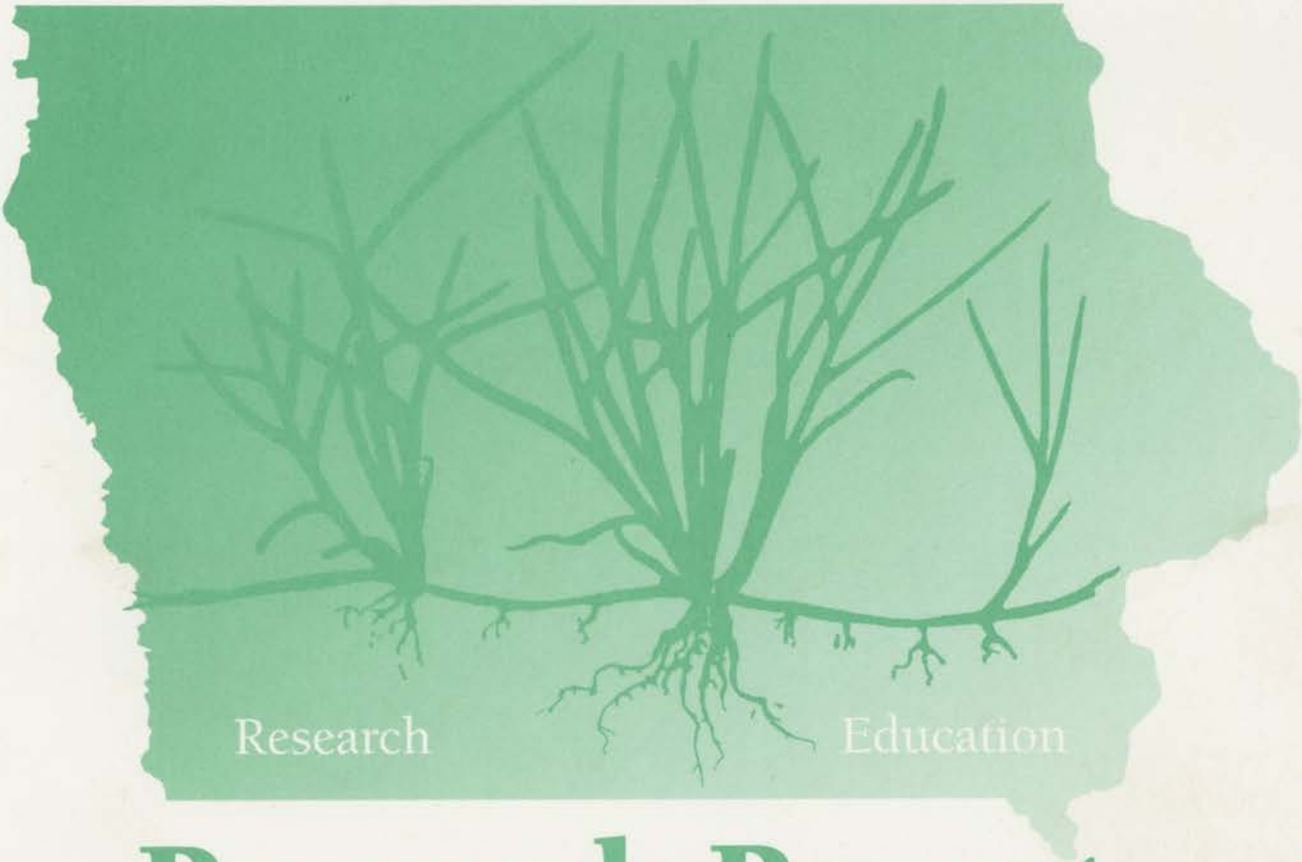
1994
Iowa Turfgrass



Research Report

Department of Horticulture
Department of Plant Pathology
Department of Entomology
Cooperative Extension
IOWA STATE UNIVERSITY

In Cooperation with the
Iowa Turfgrass Institute

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

University Extension

FG-462|July 1994

Introduction

N. E. Christians

The following research report is the 15th yearly publication of the results of turfgrass research projects performed at Iowa State University. Copies of information in earlier reports are available from most of the county extension offices in Iowa.

The 1993 season was one of the wettest in history. The response of several cultivars was different in 1993 than were the responses observed in more normal years. Turf response to fertilizer, herbicide and growth regulator treatments were also affected by the unusual weather. It is recommended that those who use the report to make decisions on the selection of grasses or pesticide products also refer to previous reports when making critical decisions.

For the fourth year, this research report contains a section titled "Environmental Research." This section is included to inform the public of our many research projects that are aimed at the many environmental issues that face the turf industry. In the past four years this has become a major thrust of the research program and many of our more extensive, in-depth projects are now aimed at environmental issues.

I would like to acknowledge Dr. Mike Agnew, who left Iowa State University in February, 1994, for his work on the projects reviewed in this report and for all of his contributions to the turf industry in the past 10 years. Mike will be missed by his coworkers at Iowa State University and by all of those involved in the Iowa turfgrass industry.

I would like to acknowledge Richard Moore, interim superintendent of the ISU Horticulture Research Station; Jim Dickson, interim manager of the turf research area; Dave Anderson, graduate research assistant; Dianna Liu, Post Doctoral researcher; Barbara Bingaman, Post Doctoral researcher; Doug Campbell, research associate, and all others employed at the field research area in the past year for their efforts in building the turf program.

Special thanks to Lori Westrum for her work in typing and helping to edit this publication.

Edited by Nick Christians, professor, Horticulture.

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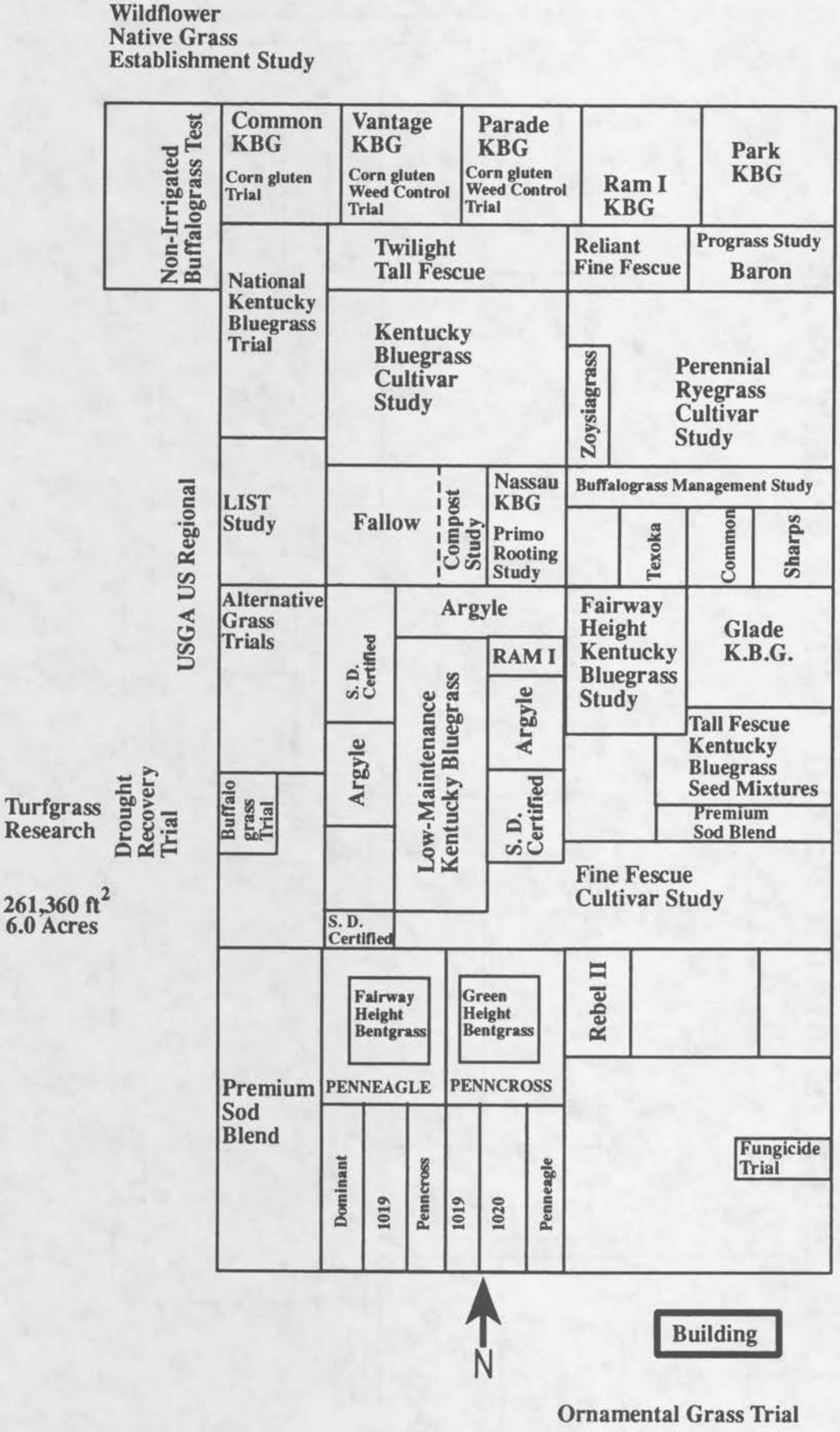
Wildflower
Native Grass
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Argyle
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Fairway Height Kentucky Bluegrass Study
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Buffalo grass Trial
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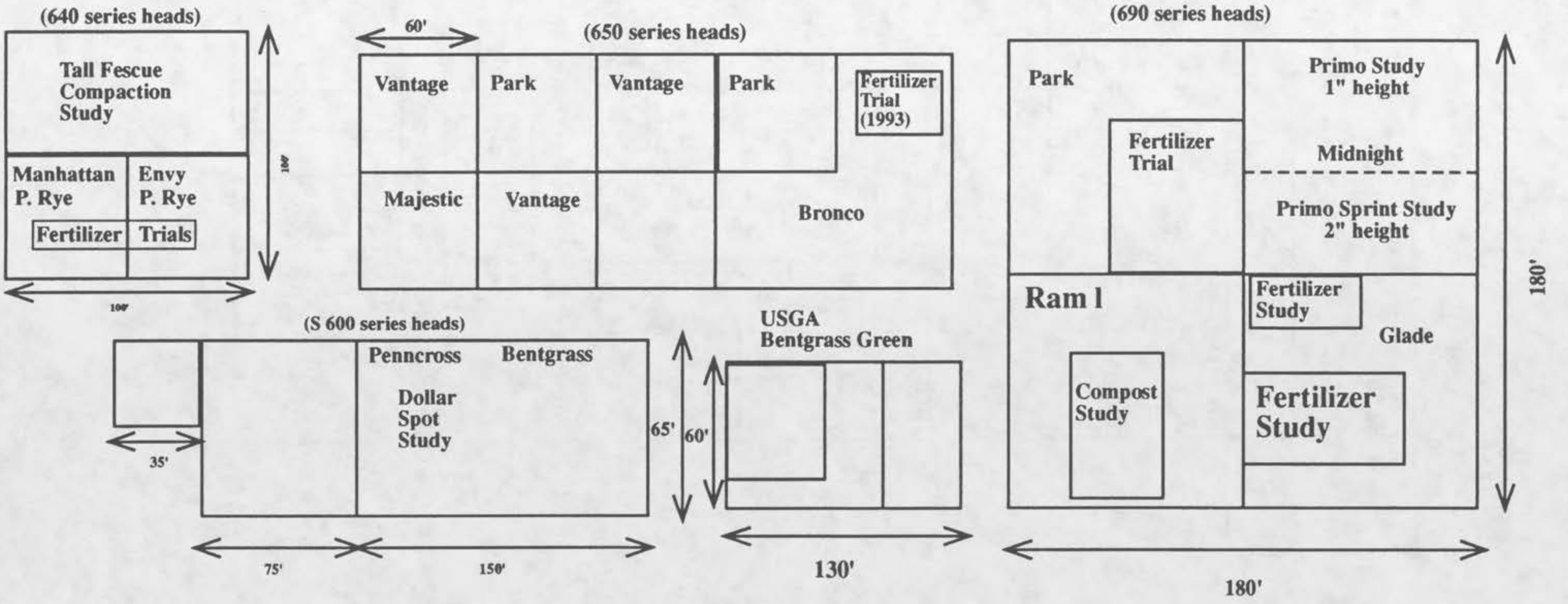
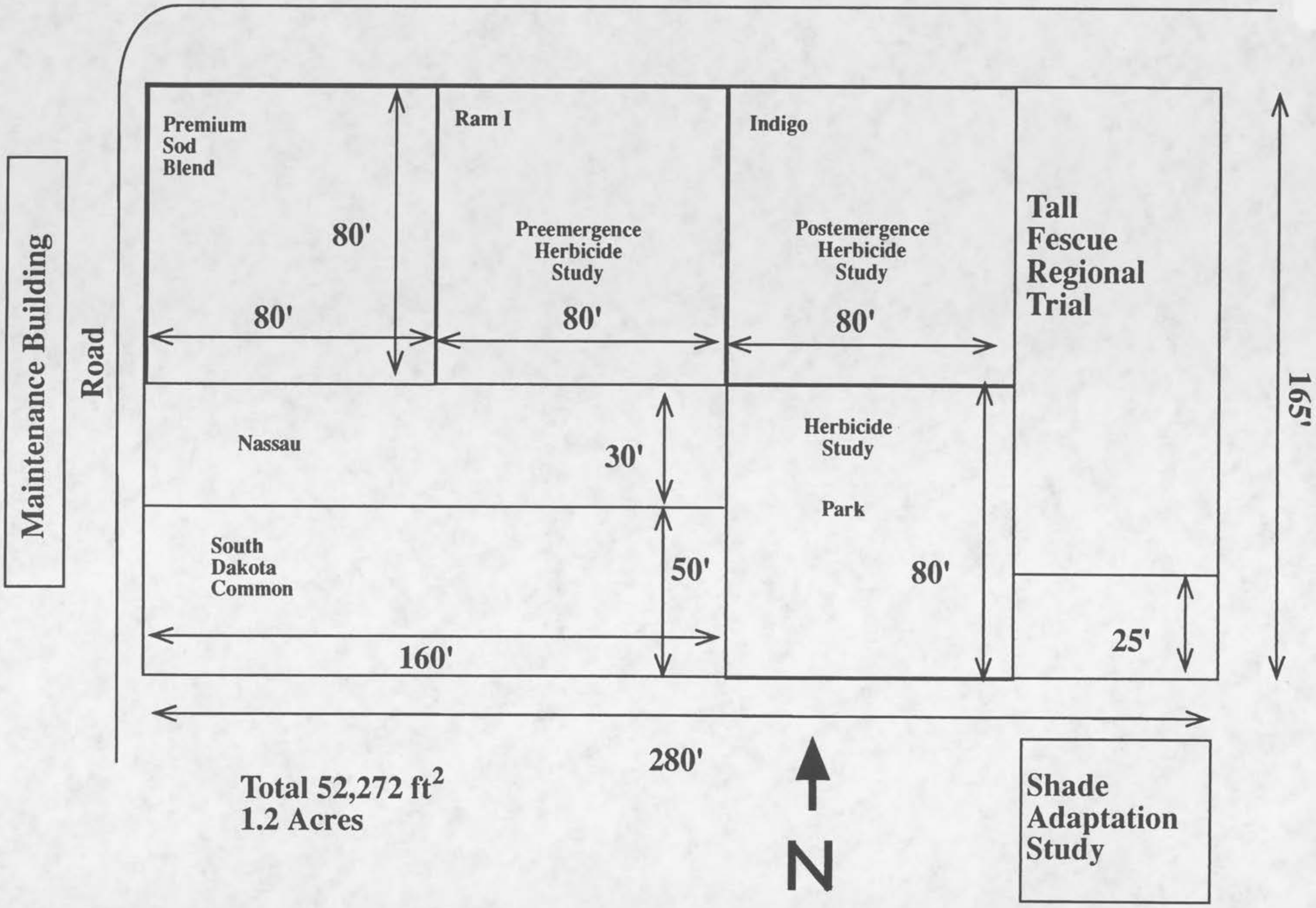
Premium Sod Blend
Fine Fescue Cultivar Study
261,360 ft^2
6.0 Acres
S. D. Certified
Fairway Height Bentgrass
Green Height Bentgrass
Rebel II
Premium Sod Blend
PENNEAGLE
PENNCROSS
Dominant
1019
Penncross
1019
1020
Penneagle
Fungicide Trial
N
Building
Ornamental Grass Trial

1984 Expansion of the Turfgrass Research Area
108,900 ft - 2.5 Acres^2



East Research Area



Environmental Data

Annual Progress Report
Iowa State University Horticulture Research Station
Ames, Iowa

Crop Season

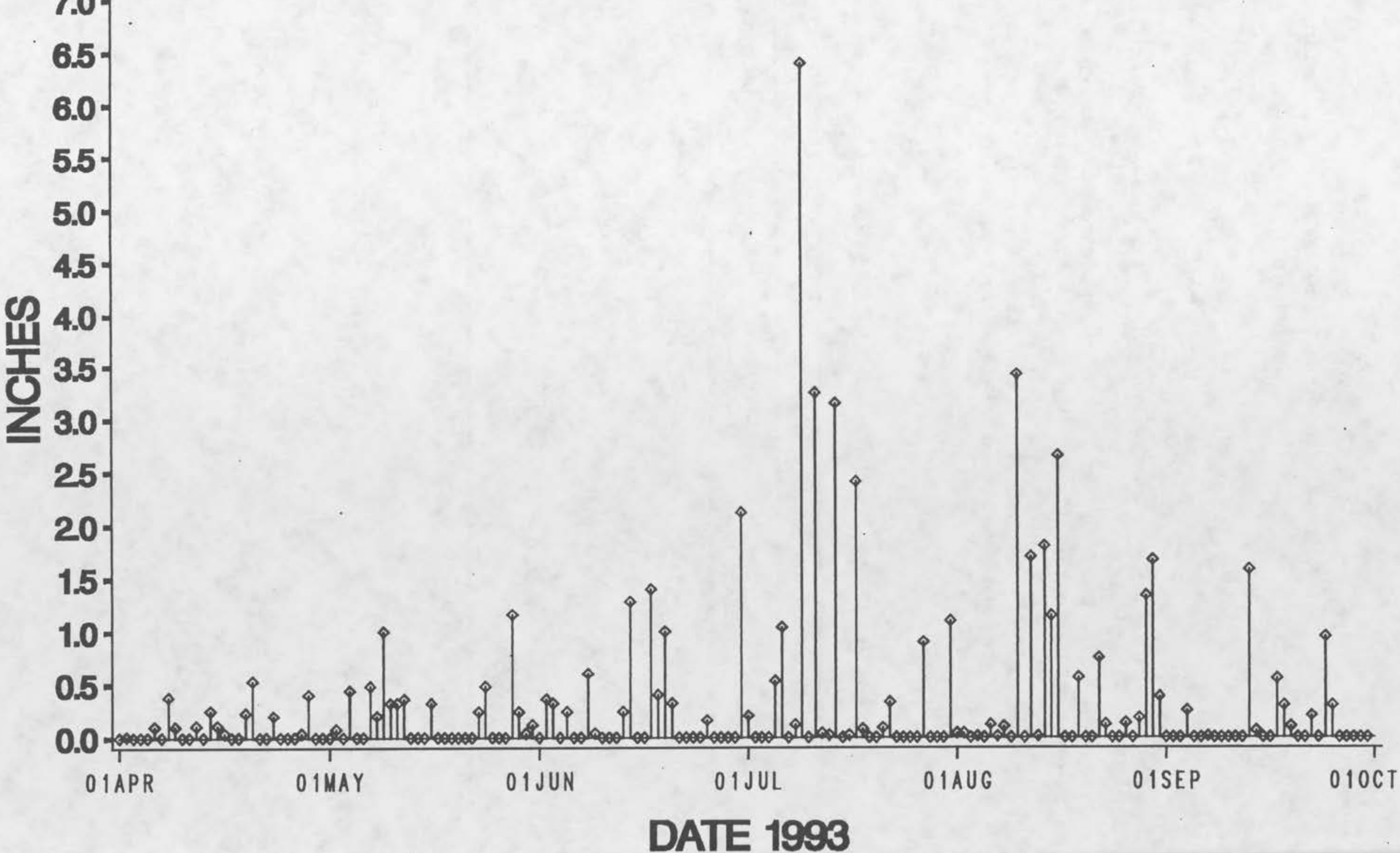
Monthly average rainfall, temperature and days with rain for the Horticulture Research Station, Ames, IA, are listed in the table below. The 1993 growing season was cold and wet. From the end of June until late September, the unrelenting rains caused the worst production disaster in the history of the state. In addition, September was the coldest on record. Most areas of the state suffered near total losses.

The last spring frost was April 22, 1993. The minimum temperature in May 1993, was 36°F, occurring on May 22. The first fall frost occurred on October 3, 1993. The respective normal 25% chance of frost is May 9 and October 6.

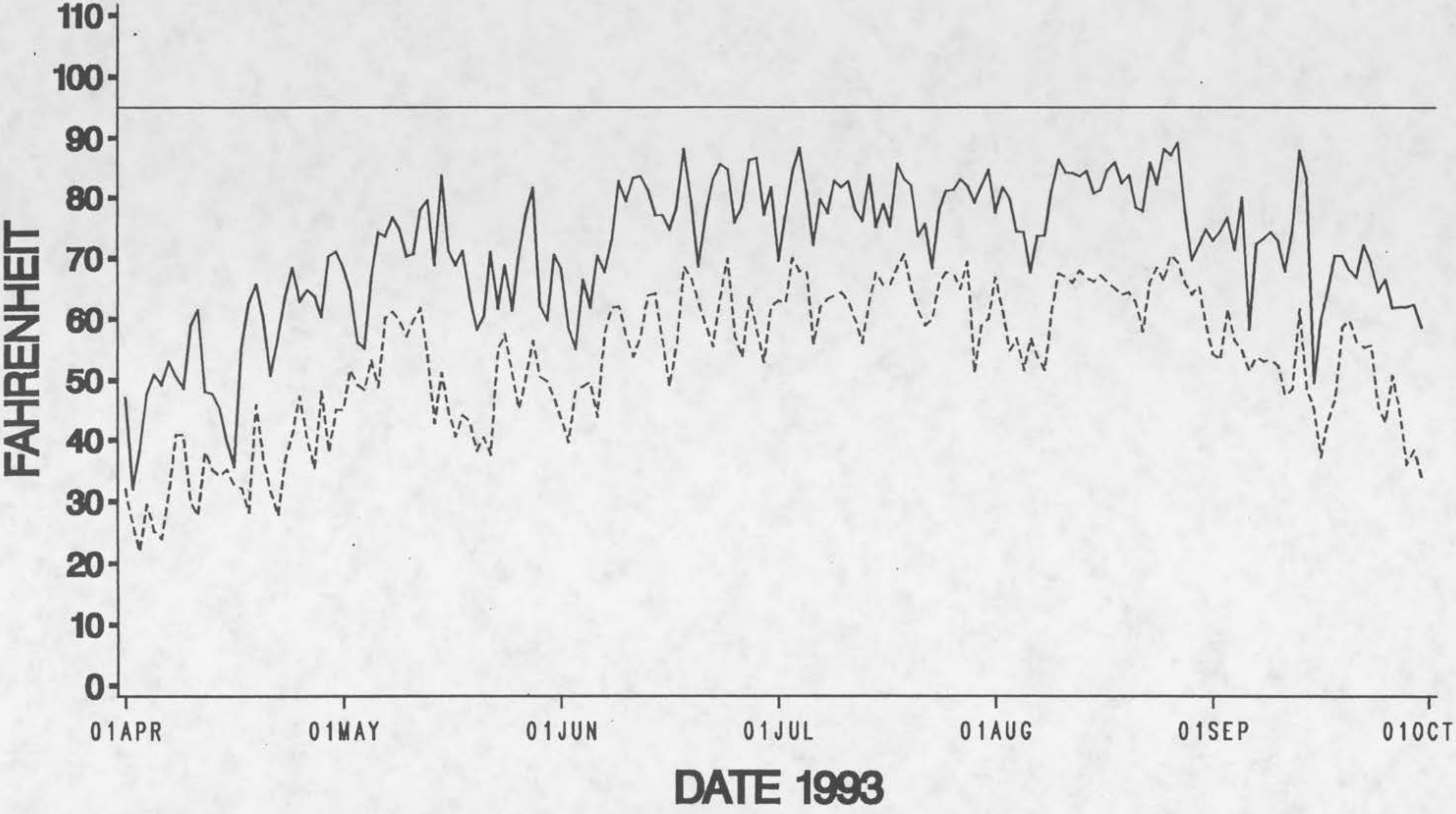
Weather data for 1993, Iowa State University Horticulture Research Station, Ames, Iowa.

	Temperature(°F)		Rainfall (inches)		
Month	Average	Deviation from Normal	Average	Deviation from Normal	Number of Rain Days
April	45	-8	2.50	-0.69	13
May	59	-2	5.80	+1.30	15
June	69	-1	8.48	+2.68	13
July	71	-4	19.68	+16.44	16
August	71	-1	16.18	+12.53	20
September	59	-6	4.30	+1.10	10

DAILY RAINFALL - AMES



DAILY TEMPERATURE – AMES



Solid Line = Max Dashed Line = Min

Species and Cultivar Trials

Results of Kentucky Bluegrass Regional Cultivar Trials - 1993

N. E. Christians and J. D. Dickson

The United States Department of Agriculture (USDA) has sponsored several regional Kentucky bluegrass cultivar trials conducted at most of the northern agricultural experiment stations. The current test consists of 62, 80, or 128 cultivars; the number depending on the year of establishment and the type of trial, with each cultivar replicated three times.

Three trials were underway at Iowa State University during the 1993 season. A high-maintenance study was established in 1990 that receives 4 lb N/1000 ft^2/yr and is irrigated as needed. The second trial was established in 1985 and receives 4 lb N/1000 ft^2/yr, but is non-irrigated. The third trial was established in the fall of 1991 and is a low-maintenance study that receives 1 lb of N/1000 ft^2/yr in September and is non-irrigated. The objective of the high-maintenance study is to investigate cultivar performance under a cultural regime similar to that used on irrigated home lawns in Iowa. The objective of the second study is to observe the cultivar response under conditions similar to those found in non-irrigated lawns that receive a standard lawn care program. The objective of the third study is to evaluate cultivars under conditions similar to those maintained in a park or school ground.

The values listed under each month in Tables 1, 2 and 3 are the averages of visual quality ratings made on three replicated plots for the three studies. Visual quality was based on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and 1 = poorest quality. Yearly means of data from each month were taken and are listed in the last column. The first cultivar received the highest average rating for the entire 1993 season. The cultivars are listed in descending order of average quality.

Because of the very wet conditions in 1993, irrigation was not necessary during the season and the non-irrigated plots received the same moisture as the irrigated plots. Of particular interest in the 1993 data is the ranking of the varieties in the low maintenance trials. Low maintenance cultivars like Kenblue and South Dakota Certified generally rank high in non-irrigated studies. In this very wet year, however, these cultivars ranked much lower than in dryer years (Table 2).

Table 1. The 1993 quality ratings for the high-maintenance, irrigated Kentucky bluegrass trial.

