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INTRODUCTION

Members of the Guelph Turfgrass Institute are pleased to present their Annual Report for 1989. The report is not a complete record of all data collected by the various researchers, but it reflects the highlights of their work. The comprehensive nature of the report is a reflection of the Guelph Turfgrass Institutes's goal to provide information on turfgrass production and management to members of the Ontario Turfgrass Industry.

Highlights of this year's report include studies on nutrition in turf, including a **Fertility survey of Kentucky bluegrass sod in Ontario** by Tom Bates, Annette Anderson, and Yvan Pomerleau, the **Nutritional status of turfgrass** by Tom Bates, and continued work on **Urban waste composted with sewage sludge as a tuf fertilizer** by Jack Eggens, Ken Carey, and Ernesto Eguiza. Questions of leaching and modified rootzones are addressed by Paul Voroney, Ken Carey, Annette Anderson and Jack Eggens in **Leaching of nitrogen from slow release fertilizers on turf in sand rootzones**. Ed Gamble and Victor Mares Martin continue their important work in turfgrass seed production with **Perennial ryegrass seed crop response to nitrogen, plant growth regulators and fungicide application**. In the area of management, **Turf renovation by sodding - Site preparation intensity and timing in low maintenance sites** is the latest work by Jack Eggens and Ken Carey in this area. Weed **control and growth regulation in turf - 1989** summarizes the work done by Chris Hall and Kathy Christensen; details of sixteen separate studies supplement this summary. Sod growers will be interested in **Control of annual bluegrass (*Poa annua*) infestations in Kentucky bluegrass (*Poa pratensis*) turf** by Chris Hall and Kathy Christensen. Control of turfgrass pests is discussed in **Evaluation of spring application of insecticides for control of european chafer** by Fred Vaughn and Mark Sears and a series of reports on **fungal diseases (dollarspot, brown patch, pythium blight) in creeping bentgrass** by Lee Burpee and A. Mueller. Pesticides and exposure is a critical topic addressed by **Applicator and bystander exposure to 2,4-D in home landscape situations** by K. R. Solomon, S. Harris, C. S. Bowhey and G. R. Stephenson. The most current data on **species, cultivar, and mixture evaluations** is presented in a series from Norm McCollum, Jack Eggens, and Ken Carey. Annette Anderson's **1989 Turfgrass extension summary** provides an important picture of the past year in the real world.

The commitment of the GTI to educational programmes for turfgrass professionals continues with a successful second annual symposium in late 1989. The third annual symposium is to be held in November 1990 in conjunction with the Ontario Ministry of Agriculture and Food, the Ontario Agricultural College, and the Division of Continuing Education of the University of Guelph.

Building on the University of Guelph's long-standing expertise in turfgrass science, the institute will continue to focus its activities in areas such as the environmental aspects of pesticide use (fate and persistence), evaluation of grass species and seeding methods, sports field construction, fertility programs, pesticide use and the biological and cultural control of diseases and weeds.

The GTI's mandate is the expansion and enhancement of turfgrass research for Canada's

$1-billion turf industry, expanded extension services, encouragement of young people to prepare for careers in the industry through undergraduate and graduate programs, and the development of a world-class turfgrass facility.

Fund raising for a new turf research and information centre is underway. The building is to be strategically located on a 53-acre Ontario Ministry of Agriculture and Food site, adjacent to the University of Guelph Arboretum. Fund raising from the turfgrass industry will be conducted by the Ontario Turfgrass Research Foundation.

The Guelph Turfgrass Research and Information Centre will call on the expertise of the University of Guelph's successful research and education programs, OMAF and the turfgrass industry.

The field laboratory and growth room facilities of the Research and Information Centre on the 53-acre site will provide researchers with the tools to generate new approaches to turfgrass production and management. The Centre will also provide within its 6,345 square feet of space: public access to publications and computer-reference material, a computer link with international turfgrass centres, a display area, conference facilities, pesticide storage and mixing areas, equipment storage, equipment research and support, office space for the director, a turfgrass extension specialist, superintendent of turf plots, and graduate student offices. Field plots will be available for research on turfgrass soils and fertility; sod production and management; evaluation and selection of varieties; control of weeds, insect pests and turfgrass diseases.

We want to thank the Ontario Turfgrass Research Foundation for its significant and increasing contribution to the GTI research programs. The support of the OTRF, along with contributions made by companies, agencies, and institutions listed on the following page helped to make 1989 a successful year for turfgrass research. Further appreciation is extended Ontario Turf Equipment Company, Duke Lawn Equipment, Brouwer Turf Equipment, and Bannerman Equipment Ltd. for loan of equipment in 1989. We would also like to express our thanks to the seed industry of Ontario for their support. These companies include Speare Seed (Harriston), OSECO Seed (Brampton), and Pick Seed (Richmond Hill).

J. C. Hall
K. Carey

Editors

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 directions the research should take to resolve problems which occur in the turf industry. We also extend sincere to the agribusiness community which provided extra operating dollars, chemicals and equipment which made many of the projects reported herein a success.

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Natural Sciences and Engineering Research Council
Ontario Turfgrass Research Foundation
Ontario Ministry of the Environment
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Beaconsfield Golf Club
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Stauffer Chemical Company of Canada Ltd.
The Guelph Cemetery Commission
(Woodlawn Cemetery)
Turf Care (Division of RMC Equipment Ltd.)
Union Carbide

GUELPH TURFGRASS INSTITUTE MEMBERS

Dr. J. Chris Hall Director, Guelph Turfgrass Institute	Dept. of Environmental Biology
Dr. Jack Alex	Dept. of Environmental Biology
Annette Anderson Turf Extension Specialist	Ontario Ministry of Agriculture and Food and Dept. of Horticultural Science
Dr. Tom Bates	Dept. of Land Resource Science
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Dr. Gerry Stephenson	Dept. of Environmental Biology
Dr. Paul Voroney	Dept. of Land Resource Science

SOILS AND NUTRITION

1989 FERTILITY SURVEY OF KENTUCKY BLUEGRASS SOD IN ONTARIO

Thomas E. Bates, Annette Anderson, and Yvan Pomerleau
Department of Land Resource Science
Ontario Ministry of Agriculture and Food

OBJECTIVES

(1) a) To measure the extent of macro and micronutrient deficiencies and/or toxicities in Kentucky bluegrass nursery sod.
b) To initiate a survey of the fertilizer practices on sod farms in Ontario.

(2) To determine the variability of nutrient status of plant tissue from Kentucky bluegrass nursery sod through the season.

RESEARCH PROCEDURE

Objective 1. One area (approximately 100 sq. ft.) of each of 20 sod fields was sampled. Sampling period occurred through the growing season from June - August, with samples taken between fertilizer applications (where possible). Soil sampling was also done at the time of tissue sampling. Questionnaires were completed regarding fertilizer and management practices of the nursery sod. Clippings were analyzed for nitrogen, phosphorus, potassium, calcium, magnesium, copper, zinc, manganese, boron and iron. Soil analyses included phosphorus, potassium, magnesium, zinc, manganese, and pH.

Objective 2. Clippings were sampled from one area of one farm (Cambridge) every two weeks from mid-June to late September. Soil sampling was done before the first tissue sample was taken.

Sampling Procedures. Sampling was done on Kentucky bluegrass sod fields. Samples were taken from an area representative of the field. Headlands, low spots, etc. were avoided when sampling. Tissue samples were collected with a mower with a clippings catcher, mowing 2 strips of 25 feet (total area approximately 100 sq. ft.) approximately 25 feet apart. Mowing height was consistent with production practices of the sod fields. Where possible, tissue samples were taken opposite to the direction of mowing or fertilizer applications for a more representative sample. Prior to tissue analysis, samples were cleaned to remove dead leaf and stem tissue.

SUMMARY

Results of tissue analysis for nitrogen, phosphorus, and potassium all fell within the acceptable ranges listed in Table 1. Some of the phosphorus levels are higher than required. Tissue and soil analysis (Table 2) for phosphorus appear to be comparable. The highest phosphorus soil level was also the highest tissue phosphorus level.

Considering tissue samples were taken from sod fields from across the province, from fields of different soil types, different fertilizer programs and at various times through the season the range of nitrogen values is not exceptionally large.

Potassium levels look reasonable and comparison of K values is narrower than for most elements. There are some magnesium levels reported below the minimum range. One sample was in an area known to have soils low in magnesium, but the others were not. There did not appear to be a relationship with magnesium and pH. Where magnesium levels are low growers should be very careful about excess applications of potassium because potassium does decrease magnesium content.

Manganese, copper, zinc and boron levels were all within acceptable ranges with the

exception of one manganese reading. High manganese can often be an indicator of poor drainage or low pH.

The results of this survey indicate that there does not appear to be a significant fluctuation of nutrient levels throughout the season (Table 3). It appears that tissue sampling done in conjunction with soil sampling can be useful in evaluating adequacy of nutrient supply. Further studies will be pursued in 1990 to determine the effects of drought stress on nutrient supply. In this particular study all samples were cleaned prior to analysis. This would not be practical for the turf manager. Split samples will be analyzed to evaluate the effect of cleaning vs. not cleaning samples on the nutrient values reported.

Table 1. 1989 Fertility survey of Kentucky bluegrass nursery sod in Ontario

Sample/Date		Location	Tissue analysis**								
			%N	%P	%K	%Ca	%Mg	Mn	Cu	Zn	B
1	June 13	Mount Hope	3.85	0.40	2.65	0.44	0.17	72	9	26	9
2*	June 14	Cambridge	3.20	0.42	2.20	0.52	0.14	64	8	30	12
3	June 13	Lynden	4.25	0.45	2.73	0.50	0.13	72	10	28	10
4	June 14	Breslau	4.00	0.42	2.75	0.63	0.19	86	7	23	12
5	June 21	Waterdown	3.10	0.42	2.69	0.53	0.17	82	7	26	14
6	June 26	Caledonia	5.00	0.52	3.02	0.49	0.20	61	9	33	11
7	June 28	Tilbury	4.75	0.57	3.34	0.57	0.21	43	8	27	14
8	June 28	Tilbury	5.00	0.56	3.32	0.54	0.24	64	8	27	14
9	June 29	Cookstown	4.70	0.40	3.24	0.54	0.14	49	4	25	16
10	June 29	Cookstown	4.25	0.52	3.51	0.57	0.18	31	11	28	16
11	June 29	Cookstown	4.35	0.46	3.27	0.69	0.15	30	4	23	9
12*	June 30	Cambridge	2.90	0.37	2.69	0.49	0.15	85	9	25	18
13	July 05	Fenwick	3.95	0.30	2.59	0.83	0.19	97	8	31	15
14	July 06	Tottenham	3.75	0.37	2.76	0.56	0.15	46	7	21	15
15	July 11	Newmarket	3.90	0.42	2.72	0.76	0.21	133	5	21	15
16	July 11	Keswick	3.60	0.40	2.58	0.67	0.13	70	7	21	24
17	July 11	Gamebridge	3.55	0.28	1.85	0.65	0.15	86	6	20	16
18	July 13	Delaware	4.75	0.41	2.23	0.98	0.30	45	10	16	11
19*	July 13	Cambridge	3.25	0.32	2.27	0.76	0.19	96	7	21	18
20	July 14	Sharon	3.30	0.29	2.00	1.17	0.19	133	7	19	13
21	July 14	Cookstown	4.60	0.34	2.67	0.72	0.16	75	8	24	13
22	July 19	Hampton	3.25	0.31	2.10	0.90	0.13	30	2	14	12
23	July 20	Kemptville	3.25	0.33	2.45	0.67	0.19	73	4	16	18
24	July 20	Osgoode	4.45	0.33	2.36	0.95	0.28	154	4	21	12
25	July 20	Carlsbad Springs	2.95	0.23	2.34	0.66	0.24	80	5	21	14
26	July 20	Carlsbad Springs	3.15	0.40	2.41	0.73	0.23	134	5	20	16
27*	July 26	Cambridge	3.90	0.41	2.50	0.67	0.19	58	9	29	12
28*	Aug 09	Cambridge	3.35	0.33	2.08	0.77	0.18	58	6	21	15
29*	Aug 23	Cambridge	3.55	0.30	2.13	0.69	0.18	64	5	21	12
30*	Sept 10	Cambridge	-	-	-	-	-	-	-	-	-
31*	Sept 24	Cambridge	-	-	-	-	-	-	-	-	-
Normal range		Minimum	2.50	0.15	0.90	0.20	0.15	20	5	10	3
		Maximum	6.00	0.55	4.00	4.50	1.00	140	30	100	30

* OMAF Pub. 383 Production Recommendations for Ornamentals and Turf (revised December 1988)

** Analysis in parts per million unless indicated as percentage.

Table 2. 1989 fertility survey of Kentucky bluegrass nursery sod in Ontario

Sample/Date		Location	Soil samples*						
			P	K	Mg	Mn	Zn	pH	Texture
1	June 13	Mount Hope	23	74	186	-	-	7.1	-
2	June 14	Cambridge	-	-	-	-	-	-	-
3	June 13	Lynden	38	182	125	-	-	6.5	M
4	June 14	Breslau	24	68	317	-	-	7.6	M
5	June 21	Waterdown	21	49	175	-	-	7.6	M
6	June 26	Caledonia	29	105	448	-	-	6.7	M
7	June 28	Tilbury	93	173	194	-	-	7.6	M
8	June 28	Tilbury	57	68	178	-	-	7.5	M
9	June 29	Cookstown	15	183	43	-	-	5.9	M
10	June 29	Cookstown	95	334	74	-	-	7.0	M
11	June 29	Cookstown	26	84	59	-	-	7.5	M
13	July 05	Fenwick	33	70	185	18	19	7.8	M
14	July 06	Tottenham	66	74	84	15	15	7.3	M
15	July 11	Newmarket	47	63	244	23	15	8.1	M
16	July 11	Keswick	67	49	73	18	15	7.8	M
17	July 11	Beaverton	11	38	72	19	17	6.7	M
18	July 13	Delaware	38	31	83	18	15	7.8	M
20	July 14	Sharon	29	30	121	18	15	7.8	M
21	July 14	Cookstown	52	300	236	21	20	8.0	F
22	July 19	Hampton	18	107	75	16	15	7.6	M
23	July 20	Kemptville	39	41	70	36	28	5.6	C
24	July 20	Osgoode	32	74	108	31	25	5.8	M
25	July 20	Carlsbad Springs	26	61	110	23	21	6.2	M
26	July 20	Carlsbad Springs	16	36	106	27	24	5.9	M

- indicates that results were not available for this report.

*Elemental analysis in parts per million

Table 3. 1989 Fertility survey - nutrient status* of plant tissue from an Ontario nursery sod farm, June - September 1989.

Sample/Date		%N	%P	%K	%Ca	%Mg	Mn	Cu	Zn	B
1	June 14	3.20	0.42	2.20	0.52	0.14	64	8	30	12
2	June 30	2.90	0.37	2.69	0.49	0.15	85	9	25	18
3	July 13	3.25	0.32	2.27	0.76	0.19	96	7	21	18
4	July 26	3.90	0.41	2.50	0.67	0.19	58	9	29	12
5	August 9	3.35	0.33	2.08	0.77	0.18	58	6	21	15
6	August 23	3.55	0.30	2.13	0.69	0.18	64	5	21	12
7	Sept 10	-	-	-	-	-	-	-	-	-
8	Sept 24	-	-	-	-	-	-	-	-	-

* Analysis in parts per million unless indicated as percentage.

Soil Test Methods. P extracted with sodium bicarbonate (Olsen). K and Mg extracted with neutral 1M ammonium acetate. Soil pH was determined on a soil-water paste. Mn extracted with 0.11 phosphoric acid (Hoff & Medeiski) adjusted for pH using equation: Mn reported = 498 - 137 soil pH + 0.248 (extr. Mn) + 9.64 (soil pH)^2; Zn reported = 208 + 4.5 (extr. Zn) - 50.7 soil pH + 3l33 (soil pH)^2.

ACKNOWLEDGEMENTS

The funding for tissue analysis was supported by the Nursery Sod Growers Association. Special thanks to each of the sod producers that participated in the survey.

Equipment required for sampling was made available on loan from Turf Care (Division of RMC Equipment Ltd.)

NUTRITIONAL STATUS OF TURF GRASS

T. E. Bates
Dept. of Land Resource Science

OBJECTIVES

1. To determine the usefulness of soil testing and plant analysis for prediction of nutrient status of turf grasses.
    - (a) on a bentgrass green
    - (b) on a bluegrass lawn
2. To determine the response of turf grasses to potassium.

Plant analysis offers potential for assessment of nitrogen, phosphorus, potassium and magnesium status of turf. In a survey of golf greens in 1988, the potassium soil test and plant analysis results were quite different. It seems probable that the plant analysis data for potassium are more reliable than soil tests on sand greens. Plants can take up much more potassium than they need and where the clippings are removed a large amount of potassium can be removed. For this reason soil tests can remain low even where the turf is receiving plenty of potassium from regular potassium fertilizer applications. This is particularly likely to happen with soils having a low exchange capacity, such as sand greens.

It was expected that plant nutrient content would change quite markedly through the season. This does not appear to be happening.

This project is intended to look at soil testing and plant analysis further with particular emphasis on potassium.

METHODS

One experiment was established in 1989 on a bentgrass green at Cambridge with clippings removed (cutting height 47 mm, 3/16").

One experiment on Kentucky bluegrass at Cambridge with clippings left on (cutting height 50 mm, 2").

5 rates of potassium

0, 40, 80, 160 and 320 kg K ha^{-1} yr^{-1}
(0, 0.4, 0.8, 1.6, 3.2 kg K (100 m^{-2}) yr^{-1})
(0, 0.48, 0.96, 1.93, 3.86 kg K_20 (100 m^{-2}) yr^{-1})

2 methods of potassium application

(1) Annual application split equally between late May, late June, early September and early November (4 applications).
(2) Late May and early November applications as above. Remaining half of the potash applied every second week from mid June until early September (7 applications for a total of 9).

Duration - preferably 2 years.

Measurements - Clippings were sampled in mid May, mid June, mid August and mid September (4 times), weights were taken and the plant material analysed for N, P, K, Ca and Mg. Mid June and mid September samplings will also be analysed for B, Cu, Mn and Zn. Soil samples were taken in April and October and analysed for P, K, Mg and pH. Colour, *Poa annua* populations and any disease problems that occur will be evaluated.

Plot size - 3 m x 1 m = 3 m^2

Yields of clippings did not differ up to September 1, 1989 and no sign of potassium deficiency on the plots without potassium is apparent.

The soil and plant analysis results have not yet been evaluated. This experiment should become increasingly interesting through 1990.

This project was funded in 1989 by the Ontario Turfgrass Research Foundation and the Ontario Ministry of Agriculture and Food.

URBAN WASTE COMPOSTED WITH SEWAGE SLUDGE AS A FERTILIZER ON BENTGRASS PUTTING GREEN AND FAIRWAY TYPE TURF

J. L. Eggens and K. Carey
Department of Horticultural Science

Composted sewage sludge (City of Windsor experimental waste recovery plant, Windsor, Ontario) is being evaluated as a general turf fertilizer on bentgrass putting green and fairway type turf.

METHODS

Plots in mature creeping bentgrass-annual bluegrass putting green and fairway type turf at the Cambridge Research Station received one of the three nitrogen treatments (sulphur-coated urea, Milorganite 6-2-0 or Windsor composted waste). Nitrogen was applied at two rates, 57.6 kg N ha^{-1} yr^{-1} and 115.2 kg N ha^{-1} yr^{-1}. Heavy wear was applied to half the plots using a tractor fitted with wear rollers which simulate wear and compaction from traffic.

RESULTS

Plots are being evaluated for botanical composition (percent annual bluegrass and creeping bentgrass as well as changes in composition), wear tolerance and recuperative potential, thatch buildup and degradation, soil compaction, soil NH_4 and NO_3, tissue N, and turf functional features (color, density, quality). Preliminary data from 1989 indicate that on putting green turf the Windsor compost is slightly less effective than the other N sources at maintaining color, equal to or better than the other treatments in maintaining general appearance, and equal to all other treatments except the high rate of SCU at promoting growth as measured by clipping yield (Table 1). On fairway type turf, there were both N source and N level effects on color, general

Table 1. Effects of nitrogen source and level on functional features[a] of annual bluegrass/creeping bentgrass putting green type turf.

