1992 Iowa Turfgrass Research Report

IOWA STATE UNIVERSITY
EXTENSION

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Introduction

N. E. Christians and M. L. Agnew

The following research report is the 12th 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. 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 second 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 two 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 Barb Erickson 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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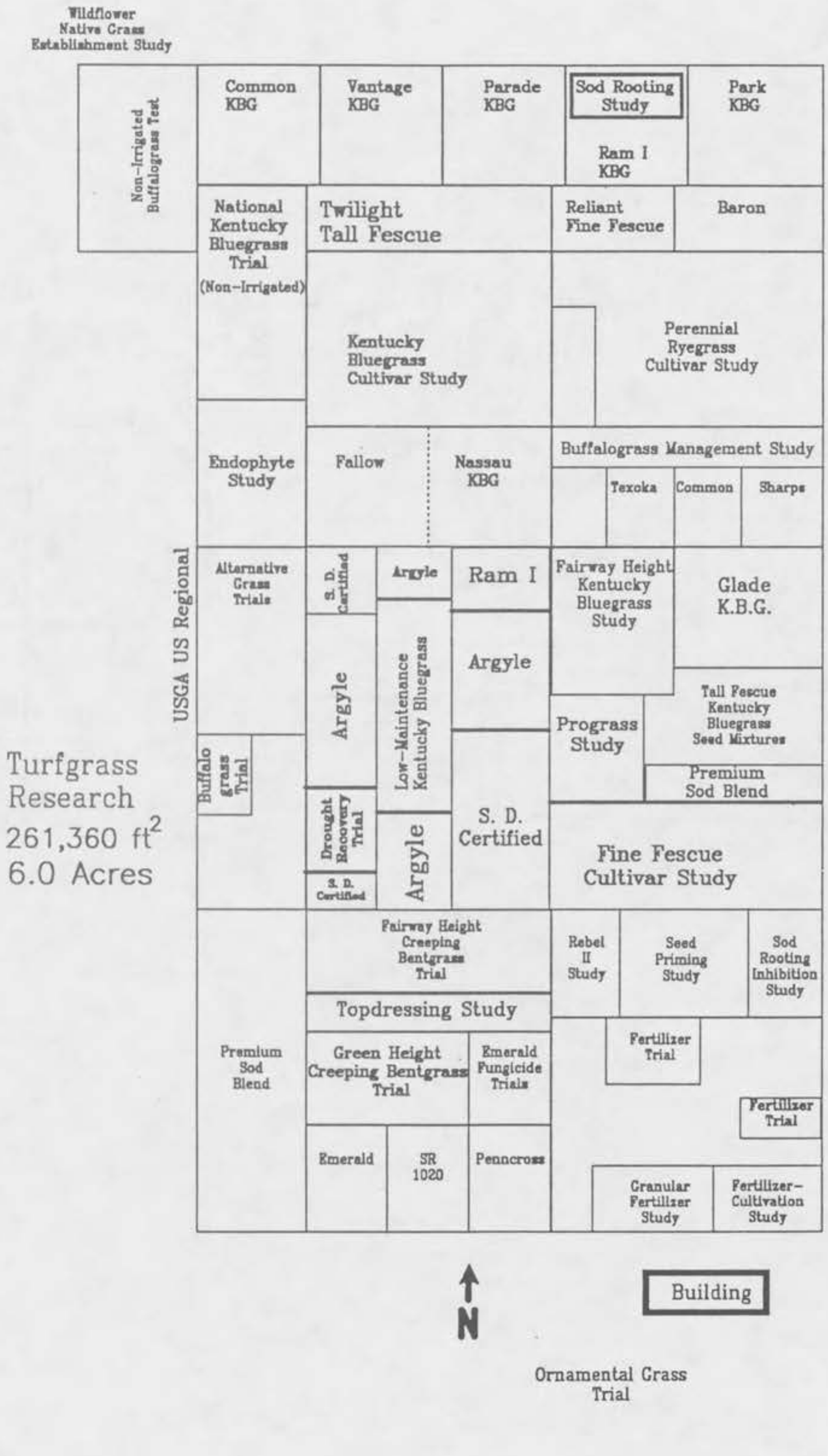
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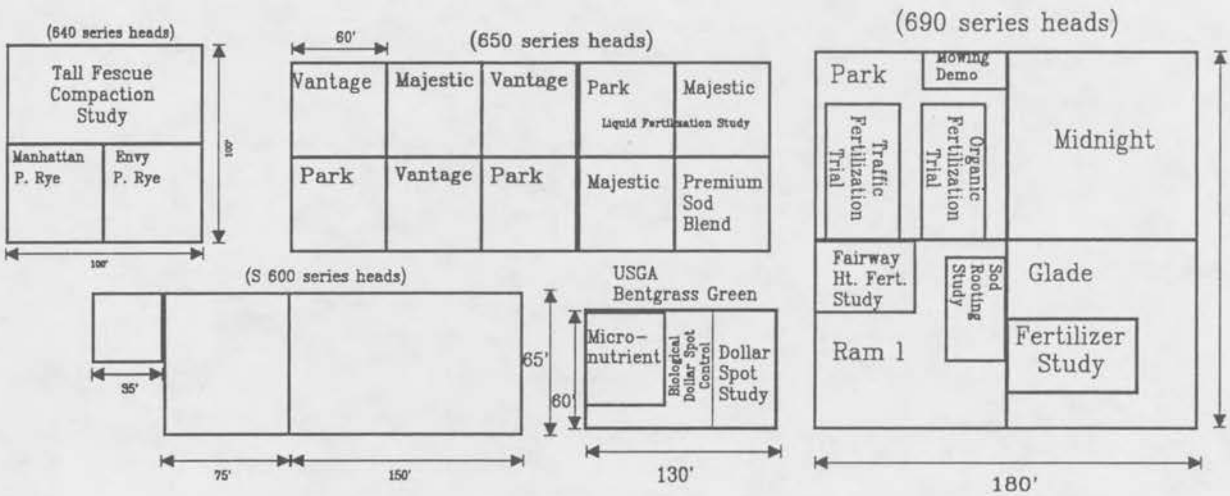
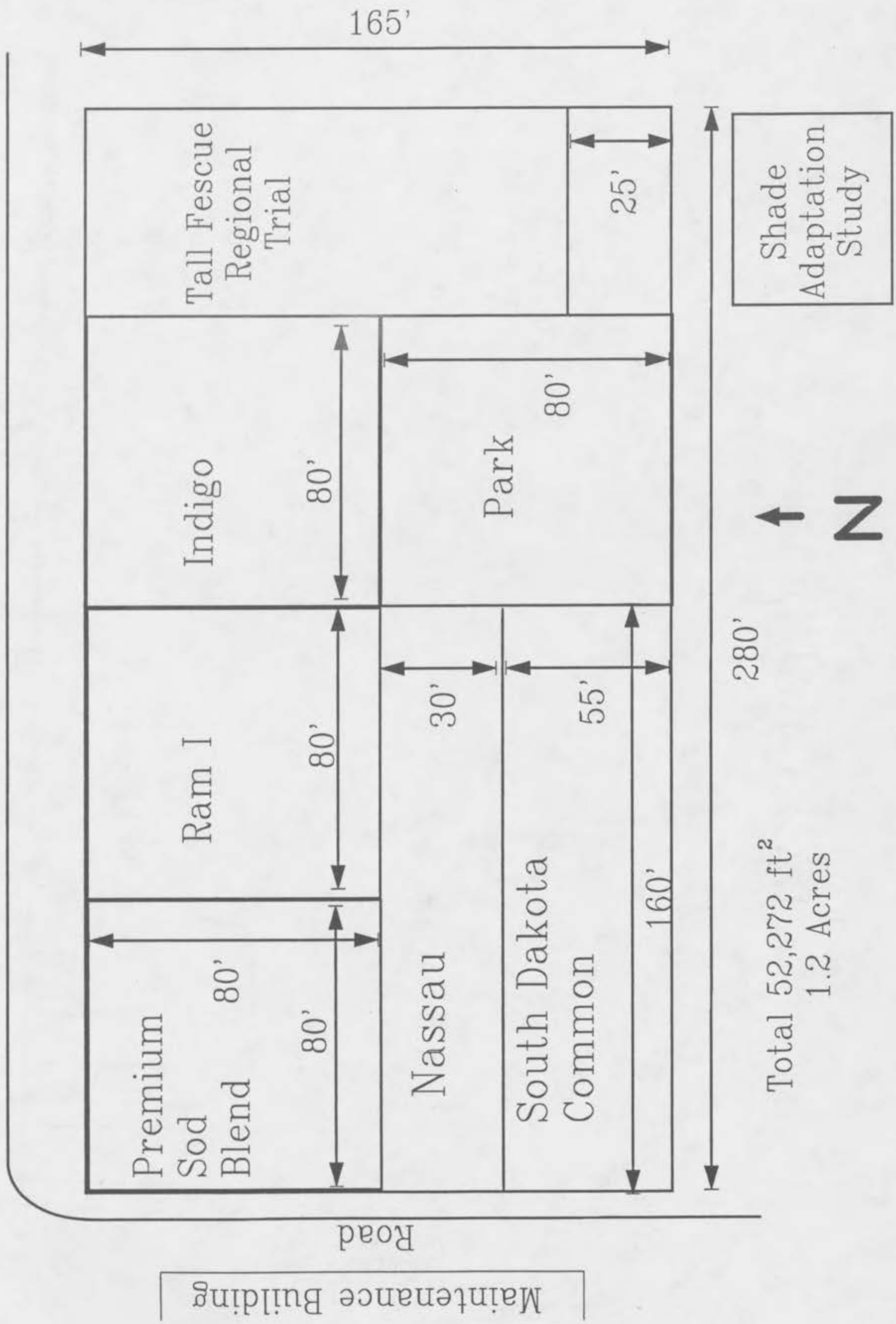
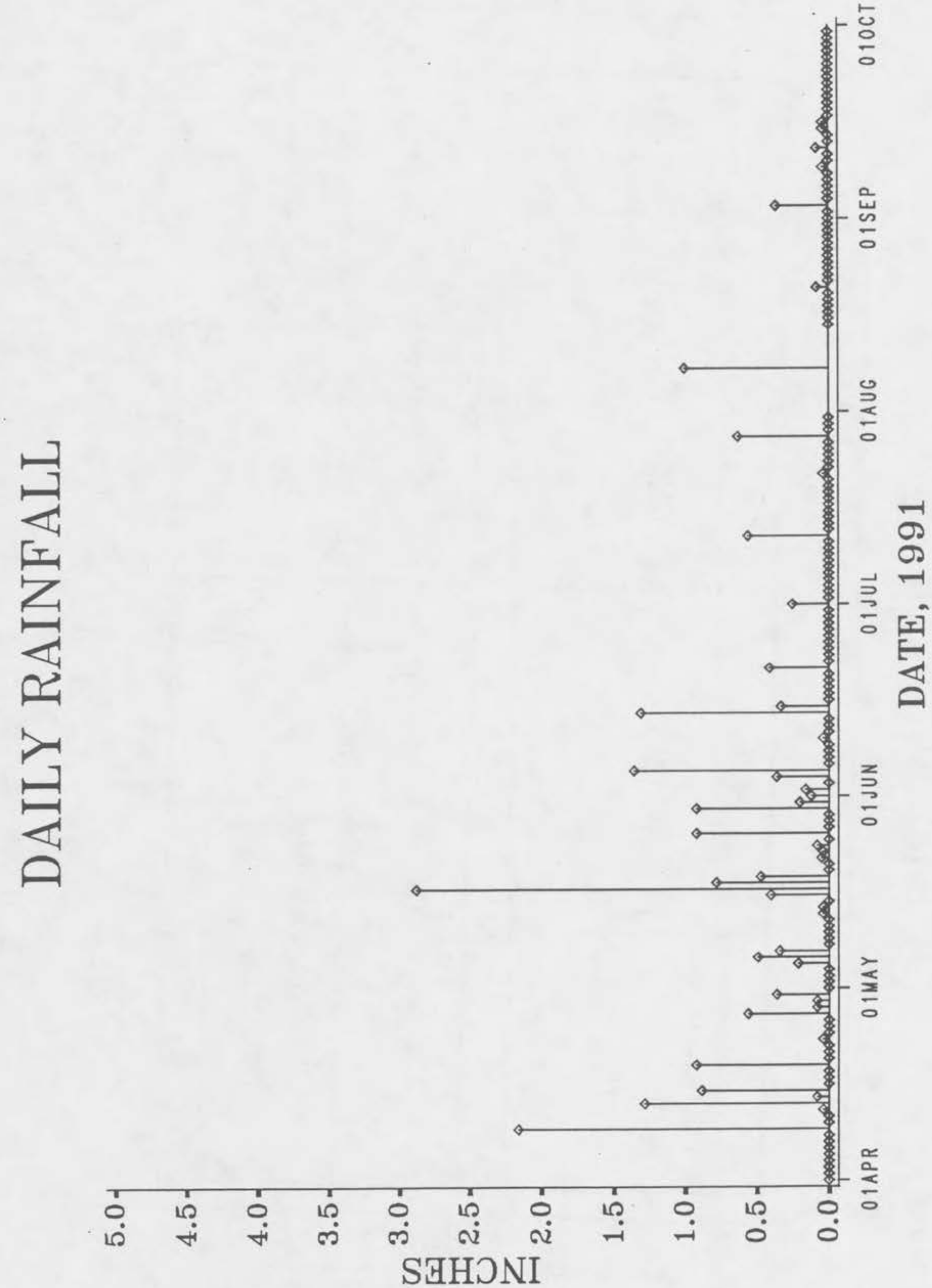
1984 Expansion of the Turfgrass Research Area
108,900 ft^2 – 2.5 Acres



