1993

Iowa Turfgrass Research Report

IOWA STATE UNIVERSITY
University Extension
Ames, Iowa

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Introduction

N. E. Christians and M. L. Agnew

The following research report is the 13th 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 1991 season was an establishment year for several new trials that were established in 1990. The 1992 season was the first full season of data collection for many of these new studies. Among the new trials established in the fall of 1990 were a low-maintenance Kentucky bluegrass trial, a high-maintenance Kentucky bluegrass trial, a perennial ryegrass trial, a green-height creeping bentgrass trial, and a creeping bentgrass green for fungicide trials.

For the third 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 three 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.

We would like to acknowledge Richard Moore, manager of the turfgrass research area; Mark Stoskopf, superintendent of the ISU Horticulture Research Station; Sue (Kassmeyer) Berkenbosch, technical assistant; Doug Campbell, technical assistant, 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; and Michael Agnew, associate professor, Horticulture.

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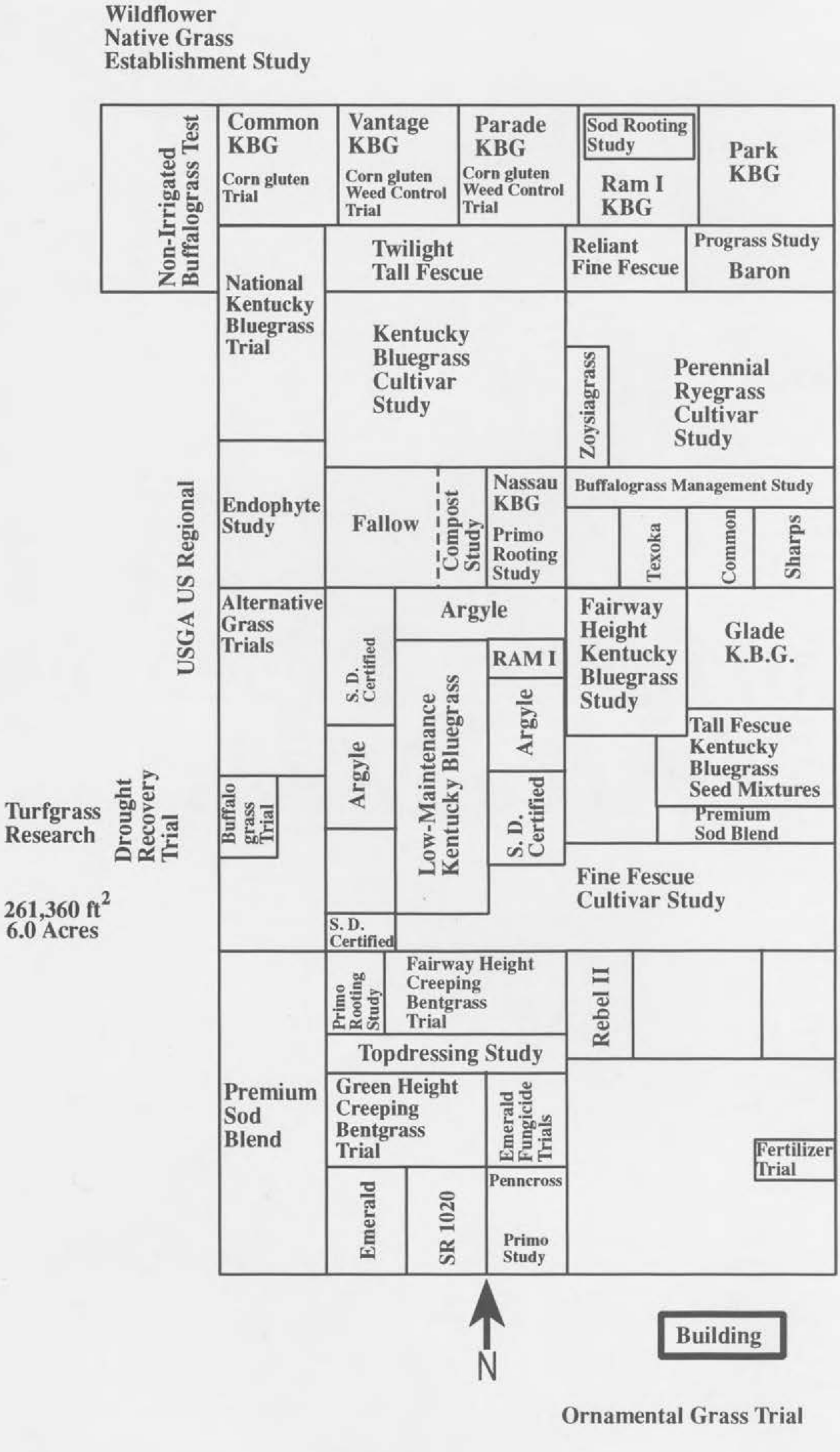
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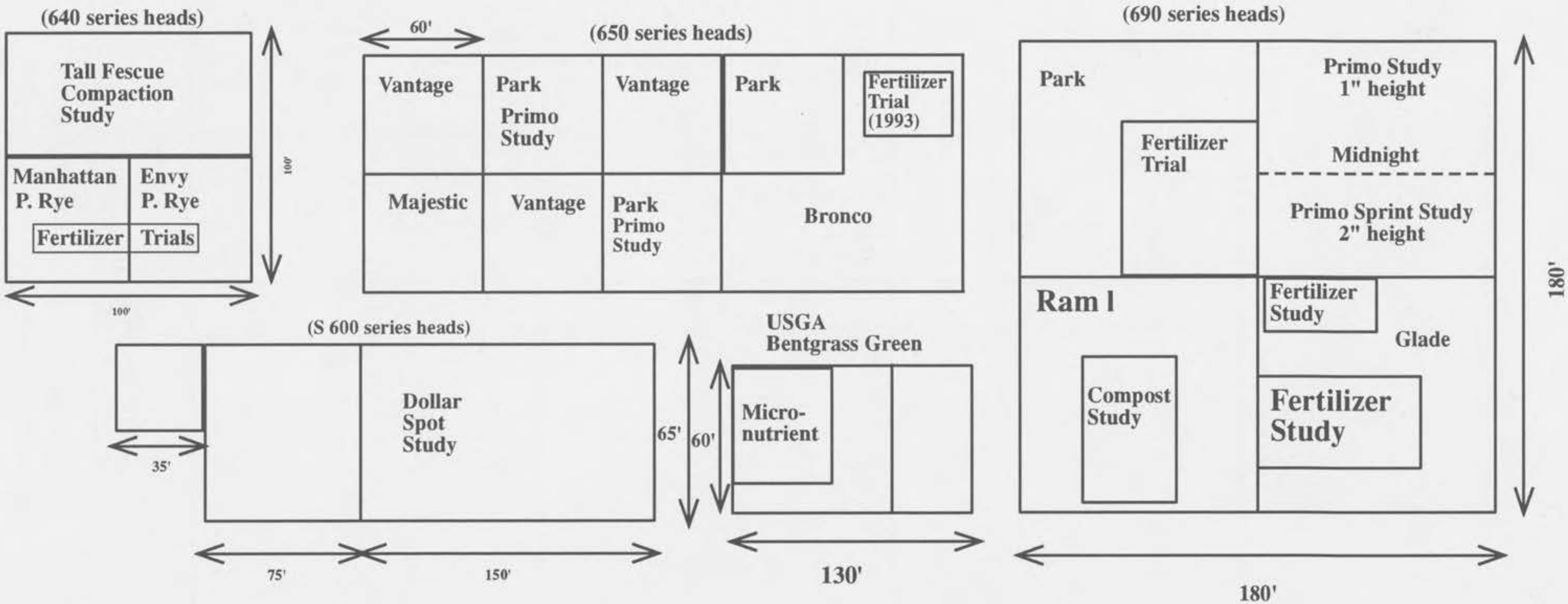
1984 Expansion of the Turfgrass Research Area
108,900 ft - 2.5 Acres^2



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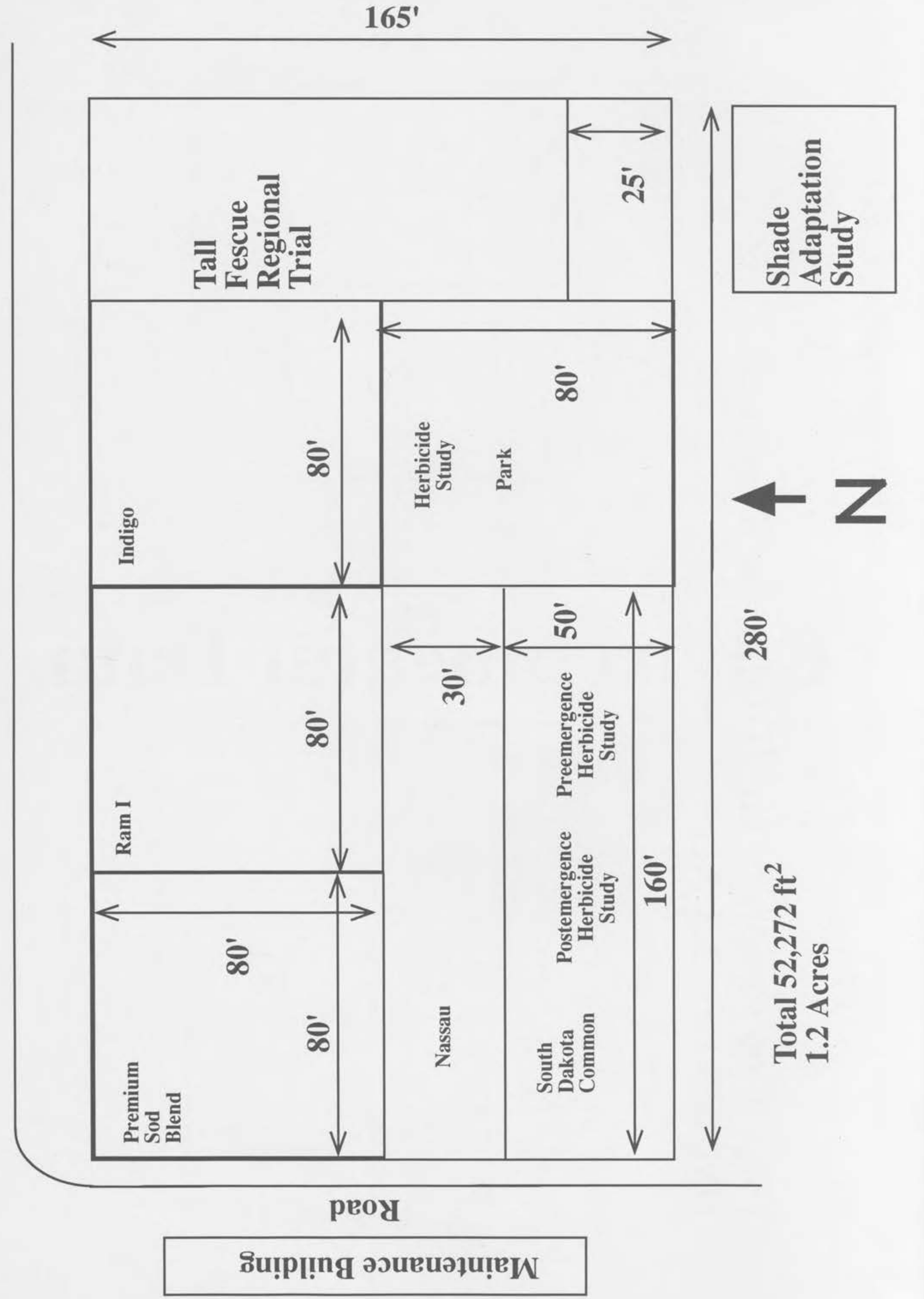

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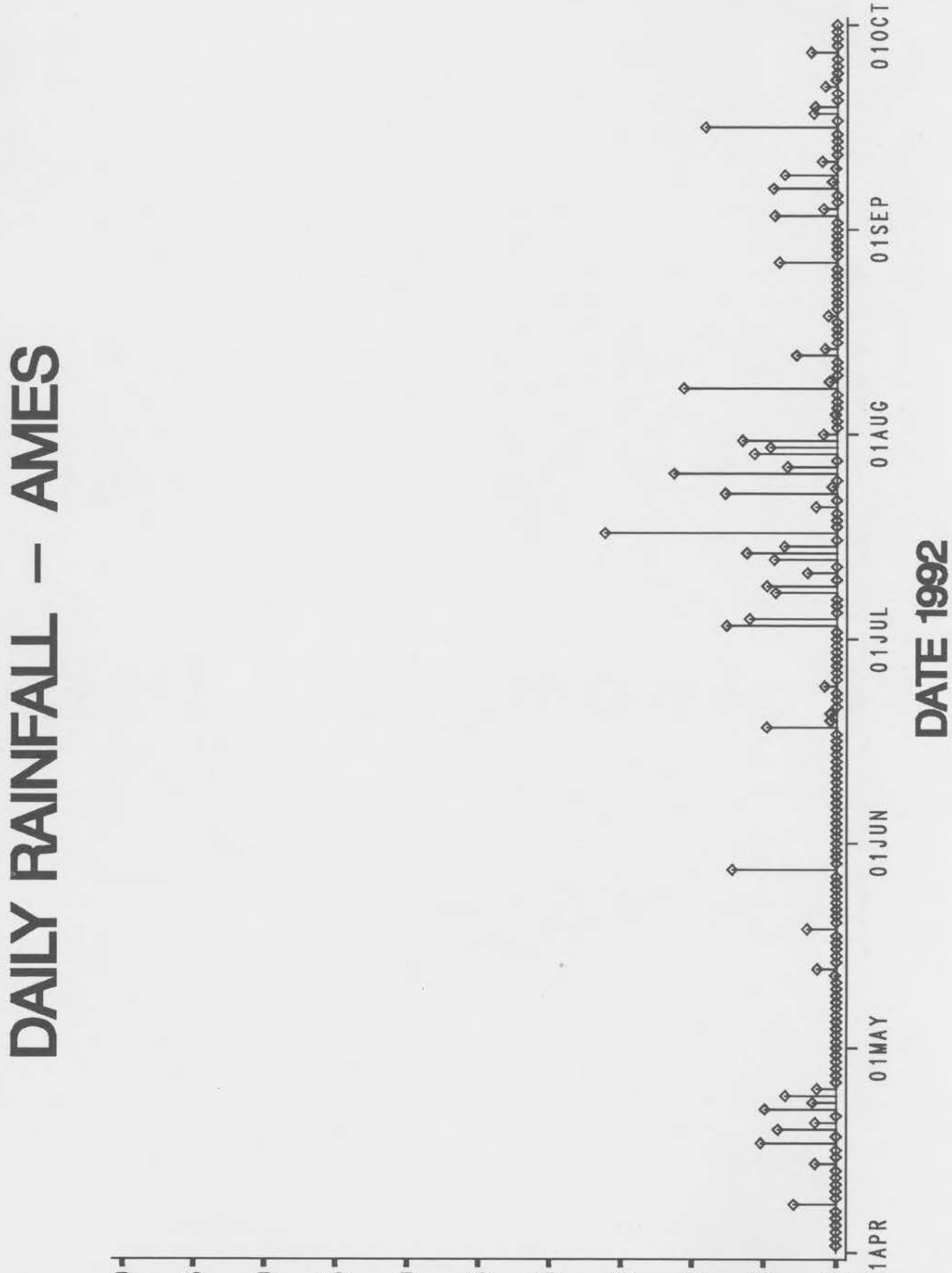
DAILY RAINFALL - AMES
INCHES
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01JUN
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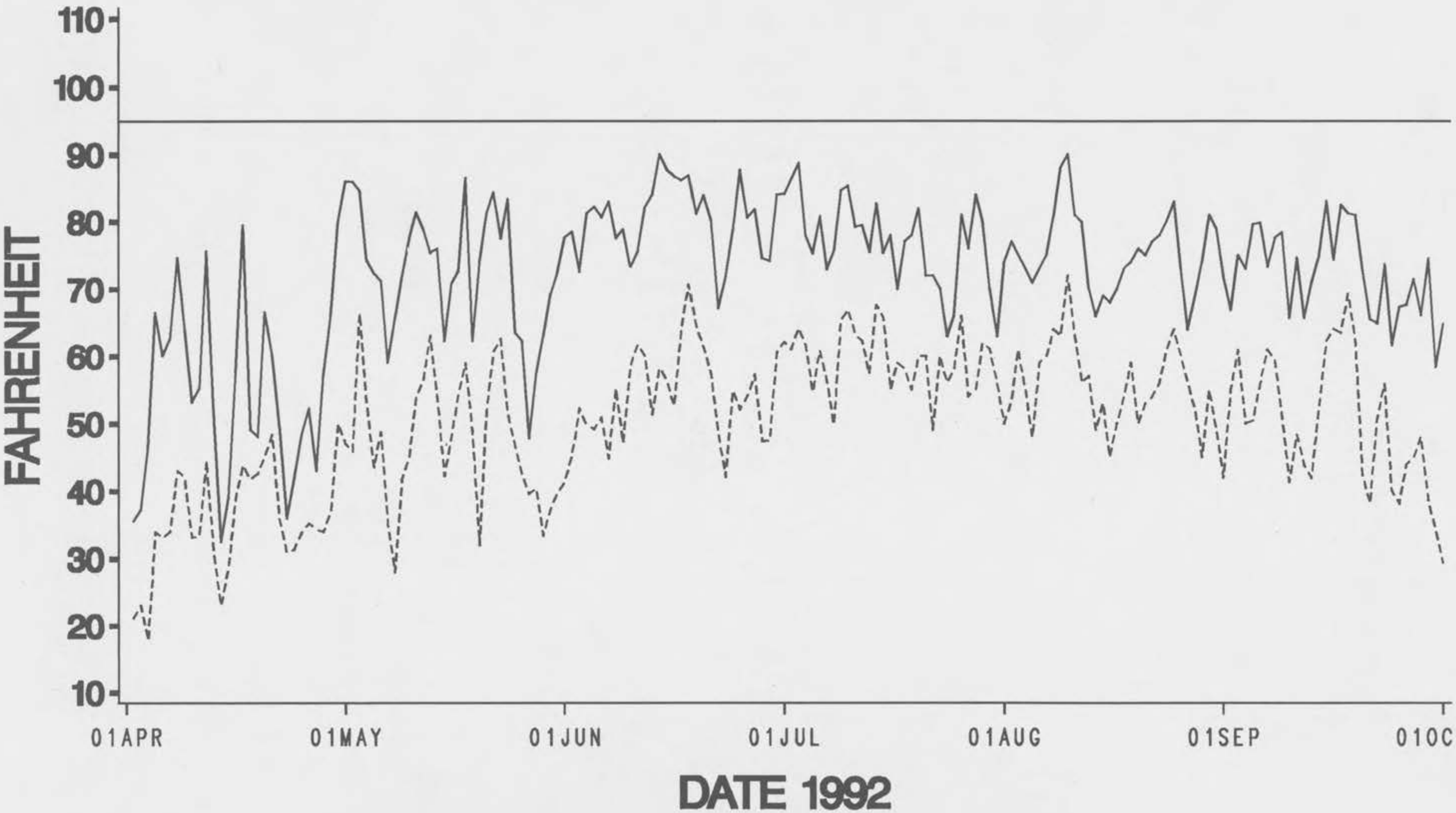
DATE 1992

DAILY TEMPERATURE – AMES



Solid Line = Max Dashed Line = Min

Species and Cultivar Trials

Results of Kentucky Bluegrass Regional Cultivar Trials - 1992

N. E. Christians and R. W. Moore

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 1992 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 not 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 cultivars 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 1 to 9: 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 1992 season. The cultivars are listed in descending order of average quality.

Table 1. The 1992 quality ratings for the high-maintenance, irrigated Kentucky bluegrass trial.

	Cultivar	May	June	July	August	Sept	Mean
1	PST-A7-1877	8.0	7.7	6.7	8.3	8.7	7.9
2	PST-B8-106	8.0	7.7	7.3	8.0	8.7	7.9
3	798	8.0	7.3	6.7	7.7	7.7	7.5
4	BA 70-131	7.7	7.7	6.3	7.7	8.0	7.5
5	Cardiff	7.0	7.3	7.0	8.0	8.0	7.5
6	PR-1	7.7	7.3	6.0	8.3	8.0	7.5
7	Cheri	8.0	7.7	6.3	7.3	7.7	7.4
8	BA 77-292	7.0	7.3	6.7	8.0	7.7	7.3
9	Challenger	7.3	6.7	6.3	8.0	8.0	7.3
10	Connie	7.3	7.7	7.0	7.0	7.3	7.3
11	Limousine	8.0	7.7	6.7	7.7	6.7	7.3
12	PST-C-76 (Unique)	7.3	7.0	6.3	7.3	8.3	7.3
13	Trenton	8.0	7.0	6.3	7.3	7.7	7.3
14	602 (Preakness)	7.3	7.7	5.7	7.3	8.0	7.2
15	BA 69-82	7.7	7.3	6.0	7.7	7.3	7.2
16	Crest	7.3	7.7	6.7	7.3	7.0	7.2
17	Classic	7.7	7.0	6.0	7.0	8.0	7.1
18	Fylking	7.3	6.3	6.7	7.7	7.3	7.1
19	Nassau	6.7	7.7	6.3	7.3	7.7	7.1
20	PST-C-224	7.3	7.0	6.0	7.7	7.3	7.1
21	RAM-1	7.7	7.3	5.7	7.0	8.0	7.1
22	BA 73-540	7.7	7.3	6.0	7.0	7.0	7.0
23	Coventry	7.7	7.0	6.0	7.3	7.0	7.0

	Cultivar	May	June	July	August	Sept	Mean
24	Estate	8.0	7.0	5.7	7.0	7.3	7.0
25	Freedom	7.7	6.7	6.0	7.0	7.7	7.0
26	J-229 (Nublue)	7.3	6.7	5.7	7.3	8.0	7.0
27	Ampellia	8.0	7.0	5.7	6.7	7.0	6.9
28	Cobalt	6.7	6.3	6.3	7.3	7.7	6.9
29	Eagleton	6.3	6.3	6.0	8.0	8.0	6.9
30	EVB 13.863	7.3	7.3	6.3	7.0	6.7	6.9
31	J13-152	7.7	7.0	6.0	7.0	7.0	6.9
32	J34-99	7.3	6.7	5.7	7.7	7.0	6.9
33	Julia	7.7	6.7	5.3	7.0	7.7	6.9
34	Kelly	7.3	7.3	6.7	6.3	6.7	6.9
35	NE 80-47	7.7	7.3	5.7	6.7	7.3	6.9
36	PST-A84-405	7.0	7.0	6.0	7.0	7.3	6.9
37	Silvia	7.3	7.3	5.7	7.0	7.3	6.9
38	WW AG 505	7.3	6.7	5.3	8.0	7.3	6.9
39	A-34	7.3	6.7	5.7	7.3	7.0	6.8
40	Baron	6.7	7.0	6.7	7.3	6.3	6.8
41	Dawn	7.7	6.3	5.7	6.7	7.7	6.8
42	Glade	7.0	7.0	5.7	6.7	7.7	6.8
43	J11-94	7.7	7.0	5.3	7.0	7.0	6.8
44	Livingston	6.7	7.0	6.0	7.0	7.3	6.8
45	Miracle	7.3	7.0	5.7	6.3	7.7	6.8
46	Miranda	7.3	7.3	6.0	7.0	6.3	6.8
47	PST-A84-928	7.0	7.0	6.3	6.7	7.0	6.8
48	PST-RE-88 (4 ACES)	7.0	7.3	6.3	6.7	6.7	6.8
49	PSU-151	7.3	6.3	5.7	7.3	7.3	6.8
50	Washington	7.3	6.3	6.0	7.0	7.3	6.8
51	Able I	6.0	6.3	6.3	7.3	7.7	6.7
52	Aspen	7.0	6.7	5.7	6.7	7.3	6.7
53	BA 77-279	6.0	6.7	5.7	7.3	8.0	6.7
54	Georgetown	7.3	7.0	5.7	6.3	7.0	6.7
55	H86-712 (Shamrock)	7.7	6.7	5.3	6.7	7.0	6.7
56	Minstrel	7.0	6.7	6.3	7.0	6.7	6.7
57	Nustar	7.3	6.7	6.0	6.7	6.7	6.7
58	PST-B8-13	6.7	6.3	7.0	7.3	6.3	6.7
59	SR 2000	7.3	7.3	5.3	6.3	7.0	6.7
60	BA 76-305	6.7	6.7	6.3	7.0	6.3	6.6
61	BAR VB 1184	6.0	6.0	5.7	7.7	7.7	6.6
62	Blacksburg	7.3	6.3	5.7	6.7	7.0	6.6
63	Summit (Apex)	6.3	6.3	5.7	7.0	7.7	6.6
64	Banff	6.7	6.3	5.3	7.0	7.0	6.5
65	BAR VB 1169	7.3	6.3	4.3	7.0	7.3	6.5
66	BAR VB 7037	7.7	6.3	5.0	6.3	7.0	6.5
67	BAR VB 895	7.7	6.3	5.0	6.3	7.0	6.5
68	Barmax	8.0	6.7	5.0	6.0	7.0	6.5
69	Cynthia	5.7	6.3	5.7	7.0	7.7	6.5
70	Eclipse	6.7	6.3	6.0	7.0	6.3	6.5
71	Fortuna	6.3	7.0	6.0	6.3	6.7	6.5
72	Gnome	6.7	7.0	5.7	6.7	6.7	6.5
73	J-335	7.0	6.3	5.3	7.0	7.0	6.5
74	J-386	6.7	6.3	6.0	7.0	6.3	6.5
75	Midnight	6.7	6.3	5.7	6.3	7.3	6.5
76	PST-0514	6.3	5.3	5.7	7.3	8.0	6.5
77	R751A	6.7	6.3	6.0	6.3	7.0	6.5

	Cultivar	May	June	July	August	Sept	Mean
78	Barzan	6.3	5.3	6.0	7.3	7.0	6.4
79	Haga	7.0	6.3	5.0	6.7	7.0	6.4
80	Indigo	7.3	6.7	5.7	6.0	6.3	6.4
81	KWS PP 13-2	6.7	6.0	6.3	6.7	6.3	6.4
82	Liberty	6.3	5.7	5.0	7.3	7.7	6.4
83	PST-UD-12	7.3	6.7	5.0	6.0	7.0	6.4
84	WW AG 508	6.0	6.0	5.7	6.7	7.7	6.4
85	BA 73-366	7.0	6.7	5.0	6.3	6.7	6.3
86	BA 73-382	6.7	7.0	6.0	5.7	6.3	6.3
87	Barsweet	7.3	6.7	5.0	6.0	6.3	6.3
88	Bartitia	6.7	6.0	5.0	7.0	7.0	6.3
89	Chelsea	5.3	6.0	6.3	7.0	7.0	6.3
90	EVB 13.703	7.0	6.3	5.3	6.0	7.0	6.3
91	Marquis	7.0	6.7	5.7	6.0	6.0	6.3
92	PST-A7-341	7.0	6.0	5.3	6.3	7.0	6.3
93	PST-R-740	6.3	6.7	6.0	6.3	6.3	6.3
94	Touchdown	7.0	5.7	5.0	7.3	6.7	6.3
95	Barblue	7.0	5.7	5.3	6.7	6.3	6.2
96	Merion	5.7	5.7	6.3	6.7	6.7	6.2
97	SR 2100	6.7	6.7	5.0	6.3	6.3	6.2
98	1757	7.0	5.7	5.3	6.3	6.3	6.1
99	Abbey	6.3	6.3	5.3	6.3	6.0	6.1
100	BA 74-114	6.3	6.3	5.7	6.0	6.0	6.1
101	BA 77-700	6.0	7.0	5.7	5.7	6.0	6.1
102	BA 78-258	6.3	6.0	5.3	6.3	6.3	6.1
103	Destiny	6.0	6.3	5.0	6.3	7.0	6.1
104	HV 125	6.7	5.3	4.7	6.7	7.3	6.1
105	Merit Cert.	6.7	6.3	5.3	6.0	6.0	6.1
106	Monopoly	6.0	6.3	5.3	6.3	6.7	6.1
107	Opal	6.3	5.7	5.3	6.7	6.3	6.1
108	Platini	7.0	6.3	4.3	6.3	6.7	6.1
109	PST-1DW	6.7	6.0	5.0	6.0	7.0	6.1
110	PST-A84-803	6.3	5.7	5.0	6.3	7.3	6.1
111	Ronde	6.0	6.0	6.0	6.3	6.0	6.1
112	Suffolk	6.7	5.7	4.7	6.7	7.0	6.1
113	BA 73-381	6.0	6.3	5.3	6.0	6.3	6.0
114	Noblesse	6.7	6.0	4.7	6.0	6.7	6.0
115	PST-UD-10	6.3	6.0	4.7	6.0	7.0	6.0
116	Gemor	6.7	5.7	5.3	6.0	6.0	5.9
117	J-333	6.3	6.0	4.3	6.0	7.0	5.9
118	Princeton 104	6.3	5.3	4.7	6.3	7.0	5.9
119	PST-HV-116	6.0	6.0	4.7	5.7	6.7	5.8
120	Alpine	5.7	5.0	4.3	6.7	7.0	5.7
121	Greenley	5.7	5.7	5.7	6.0	5.3	5.7
122	Melba	5.7	5.3	5.0	6.0	6.7	5.7
123	Donna	6.0	5.7	5.0	6.0	5.0	5.5
124	Ginger	4.7	5.0	6.0	5.7	6.0	5.5
125	South Dakota Cert.	4.7	6.0	5.7	5.7	5.3	5.5
126	Trampas	5.3	5.3	4.7	5.7	6.7	5.5
127	Broadway	5.7	5.7	4.0	5.0	6.0	5.3
128	Kenblue	5.0	4.7	5.0	5.7	6.3	5.3
	$LSD_{(0.05)}$	1.3	2.5	NS	2.4	1.5	1.5

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

Table 2. The 1992 quality ratings for the high-maintenance, non-irrigated regional Kentucky bluegrass test.

	Cultivar	April	May	July	Aug	Sept	Oct	Mean
1	Wabash	7.3	7.7	7.0	8.0	7.7	6.3	7.3
2	Mystic	6.0	6.7	8.3	9.0	6.3	6.7	7.2
3	Monopoly	6.3	7.3	7.0	7.7	6.7	6.3	6.9
4	Able I	5.5	6.0	7.5	8.0	8.5	6.0	6.9
5	Aquila	5.3	6.3	7.3	8.0	7.7	6.7	6.9
6	A-34	6.0	6.7	7.7	7.7	7.0	5.3	6.7
7	Kenblue	7.0	6.0	7.0	8.3	7.3	4.7	6.7
8	Joy	7.0	6.0	8.3	7.3	6.3	4.3	6.6
9	Destiny	6.0	6.0	6.7	8.0	7.0	5.7	6.6
10	Conni	5.7	6.0	7.3	7.7	7.0	5.3	6.5
11	F-1872 Freedom	5.7	5.7	7.0	7.0	7.3	6.3	6.5
12	Blacksburg	6.0	5.7	6.3	7.7	7.3	6.0	6.5
13	Sydsport	5.0	6.3	5.3	7.0	8.0	6.7	6.4
14	Somerset	5.7	5.7	5.3	7.0	8.3	6.7	6.4
15	NE 80-88	6.0	6.0	6.7	7.3	7.0	5.3	6.4
16	HV 97	6.0	6.0	6.3	7.3	7.0	6.0	6.4
17	Huntsville	5.3	5.7	7.0	7.7	7.7	5.3	6.4
18	NE 80-14	6.0	6.0	6.7	7.0	7.3	5.7	6.4
19	NE 80-50	6.0	6.3	5.7	6.7	7.3	6.7	6.4
20	NE 80-30	5.7	5.7	6.7	6.7	8.0	6.0	6.4
21	RAM-I	5.7	5.7	6.3	7.0	8.0	5.3	6.3
22	Compact	5.7	5.7	6.0	7.3	7.3	6.0	6.3
23	America	4.7	5.3	5.0	7.7	7.7	7.3	6.3
24	Asset	5.7	6.0	6.7	6.3	7.7	5.7	6.3
25	Amazon	5.3	5.7	6.3	6.7	8.0	5.7	6.3
26	WW AG 495	4.7	6.3	6.7	7.3	7.3	5.7	6.3
27	Park	6.0	6.0	7.3	8.0	5.7	5.0	6.3
28	Lofts 1757	5.0	5.3	7.0	7.0	6.7	6.0	6.2
29	Eclipse	5.0	5.3	6.0	7.3	7.3	6.0	6.2
30	Liberty	5.7	5.0	7.0	7.0	7.3	5.3	6.2
31	Julia	5.7	5.7	6.0	7.0	6.7	6.0	6.2
32	K1-152	5.3	5.7	6.7	6.3	7.3	5.7	6.2
33	Harmony	5.7	5.7	7.3	7.0	6.0	5.7	6.2
34	Rugby	5.7	5.3	6.3	7.3	6.7	6.0	6.2
35	PST-CB1	5.0	6.0	6.7	7.3	6.3	6.0	6.2
36	WW AG 491	5.0	6.7	6.7	6.3	6.3	6.0	6.2
37	BA 73-626	4.7	5.3	6.7	7.3	6.3	6.3	6.1
38	BAR VB 534	5.3	5.7	7.3	6.7	6.0	5.7	6.1
39	Cynthia	5.3	6.0	6.7	7.0	6.3	5.0	6.1
40	Glade	5.7	5.3	6.0	6.7	7.7	5.3	6.1
41	Trenton	5.3	5.3	6.0	7.0	6.7	6.3	6.1
42	NE 80-47	5.7	5.7	6.0	7.0	6.7	5.7	6.1
43	NE 80-55	5.0	5.0	6.0	7.3	7.0	6.0	6.1
44	Classic	3.7	5.0	6.3	7.0	7.7	6.3	6.0
45	Parade	5.0	5.0	6.3	7.3	6.7	5.7	6.0
46	Ikone	5.7	5.7	5.7	7.0	6.7	5.3	6.0
47	South Dakota Cert.	6.3	5.7	6.3	7.3	5.7	4.7	6.0
48	NE 80-110	4.3	5.3	7.0	7.3	6.3	5.7	6.0
49	Tendos	5.3	5.7	5.7	6.3	6.7	6.0	5.9
50	Georgetown	5.3	5.3	6.3	6.3	6.3	6.0	5.9
51	Merit	5.3	5.3	6.7	6.3	6.7	5.3	5.9
52	BA 70-139	4.3	5.7	5.3	6.7	7.3	6.3	5.9

	Cultivar	April	May	July	Aug	Sept	Oct	Mean
53	BA 70-242	5.0	5.3	6.3	6.7	6.7	5.3	5.9
54	BA 72-441	5.3	5.3	6.7	7.3	6.0	4.7	5.9
55	BA 72-500	4.3	6.7	5.3	6.3	7.3	5.7	5.9
56	Nassau	6.0	5.7	5.7	6.7	5.7	6.0	5.9
57	Midnight	4.7	4.3	6.7	7.0	7.3	5.3	5.9
58	NE 80-48	5.7	5.7	5.7	6.3	6.3	5.7	5.9
59	Haga	4.3	5.0	6.0	7.7	6.7	5.3	5.8
60	Annika	4.3	4.7	6.3	6.7	7.0	6.0	5.8
61	Victa	4.3	5.0	6.3	6.7	7.0	5.3	5.8
62	Merion	4.7	5.3	6.0	7.0	7.0	5.0	5.8
63	WW AG 496	5.3	5.7	5.7	6.7	6.0	5.7	5.8
64	P-104	5.0	5.0	6.3	7.0	6.0	5.0	5.7
65	BAR VB 577	5.5	5.5	6.0	6.5	5.5	5.3	5.7
66	BA 73-540	4.3	4.7	5.7	6.3	7.0	6.0	5.7
67	WW AG 468	4.3	4.7	6.0	7.3	6.7	5.3	5.7
68	Barzan	4.7	5.0	6.0	6.7	5.7	5.3	5.6
69	BA 69-82	4.7	4.0	5.7	6.7	6.7	5.7	5.6
70	Cheri	4.0	5.3	5.7	6.3	6.7	5.7	5.6
71	239	5.0	4.7	6.0	6.7	6.3	5.0	5.6
72	Challenger	4.7	5.0	6.3	6.0	6.3	5.3	5.6
73	Gnome	4.3	4.7	6.7	6.3	6.0	5.0	5.5
74	Aspen	4.3	5.0	5.3	6.3	6.3	5.7	5.5
75	K3-178	3.7	4.7	5.7	6.3	6.7	6.0	5.5
76	Dawn	4.3	4.3	5.3	6.7	6.3	5.7	5.4
77	Bristol	4.3	4.3	5.3	6.0	6.7	5.3	5.3
78	BA 72-492	4.3	4.3	5.0	6.3	6.3	5.7	5.3
79	Welcome	4.0	4.7	5.7	6.3	5.3	5.7	5.3
80	Baron	4.3	4.3	5.0	6.0	5.7	5.0	5.1
	$LSD_{(0.05)}$	NS	NS	1.5	NS	1.6	1.3	1.0

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

Table 3. The 1992 quality ratings for the low-maintenance, non-irrigated Kentucky bluegrass trial.