	Color[b]	General appearance[c]	Weeds[d]	Yield[e]
Milorganite 1X	7.3	7.0	0.3	11.91
Milorganite 2X	7.7	7.0	0.9	12.22
SCU 1X	7.9	6.9	0.8	12.25
SCU 2X	8.2	7.6	0.7	15.20
Windsor compost 1X	7.1	7.3	0.4	11.43
Windsor compost 2X	7.1	7.2	1.1	11.00
LSD 5%	0.26	0.42	0.79	2.65

[a] Data are means of 8 replicates.
[b] Visual evaluation rating 0-9, 5 = acceptable, mean of 11 evaluation dates 89/5/25 to 89/7/19.
[c] Visual evaluation rating 0-9, 5 = acceptable, mean of 11 evaluation dates 89/5/25 to 89/7/19.
[d] Visual evaluation rating of broadleaf weed infestation 0-5, 5 = acceptable, mean of 2 evaluation dates 89/7/11 and 89/7/19
[e] Dry weight (g) of leaf tissue removed at 5 mm mowing height from a 2 m^2 area, 89/6/20.

appearance and dollar spot infection, with the ranking generally SCU better than Milorganite better than Windsor compost (Table 2). All plots had color and general appearance within the acceptable range by visual evaluation.

Table 2. Effects of nitrogen source and level on functional features[a] of annual bluegrass/creeping fairway type turf.

	Color[b]	General appearance[c]	Weeds[d]	Dollar spot[e]
Milorganite 1X	7.0	7.1	1.3	2.0
Milorganite 2X	7.5	7.3	1.1	1.5
SCU 1X	7.3	7.0	1.3	2.3
SCU 2X	7.9	7.6	0.7	0.8
Windsor compost 1X	6.6	6.5	1.9	3.4
Windsor compost 2X	6.8	6.7	1.8	3.4
LSD 5%	0.16	0.29	0.92	0.62

[a] Data are means of 8 replicates.
[b] Visual evaluation rating 0-9, 5 = acceptable, mean of 10 evaluation dates 89/5/25 to 89/9/07.
[c] Visual evaluation rating 0-9, 5 = acceptable, mean of 10 evaluation dates 89/5/25 to 89/9/07.
[d] Visual evaluation rating of broadleaf weed infestation 0-5, 5 = acceptable, mean of 3 evaluation dates 89/7/17 to 89/9/07
[e] Visual rating 0-5, 89/9/07.

LEACHING OF NITROGEN FROM SLOW RELEASE FERTILIZERS ON TURF IN SAND ROOTZONES

R. P. Voroney, K. Carey, A. Anderson and J. L. Eggens.
Department of Land Resource Science
Department of Horticultural Science
Ontario Ministry of Agriculture and Food

OBJECTIVE AND METHODS

Three slow release turf fertilizers (sulfur-coated urea, Windsor compost, and Plant Products brand slow release liquid) applied at two rates (0.5 and 2.0 kg N 100 m^{-2} per application, two applications per year) are being evaluated on the "mini-greens" lysimeter at the Cambridge Research Station. The fertilizer x rate treatments are replicated four times, each replicate being a 0.65 m^2 lysimeter plot. The lysimeter plot rootzones are constructed with either calcareous (alkaline) or siliceous (acid) sand. The turf is predominantly creeping bentgrass, with some annual bluegrass contamination. Leachate samples are being collected and measured for volume and NH_4 and NO_3 nitrogen content, to determine the leaching behaviour of the applied nitrogen. The plots are also being evaluated for turf functional features (color and general appearance), and for recovery from the damage which had built up over several years of minimal maintenance.

RESULTS

Initial indications are that there is no difference among the fertilizers or N rates in their effects on turf color (Figure 1) or recovery from previous damage (Figure 2). Leaching of ammonium and nitrate nitrogen followed a similar pattern, though there was a higher rate of leaching of NO_3 nitrogen in plots treated with the non-organic sources than with the composted waste material (Figure 3).

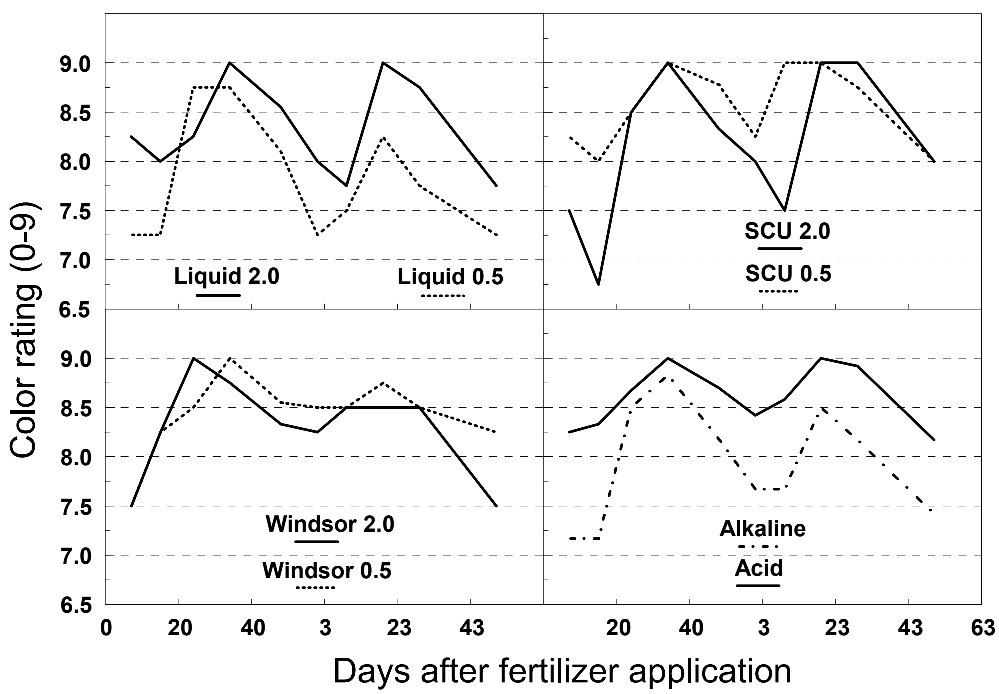

Figure 1. Color ratings of turf on sand rootzones treated with various slow release nitrogen sources.

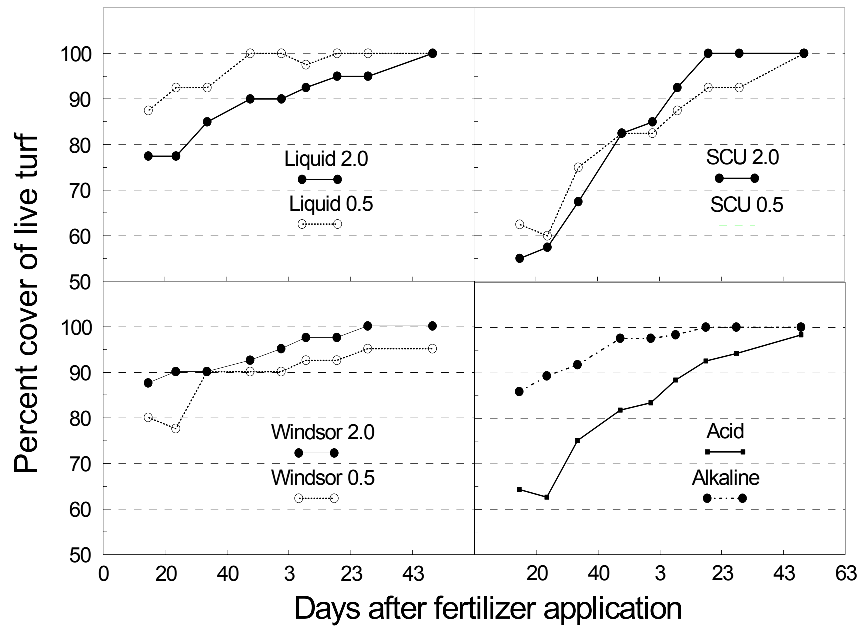

Figure 2. Cover ratings of turf on sand rootzones treated with various slow release nitrogen sources.

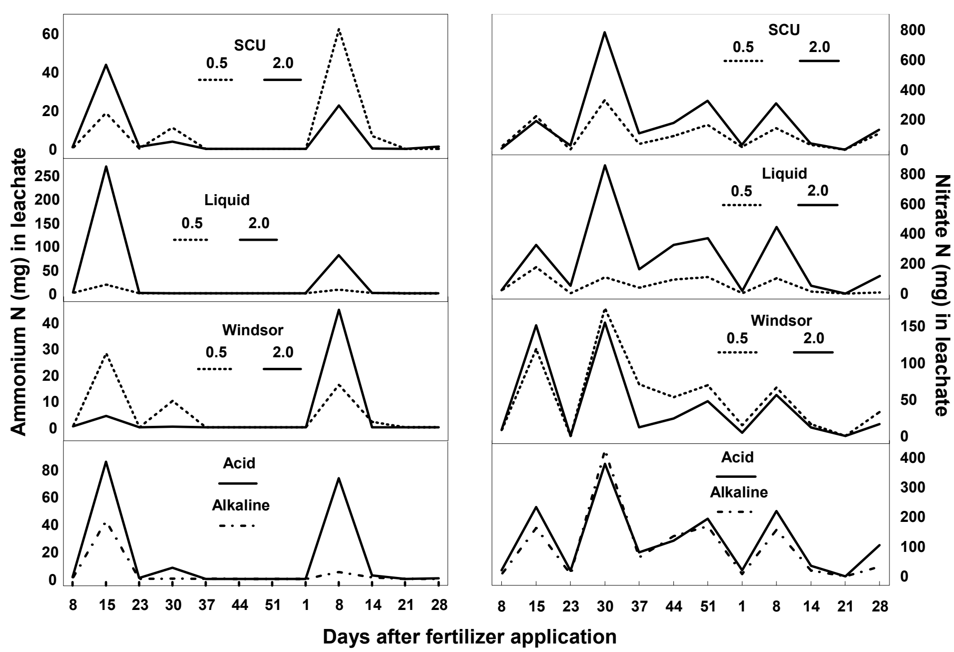

Figure3. Leaching of nitrogen from lysimeter plots (points represent means of 4 plots).

There was evidence of an increased incidence of dollar spot infection in plots treated with lower N rates, and reduced infection in acid sand plots (Figure 4).

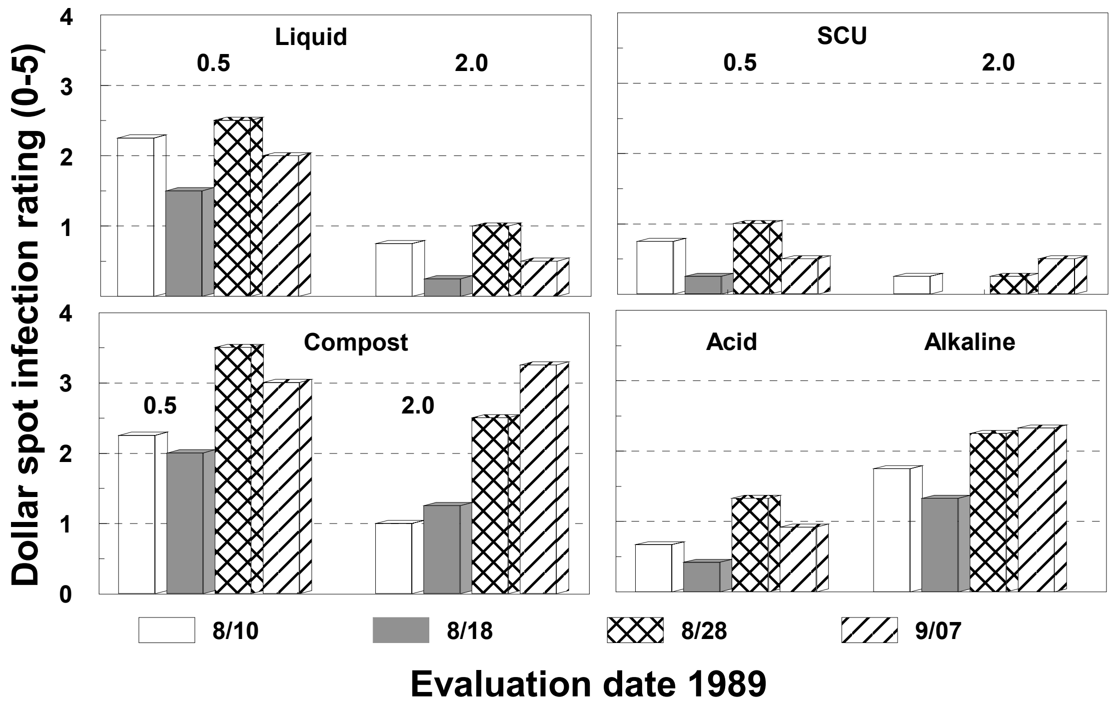

Figure 4. Dollar spot infection in bentgrass lysimeter plots. Infection rating 0 to 5, 0 = no infection, 5 = 25% of plot area affected.

TURFGRASS SEED PRODUCTION

PERENNIAL RYEGRASS SEED CROP RESPONSE TO NITROGEN, PLANT GROWTH REGULATORS AND FUNGICIDE APPLICATION

V.M. Mares Martins and E.E. Gamble
Department of Crop Science

Crop lodging can occur following high rates of nitrogen (N) application to grass seed crops. Low yields in perennial ryegrass (*Lolium perenne* L.) are generally associated with heavy lodging of the crop around the time of anthesis, competition for assimilates from late vegetative tillers causing seed abortion, and seed shattering at maturity. Moreover, lodging can reduce combine harvest efficiency. A further problem is the susceptibility of the crop to diseases, particularly those caused by fungal pathogens.

Plant growth regulators (PGR's) are widely used in cereal production for controlling crop lodging. Non-lodged crops generally yield more than lodged stands. Preliminary results of PGR and fungicide application to ryegrass were previously reported (GTI Annual Report, 1988). This report gives further information on the response of three perennial ryegrass cultivars to the application of N, PGR's and a systemic fungicide, from four experiments conducted in 1989. Three experiments were located at the University of Guelph Elora Research Station and the fourth one was conducted on sandy soils in a farmer's field in the tobacco production area (Langton) in Southern Ontario.

METHODS

At Elora, one experiment (Expt. 1) compared the efficacy of four PGR's applied to perennial ryegrass cv. Fiesta II at three rates and two developmental stages. The PGR's and rates applied were: Paclobutrazol (1.0, 1.5 and 2.0 Kg ai ha^{-1}), CCC+CC (0.46, 0.92 and 1.38 kg ai ha^{-1}), XE 1019 (0.1, 0.2 and 0.3 kg ai ha^{-1}) and Ethephon (0.24, 0.48 and 0.72 kg ai ha^{-1}). Application was carried out at spikelet initiation and floret initiation (Paclobutrazol) or early heading (CCC+CC, XE-1019 and Ethephon).

Another experiment (Expt. 2) compared the effects of Paclobutrazol (0 and 2.0 kg ai ha^{-1}), the fungicide Propiconazole (0 and 0.125 kg ai ha^{-1}) and N (60, 120 and 180 kg ha^{-1}) applied to both Fiesta II and Norlea cultivars. Paclobutrazol was sprayed at the spikelet initiation stage, following spring N application. Propiconazole was sprayed at the beginning of heading.

Expt. 3 had similar treatments as Expt. 2 but it was in its second treatment and harvest year. In Expt. 3, Paclobutrazol was applied at the booting stage.

Expt. 4 was conducted in Langton, to test rates of Paclobutrazol (0 and 2.0 kg ai ha^{-1}) and Propiconazole (0 and 0.125 kg ai ha^{-1}), and rates and timing of spring N fertilization (60, 30+30, 120, 60+60, 180 and 90+90 kg ha^{-1}) applied to cv Palmer. The split N application was two weeks apart.

RESULTS

Paclobutrazol was effective ($P < 0.01$) in controlling lodging of the crop at all rates and growth stages applied, for all cultivars and at all N levels. The degree of lodging control increased with the earliness of application and increments in application rate.

XE-1019 also showed lodging control activity but control was significant only at the medium and highest rates. Although application of XE-1019 at either developmental stage reduced lodging, the later the application the more effective the control. Ethephon nor CCC+CC did not control lodging (Table 1).

Table 1. Lodging index response to PGR application.

Experiment	PGR	Lodging index*
1	Paclobutrazol	2.3 a
	CCC+CC	6.6 c
	XE-1019	4.6 b
	Ethephon	6.6 c
	Control	6.3 c
2	Paclobutrazol	0.1 a
	Control	7.1 b
3	Paclobutrazol	0.4 a
	Control	8.2 b
4	Paclobutrazol	0.1 a
	Control	3.1 b

* Combined estimate of intensity (1 to 5) and area (0.2 to 9), multiplied by 0.2 factor. Means within experiments, followed by different letters, are statistically different ($P < 0.01$) according to Duncan's Multiple Test (Expt. 1) and LSD (all other experiments).

Stem elongation was significantly reduced ($P < 0.05$) by Paclobutrazol at all rates and growth stages applied, in all cultivars and at all N levels. However, the earlier application significantly increased the stunting effect. For XE-1019, effect on plant height was significant at the medium and high rates only and, although application at either growth stage significantly reduced plant height compared to the control, the delayed application significantly increased the plant shortening effect. Ethephon nor CCC+CC did not prevent stem elongation (Table 2).

Disease ratings indicated that all triazoles (Paclobutrazol, XE-1019 and Propiconazole) significantly reduced the incidence of leaf rust (*Puccinia* spp.). The effect was rate independent. An interaction between both PGR's and timing of application was evident. For Paclobutrazol the earlier application provided significantly better rust control. For XE-1019 the latter applications provided more rust control. Disease control by Paclobutrazol was significantly greater compared to the fungicide. No synergistic interaction between them was recorded (Table 3).

Table 2. Plant height response to PGR application.

Experiment	PGR	Plant height (cm)
1	Paclobutrazol	75.4 c
	CCC+CC	81.3 ab
	XE-1019	77.1 bc
	Ethephon	85.4 a
	Control	85.0 a
2	Paclobutrazol	73.1 a
	Control	87.3 b
3	Paclobutrazol	58.0 a
	Control	87.3 b
4	Paclobutrazol	33.2 a
	Control	65.7 b

Means within experiments, followed by different letters, are statistically different ($P < 0.05$) according to Duncan's Multiple Test (Expt. 1) and LSD (all other experiments).

Table 3. Disease index response to PGR and fungicide application.

Experiment	Treatment	Disease index*
1	Paclobutrazol	0.5 b
	CCC+CC	1.6 a
	XE-1019	0.6 b
	Ethephon	1.6 a
	Control	1.7 a
2	Paclobutrazol	0.1 a
	Propiconazole	0.7 b
	Paclobutrazol+Propiconazole	0.1 a
	Control	1.1 c

* Combined estimate of intensity (1 to 5) and plot area affected (0.2 to 9) multiplied by 0.2 factor. Means within experiments, followed by different letters are statistically different ($P < 0.05$) according to Duncan's Multiple Test (Expt. 1) and LSD (Expt. 2).

Seed shattering was affected by the PGR's although the response was inconsistent. In Expt. 1 the amount of shattered seed was significantly increased by both XE-1019 and Ethephon. However, in Expt. 2 the amount of shattered seed was significantly reduced by Paclobutrazol.

Seed shattering was also significantly affected by N rate, the lowest rate producing a significantly higher amount of shattered seed (Table 4).

The proportion of green leaves, relative to both the total dry weight of above ground plant fractions and the dry weight of the leaf fraction, was significantly increased by Paclobutrazol whereas the proportion of senescent tissue was significantly reduced (Table 5).

Table 4. Seed shattering response to PGR application and N rate.