	Cultivar	May	June	July	Aug	Sept	Oct	Mean
1	Conni	8.0	8.0	8.3	7.3	7.3	7.3	7.7
2	Apex (Summit)	7.0	7.3	8.3	7.3	7.7	7.7	7.6
3	BA 77-279	6.7	7.7	8.3	8.0	7.3	7.0	7.5
4	Alpine	7.7	7.7	7.0	8.0	7.0	7.0	7.4
5	BA 70-131	7.3	7.0	7.3	7.3	7.7	7.7	7.4
6	Blacksburg	7.3	7.7	7.7	7.7	7.0	7.3	7.4
7	Glade	7.7	7.0	7.7	8.0	7.0	7.5	7.4
8	Midnight	7.7	7.0	7.3	7.7	7.3	7.3	7.4
9	PST-0514	7.7	8.0	7.0	8.0	7.0	7.0	7.4
10	WW AG 505	6.3	8.0	8.3	7.3	7.0	7.3	7.4
11	Able I	7.7	7.7	7.0	7.3	7.0	7.0	7.3
12	Allure (BA 73-540)	6.7	7.7	7.3	7.0	7.0	7.7	7.3
13	Cynthia	6.7	7.3	8.3	7.0	6.0	7.0	7.3
14	Limousine	7.0	7.7	8.0	7.5	6.0	7.3	7.3
15	Miracle	6.7	7.3	7.7	7.3	7.7	7.0	7.3
16	Ampellia	7.3	7.0	7.3	7.7	6.7	7.0	7.2

	Cultivar	May	June	July	Aug	Sept	Oct	Mean
17	Eagleton	6.0	7.0	7.7	7.7	7.0	7.7	7.2
18	Eclipse	8.0	7.3	7.0	7.0	7.0	7.0	7.2
19	Entry 127	7.0	7.0	6.7	7.0	7.7	7.7	7.2
20	Estate	7.3	7.0	7.3	7.0	7.3	7.3	7.2
21	EVB 13.703	6.7	7.7	7.7	7.0	7.5	7.0	7.2
22	PST-1DW	6.7	7.3	7.7	7.3	7.0	7.3	7.2
23	PST-C-224	7.3	7.0	7.3	7.0	7.0	7.7	7.2
24	WW AG 508	7.0	8.0	7.7	7.0	6.7	6.7	7.2
25	Aspen	7.0	7.3	7.3	7.3	6.3	7.3	7.1
26	BAR VB 852 (Barmax)	6.7	7.3	7.3	7.5	7.0	7.0	7.1
27	Barsweet	6.0	7.3	7.7	8.0	6.7	7.0	7.1
28	Coventry	7.0	7.0	6.7	7.0	7.0	7.7	7.1
29	Indigo	7.0	7.3	7.0	7.0	7.0	7.0	7.1
30	J13-152	7.0	7.3	7.0	7.3	7.0	7.0	7.1
31	Julia	7.0	7.0	7.0	8.0	7.0	7.0	7.1
32	Nustar	7.0	7.0	7.3	7.0	7.0	7.0	7.1
33	Platini	6.7	7.0	7.3	7.3	7.0	7.0	7.1
34	Preakness (602)	7.0	7.0	7.7	7.3	6.3	7.3	7.1
35	PST-B8-106	7.0	7.0	7.3	7.0	6.0	7.0	7.1
36	PST-UD-10	7.7	7.0	7.0	7.3	6.7	7.0	7.1
37	Ram-1	6.7	7.0	8.0	7.5	6.5	7.0	7.1
38	Silvia	6.7	7.0	7.3	8.0	7.0	6.7	7.1
39	SR 2100	6.0	7.0	7.7	7.0	7.3	7.3	7.1
40	Trampas	6.7	7.0	7.3	7.0	7.3	7.0	7.1
41	Unique (PST-C-76)	7.3	7.3	6.7	7.0	7.0	7.0	7.1
42	A-34	6.3	7.0	7.3	7.3	7.0	7.0	7.0
43	BAR VB 1169	6.0	7.0	8.0	7.0	7.0	7.0	7.0
44	BAR VB 7037	6.3	7.3	7.0	7.3	7.0	7.0	7.0
45	Bartitia	6.0	6.7	7.3	7.3	7.7	7.0	7.0
46	Cardiff	6.7	7.0	7.7	7.0	6.5	7.0	7.0
47	Challenger	7.0	7.3	7.3	7.0	6.3	7.0	7.0
48	J-333	6.3	7.0	7.7	7.0	7.0	7.0	7.0
49	NE 80-47	6.7	7.3	7.3	7.0	6.7	7.0	7.0
50	Opal	6.7	7.0	7.7	7.5	6.0	6.7	7.0
51	PST-A7-1877	6.7	7.0	7.0	7.0	6.7	7.7	7.0
52	PST-UD-12	7.0	7.0	6.7	7.0	7.0	7.3	7.0
53	PSU-151	6.7	7.0	7.0	7.5	7.0	7.0	7.0
54	SR 2000	7.0	6.3	7.7	7.0	6.7	7.3	7.0
55	BA 77-292	6.3	7.0	7.7	7.0	6.5	7.0	6.9
56	Banff	7.3	7.0	7.0	6.7	6.7	6.7	6.9
57	Barcelona (BAR VB 1184)	5.7	6.7	7.3	7.7	7.0	7.3	6.9
58	Belmont (798)	6.3	6.7	6.7	7.0	7.3	7.3	6.9
59	Classic	6.7	7.3	7.0	6.5	7.0	7.0	6.9
60	Dawn	7.0	7.0	6.3	7.0	7.0	7.0	6.9
61	Entry 128	6.0	7.3	7.0	7.3	7.0	6.7	6.9
62	Freedom	7.0	6.7	6.7	7.0	7.0	7.0	6.9
63	Georgetown	7.0	6.7	6.3	7.7	7.0	7.0	6.9
64	Haga	6.7	7.0	7.0	7.0	7.0	7.0	6.9
65	HV 125	6.3	7.0	6.7	7.0	7.0	7.3	6.9
66	Liberty	7.0	7.0	6.3	7.3	6.7	7.0	6.9
67	Minstrel	6.7	7.0	7.0	7.3	6.7	6.7	6.9
68	Miranda	5.7	7.0	7.3	7.3	7.0	7.0	6.9
69	PR-1	6.3	7.0	7.3	7.0	7.0	7.0	6.9
70	PST-A84-803	6.3	7.0	7.0	7.3	6.7	7.0	6.9

	Cultivar	May	June	July	Aug	Sept	Oct	Mean
71	PST-HV-116	5.7	7.0	7.0	7.3	7.3	7.3	6.9
72	Ronde	6.0	7.0	7.7	7.5	7.0	7.0	6.9
73	Shamrock (H86-712)	6.7	6.7	7.0	7.0	7.5	7.0	6.9
74	BAR VB 895	6.7	7.0	6.3	7.0	7.0	7.0	6.8
75	Cobalt	7.0	7.0	7.0	7.0	6.3	6.3	6.8
76	Crest	6.3	7.0	7.0	6.5	7.0	7.0	6.8
77	Destiny	7.0	7.0	6.3	7.0	6.3	7.0	6.8
78	EVB 13.863	6.0	7.0	7.0	7.3	6.7	6.7	6.8
79	J-335	6.3	6.7	7.0	7.0	7.0	7.0	6.8
80	J-386	6.0	6.7	7.3	7.0	6.7	7.0	6.8
81	Kelly	6.3	7.0	6.7	7.0	6.7	7.0	6.8
82	Livingston	5.3	7.0	7.3	7.3	7.0	7.0	6.8
83	Merit	6.0	7.0	7.0	7.0	6.7	7.0	6.8
84	Nublue (J-229)	7.0	7.0	6.7	6.5	6.3	7.0	6.8
85	Princeton 104	6.0	6.7	7.0	7.3	7.0	7.0	6.8
86	PST-A7-341	6.3	7.0	7.0	7.0	6.7	7.0	6.8
87	PST-A84-405	6.3	7.0	6.7	7.0	7.0	7.0	6.8
88	Suffolk	7.0	7.0	6.3	7.0	6.7	7.0	6.8
89	Trenton	7.3	6.7	6.0	7.0	7.0	6.7	6.8
90	Washington	6.0	6.7	6.7	7.3	7.3	6.7	6.8
91	1757	6.7	6.3	6.7	7.0	7.0	6.7	6.7
92	BA 69-82	5.7	7.0	6.7	7.0	6.5	8.0	6.7
93	BA 73-382	6.7	6.7	6.7	7.0	6.7	6.3	6.7
94	BA 77-700	5.7	6.7	7.0	7.0	7.0	7.0	6.7
95	Barzan	5.7	6.3	7.0	7.0	7.0	7.0	6.7
96	Broadway	6.0	6.3	7.3	7.5	6.5	7.5	6.7
97	Chelsea	6.0	6.3	7.3	7.0	6.7	6.7	6.7
98	Fortuna	6.0	7.0	6.7	7.0	6.5	7.0	6.7
99	Gnome	6.0	7.0	6.7	7.0	6.7	6.7	6.7
100	J11-94	6.3	7.0	6.7	6.7	6.3	7.0	6.7
101	J34-99	6.3	6.7	7.0	7.0	6.5	7.0	6.7
102	Melba	5.7	6.7	7.3	7.5	7.0	7.0	6.7
103	Monopoly	5.7	6.7	7.0	7.0	6.7	7.0	6.7
104	R751A	6.7	6.7	6.7	7.0	6.5	7.0	6.7
105	Touchdown	5.7	6.3	7.3	7.0	7.0	7.0	6.7
106	Viva (BA 73-366)	6.0	7.0	6.7	7.3	6.3	7.0	6.7
107	4 Aces (PST-RE-88)	6.0	6.3	7.0	7.0	6.7	6.7	6.6
108	BA-78-258	5.7	7.0	6.7	7.0	6.5	7.0	6.6
109	Merion	6.7	6.7	7.0	6.5	6.0	6.7	6.6
110	Nassau	6.7	6.7	6.7	6.7	6.3	6.7	6.6
111	Noblesse	5.7	6.3	7.0	7.0	6.7	6.7	6.6
112	PST-A84-928	6.3	6.7	6.3	6.5	6.3	7.0	6.6
113	PST-R-740	5.7	6.7	7.0	7.0	6.5	6.7	6.6
114	Abbey	5.3	7.0	6.7	7.0	6.5	7.0	6.5
115	Barblue	7.3	6.7	6.3	6.3	5.7	6.7	6.5
116	Baron	5.3	6.3	7.0	7.0	7.0	7.0	6.4
117	Donna	5.3	6.7	6.7	6.3	6.3	7.0	6.4
118	Greenley	5.7	6.0	6.3	7.3	7.0	6.3	6.4
119	KWS PP 13-2	5.7	6.7	6.7	6.3	6.5	6.3	6.4
120	Marquis	5.7	7.0	6.0	6.7	6.3	7.0	6.4
121	Kenblue	5.0	5.3	6.3	6.7	7.3	6.7	6.2
122	Buckingham (BA 74-114)	5.7	6.0	6.0	6.3	6.0	6.3	6.1
123	South Dakota Cert.	5.7	6.0	6.3	6.5	5.5	6.3	6.1
124	Entry 126	4.3	5.3	7.0	6.3	6.7	6.3	6.0

	Cultivar	May	June	July	Aug	Sept	Oct	Mean
125	Ginger	5.0	5.3	6.3	6.3	6.0	7.0	6.0
126	BA 73-381	5.3	6.0	5.3	6.7	6.0	5.7	5.8
127	BA 76-305	5.3	6.0	5.7	6.5	6.5	6.0	5.8
128	PST-B8-13	4.7	6.3	6.3	6.5	5.3	5.7	5.8
	$LSD_{(0.05)}$	1.3	0.8	1.1	1.1	1.1	1.2	0.5

Quality based on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and 1 = poorest quality.

Table 2. The 1993 quality ratings for the high-maintenance, non-irrigated regional Kentucky bluegrass test.

	Cultivar	May	June	July	Aug	Sept	Oct	Mean
1	Aquila	6.7	8.0	9.0	7.3	8.0	7.7	7.8
2	Wabash	6.7	8.0	7.7	8.0	7.7	7.7	7.6
3	A-34	7.7	8.3	8.0	6.0	7.0	7.3	7.4
4	BA 72-500	6.7	7.7	8.0	7.7	7.3	7.3	7.4
5	BA 70-139	6.3	6.3	8.0	7.7	7.7	7.3	7.2
6	Blacksburg	5.7	7.7	9.0	7.3	6.7	7.0	7.2
7	NE 80-50	7.0	7.0	6.7	7.7	7.3	7.3	7.2
8	Sydsport	6.7	6.7	7.0	7.7	7.3	7.3	7.1
9	Mystic	7.0	8.0	8.7	6.7	5.0	7.0	7.1
10	NE 80-88	6.3	7.3	8.0	7.7	6.7	6.7	7.1
11	America	7.0	7.3	6.3	7.7	8.0	6.3	7.1
12	Asset	6.3	7.0	7.3	7.7	6.7	7.3	7.1
13	HV 97	5.7	8.0	7.3	6.7	7.3	7.3	7.1
14	Aspen	6.7	6.7	7.7	7.0	7.3	7.0	7.1
15	Georgetown	6.7	7.0	7.3	7.7	6.3	7.0	7.0
16	Amazon	6.3	7.0	7.7	7.3	7.3	6.3	7.0
17	BA 73-540	6.7	7.0	7.3	8.0	6.3	6.0	6.9
18	NE 80-14	6.0	6.7	7.0	7.3	7.3	7.0	6.9
19	Somerset	6.3	5.7	7.0	8.0	7.3	6.7	6.8
20	Eclipse	6.3	6.7	7.3	6.7	7.3	6.7	6.8
21	Dawn	6.3	5.7	7.0	7.3	7.7	7.0	6.8
22	NE 80-47	6.0	7.0	7.0	6.3	7.3	7.0	6.8
23	NE 80-30	5.7	7.3	7.7	6.7	6.3	7.3	6.8
24	Monopoly	6.3	6.7	7.0	5.3	7.7	7.3	6.7
25	Parade	6.0	6.7	6.7	7.3	6.7	7.0	6.7
26	Ikone	6.3	7.3	6.3	6.7	6.7	6.7	6.7
27	Huntsville	5.3	7.7	8.0	6.0	6.7	6.7	6.7
28	Midnight	5.3	6.3	8.0	7.3	6.7	6.3	6.7
29	NE 80-110	5.7	8.0	7.7	7.0	6.3	5.7	6.7
30	Able I	6.0	7.0	6.3	7.3	6.7	6.3	6.6
31	Glade	5.3	7.0	7.7	6.7	6.3	6.3	6.6
32	F-1872	5.3	6.3	6.3	7.3	7.7	6.7	6.6
33	Trenton	6.7	6.7	6.7	6.7	7.0	6.0	6.6
34	WW AG 491	6.3	7.3	7.0	6.3	5.3	7.0	6.6
35	Tendos	5.7	7.0	7.3	6.7	6.7	5.7	6.5
36	Compact	6.7	7.0	6.7	6.7	5.7	6.3	6.5
37	Conni	5.7	5.7	7.3	6.3	8.0	6.0	6.5
38	BA 72-441	5.7	6.7	8.0	6.3	6.3	6.0	6.5
39	Lofts 1757	6.0	6.0	7.3	6.7	6.3	6.7	6.5
40	Cheri	6.0	7.0	7.0	6.7	5.7	6.7	6.5
41	Julia	6.0	7.7	6.7	6.7	6.3	5.7	6.5
42	NE 80-48	5.7	6.7	7.3	6.0	7.0	6.3	6.5

	Cultivar	May	June	July	Aug	Sept	Oct	Mean
43	NE 80-55	6.3	6.3	7.0	7.0	6.0	6.3	6.5
44	BA 72-492	6.7	6.7	6.7	6.0	6.0	6.3	6.4
45	Destiny	6.7	6.7	6.7	6.3	6.0	6.0	6.4
46	K1-152	6.3	6.3	6.7	6.7	6.7	6.0	6.4
47	Welcome	5.3	6.7	7.0	6.3	7.0	6.0	6.4
48	WW AG 495	6.0	7.0	7.3	7.0	5.3	5.7	6.4
49	WW AG 496	6.0	7.0	7.0	6.7	6.3	5.7	6.4
50	Barzan	6.0	7.0	6.3	6.3	6.3	6.0	6.3
51	P-104	5.3	6.3	7.0	7.0	5.7	6.3	6.3
52	RAM I	5.3	6.3	7.3	6.7	5.7	6.3	6.3
53	Merit	6.0	6.0	7.0	6.0	6.3	6.3	6.3
54	BAR VB 534	6.0	6.3	7.3	6.3	5.7	6.3	6.3
55	Cynthia	5.3	6.3	6.7	6.0	6.3	7.0	6.3
56	Merion	5.7	6.3	7.3	6.0	6.7	6.0	6.3
57	Nassau	6.0	7.0	7.3	6.0	5.7	6.0	6.3
58	Haga	6.7	6.0	6.7	6.3	5.7	6.0	6.2
59	BA 70-242	6.0	6.0	6.0	6.3	6.7	6.3	6.2
60	BA 69-82	5.7	6.0	6.0	6.7	7.0	6.0	6.2
61	Rugby	5.7	6.7	6.3	5.7	6.7	6.0	6.2
62	K3-178	5.7	6.0	6.0	7.3	5.7	6.7	6.2
63	PST-CB1	5.7	6.0	6.7	5.7	6.7	6.7	6.2
64	Classic	5.7	5.3	5.7	6.7	6.0	7.0	6.1
65	Joy	5.3	6.0	7.3	5.7	6.7	5.7	6.1
66	BA 73-626	6.0	6.0	5.7	6.3	6.7	6.0	6.1
67	Liberty	5.7	5.3	7.0	6.0	6.3	6.0	6.1
68	Challenger	6.7	6.3	6.3	6.0	5.7	5.3	6.1
69	Park	5.3	6.0	8.0	6.0	6.0	5.0	6.1
70	BAR VB 577	5.3	6.7	6.0	6.3	5.3	6.3	6.0
71	Bristol	5.7	6.0	6.7	6.0	5.3	6.3	6.0
72	Victa	5.3	5.3	6.3	6.3	6.7	6.0	6.0
73	Harmony	5.3	6.0	6.3	5.7	6.3	6.3	6.0
74	WW AG 468	5.0	6.0	6.3	7.3	6.0	5.3	6.0
75	Gnome	5.0	5.7	6.3	6.0	6.7	5.7	5.9
76	Annika	5.3	6.3	6.3	6.3	5.7	5.7	5.9
77	239	5.7	6.3	6.0	6.0	6.3	5.3	5.9
78	Baron	5.3	6.0	6.3	5.3	6.3	5.3	5.8
79	Kenblue	5.0	6.0	7.0	5.3	6.0	5.3	5.8
80	South Dakota Cert.	5.0	6.0	7.0	6.0	5.7	5.3	5.8
	LSD$_{(0.05)}$	1.2	0.9	1.5	1.4	1.4	1.5	0.8

Quality based on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and 1 = poorest quality.

Table 3. The 1993 quality ratings for the low-maintenance, non-irrigated Kentucky bluegrass trial.

	Cultivar	May	June	July	Aug	Sept	Oct	Mean
1	ISI-21	7.3	7.3	6.0	7.7	7.7	6.7	7.1
2	Alene	7.3	6.3	7.0	6.7	7.3	6.3	6.8
3	BAR VB 7037	6.3	8.0	7.3	6.3	6.0	6.3	6.7
4	BAR VB 852 (Barmax)	6.7	7.7	6.7	6.7	5.3	7.0	6.7
5	Kenblue	7.3	6.0	7.0	6.0	6.7	7.0	6.7
6	Miracle	5.7	8.0	7.3	5.7	7.3	6.0	6.7
7	Monopoly	6.0	7.0	6.7	6.3	6.3	7.7	6.7
8	Barzan	5.7	6.3	7.0	6.3	7.0	7.0	6.6
9	Cynthia	6.7	7.0	8.0	6.7	5.3	5.7	6.6
10	Park	7.3	6.7	7.3	5.7	6.7	6.0	6.6
11	Voyager	7.3	7.0	6.3	6.7	5.7	6.7	6.6
12	Gen-RSP	7.7	7.3	5.7	6.7	5.7	6.0	6.5
13	Banjo (H76-1034)	7.0	6.0	5.3	7.3	6.3	6.7	6.4
14	PST-YQ	6.7	7.3	6.3	6.7	5.0	6.7	6.4
15	Washington	7.3	6.7	5.7	6.0	6.3	6.3	6.4
16	Amazon	6.0	7.3	5.7	6.7	6.0	6.0	6.3
17	BA 78-376	7.3	6.0	6.7	5.3	6.7	5.7	6.3
18	BAR VB 895	5.3	7.0	5.7	6.0	7.0	7.0	6.3
19	Bartitia	5.0	7.3	7.0	6.3	6.0	6.3	6.3
20	Bronco	6.7	7.0	6.7	6.7	5.3	5.7	6.3
21	Freedom	6.3	7.0	5.7	6.3	6.3	6.0	6.3
22	Nublue (J-229)	6.3	6.7	6.7	6.7	5.0	6.3	6.3
23	ZPS-84-749	7.7	7.0	6.7	6.3	5.0	5.3	6.3
24	Barcelona (BAR VB 118)	5.0	6.7	6.0	6.0	6.7	7.0	6.2
25	J-335	6.0	6.7	5.7	6.3	6.0	6.3	6.2
26	Livingston	5.7	6.3	5.7	6.7	6.3	6.3	6.2
27	MN 2405	6.0	6.7	7.0	6.0	6.0	5.7	6.2
28	NJIC	7.0	6.3	6.0	6.0	5.7	6.3	6.2
29	PST-C-303	5.3	7.3	5.7	6.3	6.3	6.0	6.2
30	Sophia	5.7	6.7	6.3	6.3	6.0	6.0	6.2
31	SR 2000	5.7	6.7	5.0	6.7	6.7	6.3	6.2
32	BAR VB 1169	6.3	6.3	6.3	6.0	5.7	6.0	6.1
33	Barsweet	5.3	7.3	6.7	6.7	5.3	5.0	6.1
34	Liberty	6.0	6.7	6.0	6.0	5.7	6.0	6.1
35	Opal	5.3	7.0	6.7	6.3	5.3	5.7	6.1
36	PST-A7-111	7.3	5.7	6.3	5.7	6.0	5.7	6.1
37	RAM-1	5.7	6.3	6.3	6.7	5.7	5.7	6.1
38	South Dakota Cert.	6.0	5.3	6.0	7.0	5.7	6.3	6.1
39	Suffolk	5.0	6.7	6.0	6.0	6.0	6.3	6.0
40	Cobalt	5.7	6.0	6.0	6.3	5.3	6.3	5.9
41	Destiny	5.0	6.7	5.7	6.0	6.0	6.3	5.9
42	Haga	5.7	7.0	5.7	6.0	5.7	5.3	5.9
43	Nustar	5.3	6.0	5.3	6.0	6.3	6.3	5.9
44	PST-C-391	5.3	7.0	5.3	6.0	6.0	6.0	5.9
45	Chelsea	5.7	6.0	5.7	6.0	6.0	5.7	5.8
46	EVB 13.863	5.3	6.7	5.7	5.7	5.3	6.0	5.8
47	J-386	6.0	5.3	5.3	6.0	5.7	6.7	5.8
48	Merit	5.7	6.0	5.0	6.3	5.7	6.0	5.8
49	Midnight	6.0	6.0	5.0	6.7	5.0	6.0	5.8
50	Unique (PST-C-76)	4.7	5.7	4.7	6.7	6.7	6.3	5.8
51	Baron	6.0	5.3	5.7	5.7	6.0	5.7	5.7
52	Belmont (798)	5.3	5.3	4.7	6.0	6.3	6.3	5.7

	Cultivar	May	June	July	Aug	Sept	Oct	Mean
53	Gnome	5.7	5.7	5.3	6.7	5.3	5.7	5.7
54	BA 74-017	5.7	6.0	5.0	6.3	5.7	4.7	5.6
55	Crest	5.7	6.0	5.0	5.7	5.3	5.7	5.6
56	EVN 13.703	5.3	6.7	5.3	5.3	5.7	5.3	5.6
57	KWS PP 13-2	5.3	5.7	5.0	5.7	5.7	6.0	5.6
58	Merion	5.0	5.7	5.3	6.3	5.7	5.7	5.6
59	NE 80-47	5.0	6.0	5.0	6.0	6.0	5.7	5.6
60	Fortuna	4.3	5.7	4.7	6.3	6.0	4.7	5.3
61	Kyosti	4.3	5.3	5.3	6.3	5.7	5.0	5.3
62	Unknown	4.7	4.7	4.0	5.0	5.3	4.7	4.7
	$LSD_{(0.05)}$	1.4	1.4	2.0	2.8	1.5	1.7	0.9

Quality based on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and 1 = poorest quality.

The Recovery of Kentucky Bluegrass Cultivars Following Summer Dormancy - 1993

N. E. Christians

In earlier work at Iowa State University (Grounds Maintenance 24(8):49-50) it was shown that Kentucky bluegrass cultivars vary greatly in their recovery from summer dormancy. Common, or public varieties, generally recover much more rapidly from drought-induced dormancy than do the newer improved cultivars. The objectives of this study are to further evaluate four cultivars that were previously shown to recover rapidly from dormancy and four cultivars that were slower to recover when maintained under low and high fertility regimes: 1 lb N/1000 ft^2 in September and 4 lb N/1000 ft^2 applied in 1 lb applications in April, May, August, and September.

South Dakota Common, S-21, Kenblue, and Argyle (cultivars observed to recover rapidly in earlier studies) and Midnight, Nassau, Glade, and Ram I (cultivars observed to recover more slowly). Kentucky bluegrass was established in 21 ft^2 plots on September 26, 1989 on a non-irrigated site at the turfgrass research area of the Iowa State University Horticulture Research Station north of Ames, Iowa. The soil on the site is a Nicollet (fine-loamy, mixed, mesic Aquic Hapludoll) with a pH of 6.8 and 2.3% organic matter, a P content of 20 lbs/A, and a K content of 216 lbs/A. The study was replicated three times. Each plot was split in half. The two fertility treatments were randomly applied to the two halves of the plots.

The 1990 season was very wet and at no time did the grasses on the study area go into summer dormancy. The spring of 1991 was also very wet and the late summer and fall were dry. The 1992 season was the opposite of the 1991 season. The spring and summer were very dry up to the 4th of July. The remainder of the summer and fall were very wet. The 1993 season was one of the wettest in history. The area remained saturated through most of the season. At no time was there any moisture stress.

Data were collected in July, August, and September only (Table 4). The improved varieties had deteriorated in quality during the drier years of 1990, 1991, and 1992. In the wet year of 1993, they showed considerable recovery and generally matched or exceeded the quality of the common varieties.

This study will be continued for at least one more year.

Table 4. The 1993 quality ratings for the low-moderate maintenance bluegrass study.

	July		August		September	
Cultivar	1 lb N	4 lb N	1 lb N	4 lb N	1 lb N	4 lb N
S.D. Common	6.0	7.0	5.7	6.7	6.0	7.3
S-21	6.5	7.3	7.0	6.0	6.0	7.0
Kenblue	6.0	6.3	6.3	6.0	4.3	5.0
Argyle	6.3	7.3	7.0	7.5	5.5	6.6
Midnight	5.0	6.0	5.3	7.3	3.7	5.6
Nassau	5.3	6.3	4.5	5.5	4.0	4.5
Glade	6.7	7.3	6.3	7.7	5.7	7.3
RAM-I	5.7	6.7	7.0	6.5	5.7	6.0
$LSD_{(0.05)}$	1.1	1.1	1.1	1.1	1.0	1.0

National Perennial Ryegrass Study - 1993

J. D. Dickson and N. E. Christians

This trial began in the fall of 1990 with the establishment of 125 cultivars of perennial ryegrass at the Iowa State University Horticulture Research Station. The study was established on an irrigated area and maintained at a 2-inch mowing height, fertilized with 3 to 4 lb N/1000 ft^2/yr. The area receives preemergence herbicide in the spring and broadleaf herbicide in September.

Cultivars were evaluated for turf quality each month of the growing season. Visual quality was based on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and 1 = poorest quality. The values listed under each month in Table 5 are the averages of ratings made on three replicated plots for the three studies. Yearly means of data from each month are listed in the last column. The cultivars are listed in descending order of average quality.

The winter of 1992-93 resulted in a considerable amount of winter kill in perennial ryegrass and other species in the midwestern region. The May 1993 ratings reflect winter damage (Table 5). The lowest ranked cultivars in May were severely damaged by winter conditions. The damaged cultivars showed near complete recovery by July.

Table 5. The 1993 quality ratings for the national perennial ryegrass study.

	Cultivar	May	June	July	Aug	Sept	Oct	Mean
1	HE 311	7.7	7.7	7.7	7.7	7.7	7.7	7.7
2	Barrage	7.7	7.3	7.7	7.7	7.3	7.3	7.5
3	Loretta	7.3	7.3	7.7	8.0	7.3	7.3	7.5
4	Allegro	8.0	7.3	7.3	7.0	7.3	7.3	7.4
5	Barrage ++	6.7	7.3	8.0	7.7	7.0	7.7	7.4
6	EEG 358	6.3	7.7	8.0	7.7	7.7	7.0	7.4
7	MOM LP 3147	7.0	7.7	7.7	7.5	7.5	7.0	7.4
8	Navajo (PST-2DPR)	7.7	7.3	7.7	7.3	7.3	7.0	7.4
9	Affinity (GEN-90)	6.7	7.0	7.7	7.7	7.0	8.0	7.3
10	CLP 39	7.7	7.3	7.0	7.3	7.0	7.3	7.3
11	Gator	7.7	7.3	7.3	7.3	7.0	7.0	7.3
12	Lowgrow (Pick 89LLG)	6.7	8.0	7.0	7.7	7.0	7.3	7.3
13	PST-20G	7.0	7.3	7.7	7.0	7.0	7.0	7.3
14	Taya	7.7	7.7	7.0	7.7	7.0	7.0	7.3
15	WVPB 89-92	7.0	7.7	7.7	7.3	7.0	7.3	7.3
16	Advent	6.3	7.7	8.0	7.0	7.0	7.3	7.2
17	CLP 144	7.7	7.0	7.0	7.3	7.0	7.3	7.2
18	Cutless	6.7	7.3	7.3	7.0	7.3	7.3	7.2
19	PST-2ROR	7.0	7.0	7.3	7.7	7.0	7.3	7.2
20	APM	7.0	7.0	7.0	7.3	7.0	7.3	7.1
21	Cowboy II (WM-II)	7.0	7.0	7.3	7.0	7.0	7.0	7.1
22	Delaware Dwarf (4DD)	6.3	7.0	7.7	7.0	7.3	7.0	7.1
23	MVF 89-88	6.7	6.7	7.3	7.3	7.3	7.3	7.1
24	Ovation	7.0	7.0	7.0	7.0	7.0	7.3	7.1
25	PST-290	7.0	7.0	7.3	6.7	7.3	7.3	7.1
26	Toronto	7.0	7.0	7.0	7.7	7.0	7.0	7.1
27	Danilo	6.7	7.3	7.0	6.7	7.0	7.3	7.0
28	Elite (WVPB-88-PR-C-23)	6.3	7.0	7.0	7.5	7.3	7.3	7.0

