual bluegrass; 51.4% reduction for rough bluegrass) and foliar Mg/Fe (63.7% reduction for annual bluegrass; 91.9% reduction for rough bluegrass) resulted in significant reductions in annual bluegrass and rough bluegrass in 1996, and trinexapac-ethyl treatments (81.3% reduction for rough bluegrass) reduced rough bluegrass proportion significantly (Figure 1). It is known that sulphur applications may reduce the competitive ability of annual bluegrass under some circumstances (Varco and Sartain 1966). The apparent control of annual bluegrass in subplots treated with iron sulfate, however, was not attributed to the application of sulphur because subplots receiving magnesium sulfate treatments did not differ significantly from controls. The application of iron sulfate and the subsequent creation of a more acidic soil environment may also favor the growth of creeping bentgrass in comparison with annual bluegrass (Kuo, et al. 1992). Because iron sulfate applications were made with a foliar spray and because foliar Mg/Fe was significantly more effective for controlling annual bluegrass than foliar iron alone, the acidic effect was believed to be minimal.

Color was significantly enhanced by foliar Mg/Fe, foliar iron alone, and by trinexapac-ethyl (Figure 1) when compared to plots receiving no additional input (control) in 1996. These results support those of Johnson and Carrow (1995) who found color enhancements with applications of iron in creeping bentgrass and those of Blalok, et al. (1996) who observed a darker green color in turf treated with trinexapac ethyl. Although color ratings were higher for plots receiving deficit irrigation at 100% ET than those receiving irrigation at 50% ET in 1996, the difference was not significant. Although color was acceptable (poorest rating = 5.78), the research area in general consistently rated lower than the adjacent fairway for quality of color, suggesting that the plots did not receive enough water or that the frequency of irrigation was insufficient.

Density throughout the stand remained consistent with the exception of a significant enhancement in the trinexapac-ethyl subplots (3.2% improvement) in 1996 and a significant reduction in the subplots treated with foliar Mg/Fe (3.3% reduction) in 1996 (Figure 1). Trinexapac-ethyl shortens stolon internodes resulting in increased turf density. Foliar Mg/Fe is not known to reduce stand density, and this result was attributed to the severe reduction of annual bluegrass and rough bluegrass within these subplots. The general density of this first-year turf was quite acceptable for fairway conditions with a minimal average rating of 82.8% of potential for foliar Mg/Fe treatments and a maximum average rating of 88.3% for trinexapac-ethyl treatments in 1996 (Figure 1). Subplots treated with foliar Mg/Fe retained acceptable density throughout the season in spite of losing 25.0% of the stand to the death of weed species. Density observations were higher for plots treated to 100% ET compared to 50% ET but the difference was insignificant in 1996.

These results demonstrate that applications of foliar Mg/Fe, foliar iron, and trinexapac-ethyl on a monthly basis reduce annual bluegrass and rough bluegrass weed encroachment and enhance turf quality on creeping bentgrass maintained as golf course fairway. These treatments enhance the competitive ability of creeping bentgrass in relation to annual bluegrass and rough bluegrass, resulting in the reduction of existing weeds over time. Foliar iron and foliar Mg/Fe were significantly more successful for this purpose than any pesticide tested and the combination of foliar Mg/Fe was significantly more successful than any other treatment. Proper application of these nutrients enhances the beauty and playability of golf course turf, limits the use of pesticides, and meets the demands of the golfing public.

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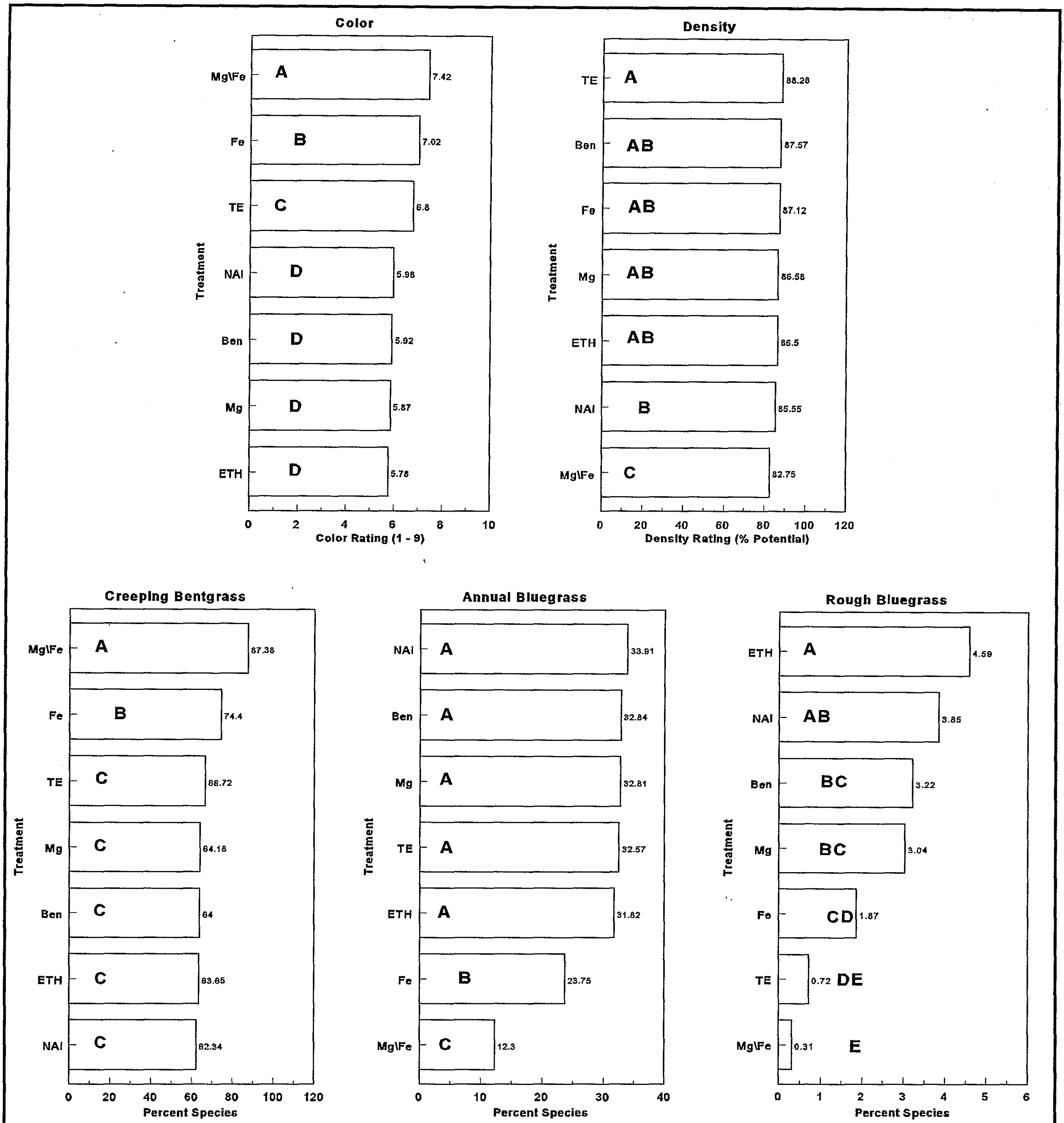


**Figure 1.** Turf color rated on a 1 through 9 scale (5 = yellow-green, 9 = blue-green) and turf density rate as percent of potential maximum density as well as percent creeping bentgrass, annual bluegrass, and rough bluegrass contained in treatment subplots and averaged over 10 replications of a control receiving no additional input (NAI), a preemergent herbicide, bensulide (Ben), a plant growth regulator, trinexapac-ethyl (TE), foliar magnesium (Mg), foliar iron (Fe), and foliar magnesium plus foliar iron (Mg/Fe). Means with same letters (A, B, C, D, E) are not significantly different based on LSD $P$=0.5.

