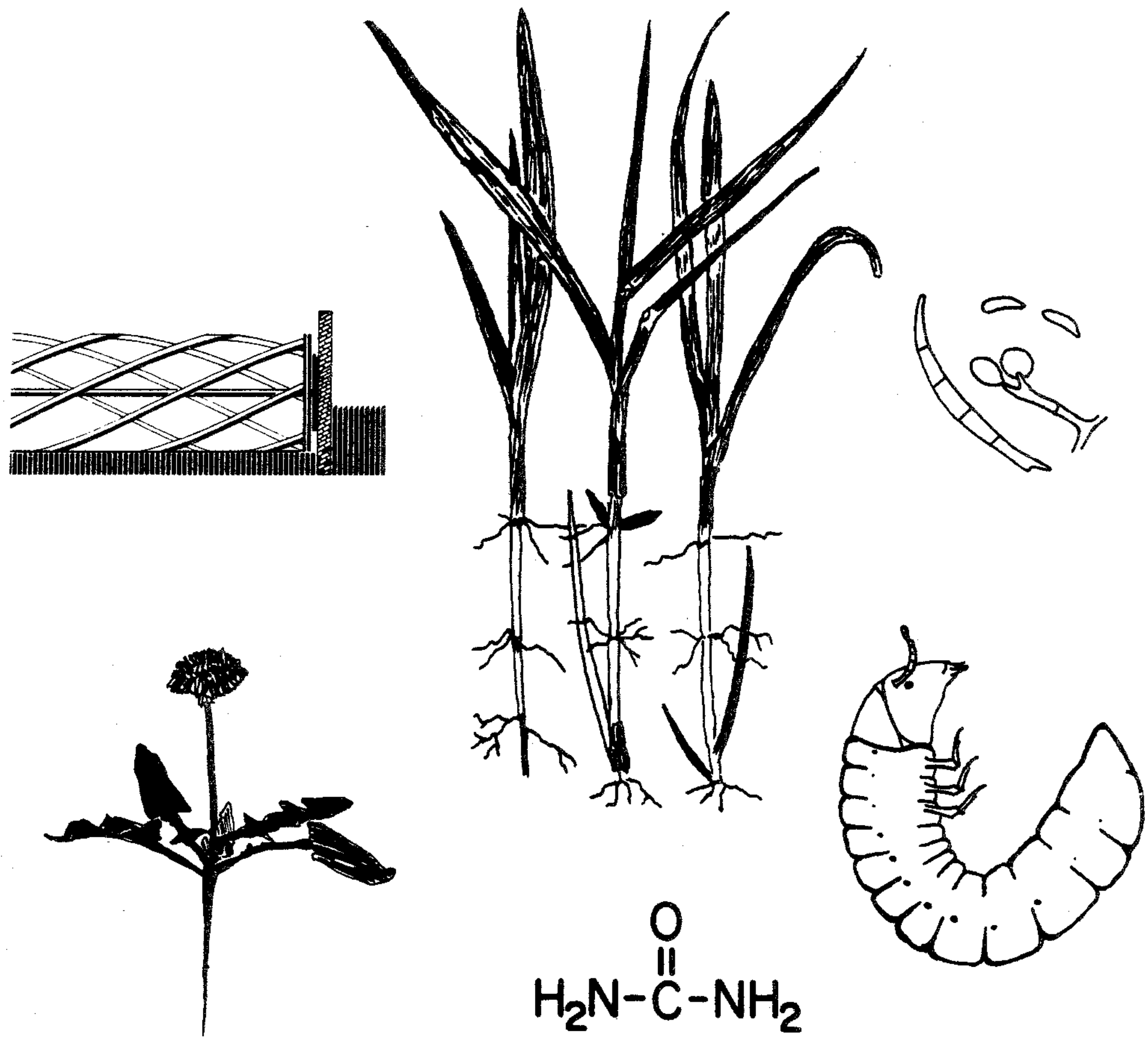
# TURFGRASS RESEARCH

ANNUAL REPORT
Ontario Agricultural College
University of Guelph



# 1985

## INTRODUCTION

The Turfgrass Research Group at the University of Guelph is pleased to present their annual report for 1985. The report is not a complete recording of all the data collected by the various investigators but it reflects the highlights of their work. If further information is required about any of the projects please contact the authors listed on the article.

The year 1985 was one of considerable change for our group. Dr. Chris Hall joined us in July from the University of Alberta. Dr. Hall will be responsible for research, teaching and extension in weed control and growth regulation in grasses. In addition, Ms. Nancy Pierce began working with Dr. Jack Eggens this summer as a research technician in turfgrass management. Nancy and Chris have been very active in establishing research plots at the Cambridge Station.

Recently renovated areas at the Turf Plots include new seedings of creeping bentgrass, Kentucky bluegrass and annual bluegrass for growth regulation experiments, a new perennial ryegrass cultivar trial and a new site developed for studies on crabgrass control. Plans for 1986 include a fine-leaf fescue cultivar trial, the establishment of some new selections of creeping bentgrass and an extension of the irrigation system. Appreciation is extended to Mr. Norm McCollum for overseeing the renovation and management of the Turfgrass Research Facility in 1985. We would also like to offer a special thanks to G.C. Duke Equipment ltd. for the loan of over $20,000 of maintenance equipment this year. This support, along with contributions made by companies, agencies and institutions listed on the following page, helped to make 1985 a successful year for turfgrass research.

L.L. Burpee
Editor

ACKNOWLEDGEMENTS

We wish to extend our appreciation to the Ontario Ministry of Agriculture and Food for continued support during the year. The Ontario Turf Research Foundation continued to play a major role, not only in providing funding for a variety of projects, but also by indicating direction the research should take to resolve the problems which occur in the field. We also extend sincere thanks to the agribusiness community who provided extra operating dollars, chemicals and equipment which made many of the projects reported herein a success.

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SDS Biotech Corporation
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The setting of this report in type by Ms. Linda Visentin is sincerely appreciated by the contributors.

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# THE EFFECT OF NITROGEN: IRON SOLUTIONS ON THE GROWTH AND QUALITY OF CREEPING BENTGRASS

B.D. Davidson and R.W. Sheard

Department of Land Resource Science

The application of N in solution to turf is becoming a common method of supplying N. One of the advantages solutions of N have is the opportunity to combine the N applications with other materials such as iron. Single applications of iron have long been recognized as a method for the short term improvement in the color of the turf. The project reported herein was to evaluate the weekly application of nitrogen: iron solutions to maintain visual quality while allowing the N rate to be adjusted to maintain minimal acceptable growth rate required for fast greens.

## RESEARCH PROCEDURE

Rates of two iron materials, ferrous sulphate ($FeSO_4$ 7 $H_20$) and iron chelate (Fe-DPTA) were supplied in conjunction with each of urea, ammonium nitrate, FLUF and Super 60 (experimental triaminotriazine: urea). Solutions were applied every seven days using 33.3 L $H_20$ per 100 m2 through 8015 nozzles at 210 kPa pressure. Urea: ferrous sulphate solutions were also applied at 14 day intervals and as a weekly solid material mixture.