	Cultivar	May	June	July	Aug	Sept	Oct	Mean
29	Fiesta II	6.3	7.0	7.3	7.3	7.0	7.0	7.0
30	PR 9119	6.0	6.7	7.3	7.3	7.3	7.3	7.0
31	C-21	6.3	7.0	6.7	7.3	7.0	7.0	6.9
32	Charger	6.0	7.3	6.7	7.0	7.3	7.3	6.9
33	Dandy	6.0	7.3	7.3	6.7	7.3	7.0	6.9
34	Derby Supreme	7.0	6.7	7.0	6.7	7.0	7.3	6.9
35	Dimension (2H7)	5.7	7.3	7.3	7.0	7.0	7.3	6.9
36	Gettysburg	6.7	7.0	7.0	6.3	7.0	7.3	6.9
37	Manhattan II (E)	6.0	7.0	7.3	6.7	7.0	7.3	6.9
38	Nomad	6.7	7.3	6.7	7.0	7.0	7.0	6.9
39	Pick DKM	6.7	7.3	7.3	6.7	6.7	7.0	6.9
40	Riviera	6.0	7.3	7.0	6.5	7.0	7.3	6.9
41	Unknown	6.0	6.7	7.0	7.0	7.3	7.3	6.9
42	Achiever (Pick 1800)	6.0	7.0	7.0	6.7	7.0	7.0	6.8
43	Cutter (Pick 89-4)	6.3	6.7	7.0	6.7	6.7	7.3	6.8
44	Envy	6.7	6.7	6.3	7.0	6.7	7.3	6.8
45	Lindsay	6.0	7.0	7.0	7.0	7.0	7.0	6.8
46	Prelude II (2P2-90)	6.3	7.0	7.0	7.0	7.0	7.0	6.8
47	Sherwood	6.0	7.0	7.0	7.0	7.0	7.0	6.8
48	Stallion Select (PS-105)	6.7	6.7	6.7	7.0	6.7	7.0	6.8
49	Troubadour	6.3	6.7	6.7	7.0	7.0	7.0	6.8
50	BAR LP 086FL	6.0	6.7	7.3	6.3	6.7	7.0	6.7
51	Essence (PR 8820)	6.7	6.7	6.7	6.7	6.7	7.0	6.7
52	Goalie	6.7	6.7	6.7	7.0	7.0	6.3	6.7
53	Mulligan (NK 89001)	6.3	6.7	7.0	6.7	6.7	6.7	6.7
54	MVF 89-90	5.3	6.7	7.3	7.0	7.0	7.0	6.7
55	N-33	6.3	6.7	6.7	7.0	6.0	7.0	6.7
56	PR 9108	6.3	6.7	7.0	6.7	6.7	7.0	6.7
57	PST-28M	5.7	6.7	6.7	7.0	7.0	7.0	6.7
58	Quickstart (PST-2FQR)	5.7	7.0	6.7	7.0	7.0	7.0	6.7
59	Rodeo II	6.3	6.7	6.7	6.0	6.5	7.0	6.7
60	WVPB-89-87A	6.3	6.7	7.0	6.3	6.7	7.0	6.7
61	Buccaneer (Koos 90-1)	6.3	7.0	7.0	6.3	6.7	6.3	6.6
62	Commander	5.0	7.0	6.7	6.7	7.0	7.0	6.6
63	Evening Shade (Poly-SH)	5.7	6.7	6.7	6.7	6.7	7.0	6.6
64	Koos 90-2	6.0	6.7	7.0	6.3	7.0	6.7	6.6
65	Meteor	5.7	6.7	7.3	7.0	6.7	6.3	6.6
66	Repell	5.7	6.7	6.7	6.3	7.3	7.0	6.6
67	Statesman (WVPB-88-PR-D-12)	5.3	6.7	6.3	7.0	7.0	7.0	6.6
68	Entrar	6.0	6.7	7.0	6.0	6.7	6.7	6.5
69	Pick EEC	6.0	7.0	7.0	6.3	7.0	5.7	6.5
70	Shining Star (PST-2B3)	6.0	6.3	6.7	6.0	7.0	6.7	6.5
71	Calypso	5.3	6.0	6.7	7.0	6.7	7.0	6.4
72	Duet	5.0	6.0	7.0	7.0	7.0	7.0	6.4
73	Legacy	6.0	6.7	6.3	6.3	6.3	7.0	6.4
74	MOM LP 3111	5.7	6.3	6.7	6.5	7.0	7.0	6.4
75	Pebble Beach	5.7	6.0	6.7	5.5	7.0	7.0	6.4
76	Pennfine	6.7	7.0	6.7	6.3	6.0	6.0	6.4
77	Prizm (ZPS-28D)	5.7	6.3	6.0	6.7	6.7	7.0	6.4
78	Saturn	5.7	6.7	6.7	6.3	6.3	6.7	6.4
79	Stallion	5.3	6.3	6.7	6.3	6.7	7.0	6.4
80	Target	5.7	6.7	6.7	6.0	7.0	6.7	6.4

	Cultivar	May	June	July	Aug	Sept	Oct	Mean
81	Yorktown III (LDRF)	5.3	6.7	7.0	6.3	6.7	6.7	6.4
82	Citation II	4.7	6.7	7.0	6.0	6.5	6.7	6.3
83	Danaro	6.0	6.0	6.3	6.0	6.7	6.7	6.3
84	Express	5.0	6.0	6.3	7.0	7.0	7.0	6.3
85	Pleasure	5.0	6.3	6.3	6.3	7.0	6.7	6.3
86	PR 9109	5.0	6.7	6.7	6.0	6.5	6.7	6.3
87	Repell II (LDRD)	5.0	7.0	6.7	6.3	6.3	6.3	6.3
88	Topeka (WVPB-88-PR-D-10)	5.3	6.3	6.7	6.3	6.7	6.7	6.3
89	ZPS-2EZ	4.7	6.3	6.3	6.3	7.3	6.7	6.3
90	Competitor	4.7	5.7	6.3	6.3	7.0	7.0	6.2
91	OFI-D4	4.7	6.7	6.3	6.3	6.7	6.7	6.2
92	PR 9118	4.3	6.0	6.7	6.7	6.7	6.7	6.2
93	PR 9121	4.7	6.0	6.7	6.0	7.0	6.7	6.2
94	SR 4200	5.3	6.3	6.0	6.0	6.7	6.7	6.2
95	Surprise	4.7	6.3	6.7	6.3	6.7	6.7	6.2
96	Equal	5.3	6.3	5.7	6.3	6.7	6.3	6.1
97	MOM LP 3184	5.3	6.0	6.3	6.5	6.0	6.3	6.1
98	Patriot II	4.7	6.0	6.3	6.0	6.7	6.7	6.1
99	Pinnacle	4.7	6.3	6.3	6.0	6.0	7.0	6.1
100	Premier	5.0	6.0	6.3	6.0	6.3	6.7	6.1
101	PST-2FF	4.7	6.0	6.7	6.0	6.5	7.0	6.1
102	Seville	4.3	6.3	6.3	6.3	6.7	6.7	6.1
103	ZW 42-176	6.0	6.7	6.3	5.3	6.0	6.3	6.1
104	89-666	4.3	6.3	6.0	6.0	6.7	6.7	6.0
105	Caliente	4.0	6.7	6.3	6.3	6.3	6.3	6.0
106	Morning Star (SYN-P)	5.0	6.0	6.0	6.5	6.5	6.7	6.0
107	Assure	4.3	6.3	6.0	5.7	6.7	6.7	5.9
108	BAR LP 852	5.0	6.0	6.0	6.0	6.3	6.3	5.9
109	Nighthawk (WVPB-89-PR-A-3)	4.3	6.3	6.3	6.0	6.5	6.7	5.9
110	Palmer II (P89)	4.3	6.0	6.0	5.7	6.3	6.7	5.8
111	Pick 9100	4.7	6.3	5.7	5.7	6.3	6.3	5.8
112	PST-23C	4.7	6.0	6.0	6.0	6.0	6.3	5.8
113	Brightstar (PST-GH-89)	5.0	5.7	5.3	5.7	6.0	6.7	5.7
114	Entry 125	4.7	5.0	6.0	6.0	6.7	6.0	5.7
115	MOM LP 3185	3.7	5.7	6.0	6.0	6.3	6.3	5.7
116	Pennant	4.0	6.0	6.0	6.0	5.5	6.3	5.6
117	Regal	5.0	6.0	5.3	5.7	5.7	5.7	5.6
118	MOM LP 3182	3.7	5.3	5.7	5.3	6.3	6.0	5.4
119	OFI-F7	4.0	5.0	5.3	5.3	6.3	6.3	5.4
120	856	3.7	5.3	6.0	5.3	6.3	5.3	5.3
121	Entry 124	3.7	5.3	5.3	5.7	6.0	5.7	5.3
122	Cartel	4.0	5.7	5.0	4.3	6.3	5.7	5.2
123	MOM LP 3179	3.7	5.3	5.0	5.3	6.3	5.7	5.2
124	Accolade	3.3	4.3	4.7	4.3	5.3	5.3	4.6
125	Linn	2.7	4.7	5.0	4.7	5.7	4.0	4.4
	LSD$_{(0.05)}$	1.9	1.4	1.1	1.2	1.0	1.0	0.9

Quality based on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and 1 = poorest quality.

Regional Fine Fescue Cultivar Evaluation - 1993

J. D. Dickson and N. E. Christians

This was the final year of data on this trial. It was established in the spring of 1990. The study was conducted in conjunction with several identical trials across the country, coordinated by the USDA. The purpose of the trial is to identify regional adaptation of 95 fine fescue cultivars. Cultivars were evaluated for quality each month of the growing season through October. Visual quality was based on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and 1 = poorest quality.

Three replications of the 95, 3 ft x 5 ft (15 ft^2) plots were established in a 5 ft by 19 ft grid. The average seeding rates were approximately 55 g per plot or about 8 lb/1000 ft^2.

The trial was maintained at a 2-inch mowing height, 3 to 4 lb N/1000 ft^2 were applied during the growing season, and irrigated when needed to prevent drought. Preemergence herbicide was applied once in the spring. The study was terminated in August of 1993 and was replaced with a new fine fescue trial sponsored by the USDA.

Table 6. The 1993 quality ratings for the fine fescue regional cultivar trial.

	Cultivar	May	June	July	Aug	Mean
1	Bargreen	7.7	7.7	7.3	7.0	7.4
2	PST-SHE	7.0	7.0	7.7	8.0	7.4
3	LD 3485	7.3	7.7	7.3	7.3	7.4
4	89.LKR	7.3	7.3	7.3	7.7	7.4
5	PST-43F	7.0	6.7	8.0	7.7	7.3
6	Atlanta	7.7	7.0	7.0	7.3	7.3
7	Mary	7.0	7.0	7.3	7.7	7.3
8	Epsom	7.3	8.0	6.7	7.0	7.3
9	Southport	7.0	7.0	7.3	7.7	7.3
10	Rainbow	7.7	7.7	6.7	7.0	7.3
11	Banner	6.7	7.3	7.3	7.7	7.3
12	LD 3488	7.3	7.7	7.7	6.7	7.3
13	PST-4FE	6.7	7.0	7.3	7.7	7.2
14	Jamestown	6.7	6.7	7.3	8.0	7.2
15	Camaro	7.0	7.3	7.0	7.0	7.1
16	Molinda	6.7	7.0	7.3	7.3	7.1
17	Barcrown	8.0	6.7	7.3	6.3	7.1
18	ZW 42-160	8.0	7.0	7.0	6.3	7.1
19	SR 5000	7.3	7.0	7.3	6.7	7.1
20	PST-4R3	6.3	6.7	7.7	7.7	7.1
21	FOT 30149	7.0	6.7	7.0	7.7	7.1
22	Jamestown	7.0	7.0	7.0	7.3	7.1
23	Herald	7.0	7.0	7.0	7.3	7.1
24	OFI 89-200	7.3	7.3	6.7	7.0	7.1
25	BAR Fr 9F	7.0	7.0	6.7	7.3	7.0
26	JMB-89	7.7	7.7	6.0	6.7	7.0
27	Scarlet	8.0	7.0	6.3	6.7	7.0
28	HF 112	6.7	7.3	7.0	7.0	7.0
29	N-105	6.7	7.3	7.7	6.3	7.0
30	Enjoy	7.7	7.0	6.7	6.7	7.0

	Cultivar	May	June	July	Aug	Mean
31	Wilma	7.3	7.3	6.7	6.7	7.0
32	NK 82492	7.0	6.7	7.3	6.7	6.9
33	PST-4CD	6.3	7.0	7.0	7.3	6.9
34	HF138	6.7	7.0	7.0	7.0	6.9
35	Cindy	6.7	7.3	6.3	7.3	6.9
36	Longfellow	7.3	7.0	6.7	6.7	6.9
37	ERG 1143	6.7	7.0	7.0	7.0	6.9
38	Attila	7.0	7.0	6.7	6.3	6.8
39	BAR Fr 9F	7.0	7.0	7.0	6.3	6.8
40	Barlotte	7.3	7.3	6.3	6.0	6.8
41	Barnica	6.7	6.7	6.7	7.3	6.8
42	SR 3000	7.7	7.3	6.7	5.7	6.8
43	PST-4HD	8.0	7.0	6.3	5.7	6.8
44	PST-4C8	6.3	6.7	7.0	7.0	6.8
45	Shadow	6.7	6.3	7.0	7.3	6.8
46	Dawson	6.7	7.3	7.0	6.3	6.8
47	Raymond	7.0	7.0	6.3	6.7	6.8
48	Capital	7.3	7.0	6.3	6.3	6.8
49	Marker	6.7	6.7	7.0	6.7	6.8
50	Jasper	6.3	6.7	6.7	7.3	6.8
51	Puma	7.0	7.0	6.3	6.7	6.8
52	SRX 89-31	8.0	7.3	6.3	5.0	6.7
53	PST-4NI	6.3	6.7	7.0	6.7	6.7
54	Vista	6.7	6.7	6.7	6.7	6.7
55	WW Rs 143	6.0	7.3	6.3	6.7	6.6
56	BARB 09A2	7.3	6.3	6.7	6.0	6.6
57	Belvedere	6.0	6.0	7.0	7.3	6.6
58	HF 102	5.7	6.3	7.3	7.0	6.6
59	LD 3438	6.7	6.7	6.7	6.3	6.6
60	Warwick	7.3	6.7	6.7	5.7	6.6
61	Shademaster	6.0	6.7	6.7	6.7	6.5
62	Silvana	7.7	6.7	6.0	5.5	6.5
63	Koket	6.0	6.3	7.0	6.7	6.5
64	Reliant w/Endophyte	7.0	7.0	6.3	5.3	6.4
65	NK88001	5.7	6.3	6.3	7.3	6.4
66	Estoril	6.7	6.3	6.0	6.7	6.4
67	Claudia	5.0	6.0	7.0	7.7	6.4
68	LD 3414	6.0	6.3	6.3	7.0	6.4
69	Franklin	5.3	6.0	6.7	7.0	6.3
70	Melody	7.7	6.3	6.0	5.0	6.3
71	WW Rs 130	6.0	6.7	6.0	6.3	6.3
72	WW Rs 138	6.0	6.7	6.3	6.3	6.3
73	Scaldis	7.0	7.0	6.0	5.0	6.3
74	ZW 42-148	5.7	6.0	6.7	7.0	6.3
75	PST-4AG	7.3	7.0	6.3	4.7	6.3
76	Aurora	7.3	7.0	6.0	4.7	6.3
77	PST-AUE	7.3	6.7	6.0	5.0	6.3
78	Flyer	5.7	6.0	6.7	6.7	6.3
79	Reliant w/o Endophyte	7.3	7.3	6.0	4.7	6.3
80	Waldorf	7.3	6.0	6.0	6.0	6.3
81	Bargena	5.3	6.0	7.0	7.0	6.3
82	Salem	6.0	6.3	6.3	6.3	6.3
83	Boreal	5.3	6.0	6.3	7.3	6.3
84	Ensylva	4.7	5.7	7.3	7.0	6.2

	Cultivar	May	June	July	Aug	Mean
85	Valda	7.0	6.7	6.0	4.7	6.1
86	Eureka	7.0	7.0	5.3	5.0	6.1
87	Serra	7.3	6.7	5.3	4.7	6.0
88	Biljart	8.0	4.7	6.3	5.0	6.0
89	Crystal	7.0	6.3	6.3	4.3	6.0
90	Bighorn	6.7	5.7	6.0	5.3	5.9
91	BAR Fr8RC3	5.0	6.0	6.3	6.3	5.9
92	Sylvester	4.7	5.7	6.3	6.3	5.8
93	Elanor	5.3	5.3	5.3	6.3	5.6
94	Barreppe	5.0	5.0	5.7	6.7	5.6
95	Mx-86	4.3	4.3	5.0	4.0	4.4
	$LSD_{(0.05)}$	1.2	1.1	1.2	1.3	3.8

Quality based on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and 1 = poorest quality.

Shade Adaptation Study - 1993

N. E. Christians

The shade adaptation study was established in the fall of 1987 to evaluate the performance of 35 species and cultivars of grasses. The species include creeping red fescue (C.R.F.), hard fescue (H.F.), tall fescue (T.F.), Kentucky bluegrass (K.B.), and rough bluegrass (*Poa trivialis*).

The area is located under the canopies of a mature stand of Siberian elm trees (*Ulmus pumila*) at the Iowa State University Horticulture Research Station north of Ames, Iowa. The grasses were mowed at a 2-inch height and received 2 lb N/1000 ft^2/year. No weed control has been required on the area. The area was irrigated during extended droughts.

Monthly quality data were collected from May through October (Table 7). Visual quality was based on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and 1 = poorest quality. This trial has been observed through the extremes of the drought year 1988 and the very wet conditions of 1993. The quality of the various species included in this trial vary greatly with moisture conditions. In dry weather, the fine fescues, especially the hard fescues, do well, whereas Rough bluegrass (*Poa trivialis*) deteriorates badly. In extended wet periods, Rough bluegrass does very well. Some of the tall fescues and chewings fescues also tend to perform better in wet conditions.

Table 7. The 1993 quality ratings for grasses in the shade trial.

	Cultivar	May	June	July	Aug	Sept	Oct	Mean
1	Sabre (Poa trivialis)	3.3	8.3	8.0	7.3	8.7	8.7	7.4
2	Victor (C.F.)	6.3	6.3	7.3	7.3	7.7	8.0	7.2
3	Rebel (T.F.)	5.3	7.0	7.3	6.7	7.0	8.3	6.9
4	Mary (C.F.)	7.7	5.7	7.0	5.3	6.7	7.7	6.7
5	Arid (T.F.)	5.3	6.7	6.3	6.3	7.7	7.7	6.7
6	Shadow (C.F.)	7.0	6.0	6.0	6.0	7.0	7.7	6.6
7	Estica (C.R.F.)	4.7	6.0	6.7	6.7	7.7	7.7	6.6
8	Jamestown (C.F.)	6.3	5.7	6.7	6.3	6.0	8.0	6.5
9	Falcon (T.F.)	5.7	6.0	6.7	6.7	6.7	7.3	6.5
10	Midnight (K.B.)	4.7	6.7	7.0	6.7	7.0	6.3	6.4
11	Pennlawn (C.R.F.)	7.7	6.3	7.7	4.3	4.7	7.0	6.3
12	Apache (T.F.)	4.3	7.0	7.0	6.0	6.3	7.3	6.3
13	Bonanza (T.F.)	4.0	7.0	6.7	6.3	7.0	7.0	6.3
14	Rebel II (T.F.)	4.7	5.7	6.3	6.3	6.3	7.3	6.1
15	Banner (C.F.)	7.0	6.0	6.0	4.7	5.3	7.0	6.0
16	Coventry (K.B.)	5.0	6.0	6.3	6.3	5.7	6.7	6.0
17	Ensylva (C.R.F.)	5.3	5.7	6.3	5.3	6.0	6.7	5.9
18	Waldorf (C.F.)	5.0	6.7	7.7	4.3	5.0	7.0	5.9
19	RAM I (K.B.)	5.0	5.7	6.0	5.7	6.7	6.7	5.9
20	Atlanta (C.F.)	5.7	6.3	6.3	4.7	5.3	6.3	5.8
21	ST-2 (SR 3000) (H.F.)	6.0	5.7	7.0	4.3	5.0	6.0	5.7
22	Waldina (H.F.)	5.3	5.0	5.7	4.7	5.3	7.0	5.5
23	BAR FO 81-225 (H.F.)	6.7	5.7	7.3	3.3	4.3	5.7	5.5
24	Agram (C.F.)	5.0	5.3	5.7	4.7	5.3	6.7	5.4
25	Glade (K.B.)	4.3	6.0	5.7	5.0	5.0	5.7	5.3

	Cultivar	May	June	July	Aug	Sept	Oct	Mean
26	Koket (C.F.)	6.3	4.7	5.3	4.0	4.3	6.3	5.2
27	Chateau (K.B.)	5.3	5.3	5.7	4.0	5.0	6.0	5.2
28	Biljart (H.F.)	5.7	5.7	6.0	3.3	4.3	5.0	5.0
29	Highlight (C.F.)	5.3	5.7	6.0	3.7	4.3	5.0	5.0
30	Wintergreen (C.F.)	5.3	5.7	7.0	3.3	3.7	5.0	5.0
31	Bristol (K.B.)	4.0	5.0	5.0	4.3	5.0	6.7	5.0
32	Spartan (H.F.)	4.3	5.0	5.3	3.0	4.0	6.7	4.7
33	Scaldis (H.F.)	5.3	5.3	6.0	3.0	3.3	4.3	4.6
34	Nassau (K.B.)	3.7	4.3	5.3	3.0	3.7	5.7	4.3
35	Reliant (H.F.)	4.3	4.7	5.0	2.7	3.7	5.0	4.2
	LSD$_{(0.05)}$	2.0	1.4	1.3	2.3	2.6	2.3	1.5

Quality based on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and
1 = poorest quality

USGA Buffalograss Trial - 1993

N. E. Christians

The USGA buffalograss trial consists of 5 buffalograss (*Buchloe dactyloides*) varieties developed as part of the USGA turfgrass breeding program that are being compared to a standard buffalograss variety 'Texoka'.

The trial was established in August, 1988, and suffered considerable winter kill because of the late planting date. Only variety 84-315 survived the first winter in a satisfactory condition. In November 1989, plugs of all varieties were established in the greenhouse and maintained during the winter of 1989-1990. All six field plots were reestablished in the last week of May, 1990. The summer of 1990 was very wet. These plugs became well established during the growing season and all reached 100% cover by dormancy in September, 1990.

The first quality ratings were taken in 1991 and the data included in this report is from the third full season of data collection (Table 8). Visual quality was based on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and 1 = poorest quality. In 1993, 84-315 was the highest rated variety. Varieties 84-409 and 84-304 were severely damaged during the winter. Very little of the grass on these plots survived the 1993 season. Data collection will continue for several more seasons on these grasses.

Table 8. The 1993 quality ratings for the USGA buffalograss study.

	Cultivar	June	July	Aug	Sept	Mean
1	84-315	7.7	8.0	7.3	7.7	7.7
2	Texoka	7.7	7.3	7.7	7.3	7.5
3	85-378	6.0	6.7	5.7	7.0	6.3
4	84-609	3.0	4.0	4.3	5.0	4.1
5	84-409	1.0	1.0	1.7	3.0	1.7
6	84-304	1.3	1.3	1.3	1.7	1.4
	$LSD_{(0.05)}$	1.8	2.0	2.4	1.9	1.7

Quality based on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and
1 = poorest quality

Alkaligrass Evaluations - 1993

N. E. Christians

Alkaligrass (*Puccinellia* spp.) is a grass that is well adapted to soils that are high in sodium (Na^+). There are many regions in the country, particularly in the west where levels of Na^+ are so high that Kentucky bluegrass, ryegrass, and other cool season grasses cannot survive. In these regions, alkaligrass is a reasonable substitute. In Iowa, there are few areas where Na^+ levels are naturally high, but Na^+ can readily be elevated to toxic levels along city streets and other road areas where salt is applied for ice melting purposes in the winter and alkaligrass is used in the state in those areas.

The United States Golf Association has been supporting research at Colorado State University for several years on the selection and development of alkaligrass for use on golf courses. Four of these varieties are presently being compared to an industry standard (Fultz weeping Alkaligrass) at the Iowa State University Turfgrass research area since 1991. The results of the 1993 test are in Table 9.

There were no significant differences among any of the varieties in 1992 and all of them generally maintained an unacceptable quality rating through the season. They showed some improvement during the spring of 1993, but then badly deteriorated in the very wet summer conditions. Nearly all of the alkaligrass had died by September, 1993. No significant differences we found among the treatments in any of the months that evaluations were taken.

Table 9. The 1993 quality ratings for the alkaligrass, non-irrigated study.

	Cultivar	May	June	July	Aug	Mean
1	Fultz	4.7	3.7	3.0	2.7	3.5
2	#2	4.7	3.3	3.7	3.0	3.7
3	#14	5.3	3.7	3.7	3.7	4.1
4	#18	5.7	4.6	4.0	2.7	4.1
5	#57	5.0	3.3	3.7	2.6	3.9
	$LSD_{(0.05)}$	NS	NS	NS	NS	NS

Quality based on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and 1 = poorest quality

Green Height Bentgrass Cultivar Trial - 1993
(Native Soil)

N. E. Christians and R. W. Moore

This is the third year of data for the 20 cultivars that were established in the fall of 1989 at the Iowa State University Horticulture Research Station. The study was reseeded in the spring of 1990 because of poor winter survival.

The cultivars are maintained with a fertilizer program of 1/4 lb N applied at 14-day intervals with an approximate total of 6 lbs of N/1000 ft^2/growing season. A 3/16-in mowing height was used. Fungicides were used as needed in a preventative program. Herbicides and insecticides were applied only in a curative program.

Table 10 contains the averages of monthly visual quality ratings. Visual quality was based on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and 1 = poorest quality. The ranking of cultivars was quite different in the very wet conditions of 1993 than in earlier years, although the standard varieties like Emerald, Penncross, and Pennlinks still performed well through the season. The two top ranked varieties were Lopez and Regent. Providence and National were the lowest ranked varieties in 1993.

Table 10. The 1993 ratings for the green height bentgrass trial.

	Cultivar	May	June	July	Aug	Mean
1	Lopez (WVPB 89-D-15)	6.3	8.3	9.0	8.3	8.0
2	Regent (Normarc 101)	5.3	7.0	7.7	6.7	6.7
3	Emerald	5.0	7.0	7.3	7.0	6.6
4	Penncross	6.0	6.7	7.3	6.3	6.6
5	Pennlinks	6.3	6.3	6.7	7.0	6.6
6	Pro/Cup (Forbes 89-12)	5.0	6.7	7.0	7.0	6.4
7	Putter	4.0	7.0	7.7	7.0	6.4
8	Bardot	5.7	7.0	6.7	6.0	6.3
9	Carmen	4.3	6.3	7.7	7.0	6.3
10	BR 1518[3]	5.3	6.3	6.7	6.3	6.2
11	Tracenta[1]	4.3	6.7	6.7	6.7	6.1
12	Entry 20 (Southshore)	5.0	6.7	6.3	5.3	5.8
13	SR 1020	5.7	5.3	6.3	5.7	5.8
14	Cobra	5.0	5.7	6.7	4.3	5.4
15	88.CBE	4.7	5.3	5.7	5.3	5.3
16	Allure	6.3	5.0	5.0	5.0	5.3
17	Egmont[2]	5.3	5.0	5.3	5.3	5.3
18	88.CBL	4.7	5.3	5.7	4.7	5.1
19	Providence	5.0	5.0	5.3	5.0	5.1
20	National	5.3	4.3	4.0	4.7	4.6
	$LSD_{(0.05)}$	NS	5.6	5.3	6.0	3.7

[1] Tracenta and Allure are colonia bentgrasses, *Agrostis tenuis*.

[2] Egmont is a browntop bentgrass, *Agrostis capillaris*.

[3] BR 1518 is a dryland bentgrass, *Agrostis castollana*.

Quality based on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and 1 = poorest quality.

Fairway Height Bentgrass Study - 1993

N. E. Christians and R. W. Moore

The fairway height bentgrass study was established in the fall of 1988 to compare the response of several new cultivars of seeded bentgrasses with the older types. The grass was kept at a 0.5-in mowing height, the standard mowing height for creeping bentgrass fairways. The area received liquid applications of urea as needed during the season (0.2 lb N/1000 ft^2/application in 3 gal water/1000 ft^2). The total N application rate was approximately 3 lbs/season. Fungicides and insecticides were used as needed. The area was irrigated as needed.

Table 11 contains monthly visual quality ratings. Visual quality is based on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and 1 = poorest quality. The area was saturated through most of May, June, and July and no significant differences were observed among varieties in those months. By August, statistically significant differences were apparent. Providence (SR 1019) was the highest rated variety in 1993.

Table 11. The 1993 quality ratings for the fairway height bentgrass study.

	Cultivar	May	June	July	Aug	Mean
1	Providence (SR 1019)	6.3	7.0	8.0	8.7	7.5
2	ISI 123	6.3	7.7	7.3	7.3	7.2
3	Pennlinks	6.3	7.3	7.3	7.7	7.2
4	Putter	6.3	7.0	7.3	8.0	7.2
5	ISI 124	6.3	7.0	7.3	7.7	7.1
6	Penneagle	7.0	7.3	7.0	7.0	7.1
7	Penncross	6.3	7.0	6.7	8.0	7.0
8	J.H. Bent	5.7	7.3	7.3	7.3	6.9
9	SR 1020	6.3	7.0	7.0	7.3	6.9
10	Emerald	6.0	7.0	7.7	6.3	6.8
11	Southshore	5.7	7.3	7.3	7.0	6.8
12	Cobra	6.0	6.3	7.3	6.7	6.6
13	Exeter (Colonial Bent)	6.0	6.3	5.7	7.0	6.3
14	Carmen	5.7	6.0	6.7	6.0	6.1
15	National	5.3	5.7	6.7	6.7	6.1
16	Prominent	5.0	5.7	6.0	5.7	5.6
	$LSD_{(0.05)}$	NS	NS	NS	1.5	1.1

Quality based on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and 1 = poorest quality.

Herbicide and Growth Regulator Studies

1993 Preemergence Annual Weed Control Study

N. E. Christians and R. G. Roe

The 1993 preemergence annual weed control study was conducted at the turfgrass research area on a Nicollet (fine-loamy, mixed, mesic Aquic Hapludoll) soil with a pH of 6.2, 2.3% organic matter, 19 ppm P, and 96 ppm K. The objectives of the project were to evaluate the efficacy of several labeled and experimental preemergence herbicides applied to a Ram 1 Kentucky bluegrass turf for the control of crabgrass. Plots measured 5 ft by 5 ft. They were arranged in a randomized, complete-block design with three replications.

The area was seeded in the fall of 1991 with a combination of large hairy and smooth crabgrass that had been harvested from the research area. Treatments were applied on April 28. Liquids were applied with a backpack carbon dioxide sprayer equipped with 8006 nozzles in the equivalent of 3 gal water/1000 ft^2. Granular materials were applied with a hand-held shaker. The summer of 1993 was the wettest in history for the region (Figure 1). The soil on the area was saturated through most of the test period. Surprisingly, excess water did not result in more weed infestation. The bluegrass was very competitive with annual weeds. Much of this competitiveness was due to the inability to mow the area on a regular basis because of the very wet conditions. The cool weather of midsummer also favored the cool season bluegrass over the competing warm season weeds.

The study was observed weekly for signs of phytotoxicity throughout the season. No damage was observed on any of the treated plots at any time during the summer of 1993. Estimates of the percentage cover of crabgrass were made on 8/20/93. Total lack of moisture stress made data collection difficult. By September, crabgrass had all but disappeared from the plot area. All treatments significantly reduced crabgrass. Several treatments provided 100% crabgrass control (Table 12). The Andersons and HoJo (Howard Johnson) materials were fertilizers loaded with different amounts of Dimension. These materials were very effective at the 0.188 lb ai rate. Barricade, Dimension 1 EL, and some of the experimentals from Rhone Poulenc (Exp) also provided 100% crabgrass control.