# "Primo" Growth Regulator Evaluation on Creeping Bentgrass

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## 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 1993-94 further showed significant benefits could also be achieved from the use of Primo on creeping bentgrass. The purpose of the 1996 study was to quantify, through a third year's evaluation, color and growth reduction benefits which accompany the use of Primo on fairway height creeping bentgrass.

This year's applications were initiated on April 24, 1996. Beginning with the late April application, treatments were repeated every 30-35 days and concluded with the September 30, 1996 treatment. A total of six applications were made in 1996. Data were collected every 6 to 9 days and included creeping bentgrass coloration data (Table 1), creeping bentgrass fresh weight data (Table 3) and creeping bentgrass discoloration.

Results of this investigation show the application of low rates of Primo (0.125-0.25 fl oz/1000 ft$^2$) enhance turfgrass coloration on creeping bentgrass (Table 1). The improvement in average monthly turfgrass coloration ratings ranged from 0.34-1.00 units from the 0.125 oz applications and 0.80-1.67 units from the 0.25 oz applications.

Additional enhancement in turfgrass coloration resulted following applications of Primo in combination with nitrogen (Coron 28-0-0). The addition of 0.50 lb nitrogen to the Primo applications further enhanced turfgrass coloration over both, the 0.50 lb nitrogen-only treatments and the Primo-only treatments. Applications of the combination of 0.50 lb nitrogen and 0.125 oz Primo improved the average monthly creeping bentgrass color ratings by 0.72-1.48 units above the standard 0.50 lb nitrogen treatment and 2.58-3.18 units above the 0.125 oz Primo-only treatment (Table 2). Applications of the combination of 0.50 lb nitrogen and 0.250 oz Primo improved the average monthly creeping bentgrass color ratings by 0.92-2.00 units above the standard 0.50 lb nitrogen treatment and 2.14-3.15 units above the 0.250 oz Primo-only treatment (Table 2).

The addition of 1.0 lb nitrogen to the Primo applications resulted in even a further enhancement of turfgrass coloration over the Primo-only applications. Applications of the combination of 1.0 lb nitrogen and 0.125 oz Primo improved the average monthly creeping bentgrass color ratings by 0.86-1.27 units above the standard 1.0 lb nitrogen treatment and 3.08-3.75 units above the 0.125 oz Primo-only treatment (Table 2). Applications of the combination of 1.0 lb nitrogen and 0.25 oz Primo improved the average monthly creeping bentgrass color ratings by 0.96-1.82 units above the standard 1.0 lb nitrogen treatment and 2.95-3.68 units above the 0.25 oz Primo-only treatment (Table 2). No turfgrass discoloration was observed anytime during the trial period.

In addition to the enhancement in coloration, the addition of Primo reduced clipping production of the creeping bentgrass (Table 3). Both the 0.125 and 0.25 oz rates of Primo, in combination with 0.5 lb of nitrogen, reduced clipping yields. These reductions ranged from 10.43% (0.125 oz Primo) to 17.33% (0.250 oz Primo) when compared with the 0.5 lb nitrogen check. Slightly less fresh weight reductions were realized when those same Primo rates (0.125 and 0.25 oz) were applied in combination with the 1.0 lb rate of nitrogen and compared to the 1.0 nitrogen-only treatment. These yield reductions ranged from 10.29% (0.125 oz) to 15.91% (0.25 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 18.63% (0.125 oz) up to 23.29% (0.25 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.

Final results of this three-year trial show the addition of Primo to nitrogen applications on creeping bentgrass will result in a dramatic enhancement in turfgrass coloration. Results of three years of testing showed the addition of 0.125 oz of Primo added to 0.5 lb nitrogen improved turfgrass coloration by 0.20-1.82 units over a 0.5 lb. nitrogen-only treatment and the use of 0.25 oz Primo improved turfgrass coloration by 0.60-2.08 units over a 0.5 lb nitrogen-only treatment. Similarly, the addition of 0.125 oz of Primo added to 1.0 lb nitrogen improved turfgrass coloration by 0.5-1.8 units over a 1.0 lb nitrogen-only treatment and the use of 0.25 oz of Primo improved turfgrass coloration by 0.5-2.3 units over a 1.0 lb. nitrogen-only treatment.

Application of Primo will also result in reduced growth rates on the creeping bentgrass. Once again, the three-year results show the addition of 0.125 oz Primo will reduce fresh weight clipping yields in 0.5 lb nitrogen programs by 10.43-12.6%. At this nitrogen rate, the addition of the 0.25 oz rate of Primo will provide 17.33-19.43% fresh weight yield reductions. Programs utilizing higher rate fertility programs can expect reduced, yet significant, growth reduction benefits from the applications of Primo. Results of this three-year trial show growth reduction benefits of 0.125 oz Primo in combination with 1.0 lb nitrogen programs will range from 5.8-10.29. The 0.25 oz rate of Primo can be expected to reduce clipping yields by 7.6-15.91% when applied in combination with a 1.0 lb rate of nitrogen.