East Research Area




DAILY RAINFALL
INCHES
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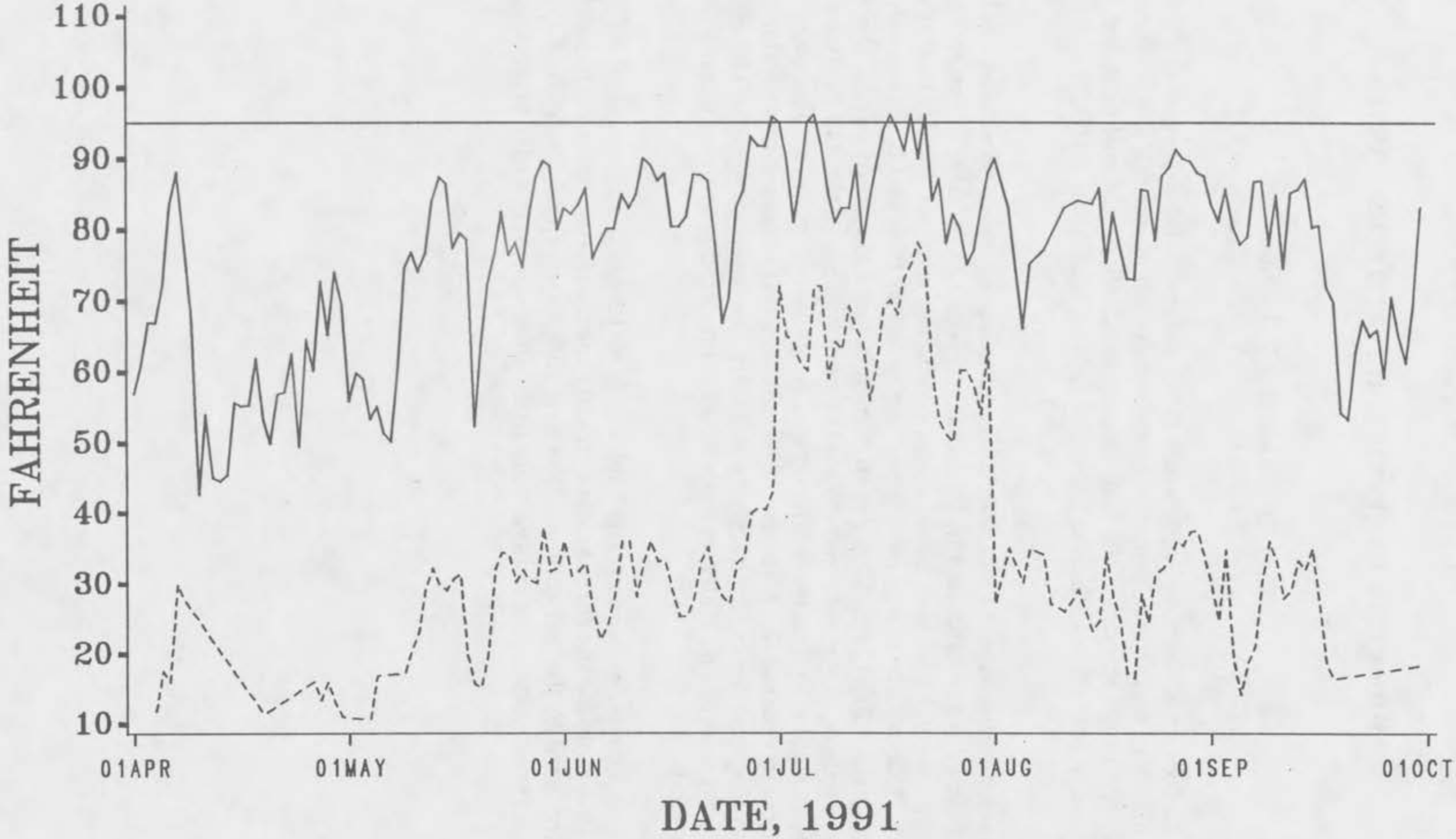
DATE, 1991

DAILY TEMPERATURE – AMES



Solid Line = Max Dashed Line = Min

Results of Kentucky

Bluegrass Regional Cultivar Trials - 1991

N. E. Christians and R. J. Moore

The United States Department of Agriculture (USDA) has initiated several regional Kentucky bluegrass cultivar trials that are currently being conducted at most of the northern agricultural experiment stations. The 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 1991 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 1990 and is a low-maintenance study that receives 1 lb of N/1000 ft^2/yr in September and is not irrigated. The objective of the high-maintenance study is to investigate the performance of the 128 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 response of 80 cultivars 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 62 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 ratings made on three replicated plots for the three studies. 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 1991 season. The cultivars are listed in descending order of average quality.

Table 1. The 1991 quality ratings for the high-maintenance irrigated Kentucky bluegrass test that was established in the fall of 1990.

	Cultivar	May	June	July	Aug	Sept	Oct	Mean
1	Ram 1	7.3	8.0	8.0	7.7	8.0	7.7	7.8
2	Conni	6.7	8.0	8.0	7.7	8.0	7.0	7.6
3	HV 125	7.0	7.3	8.0	7.3	8.0	8.0	7.6
4	PST-0514	7.3	7.7	7.7	7.3	7.7	8.0	7.6
5	Able 1	7.3	7.7	7.7	6.7	7.7	8.0	7.5
6	Crest	7.0	7.0	8.0	7.0	8.0	7.7	7.4
7	Indigo	7.0	7.7	7.7	7.3	7.7	7.0	7.4
8	PST-UD-10	7.0	7.3	7.7	7.0	7.7	8.0	7.4
9	Blacksburg	8.0	7.7	6.3	7.0	7.7	8.0	7.4
10	Glade	7.0	7.7	7.0	7.3	7.7	7.7	7.4
11	BA 77-279	7.3	7.3	7.3	6.3	7.7	7.7	7.3
12	BA 77-700	7.0	7.0	7.7	6.7	8.0	7.3	7.3
13	Fortuna	6.7	7.0	7.7	7.0	8.0	7.3	7.3
14	PST-HV-116	6.8	7.0	7.0	7.3	8.0	7.8	7.3
15	PST-HV-928	6.7	7.0	7.7	7.3	7.7	7.3	7.3
16	Nustar	6.7	7.0	7.7	7.3	7.7	7.3	7.3
17	Dawn	6.7	7.0	7.7	7.0	8.0	7.7	7.3
18	SR 2100	6.3	7.3	7.7	7.0	7.7	7.7	7.3
19	Baron	6.7	7.0	7.3	6.7	8.0	7.3	7.2
20	BAR VB 895	6.3	7.3	7.3	7.0	7.7	7.7	7.2
21	Touchdown	6.0	7.0	7.3	7.3	7.7	7.7	7.2
22	WW AG 508	6.7	7.0	7.0	7.0	7.7	7.7	7.2
23	BA 73-366	6.3	7.0	7.3	7.3	8.0	7.0	7.2
24	NE 80-47	7.0	6.7	7.3	7.0	8.0	7.3	7.2
25	Cynthia	6.0	7.3	7.7	7.3	8.0	6.7	7.2
26	602	6.7	7.3	7.7	6.7	8.0	7.0	7.2
27	PST-A7-341	6.7	7.3	7.3	6.7	7.3	7.7	7.2
28	Kelly	7.0	7.0	7.7	7.3	7.3	6.7	7.2
29	ST 2000	7.0	7.3	7.0	6.7	7.7	7.7	7.2
30	Fylking	4.7	6.7	7.7	8.0	8.0	8.0	7.2

