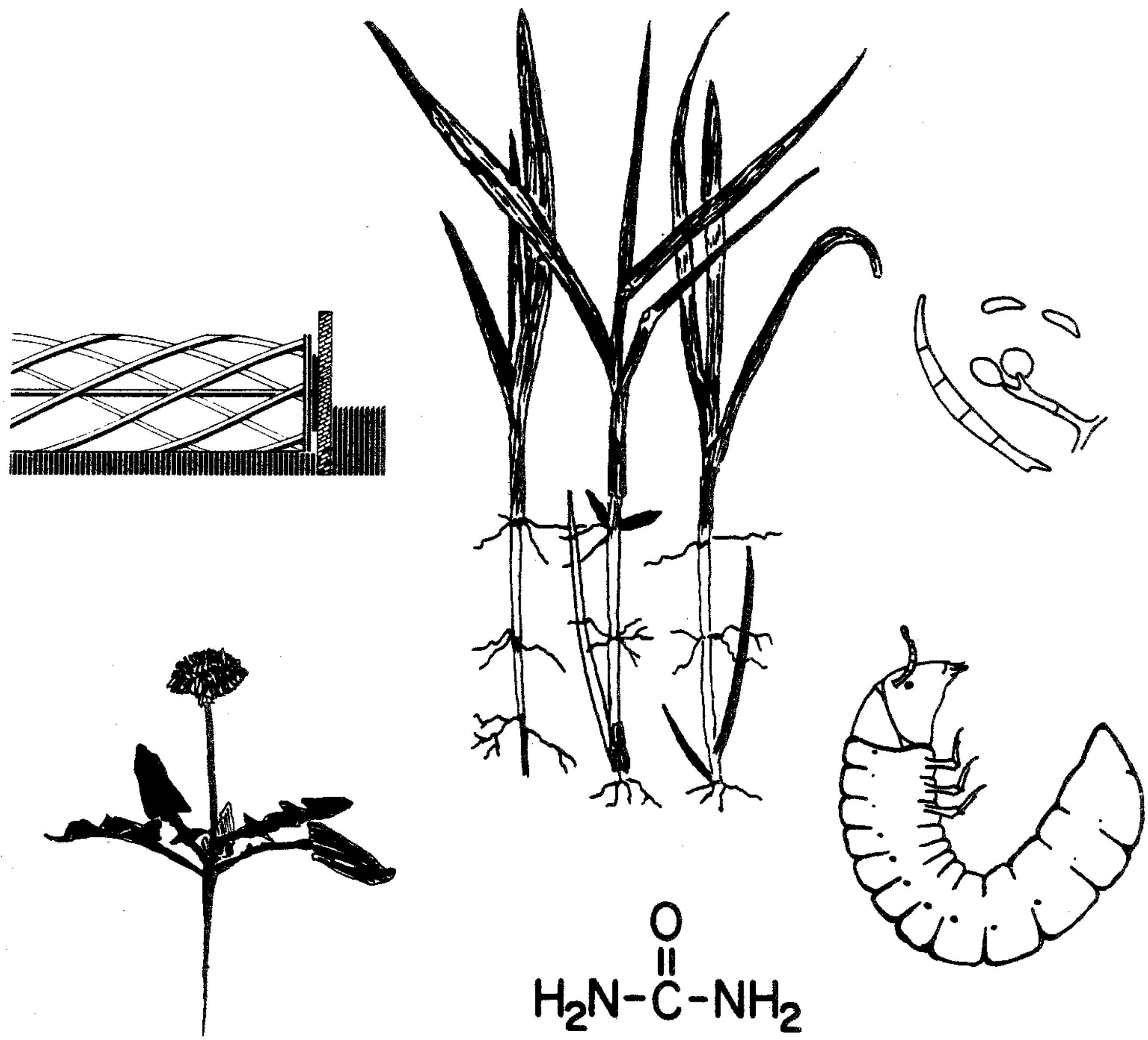
TURFGRASS RESEARCH

ANNUAL REPORT
Ontario Agricultural College
University of Guelph



1984

INTRODUCTION

In this 3rd annual Turfgrass Research Report, we, the Turfgrass Research Group at the University of Guelph, bring you a synopsis of our findings for 1984. The Report is not a complete recording of all the data obtained by the various investigators but reflects the highlights of their work. If further detail is required about any of the projects please contact the authors listed on the article.

Unfortunately the work in herbicide and growth regulator research was set aside for the 1984 season due to the appointment of Prof. C.M. Switzer as Deputy Minister of Agriculture and Food. We are hopeful that an appointment in this important area will be in place before the 1985 season. Negotiations also continue to have the service of a full-time person in turf extension activities added to the research group.

During the year the Turfgrass Research Group have met on a regular basis to unifying the overall operation of the turfgrass work at Guelph. At the same time Prof. Lee Burpee has served as a liaison person between the Group and the Ontario Turf Research Foundation. Some new and exciting initiatives are planned by the Group which will further strengthen turfgrass research, teaching and extension at Guelph.

R.W. Sheard

ACKNOWLEDGEMENTS

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

1) Natural Science and Engineering Research Council
2) Ontario Turfgrass Research Foundation
3) The Ontario Ministry of Environment
4) The Ontario Jockey Club
5) The Ontario Racing Commission
6) City of Windsor
7) The Cutten Club
8) The Toronto Board of Trade Country Club
9) Hamilton Golf and Country Club
10) Maple Downs Golf Club
11) Brouwer Turf Equipment Ltd.
12) Canadian Industries Limited
13) Chipman Inc.
14) Ciba-Geigy Canada Ltd.
15) Duke Lawn Equipment Ltd.
16) NOR-AM Chemical
17) O.M. Scott and Sons
18) OSECO
19) OTTO Pick and Sons Seeds Ltd.
20) Rothwell Seeds
21) SDS Biotech Corporation
22) Turf Care Equipment

The setting of this report in type by Mrs. Denise Brenner is sincerely appreciated by the contributors.

OAC 1984 Annual Turfgrass Research Report

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EVALUATION OF TWO DOLLARSPOT FORECASTING MODELS FOR CREEPING BENTGRASS

L.L. Burpee and L.G. Goulty

Department of Environmental Biology

Chemical management of dollarspot disease is necessary for most highly maintained grasses grown in the cool humid and cool subhumid zones of turfgrass growth. It is not uncommon for a dollarspot preventative fungicide spray program to include twelve or more applications from June through September. Recently, the details of two dollarspot forecasting models were published (1, 2). These were designed to aid turfgrass managers in deciding exactly when to apply fungicides for optimum dollarspot control at the lowest cost. Both models use weather information to predict when a fungicide should be applied. The Mills and Rothwell (M & R [2]) model states that a fungicide application is required when the maximum ambient temperature is) 25C and the maximum relative humidity is) 90 during any 3 days in 7. The Hall model (1) states that a fungicide application is required after two consecutive days with rain and a mean temperature) 22ºC or three consecutive days with rain and a mean temperature > 15ºC. For both models, reapplication of fungicide is not required if the weather criteria are met within the residual activity period of the chemical used (eg. approx. 10 days for Daconil 2787 at 114 ml/100 m^2).

In Ontario, most turfgrass managers utilize 10-21 day fungicide spray schedules for dollarspot control. The following research was conducted to determine if there are advantages to using the forecasting models described above over present spray schedules of 7, 10, 14 and 21 days.

RESEARCH PROCEDURE

1983. Research plots were established on a seven year old stand of creeping bentgraes maintained at the Univ. of Guelph Cambridge Research Station. Cultural practices were similar to those used for maintenance of golf course putting greens in Ontario. Treatments consisted of a spray schedule determined by the Hall model, a spray schedule determined by the M & R model, spray schedules of 7, 14, and 21 day intervals, and an untreated control. Each treatment plot measured 1 x 3 m. The experimental design consisted of a randomized complete block with four replicates. All fungicide applications consisted of Daconil 2787 (114 ml/100 m^2) applied in 7 L of water per 100 m^2 with a wheel-mounted compressed air boom sprayer at 138 kPa pressure. The 7, 14, and 21 day spray schedules were initiated on 22 June. The plots were visually checked for the presence of dollarspot infection centers on a daily basis from 22 June to'22 August. Each new spot was counted and marked with a golf tee. Temperature and relative humidity, were recorded by a hygrothermograph mounted approximately 1.5 m above the ground and 15 m from the treatment plots.

1984. Materials and methods were similar to those used in 1983. A 10 day spray schedule initiated on 5 July, was used in place of the 7, 14, and 21 day schedules. Dollarspots were counted and marked on a daily basis from 5 July to 11 August.

RESULTS

1983. Weather criteria were met 2 and 49 times for the Hall and M & R models, respectively (Table 1). The M & R model resulted in acceptable dollarsopot control (1 spot per plot) with six fungicide applications over

Table 1. Chemical control of dollarspot on creeping bentgrass with Daconil 2787 (114 ml/100 m^2) using two forecasting models and 7, 14 and 21 day spray schedules in 1983.