**Table 1. Turfgrass color ratings on creeping bentgrass.**

| | Turfgrass Color Ratings (1-10, 10=best) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | 5/02 | 5/09 | 5/17 | 5/23 | 5/30 | 6/06 | 6/12 | 6/20 | 6/28 | 7/05 | 7/11 | 7/18 | 7/29 | 8/01 | 8/09 |
| Fert. 0.5 lb. N | 5.8 | 6.0 | 5.9 | 6.1 | 6.3 | 6.3 | 6.6 | 6.1 | 6.4 | 6.7 | 6.6 | 6.6 | 7.1 | 7.0 | 6.8 |
| Fert. 1.0 lb. N | 7.0 | 7.1 | 6.6 | 6.8 | 7.1 | 7.1 | 7.1 | 6.8 | 6.9 | 7.5 | 7.5 | 7.5 | 7.8 | 7.8 | 7.1 |
| Fert. 0.5 lb. N + Primo 0.125 oz. | 5.8 | 6.2 | 7.1 | 7.5 | 8.0 | 8.0 | 8.1 | 7.7 | 7.5 | 7.8 | 7.7 | 7.6 | 8.1 | 8.0 | 8.2 |
| Fert. 0.5 lb. N + Primo 0.25 oz. | 5.7 | 6.1 | 7.2 | 7.5 | 8.2 | 8.5 | 8.5 | 8.3 | 8.1 | 8.2 | 8.1 | 7.8 | 8.3 | 8.3 | 8.4 |
| Fert. 1.0 lb. N + Primo 0.125 oz. | 7.0 | 7.6 | 8.0 | 8.0 | 8.3 | 8.5 | 8.6 | 7.9 | 8.0 | 8.3 | 8.4 | 8.2 | 8.6 | 8.7 | 8.6 |
| Fert. 1.0 lb. N + Primo 0.25 oz. | 6.7 | 7.7 | 8.2 | 8.3 | 8.5 | 9.0 | 9.0 | 8.8 | 8.4 | 9.0 | 8.8 | 8.5 | 9.0 | 9.2 | 9.2 |
| Primo 0.125 oz. | 4.0 | 4.2 | 4.5 | 4.5 | 4.5 | 4.5 | 4.7 | 4.7 | 4.7 | 4.5 | 4.5 | 4.5 | 5.0 | 5.0 | 5.0 |
| Primo 0.25 oz, | 4.0 | 4.5 | 5.0 | 5.3 | 5.2 | 5.3 | 5.4 | 5.0 | 5.1 | 5.0 | 5.1 | 5.0 | 5.5 | 5.5 | 5.5 |
| Check | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.1 | 4.1 | 4.1 | 4.0 | 4.0 | 4.0 |
| LSD (0.05) | 0.41 | 0.27 | 0.19 | 0.18 | 0.19 | 0.21 | 0.34 | 0.37 | 0.36 | 0.28 | 0.36 | 0.28 | 0.28 | 0.29 | 0.18 |

**Table 1 (continued). Turfgrass color ratings on creeping bentgrass.**

| | Turfgrass Color Ratings (1-10, 10=best) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | 8/16 | 8/22 | 8/29 | 9/05 | 9/12 | 9/19 | 9/26 | 10/03 | 10/14 | 10/25 |
| Fert. 0.5 lb. N | 6.6 | 6.3 | 5.8 | 6.7 | 7.1 | 7 | 6.5 | 6.6 | 7 | 7.1 |
| Fert. 1.0 lb. N | 7.1 | 7 | 6.5 | 7.2 | 7.6 | 7.6 | 7.1 | 7.2 | 7.9 | 7.9 |
| Fert. 0.5 lb. N + Primo 0.125 oz. | 8 | 7.7 | 6.8 | 6.9 | 7.5 | 8.1 | 7.7 | 7.7 | 7.8 | 8 |
| Fert. 0.5 lb. N + Primo 0.25 oz. | 8.2 | 8 | 7 | 7.1 | 7.7 | 8.4 | 8.1 | 8.1 | 8.1 | 8.3 |
| Fert. 1.0 lb. N + Primo 0.125 oz. | 8.6 | 8.2 | 7.5 | 7.7 | 8 | 8.2 | 8 | 8.3 | 8.6 | 8.8 |
| Fert. 1.0 lb. N + Primo 0.25 oz. | 9.1 | 8.6 | 7.9 | 8.1 | 8.5 | 8.8 | 8.6 | 8.7 | 8.9 | 9.2 |
| Primo 0.125 oz. | 5 | 5 | 4.5 | 4.6 | 5 | 5 | 5 | 5 | 5 | 5 |
| Primo 0.25 oz. | 5.5 | 5.5 | 5 | 5 | 5.3 | 5.9 | 6 | 6 | 5.3 | 5.7 |
| Check | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| LSD (0.05) | 0.2 | 0.21 | 0.21 | 0.28 | 0.18 | 0.19 | 0.28 | 0.22 | 0.19 | 0.21 |

**Table 2. Average monthly turfgrass color ratings on creeping bentgrass.**

| | Average Monthly Turfgrass Color Ratings (Turfgrass Color Ratings 1-10, where 10=Best) | | | | | |
|---|---|---|---|---|---|---|
| Treatment | May | June | July | Aug. | Sept. | Oct./Nov. |
| Fert. 0.5 lb. N | 6.02 | 6.35 | 6.75 | 6.50 | 6.83 | 6.90 |
| Fert. 1.0 lb. N | 6.92 | 6.98 | 7.20 | 7.10 | 7.38 | 7.67 |
| Fert. 0.5 lb. N + Primo 0.125 oz. | 6.92 | 7.83 | 7.80 | 7.74 | 7.55 | 7.83 |
| Fert. 0.5 lb. N + Primo 0.25 oz. | 6.94 | 8.35 | 8.10 | 7.98 | 7.83 | 8.17 |
| Fert. 1.0 lb. N + Primo 0.125 oz. | 7.78 | 8.25 | 8.38 | 8.32 | 7.98 | 8.57 |
| Fert. 1.0 lb. N + Primo 0.25 oz. | 7.88 | 8.80 | 8.83 | 8.80 | 8.50 | 8.93 |
| Primo 0.125 oz. | 4.34 | 4.65 | 4.63 | 4.90 | 4.90 | 5.00 |
| Primo 0.25 oz. | 4.80 | 5.20 | 5.15 | 5.40 | 5.55 | 5.67 |
| Check | 4.00 | 4.00 | 4.08 | 4.00 | 4.00 | 4.00 |

**Table 3. Fresh weight yields on creeping bentgrass.**

| | Fresh Weights Collections (grams) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | 5/02 | 5/09 | 5/17 | 5/23 | 5/30 | 6/06 | 6/13 | 6/21 | 6/28 | 7/05 | 7/11 | 7/18 | 7/25 | 8/01 | 8/09 |
| Fert. 0.5 lb. N | 91 | 171 | 360 | 111 | 127 | 97 | 119 | 113 | 62 | 91 | 82 | 63 | 131 | 315 | 183 |
| Fert. 1.0 lb. N | 168 | 417 | 453 | 164 | 200 | 173 | 212 | 171 | 84 | 211 | 145 | 153 | 249 | 489 | 239 |
| Fert. 0.5 lb. N + Primo 0.125 oz. | 93 | 105 | 305 | 119 | 75 | 65 | 115 | 112 | 65 | 65 | 84 | 94 | 104 | 235 | 202 |
| Fert. 0.5 lb. N + Primo 0.25 oz. | 87 | 87 | 246 | 117 | 85 | 58 | 101 | 105 | 63 | 54 | 73 | 94 | 77 | 215 | 189 |
| Fert. 1.0 lb. N + Primo 0.125 oz. | 155 | 243 | 365 | 187 | 135 | 162 | 249 | 261 | 87 | 126 | 139 | 159 | 194 | 397 | 248 |
| Fert. 1.0 lb. N + Primo 0.25 oz. | 149 | 255 | 357 | 177 | 119 | 166 | 225 | 236 | 87 | 115 | 128 | 155 | 124 | 365 | 267 |
| Primo 0.125 oz. | 39 | 36 | 144 | 73 | 28 | 63 | 42 | 76 | 32 | 35 | 54 | 55 | 34 | 97 | 107 |
| Primo 0.25 oz, | 40 | 33 | 125 | 69 | 19 | 43 | 39 | 68 | 31 | 23 | 56 | 65 | 35 | 70 | 123 |
| Check | 63 | 71 | 167 | 85 | 33 | 71 | 62 | 74 | 49 | 57 | 77 | 69 | 67 | 127 | 137 |