	Cultivar	May	June	July	Aug	Sept	Oct	Mean
31	Trampas	6.0	7.0	7.7	7.0	8.0	7.0	7.1
32	BA 69-82	6.3	7.3	7.3	6.0	8.0	7.3	7.1
33	Ampellia	6.7	7.0	7.0	7.0	8.0	7.0	7.1
34	Miracle	6.7	6.7	7.3	6.7	7.3	8.0	7.1
35	EVB 13.863	6.3	7.0	7.3	7.3	7.7	7.0	7.1
36	Washington	6.3	7.0	7.7	7.3	7.3	7.0	7.1
37	BAR VB 7037	6.0	7.3	7.3	7.0	8.0	6.7	7.1
38	1757	6.0	7.3	7.3	6.3	7.7	7.7	7.1
39	PST-A84-405	6.7	7.0	7.0	6.7	7.7	7.7	7.1
40	PST-A84-803	6.3	6.7	7.3	6.3	8.0	8.0	7.1
41	R751A	6.7	6.7	7.3	7.0	7.7	7.3	7.1
42	Midnight	6.3	7.7	6.7	6.7	7.7	7.7	7.1
43	PR-1	5.7	6.7	7.3	6.7	8.0	8.0	7.1
44	PSU-151	6.3	7.0	7.7	7.0	7.7	7.0	7.1
45	J13-152	6.0	6.3	7.7	7.0	8.0	7.3	7.1
46	Aspen	6.7	7.0	7.7	6.0	7.7	7.7	7.1
47	Trenton	6.0	7.0	7.3	7.3	8.0	7.0	7.1
48	Opal	6.3	7.3	7.7	6.7	7.7	6.7	7.1
49	Estate	6.3	7.3	6.7	6.7	7.3	7.7	7.0
50	H86-712	6.3	7.3	7.0	6.0	7.3	8.0	7.0
51	BA 73-382	6.3	6.7	7.0	6.7	7.7	7.7	7.0
52	BA 76-305	6.3	7.0	7.0	7.3	7.7	6.7	7.0
53	WW AG 505	7.0	7.0	6.7	6.3	7.7	7.3	7.0
54	Melba	6.0	7.0	7.3	6.7	8.0	7.0	7.0
55	Livingston	6.7	6.3	7.3	6.7	8.0	7.0	7.0
56	PST-1DW	5.5	7.5	7.0	7.0	8.0	7.0	7.0
57	Summit	5.0	7.0	7.3	7.0	8.0	7.7	7.0
58	Liberty	5.3	7.3	7.3	6.7	7.7	7.7	7.0
59	J11-94	6.0	6.3	7.0	7.3	7.7	7.7	7.0
60	Cobalt	7.0	6.3	7.0	6.3	7.3	8.0	7.0
61	Classic	6.0	6.3	7.3	7.0	7.7	7.3	6.9
62	Merit	7.3	6.7	7.0	6.0	7.3	7.3	6.9

	Cultivar	May	June	July	Aug	Sept	Oct	Mean
63	Alpine	6.0	6.7	7.0	7.3	8.0	6.7	6.9
64	BA 73-540	5.3	7.3	7.3	6.0	8.0	7.3	6.9
65	BA 73-381	6.3	6.7	7.0	6.7	7.3	7.3	6.9
66	BA 78-258	6.7	6.3	7.0	6.7	7.7	7.3	6.9
67	Abbey	6.7	7.0	7.7	6.3	7.3	6.3	6.9
68	EVB 13.703	5.7	7.0	7.0	6.3	7.7	7.7	6.9
69	PST-A7-341	6.0	7.0	6.7	6.7	7.7	7.7	6.9
70	PST-R-740	6.0	6.7	7.3	6.7	7.7	7.0	6.9
71	Nassau	6.0	7.0	7.0	6.3	7.3	7.7	6.9
72	J34-99	6.0	6.7	6.7	7.0	7.7	7.7	6.9
73	Freedom	5.7	6.0	7.0	7.3	8.0	7.7	6.9
74	Limousine	6.3	7.7	6.7	6.3	7.7	6.7	6.9
75	J-386	6.7	6.7	6.7	6.3	8.0	7.0	6.9
76	J-229	5.3	6.7	7.7	7.0	7.3	7.3	6.9
77	Chelsea	7.0	7.0	7.0	6.7	7.3	6.3	6.9
78	A-34	6.0	6.7	6.7	6.7	8.0	7.0	6.8
79	Marquis	6.7	6.3	6.7	6.3	8.0	7.0	6.8
80	Barzan	5.0	7.0	6.7	7.3	7.3	7.7	6.8
81	BA 70-131	5.3	6.7	7.3	6.0	7.7	7.7	6.8
82	Prince 104	6.7	7.0	6.3	5.7	8.0	7.3	6.8
83	PST-RE-88	5.7	6.7	7.0	6.7	7.3	7.7	6.8
84	PST-C-76	7.0	6.7	7.0	6.0	7.0	7.3	6.8
85	PST-UD-12	6.3	6.3	7.0	6.0	7.7	7.3	6.8
86	PST-B8-106	6.0	6.7	6.7	6.3	8.0	7.0	6.8
87	Suffolk	6.0	6.3	7.0	6.7	7.7	7.0	6.8
88	J-333	6.0	7.0	7.3	7.0	7.3	6.3	6.8
89	Minstrel	6.7	7.3	7.0	6.0	7.0	6.7	6.8
90	Gnome	6.3	7.0	6.7	6.3	7.3	7.0	6.8
91	Ronde	5.7	6.0	8.0	7.0	7.7	6.3	6.8
92	Cheri	5.3	7.3	6.7	6.3	7.7	7.3	6.8
93	Platini	6.0	7.3	6.3	6.3	7.3	6.7	6.7
94	Miranda	7.3	6.7	6.3	6.0	6.7	7.0	6.7

	Cultivar	May	June	July	Aug	Sept	Oct	Mean
95	Silvia	6.3	6.3	7.0	6.0	7.7	7.0	6.7
96	Eagleton	6.3	6.0	7.0	6.0	7.3	7.3	6.7
97	PST-C-224	6.0	6.7	7.0	5.7	8.0	7.0	6.7
98	Destiny	6.7	6.7	6.0	5.7	7.3	8.0	6.7
99	Eclipse	6.7	6.3	6.3	6.3	7.7	7.0	6.7
100	Haga	6.0	6.7	6.7	6.0	7.7	7.0	6.7
101	Banff	6.0	6.0	7.0	6.3	7.3	6.7	6.6
102	BA 77-292	6.3	6.0	7.0	6.7	7.3	6.3	6.6
103	Georgetown	5.7	6.3	7.0	6.0	7.7	7.0	6.6
104	Challenger	5.0	6.3	6.3	6.0	7.7	8.0	6.6
105	South Dakota Cert.	5.7	5.3	7.0	6.7	7.7	7.0	6.6
106	Monopoly	6.0	6.0	6.7	6.7	6.7	7.0	6.5
107	BAR VB 1169	5.3	6.7	6.3	6.7	7.3	6.7	6.5
108	BAR VB 1184	4.3	6.0	6.3	6.7	8.0	7.7	6.5
109	798	4.7	6.3	6.7	6.0	7.7	7.7	6.5
110	Barblue	5.7	6.0	6.3	5.7	7.0	7.7	6.4
111	Barmax	6.0	6.3	6.0	6.0	7.0	7.3	6.4
112	BA 74-114	7.3	6.3	6.0	5.0	6.3	7.3	6.4
113	PST-B8-13	5.3	6.0	6.7	6.7	7.7	6.0	6.4
114	Julia	5.0	6.3	7.0	6.0	7.3	7.0	6.4
115	J-335	5.3	6.0	7.0	6.3	7.3	6.7	6.4
116	KWS PP 13-2	6.7	6.7	6.3	6.3	6.7	6.0	6.4
117	Kenblue	6.0	5.3	7.3	6.7	7.0	6.0	6.4
118	Donna	5.3	6.3	6.0	6.0	7.3	7.0	6.3
119	Greenley	5.7	5.3	7.0	6.7	7.0	6.0	6.3
120	Coventry	5.0	6.0	6.0	5.7	7.3	7.3	6.2
121	Ginger	5.7	5.3	6.7	6.3	7.0	6.3	6.2
122	Gemor	6.0	5.0	6.0	6.3	7.3	6.7	6.2
123	Noblesse	6.0	6.3	5.7	5.7	6.3	6.3	6.1
124	Barsweet	5.7	6.3	5.3	5.3	7.0	6.0	5.9
125	Bartitia	4.0	5.0	6.0	6.3	7.3	7.0	5.9
126	Cardiff	4.3	5.7	6.0	6.7	6.3	6.7	5.9

	Cultivar	May	June	July	Aug	Sept	Oct	Mean
127	Broadway	4.7	6.3	5.3	5.3	6.7	6.0	5.7
128	Merion	4.3	6.0	5.3	4.3	5.7	5.0	5.1
	$LSD_{(0.05)}$	1.3	1.3	1.1	1.2	0.9	0.9	0.7

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

Table 2. The 1991 quality ratings for the high-maintenance, non-irrigated regional Kentucky bluegrass test that was established in the fall of 1985.

	Cultivar	May	June	Aug	Sept	Oct	Mean
1	Joy	6.0	6.3	4.3	4.3	5.3	5.3
2	South Dakota Cert.	5.7	6.7	4.7	4.7	5.0	5.3
3	Kenblue	6.3	6.3	4.0	4.3	5.0	5.2
4	Huntsville	5.7	6.0	3.3	4.0	5.3	4.9
5	J-1872	6.0	6.7	3.0	3.7	5.3	4.9
6	Monopoly	5.3	6.0	3.7	3.7	5.0	4.7
7	Lofts 1757	5.0	6.0	3.3	4.3	5.0	4.7
8	Wabash	6.0	5.3	3.3	4.3	4.7	4.7
9	Harmony	4.7	5.7	4.0	4.3	5.0	4.7
10	NE 80-14	5.7	5.0	4.0	3.7	5.0	4.7
11	Somerset	4.7	5.7	3.3	4.7	4.7	4.6
12	Aquila	6.0	6.0	2.3	3.3	5.3	4.6
13	Able I	4.7	5.7	3.7	4.0	4.3	4.5
14	Park	4.7	5.3	3.7	3.7	5.0	4.5
15	Rugby	4.7	5.3	3.7	3.0	5.3	4.4
16	Baron	4.7	4.7	4.0	3.3	4.3	4.2
17	Aspen	5.7	5.0	3.0	3.0	4.2	4.2
18	PST-CB1	4.3	5.7	2.7	3.7	4.7	4.2
19	Classic	4.7	5.7	3.0	3.0	4.3	4.1
20	Tendos	5.3	6.3	2.7	2.7	3.7	4.1
21	Georgetown	3.7	5.7	3.0	4.0	4.3	4.1
22	Eclipse	4.7	6.0	2.7	2.7	4.7	4.1
23	Dawn	5.3	5.7	2.0	3.0	4.3	4.1