Treatment	No. of times criteria met	No. of times sprayed	No. of dollarspots
Hall model	2	2	168
Mills & Rothwell model	49	6	1
7 day spray sched.	9	9	3
14 day spray sched.	4	4	70
21 day spray sched.	3	3	140
Untreated control	0	0	416

the 62-day period. This was not significantly different from the control achieved with a 7 day spray schedule which included nine fungicide applications. The Hall model and the 14 and 21 day schedules resulted in unacceptable dollarspot control.

The Hall and M & R models predicted disease unsuccessfully on 1 and 27 occasions, respectively, and they failed to predict observed disease increases on 21 and 8 occasions, respectively (Table 2)

Table 2. Frequency of dollarspot disease predictions not followed by observed increases in disease and frequency of unpredicted disease increases for two dollarspot forecasting models.

Treatment	No. of days disease was predicted but did not occur		No. of days disease occurred but was not predicted	
	1983	1984	1983	1984
	(days)		(days)	
Hall model	1	1	21	18
Mills & Rothwell model	27	22	8	0

1984. Weather criteria were met 2 and 41 times for the Hall and M & R models, respectively (Table 3). The M & R model and the 10 day spray schedule resulted in acceptable dollarspot control with four fungicide applications, each. The Hall model did not result in acceptable control.

Table 3. Chemical control of dollarspot on creeping bentgrass with Daconil 2787 (114 ml/100 m^2) and a 10 day schedule. 1984.

Treatment	No. of times criteria met	No. of times sprayed	No. of dollarspot
Hall model	2	2	142
Mills & Rothwell model	41	4	13
10 day spray ached.	4	4	8
Untreated control	0	0	220

The Hall and M & R models predicted disease unsuccessfully on 1 and 22 occasions, respectively and they failed to predict observed disease increases on 18 and 0 occasions, respectively (Table 2).

CONCLUSIONS

1) The Hall model failed to provide accurate predictions for acceptable dollarspot control.

2) Predictions provided by the M & R model resulted in acceptable dollarspot control. However, the M & R spray schedule was not significantly different from a preset 10 day spray schedule.

3) Both models predicted disease on occasions when increases in disease were not observed.

4) With the exception of the M & R model in 1984, both models failed to predict increases in disease on several occasions.

LITERATURE CITED

1) Hall, R. 1984. Relationship between weather factors and dollar spot of creeping bentgrass. Can. J. Plant Sci. 64:167-174.

2) Mills, S.G. and J.D. Rothwell. 1982. Predicting diseases - the hygrothermograph. Greenmaster 18(4):14-15

CONTROL OF DOLLARSPOT ON CREEPING BENTGRASS

L.L. Burpee and L.G Goulty

Department of Environmental Biology

More fungicides are applied per year on creeping bentgrass and annual bluegrass for control of dollar spot disease than for control of all other turfgrass diseases combined. Several contact and systemic fungicides provide acceptable control; however, residual activity varies considerably among the chemicals. Research continues to be conducted in an attempt to improve the efficacy of registered fungicides and to compare experimental chemicals with those that are used commonly.

RESEARCH PROCEDURE

Treatments were applied to a seven year old stand of creeping bentgrass maintained at the Univ. of Guelph Cambridge Research Station. Cultural practices were similar to those used for maintenance of golf course putting greens in Ontario. The experimental design consisted of a randomized complete block with four replications. Twenty-one fungicide treatments and a non-treated control were included in each block. Each treatment plot measured 1 x 3 m. Wettable powder and liquid formulations were applied in 7 L of water per 100 m^2 with a wheel mounted compressed air boom sprayer at 30 psi pressure. O.M. Scotts materials were applied with a Scotts drop spreader. Fungicides were applied on 24 July. The turf grass was inoculated with autoclaved rye grain infested with three isolates of *Sclerotinia homeocarpa* on-25 July. Disease intensity was estimated at five day intervals, beginning 6 August, using the Horsfall-Barratt rating scale. Fungicides were reapplied if the mean percent disease was > 3.0%.

RESULTS

All treatments resulted in a significant level of disease suppression (Table 1). However, only treatments that provided 10 or more days of control are considered to be acceptable for fine turf.

The efficacy of a low rate of Daconil (30 ml/100 m^2) was increased when urea (259 g/100 m^2) was added to the spray tank. A similar increase in efficacy was not observed at higher rates of Daconil (60 and 120 ml/100 m^2).

At the dosages tested, tank mixes of Daconil + Actidione TGF provided a longer duration of acceptable control than Daconil alone.

The experimental fungicides, Scotts Fungicide VII and Ronilan, provided 25-36 days of acceptable control.

Table 1. Influence of fungicides on intensity of dollar spot disease of creeping bentgrass.

Treatment	Dosage	Percent Disease	No. of Applications	Duration of Control [z]
	(product/100m2)			(days)
Rovral	60g	2.3*[y]	2	16-20
Fungicide VII	4 1/4[†]	3.5*	1	25-36
CGA 64250	5 ml	4.1*	2	10-13
Prochloraz	76 ml	4.7*	3	6-10
Actidione TGF	61 g	4.7*	2	13-16
CGA 64250	9 ml	5.3*	2	16-20
Daconil + urea (tank-mix)	60 ml + 259 g	5.9*	3	6-10
Actidione TGF	31 g	5.9*	3	6-10
Daconil + TGF	30 ml + 10 g	7.0*	3	6-10
Ronilan	60 g	8.2*	1	25-36
Daconil	120 ml	8.2*	2	16-20
Daconil + urea (tank mix)	30 ml + 259 g	8.2*	3	<6
Daconil	42 ml	9.4*	3	<6
Daconil + urea (tank-mix)	120 ml + 259 g	9.4*	2	10-13
Daconil + 15-4-4 (granular)	24 g + 259 g	9.4*	3	6-10
15-4-4	259 g	9.4*	3	0
Daconil + TGF	42 ml + 10 g	10.5*	3	6-10
Prochloraz	38 ml	10.5*	3	6-10
Daconil	60 ml	14.1*	2	10-13
Daconil	30 ml	16.4*	3	0
Urea (solution)	259 g	23.4*	3	0
Control	-	32.0	-	0

[†] Scott spreader setting.
[y] Values followed by (*) are significantly different from control at P=0.05.
[z] Number of days, post application, with mean disease intensity <3.0%.

EVALUATION OF FUNGICIDES FOR CONTROL OF PINK AND GREY SNOW MOLD ON CREEPING BENTGRASS

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Department of Enivronmental Biology

Pink and grey snow molds are the predominate winter diseases of creeping bentgrass and annual bluegrass in southern Ontario. Commonly used fungicides include Scotts FFII, Mersil and other inorganic mercury products, and Arrest. For the most part, these fungicides provide acceptable control of snow mold; however, specific problems have been associated with each of these chemicals. For example, FF11 may cause stunting and discoloration of creeping bentgrass, inorganic mercuries may be associated with human health and environmental hazards, and the efficacy of Arrest may be seriously reduced by rain or melting snow. Therefore, field trials continue to be conducted in order to solve these problems and to select a broader range of fungicides for control of snow mold.

RESEARCH PROCEDURE

A seven year old stand of creeping bentgrass cv. Penncross was maintained at a five mm cutting height at the Univ. of Guelph, Cambridge Research Station. Cultural practices were similar to those used for maintenance of golf course putting greens in Ontario. The experimental design consisted of a randomized complete block with four replications. Twenty-six fungicide treatments plus a non-treated control were included in each block. Each treatment plot measured 1 x 4 a. Wettable powder and flowable formulations were applied in 7 L of water per 100 m^2 with a wheel-mounted compressed air boom sprayer at 30 psi pressure. A Scotts drop spreader was used to apply Scotts FF11. Treatments were applied on 18 Nov. The turfgrass was inoculated with autoclaved rye grain infested with three isolates of *Gerlachia nivalis* and *Typhula ishikariensis* on 20 Nov. Disease intensity was estimated on 10 April, 1983 using the Horsfall-Barratt rating scale.

RESULTS

Results are presented in Table 1. Scotts FF11 (quintozene) provided excellent control of both diseases at the 2X (2.5 kg), 1X (1.3 kg) and 1/2X (760 g) rates. The 2X and 1X rates resulted in foliar yellowing that was visible for approximately 3 weeks in May and early June. The experimental fungicides Ronilan and CGA 64250 provided good, but less than acceptable, control at 120 g and 120 ml, respectively. Significant but less than acceptable disease suppression was also achieved with Daconil at 237 and 319 ml. The acrylic sticker Rhoplex significantly improved the activity of thiram. The fungicides Thiram, Easout, Actidione Thiram, and Arrest did not provide significant control at the rates tested.

Table 1. Influences of fungicides on the intensity of pink and grey snow mold on creeping bentgrass.