	Cultivar	April	May	June	July	Aug	Sept	Oct	Mean
1	MN 2405	6.0	6.7	5.7	7.0	7.3	6.3	6.0	6.4
2	Alene	6.0	6.3	5.7	6.7	6.7	6.7	6.3	6.3
3	Kenblue	5.3	6.7	5.3	6.3	6.3	6.3	6.3	6.1
4	Park	5.7	6.3	6.3	6.0	6.7	5.7	6.0	6.1
5	South Dakota Cert.	6.0	6.0	5.7	6.3	6.7	6.7	5.7	6.1
6	Barsweet	4.3	5.3	5.3	6.0	7.0	7.0	6.7	6.0
7	PST-A7-111	5.7	6.7	5.3	5.7	6.3	6.0	6.0	6.0
8	BA 78-376	5.0	6.0	5.7	6.7	6.7	5.0	6.3	5.9
9	BAR VB 1169	5.0	6.3	6.0	5.7	6.3	6.0	6.0	5.9
10	Voyager	5.7	7.3	5.0	5.3	5.7	5.7	6.0	5.8
11	BAR VB 7037	5.0	6.0	6.3	5.3	6.0	5.7	5.7	5.7
12	Barmax	5.7	7.3	5.0	5.0	5.0	5.7	6.0	5.7
13	Bronco	4.0	6.3	5.0	5.0	6.7	7.0	6.0	5.7
14	ISI-21	6.0	6.3	4.3	4.0	6.3	5.7	7.0	5.7
15	EVB 13.863	4.0	6.0	4.0	6.7	5.7	6.3	6.3	5.6
16	Haga	5.0	7.0	4.7	5.3	5.7	6.0	5.7	5.6
17	Sophia	4.0	6.7	5.7	5.3	5.7	6.0	5.7	5.6
18	ZPS-84-749	4.7	6.0	4.7	5.7	7.0	6.3	5.0	5.6

	Cultivar	April	May	June	July	Aug	Sept	Oct	Mean
19	Chelsea	4.3	5.7	4.7	6.3	6.3	5.0	6.0	5.5
20	Cynthia	4.7	5.3	4.7	5.3	6.7	6.0	5.7	5.5
21	Opal	4.7	6.0	5.0	5.7	5.3	6.3	5.3	5.5
22	PST-YQ	5.3	6.3	5.0	4.7	4.7	6.3	6.0	5.5
23	RAM-1	4.3	6.3	5.0	5.7	5.7	5.7	5.7	5.5
24	Washington	4.0	5.3	4.7	5.0	7.3	6.3	6.0	5.5
25	GEN-RSP	5.7	6.0	4.7	4.3	5.3	5.7	6.3	5.4
26	Monopoly	3.7	6.3	5.3	5.7	5.3	5.7	6.0	5.4
27	BAR VB 1184	4.0	4.7	4.3	5.3	7.0	6.0	5.7	5.3
28	Baron	3.7	5.0	3.7	5.3	5.3	7.7	6.3	5.3
29	Barzan	3.7	5.0	4.0	6.0	6.3	6.0	6.0	5.3
30	J-229 (Nublue)	4.0	6.0	4.0	5.7	6.0	6.7	5.0	5.3
31	Merit	4.3	5.3	3.3	5.7	6.3	6.0	6.0	5.3
32	Nustar	4.7	4.7	3.7	4.7	6.7	6.7	6.0	5.3
33	Suffolk	4.7	6.0	4.3	4.3	5.7	6.0	6.0	5.3
34	Amazon	5.0	5.7	5.0	5.0	5.0	5.7	5.3	5.2
35	BA 74-017	4.0	5.3	3.7	5.7	6.0	6.0	6.0	5.2
36	Freedom	4.7	6.0	4.3	5.0	5.0	5.3	6.0	5.2
37	H76-1034	5.7	5.3	4.3	5.0	5.7	5.3	5.3	5.2
38	KWS PP 13-2	4.3	5.7	5.0	5.7	5.7	5.0	5.3	5.2
39	BAR VB 895	4.0	5.7	4.0	4.7	6.0	5.7	6.0	5.1
40	J-386	4.0	5.0	4.7	4.7	6.0	5.7	5.7	5.1
41	Fortuna	4.7	5.0	3.7	5.3	5.3	5.3	5.3	5.0
42	J-335	3.7	5.0	4.0	5.7	6.0	5.3	5.7	5.0
43	Liberty	4.3	4.3	3.0	5.3	5.7	6.3	6.0	5.0
44	Livingston	4.7	6.0	4.0	4.3	4.7	5.3	5.7	5.0
45	Midnight	3.0	5.0	3.7	5.3	6.0	6.3	5.3	5.0
46	Miracle	3.7	5.7	4.7	4.7	5.3	5.7	5.7	5.0
47	PST-C-391	4.7	4.7	3.3	4.7	5.7	5.7	6.0	5.0
48	798	4.0	5.3	3.7	4.7	5.3	5.7	5.3	4.9
49	Destiny	4.0	5.0	3.7	5.0	5.3	5.3	5.0	4.8
50	NJIC	4.0	5.3	4.0	5.0	4.7	5.0	5.3	4.8
51	PST-C-303	4.7	5.3	3.3	4.3	5.3	5.0	5.3	4.8
52	Gnome	3.7	4.7	3.7	4.7	5.3	5.0	5.7	4.7
53	PST-C-76 (Unique)	3.7	4.37	3.7	4.3	5.3	5.7	5.7	4.7
54	Unknown	3.7	4.3	3.0	5.0	5.7	5.3	5.0	4.6
55	Crest	3.0	4.3	3.0	4.7	5.7	5.3	5.7	4.5
56	Cobalt	4.0	4.0	3.3	4.7	5.0	5.0	4.7	4.4
57	NE 80-47	4.0	4.7	3.7	4.3	4.7	4.7	5.0	4.4
58	Bartitia	3.3	4.3	3.0	4.7	4.3	5.3	5.3	4.3
59	EVB 13.703	4.0	4.0	3.3	4.0	5.0	4.7	5.0	4.3
60	Kyosti	2.3	4.3	3.3	4.7	5.7	4.0	4.0	4.0
61	Merion	2.7	4.0	2.7	4.0	4.7	4.3	4.7	3.9
62	SR 2000	3.7	3.7	3.0	4.3	3.7	4.3	4.7	3.9
	$LSD_{(0.05)}$	1.6	1.6	1.4	1.3	1.9	2.0	2.1	1.0

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

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 were to further evaluate 4 cultivars that were previously shown to recover rapidly from dormancy and 4 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 low-maintenance grasses (S.D. Common, S-21, Kenblue, and Argyle) maintained the best quality at the 1 lb N rate through the season (Table 4). At the higher N rate, the low-maintenance varieties maintained the best quality during the early dry period, but the high-maintenance varieties (Midnight, Nassau, Glade, and Ram-I) caught up late in the season during the wetter conditions.

The low-maintenance varieties are the best choice under non-irrigated conditions, particularly under low N regimes. The high-maintenance varieties are much better adapted to higher N regimes under irrigated conditions or during wet years.

This study will be continued for at least the next 2 years.

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

	April		May		June		July		August		September		October		Mean	
Cultivar	1 lb N	4 lb N	1 lb N	4 lb N	1 lb N	4 lb N	1 lb N	4 lb N	1 lb N	4 lb N	1 lb N	4 lb N	1 lb N	4 lb N	1 lb N	4 lb N
S.D. Common	5.0	6.7	5.7	7.0	5.7	6.0	6.0	7.7	6.0	8.0	6.0	7.7	6.0	6.3	5.8	7.0
S-21	5.0	6.3	5.7	7.0	6.0	6.7	6.0	7.7	6.3	8.0	7.0	8.0	6.7	6.3	6.1	7.1
Kenblue	4.3	5.3	5.3	6.7	4.3	5.3	6.0	7.0	6.3	7.7	7.0	7.7	6.0	5.0	5.6	6.4
Argyle	4.7	6.3	6.0	7.7	5.7	6.3	6.0	7.3	6.3	8.3	6.3	7.3	7.0	7.0	6.0	7.2
Midnight	2.7	4.0	3.3	6.3	3.0	5.7	4.0	7.3	3.7	8.0	4.3	8.3	4.3	7.3	3.6	6.7
Nassau	3.0	5.0	4.0	6.3	3.0	5.3	4.0	6.7	4.7	6.7	4.0	6.7	4.7	5.3	3.9	6.0
Glade	3.0	4.3	4.0	7.7	3.3	6.0	4.3	8.0	4.7	8.3	5.3	8.7	6.3	6.0	4.4	7.0
RAM-I	3.3	4.3	4.3	7.0	3.7	6.3	5.0	7.7	5.0	8.0	5.0	8.0	5.3	6.7	4.5	6.9
$LSD_{(0.05)}$	NS		1.1		0.7		0.6		0.7		0.8		1.0		0.5	

National Perennial Ryegrass Study - 1992

S. M. Berkenbosch 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-in 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. Brightstar, Palmer II, Pick 89-4, and Pick DKM were the top four performers in 1992. The cultivars are listed in descending order of average quality.

Table 5. The 1992 quality ratings for the national perennial ryegrass study.

	Cultivar	April	May	June	July	Aug	Sept	Mean
1	Brightstar (PST-GH-89)	6.7	8.7	7.0	8.0	7.7	7.3	7.6
2	Palmer II (P89)	6.7	7.7	7.0	8.3	8.0	7.3	7.5
3	Pick 89-4	7.0	8.0	6.3	7.7	7.7	7.7	7.4
4	Pick DKM	7.0	7.7	6.7	7.7	7.7	7.7	7.4
5	Prelude II (2P2-90)	6.3	7.7	6.7	7.7	8.0	7.3	7.3
6	Quickstart (PST-2FQR)	6.7	7.7	6.7	7.7	7.3	7.7	7.3
7	Assure	6.0	8.0	6.3	7.7	7.7	7.7	7.2
8	N-33	6.7	7.7	7.0	7.3	7.3	7.3	7.2
9	ZPS-2EZ	6.7	7.0	6.7	7.7	7.7	7.7	7.2
10	APM	6.7	7.3	6.3	7.3	7.3	7.3	7.1
11	KOOS 90-1	6.7	7.3	6.7	7.3	7.3	7.3	7.1
12	Legacy	5.0	7.7	7.0	7.3	7.7	7.7	7.1
13	MVF 89-88	6.3	7.7	6.7	7.0	7.3	7.3	7.1
14	Pick 1800	6.0	7.0	6.3	7.7	8.0	7.7	7.1
15	Prizm (ZPS-28D)	6.0	7.0	6.7	7.3	8.0	7.3	7.1
16	PST-290	5.3	7.7	7.0	7.7	7.7	7.0	7.1
17	Entry 124	6.0	7.0	6.7	7.3	7.7	7.3	7.0
18	PR 9118	5.3	8.3	6.7	7.0	7.3	7.3	7.0
19	Rodeo II	5.7	7.3	6.7	7.3	7.3	7.7	7.0
20	SYN-P	5.7	7.7	6.7	7.3	7.3	7.3	7.0
21	Charger	5.7	8.0	6.7	7.0	7.0	7.0	6.9
22	Cowboy II (WM-II)	4.7	7.3	6.7	7.7	7.7	7.3	6.9
23	Danaro	6.7	7.7	6.7	6.7	7.0	6.7	6.9
24	Dimension (2H7)	5.3	8.0	7.0	7.3	7.0	7.0	6.9
25	KOOS 90-2	5.7	7.3	6.7	7.0	7.3	7.7	6.9
26	MOM LP 3147	5.7	7.0	6.7	7.3	7.3	7.3	6.9
27	Navajo (PST-2DPR)	5.7	8.0	6.7	7.0	7.0	7.0	6.9
28	PR 9108	6.3	7.7	6.3	7.0	7.0	7.3	6.9
29	PST-28M	7.0	7.0	6.7	7.0	7.0	7.0	6.9
30	PST-2B3	6.0	7.3	6.0	7.3	7.3	7.3	6.9
31	PST-20G	6.7	7.0	6.7	7.3	7.3	6.7	6.9
32	Sherwood	5.7	6.7	6.3	7.3	7.7	7.7	6.9

	Cultivar	April	May	June	July	Aug	Sept	Mean
33	SR 4200	5.0	7.7	7.0	7.7	7.3	6.7	6.9
34	4DD-Delaware Dwarf	6.3	7.0	6.7	7.0	7.0	7.0	6.8
35	89-666	5.3	6.7	6.7	7.3	7.3	7.3	6.8
36	Allegro	6.0	7.0	7.0	6.7	7.0	7.0	6.8
37	Duet	6.0	6.7	6.3	7.3	7.3	7.0	6.8
38	Entry 125	5.7	7.0	6.7	7.0	7.3	7.3	6.8
39	Envy	5.3	7.3	7.0	7.0	7.0	7.0	6.8
40	Equal	5.7	7.3	6.7	7.0	7.0	7.0	6.8
41	Express	5.7	7.7	6.3	7.0	7.3	7.0	6.8
42	Gettysburg	5.3	6.7	7.0	7.3	7.3	7.0	6.8
43	Night Hawk (WVPB-89-PR-A-3)	5.3	8.0	7.0	7.3	6.7	6.7	6.8
44	Nomad	5.0	7.7	7.0	7.3	7.3	6.3	6.8
45	OFI-F7	6.0	7.0	6.7	7.0	7.0	7.0	6.8
46	Pebble Beach	6.3	7.3	6.3	7.3	7.0	6.7	6.8
47	Pinnacle	6.0	7.3	6.7	7.0	7.0	7.0	6.8
48	Pleasure	6.0	7.0	6.7	7.0	7.0	7.3	6.8
49	Regal	6.7	6.7	6.3	7.0	7.3	7.0	6.8
50	Repell II (LDRD)	5.0	7.7	6.7	7.3	7.3	6.7	6.8
51	Topeka (WVPB-88-PR-D-10)	5.7	7.3	6.7	7.0	7.0	7.0	6.8
52	WVPB-88-PR-C-23	5.3	7.3	6.7	7.3	7.3	7.0	6.8
53	WVPB-89-87A	5.3	7.3	7.0	7.0	7.0	7.0	6.8
54	ZW 42-176	5.7	7.7	6.7	7.0	7.0	7.0	6.8
55	Accolade	6.0	7.3	6.0	7.0	7.0	7.0	6.7
56	Advent	5.3	7.0	6.7	7.0	7.0	7.0	6.7
57	Affinity (GEN-90)	5.7	7.3	6.7	7.0	6.7	6.7	6.7
58	BAR LP 086FL	4.7	7.7	7.0	7.0	7.0	7.0	6.7
59	BAR LP 852	5.3	6.3	6.3	7.3	7.3	7.3	6.7
60	Competitor	6.0	7.0	6.3	7.0	7.0	7.0	6.7
61	Cutless	4.7	7.3	6.3	7.3	7.3	7.0	6.7
62	Dandy	5.3	7.0	6.7	7.0	7.0	7.0	6.7
63	Derby Supreme	5.3	7.3	6.3	7.0	7.3	7.0	6.7
64	Entrar	5.7	8.0	6.7	6.3	6.3	7.0	6.7
65	Essence (PR 8820)	4.7	7.0	6.7	7.3	7.3	7.0	6.7
66	Fiesta II	4.7	8.0	7.0	7.0	7.0	6.7	6.7
67	Goalie	6.3	7.3	6.3	6.7	6.7	6.7	6.7
68	Patriot II	6.0	7.0	6.7	7.0	7.0	6.7	6.7
69	Pennant	5.7	6.7	6.7	7.0	7.0	7.3	6.7
70	Pick 89LLG	5.0	8.0	7.0	7.0	7.0	6.0	6.7
71	Pick 9100	5.3	7.0	6.0	7.3	7.3	7.0	6.7
72	Pick EEC	5.3	7.3	6.3	7.0	7.0	7.0	6.7
73	Poly-SH	6.0	7.3	6.3	7.0	7.0	6.7	6.7
74	PR 9119	5.7	7.0	6.7	7.0	7.0	7.0	6.7
75	PST-2FF	5.7	7.0	6.3	7.0	7.0	7.0	6.7
76	PST-2ROR	5.0	7.7	7.0	6.7	7.0	6.7	6.7
77	Repell	5.0	7.0	6.7	7.0	7.3	7.0	6.7
78	Seville	5.0	7.3	6.7	7.0	7.0	7.0	6.7
79	Stallion Select (PS-105)	5.0	7.3	6.7	7.0	7.0	7.0	6.7
80	Yorktown III (LDRF)	5.3	7.7	6.3	7.0	7.0	7.0	6.7
81	856	5.3	7.7	6.7	6.3	6.7	6.7	6.6
82	C-21	5.0	7.3	6.7	6.7	7.0	7.0	6.6
83	Calypso	6.0	7.0	6.3	6.7	6.7	7.0	6.6
84	CLP 39	4.7	7.7	6.7	6.7	7.0	7.0	6.6

	Cultivar	April	May	June	July	Aug	Sept	Mean
85	EEG 358	5.3	7.0	6.7	6.7	7.0	7.0	6.6
86	HE 311	6.0	6.3	6.3	7.0	7.0	7.0	6.6
87	Manhattan II (E)	5.0	6.7	7.0	6.7	7.0	7.0	6.6
88	MVF 89-90	5.0	7.0	6.3	7.0	7.0	7.0	6.6
89	OFI-D4	5.3	7.7	7.0	6.3	6.7	6.3	6.6
90	PR 9109	5.7	7.0	6.7	6.7	6.7	6.7	6.6
91	PST-23C	4.7	7.7	6.3	7.0	7.0	7.0	6.6
92	Saturn	5.0	7.0	6.7	7.0	7.0	7.0	6.6
93	Unknown	5.0	7.7	6.0	6.7	7.0	7.0	6.6
94	Barrage	5.7	7.0	6.7	6.0	6.7	7.0	6.5
95	Commander	5.7	7.0	6.0	6.3	7.0	7.0	6.5
96	Surprise	5.3	7.0	6.3	6.3	7.0	7.0	6.5
97	WVPB 89-92	4.7	6.7	6.7	7.0	7.0	7.0	6.5
98	Danilo	5.3	7.0	6.3	6.3	7.0	6.3	6.4
99	Lindsay	5.0	7.3	6.0	6.3	7.0	7.0	6.4
100	MOM LP 3111	5.3	6.7	6.3	6.3	7.0	6.7	6.4
101	PR 9121	4.7	6.7	6.3	7.0	7.0	6.7	6.4
102	Riviera	5.0	7.0	6.0	6.7	6.7	7.0	6.4
103	Stallion	4.7	6.7	6.3	7.0	7.0	7.0	6.4
104	Statesman (WVPB-88PRD12)	5.3	7.0	6.3	6.7	6.7	6.7	6.4
105	Target	5.3	7.3	6.0	6.7	6.7	6.7	6.4
106	Taya	5.0	7.0	6.7	6.0	6.7	7.0	6.4
107	Gator	4.3	7.0	6.0	6.3	7.0	7.0	6.3
108	Mulligan (NK 89001)	5.7	6.0	6.3	6.0	6.7	7.3	6.3
109	Pennfine	6.3	6.0	6.0	6.0	6.7	6.7	6.3
110	Premier	6.0	5.7	6.3	6.3	6.7	6.7	6.3
111	Cartel	4.3	6.7	6.7	6.0	6.7	6.7	6.2
112	Citation II	5.7	6.3	6.0	6.3	6.7	6.3	6.2
113	MOM LP 3182	5.3	6.7	7.0	6.0	6.0	6.3	6.2
114	Ovation	5.0	6.3	6.3	6.0	6.3	7.0	6.2
115	Barrage ++	5.3	6.3	6.0	5.7	6.7	6.3	6.1
116	Caliente	4.7	6.7	6.3	6.0	6.3	6.3	6.1
117	CLP 144	4.7	7.0	6.7	6.0	6.3	6.0	6.1
118	MOM LP 3184	5.0	6.3	6.3	6.0	6.3	6.7	6.1
119	Loretta	5.0	7.3	6.0	5.3	6.3	6.0	6.0
120	Troubadour	4.3	7.3	6.3	5.7	6.0	6.0	5.9
121	Meteor	4.0	6.3	6.7	5.7	6.0	6.3	5.8
122	MOM LP 3185	4.3	7.0	6.3	5.7	5.7	5.7	5.8
123	MOM LP 3179	5.3	6.7	5.7	5.0	5.3	6.0	5.7
124	Toronto	4.7	6.0	6.0	5.7	6.0	6.0	5.7
125	Linn	4.3	5.3	6.0	5.0	5.0	6.0	5.4
	$LSD_{(0.05)}$	2.3	1.1	NS	0.7	0.8	0.9	0.5

Regional Fine Fescue Cultivar Evaluation - 1992

R. W. Moore and N. E. Christians

This was the second 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-in 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 and broadleaf herbicide was applied once in September to control weeds.

'Barcrown' preformed best in 1992 (Table 6). 'SR 3100', 'Napoli', 'Attila', 'Barlotte', 'Barskol', 'Biljart', 'Epsom', 'Fernando', and 'FRT-30149' were the top 10 cultivars in 1992.

Table 6. The 1992 quality ratings for the fine fescue regional cultivar trial.

	Cultivar	May	June	July	Aug	Sept	Mean
1	Barcrown	6.7	8.0	8.0	8.0	7.7	7.7
2	SR 3100 (SRX 89-31)	7.7	7.3	7.7	8.0	8.0	7.7
3	Napoli (LD 3488)	7.0	8.0	7.7	7.7	7.0	7.5
4	Attila	7.7	7.3	7.0	6.7	7.7	7.3
5	Barlotte	7.0	7.7	7.3	7.7	6.7	7.3
6	Barskol (BAR FR 9P)	7.7	7.3	7.3	7.3	6.7	7.3
7	Biljart	7.3	7.3	6.7	7.7	7.7	7.3
8	Epsom	7.7	7.3	7.0	7.7	7.0	7.3
9	Fernando (HF 112)	6.3	7.3	7.3	7.7	7.7	7.3
10	FRT-30149	7.7	8.0	7.0	7.0	7.0	7.3
11	PST-43F	7.0	7.3	7.3	7.7	7.3	7.3
12	PST-4HD	7.3	6.7	7.3	7.3	7.7	7.3
13	Smirna (ZW 42-160)	7.3	8.0	7.3	7.3	6.3	7.3
14	89.LKR	7.0	7.0	6.7	7.7	7.7	7.2
15	Aurora W/Endo (PST-AUE)	6.7	7.3	7.3	7.3	7.3	7.2
16	Bargreen	7.3	6.7	7.0	7.3	7.7	7.2
17	Bridgeport (N-105)	7.3	6.7	7.0	7.7	7.3	7.2
18	Brigade (Melody)	7.0	7.3	7.0	7.3	7.3	7.2
19	Cindy	7.0	7.3	6.7	7.7	7.3	7.2
20	Reliant W/Endophyte	6.7	7.3	6.7	7.7	7.7	7.2
21	Trophy (Estoril)	6.7	7.3	7.0	7.7	7.3	7.2
22	Warwick	7.0	7.3	7.0	6.7	8.0	7.2
23	Atlanta	7.7	6.3	6.7	7.3	7.3	7.1
24	BAR Fr 9F	6.3	7.7	7.0	7.3	7.3	7.1
25	Comfort (HF 102)	7.0	7.0	7.0	8.0	6.7	7.1
26	Enjoy	7.0	6.7	7.3	7.7	7.0	7.1
27	Jasper	6.7	7.3	7.0	7.3	7.0	7.1

	Cultivar	May	June	July	Aug	Sept	Mean
28	PST-4AG	6.3	7.0	7.3	7.0	8.0	7.1
29	PST-4C8	6.3	7.3	7.3	7.7	6.7	7.1
30	PST-4R3	6.0	7.3	7.0	8.0	7.0	7.1
31	Scarlet	7.3	6.7	6.7	7.3	7.7	7.1
32	Silvania	6.7	6.7	7.0	7.7	7.3	7.1
33	Simone (LD 3485)	7.3	6.7	6.7	7.7	7.0	7.1
34	SR 3000	7.3	7.3	6.7	7.0	7.0	7.1
35	Eureka	6.3	6.7	7.0	7.7	7.3	7.0
36	Rainbow	7.0	7.0	6.7	7.0	7.3	7.0
37	BAR FO 9A2	7.0	7.0	7.0	6.5	7.0	6.9
38	Dawson	6.7	7.3	7.3	7.3	6.0	6.9
39	HF 138	6.3	6.7	7.3	7.3	6.7	6.9
40	PST-4CD	7.0	6.0	6.7	7.7	7.3	6.9
41	PST-4NI	7.3	7.0	6.0	7.3	7.0	6.9
42	Shadow W/Endo (PST-SHE)	6.7	6.7	6.3	7.7	7.0	6.9
43	SR 5000	7.3	6.0	6.3	7.7	7.3	6.9
44	Vista	7.0	7.0	6.7	7.0	6.7	6.9
45	Waldorf	6.7	7.0	6.7	7.0	7.0	6.9
46	Aurora	7.0	7.0	6.3	6.7	7.0	6.8
47	Camaro	5.7	6.0	7.3	7.7	7.3	6.8
48	Crystal	6.3	6.0	6.7	7.3	7.7	6.8
49	ERG 1143	6.3	7.0	6.7	7.0	7.0	6.8
50	Herald	5.7	6.7	6.7	8.0	7.0	6.8
51	Jamestown II	7.0	6.3	6.3	7.3	7.0	6.8
52	Marker	5.7	7.3	8.0	6.3	6.7	6.8
53	Molinda	6.3	6.7	6.7	7.0	7.3	6.8
54	Reliant W/O Endophyte	6.0	6.7	7.0	7.0	7.3	6.8
55	Shademaster	6.8	6.8	6.8	7.3	6.5	6.8
56	Flyer	6.3	7.0	7.0	7.0	6.3	6.7
57	Longfellow	7.0	6.0	7.0	7.0	6.7	6.7
58	Mary	7.3	6.0	6.0	7.3	7.0	6.7
59	OFI 89-200	7.3	5.7	6.3	7.3	7.0	6.7
60	PST-4FE	6.3	6.0	6.7	7.7	6.7	6.7
61	Salem	7.0	6.3	6.3	7.3	6.7	6.7
62	Serra	6.7	6.3	6.7	7.0	7.0	6.7
63	Southport	7.3	5.7	6.0	7.3	7.0	6.7
64	Talus (LD 3438)	6.0	7.0	6.7	7.0	6.7	6.7
65	Capitol	6.3	6.3	6.0	7.0	7.3	6.6
66	Dover (NK 82492)	6.3	6.7	7.0	6.3	6.7	6.6
67	Puma	6.7	6.3	6.3	7.0	6.7	6.6
68	WW RS 130	6.3	6.7	6.3	7.3	6.3	6.6
69	Belvedere	6.7	6.7	6.7	6.3	6.3	6.5
70	Boreal	6.0	7.0	6.0	7.0	6.3	6.5
71	Collo (LD 3414)	5.7	6.3	6.7	7.0	7.0	6.5
72	Franklin	6.7	6.7	6.0	6.3	7.0	6.5
73	Koket	5.7	6.0	6.3	7.3	7.3	6.5
74	Raymond	6.7	6.3	6.0	7.0	6.7	6.5
75	Revere (NK 88001)	5.7	6.7	6.7	7.0	6.3	6.5
76	WW RS 138	6.7	7.3	6.3	6.3	6.0	6.5
77	WW RS 143	6.0	7.3	6.3	6.7	6.3	6.5
78	Barnica	6.0	6.0	6.0	7.0	7.0	6.4
79	Proformer (JMB-89)	7.0	5.3	6.0	7.0	6.7	6.4
80	Sunset (ZW 42-148)	5.7	6.3	6.0	7.3	6.7	6.4
81	Bargena	5.7	5.7	6.3	7.0	7.0	6.3

	Cultivar	May	June	July	Aug	Sept	Mean
82	Bighorn	5.7	6.0	6.3	6.7	6.7	6.3
83	Ensylva	5.3	5.7	6.0	7.7	7.0	6.3
84	Scaldis	5.7	6.3	6.7	6.3	6.7	6.3
85	Shadow	6.0	6.3	6.0	6.7	6.3	6.3
86	Valda	5.7	6.3	6.7	6.3	6.7	6.3
87	Wilma	6.3	5.7	6.3	6.7	6.3	6.3
88	Banner	6.3	5.3	6.0	6.7	6.7	6.2
89	Barim (BAR FR8RC3)	6.0	5.7	6.3	6.7	6.3	6.2
90	Claudia	5.3	6.0	5.7	7.0	7.0	6.2
91	Jamestown	6.3	6.0	5.7	6.0	7.0	6.2
92	Elanor	5.3	5.7	5.3	7.0	6.7	6.0
93	Sylvester	5.0	5.7	6.0	6.3	6.3	5.9
94	MX 86	5.0	5.3	6.3	6.0	6.3	5.8
95	Barreppo	4.3	5.3	6.3	5.7	6.7	5.7
	$LSD_{(0.05)}$	1.4	1.0	1.0	1.7	1.9	0.6

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

Shade Adaptation Study - 1992

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. The grasses were mowed at a 2-in 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 September (Table 7). Visual quality was based on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and 1 = poorest quality. Waldorf Chewings fescue and Arid Tall Fescue were the two highest rated grasses in 1992. The very dry conditions of early summer and the very wet conditions of late summer resulted in some unusual results for the 1992 season. The dry conditions in spring tend to greatly lower the quality ratings of the creeping red fescues and the Chewings fescues. In dry seasons, tall fescue is one of the better choices for shaded conditions in Iowa. In more normal seasons, the fine fescues tend to perform better. Sabre (*Poa trivialis)* performed very poorly in the earlier, drier years part of the season, but in the wet conditions of late 1992 it performed much better. None of the Kentucky bluegrasses maintained satisfactory quality through the entire season.

Table 7. The 1992 quality ratings for grasses in the shade trial.

	Cultivar	April	May	June	July	Aug	Sept	Oct	Mean
1	Waldorf (C.F.)	5.0	7.3	6.7	8.0	9.0	8.0	7.3	7.3
2	Arid (T.F.)	6.0	7.3	7.0	7.3	8.0	7.0	7.0	7.1
3	Bonanza (T.F.)	5.3	6.7	7.3	7.3	7.0	7.7	6.7	6.9
4	BAR FO 81-225 (H.F.)	4.7	5.3	6.0	7.0	7.0	8.0	7.3	6.5
5	Mary (C.F.)	4.7	5.3	6.3	6.7	7.0	8.0	7.0	6.4
6	Sabre (Poa trivialis)	5.3	7.7	4.3	5.7	7.0	7.7	7.0	6.4
7	ST-2 (SR 3000) (H.F.)	4.0	5.8	5.3	7.0	7.5	7.5	7.3	6.3
8	Pennlawn (C.R.F.)	4.7	5.3	5.3	6.7	7.3	7.7	6.7	6.2
9	Biljart (H.F.)	4.3	5.0	6.0	7.0	7.3	7.0	6.3	6.1
10	Atlanta (C.F.)	4.3	5.7	5.3	6.3	7.3	7.3	6.7	6.1
11	Jamestown (C.F.)	4.0	5.7	5.7	6.7	6.7	7.0	6.7	6.0
12	Shadow (C.F.)	4.7	5.3	5.0	7.0	6.7	7.0	6.7	6.0
13	Rebel (T.F.)	4.3	5.0	6.0	6.0	6.7	7.0	6.7	6.0
14	Apache (T.F.)	4.0	5.0	6.0	6.7	7.0	7.0	6.3	6.0
15	Falcon (T.F.)	4.0	6.0	6.3	6.3	6.7	7.0	6.0	6.0
16	Wintergreen (C.F.)	4.7	5.7	5.3	6.0	6.7	6.7	6.0	5.9
17	Victor (C.F.)	5.0	4.5	6.0	7.0	5.0	7.0	7.0	5.9
18	Estica (C.R.F.)	4.3	3.3	5.0	6.3	6.3	7.0	7.0	5.6
19	Rebel II (T.F.)	3.7	5.0	5.0	5.3	6.0	7.0	7.3	5.6
20	Waldina (H.F.)	4.0	4.3	5.3	7.0	6.0	6.0	6.0	5.5
21	Chateau (K.B.)	3.3	5.3	5.7	6.3	5.7	6.3	6.0	5.5
22	Midnight (K.B.)	2.7	4.3	6.0	6.0	6.7	6.3	6.7	5.5
23	Coventry (K.B.)	4.0	5.3	4.7	5.3	6.7	6.3	5.3	5.4
24	Koket (C.F.)	4.0	5.3	4.7	6.0	5.7	5.3	5.7	5.2
25	Scaldis (H.F.)	3.3	4.0	4.7	5.7	6.0	6.7	6.0	5.2
26	Ensylva (C.R.F.)	4.3	4.3	4.3	5.3	6.0	6.0	5.7	5.1
27	Banner (C.F.)	3.7	4.7	4.7	5.0	5.3	6.3	5.7	5.0
28	RAM I (K.B.)	3.0	4.3	5.0	5.7	6.0	5.3	5.3	5.0
29	Agram (C.F.)	3.0	4.3	4.0	5.7	6.0	5.7	5.7	4.9
30	Glade (K.B.)	2.7	4.3	5.0	5.0	5.7	5.3	5.7	4.8
31	Highlight (C.F.)	3.3	3.3	3.3	5.3	5.3	6.0	5.3	4.6
32	Spartan (H.F.)	2.3	3.0	3.3	4.7	4.7	5.3	6.0	4.2
33	Bristol (K.B.)	2.0	3.7	3.3	4.0	4.3	5.0	4.7	3.9
34	Nassau (K.B.)	2.3	3.0	3.3	4.0	4.0	5.0	4.7	3.8
35	Reliant (H.F.)	2.0	2.7	3.0	4.0	3.7	4.3	4.7	3.5
	$LSD_{(0.05)}$	1.7	3.0	2.1	2.2	2.6	3.0	3.0	3.0

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

USGA Buffalograss Trial 1992

N. E. Christians and R. W. Moore

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 second 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. The 84-315 variety received the highest rating during the 1992 season. This was due in part to its early spring greenup and its high density and uniformity. The 84-609, 84-304, and 84-409 varieties do not appear to be well adapted to Iowa conditions. Data collection will continue for several more seasons on these grasses.

Table 8. The 1992 quality ratings for the USGA buffalograss study.

	Cultivar	May	June	July	Aug	Sept	Mean
1	84-315	8.7	7.3	8.3	8.7	8.7	8.3
2	Texoka	5.7	5.7	6.7	7.7	7.3	6.6
3	85-378	5.3	5.7	6.3	6.7	7.3	6.3
4	84-609	3.3	4.3	5.3	5.7	6.0	4.9
5	84-304	2.0	2.7	3.7	3.7	4.0	3.2
6	84-409	2.3	2.7	3.7	4.0	4.0	3.3
	$LSD_{(0.05)}$	1.0	0.9	1.9	1.0	2.2	1.0

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

Alkaligrass Evaluations - 1992

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 1992 test are in Table 9.

It has been very difficult to get the alkaligrasses established at the ISU location. It was not until late in 1992 that they began to fill in satisfactorily. 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.