Experiment	Treatment	Shattered seed kg ha^{-1}
1	Paclobutrazol	275 b
	CCC+CC	300 b
	XE-1019	388 a
	Ethephon	438 a
	Control	246 b
2	Paclobutrazol	324 a
	Control	366 b
2	60 kg N ha^{-1}	413 a
	120 kg N ha^{-1}	298 b
	180 kg N ha^{-1}	324 b

Means within experiments, followed by different letters are statistically different ($P < 0.05$) according to Duncan's Multiple Test (Expt. 1) and LSD (Expt. 2).

Table 5. Green and senescent leaf tissue proportions relative to total weight of fraction, in response to Paclobutrazol application.

Experiment	Treatment	Green leaves	Senescent leaves
		%	
2	Paclobutrazol	44.4 a	55.6 a
	Control	24.0 b	76.0 b

Means within columns, followed by different letters are statistically different ($P < 0.05$) according to LSD.

Seed yield response to PGR application was rather inconsistent. In Expt. 1 seed yield was significantly reduced, relative to the control, by both Paclobutrazol and XE-1019. The adverse effect on yield was accounted for by the application at the earlier developmental stage (spikelet initiation) and was equally noticeable at all three rates of application. The magnitude of yield reduction was 40% for Paclobutrazol and 28% for XE-1019. Expt. 2 also showed that Paclobutrazol significantly reduced the yields of both Fiesta II and Norlea cultivars. The magnitude of the reduction was significantly greater for Fiesta II (28%) than for Norlea (15%). On the other hand Expt. 3 indicated a significant interaction between cultivar and PGR in so far as yield of Norlea was significantly increased by 49% whereas Fiesta II was unaffected. Expt. 4

gave no evidence of yield response to Paclobutrazol by the cultivar Palmer (Table 6).

Table 6. Seed yield response to PGR application.

Expt.	Cultivar	PGR	Seed yield kg ha^{-1}
1	Fiesta II	Paclobutrazol	1013 b
		CCC+CC	1314 a
		XE-1019	1081 b
		Ethephon	1268 a
		Control	1364 a
2	Fiesta II	Paclobutrazol	889 c
		Control	1234 a
	Norlea	Paclobutrazol	1047 b
		Control	1226 a
3	Fiesta II	Paclobutrazol	1347 a
		Control	1324 a
	Norlea	Paclobutrazol	916 b
		Control	615 c
4	Palmer	Paclobutrazol	659 a
		Control	698 a

Means within experiments, followed by different letters are statistically different ($P < 0.05$) according to Duncan's Multiple Test (Expt. 1) and LSD (all other experiments).

No yield response of either cultivar to N rates was recorded in Expt. 2, but Propiconazole significantly increased yield of Norlea by 11% whereas no effect on Fiesta II was evident. In Expt. 3 Norlea did not respond to N but in Fiesta II, the two higher N rates significantly outyielded the lowest rate. Rust infection did not affect Expt. 3 and no yield effect by the fungicide was evident. In Expt. 4 the two higher N rates significantly outyielded the lowest rate. No differences between a single and split spring N application were found. Propiconazole did not affect seed yield (Table 7).

Table 7. Seed yield response to N rate and Propiconazole application.

Expt.	Cultivar	Treatment	Seed yield kg ha^{-1}
2	Fiesta II	60 kg N ha^{-1}	1055 bc
		120 kg N ha^{-1}	1080 abc
		180 kg N ha^{-1}	1050 c
	Norlea	60 kg N ha^{-1}	1101 abc
		120 kg N ha^{-1}	1145 ab
		180 kg N ha^{-1}	1164 a
	Fiesta II	Propiconazole	1084 b
		Control	1039 b
	Norlea	Propiconazole	1195 a
		Control	1078 b
3	Fiesta II	60 kg N ha^{-1}	1186 b
		120 kg N ha^{-1}	1393 a
		180 kg N ha^{-1}	1428 a
	Norlea	60 kg N ha^{-1}	704 c
		120 kg N ha^{-1}	793 c
		180 kg N ha^{-1}	800 c
4	Palmer	60 kg N ha^{-1}	491 a
		120 kg N ha^{-1}	720 b
		180 kg N ha^{-1}	824 b
	Palmer	Propiconazole	698 a
		Control	658 a

Means within experiments, followed by different letters are statistically different ($P < 0.05$) according to LSD.

CONCLUSIONS

Data included in this report and elsewhere, indicated that the biological activity of Paclobutrazol in perennial ryegrass was independent of year, N rate and cultivar. However, yield effects were quite variable indicating that yield increases do not necessarily follow control of lodging and diseases. This suggests that lodging per se does not have a major effect on yield in perennial ryegrass. It appears that timing and method of harvest which were uniform for treated and untreated plots, interacted with treatments and defined the yield response. Exp 2 indicated that Paclobutrazol may increase seed retention, reducing seed shattering prior to harvest. Should Paclobutrazol increases seed retention to the point of affecting direct combining at seed moisture contents conducive to seed shattering in untreated plots, the threshability of the heads could become a critical factor. The evidence suggests that intensive management practices based on the use of Paclobutrazol should include appropriate harvesting methods which are yet to be experimentally tested.

XE-1019 showed a similar pattern of activity than Paclobutrazol but seems to be more sensitive to rates and timing of application. CCC+CC showed no effect on lodging but a consistent tendency to higher yields. It appears that increased rates of CCC+CC should be tested in perennial ryegrass.

TURFGRASS MANAGEMENT AND RENOVATION

TURF RENOVATION BY SODDING - SITE PREPARATION INTENSITY AND TIMING IN LOW MAINTENANCE SITES

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We have been examining the effects of timing and intensity of site preparation on the success of turf renovation by sodding.

METHODS

Research plots representing two sodding times (mid-summer - June 28, 1989 and fall - November 1989) have been established at the Cambridge Research Station. Within each plot the existing turf was killed with glyphosate, and 10 to 20 days later resodded with commercial Kentucky bluegrass sod after various site preparation treatments. The site preparation treatments include 1. resodding over killed turf; 2. addition of 3 mm of topsoil and resodding; 3. vertical mowing (5 cm depth) and resodding; and 4. stripping of killed turf and resodding over bare soil.

RESULTS

The higher intensity site preparations result in less stress/death and more rapid recovery in new sod (Figure 1). Differences in the summer sodded plots among all treatments had disappeared by 70 days after resodding; all treatments had recovered acceptably (80% green) by 50 days after resodding. Evaluation of stress in the fall-sodded treatments is under way.

The results observed here are comparable to earlier research in high maintenance conditions (daily irrigation). Under lower maintenance conditions, watering only when the surrounding turf is drought stressed, it appears that even sodding over low intensity site preparation may result in acceptable medium term results. The relative long term success (overwintering) is not yet completely clear, and short term browning from stress may make low intensity site preparation an unattractive alternative.

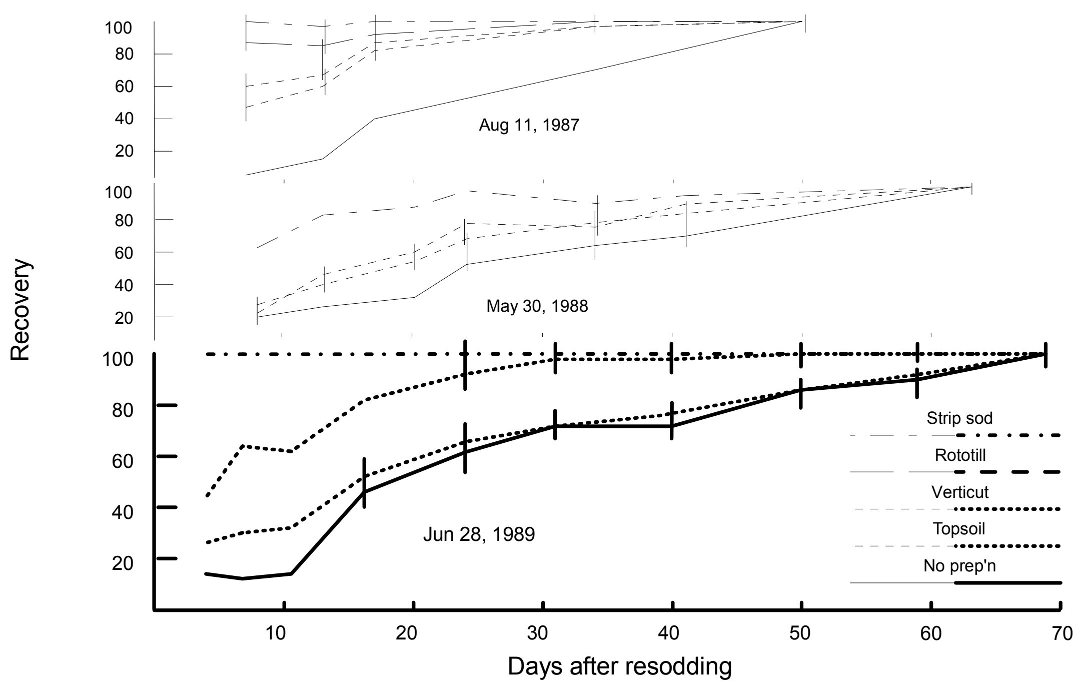

Figure 1. Recovery of Kentucky bluegrass sod laid over various site preparations.

WEED CONTROL AND GROWTH REGULATION

WEED CONTROL AND GROWTH REGULATION IN TURF

1989

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SUMMARY

Preemergence control of crabgrass. Chlorthal-dimethyl, bensulide, trifluralin, and the emulsifiable concentrate formulations of the MON-15100 series, MON-15151 and MON-15104, gave excellent season long preemergence control of crabgrass. Granular applications of oxadiazon, MON-15182 FG, MON-15175 G, MON-15111 G and MON-15112 G also gave excellent preemergence crabgrass control.

Postemergence control of crabgrass. Postemergence control of crabgrass at the two- to three-leaf and early tiller stage of development was good this year. In most cases, excellent postemergence crabgrass control was achieved with all formulations of HOE-033171, HOE-046360 and MON-15151. The granular formulations of the MON-15100 series were not as effective but did give acceptable postemergence control of crabgrass. Excellent crabgrass control was achieved with the HC89 series but in some cases there was significant injury to the turf especially with HC8916, HC8917 and HC8918. Multi-tillered crabgrass control with the MON-15100 series alone was acceptable and with the addition of HOE-033171 gave excellent control of crabgrass reducing subsequent germination of crabgrass later in the season. The addition of surfactants did not improve or reduce the efficacy of fenoxaprop-ethyl or the MON-15100 compounds. MON-15100 appears to be most efficacious as a preemergent and early post treatment. Fenoxaprop-ethyl gives excellent postemergent control at all growth stages but some reduced efficacy occurs when it is applied under dry and hot environmental conditions.

Phytotoxicity of herbicides when applied to turf species. HC8911, HC8915, HC8916, HC8917, HC8918, and MON-15104 prevented the germination of four turf species when applied just before and just after seeding. HOE-033171 and HOE-046360 delayed seed germination and reduced the % of germination thereby reducing subsequent stand density in bentgrass. When the same treatments were applied to the turf at the one- to four-leaf and early tillering stage of development there was injury and significant stand reduction in Bentgrass, Fine Fescue and Kentucky bluegrass turf. HOE-033171 and HOE-046360 were phytotoxic but did not result in significant stand reduction. There was little or no injury, when applied to mature stands of the four turfgrass species.

Selective control of annual bluegrass. Doses of linuron applied at 2.0, 2.25 and 2.5 kg ai/ha, and linuron in combination with bensulide or trifluralin gave excellent control of annual bluegrass infestations with little or no injury to Kentucky bluegrass turf. Ethofumesate does not provide adequate control of annual bluegrass as a spring application.

Phytotoxicity of Broadleaf herbicide mixtures to Bentgrass. Various combinations of MCPA, MCPP, clopyralid, triclopyr and dicamba caused some short-term injury to the bentgrass turf. Regardless of the treatment, all injured plots recovered 3 to 4 weeks after treatment and there was no stand reduction. These treatments may offer effective control for broadleaf weeds not controlled by MCPP alone.

Broadleaf weed control. MCPA/MCPP/dicamba (200/100/18) formulations at doses of 7.0, 12.0 and 16.0 l/ha provided acceptable control of wild strawberry and dandelion but gave excellent control of chickweed and black medick for up to 8 weeks after application. Clopyralid/triclopyr, clopyralid/triclopyr + dicamba mixtures gave good control of dandelion and chickweed and excellent control of black medick. Triasulfuron (CGA131036) alone and in combination with triclopyr and/or dicamba (0.25 + 0.425 + 0.108 kg ai/ha) provided excellent

broadleaf weed control. Linuron, at all doses gave more than acceptable broadleaf weed control.

Turf. Mefluidide gave excellent seedhead suppression and growth reduction for up to ten weeks after application. Some injury occurred to both Kentucky bluegrass and bentgrass with mefluidide but both turfgrasses recovered two to three weeks after application. XE-1019 and flurprimidol gave acceptable growth reduction but did not give adequate seedhead suppression.

MON 15100, OXADIAZON AND CHLORTHAL-DIMETHYL PREEMERGENT CONTROL OF CRABGRASS.

Experiment location - Cambridge Research Station.
Crop - Kentucky bluegrass and crabgrass (*Digitaria ischaemum*) mixed stand; Soil type - sandy loam.
Plot size - 1 x 2 m; Experimental design - randomized complete block; Replicates - 4.
AT APPLICATION: Date and method - May 17-PRE; Equipment - bicycle sprayer, granular applicator; Volume - 500 l/ha; Pressure - 200 kPa; Tips - SS8002LP; Date of assessment - 0524; 0621; 0719; 0816.

Treatment		Dose	% Suppression of Crabgrass (WAT)			
		kg ai/ha	1	5	9	13
1	Control		0	0	0	0
2	Mon 15151 EC	0.28	100	100	100	100
3	Mon 15151 EC	0.42	100	100	100	100
4	Mon 15151 EC	0.56	100	100	100	100
5	Mon 15151 EC	0.84	100	100	100	100
6	Mon 15104 EC	0.28	100	100	100	100
7	Mon 15104 EC	0.42	100	100	100	100
8	Mon 15104 EC	0.56	100	100	100	100
9	Mon 15104 EC	0.84	100	100	100	100
10	Mon 15104 + 2,4-D/MCPP/Dicamba*	0.42 + 1.85	100	100	100	100
11	Mon 15175 .25G	0.28	100	100	100	100
12	Mon 15175 .25G	0.42	100	100	100	100
13	Mon 15175 .25G	0.56	100	100	100	100
14	Mon 15111 .27FG	0.28	100	100	100	100
15	Mon 15111 .27FG	0.42	100	100	100	100
16	Mon 15112 .35FG	0.56	100	100	100	100
17	Mon 15112 .35FG	0.84	100	100	100	100
18	Chlorthal-dimethyl flow	11.60	100	100	100	100
19	Oxadiazon 2.0G	2.00	100	100	100	100
20	Oxadiazon 2.0G	4.50	100	100	100	100

(WAT)- weeks after treatment; EC-emulsifiable concentrate; G-granule; flow- flowable; * 2,4-D/MCPP/dicamba- 190/100/18

Excellent crabgrass suppression was achieved with all compounds at all doses up to 16 weeks after application. No injury occurred to Kentucky bluegrass.

DELAYED PREEMERGENCE CRABGRASS CONTROL.

Experiment location - Cambridge Research Station.
Crop - Kentucky bluegrass and crabgrass (Digitaria ischaemum) mixed stand; Soil type - sandy loam.
Plot size - 1 x 2 m; Experimental design - randomized complete block; Replicates - 4.
AT APPLICATION: Date and method - June 14-PRE; Equipment - bicycle sprayer, granular applicator; Volume - 500 l/ha; Pressure - 200 kPa; Tips - SS8002LP; Date of assessment - 0712; 0809; 0908.

Treatment	Dose kg ai/ha	% Suppression of crabgrass (WAT)		
		4	8	12
1 Control		0	0	0
2 Mon 15151 EC	0.56	100	100	23
3 Mon 15151 EC	0.84	100	100	100
4 Mon 15104 EC	0.56	100	100	100
5 Mon 15104 EC	0.84	100	100	100
6 Mon 15175 0.25G	0.42	100	100	100
7 Mon 15175 0.25G	0.56	100	100	76
8 Mon 15111 0.27G	0.28	100	100	100
9 Mon 15111 0.27G	0.42	100	100	100
10 Mon 15112 0.35G	0.56	100	100	100
11 Mon 15112 0.35G	0.84	100	100	100
12 Bensulide EC	14.00	100	100	100
13 Bensulide EC	16.80	100	100	38
14 Trifluralin EC	1.95	100	100	80
15 Trifluralin EC	2.20	100	100	63
16 Chlorthal-dimethyl flow	10.00	100	62	27
17 Chlorthal-dimethyl flow	15.00	100	100	67
18 Oxadiazon 2.0G	4.50	100	100	60

(WAT) - weeks after treatment; EC-emulsifiable concentrate; G-granule; flow- flowable

Crabgrass began to germinate on May 21 and preemergent treatments were applied on June 14. Acceptable crabgrass suppression was achieved with all compounds at all doses up to 8 weeks after application. Mon 15151, Mon 15104, Mon 15111 and Mon 15112 provided excellent crabgrass suppression up to 12 weeks after application. Acceptable control is feasable by delaying pre-emergence crabgrass herbicides for up to 3 weeks after commencement of crabgrass germination in an attempt to achieve crabgrass control for the entire season. No injury occurred to Kentucky bluegrass.

POSTEMERGENT CONTROL OF 1-3 LEAF CRABGRASS WITH VARIOUS FORMULATIONS OF MON 15100.

Experiment location - Cambridge Research Station.
Crop - Kentucky bluegrass and crabgrass (Digitaria ischaemum) mixed stand; Soil type - sandy loam.
Plot size - 1 x 2 m; Experimental design - randomized complete block; Replicates - 4.
AT APPLICATION: Date and method - June 14-POST; Equipment - bicycle sprayer, granular applicator; Volume - 500 l/ha; Pressure - 200 kPa; Tips - SS8002LP; Date of assessment - 0614; 0712; 0809; 0908.

Treatment	Dose kg ai/ha	% Reduction of crabgrass (WAT)			
		0	4	8	12
1 Control		0	0	0	0
2 Mon 15151 + Agral 90	0.42+0.5%	0	0	100	100
3 Mon 15151 + Agral 90	0.56+0.5%	0	0	100	100
4 Mon 15104 + Agral 90	0.28+0.5%	0	0	100	100
5 Mon 15104 + Agral 90	0.42+0.5%	0	0	80	80
6 Mon 15104 + Agral 90	0.56+0.5%	0	14	100	100
7 Mon 15104 + Agral 90	0.84+0.5%	0	0	100	100
8 Mon 15104 + 2,4-D/MCPP/Dicamba* + Agral 90	0.42 + 1.85 + 0.5%	0	0	70	50
9 Mon 15175 .25G	0.42	0	0	60	50
10 Mon 15175 .25G	0.56	0	0	78	66
11 Mon 15111 .27G	0.42	0	0	78	78
12 Mon 15112 .35G	0.56	0	36	82	71
13 Mon 15112 .35G	0.84	0	0	100	100
14 Fenoxaprop-ethyl 90EC	0.20	0	100	100	80
15 Linuron**	1.00	0	0	100	80
16 Linuron	1.50	0	0	100	100

(WAT)- weeks after treatment; EC-emulsifiable concentrate; G-granule;
*2,4-D/MCPP/dicamba- 190/100/18; ** Linuron- 450 g/l Hoechst

Mon 15151 and Mon 15104 in combination with Agral 90 provided excellent control of crabgrass when applied as an early post control. Mon 15175, Mon 15111 and Mon 15112 granular applications were not as effective. No injury occurred to Kentucky bluegrass.

POSTEMERGENT CONTROL OF 1-3 LEAF CRABGRASS WITH FORMULATED MIXES OF FENOXAPROP-ETHYL.