Treatment	Dosage	Pink Snow Mold	Grey Snow Mold
	(product/100 m^2)	(%)+	(%)+
Scotts FF II	2.5 kg	P 2.3*	P 2.3*
Scotts FF II	1.3 kg	P 2.3*	P 2.3*
Scotts FF II	760 g	2.3	5.3*
Ronilan	120 g	9.9*	10.5*
Mersil	125 ml	16.4*	8.2*
CGA 64250	120 ml	23.4	16.4*
Mersil	63 g	32.0*	28.1*
Daconil 2787	237 ml	34.4*	16.4*
Daconil 2787	319 ml	34.4	18.8*
Thiram + Rhoplex	244 g + 700 ml	37.5	37.5*
Thiram + Rhoplex	244 g + 1400 ml	43.8	37.5*
Scoot	244 ml	54.7	60.9
Scoot	122 ml	56.3	37.5*
CGA 64250	60 ml	60.1	32.8*
Easout 50 F	240 ml	61.7	83.6
Thiram	244 g	62.5	56.3
Thiram + Rhoplex	122 g + 1400 ml	62.5	50.0
SN 84364	71 g	70.3	48.8
Arrest	280 g	71.9	71.9
Actidione Thiram	120 g	76.6	78.9
Thiram + Rhoplex	122 g + 700 ml	76.6	50.0
Thiram	122 g	77.7	83.6
Rhoplex	1400 ml	84.8	82.4
Actidione Thiram	60 g	85.9	81.3
Rhoplex	700 ml	85.9	61.5
Easout 70 WP	171 g	88.3	65.6
Control	-	76.6	78.9

+ Values followed by (*) are significant from the control at P=0.05.
P = phytotoxic reaction resulting in foliar chlorosis.

INFLUENCE OF CULTIVATION PRACTICES AND FUNGICIDES ON THE DEVELOPMENT OF ANTHRACNOSE IN A GOLF COURSE FAIRWAY

L.L. Burpee and L.G. Goulty

Department of Environmental Biology

Anthracnose appears to be more severe on annual bluegrass that has been subjected to low nitrogen and high temperature stress. Turfgrass cultivation (coring and verticutting) may enhance stress tolerance of annual bluegrass making the grass more disease resistant. In addition, spring cultivation may stimulate the germination and development of "new" annual bluegrass plants that may be more disease resistant than "old" plants which developed the previous fall.

The relationship that exists between cultivation and anthracnose resistant appears to be sound; however, it has never been thoroughly tested. The following research was conducted to determine exactly what effects fairway cultivation practices have on the severity of anthracnose and on the efficacy of fungicides which are applied to control the disease.

RESEARCH PROCEDURE

1983. Research plots were established on a fairway at Burlington Golf and Country Club. Coring and verticutting treatments were arranged in a randomized complete block design with four replicates. Each treatment plot measured 2 x 35 m. Treatments were applied on 19 May. An application of Tersan LSR (116 g/100 m^2) was superimposed over the cultivation treatments on 6 July. Initial anthracnose symptoms (foliar chlorosis) were evident at the time of fungicide application. Plots were evaluated for disease intensity on 20 July.

1983-1984. The following fall and spring cultivation treatments were applied:

1. Fall coring
2. Spring coring
3. Fall and spring coring
4. Fall verticutting
5. Spring verticutting
6. Fall and spring verticutting
7. Fall coring and spring verticutting
8. Untreated

Fall treatments were applied on 29 Sept., 1983. Spring treatments were applied on 10 May and repeated 7 June, 1984. Applications of Bayleton (61 g/100 m^2), Tersan 1991 (61 g/100 m^2), Daconil 2787 (92 ml/100 m^2), Tersan LSR (122 g/100 m^2), and ferrous sulfate (31 g/100 m^2) were superimposed over the cultivation treatments on 21 June, before anthracnose symptoms were observed, or on 9 July, when foliar chlorosis were evident. Plots were evaluated for disease intensity on 1 Aug. and 23 Aug.

RESULTS

1983. Cultivation on 19 May had no significant effect on the subsequent development of anthracnose (Table 1). Disease was not significantly suppressed in plots treated with a curative application of Tersan LRS (116 g/100 m^2).

Table 1. Influence of cultivation practices (Spring, 1983) on the intensity of anthracnose on annual bluegrass in a golf course fairway on July 20.

Treatment[x]	No. of Applications	Percent Disease
Spring coring	1	14.1
Spring verticutting	1	10.6
Untreated Control	0	8.2

[x] Applied 19 May.

<u>1984.</u> Additional cultivation treatments, superimposed over those applied in 1983, had no significant effect on the intensity of anthracnose (Table 2). Preventative and curative applications of Bayleton (61 g/100 m^2) and Tersan 1991 (61 g/100 m^2) significantly suppressed the development of anthracnose for at least 62 and 44 days, respectively (Tables 3 & 4). A curative application of Tersan LSR (116 g/100 m^2) provided significant disease control for at least 22 days. Interactions between chemical and cultivation treatments were not significant.

Table 2. Influence of cultivation practices (Fall, 1983 and Spring, 1984) on the intensity of anthracnose on annual bluegrass in a golf course fairway on Aug. 23.

Treatment[x]	No. of Applications	Percent Disease
Fall coring	1	6.7
Spring coring	2	5.8
Fall and spring coring	1 fall + 2 spring	5.3
Fall verticutting	1	5.6
Spring verticutting	2	5.6
Fall and spring verticutting	1 fall + 2 spring	3.8
Fall coring + spring verticutting	1 fall + 2 spring	5.6
Untreated control	0	5.9

[x] Fall treatments applied 29 Sept., 1983. Spring treatments applied 10 May and 7 June, 1984.

Table 3. Influence of fungicides on intensity of anthracnose in plots of annual bluegrass treated prior to the development of disease symptoms.

Treatment	Dosage	Percent disease after application[x] 40 days	62 days
	(product/100 m^2)		
Bayleton	61 g	0.2*	0.1*
Tersan 1991	61 g	0.4*	2.4*
Daconil 2787	92 ml	1.0	4.4
Ferrous sulfate	122 g	1.5	5.1
Tersan LSR	122 g	1.7	5.2
Control	-	2.6	5.9

[x] Values followed by (*) are significantly different from control at P=0.05.

CONCLUSIONS

The resultes indicate that fairway cultivation in fall and/or spring has no immediate effect on the intensity of anthracaose observed in July and August. The word immediate is emphasized because long-range (>2 years) effects resulting from continued cultivation are unknown.

Fall and/or spring, cultivation has no immediate effect on the efficacy of Bayleton, Tersan 1991, Daconil 2787, or Tersan LSR in an anthracnose management program.

Single applications of Bayleton or Tersan 1991 at 61 g/100 m^2 provide acceptable, long-term (>6 weeks) control of anthracnose.

MOWING FAIRWAYS WITH GREENSMOWERS

J.L. Eggens, C.P.M. Wright, H. Arsenault, and R. Creed

Horticultural Science and Cutten Club Golf Course

The improved playing conditions resulting from closer mowing, reduced compaction and reduced scalping injury found when maintaining green surrounds and approach areas has prompted many superintendents to extend these playing conditions out into the fairway. Some superintendents are now mowing all fairways with smaller, lighter greensmower units. Considerable information is available on the economic aspects of this program but little is known of turfgrass stress tolerance under these reduced mowing heights. This study was initiated to evaluate the stress tolerance of fairway turf under 1.1 cm mowing height with clippings removed compared to standard fairway practices.

RESEARCH PROCEDURE

Research plots were located on #8 fairway at the Cutten Club Golf Course. Commencing 10 April, 1984, the plots were mowed every second day with a Toro pull-type gangmover with 9 blade reels at a 2 cm height of cut or a Toro Greensmaster III at a 1.1 cm height of cut. The baskets on the greensmower were removed so that both mowing units returned the clippings. Immediately after moving clippings from half of all plots were removed with a power sweeper. Measurements over the growing season included healing potential, stress tolerance and resistance to ball roll.

RESULTS AND DISCUSSION

The higher height of cut had a greater healing potential (Table 1). At the 2.0 cm. height of cut 77% of the divot injury was healed while at the 1.1 cm height of cut only 26% of the divot injury areas healed over the same period of time. The improved healing may be related to the greater

Table 1. Influence of moving height on divot healing and turf stress injury.

Mowing height	Divot healing+	Stress injury 5 July
(cm)	(%)	(%)
1.1	26	22
2.0	77	27

+ The percent of the original divot which was healed during the period Aug. 16 to Sept. 19, 1984.

carbohydrate production and storage at the 2 cm height of cut, resulting in a more rapid regrowth into the injured areas. Stress injury related to fertility was evaluated over the growing season. There were no differences observed between the two heights of cut.

The color of the 1.1 cm mowed fairway did not have the deep dark green color normally associated with vigorous turf. Fertility trials were initiated 22 June to evaluate turf quality related to clipping removal. Four evaluation dates (4 Aug, 16 Aug, 17 Aug and 26 Sept) indicated that higher rates of nitrogen may be required on fairways mowed at 1.1 cm when clippings are removed (Table 2).