The varieties are showing some improvement in the spring of 1993 and they will be evaluated through the 1993 season.

Table 9. The 1992 quality ratings for the alkaligrass, non-irrigated study.

	Cultivar	May	June	July	Aug	Sept	Oct	Mean
1	Fultz	3.7	2.7	3.0	3.3	3.3	3.0	3.2
2	#2	3.0	2.7	2.7	3.0	3.0	3.7	3.0
3	#14	3.7	2.7	2.7	2.7	3.7	3.7	3.2
4	#18	3.7	3.0	3.0	3.3	3.3	4.0	3.4
5	#57	3.3	3.0	3.0	3.3	4.3	3.7	3.4
	$LSD_{(0.05)}$	NS	NS	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 - 1992
(Native Soil)

N. E. Christians and R. W. Moore

This is the second 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. Penncross (Table 10) had the best quality of any cultivar in 1991, but dropped to number 12 in 1992. Forbes had the best quality rating in 1992 followed, closely by SR 1020, 88.CLB, Pennlinks, and Putter. Fifteen cultivars maintained a mean of 6 (acceptable) or better. Egmont, BR1518, and Allure had the lowest quality ratings of the 20 cultivars.

Table 10. The 1992 ratings for the green height bentgrass trial.

	Cultivar	Apr	May	June	July	Aug	Sept	Oct	Mean
1	Forbes 89-12 (PRO/CUP)	5.7	7.3	7.7	8.0	7.7	9.0	7.3	7.5
2	SR 1020	4.3	6.7	7.7	8.0	8.0	9.0	8.0	7.4
3	88.CBL	5.3	6.0	8.0	8.0	7.7	9.0	7.3	7.3
4	Pennlinks	5.3	6.7	7.0	7.7	8.0	8.3	7.7	7.2
5	Putter	4.0	6.7	7.3	7.7	8.0	8.7	7.7	7.1
6	WVPB 89-D-15 (Lopez)	6.3	7.3	6.7	7.0	6.3	8.7	7.7	7.1
7	88.CBE	5.3	6.0	7.7	7.3	7.3	7.7	7.3	7.0
8	Carmen	5.0	6.3	7.0	7.7	7.3	8.3	7.7	7.0
9	Southshore	6.0	6.3	5.7	7.7	7.3	8.0	7.3	6.9
10	Normarc 101 (Regent)	5.7	6.0	7.3	7.0	7.0	7.7	6.7	6.8
11	Providence	3.3	6.0	6.3	7.0	7.7	9.0	7.7	6.7
12	Penncross	6.3	6.3	6.0	6.3	6.7	7.3	7.0	6.6
13	Cobra	5.3	5.3	6.7	6.3	6.0	7.7	6.7	6.3
14	National	6.0	4.7	5.7	6.7	6.0	8.0	5.7	6.1
15	Emerald	5.7	5.3	5.7	6.0	5.7	7.3	6.0	6.0
16	Bardot	5.0	7.0	5.7	5.7	6.0	6.7	5.0	5.9
17	Tracenta[1]	4.3	4.7	5.7	5.3	5.0	5.3	4.3	5.0
18	Egmont[2]	3.7	4.3	4.0	5.0	4.7	4.7	4.7	4.4
19	Allure[1]	3.7	3.7	3.7	3.7	4.3	4.0	4.0	3.9
20	BR 1518[3]	3.7	3.3	3.3	4.0	4.0	4.0	3.0	3.6
	$LSD_{(0.05)}$	1.6	1.2	1.0	1.0	1.0	1.1	1.5	0.7

[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 - 1992

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 lb/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 1992 season was very dry early and very wet late in the season. J.H. Bent had the highest numerical ratings over the entire season, although there were no statistically significant differences among the yearly mean ratings for the varieties.

Table 11. The 1992 quality ratings for the fairway height bentgrass study.

	Cultivar	April	May	June	July	Aug	Sept	Oct	Mean
1	J.H. Bent	6.3	7.3	8.0	8.0	7.7	6.7	7.3	7.3
2	Emerald	5.7	6.3	7.7	7.3	8.3	7.7	7.7	7.2
3	Southshore	5.3	7.3	6.3	7.3	8.0	8.0	7.0	7.0
4	Penncross	5.7	6.7	7.7	7.3	7.3	7.0	7.0	7.0
5	Pennlinks	5.3	7.0	8.0	8.0	6.7	7.3	6.3	7.0
6	Putter	5.0	7.0	7.7	7.7	7.7	7.3	6.3	7.0
7	ISI 123	5.0	6.7	6.7	7.3	7.0	8.0	7.7	6.9
8	Providence (SR 1019)	4.7	7.0	7.7	8.0	7.3	7.0	6.3	6.9
9	ISI 124	4.3	7.7	7.3	7.3	7.0	7.7	6.3	6.8
10	Penneagle	4.7	6.0	7.0	7.7	7.7	8.0	6.7	6.8
11	SR 1020	3.7	5.7	6.7	7.7	7.0	8.7	8.3	6.8
12	Cobra	5.0	6.7	7.3	6.7	6.7	6.7	6.7	6.5
13	National	5.7	5.7	6.3	7.0	6.3	6.3	6.7	6.3
14	Prominent	5.7	5.3	5.7	7.0	6.7	6.0	6.3	6.1
15	Carmen	4.7	6.0	6.7	6.3	6.0	7.3	5.3	6.0
16	Exeter (Colonial Bent)	4.7	5.3	5.7	6.0	6.3	6.0	5.7	5.7
	$LSD_{(0.05)}$	NS	1.4	NS	NS	NS	1.6	NS	NS

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

Herbicide and Growth Regulator Studies

1992 Preemergence Annual Weed Control Study

N. E. Christians, D. L. Struyk and R. G. Roe

The 1992 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 93 ppm K. The objectives of the project were to evaluate the efficacy of several labeled and experimental preemergence herbicides applied to a South Dakota Common 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 and watered in on April 30. Liquids were applied with a backpack carbon dioxide sprayer equipped with 8006 nozzles in the equivalent of 3 gal. water/1000 sq. ft. Granular materials were applied with a hand-held shaker. The months of May, June, and the first week of July were very dry. Mid July to late August was a very wet period. The area was irrigated with 1 inch of water/wk during the dry period.

The study was observed weekly for signs of phytotoxicity and complete phytotoxicity data were collected on 5/11, 5/27, 6/11, and 6/22 (Table 12). No damage was observed on any of the treated plots at any time during the summer of 1992. Estimates of the percentage cover of crabgrass were made on 7/14, 7/28, 8/28, and 10/1. The lower % cover for 10/1 is due to frost kill of crabgrass.

Most treatments were very effective, even though the late summer was very wet. Team 2 G applied in split applications (tmt # 14) was very effective, whereas the same material incorporated on a fertilizer carrier (tmt # 15 was much less effective). The PreM 60 WDG (tmt # 19) was ineffective in this trial. This is a material that has worked quite well in most years at this location. The reason for the poor control this year is uncertain. The EXP materials (tmt # 29 to 35) are experimentals from Rhone Poulenc Inc. These materials were generally quite effective. Treatments 36 to 45 are experimental fertilizer + Dimension materials from Pursell Inc. Depending on the rate of application, these materials were very effective.

Table 12. 1992 preemergence study results at Iowa State University.

	Product	# ai/A	Phyt 5/11	Phyt 5/27	Phyt 6/11	Phyt 6/22	Crab 7/14	Crab 7/28	Crab 8/28	Crab 10/1
			----- phytotoxicity rating -----				------------% Cover-----------			
1	Control	0.0	9	9	9	9	23	37	45	7
2	46-0-0 Control	71.4	9	9	9	9	20	27	45	15
3	46-0-0 Control	250.0	9	9	9	9	13	17	27	5
4	Dacthal 75WP	10.5	9	9	9	9	3	4	18	5
5	Barricade 65WG	0.65	9	9	9	9	2	1	2	0
6	Barricade 65WG	0.75	9	9	9	9	1	0	1	1
7	Dimension 1EC	0.50	9	9	9	9	0	0	1	0
8	Mon 25134 0.1G (Dimension)	0.125	9	9	9	9	4	9	20	12
9	Mon 25134 0.1G (Dimension)	0.187	9	9	9	9	1	3	2	2
10	Mon 25134 0.1G (Dimension)	0.250	9	9	9	9	0	0	0	0
11	Balan 2.5G (8 wk split)	1.5 + 1.5	9	9	9	9	5	7	10	4
12	Team 2G	2.0	9	9	9	9	5	5	19	3
13	Team 2G	3.0	9	9	9	9	2	1	7	3
14	Team 2G (8 wk split)	1.5 + 1.5	9	9	9	9	2	4	4	3
15	Team 2G w/fert (8 wk split)	1.5 + 1.5	9	9	9	9	18	23	35	11
16	FN 9064 1.09G	2.7	9	9	9	9	1	1	6	2
17	FN 9064 1.09G	4.1	9	9	9	9	0	0	7	4
18	Pendimethalin/fert 0.75G	1.5 + 1.5	9	9	9	9	4	2	6	3
19	PreM 60WDG	3.0	9	9	9	9	24	33	52	17
20	Betasan 7G	7.5	9	9	9	9	4	2	10	4
21	Chipco Ronstar 2G-CLA	2.0	9	9	9	9	4	2	4	1
22	Chipco Ronstar 2G-CLA	4.0	9	9	9	9	1	0	2	1
23	Chipco Ronstar 2G-BIO	2.0	9	9	9	9	2	4	9	2
24	Chipco Ronstar 2G-BIO	2.0	9	9	9	9	1	1	2	1
25	Chipco Ronstar G-BIO 2G + Dimension 0.1G	2.0 0.25	9	9	9	9	0	0	0	0
26	Chipco Ronstar G-BIO 2G + Dimension 0.1G	1.0 0.25	9	9	9	9	1	0	0	1

	Product	# ai/A	Phyt 5/11	Phyt 5/27	Phyt 6/11	Phyt 6/22	Crab 7/14	Crab 7/28	Crab 8/28	Crab 10/1
			----- phytotoxicity rating -----				-------------% Cover------------			
27	Chipco Ronstar G-BIO 2G	2.0	9	9	9	9	0	0	1	0
	+ Dimension 0.1G	0.125								
28	Chipco Ronstar G-BIO 2G	1.0	9	9	9	9	1	4	4	3
	+ Dimension 0.1G	0.125								
29	EXP30742B2 3G	5.0	9	9	9	9	6	9	10	7
30	EXP30742B2 3G	6.0	9	9	9	9	0	1	3	1
31	EXP30909A 4G	5.0	9	9	9	9	3	1	3	2
32	EXP30910A 5G	5.0	9	9	9	9	3	2	6	5
33	EXP30910A 5G	6.0	9	9	9	9	2	2	3	2
34	EXP30910A 5G (6 wk split)	3.0 + 2.0	9	9	9	9	5	8	14	6
35	EXP30925A 6G	5.0	9	9	9	9	3	4	5	4
36	Mon 25114 0.21G (30-2-10)	0.063	9	9	9	9	8	14	27	5
37	Mon 25114 0.21G (30-2-10)	0.125	9	9	9	9	3	6	13	6
38	Mon 25114 0.21G (30-2-10)	0.250	9	9	9	9	1	2	4	3
39	Mon 25114 0.21G (30-2-10)	0.380	9	9	9	9	0	0	0	0
40	Mon 25112 0.06G (30-3-10)	0.500	9	9	9	9	0	0	0	0
41	Mon 25112 0.06G (30-3-10)	0.063	9	9	9	9	12	22	25	9
42	Mon 25112 0.06G (30-3-10)	0.125	9	9	9	9	3	3	5	2
43	Mon 25112 0.06G (30-3-10)	0.250	9	9	9	9	1	0	1	0
44	Mon 25112 0.06G (30-3-10)	0.380	9	9	9	9	0	0	1	1
45	Mon 25112 0.06g (30-3-10)	0.500	9	9	9	9	0	0	0	0
	$LSD_{(0.05)}$		NS	NS	NS	NS	7	8	12	6

1992 Postemergence Annual Grass Control Study

N. E. Christians, D. L. Struyk, and R. G. Roe

The objective of this study was to investigate the effectiveness of several postemergence annual grass herbicides for the control of crabgrass. It was conducted on an area adjacent to the 1992 Preemergence Annual Weed Control Study. The work was conducted on a Nicollet (fine-loamy, mixed, mesic Aquic Hapludoll) soil with a pH of 6.2, 3.3% organic matter, 19 ppm P, and 93 ppm K. Individual plots measured 5 ft by 5 ft. The grass on the area was South Dakota Common Kentucky bluegrass. They were arranged in a randomized, complete-block design with three replications. The area was irrigated as needed to achieve an irrigation + precipitation rate of 1 inch/wk.

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 1-15 were applied on 5/27/92 when the crabgrass was in the 1 to 2 leaf stage. Treatments 16 to 24 were applied on 6/23/92 when the crabgrass was in the 3 leaf to 1st tiller 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.

Ratings of phytotoxicity on the Kentucky bluegrass were made on 6/3, 6/10, and 6/22 on a scale of 9 to 1; 9 = no damage and 1 = dead turf. Ratings of 6 and above were acceptable. Estimates of percentage crabgrass cover were made on 6/22, 7/28, 8/28, and 10/1 (Table 13). Slight phytotoxicity was observed from the Dimension + Acclaim treatments (#3 and #15) applied on 5/27. Similar treatments applied 6/23 showed no damage. No other phytotoxicity was observed.

The crabgrass population was very high in the control plots (Table 13). Control with most materials was satisfactory. What appears to be a drop in crabgrass populations in most plots between the 8/28 and 10/1 rating dates is due to frost kill of crabgrass and fall growth of the bluegrass in September.

Table 13. Phytotoxicity, quality, turf injury, and control ratings for the 1992 postemergence grass control study.

	Treatment*	# ai/a	Phytotoxicity[1]			Quality[2]			% Cover		
			6/3	6/10	6/22	6/10	6/22	6/22**	7/28	8/28	10/1
1	Control	0.00	9	9	9	8	6	3	60	43	24
2	Dimension 1EC	0.50	9	9	9	8	6	1	4	10	3
3	Dimension 1EC + Acclaim 1EC	0.25 + 0.12	9	7	8	8	7	1	2	7	1
4	Dimension 1EC + MSMA 6EC	0.25 + 1.00	9	9	9	8	7	1	0	6	0
5	BAS 524 34H 75WP + Lutensol	0.375 + 1 qt	9	9	9	9	9	2	6	28	2
6	BAS 524 34H 75WP + BCH 74902S	0.376 + 2 qt	9	9	9	7	8	2	22	25	8
7	BAS 524 XXH 50WP + Lutensol	0.375 + 1 qt	9	9	9	8	8	1	17	19	11
8	BAS 524 XXH 50WP + BCH 74902S	0.375 + 2 qt	9	9	9	8	8	2	12	14	3
9	S-3681 Quinclorac	0.75	9	9	9	8	8	2	8	13	3
10	S-3064 Quinclorac	0.75	9	9	9	9	9	2	8	13	3
11	S-4177 Quinclorac + Pend	0.75 + 0.75	9	9	9	9	8	1	1	5	5
12	S-4178 Quinclorac + Pend	0.75 + 1.00	9	9	9	8	9	1	0	5	1
13	Acclaim 1EC	0.08	9	8	9	8	7	2	32	33	21
14	Dimension 1EC	0.50	9	9	9	7	7	1	0	2	0
15	Acclaim 1EC Dimension 1EC	0.08 0.50	9	9	8	7	7	1	0	1	1

	Treatment*	# ai/a	Phytotoxicity[1]			Quality[2]			% Cover		
			6/3	6/10	6/22	6/10	6/22	6/22**	7/28	8/28	10/1
16	Acclaim 1EC*	0.08	9	9	9	9	7	2	1	6	1
17	Acclaim 1EC*	0.125	9	9	9	8	7	3	1	5	3
18	Acclaim 1EC*	0.18	9	9	9	8	8	2	0	3	0
19	Dimension 1EC*	0.25	9	9	9	8	7	3	8	14	3
20	Dimension 1EC*	0.36	9	9	9	8	7	3	17	40	17
21	Acclaim 1EC* Dimension 1EC*	0.08 0.25	9	9	9	8	8	3	0	3	2
22	Acclaim 1EC* Dimension 1EC*	0.125 0.25	9	9	9	8	6	3	0	3	4
23	Acclaim 1EC* Dimension 1EC*	0.08 0.36	9	9	9	8	7	3	0	0	1
24	Acclaim 1EC* Dimension 1EC*	0.125 0.36	9	9	9	8	8	3	0	1	1
	$LSD_{(0.05)}$		NS	1.2	0.5	NS	NS	1	14	17	15

* Treatments were applied as a mid-season post treatment.
**Ratings were for seedling crabgrass; 1 = no crabgrass, 2 = a small seedling population, and 3 = a large seedling population.
[1]Phytotoxicity = scale from 9 to 1.
[2]Quality = scale from 9 to 1, with 6 being acceptable.

1992 Broadleaf Weed Control Study

N. E. Christians, D. L. Struyk, 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 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 several other weeds (Table 14). Treatments were applied on May 10, 1992, at 8:00 a.m. Conditions were nearly ideal for weed control. No rain occurred until May 18, when 0.25 inch of rain was recorded. 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 July 7, August 17, and October 1, 1992. Tables 14, 15, and 16 contain data on weed control observed on each of the observation dates. The high counts of dandelion in October were due to germination of dandelion seed during the fall.

Table 14. Weed count on broadleaf weed control trial -- July 7, 1992.

	Treatment	Rate	% Clover	Dandelion	Violet	% Black Medic	Thistle	Oxalis
1	Control	0	65	52	0	0	1	0
2	Eliminate 47DG	1.9 lb ai/A	0	15	0	0	0	0
3	Three-Way 53DG	2.2 lb ai/A	5	3	3	0	1	1
4	Triplet 4 lb/gal	3.5 pt/A	7	5	2	0	1	2
5	Turflon II Amine	3.0 pt/A	27	12	3	0	0	4
6	Turflon Ester + Trimec Classic	1.0 pt/A + 3.25 pt/A	0	1	12	0	0	0
7	Confront	1.5 pt/A	0	6	0	0	2	0
8	XRM-5202 + Gallery 75DF	3.0 pt/A + 1.0 lb ai/A	5	19	1	0	2	1
9	XRM-5202	3.0 pt/A	8	10	0	0	3	1
10	Confront + Gallery	1.5 pt/A + 1.0 lb ai/A	0	8	0	0	0	0
11	Gallery	1.0 lb ai/A	68	53	0	7	0	3
12	Turflon II Amine + Trimec Classic + Gallery	1.0 pt/A + 3.25 pt/A + 1.0 lb ai/A	0	2	0	0	0	0
13	Trimec Classic	3.25 pt/A	2	7	3	0	3	2
14	Turflon II Amine + Gallery	3.0 pt/A + 1 lb ai/A	9	14	4	0	0	2
	$LSD_{0.05}$		21	14	NS	NS	NS	NS

Table 15. Weed count on broadleaf weed control trial -- August 17, 1992.

	Treatment	Rate	% Clover	Dandelion	Violet	% Black Medic	Thistle	Oxalis
1	Control	0	77	35	0	0	0	1
2	Eliminate 47DG	1.9 lb ai/A	1	7	0	0	0	0
3	Three-Way 53DG	2.2 lb ai/A	6	3	4	2	0	0
4	Triplet 4 lb/gal	3.5 pt/A	6	8	4	0	0	3
5	Turflon II Amine	3.0 pt/A	45	33	3	0	0	5
6	Turflon Ester + Trimec Classic	1.0 pt/A + 3.25 pt/A	1	3	8	0	0	0
7	Confront	1.5 pt/A	0	7	0	0	0	0
8	XRM-5202 + Gallery 75DF	3.0 pt/A + 1.0 lb ai/A	10	27	5	0	2	0
9	XRM-5202	3.0 pt/A	4	9	0	0	0	0
10	Confront + Gallery	1.5 pt/A + 1.0 lb ai/A	0	10	0	0	0	0
11	Gallery	1.0 lb ai/A	78	33	0	7	0	0
12	Turflon II Amine + Trimec Classic + Gallery	1.0 pt/A + 3.25 pt/A + 1.0 lb ai/A	0	3	0	0	0	0
13	Trimec Classic	3.25 pt/A	7	10	2	2	0	4
14	Turflon II Amine + Gallery	3.0 pt/A + 1 lb ai/A	15	9	3	1	1	1
	$LSD_{0.05}$		24	NS	NS	NS	NS	NS

Table 16. Weed count on broadleaf weed control trial -- October 1, 1992.

	Treatment	Rate	% Clover	Dandelion	Violet	% Black Medic	Thistle	Oxalis
1	Control	0	63	63	0	1	0	0
2	Eliminate 47DG	1.9 lb ai/A	4	45	0	1	0	0
3	Three-Way 53DG	2.2 lb ai/A	6	31	4	3	2	1
4	Triplet 4 lb/gal	3.5 pt/A	8	39	4	5	1	0
5	Turflon II Amine	3.0 pt/A	39	60	2	6	1	1
6	Turflon Ester + Trimec Classic	1.0 pt/A + 3.25 pt/A	4	21	12	2	0	0
7	Confront	1.5 pt/A	1	39	0	0	1	0
8	XRM-5202 + Gallery 75DF	3.0 pt/A + 1.0 lb ai/A	23	47	0	0	2	0
9	XRM-5202	3.0 pt/A	6	48	3	0	4	0
10	Confront + Gallery	1.5 pt/A + 1.0 lb ai/A	0	31	0	0	0	0
11	Gallery	1.0 lb ai/A	63	75	0	3	1	0
12	Turflon II Amine + Trimec Classic + Gallery	1.0 pt/A + 3.25 pt/A + 1.0 lb ai/A	1	29	0	0	0	0
13	Trimec Classic	3.25 pt/A	5	38	2	5	2	0
14	Turflon II Amine + Gallery	3.0 pt/A + 1 lb ai/A	17	54	2	4	1	1
	$LSD_{0.05}$		25	27	NS	NS	NS	NS

Effects of Dithiopyr (Dimension) on the Rooting of Creeping Bentgrass

R. G. Roe and N. E. Christians

Dithiopyr (Dimension) is a new herbicide labeled for use on Kentucky bluegrass and other turf species in 1991. It functions both as a preemergence and early postemergence control of crabgrass.

The objectives of this study were to observe rooting responses and foliar phytotoxicity to dithiopyr on creeping bentgrass mowed at 3/16-inch and maintained under putting green conditions. This is the 3rd year of this study at Iowa State University.

The turf was an 11-year-old stand of 'Penncross' creeping bentgrass established on a 1:1:1 (sand:soil:peat) soil mixture with a pH of 7.1. The area received 3 to 4 lb N/1000 ft^2 in 0.2 lb increments as needed. No P or K was applied. Standard fungicide and insecticide treatments were made uniformly on all plots. Each plot measured 5 ft by 5 ft and the study was replicated three times. Treatments applied on May 8, 1992, with a carbon-dioxide backpack sprayer are listed in Table 17.

The grass on the treated plots showed no visible signs of phytotoxicity during the study. Again this year there was an initial positive response to the granular formulations of dithiopyr in some replications. This appeared to be due to a nutritional stimulation of the grass by the carrier. These responses were not consistent enough to be significant.

Root samples were collected on June 9 and August 7 to a depth of 20 cm (Table 17). The diameter of the cores was 2.54 cm and six cores were collected per plot. The samples were divided into four subsamples cut in 5 cm increments: 0-5, 5-10, 10-15, and 15-20 cm. All soil was washed from the root samples, the samples were dried, weighed, and ashed at 500°C. Root weights were reported as the difference between ashed and dry weights.

Rooting varied by depth on both June 9 and August 7, but no difference was observed with herbicide treatment.

Bensulide was used as a standard in this trial as it is labeled for use on bentgrass greens. Root weights of dithiopyr-treated bentgrass were generally similar to that of Bensulide-treated plots. This information combined with the lack of phytotoxicity has shown that after three years of repeated treatments, dithiopyr was generally safe for use on 'Penncross' creeping bentgrass maintained at green height under the conditions established in this study.

Table 17. Response of creeping bentgrass to dithiopyr and other preemergence herbicides.

			Rooting									
			June 9, 1992					August 7, 1992				
		Rate	- g -					- g -				
	Treatment	lb a.i./A	1*	2	3	4	Mean	1	2	3	4	Mean
1	Control	---	0.194	0.039	0.010	0.004	0.062	0.304	0.027	0.042	0.010	0.096
2	Dithiopyr 0.10G	0.125	0.291	0.055	0.013	0.005	0.091	0.169	0.018	0.003	0.003	0.062
3	Dithiopyr 0.10G	0.250	0.399	0.059	0.012	0.003	0.118	0.102	0.028	0.010	0.003	0.036
4	Dithiopyr 0.25G	0.380	0.281	0.047	0.011	0.002	0.085	0.107	0.055	0.005	0.001	0.046
5	Dithiopyr 0.25G	0.500	0.384	0.034	0.015	0.005	0.109	0.097	0.024	0.005	0.001	0.036
6	Dithiopyr 1EC	0.250	0.324	0.035	0.012	0.005	0.094	0.163	0.020	0.005	0.001	0.047
7	Dithiopyr 1EC	0.380	0.278	0.115	0.066	0.006	0.116	0.471	0.016	0.005	0.002	0.110
8	Dithiopyr 1EC	0.500	0.474	0.061	0.008	0.003	0.136	0.109	0.020	0.007	0.000	0.034
9	Dithiopyr 1EC	0.750	0.261	0.058	0.010	0.003	0.083	0.348	0.041	0.005	0.003	0.099
10	Bensulide 4E	10.0	0.298	0.044	0.006	0.007	0.089	0.440	0.056	0.045	0.005	0.149
11	DCPA(Dacthal)75WP	10.0	0.385	0.050	0.014	0.001	0.112	0.230	0.042	0.004	0.001	0.069
	$LSD_{(0.05)}$	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Treatments were applied May 22, 1991, in the equivalent of 3 gal water/1000 ft^2.
*Rooting depths: 1 = 0-5 cm; 2 = 5-10 cm; 3 = 10-15 cm; and 4 = 15-20 cm.

1992 Sod Rooting Trial - I

R. G. Roe and N. E. Christians

The purpose of this study was to observe the effects of selected pesticides on establishment and rooting of Kentucky bluegrass (cv. 'Ram I') sod. This study was the second year of a 2-year study. Two separate trials were conducted, one irrigated and the other on a non-irrigated area. Treatments are listed in Table 18. The test was conducted on a Nicollet (fine-loamy, mixed, mesic Aquic Hapludall) soil with a pH of 7.4, and 3.5% organic matter, 6 ppm P, and 74 ppm K on the irrigated area, and a pH of 6.9, 3.4% organic matter, 7 ppm P, and 115 ppm K on the non-irrigated area. Individual treatment cells measured 6 ft x 8 ft and were randomized in a complete block design with three replications.

The Kentucky bluegrass sod was cut at a 3/4 in depth and laid in the standard fashion on March 19 and 20, 1992. Sod pieces were transplanted into wooden frames, 6 frames per plot. The frames had 18-mesh fiberglass screen bottoms and were constructed of 1 in x 2 in pine boards with inside dimensions of 12 in x 12 in. Screw hooks were placed at each of the four corners to attach the hydraulic lift apparatus. Check frames were pulled prior to treatment to ensure rooting. Pulling pressure exceeded 500 psi and the sod in the area was assumed to be fully rooted at that time. Liquid treatments were applied to the sod on May 5, 1992, with the use of a backpack carbon-dioxide sprayer equipped with 8006 nozzles in the equivalent of 3 gal. water/1000 sq. ft. Granular materials were applied with a hand-held shaker.

Rooting was measured with a technique modified from King (King & Beard, 1969). The frames were lifted vertically with a hydraulic pump apparatus (Fig. 1). Woven steel cords were attached to each of the four hook screws on the frame and drawn to an apex over the center of the frame. The force at the point of root breakage from the soil was measured by the use of a hydraulic pressure gauge. Rooting measurements were used as an indication of sod establishment. The frames were lifted on July 7 and 8 (63 days post treatment) and September 11 and 17 (126 days post treatment, pulling the frames from the non-irrigated area was delayed due to rain). An analysis of variance was performed on all data.

Because of the longer rooting period in this trial, root development was greater. Sod pulling pressure was at least 200 psi greater than the same trial in 1991, and nearly 500 psi greater than in previous sod rooting studies. Pulling pressures were higher in the second year of this study due to modification of the frames. In nearly every case, pulling pressure exceeded the maximum gauge pressure of 1000 psi. There were no significant differences for irrigated and non-irrigated trials in sod pulling pressure at either the 63- or the 126-day testing time (Tables 18 and 19). No noticeable differences in turf quality were visible after treatment.

King, J. W. and J. B. Beard. 1969. Measuring rooting of sodded turf. Agronomy Journal 61:497-498.

Table 18. Treatments included in the 1992 rooting trial.

	Treatments	Rate/plot 6 ft x 8 ft
1	Balan 2.5 G: 2.0 lb ai/A	40 G
2	Balan 2.5 G: 2.0 + 2.0 lb ai/A - 63-day split application	40 G + 40 G
3	Team 2G: 1.5 lb ai/A	37.5 G
4	Team 2G: 3.0 lb ai/A	75 G
5	Team 2G: 1.5 + 1.5 lb ai/A -- 63-day split application	37.5 G + 37.5 G
6	Pendimethalin 60 DG: 2.0 lb ai/A	1.67 G
7	Pendimethalin 60 DG: 1.5 + 1.5 lb ai/A -- 63-day split application	1.25 G + 1.25 G
8	Ronstar 2G: 3.0 lb ai/A	75 G
9	Check 1: Sample at time of first application (3 grids/plot)	---
10	Check 2: Sample at 62 days after first appl. (3 grids/plot) Sample at 62 days after second appl. (3 grids/plot)	---

Table 19. Root weights from soil cores and the number of pounds (PSI) required to pull 1 ft^2 frames from sod treated with preemergence herbicides under irrigated conditions.

	Treatments	Pull 1[a]	Pull 2[b]
		PSI	
1	Balan 2.5G: 2.0 lb a.i./A	959	997
2	Balan 2.5G: 2.0 + 2.0 lb a.i./A -- 63 day split application	951	933
3	Team 2G: 1.5 lb a.i./A	980	998
4	Team 2G: 3.0 lb a.i./A	993	1000
5	Team 2G: 1.5 lb a.i./A -- 63 day split application	983	958
6	Pendimethalin 60DG: 2.0 lb a.i./A	950	998
7	Pendimethalin 60DG: 1.5 + 1.5 lb a.i./A -- 63 day split application	964	969
8	Ronstar 2G: 3.0 lb a.i./A	942	975
9	Control: Sample at 63 days after first appl. (3 grids/plot) Sample at 63 days after second appl. (3 grids/plot)	984	989
	LSD	NS	NS

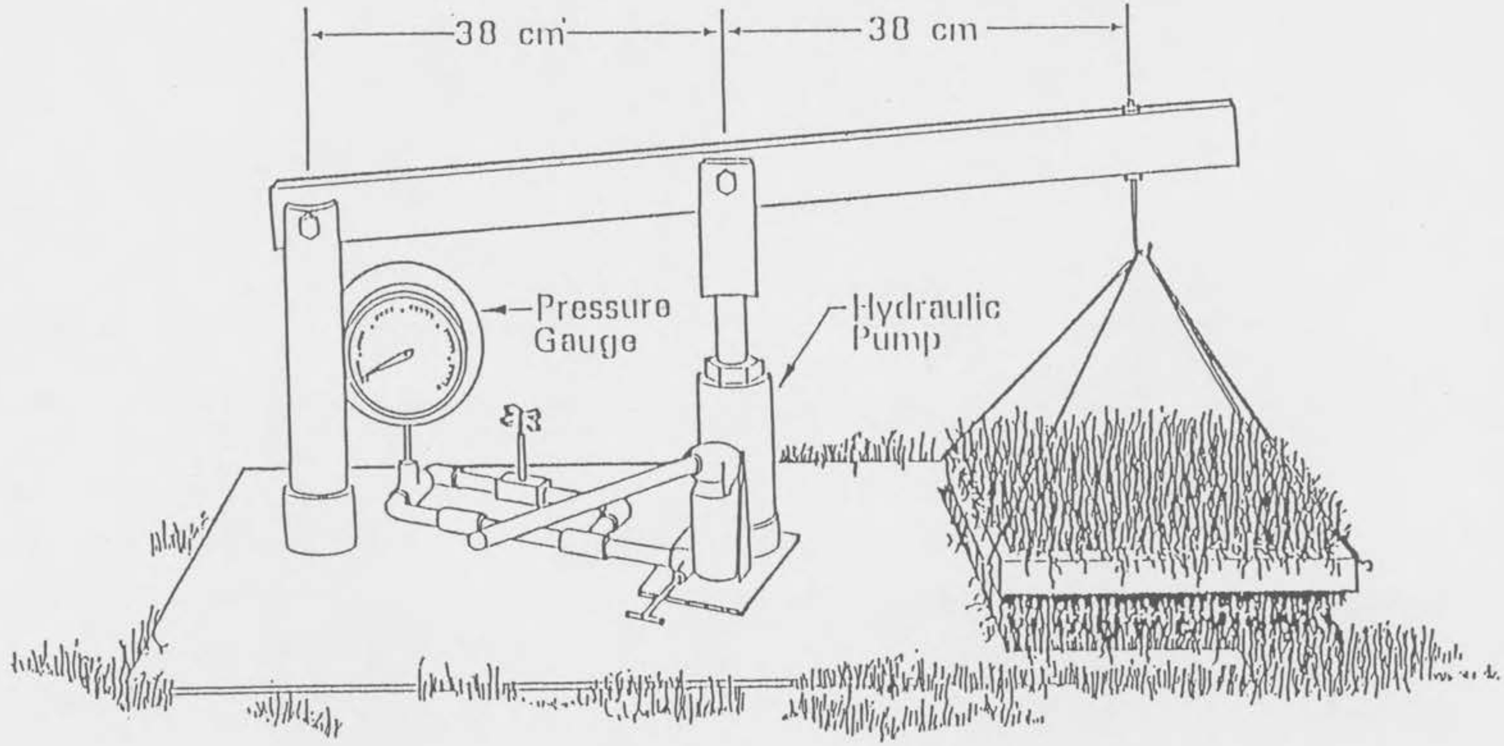
[a]Sod pulled July 7 and 8.
[b]Sod pulled September 11 and 17.

Table 20. Root weights from soil cores and the number of pounds (PSI) required to pull 1 ft^2 frames from sod treated with preemergence herbicides under non-irrigated conditions.

	Treatments	Pull 1[a]	Pull 2[b]
		PSI	
1	Balan 2.5G: 2.0 lb a.i./A	929	919
2	Balan 2.5G: 2.0 + 2.0 lb a.i./A -- 63 day split application	936	915
3	Team 2G: 1.5 lb a.i./A	1000	916
4	Team 2G: 3.0 lb a.i./A	954	873
5	Team 2G: 1.5 lb a.i./A -- 63 day split application	927	946
6	Pendimethalin 60DG: 2.0 lb a.i./A	987	916
7	Pendimethalin 60DG: 1.5 + 1.5 lb a.i./A -- 63 day split application	981	935
8	Ronstar 2G: 3.0 lb a.i./A	981	891
9	Control: Sample at 63 days after first appl. (3 grids/plot) Sample at 63 days after second appl. (3 grids/plot)	981	985
	LSD	NS	NS

[a]Sod pulled July 7 and 8.
[b]Sod pulled September 11 and 17.

Figure 1.



1992 Sod Rooting Trial - II

R. G. Roe and N. E. Christians

The purpose of this study was to observe the effects of selected pesticides on the establishment and rooting of Kentucky bluegrass (cv 'Majestic') sod. The test was conducted on a Nicollet (fine-loamy, mixed, mesic Aquic Hapludoll) soil with a pH of 6.9 and 2.3% organic matter. Individual treatment cells measured 5 ft x 5 ft and were randomized in a complete block design with three replications. Water was applied as required.