Experiment loction - Cambridge Research Station.
Crop - Kentucky bluegrass and crabgrass (Digitaria ischaemum); Soil type - sandy loam.
Plot size - 1 x 2 m; Experimental design - randomized complete block; Replicates - 4.
AT APPLICATION: Date and method - June 28-POST; Equipment - bicycle sprayer; Volume - 500 l/ha; Pressure - 200 kPa; Tips - SS8002LP; Date of assessment - 5,7,10,14 and 21 DAT.

Treatment	Dose kg ai/ha	Days after treatment							
		5		7	10	14		21	
		I*	R*	I	I	I	R	I	R
1 Control		0	0	0	0	0	0	0	0
2 HC8911	5.00 l/ha	10	0	20	20	20	100	20	100
3 HC8915	5.00 "	10	0	20	20	20	67	20	67
4 HC8916	5.00 "	10	0	10	10	10	100	10	100
5 HC8917	5.00 "	10	0	10	10	10	100	10	100
6 HC8918	5.00 "	30	0	40	50	40	100	40	100
7 Hoe 033171 90 EC	0.20	10	0	30	30	40	100	40	100
8 Hoe 046360 60 EW	0.10	10	0	10	10	10	100	10	100
9 HFB001	0.03+0.125	70	0	70	80	80	100	80	100
10 HFB002	0.06+0.250	50	0	60	70	90	100	90	100
11 Mon 15104 EC	0.84	30	0	30	30	30	100	30	100

* I= injury to turf (0-100); R= % crabgrass reduction; EC-emulsifiable concentrate; EW-emulsifiable water

Postemergence crabgrass control with fenoxaprop-ethyl and formulated mixes of fenoxaprop-ethyl was excellent, although there was some injury to Kentucky bluegrass especially with HFB001 and HFB002.

POSTEMERGENT CONTROL OF CRABGRASS AT THE 1-3 TILLER STAGE WITH MON 15100: FORMULATION/TANK MIX COMPARISONS.

Experiment location - Cambridge Research Station.
Crop - Kentucky bluegrass and crabgrass (Digitaria ischaemum) mixed stand; Soil type - sandy loam.
Plot size - 1 x 2 m; Experimental design - randomized complete block; Replicates - 4.
AT APPLICATION: Date and method - July 13-POST; Equipment - bicycle sprayer; Volume - 500 l/ha; Pressure - 200 kPa; Tips - SS8002LP; Date of assessment - 0713; 0727; 0810; 0824.

Treatment	Dose kg ai/ha	% Reduction of crabgrass (WAT)			
		0	2	4	6
1 Control		0	0	0	0
2 Mon 15151 + Agral 90	0.56+0.5%	0	14	83	83
3 Mon 15104 + Agral 90	0.56+0.5%	0	60	90	90
4 Mon 15104 + Agral 90	0.84+0.5%	0	27	100	100
5 Mon 15151 + MSMA + Agral 90	0.56+1.12+0.5%	0	42	100	100
6 Mon 15104 + MSMA + Agral 90	0.28+1.12+0.5%	0	49	100	100
7 Mon 15151 + MSMA + Agral 90	0.56+1.12+0.5%	0	46	100	100
8 Mon 15151+Hoe 033171*+Agral 90	0.56+0.20+0.5%	0	88	100	100
9 Mon 15104+Hoe 033171*+Agral 90	0.28+0.10+0.5%	0	48	100	100
10 Mon 15104+Hoe 033171*+Agral 90	0.56+0.10+0.5%	0	52	100	100
11 Mon 15104+Hoe 033171*+Agral 90	0.28+0.20+0.5%	0	56	100	100
12 Mon 15104+Hoe 033171*+Agral 90	0.56+0.20+0.5%	0	64	100	100
13 MSMA	2.25	0	29	24	24
14 Hoe 033171*	0.20	0	100	100	100
15 Linuron**	1.00	0	12	0	0
16 Linuron	1.50	0	18	0	0

(WAT) weeks after treatment; * Hoe 033171 90 EC (emulsifiable concentrate);
** Linuron 450 g/l Hoechst

Mon 15151, Mon 15104 in combination with MSMA or fenoxaprop-ethyl and Agral 90 provided excellent crabgrass control when applied at the early tiller stage of development. MSMA alone did not give acceptable control of crabgrass. Fenoxaprop-ethyl 90 EC alone gave excellent control of crabgrass at the 1-3 tiller stage. There was no injury to Kentucky bluegrass.

POSTEMERGENT CONTROL OF CRABGRASS AT THE ADVANCED TILLER STAGE WITH VARIOUS FORMULATION MIXTURES OF FENOXAPROP-ETHYL.

Experiment location - Cambridge Research Station.
Crop - Kentucky bluegrass and crabgrass (Digitaria ischaemum) mixed stand; Soil type - sandy loam.
Plot size - 1 x 2 m; Experimental design - randomized complete block; Replicates - 3.
AT APPLICATION: Date and method - August 9-POST; Equipment - bicycle sprayer; Volume - 500 l/ha; Pressure - 200 kPa; Tips - SS8002LP; Date of assessment - 0809; 0823; 0906.

Treatment	Dose kg ai/ha	% Reduction of crabgrass (WAT)		
		0	2	4
1 Control		0	0	0
2 HC8911	5.00 l/ha	0	100	100
3 HC8915	5.00 "	0	100	100
4 HC8916	5.00 "	0	100	100
5 HC8917	5.00 "	0	100	100
6 HC8918	5.00 "	0	100	100
7 Hoe 033171 90 EC	0.20	0	100	100
8 Hoe 046360 60 EW	0.10	0	100	100
9 HFB001	0.03+0.125	0	100	100
10 HFB002	0.06+0.250	0	100	100
11 Mon 15104 EC	0.84	0	100	100

(WAT) weeks after treatment; EC emulsifiable concentrate; EW emulsifiable water

Fenoxaprop-ethyl and formulated mixes of fenoxaprop-ethyl provided excellent postemergence crabgrass control at the advanced tiller stage of crabgrass development. No injury occurred to Kentucky bluegrass except with HFB001 and HFB002.

POSTEMERGENCE CONTROL OF CRABGRASS AT THE 1-3 TILLER STAGE WITH VARIOUS FORMULATION MIXTURES OF FENOXAPROP-ETHYL.

Experiment location - Cambridge Research Station.
Crop - Kentucky bluegrass and crabgrass (Digitaria ischaemum) mixed stand; Soil type - sandy loam.
Plot size - 1 x 2 m; Experimental design - randomized complete block; Replicates - 4.
AT APPLICATION: Date and method - July 13-POST; Equipment - bicycle sprayer; Volume - 500 l/ha; Pressure - 200 kPa; Tips - SS8002LP; Date of assessment - 0713; 0727; 0810; 0824.

Treatment	Dose kg ai/ha	% Reduction of crabgrass (WAT)			
		0	2	4	6
1 Control	0	0	0	0	
2 RTU 0.20 EW	50 mls/m^2	0	9	52	52
3 RTU 0.20 EC	50 mls/m^2	0	9	66	66
4 RTU 0.40 EC	50 mls/m^2	0	8	53	53
5 Hoe 033171 10 EC	0.20	0	31	58	58
6 Hoe 046360 5 EC	1.0 l/ha	0	21	62	62
7 Hoe 046360 5 EW	1.0 l/ha	0	15	47	47
8 Hoe 033171 60 EW	0.10	0	16	76	76
9 Hoe 033171 90 EC	0.20	0	20	44	44
10 Hoe 046360 75 EW	0.10	0	20	64	64
11 Hoe 046360 60 EW	0.10	0	27	82	82

(WAT) weeks after treatment; EW emulsifiable water; EC emulsifiable concentrate

Different formulated mixes of fenoxaprop-ethyl provided acceptable control of crabgrass at the 1-3 tiller stage. At the time of application the turf in this area was under drought stress and as a result crabgrass control was poor. No injury occurred to Kentucky bluegrass.

SEED GERMINATION AFTER APPLICATIONS OF FORMULATED MIXES OF FENOXAPROP-ETHYL .

Experiment location - Cambridge Research Station.
Crop - Penncross bentgrass, Repell perennial ryegrass, Banner fine fescue, and Haga Kentucky bluegrass; Soil type - sandy loam.
Plot size - 1 x 2 m; Experimental design - randomized complete block; Replicates - 4.
AT APPLICATION: Date and method - July 12 for preseeding and July 14 for postseeding; Equipment - bicycle sprayer; Volume - 500 l/ha; Pressure - 200 kPa; Tips - SS8002LP; Date of assessment - 0726; 0823.

Treatment[1] (seeding one day after treatment)	Dose kg ai/ha	% Germination (WAT) BG*		PR*		FF*		KB*	
		2	4	2	4	2	4	2	4
1 Control		100	100	100	100	100	100	100	100
2 HC8911	5.00 l/ha	0	0	0	0	0	0	0	0
3 HC8915	5.00 "	0	0	0	0	0	0	0	0
4 HC8916	5.00 "	0	0	0	0	0	0	0	0
5 HC8917	5.00 "	0	0	0	0	0	0	0	0
6 HC8918	5.00 "	0	0	0	0	0	0	0	0
7 Hoe 033171 90 EC*	0.20	48	83	33	100	50	100	35	100
8 Hoe 046360 60 EW*	0.10	58	85	43	100	58	100	45	100
9 HFB001	0.03+0.125	10	58	0	58	0	53	0	0
10 HFB002	0.06+0.250	0	0	0	0	0	0	0	0
11 Mon 15104 EC	0.84	0	0	0	0	0	0	0	0

Treatment[2] (seeding two days after treatment)	Dose kg ai/ha	% Germination (WAT) BG		PR		FF		KB	
		2	4	2	4	2	4	2	4
1 Control		100	100	100	100	100	100	100	100
2.HC8911	5.0	0	0	0	0	0	0	0	0
3.HC8916	5.0	0	0	0	0	0	0	0	0
4 HC8917	5.0	0	0	0	0	0	0	0	0
5 HC8918	5.0	0	0	0	0	0	0	0	0

* BG Penncross bentgrass; PR Repell perennial ryegrass; FF Banner fine fescue; KB Haga Kentucky bluegrass; (WAT) weeks after treatment; EC emulsifiable concentrate; EW emulsifiable water

[1] Plots were seeded one day after treatment.

[2] Plots were seeded two days prior to treatment.

Germination of turfgrass occurred on July 24.

TURF TOLERANCE TO FENOXAPROP AND FENOXAPROP/TRIFLURALIN IN FOUR GRASS SPECIES AT TWO DIFFERENT GROWTH STAGES.

Experiment location - Cambridge Research Station.
Crop - Penncross bentgrass, Repell perennial rye, Banner fine fescue and Haga Kentucky bluegrass; Soil type - sandy loam.
Plot size - 1 x 2 m; Experimental design - randomized complete block; Replicates - 4.
AT APPLICATION: Date and method - August 3 for 1-4 leaf stage and August 17 for the advanced tiller stage; Equipment - bicycle sprayer; Volume - 500 l/ha; Pressure - 200 kPa; Tips - SS8002LP; Date of assessment - 7 and 21 DAT; Injury, I= (0-10); Stand, %S= (0-100).

Treatment- 1	Dose l/ha	Days after treatment															
		BG*				PR*				FF*				KB*			
		7		21		7		21		7		21		7		21	
		I*	%S*	I	%S	I	%S	I	%S	I	%S	I	%S	I	%S	I	%S
1 Control		0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100
2 HC8911	5.00	6	100	10	0	8	100	0	48	6	100	10	0	10	0	10	0
3 HC8915	5.00	6	100	10	0	8	100	0	68	6	100	10	0	10	0	10	0
4 HC8916	5.00	6	100	10	0	8	100	0	38	7	100	10	0	10	0	10	0
5 HC8917	5.00	6	100	10	0	8	100	0	70	6	100	10	0	10	0	10	0
6 HC8918	5.00	6	100	10	0	8	100	0	85	6	100	10	0	10	0	10	0
7 Hoe033171#	0.20	6	100	10	0	0	100	0	100	0	100	0	100	10	0	10	0
8 Hoe046360#	0.10	6	100	10	0	0	100	0	100	0	100	0	100	10	0	10	0
9 HFB001#	0.03+0.125	6	100	10	0	0	100	0	100	4	100	0	100	10	0	10	0
10.HFB002#	0.06+0.250	7	100	10	0	8	100	0	50	6	100	0	100	10	0	10	0
11 Mon 15104#	0.84	7	100	10	0	4	100	0	98	6	100	10	0	10	0	10	0
Treatment - 2	Dose l/ha	7		21		7		21		7		21		7		21	
		I*	%S*	I	%S	I	%S	I	%S	I	%S	I	%S	I	%S	I	%S
1 Control		0	100	0	100	0	100	0	100	0	100	0	100	0	100	0	100
2 HC8911	5.00	8	100	10	20	4	100	0	100	8	100	10	0	8	100	10	0
3 HC8915	5.00	8	100	10	20	4	100	0	100	9	100	10	10	8	100	10	0
4 HC8916	5.00	9	100	10	20	5	100	0	100	8	100	10	10	8	100	10	0
5 HC8917	5.00	9	100	10	10	5	100	0	100	9	100	10	10	8	100	10	0
6 HC8918	5.00	8	100	10	10	5	100	0	100	9	100	10	10	8	100	10	0
7 Hoe033171#	0.20	8	100	10	10	5	100	0	100	5	100	0	100	7	100	10	20
8 Hoe046360#	0.10	8	100	10	10	5	100	0	100	5	100	0	100	7	100	10	40
9 HFB001#	0.03+0.125	8	100	10	0	8	100	0	100	5	100	0	100	8	100	10	40
10 HFB002#	0.06+0.250	9	100	10	0	8	100	0	100	7	100	0	100	9	100	10	20
11 Mon 15104#	0.84	0	100	0	100	0	100	0	100	10	100	10	30	0	100	0	100

* BG Penncross bentgrass; PR Repell perennial rye; FF Banner fine fescue; KB Haga Kentucky bluegrass; I= injury (0 10); %S= stand (0 100) # kg ai/ha
1 Turfgrasses were at the 1 4 leaf stage of development when treated.
2 Turfgrasses were at the advanced tiller stage of development when treated.

Germination of turfgrass occurred on July 24.

LINURON, BENSULIDE, TRIFLURALIN AND ETHOFUMESATE FOR THE CONTROL OF ANNUAL BLUEGRASS IN KENTUCKY BLUEGRASS TURF.

Experiment location - Cambridge Research Station.
Crop - annual bluegrass and Kentucky bluegrass mixed stand; Soil type - sandy loam.
Plot size - 1 x 2 m; Experimental design - randomized complete block; Replicates - 4.
AT APPLICATION: Date and method - May 13-POST; Equipment - bicycle sprayer; Volume - 700 L/Ha; Pressure - 200 kPa; Tips - SS8002LP; Date of assessment - 0513; 0601; 0615; 0629.

Treatment	Dose kg ai/ha	% Reduction of annual bluegrass (WAT)			
		0	2	4	6
1 Control		0	0	0	0
2 Linuron	1.50	0	0	0	0
3 Linuron	1.75	0	11	29	54
4 Linuron	2.00	0	8	28	88
5 Linuron	2.25	0	0	63	100
6 Linuron	2.50	0	0	86	92
7 Linuron + Bensulide	1.00 + 14.0	0	0	86	91
8 Linuron + Bensulide	1.25 + 14.0	0	0	85	91
9 Linuron + Bensulide	1.50 + 14.0	0	0	81	85
10.Linuron + Trifluralin	1.00 + 2.20	0	0	43	77
11 Linuron + Trifluralin	1.50 + 2.20	0	0	67	93
12 Linuron + Trifluralin	2.00 + 2.20	0	0	74	92
13 Ethofumesate	0.84	0	0	0	14
14 Ethofumesate	1.12	0	0	0	30

Linuron 450 g/l Hoechst; (WAT) weeks after treatment

Linuron, at 1.75 to 2.25 Kg/ha, and linuron in combination with bensulide or trifluralin gave excellent control of annual bluegrass infestations with little or no injury to Kentucky bluegrass turf. Ethofumesate does not provide adequate control of annual bluegrass as a spring application.

PHYTOTOXICITY OF BROADLEAF HERBICIDE MIXTURES TO BENTGRASS.

Experiment location - Cambridge Research Station.
Crop - bentgrass; Soil type - sandy loam.
Plot size - 1 x 2 m; Experimental design - randomized complete block; Replicates - 4.
AT APPLICATION: Date and method - May 30; Equipment - bicycle sprayer, granular applicator; Volume - 2000 l/ha; Pressure - 200 kPa; Tips - SS8002LP; Date of assessment - 0606; 0613; 0627; 0711; 0725.

Treatment	Dose l/ha	Injury (WAT)				
		1	2	4	6	8
1 Control		0	0	0	0	0
2 MCPA/MCPP/Dicamba (200/100/18)	3.0	60	60	0	0	0
3 2,4 D/MCPP/Dicamba (95/50/9)	12.0	60	70	20	20	0
4 Clo/Tri/Dicamba (23.6/47/8.8)	6.0	60	60	0	0	0
5 Clo/Tri/Dicamba (23.6/47/8.8)	9.0	60	60	0	0	0
6 Clo/Tri/Dicamba (23.6/47/8.8)	12.0	60	60	0	0	0
7 Clo/Tri (92/277)	2.0	60	60	0	0	0
8 Clo/Tri (92/277)	2.3	60	60	0	0	0
9 Clo/Tri + Dicamba (92/277+108)	2.0	60	60	0	0	0
10 Clo/Tri + Dicamba (92/277+108)	2.0	60	70	0	0	0
11 S 2766	0.561 kg ai/ha	0	0	0	0	0
12 S 2766	1.120 "	0	0	0	0	0
13 Mon 15126 0.5% G	0.561 "	60	70	0	0	0
14 Mon 15126 0.5% G	1.120 "	70	70	10	10	0

(WAT) weeks after treatment; Clo clopyralid; Tri triclopyr; I=injury (0 100)

There was some injury to the bentgrass for up to 2 weeks after application with all treatments except for S-2766. Regardless of the treatment, all injured plots recovered 3 to 4 weeks after treatment and there was no stand reduction. These treatments may offer effective control for broadleaf weeds not controlled by MCPP alone.

EFFECT OF PLANT GROWTH REGULATORS ON KENTUCKY BLUEGRASS AND BENTGRASS.

Experiment location - Cambridge Research Station.
Crop - Kentucky bluegrass; bentgrass; Soil type - sandy loam.
Plot size - 1 x 2 m; Experimental design - randomized complete block; Replicates - 4.
AT APPLICATION: Date and method - May 13; Equipment - bicycle sprayer; Volume - 700 l/ha; Pressure - 200 kPa; Tips - SS8002LP; Date of assessment - 0526; 0623; 0721.

Treatment	Dose kg ai/ha	Weeks after treatment Kentucky bluegrass						Bentgrass					
		2		6		10		2		6		10	
		I*	SH*	I	SH	I	SH	I	SH	I	SH	I	SH
1 Control		0	0	0	53	0	38	0	0	0	63	0	23
2 XE 1019 50 WP	0.14	0	0	0	55	0	23	0	0	0	70	0	25
3 XE 1019 50 WP	0.21	0	0	0	53	0	18	0	0	0	63	0	33
4 XE 1019 50 WP	0.28	0	0	0	43	0	20	0	0	0	60	0	15
5 Flurprimidol	1.50	0	0	0	50	0	25	0	0	0	68	0	23
6 Flurprimidol	2.00	0	0	0	50	0	15	0	0	0	63	0	23
7 Flurprimidol	2.50	0	0	0	43	0	18	0	0	0	60	0	18
8 Flurprimidol	3.00	0	0	0	50	0	25	0	0	0	50	0	25
9 Mefluidide	0.20	70	0	0	0	0	0	60	0	0	0	0	0
10 Control	0	0	0	50	0	18	0	0	0	60	0	23	

* I = injury (0 100); SH = % seedhead (0 100)

Mefluidide gave excellent seedhead suppression and growth reduction for up to 10 weeks after application. Some injury occurred to both Kentucky bluegrass and bentgrass with mefluidide but both turfgrasses recovered 2-3 weeks after application. XE-1019 and flurprimidol expressed acceptable growth reduction but did not give adequate seedhead suppression.