Table 2. The influence of higher fertility rates over the growing season on turf quality.

Fertility	Evaluation dates			
	4 Aug	16-Aug	27-Aug	26 Sept
	(Scale 1-10 with 10 highest)			
Control	5.5	7.0	7.0	9.3
Milorganite	8.3	7.5	8.8	9.8
Unfortified sewage sludge	7.0	8.5	8.3	9.5

Both June and Sept. measurements indicated that the lower height of cut resulted in smaller divots (Table 3). The lower height of cut had a higher shoot density allowing the golf ball to sit on the upper leaf blades and not within the turf plants. In the higher cut turf the golf club bites deeper into the turf, resulting in a larger divot.

Table 3. Influence of mowing height on size of divots removed.

	Divot size	
Mowing height	June, 1984	Sept., 1984
(cm)		(cm^2)
1.1	56	31
2.0	86	48

Under the 1.1 cm height of cut, the ball rolls almost twice as far as compared to the 2.0 cm height of cut (Table 4). With appropriate cultural practices such as adequate fertility and irrigation, the lower height of cut does improve turf quality without significantly decreasing the stress tolerance of the turf during the growing season.

Table 4. Stimpmeter-measured ball roll.

Mowing height	Ball roll
	(cm)
1.1	111
2.0	68

ANNUAL BLUEGRASS SEEDHEAD SUPPRESSION

J.L. Eggens and C.P.M. Wright

Department of Horticultural Science

Many of the problems associated with the summer decline of annual bluegrass may be due to the utilization of carbohydrates and other growth factors for seed production and maturation at the expense of other plant parts such as root and shoot growth. The object of this study was to evaluate the influence of spring applied growth retardant 'Embark' on seedhead suppression of annual bluegrass.

RESEARCH PROCEDURE

Embark at 0, .2, .3 and .4 kg/ha was applied to annual bluegrass on 2 by 3 m plots at the Cambridge Research Station. The applications were made on the 4, 15 and 25 May, 1984. Measurements over the growing season included visual quality and color evaluation and amount of seedhead reduction.

RESULTS

Time of application is important in suppressing annual bluegrass seedhead production. The optimum time of application occurs when the seedhead is in the boot stage. In the spring of 1984, 15 May was the best application time and provided excellent control at the .2 kg/ha rate (Table 1). Spraying prior to or after the optimum date requires a higher rate of Embark to achieve a similar seedhead reduction. After 24 May, the annual bluegrass seedhead has passed the boot stage and adequate control was not obtained. Significant differences in seedhead reduction were not observed on 4 July and 30 October, 1984 (data not shown).

Table 1. Influence of Embark on percent annual bluegrass seedhead per plot.

Time of application	Embark rate	Seedheads	
		11-Jun	30 Oct.
	(kg/ha)	(% of plot)	
4 May	0.0	63	25
	0.2	35	20
	0.3	20	23
	0.4	11	20
15 May	0.0	78	20
	0.2	10	23
	0.3	8	23
	0.4	9	18
24 May	0.0	65	20
	0.2	18	15
	0.3	28	23
	0.4	16	18

By 11 June plots which had been sprayed 4 and 15 May were significantly darker green than the controls (Table 2). The turf on the plots sprayed 24 May did not have sufficient time to respond to the Embark treatment by the 11 June evaluation. However by the 4 July evaluation, quality of all plots were not significantly different from the control.

Table 2. Influence of Embark on annual bluegrass color.

Time of application	Embark rate	Color[z]		
		22-May	31-May	11-Jun
	(kg/ha)			
4 May	0.0	6.3	5	6.8
	0.2	2	5.8	9.0
	0.3	2.4	3.5	9.5
	0.4	2.3	3.3	9.8
15 May	0.0	7.0	5.3	7.5
	0.2	4.3	3.5	8.5
	0.3	3.0	3.3	9.3
	0.4	2.8	3.3	9.3
24 May	0.0	-[y]	5.0	6.5
	0.2	-	5.0	6.5
	0.3	-	5.0	5.3
	0.4	-	4.8	5.3

[z] Scale 0-10, 10 dark green.
[y] Plots had not been sprayed by this date.

URBAN WASTE AS A MULCH IN LAND RECLAMATION

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Department of Horticultural Science

The large production of municipal solid waste that is generated has led many municipalities to search out alternate ways of utilizing organic wastes. The compost that is produced from these organic wastes has been used successfully as a soil amendment for turf establishment. Encouraged by this positive response, the composted organic waste was evaluated as a mulch for the revegetation of gravel slopes at the TCG gravel pit operation in Aberfoyle, Ontario.

RESEARCH PROCEDURE

. Two by six meter plots on a 22° slope were treated with three slope stabilization materials. Three replicated treatments consisted of the Ontario Ministry of the Environment compost, Ontario Ministry of the Environment mulch and a commonly used commercial wood fiber mulch. Application rates of the mulches were 50, 100 or 400 m^3 per ha. The plots were seeded and treated 27 Aug 1983. One reclamation grass mixture, PHD-1 from Oseco Inc., Brampton, Ontario was seeded at a rate of 160 kg per ha. The grass mixture contained the following species. 30% Canada bluegrass; 50% chewinge fescue, 15% perennial ryegrass and 5% red top. There was no supplemental irrigation or fertilization.

RESULTS

Plant establishment and slope stabilization was best in the compost treatment especially at higher treatment rates (Table 1). Higher application rates of the mulch material did not stabilize the slope and thus grass establishment was less. The wood fiber mulch had an excellent capacity for slope stabilization but resulted in an exceptionally poor plant establishment.

Table 1. Effect of treatment on amount of erosion and plant establishment.

			Plant establishment		
Treatment	Rate	Erosion	Nov. '83	June '84	Nov. '84
	(m^3/ha)	(% of plot)	(% groundcover)		
Control	0	23	54	27	50
Compost	50	17	80	63	70
	100	17	86	75	82
	400	0	100	85	92
Mulch	50	30	40	48	48
	100	20	14	23	18
Wood fiber mulch	100	3	46	43	33

NITROGEN EFFECTS ON ANNUAL BLUEGRASS AND CREEPING BENTGRASS

J.L. Fggens and C.P.M. Wright

Department of Horticultural Science

Annual bluegrass is an undesirable but persistent component of golf course greens, tees and fairways. While it has been shown to invade 'Penncross' creeping bentgrass swards, little information is available on the differences in growth characteristics of annual bluegrass and creeping bentgrass to account for its invasive nature. Earlier research noted that less annual bluegrass was present in 'Penncross' turf when the nitrogen source was urea or a slow release nitrogen fertilizer containing urea than when the nitrogen was from a non-urea source. The object of this research was to determine the effect of nitrogen source on the growth of annual bluegrass and 'Penncross' creeping bentgrass.

RESEARCH PROCEDURE

Polystands of annual bluegrass and Penncross were established in pots in silica sand. After a 3-week establishment period a fertility regime was initiated with nitrogen as 0, 25, 50, 75 or 100% NH_4^+-N (ammonium nitrogen). Nitrate nitrogen ($N0_3^-$-N) constituted the remainder of the nitrogen applied. The treatments were arranged in a randomized complete block design with 5 replications. The experiment was terminated 55 days after the nitrogen treatments were started.

RESULTS

Annual bluegrass and 'Penncross' creeping bentgrass responded differently to NH_4 +N. The shoot dry weight and tiller number of annual bluegrass decreased when the concentration of NH_4+-N exceeded 25% of nitrogen in solution while creeping bentgrass was not significantly affected (Table 1). These results suggest that for sand rootzone putting greens consisting primarily of annual bluegrass, a nitrate nitrogen source may provide better annual bluegrass growth than an ammonium nitrogen source.

Table 1. Influence of NH_4+:$N0_3^-$ ratio on annual bluegrass and Penncross in polystands.

Nitrogen Source		Shoot Dry Weight		Tiller Number	
NH_4^{-+}	$N0_3^-$	Annual Bluegrass	Penncross	Annual Bluegrass	Penncross
(%)	(%)	(mg/pot)		(tillers/plant)	
0	100	442	97	20.7	7.2
25	75	500	152	19.5	8.3
50	50	418	124	15.2	8.2
75	25	403	126	16.3	8.1
100	0	299	104	13.8	6.9
F value		L**Q* *	NS	L**	NS
LSD		92.3*, 122.8**			

[z] Treat. effects were nonsignificant (NS) or significant linear and/or quadratic effects at P=.05* or P=.01**.

A COMPARISON OF SOLUTION AND SOLID NITROGEN CARRIERS

R.W. Sheard and J.A. Ferguson

Department of Land Resource Science

The primary nutrient required for the production of turf is N. In general several applications per season are necessary although the number of applications may be reduced by the use of slow release N. The materials are applied as granular products which must be very fine or soluble in irrigation water applied immediately after spreading or significant pickup and removal in the basket may occur. Furthermore applicators, particularly spinner types,. are subject to non-uniform spreading patterns.