The Kentucky bluegrass sod was cut at a 3/4 in depth on May 7, 1992, and laid in the standard fashion. Sod pieces were transplanted into wooden frames, 3 frames per plot. The frames had 18-mesh fiberglass screen bottoms and were constructed of 1 in x 2 in pine boards with inside dimensions of 12 in x 12 in. Screw hooks were placed at each of the four corners to attach the hydraulic lift apparatus. Liquid treatments were applied to the sod on May 8, 1992, with a backpack carbon-dioxide sprayer equipped with 8006 nozzles in the equivalent of 3 gal. water/1000 sq. ft. Granular materials were applied with a hand-held shaker (Table 21).

Rooting was measured with a technique modified from King (King & Beard, 1969). Woven steel cords were attached to each of the four hook screws on the frame and drawn to an apex over the center of the frame. The frames were lifted vertically with a hydraulic pump apparatus (Fig. 1). The force at the point of root breakage from the soil was measured by the use of a hydraulic pressure gauge. Rooting measurements were used as an indication of sod establishment. The frames were lifted 2, 4, and 6 weeks following treatment. Visual quality ratings were recorded on June 18. Quality was rated on a scale of 9 to 1, 9 = best, 5 = acceptable, and 1 = dead turf.

There were significant differences in sod-pulling pressure at all three testing times (Table 21). By the second week following treatment, Barricade 65DG at the 0.65 lb ai/a single application rate showed the greatest numerical pulling pressure. As would be expected, Surflan 1G at 2 lb ai/a showed the greatest reduction in pulling pressure 2 wks after treatment. Surflan is not labeled for use on Kentucky bluegrass. Six weeks after treatment Banner 1.1E at 2 oz/1000 ft^2 and EXP30910A 5G at 6 lb ai/a had numerically greater pulling pressure than the other treatments. Again Surflan 1G at 2 lb ai/a showed the greatest reduction in rooting, followed by Dimension 0.1G at 1 lb ai/a. These differences were significant at a 0.05 level.

Noticeable differences in turf quality were not visible during the study with the exception of Surflan which discolored the Kentucky bluegrass for 6 weeks after application.

King, J. W. and J. B. Beard. 1969. Measuring rooting of sodded turf. Agronomy Journal 61:497-498.

Table 21. Pulling pressures required to pull sod frames from Kentucky bluegrass plots.

Treatment	Rate (lb ai/a)	2 weeks	4 weeks	6 weeks
		------- PSI Pulling Pressure -------		
1. Control	----	487	588	660
2. Ronstar 2G	4	502	712	625
3. EXP30910A 5G	6	420	585	737
4. Pendimethalin 2G	3	518	625	618
5. Dimension 0.1G	1	347	545	553
6. Barricade 65DG	0.65	577	563	620
7. Surflan 1G	2	167	227	292
8. Banner 1.1E	2 oz/1000 ft^2	537	763	812
$LSD_{(0.05)}$		118	186	115

Ethofumesate (Prograss) Demonstration on a Green, Tee, and Fairway at Veenker Golf Course in Ames, Iowa

N. E. Christians and D. L. Struyk

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

In this demonstration, ethofumesate was applied in 15 ft wide strips on #14 fairway and #14 green, and on #15 ladies tee at Veenker Golf Course in Ames, Iowa. Treatments included a control, 0.50, and 0.75 lb ai/A on the fairway and tee. On the green, rates included a control, 0.25, 0.50, and 0.75 lb ai/A. The fairway treatments were replicated 2 times. The treatments on the green and tee were not replicated.

All areas were treated in September and October 1991 at the listed rates. The standard November treatment was not possible because of early snow in the Ames area in late October 1991. In May 1991, 5-ft wide sub-plots within the existing treated areas were retreated at the same rates applied to those plots in the fall.

On July 28, 1992, four 4-inch diameter plugs were taken from each treated area and estimates of the % Poa annua per plug were made visually. These four values were averaged and the data is reported in Tables 1 through 3.

Ethofumesate was quite effective in reducing Poa annua on the green (Table 22). Initially in the spring, treated areas appeared to have a very thin stand of grass because of the loss of Poa annua. The appearance of the area and putting quality returned to normal by late May to early June. This was a non-replicated demonstration and no evaluation of statistical significance of Poa annua control is possible. But it is apparent from the data listed in Table 22, that Poa annua populations were reduced by the ethofumesate treatments and that the additional spring treatment provided increased control over the fall-only treatments.

There was no visible reduction of Poa annua on the fairway or the tee and no Poa annua differences were found at the July 28 evaluation (Tables 23 and 24). This lack of control is surprising. Treatments were made to all areas at the same time with the same tank of material. The only difference was the low mowing height on the green. There may have been biotype differences among Poa annua types on the three areas, although this will take further work to determine.

Table 22. The effect of ethofumesate (Prograss) on Poa annua populations on a Penncross creeping bentgrass green.

Treatments	Fall Treatments Only*	Fall Treatments Followed by a Spring Treatment
--- lb ai/A ---	----------- % Poa annua -----------	
Control	90	73
0.25	37	36
0.50	48	12
0.75	43	22

*The treatments were made in September and October 1991 in the "fall only" treatments and were made in September, October 1991 and May of 1992 in the fall treatments followed by a spring treatment.

Table 23. The effect of ethofumesate (Prograss) on Poa annua populations on a creeping bentgrass + Kentucky bluegrass + perennial ryegrass tee.

Treatments	Fall Treatments Only*	Fall Treatments Followed by a Spring Treatment
--- lb ai/A ---	----------- % Poa annua -----------	
Control	14	11
0.50	18	13
0.75	34	11

*The treatments were made in September and October 1991 in the fall only treatments and were made in September, October 1991 and May 1992 in the fall treatments followed by a spring treatment.

Table 24. The effect of ethofumesate (Prograss) on Poa annua populations in a Kentucky bluegrass + perennial ryegrass fairway.

Treatments	Fall Treatments Only*	Fall Treatments Followed by a Spring Treatment
--- lb ai/A ---	----------- % Poa annua -----------	
Control	31	16
0.50	30	45
0.75	28	9

*The treatments were made in September and October 1991 in the fall only treatments and were made in September, October 1991 and May 1992 in the fall treatments followed by a spring treatment.

The Efficacy of Ignite as a Non-selective Herbicide, 1992

T. R. Bormann and N. E. Christians

The objective of this study was to evaluate the initial and residual efficacy of Ignite from American Hoechst Corporation as a non-selective herbicide for the control of Kentucky bluegrass. The study was conducted on an established 'Majestic' Kentucky bluegrass turf. The soil on the site is Nicollet with 3.3% organic matter, a pH of 6.7, 9 ppm phosphorus, and 90 ppm potassium.

Individual plots measured 3 ft by 5 ft. Each plot was then divided into 18 in by 5 ft plots. One-half of each plot was treated with one of the three treatments (Table 25), and one-half was used as a control. Each treatment was replicated three times and data on percent dead tissue was taken weekly for 7 weeks following treatment.

All treatments were applied June 5, 1992, at a time when the grass was being watered to prevent drought stress. All treatments were applied at the equivalent of 3 gal water per 1000 ft^2.

After the June 5 application, 7 weekly ratings were made on a percent damage scale where 100 = complete kill and 0 = no damage. The study was concluded on July 17, 1992 (Table 25).

The best control obtained by Ignite at the rate of 2 fl oz/gal was 68% and the Ignite at 4 fl oz/gal reached 88%. The grass treated with Ignite contact herbicide started to recover from its rhizomes after two weeks. Glyphosate, which is a systemic herbicide, reached 100% at the third week and maintained the total kill throughout the 7 weeks of the study.

Ignite can be used as a quick, "knock down" treatment for grasses, but extended control of rhizomatous grasses requires a systemic control.

Table 25. Percentage kill of 'Majestic' Kentucky bluegrass by Ignite and glyphosate over a 7 wk period.

	Weeks after Treatment (% Dead Tissue)						
Treatment	1	2	3	4	5	6	7
Ignite 2 fl oz/gal	68	67	56	37	15	10	8
Ignite 4 fl oz/gal	88	80	72	80	72	58	42
Glyphosate 2.5 fl oz/gal	52	95	100	100	100	100	100
$LSD_{(0.05)}$	18	4	10	14	24	25	22

The Effects of Quinclorac on the Establishment of Three Grass Species

D. L. Struyk and N. E. Christians

Quinclorac is an experimental herbicide that is being tested as a selective, postemergence material for the control of crabgrass, white clover, and other weeds in turf areas. It is a product of the BASF Company and will be marketed under the name "Drive" when it is registered.

The objectives of this study were to observe the effects of quinclorac on the establishment of 'Ram I' Kentucky bluegrass, 'Dandy' perennial ryegrass, and 'SR1020' creeping bentgrass following both pre and postemergence application.

The study was conducted on newly tilled soil in a strip split-plot arrangement with 6 quinclorac treatments as main plots. The treatments included a control and 5 quinclorac treatments applied at 0.75 lb a.i./A at different times before and after seeding; immediately after seeding, 1 week after seeding, 2 weeks after seeding, 4 weeks after seeding, and 8 weeks after seeding. BAS 0900 2S was included at 1 qt/A with all treatments applied after emergence (treatments 3-6). The three grass species were included as strip plots. The grasses were seeded on May 18, 1992. The bluegrass was seeded at a rate of 1.5 lb/1000 ft^2, the ryegrass at 3 lb/1000 ft^2, and the creeping bentgrass at 0.75 lb/1000 ft^2. The soil on the site is a Nicollet (fine-loamy, mixed, mesic Aquic Hapludoll) with a pH of 6.7 and 2.9% organic matter. Soil test levels on the site were 32 ppm P and 99 ppm K.

The three species were germinated at different times. The last to emerge was Kentucky bluegrass on May 30. Data was taken 2, 4, 6, and 12 weeks after planting. Crop injury, stand loss, color, and quality were taken on all four of these dates. Weed control was recorded 4 and 6 weeks after planting.

Factors that had some effect on the results include flooding of lower areas in the plot and a heavy infestation of purslane in the Kentucky bluegrass plots due to its slow establishment. "Drive" had no effect on the purslane.

All treatments showed some visual injury for several weeks after application (Table 26). Preemergence applications had no effect on creeping bentgrass. The treatments applied to the Kentucky bluegrass 2 weeks after seeding resulted in consider stand loss. Kentucky bluegrass appeared to be more sensitive to the treatments by the high losses shown in week 12. This could have been due to a large purslane population caused by the slow germination of the bluegrass. Grassy weed control was satisfactory in the PRE, 1 week, and 2 weeks after seeding treatments. Control was not adequate 8 weeks after seeding treatments.

Table 26. BASF seeding study - 1992.

		Time (weeks after seeding)								
		2 weeks				4 weeks				
Treatments	Application Time	Injury	Loss	Color	Quality	Injury	Loss	Color	Quality	Control
Kentucky Bluegrass										
1. Control		0	0	9	9	0	0	9	9	6
2. BAS 514 34H	PRE (cover the seed)	1	0	9	9	0	1	8	9	9
3. BAS 514 34H + Lutensol	1 week after seeding	1	2	8	8	1	3	9	8	9
4. BAS 514 34H + Lutensol	2 weeks after seeding	0	0	9	9	1	1	9	8	9
5. BAS 514 34H + Lutensol	4 weeks after seeding	0	0	9	9	0	0	9	9	5
6. BAS 514 34H + Lutensol	8 weeks after seeding	0	0	9	9	0	0	9	9	4
Perennial Rye										
1. Control		0	0	9	9	0	1	9	9	8
2. BAS 514 34H	PRE (cover the seed)	2	0	8	8	1	1	8	8	9
3. BAS 514 34H + Lutensol	1 week after seeding	1	0	8	9	1	1	9	9	9
4. BAS 514 34H + Lutensol	2 weeks after seeding	0	0	9	9	2	1	8	8	9
5. BAS 514 34H + Lutensol	4 weeks after seeding	0	0	9	9	0	1	8	9	7
6. BAS 514 34H + Lutensol	8 weeks after seeding	0	0	9	9	1	1	8	8	8
Creeping Bentgrass										
1. Control		0	0	9	9	0	0	9	9	6
2. BAS 514 34H	PRE (cover the seed)	1	0	7	9	1	1	7	8	9
3. BAS 514 34H + Lutensol	1 week after seeding	0	0	7	9	0	1	8	8	9
4. BAS 514 34H + Lutensol	2 weeks after seeding	0	0	9	9	1	0	7	8	9
5. BAS 514 34H + Lutensol	4 weeks after seeding	0	0	9	9	0	1	9	9	5
6. BAS 514 34H + Lutensol	8 weeks after seeding	0	0	9	9	0	0	9	9	5

Injury = phytotoxicity on a 0 to 9 scale. Loss = stand loss on a 0 to 9 scale.
Color = turf color on a 9 to 1 scale. Quality - turf quality on a 9 to 1 scale.

Table 27. Quinclorac effects on the establishment of 3 grass species.

		Time (weeks after seeding)								
		6 weeks					12 weeks			
Treatments	Application Time	Injury	Loss	Color	Quality	Control	Injury	Loss	Color	Quality
Kentucky Bluegrass										
1. Control		1	0	8	9	2	0	3	8	8
2. BAS 514 34H	PRE (cover the seed)	0	0	8	9	8	1	4	8	8
3. BAS 514 34H + Lutensol	1 week after seeding	0	0	9	9	9	0	2	9	9
4. BAS 514 34H + Lutensol	2 weeks after seeding	1	1	8	8	9	0	5	8	7
5. BAS 514 34H + Lutensol	4 weeks after seeding	1	0	8	9	6	0	3	8	8
6. BAS 514 34H + Lutensol	8 weeks after seeding	1	0	8	9	2	0	3	8	8
Perennial Rye										
1. Control		2	1	7	8	7	2	2	7	7
2. BAS 514 34H	PRE (cover the seed)	1	1	8	8	9	1	2	8	7
3. BAS 514 34H + Lutensol	1 week after seeding	0	0	8	8	8	0	0	9	9
4. BAS 514 34H + Lutensol	2 weeks after seeding	1	1	8	8	7	0	0	9	9
5. BAS 514 34H + Lutensol	4 weeks after seeding	0	1	8	8	6	0	1	9	9
6. BAS 514 34H + Lutensol	8 weeks after seeding	1	1	8	8	5	1	1	8	8
Creeping Bentgrass										
1. Control		0	0	9	9	3	0	0	9	9
2. BAS 514 34H	PRE (cover the seed)	1	1	8	8	9	0	1	9	8
3. BAS 514 34H + Lutensol	1 week after seeding	0	1	9	8	9	0	0	9	9
4. BAS 514 34H + Lutensol	2 weeks after seeding	2	1	8	7	9	0	0	9	9
5. BAS 514 34H + Lutensol	4 weeks after seeding	1	0	8	9	8	0	0	9	9
6. BAS 514 34H + Lutensol	8 weeks after seeding	0	0	9	8	5	0	0	9	8

Table 28. Statistical analysis for quinclorac study.

	Week 2				Week 4					Week 6				
Source of Variation	Injury	Loss	Color	Quality	Injury	Loss	Color	Quality	Control	Injury	Loss	Color	Quality	Control
Treatment	.0001	.0001	.0013	.0585	.0464	.3600	.0314	.0132	.0001	.1805	.6050	.1921	.6840	.0006
Species	.1756	.0156	.1231	.1736	.2942	.1885	.0772	.5722	.0162	.8186	.0467	.0287	.2318	.2124
Species X Treatment	.1795	.0145	.0454	.3017	.9959	.2755	.7068	.8348	.0292	.2552	.9009	.4582	.7278	.0460

	Week 12				Means				
Source of Variation	Injury	Loss	Color	Quality	Injury	Loss	Color	Quality	Control
Treatment	.1534	.1065	.2641	.1072	.0922	.0188	.0354	.0923	.0001
Species	.4692	.0076	.1884	.2323	.1870	.2864	.1031	.1909	.0466
Species X Treatment	.3296	.7343	.1531	.3159	.5462	.6514	.3325	.5995	.0097

Injury = phytotoxicity on a 0 to 9 scale with 0 being no injury and 9 being maximum injury; loss = stand loss on a 0 to 9 scale with 0 being no loss and 9 being maximum loss; Color = turf color on a 9 to 1 scale with 9 being excellent and 1 being poor; Quality = turf quality on a 9 to 1 scale with 9 being good quality and 1 being poor quality; Control = grassy weed control on a 9 to 1 scale with 9 being excellent control, 6 unsatisfacotyr, and 0 being no control.

1992 Growth Regulator Study

T. R. Bormann and N. E. Christians

Recently many states have banned grass clippings and other yard debris from public landfills. One solution to this is to reduce the amount of clippings produced by a turfgrass area. One way to do this is by the use of a growth regulator which reduces the amount of growth of the turf plant. In this trial, an experimental growth regulator, Primo (WP and EC), was tested against a combination of Limit and Embark. The soil on the test area was a Nicollet with 3.3% organic matter, a pH of 6.7, 9 ppm phosphorus, and 86 ppm potassium.

The treatments include an untreated control, Primo 1EC at 0.27 lb ai/A, Primo 1 EC at 0.41 lb ai/A, Primo 25WP at 0.27 lb ai/A, Primo 25WP at 0.41 lb ai/A, and a combination of Limit at 1 lb ai/A with Embark at 0.1 lb ai/A. The treatments were applied on May 8, 1992, to 10 ft by 10 ft plots of 'Park' Kentucky bluegrass. The area was mowed 2 days before treatment. The plots were watered to prevent stress. Quality ratings based on color, uniformity, and density were made on a scale of 9 to 1, 9 = best, 5 = acceptable, and 1 = worst.

Beginning 7 days after treatment, one-half of each treated plot was mowed and fresh weight of clippings was determined. Height of growth of the unmowed canopy was measured following each weekly mowing. Quality rating, height measurement, and clipping weights were taken weekly through the 10th wk after treatment (DAT).

The height of tissue was reduced by the treatments through the first 8 wks after treatment (Table 29). The most effective treatment at reducing tissue height was the Limit + Embark material.

The treated plots produced lower clipping yields through the 7th wk after treatment (Table 30), but by the 8th wk the clipping heights from most of the treated plots exceeded that of the control. This post-inhibition growth is often observed on grasses that have been treated with growth regulating compounds. Total clipping yield over the 10-wk period was significantly reduced by all treatments except the Primo 25WP at the 0.27 lb ai/A rate. The most effective treatment was the Limit + Embark treatment that reduced total clippings by 21%.

The treated plots, except for the Limit and Embark combination, were observed to have lower quality ratings throughout the study except for the 3rd wk (Table 31). The lower ratings for the Primo treatments were due to a gray-green coloration of tissue through must of the test period.

Table 29. Height of tissue in cm measured from the surface of the ground.

Treatment	5/15	5/22	5/29	6/5	6/12	6/19	6/26	7/3	7/10	7/17	Avg Ht
--- lb ai/A ---		----------	----------	----------	----------	----------	cm	----------	----------	----------	----------
1. Control	X	15	23	28	33	35	35	31	34	33	30
2. Primo 1EC 0.27	X	12	17	22	27	30	29	26	30	32	25
3. Primo 1EC 0.41	X	10	18	27	29	28	27	28	29	35	26
4. Primo 25WP 0.27	X	10	20	23	28	31	33	32	31	33	27
5. Primo 25WP 0.41	X	12	18	23	29	35	31	28	31	32	27
6. Limit + Embark 1 + 0.1	X	11	12	18	15	18	19	20	24	29	18
$LSD_{(0.05)}$		1.5	5.3	7.3	5.9	5.4	5.5	3.9	N.S.	N.S.	27

Table 30. Weight of clippings from the mowed side of each treated plot.

Treatment	5/15	5/22	5/29	6/5	6/12	6/19	6/26	7/3	7/10	7/17	Total
--- lb ai/A ---	----------	----------	----------	----------	----------	g	----------	----------	----------	----------	----------
1. Control	82.9	101.2	48.6	27.7	33.0	55.5	49.9	54.9	81.3	111.7	646.1
2. Primo 1EC 0.27	59.5	69.5	51.1	15.2	14.6	40.7	40.3	66.2	89.1	110.6	556.8
3. Primo 1EC 0.41	39.8	53.0	46.4	18.4	12.9	31.8	28.1	48.5	78.0	103.7	460.6
4. Primo 25WP 0.27	63.2	79.1	45.3	16.3	20.4	49.5	39.2	56.1	93.0	108.1	570.2
5. Primo 25WP 0.41	45.6	72.1	46.2	12.8	14.1	40.8	38.4	57.1	86.1	104.8	517.9
6. Limit + Embark 1 + 0.1	46.7	28.2	36.3	18.8	15.8	45.6	41.5	59.2	97.7	116.1	505.9
$LSD_{(0.05)}$	24.4	23.5	N.S.	N.S.	10.8	11.7	11.0	N.S.	N.S.	N.S.	78.2

Table 31. Visual quality ratings of grass treated with five growth regulator treatments.

Treatment	5/15	5/22	5/29	6/5	6/12	6/19	6/26	7/3	7/10	7/17
--- lb ai/A ---										
1. Control	9	7	5	5	5	5	5	6	5	5
2. Primo 1EC 0.27	9	6	6	6	4	5	5	5	5	4
3. Primo 1EC 0.41	9	5	6	5	4	4	4	5	5	4
4. Primo 25WP 0.27	9	5	5	4	4	4	4	6	5	4
5. Primo 25WP 0.41	9	6	5	4	4	4	4	6	5	5
6. Limit + Embark 1 + 0.1	9	7	7	5	6	6	6	7	6	6
$LSD_{(0.05)}$	N.S.	1	0.6	0.6	0.5	0.8	0.9	0.4	0.5	0.6

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

Turfgrass Disease and Insect Research

Evaluation of Fungicides for Control of Snow Molds on Creeping Bentgrass, 1992-1993

M. L. Gleason

The trial was conducted on a creeping bentgrass tee (Hole #4) at the Waverly Municipal Golf Course, Waverly, IA. This tee had a history of outbreaks of gray and pink snow molds 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 11, 1992, using a modified bicycle sprayer at 30 psi and a dilution rate of 5 gal/1000 ft^2.

Snow cover persisted on the tee from November 20, 1992 until March 30, 1993. Symptoms were rated on April 5, 1993.

Snow mold development on untreated check plots was light to moderate (Table 32). Only gray snow mold symptoms were found in plots this year. All fungicide treatments gave significantly better control of snow mold than the untreated check; 11 of 29 fungicide treatments were free of snow mold damage. None of the fungicide treatments were significantly different from the others in disease suppression.

Table 32. 1992-1993 evaluation of fungicides for control of snow molds on creeping bentgrass at Waverly Municipal Golf Course, Waverly, IA.

Company	Product	Rate/1000 ft^2	Disease rating[a]
	Control		1.75a
ISK Biotech	Daconil Flo	8 oz.	0.00 b
	Daconil Flo	8 oz.	0.00 b
	+fluazanim flo (ASC66825)	2 oz.	
	Daconil Flo	8 oz.	0.00 b
	+ASC 67103 flo	1.25 oz.	
	Daconil Flo	8 oz.	0.25 b
	+ASC 67106	0.33 oz.	
	Daconil Flo	8 oz.	0.25 b
	+fluazanim flo (ASC66825)	3 oz.	
Grace-Sierra	GS/SM 92-01		0.00 b
	GS/SM 92-02		0.50 b
	GS/SM 92-03		0.25 b
	GS/SM 92-04		0.00 b
	GS/SM 92-05		0.25 b
	GS/SM 92-06		0.00 b

Company	Product	Rate/1000 ft^2	Disease rating[a]
	Control		1.75a
Grace-Sierra (cont.)	GS/SM 92-07		0.50 b
	GS/SM 92-08		0.75 b
	GS/SM 92-09		0.25 b
	GS/SM 92-10		0.75 b
	GS/SM 92-11		0.00 b
	GS/SM 92-12		0.00 b
DowElanco	Rubigan AS	8 oz.	0.50 b
	Rubigan AS	4 oz.	0.50 b
	Rubigan AS	2 oz.	0.75 b
BASF	Ronilan DF	1 oz. a.i.	0.75 b
	Ronilan DF	1 oz. a.i.	0.00 b
	+Daconil 75	4 oz. a.i.	
	Silbos 75 DF	5.7 oz. a.i.	0.50 b
Rhone-Poulenc	Chipco 26019WDG (EXP10370A)	4 oz.	0.25 b
	+Daconil 2787 flo	8 oz.	
	Chipco 26019WDG (EXP10370A)	2 oz.	0.00 b
	+Daconil 2787 flo	8 oz.	
	EXP10364A flo	3 oz.	0.25 b
	EXP10364A flo	4 oz.	0.00 b
Terra Int'l	Chlorothalonil 90DF	4 oz.	0.75 b
	+Chipco 26019 flo	8 oz.	
	Chlorothalonil 90DF	8 oz.	0.25 b
	+Chipco 26019 flo	8 oz.	

[a]Means of 4 replications. 0 = no disease; 1 = 1-10% of plot showing symptoms; 2 = 10-25% of plot; 3 = 25-50% of plot; 4 = > 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

M. 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 2-ft-wide strips of untreated turf in order to help create uniform disease pressure.

Fungicide applications began on May 25 and continued at recommended intervals (7, 14, 21, or 28 days) until August 7. Disease development was rated on July 17, August 1, and August 14.

The summer of 1992 was the second coolest in Iowa in 120 years. Low temperatures in June through August suppressed development of brown patch symptoms, despite above-average rainfall in July.

Despite the light to moderate disease pressure, several materials were not significantly better for disease control than the untreated check: Ronilan 50 DF at 0.5 and 1 oz a.i. at a 14-day interval; Chipco Flo at 2 and 4-oz rates at 21 days; and Vorlan Flo at a 2 oz rate at 21-day interval. All other treatments gave significantly better control than the check on at least 2 of the 3 rating dates.

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 33. 1992 Fungicide tests for brown patch.

Company	Product	Rate/1000 ft^2	Application Interval (days)	Disease Development[1] July 17	August 1	August 14
	UNTREATED			1.00 ab	0.00 c	1.33 ab
Rhone-Poulenc	Chipco 26019 WDG	2.0 oz	14	0.00 c	1.0 abc	0.00 d
	Chipco 26019 WDG	2.0 oz	21	0.00 c	0.33 c	1.00 bc
	Chipco 26019 Flo	4.0 oz	21	0.00 c	0.67 bc	0.67 bcd
	EXP 10064 C	1.0 oz	21	0.00 c	0.00 c	0.00 d
	EXP 10064 C	2.0 oz	21	0.00 c	0.00 c	0.00 d
	Chipco 26019 WDG	2.0 oz	21	0.00 c	0.00 c	0.00 d
	+ EXP 10064 C	1.0 oz				
	Chipco 26019 WDG	2.0 oz	21	0.00 c	0.00 c	0.00 d
	+ EXP 10357 A	0.25 oz				
DowElanco	Broadway	6.0 oz	7	0.00 c	0.00 c	0.00 d
Rohms & Haas	Eagle	0.6 oz	14	0.00 c	0.00 c	0.00 d
Miles	Lynx 25 DF	0.5 oz	14	0.00 c	0.00 c	0.00 d
BASF	Curalan F	0.5 oz a.i.	14	0.00 c	1.0 abc	0.00 d
	(4.17 lb ai/gal)					
	Ronilan 50 DF	1.0 oz a.i.	14	1.00 ab	2.00 a	0.33 cd
	Ronilan 50 DF	0.5 oz a.i.	14	0.67 bc	0.33 c	0.33 cd
	Ronilan 50 DF	0.5 oz a.i.	14	0.00 c	0.33 c	0.00 d
	+ Thiram 75 WP	0.5 oz a.i.				
	Ronilan 50 DF	0.5 oz a.i.	14	0.00 c	0.00 c	0.00 d
	+ Daconil 75 WP	3.0 oz a.i.				
	Silbos 75 DF	5.7 oz a.i.	14	0.00 c	0.00 c	0.00 d
Nor-Am	ProStar 70 WG NA 248	1.43 oz	14	0.00 c	0.00 c	0.00 d
	ProStar 70 WG NA 248	2.14 oz	21	0.00 c	0.00 c	0.00 d
	ProStar 50 WP NA 211	2.0 oz	14	0.00 c	0.33 c	0.00 d
	ProStar 50 WP NA 211	3.0 oz	21	0.00 c	0.00 c	0.00 d
	ProStar 70 WG NA 248	1.43 oz	28	0.00 c	0.00 c	0.00 d
	+ Cyproconazole 40 WG	0.17 oz				
	ProStar 70 WP NA 313	1.79 oz	28	0.00 c	0.00 c	0.00 d
	+ Cyproconazole 40 WG	0.17 oz	28	0.00 c	0.00 c	0.00 d
	Bayleton 25 WG	1.0 oz	28	0.67 bc	0.00 c	0.00 d
	ProStar 70 WP NA 304	1.43 oz	14	0.00 c	0.00 c	0.00 d
	ProStar 70 WP NA 304	2.14 oz	21	0.00 c	0.00 c	0.00 d

Company	Product	Rate/1000 ft^2	Application Interval (days)	Disease Development[1]		
				July 17	August 1	August 14
Sandoz	Sentinel 40 WG	0.25 oz	21	0.00 c	0.00 c	0.00 d
	Sentinel 40 WG	0.25 oz	28	0.00 c	0.00 c	0.00 d
	Sentinel 40 WG	0.33 oz	28	0.00 c	0.00 c	0.00 d
*Grace-Sierra	GSTG-9214 (PCNB 75W)	4.0 oz	7	0.00 c	0.00 c	0.00 d
	GSTG-9218 (PCNB 75W)	4.0 oz	7	0.00 c	0.00 c	0.00 d
	GSTG-9207:		21	0.00 c	0.00 c	0.00 d
	Myclobutanil 40 WP	0.5 oz				
	Fungo 85 DF	0.6 oz				
	GSTG-9208:		21	0.00 c	0.00 c	0.00 d
	Myclobutanil 40 WP	0.5 oz				
	Fungo 85 DF	1.2 oz				
	GSTG-9209:		21	0.00 c	0.00 c	0.00 d
	Myclobutanil 40 WP	0.75 oz				
	Fungo 85 DF	0.6 oz				
	Vorlan Flo	2.0 fl oz	21	1.33 a	1.67 ab	2.00 a
	Vorlan Flo	4.0 fl oz	21	0.67 bc	0.00 c	0.33 cd
ISK Biotech	Daconil 2787 F	6.0 fl oz	14	0.00 c	0.00 c	0.00 d
	ASC-66518	3.8 oz	14	0.00 c	0.00 c	0.00 d
	ASC-66825 F	1.0 fl oz	21	0.00 c	0.00 c	0.00 d
	ASC-66825 F	2.0 fl oz	28	0.00 c	0.00 c	0.67 bcd
	Daconil 2787 F	3.0 fl oz	21	0.00 c	0.00 c	0.00 d
	+ ASC-66825	0.4 fl oz				
ICIA	Hexaconozole	4.0 g a.i.	21	0.00 c	0.00 c	0.00 d
	Hexaconozole	6.0 g a.i.	21	0.00 c	0.00 c	0.00 d

[1]Ratings are as follows:

0 = no disease
1 = 1-10% of plot area with symptoms
2 = 10-25% of plot area with symptoms
3 = 25-50% of plot area with symptoms
4 > 50% of plot area with symptoms

*Means in the same column followed by the same letter are significantly different (DMRT, P=0.05).

Evaluation of Fungicides for Control of Dollar Spot in 'Penncross' Bentgrass -- 1992

M. L. Gleason

Trials were conducted at the Turfgrass Research Area of Iowa State University's Horticulture Research Station. 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 on June 1 and continued at recommended intervals (7, 15, 21, or 28 days) until July 27. Disease development was rated on June 30, July 15, and August 3.

Disease development was moderate during the test period. Several materials were not significantly better for disease control than the untreated check on at least two rating dates: Chipco 26019 Flo and WDG at 2 oz and a 28-day interval; and tank mixes of EXP 10357 A with Chipco at 28 days. Other treatments varied widely in efficacy.

PCNB 75 W at the 10 oz rate and a 7-day interval caused moderately severe yellowing and browning of the turf in July and August. Hexaconazole at the 6 g a.i. rate and 21-day interval caused a slight browning of turf on June 30, but not on later rating dates.

Table 34. 1992 Fungicide tests for Dollar spot.

Company	Product	Rate/1000 ft^2	Application Interval (days)	# Spots per plot[1] June 30	# Spots per plot[1] July 15	# Spots per plot[1] August 3
	UNTREATED			96.50 a	120.00 ab	125.00 a
Rhone-Poulenc	EXP 10064 C	0.5 fl oz	28	13.50 ef	54.50 def	32.00 cd
	EXP 10064 C	1.0 fl oz	28	1.00 f	29.25 efg	31.00 cd
	Chipco 26019 WDG	2.0 oz	28	62.00 bcd	101.25 abc	112.25 ab
	Chipco 26019 Flo	2.0 oz	28	71.75 abc	131.25 a	114.25 ab
	EXP 10064 C	0.5 fl oz	28	65.50 bcd	22.25 fg	51.25 cd
	+ Chipco 26019 WDG	1.0 oz				
	EXP 10357 A	0.125 oz	28	87.00 ab	101.25 bc	138.50 a
	+ Chipco 26019 WDG	1.0 oz				
	EXP 10357 A	0.063 oz	28	45.25 cd	84.75 bcd	108.00 ab
	+ Chipco 26019 WDG	1.0 oz				
DowElanco	Rubigan AS	1.5 fl oz	14	0.00 f	0.25 g	0.00 d
	Broadway	4.5 fl oz	14	0.00 f	0.75 g	0.00 d
Rohms & Haas	Eagle	0.6 oz	21	0.00 f	0.25 g	0.00 d
	RH-0611 F	6.0 oz	14	0.00 f	0.00 g	0.00 d
Miles	Lynx 25 DF	0.5 oz	21	0.00 f	0.75 g	0.00 d
	Bayleton 25 DF	1.0 oz	21	0.50 f	1.25 g	9.50 d
	Bayleton 25 DF	0.5 oz	14	0.00 f	0.25 g	0.25 d
	+ Dyrene 4F	4.0 fl oz				
	Dyrene 4F	6.0 fl oz	14	4.00 ef	54.75 def	29.50 cd
Nor-Am	ProStar 70 WG NA 248	1.43 oz	28	3.75 ef	0.25 g	0.75 d
	+ Cyproconazole 40 WG	0.17 oz				
	ProStar 70 WP NA 313	1.79 oz	28	11.25 ef	4.00 g	9.50 d
Sandoz	Sentinel 40 WG	0.166 oz	28	1.75 f	0.00 g	0.25 d
Grace-Sierra	Vorlan Plus	2.0 oz	21	0.25 f	2.00 g	0.00 d
	GSTG-9215 (PCNB 75 W)	10 oz	7	0.00 f	0.00 g	0.00 d
ISK Biotech	Daconil 2787 F	6.0 fl oz	14	9.50 ef	67.75 cde	38.00 cd
	ASC-66518	3.8 oz	14	7.00 ef	73.50 cd	37.50 cd
	ASC-66825 F	1.0 fl oz	21	0.00 f	14.00 fg	0.50 d
	ASC-66825 F	2.0 fl oz	28	35.25 de	11.00 g	40.75 cd
	Daconil 2787 F	3.0 fl oz	21	1.00 f	71.25 cd	66.25 bc
	+ ASC-66825 F	0.4 fl oz				
ICIA	Hexaconozole	4.0 g a.i.	21	0.50 f	0.75 g	0.00 d
	Hexaconozole	6.0 g a.i.	21	0.00 f	0.00 g	0.00 d

[1]Means in the same column followed by the same letter are not significantly different (DMRT, P=0.05).