2,4-D/MCPP/DICAMBA AND MCPA/MCPP/DICAMBA FORMULATIONS FOR BROADLEAF WEED CONTROL IN TURF.

Experiment location - Guelph Airport.
Crop - Kentucky bluegrass; Soil type - sandy loam.
Plot size - 1 x 2 m; Experimental design - randomized complete block; Replicates - 4.
AT APPLICATION: Date and method - June 9-POST; Equipment - bicycle sprayer; Volume - 1000 l/ha; Pressure - 200 kPa; Tips - SS8002LP; Date of assessment - T1=0703; T2=0814. Additional information- weed counts were taken from a 2 m2 area/plot.

Treatment	Dose	Mean % Reduction /8 m^2							
	l/ha	WS*		D*		CH*		BM*	
		T1	T2	T1	T2	T1	T2	T1	T2
1 Control		0	0	0	0	0	0	0	0
2 2,4 D/MCPP/Dicamba (190/100/18)	4.0	3	16	21	37	67	100	72	72
3 2,4 D/MCPP/Dicamba (190/100/18)	5.5	15	38	34	34	100	100	100	100
4 2,4 D/MCPP/Dicamba (95/50/9)	12.0	8	41	41	100	100	100	100	100
5 MCPA/MCPP/Dicamba (200/100/18)	5.5	19	47	48	54	100	100	100	100
6 MCPA/MCPP/Dicamba (200/100/18)	7.0	10	37	24	53	100	100	100	100
7 MCPA/MCPP/Dicamba (200/100/18)	12.0	11	25	25	48	100	100	100	100
8 MCPA/MCPP/Dicamba (200/100/18)	16.0	15	50	62	84	100	100	100	100

* WS Wild strawberry; D Dandelion; CH chickweed; BM Black medick

CLOPYRALID, TRICLOPYR AND DICAMBA FORMULATED MIXES FOR BROADLEAF WEED CONTROL IN TURF.

Experiment location - Guelph Airport.
Crop - Kentucky bluegrass; Soil type - sandy loam.
Plot size - 1 x 2 m; Experimental design - randomized complete block; Replicates - 4.
AT APPLICATION: Date and method - June 9-POST; Equipment - bicycle sprayer; Volume - 1000 l/ha; Pressure - 200 kPa; Tips - SS8002LP; Date of assessment - T1=0703; T2=0814. Additional information- weed counts were taken from a 2 m2 area/plot.

Treatment	Dose	Mean % Reduction /8 m^2							
	l/ha	WS*		D*		CH*		BM*	
		T1	T2	T1	T2	T1	T2	T1	T2
1 Control		0	0	0	0	0	0	0	0
2 2,4 D/MCPP/Dicamba (95/50/9)	12.0	21	48	48	79	100	100	100	100
3 Clo/Tri/Dicamba (23.6/47/8.8)	6.0	0	0	40	65	35	75	100	100
4 Clo/Tri/Dicamba (23.6/47/8.8)	9.0	0	0	56	75	38	68	100	100
5 Clo/Tri/Dicamba (23.6/47/8.8)	12.0	13	14	86	100	51	100	100	100
6 Clo/Tri (92/277)	2.0	20	21	53	71	60	83	100	100
7 Clo/Tri (92/277)	2.3	28	36	100	100	52	80	100	100
8 Clo/Tri + Dicamba (92/277+108)	2.0 + 0.108*	24	47	72	87	66	84	100	100
9 Clo/Tri + Dicamba (92/277+108)	2.3 + 0.108*	23	28	86	85	30	70	100	100

* WS Wild strawberry; D Dandelion; CH chickweed; BM Black medick; * kg ai/ha

TRIASULFURON, DICAMBA AND TRICLOPYR FORMULATED MIXES FOR BROADLEAF WEED CONTROL IN TURF.

Experiment location - Guelph Airport.
Crop - Kentucky bluegrass; Soil type - sandy loam.
Plot size - 1 x 2 m; Experimental design - randomized complete block; Replicates - 4.
AT APPLICATION: Date and method - June 9-POST; Equipment - bicycle sprayer; Volume - 1000 l/ha; Pressure - 200 kPa; Tips - SS8002LP; Date of assessment - T1=0703; T2=0814.

Treatment	Dose kg ai/ha	Mean % Reduction /8 m^2							
		WS*		D*		CH*		BM*	
		T1	T2	T1	T2	T1	T2	T1	T2
1 Control		0	0	0	0	0	0	0	0
2 Triasulfuron	0.15	36	64	7	11	100	100	38	52
3 Triasulfuron	0.20	46	27	27	29	100	100	100	100
4 Triasulfuron	0.25	49	67	26	24	100	100	80	79
5 Dicamba	0.108	13	13	2	6	97	100	64	56
6 Triclopyr	0.425	60	66	6	6	100	100	57	70
7 Triasulfuron + Dic	0.15+0.108	44	100	22	22	79	100	65	65
8 Triasulfuron + Dic	0.20+0.108	64	85	41	30	90	100	100	100
9 Triasulfuron + Dic	0.25+0.108	90	100	21	21	86	100	100	100
10 Triasulfuron + Tri	0.15+0.425	77	82	17	17	87	100	64	89
11 Triasulfuron + Tri	0.20+0.425	90	64	21	25	100	100	85	80
12 Triasulfuron + Tri	0.25+0.425	84	100	12	23	76	100	100	100
13 Triasulfuron+Dic+Tri	0.15+0.108+0.425	80	89	21	22	89	100	87	87
14 Triasulfuron+Dic+Tri	0.20+0.108+0.425	84	70	21	29	89	100	100	100
15 Triasulfuron+Dic+Tri	0.25+0.108+0.425	87	100	25	18	100	100	100	100
16 2,4 D/MCPP/Dicamba*	5.5 l/ha	37	73	33	40	100	100	100	72
17 MCPA + MCPP	1.45+0.56	31	38	18	30	100	100	82	100

* WS wild strawberry; D dandelion; CH chickweed; BM Black medick; Dic dicamba; Tri triclopyr; Triasulfuron CGA131036; * Killex (190/100/18)

LINURON FOR BROADLEAF WEED CONTROL IN TURF.

Experiment location - Guelph Airport.
Crop - Kentucky bluegrass; Soil type - sandy loam.
Plot size - 2 x 2 m; Experimental design - randomized complete block; Replicates - 4.
AT APPLICATION: Date and method - June 9; Equipment - bicycle sprayer; Volume - 1000 l/ha; Pressure - 200 kPa; Tips - SS8002LP; Date of assessment - T1=0703; T2=0814.

Treatment	Dose kg ai/ha	Mean % Reduction /8 m^2							
		WS*		D*		CH*		BM*	
		T1	T2	T1	T2	T1	T2	T1	T2
1 Control		0	0	0	0	0	0	0	0
2 Linuron	0.50	79	88	7	21	62	100	68	87
3 Linuron	1.00	84	89	13	42	100	100	100	100
4 Linuron	1.50	100	100	19	26	100	100	79	87
5 Linuron	2.00	100	100	10	33	100	100	100	100

* WS wild strawberry; D dandelion; CH chickweed; BM black medick; Linuron 450 g/l Hoechst

CONTROL OF ANNUAL BLUEGRASS (*POA ANNUA*) INFESTATIONS IN KENTUCKY BLUEGRASS (*POA PRATENSIS*) TURF

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SUMMARY

Currently, there are no herbicides registered for use in Ontario for the postemergence control of annual bluegrass infestations that occur in Kentucky bluegrass swards grown for commercial sod production. In controlled environment growth room experiments, a commercially available flowable suspension of linuron [N^1-(3,4-dichlorophenyl)-N-methoxy-N-methylurea] was applied to pure stands of annual bluegrass and six Kentucky bluegrass cultivars. The rates of application were 0.063, 0.125, 0.250, 0.500 and 0.750 kg ai ha^{-1}. The two highest doses of the herbicide gave excellent control of annual bluegrass, reducing the population by more than 85% when compared to the control, 4 weeks after treatment. Six weeks after treatment, the population of annual bluegrass was reduced by 65% after application of 0.500 kg ai ha^{-1}, while less than 8% of the annual bluegrass stand remained after application of the highest dose of linuron. Little or no injury was observed on the six cultivars of Kentucky bluegrass at any time after treatment. Analysis of dry weight data showed that the most severe reduction in growth of the six cultivars occurred two weeks after linuron application. The most sensitive cultivar was America, which had dry weight reductions of 70 and 30% when compared to the control, 2 and 6 weeks after application of 0.750 kg ai ha^{-1}, respectively. Results of preliminary experiments conducted under field conditions show that doses of 1.00, 1.25 and 1.50 kg ai ha^{-1} will effectively remove annual bluegrass from two-year-old stands of Kentucky bluegrass, without damaging the latter species.

INTRODUCTION

Throughout the temperate regions of Canada, annual bluegrass (*Poa annua L.*) is regarded as a severe weed problem in turfgrass swards established for either the production of sod or as playing surfaces for sports such as golf, lawn, bowling, or football. Besides competing for soil nutrients, soil moisture, light, and carbon dioxide, annual bluegrass disrupts the uniformity of a turfgrass sward due it's substantially different leaf width, shape, growth habit and colour resulting in poor quality turf in terms of aesthetic appearance, durability, and/or texture. Warwick lists several characteristics of annual bluegrass that contribute to the success of this species as weed which include: great genotypic and phenotypic variability; rapid seed germination and a generally short life cycle; small size; lack of ease in being uprooted and great powers of survival when uprooted; development of a shallow root system in response to soil compaction; and a small light seeds which are easily dispersed. Two distinct variants of this species exist, the erect-annual and the prostrate-perennial types, depending on the habitat. Annual bluegrass is well adapted to close mowing and responds favourably to cool climates, irrigation and fertilization; preferring wet, poorly aerated and compact soils. Under these conditions it will produce significantly more top growth than Kentucky bluegrass (*Poa pratensis*) species. The cool, moist environmental of the temperate regions of southern Canada are extremely conducive to the establishment of annual bluegrass. However, it is susceptible to midsummer heat and drought stress, which result in the death of this species, leaving dry, brown patches in desirable turf.

Kentucky bluegrass is one of the major turfgrass species grown in the temperate regions of Canada. Currently, the selective control of annual bluegrass infestations in Kentucky bluegrass swards is very difficult to achieve with herbicides. Preemergence control can be achieved with chlorthal-dimethyl (dimethyl 2,3,5,6-tetrachloro- 1,4-benzenedicarboxylate) or bensulide (O,O-bis(1- ethylethyl)- -[2- [(phenylsulphonyl) amino]ethyl]- phosphorodithioate) applied early in the spring or in the fall. However, these herbicides are expensive, must be applied several times, and do not permit reseeding for several months after application.

In 1979, Ingratta et al. examined the germination and growth of annual bluegrass under various environmental conditions in a controlled environment growth chambers to determine the influence of these conditions on the control of annual bluegrass with linuron (3-(3,4-dichlorophenyl)-1)-methylurea). Twelve weeks after application, linuron (50 WP) provided excellent control of annual bluegrass grown in pots under a short day and moderate temperature (24/12°C day/night; 16 hr photoperiod) regime. Under the same environmental conditions Kentucky bluegrass turf was not injured. All Kentucky bluegrass varieties tested under field conditions, with the exception of Fylking, were not injured. Of the two formulations of linuron tested, the granular formulation was less phytotoxic than the wettable powder. The authors concluded that the granular formulation was less phytotoxic because it was not absorbed by the grass leaves to the same extent as was the wettable powder. Although the granular formulation was not phytotoxic to most varieties of established seedling Kentucky bluegrass, it was found that enough linuron residue remained in the soil to injure germinating Kentucky bluegrass for as long as three months after treatment. The authors concluded that early spring or early fall may be the best time to apply linuron for the selective control of annual bluegrass infestations in Kentucky bluegrass swards.

Currently, there are no herbicides registered in Canada for the selective control of annual bluegrass in turfgrass swards. Although linuron is registered for field agricultural use, it cannot be legally used on turfgrasses. Furthermore, no further research has been conducted on the efficacy and phytotoxicity of linuron for the control of annual bluegrass in established Kentucky bluegrass since the original report by Ingratta et al. Additionally, the granular formulation of linuron which was the best formulation tested by Ingratta et al. is no longer available in Canada. Therefore the object of this study was to establish conclusively the advantages and limitations of linuron used for the selective removal of annual bluegrass from Kentucky bluegrass swards. Growth room and field experiments were conducted on newly seeded and established annual and Kentucky bluegrass swards to determine the response of these two species to various doses of the dry flowable suspension of linuron. In the growth room the dose found to control annual bluegrass and least phytotoxic to Kentucky bluegrass. Also to test the tolerance of several varieties of Kentucky bluegrass to selective doses of linuron. Fields studies to establish the efficacy of linuron on annual bluegrass in established Kentucky bluegrass and to examine the tolerance of several varieties of newly seeded Kentucky bluegrass to linuron.

MATERIALS AND METHODS

Controlled environment growth room experiments. Seeds of annual bluegrass (*Poa annua* L.) or Kentucky bluegrass (*Poa pratensis* L.) were sown in 10-cm-diameter plastic pots containing 0.5 l of fine vermiculite as the growth medium (Terra-Lite; mica-like mineral, pH 6.0-6.5; W.R. Grace and Co. of Canada Ltd. 294 Clements Rd., Ajax, Ont. L1S 3C6). The eight Kentucky bluegrass cultivars used in the experiments were: America, Banff, Cheri, Dormie, Fylking, Nugget, Ram, and Touchdown. The turf was watered as required and fertilized once every week with a solution of 20:20:20 N:P:K (3 g l^{-1}). Plants were grown in a controlled environment room maintained at 23/18 +/- 1°C day/night with a 16-h photoperiod and average relative humidity of 45%. The intensity of light (400-725 nm) was constant at 450 uE.m^{-2}.s^{-1}.

Six weeks after planting or approximately 4 to 5 weeks after germination of the seed herbicide treatments were applied with a motorized laboratory hood sprayer equipped with a flat-fan nozzle calibrated to deliver 195 l ha^{-1} at 276 kPa. A flowable suspension formulation of linuron (450 g l^{-1}) was applied at doses of 62.5, 125, 250, 500, or 750 g ai ha^{-1}. Controls consisted of water sprayed plants. A visual rating of turf injury (0 to 100) was used, with 0 indicating healthy, green turf and 100 indicating brown, dead turf. The percentage of the pot covered with turf and injury ratings were made at one week intervals commencing after herbicide application. Fresh and dry weights of harvested turf clippings were determined at two week intervals after treatment. Each experiment was terminated six weeks after treatment.

Four replicate pots of turf were used per treatment and the experiment was repeated three times. In some cases the data from two representative replications of an entire experiment are presented separately, whereas in other cases the data from all replications of an entire experiment were pooled. In all cases, data were subjected to an completely randomized analysis of variance and regression analysis. Means were separated using a Fisher's protected LSD ($P<0.05$ and $P<0.01$). Where necessary, an analysis of covariance was conducted to test the equality of the line slopes and elevations of two linear regression equations.

Field experiments. Research was conducted at the Cambridge Research Station, Cambridge, Ontario, Canada on a sandy loam with 63% sand, 26% silt, 11% clay, 2% organic matter and pH 7.2. Four adjacent blocks (10m width x 19m depth) were each subdivided into twenty-three strips (1m x 10m) extending across the width of each block. Each strip (1m x10m) of soil was seeded with 122 to 146 kg ha^{-1} of one of nineteen varieties of Kentucky bluegrass which included: A-34, America, Banff, Barblue, Baron, Bronco, Cheri, Fylking, Gnome, Haga, Julia, Majestic, Midnight, Nallo, Nassau, Nugget, Ram I, Sydsport, and Touchdown. Seeding occurred on June 10, 1987 and a flowable suspension formulation of linuron (450 g l^{-1}) was applied on August 11, 1987. Following seeding, each block of turf again was subdivided into five strips (1m x 19m) extending the length of a block. One strip (1m x 19m) was treated with water and the remaining other strips (1m x 19m) received a dose of 1.0, 1.5, 2.0, and 2.5 kg ha^{-1} of the herbicide, respectively. Herbicide solutions were applied in water with a compressed air bicycle sprayer equipped with four flat-fan nozzles and calibrated to deliver 700 l ha^{-1} at 200 kPa.

At the time of seeding, phosphate fertilizer was applied at a dose of 50.8 kg ha^{-1} to the experimental area to stimulate root development. The area was fertilized again at germination with potassium and nitrogen (ammonium nitrate) both applied at 50.8 kg ha^{-1}. Three weeks after herbicide application the plots were fertilized with 25:4:10 N:P:K at 50.8 kg ha^{-1}. The turf was maintained at a 2.5 cm cutting height and clippings were removed from the plots. The experimental area was irrigated as required. The experiment was designed as a randomized split block with four replications. Plot size was 1m by 1m. The percentage ground cover of each Kentucky bluegrass variety in the treated plots was compared to the percentage ground cover of the respective Kentucky bluegrass variety in the untreated plot in each block. A visual rating of turf injury (0 to 100) was used, with 0 indicating healthy, green turf and 100 indicating brown, dead turf.

Data were subjected to a Freeman Tukey's arcsin transformation and then to an analysis of variance. Treatment means for each variety of Kentucky bluegrass were separated using a protected least significant difference range test at the 0.05 probability level.

RESULTS AND DISCUSSION

In preliminary experiments conducted under controlled environment growth room conditions 500 and 750 g ai/ha doses of linuron gave excellent control of annual bluegrass and yet had little or no effect in terms of injury or reduction in fresh and dry weight accumulation after application to Nugget Kentucky bluegrass (Fig. 1). Based on these results, we felt that linuron probably could be used as a selective postemergence herbicide for the eradication of annual bluegrass infestations in various cultivars of established Kentucky bluegrass.

With these results in mind, eight commercial cultivars of Kentucky bluegrass which included Nugget, Cheri, Dormie, Ram, Fylking, Banff, Touchdown, and America were selected to determine whether they responded in a similar manner to linuron under growth room conditions. Six weeks after application of 500 g/ha of linuron, there was less that a 25% reduction in the dry weight of clippings of all cultivars except Fylking (Table 1). When a 750 g/ha dose was applied to the cultivars there was greater reduction in clipping dry weights with America being the most sensitive cultivar (Table 1). Although the clipping weights were significantly different than the clipping weights of the non-treated controls there was no stand reduction or visible injury six weeks after application of 500 or 750 g/ha of linuron. In contrast, the clipping weights of annual bluegrass were reduced by more than 80% after application of 500 and 750 g/ha of linuron. Furthermore, there was severe damage to the annual bluegrass and the stand density was severely reduced (Table 1).