**Table 3 (continued). Fresh weight yields on Creeping Bentgrass.**

| | Fresh Weight Collections (grams) | | | | | | | | | | | % Reduction vs. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | 8/16 | 8/22 | 8/29 | 9/05 | 9/12 | 9/19 | 9/26 | 10/04 | 10/14 | 10/25 | Totals | Same Fert. Checks | |
| Fert. 0.5 lb. N | 113 | 89 | 72 | 121 | 221 | 69 | 46 | 54 | 64 | 65 | 3,030 | Check | -- |
| Fert. 1.0 lb. N | 153 | 103 | 78 | 176 | 315 | 107 | 57 | 80 | 169 | 142 | 4,908 | -- | Check |
| Fert. 0.5 lb. N + Primo 0.125 oz. | 153 | 127 | 107 | 81 | 151 | 84 | 58 | 57 | 25 | 33 | 2,714 | -10.43 | -- |
| Fert. 0.5 lb. N + Primo 0.25 oz. | 171 | 138 | 121 | 65 | 122 | 78 | 69 | 42 | 22 | 25 | 2,505 | -17.33 | -- |
| Fert. 1.0 lb. N + Primo 0.125 oz. | 192 | 136 | 108 | 136 | 273 | 123 | 73 | 77 | 79 | 99 | 4,403 | -- | -10.29% |
| Fert. 1.0 lb. N + Primo 0.25 oz. | 217 | 149 | 125 | 103 | 210 | 112 | 81 | 73 | 61 | 71 | 4,127 | -- | -15.91% |
| Primo 0.125 oz. | 116 | 111 | 99 | 60 | 75 | 36 | 39 | 28 | 11 | 12 | 1,502 | -18.63% | -- |
| Primo 0.25 oz. | 134 | 120 | 120 | 41 | 46 | 36 | 36 | 26 | 9 | 9 | 1,416 | -- | -23.29% |
| Check | 139 | 101 | 110 | 61 | 91 | 34 | 35 | 27 | 15 | 24 | 1,846 | Check | -- |

APPLICATION INFORMATION:
LOCATION: OSU Turfgrass Research Center-Range #1, North End
Application #1: Date: April 24, 1996 Time: 4:00 P.M. Temperature: 60 F Soil Moisture: Saturated Wind Speed: 15 mph, From W Rain/Irr. after App.: 20 Hours-0.10" Relative Humidity: 51% Skies: Clear - Sunny
Application #2: Date: May 21, 1996 Time: 3:00 P.M. Temperature: 77 F Soil Moisture: Field Capacity Wind Speed: 7 mph, From NWRain/Irr. after App. 20 Hours-0.50" Relative Humidity: 48% Skies: Clear - Sunny
Application #3: Date: June 25, 1996 Time: 2:00 P.M. Temperature: 72 F Soil Moisture: Field Capacity Wind Speed: 12 mph, from N Rain/Irr. After App. 50 Hours-0.25" Relative Humidity: 53% Skies: Partly Cloudy
Application #4: Date: July 21, 1996 Time:11:00 A.M. Temperature: 71 F Soil Moisture: Field Capacity Wind Speed: 6 mph, From SE Rain/Irr. After App. 12 Hours-0.20" Relative Humidity: 53% Skies: Partly Cloudy
Application #5: Date: Aug. 30, 1996 Time: 9:00 A.M. Temperature: 65 F Soil Moisture: Field Capacity Wind Speed: 3 mph, From E Rain/Irr. After App. 2 Hours-0.20" Relative Humidity: 68% Skies: Clear - Sunny
Application #6: Date: Sept. 30, 1996 Time: 7:30 A.M. Temperature: 47 F Soil Moisture: Field Capacity Wind Speed: 0 mph, Calm Rain/Irr. After App. 20 Hours-0.20" Relative Humidity: 96% 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 - All Applications:
Liquid: X Spray: Volume 2 gallons/1000 $ft^{2}$,Pressure 35 psi Nozzle Teejet 8002; Technique Single Hand Wand

EXPERIMENTAL DESIGN: Randomized Complete Block Design Plot Size: 3.0' X 20.0'; No. Of Reps.: 3; Aisle Between: Treatments 0 Replications 0

COMMENTS/CORRECTIONS: Turfgrass Color, Phytotoxicity and Fresh Weight collections to be taken weekly. Fertilizer (nitrogen) source was Coron Corporation's 28-0-0.

# Influence of Dollar Spot on a Blend of Two Creeping Bentgrass Cultivars

Robert C. Golembiewski, T. Karl Danneberger, and Patricia M. Sweeney
Horticulture and Crop Science

## Introduction

Significant changes have occurred in the formulation of grass seed mixtures over the past two decades. Complex mixtures involving several turfgrass species are now being replaced by blends. Blending, planting two or more cultivars of the same species together, has become a common turfgrass management practice on golf courses (Vargas, 1994). The purpose for using a blend is to create a genetically diverse plant community which will have greater resistance to stress and disease than a stand composed of a single species or cultivar (Vargas and Turgeon, 1977). By increasing the genetic diversity of the turfgrass ecosystem, severe epidemics that destroy large turfgrass areas may be avoided.

Most research to date has focused on interspecific competition rather than intraspecific competition because it is easier to separate different turfgrass species based on identifiable morphological features. To effectively evaluate intraspecific competition in turfgrass blends, cultivar identification becomes essential. Seeded creeping bentgrass cultivars are synthetics produced by selecting several superior genotypes and intermating them to form a single cultivar which consists of a number of unique individuals that share many characteristics of the selected parents (Sweeney and Danneberger, 1994). Cultivar identification is difficult because no two plants are genetically identical within a synthetic cultivar. Traditionally, cultivar identification has been accomplished using morphological traits expressed by the seed, seedling, and/or mature plant, but this becomes very difficult when new lines are registered every year which may differ from another cultivar by only one clonal parent. Recently, Golembiewski et al. (1997) have shown that randomly amplified polymorphic DNA (RAPD) markers produced using DNA extracted from bulk seed samples could be used to identify synthetic creeping bentgrass cultivars.

There have been few studies of disease epidemics in turfgrass blends. RAPD markers have the potential to be useful in assaying individuals in a heterogeneous population to study the behavior of cultivars in a blend in response to selection pressure (Sweeney and Danneberger, 1994). Therefore, the primary objective of this field investigation was to evaluate the influence of disease (dollar spot) stress on intraspecific competition in a blend of two creeping bentgrass cultivars using RAPD markers. The goal was to identify if varying the amount of disease pressure affected the composition of the blend and altered the proportion of cultivars.

Plots were seeded September 1994 with a 50/50 blend of Crenshaw and Penncross creeping bentgrass in a completely randomized design. Dollar spot was controlled at disease levels of 0, 25, and 90%. Samples were taken 2, 13, and 24 months after establishment.

## Discussion/Summary

Turfgrass blends are used to establish genetic diversity and increase population resistance to disease. Three dollar spot disease levels were evaluated for their effect on the composition of a blend in this two-year field study. In 1995, dollar spot symptoms did not appear until late June, but disease incidence continued to be severe through September. Dollar spot activity was reversed in 1996. Symptoms appeared in May, and disease incidence decreased by September.