	Cultivar	May	June	Aug	Sept	Oct	Mean
24	239	4.0	5.7	3.0	3.3	4.3	4.1
25	K3-178	4.0	5.7	3.0	3.7	4.0	4.1
26	NE 80-110	5.0	6.0	3.0	2.3	4.0	4.1
27	A-34	3.3	5.0	3.7	3.7	4.3	4.0
28	Julia	4.0	4.3	2.7	4.7	4.3	4.0
29	Trenton	3.3	5.0	3.7	3.3	4.7	4.0
30	WW AG 496	4.0	5.3	2.7	4.0	4.0	4.0
31	Victa	4.7	5.7	2.7	2.3	4.0	3.9
32	BA 70-242	5.0	4.7	3.3	2.7	4.0	3.9
33	NE 80-88	4.0	4.7	3.0	4.0	4.0	3.9
34	America	3.0	4.0	3.7	4.7	4.0	3.9
35	Liberty	4.0	5.0	3.7	3.0	4.0	3.9
36	Nassau	4.3	5.3	3.0	3.0	3.7	3.9
37	Ikone	3.7	5.0	2.7	4.0	4.3	3.9
38	WW AG 495	3.7	5.0	2.7	3.3	4.7	3.9
39	Mystic	3.3	5.0	3.7	4.0	3.0	3.8
40	Parade	4.3	5.0	2.0	3.3	4.3	3.8
41	Welcome	4.7	5.0	2.3	3.0	4.0	3.8
42	WW AG 468	4.7	5.7	3.0	2.3	3.3	3.8
43	WW AG 491	4.0	6.0	2.0	3.0	4.0	3.8
44	Merit	4.3	5.0	2.7	2.7	4.0	3.7
45	Bristol	3.7	4.7	3.0	3.0	4.3	3.7
46	BA 72-441	4.3	5.3	3.0	2.3	3.3	3.7
47	BA 73-626	4.3	5.0	3.0	3.0	3.3	3.7
48	Destiny	5.0	4.7	2.7	2.3	4.0	3.7
49	Glade	4.0	5.0	2.7	3.0	4.0	3.7
50	NE 80-50	4.0	4.7	2.3	3.0	4.7	3.7
51	Gnome	3.7	4.0	3.0	3.0	4.3	3.6
52	P-104	3.7	4.3	2.7	3.7	3.7	3.6
53	BAR VB 577	3.7	5.0	2.0	3.3	4.0	3.6
54	BAR VB 534	4.3	5.0	2.3	2.7	3.7	3.6
55	Cynthia	4.3	4.3	2.7	2.7	4.0	3.6

	Cultivar	May	June	Aug	Sept	Oct	Mean
56	Merion	4.7	5.0	2.3	2.3	3.7	3.6
57	K1-152	4.0	5.3	2.3	2.7	3.7	3.6
58	NE 80-47	4.0	4.7	2.0	3.3	4.0	3.6
59	NE 80-48	4.0	5.3	2.3	2.3	4.0	3.6
60	Ram I	3.3	5.0	3.0	2.7	3.7	3.5
61	Haga	4.0	5.0	2.3	2.7	3.3	3.5
62	Annika	3.3	5.3	2.3	2.7	3.7	3.5
63	Asset	3.7	4.3	2.7	3.3	3.3	3.5
64	Amazon	4.0	4.0	3.0	2.0	3.7	3.5
65	Challenger	4.0	4.7	2.7	3.0	3.3	3.5
66	Blacksburg	3.7	5.0	3.0	2.0	4.0	3.5
67	NE 80-30	3.0	4.3	2.7	3.0	4.3	3.5
68	Barzan	4.0	4.0	2.0	3.3	3.7	3.4
69	BA 69-82	3.3	5.0	2.3	2.3	4.0	3.4
70	Midnight	4.0	5.0	2.3	2.3	3.3	3.4
71	Conni	3.0	3.3	2.7	3.3	4.3	3.3
72	BA 72-500	4.3	4.3	2.3	2.0	3.7	3.3
73	BA 73-540	4.0	4.7	2.0	2.7	3.3	3.3
74	Compact	3.3	4.0	2.3	2.7	3.3	3.1
75	Sydsport	3.3	4.0	2.0	2.7	3.3	3.1
76	Cheri	4.0	4.7	2.0	2.0	3.0	3.1
77	BA 72-492	2.7	4.0	2.3	2.0	4.0	3.0
78	80-55	3.0	4.0	2.0	3.0	3.0	3.0
79	BA 70-139	3.3	4.0	2.0	2.0	3.0	2.9
80	HV 97	3.0	4.0	2.0	2.3	3.0	2.9
	$LSD_{(0.05)}$	1.6	1.4	1.3	1.7	NS	1.0

Table 3. The 1991 quality ratings for the low-maintenance, non-irrigated regional Kentucky bluegrass test that was established in the fall of 1990.

	Cultivar	April	May	June	July	Aug	Oct	Mean
1	PST-A7-111	6.7	7.3	7.0	7.0	6.3	6.7	6.8
2	GEN-RSP	7.0	7.3	7.3	6.7	5.0	6.0	6.6

	Cultivar	April	May	June	July	Aug	Oct	Mean
3	MN 2405	6.3	6.3	6.7	6.0	7.0	6.0	6.4
4	Bronco	5.7	5.7	7.0	6.7	6.3	6.3	6.3
5	Kenblue	6.3	7.3	6.0	5.7	6.3	5.7	6.2
6	Alene	6.7	7.0	6.3	5.3	5.7	6.0	6.2
7	Park	6.0	7.0	6.3	6.0	5.7	5.7	6.1
8	Barmax	7.3	7.3	7.0	6.0	4.3	4.7	6.1
9	PST-YQ	6.0	6.0	6.3	6.0	6.3	5.7	6.1
10	South Dakota Cert.	6.3	5.7	6.7	6.0	5.3	6.0	6.0
11	NJIC	6.7	6.7	6.7	6.3	4.0	5.3	5.9
12	Ram I	5.0	5.0	6.7	6.7	6.3	5.7	5.9
13	ZPS-84-749	6.0	6.0	6.0	5.7	6.3	5.3	5.9
14	Voyager	6.3	6.0	6.7	6.0	5.0	5.7	5.9
15	Gnome	5.3	5.7	6.3	6.0	6.3	6.0	5.9
16	BAR VB 895	5.7	5.7	6.3	6.3	6.0	4.7	5.8
17	BA 78-376	6.3	6.0	5.7	5.7	5.7	5.3	5.8
18	Sophia	5.3	5.0	6.7	6.0	5.7	6.3	5.8
19	BAR VB 7037	4.0	5.3	6.3	6.3	6.0	5.7	5.8
20	Monopoly	6.0	6.3	6.7	5.7	5.0	4.7	5.7
21	ISI-21	6.0	6.3	6.3	5.3	5.0	5.3	5.7
22	PST-C-391	5.3	5.7	6.7	6.0	5.7	4.7	5.7
23	J-229	5.3	5.7	6.0	5.7	5.3	6.0	5.7
24	Haga	5.3	6.0	6.7	6.3	5.0	5.0	5.7
25	Opal	5.3	5.3	6.7	5.3	5.7	5.7	5.7
26	Baron	5.0	5.0	6.7	6.0	5.3	5.7	5.6
27	Miracle	4.7	5.3	6.0	6.3	5.7	5.7	5.6
28	PST-C-303	5.3	5.0	6.3	6.0	5.3	5.7	5.6
29	Suffolk	5.0	5.7	6.0	5.7	5.3	6.0	5.6
30	Washington	6.3	5.3	6.0	5.7	5.3	4.3	5.5
31	Freedom	5.0	5.3	5.7	5.7	6.0	5.3	5.5
32	Destiny	5.3	5.7	6.0	5.3	5.3	5.0	5.4
33	Merit	5.0	5.7	5.7	5.7	5.0	5.0	5.3
34	Crest	5.0	5.0	5.3	5.3	5.7	5.3	5.3

	Cultivar	April	May	June	July	Aug	Oct	Mean
35	Livingston	5.0	5.3	6.0	5.7	5.3	4.7	5.3
36	PST-C-76	5.3	5.7	5.3	5.7	5.0	4.7	5.3
37	H76-1034	5.7	6.0	5.3	5.3	5.0	4.7	5.3
38	BA 74-017	5.0	5.0	5.0	5.3	5.3	5.7	5.2
39	Amazon	4.0	4.3	5.7	5.3	5.7	6.3	5.2
40	EVB-13.863	3.7	4.0	5.0	5.7	6.0	5.7	5.0
41	Cynthia	4.3	4.7	5.3	5.0	4.7	5.3	4.9
42	Midnight	4.7	5.3	5.3	5.3	4.3	4.3	4.9
43	Nustar	4.0	4.7	5.3	5.0	5.3	5.0	4.9
44	J-386	5.3	4.3	5.0	4.3	5.3	5.0	4.9
45	Chelsea	4.0	4.7	5.3	4.7	5.3	5.3	4.9
46	BAR VB 1169	3.7	4.3	5.7	5.3	5.0	5.3	4.9
47	Fortuna	4.3	4.3	4.3	5.0	5.7	5.0	4.8
48	Liberty	4.7	4.7	4.7	5.0	5.0	4.7	4.8
49	KWS PP 13-2	4.7	5.0	5.7	5.0	4.3	4.0	4.8
50	798	4.3	4.3	5.0	5.3	4.3	4.7	4.7
51	Unknown	5.0	4.0	4.7	4.7	5.0	5.0	4.7
52	J-335	4.0	4.7	5.3	5.3	4.7	4.3	4.7
53	SR 2000	5.0	4.7	5.3	4.7	4.3	4.0	4.7
54	NE 80-47	4.3	4.3	4.7	5.0	4.7	4.7	4.6
55	Cobalt	4.0	4.3	4.7	5.0	4.7	4.7	4.6
56	Barsweet	3.3	3.3	4.7	4.3	4.7	4.7	4.2
57	EVB-13.703	3.7	4.0	4.7	4.7	4.3	4.0	4.2
58	Barzan	2.7	3.3	4.0	4.7	5.0	5.0	4.1
59	Bartitia	3.7	3.3	3.7	4.3	4.7	4.7	4.1
60	Kyosti	3.7	4.3	4.3	4.7	3.3	3.0	3.9
61	BAR VB 1184	3.3	3.3	4.3	4.3	4.0	4.3	3.9
62	Merion	3.0	2.7	3.3	3.7	3.0	3.0	3.1
	$LSD_{(0.05)}$	1.2	1.4	1.2	1.2	1.4	1.5	1.0

The Recovery of Kentucky Bluegrass Cultivars

Following Summer Dormancy

Nick 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 four cultivars that were previously shown to recover rapidly from dormancy and four cultivars that were slower to recover when maintained under low and high fertility regimes: 1 lb N/1000 ft^2 in September and 4 lb N/1000 ft^2 applied in 1 lb applications in April, May, August, and September.