Figure 1. 1993 Weather Data

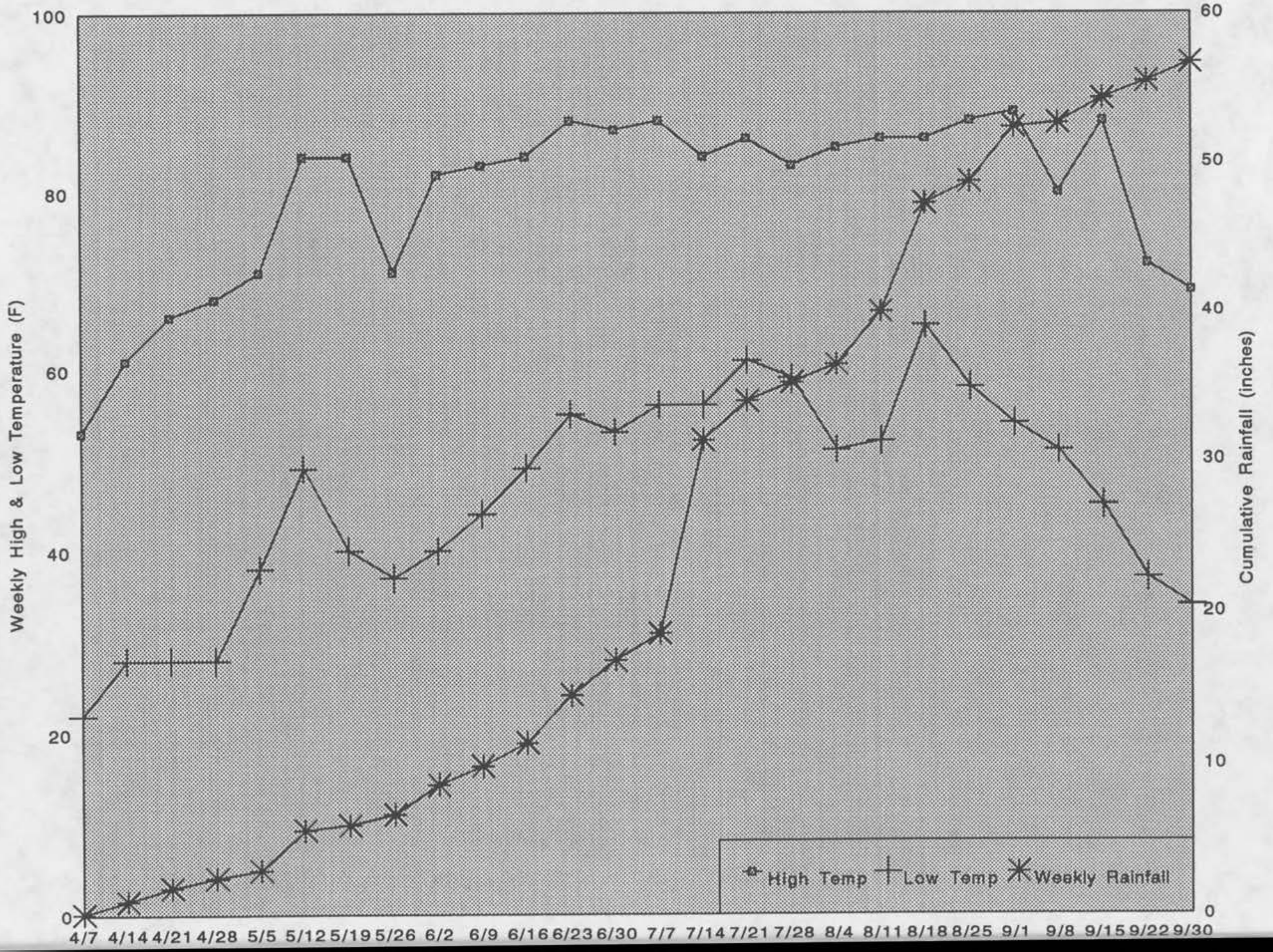


Table 12. Percentage cover of crabrass on Kentucky bluegrass plots.

Product	lbs a.i./A	Crabgrass % Cover
1. Control	---	14
2. Pendimethalin 60WP	1.5	1
3. Pendimethalin 60WP	3.0	1
4. Barricade 65WG	0.33	0
5. Barricade 65WG	0.5	0
6. Barricade 65WG	0.65	0
7. Dacthal 75WG	10.0	2
8. 022094 50WG	1.5	4
9. 022094 50WG	3.0	5
10. Exp 30742B 2.3G	5.0	1
11. Exp 30742B 2.3G	6.0	0
12. Exp 31068A 5G	5.0	0
13. Exp 31068A 5G	6.0	1
14. Exp 30911A 5G	5.0	0
15. Chipco Ronstar G. Bio 2G	3.0	1
16. Dimension 1EL	0.375	0
17. Anderson 65105	0.063	2
18. Anderson 65105	0.125	2
19. Anderson 65105	0.188	0
20. HoJo 651XX	0.063	0
21. HoJo 65135	0.125	2
22. HoJo 65135	0.188	0
23. O.M. Scotts 30-3-10 w/Pendimethalin 1.15%	1.5	1
24. O.M. Scotts 30-3-10 w/Pendimethalin 1.15%	1.8	2
$LSD_{0.05}$		4

1993 Postemergence and Preemergence Annual Grass Control Study

N. E. Christians and R. G. Roe

The objective of this study was to investigate the effectiveness of several postemergence and preemergence annual grass herbicides for the control of crabgrass. The work was conducted on a Nicollet (fine-loamy, mixed, mesic Aquic Hapludoll) soil with a pH of 6.1, 3.3% organic matter, 20 ppm P, and 96 ppm K. Individual plots measured 5 ft by 5 ft. The grass on the area was Indigo Kentucky bluegrass. The treatments were arranged in a randomized, complete-block design with three replications. The summer of 1993 was the wettest in history for the region (Figure 1 Page 28). The soil on the area was saturated through most of the test period. Surprisingly, excess water did not result in more weed infestation. The bluegrass was very competitive with annual weeds. Much of this competitiveness was due to the inability to mow the area on a regular basis because of the very wet conditions. The cool weather of midsummer also favored the cool season bluegrass over the competing warm season weeds.

The study area was seeded in the fall of 1991, with a combination of large hairy and smooth crabgrass that had been harvested at the research area. Treatments 2, 3, and 8 were applied preemergently on 5/12/93. Treatments 4, 5, 6, 7, 9, and 10 were applied on 6/11/93 when the crabgrass was in the 1 to 2 leaf stage. All treatments were applied with a backpack carbon dioxide sprayer equipped with 8006 nozzles. The spray pressure was 20-25 psi. Treatments were applied with the equivalent of 3 gal water/1000 ft^2.

The plots were observed weekly for signs for phytotoxicity. No damage was observed on any of the plots during the season. This may have partly been due to the very wet and cool conditions. Estimates of percentage crabgrass cover were made on 8/20/93 (Table 13). The preemergence applications were very effective. The postemergence applications with Dimension were surprising ineffective. This material has proven to be a very effective postemergence material in past studies at this location. The reason for this ineffectiveness this years is uncertain, although it was likely related in some way to the unusual weather conditions.

Table 13. Percentage cover of crabrass on Kentucky bluegrass plots.

Product	lbs a.i./A		Crabgrass % Cover
1. Control	---		37
2. Pre-M 60WP	3.0	Pre*	3
3. Barricade 65WG	0.75	Pre	1
4. Acclaim 1EC + Pre-M	0.8 + 2.0	E Post	2
5. Acclaim 1EC + Pre-M	0.125 + 2.0	E Post	8
6. Acclaim 1EC + Barricade	0.08 + 0.75	E Post	2
7. Acclaim 1EC + Barricade	0.125 + 0.75	E Post	1
8. Dimension 1EL	0.50	Pre	4
9. Dimension 1EL	0.375	E Post	40
10. Dimension 1EL	0.50	E Post	19
$LSD_{0.05}$			24

Broadleaf Weed Control Study - 1993

N. E. Christians and R. G. Roe

The objective of this study was to investigate the efficacy of several herbicides as postemergence controls of broadleaf weeds in turf areas. The study was conducted at the Iowa State University Horticulture Research Station north of Ames, Iowa. The soil on the site was a Nicollet (fine-loamy, mixed, mesic Aquic Hapludoll) with an organic matter content of 3.0%, a pH of 7.25, 10 ppm P, and 105 ppm K. Individual plots measured 5 ft by 10 ft. They were arranged in a randomized, complete-block design with three replications. The area was irrigated as needed to prevent dormancy of the Kentucky bluegrass turf. The grass on the area is a common Kentucky bluegrass established in 1968.

This site had a good population of dandelion (*Taraxacum officianale*), white clover (*Trifolium repens*), and Black Medic (*Medicago sativa*) (Table 14). Treatments were applied on June 15, 1993, at 8:00 a.m. Conditions were nearly ideal for weed control. No rain occurred until June 16, more than 24 hours after treatment. All treatments were applied with a backpack carbon dioxide sprayer equipped with 8006 nozzles. The spray pressure was 20-25 psi. Treatments were applied with the equivalent of 3 gal water/1000 ft^2.

No phytotoxicity on the Kentucky bluegrass was observed. Weed counts and estimations of percentage weed cover were made on August 3, 1993 (Table 14) when maximum control was achieved and before germination of a new weed crop occurred on the area. Normally, later dates of data collection would have been included, but due to extremely wet weather conditions (Figure 1 Page 28), germination of weeds occurred in mid August and data would not have reflected weed control by the herbicides. All treatments significantly reduced weeds on August 3. There was a considerable difference in clover control among treatments. Trimec and Confront (in both the liquid and granular forms) provided excellent control as did some of the experimental materials. There was a very high population of dandelions. None of the products provided 100% control of this species. Trimec and liquid Confront provided the best dandelion control. Black Medic was less widely distributed in the test area. Most materials provided good control of this species.

Table 14. Weed count on broadleaf weed control trial -- June 15, 1993

	Treatment	Rate (lb ai/A)	Clover % Cover	# of Dandelion	# of Black Medic
1	Control	---	65	213	10
2	Exp 31044A 3.25 SL	1.73	2	16	0
3	Trimec 4.25 EC	2.13	1	12	0
4	Chipco Weedone Amine 3.7 SL	1.85	30	32	2
5	Confront XRM 5085 3 SL	0.75	0	9	0
6	Turflon ester XRM 4714 4 EC + 2,4-D ester	 0.5 1.0	4	15	0
7	Confront/Fert NAF 0.47%	0.75	1	30	1
8	Scotts TB + 2 2.34%	3.0	18	57	1
9	S-4278 32-3-4	0.5	2	33	0
10	S-4278 32-3-4	0.75	1	27	0
11	S-4281 Biodac	0.5	18	43	0
12	S-4281 Biodac	0.75	7	40	0
13	S-4281 Biodac	1.0	0	36	0
	$LSD_{0.05}$		21	27	5

The Effects of High and Low Nitrogen Regimes on the Response of Creeping Bentgrass and Kentucky Bluegrass to Growth Regulating Compounds

N. E. Christians

The response of turfgrasses to growth regulating compounds are known to vary with differing environmental conditions and with a variety of other external factors. In this study, the effects of high and low nitrogen (N) regimes were studied on the response of creeping bentgrass and Kentucky bluegrass maintained under fairway conditions to Primo (Trinexapac-ethyl) and Cutless (Flurprimodol).

The study was conducted during the 1993 season at the Iowa State University Horticulture Research Station north of Ames, Iowa. The creeping bentgrass area was initiated on a 14 year old stand of Penncross creeping bentgrass maintained at fairway mowing height (0.5 inches). The area had received 0.5 lbs N/1000 ft^2 in the early spring before the study was established. The site is watered as needed to prevent stress, but due to very heavy rainfall in 1993, irrigation was not necessary through most of the study period. The soil on which the turf was established was a modified soil mix consisting of 5% gravel, 62% sand, 21% silt and 12% clay with 1.7% organic matter. The pH of this soil is 7.9, with P levels of 9 ppm, and K levels of 128 ppm. The Kentucky bluegrass was established on a Nicollet (fine-loamy, mixed, mesic Aquic Hapludoll) soil with a pH of 7.75, P level of 20 ppm, K level of 114 ppm and an organic matter content of 3.4%. The cultivar was Midnight and the area was established in 1985. It was maintained at a 1 inch mowing height.

Both the creeping bentgrass and Kentucky bluegrass trials were conducted in split plot designs with 3 replications. The main plots were two nitrogen regimes: 0.5 and 1.0 lb N/1000 ft^2 per month. The N source was urea, which was applied in the liquid form with a backpack sprayer in the equivalent of 3 gal water/1000 ft^2. The first applications of N were made 2 weeks before growth regulator treatments were established. Follow-up treatments were made at 30 day intervals throughout the study period.

The growth regulator treatments were applied as subplots within the two N regime main plots. There were 3 growth regulator treatments in the creeping bentgrass study, including a control, Primo at 0.09 lb a.i./acre (0.75 pints/acre), and Cutless 50 WP at 2.19 lb a.i./acre (1120 g a.i./ha). There were 4 growth regulator treatments in the Kentucky bluegrass study, including a control, Primo at 0.09 lb a.i./acre (0.75 pints/acre), and 0.18 lb a.i./acre (1.5 pints/acre), and Cutless at 2.19 lb a.i./acre (1120 g a.i./ha). The treatments were applied as liquids in the equivalent of 3 gal water/1000 ft^2 with a backpack sprayer equipped with 8006 nozzles at 20 psi. The individual growth regulator plots measure 5 ft X 5 ft. The treatments were initiated on 6/11/93 with a follow-up treatment at the same rate on 7/16/93.

The N content of the tissue was determined at 5 intervals during the study (Table 15). Clippings were collected separately in each of the 3 replications of the 0.5 and 1.0 lb N a.i./1000 ft^2 treatments and submitted to the Ohio Agricultural Research Development Center nutrient tissue testing laboratory for N determination. The data presented in Table 15 are the means of the 3 replications.

The summer of 1993 was the wettest in recorded history with more than 40 inches of rain recorded during the test period (Figure 1 Page 28). The plot area was saturated through much of this time.

Quality data were also collected on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and 1 = poorest quality. Clippings were collected from the 5 ft X 5 ft plots on 2 dates following each of the 2 applications. Clippings were ovendried at 75°C for 48 hours and data were reported as average dry weight of clippings for the 3 replications. Initially, additional dates of clipping collection were planned, however, the difficulty of collecting clippings at the low mowing height maintained in the studies, when the soil surface was wet, limited clipping collection.

The tissue N content of the grass in the high N treated plots was consistently 0.2 to 0.3% higher than the N level in the grass maintained under the low N regime for the Kentucky bluegrass study. The only exception was the third clipping date which occurred on 8/3 after a very wet period and shortly before N retreatment (Table 15). The grass in the high N plots in the bentgrass area were 0.2 to 0.6% greater than the grass in the low N plots.

An analysis of variance was conducted on the data (Table 16). Of greatest interest is the treatment by nitrogen rate interaction (TMT*N), which tests the hypotheses that the response to the growth regulator treatments varied with nitrogen rate. A significant TMT*N interaction was observed on 6/24 and 8/17 only for quality response of the Kentucky bluegrass. Nitrogen rate affected clipping treatment response on 7/16 and 8/17. No TMT*N interactions were observed at any of the quality rating dates or at any of the clipping collection dates in the creeping bentgrass study.

The interaction between the growth regulator treatment and the nitrogen level on Kentucky bluegrass at the 6/24 rating date was due to a reduction of discoloration of plots treated with both Primo and Cutless at the 1.0 lb N rate (Table 17). This same trend was observed on some of the later rating dates as well, but was statistically significant on the 8/17 date only. Although there were some small reductions in discoloration of bentgrass at the higher N level, at no time was there a significant interaction of N and growth regulator treatment. The lack of an interaction was partly due to less discoloration of bentgrass than Kentucky bluegrass at both N rates.

Clipping weights varied greatly from testing date to testing date due to the extremely wet conditions. Because of the low mowing height, there was a need to harvest clippings with a reel mower which requires a relatively dry soil surface. The area was saturated through most of July and early August which made clipping collection difficult. The very high clipping levels recorded on 8/3 on the Kentucky bluegrass area was due to the inability to mow the site for several days before clipping collection and to an unusually low mowing height setting on the mower. Clipping weights should be compared among growth regulator treatments and N levels within a collection date only.

The Primo and Cutless were effective at reducing tissue production even though the area was very wet during the study period. This was particularly true for the creeping bentgrass. The significant TMT*N interactions observed on 7/16 on the bluegrass area appears to be due to a greater reduction on growth relative to the control at the lower N rate. There is evidently less growth reduction at the higher N rate (Table 16 and Table 19). On 8/17, a similar trend occurs for the Primo, but not for the Cutless. The growth reduction for the Cutless was relatively greater at the higher N level. There were no TMT*N interactions observed on the bentgrass area (Table 16).

It is not possible to draw final conclusions from data collected in such an unusually wet year, however, it does appear that for the Kentucky bluegrass maintained at fairway height there is reason to believe that higher N levels do reduce discoloration. High N levels may also reduce the effectiveness of the growth regulating materials on this species. More work to substantiate these results in a normal year should be considered.

Table 15. Percentage nitrogen in the tissue of Kentucky bluegrass and creeping bentgrass.

	Percentage N in Tissue				
	Kentucky Bluegrass				
lbs N/1000 ft^2	Pre TMT	1st Clipping	2nd Clipping	3rd Clipping	4th Clipping
0.5	3.87	3.58	3.70	3.31	3.52
1.0	4.02	3.83	3.99	3.33	3.78
	Creeping Bentgrass				
0.5	3.36	4.06	4.85	4.34	4.58
1.0	3.81	4.53	5.06	5.00	4.75

Percentage nitrogen data are the means of 3 replications.

Table 16. Statistical significance of treatment effect, nitrogen level, and the tmt*nitrogen interaction.

	Quality Ratings							Clipping Weights			
	Kentucky Bluegrass										
Source	6/24	7/2	7/8	7/29	8/3	8/10	8/17	6/25	7/16	8/13	8/17
Treatment	NS	*	NS	**	NS	NS	NS	*	NS	*	*
Nitrogen	**	**	**	**	**	**	**	NS	**	**	**
TMT*N	*	NS	NS	NS	NS	NS	**	NS	*	NS	**
	Creeping Bentgrass										
Treatment	**	**	NS	**	**	NS	NS	**	**	*	**
Nitrogen	**	NS	NS	**	NS	*	**	*	*	NS	*
TMT*N	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 17. Quality ratings for the Kentucky bluegrass study.

Treatment	Nitrogen Level	6/24	7/2	7/8	7/29	8/3	8/10	8/17
Control	0.5	7	8	7	8	8	8	8
Control	1.0	7	8	8	9	9	8	8
Primo .75	0.5	6	7	7	8	8	7	7
Primo .75	1.0	7	8	8	9	9	8	9
Primo 1.5	0.5	5	6	7	8	8	7	7
Primo 1.5	1.0	7	7	9	9	9	9	9
Cutless	0.5	6	7	7	7	8	8	8
Cutless	1.0	7	8	9	8	9	8	8

Table 18. Quality ratings for the creeping bentgrass study.

Treatment	Nitrogen Level	6/24	7/2	7/8	7/29	8/3	8/10	8/17
Control	0.5	7	9	7	9	9	8	7
Control	1.0	8	8	8	9	9	8	8
Primo .75	0.5	6	8	7	8	9	7	8
Primo .75	1.0	7	8	7	9	9	9	9
Cutless	0.5	6	6	7	7	8	7	8
Cutless	1.0	6	7	7	7	7	8	9

Quality is based on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and 1 = poorest quality.

Table 19. Clipping weights from the Kentucky bluegrass study.

Treatment	Nitrogen Level	6/25	7/16	8/3	8/17
Control	0.5	20.6	56.3	238.5	27.9
Control	1.0	18.3	76.3	261.5	37.2
Primo .75	0.5	16.5	36.4	159.0	19.6
Primo .75	1.0	16.5	80.4	264.1	37.5
Primo 1.5	0.5	8.9	34.5	151.4	15.6
Primo 1.5	1.0	13.7	67.2	213.2	26.7
Cutless	0.5	14.3	49.7	212.0	23.1
Cutless	1.0	13.9	53.7	233.4	23.8

Clipping weights are in grams of tissue from 5 ft x 5 ft plots. Data are the means of 3 replications.

Table 20. Clipping weights from the creeping bentgrass study.

Treatment	Nitrogen Level	6/25	7/16	8/3	8/17
Control	0.5	8.0	6.1	9.0	34.0
Control	1.0	13.5	8.0	9.7	45.7
Primo .75	0.5	3.8	5.5	5.8	34.2
Primo .75	1.0	5.1	8.0	6.8	58.1
Cutless	0.5	3.6	9.3	4.2	54.2
Cutless	1.0	3.6	10.7	4.4	60.8

Clipping weights are in grams of tissue from 5 ft x 5 ft plots. Data are the means of 3 replications.

The Rooting of Creeping Bentgrass and Kentucky Bluegrass Treated with Growth Regulating Compounds

N. E. Christians

Growth regulating compounds have the capability of reducing shoot growth of grasses and thereby reducing the need for mowing. However, there is little information on the effects of many of the newer compounds on the root growth of these grass species. The objectives of this study were to investigate the effects of Primo (Trinexapac-ethyl) and Cutless (Flurprimodol) on the rooting of creeping bentgrass and Kentucky bluegrass turf.

The study took place over a two year period at the Iowa State University Horticulture Research Station north of Ames, Iowa. The creeping bentgrass area was a 5 year old stand of Penncross creeping bentgrass maintained at fairway mowing height (0.5 inches). The area receives 4 lbs N/1000 ft^2 per year and is watered as needed to prevent stress. The soil on which the turf was established is a Nicollet (fine-loamy, mixed, mesic Aquic Hapludoll) with a pH of 7.75, P level of 3 ppm, K level of 48 ppm and an organic matter content of 2.8%. The Nassau Kentucky bluegrass was maintained at lawn height (2 inches). The area also received 4 lbs N/1000 ft^2 per year. It is established on a Nicollet soil with a pH of 7.4, P level of 6 ppm, a K level of 74 ppm and organic matter content of 3.5%.

The treatments included an untreated control, Primo at 300 g a.i./ha, and Cutless at 1120 g a.i./ha. The first application was applied on August 15, 1992. Rooting data were collected on 9/15/92, 9/29/92, and 10/25/92. Data were taken by collecting four 2.5 cm cores to a 20 cm depth. The soil was washed from the roots of the cores with a hydropneumatic elutriation machine as described by Smucker (Agron. J. 74:500-503). The roots were oven dried for 24 hours at 75°C, weighed, ashed in a muffle furnace at 500°C for 24 hours and weighed again. Rooting was reported as the difference in weight between oven dried and ashed root samples. Quality data were also collected on a scale of 9 to 1, 9 = best quality, 1 = dead turf, and 6 = acceptable quality.

The study was repeated in 1993 on the same plot areas. The same rates of Primo and Cutless were applied on 5/10/93 and 6/11/93. Rooting data were collected in the same way as previously described at 4 weeks after the first application on 6/11, just before the second application. Rooting data were scheduled for collection at 4, 6, 8, 10, and 12 weeks after the first application. Actual data collection occurred at somewhat different intervals due to the very heavy rains of 1993 (Tables 23 and 24). Quality data were collected throughout the test period as described earlier.

The weather in the fall of 1992 was normal for Iowa and some irrigation was required to maintain the plots. The summer of 1993 was the wettest in recorded history with more than 40 inches of rain recorded during the test period (Figure 1 Page 28). The plot area was saturated through much of this period.

In 1992, there was some initial reduction of turf quality on Kentucky bluegrass by both Primo and Cutless, but at no time did the ratings drop below an acceptable level of 6 (Table 22). There was some initial discoloration of creeping bentgrass, but no statistically significant differences occurred (Table 21). No reductions in creeping bentgrass quality were observed on 9/15 or 9/29.

Numerical reductions in root weights of creeping bentgrass by both Primo and Cutless were observed at the 9/15 collection date, but the reductions were not significantly different (Table 21). No reductions in rooting of bentgrass were observed at either 9/29 or 10/25. There was no reduction of Kentucky bluegrass rooting on 9/15 (Table 22). Significant reductions in Kentucky bluegrass were measured on 9/29 in response to applications of both Primo and Cutless. A significant increase in rooting beyond that observed in the control was measured in plots treated with Cutless on 10/25. This may have been due to a postinhibitory stimulation. No reduction of rooting on plots treated with Primo was observed on 10/25.

The soil in the test area was saturated through much of the 1993 test period. Soil cores were collected during brief dry periods that occurred during the season. Cutless resulted in initial reductions in turf quality below acceptable levels (Table 23). The grass treated with Cutless recovered later during the very wet period of mid-summer. Quality was not reduced below acceptable levels following the second treatment on 6/11/93. There was some initial reduction in quality of grass treated with Primo, but at no time did quality ratings fall below acceptable levels. Quality ratings of Kentucky bluegrass treated with Cutless fell below the acceptable level following the second application (Table 24). By 7/29, the Kentucky bluegrass treated with Cutless had recovered, although ratings were still below that of the control. By August, complete recovery had occurred. Primo reduced quality ratings slightly through much of the summer, as compared to the control, but at no time did ratings fall below an acceptable level of 6.

There were some numerical reductions in rooting measured in plots of creeping bentgrass and Kentucky bluegrass in response to both Primo and Cutless (Tables 23 and 24). At no testing date were these reductions found to be statistically significant.

Although it is difficult to draw final conclusions from data collected in such an unusual season as was experienced in 1993, it is apparent from the two years of data reported here that both Primo and Cutless have little impact on rooting of Kentucky bluegrass and creeping bentgrass managed under these conditions.

Table 21. The effects of Primo and Cutless on the turf quality and rooting of creeping bentgrass in 1992.

	8/29/92	9/15/92	9/29/92	9/15/92	9/29/92	10/25/92
Treatment	Quality Rating*			Root Weight (g)		
1. Control	9	9	9	0.1248	0.0719	0.0451
2. Primo 25 WP	7	9	9	0.0512	0.0784	0.0463
3. Cutless 50 WP	7	9	9	0.0552	0.0652	0.0500
$LSD_{0.05}$	NS	NS	NS	NS	NS	NS

Table 22. The effects of Primo and Cutless on the turf quality and rooting of Kentucky bluegrass in 1992.

	8/29/92	9/15/92	9/29/92	9/15/92	9/29/92	10/25/92
Treatment	Quality Rating*			Root Weight (g)		
1. Control	9	9	9	0.0184	0.0374	0.0360
2. Primo 25 WP	7	8	8	0.0237	0.0225	0.0349
3. Cutless 50 WP	8	9	9	0.0292	0.0238	0.0494
$LSD_{0.05}$	1.0	1.0	1.0	NS	0.0111	0.0112

Quality is based on a scale of 9 to 1: 9 = best, 6 = acceptable, and 1 = poorest quality.
Root weight are the difference between oven dried root samples and ashed weights of 4, 2.5 cm diameter, 20 cm deep samples from each treated plot.

Table 23. The effects of Primo and Cutless on the turf quality and rooting of Creeping bentgrass in 1993.

	5/20	5/29	6/10	6/24	7/8	7/29	8/3	8/17	6/11	6/25	7/19	8/2	8/17
Treatment	Quality Rating*								Root Weight (g)				
1. Control	9	9	8	7	8	8	8	8	0.1691	0.1584	0.0308	0.0254	0.0243
2. Primo 25 WP	7	7	8	7	8	8	8	8	0.0716	0.1312	0.0440	0.0246	0.0242
3. Cutless 50 WP	5	5	7	6	6	8	8	8	0.1223	0.1512	0.0535	0.0166	0.0213
$LSD_{0.05}$	1.3	0.9	NS	NS	1.2	NS	NS	NS	NS	NS	NS	NS	NS

Table 24. The effects of Primo and Cutless on the turf quality and rooting of Kentucky bluegrass in 1993.

	5/20	5/29	6/10	6/24	7/8	7/29	8/3	8/17	6/11	6/25	7/19	8/2	8/17
Treatment	Quality Rating*								Root Weight (g)				
1. Control	9	9	8	8	9	8	8	8	0.0490	0.2846	0.0128	0.0110	0.0135
2. Primo 25 WP	8	8	8	6	8	8	8	8	0.0250	0.0959	0.0132	0.0105	0.0107
3. Cutless 50 WP	6	6	7	5	5	7	8	8	0.0459	0.1139	0.0229	0.0065	0.0162
$LSD_{0.05}$	1	1.3	NS	0.8	0.8	0.9	NS	NS	NS	NS	NS	NS	NS

Quality is based on a scale of 9 to 1: 9 = best, 6 = acceptable, and 1 = poorest quality.
Root weight are the difference between oven dried root samples and ashed weights of 4, 2.5 cm diameter, 20 cm deep samples from each treated plot.

Primo Grass Seed Germination Study - 1993

T. Roethler and N.E. Christians

The objective of this experiment was to determine if Primo affects the germination and establishment of creeping bentgrass, Kentucky bluegrass, and perennial ryegrass.

An experiment was conducted in the field at the Iowa State University Horticulture Research Station north of Ames, Iowa, and in the Iowa State University Horticulture greenhouse. The project at the research station was established on 8/26/93 and the greenhouse study was established on 10/23/93.

Field Study

The field study was conducted as a split plot with the Primo treatments as main plots and the 3 grass species as sub plots. The study was replicated 3 times. The growth regulator main plots measured 5 ft by 5 ft. They were divided evenly into 3 sections and planted with the 3 grasses: Penncross creeping bentgrass at 1.0 lb/1000 ft^2, Bronco Kentucky bluegrass at 1.5 lb/1000 ft^2, Manhattan II perennial ryegrass at 3 lb/1000 ft^2.

The three Primo treatments were as follows:

1. Control
2. Primo at 0.5 oz/1000 ft^2 (0.36 ml/plot)
3. Primo at 1.0 oz/1000 ft^2 (0.72 ml/plot)

The treatments were applied in 285 ml of water/plot (approximately 3 gal/1000 ft^2). Data were collected on days to germination and on percentage cover following germination for 9 weeks.

Greenhouse Study

The objective of the greenhouse study was to determine if the three species used in the field study were affected by very high rates of Primo. This study was established on 10/23/93.

Seventy-two 3.5 inch by 3.5 inch pots were filled with soil from the ISU field area. Each pot was 0.085 ft^2 in surface area. The same seed was used as in the outdoor experiment. Twenty-four pots were seeded with the Kentucky bluegrass, twenty-four with creeping bentgrass, and twenty-four with the perennial ryegrass. The seeding rates were the same as in the field: Kentucky bluegrass at 1.5 lb/1000 ft^2 = 0.0578 g/pot, creeping bentgrass at 1 lb/1000 ft^2 = 0.0385 g/pot, perennial ryegrass at 3 lbs/1000 ft^2 = 0.116 g/pot.