Dollar spot incidence was severe enough in both years to evaluate the effect of all three disease levels on the composition of the blend. The proportion of Crenshaw and Penncross for each disease level is reported in Table 1. There was no statistical difference (P=0.05) between the three disease levels in 1995 or 1996 (data not shown). The cultivars were chosen based on their level of dollar spot susceptibility when planted alone, but their response in a blend was unknown. Watkins et al. (1981) and Vargas and Turgeon (1977) reported that disease incidence in Kentucky bluegrass blends was either intermediate between that of the component cultivar monostands or not significantly different from the components. Vargas and Turgeon (1977) theorize that when cultivars of various tolerances are combined in a blend, two things happen. The susceptible cultivar is diluted by the resistant cultivar so that the buildup of inoculum is not as extreme, and the resistant cultivar is subjected to a more intensive bombardment of inoculum from adjacent shoots of the susceptible cultivar. Therefore, more severe infection is likely to occur on the resistant cultivar in a blend than if that resistant cultivar were grown alone. The result is that the normally resistant cultivar can not exploit the competitive disadvantage of the susceptible cultivar and consequently, the blend is more stable than predicted. In this study, the cultivars differed in their dollar spot susceptibility levels, but neither was resistant to the disease. The lack of significant differences between the three disease levels indicates that the blend was relatively stable.

There also was no significant difference (P=0.05) in the proportion of Crenshaw and Penncross between years for the three disease levels (data not shown). Begon et al. (1990) stated that intraspecific competition can regulate populations at a stable density known as the carrying capacity of the population. Intraspecific competition, however, does not hold natural populations to a predictable and unchanging carrying capacity. It may act upon a wide range of starting densities and bring them to a much narrower range of final densities. The final proportion of Crenshaw and Penncross in 1995 and 1996 did not differ despite potentially large fluctuations within each year. Intraspecific competition may keep density within certain limits and, therefore, is capable of regulating population size (Begon et al., 1990).

Although there was no significant difference among the three disease incidence levels in 1995 and 1996, there was a significant change in the proportions of Crenshaw and Penncross in the blend, from two months after establishment until the conclusion of the two-year field study. The ratio of Penncross to Crenshaw changed from approximately 1:1 to 2:1 after two years (Table 1). A possible explanation for this change is that turfgrass mainly propagates vegetatively once established. The relative aggressiveness of cultivars within a blend at maturity may substantially influence the characteristics of the resulting turf. Competition between cultivars may involve the physical crowding out of a weaker cultivar by a more vigorous one (Vargas and Turgeon, 1977). In creeping bentgrass blends, cultivars are highly stoloniferous and will compete, and those best suited for the growing conditions will dominate, thus reducing genetic diversity. Turf that was initially composed of several cultivars may eventually become a monostand due to an imbalance in the competitive aggressiveness of component cultivars. In this instance, the presumed advantages of blending are lost and the future capacity of the turfgrass to adapt to changing conditions is limited to the inherent characteristics of the remaining cultivar or cultivars.

Turfgrass blends are recommended to provide improved disease resistance however, based on these results caution should be taken in selecting cultivars for use in a blend or a less than desirable turf may result compared to a single superior cultivar. Further research is needed to assess the competitive ability of creeping bentgrass cultivars under several different management regimes.

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**Table 1. Proportions of Crenshaw and Penncross as influenced by three dollar spot incidence levels.**

| | Crenshaw | | Penncross | |
|---|---|---|---|---|
| Treatment[z] | 1995 | 1996 | 1995 | 1996 |
| 2 MAE | 56 | | 44 | |
| 0% Disease | 41 | 36 | 59 | 64 |
| 25% Disease | 35 | 37 | 65 | 63 |
| 90% Disease | 37 | 33 | 63 | 67 |

[z] MAE = months after establishment.

# Dollar Spot Severity as Influenced by Primo, Creeping Bentgrass Cultivars, and Nitrogen Fertility

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## Introduction

*Sclerotinia homoeocarpa* F.T. Bennett (Smiley et al., 1992), the causal agent of dollar spot, is a widely distributed and destructive pathogen of turfgrass in the United States (Vargas, 1994). Limited information regarding the influence of Primo (trinexapac-ethyl), creeping bentgrass cultivars, and nitrogen fertilization on the severity of the disease is known. Trinexapac-ethyl (TE) is a Type II plant growth regulator (PGR) used to reduce mowing frequency and clipping production, while enhancing turfgrass color (Calhoun and Branham, 1995; Bigelow et al., 1995). It suppresses plant growth by interfering with the production of gibberellins late in the biosynthetic pathway, thus reducing cell elongation and subsequent organ expansion (Kaufmann, 1986). At the standard application rate, TE will provide approximately 50% growth reduction for a four- week period.

Early PGRs introduced in the mid-1940s reduced mowing frequency, but turf quality was diminished (Watschke et al., 1992). Disease incidence on turf was higher because the reduced growth rate and recuperative potential of the turf prevented the masking of disease blighted plants (Danneberger and Street, 1986). However, during the past four decades PGRs have been improved resulting in enhanced turfgrass quality. Today trinexapac-ethyl is used on golf course putting greens, tees, fairways, roughs, and clubhouse grounds. Fagerness and Penner (1996) found that maximum absorption of TE takes place in the crown and leaf blade of the turfgrass plant. With the majority of TE being partitioned in the upper portion of the turfgrass plant, disease susceptibility becomes an issue due to the extended period of reduced turfgrass growth.

Bigelow et al. (1995) and Burpee (1995) reported an increase in dollar spot severity following applications of trinexapac-ethyl. In both studies, trinexapac-ethyl was applied to creeping bentgrass greens which are generally mowed at 0.6 cm or less. Vargas (1994) reports that turfgrass plants maintained below their optimal height of cut are more susceptible to diseases. Davis and Dernoeden (1991) reported that higher cut Kentucky bluegrass (*Poa pratensis* L.) was injured less by summer patch than low cut plots. A 1.3 cm height of cut would be preferable for creeping bentgrass, but it is not possible on greens (Vargas, 1994). However, golf course fairways composed of creeping bentgrass mowed at 1.3 cm or higher should be more tolerant of stress (dollar spot) following trinexapac-ethyl applications.

Integrated pest management (IPM) programs for turfgrass diseases involve a combination of cultural practices and chemical use to ensure quality turf with minimal fungicide inputs. Golf course superintendents, however, spend more money on fungicides to manage dollar spot than on any other turfgrass disease (Vargas, 1994).

Benzimidazole, dicarboximide, and sterol demethylation inhibitor fungicides have been used for dollar spot management. The identification of resistance in field populations of *S. homoeocarpa* to these chemicals (Golembiewski et al., 1995; Detweiler et al., 1983; Warren et al., 1974) poses a significant challenge to turfgrass managers. Management programs must be developed to reduce the number of fungicide applications made in a season. Cultural management strategies for controlling dollar spot include maintaining adequate nitrogen fertility, preventing soil moisture stress, and good air circulation (Smiley et al., 1992).