## RESULTS

Weekly applications of solid urea: ferrous sulphate were inferior, except at high rates of N, due to the dappled appearance of the turf resulting from concentration zones around pellets.

Iron maintained visual quality when applied at seven day intervals in solution, however, 14 days between applications permitted the quality to deteriorate. Iron did not affect turf growth. Significant differences could not be shown between iron sources. A weekly application rate of 14 g Fe/100 $m^2$ (70 g product/100 $m^2$) resulted in the optimum response.

The N carries ranked in the order of urea > ammonium nitrate > Super 60 > Fluf. The growth and quality response to N was linear over the range of 46 to 204 g/100 $m^2$ per week. Previous studies suggest bentgrass density can be maintained at 4.5% N in the tissue. It was found that 75 g N/100 $m^2$ per week would maintain that N concentration in the tissue. The addition of 14 g Fe/100 $m^2$ to the solution containing 75 g N/100 $m^2$ had the same effect on quality as the application of an additional 125 g N/100 $m^2$ per. week. The resulting growth rate, however, was 50% greater where the additional N was applied.
The study suggests that the application of a solution containing 75 g N plus 14 g Fe/100 $m^2$ at 7 to 10 day intervals throughout the growing season will maintain high visual quality while minimizing the growth rate of bentgrass. The compatability of the N:Fe mix with other chemicals is not known. It is suggested that the solution be applied within hours of mixing to avoid oxidation and precipitation of red iron oxides in the tank and potential clogging of the spray system. High quality urea is also suggested to avoid insoluble materials which may clog spray nozzles.

EFFECT OF $NH_4^+$:$NO_3^-$ RATIO AND ROOT TEMPERATURE ON GROWTH OF ANNUAL BLUEGRASS AND CREEPING BENTGRASS GROWN IN POLYSTAND

J.L. Eggens, N.L. Pierce and K. Olson

Department of Horticulture

Studies of tomato, lettuce, rice and other crops have shown a differential utilization of $NH_4^+$-N and $NO_3^-$-N at various root temperatures. Most of these responses occurred under root zone conditions where nitrification was restricted by either waterlogged or compacted soils, by heavy application of certain fungicides or by cold soil temperatures. The object of this study was to evaluate the effect of $NH^+$-N and $NO_3^-$ on growth of annual bluegrass and creeping bentgrass grown in polystand under early spring conditions.

## RESEARCH PROCEDURE

Polystands of annual bluegrass and "Penncross" creeping bentgrass were established at the one leaf stage in pots of silica sand in growth chambers. Root temperatures were maintained at 8, 12, and 16°C by refrigerated circulating water baths. The nutrient solution consisted of 0, 50 or 100% nitrogen in the form of $NH_4^+$ with $NO_3^-$-N constituting the remainder. Each treatment was terminated after 40 days, at which time the dry shoot weight, dry root weight and tiller number per plant was determined. Plant weight was determined by combining the shoot weight with the root weight.

## RESULTS AND DISCUSSION

At all combinations of $NH_4^+$:$NO_3^-$ ratios tested, the total plant weight of annual bluegrass increased as root temperature increased, except at root temperature 16°C with 50% $NH_4^+$ (Table 1). Tiller number (Table 2) closely followed this trend, except at 16°C with 50 and 100% $NH_4^+$ where the values decreased slightly. Plant weight also increased as root temperature increased for "Penncross", but only at the 50% $NH_4^+$ treatment. Here too, tiller number decreased slightly at 16°C. The most vigorous growth (i.e. the highest plant weight and largest tiller number) of annual bluegrass occurred at 0% $NH_4^+$ (100% $NO_3^-$) and a root temperature of 16°C. "Penncross" also exhibited its most vigorous growth at 0% $NH_4^+$ but at a root temperature of 12°C. "Penncross" growth was so vigorous at this condition that it surpassed that of annual bluegrass. Plant weight of "Penncross" only surpassed that of annual bluegrass at one other condition - 50% $NH_4^+$ and a root temperature of 16°C, however annual bluegrass had a larger number of tillers. Both grasses experienced their poorest growth at a root temperature of 8°C and 0% $NH_4^+$, although plant weight for annual bluegrass was almost twice that of "Penncross". Tiller number was identical for each grass at this condition.

Table 1. Effect of NH4+:N03- ratio and root temperature on plant weight of annual bluegrass (A.b) and creeping bentgrass "Penncross" (P) grown in polystand.

| Root temp. (C) | $NH_4^+$:$NO_3^-$ ratio | | | | | |
|---|---|---|---|---|---|---|
| | 0:100 | | 50:50 | | 100:0 | |
| | (A.b) | (P) | (A.b) | (P) | (A.b) | (P) |
| 8 | 15.7 | 9.1 | 218.5 | 166.6 | 154.5 | 87.5 |
| 12 | 619.1 | 691.3 | 346.5 | 236.3 | 455.5 | 282.3 |
| 16 | 928.8 | 537.6 | 258.7 | 450.1 | 465.1 | 162.4 |

Table 2. Effect of NH4+:N03- ratio and root temperature on tiller number of annual bluegrass (A.b) and creeping bentgrass "Penncross" (P) grown in polystand.

| Root temp. (C) | $NH_4^+$:$NO_3^-$ ratio | | | | | |
|---|---|---|---|---|---|---|
| | 0:100 | | 50:50 | | 100:0 | |
| | (A.b) | (P) | (A.b) | (P) | (A.b) | (P) |
| 8 | 1.2 | 1.2 | 13.5 | 7.7 | 5.9 | 4.4 |
| 12 | 17.6 | 19.0 | 18.6 | 12.3 | 19.2 | 10.6 |
| 16 | 25.0 | 16.9 | 16.0 | 10.2 | 17.0 | 8.4 |

These preliminary results indicate that there is a soil temperature-nitrogen form interaction for these two species and it may be possible to reduce the competitive ability of annual bluegrass when grown with "Penncross". Experiments still in progress will aid in clarifying these interactions.

USE OF SEWAGE SLUDGE COMPOST AS A TURF FERTILIZER

J.L. Eggens and N.L. Pierce

Deportment of Horticulture

A growing awareness that municipal wastes can be managed as potential resources have led to attempts by some municipalities to transform sewage sludge into a biologically safe and easily used product. Sewage sludges have long been known to contain nutrients necessary for plant growth, and benefits from using composted sewage sludge as a turf fertilizer have been well documented. Besides supplying readily available nitrogen and phosphorous, these sludges are a good source of organic matter which helps to condition the soil and provide a slow release form of nitrogen that is safer from the standpoint of burn than most commercial fertilizers.