The Primo rates used in the greenhouse were much higher than the outdoor experiment to determine what effects extremely high rates would have on germination. The rates were as follows:

Treatment	ml Primo/pot	Dilution
1. Control	0.0	0
2. Primo at 1 oz/1000 ft^2	0.002454	12.5 ml in 187.5 ml
3. Primo at 2 oz/1000 ft^2	0.005	25 ml in 175 ml
4. Primo at 4 oz/1000 ft^2	0.01	50 ml in 150 ml
5. Primo at 8 oz/1000 ft^2	0.02	1600 ml in 100 ml
6. Primo at 16 oz/1000 ft^2	0.04	200 ml

The study was conducted as a split plot in 4 replications with the species as main plots and the primo treatments as sub plots.

The pots were initially irrigated with 50 ml of water and the pots were watered regularly throughout the experiment when needed. Data were initially taken daily to record the days to germination and percent cover of the pots was recorded weekly for 9 weeks. Clipping weight was taken at the end of the study.

The results of the field study showed that at recommended rates there was no substantial effect on the germination or establishment of the 3 grass species (Table 25). No visual differences were recorded among treatments at any time during the 9 week study period.

In the greenhouse study, there was no effect on the germination of the 3 species, as was the case in the field. But there was a difference in percent cover and clipping weight at the higher rates of Primo. Clipping weight decreased as the treatment rates increased uniformly for all species and the data for all three species were combined for analysis (Table 26). The control treatment had an average weight of 1.268 g while treatment 6 had an average clipping weight of 0.292 g, showing a dramatic effect at the higher treatments. There was a significant species by treatment interaction on percent cover over the 9 week test period (Table 27). Kentucky bluegrass showed a slight drop in percent cover as the rates increased. The final cover of the control was 75%, while treatment 6 had a final cover of 67%. The creeping bentgrass followed the same pattern as the Kentucky bluegrass, with a drop from 91% cover to 66% cover from the control to treatment 6. Perennial ryegrass appears not to have a substantial affect on the percent cover at any level of the treatments (Table 27).

In conclusion, no effect was observed on the germination of Kentucky bluegrass, creeping bentgrass, or perennial ryegrass at the recommended rate of Primo. However, there may be an affect on percent cover and clipping weight at higher rates. One must keep in mind though that Primo is recommended at much lower rates than were used in the greenhouse.

Table 25. The effects of Primo on germination of three grass species in the field.

			Number of Weeks Following Establishment								
			1	2	3	4	5	6	7	8	9
Grass Species	Primo Treatment	Days	Percent Cover								
Kentucky bluegrass	Control	6	3	5	7	8	33	37	41	50	67
	0.5 oz/1000 ft^2	6	3	5	7	8	38	41	46	50	69
	1.0 oz/1000 ft^2	7	2	5	7	8	38	41	45	50	70
Creeping bentgrass	Control	8	0	2	3	3	7	8	10	12	18
	0.5 oz/1000 ft^2	8	0	2	3	3	4	6	8	10	15
	1.0 oz/1000 ft^2	8	0	2	3	3	6	8	9	10	16
Perennial ryegrass	Control	4	18	21	26	43	60	73	77	80	88
	0.5 oz/1000 ft^2	4	18	20	25	42	60	73	77	80	90
	1.0 oz/1000 ft^2	4	18	20	25	40	58	73	76	78	88
LSD$_{(0.05)}$			NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 26. The effect of Primo on the average clipping weight of the three species in the greenhouse.

Treatment	Clipping Weight
1	1.268
2	1.131
3	0.935
4	0.696
5	0.475
6	0.292
$LSD_{(0.05)}$	0.05

Table 27. The effect of Primo on the percent cover of the three species in the greenhouse study.

Species	Primo Treatment	Percent Cover
Kentucky bluegrass	1	75
	2	71
	3	72
	4	74
	5	67
	6	67
Creeping bentgrass	1	91
	2	86
	3	87
	4	84
	5	76
	6	66
Perennial ryegrass	1	84
	2	85
	3	82
	4	83
	5	82
	6	82

1993 CIBA Primo Study

M. L. Agnew

Objectives:
1) To evaluate the effects of Primo on the growth and quality of 'Midnight' Kentucky bluegrass;
2) To compare the effects of Sprint 330 when added to 2 rates of Primo 1 EC;
3) To evaluate the benefits of adding nitrogen to Primo 1 EC.

This study was established at the Iowa State University Horticulture Research Station north of Ames, Iowa, on an 8-year- old stand of *Poa pratensis* 'Midnight'. The soil on the test area is a Nicollet (fine-loamy, mixed, mesic Aquic Hapludoll) with 3.3% organic matter, a pH of 7.1, 7 ppm P, and 109 ppm of K.

Treatments:

Product	Rate (oz / 1000 ft^2)
1. Primo 1EC	0.50
2. Primo 1EC	0.75
3. Primo 1EC + Sprint 330	0.50 + 1.0
4. Primo 1EC + Sprint 330	0.75 + 1.0
5. Primo 25WP	0.40
6. Primo 1EC + CoRoN	0.75 + 21.0
7. Check	------

The turf was maintained as a 2 inch mowing height and irrigated to prevent moisture stress. Plot measured 5' X 5' and were randomized in a complete block design. All plots were fertilized on May 15, 1993 with 1.0 lb N/1000 ft^2 as sulfur coated urea (37-0-0).

Treatments were applied on May 20, and July 23, 1993 with a pressurized backpack sprayer. The May 20 application was made at 10:45 am and the soil temperature was 55°F. The July 23 application was at 9:30 am and the soil temperature was 78°F.

Data collected during the summer of 1993 included visual quality, clipping yields and thatch development. All plots were rated weekly on a visual scale of 9 to 1: 9 = dark-green, dense turf, 6 = minimum acceptable quality, and 1 = straw-brown turfgrass stand. Clipping yields were collected on a weekly basis or when enough grass was present to collect. Clippings were collected by removing all the leaf tissue above 2 inches within a 21 in by 5 ft area (8.75 ft^2) down the center of each plot. Clippings were placed in paper sacks and dried. Weights were recorded as grams per 8.75 ft^2. Plots were rated for seed head development on June 15, 1993, as percent of plots covered with seedheads. Plots were rated on August 8, 1993, for phytotoxicity damage. A scale of 1 to 5: 1 = no damage and 5 = brown turf was used.

The weather in 1993 can be classified as cool and wet. For 36 days after application (DAA) in the spring the high temperature only reached 85°F one time and the cumulative rainfall reached over 8 inches (Figure 2). The temperatures were warmer after the second application, but not considered to be excessive (Figure 3). The cumulative rainfall was over eight inches, 24 DAA.

The visual quality, seed head development and phytotoxicity data is presented in Table 28. Primo (0.5 rate) + Sprint and Primo (0.75 rate) + CoRoN provided improved quality over the control and other Primo treatments on May 30. The Primo (0.75 rate) + CoRoN provided improved quality over the control and other Primo treatments on July 23, September 8 and overall. A greater amount of seed heads were noted on turf treated with Primo. This was largely due to the seed heads being removed on other plots at earlier mowings. The seed heads will set lower in the grass on the Primo treated plot. The phytotoxicity ratings showed that Primo (0.75) sustained the greatest amount of damage. The addition of CoRoN negated any phytotoxic effects.

Clipping yield data is presented in Table 29. The totals are separated into spring application and summer application. All primo treated plots reduced clippings during the spring. The clipping production after the summer application demonstrated that the initial nitrogen application was depleted. The addition of CoRoN increased the overall clipping during this time period, and significantly improved the quality.

The cumulative clipping yields are presented in Figures 3 and 4. For the spring application, the greatest increase in clipping accumulation occurred 20 DAA, and accumulation tapered off by 40 DAA. For the summer application, the accumulation of clipping were more gradual than in the spring.

Primo treated plots successfully reduced clipping production while having very little effect on visual quality. Because the summer of 1993 was very cool and wet, the effect of the sprint application were not evident. However, it is very clear from these trials that nitrogen application is very important to maintain minimal growth and quality.

Table 28. The influence of Primo on visual quality[1] of Midnight Kentucky bluegrass.

Treatment	Rate oz/1000 ft^2	Dates of Collection												Phytotoxicity[2]	Seed Head[3]
		5/25	5/30	6/11	6/15	6/25	6/30	7/12	7/23	7/27	8/6	9/8	Avg	8/17	6/15
1. Primo 1 EC	0.50	8.0	8.0	7.7	8.0	7.0	7.7	8.0	6.7	7.3	7.7	7.7	7.6	2.3	67
2. Primo 1 EC	0.75	8.0	8.0	8.0	7.7	7.0	9.0	8.0	7.3	7.3	7.7	7.0	7.7	3.3	37
3. Primo 1 EC + Sprint	0.50 + 1.0	8.0	8.7	8.0	8.0	6.7	8.7	8.0	7.3	7.3	8.3	7.3	7.8	1.7	33
4. Primo 1 EC + Sprint	0.75 + 1.0	8.0	8.3	7.7	7.7	6.7	8.7	8.0	6.7	7.3	8.0	7.0	7.6	2.3	50
5. Primo 25 WP	0.40	8.0	8.0	7.3	7.7	7.3	8.3	8.0	7.7	7.3	8.0	7.0	7.7	1.3	60
6. Primo 1 EC + CORON	0.75 + 21.0	8.0	9.0	7.7	8.0	7.7	9.0	8.0	8.0	8.7	9.0	9.0	8.4	1.0	23
7. Check		8.0	8.0	7.0	7.0	6.7	7.7	7.7	7.0	7.0	7.3	7.3	7.3	1.0	10
LSD$_{0.05}$		NS	0.6	NS	NS	NS	NS	NS	NS	1.0	NS	1.1	0.5	1.2	17

[1] Quality ratings based on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and 1 = worst quality.
[2] Phytotoxicity is based on a scale of 1 to 5: 1 = no injury and 5 = severe injury.
[3] Seed head is an estimate of the percent of plot covered with seed head.

Table 29. The influence of Primo on clipping production[1] of Midnight Kentucky bluegrass.

Treatment	Rate oz/1000 ft^2	Dates of Collection												Totals		
		5/26	6/3	6/9	6/18	6/29	7/7	7/12	7/29	8/6	8/17	8/27	9/8	Overall	Spring	Summer
1. Primo 1 EC	0.50	6.8	5.0	8.6	7.4	1.6	7.1	3.6	5.1	1.6	0.5	1.2	3.6	52.1	29.4	12.0
2. Primo 1 EC	0.75	8.7	6.9	12.9	9.5	2.1	6.7	3.1	4.3	1.2	0.5	1.3	4.3	61.5	40.0	11.6
3. Primo 1 EC + Sprint	0.50 + 1.0	8.4	7.5	11.5	7.8	1.8	7.6	3.3	4.5	1.5	0.8	1.2	5.6	61.8	37.0	13.8
4. Primo 1 EC + Sprint	0.75 + 1.0	7.9	5.6	9.7	6.2	1.4	6.9	3.9	5.3	1.5	0.5	0.8	3.5	53.2	30.9	11.6
5. Primo 25 WP	0.40	8.5	6.4	9.1	7.1	1.6	7.4	3.8	6.2	2.5	1.6	1.6	6.0	61.6	32.6	17.9
6. Primo 1 EC + CORON	0.75 + 21.0	10.6	7.6	13.8	10.8	3.4	10.1	4.1	5.6	1.8	0.7	2.3	9.6	80.4	46.2	19.9
7. Check		20.8	11.3	7.5	11.4	2.8	5.9	2.7	6.1	3.7	3.7	0.8	3.4	80.1	53.8	17.7
LSD$_{0.05}$		1.7	1.2	4.4	2.7	1.2	2.2	NS	1.3	0.5	0.7	0.5	2.4	5.4	5.2	3.6

[1] Clipping production is presented as grams of dried clippings per .8 m^2.

Figure 2. Spring Application Weather Data

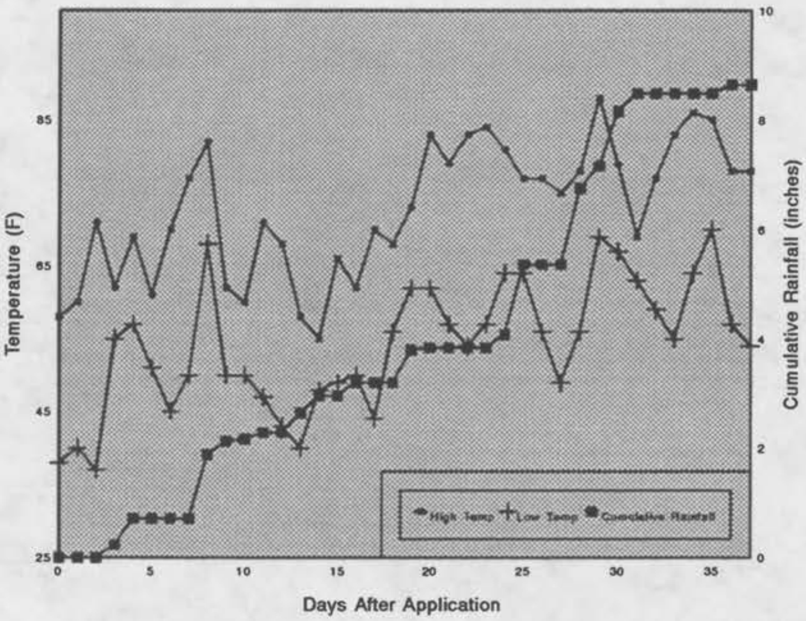


Figure 3. Summer Application Weather Data

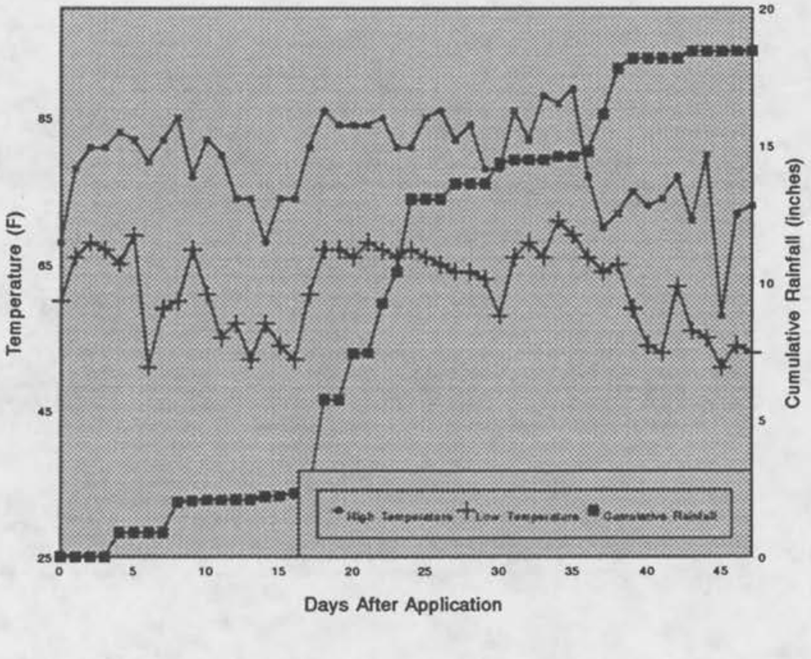


Figure 4. Cumulative Clipping Yields Following Spring Application

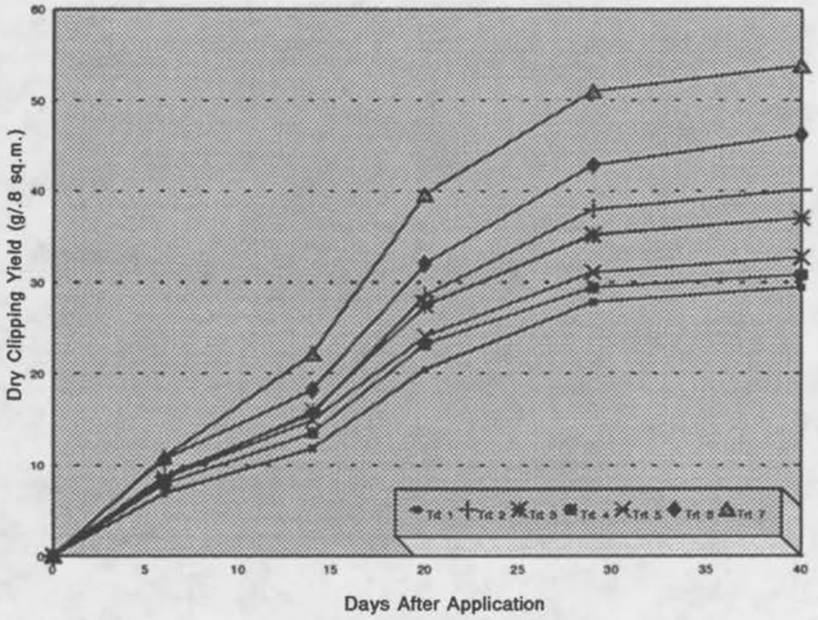
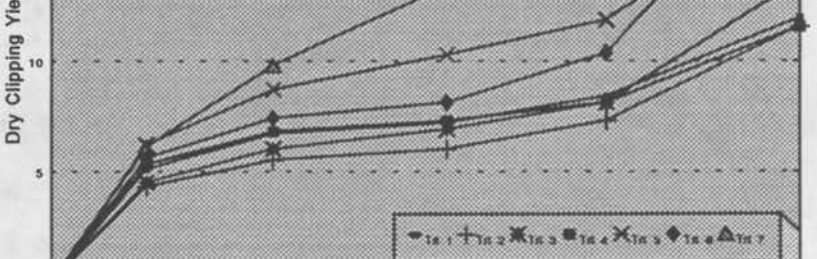


Figure 5. Cumulative Clipping Yields Following Summer Application



The Effect of Ethofumesate (Prograss) on a Putting Green at Veenker Memorial Golf Course in Ames, Iowa

J. B. Unruh, J. Livingston and N. E. Christians

Ethofumesate (Prograss) is marketed as an annual bluegrass (*Poa annua*) control for golf course fairways. It is labeled for use on Kentucky bluegrass (*Poa pratensis*), perennial ryegrass (*Lolium perenne*), and creeping bentgrass (*Agrostis palustris*) maintained at fairway mowing heights. It is not labeled for low-mowed creeping bentgrass on putting greens.

The objective of this study was to assess annual bluegrass control in addition to injury to creeping bentgrass from ethofumesate applications. Additionally, the effect of fertilizer on injury to creeping bentgrass caused by ethofumesate was determined.

The experiment was initiated on September 24, 1994 and treatments were applied as indicated in Table 30. Plots measured 5 ft by 5 ft. and were situated on the practice green at Veenker Memorial Golf Course in Ames, Iowa. Phytotoxicity data were taken 3.5 weeks after initial ethofumesate treatment. Turf quality and density estimates were taken on April 4, 1994 and April 29, 1994. Density estimates were obtained by visually estimating the percentage of annual bluegrass, creeping bentgrass or dead grass contained within the area of a small wire grid. This procedure was done at three randomly determined locations within the plot area.

Phytotoxicity ratings taken 3.5 weeks after treatment revealed that only the 0.75 lb rate (without fertilizer) yielded any appreciable damage. These plots, however, were still at an acceptable level. Initially in the spring, treated plots exhibited less than acceptable quality, with the fertilizer supplemented plots being the best among treated plots. The lower rates of ethofumesate significantly reduced the annual bluegrass density.

By April 29, the quality of the plots were all above the acceptable level except for the 0.56 lb rate plots. This could be because of the significant amount of dead grass within the plots. All four treatments significantly reduced the annual bluegrass density within the plots, however, there were no differences among treatments.

Table 30. The effect of Ethofumesate (Prograss) treatment on a Putting Green

				Oct. 19, 1993	April 4, 1994				April 29, 1994			
Treatment	lb ai / Ac	Frequency (days)	Total Applied	Phytotoxicity on Bentgrass	Quality	Poa annua Count	Bentgrass Count	Dead Grass	Quality	Poa annua Count	Bentgrass Count	Dead Grass
Control	0		0	8.25	6.75	43.33	56.67	0.00	8.00	45.00	55.00	0.00
Prograss SC	0.75	28	1.50	6.50	5.00	24.38	62.30	13.33	6.50	17.09	80.42	2.50
Prograss SC	0.56	21	1.68	8.25	5.50	29.79	69.17	1.04	5.25	10.00	80.83	9.17
Prograss SC	0.38	14	1.52	8.50	5.00	19.79	76.04	4.17	7.13	11.24	87.09	1.67
Prograss SC + Nutralene[z]	0.75	28	1.50	7.50	6.00	19.58	78.54	1.88	7.38	10.42	89.58	0.00
$LSD_{0.05}$				1.50	1.38	18.55	NS	NS	1.45	15.70	16.55	5.87

[z] Nutralene (40-0-0) was applied at 0.5 lb N/1000 ft^2 after each Prograss SC treatment.
Phytotoxicity on a 0 to 9 scale: 0 = dead turf, 9 = no injury.
Quality on a 0 to 9 scale: 0 = dead turf, 9 = best quality with 6 being acceptable.

Turfgrass Disease and Insect Research

Evaluation of Fungicides for Control of Snow Molds on Creeping Bentgrass, 1993-1994

M. L. Gleason

The trial was conducted on a bentgrass green (cv. unknown) at the Nashua Town and Country Club Golf Course, Nashua, IA. This green has a high thatch content, is subject to drifting snow, and has had severe outbreaks of snow mold in most of the last 10 years. The experimental design was a randomized complete block with 4 replications. All plots measured 5 ft x 5 ft. Fungicides were applied on November 17, 1993, using a modified bicycle sprayer at 30 psi and a dilution rate of 5 gal/1000 ft^2.

Snow cover persisted from about January 1 until March 20, 1994. On March 23, symptoms of gray snow mold were evident on the part of the green where snow cover persisted longest. Snow mold development on untreated check plots was light, with an average of less than 10% of the plot area symptomatic (Table 31). All fungicide treatments gave significantly better control of snow mold than the untreated check, except TRA 0028 at 8 oz + Chipco 26019 Flo at 4 oz, BAS 490 at 0.0064 g a.i., and BAS 490 at 0.0129 g a.i. No phytotoxicity symptoms were observed.

Table 31. 1993-1994 evaluation of fungicides for control of snow molds on creeping bentgrass at Nashua Town & Country Club Golf Course, Nashua, IA.

Company	Product	Rate/1000 ft^2	Disease Rating[a]
	Check		1.75 a
Grace-Sierra	GS/SM 93-01		0.25 b
	GS/SM 93-02		0.00 b
	GS/SM 93-03		0.00 b
	GS/SM 93-04		0.00 b[c]
	GS/SM 93-05		0.33 b[c]
	GS/SM 93-06		0.00 b[c]
	GS/SM 93-08		0.25 b
	GS/SM 93-09		0.00 b
	GS/SM 93-10		0.00 b
	GS/SM 93-11		0.00 b
	GS/SM 93-12		0.00 b
	GS/SM 93-13		0.00 b
ISK Biotech	Fluazinam 500	2.5 oz.	0.00 b
	Fluazinam 500+	1.0 oz.	0.00 b
	Daconil F	8.0 oz.	
	ASC67153 SC	8.0 oz.	0.25 b
	Daconil F+	8.0 oz.	0.00 b
	ASC67103	16 ml	
	Fluazinam 500	1.0 oz.	0.33 b[c]

Company	Product	rate/1000 ft^2	Disease Rating[a]
Terra	Thalonil 90+	4.5 oz.	0.25 b
	Chipco 26019FLO	4 fl. oz.	
	Thalonil 90+	9 oz.	0.00 b
	Chipco 26019FLO	4 fl. oz.	
	TRA 0028+	8 fl. oz.	0.75 ab
	Chipco 26019FLO	4 fl. oz.	
	TRA 0028+	16 fl. oz.	0.00 b
	Chipco 26019FLO	4 fl. oz.	
Rhone-Poulenc	Chipco 26019+	4 oz.	0.00 b
	Daconil 2787	8 oz.	
	Chipco 26019+	8 oz.	0.00 b
	Daconil 2787	8 oz.	
Ciba-Geigy	CGA 173506 50WP+	3.5g a.i.	0.00 b
	Banner 1.1 ED	2 oz.	
	CGA 173506 50 WP	7g a.i.	0.00 b
	Banner 1.1 EC	4 oz.	0.00 b
BASF	BASF Exp.	.0032g a.i.	0.00 b[b]
	BASF Exp.	.0064g a.i.	1.50 a
	BASF Exp.	.0129g a.i.	1.00 ab[b]

[a] Means of four replications unless otherwise noted ([b]n=2, [c]n=3). 0 = no disease; 1 = 1-5% of plot showing symptoms: 2 = 5-10% of plot; 3 = 10-25%; 4 = 25-50% of plot 5 = >50% of plot. Means followed by the same letter are not significantly different (DMRT, P=0.05).

Evaluation of Fungicides for Control of Brown Patch in Creeping Bentgrass -- 1993

Mark L. Gleason

Trials were conducted at Veenker Memorial Golf Course on the campus of Iowa State University, Ames, IA. Fungicides were applied to creeping bentgrass maintained at 5/32-inch cutting height, using a modified bicycle sprayer at 30 psi and a dilution rate of 5 gal/1000 ft^2. The experimental design was a randomized complete block with three replications. All plots measured 4 ft x 5 ft. All plots were surrounded by 1-ft-wide strips of untreated turf in order to help create uniform disease pressure.

Fungicide applications began on June 11 and were repeated at recommended intervals on June 19 and 25 and July 2, 9, 16, 23, and 30. Disease development was rated on July 14, July 30, and August 6.

The summer of 1993 was the wettest in Iowa since 1851. Heavy, frequent rainfall in June through August favored disease development, but below-normal temperatures helped to suppress brown patch. Disease pressure on the test plot was moderate to severe on July 14 and August 6 and severe on July 30.

Most formulations suppressed disease significantly on each rating date. Several treatments provided excellent control on all rating dates; two treatments, 1) Thalonil 90 and 3.5 oz and 2) TRA 0028 at 6.0 oz on 14-day intervals, showed no disease on all dates. No phytotoxicity was observed for any treatments.

PCNB 75 W formulations at the 4-oz rate and 7-day intervals caused moderately severe yellowing and browning of the turf in July and August. Sentinel 40 WG caused a slightly enhanced green color of the turf by early August.

Table 32. 1993 Fungicide Trial for Brown Patch.

Company	Product	Rate/1000 ft^2	Spray Interval (days)	Severity of Symptoms[1]		
				July 14	July 30	August 6
	Check			3.3 a[2]	4.0 a	3.0 a
Terra	Thalonil 90	3.5 oz	14	1.7 bc	1.0 defg	0.7 abcd
	TRA 0028	6.0 fl oz	14	0.0 d	1.0 defg	1.0 bcd
	Thalonil 90	3.5 oz	7	0.0 d	0.0 g	0.0 d
	TRA 0028	6.0 fl oz	7	0.0 d	0.0 g	0.0 d
Miles	Lynx 25DF	1.0 oz	21	0.3 cd	0.3 fg	0.7 cd
	+ Bayleton 25DF	1.0 oz				
Sandoz	Sentinel 40WG	0.25 oz	21	0.7 bcd	1.7 def	0.3 d
	Sentinel 40WG	0.25 oz	28	1.3 bcd	3.7 ab	3.0 a
	Sentinel 40WG	0.33 oz	28	0.3 cd	1.7 def	1.0 bcd
Rhone-Poulenc	Chipco 26019WDG	2.0 oz	14	0.7 bcd	1.0 defg	0.7 cd
	EXP10452A 50WG	1.0 oz	14	0.3 cd	0.3 fg	0.3 d
	EXP10452A 50WG	2.0 oz	14	0.0 d	0.3 fg	0.0 d
	EXP10064C 1.67SC	1.0 fl oz	14	0.3 cd	0.7 efg	1.0 bcd
	EXP10307A 0.84SC	1.5 fl oz	14	0.3 cd	1.0 defg	1.3 abcd
	EXP10307A 0.84SC	2.0 fl oz	14	0.0 d	0.7 efg	0.7 cd
	EXP10307A 0.84SC	1.0 fl oz	14	0.3 cd	1.7 def	0.3 d
	+ EXP02164B 4SC	0.9 fl oz	14			
	EXP10307A 0.84SC	1.5 fl oz	14	0.0 d	1.3 defg	0.0 d
	+ EXP02164B 4SC	1.2 fl oz	14			
ISK Biotech	Daconil	6.0 oz	14	0.0 d	1.3 defg	0.3 d
	Fluazinam 500	2.0 fl oz	28	1.7 bc	3.3 abc	2.7 ab
	Fluazinam 500	1.0 fl oz	21	0.0 d	1.3 defg	3.0 a
	ASC 67098	4.0 oz	21	0.0 d	0.0 g	0.7 cd
	ASC 67098	6.0 oz	14	0.0 d	0.3 fg	0.0 d
Rohm & Haas	EAGLE	0.6 oz	14	0.3 cd	2.0 cde	0.3 d
	RH-7592 2F	0.5 fl oz	14	2.0 ab	2.3 bcd	1.0 bcd
	RH-7592 2F	1.0 fl oz	14	1.3 bcd	2.3 bcd	2.3 abc

[1] 0 = no disease; 1 = 1-10% of plot diseased; 2 = 10-25% diseased; 3 = 25-50% diseased; and,4 = >50% diseased.

[2] Numbers in a column followed by the same letter are not significantly different (DMRT, P=0.05). n=3.

Evaluation of Fungicides for Control of Dollar Spot in 'Penncross' Bentgrass - 1993

Mark L. Gleason

Trials were conducted at the Iowa State University Horticulture Research Station north of Ames, Iowa. Fungicides were applied to Penncross creeping bentgrass maintained at 5/32-inch cutting height, using a modified bicycle sprayer at 30 psi and a dilution rate of 5 gal/1000 ft^2. The experimental design was a randomized complete block with four replications. All plots measured 4 ft x 5 ft.

Fungicide applications began in early June, following inoculation with infested rye grain. However, due to a communication error, the plot had been sprayed with Daconil 2 weeks earlier, so the inoculation was ineffective. Sprays were discontinued on June 30. The plot was reinoculated on August 1, and all treatments were reapplied on August 6. Subsequent applications were made at specified intervals on August 13, 20, and 27. Disease development was rated on July 30 (before the reinoculation), August 20, and September 3.