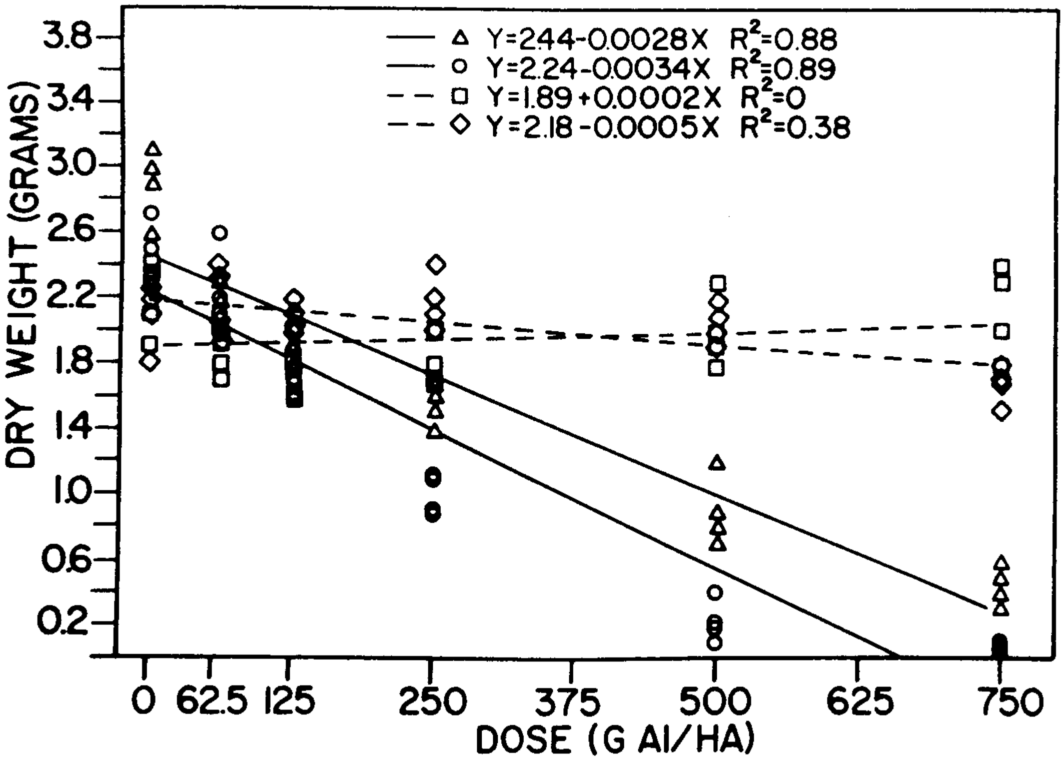

Figure 1. Effect of linuron concentrations on the total dry weights of clippings taken from annual bluegrass (expt #1, -Δ-; expt #2, -o-) and the Kentucky bluegrass variety Nugget (expt #1, ---□---, expt #2, ---<>---). Total clipping weights were determined by summing clipping weights taken 2, 4 and 6 weeks after application of a specific linuron dose.

Table 1. Comparisons of total clipping dry weights, expresses as a percentage of control, among eight varieties of Kentucky bluegrass and one type of annual bluegrass after application of 500 or 750 g ai ha^{-1} of linuron[1].

Variety	Dry weight (% of control)[2]	
	Linuron at 500 g ha^{-1}	Linuron at 750 g ha^{-1}
Nugget	79 b	62 bc
Dormie	104 a	96 a
Cheri	80 b	61 bcd
Ram	83 b	73 bc
Fylking	67 b	62 bc
Banff	77 b	57 cd
Touchdown	74 b	80 ab
America	74 b	42 d
Annual bluegrass	22 c	18 e
LSD	16	19

[1]Total clipping dry weight was determined by summing the clipping dry weights taken 2, 4 and 6 weeks after application of the various linuron doses.

[2] Means followed by the same letter(s) are not significantly different at the 5% level according to a Fisher's protected LSD range test.

Although the clipping weights of all eight cultivars were reduced over the six week period after application of 750 g/ha of linuron, it is important to realize that weights were taken 2, 4, and 6 weeks after treatment and added together to determine the total dry weight reduction over the entire six week interval after treatment. Most of the reduction dry weight of the eight Kentucky bluegrass cultivars (Table 1, Figure 2D) reflects the effect of the herbicide on growth during the 0 to 2 and 2 to 4 week period after application of linuron (Figure 2A and 2B). There was little or no difference between the clipping weights of controls and those varieties treated with 750 g/ha of linuron in the 4 to 6 week time interval (Figure 2B and 2C). As stated earlier, it is important to remember that six weeks after application of 750 g/ha of linuron there were no visual injury symptoms or stand density reductions in any of the eight cultivars that were treated.

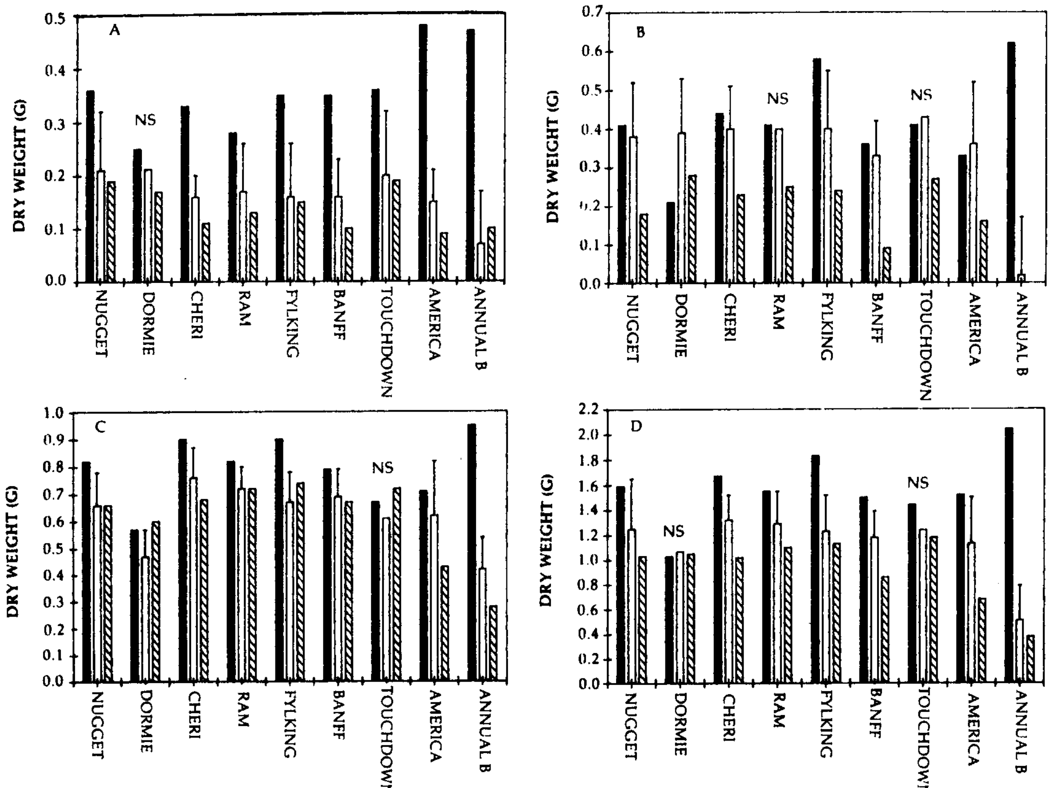

Figure 2. Clipping dry weights of eight Kentucky bluegrass varieties and one type of annual bluegrass after application of water (■), 500 g ha⁻¹ (□) or 750 g ha⁻¹ (▨) of linuron. Harvest intervals for dry weight determinations were 0 to 2 (Fig. 2A), 2 to 4 (Fig. 2B) and 4 to 6 (Fig. 2C) weeks after treatment. Fig. 2D represents the total dry weight which was determined by summing the data from Figs. 2A, 2B and 2C. Vertical bars represent Fisher's protected l.s.d. 0.05 value for comparison of treatment effects within a variety of species.

Based on the above information, it is apparent that annual bluegrass infestations can be selectively removed from various cultivars of Kentucky bluegrass with postemergence applications of linuron. Although there may be some short term injury and growth reduction in the Kentucky bluegrass cultivars during a three to four week period immediately after application of the herbicide, the cultivars will recover with little or no long term injury. Based on the success of the controlled environment growth room experiments the efficacy of linuron for the selective removal of annual bluegrass from Kentucky bluegrass swards was investigated under field conditions at the Cambridge Research Station. In these field experiments, linuron was applied at higher doses than those used under the more ideal circumstances in the controlled environment growth room conditions.

In all cases, linuron effectively reduced or eliminated infestations of annual bluegrass in established Kentucky bluegrass swards during the 1987, 1988, and 1989 field seasons (Table 2). The Kentucky bluegrass used in these experiments had been established for at least one year prior to treatment. Little or no apparent injury was seen when the plots were treated in early May to June when growing conditions were optimal; that is the temperatures were not extreme and there was

Table 2. Percentage reduction in the density of annual bluegrass infestations in established Kentucky bluegrass swards during the 1987, 1988, and 1989 field seasons. Plots were established at the Cambridge Research Station, Cambridge, Ontario.

Treatment	Dose (kg ai/ha)	Number of weeks after linuron application[1]			
		0 WAT	1 WAT	3 WAT	4 WAT
		(% reduction in annual bluegrass)			
1987 FIELD SEASON - May Application					
Control		100	100	100	100
Linuron	1.5	100	32	20	20
Linuron	1.75	100	25	17	17
Linuron	2.0	100	20	4	4
		(% reduction in annual bluegrass)			
1987 FIELD SEASON - July Application					
Control		100 (0)	100 (0)	100 (0)	100 (0)
Linuron	1.5	100 (0)	50 (6)	50 (1)	50 (0)
Linuron	1.75	100 (0)	10 (6)	10 (2)	10 (0)
Linuron	2.0	100 (0)	6 (6)	6 (3)	6 (0)
		(% reduction in annual bluegrass)			
1988 FIELD SEASON - May Application					
Control		100	100	100	100
Linuron	1.5	100	25	47	65
Linuron	1.75	100	25	25	10
Linuron	2.0	100	20	20	24
		(% reduction in annual bluegrass)			
1989 FIELD SEASON - May Application					
Control		100	100	100	100
Linuron	1.5	100	71	43	43
Linuron	1.75	100	71	14	14
Linuron	2.0	100	34	5	8
Linuron	2.5	100	14	0	0

[1]Numbers in brackets represent the injury rating based on a scale of 0 to 10. Where no injury ratings are recorded, there was no visible injury apparent for the duration of the experiment.

drought stress. It is important to note that this is also the time when annual bluegrass is in its most prolific growth and development stage. The most effective doses of linuron were found in the range of 1.5 to 2.5 kg ai/ha. In those cases where injury was apparent of the Kentucky bluegrass, the turf recovered within four to five weeks after treatment with no stand reduction. Furthermore, Kentucky bluegrass turf can be safely overseeded with within two weeks after application of linuron without any reduction in germination.

In other experiments, it was determined that the control of annual bluegrass was reduced when linuron was applied in summer (late June to mid August) when there was moderate to severe drought and temperature stress on both Kentucky and annual bluegrass.

Fifteen cultivars of newly seeded and established stands of Kentucky bluegrass which included the cultivars Fylking, A-34, Nassau, Julia, Gnome, Baron, Majestic, America, Touchdown, Nugget, Cheri, Barblue, Sydsport, and Haga were treated with doses of linuron ranging from 1.0 to 2.5 kg ai/ha. The established stands were seeded in the previous summer one year before the herbicide was applied whereas the newly seeded varieties were treated two months after seeding. In the established cultivars, there was no injury after application of 1.0 and 1.5 kg ai/ha. There was some short term injury which lasted for two weeks in the established cultivars that were treated with 2.0 and 2.5 kg ai/ha. Injury symptoms included some tip burn of the grass blades and slight yellowing of the grass. Three weeks after treatment of the established stands there was no visible injury and no stand reduction was observed. After application of 1.0 and 1.5 kg ai/ha of linuron to the newly seeded cultivars the injury was similar to that observed in the established cultivars treated with 2.0 and 2.5 kg ai/ha with cultivars showing no injury or stand reduction three to four weeks after treatment. Injury was more severe to the newly seeded cultivars treated with 2.0 and 2.5 kg ai/ha with moderate to severe tip burn and yellowing being evident one to two weeks after treatment. However, six to seven weeks after treatment all the cultivars completely recovered, being no different than untreated control plots in term of stand density and turf quality.

CONCLUSION

Under field conditions, linuron doses ranging from 1.5 to 2.0 kg ai/ha can be selectively used to provide postemergence control of annual bluegrass infestations in newly seeded and established Kentucky bluegrass swards. Linuron is most effective when applied in mid May to early June when the growth conditions in terms of moisture and temperature are optimal. Later application in the season are not recommended because severe moisture and temperature stress may cause unacceptable long term damage to Kentucky bluegrass swards. Furthermore, mid summer applications of linuron are not recommended because annual bluegrass is too well established by this time in the season for effective control with linuron.

ECONOMIC BENEFITS

Ontario sod producers are known throughout North America and indeed the world for their excellence in producing high quality sod. These producers are under considerable pressure to produce extremely high quality Kentucky bluegrass sod for the multi-billion dollar landscape industry across Canada and the Northeastern portion of the United States. With current technologies available in the area disease and broadleaf weed control they have been able to eliminate or minimize many of their production problems. However, one of the sod industries major weed problems over the past three decades has been annual bluegrass infestations in Kentucky bluegrass. Therefore, the reduction or elimination of annual bluegrass infestations with linuron may help to reduce or eliminate one of this industries major production problems.

ACKNOWLEDGEMENTS

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TURFGRASS PATHOLOGY

EVALUATION OF SPRING APPLICATION OF INSECTICIDES FOR CONTROL OF EUROPEAN CHAFER

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This experiment was designed to evaluate the efficiency of a spring application of various insecticides for the control of European Chafer. There is concern that some populations of chafer are becoming resistant to pesticides registered for control of this pest. This research study was conducted to assess possible resistance in Galt and Kilbride, Ontario, and to determine the effectiveness of experimental pesticides.

RESEARCH PROCEDURE

Treatments (Table 1) were applied to turfgrass fairways in two locations at Galt and Kilbride, Ontario. Treatments were replicated four times on plots (2 x 5 m) arranged in a randomized complete block design. Liquid formulations were applied with a hand-held CO_2-pressurized spray boom with four TJ8004 nozzles. The volume delivered was 500 L/ha (200 mL per plot) at 200 kPa. Granular products were weighed, placed in a 2 L bottle and evenly distributed over the plot through a fan-shaped funnel attached to the bottle.

Applications were made on 28 April between 1800 and 2200 h. All treatments were irrigated with 1 cm of water two hours after application at Galt and 14 hours after application at Kilbride. Thatch thickness was between 1.5 and 2 cm at Galt and <1 cm at Kilbride. Three samples (0.1 m^2) were taken in each plot by lifting the sod and inspecting the roots and underlying soil for live and dead grubs. Pre-treatment densities of grubs (entirely 3rd instar) were 6.9 per 0.1 m^2 at Galt and 10.0 per 0.1 m^2 at Kilbride.

RESULTS

Table 1. Insecticides, formulations and rates of application for evaluation of control of European Chafer.

Treatment	Rate kg ai/ha	Amount per 40 m^2	Live grubs per 0.1 m^2			
			Kilbride		Galt	
			May 16	May 26	May 10	May 25
Check	-	-	13.5 bc	10.8 bc	14.3 a	8.8 b
Diazinon 300 CS	7.5	100 ml	13.8 bc	5.8 ab	9.0 a	5.5 a
Triumph 480 L	2.3	19.2 ml	4.5 a	2.5 a	11.5 a	3.5 ab
Triumph 10 G	2.3	92 gm	4.3 a	3.5 ab	10.8 a	2.8 a
GXS 8743	15.0 L	60 ml	17.8 c	8.5 abc	13.8 a	3.3 a
GXS 8743	20.0 L	80 ml	16.3 c	15.0 c	15.3 a	6.3 ab
Basudin 500 EC	7.5	60 ml	8.3 ab	4.3 ab	9.0 a	3.5 ab
Basudin 500 EC	7.5	60 ml	10.0 abc	5.3 ab	8.3 a	2.0 a
Banisect 100 EC	2.0	80 ml	15.3 bc	10.0 abc	13.5 a	2.8 a
Dylox 420 EC	9.0	85.7 ml	10.0 abc	7.8 abc	11.0 a	6.3 ab
Diazinon 5 G	7.5	600 gm	10.5 abc	5.3 ab	12.8 a	5.3 ab
LSD 5%			6.9	6.5	11.2	4.6
CV %			42.7	62.8	66.3	70.3

CONCLUSIONS

Triumph 10 G, Basudin 500 EC, Banisect 100 EC, and possibly the insecticidal soap GXS 8743 provided some control of grubs 27 days after application at Galt (Table 1). At Kilbride, only Triumph 480 L and 10 G significantly reduced the number of live grubs 18 days after application, and by 28 days after application only plots treated with Triumph 480 L had fewer live grubs than the control plots (Table 1). Results were variable due to the small number of samples relative to the clumped dispersion of the grubs in the plots.

CONTROL OF DOLLARSPOT OF CREEPING BENTGRASS - 1989

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Dept. of Environmental Biology

PATHOGEN

Sclerotinia homeocarpa

METHODS

Treatments were applied to a 12-year-old sward of creeping bentgrass. 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. Treatments were applied on 18 September in 7 L of water per 100 m^2 with a wheelmounted compressed air boom sprayer at 138 kPa. The turfgrass was inoculated with autoclaved rye-grain infested with *S. homeocarpa* on 19 September. Disease intensity was estimated on 26 September and 3 October. Location: Cambridge, Ontario.

RESULTS

Disease intensity values are listed in the table below.

Treatment	Rate (g. ai/100m^2)	DISEASE INTENSITY (%)	
		7 days	14 days
HWG 1608	1.9	1.8 A*	2.3 A
HWG 1608	3.8	0.0 A	0.6 A
DYRENE 4 F	5.2	2.9 A	4.1 B
DYRENE 4 F	10.4	1.8 A	4.1 B
DYRENE 50 WP	62.5	2.9 A	4.7 B
DYRENE 50 WP	125.0	1.8 A	3.5 B
FORE 80 WP	200.0	2.9 A	5.8 B
BANNER EC	3.9	0.0 A	0.6 A
BANNER EC	7.8	0.0 A	0.0 A
NITROFORM+BANNER	153.0N+8.0	2.9 A	3.5 B
NITROFORM	153.0N	7.0 B	8.2 C
BANNER+FERTILIZER	1.7+45.7N	1.8 A	2.3 A
BANNER+FERTILIZER	3.4+91.5N	0.0 A	0.0 A
DACONIL+BANNER+FERTILIZER	18.3+.8+43.7N	1.8 A	4.1 B
DACONIL+BANNER+FERTILIZER	36.7+1.5+87.3N	1.2 A	1.2 A
DACONIL 2787	51	2.3 A	4.1 B
EASOUT+FERTILIZER	8.5+45.6N	1.2 A	0.6 A
EASOUT+FERTILIZER	17.0+91.0N	1.2 A	0.6 A
UNTREATED CHECK	-	7.6 B	10.5 C

* Values followed by the same letter are not significantly different according to cluster analysis.

CONCLUSIONS

All treatments except nitroform provided acceptable control (< 3% disease) of dollarspot for 7 days. HWG 1608 at 1.9 or 3.8 g a.i. 100 m^2, Banner at 3.9 or 7.8 g a.i., Banner + Fertilizer at 1.7 g a.i. + 45.7 g N or 3.4 g a.i. + 91.5 g N, Daconil + Banner + Fertilizer at 36.7 g a.i. + 1.5 g a.i. + 87.3 g N, and Easout + Banner at 8.5 g a.i. + 45.6 g N or 17.0 g a.i. + 91.0 g N provided acceptable control of dollarspot for 14 days.

CONTROL OF BROWN PATCH OF CREEPING BENTGRASS - 1989

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Dept. of Environmental Biology

PATHOGEN

Rhizoctonia solani

METHODS

Treatments were applied to a 12-year-old sward of creeping bentgrass. 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. Treatments were applied on 24 July in 7 L of water per 100 m^2 with a wheelmounted compressed air boom sprayer at 138 kPa. The turfgrass was inoculated with autoclaved rye-grain infested with *R. solani* on 25 July and 1 August. Disease intensity was estimated on 1 and 8 August. Location: Cambridge, Ontario.

RESULTS

Disease intensity values are listed in the table below.

Treatment	Rate(ai/100 m^2)	DISEASE INTENSITY (%) 7 days	DISEASE INTENSITY (%) 14 days
1) HWG 1608 45 DF	7.5 g	1.17 A*	50.00 A
2) HWG 1608 45 DF	14.9 g	1.17 A	62.50 A
3) DYRENE 4 F	62.2 g	57.42 B	50.00 A
4) DYRENE 4 F	124.5 g	60.94 B	50.00 A
5) DYRENE 50 WP	62.5 g	60.94 B	25.78 A
6) DYRENE 50 WP	125.0 g	21.48 A	51.56 A
7) FORE (Mancozeb 80%)	200.0 g	21.09 A	54.69 A
8) BANNER + FERTILIZER	3.4 ml (+91.5 g N)	1.76 A	35.55 A
9) UNTREATED CHECK			

*Values followed by the same letter are not significantly different according to cluster analysis.