Earlier research has demonstrated that annual bluegrass perfers relatively high nitrogen and phosphorous levels, and for this reason it was chosen as the test species. The intent of this study was to evaluate the suitability of a sewage sludge compost as a fertilizer on annual bluegrass turf maintained under fairway conditions. It is hoped not only that sewage sludges will soon be regarded as a valuable resource in themselves, but also that the use of such a fertilizer containing both a slow-release nitrogen supplemented with a soluable nitrogen source will be a valuable commodity to people in the turfcare industry.

## RESEARCH PROCEDURE

Research plots were established in the fall of 1985 on a predominantly annual bluegrass turf maintained under fairway conditions. The plots, each 2 x 3 m, were arranged in a randomized complete block design with 4 replications. Treatments consisted of 4 nitrogen sources (urea, calcium nitrate, Milorganite, and Windsor composted sewage sludge) and 5 application rates (0, 1, 2, 4 and 8 kg N/100 $m^2$/yr). Each treatment will be applied 8 times over the growing season. One application was made this year on Oct. 23. The Windsor material contains about 2% nitrogen on a dry weight basis and has been fortified with ammonium nitrate to raise its nitrogen level tothat of Milorganite. Evaluations over a 3 year period will include measurements of turf density, color, botanical composition, thatch, recuperative potential, disease, damage, weed infestation and clipping yields.

## RESULTS

Although it is too soon to distinguish differences in the plots due to the treatments, several important observations have resulted from the first application. To increase the spreadability of the sludge and its appearance on low cut turf, finer screens will be required during the sieving process. The material presently being used has been sieved through 2 x 2 cm screens and particles large enough to interfere with its application and with ball roll on a green are present.

An important advantage attributable to the composted sewage sludge is its lack of a disagreeable odour. An objectionable odour was noticed during the Milorganite applications despite the fact that the composted sludge had a higher moisture content.

A better indication of the effect of organic and inorganic nitrogen sources on turfgrass will be available at the end of the 1986 growing season.

# FERTILITY TRIALS ON A GOLF COURSE FAIRWAY

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Department of Horticulture

Fertilization is an important component of turfgrass culture that often directly or indirectly affects all other management decisions. Some factors affecting the nutritional requirements of turf are irrigation, clipping removal, species present, soil texture and nutritional status of the soil. Proper nitrogen, phosphorous and potassium levels will impart ideal shoot growth and density, root growth, recuperative potential, disease resistance, heat, cold and drought hardiness and good color. Insufficient levels of nutrients will result in a rapid decrease in quality and excessive use of fertilizers wastes time and money and actually increases the susceptibility of turfgrasses to some fungal diseases.

The purpose of this study was to determine the amount of fertilizer required on a annual bluegrass/bentgrass fairway to maintain it at acceptable standards.

## RESEARCH PROCEDURE

Research plots were located on number 8 fairway at the Cutten Club Golf Course in May, 1985. This fairway is comprised of approximately 80% annual bluegrass and 20% creeping bentgrass. During the 1985 growing season the fairway received 1.5 kg N/100 $m^2$ as SCU as part of its regular maintenance program and clippings were removed. Mowing was accomplished with a greensmower at a height of 0.9 cm. The treatment plots were 2 x 3 m and arranged in a randomized complete block design with five replications. Treatments consisted of applying 0.5, 1.0, 1.5, 2.0, 3.0 and 4.0 kg N/100 $m^2$/year from a 32-4-8-fertilizer applied montly in May, June, July, August and September. On July 2, a divot was made in each plot and healing potential was evaluated over a 8 week period. Plots were evaluated for color on Nov. 13.

## RESULTS

Significant color effects were observed between the different fertility levels (Table 1). As the amount of fertilizer applied increased, so did the quality of turf from a color standpoint. Only the lowest application rate (0.5 kg N/100 $m^2$) had a rating that was not significantly different from that of the control. The two highest application rates (3.0 and 4.0 kg N/100 $m^2$) showed excellent color results but were not significantly different from each other.

Results for the healing potential of divots was not so clear cut. There was no significant difference between the control and the highest application rate until week 8, at which time the size of the divots in the control plots were significantly larger than those in the plots receiving high nitrogen levels. From a practical viewpoint, this is not as important as it first seems, as the actual area remaining unhealed in the control plots was very small. In general, with a few exceptions resulting more from high variances than from differences in treatments, there was little difference in healing potential of divots subjected to different nitrogen applications.

Table 1. Area of unhealed divots (%) and color in plots receiving various amounts of fertilizer.

| Amount of Fertilizer Kg N | Percent Divot Remaining | | | | | | | Color+ |
|---|---|---|---|---|---|---|---|---|
| | 2 wk | 3 wk | 4 wk | 5 wk | 6 wk | 7 wk | 8 wk | |
| 0 | 92 | 62 | 44 | 22 | 9 | 1 | 1 | 4.7 d* |
| 0.5 | 95 | 69 | 56 | 22 | 10 | 2 | 1 | 5.2 cd |
| 1 | 90 | 56 | 42 | 12 | 6 | 1 | 0.5 | 5.7 c |
| 1.5 | 81 | 48 | 41 | 20 | 8 | 2 | 1 | 6.5 b |
| 2 | 77 | 52 | 35 | 16 | 7 | 1 | 0 | 7.0 b |
| 3 | 81 | 56 | 38 | 22 | 11 | 5 | 0 | 8.6 a |
| 4 | 72 | 56 | 31 | 10 | 6 | 5 | 0 | 9.1 a |

+ Color on a scale of 0-10; 0-brown; 10-dark green.
* Means followed by the same letters are not significantly different at the 0.05% level (Duncan's Multiple Range Test).

# ANNUAL BLUEGRASS SEEDHEAD PRODUCTION

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Department of Horticulture

Regardless of one's viewpoint on the suitability of annual bluegrass (*Poa annua*) as a desirable turfgrass species, its seehead formation ability is a major drawback. It is a prolific seed producer, capable of seedhead production even at putting green mowing heights. This becomes a concern to golfers on a green that has any significant amount of annual bluegrass present, as the seedheads interfere with ball roll.

For those superintendents who have decided to promote the growth of annual bluegrass, any technique that controls this seedhead production would be welcome. Chemical control has been practiced on a limited basis for several years, with maleic hydrazide (MH-30) showing good seedhead suppression provided it is applied at the proper stage of floral development. Unfortunately, reduction in turf quality usually accompanies seedhead suppression, permitting its use only under roadside conditions where some discoloration is acceptable.

This research was conducted to test a new formulation of maleic hydrazide (MH-60) on annual bluegrass seedhead production and to observe any phytotoxic effects.

## RESEARCH PROCEDURE

Maleic hydrazide (60% - present as potassium salt in a soluable granular form) was sprayed at the recommended rates on 0.5 x 2 meter annual bluegrass plots mowed at fairway height at the Cambridge Research Station. The treatments were arranged in a randomized complete block design with four replicates. Treatments consisted of a control, maleic hydrazide in water and water only. Fall treatments were applied on Oct. 3 and Oct. 17. Three spring applications will also be made on or about May 1, May 15 and June 1. Plots were evaluated 1 and 2 weeks after spraying for signs of seedhead suppression and injury. Plots that received fall applications will also be evaluated in the spring of 1986.