Disease development was severe during the test period, which was unusually rainy (twice the normal rainfall total during August). Two materials were not significantly better for disease control than the untreated check on the August rating dates: Thalonil 90 at 3.5 oz and TRA 0028 at 6 oz at a 14-day interval. Other treatments varied widely in efficacy. No phytotoxicity symptoms were observed.

Table 33. 1993 Fungicide trial for Dollar spot.

			Spray	Number of Spots per Plot[1]		
Company	Product	Rate/1000 ft^2	Interval (days)	July 30[2]	August 20	September 3
	Check			13.0 a[3]	90.0 a	132.5 ab
Terra	Thalonil 90	3.5 oz	14	15.0 a	104.3 a	166.3 a
	TRA 0028	6.0 fl oz	14	3.5 bc	76.8 ab	122.5 bc
Ciba-Geigy	CGA173506 50WP	3.5 g	7	2.5 bc	51.3 bcde	87.5 cdef
	CGA173506 50WP	7.0 g	7	1.3 c	42.5 cdef	58.3 defgh
	Banner 1.1 EC	15.2 ml	7	1.0 c	0.0 g	0.3 j
	Banner 1.1 EC + CGA173596 50WP	15.2 ml	7	0.0 c	0.0 g	0.0 j
Miles	Lynz 25DF	0.75 oz	28	0.5 c	22.3 defg	51.3 efgh
	Bayleton 25DF	1.0 oz	28	2.0 bc	54.0 bcd	76.0 defg
Sandoz	Sentinel 40WG	0.17 oz	28	0.0 c	18.0 fg	34.8 ghij
Rhone-Poulenc	EXP10307A 0.84SC	1.0 fl oz	28	1.3 c	24.5 cdefg	49.3 efgh
	EXP10512A 1.04SC	0.8 fl oz	28	3.0 bc	44.0 cdef	57.3 defgh
	EXP10512A 1.04SC	1.6 fl oz	28	0.8 c	20.3 efg	42.8 ghi
	Chipco 26019WDG	2.0 oz	28	7.8 abc	44.3 cdef	96.5 bcd
Dow-Elanco	Rubigan AS	1.5 fl oz	14	0.0 c	25.3 cdefg	3.3 ij
ISK Biotech	Daconil	6.0 oz	14	3.0 bc	55.0 bc	51.8 efgh
	Fluazinam 500	2.0 fl oz	28	0.5 c	1.3 g	24.8 hij
	ASC67098	6.0 oz	14	0.0 c	1.3 g	0.0 j
	ASC67098	4.0 oz	21	11.0 ab	12.3 fg	91.0 cde
Rohm & Haas	Eagle	0.6 oz	21	3.3 bc	30.8 cdefg	48.0 fgh
	RH-7592 2F	0.5 fl oz	21	2.0 bc	8.5 g	19.5 hij
	RH-7592 2F	1.0 fl oz	28	0.3 c	2.0 g	5.3 ij

[1] Number of infection centers per plot.

[2] Inoculation with infested grain was done on August 1.

[3] Numbers in a column followed by the same letter are not significantly different (DMRT, P=0.05). n=4.

Evaluation of Fungicides for Control of Leaf Spot in 'Park' Bluegrass - 1993

Mark L. Gleason

Trials were conducted at the Iowa State University Horticulture Research Station north of Ames, Iowa. Fungicides were applied to Kentucky bluegrass (cv. Park) maintained at 2 1/2-inch cutting height, using a modified bicycle sprayer at 30 psi and a dilution rate of 5 gal/1000 ft^2. The experimental design was a randomized complete block with four replications. All plots measured 4 ft x 5 ft.

Fungicide applications began on June 10 and continued at recommended intervals (14 or 21 days) until August 12. Disease development was rated on July 14, July 30, and August 18.

Disease development was light to moderate during the test period, which was unusually rainy. Several compounds suppressed disease significantly in comparison to the untreated check on each rating date. Daconil SDG at 3.8 oz and a 14-day interval gave the most consistent disease control, closely followed by ASC 67098 at 6.0 oz and a 14-day interval. No evidence of phytotoxicity was observed during the test period.

Table 34. 1993 Fungicide Trial for Leaf Spot.

Company	Product	Rate/1000 ft^2	Spray Interval (days)	Severity of Symptoms[1]		
				July 14	July 30	August 18
	Check			2.8 a[2]	2.5 a	2.0 ab
Terra	Thalonil	3.5 oz	14	1.3 b	1.8 ab	0.8 c
	TRA 0028	6.0 fl oz	14	1.3 b	1.0 bc	0.8 c
ISK Biotech	Daconil SDG	3.8 oz	14	0.8 b	0.8 c	0.8 c
	ASC 67098	6.0 oz	14	0.9 b	0.8 c	1.0 bc
	ASC 67098	4.0 oz	21	1.0 b	1.0 bc	1.0 bc
Rohm & Haas	Eagle	0.6 oz	14	1.3 b	1.3 bc	2.3 a
	RH-7592 2F	0.5 fl oz	14	1.6 b	1.0 bc	2.3 a
	RH-7592 2F	1.0 fl oz	14	1.5 b	1.8 ab	2.0 ab

[1] 0 = no disease; 1 = trace; 2 = light; 3 = moderate; and, 4 = severe.

[2] Numbers in a column followed by the same letter are not significantly different (DMRT, P=0.05). n=4.

Potential Control of Symptom Expression by Leaf Spotted (Bipolaris sorokiniana) Kentucky Bluegrass Leaves

C. F. Hodges and D. A. Campbell

Bipolaris sorokiniana is the cause of leaf spot of Kentucky bluegrass throughout the north central states and is a serious pathogen of numerous grass species (turf and non-turf) world wide (11,12). In addition to the attack of leaves, this pathogen can infect crowns, roots, inflorescence, and germinating seedlings. The leaf infecting stage of the disease can be found throughout the growing season. Leaf spot damage is common in the spring, but the environmental conditions of fall provide optimum conditions for severe leaf spotting and chlorosis (9, 10). The fall season with periods of prolonged overcast, cool, wet, weather and progressively shorter daylengths increase the extent to which infected leaves yellow.

Research in our laboratory over several years has established that the physiology of yellowing of infected leaves is related to senescence, ethylene, and a nonspecific phytotoxin produced by the pathogen (1, 6, 8). Yellowing is typically most severe in the fall on older infected leaves. This is due to enhancement of the rate of leaf senescence in response to shorter daylengths; a condition that is exploited by the pathogen. The interaction can be further enhanced by postemergence herbicides (4, 5, 7) and perhaps nitrogen fertilization (2, 3). The actual cause of yellowing of infected leaves is due in large part to the production of endogenous ethylene during the infection process. The phytotoxin produced by the pathogen also seems to cause some direct yellowing at the margin of the lesions formed on the leaves.

Traditional approaches to the control of *B. sorokiniana* leaf spot of Kentucky bluegrass have included a combination cultural practices and application of fungicides. The cultural approaches include moderate nitrogen fertilization, thatch reduction, raising mowing heights, avoidance of afternoon and evening irrigation, and the use of resistant cultivars. Cultural practices generally have only a modest affect on controlling this pathogen and resistant cultivars tend to be regionally effective and the nature of the resistance is often precarious over time and with environmental stress. Several fungicides are effective against *B. sorokiniana* (11), but the quantities required and their cost become a major factor in their use. This pathogen can be exceptionally costly to control because it can be active on some portion of the plant during the entire growing season.

In that we grow turf for its aesthetic value, it might not be necessary to prevent infection of Kentucky bluegrass leaves by *B. sorokiniana*, if we could inhibit the yellowing symptoms that occur following infection. If for example, the biosynthesis of ethylene could be prevented during infection, the yellowing of the leaves would be substantially reduced. The presence of small lesions on the leaves without yellowing would be of little consequence to the aesthetic value of the turf, and the infected leaves would be periodically removed with mowing. The research conducted in our laboratory over the last three years has examined the potential for preventing the yellowing of Kentucky bluegrass leaves infected by *B. sorokiniana.*

OBJECTIVES OF RESEARCH

The primary objective of this research project has been to evaluate substances known to prevent the biosynthesis and/or mode of action of the endogenous ethylene generated during the infection of Kentucky bluegrass by *Bipolaris sorokiniana*. Control of this process could feasibly reduce or eliminate the use of fungicides for the control of this disease (and possibly others) by preventing the yellowing associated with disease development.

RESEARCH OBSERVATIONS

The primary source of endogenous ethylene during infection is from the biosynthetic pathway in the host plant. Some ethylene also is produced by the pathogen from a second pathway, but the amount is believed to be negligible in most cases. Therefore, the biosynthesis and/or mode of action of endogenous ethylene produced by the host has been targeted for control. The following substances have been evaluated for their ability to prevent the biosynthesis of ethylene during the infection process and to prevent or reduce yellowing of the leaves:

1. Aminooxyacetic Acid (AOA)
2. Aminoisobutyric Acid (AIB)
3. Canaline (CAN)
4. Carbonyl Cyanide m-Chlorophyenylhydrazone (CCCP)
5. Cobalt Chlorophylloride (COCL)
6. Propyl Gallate (PG)

Ten milliliters of each substance at concentrations of 10^{-3}M were applied to the soil in pots containing Kentucky bluegrass each of 3 days preceding inoculation, and then each of 4 days during pathogenesis which included the assay days for endogenous ethylene evolution by the infected leaves. The four youngest visible leaves were inoculated with four agar plugs (4mm) containing the mycelium of the pathogen.

1. Ethylene Production:

Inoculated plants were assayed for endogenous ethylene generation at 24, 48, 72, and 96 hours after inoculation. The normal levels of endogenous ethylene in healthy leaves ranged from 0.28 to 0.32 $\mu l\ l^{-1}$. All ethylene inhibiting substances, except AIB, decreased endogenous ethylene at one or more of the four 24h sampling periods.

None of the ethylene inhibiting substances applied to the roots of Kentucky bluegrass prevented infection by *B. sorokiniana* and lesion development was typical of that on inoculated control plants. Ethylene in nontreated, inoculated plants increased to 1.48 $\mu l\ l^{-1}$ at 48 hours after inoculation. All ethylene inhibiting substances decreased the surge of endogenous ethylene at 24h and 48h during the early stages of pathogenesis. At 72h, as pathogenesis progressed, AIB and COCL ceased to decrease ethylene evolution. CAN, AOA, CCCP, and PG continued to decrease endogenous ethylene production at 72h and 96h. AOA and CAN were among the more consistent substances at decreasing endogenous ethylene in inoculated leaves; these materials held the ethylene in a range of 0.4 to 0.9 $\mu l\ l^{-1}$ over each of the 24 hour observation periods.

2. Chlorophyll Loss:

Inoculation of leaves of untreated control plants with *B. sorokiniana* decreased the chlorophyll content of the leaves to 43% of that in healthy control leaves at 96h after inoculation. Ethylene inhibiting materials applied to the roots of healthy plants did not significantly change the chlorophyll content of the leaves. Plants treated with AIB, CCCP, COCL, and PG and leaf inoculated with *B. sorokiniana* failed to prevent the loss of chlorophyll during pathogenesis. Inoculated plants treated with CAN and AOA substantially decreased the loss of chlorophyll compared to that of inoculated control plants. Inoculated leaves of plants treated with CAN and AOA retained 74% and 80% of their chlorophyll, respectively.

CONCLUSIONS AND OUTLOOK

1. CAN, AOA, CCCP, and PG proved effective in decreasing the surge of endogenous ethylene during infection when applied to the roots of inoculated plants. However, only CAN and AOA maintained a substantial portion of the chlorophyll during pathogenesis. The treatment of roots did not prove as effective as we had hoped and we are now in the process of conducting foliar application tests that we believe will be more effective with a broader spectrum of materials. The primary drawback of foliar application is the possibility of increased phytotoxicity. Preliminary observations with foliar applications of CAN and AOA look more promising than the results obtained with soil treatments. Other considerations relative to the observations of this research are presented below.

    a. The soil treatment studies conducted in this project utilized very high levels of inoculum in an effort to see how effective the materials tested could be at containing ethylene production and subsequent chlorophyll loss. In retrospect, it is probable that the inoculum pressure exerted by this approach simply overwhelmed the plant tissue and any good that the substances being tested might have done. The inoculum levels originally used would be several hundred times greater than any level encountered in the field. Foliar treatments are currently being reexamined with substantially lower levels of inoculum and somewhat different environmental parameters. This could make a major difference in the results.

    b. It is unlikely that the ethylene inhibiting substances alone will prevent loss of chlorophyll from infected leaves. Some chlorophyll loss may be related to other hormones and to senescence induced by the pathogen. Work on the potential manipulation of these factors will be a goal of future research. Control of senescence physiology is another primary goal. If senescence retardation can be achieved and combined with a decrease in ethylene (which induces senescence) production, the potential for symptom expression control is very good.

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The Screening of Allelopathic Compounds as Potential Herbicides

D. A. Campbell and N. E. Christians

Laboratory petri dish germination and greenhouse pre- and postemergence treatment studies were initiated to determine the efficacy of certain water soluble and less soluble compounds, identified in the literature as having allelopathic activity in other plant species, to inhibit the germination of *Lolium perenne* (perennial rye).

Procedure

Initially four compounds were investigated Arbutin, Catechol (Pyrocatechol), Camphor, and Tannic acid. Of these four, Camphor was dropped due to it's relatively insoluble nature.

In addition five more compounds (Aloin (Barbaloin), Esculin, Gramine, Succinic acid, and Syringic acid) were investigated. Plant survival data were also collected.

All compounds were brought into solution at various Molar (M) concentrations using distilled water (Table 35 & 36). A petri dish germination inhibition assay was initiated using 1 ml of the various Molar concentrations on a 7 cm piece of Whatman #1 filter paper disk in a 15 x 100 mm disposable petri dish. After applying the solution to the filter paper, 10 seeds of *Lolium perenne* were placed equidistantly over the surface. The dishes were then wrapped with two layers of Parafilm and placed in a growth chamber with 8 hours of light per day and 25°C day and 15°C night. The seeds were allowed to germinate for 14 days with data taken at days 7 and 14. In addition to total germination inhibition (the ability of a compound to completely stop the emergence of either the root radical or coleoptile through the seed coat), visual observations were made to assess the degree to which the compounds retarded normal development of the root or shoot compared to the heathy control seedlings. Three separate replicated studies were conducted with each of these compounds to obtain the data.

Greenhouse assays were preformed using 4" X 4" pots filled with field soil to 1/2" below the top. The seed bed was firmed and 0.309 g (8 lbs/1000 ft^2) of perennial rye seed were applied. The seeds were then covered with 28 cm^2 of field soil. Preemergence assays were performed by applying 2.5 ml of the compound per pot, to the soil surface by atomizing with a DeVilbiss 561 series air compressor and an atomizing nozzle to assure complete, uniform coverage. After preemergence treatments were applied, the pots were placed on a mist bench for 24 hours to water in, as is commonly done with commercial preemergence products. Postemergence applications were done by using the same procedure as above to establish a stand. Seedlings were then allowed to grow until the first leaf reached a height of 5 cm. The treatments were then applied at the same rate in the same fashion as above, but on the established leaf tissue. Treated seedlings were allowed to stand for 48 hours without watering.

Results

In the petri dish assay Tannic Acid and Catechol were effective at completely inhibiting germination at -1 Molar (1×10^{-1}M) concentrations, while Arbutin effectively inhibited germination by 75% at that concentration. At the -2M concentration Tannic Acid, Catechol and Arbutin inhibited germination 17%, 22% and 0% respectively. The -3M concentrations of these compounds offered little germination inhibition (0 - 2%) (Table 35).

Visual observations of the -2 and -3 Molar concentrations of Tannic Acid, Arbutin, and Catechol offered more interesting results than the percent of inhibition would indicate (Table 35). Tannic Acid at the -2M concentration caused a 30% reduction in shoot length and a 80% reduction in root length, at -3M it caused little shoot reduction and a 50% reduction in root length. Arbutin while inhibiting germination by 75% at -1M caused a 50% reduction in shoot length and 100% inhibition of root formation in the seedlings that did emerge. At -2M a 30% reduction in shoot length was observed with a 90% reduction in root length. The -3M concentration showed little effect on either shoot or root length. Catechol at -2M caused a 80% reduction in shoot length and a 80% reduction in root length in the seedlings that did germinate. At -3M little shoot reduction was observed with a 20% reduction in root length (Table 35).

Petri dish germination assays of the five new compounds showed that only one had any effect on germination. Succinic acid at -1M (1 X 10^{-1}M) concentration, with germination being reduced to 37.5% of non-treated control (Table 1A). Inhibition was not present at the -2M concentration. Visual observation of the shoot and roots showed no reduction, except in the case of Succinic acid at -1M, with 100% reduction in root production and 80% reduction in shoot development compared to non-treated control. No reduction was observed at -2M (Table 36).

Pre and postemergence greenhouse assays have been completed on all of the compounds. None of the compounds tested showed any significant decrease in stand compared to the non-treated controls in preemergence assays (Table 37 & 38). Postemergence applications had only one treatment that showed any effect. Catechol at -1M caused tip burning, but the seedlings fully recovered in about two weeks. All compounds were tested at the lowest dilution.

Conclusions

While most of these compounds were quite effective at inhibiting germination at the -1M concentration and a seemingly small inhibition at -2M and -3M the extent to which they retard shoot and root formation should affect a seedlings ability to survive once it has germinated.

Any of the compounds that show promise will be tested against other turf weed species. Phytotoxicity studies will be conducted on mature desired turf species to determine if the dose levels that show allelopathic activity on seedling germination have any deleterious effects on these species.

Table 35. Summary of germination inhibition from petri dish assay.

Treatment	% Germination	% Visual Reduction
Tannic Acid -1M	0	100% root 100% shoot
Tannic Acid -2M	83	80% root 30% shoot
Tannic Acid -3M	100	50% root > 5% shoot
Arbutin -1M	25	100% root 50% shoot
Arbutin -2M	100	90% root 30% shoot
Arbutin -3M	98	> 5% root and shoot
Catechol -1M	0	100% root 100% shoot
Catechol -2M	78	80% root 80% shoot
Catechol -3M	98	20% root > 5% shoot

Table 36. Summary of germination inhibition from petri dish assay.

Treatment	% Germination	% Visual Reduction
Aloin -3M	100	0
Aloin -4M	100	0
Esculin -3M	100	0
Esculin -4M	100	0
Gramine -2M	100	0
Gramine -3M	100	0
Succinic acid -1M	37.5	100% root 80% shoot
Succinic acid -2M	100	0
Syringic acid -3M	100	0
Syringic acid -4M	100	0

Table 37. Comparison of mean stand count for first run of preemergence applications.

Treatment	Mean Stand Count
Control	144
Arbutin	143
Pyrocatechol (catechol)	141
Tannic acid	140
$LSD_{(0.05)}$	4.76

Table 38. Comparison of mean stand count for preemergence applications, on second set of compounds.

Treatment	Mean Stand Count
Barbaloin (Aloin) -3M	142
Syringic acid -3M	141
Succinic acid -1M	141
Gramine -2M	141
Esculin -3M	141
Control	139
$LSD_{(0.05)}$	7.01

Fertilizer Trials and Soil Studies

Natural Organic Source Study

M. L. Agnew

The objective of this study is evaluate the effects of different natural organic nitrogen sources on Kentucky bluegrass growth.

Treatments included 6 natural organic nitrogen sources and a non-fertilized control. Nitrogen sources include: blood meal, corn gluten meal, leather meal, composted turkey manure, composted chicken manure, and activated sewage sludge. Applications of 1 lb N were made on May 27, July 1, and August 15, 1993. Treatments were made on newly established 'Bronco' Kentucky bluegrass mowed at 2 inches and irrigated to prevent drought.

Plots were rated for quality in June, July, August, and September. Visual quality is measured on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and 1 = poorest quality. Clippings were collected from a 2 ft X 5 ft area in June, July, August, September, and October. Clippings were oven dried, weighed and reported as grams of dried tissue per 10 ft^2. Roots were collected in November of 1993. These were segmented into 4 depths, washed and oven dried, then reported as grams of root tissue per depth.

Composted chicken manure produced the best quality turf followed by composted turkey manure, corn gluten meal, and blood meal (Table 39).

Composted chicken manure produced over 100% more clippings than any other nitrogen source (Table 40), while it produced the least amount of roots (Table 41). The free ammonia in chicken manure obviously benefitted shoot growth, however, it was also aided record rainfalls that negated any potential ammonia toxicity. This was noted in previous natural organic nitrogen trials.

This study will be repeated in 1994 to validate the data.

Table 39. The influence of organic nitrogen source on turfgrass quality.

Fertilizer Source	June			July			August			Sept	
	11	17	30	12	23	27	6	17	27	7	Avg
Blood Meal	4	6	8	8	8	8	9	7	7	8	7
Corn Gluten Meal	5	6	8	7	8	7	8	7	7	8	7
Leather Meal	5	6	5	6	7	6	7	7	7	6	6
Turkey Manure	6	7	7	7	7	7	7	6	7	7	7
Chicken Manure	7	8	9	9	9	7	8	7	9	9	8
Sewage Sludge	5	6	6	6	6	7	7	7	7	7	6
Control (0)	4	4	4	4	4	4	5	6	5	5	5
$LSD_{(0.05)}$	1.5	0.8	0.9	0.5	0.8	0.7	0.9	NS	1.1	1.0	0.3

Table 40. The influence of organic nitrogen source on turfgrass clipping production.

Fertilizer Source	June			July		August			Sept	Oct	
	17	24	30	12	27	6	17	27	17	22	Total
Blood Meal	3.5	3.9	5.1	17.8	14.8	13.0	11.9	10.5	13.0	10.1	103.5
Corn Gluten Meal	4.6	7.3	7.7	17.0	14.6	10.6	10.3	8.6	12.2	14.1	107.0
Leather Meal	4.0	2.9	3.0	8.3	8.8	7.3	7.4	6.7	9.5	6.8	64.6
Turkey Manure	7.8	6.9	6.3	15.9	13.1	9.8	14.4	13.4	13.6	11.5	112.7
Chicken Manure	48.2	29.7	21.1	51.7	20.4	16.3	6.3	31.0	25.7	25.7	275.9
Sewage Sludge	4.9	3.8	3.3	7.1	8.8	6.5	7.7	9.8	10.9	8.4	71.1
Control (0)	2.0	1.3	1.3	1.5	1.8	1.8	4.8	2.5	4.0	2.7	23.7
$LSD_{(0.05)}$	4.9	2.5	1.7	4.8	4.0	2.9	6.0	4.4	1.9	2.7	15.8

Table 41. The influence of organic nitrogen source on turfgrass rooting.

	Depth (cm)				
Fertilizer Source	0 - 5	5 - 10	10 - 15	15 - 20	Total
Blood Meal	47.5	22.7	14.2	7.7	92.2
Corn Gluten Meal	67.7	20.9	12.5	7.7	108.9
Leather Meal	49.3	25.2	14.3	9.2	98.0
Turkey Manure	70.8	21.6	16.4	9.4	118.2
Chicken Manure	46.6	20.5	13.4	6.9	87.4
Sewage Sludge	74.5	26.5	16.4	6.6	123.9
Control	70.2	24.6	14.0	8.0	116.8
$LSD_{(0.05)}$	21.9	NS	NS	NS	NS

Fertilizer Rate Evaluation

M. L. Agnew

This study was established in Spring, 1993, to compare the effects of seven different nitrogen formulations on a nine-year-old stand of 'Ram I' Kentucky bluegrass. Individual plots measured 3 ft x 10 ft and the treatments were replicated three times in a randomized block design. The plots were mowed weekly, collecting all leaf tissue above 2 ft, with one mower pass. Irrigation was added to reduce plant stress.

Nitrogen fertilizers used in this study include: Nutralene, SCU, Coron, Urea, Nutralene + Urea, SCU + Urea, and Coron + Urea. The fertilizers were applied at 3 rates on May 10, June 26, and August 14.

Data collected included fresh visual quality ratings, clipping weights, and root density. Visual quality ratings were collected weekly prior to clipping removal. Ratings are based on a scale of 9 to 1: 9 = dark-green turfgrass stand, 6 = minimum acceptable quality, and 1 = dead, straw-brown turf. Clippings were collected each week or when enough growth warranted clipping removal. Clippings were collected with a Toro rotary mower and placed in bags. Clippings were dried and the weights were recorded. In November, roots were collected, washed, oven dried and recorded as mg of dry tissue.

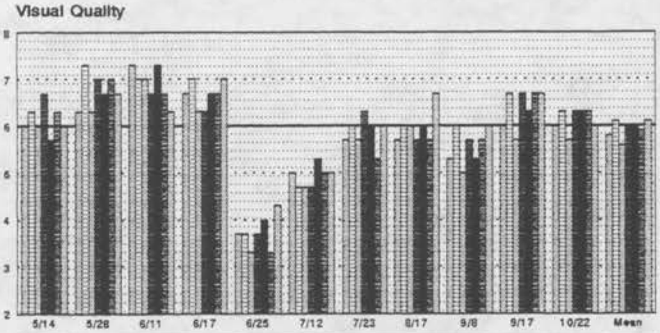
Visual quality ratings are shown in Figure 6. For the 0.5 lb N rate SCU and Coron + Urea had the highest overall quality. For the 0.75 lb N rate Nutralene, SCU, Urea, and Coron + Urea had the highest overall quality. For the 1.0 lb N rate Urea, Nutralene, Nutralene + Urea, and SCU + Urea had the highest overall quality.

Clipping weight data is shown in Figure 7. In general for all rates, Urea treated plots produced the greatest amount of clippings. This was followed by SCU treated plots.

Rooting data is presented in Figure 8. For the 0.5 and 0.75 lb N rates, Coron and Coron + Urea treated plots had the greatest amount of roots. At the 1.0 lb N rate the Urea treated plots had significantly less roots than SCU, Coron, SCU + Urea, and Coron + Urea treated plots.

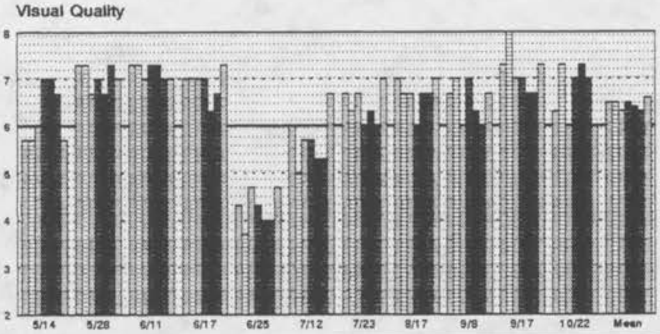
Figure 6.

Nitrogen Source
0.5 N/M Rate
Visual Quality



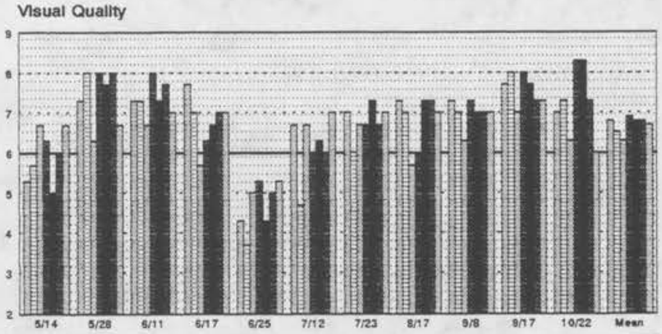
		5/14	5/28	6/11	6/17	6/25	7/12	7/23	8/17	9/8	9/17	10/22	Mean
Nutralene	▨	6	6.3	7.3	6.7	3.7	5	5.7	5.7	5.3	6	6	5.8
SCU	☐	6.3	7.3	7	7	3.7	4.7	6	6	6	6.7	6.3	6.1
CORON	▨	6	6.3	7	6.3	3.3	4.7	5.7	6	5	5.7	5.7	5.6
Urea	■	6.7	7	6.7	6.3	3.7	4.7	6.3	5.7	5.7	6.7	6.3	6
Nutralene + Urea	■	5.7	6.7	7.3	6.7	4	5.3	6	6	5.3	6.3	6.3	6
SCU + Urea	■	6.3	7	6.7	6.7	3.3	5	5.3	5.7	5.7	6.7	6.3	5.9
CORON + Urea	▨	6	6.7	6.3	7	4.3	5	6	6.7	6	6.7	6	6.1

Nitrogen Source
0.75 N/M Rate
Visual Quality



		5/14	5/28	6/11	6/17	6/25	7/12	7/23	8/17	9/8	9/17	10/22	Mean
Nutralene	▨	5.7	7.3	7.3	7	4.3	6	6.7	7	6.7	7.3	6.3	6.5
SCU	☐	5.7	7.3	7.3	7	3.7	6	6.3	6.7	7	8	7.3	6.6
CORON	▨	6	6.7	7	7	4.7	5.7	6.7	6.7	6	7	6	6.3
Urea	■	7	7	7.3	7	4.3	5.7	6	6	7	7	7	6.5
Nutralene + Urea	■	7	6.7	7.3	6.3	4	5.3	6.3	6.7	6.3	6.7	7.3	6.4
SCU + Urea	■	6.7	7.3	7	6.7	4	5.3	6	6.7	6	6.7	7	6.3
CORON + Urea	▨	5.7	7	7	7.3	4.7	6.7	7	7	6.7	7.3	6	6.6

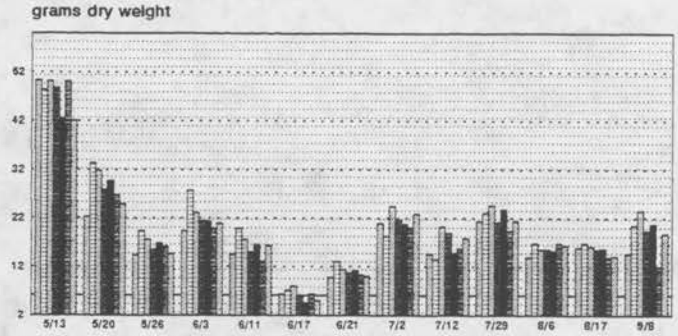
Nitrogen Source
1.0 N/M Rate
Visual Quality



		5/14	5/28	6/11	6/17	6/25	7/12	7/23	8/17	9/8	9/17	10/22	Mean
Nutralene	▨	5.3	7.3	7.3	7.7	4.3	6.7	7	7.3	7.3	7.7	7	6.8
SCU	☐	5.7	8	7.3	7	3.7	4.7	6	7	7	8	7.3	6.5
CORON	▨	6.7	6.3	6.7	5.7	5	6.7	6.7	5.7	6.3	7	6.3	6.3
Urea	■	6.3	8	8	6.3	5.3	6	6.7	6	7.3	8	8.3	6.9
Nutralene + Urea	■	5	7.7	7.3	6.7	4.3	6.3	7.3	7.3	7	7.7	8.3	6.8
SCU + Urea	■	6	8	7.7	7	5	6	6.7	7.3	7	7.3	7.3	6.8
CORON + Urea	▨	6.7	6.7	7	7	5.3	7	7	7	7	7.3	6	6.7

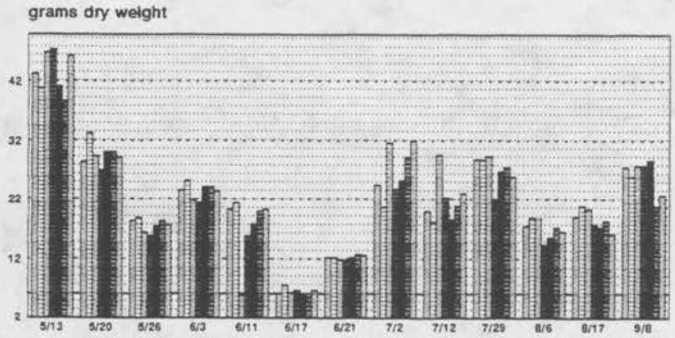
Figure 7.