South Dakota Common, S-21, Kenblue, and Argyle (cultivars observed to recover rapidly in earlier studies) and Midnight, Nassau, Glade, and Ram I (cultivars observed to recover more slowly) Kentucky bluegrass were 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 Nicolett (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. By May, 1991 all cultivars were uniformly established. It became very dry beginning in June and the grass went into a dormancy period. The drought extended into August, at which time late summer rains began to bring the grass out of dormancy. Quality ratings based on a scale of 9 to 1 (9 = best quality, 6 = acceptable, 1 = dead turf) were collected on the area in late August and late September.

South Dakota Common, S-21, Kenblue, and Argyle showed the best recovery following the drought in late August (Fig. 1). While each of these cultivars regained an acceptable quality very quickly after the drought, the four improved cultivars, Midnight, Nassau, Glade and Ram I, recovered more slowly. The improved cultivars were especially slow to recover at the low fertility level, whereas the common cultivars recovered well even at the low fertility level. This trend continued into September (Fig. 2). The higher recovery in September at the higher fertility level is due to the September fertilizer treatment. Nassau and Glade reached an acceptable quality rating at the high fertility level in September but Midnight and Ram I did not. As in earlier studies, the improved cultivars were very slow to recover following extended drought. Low fertility levels tended to affect the common cultivars less than the improved cultivars. This work will continue for 3 to 4 more seasons to observe the long-term effects of fertility level on the drought recovery of these eight Kentucky bluegrass cultivars.

Figure 1.

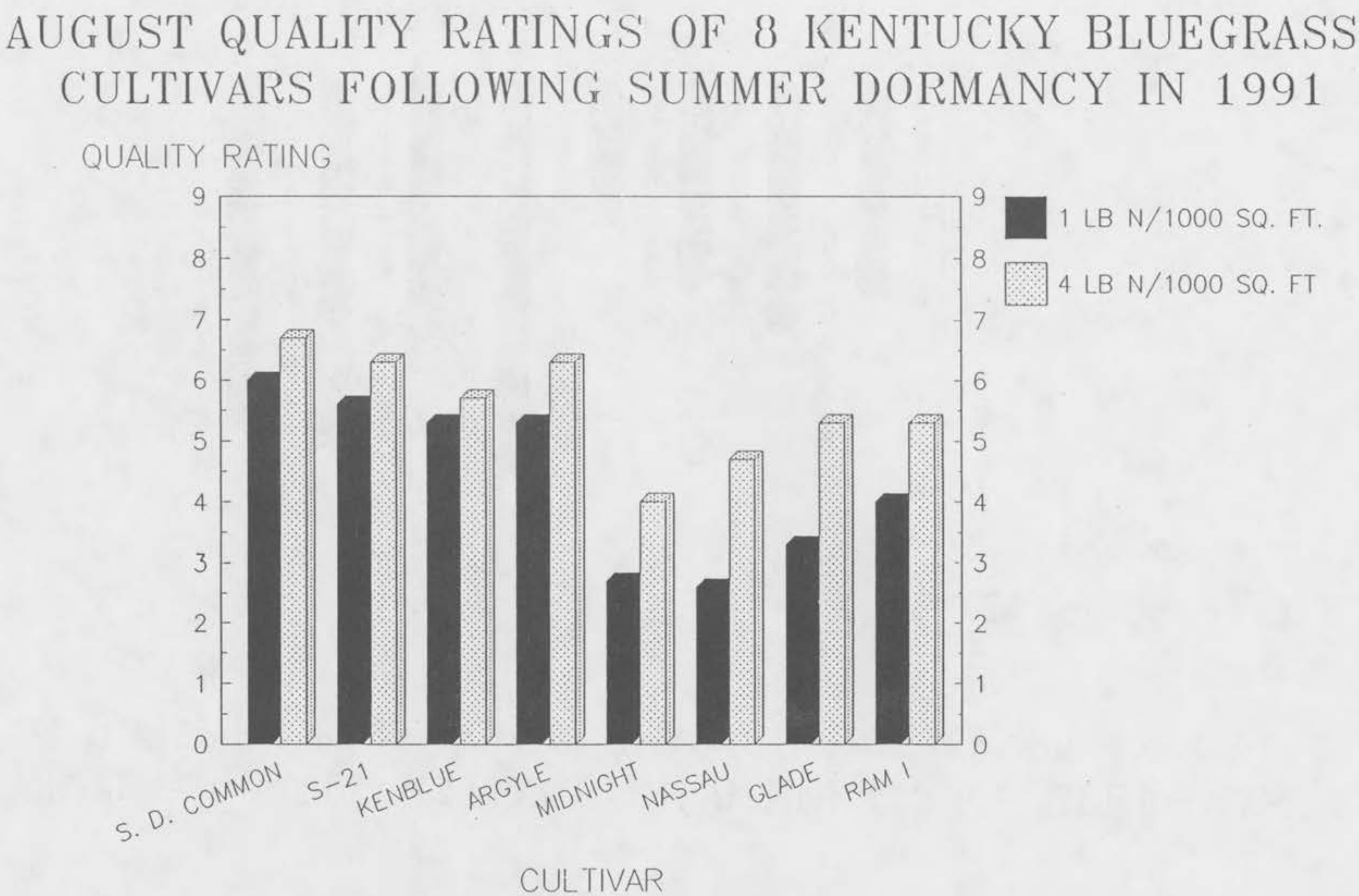
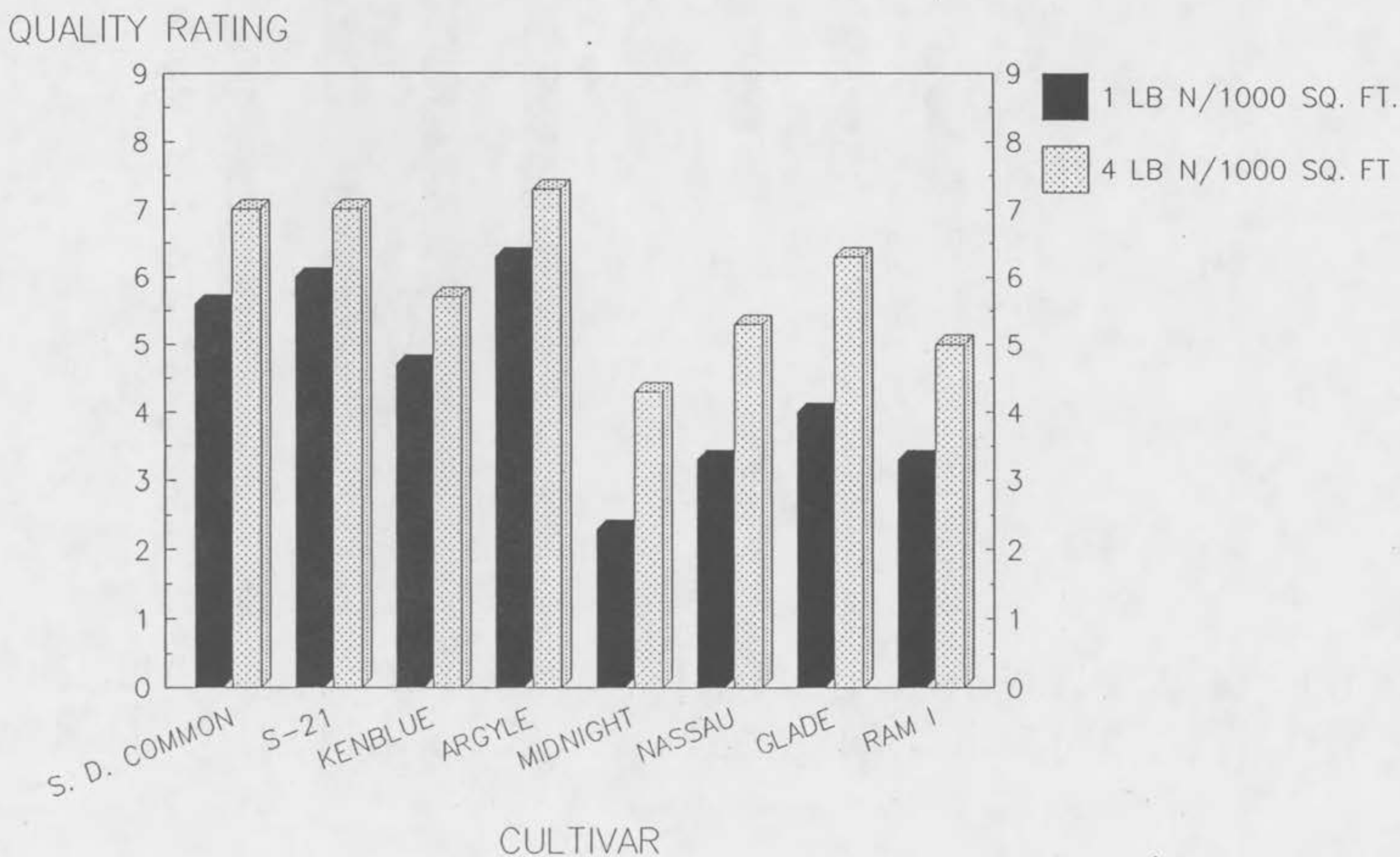

AUGUST QUALITY RATINGS OF 8 KENTUCKY BLUEGRASS CULTIVARS FOLLOWING SUMMER DORMANCY IN 1991
QUALITY RATING
9
8
7
6
5
4
3
2
1
0
1 LB N/1000 SQ. FT.
4 LB N/1000 SQ. FT
S. D. COMMON
S-21
KENBLUE
ARGYLE
MIDNIGHT
NASSAU
GLADE
RAM I
CULTIVAR

Figure 2.

SEPT. QUALITY RATINGS OF 8 KENTUCKY BLUEGRASS CULTIVARS FOLLOWING SUMMER DORMANCY IN 1991



National Perennial Ryegrass Study

S. M. Berkenbosch and N. E. Christians

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

Cultivars were evaluated for turf quality each month of the growing season. Ratings were low because this was the establishment year. The values listed under each month in Table 4 are the averages of ratings made on three replicated plots for the three studies. Yearly means of data from each month were taken and listed in the last column. Pick 89LLG, PST-20G, and Pick 89-4 were the top three performers in the first year. The cultivars are listed in descending order of average quality.

Table 4. The 1991 quality ratings for the national perennial ryegrass study.