## RESULTS

An evaluation for the two fall applications showed no significant effect on the number of seedheads present in the plots or color one and two weeks after application. It is expected that any suppression in production will not be noticed until growth resumes in the spring. No damage to the turf was noticed for either application date.

# TURFGRASS RESPONSE TO GROWTH RETARDANTS

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Department of Environmental Biology

Mowing is a time consuming and expensive maintenance procedure for turf. Many turfgrass sites are not easily accessible for mowers and are often dangerous for both the operator and nearby personnel. One alternative is to slow the rate of turfgrass growth to reduce mowing. Recently, the plant growth regulators flurprimidol, paclobutrozol, and XE-1019 have been shown to be potent turf-growth retardants. Therefore, research was implemented to determine if these growth retardants alone or in combination with mefluidide resulted in season long reduction in growth without the expression of phytotoxicity.

## RESEARCH PROCEDURE

Treatments were applied to a mixed stand of turf that contained perennial ryegrass, Kentucky bluegrass, and creeping red fescue that were maintained at the University of Guelph Cambridge Research Station. The experimental design consisted of a randomized complete block with four replications. Fifteen growth retardant treatments and one non-treated control were included in each block. Each treatment plot measured 1. x 2 m. Wettable powder and liquid formulations were applied with a wheel mounted compressed air boom sprayer equipped with 8002 flat-fan nozzles calibrated to deliver 7 L/100 $m^2$ at 138 kPa. The turf plots were cut two days prior to treatment and were left unmowed for the rest of the season. Growth retardants were applied on 23 July at 6 a.m. At the time of treatment the turf was covered with a heavy dew, the temperature was 16°C, and it was a clear and sunny day with no wind. Turf height was assessed on 16 October. Means representing plant height were compared by using a Least Significant Difference (LSD) value that was generated after an analysis of variance was found to be significant.

## RESULTS

All treatments, except mefluidide applied alone, resulted in a significant level of growth reduction (Table 1).

Mefluidide provided adequate control of turfgrass growth for approximately five weeks. However during this five week period growth control was less than that in plots receiving applications of flurprimidol, paclobutrazol, or XE-1019. Furthermore, by 16 October there was no difference between the height of turf in the control and plots receiving the mefluidide treatments only.

All plots that received mefluidide alone or in combination with other compounds became yellow several days after treatment and remained in this state for approximately one month. Although treatment combinations of paclobutrazol or XE-1019 with fefluidide were initially yellow, the plots that received these combinations were superior in quality one month after treatment and remained so throughout the season.

Some browning of the tips of leaf blades was evident with the two highest doses of paclobutrazol.

Table 1. Effect of plant growth retardants on the growth of turf.

| Treatment | Dosage (g a.i./100 $m^2$) | Height[1] (cm) |
|---|---|---|
| Control | — | 21.3 |
| Paclobutrazol | 11.0 | 8.9 |
| Paclobutrazol | 22.0 | 7.2 |
| Paclobutrazol | 44.0 | 5.5 |
| Flurprimidol | 10.0 | 14.8 |
| Fluriprimidol | 20.0 | 12.8 |
| Fluriprimidol | 40.0 | 8.5 |
| XE-1019 | 1.4 | 12.2 |
| XE-1019 | 2.8 | 7.7 |
| XE-1019 | 5.6 | 6.9 |
| Mefluidide | 2.0 | 22.2 |
| Mefluidide | 4.0 | 21.2 |
| Paclobutrazol + mefluidide | 11.0 + 2.0 | 10.9 |
| Paclobutrazol + mefluidide | 22.0 + 2.0 | 6.6 |
| XE-1019 + mefluidide | 2.8 + 2.0 | 8.7 |
| XE-1019 + mefluidide | 5.6 + 2.0 | 5.6 |

[1] LSD (0.05) = 3.7; LSD (0.01)

# MOWING FAIRWAYS WITH GREENSMOWERS

J.L. Eggens, N.L. Pierce, V. Hoyt and R. Creed

Department of Horticulture

Golf course fairways have traditionally been mowed lengthwise with pulltype gangmowers having 5, 7 or 9 blade reels. However, the mechanical damage inflicted on turf by these large fairway units, especially during turns, has led superintendents to search for more acceptable mowing tecniques. Excellent results have been obtained by using greensmowers. These machines are lighter than the traditional fairway units, thereby eliminating mechanical damage to the turf, and have more blades per reel resulting in a finer cut. This study was initiated to observe the differences in quality of turf mowed at a height of 2.0 cm with a traditional fairway unit and turf mowed at 0.9 cm with a greensmower.

## RESEARCH PROCEDURE

Research plots were located on a par 4 fairway at the Cutten Club Golf Course in the spring of 1984. During the 1984 season, the plots were mowed every Monday, Wednesday and Friday with a Toro pull-type gangmower with 9 reel blades at a 2.0 cm height of cut or a Toro Greensmaster III at a 1.1 cm height of cut. For the 1985 growing season, the mowing height of the greensmower was lowered to 0.9 cm. The baskets on the greensmower were removed so that both units returned the clippings. A power sweeper removed clippings from half the plots. This essentially gave four treatments - a 2.0 cm mowing height and a 0.9 cm mowing height with clippings either returned or removed. On July 2, 1985, 10 divots were mode in each treatment area with an artificial divot maker, and the healing of the divots was observed over a 2 month period. Weed infestation for each treatment was measured by recording the amount of knotweed in a 1/2 x 1/2 m quadrat. Eighteen measurements were made for each treatment on Aug. 22.

An analysis of botanical composition was also begun comparing traditional mowing practices (i.e. a 2.0 cm cut with clippings returned) with more recent mowing practices (i.e. a 0.9 cm cut with clipping removed). Eight bentgrass patches were located and marked for both treatments on June 6, and the area and botanical composition of these patches was recorded. On Nov. 9. these patches were evaluated again for size and botanical composition.

## RESULTS

Mowing practices had no significant effect on the healing potential of divots with one exception (Table 1). Four weeks after the divots were made, those in the 2.0 cm height, clippings returned area were signifciantly smaller than those in the 0.9 cm, clippings returned area. This effect disappeared by week 5 and by week 7 the divots in all the treatment area were essentially healed.

Table 1. Effect of mowing practices on the healing potential of divots.

| Treatment | Percent divot remaining after initial injury | | | | | |
|---|---|---|---|---|---|---|
| | 2 wk | 3 wk | 4 wk | 5 wk | 6 wk | 7 wk |
| 0.9 cm swept | 86 | 53 | 46 ab* | 18 | 11 | 2 |
| 0.9 cm unswept | 95 | 56 | 52 a | 19 | 10 | 1 |
| 2.0 cm swept | 87 | 49 | 41 | 17 | 13 | 2 |
| 2.0 cm unswept | 84 | 49 | 31 | 15 | 7 | 1 |

* Means followed by the same letter are not significantly different at the 0.05% level (Duncan's Multiple Range Test).