CONCLUSIONS

HWG 1608 at 7.5 g and 14.9 g a.i./100 m^2, Dyrene 50 WP at 125 g a.i./100 m^2, Fore at 200 g a.i./100 m^2 and Banner + Fertilizer signifcantly supressed brown patch for 7 days. None of the fungicides tested significantly suppressed disease for 14 days.

CONTROL OF PYTHIUM BLIGHT OF CREEPING BENTGRASS - 1989

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PATHOGEN

Pythium aphanidermatum

METHODS

Treatments were applied to a 12-year-old sward of creeping bentgrass. 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 L of water per 100 m^2 with a wheelmounted compressed air boom sprayer at 138 kPa. The granular formulation of Subdue was applied by hand in a jar with a perforated top. Treatments were applied on 5 July and the turfgrass was inoculated with autoclaved rye-grain infested with *P. aphanidermatum* on 6,13 and 20 July. Disease intensity was estimated on 13, 20 and 27 July. Location: Cambridge, Ontario.

RESULTS

Disease intensity values are listed in the table below.

Treatment	Rate (g ai/100 m^2)	DISEASE INTENSITY (%)		
		7 days	14 days	21 days
Subdue 2G	15	0.78 A*	0.00 A	0.00 A
Subdue 2E	15	0.00 A	0.00 A	0.00 A
Ridomil (MZ 72 WP)	140	0.00 A	0.00 A	0.00 A
Fore (Mancozeb 80%)	215.3	1.56 A	3.90 B	2.34 B
Lesan 35 WP	52.5	3.90 B	5.46 C	5.46 C
Check-untreated	-	2.34 B	3.12 B	3.12 B

* Values followed by the same letter are not significantly different according to cluster analysis.

CONCLUSIONS

Subdue (2 G and 2 E) and Ridomil provided 21 days control of Pythium blight. Fore controlled Pythium for 7 days. Lesan provided < 7 days control.

PESTICIDE RESIDUES

APPLICATOR AND BYSTANDER EXPOSURE TO 2,4-D IN HOME LANDSCAPE SITUATIONS

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1 INTRODUCTION

1.1 Home and landscape use of pesticides

A large number of households in Ontario use pesticides in one form or another. Common amongst these are garden pesticides used for controlling insects, fungi and weeds. During use, exposure to these pesticides may occur during mixing, application and/or cleaning of equipment. Several pesticides are used extensively in and around the home and, while exposure is probably infrequent, they are of concern because of the large number of persons who may be exposed to these chemicals. The herbicide 2,4-D is one of the most widely used chemicals in the home garden and in landscape weed control and the recent Panel Report pointed to the lack of adequate information on bystander and household exposure to this chemical.

1.2 Exposure study methodology

Two general methods of assessing exposure to pesticides have been used in the several existing studies on 2,4-D. These general methods make use of two techniques, one of which measures actual exposure via sampling of the several possible routes of entry of the pesticide and the other measures actual dose which penetrates into the body. The former method makes use of patches or other similar devices attached to parts of the body, personal air samplers and analysis of these then allows an estimation of the exposure on that particular part of the body. By extrapolation and the making of an assumption with regard to uptake via the skin, a dose may then be estimated. This method is useful in estimating exposure to different parts of the body but may miss important areas of exposure should a patch not be used in that location. It also fails to take into account variability in and lower-than-predicted rates of skin absorption. This method also involves several analyses per individual for each time period of exposure.

The method by which total body dose is measured depends on a good knowledge of the metabolism and pharmacokinetics of the pesticide in question. Measurement of excretion of the pesticide or a major metabolite will, in the case of certain pesticides, indicate the total dose absorbed by the body. This method gives a good estimation of the actual dose to which the body is exposed, a useful parameter for assessing possible toxicity, and requires fewer analyses. It also has the advantage that unknown routes of exposure are taken into consideration but it does not allow the verification of the relative importance of these routes. These studies also suggest that, in workers who use 2,4-D regularly, the amount excreted in the urine over a 24-hour period is a reliable measure of the absorbed systemic dose, provided that they have achieved steady state pharmacokinetics. Extraction of 2,4-D from urine is relatively easy and only a single analysis is needed for the period of observation. Because of the relevance of the dose absorbed and the reduced number of analyses, this method was used in this study.

1.3 Need for further study

The risk associated with exposure to a pesticide or any toxic substance is dependent on both the toxicity of the chemical in question and the dose which enters the exposed person. While many of the questions associated with toxicity and hazard may be addressed through the use of animal tests and procedures, the dose received by users of these substances is often poorly defined. Some exposure studies are required for registration purposes but these usually address exposure under conditions of farm or large-scale use of the pesticide. Very little information is available on exposure of homeowners and the general public to pesticides and even less is known of bystander exposure under these use conditions. This was the basis upon which this study was initiated.

2 METHODS FOR THIS STUDY

2.1 Homeowners

2.1.1 Selection of volunteers

Initial contact of all volunteers was made by telephone. Interested persons were sent letters outlining the research project and to ask for cooperation. Upon receipt of replies, the participants were contacted to arrange a possible date and time for application. All applications which were cancelled due to weather or other various reasons were rescheduled.

Forty-four volunteers were selected to participate in the exposure study (22 applicators and 22 bystanders). The volunteers were randomly split into two groups (protective and non-protective) before applications commenced. Four volunteers withdrew from the study for personal reasons, leaving forty participants.

Each applicator agreed to apply a Weed-N-Feed fertilizer in the spring and a liquid formulation of 2,4-D in the fall. Both applicator and bystander agreed to supply four day urine samples following both the spring and fall application, under suitable conditions of anonymity.

2.1.2 Air sampling

Air sampling pumps (Gilian Model HFS 113A) connected to absorption tubes via 1.5 metres of TYGON tubing (R-3603 or equivalent) were calibrated using a bubble flow meter and set to draw air at a rate of 1 L/minute. The calibration of each pump was verified before each application. Absorption tubes were made by filling capillary pipettes with 2 g of florisil (60 mesh) and stopped at both ends with glass wool. Absorption tubes were stored in capped KIMAX test tubes until needed.

Prior to each application, two air sampling pumps connected to absorption tubes were set up, one in the front hallway of the house and one downwind of the application site within 3 metres of the property line. Sampling pumps were run from approximately ten minutes before and up to thirty minutes after each application. All sampling times were recorded.

At the end of each application, one new absorption tube was spiked at the field site with 2.2 μg 2,4-D acid dissolved in methanol using a 100 μl Eppendorf pipette, to serve as a field recovery check. All absorption tubes were returned to their original containers and stored in the freezer until extraction the following day.

2.1.3 Applications

Eleven applicators (and eleven bystanders) were selected to participate in the protective group. This group was given verbal instruction regarding measuring, mixing, application, disposal of containers and cleaning of equipment prior to and during the application. Clean overalls, gloves and rubber boots were supplied to the applicator before any equipment or pesticides were handled. The applicator was instructed to keep the additional clothing on until the end of the application.

The nine applicators (and nine bystanders) in the non-protective or control group wore what they normally would for pesticide application and were allowed to apply the pesticide as they normally would. Only minimal verbal instructions were given if requested. Clothing and footwear worn during the application was noted.

A Weed-N-Feed formulation (Beaver Lumber, 10-6-4) with 1% 2,4-D was used for the spring application. If necessary, a professional Scott's 36 inch drop spreader was supplied for the larger properties and a 24 inch True Temper (Cyclone) drop spreader was used on smaller properties. The application equipment used in all cases was noted. A liquid formulation of 2,4-D (Mastercraft Dandelion Killer, 250 g/L 2,4-D amine) was used for the fall application and all applicators were supplied with a clean hose-end sprayer (Green Cross Dial-A-Spray). One hundred and fifty feet of hose which was rinsed after each use was available to the applicators to reach the far ends of their properties if necessary.

All measuring and mixing and portions of spreading or spraying were videotaped for later visual review. Videotapes were transferred to VHS tape. Information regarding product used, rates, area treated, weather, applicator and bystander sex, age and weight was recorded after application.

2.1.4 Biological monitoring

To check for pre-exposure, a morning urine sample was obtained from both the applicator and the bystander on the day of application and was stored in the refrigerator in 500 ml NALGENE bottles until picked up that afternoon or evening. Shortly after the application, sub-samples of approximately 100 ml were taken from the morning pre-exposure samples supplied and were spiked with 11 μg 2,4-D acid dissolved in methanol to serve as field recovery checks. Spikes were stored in 125 or 500 ml NALGENE bottles and were returned to the volunteers after application. Volunteers were instructed to store the spiked samples with their day-1 samples either in the refrigerator or in supplied styrofoam coolers with frozen ice packs.

Immediately following application, both the applicator and the bystander were instructed to collect all urine for a consecutive 4 day period. A minimum of 4 clearly labelled 2 1 NALGENE bottles were supplied to each volunteer, one or more for each day. For ease of collection, volunteers were instructed to void all samples immediately following application until 8:00 or 9:00 am the following day. This day-1 period varied from 12 to 24 hours depending on the time of application. The day-1 sample period for each volunteer was recorded. Day 2 to day 4 samples were collected over 24 hour periods and picked up each day at the home or work address.

Upon arrival in the laboratory, all samples (pre-exposure, spike, day 1,2,3 and 4) were measured and 5 ml sub-samples were taken and stored in the freezer for later use in radioimmunoassay. Sub-samples of 1 ml each were taken from day 1, 2, 3 and 4 samples and sent to MDS Laboratories for urinary creatinine analysis to verify compliance of complete urinary collections.

2.2 Professional Applicator Exposure

2.2.1 Selection of Volunteers

A professional lawn care company representative of the industry in Ontario was asked to participate in the study. Agreement from managers/owners from two locations was obtained. Five lawn care technicians from the Guelph area and seven technicians (including one mixer/loader) from the Kitchener location agreed to participate in the study.

2.2.2 Biological monitoring

Prior to the commencement of spraying in the spring (Guelph location), and in the fall (Kitchener area), a pre-exposure morning urine sample was collected from each participant on the first day of the study. Full, daily samples were collected from each of the technicians for a period of 14 days including week-ends or days off. The technicians were instructed to store their urine samples in the supplied cooler bags with frozen ice packs while at work and in the refrigerator while at home overnight. Frozen ice packs were supplied each day of the study.

Field recovery spikes of 100 µl of 0.11 mg/ml 2,4-D acid in methanol in approximately 100 ml of urine were done to verify % recovery of 2,4-D in 1, 2 and 3 day samples that were not possible to collect (i.e. long weekend, holiday). If possible all samples were picked up each day and extracted that same day.

Sub-samples of 1 ml and 5 ml were taken from each daily sample provided by the technicians and frozen for use in creatinine analysis and radioimmunoassay. Records of the amount of 2,4-D (g a.i.) sprayed were kept for each technician throughout the 14 day period. All technicians were asked to supply information regarding application procedures, sex, age and weight.

2.3 Bystander Exposure - Professional Application

2.3.1 Selection volunteers

Ten volunteers were selected in the Guelph area to participate in the bystander exposure portion of the study. Three volunteers withdrew from the study for personal reasons, leaving three more applications to be done in spring 1990. All professional applications were set up to be completed in one day by one applicator.

2.3.2 Air sampling

Air sampling methods were conducted as stated in section 2.1.2. Samplers were set up immediately prior to each application and left running for a period of up to 15 minutes following completion of professional application.

2.3.3 Applications

Once air samplers were running, the technician was free to apply the pesticide in the manner in which he had been trained. Portions of the spraying were videotaped for later visual review. After each application, the property was measured and a sign was posted indicating pesticide application.

Records on trade name and formulation of product were taken. Tank dip measurements recorded by the technician were used to estimate the amount of pesticide sprayed on each property.

2.4 Biological Monitoring

The urine sampling procedures were those of the home-owner exposure procedures addressed in section 2.1.4

3 ANALYTICAL METHODS FOR 2,4-D

3.1 Materials

3.1.1 Chemicals and Materials

All solvents were of pesticide grade (Caledon Laboratories Ltd., Georgetown, Ont., Canada). The analytical standard of 2,4-D was obtained from Sigma Chemical Company (P.O. Box 14508, St. Louis, Mo 63178).

3.1.2 Extraction

3.1.2.1 Water

One litre of water containing 2,4-D was acidified with 2.5 ml of 1:1 H_2SO_4 and extracted twice with 50 mL of diethyl ether. The ether extracts were combined and dried with Na_2SO_4 and evaporated to dryness.

3.1.2.2 Urine

Urine samples (50 mL) were first hydrolysed with 250 mL of 0.1 N NaOH for 40 min at 70^o and washed three times with 50 mL of dichloromethane/hexane (20:80, v/v). The aqueous portions of each urine extraction were then processed as the waters.

3.1.2.3 Esterification

The herbicide residues were esterified with boron trifluoride in methanol (14% BF_3) at 90^{o}C for 30 min. The methyl esters of the herbicide were extracted with three x 5 ml petroleum ether and 25 ml distilled water was added to the mixture to remove the excess boron trifluoride. The petroleum ether extracts were dried with anhydrous Na_2SO_4 and the total volume adjusted to 5 mL by evaporation. Isooctane was added as a keeper.

3.1.3 Gas chromatography

Either a Tracor 550 and a Varian 3700 gas chromatograph equipped with an electron capture (^{63}Ni) detector was used to quantitate herbicide residues. The gas chromatographic column was a glass column, 2 mm I.D. x 2 m in length, packed with 3% OV 17 on GasChrom Q. The temperature was kept isothermal at 180 the detector at 300 and the injector at 200^{o}C. The peak heights obtained in each fortified sample or unknown sample were quantitated relative to peak heights obtained for a known quantity of 2,4-D (a stock of 1000 μg/L was diluted to a working concentration of 0.1 μg/L.

4 PRELIMINARY RESULTS FROM ANALYSES

To date more than 400 of the urine and air samples have been analyzed. Preliminary results indicate that the exposure of professional spray applicators is similar to that reported in the Yeary study conducted in the USA. Exposure has been noted in some homeowners but most are at or below the level of detection. No 2,4-D residues have been found in the air samples analyzed to date. It is expected that all the samples will be analyzed by spring 1990. All samples that show trace or detectable levels of 2,4-D by gas liquid chromatographic analysis will be reanalysed by a new immuno-assay method. Research plans for 1990 include human exposure studies for insecticides as well as herbicides that are important in turf.

5 REFERENCES

Yeary, R.A. 1986. Urinary excretion of 2,4-D in commercial lawn specialists. Applied Industrial Hygiene, 1: 119-121.

EVALUATIONS OF SPECIES AND CULTIVARS

FINE FESCUE AND TALL FESCUE CULTIVAR EVALUATION

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Fine and tall fescue cultivars (seeded in 1986) are being assessed for general appearance (uniformity and density), color, resistance to weed infestation, disease, and drought stress. Rankings based on data through 1989 are given in Tables 1 through 4.

Table 1. Turf color[a] of fescue cultivars.

Cultivar	Color
Spartan	7.6a
Fortress	7.5ab
Scarlet	7.5ab
Scaldis	7.3abc
Peremid T	7.1bcd
Wilma	7.1bcde
Luster	7.0cdef
Jamestown	7.0cdef
Victory	7.0cdef
Biljart	7.0cdef
Banner	6.9cdefg
Common creeping	6.7defgh
Rebel II T	6.7defgh
Atlanta	6.7efgh
Mustang T	6.6fgh
Azay	6.5gh
Center	6.5gh
Epsom	6.3h
Rebel T	6.3h
Clemfine T	5.8i
Kentucky 31 T	5.7i

[a] Visual rating 0 9, 5 = acceptable color. Data are means of 16 evaluation dates.
T - Tall fescue cultivars.

Table 2. Turf general appearance[a] of fescue cultivars.

Cultivar		General appearance
Epsom		7.4 a
Rebel II	T	7.4 a
Mustang	T	7.2 a
Rebel	T	7.0 ab
Scarlet		7.0 ab
Victory		7.0 ab
Center		6.9 ab
Atlanta		6.8 ab
Jamestown		6.8 ab
Wilma		6.7 abc
Banner		6.3 bcd
Peremid	T	6.2 bcde
Luster		6.1 bcde
Spartan		5.8 cdef
Clemfine	T	5.8 cdef
Biljart		5.8 cdef
Kentucky 31	T	5.6 def
Scaldis		5.5 def
Fortress		5.4 def
Common creeping		5.3 ef
Azay		5.1 f

[a] Visual rating 0 9, 5 = acceptable appearance. Data are means of 14 evaluation dates.
T - Tall fescue cultivars.

Table 3. Mower shredding[a] of fescue cultivars.

Cultivar		Shredding
Scarlet		0.3 d
Mustang	T	0.5 cd
Epsom		0.5 cd
Kentucky 31	T	0.5 cd
Rebel II	T	0.5 cd
Peremid	T	0.5 cd
Atlanta		0.5 cd
Biljart		0.7 bcd
Center		0.8 abcd
Clemfine	T	0.8 abcd
Rebel	T	0.8 abcd
Common creeping		1.0 abcd
Luster		1.2 abcd
Fortress		1.2 abcd
Azay		1.2 abcd
Wilma		1.2 abcd
Spartan		1.2 abcd
Jamestown		1.3 abc
Banner		1.6 ab
Victory		1.7 ab
Scaldis		1.8 a

[a] Visual rating 0 2, 0 = none, 2 = worst. Data are means of 2 evaluation dates.
T - Tall fescue cultivars.

Table 4. Weed infestation[a] of fescue cultivars.

Cultivar		Weed infestation
Rebel	T	0.5 f
Rebel II	T	1.2 ef
Atlanta		2.0 def
Mustang	T	2.1 def
Center		2.4 cdef
Clemfine	T	2.6 cdef
Scarlet		2.6 cdef
Wilma		2.8 cde
Victory		3.0 bcde
Banner		3.0 bcde
Kentucky 31	T	3.0 bcde
Epsom		3.2 bcde
Jamestown		3.2 bcde
Spartan		3.6 abcd
Peremid	T	3.7 abcd
Luster		3.9 abcd
Biljart		4.2 abcd
Scaldis		4.7 abc
Fortress		5.2 ab
Common creeping		5.6 a
Azay		5.8 a

[a] Visual rating 0 10, 0 = none, 10 = 50% weed. Data are means of 7 evaluation dates.
T - Tall fescue cultivars.

KENTUCKY BLUEGRASS CULTIVAR EVALUATION

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Kentucky bluegrass cultivars (seeded in 1987 and 1988) are being assessed for general appearance (uniformity and density), color, resistance to weed infestation, disease, and drought stress. Rankings based on data through 1989 are given in Tables 1 through 3 (1987 seedings) and Tables 4 through 6 (1988 seedings).

Table 1. Color[a] of Kentucky bluegrass cultivars (seeded 1987).

Cultivar	Color
Midnight	8.6
Ram I	7.5
Nassau	7.5
America	7.4
Barblue	7.4
Majestic	7.4
Alpine	7.3
Gnome	7.2
Baron	7.1
Nugget	7.1
Cheri	7.0
Touchdown	6.9
Haga	6.8
Sydsport	6.7
Banff	6.6
Julia	6.6
Fylking	6.6
Bronco	6.6
Nallo	6.5
A 34	6.0
LSD 5%	0.51

[a] Visual rating 0 9, 5 = acceptable color. Data are means of 2 replicates and 21 evaluation dates.

Table 2. General appearance[a] of Kentucky bluegrass cultivars (seeded 1987).

Cultivar	General appearance
Touchdown	7.7
Barblue	7.6
America	7.4
Midnight	7.3
Banff	7.3
A 34	7.3
Haga	7.2
Gnome	7.1
Bronco	7.1
Nallo	7.0
Baron	7.0
Cheri	7.0
Nugget	6.9
Alpine	6.9
Sydsport	6.8
Julia	6.8
Ram I	6.7
Majestic	6.7
Fylking	6.5
Nassau	6.4
LSD 5%	0.55

[a] Visual rating 0 9, 5 = acceptable appearance. Data are means of 2 replicates and 9 evaluation dates

Table 3. Weed infestation[a] in Kentucky bluegrass cultivars (seeded 1987).