Recently the use of soluble N carriers, dissolved or suspended in water, have become popular in the home lawn care industry. Whilst solutions are in reality only another mechanical system for spreading N, they do offer several advantages such as i) ellimination of mower pickup, 2) inclusion of other chemicals such as fungicides and iron in the application, 3) consistency of color, 4) uniformity of application at low rates, and 5) speed of application.

This report contains data from an initial experiment to assess some N carriers applied as solutions in comparison with granular forms.

RESEARCH PROCEDURE

A compressed air liquid fertilizer unit using four 8015 spray nozzles was mounted on the precision granular fertilizer spreader and calibrated to deliver 2 L of solution at 30 psi over a 1 m x 6 m plot (3333 L/ha). Four replications of treatments involving the N materials, N rates, methods and frequency of application listed in Table 1 were used. Two four-week rounds of application to bentgras maintained as a golf green were made, the first commencing on Aug. 3, 1983 and the second on Aug. 31, 1983. Color evaluations were made and clipping weights obtained prior to commencing the second round on Aug. 31 and again on Sept. 28. The dried clippings were analyzed for total nitrogen.

RESULTS

Superior color was achieved by weekly spraying of .125 kg 8/100 m^2 as urea (Table 1). Following the second round urea plus Fe proved superior. Spraying at two week intervals failed to achieve the same color. Reducing by one-half the rate of application of N in association with Fe decreased the color quality attained. Likewise inclusion of a surfactant in combination with urea did not enhance color. Several other dissolveable or suspendable N carriers did not produce better or equivalent color to that obtained from urea. With the exception of Fluff all solution materials provided better color at the end of a round than the solid materials applied once every four weeks.

The amount of growth (clipping weight) was primarily related to the amount and timing of the N applications (Table 1). The addition of Fe to the solution did not alter the amount of clippings produced. Similar trends were noted in the concentration of N in the clippings. The site chosen for the experiment was N deficient at the beginning of the experiment, hence application of a solid slow-release material such as SCU at 0.5 kg N/100 m^2 every four weeks would provide insufficient N to overcome the deficiency. Foliar burn or discoloration without irrigation was not noted with any materials tested except where Fe was included in the first round of four applications. As a result the application rate of Fe was reduced by one-half.

Urea proved to be the most satisfactory material, however, the urea must be free of all foreign material to avoid nozzle clogging. Iron may increase color enhancement without increased growth but further studies on preventing immediate oxidation of the iron by well water must be carried out.

Table 1. Influence of source, rate, method and interval of application of nitrogen carriers on the color, clipping weight and tissue N concentration in bentgrass.

Treatment				Color Evaluation		Clipping Weight		N Concentration	
Material	Nitrogen Application			Aug. 31	Sept. 28	Aug. 31	Sept. 28	Aug. 31	Sept. 28
	Rate	Method	Interval						
	(Kg N/100 m^2/Appl.)		(Weeks)	(1-10 with 10 best)		(g/m^2)		(% of dry wt.)	
SCU	0.5	Solid	4	5.5 g*	5.3 e	12.38 abc	2.45 cd	3.94 d	4.46 de
Urea	0.5	Solid	4	6.4 def	6.3 d	12.38 abc	3.27 b	4.51 abc	4.67 abc
Urea	0.25	Liquid	2	7.2 bed	7.1 be	13.10 ab	3.85 a	4.50 abc	4.82 a
Urea	0.125	Liquid	1	7.8 ab	7.2 be	13.57 ab	3.34 ab	4.72 ab	4.72 ab
Urea + Fe[1]	0.25	Liquid	2	7.0 bcde	7.1 be	11.67 abc	3.05 b	4.47 be	4.62 bed
Urea + Fe	0.125	Liquid	1	8.3 a	8.1 a	13.33 ab	3.38 ab	4.86 a	4.66 abc
Urea + Fe	0.0625	Liquid	1	6.1 fg	7.0 bed	10.26 c	2.07 d	4.30 be	4.36 e
Urea + Aqua-Gro[2]	0.125	Liquid	1	7.2 bed	7.4 b	13.25 ab	3.16 b	4.66 abc	4.70 abc
Urea + 8% DCD[3]	0.125	Liquid	1	7.1 bed	6.6 cd	12.86 ab	3.18 b	4.39 be	4.62 bed
Fluff	0.125	Liquid	1	6.2 efg	5.6 e	12.54 abc	2.80 be	4.42 be	4.46 de
Formalene[4]	0.125	Liquid	1	7.5 abc	6.9 bed	13.97 a	3.03 b	4.57 abc	4.57 bed
Super 60[5]	0.125	Liquid	1	6.9 cdef	6.7 bed	11.59 be	3.03 b	4.59 abc	4.52 cde

*Treatment means followed by the same letter are not significantly different at P=0.05.

[1] Fe applied as $FeSO_4.7H_2O$ at 0.6 g Fe/100 m^2 (77 g $FeS0_4.7H_20$/100 m). Reduced to 1/2 rate for 2nd round.

[2] Aqua-Gro, a surfactant, applied at 123 ml/100 m^2.

[3] DCD - dicyandiamide, a nitrification inhibitor.

[4] Formalene - liquid urea - formaldehyde mixture.

[5] Super 60 - urea plus 2,4,6-triamino-1,3,5.triazine.

IRON-NITROGEN INTERACTIONS ON BENTCRASS

D.B. Davidson and R.W. Sheard

Department of Land Resource Science

In 1983 R.W. Sheard (see pp) initiated an experiment, the purpose of which was to compare the effects of various solution applications of nitrogen materials on the quality and growth of a bentgrass turf. A conclusion of the first years work was that urea plus $FeSO_4$ resulted in the best quality turf. This study is an expansion of the 1983 work.

Iron is known to have a substantial short term effect on the colour of turf but the nature of its interaction with nitrogen is largely unknown. Also there have been reports that iron chelates have a slight negative effect upon the growth of bentgrass although the work was carried out in Virginia using late fall applications. The goal of this experiment is to determine the nature of the iron : nitrogen interaction over a range of rates of the two elements and to determine the effect iron has upon turf quality and turf growth.

RESEARCH PROCEDURE

The research was carried out at the Cambridge Research Station on a 6 year old Penncrosa bentgrass turf maintained as a putting green. A rotatable second order composite design was used to study the response to turfgrass growth and turfgrass quality to varying rates of iron and nitrogen fertilizers. Eight different combinations of rates were used (Table 1) and the experiment was repeated for seven different combinations of materials (Table 2). There were 26 6m x lm plots per experiment and the plots were completely randomized within each experiment. All materials were applied using deionized water.

Table 1. Combinations of Fertilizer Materials Used*

N-Source	Fe-Source	Application frequency
Urea	$FeSO_4$	weekly
Urea (solid)	$FeSO_4$ (solid)	weekly
Urea	$FeSO_4$	biweekly
NH4NO3	$FeSO_4$ **	weekly
Urea	Fe-chelate	weekly
Super 60	Fe-chelate	weekly
Fluf	Fe-chelate	weekly

* All applied as solutions except as noted
**Sequestrene 330-Fe

Table 2. Rates of Fertilizer Applied

Nitrogen Rate	Iron Rate
(kg N/100 m^2/application**)	(g Fe/100 m^2/application)
0.19	0
0.28	1.2
0.50	14
0.72	41
0.81	56

*Equals 2.5 ounces $FeS0_4$/l000 ft^2.
**Double rate for biweekly application.

Relative growth rate was measured four times, at the completion of. each 4-week interval, from June through September. Visual estimates of quality were made on seven separate occasions, four coinciding with the dates on which relative growth rate was measured and one day prior to the next fertilizer application. The other three measures were made one day after applications of fertilizers.

RESULTS

The results of the series of trials exhibit some common trends. The first is iron had a very small effect or no effect on the growth rate of the bentgrass. The second is iron had a significant positive impact on the quality of the turf. For example, the relative growth rate response and the quality response of the bentgrass on September 18 are shown in Figures 1 and 2. The graphs are a depiction of the significant factors from a regression analysis of a full quadratic model. The conclusion that can be drawn is that a turf manager can set the nitrogen regime for the growth rate he desires and then use supplemental iron to improve the quality. Also of note is iron provided relatively little improvement in quality beyond 17 g/100 m^2/application or 2.5 ounces of $FeS0_4$/1000 ft^2. Burning of the turf due to iron was not noted until rates in excess of 34 g Fe/100 m^2/application were used.

Observations from the other experiments (data not presented) show 1) the effect of iron on quality is greater where a slow release N-source is used, 2) iron applied as a solid had a negligible effect and that Fe chelate showed a slightly greater tendency to burn. Burning was usually associated with the soluble N-sources such as urea or NH_4N0_3. Data on quality measurements tended to show that if $FeS0_4$ was the iron source the quality effect lasted in the order of one week. Therefore weekly applications would be necessary to maintain a constant turf quality throughout the summer.