Clipping removal did have a significant effect on the amount of knotweed present in the plots (Table 2). For both heights of cut, the areas in which the clippings were returned had significantly less knotweed present than the corresponding height where clippings were removed.

There was no significant difference in knotweed incidence between height of cut for those areas where clippings were returned, and these two treatments resulted in the least amount of knotweed present. In areas where clippings were removed, there was a significant difference in knotweed incidence between the two heights of cut, with the higher cut having the greatest percentage of knotweed of all the treatments.

Table 2. Effect of mowing practice on the presence of knotweed.

| Treatment | Knotweed Present (%) |
|---|---|
| 0.9 cm unswept | 13.1 a* |
| 0.9 cm swept | 29.2 b |
| 2.0 cm unswept | 20.6 ab |
| 2.0 cm swept | 56.4 c |

*Means followed by the some letter are not significantly different at the 0.05% level (Duncan's Multiple Range Test).

Mowing practice significantly affected the area of bentgrass patches over a 5 month period but not their botanical composition (Table 3). Those patches in the area being mowed in the conventional manner (i.e. 2.0 cm, unswept) showed a significant decrease in patch area while those patches in the area mowed at 0.9 and swept showed a significant increase in patch size.

Table 3. Change in the area and composition of bentgrass patches over a 5 month period.

| Treatment | Change in patch area ($cm^2$) | Change in bentgrass Composition (%) |
| --- | --- | --- |
| 2.0 cm unswept | -32.20 | -3.13 |
| 0.9 cm swept | +57.34* | 5.00 |

+ A minus sign represents a decrease, a plus sign represents an increase.
* Significant at the 5% level.

# DISLODGABLE-RESIDUES OF 2,4-D AMINE AND ESTER FORMULATIONS ON TURFGRASS

H.L. McLeod, C.S. Bowhey, N.M. Swanson and G.R. Stephenson

Department of Environmental Biology

2,4-D is extensively used for broadleaf weed control in turfgrasses in parks, golf courses, highway rights-of-way and home lawns. Its persistence in these situations is of interest as the general public may unknowingly come into contact with recently treated turf. The effects of formulation and application rate on this persistence are reported here.

## RESEARCH PROCEDURE

Field experiments were conducted on a five year old mixed stand of Red Fescue and Kentucky bluegrass maintained at the University of Guelph Cambridge Research Station. The plot was neither irrigated nor mowed during the two week testing period. The only precipitation during the experiment was a trace of rain between days seven and eight.

Two liquid formulations of 2,4-D (dimethylamine salt; 500 g litre$^{-1}$ and isooctyl ester; 600 g litre$^{-1}$) were applied separately to 2 m x 10 m strips of turf at rates of 1.0, 2.0 and 4.0 kg a.i. ha$^{-1}$ using a backpack sprayer. These treatments were arranged in a completely randomized design with five replicates per treatment. The central 1 m$^2$ of each of the ten successive 2 m$^2$ plots per strip were staked out as sampling subplots to avoid possible variation near the edge of the spray swath.

The herbicide was dislodged by a vigorous mechanical wiping of the leaf surfaces with moistened cheesecloth fastened over boots. The chemical was then extracted from the cheesecloth and prepared for analysis as previously outlined (Thompson et al. 1983). Analysis was performed by gas-liquid chromatography and the results were corrected for clean-up and methylation efficiencies and slight application rate variation.

## RESULTS

As expected, on day 0, dislodgable residues did increase with higher application rates. In fact, doubling and quadrupling of this rate, generally resulted in a greater than doubling or quadrupling of dislodgable residues. This may be the result of some type of binding threshold within the leaf cuticle.

Near the end of the experiment, more amine than ester was dislodgable at the various application rates. This was likely due to the greater penetration and/or higher volatility of the ester formulation.

Regardless of application rate or formulation, dislodgable residues had declined to 0.3% or less by day 8 and to less than 0.1% by day 10. While dislodgable residues were variable during the first four days, there was a consistent decline by day four in all treatments and dislodgable residues never exceeded 5% of applied even at day 0.

Acknowledgements

D.G. Thompson and H. Braun are gratefully acknowledged for their assistance with application and analytical procedures.

Reference

Thompson, D.G., G.R. Stephenson and M.K. Sears. 1984. Persistence, Distribution and Dislodgable Residues of 2,4-D Following its Application to Turfgrass. Pesticide Science 15:353-360.

Table 1. Dislodgable residues of 2,4-D (ug/$m^2$)

| Day | 2,4-D Amine | | | 2,4-D Ester | | |
|---|---|---|---|---|---|---|
| | l kg/ha | 2 kg/ha | 4 kg/ha | 1 kg/ha | 2 kg/ha | 4 kg/ha |
| 0 | 2351 (2)* | 6558 (3) | 16265 (4) | 3611 (4) | 6024 (3) | 17338 (4) |
| 1 | 3169 (3) | 6207 (3) | 12906 (3) | 3404 (3) | 5302 (3) | 10729 (3) |
| 2 | 1481 (1) | 4506 (2) | 8286 (2) | 1764 (2) | 2602 (1) | 6018 (2) |
| 3 | 2015 (2) | 4045 (2) | 9841 (3) | 1285 (1) | 3229 (2) | 9797 (3) |
| 4 | 1291 (1) | 3003 (2) | 11506 (3) | 927 (1) | 1634 (1) | 5848 (2) |
| 8 | 319 (0.3) | 540 (0.3) | 1317 (0.3) | 170 (0.2) | 322 (0.2) | 754 (0.2) |
| 10 | 47 (0.05) | 126 (0.06) | 664 (0.1) | 46 (0.04) | 116 (0.06) | 342 (0.1) |

• percent dislodgable (of that applied) is given in parenthesis.

# BIOLOGICAL CONTROL OF GRAY SNOW MOLD ON CREEPING BENTGRASS

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Gray or speckled snow mold, caused by *Typhula ishikariensis* Imai, is a serious disease of turfgrasses in eastern Canada. Occassionally, other species of *Typhula* are found associated with plant debris after snow-melt, but their biology is not well understood. In 1982, we found a lowtemperature-tolerant fungus, *Typhula phacorrhiza* Fr., growing on leaf clippings of Kentucky bluegrass in Cambridge, Ontario. Since this fungus hod never been reported to be a pathogen of turfgrass, we conducted some preliminary experiments and found that, as suspected, the fungus was nonpathogenic. Our next series of experiments (reported here) were designed
to determine if *T. phacorrhiza* influenced the development of snow mold caused by *T. ishikariensis.*

## RESEARCH PROCEDURE

Three experiments were conducted during 1983 and 1984 on a 7-yr-old stand of creeping bentgrass, cultivar Penncross, maintained at the OMAF Horticultural Research Station, Cambridge, Ontario. Mowing, fertilization and irrigation schemes were similar to those prescribed for bentgrass golf putting greens. Isolates of *Typhula* spp. used in the experiments included isolate T011 of T. phacorrhiza collected from the thatch layer of Kentucky bluegrass at Cambridge, Ontario in 1982 and isolate T004 of *T. ishikariensis* var. *ishikariensis* collected from foliage of creeping bentgrass at Galt, Ontario in 1982. Initial cultures of both isolates were derived from single sclerotia.