Cultivar	Weeds
Gnome	8.0
Baron	6.5
Midnight	6.5
Barblue	6.0
America	6.0
Majestic	6.0
Cheri	6.0
Nassau	5.5
Alpine	5.0
Bronco	4.5
Nugget	4.5
Haga	4.5
Nallo	4.5
A 34	4.0
Sydsport	4.0
Banff	3.5
Julia	3.5
Ram I	3.5
Fylking	3.0
Touchdown	1.0
LSD 5%	4.64

[a] Visual rating 0 10, 0 = none, 10 = 50% weed. Data are means of 2 replicates and 2 evaluation dates

Table 4. Germination[a] of Kentucky bluegrass cultivars (seeded 1988).

Cultivar	Germination
A 34	5.0
Baron	5.0
America	5.0
Haga	5.0
Julia	5.0
Cheri	5.0
Nassau	5.0
Regent	5.0
Liberty	4.5
Eclipse	4.5
Banff	4.5
Midnight	4.5
Majestic	4.5
Sydsport	4.0
Touchdown	4.0
Gnome	4.0
Fylking	3.5
Alpine	3.0
Barblue	3.0
Nugget	2.5
Freedom	1.5
LSD 5%	1.43

[a] Visual rating 0 5, 5 = complete germination. Data are means of 2 replicates, evaluated 88/06/21.

Table 5. Color[a] of Kentucky bluegrass cultivars (seeded 1988).

Cultivar	Color
Midnight	7.7
Freedom	7.4
Touchdown	7.4
Gnome	7.4
Alpine	7.2
Baron	7.1
Majestic	7.1
Nassau	7.1
America	7.1
Sydsport	7.0
Barblue	7.0
Eclipse	6.9
Haga	6.7
Nugget	6.7
Cheri	6.7
Liberty	6.7
Julia	6.6
Regent	6.4
A 34	6.4
Fylking	6.3
Banff	6.3
LSD 5%	0.58

[a] Visual rating 0 9, 5 = acceptable color. Data are means of 2 replicates and 7 evaluation dates.

Table 6. General appearance[a] of Kentucky bluegrass cultivars (seeded 1988).

Cultivar	General appearance
Alpine	8.5
Touchdown	8.3
Sydsport	8.0
Barblue	7.8
Fylking	7.8
Majestic	7.6
Freedom	7.5
Haga	7.5
Cheri	7.4
Liberty	7.4
A 34	7.1
Banff	7.1
Nugget	7.1
Gnome	7.0
Midnight	7.0
Baron	6.9
America	6.8
Eclipse	6.8
Nassau	6.6
Julia	6.6
Regent	6.4
LSD 5%	1.03

[a] Visual rating 0 9, 5 = acceptable appearance. Data are means of 2 replicates and 4 evaluation dates.

TALL FESCUE CULTIVAR EVALUATION

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Tall fescue cultivars (seeded in 1988) are being assessed for general appearance (uniformity and density), color, resistance to weed infestation, disease, and drought stress. Rankings based on data through 1989 are given in Tables 1 through 3.

Table 1. Germination[a] of tall fescue cultivars.

Cultivar	Germination
Rebel II	5.0
Tribute	4.7
Jaguar	4.3
Rebel	4.0
Arid	3.7
Chesapeake	3.7
Pacer	3.7
Houndog	3.3
Thoroughbred	2.7
Mustang	2.0
972 (Pick 127)	1.7
973 (Pick GH6)	1.7
LSD 5%	1.09

[a] Visual rating 0-5, 5 = complete germination. Data are means of 3 replicates, 88/06/21.

Table 2. Color[a] of tall fescue cultivars.

Cultivar	Color
972 (Pick 127)	8.7
Thoroughbred	7.9
973 (Pick GH6)	7.8
Mustang	7.7
Rebel II	7.6
Tribute	7.5
Houndog	7.4
Arid	7.0
Rebel	7.0
Pacer	6.9
Jaguar	6.9
Chesapeake	6.3
LSD 5%	0.43

[a] Visual rating 0-9, 5 = acceptable color. Data are means of 3 replicates over 12 evaluation dates.

Table 3. General appearance[a] of tall fescue cultivars.

Cultivar	General appearance
Arid	7.4
Chesapeake	7.4
Rebel	7.4
Rebel II	7.4
Tribute	7.2
Houndog	7.1
Jaguar	6.9
Thoroughbred	6.8
Pacer	6.6
Mustang	6.0
973 (Pick GH6)	6.0
972 (Pick 127)	5.5
LSD 5%	0.63

[a] Visual rating 0 9, 5 = acceptable appearance. Data are means of 3 replicates and 10 evaluation dates

PERENNIAL RYEGRASS CULTIVAR EVALUATION

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Perennial ryegrass cultivars (seeded in 1989) are being assessed for general appearance (uniformity and density), color, resistance to weed infestation, disease, and drought stress. Rankings based on data through 1989 are given in Tables 1 through 5.

Table 1. Germination[a] of perennial ryegrass cultivars.

Cultivar	Germination
Pennant	7.1
Omega II	6.3
Nova	6.3
Caliente	6.3
Saturn	6.2
Competitor	6.1
Barry	5.9
2H7	5.9
Aquarius	5.2
Sheriff	4.6
LSD 5%	1.52

[a] Visual rating 0 5, 5 = complete germination. Data are means of 3 replicates and 4 evaluation dates.

Table 2. Color[a] of perennial ryegrass cultivars.

Cultivar	Color
Aquarius	8.2
2H7	8.1
Competitor	8.0
Saturn	7.4
Caliente	7.3
Nova	7.3
Barry	7.3
Omega II	7.3
Sheriff	6.9
Pennant	5.1
LSD 5%	2.01

[a] Visual rating 0 9, 5 = acceptable color. Data are means of 3 replicates and 3 evaluation dates.

Table 3. General appearance[a] of perennial ryegrass cultivars.

Cultivar	General appearance
Competitor	9.2
2H7	9.0
Aquarius	8.8
Sheriff	8.7
Saturn	8.7
Barry	8.5
Caliente	8.3
Omega II	8.3
Nova	7.5
Pennant	6.8
LSD 5%	1.40

[a] Visual rating 0 10, 5 = acceptable appearance. Data are means of 3 replicates and 2 evaluation dates.

Table 4. Weed infestation[a] in perennial ryegrass cultivars.

Cultivar	Weeds
Competitor	3.7
Aquarius	3.7
Barry	3.3
Omega II	3.3
Nova	3.0
Caliente	2.3
Saturn	2.3
Pennant	2.0
Sheriff	1.7
2H7	1.3
LSD 5%	2.44

[a] Visual rating 0 5, 5 = 50% weed. Data are means of 3 replicates, evaluated 89/08/09.

Table 5. Red thread infection[a] in perennial ryegrass cultivars

Cultivar	Infection
Nova	6.3
Omega II	5.0
Pennant	4.7
Barry	4.3
Caliente	3.7
Saturn	1.3
Aquarius	1.0
2H7	0.3
Competitor	0.0
Sheriff	0.0
LSD 5%	2.09

[a] Visual rating 0 10, 10 = 50% infected. Data are means of 3 replicates, evaluated 89/08/09.

SPORTS TURF MIXTURE EVALUATION AND THE EFFECT OF WEAR ON SPORTS TURF MIXTURES

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Mixes of various ratios of seed of different turfgrass species were seeded at the Cambridge Research Station on August 18, 1988. These mixes are being evaluated for functional features (germination, cover, color, general appearance, winter hardiness) and will be subjected to artificial wear to evaluate wear tolerance and recuperative potential. Changes in botanical composition of the plots will also be evaluated.

Rankings based on data through 1989 are given in Tables 1 through 3. The compositon ratios presented are percentages by weight of perennial ryegrass: Kentucky bluegrass: tall fescue: fine fescue seed in the seed mix.

Table 1. Ratings of sports mixtures for turf color.

Mix	Composition				Color[a]
15	10	:65	:	:25	8.2
11	50	:	:	:50	8.2
22	10	:50	:	:40	8.0
23	15	:55	:	:30	7.9
21	30	:25	:	:45	7.9
5	30	:35	:10	:25	7.8
10	25	:50	:	:25	7.7
12	60	:20	:	:20	7.7
9	50	:	:	:50	7.6
3	20	:40	:20	:20	7.5
8	25	:25	:25	:25	7.5
4	75	:	:	:25	7.5
6	50	:25	:	:25	7.3
1	50	:50	:	:	7.2
2	75	:	:25	:	7.1
14	25	:25	:50	:	7.1
7	75	:25	:	:	7.0
16	80	:20	:	:	7.0
26		:	:80	:20	6.8
24	20	:	:80	:	6.8
27		:10	:90	:	6.8
25		:	:100:		6.6
13		:10	:90	:	6.6
20		:	:100:		6.4
LSD5%					0.47

[a] Visual rating 0-9, 5 = acceptable color. Data are means of 3 replicates over 9 evaluation dates 10/18/88 to 10/12/89.

Table 2. Ratings of sports mixtures for cover.

Mix	Composition				Cover[a]
2	75	:	:25	:	9.3
16	80	:20	:	:	9.0
7	75	:25	:	:	8.6
4	75	:	:	:25	8.4
12	60	:20	:	:20	8.2
6	50	:25	:	:25	7.7
1	50	:50	:	:	7.6
10	25	:50	:	:25	7.5
14	25	:25	:50	:	7.5
3	20	:40	:20	:20	7.3
9	50	:	:	:50	7.3
8	25	:25	:25	:25	7.2
11	50	:	:	:50	7.2
24	20	:	:80	:	7.1
21	30	:25	:	:45	6.8
23	15	:55	:	:30	6.8
26		:	:80	:20	6.5
5	30	:35	:10	:25	6.4
13		:10	:90	:	6.3
25		:	:100:		6.2
22	10	:50	:	:40	5.9
27		:10	:90	:	5.8
15	10	:65	:	:25	5.5
20		:	:100:		5.2
LSD5%					1.53

[a] Visual rating 0-10, 10 = 100% cover. Data are means of 3 replicates over 11 evaluation dates 8/26/88 to 6/28/89.

Table 3. Ratings of sports mixtures for turf general appearance.

Mix	Composition				General appearance[a]
4	75	:	:	:25	8.3
12	60	:20	:	:20	8.3
1	50	:50	:	:	8.2
10	25	:50	:	:25	8.2
11	50	:	:	:50	8.2
7	75	:25	:	:	8.0
9	50	:	:	:50	8.0
16	80	:20	:	:	8.0
6	50	:25	:	:25	7.8
21	30	:25	:	:45	7.8
22	10	:50	:	:40	7.8
3	20	:40	:20	:20	7.8
23	15	:55	:	:30	7.7
14	25	:25	:50	:	7.7
8	25	:25	:25	:25	7.7
5	30	:35	:10	:25	7.5
15	10	:65	:	:25	7.5
24	20	:	:80	:	7.5
26		:	:80	:20	7.2
2	75	:	:25	:	7.2
13		:10	:90	:	6.8
25		:	:100:		6.7
27		:10	:90	:	6.7
20		:	:100:		6.2
LSD 5%					1.03

[a] Visual rating 0-9, 5 = acceptable appearance. Data are means of 3 replicates over 2 evaluation dates 8/01/89 and 9/18/89.

TURFGRASS EXTENSION

1989 TURFGRASS EXTENSION SUMMARY

Annette Anderson, OMAF Turf Extension Specialist

In general, most in the turf industry enjoyed a good growing season, although things got off to a frustrating start in the spring. The extended period of cool, wet weather in the spring was a precursor of many of the problems experienced later on in the season. Turf diseases have probably been the biggest problem this season, although stress-related problems were reported in higher than normal numbers.

The issue of most concern in 1989 has been the proposed changes to Regulation 751 requiring notification (posting) of pesticide applications in public land areas and residential land properties treated by licenced applicators. The Ministry of Environment received responses from numerous industry associations and agencies and is taking this information under consideration before drafting the final changes, therefore delaying implementation date until early 1990.

SOD PRODUCTION

Spring weather conditions created a number of problems for sod producers. Response to early spring fertilizer application was slow. In several cases additional fertilizer was applied which resulted in lush growth that was very susceptible to disease and drought stress. There were several severe outbreaks of helminthosporium leaf spot and melting out due to these conditions. Wet weather in late spring prevented frequent mowing. Excess clippings became a problem either due to severe yellowing of the turf or complete suffocation of the turf. In several cases forage harvesters had to be used to remove the clippings.

Demand for sod was strong again this year. Predictions for 1990 are optimistic that demand will remain fairly strong. Demand is closely linked to the housing/construction market, which has extended 3 years longer than the normal 7 year cycle. There did not appear to be a significant increase in Kentucky bluegrass acreage seeded this year but there has been an increase in creeping bentgrass acreage due to demand created by new golf course construction. The average price for #1 sod was .95 - 1.05 per roll wholesale. The ratio in acreage of two year old versus one year old sod seems to have returned to normal. Most growers were able to avoid shutdown periods in the summer that sometimes occurs due to lack of mature sod.

Several growers are growing sod with netting. This enables growers to use a mixture of grasses rather than monostands of Kentucky bluegrass, and it may also shorten the time to harvest by several months. A small acreage of turf-type tall fescue sod was commercially available and marketed for sports fields this year. A few growers are considering installing pivot irrigation, although for the most part, irrigation demands in 1989 were considerably less than in 1988.

Generally, good weather conditions were reported at seeding time. The last three years have shown that seeding earlier than mid-August does not appear to be much of an advantage and usually results in more inconsistent results, and significantly more weed problems.

LAWN CARE

A significant increase in disease problems was reported on home lawns in 1989. Leaf spot was prevalent in many lawns this spring which resulted in severe melting out as temperatures increased. The wet conditions in late May and early June resulted in many reports of slime mold, mushrooms, and red thread. But the biggest disease problems reported due to these spring conditions were the patch diseases. High nitrogen conditions and wet weather resulted in succulent lawns more predisposed to heat and drought stress. Due to these conditions, more lawns appeared to go dormant earlier than last year. There were a number of cases of turf injury and/or disease due to fertilizer applied in late June, in high heat, high humidity and using fertilizers sources with a high percentage of water soluble N.

On most of the lawn samples received for disease diagnosis, excessive thatch was also a problem. More lawn care companies are considering to provide aerification/dethatching services as part of their lawn care programs. A few lawn care companies are also marketing 'organic lawn care' to meet consumer demands.

Crabgrass has not been as much of a problem this year as in the past two years due to a more 'normal' spring and more predictable results with pre-emergent applications. A new post-emergent herbicide, fenoxaprop ethyl was registered and scheduled in July. This now allows lawn care companies the option of being able to control any crabgrass escapes not controlled by the pre-emergents. Some lawn care companies are considering using only postemergent control, but the trend will most likely be the use of a preemergent herbicide followed up with the postemergent herbicide as a spot treatment to control escapes.

European chafer grubs were active in the spring and fall, but reports of June Beetle and Japanese Beetle grub damage was lower this year than in the past two years.

Damage on Kentucky bluegrass lawns caused by bluegrass billbug in late June -early August was reported in significantly higher numbers than in 1988 and often symptoms of this insect problem was misdiagnosed as a patch disease.

Occurrence of turfgrass scale was reported as far north as Georgian Bay and Muskoka region. High populations of turfgrass scale were reported to have severely damaged several lawns in southwestern Ontario but this was not confirmed.

Sod webworm populations appeared to be high in some areas this year. Extensive damage was most noticeable on dormant turf that did not green up in the fall.

GOLF COURSES

Many golf courses reported a slow start to the season. Discolouration of golf greens in early spring was widely reported. Poor conditions for overseeding or turf establishment and poor response to fertilizers were also common problems. There were many reports of 'root pythium' causing thinning and loss of turf on putting greens. However, in most cases where samples were taken other causes of turf decline such as saturated soil, anaerobic conditions, poor root development and physical wear from equipment figured more prominently.

There have been several problems noted on seedling bentgrass this year but nutrient deficiency seemed to be more prevalent than damping-off diseases or concerns about seed quality.

Populations of black turfgrass ataenius were significant this year. However, damage to annual bluegrass was minimized due to the fact that stress conditions during the peak of the first generation larvae were not as severe as in previous years and adequate fertility and irrigation reduced visible feeding damage of the grubs.

SOIL TESTING

Several Ontario laboratories will be providing analyses under the Ontario Ministry of Agriculture and Food's new laboratory accreditation program which came into effect September 1, 1989.

In March, 1989 the ministry announced its intentions to further privatize the laboratory testing services for farms, home lawn and garden, greenhouse media, plant tissues and livestock feeds. Ontario-based laboratories were invited to provide the testing services.

Until five years ago, the ministry's laboratory testing services were handled by the University of Guelph. At that time, the ministry tendered for testing services and one laboratory was given a five year contract which expired August 31, 1989.

Clients will be required to pay for all analyses. To date, they were not paying analyses of farm soils.

Submission forms are available in English and French from your local OMAF office with a comprehensive listing of all accredited labs, analyses offered and details on how to submit samples.

1989 EXTENSION ACTIVITIES

Approximately 70% of extension time was spent on advisory and diagnostic services (phone, office and field contacts, control recommendations, newsletters, hotline, extension publications, etc.).

Approximately 25% of time was allocated towards presentations, organizing meetings, conferences, field days, and research and demonstration projects.

Several major projects that were undertaken this year include:

1. Integrated Pest Management

   Weekly monitoring of 7 sites in the Guelph area was done June to August to experiment with various IPM techniques and to monitor occurrence of insect, disease and weed problems on low to moderately mantained turf. This information was reported on the turf hotline. Disease detection kits were also used to monitor occurrence of dollar spot on a golf course fairway and pythium blight on a golf course green.

2. Weather Data

   Degree-day information was collected and tabulated from 7 OMAF weather stations across Ontario. This information proved useful in predicting the occurrence and peak populations for various turf insects. Information in Table 1 is an example of how this information can be useful to the turf manager.

Table 1. Date of occurrence of peak chinch bug activity based on degree-day (air) information from weather stations in Ontario

Stage:	Egg laying	1st Instar	3rd Instar
Degree-day 7(°C)	(275)	(550)	750 -800
Harrow	May 28	June 21	July 5 - 10
London	June 1	June 25	July 10 - 18
Guelph	June 3	June 30	July 16 - 23
Hamilton	June 2	June 28	July 12 - 20
Alliston	June 2	June 26	July 10 - 19
Bowmanville	June 5	June 29	July 15 - 23
Smithfield	June 1	June 25	July 9 - 17
Kemptville	June 2	June 26	July 10 - 18

3. Liaison with GTI Research

a. 1989 Fertility Survey of Kentucky bluegrass on Sod Farms in Ontario

b. Leaching of Slow Release Nitrogen Sources in Sand Rootzones

Results of these projects are presented elsewhere in this report.

4. OMAF TURF HOT LINE (519) 767-1211

The OMAF Turf Hotline has been well received by the turf industry.

The objective of the hotline is to provide information on the type of turf problems that have been occurring as well as what problems could potentially develop.

The hotline was updated weekly from April - October and proved to be an excellent method of disseminating up to date information on turf management. This service will be offered in the 1990 season to provide turf management information across the province.

5. TURFNOTES

Turfnotes is a quarterly extension newletter published by the Ontario Ministry of Agriculture and Food to provide information on the production and management of turfgrass. Anyone interested in receiving this publication can contact

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1990 TURF INDUSTRY EVENTS

January 9 - 10	OGSA Symposium, University of Guelph
January 23 - 25	Landscape Ontario Congress, Toronto
February 5 - March 2	Turf Managers' Short Course, University of Guelph
February 1990	Algonquin College Turf Management Short Course, Ottawa
March 12	1990 Pesticide Symposium, Seneca College, Toronto
March 13	1990 Pesticide Symposium, London
March 15	1990 Pesticide Symposium, R.A. Centre, Ottawa

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