Pythium and Root Disease of Creeping Bentgrass

C. F. Hodges and D. A. Campbell

The ability of *Pythium* species to cause root diseases in grasses adapted to turf culture is well recognized (Smiley et al. 1992; Smith et al. 1989), but the number of critical studies of *Pythium* species as root pathogens of *Agrostis palustris* (creeping bentgrass) is relatively limited. Recognition of *Pythium* species as root pathogens of *A. palustris* seems based on seedling inoculations (seminal roots) (Endo 1961, Kraft and Endo 1966, Kraft et al. 1967, Nelson and Craft 1991), inoculations of adventitious roots (Hodges 1992, Hodges and Coleman 1985, Nelson and Craft 1991), and to some extent an inference of pathogenicity on the basis of isolations from soils and roots supporting this turf species. The general recognition of *Pythium* species as root pathogens of *A. palustris* makes little distinction between the response of seminal and adventitious root infection; i.e., a kind of unstated acceptance that the response of one root system is typical of the other. In this respect, seminal root infection may be more representative of postemergence damping-off diseases and may have little or no relevance to more complex *Pythium* interactions with the adventitious root systems of mature stands of *A. palustris*.

Research in our laboratory has concentrated on the infection of adventitious roots of *A. palustris* with numerous species and isolates of *Pythium* (Table 35). Most *Pythium* species isolated from adventitious roots of diseased *A. palustris* will infect adventitious roots of healthy plants in controlled studies. The ability to infect is isolate specific and temperature dependent (Table 36) in many species; i.e., isolates of the same species show different levels of pathogenicity and may be indifferent to temperature, or may require high or low temperatures to damage plants. Damage under controlled studies, however, is limited to reduced growth and infection of the roots is confined to root tips, root hairs, and epidermal and cortical tissues without causing rot. These infection characteristics place *Pythium* species within the broad class of minor root pathogens (Salt 1979). The term "minor" does not mean that these pathogens are unimportant; the term refers to pathogens found primarily in juvenile tissues that generally do not kill the host plant unless it is under stress and/or occurs in combination with other minor pathogens.

Research conducted in our laboratory over the last eight years suggests that the damage to *A. palustris* by *Pythium* species falls into two broad categories, both of which typify the behavior of minor root pathogens. The first category is represented by the disease termed *Pythium* root dysfunction (Hodges and Coleman 1985) and other disorders that occur in stands of *A. palustris* turf one-year old or younger (Nelson and Craft 1991). These diseases of youthful stands of turf can cause extreme damage on newly established greens within the first year of establishment, but it rarely occurs after the first year. This type of disease development reflects the ability of *Pythium* to severely infect young maturing tissues as plants establish and to kill those plants when they are subjected to heat stress. The second category is represented by *Pythium* damage to mature stands of *A. palustris* turf five or more years of age. Under these circumstances, turf is lost in a rather nondescript fashion (chlorosis, wilting, thinning). Typically the adventitious roots yield *Pythium*, but they also yield other potential root pathogens. Most common among the other organisms isolated are *Microdochium bolleyi* and *Acremonium* (*Cephalosporium*); to a lesser extent, *Bipolaris sorokiniana*, *Curvularia geniculata*, *C. lunata*, and species of *Fusarium* are isolated. It is also common to isolate *Pythium* from *A. palustris* roots with prominent populations of ectotrophic hyphae. Diseased adventitious roots that yield *Pythium* and a host of other potential root pathogens are typical of minor root pathogen interactions and the resulting disease cannot be attributed entirely to *Pythium* species. *P. torulosum* is a common isolate from *A. palustris* roots and interacts with *Desulfovibrio desulfuricans* in black-layered sand to decrease shoot and adventitious root growth more than that caused by either organism alone (Hodges 1992).

Table 35. *Pythium* species and isolates evaluated for pathogenicity to adventitious roots of *Agrostis palustris*.[1]

1. *Pythium graminicola/arrhenomanes* isolates

PGA-1 *P. graminicola*
PGA-2 *P. graminicola*
PGA-3 *P. graminicola*
PGA-4 Intermediate between *P. graminicola* and *P. arrhenomanes*
PGA-5 Intermediate between *P. graminicola* and *P. arrhenomanes*
PGA-6 Intermediate between *P. graminicola* and *P. arrhenomanes*
PGA-7 Characteristics closer to *P. arrhenomanes* than *P. graminicola*

2. *Pythium rostratum* isolates

PR-1 *P. rostratum*

3. *Pythium torulosum* isolates

PT-1 *P. torulosum*
PT-2 *P. torulosum*
PT-3 *P. torulosum*
PT-4 Characteristics closer to *P. torulosum* than *P. vanterpooli*
PT-5 Characteristics closer to *P. torulosum* than *P. vanterpooli*

4. *Pythium vanterpooli* isolates

PV-1 *P. vanterpooli*
PV-2 *P. vanterpooli*

5. Unclassified *Pythium* isolates
UP-1 Unclassified

[1]Classification of the *Pythium* species in this table was provided by Dr. W. A. M. de Cock, Centraalbureau voor Schimmelcultures, Julianalaan 67a, 2628 BC DELFT (Netherlands). All *Pythium* species were isolated from the roots of diseased *Agrostis palustris* on golf greens.

There is little to be gained by future adventitious root inoculation studies with isolates of *Pythium*. It is clear that most will infect, but severity of disease and the environmental requirements for disease vary with each isolate of a given species. Future work must begin to examine the genetics of pathogenicity of *Pythium* isolates and the physiology of the diseases they cause. Although controlled inoculations of *A. palustris* adventitious roots do not kill plants, it often severely stunts their growth. The stunting is remarkable in that the infection is often light and relatively superficial in the root tissue. This suggests that potent growth regulating substances are produced (hormones and/or toxins). None of these relationships have been extensively researched and they may hold the key to understanding the wide range of pathogenic responses associated with *Pythium* infections.

Table 36. The Effect of Temperature on the Growth Response of *Agrostis Palustris* to Root Inoculation with Various *Pythium* Isolates

Isolate	Low temperature growth (% of control)	High temperature growth (% of control)
A. Low Temperature Damage Only		
PGA-3	49*	89
PR-1	59*	95
PV-2	75*	90
B. High Temperature Damage Only		
PGA-1	101	81*
PGA-4	90	53*
PGA-6	95	60*
C. Low and High Temperature Damage		
PGA-5	35*	69*
PT-2	44*	69*
PT-3	59*	74*
PT-5	49*	84*
PV-1	59*	74*
UP-1	46*	83*
PT-1	74*	67*

*Significant increase or decrease in growth.

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Comparative Effectiveness of Insecticides Against Annual White Grubs, 1992

D. R. Lewis and N. E. Christians

Damage to turfgrass by annual white grubs (*Cyclocephala* spp.) is a common, but spotty and locally severe problem in Iowa. The amount of damage varies greatly from place to place and from year to year, depending on several factors such as grass variety, cultural maintenance practices, irrigation and weather. Root feeding by these masked chafer larvae characteristically causes grass to wilt, turn tan and finally die, usually in late August or early September. Several granular and sprayable insecticide products are registered for white grub control. Timing of insecticide application is very important in achieving effective control of white grubs before damage becomes severe.

The objective of this study was to evaluate and compare the efficacy of several registered and experimental insecticides against annual white grubs infesting turfgrass.

The trial was conducted on the Turfgrass Research Plots at the Horticulture Research Station of Iowa State University near Ames, IA. The study site was a healthy and vigorous 8-year old stand of Majestic Kentucky bluegrass established on a Nicollet (fine loamy, mixed, mesic Aquic Hapludoll) soil with a pH of 6.7, 3.4% organic matter, 9 ppm phosphorous and 86 ppm potassium. The turfgrass received 3 to 4 lbs N/1000 ft^2 annually, was maintained at a 2 - 3 inch mowing height and irrigated as needed. The plot area was on level ground and had less than 1/4 inch of thatch.

Grubs were not present in the plot area through mid- to late-summer. Two thousand annual white grubs were collected from a natural infestation beneath a street light at the south edge of Ames, IA on September 29 & 30 and transferred immediately following collection to the treatment plots. A sod cutter, set to cut 1 3/4 inch deep, and a spade had been used to remove the sod from a 12 by 18 inch area (1.5 sq ft) in the center of each plot before the grubs were collected. The loose sod was lifted and 45 mixed age white grubs (75% third instar, 25% second instar) were uniformly scattered on the soil surface and the sod piece gently replaced.

The insecticide treatments were applied 9 to 14 days following establishment of the grubs at the treatment site. The granular insecticides were applied on October 8; liquid sprays were applied on October 12.

The experimental design consisted of 12 treatment plots and one untreated check plot, randomly assigned in each of three replications. Each plot consisted of a five foot square area (25 ft^2). All insecticides were applied at the rate specified on the manufacturer's label or product guidelines. Liquid and dry flowable insecticides were diluted with water. Sprays were applied with a carbon-dioxide, back pack sprayer, connected to a hand-held, three-nozzle boom. The sprayer operated at 20 psi and was equipped with number 8006 nozzles. The boom covered a 5-foot wide area, and diluted insecticide spray was applied to the test plots with alternating perpendicular passes over the treatment plot. The amount of spray solution applied to each plot was the equivalent of 131 gallons per acre or 3 gal/1000 ft^2. Granular insecticides were premeasured into round, cardboard containers and applied uniformly over the plot by shaking through a perforated lid.

A light rain fell overnight following granular application and 1/2 inch mechanical irrigation of the entire trial was applied immediately following the liquid spray applications. An additional 1 inch of irrigation was applied on October 21 and on October 27. There was no significant rainfall between application and data collection.

Annual white grub population counts were made on October 27, 15 days after the final treatments and watering in. Surviving grubs were counted by lifting the cut sod piece from the center of each plot and examining the soil surface and underside of the sod for grubs. Soil beneath the cut sod was removed to a depth of 6 inches and carefully pulverized by hand, the grubs removed and counted.

The insecticides used in this project, the formulation, rate of application and mean number of white grubs per square foot are given in Table 37. The number of grubs per square foot was calculated from the total number found in each 1.5 ft^2 plot sample. Experimental insecticides covered by a confidentiality agreement are not included in this table.

Significant differences among treatments and between treatments and the untreated check were determined by analysis of variance. Means followed by the same letter are not significantly different at the 0.05 level.

The average number of grubs surviving in the untreated check plots was approximately 10 per square foot, a population density that is considered likely to cause significant damage to turfgrass. However, the grass in the plots looked very good at the time of the grub counts with evidence that the cut sod was rooting to the soil.

The ANOVA analysis reported in Table 37 shows that all products significantly reduced the number of grubs surviving in the treated plots. Converting the surviving number of grubs to "percent control" by dividing the difference between the treated and control counts by the number in the check, as is often done for comparison purposes, indicates a 41 to 80% population reduction by the insecticides.

The top performing compounds in this study were Turcam, Mocap, diazinon and an experimental Miles product, soon to be released under the trade name Merit. High levels of control achieved by Turcam products in this test contrast with results in earlier Iowa trials, but compares to results achieved in other states. Sevimol and Triumph significantly reduced the number of grubs in the plots, but not as well, in this test, as the other products. The level of control for Sevimol (active ingredient carbaryl) was about what was expected based upon other tests. Triumph has been a top-performing compound in earlier Iowa tests and in other trials around the country and its relatively low performance in this trial came as a surprise.

The relatively low rates of control (40 to 80%) achieved in this test may be due to the time and method of this study. The study was conducted later than the optimum time for grub treatment because cool, rainy weather in July through September slowed grub development and eliminated the chances of doing the study at a naturally infested site. The number of grubs in the check indicates only a 32% survival rate for transplanted grubs. During the final sampling, grubs were found at depths up to 6 inches in all plots, indicating they were already migrating deep into the soil in preparation for winter. If these grubs migrated downward at the time they were transplanted, they would have escaped the toxic effect of surface applied insecticides that are generally confined to the top layers of soil.

No phytotoxicity was observed in any of the treatment plots.

Table 37. 1992 Insecticide Efficacy Trial for White Grubs

Insecticide Product	Rate lb ai/A	Mean number white grubs per square foot		Percent Control
Check		9.8	A	
R-P Chipco Sevimol (4 E)	8.0	5.8	B	41
Ciba-Geigy Triumph 4 E	2.0	4.7	BC	52
Miles BAY NTN 33893	6.0 oz	3.5	CD	64
Ciba-Geigy Diazinon 14 G	4.0	3.3	CD	66
Nor-Am Turcam 2.5 G	3.0	3.1	CD	68
Nor-Am Turcam 76 WP	3.0	2.7	CD	73
R-P Chipco Mocap 5 G	5.0	2.5	D	75
Nor-Am Turcam 2.5 G	2.0	2.0	D	80

Means followed by the same letter are not significantly different.

Fertilizer Trials

The Effects of Granular Nitrogen Fertilizer Sources on the Growth and Quality of 'Vantage' Kentucky Bluegrass

M. L. Agnew and S. M. Berkenbosch

Turfgrass manager are presented with many choices of nitrogen fertilizers. Slowly available nitrogen sources are promoted to provide longer residual nitrogen response, decreased foliar burn, and deceased loss of nitrogen through leaching and volatilization. Slowly available nitrogen sources may be classified as either natural organic, synthetic organic, or coated.

The objective of this study is to measure the efficacy of several slowly available nitrogen fertilizer sources and the rate of nitrogen application on the growth and development of Kentucky bluegrass.

Research was conducted at the Iowa State University Horticulture Research Station. Treatments included fertilizer source and fertilizer rate of application. With the exception of Pursell Industries products, all slowly available nitrogen sources were applied at a 1 and 2 lb N/1000 ft^2 rated. A 1-lb N/1000 ft^2 rate of urea and a non-fertilized control were included for comparison purposes. All treatments are listed in Table 38. The turf was a 'Vantage' Kentucky bluegrass. Plots measure 2.5' X 10' and are replicated 3 times in a complete randomized block design. Fertilizers were applied on May 8 and August 18.

All plots were mowed at a 2-in height with all clippings removed. The plots were irrigated with a minimum of 1.0 in water/growing week when sufficient rains did not occur. The early part of the summer was very dry, however rainfall was ample after June 15.

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 within a 1.75 ft by 10 ft (17.5 ft^2) area. Clippings were dried at 65°F for 48 hours and weights recorded.

Due to the size of this study, the visual quality data is separated into four tables. Tables are separated as synthetic slow release nitrogen sources (Table 39), natural organic nitrogen sources (Table 40), combination fertilizer source; ie. nitrogen sources that contain a natural organic nitrogen source and another nitrogen fertilizer source (Table 41), and resin coated fertilizer provided by Pursell Industries (Table 42).

For synthetic slow release nitrogen sources, the 2 lb N application rate substantially improved the overall quality of turfgrass plants over the 1 lb N treatment (Table 39). Scott's methylene urea, Norman's Nutralene, Noram's MUAS, and Lesco's SCU elite provided the best overall quality for synthetic slow release nitrogen sources at the 2 lb N applications. Scott's 42-0-0 treated plots exhibited the best overall quality at the 1 lb N applications.

For natural organic nitrogen sources, the 2 lb N application rate improved visual quality over the 1 lb N rate (Table 40). Corn Gluten meal, Terrene 5-2-0, and Turf 10-2-6 exhibited the best overall quality of the natural organic nitrogen sources at the 2 lb N levels, while Corn Gluten meal, Turf 10-2-6, Sustane 5-2-4, Terrene 5-2-0, and Naturall 8-1-3 treated plots performed best at 1 lb N levels.

For the combination fertilizer sources, the 2 lb N application rate improved visual quality over the 1 lb N rate (Table 41). There was essentially no difference between fertilizer sources at either the 1 and 2 lb N application rates levels.

For the Pursell Industries products, the fertilizer sources applied at the 1 lb N rate had an overall visual quality rating similar to the fertilizer sources applied at the 2 lb N rate (Table 42). The 4 lb N application rate provided excellent season long quality of Kentucky bluegrass.

As with the visual quality data, the clipping yield data is separated into four tables. Tables are separated as synthetic slow release nitrogen sources (Table 43), natural organic nitrogen sources (Table 44), combination fertilizer source (Table 45), and resin coated fertilizer provided by Pursell Industries (Table 46).

For synthetic slow release nitrogen sources, the 2 lb N application rate increased clipping production when compared to the 1 lb N rate (Table 43). Scott's 42-0-0, Noram's Nutralene, Lesco's SCU elite, and Noram's MUAS produced the greatest amount of clippings at the 1 and 2 lb N rates.

For natural organic nitrogen sources, the 2 lb N application rate improved clipping yields for corn gluten meal, Turf 10-2-6, Milorganite 6-2-0, and Terrene 5-2-0 over the 1 lb N rate (Table 44). UHS 3-4-2 produced the least amount of clippings of the natural organic nitrogen sources.

For the combination fertilizer sources, the 2 lb N application rate increased clipping yields for UHS 12-1-1, UHS 9-4-4, and UHS 12-2-8 (Table 45). There was essentially no difference between fertilizer source at either the 1 or 2 lb N application rates levels.

For the Pursell Industries products, there was very little difference in clipping yields between fertilizer sources applied at the 1 and 2 lb N rates (Table 46). The 4 lb N application rate produced the greatest amount of clippings total for all fertilizers tested.

Table 38. List of treatments.

Fertilizer Source	**#N/1000 ft^2/application**
Nutralene 40-0-0	1.0
Nutralene 40-0-0	2.0
MUAS 32-0-0	1.0
MUAS 32-0-0	2.0
Ureaform 38-0-0	1.0
Ureaform 38-0-0	2.0
Scott's 42-0-0	1.0
Scott's 42-0-0	2.0
LESCO SCU 37-0-0	1.0
LESCO SCU 37-0-0	2.0
LESCO SCU elite 29-0-0	1.0
LESCO SCU elite 29-0-0	2.0
Corn Gluten 10-0-1	1.0
Corn Gluten 10-0-1	2.0
Turf 10-2-6	1.0
Turf 10-2-6	2.0
Milorganite 6-2-0	1.0
Milorganite 6-2-0	2.0
Naturall 8-1-3	1.0
Naturall 8-1-3	2.0
UHS 3-4-2	1.0
UHS 3-4-2	2.0
Sustane medium 5-2-4	1.0
Sustane medium 5-2-4	2.0
Terrene 5-2-0	1.0
Terrene 5-2-0	2.0
Terrene 6-2-0	1.0
Terrene 6-2-0	2.0
Ringer Fairway/LCO 12-2-6	1.0
Ringer Fairway/LCO 12-2-6	2.0
UHS 12-1-1	1.0
UHS 12-1-1	2.0
UHS 9-4-4	1.0
UHS 9-4-4	2.0
UHS 12-2-8	1.0
UHS 12-2-8	2.0
Earthgro 8-2-4	1.0
Earthgro 8-2-4	2.0
Sustane + Polyon 10-2-10	1.0
Sustane + Polyon 10-2-10	2.0
Sustane + Polyon 12-2-8	1.0
Sustane + Polyon 12-2-8	2.0
Urea 46-0-0	1.0
Control	0.0
Pursell 44.5-0-0	1.0
Pursell 42.5-0-0	2.0
Pursell 43-0-0	1.0
Pursell 44-0-0	2.0
Pursell 42-0-0	4.0 (spring only)

Table 39. The effects of synthetic slow release nitrogen fertilizer source and application rate on the visual quality of Kentucky bluegrass following applications.

Nitrogen Source		May		June					July			August	September			
Synthetic Slow Release	lbs N/ Appl.	18	27	2	9	16	24	29	9	21	30	10	3	17	30	Average
Nutralene 40-0-0	1	8.0	7.0	7.3	7.0	6.7	6.7	6.3	7.0	7.0	8.3	7.3	8.0	8.0	6.7	7.2
Nutralene 40-0-0	2	9.0	9.0	8.3	8.0	7.0	7.7	7.3	8.7	8.0	8.7	7.7	9.0	9.0	8.0	8.2
MUAS 32-0-0	1	8.7	7.3	7.7	7.0	6.3	7.0	6.3	6.7	7.0	7.3	7.0	8.0	7.3	6.0	7.1
MUAS 32-0-0	2	9.0	8.7	8.0	7.7	7.0	7.7	7.0	8.7	8.0	9.0	8.0	9.0	8.7	7.3	8.1
Ureaform 38-0-0	1	7.0	6.7	6.7	6.0	6.0	6.0	6.0	7.3	6.7	7.0	7.0	7.0	6.0	5.7	6.5
Ureaform 38-0-0	2	8.3	7.7	7.0	7.0	6.3	6.3	6.7	7.3	7.3	8.7	7.7	8.0	7.0	6.7	7.3
Scotts M.U. 42-0-0	1	9.0	8.3	7.7	7.7	7.0	7.7	7.0	8.0	7.7	8.0	7.3	8.3	8.0	6.7	7.7
Scotts M.U. 42-0-0	2	9.0	9.0	9.0	8.0	7.3	8.0	7.0	9.0	8.0	8.3	8.0	9.0	8.7	7.3	8.3
Lesco SCU 37-0-0	1	7.0	7.3	7.0	6.7	6.3	6.7	6.3	7.0	7.3	8.0	7.3	7.0	7.3	6.0	7.0
Lesco SCU 37-0-0	2	8.0	7.7	7.3	7.3	6.3	7.3	7.0	8.7	8.3	9.0	8.3	8.3	8.3	7.7	7.8
Lesco SCU elite 29-0-0	1	8.0	8.0	7.7	7.3	6.3	6.3	7.0	7.3	7.3	8.0	7.3	7.0	6.3	6.0	7.1
Lesco SCU elite 29-0-0	2	9.0	9.0	9.0	8.3	7.0	8.3	7.7	8.3	9.0	9.0	8.0	8.0	7.0	6.3	8.1
Urea 46-0-0	1	8.0	8.3	7.7	7.7	7.0	8.0	7.0	8.0	7.0	7.7	7.0	9.0	8.0	6.7	7.6
Control	--	7.0	6.7	7.0	6.3	6.7	6.0	5.7	6.3	6.3	7.0	7.0	6.3	5.3	5.3	6.4
LSD $_{(0.05)}$		1.2	1.1	1.0	N.S. *	1.2	0.7	0.8	1.0	0.8	0.9	0.8	0.7	0.7	1.1	0.4

* Significant at a 0.10 level

Table 40. The effects of natural organic slow release nitrogen fertilizer source and application rate on the visual quality of Kentucky bluegrass following applications.

Nitrogen Source	lbs N/	May		June					July			August	September			
Natural Organic	Appl.	18	27	2	9	16	24	29	9	21	30	10	3	17	30	Average
Corn Gluten Meal 10-0-1	1	7.0	7.0	6.3	7.0	6.3	7.0	6.7	7.7	7.3	7.7	7.7	7.7	8.0	7.0	7.2
Corn Gluten Meal 10-0-1	2	7.3	7.7	7.7	7.3	6.7	8.0	7.3	9.0	8.7	9.0	8.3	7.7	8.7	8.3	8.0
Turf 10-2-6	1	6.3	7.0	7.0	7.0	6.7	7.0	7.0	8.0	7.3	8.0	7.7	7.7	7.7	6.7	7.2
Turf 10-2-6	2	7.3	8.0	7.3	7.7	6.7	8.0	7.7	8.3	8.3	8.3	7.3	9.0	9.0	7.7	7.9
Milorganite 6-2-0	1	6.3	6.3	6.0	6.0	5.7	6.0	6.0	6.7	7.0	7.7	7.3	7.0	7.0	6.0	6.5
Milorganite 6-2-0	2	7.0	7.7	8.0	7.0	6.0	7.7	7.0	8.0	8.3	8.0	7.7	8.0	8.0	7.0	7.5
Naturall 8-1-3	1	7.3	7.3	7.0	6.0	5.0	6.7	6.3	8.0	7.7	8.0	8.0	7.3	6.7	6.0	7.0
Naturall 8-1-3	2	7.7	8.0	7.7	7.3	6.7	7.7	7.3	9.0	8.7	8.3	7.7	8.3	9.0	7.3	7.9
UHS 3-4-2	1	7.3	6.3	6.3	6.0	6.0	6.0	6.0	6.7	7.0	7.0	7.0	6.0	5.3	5.3	6.3
UHS 3-4-2	2	6.3	7.0	6.7	6.7	6.7	6.3	6.3	7.0	7.3	8.0	7.3	6.0	6.0	6.0	6.7
Sustane 5-2-4	1	7.7	6.3	6.7	6.3	6.0	6.7	7.0	8.0	7.3	7.7	7.3	7.7	7.7	6.7	7.1
Sustane 5-2-4	2	7.7	7.3	7.3	6.7	6.3	7.3	7.0	8.0	8.3	8.0	7.3	8.7	8.3	7.3	7.5
Terrene 5-2-0	1	6.7	7.0	7.0	6.7	6.7	7.0	6.7	7.7	7.0	7.7	7.3	7.7	7.3	6.0	7.0
Terrene 5-2-0	2	7.0	8.0	8.7	8.0	7.0	8.0	7.7	8.7	9.0	9.0	8.0	9.0	9.0	7.7	8.2
Terrene 6-2-0	1	7.0	7.0	6.7	6.7	6.0	6.3	6.0	7.0	7.0	7.7	7.3	7.3	6.7	6.0	6.8
Terrene 6-2-0	2	7.7	7.7	7.0	7.0	5.7	7.0	7.0	7.7	7.7	8.0	7.7	8.0	7.3	6.3	7.3
Urea	1	8.0	8.3	7.7	7.7	7.0	8.0	7.0	8.0	7.0	7.7	7.0	9.0	8.0	6.7	7.6
Control	--	7.0	6.7	7.0	6.3	6.7	6.0	5.7	6.3	6.3	7.0	7.0	6.3	5.3	5.3	6.4
$LSD_{(0.05)}$		1.2	1.1	1.0	N.S.*	1.2	0.7	0.8	1.0	0.8	0.9	0.8	0.7	0.8	1.1	0.4

* Significant at a 0.10 level

Table 41. The effects of combination nitrogen fertilizer sources and application rate on the visual quality of Kentucky bluegrass following applications.

Nitrogen Sources		May		June					July			August	September			
Combination Fertilizers	lbs N/ Appl.	8	27	2	9	16	24	29	9	21	30	10	3	17	30	Average
Ringer 12-2-6	1	7.7	7.7	7.3	7.0	7.0	7.0	6.7	7.7	7.3	8.3	7.3	8.0	7.3	6.0	7.3
Ringer 12-2-6	2	9.0	8.7	8.3	8.0	7.0	8.0	7.3	8.7	8.3	8.3	7.7	9.0	9.0	6.7	8.1
UHS 12-1-1	1	7.0	7.0	6.7	6.7	6.0	7.0	7.0	7.3	8.0	7.7	7.3	6.3	6.3	5.3	6.8
UHS 12-1-1	2	6.7	7.7	7.3	7.0	7.0	8.0	7.7	9.0	9.0	9.0	9.0	6.7	6.7	6.0	7.6
UHS 9-4-4	1	6.3	7.3	6.7	7.0	6.7	7.0	7.0	7.7	7.7	8.0	7.3	6.3	6.3	5.7	6.9
UHS 9-4-4	2	6.7	7.3	6.7	7.0	5.7	8.0	8.0	8.7	9.0	9.0	8.3	6.7	7.0	6.0	7.4
UHS 12-2-8	1	8.0	7.7	7.0	6.7	6.3	6.7	6.3	6.7	7.0	8.0	7.3	7.0	6.3	6.3	7.0
UHS 12-2-8	2	9.0	9.0	8.0	8.0	6.7	7.7	7.3	8.3	8.0	8.0	7.3	7.0	6.7	5.3	7.6
Earthgro 8-2-4	1	7.7	8.0	7.3	7.0	6.3	6.7	6.0	7.0	6.7	8.0	7.3	8.0	7.7	6.7	7.2
Earthgro 8-2-4	2	8.0	7.3	7.7	7.0	6.7	7.3	7.0	7.7	8.0	8.3	7.7	9.0	9.0	7.3	7.8
Sustane + Polyon 10-2-10	1	6.7	7.3	7.3	6.3	6.0	7.0	6.7	8.0	7.7	7.7	7.3	7.7	8.0	6.0	7.1
Sustane + Polyon 10-2-10	2	7.7	8.0	7.7	7.3	6.3	7.0	7.3	8.3	8.3	7.7	7.3	8.7	8.7	7.3	7.7
Sustane + Polyon 12-2-8	1	7.0	6.7	6.3	6.3	6.0	6.7	6.7	7.7	7.3	7.0	7.3	8.0	7.7	6.7	7.0
Sustane + Polyon 12-2-8	2	7.0	6.7	7.0	7.0	6.7	7.7	7.7	8.7	8.3	9.0	8.0	8.7	9.0	8.0	7.8
Urea	1	8.0	8.3	7.7	7.7	7.0	8.0	7.0	8.0	7.0	7.7	7.0	9.0	8.0	6.7	7.6
Control	--	7.0	6.7	7.0	6.3	6.7	6.0	5.7	6.3	6.3	7.0	7.0	6.3	5.3	5.3	6.4
$LSD_{(0.05)}$		1.2	1.1	1.0	N.S.*	1.2	0.7	0.8	1.0	0.8	0.9	0.8	0.7	0.8	1.1	0.4

* Significant at a 0.10 level

Table 42. The effects of resin coated slow release nitrogen fertilizer source and application rate on the visual quality of Kentucky bluegrass following applications.

Nitrogen Source		May		June					July			August	September			
Pursell Products	lbs N/ Appl.	18	27	2	9	16	24	29	9	21	30	10	3	17	30	Average
Pursell 44.5-0-0	1	7.3	8.0	8.0	8.0	6.7	7.7	7.0	8.0	7.7	8.0	7.3	7.3	7.7	7.0	7.5
Pursell 42.5-0-0	2	8.0	8.0	7.0	7.0	7.0	7.7	7.3	8.7	8.7	8.7	8.0	8.3	7.7	7.0	7.8
Pursell 43-0-0	1	7.3	6.7	7.0	6.3	7.7	7.0	6.3	7.7	7.7	8.0	7.7	8.0	7.3	6.7	7.2
Pursell 44-0-0	2	7.3	7.3	6.7	7.3	6.3	8.0	7.0	8.3	7.3	8.0	7.3	8.3	9.0	8.3	7.6
Pursell 42-0-0	4	8.0	7.7	7.0	7.3	6.7	8.0	8.0	9.0	9.0	9.0	8.3	9.0	7.7	6.7	8.0
Urea 46-0-0	1	8.0	8.3	7.7	7.7	7.0	8.0	7.0	8.0	7.0	7.7	7.0	9.0	8.0	6.7	7.6
Control	--	7.0	6.7	7.0	6.3	6.7	6.0	5.7	6.3	6.3	7.0	7.0	6.3	5.3	5.3	6.4
$LSD_{(0.05)}$		1.2	1.1	1.0	N.S.*	1.2	0.7	0.8	1.0	0.8	0.9	0.8	0.7	0.8	1.1	0.4

* Significant at a 0.10 level

Table 43. The effects of synthetic slow release nitrogen fertilizer source and application rate on the clipping yields of Kentucky bluegrass following applications.

Nitrogen Source		May		June			July			August	September			
Synthetic Slow Release	lbs N/ Appl.	19	28	4	11	26	8	22	31	10	2	17	30	Average
Nutralene 40-0-0	1	78.9	33.7	10.8	19.5	21.6	23.8	36.9	32.4	48.6	50.8	32.6	22.3	412.0
Nutralene 40-0-0	2	77.6	43.3	14.2	17.9	32.4	39.0	51.5	36.5	53.5	73.8	57.8	29.8	527.3
MUAS 32-0-0	1	62.9	31.3	8.7	14.4	26.2	21.3	30.0	23.7	41.4	46.8	47.8	19.9	373.3
MUAS 32-0-0	2	88.5	40.8	10.0	20.7	33.6	32.9	49.3	33.6	52.5	67.6	56.4	28.0	513.9
Ureaform 38-0-0	1	54.6	24.2	6.5	16.3	28.0	16.4	27.0	20.8	37.2	24.6	19.3	12.5	287.3
Ureaform 38-0-0	2	88.7	33.3	7.1	13.5	27.7	30.6	49.8	30.4	51.8	39.8	30.4	18.7	411.7
Scotts M.U. 42-0-0	1	85.6	40.7	12.3	18.1	29.1	29.1	41.0	30.0	47.9	54.6	41.7	20.8	451.0
Scotts M.U. 42-0-0	2	94.9	59.1	16.7	21.5	42.7	47.6	51.7	33.4	49.3	79.2	65.9	30.4	592.5
Lesco SCU 37-0-0	1	73.8	30.0	9.3	20.3	21.8	27.9	34.9	28.0	47.7	35.5	30.4	20.5	380.0
Lesco SCU 37-0-0	2	85.2	38.1	9.6	16.7	35.9	47.7	55.4	36.9	63.1	52.8	51.3	31.5	524.2
Lesco SCU elite 29-0-0	1	80.6	36.7	11.6	20.6	18.8	28.2	40.6	27.9	48.5	36.6	27.4	17.1	394.6
Lesco SCU elite 29-0-0	2	83.7	48.5	14.9	21.6	26.3	46.5	58.2	39.1	57.7	46.4	35.5	21.4	499.9
Urea 46-0-0	1	76.9	34.6	8.0	19.0	35.6	24.4	35.9	27.9	43.4	56.5	45.0	21.2	428.3
Control	--	63.3	26.6	5.5	9.8	28.1	37.2	47.3	28.0	46.1	24.0	17.8	12.0	302.9
$LSD_{(0.05)}$		N.S.*	12.6	N.S.*	9.4	14.4	17.8	17.1	8.5	10.7	10.5	9.6	5.1	83.9

* Significant at a 0.10 level

Table 44. The effects of natural organic slow release nitrogen fertilizer source and application rate on the clipping yields of Kentucky bluegrass following applications.

Nitrogen Source		May		June			July			August	September			
Natural Organic	lbs N/ Appl.	19	28	4	11	26	8	22	31	10	2	17	30	Average
Corn Gluten Meal 10-0-1	1	68.9	26.6	8.1	18.2	27.4	36.3	43.3	28.1	28.1	32.3	36.2	21.6	392.3
Corn Gluten Meal 10-0-1	2	64.1	32.3	11.6	16.7	33.0	57.7	72.0	43.7	43.7	40.5	43.3	29.2	498.7
Turf 10-2-6	1	57.8	27.2	7.8	14.2	26.2	30.8	43.7	28.6	28.6	39.8	34.1	19.6	377.0
Turf 10-2-6	2	69.6	34.6	8.7	20.6	42.8	53.0	60.4	37.5	37.5	60.4	60.2	29.5	525.3
Milorganite 6-2-0	1	70.1	24.3	4.9	8.6	35.7	28.6	41.7	29.5	29.5	36.0	26.5	17.8	370.4
Milorganite 6-2-0	2	70.8	35.0	10.3	12.7	4.01	45.3	56.5	36.8	36.8	44.0	41.7	25.8	473.7
Naturall 8-1-3	1	77.4	28.9	4.8	8.1	28.2	41.3	52.9	35.6	35.6	35.5	38.8	21.6	423.5
Naturall 8-1-3	2	79.2	38.9	11.1	19.1	42.8	54.6	56.3	35.1	35.1	56.9	64.1	34.6	545.0
UHS 3-4-2	1	62.8	27.2	6.4	12.3	27.0	25.3	35.1	26.7	26.7	25.7	18.5	13.0	322.8
UHS 3-4-2	2	73.6	29.3	8.8	17.9	26.6	24.3	41.8	31.6	31.6	29.3	20.1	13.9	374.8
Sustane 5-2-4	1	89.2	28.6	6.5	14.3	32.3	37.6	46.9	30.1	30.1	40.6	34.2	20.6	427.9
Sustane 5-2-4	2	89.7	33.0	8.8	14.4	32.3	47.2	55.1	36.7	36.7	67.6	47.2	25.2	504.2
Terrene 5-2-0	1	65.8	30.7	9.4	17.8	22.7	33.9	46.3	31.5	31.5	40.3	35.5	22.1	400.3
Terrene 5-2-0	2	68.6	40.9	12.6	14.5	40.3	46.3	64.1	38.7	38.7	57.1	56.5	30.4	527.2
Terrene 6-2-0	1	69.7	30.1	6.9	13.0	25.9	29.2	39.0	28.3	28.3	33.2	28.1	15.8	366.2
Terrene 6-2-0	2	75.5	37.6	9.8	13.0	29.2	29.8	42.2	28.6	28.6	41.3	35.7	20.0	413.3
Urea 46-0-0	1	76.9	34.6	8.0	19.0	35.6	24.4	35.9	27.9	43.4	56.5	45.0	21.2	428.3
Control	--	63.3	26.6	5.5	9.8	30.8	22.4	30.2	21.4	39.2	24.0	17.8	12.0	302.9
LSD $_{(0.05)}$		N.S.*	12.6	N.S.*	9.4	14.4	17.8	17.1	8.5	10.7	10.5	9.6	5.1	83.9

* Significant at a 0.10 level

Table 45. The effects of combination nitrogen fertilizer sources and application rate on the clipping yields of Kentucky bluegrass following applications.