**Pathogenicity and isolate interactions.** A field study was conducted from Nov., 1983 through April, 1984 to evaluate virulence of isolates T011 and T004 alone and in combination on creeping bentgrass. Inoculum was prepared by transferring mycelial plugs from colonies on BASM agar to 1-L Mason jars containing moist, autoclaved rye grain (100 $cm^3$ grain, 20 ml $H_20$). Cultures were incubated for 12 wk at 10°C.

A 1 x 6 m sward of creeping bentgrass was selected as an inoculation site. Snow mold was not observed on the site the previous spring. Treatments included inoculations of turf with autoclaved (heat-killed) and nonautoclaved inocula of isolate T004, isolate T011, and a mixture of T004 and T011. Ten-or 20-$cm^3$ aggreates of grain inoculum were placed 25 cm apart on the turf. Treatments were arranged in a randomized complete block design with four replicates. Immediately after inoculation, the turfgrass foliage was sprayed with water until runoff and the turf was covered with wooden frames (300 x 100 x 15 cm) overlain with 4-mil transparent plastic sheeting. The frames were used as a means of maintaining an extended period of leaf wetness for disease development in the possible absence of an extended period of snow cover.

The frames were removed 127 days after inoculation. A quantitative estimate of disease was made by measuring the diameter of the necrotic area of turf surrounding each aggregate of inoculum. Values were subjected to analysis of variance and means were statistically separated using Duncan's

Modified (Bayesian) least significant difference test. Samples of leaf tissue and fragments of grain inoculum were collected after the measurements were made. The material was washed for 1 hr in running tap water, blotted dry, and placed on acidified potato dextrose agar (APDA), in Petri dishes stored at 10C. Fungi growing from the samples were identified after 2-4 wk of incubation.

**Disease suppression studies.** The snow mold suppression potential of *T. phacorrhiza* (isolate T011) was evaluated on creeping bentgrass turf with a history of severe infection by T. ishikariensis. Grain inoculum of isolates T011 and T004 was prepared as described above. One-$m^2$ plots of turf were infested with 100 or 200 g of inoculum of one or both isolates on 18 Nov., 1983 or 21 Nov., 1984, respectively. Inoculum was dispersed by hand onto the turf surface. Additional treatments included uninfested plots and, in 1984, plots infested with autoclaved, uncolonized grain. Treatments were arranged in a randomized complete block design with four replicates.

The Horsfall-Barratt rating system was used to estimate disease incidence (percent necrotic foliage per plot) beginning at 140 and 147 days after inoculation in 1983 and 1984, respectively. Statistical procedures and post-evaluation sampling and isolation techniques were the same as those described above.

## RESULTS

**Pathogenicity and isolate interactions**. *Typhula ishikariensis* (isolate T004) was pathogenic on creeping bentgrass and *T. phacorrhiza* (isolate T011) was nonpathogenic (Table 1). Significantly less necrotic foliage was observed in plots infested with a mixture of isolates T004 and T011 than in plots infested with isolate T004 alone. The incidence of necrotic foliage was not limited significantly in plots infested with a mixture of isolate T004 and autoclaved inoculum of isolate T011.

**Disease suppression studies.** Snow mold, caused by *T. ishikariensis*, was the only disease observed in the experimental plots after snow-melt in 1983 and 1984. A 70% incidence of necrotic foliage was observed initially in uninoculated plots in 1983 (Table 2). For at least 190 d after inoculation (54 d after snow melt), turfgrass incoulated with isolate T011 exhibited significantly less necrosis than turf subjected to the other treatments. A similar effect was noted in 1984 (Table 3). In both years, incidence of necrosis declined in all plots after snow-melt due to the development of symptomless foliage.

## CONCLUSIONS

Isolate T011 of *Typhula phacorrhiza* suppressed gray snow mold, caused by *T. ishikariensis*, by as much as 70%. Further studies, designed to improve the efficacy of control, are warranted.

Table 1. Interaction between *Typhula phaccrrhiza* (isolate TO11) and *T. ishikariensis* var. *ishikariensis* (isolate T004) on creeping bentgrass.

| Treatment | Size of inoculum aggregate ($cm^3$)$^x$ | Diameter of Necrotic turf (cm)$^{yz}$ |
|---|---|---|
| IsolateT004 | 20 | 5.6 a |
| IsolateT011 | 20 | 0.0 b |
| T004 +TO11 | 20 | 2.9 c |
| T004 +autoclavedTO11 | 20 +20 | 4.1 ac |
| Autoclaved TO11 | 20 +20 | 0.0 b |
| Untreated | - | 0.0 b |

$^x$ Placed on turf surfaces Nov. 1983.
$^y$ days after inoculation. Mean of four replicates.
$^z$ Values followed by the same letter are not significantly different according to Duncan's LSD at P = 0.05.

Table 2. Effect of *Typhula phacorrhiza* (isolate TO11) on the incidence of gray snow mold of creeping bentgrass, 1983.

| | Percent Foliar Necrosis After Snow-Melt$^x$ | | |
|---|---|---|---|
| Treatment | 4 days | 25 days | 54 days |
| Isolate T011* | 26 a | 24 a | 9 a |
| Untreated | 70 b | 50 b | 34 b |

* Infested rye-grain inoculum (100 g/$m^2$).
$^x$ Within a column, values are significantly different at P=0.05.

Table 3. Effect of *Typhula phacorrhiza* (isolate TO11) on the incidence of gray snow mold of creeping bentgrass, 1984.

| Treatment | Percent Foliar Necrosis After Snow-Melt$^x$ | |
|---|---|---|
| | 2 days | 9 days |
| Grain infested with TO11* | 25 a | 9 a |
| Uninfested grain | 94 b | 72 b |
| Untreated | 95 b | 72 b |

* 200 g/$m^2$
$^x$ With a column, values followed by the same letter are not significantly different at P=0.05.

# INFLUENCE OF POTASSIUM SULFATE AND FUNGICIDES ON PINK AND GREY SNOW MOLD OF CREEPING BENTGRASS

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Many turf managers are applying high potash (potassium fertilizers to maximize stress tolerance in grasses. In this study, we wanted to determine if fall applications of potassium (0.4 lbs. K/MO.), on K-deficient creeping bentgrass, would reduce the incidence of snow mold and increase efficacy of snow mold fungicides.