Blending two or more cultivars of the same turfgrass species has become a common management strategy. Turfgrass blends are presumed to provide an advantage over single-cultivars by creating a diversified plant community which will have greater resistance in habitats where disease or insect problems are likely to develop (Vargas and Turgeon, 1977; Beard, 1973).

Therefore, the primary objectives of this field investigation were to evaluate the severity of dollar spot as influenced by trinexapac-ethyl applications, three rates of nitrogen fertility, and a blend of two creeping bentgrass cultivars maintained under golf course fairway conditions. The goal was to identify management strategies which would provide an acceptable level of dollar spot suppression and reduce the frequency of fungicide application.

Crenshaw creeping bentgrass was seeded alone or in a 50/50 blend with Penncross creeping bentgrass. Plots were fertilized at 0, 0.5, or 1.0 lb N/1000 $ft^2$ per application. One-half of each plot received trinexapac-ethyl [4-(cyclopropyl-alpha-hydroxy-methylene)-3,5-dioxo-cyclohexane- carboxylic acid methyl ester] (0.25 oz. per 1000 $ft^2$) treatments and the other half received none. Trinexapac-ethyl and fertilizer treatments were initiated in May with subsequent applications made at 30-d intervals. A total of five applications were made in 1995 and in 1996.

## Discussion/Summary

In 1995, dollar spot symptoms did not appear until late June, but disease incidence continued to be severe through September. Dollar spot activity was reversed in 1996. Symptoms appeared in May and disease incidence decreased by September.

During this two year study, the blend of Penncross and Crenshaw creeping bentgrass did not provide any advantage over Crenshaw alone in reducing dollar spot severity (Table 1), even though Crenshaw is reported to be very susceptible to dollar spot (Colbaugh and Engelke, 1993). Watkins et al. (1981) and Vargas and Turgeon (1977) reported that disease incidence in Kentucky bluegrass blends was either intermediate between that of the component cultivar monostands or not significantly different from the components for three to four years following establishment. Turfgrass blends are recommended to provide improved disease resistance; however, caution must be taken in selecting cultivars for use in a blend or a less than desirable turf may result compared to a single superior cultivar.

Trinexapac-ethyl reduced dollar spot severity each month compared to the untreated control (Table 1). Application of trinexapac-ethyl every four weeks beginning in May resulted in significantly less dollar spot at the conclusion of each year (Table 2). These results contradict previously published reports (Bigelow et al., 1995; Burpee, 1995). The difference in results may be due to the total nonstructural carbohydrate (TNC) content of the creeping bentgrass. The TNC content of tissues is often used as an indicator of the physiological status of turfgrasses (Sheffer et al., 1979). Turfgrasses have been shown to increase their TNC content when subjected to certain stresses (Yougner and Nudge, 1976; Duff and Beard, 1974). Plants use stored carbohydrates to recover from disease and other plant stresses.

Han and Fermanian (1995) found that creeping bentgrass treated with trinexapac-ethyl significantly increased total nonstructural carbohydrate content of verdure two weeks after treatment (WAT) but TNC began to decrease at 4 WAT compared to the control. Davis and Dernoeden (1991) also found a higher TNC content in higher cut turf as a result of less disease. Bigelow et al. (1995) made trinexapac-ethyl applications to creeping bentgrass putting greens at six week intervals and Burpee (1995) made only one application. In our study, applications of trinexapac-ethyl were made every 4 weeks to creeping bentgrass mowed at 1.3 cm and probably resulted in relatively high levels of TNC within the turfgrass plant. The elevated levels of TNC allowed the creeping bentgrass to remain healthier and more tolerant when stress (dollar spot) occurred. These results suggest that a turfgrass manager would benefit from continuous TE applications every four weeks once started. Otherwise, the growth surge that would result as the TE is degraded in the plant would reduce TNC content and weaken the plant, thus affecting its tolerance to stress. Further research is needed to evaluate trinexapac-ethyl and its effect on TNC in the field.

Nitrogen fertilization reduced dollar spot severity each month during the two year study (Table 1). As the nitrogen level was increased from 0 to 1.0 lb N/1000 $ft^2$ per month, dollar spot incidence was greatly reduced. This agrees with previous reports that increasing nitrogen levels decreases dollar spot severity (Williams et al., 1996; Burpee and Goulty, 1987; Markland et al., 1969). However, the elevated nitrogen rates resulted in a significant increase (50%) in thatch thickness after two years (Tables 3, 4). These results support Vargas (1994) who states that there is little correlation between thatch and disease and that adequate nitrogen should be provided when dollar spot is a problem.

Dollar spot severity was significantly reduced as a result of trinexapac-ethyl application and nitrogen fertility (Table 2). Although no interaction was observed in 1995 or 1996, a combined analysis of the two years showed a significant interaction between trinexapac-ethyl and nitrogen fertilization (Table 2). This observed interaction after two years indicates that continual application of both treatments over an extended period or time results in a significant reduction in dollar spot severity. Upon further analysis, the application of trinexapac-ethyl and the high rate of nitrogen resulted in an average of 12% dollar spot incidence for two years (Table 5). The combination of these two treatments holds great promise for managing dollar spot and reducing the need for fungicide applications on golf course fairways.

Trinexapac-ethyl application and nitrogen fertility were associated with reduced dollar spot severity and a high level of turf quality compared to the untreated control. Hence, on golf course fairways where dollar spot may be severe, incorporation of these treatments into a quality turfgrass management program will enhance dollar spot suppression and help reduce the need for fungicide applications. Creeping bentgrass showed good recuperative ability in late fall, so the summer quality achieved with trinexapac-ethyl and nitrogen may be considered acceptable for most golf course fairway IPM programs.

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**Table 1. Evaluation of Primo, creeping bentgrass cultivars, and nitrogen fertilization on dollar spot severity.**

| | % Dollar spot | | | | | |
|---|---|---|---|---|---|---|
| | 1995[b] | | | 1996[c] | | |
| Treatment[a] | July | August | September | July | August | September |
| Primo | 16.2 | 32.2 | 44.2 | 35.4 | 39.4 | 10.4 |
| Untreated control | 21.4 | 38.6 | 48.4 | 40.6 | 50.8 | 19.8 |
| No N | 25.4 | 62.4 | 88.6 | 61.8 | 64.6 | 25.4 |
| 0.5# N | 21.4 | 35.8 | 37.4 | 34.0 | 41.0 | 12.0 |
| 1.0# N | 9.8 | 8.2 | 13.0 | 18.2 | 29.6 | 8.0 |
| Crenshaw | 24.2 | 36.6 | 43.6 | 33.2 | 45.0 | 15.8 |
| Blend | 13.4 | 34.4 | 49.0 | 42.8 | 45.0 | 14.4 |

a Primo applied at 0.25 oz. per 1000 $ft^2$ per month. Amount nitrogen applied per 1000 $ft^2$ per month. Blend consists of 50% Crenshaw and 50% Penncross creeping bentgrass.

b Based on four replications per treatment over 4, 5, and 4 rating dates for July, August, and September respectively.

c Based on four replications per treatment over 4, 5, and 3 rating dates for July, August, and September respectively.