Nitrogen Source		May		June			July			August	September			
Combination Fertilizers	lbs N/ Appl.	19	28	4	11	26	8	22	31	10	2	17	30	Average
Ringer 12-2-6	1	68.4	31.3	6.3	12.6	35.1	34.6	45.9	30.5	46.5	46.9	39.4	17.3	414.6
Ringer 12-2-6	2	89.8	36.1	12.7	23.1	34.1	50.3	57.1	32.0	46.2	73.2	61.8	27.1	543.4
UHS 12-1-1	1	72.6	32.0	9.6	20.0	30.7	41.4	41.4	34.9	41.2	23.9	20.5	16.2	384.4
UHS 12-1-1	2	73.2	35.0	13.3	20.6	32.1	60.9	67.6	42.9	50.5	38.6	28.1	19.8	486.2
UHS 9-4-4	1	70.5	27.7	9.9	19.9	29.5	37.2	49.6	33.7	47.9	29.3	24.3	15.6	395.2
UHS 9-4-4	2	84.4	35.1	9.2	19.3	47.3	66.7	77.1	45.9	61.0	33.5	26.9	18.8	525.3
UHS 12-2-8	1	81.2	36.6	9.2	12.7	30.5	28.1	43.9	28.0	44.5	32.5	27.3	17.7	392.2
UHS 12-2-8	2	108.8	40.7	12.1	19.2	40.1	43.1	57.9	34.7	49.4	34.9	25.8	14.6	481.2
Earthgro 8-2-4	1	81.3	30.5	6.9	13.4	28.7	28.0	41.1	29.3	45.6	53.6	42.9	24.1	425.4
Earthgro 8-2-4	2	83.6	36.3	3.5	9.6	34.7	43.4	55.1	35.8	46.9	90.5	63.8	31.8	535.2
Sustane + Polyon 10-2-10	1	69.6	29.9	8.0	12.1	28.1	37.2	47.3	47.3	28.0	36.3	35.3	19.6	397.4
Sustane + Polyon 10-2-10	2	82.1	37.6	7.4	12.5	35.0	56.7	58.4	58.4	35.3	51.8	57.5	26.3	507.9
Sustane + Polyon 12-2-8	1	76.9	26.9	7.0	12.4	33.5	41.9	48.3	48.3	29.9	32.9	42.8	23.8	424.4
Sustane + Polyon 12-2-8	2	79.3	30.0	7.8	13.6	36.5	63.5	69.8	69.8	42.2	50.5	63.5	33.3	543.0
Urea 46-0-0	1	76.9	34.6	8.0	19.0	35.6	24.4	35.9	27.9	43.4	56.5	45.0	21.2	428.3
Control	--	63.3	26.6	5.5	9.8	30.8	22.4	30.2	21.4	39.2	24.0	17.8	12.0	302.9
LSD $_{(0.05)}$		N.S.*	12.6	N.S.*	9.4	14.4	17.8	17.1	8.5	10.7	10.5	9.6	5.1	83.9

* Significant at a 0.10 level

Table 46. The effects of resin coated slow release nitrogen fertilizer source and application rate on the clipping yields of Kentucky bluegrass following applications.

Nitrogen Source	lbs N/	May		June			July			August	September			
Pursell Products	Appl.	19	28	4	11	26	8	22	31	10	2	17	30	Average
Pursell 44.5-0-0	1	68.6	42.0	13.5	17.6	31.7	44.3	49.4	29.5	50.1	39.4	37.4	24.1	447.7
Pursell 42.5-0-0	2	79.1	34.3	11.3	14.3	33.0	61.8	69.9	43.3	60.0	44.1	39.9	26.4	517.4
Pursell 43-0-0	1	75.3	32.0	8.9	15.9	40.4	39.5	46.1	31.2	49.4	36.2	30.9	19.4	425.2
Pursell 44-0-0	2	87.3	35.9	10.1	18.3	28.1	49.3	58.0	35.1	45.7	45.3	51.4	34.1	498.5
Pursell 42-0-0	4	85.6	38.4	10.5	22.9	42.3	93.1	109.5	71.2	84.6	56.2	41.6	25.5	681.5
Urea 46-0-0	1	76.9	34.6	8.0	19.0	35.6	24.4	35.9	27.9	43.4	56.5	45.0	21.2	428.3
Control	--	63.3	26.6	5.5	9.8	30.8	22.4	30.2	21.4	39.2	24.0	17.8	12.0	302.9
$LSD_{(0.05)}$		N.S.*	12.6	N.S.*	9.4	14.4	17.8	17.1	8.5	10.7	10.5	9.6	5.1	83.9

* Significant at a 0.10 level

Perennial Ryegrass Fertilizer Study

M. L. Agnew and S. M. Berkenbosch

Many golf courses are currently converting their fairways and tees to perennial ryegrass. The goal is to use a species of grass that is more resistant to traffic stress and easy to establish if injured by stress. However, mowing perennial ryegrass at heights less than 1 inch places additional stress on the plant. Most recommendations on fertility levels for perennial ryegrass are based on mowing heights near 2 inches.

The objective of the study is to investigate the effects of nitrogen fertilizer source, rate of nitrogen application, and potassium application on the growth and development of fairway height perennial ryegrass.

Research was conducted at the Iowa State University Horticulture Research Station. Treatments included four fertilizer sources, two nitrogen application rates, and two potassium application rates Table 47. Manhattan II, perennial ryegrass was maintained at a 1 inch mowing height to simulate a golf course fairway. Plots were irrigated to prevent moisture stress.

Data collected included visual quality and clipping yields. Visual quality is based on a scale of 1 to 9: 9 = dark green turfgrass, 6 = minimum quality, and 1 = straw-colored turf. Clipping yields were obtained at each mowing by collecting all leaf tissue within a 1.75 ft by 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 47 and 48. All fertilizer sources provided acceptable quality. Plots treated with Scott's Poly- S 39-0-0 had a spring and fall mean of 7.3, Nutralene treated plots had a spring mean of 6.9 and a fall mean of 7.0, Corn Gluten Meal treated plots had a spring mean of 6.9 and a fall mean of 6.8, and Milorganite treated plots had a spring mean of 6.6 and a fall mean of 6.8. Plots fertilized at the 2 lb N rate substantially improved plant quality over the 1 lb. N rate. Additional potassium did not affect the visual quality during the first year.

Dried clipping weights are presented in Table 49 and 50. Plots treated with Scott's Poly- S 39-0-0 had the greatest amount of clippings with 385 g in the spring and 124 g in the fall. Corn Gluten Meal and Nutralene treated plots produced the next greatest amount of clippings with an average 353 g and 343 g of clippings in the spring and 117 g and 114 g in the fall, respectively. Milorganite treated plots produced the least amount of clippings, with an average 284 g of clippings in the spring and 90 g in the fall. Plots fertilized at the 2 lb N rate substantially increased the amounts of clippings over the 1 lb N rate.

These plots were severely injured by low temperature stress during the winter of 1993. Bare spots have been overseeded and treatments applied for 1993.

Table 47. The effects of fertilizer, rate, and potassium of visual quality on perennial ryegrass.

Fertilizer Source	N Rate	K Rate	May			June					July		August	Spring Application Average
			14	18	27	2	9	16	24	29	8	27	16	
Nutralene 40-0-0	1	0	7.7	8.0	7.7	6.7	7.3	6.7	6.7	6.3	6.3	6.3	6.3	6.9
Nutralene 40-0-0	1	1	7.7	8.0	7.7	7.0	7.0	6.7	6.3	6.3	6.0	6.7	6.3	6.9
Nutralene 40-0-0	2	0	8.3	9.0	9.0	9.0	8.7	8.0	7.7	7.0	7.7	8.0	7.0	8.1
Nutralene 40-0-0	2	1	8.3	9.0	8.7	8.7	7.7	7.3	7.3	6.7	7.3	7.0	7.0	7.7
Scotts 39-0-0	1	0	8.0	7.7	7.7	7.3	8.0	7.7	7.7	7.3	8.0	7.7	7.0	7.6
Scotts 39-0-0	1	1	7.7	8.3	7.7	7.3	7.0	7.7	8.0	7.0	8.3	7.3	6.3	7.5
Scotts 39-0-0	2	0	7.7	9.0	8.7	8.7	9.0	9.0	8.3	8.0	9.0	9.0	7.7	8.5
Scotts 39-0-0	2	1	9.0	9.0	9.0	8.7	8.7	9.0	7.3	8.0	8.7	9.0	7.7	8.5
Corn Gluten 10-0-1	1	0	6.0	7.0	8.7	8.0	8.0	7.0	7.3	7.0	6.7	7.0	6.7	7.2
Corn Gluten 10-0-1	1	1	6.3	7.0	8.3	8.3	7.3	7.3	7.7	6.3	6.0	6.0	6.0	7.0
Corn Gluten 10-0-1	2	0	6.0	7.3	9.0	9.0	9.0	8.3	7.7	7.0	8.0	7.3	7.3	7.8
Corn Gluten 10-0-1	2	1	6.7	8.3	9.0	9.0	9.0	8.7	7.3	7.0	7.0	7.3	7.3	7.9
Milorganite 6-2-0	1	0	7.7	7.3	6.7	6.3	6.3	6.3	6.7	6.3	6.0	6.3	6.3	6.6
Milorganite 6-2-0	1	1	6.3	7.0	7.0	6.3	6.3	7.0	6.7	6.3	6.3	6.7	6.3	6.6
Milorganite 6-2-0	2	0	7.7	8.3	7.7	7.3	7.0	7.7	7.3	6.7	7.3	7.7	7.3	7.5
Milorganite 6-2-0	2	1	6.7	8.7	8.0	7.7	7.3	7.3	7.0	7.0	7.0	8.0	7.3	7.5
Control	0	0	6.0	6.0	6.0	5.3	6.0	5.7	6.3	5.7	6.0	5.7	5.3	5.8
Control	0	1	6.3	6.0	6.0	5.7	6.0	5.7	6.0	6.0	6.0	5.7	6.0	5.9
LSD $_{(0.05)}$ Fert			0.4	0.3	0.2	0.3	0.3	0.4	0.4	0.3	0.3	0.4	0.4	0.1
LSD $_{(0.05)}$ Rate			0.3	0.2	0.2	0.3	0.3	0.3	0.4	0.2	0.2	0.3	0.3	0.1
LSD $_{(0.05)}$ K			N.S.	N.S.	N.S.	N.S.	0.2	N.S.	N.S.	N.S.	0.2	N.S.	N.S.	N.S.

Table 48. The effects of fertilizer, rate, and potassium on visual quality of perennial ryegrass.

Fertilizer Source	N Rate	K Rate	August 27	September 15	September 23	October 12	Fall Application Average
Nutralene 40-0-0	1	0	7.3	7.7	6.7	7.0	7.2
Nutralene 40-0-0	1	1	7.7	8.0	7.0	6.3	7.3
Nutralene 40-0-0	2	0	8.7	9.0	7.3	6.3	7.8
Nutralene 40-0-0	2	1	9.0	9.0	7.7	6.7	8.1
Scotts 39-0-0	1	0	7.3	8.0	7.7	7.7	7.7
Scotts 39-0-0	1	1	6.7	8.0	7.3	7.0	7.3
Scotts 39-0-0	2	0	8.7	9.0	8.3	7.7	8.4
Scotts 39-0-0	2	1	8.7	9.0	8.7	7.7	8.5
Corn Gluten 10-0-1	1	0	6.7	7.7	7.3	6.7	7.1
Corn Gluten 10-0-1	1	1	6.0	7.7	7.3	6.3	6.8
Corn Gluten 10-0-1	2	0	6.7	9.0	8.0	7.0	7.7
Corn Gluten 10-0-1	2	1	6.7	9.0	8.3	7.0	7.8
Milorganite 6-2-0	1	0	6.7	7.0	6.3	6.7	6.7
Milorganite 6-2-0	1	1	6.3	7.0	6.3	7.0	6.7
Milorganite 6-2-0	2	0	7.3	8.3	7.3	8.0	7.8
Milorganite 6-2-0	2	1	7.0	8.7	7.3	8.0	7.8
Control	0	0	5.7	5.7	5.3	6.3	5.8
Control	0	1	6.0	6.0	5.7	6.3	6.0
$LSD_{(0.05)}$ Fert			0.3	0.2	0.3	N.S	0.2
$LSD_{(0.05)}$ Rate			0.3	0.2	0.3	0.6	0.2
$LSD_{(0.05)}$ K			N.S.	N.S.	0.2	N.S	N.S.

Table 49. The effects of fertilizer, rate, and potassium on clipping production of perennial ryegrass.

Fertilizer Source	N Rate	K Rate	May 14	May 19	May 22	May 28	June 2	June 9	June 16	June 24	July 8	July 24	August 14	Clipping Yield Spring
Nutralene 40-0-0	1	0	64.4	39.6	40.1	33.8	25.5	29.5	14.2	26.2	15.3	20.1	18.1	326.7
Nutralene 40-0-0	1	1	64.8	44.5	40.6	37.7	26.5	34.1	16.3	27.4	15.5	19.8	20.6	347.6
Nutralene 40-0-0	2	0	78.5	68.0	66.0	58.4	47.1	54.9	28.3	37.6	24.1	32.3	31.4	526.6
Nutralene 40-0-0	2	1	83.8	68.8	54.3	56.6	33.7	53.7	23.5	34.4	24.1	29.0	25.2	487.2
Scotts 39-0-0	1	0	64.9	42.3	40.1	36.2	29.6	42.2	19.6	35.5	28.5	35.7	35.5	410.1
Scotts 39-0-0	1	1	62.7	40.6	40.7	36.3	29.7	38.9	21.6	36.1	27.9	31.8	24.7	390.9
Scotts 39-0-0	2	0	71.4	58.3	55.6	53.3	47.4	63.4	35.5	52.1	43.6	49.8	37.1	567.4
Scotts 39-0-0	2	1	73.7	57.6	55.0	55.3	44.6	64.0	35.6	50.2	44.6	51.4	37.8	569.9
Corn Gluten 10-0-1	1	0	47.1	28.2	39.2	45.2	34.3	38.7	15.5	27.6	16.9	21.2	24.9	338.8
Corn Gluten 10-0-1	1	1	45.2	34.1	43.3	47.8	36.1	38.6	15.2	27.4	15.3	20.2	18.5	341.7
Corn Gluten 10-0-1	2	0	55.2	37.7	57.5	71.8	68.9	76.9	39.2	44.1	35.3	38.3	31.8	556.6
Corn Gluten 10-0-1	2	1	51.5	41.2	61.9	74.4	63.9	66.3	29.6	39.7	23.1	29.4	29.2	510.3
Milorganite 6-2-0	1	0	53.2	31.0	32.1	25.8	23.6	24.6	9.7	22.0	13.1	17.7	21.1	273.9
Milorganite 6-2-0	1	1	51.8	29.7	30.3	27.2	20.5	23.2	10.5	19.2	11.6	17.8	17.9	259.6
Milorganite 6-2-0	2	0	60.2	47.4	48.9	44.1	31.4	39.1	16.7	34.4	24.3	34.7	33.7	414.9
Milorganite 6-2-0	2	1	49.6	46.8	47.9	44.2	34.0	36.4	15.6	30.3	18.7	29.9	31.1	384.5
Control	0	0	42.9	18.4	17.9	17.4	13.3	17.0	6.7	17.2	9.0	12.7	11.6	184.0
Control	0	1	38.6	18.2	19.5	17.9	14.0	17.4	5.9	17.8	9.4	13.1	13.0	184.7
$LSD_{(0.05)}$ Fert			4.4	3.2	3.9	2.1	3.7	3.2	1.7	2.5	2.3	2.7	4.3	21.9
$LSD_{(0.05)}$ Rate			3.8	2.8	3.4	1.8	3.2	2.7	1.5	2.1	2.0	2.3	3.8	19.0
$LSD_{(0.05)}$ K			N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Table 50. The effects of fertilizer, rate, and potassium on clipping production of perennial ryegrass.

Fertilizer Source	N Rate	K Rate	September 14	September 24	October 15	Clipping Yield Fall
Nutralene 40-0-0	1	0	56.3	17.5	33.1	106.9
Nutralene 40-0-0	1	1	67.9	22.4	34.2	124.5
Nutralene 40-0-0	2	0	108.9	31.4	47.0	187.3
Nutralene 40-0-0	2	1	118.2	29.5	43.3	191.1
Scotts 39-0-0	1	0	66.7	29.8	44.6	141.1
Scotts 39-0-0	1	1	62.4	21.2	41.7	125.4
Scotts 39-0-0	2	0	102.9	35.9	55.9	194.7
Scotts 39-0-0	2	1	116.2	35.9	53.2	205.3
Corn Gluten 10-0-1	1	0	56.9	23.6	35.4	115.9
Corn Gluten 10-0-1	1	1	59.3	19.2	36.2	114.7
Corn Gluten 10-0-1	2	0	120.5	33.3	47.1	200.9
Corn Gluten 10-0-1	2	1	114.7	33.2	48.9	196.8
Milorganite 6-2-0	1	0	39.3	14.0	30.4	83.7
Milorganite 6-2-0	1	1	37.4	12.4	27.6	77.4
Milorganite 6-2-0	2	0	84.4	25.7	42.7	154.8
Milorganite 6-2-0	2	1	81.0	27.7	41.8	148.6
Control	0	0	16.0	5.8	16.6	38.4
Control	0	1	14.6	6.5	16.6	37.7
$LSD_{(0.05)}$ Fert			6.7	3.3	3.4	11.9
$LSD_{(0.05)}$ Rate			5.8	2.8	2.9	10.3
$LSD_{(0.05)}$ K			N.S.	N.S.	N.S.	N.S.

Scott's Poly-S Study

M. L. Agnew and S. M. Berkenbosch

The objective of this study was to evaluate 3 formulations of resin-coated nitrogen sources for the O. M. Scotts Company. The fertilizers ratio were 40-0-0, 39-0-0, and 38-0-0. Each were applied at both a 2 lb N application rates on May 8 and August 18 and a 1 lb N application rate on May 8, June 29, August 18 and September 15 1992. A non fertilized control was added for comparison purpose. The turfgrass was a "Envy" perennial ryegrass mowed at 1 inch with all clippings removed. The site was irrigated to prevent moisture stress.

The 1993 growing season ended early with a killing frost early in October, thus, the effect of the final fertilization was not fully realized.

Data collected included visual quality and clipping yields. Visual quality is based on a scale of 1 to 9: 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 in with a 1.75 ft by 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 51. 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 52. 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. There were no differences between fertilizer source for either the 1 or 2 lb N rates.

In conclusion, the Poly-S fertilizers are probably best applied at the 1 lb N rate. The 2 lb N rate created excessive growth that more then likely biased visual quality ratings.

Table 51. The effects of fertilizer source and rate of application on visual quality.

Fertilizer Source	Rate	May 14	May 18	May 27	June 2	June 9	June 16	June 24	June 29	July 8	July 27	August 16	August 27	September 15	September 23	October 12	Means
40-0-0	1	8.0	7.3	7.3	7.7	7.0	6.7	6.3	7.0	7.3	8.3	6.7	8.3	8.0	6.7	8.0	7.3
40-0-0	2	9.0	9.0	9.0	8.3	8.3	8.0	7.3	7.0	7.0	7.3	8.0	7.3	9.0	7.3	7.0	7.9
39-0-0	1	7.7	7.0	7.3	7.3	7.0	7.0	6.3	7.0	7.3	9.0	7.0	9.0	7.3	6.7	7.3	7.2
39-0-0	2	8.0	9.0	8.7	8.3	8.0	8.0	7.7	7.7	7.7	8.3	8.0	8.3	9.0	8.3	8.3	8.0
38-0-0	1	6.7	6.7	7.3	7.0	7.0	7.0	6.3	7.0	7.0	9.0	7.0	9.0	7.7	7.0	8.7	7.3
38-0-0	2	8.3	7.7	8.3	8.3	8.3	8.3	8.3	8.0	7.7	8.3	8.3	8.3	8.7	8.0	8.7	8.0
Control	--	6.3	6.0	6.0	6.0	6.0	5.7	6.0	6.0	6.0	5.0	5.7	5.0	5.3	5.0	4.0	5.6
LSD $_{(0.05)}$		0.8	0.7	0.8	0.8	0.8	0.7	1.0	0.4	0.8	1.0	1.0	0.8	1.1	0.8	0.8	0.4

Table 52. The effects of fertilizer source and application rate on clipping production.

Fertilizer Source	Rate	May 14	May 22	May 28	June 2	June 9	June 16	June 29	July 8	July 24	August 16	August 25	September 14	September 25	October 15	Clipping Yield Total
40-0-0	1	28.2	27.1	21.4	17.8	22.6	12.3	23.0	19.4	37.9	21.1	12.7	68.5	21.2	51.4	384.7
40-0-0	2	43.6	42.3	34.1	28.7	36.2	22.4	32.0	23.4	22.3	14.2	23.7	129.3	39.3	34.9	526.6
39-0-0	1	28.2	27.6	23.6	18.9	22.7	14.8	29.3	23.8	43.8	30.5	14.3	75.9	29.8	46.8	429.9
39-0-0	2	34.5	34.2	31.6	26.3	33.5	21.9	31.7	28.2	27.6	15.8	14.5	107.1	42.1	52.8	501.7
38-0-0	1	27.5	20.7	21.4	16.3	22.0	13.1	25.8	23.1	37.2	27.2	10.6	60.2	31.1	55.3	391.6
38-0-0	2	32.8	34.6	31.1	27.4	38.1	29.4	37.1	35.9	33.4	18.1	11.2	95.2	46.2	65.2	535.7
Control	--	16.3	14.7	14.3	10.9	13.2	8.3	17.6	10.4	10.6	6.2	2.1	13.2	7.6	15.6	160.9
LSD $_{(0.05)}$		8.7	4.6	5.8	3.3	6.5	8.6	6.7	5.4	8.4	8.3	6.1	20.5	9.0	13.3	75.1

Plant and Soil Response to Nitrogen Fertilizer Source

M. L. Agnew, N. E. Christians, and J. N. Ryan

Turfgrass managers have several nitrogen sources from which to choose. Quick-release sources provide fast green-up and are relatively inexpensive. Slow-release sources extend the feeding time by slowing the release rate of available nitrogen. Some advantages claimed from using slow-release sources are reduced chance of fertilizer burn, less volatilization, and less leaching.

With the environmental concerns currently surrounding fertilizers and the leaching of nitrates into the groundwater, it is important to understand the possible differences among nitrogen sources as they pertain to nitrogen use efficiency and the movement of nitrates in the soil.

This study will evaluate 8 fertilizer sources as to their effects on plant growth and nitrogen content in plant tissue. In addition, the movement of nitrates through the soil will be monitored. The study was initiated in the spring of 1991 on an established turf of 'Glade' Kentucky bluegrass mowed at 2 in.

All treatments were applied at a rate of 1 lb N/1000 ft^2 on (May 2, June 10, August 15, and September 15, 1991) and (May 8, June 29, August 20, and September 17, 1992). The study was replicated three times in a randomized complete-block design. Individual plots measured 5 ft by 9 ft. The following is a list of the treatments:

(1) Coron 28-0-0
(2) Nutralene 40-0-0
(3) Sulfur-coated Urea 37-0-0
(4) Urea 46-0-0
(5) Ringer Lawn Restore 10-2-6
(6) Ureaform 38-0-0
(7) N-Sure 28-0-0
(8) ISU Experimental 10-1.5-.5
(9) Control -- no fertilizer

Measurements of plant growth included weekly observations of visual quality, clipping yields, and chlorophyll content. Plant development was monitored by measuring plant density, thatch depth, thatch organic matter content, rhizome weights, and root distribution. These measures were taken prior to the first treatment, in the middle of summer, and at the end of the season.

Nitrogen content in leaf tissue was measured weekly and nitrate content in the soil at several different depths up to 3 ft were taken initially, in midsummer, and at the end of the season.

Quality data is presented in Table 53. All fertilizer sources provided acceptable quality. However, plots treated with sulfur coated urea, urea, Nutralene, Ringer Restore, and corn gluten meal had consistently darker green color.

Dried clipping weights are presented in Table 54. Plots treated with urea and sulfur coated urea produced the most clippings, while N-Sure, Ureaform, and Coron produced the least clippings.

Total chlorophyll content data is presented in Tables 55. Total chlorophyll is a quantitative measure of plant color. Urea-treated plots tended to have higher chlorophyll content.

Root data is presented in Tables 56 and 57. Unlike 1991, there were no differences in root mass production. Root mass varied greatly between replications, thus causing too much variability. This is most likely due to drought spring conditions and wet summer conditions.

Soil nitrate data is presented in Table 58. There were no differences between fertilizer treatments in 1992.

Table 53. The effects of fertilizer source on the visual quality[a] of Kentucky bluegrass during 1992

Fertilizer Source	May		June				July			August		September		October	Mean
	18	27	4	9	16	24	8	24	27	4	27	15	24	12	
Coron 28-0-0	8.3	8.0	7.7	7.0	7.0	6.7	7.3	6.0	8.3	7.0	7.3	7.7	6.3	7.0	7.3
Nutralene 40-0-0	8.7	9.0	8.3	7.3	8.3	7.3	8.0	7.0	9.0	7.3	8.7	8.3	8.0	8.7	8.1
Sulfur Coated Urea 37-0-0	7.7	8.3	8.0	8.0	9.0	8.7	7.7	7.0	9.0	8.0	9.0	9.0	8.3	9.0	8.3
Urea 46-0-0	9.0	9.0	9.0	8.0	8.3	7.3	8.7	6.0	9.0	6.7	8.7	9.0	8.0	9.0	8.3
Ringer Restore 10-2-6	7.7	8.7	8.7	8.0	8.7	8.0	7.7	7.0	9.0	8.0	7.3	8.7	7.7	8.0	8.1
Ureaform 38-0-0	7.7	7.7	7.7	7.0	7.7	7.0	6.7	6.7	8.3	6.7	7.0	7.7	7.0	7.3	7.3
N-Sure 28-0-0	8.0	8.0	7.3	7.0	7.3	7.0	6.7	6.3	8.0	6.0	7.0	7.7	6.7	8.0	7.2
Corn Gluten Meal 10-1-0	7.7	8.0	9.0	8.0	9.0	8.3	7.0	7.0	9.0	7.7	7.7	8.7	7.3	7.7	8.0
Control -- no fertilizer	6.3	7.0	6.0	6.0	6.0	6.0	5.0	5.7	6.0	4.0	5.0	5.3	4.3	3.3	5.4
LSD $_{(0.05)}$	0.9	0.6	0.7	0.3	0.8	0.8	0.8	0.6	0.5	0.6	0.8	0.9	1.3	0.8	0.3

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

Table 54. The effects of fertilizer source on dried clipping weights (a) of Kentucky bluegrasss for 1992.

Fertilizer Source	May		June				July		August		September		October	Clipping Yield Total
	18	27	3	10	16	26	8	24	10	28	14	24	15	
Coron 28-0-0	38.5	36.2	24.2	9.1	11.4	18.4	23.5	54.4	37.9	18.0	29.6	11.9	29.6	342.6
Nutralene 40-0-0	35.8	39.3	28.9	13.5	14.9	24.4	27.1	60.5	46.4	27.6	44.0	20.6	32.4	415.4
Sulfur Coated Urea 37-0-0	26.8	35.1	27.9	14.5	15.7	33.8	24.0	59.0	58.4	34.2	55.7	23.8	51.7	460.8
Urea 46-0-0	53.2	59.7	37.1	17.9	21.0	32.9	33.1	72.4	44.1	29.8	41.9	22.8	46.0	511.9
Ringer Restore 10-2-6	28.7	33.4	32.8	13.1	13.9	22.5	27.6	74.8	46.7	23.8	43.0	19.7	28.5	408.6
Ureaform 38-0-0	34.0	31.7	24.3	10.7	11.8	22.9	21.2	38.0	39.6	24.2	27.5	15.7	25.0	326.8
N-Sure 28-0-0	44.5	36.0	18.7	10.4	12.4	21.7	13.8	45.1	30.1	16.8	25.2	12.1	28.3	315.1
Corn Gluten Meal 10-1-0	24.3	29.6	33.9	11.8	15.1	24.6	29.3	62.2	45.6	20.8	40.9	18.2	27.8	384.1
Control -- no fertilizer	15.1	14.0	16.6	2.8	3.5	8.8	14.7	7.7	12.7	6.3	7.1	2.2	5.4	116.9
LSD $_{(0.05)}$	13.5	12.1	N.S.	6.2	5.4	8.4	N.S.	14.9	9.1	5.8	20.2	6.8	13.3	88.3

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

Table 55. The effect of fertilizer source on the chlorophyll content of Kentucky bluegrass for 1992.

	May		June			July		August		September	October
Fertilizer Source	22	29	4	15	26	9	24	6	25	14	5
Coron 28-0-0	79.3	81.8	77.0	52.7	73.4	74.0	99.3	82.0	109.3	130.1	79.4
Nutralene 40-0-0	100.3	85.7	81.0	83.3	82.5	80.3	106.9	101.9	112.9	132.1	90.1
Sulfur Coated Urea 37-0-0	100.7	87.4	83.5	64.5	77.2	92.8	103.7	101.9	129.6	143.0	89.1
Urea 46-0-0	92.3	97.7	100.4	70.9	81.3	99.2	111.0	82.6	118.3	146.9	94.4
Ringer Restore 10-2-6	80.4	83.6	88.7	81.1	87.2	79.2	119.1	99.1	100.4	150.6	76.9
Ureaform 38-0-0	96.6	82.1	81.7	58.9	73.1	74.5	92.7	86.0	106.2	128.6	81.3
N-Sure 28-0-0	90.4	90.4	73.9	46.8	75.9	73.9	84.4	72.8	103.3	130.8	82.3
Corn Gluten Meal 10-1-0	88.1	81.4	86.0	69.4	83.7	77.7	118.3	94.0	98.8	147.7	78.5
Control -- no fertilizer	81.9	69.2	59.2	44.5	61.3	53.5	59.8	62.1	80.5	101.5	65.3
$LSD_{(0.05)}$	N.S.	11.3	N.S.	N.S.	N.S.	12.7	13.7	13.6	13.1	16.2	9.0

Table 56. The effects of fertilizer source on the rooting[a] of Kentucky bluegrass on June 2, 1992.

	Rooting Depth (cm)				
Fertilizer Source	0-5	5-10	10-15	15-20	Total
Coron 28-0-0 (liquid)	105.3	93.1	12.0	4.6	215.0
Nutralene 40-0-0 (granular)	57.3	22.4	3.2	2.1	85.0
Sulfur Coated Urea 37-0-0 (granular)	88.0	35.1	11.2	2.1	136.5
Urea 46-0-0 (granular)	63.7	6.3	4.5	2.0	76.5
Ringer Lawn Restore 10-2-6 (granular)	228.4	28.4	4.0	1.9	262.7
Ureaform 38-0-0 (granular)	79.5	31.6	22.8	3.6	137.6
N-Sure 28-0-0 (liquid)	284.9	38.1	7.3	3.4	184.6
Corn Gluten Meal (10-1-0) (granular)	125.0	22.8	24.6	7.5	222.9
Control -- no fertilizer	92.4	53.4	13.5	4.9	164.2
$LSD_{(0.05)}$	NS	NS	NS	NS	NS

[a]Rooting is reported as mg per 150 cm^3 of soil.

Table 57. The effects of fertilizer source on the rooting[a] of Kentucky bluegrass on October 8, 1992.

	Rooting Depth (cm)				
Fertilizer Source	0-5	5-10	10-15	15-20	Total
Coron 28-0-0 (liquid)	136.3	40.4	8.9	5.3	190.9
Nutralene 40-0-0 (granular)	194.0	40.6	9.0	4.3	247.9
Sulfur Coated Urea 37-0-0 (granular)	100.3	18.9	7.0	5.4	131.6
Urea 46-0-0 (granular)	112.0	32.5	9.8	1.2	155.5
Ringer Lawn Restore 10-2-6 (granular)	176.6	54.4	13.3	3.6	247.9
Ureaform 38-0-0 (granular)	116.2	25.9	11.0	4.2	157.2
N-Sure 28-0-0 (liquid)	135.1	30.9	5.6	3.0	174.7
Corn Gluten Meal (10-1-0) (granular)	93.0	12.2	8.3	1.3	114.8
Control -- no fertilizer	91.5	2.72	6.55	5.2	129.9
$LSD_{(0.05)}$	NS	NS	NS	NS	NS

[a]Rooting is reported as mg per 150 cm^3 of soil.

Table 58. The effects of fertilizer source on soil nitrate content[a] on May 2, 1992.

	Nitrate Depth (cm)						
Fertilizer Source	0-5	5-10	10-15	15-20	30-35	60-65	90-95
Coron 28-0-0 (liquid)	27.7	11.3	8.0	13.3	14.6	6.3	4.8
Nutralene 40-0-0 (granular)	9.9	11.7	16.5	16.1	4.2	4.7	3.4
Sulfur Coated Urea 37-0-0 (granular)	19.9	24.5	21.1	8.5	3.0	7.7	3.8
Urea 46-0-0 (granular)	18.7	13.7	9.3	6.7	3.5	2.3	1.7
Ringer Lawn Restore 10-2-6 (granular)	8.2	5.7	3.8	11.5	7.4	5.6	4.6
Ureaform 38-0-0 (granular)	10.2	8.9	7.5	6.5	4.2	7.6	3.5
N-Sure 28-0-0 (liquid)	12.9	13.1	9.3	6.5	8.9	5.3	6.2
Corn Gluten Meal 10-1-0 (granular)	6.9	7.4	8.1	8.7	3.6	3.1	5.9
Control -- no fertilizer	9.1	6.1	18.1	4.1	2.8	17.1	4.5
$LSD_{(0.05)}$	NS	NS	NS	NS	NS	NS	NS

[a]Soil nitrate is reported as parts per million (ppm).

1992 Soil Activator Study

R. W. Moore and N. E. Christians

The objectives of this study were to compare the "Harmony" soil activator turf program to an untreated control and a Scotts fertilizer (Table 59). The study was initiated on June 15, 1991, and will continue through the 1992 season. The study was conducted on a 1-year-old stand of non-irrigated South Dakota Common Kentucky bluegrass turf. The soil is a Nicollet (fine-loamy, mixed, mesic Aquic Hapludoll) with a pH of 6.8 and 2.3% organic matter, a P content of 29 lbs/A, and a K content of 216 lbs/A. The plots measured 5 ft by 10 ft and were replicated three times in a randomized complete-block design.

The control plot received no treatment, while the Scotts plots received a 32-3-10 at a rate of 0.83 lb of N/1000 ft^2, applied in May, August, and September. The Harmony program (Table 60), consisted of a Microbial Soil Activator applied at 1.6 oz/1000 ft^2 on May 20 and September 20; a 25-15-10-3S turf food applied at 0.25 lbs/1000 ft^2 on June 1, July 1, August 1, and September 1; and a 3-4-3 organic fertilizer applied at 40 lb/1000 ft^2 on May 1 and September 1. The total N applied was 2.49 lbs N/1000 ft^2 in the Scotts program and 2.65 lbs N/1000 ft^2 in the Harmony program in the May 20 through September 20 time period.

Data collected included visual quality and clipping yields as fresh weight. Quality data was based on a 9 to 1 rating: 9 = best, 6 = acceptable, and 1 = no live grass. Clipping yields were obtained by taking a 21-inch swath through the 10 ft plot (17.5 ft^2) at a 2-in cutting height.

The grass in the control plots did not receive an acceptable quality rating of 6 or better during the 1992 season (Table 61). The Scotts plots received higher quality ratings on 7 out of 9 dates. There was no period of dormancy in 1992 as the central Iowa area received record rainfall in the summer months.