## RESEARCH PROCEDURE

Treatments were applied to a 8-year-old sward of creeping bentgrass in Cambridge, Ontario. Turfgrass cultural treatments were similar to those used for maintenance of golf course putting greens in Ontario. Experimental, design consisted of a randomized complete block design with four replications. Each treatment plot measured 1 x 2 m. Wettable powder and flowable formulations were applied in 7 1 of water per 100 m2 with a wheelmounted compressed air boom sprayer at 138 kPa. A Scotts drop spreader was used to apply Scotts FFII. Potassium sulfate was applied on 18 Sept. (227 g/100 m2) and 16 act. (227 g/100 m2). Fungicides were applied on 20 Nov. Turfgross was inoculated with autoclaved rye grain infested *with Microdochium nivale* and *Typhula ishikariensis* on 21 Nov. Disease intensity was estimated on 14 April.

## RESULTS

Scotts LDP at 225 and 450 g a.i./100 $m^2$, Scotts FFII at 225 and 450 g a.i./100 $m^2$, Mersil at 125 g product/100 $m^2$ and Daconil 2787 at 119 g a.i./100 $m^2$ provided significant suppression of pink and grey snow mold (Table 1). The potassium sulfate treatments enhanced the efficacy of Scotts LOP at 112 g a.i./100 $m^2$ and Ronilan at 45 g a.i./100 $m^2$. Treatments resulting in < 10% disease are considered acceptable for fine turf.

Foliar K levels were 1.4% and 0.9% for the K-amended and unamended turf, respectively. Both of these were below the optimum of 3-4%. This may explain why the K treatments had little effect on disease tolerance.

Table 1. Influence of $K_2SO_4$ and fungicides on snow mold of creeping bentgrass.

| Treatment | Rate (a.i./100 $m^2$) | Pink Snow Mold (%) | Grey Snow Mold (%) |
|---|---|---|---|
| Scott's LDP | 450g | 0.0* | 2.5* |
| Scott's LDP | 225g + 454g** | 6.3* | 7.5* |
| Scott's LDP + $K_2SO_4$ | 112g + 454g** | 11.3* | 18.8* |
| Scott's LDP + $K_2SO_4$ | 225g | 8.8* | 12.5* |
| Scott's FFII | 225g | 15.0* | 11.3* |
| Mersil | 125g† | 15.0* | 18.8* |
| Scott's FFII | 112g | 18.8 | 21.3* |
| Scott's FFII | 450g | 13.8* | 16.3* |
| Scott's FFII + $K_2SO_4$ | 112g + 454g** | 16.3* | 18.8* |
| Ronilan + K | 45g + 454g** | 30.0 | 35.0* |
| Scott's FFII + $K_2SO_4$ | 225g + 454g** | 16.3* | 11.3* |
| Daconil 2787 | 119g | 17.5* | 23.8* |
| Daconil 2787 + $K_2SO_4$ | 119g + 454g** | 21.3 | 26.3* |
| Rovral | 90g | 21.3 | 50.0 |
| Scott's LDP | 112g | 35.0 | 37.5* |
| Ronilan | 60g | 50.0 | 48.8 |
| Ronilan | 90g | 53.8 | 46.3 |
| Ronilan | 45g | 52.5 | 55.0 |
| $K_2SO_4$ | 454g** | 50.0 | 75.0 |
| Control | - | 48.8 | 67.5 |

† product/100 $m^2$
* significantly different from control at P = 0.05
**$K_2SO_4$ applied on 18 Sept. (227 g/100 $m^2$) and 16 Oct. (227 g/100 $m^2$).

CHEMICAL CONTROL OF PINK AND GRAY SNOW MOLD ON
CREEPING BENTGRASS

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The following study was designed to evaluate the efficacy of several fungicides for control of pink and gray snow mold of creeping bentgrass. Some of the systemic fungicides (ie. Arrest, Fungicide VII and UBI 2382) were applied in October, as well as November, to determine if early application enhances effectiveness by allowing for root uptake at warmer temperatures. In addition, the acrylic polymer, Rhoplex AC33, was tested to determine if it enhances the residual activity of Daconil 2787.

## RESEARCH PROCEDURE

Treatments were applied to a 8-year-old sward of creeping bentgrass in Cambridge, Ontario. Turfgrass cultural treatments were similar to those used for maintenance of golf course putting greens in Ontario. Experimental design consisted of a randomized complete block design with three replications. Each treatment plot measured 1 x 2 m. Wettable powder and flowable formulations were applied in 7 1 of water per 100 $m^2$ with a wheelmounted compressed air boom sprayer at 138 kPa. A Scotts FFII and the Granular Quintozene were applied with a Scotts drop spreader. Treatments were applied on 16 Oct. and/or 20 Nov. Turfgrass was inoculated with autoclaved rye grain infested with *Microdochium nivale* and *Typhula ishikariensis* on 21 Nov. Disease intensity was estimated on 14 April.

## RESULTS

Prochloraz at 142 g a.i./100 $m^2$ and CGA64250 at 22 g a.i./100 $m^2$ provided significant suppression of pink and grey snow mold (Table 1). Several treatments resulted in significant control of grey snow mold without significantly suppressing pink snow mold. Efficacy of UBI 2382 and Arrest was improved when applications were made in Oct. and Nov. as opposed to Oct. or Nov. Treatments resulting in < 10% disease are considered acceptable for fine turf.

Table 1. Influence of fungicides on the incidence of snow molds on creeping bentgrass.

| Treatment | Rate (a.i./100 $m^2$) | Pink Snow Mold (%) | Grey Snow Mold (%) |
|---|---|---|---|
| Prochloraz (Nov.) | 142g | 0.0* | 3.3* |
| CGA64250 (Nov.) | 22g | 3.3* | 5.0* |
| CGA64250 (Nov.) | 16g | 10.0 | 6.7* |
| Fungicide VII (Nov.) | 15g | 10.0 | 11.7* |
| Daconil 2787 (Nov.) | 119g | 11.7 | 11.7* |
| UBI 2382 (Oct. & Nov.) | 300 g + 300 g† | 10.0 | 13.3* |
| Fungicide VII (Oct.) | 15g | 18.3 | 15.0* |
| Fungicide VII (Oct. & Nov.) | 15g + 15g | 10.0 | 15.0* |
| Daconil 2787 + Rhoplex (Nov.) | 119g + 1:5** | 20.0 | 15.0* |
| Granular quintozene + K (Nov.) | 1500g† | 16.7 | 16.7* |
| Arrest (Nov.) | 300g† | 13.3 | 18.3* |
| Arrest (Oct. & Nov.) | 300g + 300g† | 8.3 | 20.0* |
| SN84634 (Nov.) | 50g | 31.7 | 21.7* |
| UBI 2382 (Nov.) | 300g† | 20.0 | 28.3 |
| Prochloraz (Nov.) | 71g | 16.7 | 28.3 |
| Arrest (Oct.) | 300g† | 26.7 | 33.3 |
| Rhoplex (Nov.) | 1:5** | 38.3 | 33.3 |
| UBI 2382 (act.) | 300g† | 30.0 | 35.0 |
| Control | - | 40.0 | 50.0 |

† product/100 $m^2$
* significantly different from control at P = 0.05.
**one part Rhoplex in five parts water.