**Table 2. Factorial analysis of variance of dollar spot severity as influenced by Primo, creeping bentgrass cultivars, and nitrogen fertilization.**[a]

| Source of Variation | df | Mean Square[b] 1995 | 1996 | 1995-1996 |
|---|---|---|---|---|
| Cultivar © | 1 | 55.25 | 66.15 | 0.32 |
| N Fertilization (NF) | 2 | 7056.03*** | 3198.94** | 10035.19*** |
| C x NF | 2 | 53.79 | 48.46 | 41.54 |
| Error | 18 | 765.12 | 577.97 | 576.90 |
| Growth Regulator (GR) | 1 | 240.25*** | 662.21*** | 913.07*** |
| C x GR | 1 | 1.52 | 1.60 | 8.00 |
| NF x GR | 2 | 34.25 | 20.06 | 61.38* |
| C x NF x GR | 2 | 13.95 | 0.88 | 9.25 |
| Error | 18 | 14.56 | 16.64 | 14.97 |

[a] Factorial is a completely randomized design for creeping bentgrass cultivars and nitrogen fertilization with Primo split over both factors.

[b] Based on three months of ratings in 1995 and in 1996.

*, **, *** Significant F-test at the 0.05, 0.01, and 0.001 probability levels, respectively. df = degrees of freedom.

**Table 3. Thatch development as influenced by Primo, creeping bentgrass cultivars, and nitrogen fertilization.**

| Cultivar[b] | Amt. N[c] | Primo App.[d] | Thatch[a] Thickness (mm) | Dry Weight (g) |
|---|---|---|---|---|
| Crenshaw | 0.0 | Yes | 8.20 | 3.92 |
| Crenshaw | 0.5 | Yes | 11.40 | 4.11 |
| Crenshaw | 1.0 | Yes | 13.95 | 5.45 |
| Crenshaw | 0.0 | No | 6.17 | 4.33 |
| Crenshaw | 0.5 | No | 11.90 | 4.62 |
| Crenshaw | 1.0 | No | 14.35 | 4.94 |
| Blend | 0.0 | Yes | 7.63 | 3.41 |
| Blend | 0.5 | Yes | 11.75 | 4.65 |
| Blend | 1.0 | Yes | 12.80 | 4.83 |
| Blend | 0.0 | No | 7.75 | 3.49 |
| Blend | 0.5 | No | 10.90 | 4.06 |
| Blend | 1.0 | No | 12.10 | 4.35 |

[a] Measurements are a mean of 4 replications with 5 samples per replication.

[b] Blend consists of 50% Crenshaw and 50% Penncross creeping bentgrass.

[c] Pounds nitrogen applied per 1000 $ft^2$ per month.

[d] Primo applied at 0.25 oz. per 1000 $ft^2$ per month.

**Table 4. Factorial analysis of variance of thatch accumulation as influenced by Primo, creeping bentgrass cultivars, and nitrogen fertilization.[a]**

| Source of Variation | df | Mean Square |
|---|---|---|
| Cultivar © | 1 | 8.42 |
| N Fertilization (NF) | 2 | 119.35*** |
| C x NF | 2 | 2.26 |
| Error | 18 | 4.38 |
| Growth Regulator (GR) | 1 | 0.11 |
| C x GR | 1 | 1.73 |
| NF x GR | 2 | 0.05 |
| C x NF x GR | 2 | 0.67 |
| Error | 18 | 0.43 |

[a] Factorial is a completely randomized design for creeping bentgrass cultivars and nitrogen fertilization with Primo split over both factors.

*, **, *** Significant F-test at the 0.05, 0.01, and 0.001 probability levels, respectively. df = degrees of freedom.

**Table 5. Dollar spot severity as influenced by the interaction of Primo and nitrogen fertilization.**

| | | % Dollar Spot | | |
|---|---|---|---|---|
| Primo Applied[a] | Amount N[b] | 1995[c] | 1996[d] | Average |
| Yes | 0.0 | 54.8 | 44.8 | 49.8 |
| Yes | 0.5 | 28.4 | 25.2 | 26.8 |
| Yes | 1.0 | 9.6 | 15.2 | 12.4 |

[a] Primo applied at 0.25 oz. per 1000 $ft^2$ per month.
[b] Pounds nitrogen applied per 1000 $ft^2$ per month.
[c] Mean based on four replications per treatment over 13 rating dates.
[d] Mean based on four replications per treatment over 12 rating dates.

# Identification of Bulk Samples of Perennial Ryegrass Cultivars with RAPD Markers

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## Introduction

As the number of perennial ryegrass (*Lolium perenne* L.) cultivars continues to increase, it has become important to develop reliable methods to identify them. In the past, few markers were available for use in cultivar identification. Recently, however, random amplified polymorphic DNA (RAPD) markers show promise as affordable markers for perennial ryegrass identification.

Perennial ryegrass cultivars are synthetic cultivars. Thus, the task of finding markers that distinguish cultivars is difficult since the cultivars are a composite of genotypes rather than a single genotype. Two approaches to identifying synthetic cultivars are possible. Identification may be based on RAPD markers amplified separately from numerous individuals of a cultivar or based on a single composite (bulk) sample of the individuals in the cultivar. The first approach is useful when relatedness of cultivars is of interest but is too laborious when the routine cultivar identification is desired. The second approach gives less information on the relatedness of the cultivars, but, since it requires the amplification of fewer samples, is adaptable to use in a routine cultivar identification. We choose the second approach to identify perennial ryegrass cultivars.

Two methods were used to extract DNA from composite samples of each of 11 cultivars of perennial ryegrass. In the first or "QUICK" extraction, seed samples were crushed with a metal rod, then buffer added. Samples were centrifuged prior to isopropanol precipitation of DNA from the supernatant. After a second centrification, pellets were dried, then re-suspended in buffer.

The second extraction (CTAB) was more involved. After grinding in a mechanical mill, seed was placed in buffer and incubated 1 hr at 65 °C. After cooling, chloroform/octanol was added. After centrification, DNA was precipitated from the aqueous phase with isopropanol. A bent Pasteur pipette was used to hook out the DNA. The DNA was washed twice then re-suspended in buffer. DNA was quantified then diluted to 3 g/ml.

Thirty oligonucleotides were screened for use as primers to amplify DNA extracted using the QUICK protocol. Eleven primers that produced numerous RAPD markers were re-screened using CTAB extracted DNA. Agarose gels were used to separate amplification products. Amplified DNA fragments were detected and photographed under ultraviolet light using a computer imaging system. All extractions and amplifications were repeated.

The concentration of samples extracted using the QUICK extraction protocol ranged from 14 to 70 g/ml. After screening 30 primers using the first extraction, eleven primers that identified all eleven cultivars were found. When amplification was repeated with these primers on replicate extractions of the cultivars, results were disappointing. Only Yorktown II, SR 4000, and

Advent could be reliably identified. In most cases, the unique RAPD markers that identified a cultivar in amplification of the first extraction were not amplified. The RAPD marker that identified SR 4300, however, could not be verified because DNA from the replicate extraction of that cultivar did not amplify. Observation of amplification of the first QUICK extraction indicated that some cultivars routinely amplified better than others. For example, in screening the 30 primers using the first QUICK extraction, SR 4300 and Omni had virtually no amplification in 11 and 8 cases, respectively. For other cultivars the range was 1 to 4. When the experiment was repeated for 15 primers on replicate extractions, SR 4300 was never amplified. This implied that something unique to this cultivar or seed lot was present in the crude extraction and was interfering with amplification of the DNA.