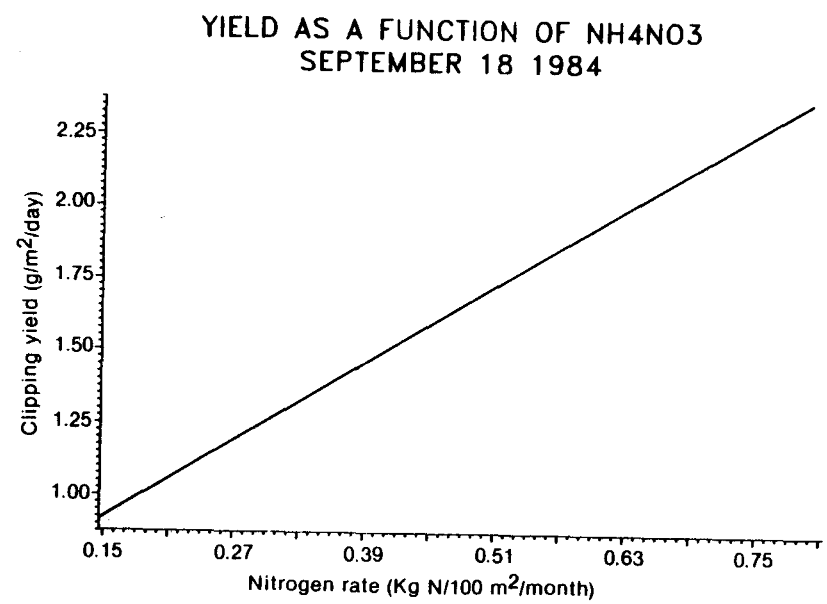

Figure 1. Growth rate (g clippings/m^2/day) of bentgrass fertilized at weekly intervals with ammonium nitrate solutions.

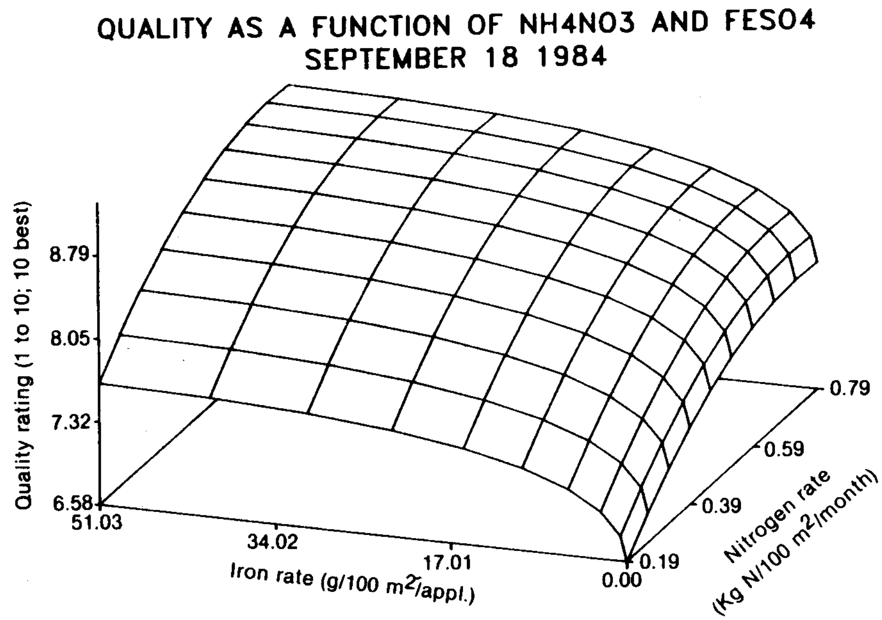

Figure 2. Quality of bentgrass fertilized at weekly intervals with solutions containing rates of nitrogen as ammonium nitrateand rates of iron as ferrous sulphate.

THE NUTRITIONAL REQUIREMENTS OF BENTGRASS ON ALL-SAND ROOTING MEDIA

R.W. Sheard, M.A. Haw and J.A. Ferguson

Department of Land Resource Science

An initial summary of the data obtained from a micro-green installation at the Cambridge Research Station was presented in the 1983 Turfgrass Research Report. A summary of the 1983 data for nitrogen (N), phosphorus (P) and potassium (K) removal as clippings and lost through drainage is provided herein.

RESEARCH PROCEDURE

Twelve, 0.65 m^2 micro-greens of an alkaline sand and 12 of an acid sand were contained within fiberglass tanks, which were equiped with drainlines to permit the collection of drainage water, were seeded to Penncross bentgrass in 1982. In 1983 the greens were clipped on 34 occasions at a height of 0.6 cm and all clippings from each tank were collected, dried at 30ºC and weighed prior to analysis for N, P and K. Drainage events occurred at 40 dates throughout the year from which samples were obtained for N, P and K analysis. During the growing season five applications of 0.5 Kg N/100 m^2, two applications of 1.0 Kg p/100 m^2 and three applications of 1.0 Kg K/100 m^2 were made.

RESULTS

Analysis of the pant tissue obtained between April 29 and Oct. 11 showed a N concentration ranging from 3.0 to 4.5% N. The days since the last application of N was the major factor influencing the concentration. The removal of clippings accounted for 60.04% of the 2.5 Kg N/100 m^2 which had been applied during the 1983 season (Table 1). In sharp contrast very

Table 1. The influence of pH of sand, nitrogen source and potassium source on the nitrogen removed in clippings and lost in the drainage water between April 29 and Oct. 15, 1983.

Treatment		Nitrogen Applied	Clipping Removal	Drainage Loss	Total
		(Kg N/100 m^2)	(%)	(%)	(%)
Sand	Acid	2.5	61.36	0.8	62.16
	Alkaline	2.5	58.72	0.59	59.31
Nitrogen	Urea	2.5	60.56	0.83	61.39
	SCU*	2.5	59.52	0.57	60.09
Potassium	KCl	2.5	58.82	0.73	59.55
	SCKCl**	2.5	61.27	0.67	61.94

* Sulphur coated urea
** Sulphur coated potassium chloride

little N, averaging 0.69%, was lost in the drainage water during the growing season. Of more significance was the small amount of N lost during the non-growing season which added another 0.88 percentage points for an average total loss of applied N through drainage of 1.57%. Although the differences were minute more N was removed in clippings or lost in the drainage water where an acid sand was used in contrast to an alkaline sand. Likewise slightly more N was removed in clippings or lost in the drainage water from urea treated plots than from SCU plots. Although sample analysis is not available for confirmation a significant amount of the unexplained N must remain in the thatch, roots and verdure not harvested during the season. Total N concentrations in the drainage water seldom exceed 1 ppm during the growing season and were always less than 2 ppm during the non-growing season.

The concentration of K in clippings ranged from 1.9 to 2.8% but the differene between treatments on any date was rarely more than 0.2% K. The removal of clippings accounted for an average of 33.6% of the K applied during the growing season (Table 2). The removal of K by clippings was slightly higher where the bentgrass was growing on an acid sand and where

Table 2. The influence of pH of sand, nitrogen source and potassium source on the nitrogen removed in clippings and lost in the drainage water between April 29 and Oct. 15, 1983.

Treatment		Potassium Applied	Clipping Removal	Drainage Loss	Total
		(Kg K/100 m^2)	(%)	(%)	(%)
Sand	Acid	3.0	35.44	33.63	69.07
	Alkaline	3.0	31.73	16.53	48.26
Nitrogen	Urea	3.0	33.61	22.27	55.88
	SCU	3.0	33.56	27.9	61.46
Potassium	KCI	3.0	31.55	24.57	56.12
	SCKC1**	3.0	35.62	25.6	61.22

* Sulphur coated urea

** Sulphur coated potassium chloride

SCKCl was used as a source of K. Drainage losses of K were twice"as great from the acid sand as from the alkaline sand. Likewise 25% more K leached from the SCU treated sand than from the urea treated sand. There was little advantage of using SCKCl to prevent the movement of K from the system. The sand system continued to lose K by leaching when the turf was dormant with 28.7% of the applied K being lost during the non-growing season.

The clippings contained an average of 0.6% P suggesting an over supply of P in the system. Although only 2 Kg P/100 m^2 had been applied in 1983 a total of 9 Kg P/100 m^2 had been applied to each micro-green since the beginning of the experiment. As a result the average soil test for the greens on Aug. 10, 1983, was 40 ppm P. Nevertheless an average of only 12.8% of the P applied in 1983 was removed in the clippings with only slight differences due to treatments (Table 3). Leaching losses were also

Table 3. The influence of pH of sand, nitrogen source and potassium source on the phosphorus removed in clippings and lost in the drainage water between April 29 and Oct. 15, 1983.