There were significant differences in clipping yields (Table 61). Scotts plots had a consistently greater amount of clippings produced throughout the year. The Harmony program did demonstrate near equal or better quality ratings, as well as clipping yields in the dryer and warmer months.

Table 59. Treatments in the 1992 soil activator fertilizer study.

Treatment		**When Applied**
1.	**Control**	
2.	**Harmony Program**	
	Microbial Soil Activator @ 1.6 oz/1000 ft^2	May 20, 1992
	3-4-3 organic fertilizer @ 40 lbs/1000 ft^2	May 20, 1992
	25-15-10-3S Turf Food @ 0.25 lbs/1000 ft^2	June 1, 1992
	25-15-10-3S Turf Food @ 0.25 lbs/1000 ft^2	July 1, 1992
	25-15-10-3S Turf Food @ 0.25 lbs/1000 ft^2	August 1, 1992
	25-15-10-3S Turf Food @ 0.25 lbs/1000 ft^2	September 1, 1992
	Microbial Soil Activator @ 1.6 oz/1000 ft^2	September 20, 1992
	3-4-3 organic fertilizer @ 40 lbs/1000 ft^2	September 20, 1992
3.	**Scotts**	
	Scotts 32-3-10 applied @ 0.83 lbs N/1000 ft^2	May 20, 1992
	Scotts 32-3-10 applied @ 0.83 lbs N/1000 ft^2	August 1, 1992
	Scotts 32-3-10 applied @ 0.83 lbs N/1000 ft^2	September 10, 1992

Table 60. 1992 soil activator trial -- quality ratings.

	Date									
Treatment	5/27	6/10	6/22	7/8	7/23	8/11	8/31	9/18	10/15	Mean
Control	5.0	5.0	5.0	5.0	5.0	4.0	4.0	3.0	4.0	4.4
Harmony Program	6.0	7.0	6.7	6.0	7.0	6.0	5.0	5.0	6.0	6.1
Scotts 32-3-10	7.3	8.0	8.0	7.0	6.0	5.0	6.0	6.0	7.0	6.7
$LSD_{(0.05)}$	0.76	0.01	0.76	0.01	0.01	0.01	0.01	0.01	0.01	0.1

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

Table 61. 1992 soil activator trial -- clipping yields (g).

	Date								
Treatment	5/27	6/10	6/22	7/8	7/23	8/11	8/31	9/18	Mean
Control	9.6	6.1	7.5	3.1	9.5	17.7	12.9	31.7	12.3
Harmony Program	15.7	18.4	18.1	8.2	34.6	35.1	25.3	61.0	27.0
Scotts 32-3-10	23.8	28.6	23.9	10.1	20.5	37.9	36.9	97.2	35.0
$LSD_{(0.05)}$	NS	11.7	8.7	NS	12.8	NS	11.5	26.5	6.7

The Effects of Application Rate of Sprint 330 on the Quality of 'Penncross' Creeping Bentgrass

M. L. Agnew

In Iowa the pH of sand-based golf greens ranges from 7.8 to 8.3. The availability of micronutrients, especially iron, can be reduced at these pH levels. Thus, many golf course superintendents apply supplemental micronutrients to alleviate deficiencies attributed to high pH.

The objective of this study was to evaluate the quality of creeping bentgrass when treated with four levels of Sprint 330. Sprint 330 is a chelated iron source.

Treatments included :

1. Sprint 330 Fe at 1 oz/1000 ft^2
2. Sprint 330 Fe at 2 oz/1000 ft^2
3. Sprint 330 Fe at 3 oz/1000 ft^2
4. Sprint 330 Fe at 4 oz/1000 ft^2
5. None

Treatments were replicated three times in a randomized complete-block design. Plots were rated for color as visual quality 1, 2, 4, 6, 9, and 13 days after application (DAA). Visual quality was based on a scale of 9 to 1: 9 = dark green turf, 6.5 = minimum acceptable quality, and 1 = dead turf.

Research was conducted at the ISU Horticulture Research Station, on a modified sand green constructed with 80% sand, 10% hypnum peat, 10% soil and 8.1 pH. 'Penncross' creeping bentgrass greens were fertilized with .5 lb N/1000 ft^2 DAA.

All rates of Sprint 330 improved visual quality over the non-treated control (Table 62). No rate of Sprint 330 fell below the minimum acceptable quality rating of 6.5. Sprint rates of 2, 3, and 4 oz/1000 ft^2 were statistically better than the 1 oz/1000 ft^2 rate from DAA 1 to 4. After nitrogen was applied on DAA 5, there were no differences between Sprint 330 rates.

Golf course superintendents could use Sprint 330 rates as low as 1 oz/1000 ft^2 if added to a regular nitrogen fertility program. If the superintendent wishes to reduce nitrogen rates, then a minimum of 2 oz/1000 ft^2 would be needed to enhance color and quality.

Table 62. Effects of application rate of Sprint 330 on creeping bentgrass quality.[a]

	DAA[b]					
Rate	1	2	4	6	9	13
1 oz	7.0	7.0	7.3	8.0	8.0	8.0
2 oz	7.7	7.7	8.0	8.0	8.0	8.0
3 oz	8.0	8.0	8.0	8.0	8.0	8.0
4 oz	8.0	8.0	8.0	8.0	8.0	8.0
None	4.0	4.0	4.0	5.7	6.0	7.0
$LSD_{(0.05)}$	0.5	0.5	0.5	0.6	0.5	NS

[a]Visual quality is based on a scale of 9 to 1 with 9 = dark green turf and 1 = brown turf.
[b]DAA = days after application. Treatment was applied June 2, 1992.

Soil Relation Studies

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

Soil compaction and wear are serious problems for athletic fields and thus play a role in the selection of the turfgrass used. Tall fescue is a good grass to use on sport fields because it possesses excellent wear tolerance. However, when subjected to soil compaction, K-31 tall fescue did not perform as well when compared to perennial ryegrass and Kentucky bluegrass. Improved varieties of tall fescue have been developed, but it is not known how these new varieties will perform when subjected to soil compaction.

Soil compaction is often described as a hidden stress, not revealing its presence until a turf stand is under stress conditions. Compaction increases a soil's bulk density by destroying the soil structure. Large soil pores are destroyed resulting in the reduction of air porosity and thus soil aeration and water permeability are decreased.

Compaction generally occurs within the top 3 cm of soil surface, resulting in a limited space in which oxygen is able to permeate. In situations where oxygen is limiting to a root system, root extension is inhibited and adventitious rooting is promoted. The plant produces a root system that has the majority of its roots near the soil surface, increasing the chances of a plant to die when it becomes stressed.

The measurement of soil compaction generally requires extensive soil sampling in order to calculate the bulk density. The problem with soil sampling is that the soil is disturbed when the sampling takes place, decreasing the accuracy of the test. A new method for calculating soil compaction entails the use of a soil strain gauge. When the strain gauge is set into the soil it can measure the change in compression caused by a compactive force. The use of this system for measurement in turfgrass situations has great potential and requires evaluation.

The objectives of this research project are to compare 5 tall fescue cultivars when subjected to soil compaction and to compare the strain gauge to soil physical properties for soil compaction studies.

On May 3, five cultivars of tall fescue were seeded at a rate of 2.7 Kg $\cdot$ 90 m^{-2} at the Iowa State research farm. Three replicated plots of each cultivar were created in a completely randomized design, measuring 6 m by 4.5 m. Individual treatment plots will be .75 m by 3 m. The five cultivars to be studied are K31, Crossfire, Rebel II, Rebel Jr, and Twilight. Three levels of compaction were applied in the fall of 1992 using a smooth power roller. The three levels were 0x, 10x and 20x. 1x equals 1 pass with a smooth power roller at 0.193 MPa. Prior to the compaction treatments, strain gauges will be placed in the soil to measure the compactive force being applied.

The plots are irrigated using athletic field type sprinkler heads at a rate of 2.5 cm per week to prevent moisture stress. Fertilization is applied at a rate of 1 lb/1000 ft^2 in May, August, and September. The grass is maintained at a mowing height of 2 inches. Herbicides are used as needed to prevent weed populations from developing.

Data collected includes root density May 1993, shoot dry mass, visual quality, shoot density, bulk density, water retention, and strain gauge measurement. Visual quality was based on a scale of 9 to 1: 9 = best quality, 6 = acceptable quality, and 1 = poorest quality.

Data is included in Table 63. Soil compaction decreased both clippings and visual quality. K-31 tall fescue performed poorly, while Crossfire and Reble Jr. had the highest quality ratings.

Table 63. Effect of soil compaction and tall fescue cultivars on clipping production and visual quality.

		Clipping Weights			Visual Quality		
Cultivar	Compaction Treatment	9/15	9/22	10/6	9/15	9/22	10/20
K 31	0	30.4	21.0	25.2	6.0	6.3	6.0
	10	26.9	18.4	22.7	4.0	4.0	4.7
	20	24.8	18.3	24.3	4.0	4.0	4.7
Crossfire	0	33.1	22.0	23.2	7.7	8.0	8.0
	10	23.6	16.0	17.7	5.7	6.3	6.7
	20	22.1	14.4	17.1	5.7	5.3	6.3
Twilight	0	33.7	20.9	21.3	7.3	6.7	6.7
	10	22.2	13.7	13.9	5.3	5.0	5.3
	20	21.6	13.9	15.2	5.0	4.0	5.0
Rebel II	0	31.9	21.0	24.0	7.7	8.0	7.3
	10	28.5	19.8	21.7	6.7	7.0	7.0
	20	24.8	17.0	19.5	6.3	6.0	6.0
Rebel Jr	0	31.9	18.9	22.0	8.0	8.0	8.0
	10	26.5	18.5	18.8	7.0	6.7	6.3
	20	23.0	13.8	26.2	6.3	6.0	6.0
LSD_{CV}		NS	NS	NS	0.4	0.5	0.5
LSD_{COM}		2.7	2.3	NS	0.3	0.4	0.4
$LSD_{CS\ x\ COMP}$		NS	NS	NS	NS	NS	NS

Modification of Disturbed Soils

M. L. Agnew

The construction of new houses is a sign of a healthy economy. When housing starts are up, the sod production and landscape contracting industry will benefit. However, too little monetary resources are placed on the turfgrass and landscape development. This results in either the removal or burial of topsoil. All too often, only subsoil clays remain. Lawns and landscape plants demonstrate poor growth when established on these soils

The objective of this study is to investigate the effects of soil amendments on disturbed soils derived from the parent material.

This study was conducted in the Iowa State University greenhouses in Ames Iowa. The soil was obtained from a construction site on campus. It consisted of 30% clay, 44% sand and 26% silt. The soil was shredded prior to the addition of amendments. The soil amendments included:

Earthgro Compost I (ECI) (chicken manure based compost),
Earthgro Compost II (ECII) (lawn clippings based compost),
Rebuild (RB) (organic bio-remediation product),
Organic Technologies Compost (OTC) (local yard waste compost), and
Sphagnum Peat Moss (SPM).

Soil amendments were mixed at the following volumes with the soil in a soil mixer: 10%, 20%, and 30%. A non-amended soil was used as a control. Each soil/soil amendment treatment was placed in PVC containers with a 15 cm. diameter and a 60 cm. depth. Each container was irrigated and allowed to settle. Perennial ryegrass was seeded at a rate of 3 lb. per 1000 ft^2. The turfgrass was fertilized at a rate of 1 lb. N/1000 ft^2 at 6 weeks after seeding. Irrigation was added to prevent moisture stress until the plant were established. On September 21, the container received enough water to bring the soil to saturation. Water was withheld from the containers until October 26. Each container was then irrigated and an undisturbed soil sample was taken from each container. Visual quality ratings and clipping weights were taken throughout the dry down cycle.

Visual quality data is presented in Table 64. Prior to the dry down cycle, all treatments had equal quality with the exception of ECI - 30%. This is not surprising, since this material contains chicken manure. Fifteen days after irrigation (Oct. 6), only treatments amended with SPM exhibited quality ratings less than 6.0. Only ECI (20% and 30%), and RB (20%) exhibited acceptable quality by the termination of the dry down cycle on October 26. Clipping weight (both fresh and dry) support the visual quality data (Tables 65 and 66). ECI (30%) maintain the best growth by the end of the dry down cycle. Treatments amended with SPM had substantially less fresh and dry clipping weight. SPM amended soils also had a lower relative water content in the plant (Table 67). The ECI (30%) had the lowest relative water content prior to the dry down cycle, but had the highest relative water content by the end of the dry down cycle.

Soil physical property data is presented in Table 68. ECI (20% and 30%), ECII (10%), RB (20% and 30%), OTC (20% and 30%), and SPM (30%) amended soils had bulk densities less than the control. Total pore space was improved over the control by ECI (20% and 30%), RB (30%), OTC (30%) and SPM (30%). In general, a minimum application of 20% is needed to amend soil.

Table 64. The effects of 5 different organic matter sources and three volumes on visual quality of perennial ryegrass.

Soil Amendment	Amendment Volume	September			October			Avg.
		11	21	28	6	13	26	
Earthgro Compost I	10%	8.0	7.7	8.0	8.0	6.3	5.0	7.2
Earthgro Compost I	20%	8.0	8.0	8.0	7.7	6.7	6.7	7.5
Earthgro Compost I	30%	7.0	7.0	7.7	8.0	7.0	7.3	7.3
Earthgro Compost II	10%	8.0	8.0	8.0	7.3	5.7	4.0	6.8
Earthgro Compost II	20%	8.0	8.0	8.0	7.7	6.0	3.7	6.9
Earthgro Compost II	30%	8.0	8.0	8.0	7.7	6.7	5.0	7.2
Rebuild	10%	8.0	8.0	8.0	8.0	6.3	4.0	7.1
Rebuild	20%	8.0	8.0	8.0	7.7	5.3	5.0	7.0
Rebuild	30%	8.0	8.0	7.7	7.7	6.0	6.7	7.3
Organic Tech	10%	8.0	8.0	8.0	8.0	5.7	4.3	7.0
Organic Tech	20%	8.0	8.0	8.0	8.0	6.7	4.3	7.2
Organic Tech	30%	8.0	8.0	8.0	8.0	6.7	5.0	7.3
Sphagnum Peat	10%	8.0	8.0	7.7	6.3	4.0	3.7	6.3
Sphagnum Peat	20%	8.0	8.0	7.3	5.3	4.0	3.3	6.0
Sphagnum Peat	30%	8.0	8.0	7.3	5.7	3.7	3.3	6.0
Control	--	8.0	8.0	8.0	7.0	5.0	3.7	6.6
$LSD_{(0.05)}$		N.S.	0.2	N.S.	0.7	1.1	1.0	0.3

Table 65. The effects of 5 different organic matter sources and three volumes on dry clipping weights of perennial ryegrass.

Soil Amendment	Amendment Volume	September			October			Total
		11	21	28	6	13	26	
Earthgro Compost I	10%	1.02	0.89	0.67	0.67	0.18	0.17	3.60
Earthgro Compost I	20%	0.96	0.81	0.78	0.67	0.26	0.25	3.74
Earthgro Compost I	30%	0.78	0.72	0.55	0.55	0.21	0.43	3.25
Earthgro Compost II	10%	1.18	0.99	0.57	0.49	0.17	0.12	3.50
Earthgro Compost II	20%	1.22	1.22	0.76	0.61	0.18	0.11	4.11
Earthgro Compost II	30%	1.22	1.13	0.63	0.51	0.23	0.23	3.95
Rebuild	10%	1.39	1.28	0.95	0.85	0.24	0.09	4.80
Rebuild	20%	1.10	1.08	0.92	0.53	0.10	0.19	3.92
Rebuild	30%	1.08	0.99	0.70	0.47	0.13	0.31	3.67
Organic Tech	10%	1.30	1.13	0.81	0.64	0.13	0.17	4.18
Organic Tech	20%	1.34	1.34	0.90	0.77	0.24	0.20	4.79
Organic Tech	30%	1.24	1.26	0.86	0.82	0.30	0.26	4.74
Sphagnum Peat	10%	1.09	1.00	0.48	0.21	0.03	0.07	2.88
Sphagnum Peat	20%	1.02	0.67	0.35	0.16	0.08	0.06	2.33
Sphagnum Peat	30%	0.91	0.63	0.33	0.14	0.06	0.08	2.15
Control	--	1.02	0.94	0.54	0.36	0.14	0.08	3.08
$LSD_{(0.05)}$		0.23	0.31	0.21	0.23	0.09	0.12	0.75

Table 66. The effects of 5 different organic matter sources and three volumes on fresh clipping weights of perennial ryegrass.

Soil Amendment	Amendment Volume	September			October			Total
		11	21	28	6	13	26	
Earthgro Compost I	10%	5.8	5.8	4.2	3.3	1.1	0.6	20.7
Earthgro Compost I	20%	5.5	5.1	4.7	3.9	1.6	0.9	21.7
Earthgro Compost I	30%	4.5	4.5	3.3	3.3	1.2	2.0	18.9
Earthgro Compost II	10%	6.7	6.1	3.5	2.9	0.9	0.4	20.4
Earthgro Compost II	20%	7.1	8.1	4.7	3.8	1.1	0.4	25.1
Earthgro Compost II	30%	7.1	7.2	4.2	3.1	1.4	0.9	23.7
Rebuild	10%	7.3	7.9	5.7	5.1	1.4	0.3	27.6
Rebuild	20%	5.8	6.5	4.7	3.0	0.7	0.8	21.4
Rebuild	30%	5.8	5.7	3.5	2.7	0.8	1.3	19.8
Organic Tech	10%	7.5	7.4	5.2	3.8	0.9	0.7	25.5
Organic Tech	20%	7.6	8.5	5.7	4.7	1.4	0.7	28.5
Organic Tech	30%	7.2	8.2	5.4	4.9	1.2	1.1	28.0
Sphagnum Peat	10%	6.1	6.4	2.9	1.1	0.3	0.4	17.2
Sphagnum Peat	20%	6.0	4.5	2.0	0.9	0.4	0.3	14.1
Sphagnum Peat	30%	5.2	4.2	2.0	0.8	0.9	0.4	13.4
Control	--	5.7	5.9	3.2	1.9	0.8	0.3	17.8
$LSD_{(0.05)}$		1.2	1.8	1.4	1.4	0.7	0.5	4.4

Table 67. The effects of 5 different organic matter sources and three volumes on relative water content.

Soil Amendment	Treatment Volume	September			October		
		11	21	28	6	13	26
Earthgro Compost I	10%	4.73	4.87	3.55	2.63	0.91	0.43
Earthgro Compost I	20%	4.58	4.25	3.87	3.26	1.29	0.67
Earthgro Compost I	30%	3.75	3.73	2.77	2.75	1.03	1.61
Earthgro Compost II	10%	5.53	5.06	2.94	2.37	0.69	0.33
Earthgro Compost II	20%	5.84	6.85	3.98	3.14	0.89	0.25
Earthgro Compost II	30%	5.83	6.06	3.53	2.54	1.14	0.70
Rebuild	10%	5.89	6.59	4.74	4.20	1.20	0.22
Rebuild	20%	4.65	5.39	3.81	2.50	0.55	0.57
Rebuild	30%	4.72	4.74	2.84	2.25	0.64	0.97
Organic Tech	10%	6.16	6.28	4.35	3.16	0.81	0.52
Organic Tech	20%	6.29	7.17	4.75	3.88	1.17	0.46
Organic Tech	30%	5.97	6.98	4.54	4.04	0.94	0.83
Sphagnum Peat	10%	5.04	5.40	2.37	0.88	0.26	0.32
Sphagnum Peat	20%	4.99	3.81	1.62	0.74	0.33	0.25
Sphagnum Peat	30%	4.25	3.59	1.62	0.68	0.80	0.27
Control	--	4.72	5.00	2.66	1.52	0.62	0.24
$LSD_{(0.05)}$		1.04	1.51	1.20	1.19	N.S.	0.42

Table 68. The effects of 5 different organic matter sources and three volumes on soil physical properties.

Soil Amendment	Amendment Volume	Bulk Density	Total Pore Space
Earthgro Compost I	10%	1.27	47.5
Earthgro Compost I	20%	1.09	52.1
Earthgro Compost I	30%	1.01	54.3
Earthgro Compost II	10%	1.16	50.0
Earthgro Compost II	20%	1.24	49.8
Earthgro Compost II	30%	1.18	48.5
Rebuild	10%	1.25	46.3
Rebuild	20%	1.06	48.4
Rebuild	30%	1.04	60.6
Organic Tech	10%	1.27	45.5
Organic Tech	20%	1.15	50.4
Organic Tech	30%	1.15	52.1
Sphagnum Peat	10%	1.29	49.5
Sphagnum Peat	20%	1.18	51.3
Sphagnum Peat	30%	1.05	58.5
Control	--	1.33	44.9
$LSD_{(0.05)}$		0.16	7.0

The Effects of Compost Topdressing on Compacted Soils

M. L. Agnew and S. M. Berkenbosch

Soil compaction is considered by many to be the number one stress of turfgrasses. It predisposes the turfgrass plant to injury by environmental stress and disease activity. Previous research has demonstrated that compacted soils have low oxygen levels and high soil strength. The most common means of alleviating soil compaction is to core cultivate the site. However, core cultivation may not be the total answer in soils that receive repeated traffic. It would be important in these situations to amend the soils so that they are less prone to compactive forces. Many turfgrass managers believe that the application of pure sand to the soil surface will amend the compacted soil condition. Instead, the result is a layered soil profile which results in a shallow root system. One possible amendment that may prove to be beneficial is the application of organic matter to the soil surface. This type of soil amendment is not as drastic of a change in physical properties as is sand.

The purpose of this study is to investigate the influence of compost topdressing on compacted soils.

The study was established at the Turfgrass Research Plots at the ISU Horticulture Research Station on August 10, 1992. The soil is fine silt loam. Treatments were applied to a 'Nassau' Kentucky bluegrass stand. Plots were fertilized at a 1 lb N/1000 ft^2 on September 15. Plots were irrigated to prevent moisture stress. Individual treatments are as listed in the tables. Soil compaction treatments consisted of 20 passes with a smooth power roller that exerted a pressure of 0.193 MPa per pass. Fall compaction was applied on August 10, 1992. Compost treatments were applied on August 21, 1992. Compost sources were from the Earthgro Company, Lebanon, CT. Earthgro Compost I is derived from a low moisture, dehydrated and composted manures. It has a 2-1-1 fertilizer analysis. Earthgro Compost II is derived from composted yard waste. Core cultivation treatments were applied as 2 passes with a Cushman Ryan Lawnaire 28 with 1.9 cm diameter tines, spaced 8.75 cm by 12.5 cm and a soil penetration of 7.5 cm. Cultivation treatments were applied just prior to the application of the topdress.

Clipping yields and visual quality were collected during the fall of 1992 and are presented in Tables 69 and 70. Compost source and soil compaction affected both clipping yields and visual quality. Earthgro Compost I had the greatest amounts of clippings produced (Table 69). This is not surprising, since this compost contains a minimum amount of nutrients. Earthgro Compost II improved clipping production over the non-topdressed control treatment. Both Earthgro compost sources improved the visual quality ratings when compared to the non-topdressed control (Table 70), however there were very little differences between compost sources. The 1/4 inch topdressing rate improved visual quality over the 1/8 inch topdress rate. Clipping yields and visual quality ratings were decreased by soil compaction.

This study will be carried on through 1993. Treatments will be applied in both the spring and fall. Data to be collected include clipping yields and plant quality (bi-weekly), root growth (October), soil bulk density and water holding capacity (April and October), and earthworm counts (October).

Table 69. The effects of compost, rate, core cultivation, and soil compaction on clipping production of Kentucky bluegrass.

Compost	Rate	Coring	Compaction	Clippings 9/5	Clippings 9/16	Clippings 10/17	Clipping Yield Total
Earthgro I	1/8"	no	no	39.4	29.4	30.7	99.5
Earthgro I	1/8"	no	yes	38.0	28.5	30.0	96.5
Earthgro I	1/8"	yes	no	41.9	35.4	31.3	108.6
Earthgro I	1/8"	yes	yes	40.7	32.5	32.5	105.7
Earthgro I	1/4"	no	no	52.0	37.1	31.4	120.5
Earthgro I	1/4"	no	yes	41.3	32.7	33.4	107.4
Earthgro I	1/4"	yes	no	57.1	37.0	32.0	126.2
Earthgro I	1/4"	yes	yes	38.0	28.1	26.4	92.4
Earthgro II	1/8"	no	no	33.2	27.2	28.4	88.8
Earthgro II	1/8"	no	yes	28.1	23.7	28.4	80.2
Earthgro II	1/8"	yes	no	40.9	30.8	31.6	103.3
Earthgro II	1/8"	yes	yes	32.9	25.3	25.2	83.4
Earthgro II	1/4"	no	no	43.6	33.2	36.0	112.8
Earthgro II	1/4"	no	yes	28.5	22.2	24.1	74.8
Earthgro II	1/4"	yes	no	39.4	30.0	31.7	101.1
Earthgro II	1/4"	yes	yes	28.5	24.0	25.2	77.7
Control	--	no	no	25.6	23.0	21.7	70.3
Control	--	no	yes	27.3	21.7	23.9	72.9
Control	--	yes	no	32.0	25.2	23.7	80.9
Control	--	yes	yes	35.0	22.2	23.1	80.3
LSD (0.05) O.M.				5.3	2.9	2.4	9.1
LSD (0.05) Rate				NS	NS	NS	NS
LSD (0.05) Core				NS*	NS	NS	NS
LSD (0.05) Comp				4.3	2.4	1.9	7.4

* Significant at a 0.10 level

Table 70. The effects of compost, rate, core cultivation and soil compaction on visual quality of Kentucky bluegrass.

				Quality Ratings			
Compost	Rate	Coring	Compaction	9/4	9/16	10/5	Mean
Earthgro I	1/8"	no	no	8.7	8.0	7.7	8.1
Earthgro I	1/8"	no	yes	8.0	7.7	7.7	7.8
Earthgro I	1/8"	yes	no	8.7	8.7	7.7	8.3
Earthgro I	1/8"	yes	yes	8.7	8.0	8.0	8.2
Earthgro I	1/4"	no	no	8.7	8.7	8.0	8.4
Earthgro I	1/4"	no	yes	9.0	8.3	8.0	8.4
Earthgro I	1/4"	yes	no	8.7	8.0	8.0	8.2
Earthgro I	1/4"	yes	yes	9.0	7.3	7.7	8.0
Earthgro II	1/8"	no	no	8.0	8.0	8.0	8.0
Earthgro II	1/8"	no	yes	7.7	7.7	7.7	7.7
Earthgro II	1/8"	yes	no	8.0	7.7	7.3	7.7
Earthgro II	1/8"	yes	yes	7.7	7.7	7.3	7.6
Earthgro II	1/4"	no	no	9.0	9.0	8.0	8.7
Earthgro II	1/4"	no	yes	8.0	8.0	7.7	7.9
Earthgro II	1/4"	yes	no	8.3	8.3	8.0	8.2
Earthgro II	1/4"	yes	yes	8.3	8.0	8.0	8.1
Control	--	no	no	7.3	6.7	7.0	7.0
Control	--	no	yes	7.3	7.0	7.0	7.1
Control	--	yes	no	7.7	7.0	7.0	7.2
Control	--	yes	yes	7.3	7.0	7.0	7.1
LSD (0.05) O.M.				0.3	0.3	0.2	0.2
LSD (0.05) Rate				0.2	N.S.	0.1	0.2
LSD (0.05) Core				N.S.	N.S.	N.S.	N.S.
LSD (0.05) Comp				N.S.	0.2	N.S.	0.1

The Effects of Compost Topdressing on Existing Thatch

M. L. Agnew and S. M. Berkenbosch

Thatch buildup on Kentucky bluegrass lawns is a normal process. Excessive amounts are detrimental to turfgrass growth and development. Thatch removal can be expensive and the disposal of debris may be difficult. Any process that can improve microbial content within the thatch layer can theoretically decrease the thickness of the thatch.

The purpose of this study is to investigate the influence of compost topdressing on thatch decomposition.

The study was established at the Turfgrass Research Plots at the ISU Horticulture Research Station on August 15, 1992. The soil is fine silt loam. Treatments were applied to a 'Ram I' Kentucky bluegrass stand. Plots were fertilized at a 1 lb N/1000 ft^2 on September 15. Plots were irrigated to prevent moisture stress.

Treatments are listed in the tables. Compost treatments were applied on August 21, 1992. Compost sources were from the Earthgro Company, Lebanon, CT. Earthgro Compost I is derived from a low moisture, dehydrated and composted manures. It has a 2-1-1 fertilizer analysis. Earthgro Compost II is derived from composted yard waste. Core cultivation treatments were applied as 2 passes with a Cushman Ryan Lawnaire 28 with 1.9 cm diameter tines, spaced 8.75 cm by 12.5 cm and a soil penetration of 7.5 cm. Cultivation treatments were applied just prior to the application of the topdress. Earth random thatch measurement were taken to determine thatch depth. The average depth was 1 inch + or - 1/10 inch.

Clipping yields and visual quality were collected during the fall of 1992 and are presented in Tables 71 and 72. Compost source affected both clipping yields and visual quality. Earthgro Compost I had the greatest amounts of clippings produced (Table 71). This compost contains a minimum amount of nutrients. Both Earthgro compost sources improved the visual quality ratings when compared to the non-topdressed control (Table 72), however there were very little differences between compost sources. This study will be carried on through 1993. Treatments will be applied in both the spring and fall. Data to be collected include clipping yields and plant quality (bi-weekly), root growth (October), soil bulk density and water holding capacity (April and October), and earthworm counts (October).

Table 71. The effects of compost, rate, core cultivation on clipping production of Kentucky bluegrass.

Compost	Rate	Coring	Clippings 8/10	8/26	9/14	10/16	Clipping Yield Totals
Earthgro I	1/8"	no	94.0	51.0	56.6	50.0	251.5
Earthgro I	1/8"	yes	76.6	38.8	47.2	45.4	208.0
Earthgro I	1/4"	no	88.2	45.7	46.5	42.4	222.8
Earthgro I	1/4"	yes	73.8	42.4	43.6	44.8	204.7
Earthgro I	1/2"	no	74.2	37.7	36.7	38.6	187.2
Earthgro I	1/2"	yes	74.3	37.3	39.8	44.7	196.1
Earthgro II	1/8"	no	81.2	42.3	44.6	39.3	207.4
Earthgro II	1/8"	yes	75.1	40.8	40.0	37.9	193.7
Earthgro II	1/4"	no	55.2	35.4	40.0	41.3	172.0
Earthgro II	1/4"	yes	65.1	36.5	40.7	41.1	183.3
Earthgro II	1/2"	no	59.1	34.2	40.4	39.0	172.7
Earthgro II	1/2"	yes	54.9	31.3	33.8	36.3	156.4
Control	--	no	65.4	41.7	36.7	35.5	179.3
Control	--	yes	80.8	39.5	36.6	31.2	188.0
Control	--	no	65.4	41.7	36.7	35.5	179.3
Control	--	yes	80.8	39.5	36.6	31.2	188.0
LSD (0.05) O.M.			NS*	NS*	6.2	6.7	24.6
LSD (0.05) Rate			NS	NS*	NS	NS	NS
LSD (0.05) Core			NS	NS	NS	NS	NS

* Significant at a 0.10 level

Table 72. The effects of compost, rate, core cultivation on visual quality of Kentucky bluegrass.

			Quality Ratings				
Compost	Rate	Coring	8/4	8/26	9/16	10/16	Means
Earthgro I	1/8"	no	7.7	6.7	7.3	7.0	7.2
Earthgro I	1/8"	yes	7.7	6.3	8.0	7.0	7.3
Earthgro I	1/4"	no	8.0	6.7	7.7	7.0	7.3
Earthgro I	1/4"	yes	8.0	7.0	7.7	7.0	7.4
Earthgro I	1/2"	no	7.7	7.0	7.7	7.0	7.3
Earthgro I	1/2"	yes	6.7	6.0	7.7	7.7	7.0
Earthgro II	1/8"	no	7.3	5.7	7.7	6.3	6.8
Earthgro II	1/8"	yes	6.3	6.7	7.7	6.3	6.8
Earthgro II	1/4"	no	7.0	6.0	8.3	6.7	7.0
Earthgro II	1/4"	yes	6.0	7.0	8.0	6.7	6.9
Earthgro II	1/2"	no	7.0	5.3	8.3	7.7	7.1
Earthgro II	1/2"	yes	5.7	6.0	7.7	6.7	6.5
Control	--	no	6.7	5.7	7.0	6.0	6.3
Control	--	yes	6.3	6.3	7.3	5.7	6.4
Control	--	no	6.7	5.7	7.0	6.0	6.3
Control	--	yes	6.3	6.3	7.3	5.7	6.4
LSD (0.05) O.M.			0.4	NS	0.5	0.5	0.4
LSD (0.05) Rate			NS	NS	NS	NS	NS
LSD (0.05) Core			0.3	NS	NS	NS	NS

* Significant at a 0.10 level

The Effects of Topdress Sand Source and Potassium Level on the Growth and Development of Creeping Bentgrass Greens

M. L. Agnew

Many golf courses currently have greens constructed either from native soils or a mix consisting of 1 part soil, 1 part peat, and 1 part sand. Most of these greens have either poor or no subsurface drainage. Many superintendents are currently using a 100% sand topdress to create a more porous medium for root growth. These sand sources range from calcareous sands to silica sands.

This project investigates the effects of 3 sand sources (silica, g-sand, and calcareous) and traffic on the growth and development of creeping bentgrass. The topdress portion of this field project was initiated at the 1991 field day. Traffic treatments were initiated in the spring of 1993. Data to be collected include root and shoot growth and soil physical data.

Treatments:

Trt#	Sand Source	Traffic Level
1	G-Sand	0X
2	G-Sand	2X
3	Silica	0X
4	Silica	2X
5	Calcareous	0X
6	Calcareous	2X

Plots will be topdressed every 30 days beginning April 15 each spring. Nitrogen fertilizers will be applied at a rate of 0.5 lb N/1000 ft^2 every 20 days. Potassium applications will be applied at rate of 1.0 lb of K/1000 ft^2 as potassium sulfate every 45 days. Traffic is split across topdress treatments.

Environmental Research

Pesticide and Fertilizer Fate in Turfgrasses Managed Under Golf Course Conditions

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

The fate of Trimec, pendimethalin, Subdue, Triump, and Dursban are currently being investigated. The data from a 2 year field study is being analyzed and an ongoing greenhouse study will conclude this fall. The experimental setup is similar to the setup used for the fate of fertilizer study reported on last year. Following is an abstract from new work we concluded this winter. All research has been funded by the United States Golf Association (USGA).

Comparing Solute Transport in Undisturbed and Disturbed Soil Columns Under Turfgrass Conditions

Research relating to soil leaching properties under turfgrass conditions have often been conducted on repacked soils where the macropore structure has been destroyed. The objective of this study was to compare the solute movement characteristics of undisturbed and disturbed soil columns under turfgrass conditions. We studied three parameters: total solute leached, total leachate, and total solute retained in the soil. Chloride was applied as a conservative tracer. Distilled water was applied twice daily for 7 days at a rate of 0.69 cm (0.27 in) per application. Soil columns were excavated into 4 sections. These soil sections and the leachate samples were tested for chloride concentrations. The average bulk density was 1.72 Mg m^{-3} for the undisturbed columns and 1.43 Mg m^{-3} for the disturbed columns. The total amount of chloride leached was 2.0 times higher for the undisturbed columns than for the disturbed columns, and the total quantity of leachate was 1.4 times higher for undisturbed columns than for the disturbed columns. Total chloride found in the B layer (6.7 to 13.4 cm, 2.6 to 5.3 in) was 1.79 times higher and in the C layer (13.4 to 20.0 cm, 5.3 to 8 in) was 2.72 times higher for the disturbed soils than for the undisturbed. For the T (thatch) layer (0.0 to 2.0 cm) the opposite was observed, with total chloride in the undisturbed columns 2.4 times higher than in the disturbed columns. Comparing conclusions from solute movement studies using repacked columns to actual undisturbed field conditions could lead to errors in interpretation because the effect of the macropore structure.