To continue the experiment to identify perennial ryegrass cultivars using RAPD markers, we used an extraction protocol that yields cleaner DNA. The CTAB extraction protocol could not be done using the small sample amounts adequate for the QUICK extraction. Thus, concentrations of DNA resulting from CTAB extractions were much higher (74-960 g/ml) than from the QUICK extraction. Dilutions ranging from 1:25 to 1:300 (versus 1:4 to 1:20 for QUICK extracted samples) were made to reach the final concentration of 3 g/ml desired for amplification. Thus, in addition to the protocol itself yielding cleaner DNA, any contaminates in the final solution were diluted more than in the QUICK extraction protocol.

Only primers that produced polymorphic amplification fragments in the QUICK extraction amplification were screened using CTAB extracted DNA. After screening eleven primers, eight of the eleven cultivars could be identified using primers 203, 248, 250 and 268 . Some cultivars, such as Yorktown II were identified by many primers. Amplification profiles for primers 250 and 203 are shown in Figures 1 and 2. These results were verified using the replicate CTAB extraction. Amplification of SR 4300 was not a problem when CTAB procedure was used to extract DNA.

## Summary

In general, amplification of DNA extracted using the CTAB protocol was better for our purposes. Although the CTAB protocol was more labor intensive, more reliable RAPD markers were observed and more cultivars were identified when it was used to extract DNA. Eight of eleven cultivars could be distinguished based on specific RAPD markers amplified from bulk seed samples. We concluded that it is possible to distinguish perennial ryegrass cultivars based on RAPD markers generated using bulk samples of seed.

**Figure 1. RAPD markers in bulk seed samples of perennial ryegrass cultivars (1. Prelude II, 2. Yorktown II, 3. Palmer II, 4. Repel, 5. SR 4300, 6. SR 4010, 7. SR 4000, 8. Omni, 9. SR 4400, 10. Dandy, 11. Advent) amplified using primer 203 and 3 ng CTAB extracted DNA. Arrows point to RAPD markers unique to particular cultivars.**

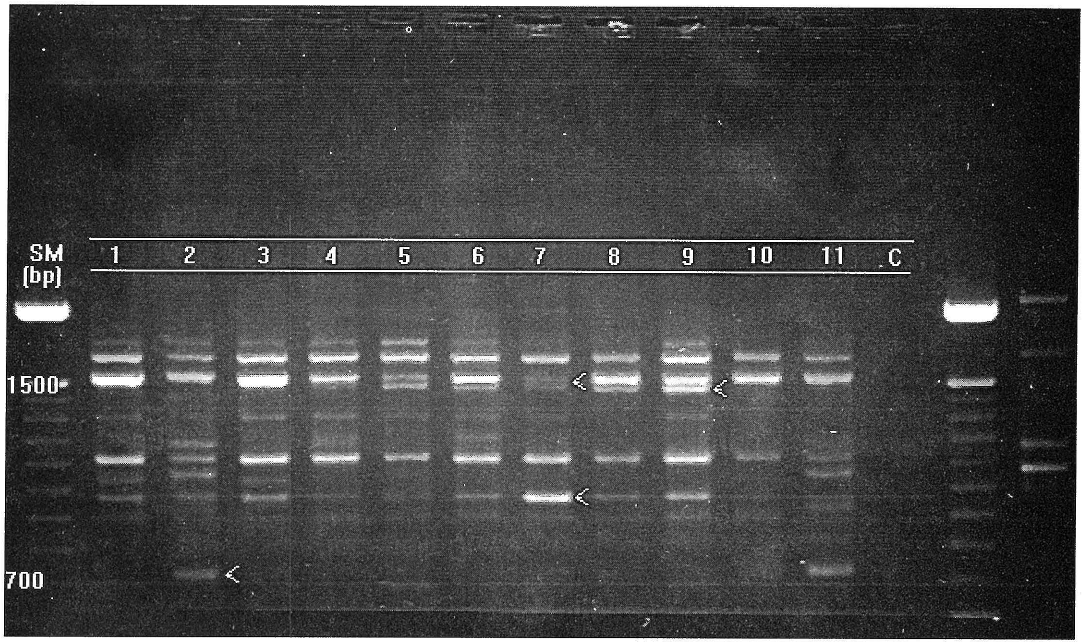
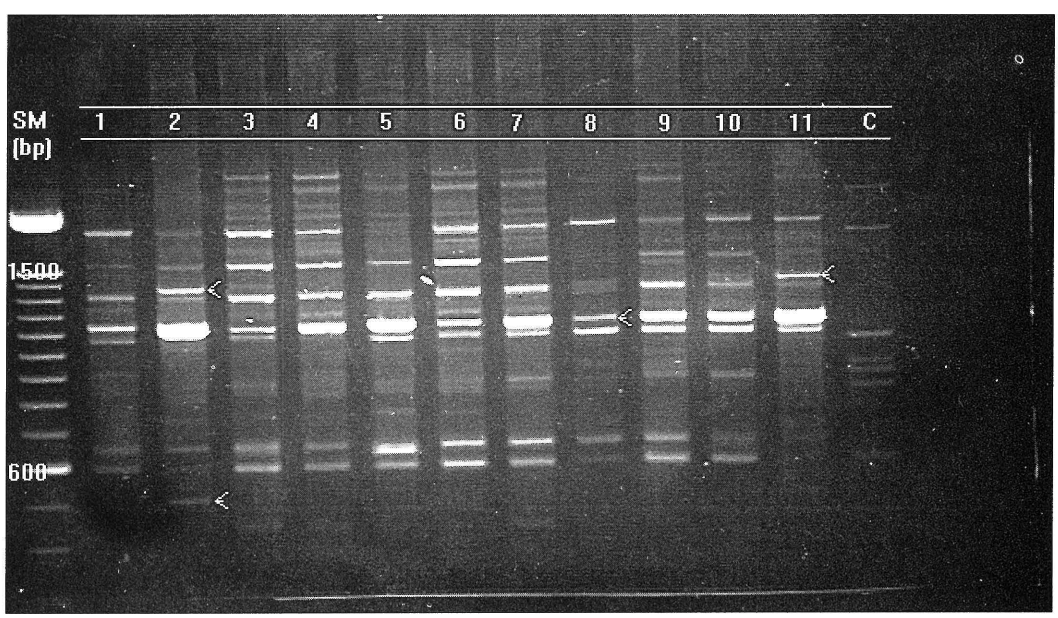



**Figure 2. RAPD markers in bulk seed samples of perennial ryegrass cultivars (1. Prelude II, 2. Yorktown II, 3. Palmer II, 4. Repel, 5. SR4300, 6. SR 4010, 7. SR 4000, 8. Omni, 9. SR 4400, 10. Dandy, 11. Advent) amplified using primer 250 and 3 ng CTAB extracted DNA. Arrows point to RAPD markers unique to particular cultivars.**



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