Treatment		Phosphorus Applied	Clipping Removal	Drainage Loss	Total
		(kg P/100 m^2)	(%)	(%)	(%) .
Sand	Acid	2.0	13.3	12.5	25.8
	Alkaline	2.0	12.3	4.0	16.3
Nitrogen	Urea	2.0	12.6	8.6	21.2
	SCU	2.0	13.0	7.9	20.9
Potassium	KCl	2.0	12.6	8.2	20.7
	SCKCl**	2.0	13.1	8.4	21.4

* Sulphur coated urea
** Sulphur coated potassium chloride

relatively low but varied markedly between the acid and the alkaline sand, ranging from 12.5% on the acid sand to 4.0% on the alkaline sand.

Analysis of the clippings from July 18, 1983, showed the plant tissue to be adequately supplied with all trace elements (Table 4). The data indicated that the pH of the sand had a significant influence on the concentration of Zn, Cu and Mn in the tissue. Higher concentrations of 7.n and Cu were found in the bentgrass growing on the acid sand whereas the reverse was found for Mn in that the acid sand produced turf with twice the Mn concentration found in the alkaline sand. Urea fertilization increased the Cu concentration by 9%. The pH of the sand and N fertilization interacted to increase the Mn concentration by 113% where SCU was used in comparison to urea on the acid sand in contrast to an increase of 26% where SCU was applied to the alkaline sand. Iron and boron were not influenced by the treatments.

In view of the reduced drainage loss of N, P and K and the increased concentration of Zn and Cu in the plant tissue where the alkaline sand was used it must be concluded that the high carbonate sands found in Southern Ontario are not detrimental to bentgrass production. In terms of N concentration in the tissue and N losses through leaching there was little evidience of a marked advantage for the use of SCU in contrast to urea.

Table 4. The influence of sand pH, nitrogen source and potassium source on the trace element concentration in the bentgrass clippings obtained on July 18, 1983.

Element	Nitrogen Source	Potassium Source	Sand Acid	Sand Alkaline	Statistical Sig. Treatment(s)
			(ppm)		
Zinc	Urea	KCl**	252	323	Sand pH
		SCKCl**	226	312	
	SCU*	KCl	255	305	
		SCKCl	234	306	
Copper	Urea	KCl	79.8	91.6	Sand pH
		SCKCl	73.8	87.1	Nitrogen source
	SCU	KCl	65.6	82.3	
		SCKCI	73.2	83.6	
Manganese	Urea	KCl	1342	660	Sand pH
		SCKCl	1005	679	Nitrogen source
	SCU	KCl	2459	784	Nitrogen x pH
		SCKCl	2532	900	
Iron	Urea	KCl	1394	1268	N.S.
		SCKCl	1129	1177	
	SCU	RCl	1132	1064	
		SCKCl	1279	1118	
Boron	Urea	KCl	16	14	N.S.
		SCKCl	13	13	
	SCU	KCl	16	13	
		SCKCl	13	14	

*Sulphur coated urea
**Sulphur coated potassium chloride

There was no advantage of any significance which could be attributed to the use of SCKCl. Likewise no evidence of a need for trace elements was obtained.

The data indicate that small, frequent applications of N and K at intervals of not longer than four weeks are preferred to minimize loss through leaching or excessive uptake of nutrients by turf produced on all sand systems. The high level of K loss by leaching would suggest each application of N be accompanied by an application of K at a ratio of 4 parts N to 3 parts K_20, i.e., a 20-0-15 fertilizer.

IMPACT AND SHEAR RESISTANCE OF TURFGRASS RACING SURFACES FOR THOROUGHBREDS

B.J. Zebarth and R.W. Sheard

Department of Land Resource Science

Each year, the American thoroughbred industry loses an estimated 250 million dollars due to lameness. The importance of racing surface hardness in contributing to lameness has been clearly established. It is generally accepted that turf surfaces have a lower impact resistance and lower incidence of lameness than non-turf surfaces. Thus, owners and trainers from countries that race primarily on turf are reluctant to race on non-turf surfaces, limiting their involvement in Canadian racing events.

The purpose of this study is to determine the influence of soil and turf factors on impact resistance and shear strength of turf racing surfaces for thoroughbreds. The turf and soil factors to be considered include turf mowing height, root weight, depth of thatch, soil bulk density, moisture content, texture or gradation index, and soil elasticity.

RESEARCH PROCEDURE

The dominant processes involved in the horse hoof/racing surface interaction are the impact loading of the horse hoof and leg and the "cutting-in" action of the horse hoof. Impact loading was measured as impact resistance, i.e., the deceleration-time response of a simulated horse hoof upon impact with a test surface. The response was measured by an accelerometer in conjunction with a waveform recording chart recorder. The "cutting-in" action of the horse hoof was measured as resistance to shear, i.e., the peak force required to rotate a metal plate through the test surface. The force-time response was measured by strain gauges and a waveform recording chart recorder. Measurements were made on a variety of turf surfaces at Woodbine, Toronto and the Cambridge Research Station.

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RESULTS

Horse performance, measured as average race time for the first three finishers, showed a strong negative correlation with impact resistance measurements (Fig. 1). Impact resistance, in turn, was found to increase with increasing bulk density and decreasing soil moisture content. In practice, however; turf surfaces were found to be relatively resistant to changes in bulk density and most seasonal changes in hardness of the turf track could be attributed to changes in soil moisture content. Therefore, control over soil water through irrigation and drainage will provide significant control over track hardness.

Soil particle size distribution had a major influence on modifying the range of bulk density and moisture content values of the soil system. Hence, careful attention should be paid to the selection of the soil material during construction of a new racing surface. In general, sand rooting materials wre found to give higher values of impact resistance and lower values of resistance to shear than soil rooting materials. Therefore, impact loading on a horse's leg will be higher and resistance to hoof rotation will be lower for a sand rooting system than for a soil rooting system. In all cases, elasticity of the sand or soil materials was low (0 to 4% energy return) and of questionable importance.

Turf roots were responsible for a significant increase in impact resistance and resistance to shear. For example, at comparable values of bulk density and water content, impact resistance values of 511 and 276 ms^{-2} respectively were measured for soil plus turf and soil only systems. In contrast the high values of bulk density present in the base of the Woodbine dirt track result in relatively high values of impact resistance, i.e., 651 ms^{-1} for a 7.5 cm cushion. Likewise, resistance to shear was estimated to increase three-fold as a result of introducing turf roots into a soil system. A high resistance to the "cutting-in" action of the horse hoof is important in minimizing damage to a turf surface.

Turf mowing height (Table 1) and thatch accumulation (Table 2) did not alter racing surface hardness. Therefore, management of a turf surface for thoroughbred racing should be to optimize turf growth and recovery.

Table 1. Influence of thatch on impact resistance .

Soil	Thatch	No Thatch
	ms^{-2}†	
Brick sand	872*	850
Freeport sandy loam	633	596

* Influence of thatch on impact resistance not significant at P=0.05.
†Deacceleration of moving body in meters per second^2.

Table 2. Influence of turf mowing height on impact resistance*.

Mowing Height	Impact Resistance
(cm)	(ms^{-2})
3	635
9	629
15	624

* Influence of mowing height on impact resistance not significant at P=0.0 5.

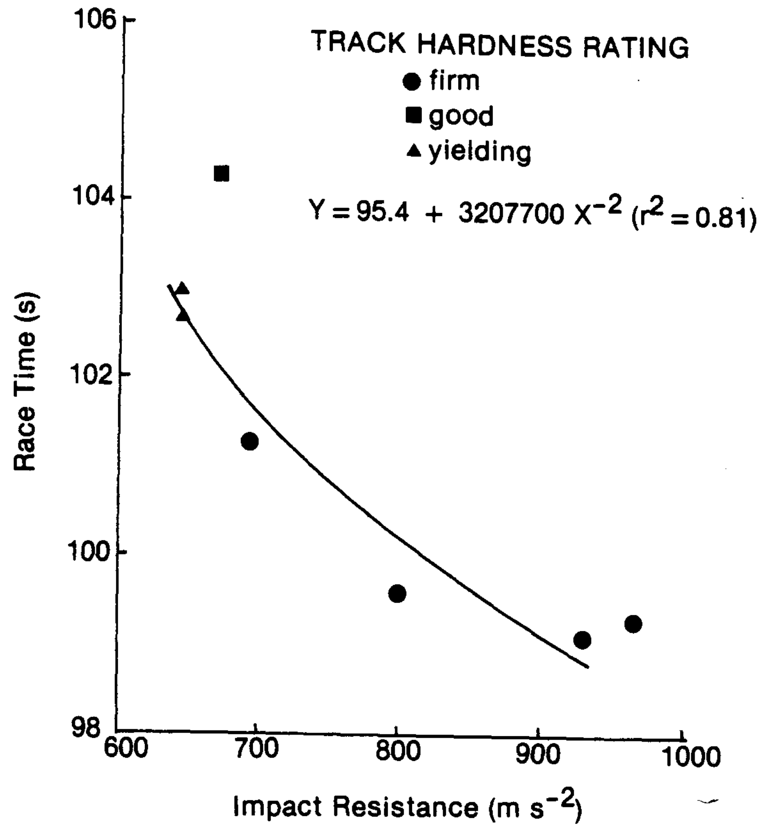


Figure 1. The relationship between track hardness and race time in thoroughbred racing.