Table 73. Average percentage of applied chloride and irrigation that leached through 4 replications of undisturbed and disturbed soil columns.†

Category	Undisturbed Soil		p-value ‡	Disturbed Soil	
	Mean (%)	Std. Dev. (%)		Mean (%)	Std. Dev. (%)
Chloride	30.0	1.6	0.0017	14.8	5.4
Irrigation	64.5	5.7	0.0335	47.5	11.0

† Values from four replications.
‡ *t* - test, based on the hypothesis that undisturbed and disturbed are the same.

Table 74. Average percentage of applied chloride in each soil layer for 4 replications of undisturbed and disturbed soil columns.†

Layer ‡	Undisturbed Soil		p-values§	Layer ‡	Disturbed Soil	
	Mean (%)	Std. Dev. (%)			Mean (%)	Std. Dev. (%)
T	37.5	4.4	0.0018	T	15.7	1.9
A	13.0	6.9	0.8733	A	14.0	5.7
B	19.5	11.8	0.0198	B	35.0	7.4
C	19.5	2.9	<0.0001	C	53.0	17.6

† Values from four replications.
‡ Layers
T = (0.0-2.0 cm).
A = (2.0-6.7 cm).
B = (6.7-13.4 cm).
C = (13.4-20.0 cm).
§ *t* - test, based on the hypothesis that undisturbed and disturbed are the same.

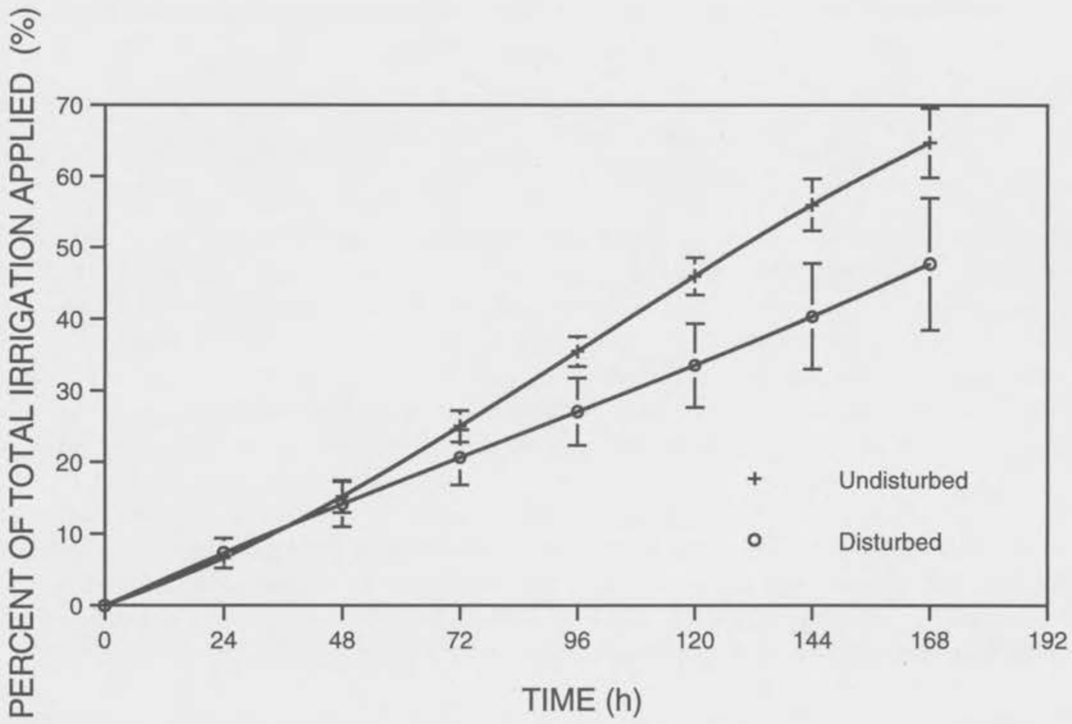


Fig. 2. Percent of total applied irrigation collected as leachate for undisturbed and disturbed soil columns. Bars represent 1 standard deviation.

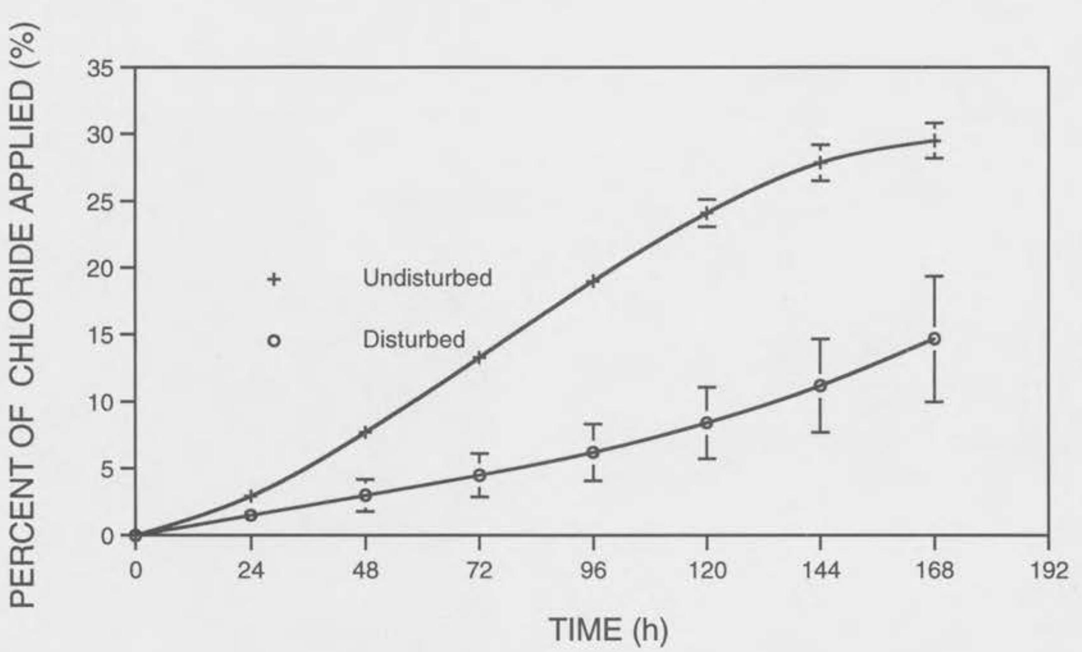


Fig. 3. Percent of total applied chloride collected in leachate for undisturbed and disturbed soil columns. Bars represent 1 standard deviation.

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

D. L. Liu and N. E. Christians

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 is useful as a natural preemergence herbicide and feed material for various plant production systems. The active component(s) responsible for the herbicidal activity of corn gluten meal could potentially be used as natural herbicides. The objectives of this study were to select water-soluble corn gluten meal related materials and to isolate and identify the active compound(s) responsible for the inhibitory activity.

Three species of grass plants were used to test the inhibitory activity of corn gluten meal derived samples, to select a water soluble material to be used in the isolation process. Based on the results from greenhouse and growth chamber bioassays, it was found that an extract of the corn gluten meal was more herbicidally active than the corn gluten meal itself and was highly water-soluble. Roots were found to be more sensitive than shoots to the inhibitory compounds.

Five root-inhibitory compounds were isolated from the water soluble extract protein from corn gluten meal and their structures were identified. Synthetically produced samples of these five compounds were bioassayed and their inhibitory effects on the roots of the test plant were demonstrated. Two U.S. patent applications based on this work have been filed with the Patent Office.

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 of 1991. Marketing agreements with several companies are presently being negotiated.

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. by 5 ft. plots at the research station during 1991 and 1992 at levels of 0, 2, 4 , 6, 8, and 10 lb N per 1000 sq. ft. (20, 40, 60, 80, and 100 lbs corn gluten meal per 1000 sq. ft.) Data from the second year of this multiple year study on crabgrass control with corn gluten meal are shown in Figures and . Crabgrass was reduced by from 80 to 85 % at the 2 lb N per 1000 sq. ft rate (20 lb of corn gluten meal per 1000 sq. ft.). 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 crabgrass season (September data) even though the late summer time period was very wet.

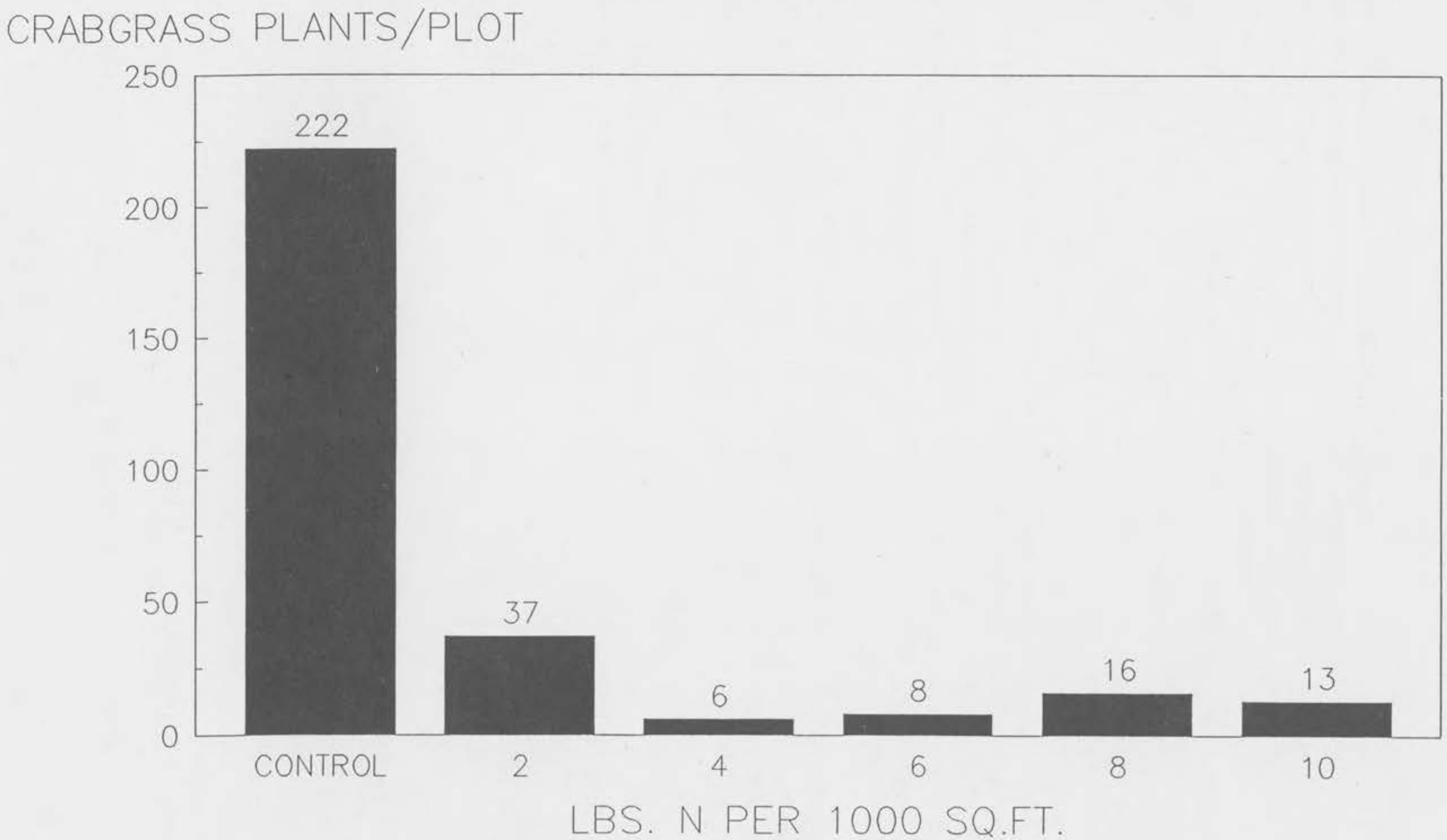
Applications of this same rates of corn gluten meal were applied to the same plots in the spring of 1993.

Figure 4.

1992 CRABGRASS CONTROL TRIAL

CORN GLUTEN MEAL

AUGUST 6, 1992

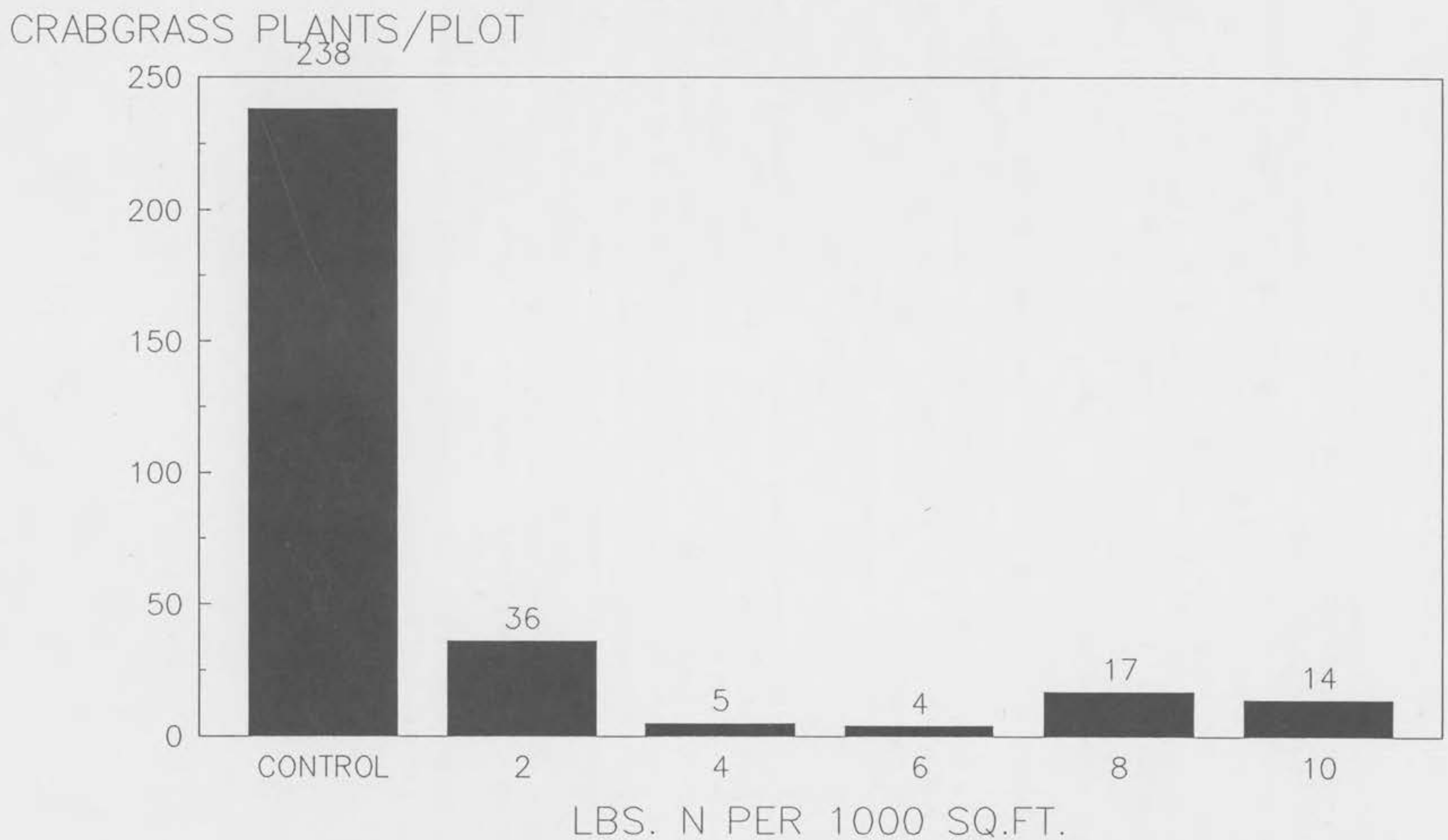


LSD 0.05 = 97

Figure 5.

1992 CRABGRASS CONTROL TRIAL

CORN GLUTEN MEAL
SEPTEMBER 3, 1992



LSD 0.05 = 101

Drift of Postemergence Herbicide Spray During a Turfgrass Application

H. Hatterman-Valenti, M. Owen, and N. E. Christians

Pesticide spray drift is one of the key environmental issues receiving public attention. This is especially true for the lawn care industry because the majority of their business is in residential areas. Therefore, research has been conducted at Iowa State University to quantify the level of off-target particle movement of three common lawn-care spray nozzles under varying wind conditions. A carbon-dioxide pressurized backpack sprayer was used to apply the triethylamine salt of triclopyr at a rate of 1.5 lb a.i./A with the addition of 1% w/v Fluorescein, a fluorescent dye. The three spray nozzles consisted of the XR8004 VS® flat fan nozzles, the RA-6 Raindrop® swirl chamber nozzles, and the Lesco® spray gun. The delivery rates for the three spray nozzles were 0.27, 0.54, and 3.17 gal/min, respectively. The operating pressure and ground speed was adjusted for each sprayer so that the mean volume rates were 20, 40, and 125 gal/A, respectively.

The spray application was made along a line perpendicular to the wind direction. Three sampling lines were set perpendicular and downwind from the spray swath edge. Sample location spacing was approximately 1, 3, 5, and 7 ft. Each location had two mylar sheets mounted on poster board and two tomato plants. Wind speed was recorded during the spray application. Immediately following the application, plant samples and mylar sheets were collected and individually stored until fluorescent analysis. One of the two tomato plants at each sampling site was returned to the greenhouse for visual observations of triclopyr injury.

Data from the six trials showed that the percentage of application volume lost to spray drift with the mylar or the tomatoes decreased with distance for all nozzle types (Table 75). The greatest percentage was detected with the XR8004 VS® flat fan nozzles at all distances. This was followed by the RA-6 Raindrop® swirl chamber nozzles, with the Lesco® spray gun having the lowest percentage of application volume detected. The measurements taken on the tomatoes returned to the greenhouse indicated that plants within the Lesco® spray gun treatment had the least amount of injury while plants within the 8004 VS® flat fan treatment had the greatest amount of injury (Tables 76, 77, and 78). This was true not only for visual injury symptoms, but also height and fresh weight measurements taken four weeks after the treatment. Distance decreased the triclopyr drift injury on tomato plants. The least growth (i.e. height and fresh weight) occurred with plants at the 1 ft downwind location. On the other hand, plants at the 5 or 7 ft distances were the tallest, with significant differences between them and the control plants. Finally, the least amount of visual injury to tomato plants at all distances occurred with the Lesco® spray gun.

Table 75. Percent of application volume lost to drift[a].

	Distance Downwind				
Nozzle Type	30 cm	90 cm	150 cm	210 cm	Mean
Fluorescein Dye Collected on Tomato					
Flat fan	5.63	1.83	0.72	0.69	2.22 c
Swirl chamber	4.37	0.61	0.49	0.31	1.48 b
Spray gun	1.03	0.17	0.15	0.08	0.36 a
Mean	3.68 b	0.87 a	0.45 a	0.36 a	
Fluorescein Dye Collected on Mylar					
Flat fan	27.91	4.83	4.02	2.77	9.88 b
Swirl chamber	21.13	2.75	1.41	0.91	6.55 ab
Spray gun	10.24	0.49	0.30	0.25	2.82 a
Mean	19.76 b	2.69 a	1.97 a	1.31 a	

[a]Means within a column or row followed by the same letter do not differ significantly at the P>0.05 level.

Table 76. Mean increase in tomato height 4 weeks after treatment[a].

		Distance Downwind				
Nozzle Type	Control	30 cm	90 cm	150 cm	210 cm	Mean
Control	8.54					8.54 a
Flat fan		1.44	3.64	5.91	8.04	4.99 a
Swirl chamber		4.11	13.69	14.03	12.89	11.18 b
Spray gun		9.44	13.56	15.97	13.97	13.23 b
Mean*	8.54 a	5.00 a	10.30 ab	11.97 b	11.93 b	

[a]Means within a column or row followed by the same letter do not differ significantly at the P>0.05 level.

Table 77. Mean increase in tomato weight 4 weeks after treatment[a].

		Distance Downwind				
Nozzle Type	Control	30 cm	90 cm	150 cm	210 cm	Mean
Control	87.65					87.65 ab
Flat fan		46.22	61.61	79.56	89.13	69.13 a
Swirl chamber		38.93	72.81	85.07	100.56	74.34 ab
Spray gun		71.05	90.91	99.12	106.69	91.94 b
Mean*	87.65 b	52.07 a	75.11 b	87.92 b	98.79 b	

[a]Means within a column or row followed by the same letter do not differ significantly at the P>0.05 level.

Table 78. Mean percent injury to tomato 4 weeks after treatment[a].

	Distance Downwind				
Nozzle Type	30 cm	90 cm	150 cm	210 cm	Mean
Flat fan	61.11	41.11	26.39	14.78	35.85 b
Swirl chamber	61.38	7.50	2.22	0.28	17.85 a
Spray gun	8.61	2.50	0.01	0.28	2.85 a
Mean	43.7 c	17.04 b	9.54 a	5.11 a	

[a]Means within a column or row followed by the same letter do not differ significantly at the P>0.05 level.

Ground Ivy Control with Borax

H. Hatterman-Valenti and N. E. Christians

Borax (sodium tetraborate) has been tested for two years as a herbicide to control ground ivy in a cool-season lawn. Borax is labeled for nonselective vegetation control under asphalt or for spot treatment of johnsongrass in cotton. The application rate for these applications is 5 to 15 lb/100 ft^2, depending on which borax form (i.e. anhydrous, pentahydrate, or decahydrate) is used. The element in borax responsible for the physiological action in higher plants is boron. Boron is an essential mineral element for all vascular plants. There is a certain minimum requirement of boron for a plant and a certain maximum level of tolerance. It is the toxicity from high levels of boron that has a herbicidal effect. Sensitivity to boron varies greatly between species. Toxicity symptoms typically show first on older leaf margins as either a yellowing or drying of leaf tissues.

The experimental design was a randomized complete block with three replications. Individual plot dimensions were 5 by 5 ft. Treatments included:

5 oz Borax/1000 ft^2 (borax mixture with water)
10 oz Borax/1000 ft^2 (borax mixture with water)
20 oz Borax/1000 ft^2 (borax mixture with water)
1.1 oz/1000 ft^2 Super Trimec®
20 oz Borax/1000 ft^2 (dry or granular application)
Sharpshooter® (ready to use mixture)
Weedy control

20 MuleTeam Borax® was used for the borax applications. The borax was dissolved in a small amount of hot water and then diluted to its final spray volume of 2.5 gal/1000 ft^2. Applications of Super Trimec® and Sharpshooter® were also included for comparison. Super Trimec® is a combination product consisting of: 2,4-D; 2,4-DP; and dicamba while Sharpshooter® is a fatty acid based, non-selective contact herbicide. A CO_2-charged backpack sprayer was used to apply the liquid borax and Super Trimec®. Herbicide applications were made 6/27/91 and 5/29/92.

Control and injury ratings were taken 4 and 8 weeks after treatments (WAT) and finally the following spring. A summary of the results is given in Tables 79 and 80. The liquid applications of borax provided acceptable control of ground ivy and were comparable to the Super Trimec® application for both years. There was not as much injury to the turfgrass in 1992, however, the ground ivy control also decreased slightly. The mild winter in 1992 may have contributed to the recovery of the ground ivy.

The study was also repeated 6/12/92 at another location. However, because of the hot dry weather during this period, none of the treatments provided satisfactory control. Therefore, treatments were reapplied 9/29/92 along with a 30 oz borax/1000 ft^2 treatment in order to assess ground ivy control in the fall and the potential buildup of boron in the soil. Results were similar to those observed in 1991 and the May application in 1992. The 30 oz borax treatment did cause turfgrass to turn chlorotic for approximately 4 weeks after the application, however, no injury was evident the following spring.

This year Solubor® will be compared with borax. Applications will be made on a volume to volume basis (i.e. 3 tsp./1 gal. water) which should make spot applications easier. Greenhouse studies will also be conducted to investigate the sensitivity of ground ivy to boron.

Table 79. Percent control of ground ivy.

	1991			1992		
Treatment	4 WAT	8 WAT	Spring	4 WAT	8 WAT	Spring
5 oz L. Borax	73.3	68.3	97.7	86.7	55.0	70.0
10 oz. L. Borax	80.0	93.3	93.3	90.0	80.0	68.3
20 oz. L. Borax	91.7	97.0	100.0	93.3	90.0	85.0
Super Trimec®	95.0	71.7	100.0	85.0	66.7	80.0
20 oz. D. Borax	56.7	51.7	94.3	50.0	46.7	53.3
Sharpshooter®	30.0	16.7	63.3	63.3	23.3	33.3
Weedy Control	0.0	0.0	11.7	0.0	0.0	23.3
$LSD_{(0.05)}$	18.4	23.8	37.0	27.6	46.1	28.8

@L. Borax = Liquid Borax Mixture
D. Borax = Dry Borax Application

Table 80. Percent injury to cool-season turfgrass.

	1991			1992		
Treatment	4 WAT	8 WAT	Spring	4 WAT	8 WAT	Spring
5 oz L. Borax	3.3	10.0	5.0	0.0	1.7	0.0
10 oz. L. Borax	18.3	30.0	11.7	0.0	0.0	0.0
20 oz. L. Borax	13.3	40.0	10.0	0.0	1.7	0.0
Super Trimec®	10.0	8.3	1.7	8.3	15.0	0.0
20 oz. D. Borax	13.3	16.7	8.3	23.0	10.0	0.0
Sharpshooter®	10.0	16.7	8.3	23.0	10.0	0.0
Weedy Control	0.0	0.0	0.0	0.0	0.0	0.0
$LSD_{(0.05)}$	NS	21.7	NS	21.6	NS	NS

@L. Borax = Liquid Borax Mixture
D. Borax = Dry Borax Application

National Crabapple Evaluation Program

J. K. Iles

In 1983 the National Crabapple Evaluation Program (NCEP) was established by Dr. Thomas Green, Plant Pathologist at the Morton Arboretum, Lester P. Nichols, Professor Emeritus of Plant Pathology at Penn State University, and Dr. Ed Hasselkus, Extension Horticulturist at the University of Wisconsin.

The purpose of this program is to test approximately 50 of the best taxa of flowering crabapples over a broad geographical range. Information on disease resistance and aesthetic characteristics such as fruit color, size, persistence, flower color, plant form, and mature growth habit has been obtained. This information will provide guidance to landscape architects, landscape contractors, nursery operators, municipal arborists, park superintendents, and homeowners for selecting appropriate crabapple species for the landscape.

Cooperators for the program were selected at locations in parks, universities, and arboreta in the following states: North Carolina, Rhode Island, Ohio, Illinois, Kentucky, Michigan, Minnesota, Wisconsin, Nebraska, Iowa, North Dakota, Colorado, Oklahoma, Utah, Oregon, Washington, and the District of Columbia. Partial collections have also been sent to Killen, Alabama and Spartenburg, South Carolina. Every fall, cooperators at each site evaluate their collection and submit the data for compilation.

Fall Aesthetic Evaluation

The most important evaluation in the fall is the aesthetic rating. Certain crabapple cultivars may demonstrate little defoliation and still have a pleasing appearance even though they are moderately or severely susceptible to apple scab and/or cedar-apple rust. Others may defoliate but still have an outstanding display of fruit. Therefore, the aesthetic rating attempts to answer the question, "How does this tree look (as an ornamental) at this time of the year?" Theoretically, if the plant looks good in the fall, it should have looked good since the time of flowering. The aesthetic rating is useful in judging the overall aesthetic impact of the tree.

Aesthetic Rating System

0 = Perfect Tree: A tree that has a little something extra going for it such as blemish-free, dark-green foliage, early coloration of fruit, vivid fruit display, abundant and persistent fruit, attractive form, and good fall leaf color. The tree rated **0** stands out from all the rest.

1 = Highly Ornamental: A nearly perfect tree. Foliage may be dull green or some scab may be present, fruit fairly abundant but less than the **0** rated tree, fruit color may be less vivid or less persistent, and it may not have noteworthy fall foliage color.

2 = Ornamental: A totally acceptable tree but less than perfect. Leaves may have slight to severe scab, but little defoliation occurs. Fruit may not be as abundant or particularly ornamental. For example, the cultivar `Indian Magic´ may defoliate prematurely because of apple scab, but the persistent orange fruit are extremely ornamental.

3 = Barely Ornamental: A tree receiving this rating is essentially a green plant with very little ornamental value. Fruit may be dull, too large, and/or not persistent. Foliage may be infected with scab, cedar-apple rust, or moderately damaged by insects or mites but the tree remains green with little defoliation.

4 = Undesirable: Trees earning a 4 are undesirable because of defoliation from disease, ugly or messy fruit, and/or poor form. Trees with large fruit that drop in late summer or early fall are given this rating.

5 = Unacceptable: Trees having messy fruit, poor form, and totally defoliate because of disease fall into this category.

Table 81. Composite NCEP Evaluation (1990-1992), Iowa State University Research Station.

	Tree Name	#Trees	0	1	2	3	4	5	Avg.
1	'Sentinel'	7	2	4	1	0	0	0	0.86
2	Candied Apple®	7	1	5	1	0	0	0	1.00
3	'Donald Wyman'	7	2	3	2	0	0	0	1.00
4	'Indian Magic'	9	3	3	3	0	0	0	1.00
5	'Professor Sprenger'	9	2	5	2	0	0	0	1.00
6	'Adams'	9	0	8	1	0	0	0	1.11
7	*zumi* 'Calocarpa'	9	2	5	1	1	0	0	1.11
8	'David'	9	4	1	2	2	0	0	1.22
9	'Profusion'	9	1	5	3	0	0	0	1.22
10	Sugar Tyme®	9	2	4	2	1	0	0	1.22
11	Centurion®	4	1	2	0	1	0	0	1.25
12	'Snowdrift'	8	3	0	5	0	0	0	1.25
13	'Henningi'	9	0	6	3	0	0	0	1.33
14	'Bob White'	9	1	4	3	1	0	0	1.44
15	Christmas Holly™	9	1	4	3	1	0	0	1.44
16	'Red Barron'	6	0	4	1	1	0	0	1.50
17	Red Jewel®	9	3	0	4	2	0	0	1.56
18	Molten Lava®	8	2	0	5	1	0	0	1.63
19	'Ralph Shay'	9	0	4	4	1	0	0	1.67
20	'Winter Gold'	3	0	2	0	1	0	0	1.67
21	*baccata* 'Jackii'	8	0	4	2	2	0	0	1.75
22	'Ormiston Roy'	8	0	4	2	2	0	0	1.75
23	Harvest Gold®	9	0	2	7	0	0	0	1.78
24	'Velvet Pillar'	9	0	2	7	0	0	0	1.78
25	'White Angel'	9	0	5	1	3	0	0	1.78
26	'Prairifire'	6	0	1	5	0	0	0	1.83
27	'Indian Summer'	3	0	0	3	0	0	0	2.00
28	'Mary Potter'	9	0	3	3	3	0	0	2.00
29	'Robinson'	9	0	2	6	0	1	0	2.00
30	'Silver Moon'	7	0	4	0	2	1	0	2.00
31	'Jewelberry'	9	0	2	4	3	0	0	2.11
32	*hupehensis*	9	0	1	5	3	0	0	2.22
33	'Red Splendor'	9	0	3	1	5	0	0	2.22
34	*halliana* 'Parkmanii'	3	0	0	2	1	0	0	2.33
35	*floribunda*	9	0	0	5	4	0	0	2.44
36	'Beverly'	9	0	2	0	6	1	0	2.67
37	'Liset'	7	0	0	2	5	0	0	2.71
38	'Red Jade'	5	0	0	1	3	1	0	3.00
39	*tschonoskii*	3	0	0	0	3	0	0	3.00
40	*sargentii*	5	0	1	0	2	1	1	3.20
41	'Strawberry Parfait'	9	0	0	1	4	4	0	3.33
42	'Dolgo'	9	0	0	0	5	4	0	3.44
43	'Selkirk'	8	0	0	0	4	4	0	3.50
44	'Ruby Luster'	9	0	0	0	4	5	0	3.56
45	'Radiant'	9	0	0	0	3	6	0	3.67
46	'Royalty'	9	0	0	0	3	6	0	3.67
47	'White Cascade'	9	0	0	0	2	7	0	3.78
48	'Hopa'	9	0	0	0	2	5	2	4.00
49	*yunnanensis* var. *veitchii*	2	0	0	0	0	0	2	5.00

Table 82. Composite NCEP Evaluation (1990-1992), (All Trial Sites).

	Tree Name	0	1	2	3	4	5	Sum	Avg.
1	*zumi* 'Calocarpa'	35	37	23	7	1	0	103	1.04
2	'Professor Sprenger'	35	43	27	7	3	0	115	1.13
3	'Donald Wyman'	34	55	24	2	6	1	122	1.13
4	Molten Lava®	38	39	28	3	8	0	116	1.17
5	Sugar Tyme®	30	37	38	16	2	0	123	1.37
6	Red Jewel®	18	32	21	10	4	0	85	1.41
7	'Snowdrift'	18	40	39	12	0	0	109	1.41
8	'David'	23	39	29	15	3	0	109	1.41
9	'Sentinel'	28	38	37	8	4	3	118	1.41
10	'Indian Magic'	19	49	30	14	3	0	115	1.41
11	Christmas Holly™	11	42	20	7	3	3	86	1.51
12	'Bob White'	3	49	43	7	1	0	103	1.55
13	'Mary Potter'	18	46	30	14	5	3	116	1.57
14	'Adams'	5	56	46	14	1	1	123	1.61
15	'Prairifire'	10	50	27	13	10	0	110	1.66
16	'Indian Summer'	14	36	42	19	2	1	114	1.66
17	'Henningi'	5	47	38	15	4	0	109	1.68
18	'Profusion'	8	52	27	11	11	1	110	1.70
19	'Ormiston Roy'	11	48	33	15	7	3	117	1.72
20	'Red Splendor'	5	32	55	15	1	0	108	1.76
21	*baccata* 'Jackii'	2	32	46	12	2	0	94	1.78
22	'Ralph Shay'	3	50	58	7	11	1	130	1.81
23	'White Angel'	6	37	36	20	3	2	104	1.83
24	'Jewelberry'	3	34	34	18	4	0	93	1.84
25	Centurion®	10	39	34	19	12	0	114	1.85
26	*sargentii*	8	34	33	17	8	2	102	1.89
27	'Red Jade'	5	43	29	18	8	5	108	1.96
28	'Silver Moon'	5	22	38	15	7	2	89	2.03
29	'Robinson'	0	32	55	20	9	0	116	2.05
30	Candied Apple®	6	26	40	9	18	1	100	2.10
31	'Beverly'	6	30	42	22	16	0	116	2.10
32	*hupehensis*	0	25	34	19	9	0	87	2.13
33	*halliana* 'Parkmanii'	0	18	28	14	7	0	67	2.14
34	*floribunda*	1	27	39	23	15	0	105	2.22
35	'White Cascade'	2	16	35	15	12	0	80	2.23
36	'Red Baron'	2	27	37	25	17	2	110	2.30
37	Harvest Gold®	1	16	43	12	17	0	89	2.31
38	'Liset'	1	16	42	20	15	0	94	2.34
39	*tschonoskii*	6	12	27	29	9	2	85	2.34
40	'Strawberry Parfait'	0	18	31	37	9	0	95	2.38
41	'Winter Gold'	4	17	38	24	22	0	105	2.40
42	'Velvet Pillar'	1	13	37	28	33	0	112	2.70
43	*yunnanensis* var. *veitchii*	0	9	12	34	20	8	83	3.07
44	'Selkirk'	0	2	18	48	36	1	105	3.15
45	'Dolgo'	1	6	13	47	43	1	111	3.15
46	'Royalty'	0	4	12	44	35	2	97	3.19
47	'Ruby Luster'	1	1	5	30	63	3	103	3.57
48	'Radiant'	1	2	10	31	55	14	113	3.58
49	'Hopa'	2	1	8	16	60	14	101	3.71

Introducing

Introducing

Iowa State University Personnel
Affiliated with the Turfgrass Research Program

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Companies and Organizations

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or Supplied Products to

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