Cultivar	May	June	July	August	September	Mean
Pick 89LLG	8.0	7.0	6.0	6.0	6.0	6.6
PST-20G	6.7	6.3	6.6	6.7	6.7	6.6
Pick 89-4	6.7	6.0	6.6	6.7	6.7	6.5
PST-GH-89	7.7	6.3	6.0	6.3	6.3	6.5
EEG 358	7.0	6.3	6.0	6.3	6.3	6.4
Poly-SH	7.0	6.3	6.3	6.3	6.0	6.4
4DD-Delaware Dwa	6.3	6.0	6.3	6.7	6.3	6.3
Pick DKM	6.7	6.7	6.0	6.3	6.0	6.3
PST-28M	6.7	6.0	6.3	6.3	6.3	6.3
WVPB-89-PR-A-3	7.0	6.0	6.0	6.0	6.0	6.2
Pinnacle	6.8	5.8	6.0	6.3	6.0	6.2
HE 311	6.7	5.7	6.3	6.0	6.3	6.2
PST-2FQR	6.3	6.0	6.0	6.3	6.0	6.1
PS-105	6.7	5.7	6.0	6.0	6.0	6.1
2P2-90	6.7	5.7	6.0	6.3	6.0	6.1
PST-2DPR	7.0	6.0	5.7	5.7	5.7	6.0
Rodeo II	6.7	5.7	6.0	5.7	6.0	6.0

Cultivar	May	June	July	August	September	Mean
Nomad	7.0	6.0	5.7	5.7	5.7	6.0
KOOS 90-1	6.7	5.3	6.0	5.7	5.7	5.9
GEN-90	6.7	5.7	5.7	5.7	5.7	5.9
PR 9108	6.0	5.7	6.0	6.0	6.0	5.9
SYN-P	6.7	6.3	5.3	5.7	5.7	5.9
Charger	6.0	5.0	6.0	6.0	6.3	5.9
PST-2B3	5.7	5.3	6.0	6.3	6.0	5.9
89-666	6.0	5.7	5.7	6.0	6.0	5.9
PR 9109	5.7	6.7	5.7	5.7	5.7	5.9
Advent	6.0	5.7	6.0	6.0	6.0	5.9
KOOS-90-2	6.7	5.3	5.7	5.7	5.7	5.8
BAR LP 086FL	6.5	5.3	5.8	5.8	5.5	5.6
Duet	5.3	5.7	6.0	5.7	6.3	5.8
PR 9119	6.0	5.0	6.0	6.0	6.0	5.8
PR 8820 (Essence)	6.7	5.3	5.7	5.7	5.7	5.8
Pick 1800	6.0	6.0	5.7	5.7	5.7	5.8
N-33	6.0	5.0	6.0	6.0	6.0	5.8
2H7	6.7	5.3	5.7	5.7	5.7	5.8
PST-23C	6.3	5.7	5.7	5.7	5.7	5.8
MVF 89-88	6.3	4.7	6.0	6.0	6.0	5.8
OFI-D4	6.0	5.3	6.0	5.7	6.0	5.8
LDRF	6.7	6.0	5.3	5.7	5.3	5.8
Assure	6.7	5.0	5.3	5.7	5.7	5.7
Dandy	5.7	6.0	5.7	5.7	5.7	5.7
MOM LP 3147	5.7	5.0	6.0	5.7	6.0	5.7
Gettysburg	6.7	5.7	5.3	5.3	5.3	5.7
Pebble Beach	6.3	6.0	5.3	5.3	5.7	5.7
WVPB-89-87A	6.3	5.0	5.7	5.7	5.7	5.7
Cutless	6.3	5.0	5.7	5.7	5.7	5.7
ZPS-28D	6.7	5.7	5.3	5.3	5.3	5.7
PST-2ROR	6.3	5.7	5.3	6.7	5.3	5.7
PST-2FF	5.7	5.3	5.7	6.0	5.7	5.7

Cultivar	May	June	July	August	September	Mean
C-21	5.7	6.0	5.7	5.7	5.7	5.7
MVF 89-90	6.3	6.0	5.3	5.7	5.3	5.7
PR 9118	6.3	4.7	6.0	5.7	6.0	5.7
SR 4200	7.0	5.7	5.3	5.3	5.0	5.7
OFI-F7	6.0	5.3	5.7	5.7	5.7	5.7
Target	7.0	5.7	5.3	5.3	5.3	5.7
APM	6.3	5.3	5.7	5.7	5.7	5.7
WM-II	6.0	4.7	6.0	6.0	6.0	5.7
Calypso	5.7	5.7	5.3	5.7	5.7	5.6
ZW 42-176	6.7	5.3	5.3	5.3	5.3	5.6
Repell	6.0	5.7	5.3	5.7	5.3	5.6
BAR LP852	6.0	6.0	5.3	5.7	5.7	5.5
Barrage ++	5.7	5.0	5.3	5.7	5.7	5.5
Commander	4.3	5.7	5.3	6.0	6.0	5.5
WVPB 89-92	6.7	4.7	5.3	5.3	5.3	5.5
Pleasure	6.0	5.0	5.3	5.7	5.3	5.5
WVPB-88-PR-D-12	6.0	4.7	5.3	5.7	5.7	5.5
Fiesta II	6.0	5.3	5.3	5.3	5.3	5.5
Meteor	5.7	5.0	5.7	5.3	5.7	5.5
Pennant	5.3	5.3	5.3	5.7	5.7	5.5
Competitor	6.3	5.3	5.3	5.3	5.3	5.5
Derby Supreme	6.0	5.3	5.3	5.3	5.3	5.5
CLP 144	6.7	5.3	5.0	5.3	5.3	5.5
Manhattan II (E)	6.0	5.3	5.3	5.3	5.3	5.5
P89	7.3	6.0	4.7	5.0	4.7	5.5
Danaro	6.0	4.7	5.0	5.7	5.7	5.4
WVP-88-PR-C-23	6.0	4.7	5.3	5.7	5.3	5.4
Sherwood	6.0	5.0	5.3	5.3	5.3	5.4
PR 9121	6.7	5.0	5.0	5.3	5.0	5.4
Express	6.0	4.7	5.3	5.3	5.7	5.4
Patriot II	6.7	5.3	5.0	5.3	4.7	5.4
Equal	6.0	5.0	5.3	5.3	5.3	5.4

Cultivar	May	June	July	August	September	Mean
Barrage	6.0	5.3	5.0	5.0	5.0	5.3
MOM LP 3184	5.3	5.0	5.3	5.3	5.3	5.3
CLP 39	6.3	5.0	5.0	5.0	5.0	5.3
Gator	6.0	5.0	5.0	5.3	5.3	5.3
Pick EEC	7.0	5.3	4.7	4.7	5.0	5.3
Troubadour	5.7	5.0	5.0	5.3	5.3	5.3
Entrar	6.0	4.7	5.3	5.3	5.3	5.3
Citation II	6.0	5.3	5.0	5.3	5.0	5.3
ZPS-2EZ	5.7	5.3	5.0	5.3	5.3	5.3
Envy	6.0	4.7	5.3	5.0	5.3	5.3
Saturn	6.0	5.0	4.7	5.3	5.3	5.3
856	5.0	4.3	5.7	5.7	5.7	5.3
MOM LP 3182	5.7	4.7	5.0	5.7	5.7	5.3
PST-290	6.3	5.0	5.0	4.7	5.0	5.2
Unknown	5.7	5.0	5.0	5.0	5.3	5.2
LDRD	7.0	5.3	4.3	4.7	4.7	5.2
Riviera	5.7	5.0	4.7	5.0	5.0	5.1
Seville	6.3	5.0	4.7	4.7	4.7	5.1
Allegro	6.7	5.0	4.7	4.7	4.7	5.1
Taya	6.7	4.7	4.7	4.7	4.7	5.1
Premier	5.3	4.7	4.7	5.3	5.3	5.1
Pick 9100	7.0	5.0	4.3	4.3	4.7	5.1
Legacy	5.7	4.0	5.0	5.0	5.3	5.0
Loretta	6.3	4.7	4.3	4.7	4.7	4.9
WVPB-88-PR-D-10	5.7	4.7	4.7	4.7	4.7	4.9
Accolade	5.7	4.7	4.7	4.7	4.7	4.9
Surprise	5.3	5.3	4.7	4.7	4.7	4.9
Stallion	5.0	4.3	5.0	5.0	5.3	4.9
Ovation	5.0	4.3	4.7	5.0	5.0	4.8
NK 89001	5.3	5.3	4.0	4.7	4.7	4.8
MOM LP 3185	5.0	4.7	4.7	4.7	4.7	4.7
Regal	6.0	5.7	3.3	4.7	4.0	4.7

Cultivar	May	June	July	August	September	Mean
Lindsay	6.0	4.0	4.5	4.5	4.5	4.7
MOM LP 3111	5.3	4.7	4.3	4.3	4.7	4.7
Caliente	5.0	4.7	4.3	4.7	4.3	4.6
Danilo	6.0	5.0	4.0	4.0	4.0	4.6
Cartel	5.0	4.7	4.0	4.7	4.7	4.6
Goalie	5.3	4.3	4.3	4.3	4.3	4.5
Toronto	5.0	4.3	4.0	4.3	4.7	4.5
MOM LP 3179	5.0	4.0	4.0	5.0	4.7	4.5
Pennfine	5.0	4.3	4.0	4.3	4.3	4.4
Linn	4.0	3.7	4.3	4.7	5.0	4.3
$LSD_{(0.05)}$	0.8	1.3	1.2	3.0	1.2	0.8

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

Regional Fine Fescue Cultivar Evaluation

R. W. Moore and N. E. Christians

This was the first 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.

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.

'Jamestown II' performed best in 1991 (Table 5). 'SR 5000', 'PST-4CD', 'Epsom', 'N-105', 'Southport', 'Longfellow', '89.LKR', 'PST-4C8', and 'Herald' were the top 10 cultivars. 'MX-86', 'Silvana', 'Valda', and 'Barreppo' received the poorest quality ratings.

This data is for the first year following establishment and successive years may yield different results as the cultivars mature.

Table 5. The 1991 quality ratings for the fine fescue regional cultivar trial.