Nitrogen Source
0.5 N/M Rate
Clipping Weights



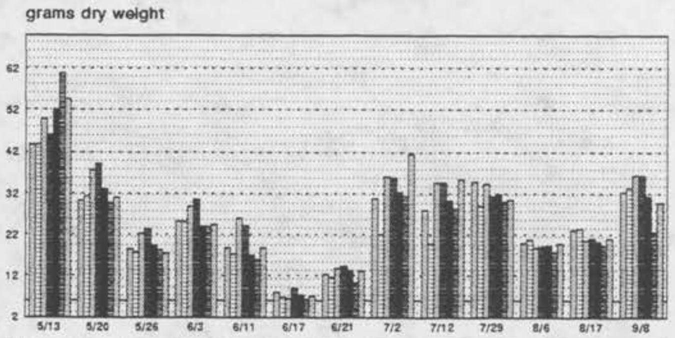
	5/13	5/20	5/26	6/3	6/11	6/17	6/21	7/2	7/12	7/29	8/6	8/17	9/8
Nutralene ☐	50.2	22.1	14.3	19.3	14.6	6.2	9.7	20.9	14.6	21.2	13.8	15.9	14.6
SCU ☐	48.3	33.3	19.4	27.6	19.7	7.1	13.1	18.3	13.4	22.9	16.8	16.6	20.4
Urea ☐	50	31.6	17.6	22.9	17.5	8	11.2	24.2	20.2	24.8	15.5	16	23.5
Nutralene + Urea ■	48.6	27.8	15.5	21.2	14.9	5.8	10.6	21.4	18.9	21	15.3	15.5	19.4
SCU + Urea ■	42.3	29.6	16.6	21.2	16.5	4.6	11.1	20.7	14.7	23.7	15.2	15.6	20.7
Coron ▨	49.9	26.7	16.1	19.7	12.9	6.2	10.2	20	15.6	19.2	16.6	13.8	12
CORON + Urea ☐	41.9	24.7	14.5	20.9	16.2	4.9	10	22.7	17.7	21.2	16.2	14.1	18.7

Nitrogen Source
0.75 N/M Rate
Clipping Weights



	5/13	5/20	5/26	6/3	6/11	6/17	6/21	7/2	7/12	7/29	8/6	8/17	9/8
Nutralene ☐	43.4	28.3	18.3	23.6	20.3	6	12.1	24.4	19.9	28.8	17.4	19.1	27.5
SCU ☐	40.8	33.2	18.9	26.2	21.3	7.5	12.1	20.7	18.2	28.8	18.9	20.9	26.9
Urea ☐	46.9	29.2	16.3	21.9	5.7	6.3	11.8	31.7	29.4	29.3	19	20.3	27.8
Nutralene + Urea ■	47.5	27	15.8	21.3	15.8	6.6	11.9	23.7	22.2	22.1	14.4	17.7	27.6
SCU + Urea ■	41.1	30	17.4	24	17.8	6	12.2	26.2	18.4	26.7	15.6	17.2	28.6
Coron ▨	38.6	30	18.3	24.1	19.9	5.6	12.8	29.1	20.8	27.5	17.3	18.3	20.8
CORON + Urea ☐	46.4	29.1	17.5	23.3	20.2	6.6	12.6	31.9	23	25.8	16.5	16.2	22.6

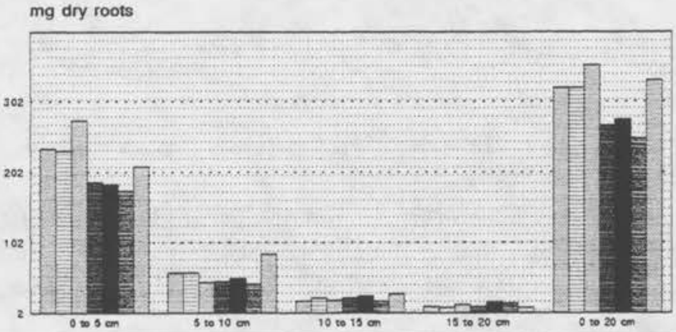
Nitrogen Source
1.00 N/M Rate
Clipping Weights



	5/13	5/20	5/26	6/3	6/11	6/17	6/21	7/2	7/12	7/29	8/6	8/17	9/8
Nutralene ☐	43.6	30.3	18.5	25.2	18.6	8.1	12.3	30.6	27.9	34.7	19.9	23	32.2
SCU ☐	43.6	31.1	17.6	25.2	17.3	6.8	11.6	22	19.7	28.9	20.7	23.4	33.3
Urea ☐	49.9	37.7	22.3	28.7	25.9	6.5	13.9	36.1	34.6	34.4	18.6	20.5	36.2
Nutralene + Urea ■	45.9	39.1	23.4	30.4	24.2	9.1	14.4	35.8	34.6	31.3	18.9	21.1	36.2
SCU + Urea ■	52.1	33.1	19.3	23.7	16.9	7.3	13.2	32.3	30.1	31.8	19.2	20.3	31.1
Coron ▨	60.7	29.7	18.2	23.7	16	6.2	10.4	31.3	28.2	30	17.8	19.2	22.6
CORON + Urea ☐	54.8	30.9	17.5	24.4	18.6	7.1	13	41.4	35.3	30.5	19.7	21.1	29.7

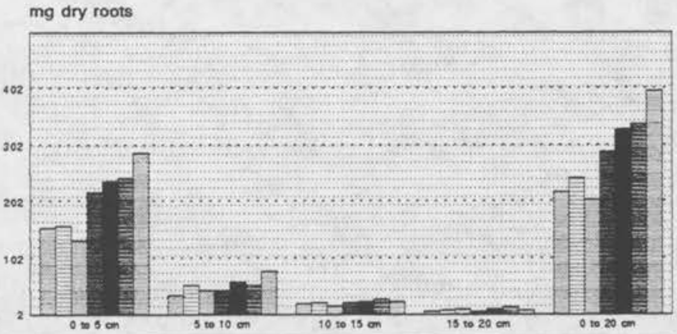
Figure 8.

Nitrogen Source
0.5 N/M Rate
Root Density



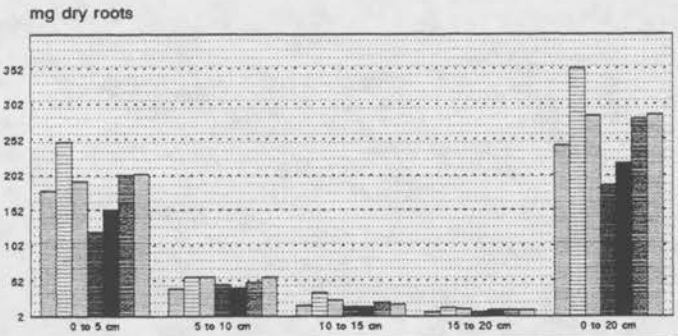
		0 to 5 cm	5 to 10 cm	10 to 15 cm	15 to 20 cm	0 to 20 cm
Nutralene	▢	233.7	56.8	17.2	10.5	320.2
SCU	▢	230.6	58.3	22.4	9	320.3
CORON	▢	275.1	44.5	19.9	12.6	352.1
Urea	■	186.7	46.8	22.5	10.9	266.9
Nutralene + Urea	■	183.4	51.3	25.6	15.6	276
SCU + Urea	▨	173.8	43.3	18.2	14.4	249.7
CORON + Urea	▢	208.4	84.8	28.3	9.1	330.5

Nitrogen Source
0.75 N/M Rate
Root Density



		0 to 5 cm	5 to 10 cm	10 to 15 cm	15 to 20 cm	0 to 20 cm
Nutralene	▢	155	35	20.1	7	217.1
SCU	▢	168.6	63.1	22.4	9.4	241.2
CORON	▢	132.6	44.9	17	10	204.4
Urea	■	217.5	43.9	21.3	7	289.6
Nutralene + Urea	■	235.6	58.7	22.9	11.1	328.4
SCU + Urea	▨	241.2	53.8	27	14.7	336.7
CORON + Urea	▢	286.2	77.9	24.2	9.5	397.8

Nitrogen Source
1.00 N/M Rate
Root Density



		0 to 5 cm	5 to 10 cm	10 to 15 cm	15 to 20 cm	0 to 20 cm
Nutralene	▢	179.2	39.6	16.3	7.4	242.5
SCU	▢	247.4	67	34.2	13.3	361.9
CORON	▢	192.6	56	23.9	12	284.5
Urea	■	120.2	45.4	14.7	6.7	187.1
Nutralene + Urea	■	151.5	41.1	14.6	10.6	217.8
SCU + Urea	▨	200.6	48.5	20.9	10.8	280.7
CORON + Urea	▢	202.8	55.9	17.4	10.6	286.8

UHS Controlled Release Nitrogen Study

M. L. Agnew

The objective of this study was to evaluate two UHS polymer coated ureas in field situations.

This site was located at the Iowa State University Research Station north of Ames, Iowa. The soil type is Nicollet (fine-loamy, mixed, mesic Aquic Hapludoll). The turfgrass is a 9-year-old stand of 'Glade' Kentucky bluegrass. The turf was mowed at 2 inches and irrigated to prevent moisture stress.

The treatments include four nitrogen sources and 2 nitrogen rates.

Trt #	N Source	Total N/Plot	N/Application
1	urea	4	1.33
2	UHS2002	4	1.33
3	UHS2003	4	1.33
4	ureaform	4	1.33
5	urea	3	1.00
6	UHS2002	3	1.00
7	UHS2003	3	1.00
8	ureaform	3	1.00
9	control	0	0.00

Treatments were arranged in a randomized complete block design with 3 replications. Individual treatment plots measured 5 ft x 10 ft.

Plots were rated for quality in May, June, July, August, and September. Visual quality is measured on aa scale of 9 to 1: 9 = lush green turf, 6 = the minimum acceptable level, and 1 = brown turf. Clippings were collected from a 2 ft x 5 ft area in May, June, July, August, and September. Clippings were oven dried, weighed and reported as grams of dried tissue per 10 ft^2.

Visual quality data is listed in Table 42. Nitrogen sources applied at the 1.33 lb N/1000 ft^2 rate continually had better quality ratings. In addition, urea treated plots had better quality rating following application, whereas the UHS experimental products exhibited better quality than urea by 4 weeks after application.

Clipping yield data is listed in Table 43. Nitrogen sources applied at the 1.33 lb N/1000 ft^2 rate produced greater clippings. Urea treated plots produced the greatest amount of total clippings.

Table 42. UHS visual quality data 1993.

Fertilizer Source	Fertilizer Rate	5/28	6/11	6/15	6/25	6/30	7/12	7/23	7/27	8/4	9/4	9/17	Average
Urea	4	8.0	7.7	9.0	7.7	7.7	9.0	8.3	7.3	7.0	8.7	8.3	8.1
UHS 2002	4	7.0	6.7	8.0	8.0	8.3	8.3	8.7	7.7	8.0	8.3	7.7	7.9
UHS 2003	4	7.0	7.3	8.3	8.0	8.7	8.0	8.7	7.3	7.7	8.0	7.3	7.8
Ureaform	4	7.3	7.7	8.0	6.7	7.3	8.0	8.0	7.3	7.0	9.0	6.7	7.5
Urea	3	8.0	7.3	8.3	7.3	7.7	8.0	8.0	6.7	7.0	8.0	7.0	7.6
UHS 2002	3	7.0	7.3	7.7	7.7	8.0	7.7	8.7	7.0	7.7	8.0	6.7	7.6
UHS 2003	3	7.0	7.3	8.7	8.0	8.0	7.7	8.0	7.0	8.0	8.0	6.0	7.6
Ureaform	3	7.0	7.3	8.0	7.3	7.3	7.7	7.3	6.7	7.0	8.3	6.3	7.3
Control	0	6.0	6.3	7.3	6.0	6.7	5.7	6.3	5.7	6.3	6.0	4.3	6.1
$LSD_{(0.05)}$		0.3	0.9	NS	1.1	1.1	0.9	0.8	0.8	0.6	1.3	1.4	0.4

Table 43. UHS clipping yield data 1993.

Fertilizer Source	Fertilizer Rate	5/20	5/26	6/3	6/11	6/15	6/29	7/2	7/12	7/27	8/4	8/13	9/3	9/17	Total
Urea	4	51.9	51.2	63.4	53.5	30.7	28.3	24.8	54.2	36.9	20.4	21.6	106.8	32.6	576.4
UHS 2002	4	46.5	40.5	53.0	44.9	23.2	24.7	24.9	44.3	44.3	24.0	27.0	88.6	29.0	514.9
UHS 2003	4	44.2	40.5	51.6	44.3	24.7	29.1	26.4	46.6	49.3	26.3	29.1	92.6	27.5	532.1
Ureaform	4	46.4	45.4	56.5	45.2	23.0	21.5	22.0	32.7	37.6	16.7	20.2	87.2	26.4	480.9
Urea	3	48.6	45.8	59.1	46.9	25.0	21.5	23.7	40.4	36.8	15.8	17.7	80.0	26.2	487.6
UHS 2002	3	48.2	41.6	53.5	44.3	24.5	24.7	21.9	31.2	36.4	18.5	21.2	86.2	25.7	477.9
UHS 2003	3	44.2	38.8	48.2	41.8	21.8	22.3	22.3	28.1	35.4	20.6	22.0	84.4	24.7	454.5
Ureaform	3	51.5	43.7	53.3	45.0	21.7	19.9	21.0	26.9	28.2	16.6	17.4	81.4	24.0	450.7
Control	0	40.1	31.4	37.8	31.2	16.0	13.9	18.4	6.6	20.9	7.8	11.7	49.4	10.7	295.8
$LSD_{(0.05)}$	0	NS	6.6	6.7	5.6	5.8	4.7	NS	7.3	7.5	3.0	2.8	8.6	3.7	41.3

Scott's Poly-S Study

M. L. Agnew

The objective of this study was to evaluate three formulations of resin-coated nitrogen sources and sulfur-coated urea for the O. M. Scotts Company. The resin-coated fertilizer ratios were 40-0-0, 39-0-0, and 38-0-0. Each were applied at a 2 lb N application rate on May 8 and August 6 and a 1 lb N application rate on May 8, June 29, August 6 and September 15, 1993. A non-fertilized control was added for comparison purpose. The turfgrass was "Envy" perennial ryegrass mowed at 1-inch with all clippings removed. The site was irrigated to prevent moisture stress.

The 1993 growing season began with the site being injured by desication. Plots were removed by mid-June.

Data collected included visual quality and clipping yields. Visual quality is based on a scale of 9 to 1: 9 = dark green turfgrass, 6 = minimum quality, and 1 = straw-colored turf. Clipping yields were obtained at each mowing by collecting all leaf tissue over 2-inch with a 1.75 ft x 10 ft (17.5 ft^2) area. Clippings were dried at 65°F for 48 hours and weights recorded.

Visual quality data is presented in Table 44. Generally, the 2 lb N rate provided superior quality. However, no fertilizer rate had an unacceptable quality. There were no differences between fertilizer source for either the 1 or 2 lb N rates.

Clipping yield data is presented in Table 45. Applying fertilizers at a 2 lb N rate substantially increased the amount of clippings that were produced. This was most evident just after the May and August application dates. The 40-0-0 produced the greatest amount of clippings for the 2 lb N rate, while 38-0-0 produced the greatest amount of clippings for the 1 lb N rate.

Table 44. The effects of fertilizer on visual quality.

Fertilizer		May		June				July			August		September			October	
Source	Rate	20	27	11	17	23	29	6	12	23	4	11	10	17	29	22	Means
40-0-0	1	5.0	4.7	6.7	5.7	3.3	4.0	7.3	6.3	6.0	5.3	6.7	7.0	6.3	8.0	7.7	6.0
40-0-0	2	4.0	4.3	7.7	7.3	5.3	4.7	6.0	5.3	5.3	5.3	6.3	8.3	8.3	9.0	8.7	6.4
39-0-0	1	4.7	4.0	6.0	5.7	3.3	4.7	7.0	5.7	5.7	6.3	6.3	7.3	6.7	8.3	7.7	6.0
39-0-0	2	4.3	4.0	7.0	7.0	5.7	4.7	6.7	6.7	6.3	6.7	6.7	8.0	7.7	9.0	8.7	6.6
38-0-0	1	4.7	4.0	5.7	5.3	3.3	3.7	7.0	6.3	6.7	7.0	7.7	7.7	7.0	8.7	8.0	6.2
38-0-0	2	4.0	3.7	6.3	6.3	4.7	4.7	6.7	6.0	6.0	6.7	7.3	7.7	8.0	9.0	8.7	6.4
SCU	1	4.7	4.3	6.0	6.0	4.0	5.0	8.0	7.3	6.7	6.3	6.3	8.0	7.3	9.0	8.3	6.5
SCU	2	4.3	4.7	6.7	7.0	5.0	5.0	6.7	5.0	4.7	5.7	6.0	6.7	8.0	9.0	8.3	6.3
Control	--	2.0	3.0	4.0	4.0	1.0	2.0	5.0	3.0	3.0	3.0	4.7	6.0	5.0	5.3	5.7	3.8
LSD $_{(0.05)}$		NS	NS	0.8	0.8	0.9	1.0	0.8	1.2	1.2	1.3	1.0	1.2	1.2	1.0	1.0	0.4

Table 45. The effects of fertilizer source and application rate on clipping production.

Fertilizer Source	Rate	June					July		August		September		October	Clipping Yield Total
		5	9	15	22	30	7	26	4	13	10	17	27	
40-0-0	1	16.7	8.7	15.5	3.3	1.4	17.0	17.6	7.0	11.3	12.4	2.9	9.0	122.9
40-0-0	2	31.2	20.4	19.8	6.6	2.7	13.6	15.8	6.7	12.2	29.9	10.2	24.0	193.1
39-0-0	1	15.0	8.6	14.7	2.9	1.9	16.8	18.6	8.7	13.7	13.3	3.7	13.3	131.1
39-0-0	2	23.1	13.7	15.6	5.0	2.8	13.2	16.9	8.0	12.0	21.1	6.6	21.6	159.5
38-0-0	1	17.9	10.7	17.2	4.2	2.1	16.9	23.0	11.4	19.0	17.1	4.3	14.1	157.8
38-0-0	2	18.9	13.6	17.3	5.9	2.9	16.1	21.4	10.1	16.1	22.7	6.8	18.8	170.6
SCU	1	12.1	7.1	12.2	2.4	2.5	21.0	16.9	6.8	13.6	19.3	7.5	17.6	139.1
SCU	2	15.3	9.6	15.2	4.9	1.5	10.9	13.9	8.2	13.6	26.3	10.1	21.0	150.6
Control	--	4.0	2.3	10.3	1.4	0.8	6.1	8.6	5.0	8.8	5.3	1.1	1.8	55.2
LSD $_{(0.05)}$		5.4	4.9	3.9	2.4	NS	4.5	5.5	4.1	4.6	9.5	4.7	7.5	36.1

Plant Response to Nitrogen Source

M. L. Agnew

The objective of this study is evaluate the effects of eight different nitrogen sources on Kentucky bluegrass growth.

Treatments included 2 natural organic nitrogen sources, six synthetic nitrogen sources, and a non-fertilized control. Nitrogen sources includes: Coron (28-0-0), Nutralene (40-0-0), Sulfur-Coated Urea (37-0-0), Urea (46-0-0), Ureaform (38-0-0), N-Sure (28-0-0), Ringer's Lawn Restore (10-2-6), and Corn Gluten Meal (10-0-0). Applications at 1 lb N were made on May 10, June 4, August 15, and September 15, 1993. Treatments were made on 'Glade' Kentucky bluegrass. This was the third and final year of this research project.

Plots were rated for quality in May, June, July, August, September and October. Visual quality is measured on a scale of 9 to 1: 9 = dark green turf, 6 = minimum acceptable level 1 = straw-colored turf. Clippings were collected from a 2 ft x 10 ft area in June, July, August, and September. Clippings were oven dried, weighed and reported as grams of dried tissue per 20 ft^2.

Nutralene, Sulfur-Coated Urea, and Urea had the best overall quality, while there was very little difference in quality of the other treatments (Table 46). This is not surprising, since the plots received 60+ inches of rainfall in 1993.

Sulfur-Coated Urea and Urea produced the greatest amount of clippings. Ureaform, Coron, and N-Sure produced significantly less clippings while maintaining an acceptable quality level (Table 47).

Roots were collected in April and November. Coron and Ureaform had the greatest amount of roots following a winter that exhibited much winter injury in Iowa (Table 48). There was no difference in root growth following the extremely wet summer (Table 49).

Table 46. The effects of fertilizer source on the visual quality of Kentucky bluegrass in 1993.

Fertilizer Source	May		June			July			Aug	September			Oct	Mean
	20	28	11	15	25	12	23	27	4	3	15	24	22	
Coron (28-0-0)	6	7	7	8	7	6	7	7	7	8	8	8	9	7
Nutralene (40-0-0)	6	7	7	8	7	7	8	7	8	8	8	8	9	8
Sulfur Coated Urea (37-0-0)	7	8	8	8	7	8	8	7	8	8	7	8	8	8
Urea (46-0-0)	6	8	8	9	8	8	8	7	7	8	8	8	9	8
Ringer Lawn Restore (10-2-6)	6	7	7	8	5	7	7	6	8	7	7	8	7	7
Ureaform (38-0-0)	6	7	7	8	7	6	7	7	8	7	6	7	8	7
N-Sure (28-0-0)	6	6	7	7	6	6	7	7	7	8	7	8	8	7
Corn Gluten Meal (10-0-0)	6	8	8	8	6	7	8	7	7	7	8	8	8	7
Control	4	3	5	6	3	4	5	6	5	6	5	5	6	5
LSD$_{(0.05)}$	1.0	0.8	0.8	0.9	0.6	0.8	0.5	0.9	0.7	0.7	1.0	1.0	0.9	0.2

Quality is based on a scale of 1 to 9: 1 = straw-brown turf, 6 = minimum acceptable quality, and 9 = dark green, dense turfgrass stand.

Table 47. The effects of fertilizer source on clipping production of Kentucky bluegrass in 1993.

Fertilizer Source	May			June				July			August		September			Mean
	13	20	26	3	11	17	21	2	12	27	4	13	3	15	24	
Coron (28-0-0)	22.3	16.1	14.9	19.2	9.6	15.1	13.7	33.3	36.2	5.7	16.2	9.3	32.9	37.5	8.0	290.0
Nutralene (40-0-0)	26.7	18.7	18.3	22.8	12.3	17.6	17.5	35.8	43.8	7.2	20.0	13.6	35.8	33.7	7.7	331.8
Sulfur Coated Urea (37-0-0)	43.3	28.2	24.3	30.4	17.7	23.0	22.0	45.2	52.1	7.8	21.4	13.7	34.7	38.6	10.0	411.8
Urea (46-0-0)	33.2	25.6	25.1	29.0	17.5	21.4	18.8	43.8	49.4	8.4	19.0	11.1	33.5	36.9	8.9	381.7
Ringer Lawn Restore (10-2-6)	18.5	14.7	16.7	20.9	13.0	19.2	16.2	27.4	44.9	7.6	21.6	12.4	30.1	31.9	6.7	302.0
Ureaform (38-0-0)	22.7	15.5	16.4	18.3	12.6	16.8	15.8	26.6	28.0	7.1	17.9	10.9	26.9	27.8	6.4	268.6
N-Sure (28-0-0)	21.3	17.3	14.6	17.5	9.3	14.8	15.2	32.2	38.0	6.9	18.0	10.4	36.3	35.5	6.4	293.6
Corn Gluten Meal (10-0-0)	17.6	17.1	19.2	26.0	14.7	22.1	16.9	27.0	46.6	9.4	22.5	11.1	22.4	28.3	7.8	308.7
Control	3.5	3.5	4.8	5.5	2.6	5.5	4.2	5.5	5.9	1.5	6.0	3.3	8.1	8.3	0.7	69.1
LSD$_{(0.05)}$	6.5	5.0	3.5	4.6	5.0	3.4	4.0	6.4	7.5	3.1	3.6	3.4	6.7	5.5	3.0	43.6

Clipping weights are reported as grams dry weight/17.5 ft^2.

Table 48. The effects of nitrogen source on dry root weight (mg/150 cm^3) -- April, 1993.

	Soil Depth (cm)				
Fertilizer Source	0-5	5-10	10-15	15-20	Total
Coron 28-0-0 (liquid)	246.8	54.4	18.0	5.4	324.6
Nutralene 40-0-0 (granular)	88.5	37.7	10.2	5.9	142.3
Sulfur Coated Urea 37-0-0 (granular)	132.9	38.3	9.2	2.7	183.1
Urea 46-0-0 (granular)	170.3	31.9	10.1	4.7	217.0
Ringer Lawn Restore 10-2-6 (granular)	147.9	30.9	7.8	2.4	189.0
Ureaform 38-0-0 (granular)	235.6	53.2	20.6	11.5	320.9
N-Sure 28-0-0 (liquid)	134.7	24.4	8.5	22.0	189.6
Corn Gluten Meal (10-0-0) (granular)	125.7	38.9	52.9	2.8	220.3
Control	110.8	39.4	6.6	6.3	163.1
$LSD_{(0.05)}$	NS*	NS	NS	NS	NS*

*Significant at a 0.1 level.

Table 49. The effects of nitrogen source on dry root weight (mg/150 cm^3) -- November, 1993.

	Soil Depth (cm)				
Fertilizer Source	0-5	5-10	10-15	15-20	Total
Coron 28-0-0 (liquid)	175.0	45.8	13.1	5.0	238.9
Nutralene 40-0-0 (granular)	220.9	33.6	10.1	3.5	268.1
Sulfur Coated Urea 37-0-0 (granular)	181.1	34.8	7.0	5.7	228.6
Urea 46-0-0 (granular)	272.2	34.9	9.5	4.7	321.3
Ringer Lawn Restore 10-2-6 (granular)	240.6	37.3	9.7	3.4	291.1
Ureaform 38-0-0 (granular)	253.2	44.0	10.4	5.2	312.9
N-Sure 28-0-0 (liquid)	237.1	31.1	13.3	6.5	287.9
Corn Gluten Meal (10-0-0) (granular)	320.5	42.4	8.7	6.7	378.4
Control	246.8	54.6	17.1	5.7	324.2
$LSD_{(0.05)}$	NS*	NS	NS	NS	NS*

*Significant at a 0.1 level.

The Effects of Soil Compaction on Soil Physical Properties and Plant Growth of Five Cultivars of Tall Fescue

D. L. Anderson and M. L. Agnew

The selection of a turfgrass species for use in an athletic facility is based upon tolerance of traffic, cold temperature stress, and irrigation requirements. Due to its tolerance of drought and wear stresses, tall fescue makes an excellent turf for low maintenance athletic fields in southern Iowa. In a comparison study, tall fescue was found to have a higher wear tolerance than Kentucky bluegrass (KBG) and perennial ryegrass (PR), but its tolerance of compaction was inferior to both Kentucky bluegrass and perennial rye. This study used improved turf-type cultivars of both KBG and PR while using K 31 tall fescue, a grass which is more like a forage type fescue.

The objective of this study was to compare the compaction tolerances of four improved, turf type cultivars of tall fescue with that of K 31.

On May 3, 1992, the cultivars K 31, Crossfire, Twilight, Rebel II, and Rebel Jr. were seeded at the Iowa State University Research Station north of Ames, Iowa, at a rate of 6 lbs/1000 ft^2. Three replicated plots of each cultivar, measuring 20 ft x 15 ft, were created in a randomized block design. Each plot was divided into six treatment plots measuring 10 ft x 2 ft, three of which were compacted in the fall of 1992 and three in the summer of 1993 using a smooth power roller. Three levels of compaction were applied: 0X, 10X, and 20X, where 1X equals 1 pass with the roller at 0.193 MPa. Fall treatments were applied once per week over a 4 week period beginning August 31. The summer compaction treatments were applied as 0X, 20X, and 40X on June 23 and 30, and 0X, 10X, and 20X on August 12. The site was irrigated with an inch of water 24 hours prior to treatments to achieve maximum soil compaction.

The plots were irrigated using athletic field type sprinkler heads at a rate of 1-inch per week to prevent moisture stress. Fertilization was applied at a rate of 1 lb N/1000 ft^2 in May, August, and September. The grass was maintained at a mowing height of 2 inches. Herbicides were applied as needed to control weeds.

The data collected included rooting density, dried clipping weight, visual quality, bulk density and water retention. Visual quality was based on a scale from 9 to 1: 9 = thick, dark green turf, 6 = minimum acceptable level, and 1 = dead turf.

The cultivars did not differ in their response to compaction (Tables 50-53). All of the cultivars reacted to increasing soil compaction with a reduction in visual quality, clipping weights, and rooting density. Differences were observed between the cultivars. Regardless of the compaction treatments, Rebel Jr. consistently performed the best visually, followed by Crossfire, Twilight, and Rebel II. K 31 performed poorly, never surpassing the acceptable quality rating of 6.