# CONTROL OF DOLLARSPOT ON CREEPING BENTGRASS

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Field studies continue to be conducted to evaluate fungicides for control of dollarspot. This report includes results obtained with some experimental fungicides. In addition, we evaluated the efficacy of Daconil 2787 at less than label rates.

## RESEARCH PROCEDURE

Treatments were applied to a 8-year-old sward of creeping bentgrass in Cambridge, Ontario. The turfgrass was maintained at a 5 mm cutting height. Cultural practices were similar to those used for maintenance of golf course putting reens in Ontario. The experimental design consisted of a randomized complete block design with four replicates. Twenty-one treatments and a non-treated control were included in each block. Each treatment plot measured 1 x 3 m. Wettable powder and liquid formulations were applied in 7 1 of water per 100 $m^2$ with a wheel mounted compressed air boom sprayer at 138 kPa. O.M. Scotts materials were applied with a Scotts drop spreader. Fungicides were applied on 15 July. The turfgrass was inoculated with autoclaved rye grains infested with three isolates of *Sclerotinia homeocarpa* (=*Lanzia* sp. or *Moellerodiscus* sp.) on 16 July. Disease intensity was estimated at two day intervals, beginning 18 July, using the Horsfoll-Barratt rating scale. Fungicides were reapplied if the mean incidence of disease exceeded one dollarspot per plot.

## RESULTS

Scotts Fungicide VII at 7.5 and 15 g a.i./100 $m^2$, Rovral Green at 15 g a.i./100 $m^2$, CGA 64250 at 1, 2 and 4 g a.i./100 $m^2$ and prochloraz at 76 g a.i./100 $m^2$ provided acceptable control of dollarspot for 4 wk or longer (Table 1). Rovral at 15 g a.i./100 $m^2$ provided acceptable control for approximately 3 wk. Treatments of Rizolex at 100 g a.i./100 $m^2$ and CO 6054 at 30 g a.i./100 $m^2$ provided control of approximately 2 wk. The remaining treatments resulted in less than 10 days control. Tank mixing urea at 124 g N/100 $m^2$ with Daconil at 7.5 & 15 g a.i./100 $m^2$ did not enhance control significantly.

Table 1. Influence of fungicides on dollarspot disease of creeping bentgrass.

| Treatment | Rate (g a.i./100 $m^2$) | No. of Applications** | Mean no. of Unacceptable Ratings† | Duration of acceptable control (days) |
|---|---|---|---|---|
| Scotts Fungicide VII | 15 | 1 | 6.3* | >36 |
| Rovral Green | 15 | 2 | 8.3* | 36 |
| CGA 64250 | 4 | 2 | 10.0* | 36 |
| Prochloraz | 76 | 2 | 10.0* | 30 |
| CGA 64250 | 2 | 2 | 10.3* | 36 |
| Rovral | 15 | 3 | 10.5* | 19-23 |
| Rizolex | 100 | 4 | 11.8* | 10-20 |
| CGA 64250 | 1 | 2 | 12.0* | 28 |
| CO 6054 | 30 | 2 | 12.3* | 10-19 |
| Urea | 124+ | 4 | 12.3* | <10 |
| Scotts Fungicide VII | 7.5 | 2 | 12.3* | 36 |
| Daconil | 30 | 3 | 12.8* | <10 |
| Daconil | 45 | 4 | 12.8* | <10 |
| CO 6054 | 15 | 3 | 13.8* | <10 |
| Prochloraz | 38 | 4 | 15.0 | <10 |
| Daconil + Urea | 7.5 + 124[+] | 4 | 15.8 | <10 |
| Rizolex | 50 | 5 | 16.5 | <10 |
| Doconil + Urea | 15 + 124[+] | 4 | 17.0 | <10 |
| Daconil | 22 | 4 | 17.5 | <10 |
| Doconil | 15 | 4 | 18.3 | <10 |
| Control | - | - | 18.8 | - |
| Daconil | 7.5 | 6 | 19.5 | <10 |

[+] Grams of nitrogen per 100 $m^2$.
**Over a 45-day test period. Treatments were reapplied if the mean incidence of disease exceeded one dollarspot per plot.
† Disease incidence greater than one dollarspot per plot was considered unacceptable.
*Significantly different from the control at $P = 0.05$.

# EVALUATIONS OF PERENNIAL RYEGRASS CULTIVARS

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In recent years, there has been an increased interest in the utilization of perennial ryegrasses in golf course fairways, athletic fields and home lawns. Therefore, in 1984 Norm McCollum established a replicated trial of 15 cultivars of perennial rye at the Cambridge Research Station. In 1985, the plots were evaluated for variation in color and density (quality), resistance to pink snow mold and invasion by annual bluegrass.

## RESEARCH PROCEDURE

Fifteen cultivars of perennial ryegrass were seeded (2 kg/100m$^2$) in 1 x 40 m plots on 1 August, 1984 at the Cambridge Research Station. Plots were randomized, and replicated 3 times. The cultivars were also established at the Elora Research Station for evaluation of forage quality. The Cambridge plots wee evaluated for color and density at monthly intervals from May through October using a 1-10 (10 best) scale. In addition, the plots were assessed for invasion by annual bluegrass on 9 Sept. The forage plots were evaluated for incidence of pink snow mold on 23 April.

## RESULTS

Yorktown II, Palmer, Fiesta, Barry, Blazer and Prelude had mean quality ratings of 8.0 or greater and are therefore considered acceptable. However, Yorktown II was the only cultivor that exhibited low invasion by annual bluegrass. Yorktown II, Manhattan, Ensilo, Norlea, Omega, and Fiesta exhibited relatively low incidences of pink snow mold.

Table 1. 1985 evaluations of perennial ryegrass cultivars seeded 1 Aug. 1984.

| Cultivar | Mean Quality rating (10-best)[x] | Annual blue invasion (%)[y] | Pink Snow Mold (%)[z] |
|---|---|---|---|
| Gambit | 5.3 | 60 | 68.8 a |
| Yorktown II | 9.4 | 10 | 23.8 b |
| Cowboy | 6.7 | 80 | 43.8 c |
| Bison | 4.9 | 90 | 93.8 a |
| Manhattan | 7.3 | 90 | 13.8 b |
| Barry | 8.1 | 70 | - |
| Ranger | 7.2 | 70 | - |
| Ensilo | 6.3 | 90 | 27.5 b |
| Palmer | 8.9 | 80 | 31.3 c |
| Blazer | 8.0 | 90 | 43.8 c |
| Norlea | 7.0 | 90 | 15.0 b |
| Hunter | 7.3 | 90 | 32.5 c |
| Omega | 7.8 | 80 | 26.3 b |
| Fiesta | 8.2 | 80 | 21.3 b |
| Diplomat | 7.0 | 80 | - |
| Prelude | 8.0 | 80 | 29.8 c |

[x] Yearly mean

[y] Evaluated 9 Sept. 1985

[z] Means followed by the same letter are not significantly different P=0.05.