	Cultivar	July	August	September	October	November	Mean
1	Jamestown II	7.7	7.3	8.0	8.0	8.0	7.8
2	SR 5000	8.0	6.7	7.7	8.0	8.0	7.7
3	PST-4CD	7.7	7.0	8.0	8.0	8.0	7.7
4	Epsom	7.7	7.0	8.0	8.0	7.7	7.7
5	N-105	7.7	7.0	7.7	8.0	8.0	7.7
6	Southport	8.0	7.0	7.7	8.0	8.0	7.7
7	Longfellow	8.0	7.0	7.3	8.0	8.0	7.7
8	89.LKR	7.7	7.0	8.0	8.0	8.0	7.7
9	PST-4C8	7.0	7.0	8.0	8.0	8.0	7.6
10	Herald	7.3	7.6	8.0	8.0	8.0	7.6
11	PST-43F	7.7	7.0	7.7	7.7	7.7	7.5
12	PST-4FE	8.0	7.0	7.3	8.0	7.3	7.5

	Cultivar	July	August	September	October	November	Mean
13	JMB-89	7.3	6.7	7.3	8.0	7.7	7.4
14	PST-4R3	7.0	7.0	7.7	7.7	7.7	7.4
15	PST-4NI	7.3	6.7	7.7	7.7	7.7	7.4
16	PST-SHE	7.3	7.0	7.0	7.7	7.7	7.3
17	Cindy	7.7	6.7	7.7	7.3	7.3	7.3
18	Banner	7.7	7.0	7.0	7.7	7.3	7.3
19	OFI-89-200	7.3	6.3	7.3	8.0	7.7	7.3
20	Shadow	7.7	6.7	6.7	7.7	7.3	7.2
21	Salem	6.7	7.0	7.0	8.0	7.3	7.2
22	NK 82492	7.3	6.3	7.0	7.7	7.3	7.1
23	Molinda	7.0	6.7	6.7	7.3	7.7	7.1
24	BAR FR 9F	7.3	7.0	6.3	7.7	7.0	7.1
25	Bargreen	7.7	6.7	6.7	7.7	7.0	7.1
26	Scarlet	7.3	7.0	6.7	7.7	7.0	7.1
27	Mary	7.0	7.0	6.3	7.7	7.3	7.1
28	Dawson	7.0	7.0	6.7	7.7	7.0	7.1
29	Jasper	7.0	6.7	7.0	7.3	7.3	7.1
30	Wilma	7.7	6.3	6.7	7.7	7.0	7.1
31	Puma	7.3	6.3	6.7	8.0	7.0	7.1
32	Atilla	7.7	6.3	6.3	7.7	7.0	7.0
33	Barcrown	8.0	6.7	6.3	7.3	6.7	7.0
34	Atlanta	7.7	6.0	6.3	7.3	7.7	7.0
35	HF 112	7.7	6.3	6.7	7.3	7.0	7.0
36	Waldorf	8.0	6.3	6.3	7.3	7.0	7.0
37	Capital	7.0	6.7	7.0	7.3	7.0	7.0
38	Fot 30149	7.3	6.0	6.7	7.3	7.3	6.9
39	HF 138	7.0	7.0	6.7	7.0	7.0	6.9
40	Koket	7.3	6.7	6.7	7.0	7.0	6.9
41	LD 3485	7.3	6.3	7.0	7.0	6.7	6.9
42	Camaro	7.0	6.3	6.7	7.0	7.0	6.8
43	Barlotte	7.3	6.7	6.0	7.0	7.0	6.8
44	Barnica	7.3	6.3	6.3	7.0	7.0	6.8

	Cultivar	July	August	September	October	November	Mean
45	ZW 42-160	8.0	6.7	6.0	6.7	6.7	6.8
46	Jamestown	7.3	6.3	6.3	7.3	6.7	6.8
47	Vista	6.7	6.0	6.7	7.3	7.3	6.8
48	Enjoy	7.7	6.3	6.0	7.3	6.7	6.8
49	WW RS 130	7.0	6.3	6.7	7.0	6.3	6.7
50	WW RS 138	6.7	6.3	6.3	7.0	7.3	6.7
51	BAR FR 9F	7.0	6.3	6.3	7.0	6.7	6.7
52	Shademaster	6.0	6.3	7.0	7.0	7.3	6.7
53	Flyer	6.7	6.0	6.7	7.0	7.0	6.7
54	Rainbow	7.0	6.7	6.3	7.0	6.3	6.7
55	SRX 89-31	7.0	5.7	6.0	7.7	6.7	6.6
56	LD 3488	7.3	6.3	5.7	7.0	6.7	6.6
57	Raymond	7.0	6.0	6.3	6.7	6.7	6.5
58	Estoril	7.7	6.0	6.3	6.7	6.0	6.5
59	Boreal	6.0	6.3	6.7	7.0	6.3	6.5
60	ZW 42-148	6.3	6.3	6.3	7.0	6.0	6.4
61	Elanor	6.7	6.3	6.0	6.7	5.7	6.3
62	Franklin	6.3	5.7	6.3	6.3	6.7	6.3
63	WW RS 143	6.7	6.0	6.0	6.3	6.7	6.3
64	BAR FO 9A2	6.3	5.3	6.3	7.0	6.7	6.3
65	Aurora	6.0	5.7	6.0	7.3	6.3	6.3
66	Belvedere	6.7	6.0	6.3	6.3	6.3	6.3
67	Bargena	6.3	5.7	5.7	6.7	7.0	6.3
68	NK 88001	6.3	6.7	6.3	6.3	6.0	6.3
69	Claudia	5.7	6.0	6.0	7.0	7.0	6.3
70	ERG 1143	6.3	6.3	6.3	6.3	6.0	6.3
71	LD 3414	6.3	6.0	6.0	6.7	6.3	6.3
72	Melody	6.0	5.3	5.7	7.0	7.0	6.2
73	BAR FR 8RC3	5.7	6.0	6.7	7.0	5.7	6.2
74	Bighorn	6.0	6.0	6.0	7.0	5.7	6.1
75	HF 102	5.7	5.7	6.0	6.7	6.3	6.1
76	Warwick	6.0	5.7	5.7	7.0	6.3	6.1

	Cultivar	July	August	September	October	November	Mean
77	Crystal	6.0	5.3	6.0	6.3	6.7	6.1
78	Sylvester	6.0	5.7	6.0	6.7	5.7	6.0
79	Ensylva	5.3	6.0	6.0	6.3	6.3	6.0
80	Marker	6.3	5.3	5.7	6.7	6.0	6.0
81	LD 3438	6.3	6.0	6.0	6.3	5.3	6.0
82	PST-4HD	5.7	5.0	5.3	7.0	6.3	5.9
83	Reliant w/o endo.	5.3	6.0	5.3	6.7	6.3	5.9
84	PST-AUE	6.3	4.7	5.0	6.3	6.0	5.7
85	Reliant w/endo.	5.0	5.0	5.3	6.7	6.3	5.7
86	Biljart	5.7	5.0	5.3	6.3	6.0	5.7
87	Scaldis	6.0	5.7	5.7	6.3	5.3	5.6
88	SR 3000	5.7	5.0	5.0	6.3	6.0	5.6
89	PST-4AG	5.3	4.7	5.3	6.7	6.0	5.6
90	Serra	4.7	5.3	4.7	6.7	6.0	5.5
91	Eureka	5.3	5.0	5.0	6.3	5.7	5.5
92	MX-86	5.0	5.3	5.3	5.7	5.0	5.3
93	Silvana	5.3	4.3	5.0	6.0	5.7	5.3
94	Valda	4.7	4.7	5.3	6.0	6.0	5.3
95	Barreppo	4.7	4.3	5.3	5.7	5.0	5.0
	$LSD_{(0.05)}$	1.4	1.0	1.2	1.1	1.2	0.9

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

Tall Fescue Cultivar Trial

M. L. Agnew and N. E. Christians

The 65 tall fescue cultivars were established in the fall of 1987 at the Iowa State University Horticulture Research Station. The study was maintained at a 2-in mowing height and fertilized with 2 lb N/1000 ft^2/yr. The area was unirrigated and receives no fungicide or insecticide applications.

The data in Table 6 reflects the quality data from 1991. Rainfall was heavy in the spring. Interestingly, Shenandoah and Tribute were tall fescue cultivars that also grew well under drought conditions.

Table 6. Mean turfgrass quality ratings of tall fescue cultivars in the 1987 National Tall Fescue Test at Ames, Iowa. 1991 Data.

	Monthly Rating[a]						
Tall Fescue Cultivar	May	June	July	Aug	Sept	Oct	Mean
KWS-BG-6 (Twilight)	7.0	7.7	7.3	8.3	6.0	8.0	7.4
BEL 86-2	6.3	7.3	8.3	7.7	6.7	7.3	7.3
PE-7E (Shenandoah)	7.3	7.0	7.3	8.3	6.3	7.7	7.3
Tribute	7.0	7.0	7.3	8.3	6.3	8.0	7.3
Sundance	7.0	7.3	7.7	7.7	6.0	7.3	7.2
Pick DDF (Shortstop)	7.7	7.3	6.7	7.0	6.0	7.7	7.1
Apache	7.0	6.7	7.0	7.3	6.0	7.3	6.9
Hubbard 87	8.3	7.7	7.3	7.0	4.0	7.0	6.9
KWS-DUR	7.7	7.0	6.7	7.7	5.3	7.0	6.9
Normarc 77 (Phoenix)	7.0	7.7	7.7	7.0	5.3	7.0	6.9
Normarc 99 (Vegas)	7.0	7.0	7.3	7.0	6.0	7.0	6.9
PST-5AP	7.3	7.0	7.0	7.3	6.0	7.0	6.9
Mesa	6.3	7.0	7.3	7.0	5.3	7.7	6.8
Pick 127 (Cochise)	8.0	8.0	8.3	6.0	3.7	6.7	6.8
PST-5D1 (Eldorado)	6.3	7.0	7.3	7.7	4.7	8.0	6.8
PST-5F2 (Winchester)	7.3	7.0	7.0	7.0	5.7	7.0	6.8
Trident	6.7	7.0	6.7	7.0	6.3	7.0	6.8
BAR FA 7851 (Barnone)	6.7	6.3	6.7	7.3	5.7	7.3	6.7