Differences were also observed in the soil physical properties between the fall and summer compaction treatments. Compaction in the fall of 1992 resulted in an increased bulk density from a control of 1.31 to 1.41 under 10X, and 1.42 under 20X treatments. Aeration porosities were reduced due to increased soil compaction. The summer treatments resulted in no significant difference between the bulk densities or the aeration porosities of the three treatments. This is believed to be due to the excessive rainfall received last year saturating the soil, preventing any soil compaction from taking place.

Table 50. 1992 Fall Compaction Rooting Data By Depth (cm)

	1992 Rooting Data By Depth (cm)				
Cultivar	0 - 5	5 - 10	10 - 15	15 - 20	Total
K 31	285.4	81.4	44.0	31.0	441.8
Crossfire	393.3	73.7	41.9	35.7	544.5
Twilight	301.9	57.7	35.6	25.0	420.3
Rebel II	306.0	48.6	40.7	31.4	456.7
Rebel Jr	303.3	88.7	47.3	26.4	465.6
Treatment	0 - 5	5 - 10	10 - 15	15 - 20	Total
10 Pass	316.9	84.2	41.3	32.6	475.1
10 Pass	293.3	67.1	42.7	30.1	433.2
20 Pass	343.7	76.8	41.6	27.1	489.2
$LSD_{(0.05)}$ cv	7.6	1.8	NS	NS	NS
$LSD_{(0.05)}$ comp	NS	1.4	NS	NS	NS

Table 51. Summer Compaction 1993 Clipping Weights (g)

	1993 Clipping Weights (g)						
Cultivar	7/6	7/20	7/29	8/19	9/1	10/5	Mean
K 31	14.2	39.2	40.6	21.8	32.5	36.6	30.8
Crossfire	3.6	14.6	28.5	16.3	22.9	20.1	17.7
Twilight	3.7	13.6	29.1	15.7	24.7	22.3	18.2
Rebel II	4.6	16.2	31.6	18.4	28.0	32.9	22.0
Rebel Jr	2.6	8.9	22.0	14.7	21.4	20.2	15.0
Treatment	7/6	7/20	7/29	8/19	9/1	10/5	Mean
0 Pass	8.2	23.2	34.1	26.4	34.3	32.4	26.4
10 Pass	4.8	17.0	29.2	14.1	22.8	25.0	18.8
20 Pass	4.2	15.3	17.7	11.7	20.7	21.9	16.9
$LSD_{(0.05)}$ cv	1.1	3.9	4.7	3.2	6.4	9.3	4.4
$LSD_{(0.05)}$ comp	0.8	3.1	3.6	2.4	5.0	7.2	3.4

Table 52. 1993 Summer compaction visual quality ratings.

	1993 Visual Quality Ratings							
Cultivar	6/30	7/6	7/12	7/23	7/28	8/19	8/27	Mean
K 31	5.0	5.0	5.9	6.0	6.0	5.6	5.6	5.6
Crossfire	5.6	5.3	6.4	7.1	7.8	6.7	6.7	6.5
Twilight	5.7	5.6	6.3	7.4	7.9	6.2	6.4	6.5
Rebel II	5.6	5.2	6.2	6.6	7.9	6.7	6.6	6.4
Rebel Jr	6.2	6.0	6.4	7.6	8.0	7.4	7.3	7.0
Treatment	6/30	7/6	7/12	7/23	7/28	8/19	8/27	Mean
0 Pass	7.2	6.9	7.5	6.8	7.4	7.5	7.0	7.2
10 Pass	5.3	5.1	6.0	6.9	7.5	6.2	6.3	6.2
20 Pass	4.3	4.3	5.3	7.1	7.6	5.9	6.2	5.8
$LSD_{(0.05)}$ cv	0.4	0.4	NS	0.5	0.3	0.4	0.6	0.2
$LSD_{(0.05)}$ comp	0.3	0.3	0.4	NS	NS	0.3	0.5	0.2

Quality based on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and 1 = poorest quality

Table 53. 1993 Summer Compaction Rooting Data by Depth (cm)

	1993 Rooting Data by Depth (cm)				
Cultivar	0 - 5	5 - 10	10 - 15	15 - 20	Total
K 31	194.2	61.5	33.6	17.9	307.3
Crossfire	164.1	57.2	32.4	20.5	274.1
Twilight	139.5	44.8	21.5	14.5	220.4
Rebel II	128.7	48.1	30.1	22.8	232.7
Rebel Jr	165.4	59.4	27.9	25.4	278.1
Treatment	0 - 5	5 - 10	10 - 15	15-20	Total
0 Pass	134.8	48.8	27.0	19.9	232.5
10 Pass	161.8	59.7	29.0	18.7	269.2
20 Pass	178.5	54.2	31.2	22.0	285.9
$LSD_{(0.05)}$ cv	NS	NS	NS	7.0	NS
$LSD_{(0.05)}$ comp	NS	NS	NS	NS	NS

Environmental Research

Fate of Nitrogen, Phosphorus, Pendimethalin, Chlorpyrifos, Isazofos, Metalaxyl, Dicamba, 2,4-D, and MCPP Applied to Turfgrass Maintained in Golf Course Fairway Condition

S. K. Starrett, N. E. Christians, and T. A. Austin

Current public concern for the environment has focused attention on the environmental effects of chemical applications to turfgrass areas. Little research has been done concerning the environmental effects of N, P, and pesticides applied to turfgrasses. The objectives of this study were: 1) to investigate the hydrology of undisturbed soil columns with a Kentucky bluegrass turfgrass and intact macropores under a heavy and light irrigation regime and, 2) to measure the fate of N (using ^{15}N as a tracer), P, and 7 turf type pesticides. Dicamba, 2,4-D, and MCPP data is still being analyzed. Preliminary results are: macropores transport surface-applied N through soil profiles; a heavy irrigation increases N, pendimethalin, chlorpyrifos, isazofos, and metalaxyl transport compared with light irrigation; volatilization of liquid urea is negligible when followed with irrigation; and irrigation rate does not affect P transport after a 4-week period. N losses can be reduced by irrigation management procedures. By applying light, more-frequent irrigations instead of heavy, less-frequent irrigations for several weeks after N application, N leaching is reduced.

Golf courses can be managed in such a way that even phosphorus, which is known to be fairly immobile, can be moved through a 20-inch soil profile and potentially into the ground water. However, there are management practices that the superintendent has control of that can greatly affect the potential for movement of fertilizers. These practices include rate of application, timing (just before a heavy rainfall is not recommended), and particularly irrigation practices. In our study, 1-inch irrigations vs. 0.25 inch irrigations, after a surface application of nitrogen, increased the amount of nitrogen that leached 20 inches into the soil profile by 40 times.

The fate of these pesticides were also studied under field conditions. Iowa State University and the University of Nebraska-Lincoln conducted identical experiments over the summers of 1991 and 1992. Preliminary results are that while the verdure (the tissue between the soil surface and the mowing height) contained high concentrations of the pesticides immediately after application, irrigation, rainfall and clipping reduced the amount of pesticide recovered from the plant material with time. The thatch layer was highly retentive of the pesticide residues. Dicamba, 2,4-D, and MCPP were most mobile, followed by metalaxyl and isazofos. Chlorpyrifos and pendimethalin were the least mobile. Pendimethalin, chlorpyrifos, isazofos, and metalaxyl appeared to degrade more rapidly in the turfgrass environment than typically reported for other agronomic crop systems.

Herbicidal Activity of Hydrolysed Corn Gluten Meal on Three Grass Species under Controlled Environments

D. L. Liu, N. E. Christians, and J. T. Garbutt

Synthetic organic pesticides have become a major component of agricultural, forestry, and turfgrass management systems. Environmental and human health problems associated with pesticides have been documented. Public awareness and concern for environmental protection and human safety has led to the search for naturally occurring compounds that are able to inhibit growth and development of weed plants. Commonly-assigned U.S. Patent 5,030,268 disclosed that corn gluten meal can be used as a natural preemergence herbicide, however, it is quite insoluble in water and this characteristic renders it hard to apply as a herbicide. The herbicidal activity of 17 samples derived from corn gluten meal and other crop materials were evaluated using 3 different grass species under controlled environments. Based on the results from greenhouse and growth chamber bioassays, it was found that samples of enzymatically hydrolyzed corn gluten meal were more herbicidally active than the corn gluten itself and were highly water-soluble. Corn gluten hydrolysate derived from the action of bacterial proteinase had the highest inhibitory activity. This water soluble material derived from corn gluten meal had a growth-regulating effect on the root system, therefore it can potentially be used as a natural herbicide. A patent entitled "Preemergence Weed Control Using Plant Protein Hydrolysate" was applied for on July 28, 1993, a notice of allowance was granted on September 28, 1993, and a patent number of 5,290,749 was issued on March 1, 1994 by U.S. Patent and Trademark Office.

Isolation and Identification of Root-Inhibiting Compounds from Corn Gluten Hydrolysate

D. L. Liu and N. E. Christians

Since pesticides are toxic or biologically active by design, there is a concern regarding their effects on human health and environmental quality. Interest has centered on the use of plant derived compounds as natural herbicides and they are considered to represent an environmentally sound approach to weed control. Corn gluten hydrolysate found to have a growth-regulating effect on the root system of germinating grass seeds has been suggested to be used as a natural herbicide. If the bioactive compounds in corn gluten hydrolysate can be isolated and identified, they could be used as natural herbicide to serve as a starting point for chemical synthesis of biodegradable herbicides. The objective of this study was to develop a protocol to extract, isolate, and identify the root-inhibiting compounds from corn gluten hydrolysate. An aqueous solution of corn gluten hydrolysate was used for isolation of root-inhibiting compounds from *Zea mays* L. and a perennial ryegrass bioassay was developed to test the root-inhibiting activity. Five bioactive dipeptides were isolated by using Sephadex G-15 gel filtration, solid phase extraction, and C18 reversed-phase high performance liquid chromatography procedures. The five dipeptides were glutaminyl-glutamine, alaninyl-asparagine, alaninyl-glutamine, glycinyl-alanine, and alaninyl-alanine. Their root-inhibiting activity on perennial ryegrass was demonstrated in petri dish bioassays. They could be used as a substitute for synthetic chemical herbicides or as a supplement to synthetic herbicides to reduce the concentration of these pesticides in the environment. A patent entitled "Preemergence Weed Control Using Peptides Isolated from Corn Gluten Hydrolysate" was applied for on July 28, 1993, a notice of allowance was granted on October 1, 1993, and a patent number of 5,290,757 was issued on March 1, 1994 by U.S. Patent and Trademark Office.

Evaluation of Corn Gluten Meal as a Natural Weed Control Product Under Greenhouse Conditions

B. R. Bingaman and N. E. Christians

Recent research has shown that the protein fraction of corn grain extracted in the wet-milling process, corn gluten meal, can be effective in controlling several monocotyledonous and dicotyledonous weed species and has the potential for use as a natural product herbicide in both turfgrass (Christians, 1993) and strawberry ecosystems (Nonnecke and Christians, 1993). Root formation during germination is inhibited by corn gluten meal in susceptible species. When the affected plants are then submitted to moisture stress, mortality results because of the poorly developed root systems (Christians, 1993). In addition, corn gluten meal is approximately 10% nitrogen by weight and provides an additional nitrogen source to plant species with well developed root systems. United States Patent Number 5,030,268 has been granted for the use of corn gluten meal as a surface applied preemergence herbicide.

Twenty-two plant species were screened for susceptibility to corn gluten meal under greenhouse conditions. Ten dicotyledonous species were used: velvetleaf (*Abutilon theophrasti* Medic.), redroot pigweed (*Amaranthus retroflexus* L.), lambsquarters (*Chenopodium album* L.), catchweed bedstraw (*Galium aparine* L.), black medic (*Medicago lupulina* L.), buckhorn plantain (*Plantago lanceolata* L.), purslane (*Portulaca oleracea* L.), curly dock (*Rumex crispus* L.), black nightshade (*Solanum nigrum* L.), and dandelion (*Taraxacum officinale* Weber). Eleven monocotyledonous species were screened: quackgrass (*Agropyron repens* (L.) Beauv.), orchardgrass (*Dactylis glomerta* L.), smooth crabgrass (*Digitaria ischaemum* (Schreb.) Schreb. ex Muhl), large crabgrass (*Digitaria sanguinalis* (L.) Scop.), barnyardgrass (*Echinochloa crus-galli* (L.) Beauv.), woolly cupgrass (*Eriochloa villosa* (Thunb.) Kunth), annual bluegrass (*Poa annua* L.), giant foxtail (*Setaria faberi* Herrm.), yellow foxtail (*Setaria lutescens* (Weigel) Hubb.), green foxtail (*Setaria viridis* (L.) Beauv.), shattercane (*Sorghum bicolor* L.), and creeping bentgrass (*Agrostis palustris* Huds.).

Corn gluten meal was applied at 0.0, 30.2, 60.4, and 90.5 g ft^{-2}. The treatments were applied to the soil surface for the preemergence (PRE) treatments and were mixed with the top 2.5 cm of soil for the preplant incorporated (PPI) treatments.

Treatment with corn gluten meal reduced the survival rates of all broadleaf and grass species tested (Table 54). The results of these greenhouse screenings substantiate the preliminary observations from previous studies that the efficacy of corn gluten meal may extend to a broad spectrum of monocotyledonous and dicotyledonous plant species (Christians, 1993). All tested broadleaf and grass species exhibited some degree of susceptibility to the herbicidal properties of corn gluten meal.

More field trials are necessary to confirm the efficacy of corn gluten meal for specific problem weed species. Additional work is being conducted to determine the optimum treatment levels and application methods necessary to provide satisfactory weed control in different management systems.

Table 54. Reductions in the Survival of Plants Treated with Three Levels of Corn Gluten Meal[a]

	% Reduction in Plant Survival[b]		
Plant Species	30.2 g ft^{-2}	60.4 g ft^{-2}	90.5 g ft^{-2}
annual bluegrass	60	81	72
barnyardgrass	31	35	41
black medic	49	63	63
black nightshade	78	99	100
buckhorn plantain	80	95	96
catchweed bedstraw	66	33	94
common lambsquarters	82	88	99
creeping bentgrass	85	85	96
curly dock	75	94	97
dandelion	42	90	100
giant foxtail	63	54	83
green foxtail	37	78	100
large crabgrass	51	70	82
orchardgrass	56	53	92
purslane	97	95	100
quackgrass	0	20	71
redroot pigweed	87	96	99
shattercane	42	43	51
smooth crabgrass	51	85	97
velvetleaf	0	18	35
woolly cupgrass	6	29	79
yellow foxtail	43	65	78

[a] $LSD_{(0.05)}$ = 40 for mean comparisons among corn gluten meal treatment levels for each species.

[b] These data are mean percentages of the plant survival reductions as compared with the survival of the control plants. These reductions are the means for surface applied (PRE) and preplant incorporated (PPI) treatments (n=12 for each treatment).

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A Study on the Effects of Corn Gluten Meal and Corn Gluten Hydrolysate on the Establishment of <u>Agrostis</u> <u>Palustris</u>

J. A. Livingston and N. E. Christians

The purpose of this study was to test the inhibitory effects of different rates of corn gluten meal and gluten hydrolysate on the seed germination of creeping bentgrass (<u>Agrostis</u> <u>palustris</u>).

"Corn gluten meal is a 60% corn protein material that is produced in the wet-milling process." It contains about 10% nitrogen (N) by weight and has been used as a feed material for many different animals. Although normally produced as a powder, corn gluten meal can be made in pellet form for easy application. Corn gluten meal is not very water soluble (Table 55).

Research by Dr. Nick Christians led to the eventual patent of corn gluten meal as a preemergence weed control in 1991. The corn gluten meal was found to inhibit root formation of germinating seed, which is detrimental to the plant when water is withheld from it. Further research has shown that when used on established turf, corn gluten meal is an excellent natural fertilizer (Table 55).

Gluten hydrolysate, a water soluble extract of corn gluten meal, also has comparable preemergence control capabilities to corn gluten meal. One advantage of gluten hydrolysate is that it can be used as a liquid spray. A patent was also issued in 1993 for the use of the hydrolysate as a natural herbicide (Table 6).

The objective of this experiment was to do a comparison of corn gluten meal and gluten hydrolysate. The study will help to determine which rates of material provide the most effective inhibition of germinating seed.

The experiment was started on March 10, 1994. Eighty-four 3x3 in^2 pots were filled with sifted soil from the greenhouse. The creeping bentgrass was applied to the pots at a rate of 5g/10,000 cm^2 (0.029 g/pot). After the seed was applied, seven rates of corn gluten meal and gluten hydrolysate were added to the pots. The materials were applied at the following rates: 0, 0.2, 0.5, 2.0, 6.0, 8.0, 10.0 g/dm^2, (0, 0.12, 0.29, 1.16, 3.48, 4.65, and 5.81 g/pot). Each treatment was replicated three times.

Two watering methods were used in the experiment. Twenty-one pots with each of the seven corn gluten meal treatments were placed on a greenhouse mist bench, while the other twenty-one corn gluten meal treated pots were wetted and then wrapped in parafilm. The same was done to the hydrolysate treatments.

After the seeds started to germinate, the pots on the mist bench were moved to a greenhouse bench where they were watered every two to three days. The parafilm covered pots were opened at night to prevent mold from growing and covered again during the day to prevent drying.

Six days after the beginning of the experiment, all pots were surface watered using a watering can. The next day the parafilm treatments were placed in a plastic flat which was half filled with water. The parafilm treatments were removed from the flat two days later. For the remainder of the experiment, all pots were kept quite dry and were watered lightly only when needed. Photographs and visual data were taken towards the end of the experiment.

Visual data showing percentage (%) cover of the treated pots compared to the control was taken after twenty and twenty-six days respectively. After twenty days, the surface watered hydrolysate treatments showed the greatest amount of inhibition on the creeping bentgrass. The surface watered corn gluten meal treatments had the least effect on the germinating seed. Subsurface watering had greater inhibition on the corn gluten meal treated pots; however, surface watering provided greater inhibition on the hydrolysate treated pots. The hydrolysate treatments showed the most overall control on the germinating creeping bentgrass. The data after twenty-six days also gave results similar to the twenty day data. The visual data for both dates is summarized in Tables 55 and 56.

A very wide range of rates was used in this experiment. No seed germination occurred at rates equal to or greater than 6.0 g/dm^2. Therefore, more experimentation will be conducted to determine the amount of inhibition that can be expected at lower rates of application. New experiments will be conducted with the same procedure with a smaller range of rates.

Table 55. Percentage of cover (%) 20 days.

	Corn Gluten Meal		Hydrolysate	
Treatment g/dm^2	Surface Watered	Subsurface Watered	Surface Watered	Subsurface Watered
Control	100	100	100	100
0.2	95	78	32	92
0.5	37	72	5	25
2.0	5	2	0.3	0.3
6.0	0	0	0	0
8.0	0	0	0	0
10.0	0	0	0	0
LSD$_{(0.05)}$	3.8	3.2	2.0	1.9

Table 56. Percentage of cover (%) 26 days.

	Corn Gluten Meal		Hydrolysate	
Treatment g/dm^2	Surface Watered	Subsurface Watered	Surface Watered	Subsurface Watered
Control	100	100	100	100
0.2	90	55	28	98
0.5	60	45	0.7	22
2.0	5.0	0.3	0.3	0
6.0	0	0	0	0
8.0	0	0	0	0
10.0	0	0	0	0
LSD$_{(0.05)}$	11.5	6.6	1.9	1.9

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Innovative Production Techniques for Shade and Ornamental Trees

J. K. Iles

Introduction

Producing landscape plants in containers has become a permanent and important part of the nursery industry. In some parts of the country, container culture has replaced field culture as the primary method of production. Still, production costs for container-grown ornamentals can be quite high prompting nursery managers to grow only plants that perform reliably in containers and reach marketable size quickly. Since the early 1980's, several **in-ground** container production systems have been developed to overcome three serious problems associated with traditional container-growing methods: root circling in the container; plant stability; and low-temperature injury to roots.

Trees produced using in-ground containers will not blow over, can be overwintered in place, are protected from harmful high root zone temperatures during the summer, require less water than above-ground culture, and are far easier to transplant than traditional field-grown stock.

Pot-in-pot - The innovative pot-in-pot system involves sinking an outer sleeve pot into the ground, and inserting a second pot, the actual production pot that is harvested with the tree, inside the sleeve pot. The production container often has vertical basal ribs, or may be copper-treated to reduce root circling.

In-ground plastic containers - In the past, trees could not be grown in-ground using single plastic containers because of drainage problems. Recently, a rigid plastic container has been developed which has rows of small holes around the container sides and throughout the container base. The many perforations should help moisture drain from the container and reduce the potential for circling roots, however, no comparative tests have yet been conducted.

In-ground container culture will help reduce root zone temperature and moisture extremes, but will the improved container/media environment result in accelerated growth for nursery stock? **Treeshelters** (cylindrical polypropylene tubes) have been broadly used in Great Britain to reduce costs of establishing small forest and landscape trees. Treeshelters protect young trees against herbicidal drift and animal browsing, but their most noteworthy benefit is the 60 to 600% increase in plant growth that results from their use. Elevated temperature, humidity, and/or carbon dioxide concentration within treeshelters have all been suggested as probable causes for the increased growth. But the advantages of using treeshelters in container culture has not been fully explored.

Therefore we have initiated a study to: (1) determine how several tree species would respond to being grown in in-ground plastic containers with and without treeshelters, and (2) compare their growth with growth and survival of trees grown using traditional field production techniques.

Materials and Methods

In spring 1994, seedlings (18-24 inch) of five tree species (Table 57) were obtained from Lawyer Nursery, Inc. (Plains, Mont.) and randomly assigned to six nursery production treatments (Table 58). A randomized complete block design was used. Plant height was measured at the beginning of the experiment, and will be measured again at the end of the first year (Sept. 1994) and at the end of the second year (Sept. 1995) of the study. Temperature, relative humidity, and carbon dioxide concentration will be measured inside and outside treeshelters twice during each year of the study. At the completion of the experiment, fresh and dry weights of shoots and roots will be obtained.

Table 57. Tree species used to evaluate in-ground container/treeshelter production systems.

Acer buergeranum - Trident maple
Cercidiphyllum japonicum - Katsuratree
Corylus colurna - Turkish filbert
Maackia amurensis - Amur maackia
Sorbus alnifolia - Korean mountainash

Table 58. Tree production treatments.

Control - Field-grown/no treeshelter.
Treatment 1 - Field-grown/with treeshelter.
Treatment 2 - In-ground single container.
Treatment 3 - In-ground single container/with treeshelter.
Treatment 4 - In-ground pot-in-pot.
Treatment 5 - In-ground pot-in-pot/with treeshelter.

Determination of the Site of Action of a Root Inhibiting Compound Derived from Corn Gluten Meal

J.B. Unruh and N.E. Christians

In 1985, it was observed that unprocessed corn meal applied at large quantities to soil areas had an inhibitory effect on the establishment of germinating plants. Further studies showed that the protein fraction of corn grain, corn gluten meal, had higher levels of the inhibitor. The work of D. L. Liu and N. E. Christians, Iowa State University, subsequently led to the isolation and identification of five root inhibitory compounds contained in the water soluble protein extract from corn gluten meal.

In an effort to better understand the efficacy of these root inhibiting compounds for weed control purposes, investigations are currently underway to determine the site of action of these root inhibiting compounds.

Microscopic studies focusing on cellular activity of treated and untreated plants are currently being done. These studies are revealing structural and morphological differences between treated and untreated seedlings, as well as differences in cell processes such as cell division.

The next major phase in this project will be to label the root inhibiting compound with a radioactive marker, and then through special processes, trace the compound's movement through the plant. This project should be completed within the next year.

The Use of a Natural Product for the Preemergence Control of Annual Weeds

N. E. Christians

In 1985, it was observed that unprocessed corn meal applied in large quantities to soil areas had an inhibitory effect on the establishment of germinating plants. Further evaluations showed that there was a naturally occurring, organic compound (or compounds) within the corn meal that had a growth regulating effect on the root system of germinating plants. Studies were conducted to determine if any of the components of the corn meal contained higher concentrations of the inhibitory substance. It was discovered that high levels of the inhibitor were found in the corn gluten meal, the protein fraction of the corn grain.

The corn gluten meal contains 10% nitrogen by weight and was shown to be a good natural source of fertilizer nitrogen for mature plants that had well established root systems. Further studies demonstrated that the corn gluten meal could be used as a natural 'weed and feed' material for lawn areas. The nitrogen in the product serves as a nutrient source to improve lawn quality, while the inhibitory substance acts to prevent germinating weeds, such as crabgrass, from infesting the lawn. Several grassy and broadleaf weeds have been shown to be controlled by preemergence application of the corn gluten meal. United States patent 5,030,268 was issued for the use of corn gluten meal as a natural preemergence herbicide in July, 1991 and reissued with broader claims as Re. 34,594 on April 26, 1994. A marketing agreement has been reached with Gardens Alive Corporation and marketing should begin in late summer 1994. Marketing agreements with other companies are also being pursued.

Corn gluten meal is a byproduct of the wet-milling process. It has been used for decades as an animal feed for dogs, poultry, fish, and many other animal species. The product is being promoted as an environmentally safe, natural herbicide that can be used to control weeds preemergently in turf areas without the use of synthetic preemergence herbicides that are presently used in large quantities in the U.S.

Work has also been conducted on other crop systems, such as strawberries, floral crops, and vegetable crops. It anticipated that the corn gluten meal will find a market for these crop systems as well as for home gardening.

Some discussion on the registration of this material have taken place with representatives of the Environmental Protection Agency. A package of information to initiate the registration process should be submitted within the next few weeks.

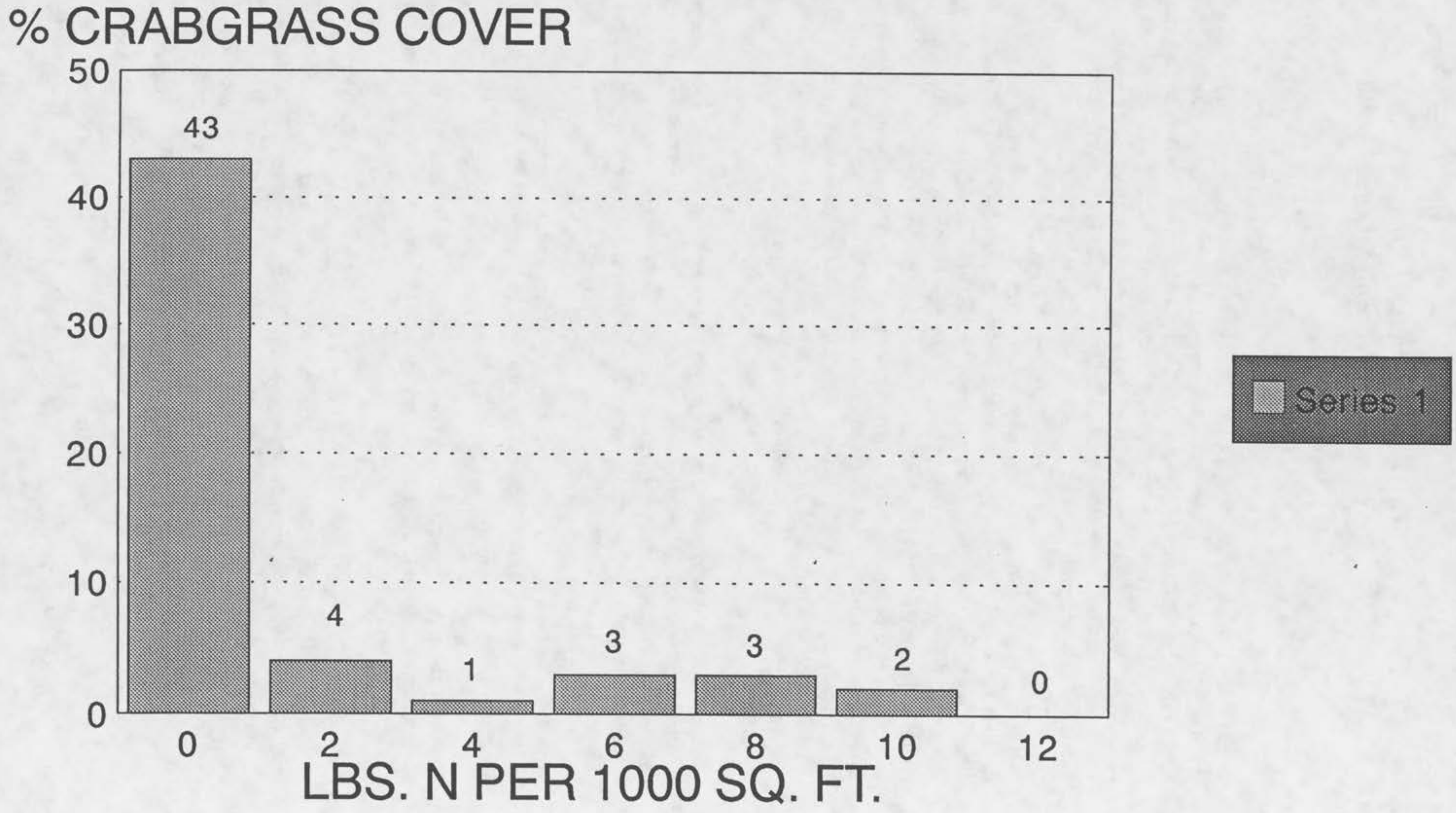
Corn gluten meal was applied to 5 ft x 5 ft plots at the research station during 1991, 1992, and 1993 at levels of 0, 2, 4, 6, 8, and 10 lb N/1000 ft^2 (20, 40, 60, 80, and 100 lbs corn gluten meal/1000 ft^2). Data from the 1993 season on crabgrass control with corn gluten meal are shown in Figure 9. Crabgrass was reduced by 90% at the 2 lb N/1000 ft^2 rate (20 lb of corn gluten meal/1000 ft^2). Higher levels of control were achieved at higher rates of corn gluten meal, but these rates are generally impractical for use on turf. The control held to the end of the 1993 crabgrass season even though the late summer of 1993 was extremely wet.

Applications of this same rates of corn gluten meal were applied to the same plots in the spring of 1994.

Figure 9.

1993 CRABGRASS CONTROL TRIAL

WITH CORN GLUTEN MEAL: SEPT. 1993



Introducing

Introducing

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