BIOLOGY OF THE TURFGRASS SCALE

M.K. Sears and K. Maitland

Department of Environmental Biology

RESEARCH PROCEDURE

Two locations were selected for sampling the population of turfgrass scale in Guelph, Ontario during 1984. One location, a residential lawn, received a moderate amount of maintenance including regular irrigation, fertilization, mowing and one herbicide (Killex) treatment. The other location was a city park that received minimal maintenance which including occasional mowing, no irrigation and no fertilizer or herbicide. Insecticides were not applied to either site in 1984. One objective of the study was to determine if the degree of maintenance of the two locations had an appreciable effect on populations of the turfgrass scale.

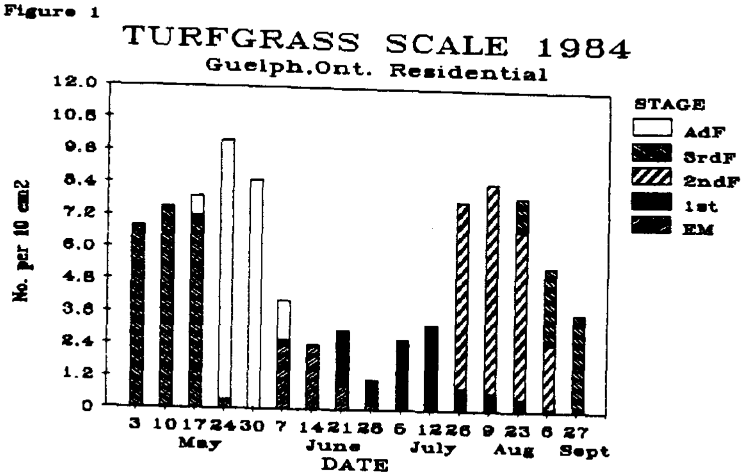
At each location, 3 sites were selected where a 1 m^2 quadrat was randomly placed on each sampling date. Thirty sampling points were selected from each quadrat and a soil core 3 cm^2 in area was taken from each point. The cores were taken to the laboratory for examination and the number, stage and **sex** of the scales determined.

RESULTS

A single generation of the scale insect was found to occur during the season (Figure 1). The resting stage or pupa of the male and the mature 3rd-instar female nymph were the only stages that were found to overwinter. Egg masses produced by the females (approx. 85 eggs/mass) were present throughout June. The crawlers or 1st-instar nymphs that hatched from the eggs were most numerous in late June and July. Males and females can be distinguished under the microscope in the 2nd-instar nymph and these were present from mid-July until the end of September. Only the numbers of females are designated in Figure t because the proportion of males in the population constituted less than 107 of the total. By the end of August, the overwintering stages were again present and comprised the entire sample by October. The scale completes one generation each year.

Fewer scales were found in the turfgrass of the park site than on the residential lawn giving some indication that nutrition might lave some influence on the density of turfgrass scale populations. This aspect of the scale's biology must be examined further. In a separate experiment scales were placed on various turfgrass species grown in 6" pots. 'do conclusions could be drawn about the preference of this insect for various grasses as survival was equally poor on all species examined.

Figure 1



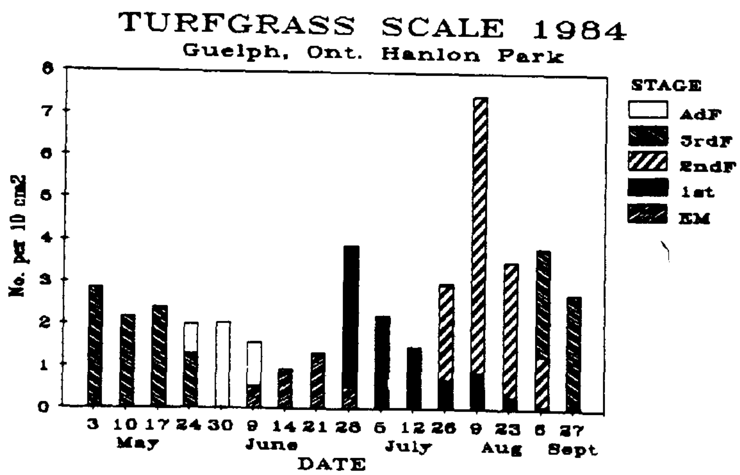


Figure 1. Population changes in the life cycle of the turfgrass scale insect under moderate (residential) and minimal (Hanlon Park) management conditions.

TURF-TYPE PERENNIAL RYEGRASS STUDIES

N.E. McCollum

As a result of the performance of ryegrasses in cultivar trials seeded since 1978 we decided to expand our studies of this species. The turf type ryegrasses, because of improved winter hardiness, colour and mowability, are becoming useful as a perennial turf grass, particularly on sports fields and golf courses.

On August 1st 1984 we seeded 17 cultivars of ryegrasses and tall fescues in plots 1 x 40 meters, replicated 3 times. We noted the rate of germination and percent cover (Table 1).

Although the ryegrasses have demonstrated improved winter hardiness and good density there are some questions yet to be answered, one of which is tolerance to various mowing heights, response to various fertility regimes and resistance to disease.

Dr. Lee Burpee has initiated studies in evaluation for snow mold resistance, with and without winter fungicide protection. The management (mowing and fertility) program will begin in spring of 1985.

Table 1. Evaluation of perennial ryegrass cultivars and tall fescues seeded August 1, 1984.

Cultivar	Aug. 13	Aug. 19 (after 1st mowing)
	(Rating 1 to 10; 10 best)	
Arno	4.5	6.0
Barry	6.7	7.3
Bison	5.0	6.5
Blazer	5.0	6.7
Cowboy	4.7	5.3
Diplomat	6.0	6.7
Ensilo	4.0	5.5
Fiesta	6.0	6.7
Gambit	3.0	2.5
Hunter	2.0	4.0
Kenhy	2.5	3.0
Manhattan	6.5	7.0
Norka	3.5	5.5
Omega	7.5	8.0
Palmer	7.3	7.3
Prelude	6.5	7.5
Ranger	5.7	6.7
Yorktown II	7.5	8.0

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Pathology Observation - L.L. Burpee. Problems continue to exist on sand greens in a few areas of Ontario. The loss of creeping bentgrass at these sites cannot be attributed to a single cause. For example, turf was lost at 2 sites during *very* cool, wet weather in May while greens at 3 other locations began to suffer only after several weeks of high temperatures in .July and August. A *Pythium* species was isolated from the turf that exhibited the cold-weather blight. However, no definitive pathogen could be isolated from roots or foliage of the summer-blighted turf. Some superintendents have been reporting beneficial effects of applying chloroneb (Tersan SP) on blighted sand greens. Many of the effected greens are in sites that reca.ive low amounts of morning sun and air circulation. Every effort should be made to prevent overwatering these greens and to enhance drying by pruning or removing surrounding trees and shrubs.

Summer patch disease (Fusarium blight) continues to be a problem on Kentucky bluegrass home lawns. Preventative practices including cultivation (dethatching), increased summer irrigation, and the use of very slow release form of nitrogen (ie., organic N) are suggested. Recovery of blighted turf is enhanced by overseeding with a 3:1 mix of resistant perennial rye (cultivars-Manhattan II, Fiesta, Yorktown II) and resistant Kentucky bluegrass (cultivars-Adelphi, Touchdown, Parade, Baron.

Changes in Soil Testing Procedures - R.W. Sheard. On Sept. 1, 1984 the analytical function for the O.M.A.F. Soil Testing Service was assumed by Agri-Food Labs., Unit 1, 503 Imperial Road, Guelph, Ont. N1H 6T9. There is no charge for the service for samples submitted by golf courses, lawn care operators and others engaged in the turf industry. Prof. R.W. Sheard will continue to provide interpretation of the results unless the otherwise requested.

In order to provide a correct printout of the recommendations the turf manager should use the information sheets and soil sample boxes which may be obtained without charge by writing to the Lab. or from your local county Ag. Rep. Office. When completing the information sheet pay special attention to the classification of the type of turf, a system which is outlined at the bottom of the information sheet.

The Dept. of Land Resource Science, Univ. of Guelph will continue to provide particle size distribution analysis and moisture characteristics on sands and sand:soil mixes for greens and playing field construction and top dressing. Three to six weeks lead-time between submitting the sample and use of the analysis and interpretation of the data for construction is necessary in case your sample is not satisfactory and another source of materials must be located. At least 2 kilogram samples of the materials to be tested are required. There is a charge of $20.00/sample for particle size distribution analysis and $100.00 for moisture characteristics analysis.

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