Tall Fescue Cultivar	Monthly Rating[a]						
	May	June	July	Aug	Sept	Oct	Mean
Chieftain	6.7	7.3	6.7	7.0	5.3	7.3	6.7
Pick DM (Avanti)	7.0	7.0	6.7	7.0	5.3	7.3	6.7
PST-5HF (Amigo)	7.0	7.3	7.0	6.3	5.7	7.0	6.7
Cimmaron	7.0	7.0	6.7	7.0	5.0	7.0	6.6
PE-7	7.3	7.3	8.0	6.4	4.7	6.0	6.6
Pick 845PN (Guardian)	7.7	6.7	6.7	6.7	5.3	6.7	6.6
PST-5D7 (Murietta)	7.3	7.0	7.0	6.3	4.7	7.0	6.6
PST-5EN	7.0	7.0	6.7	7.0	5.0	7.0	6.6
PST-DBC (Tradition)	7.0	6.7	6.7	6.3	6.0	6.7	6.6
Thoroughbred	7.3	6.7	6.7	6.7	5.3	6.7	6.6
Bonanza	6.3	6.7	7.3	6.7	5.3	6.7	6.5
PST-5AG	6.0	6.3	7.0	6.7	5.7	7.3	6.5
Arid	5.7	6.7	6.7	7.3	5.3	7.0	6.4
PST-5DM (Arriba)	7.7	7.7	7.0	6.0	4.3	6.0	6.4
Taurus	6.3	7.0	7.0	6.7	5.0	6.7	6.4
BEL 86-1	6.3	6.0	6.3	6.7	5.3	7.0	6.3
Jaguar II	7.0	7.0	7.0	6.0	4.3	6.7	6.3
Pick SLD (Emperor)	6.7	6.7	7.0	6.7	4.3	6.7	6.3
PST-5MW (Safari)	6.7	7.0	7.3	5.7	4.7	6.3	6.3
Rebel II	6.7	6.7	6.7	7.0	4.3	6.7	6.3
Titan	6.7	6.7	6.3	6.3	4.7	7.0	6.3
Finelawn 5GL	6.3	6.3	6.3	6.3	5.3	6.7	6.2
Legend (Brahma)	6.7	7.0	7.3	5.7	4.3	6.3	6.2
Normarc 25 (Austin)	7.0	7.0	7.0	5.7	4.3	6.3	6.2
PST-5BL (Silverado)	8.0	7.3	7.3	5.3	3.0	6.0	6.2
PST-5OL (Olympic II)	6.0	6.3	6.3	6.3	5.7	6.3	6.2
Pick TF9 (Crossfire)	7.3	7.3	7.3	5.0	4.0	5.7	6.1
Aztec	7.0	7.3	7.7	4.7	3.3	5.3	5.9
Carefree	6.0	6.3	6.3	6.7	4.0	6.3	5.9
Falcon	7.0	7.0	6.7	5.0	3.7	6.0	5.9
Pacer	6.0	6.0	6.3	6.0	4.7	6.3	5.9

Tall Fescue Cultivar	Monthly Rating[a]						
	May	June	July	Aug	Sept	Oct	Mean
Pick GH6 (Maverick II)	7.3	6.7	6.7	5.3	4.0	5.7	5.9
Fatima	5.7	6.3	6.7	6.0	4.0	6.0	4.8
Jaguar	6.0	6.7	7.0	5.3	4.0	5.7	5.8
Rebel	6.0	5.7	5.7	6.0	5.3	6.3	5.8
SYN GA (Aquara)	6.0	6.3	6.3	6.0	4.0	6.3	5.8
Finelawn I	6.3	6.3	6.0	5.3	4.3	5.7	5.7
Monarch	6.3	6.3	7.0	5.7	3.3	5.7	5.7
Olympic	6.7	6.7	6.7	4.7	4.0	5.3	5.7
Richmond	5.7	6.0	6.0	5.7	4.7	6.0	5.7
Adventure	6.0	6.0	6.0	5.0	4.3	5.7	5.5
JB-2	6.0	6.3	6.0	5.0	3.7	5.3	5.4
Tip	6.0	6.0	5.3	4.7	4.7	5.7	5.4
Trailblazer	7.7	6.7	5.3	4.3	3.0	5.3	5.4
Willamette	5.7	6.3	6.3	5.0	3.7	5.3	5.4
Wrangler	6.7	6.3	6.3	5.0	3.3	5.0	5.4
KY-31	5.7	6.3	6.0	4.7	3.0	6.0	5.3
$LSD_{(0.05)}$	1.8	1.4	2.2	2.0	2.8	2.4	1.4

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

Shade Adaptation Study - 1991

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 was collected from May through September. The hard fescues (H.F.) and creeping red fescue (C.R.F.) were the best performers in 1990 (see last year's report), but in the very wet conditions of 1991, these species deteriorated badly (Table 7). The tall fescues maintained very good quality all season long in 1991. Some of the Kentucky bluegrasses also maintained an acceptable quality through much of the season. Sabre (*Poa trivialis*) performed very poorly in the earlier, drier years of the test, but in the wet conditions of 1991 this species performed the best of all grasses in the study.

Table 7. The 1991 quality ratings for grasses in the shade trial.

	Cultivar	May	June	July	August	September	Mean
1	Sabre (*Poa trivialis*)	7.3	8.0	7.0	4.7	7.3	6.9
2	Bonanza (T.F.)	5.3	7.0	7.3	6.0	6.7	6.5
3	Chateau (K.B.)	6.0	6.0	6.3	6.0	6.7	6.2
4	Apache (T.F.)	6.0	6.7	7.0	5.0	5.3	6.0
5	Arid (T.F.)	5.3	6.0	6.3	5.7	6.7	6.0
6	Midnight (K.B.)	6.0	6.3	6.3	5.0	5.7	5.9
7	Coventry (K.B.)	6.3	6.0	6.3	4.7	5.0	5.7
8	Waldorf (C.F.)	6.7	5.0	4.7	4.3	6.7	5.5
9	Glade (K.B.)	6.7	6.3	5.3	4.0	5.3	5.5
10	Rebel (T.F.)	5.7	5.0	5.7	5.3	5.0	5.3
11	Rebel II (T.F.)	5.7	5.0	5.0	5.0	5.7	5.3
12	Falcon (T.F.)	6.0	4.3	5.7	5.3	5.3	5.3
13	ST-2 (SR 3000) (H.F.)	7.0	4.3	4.0	4.7	5.3	5.1
14	Biljart (H.F.)	6.3	4.7	4.3	4.0	5.7	5.0

	Cultivar	May	June	July	August	September	Mean
15	Ram I (K.B.)	5.0	5.0	5.7	4.0	5.3	5.0
16	Atlanta (C.F.)	6.7	5.0	4.3	3.7	5.0	4.9
17	BAR FO 81-225 (H.F.)	6.7	4.3	4.3	3.7	5.7	4.9
18	Pennlawn (C.R.F.)	6.7	5.0	3.7	3.0	5.3	4.7
19	Shadow (C.F.)	6.7	4.7	3.3	3.3	5.3	4.7
20	Wintergreen (C.F.)	6.0	4.3	4.7	3.0	5.0	4.6
21	Banner (C.F.)	7.3	3.7	3.7	3.0	4.7	4.5
22	Victor (C.F.)	6.3	3.0	3.7	3.3	5.0	4.3
23	Jamestown (C.F.)	5.7	3.7	3.7	3.3	4.7	4.2
24	Koket (C.F.)	5.7	4.3	3.0	3.3	4.7	4.2
25	Estica (C.R.F.)	7.0	3.7	3.3	2.3	4.0	4.1
26	Waldina (H.F.)	5.7	3.3	3.3	3.3	4.7	4.1
27	Ensylva (C.R.F.)	4.7	3.3	3.3	3.7	5.0	4.0
28	Agram (C.F.)	6.0	4.3	2.7	2.7	3.7	3.9
29	Mary (C.F.)	6.0	3.7	3.3	2.7	4.0	3.9
30	Bristol (K.B.)	5.3	3.7	3.7	3.0	4.0	3.9
31	Scaldis (H.F.)	5.3	3.3	3.3	2.7	3.7	3.7
32	Highlight (C.F.)	5.7	3.0	2.7	2.3	4.0	3.5
33	Spartan (H.F.)	6.3	2.7	2.3	2.7	3.3	3.5
34	Nassau (K.B.)	4.0	3.7	3.0	3.3	3.0	3.4
35	Reliant (H.F.)	5.3	3.0	2.3	2.0	2.7	3.1
	$LSD_{(0.05)}$	1.3	1.5	1.7	1.7	NS	1.4

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

USGA Buffalograss Trial - 1991

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 of 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 of 1989, plugs of all varieties were established in the greenhouse and were 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 established well during the growing season and all had reached 100% cover by dormancy in September 1990.

First quality data on the study were collected in 1991 (Table 8). The 84-315 variety received the highest rating through the season. This was due in part to its early spring greenup and to its high density and uniformity. The 84-609, 84-304,and 84-409 do not appear to be well adapted to Iowa conditions. Data collection will continue for several more seasons on these grasses.

Table 8. The 1991 quality ratings for the USGA buffalograss study.

	Cultivar	May	June	July	August	Mean
1	84-315	9.0	9.0	7.3	7.3	7.3
2	Texoka	8.3	6.3	6.0	6.3	6.8
3	85-378	8.0	6.7	6.3	6.0	6.8
4	84-609	2.7	3.3	3.7	5.7	3.8
5	84-304	2.7	3.7	3.0	4.7	3.5
6	84-409	2.7	3.7	3.0	4.7	3.5
	$LSD_{(0.05)}$	1.4	1.3	1.1	0.8	0.7

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

Green Height Bentgrass Cultivar Trial

(Native Soil)

N. E. Christians and R. W. Moore

This is the first 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 were maintained with a fertilizer program of 1/4 lb N applied at 14-day intervals with an approximate total of 6 lb 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.

'Penncross' (Table 9) had the best quality of any cultivar. Nine cultivars maintained a mean of 6 (acceptable) or better. Other top cultivars were 'WVPB 89-D-15', 'Bardot', 'Forbes 89-12', '88.CBL', and 'Normarc 101'. 'Pennlinks', 'Cobra', and 'SR 1020' were also in the top 9 cultivars. 'Egmont', 'BR 1518', and 'Allure' had the lowest quality ratings of the 20 cultivars. This was an establishment year and may not reflect the true attributes of these cultivars. The results may change as the study matures.

Table 9. The 1991 ratings for the green height bentgrass trial.

	Cultivar	May	June	July	August	Mean
1	Penncross	6.7	6.7	6.0	7.7	6.8
2	WVPB 89-D-15	6.0	6.3	6.0	7.0	6.3
3	Bardot	7.0	6.3	5.7	6.3	6.3
4	Forbes 89-12	5.7	6.3	6.3	7.0	6.3
5	88.CBL	5.7	6.3	6.0	7.3	6.3
6	Normarc 101	5.3	6.7	5.7	7.0	6.2
7	Pennlinks	5.7	6.0	5.7	7.0	6.1
8	Cobra	5.7	6.0	5.0	7.3	6.0
9	SR 1020	5.3	6.0	6.0	6.7	6.0
10	Providence	3.3	6.3	6.7	7.3	5.9
11	Putter	4.7	6.7	5.7	6.7	5.9
12	88.CBE	5.3	6.3	6.0	6.0	5.9
13	Southshore	6.3	5.7	5.3	6.0	5.8
14	Carman	5.7	5.7	5.3	6.3	5.8
15	Tracenta[1]	6.7	5.7	5.7	4.7	5.7
16	Emerald	5.7	5.7	5.3	6.0	5.7
17	National	6.0	5.3	4.7	6.0	5.5
18	Egmont[2]	5.0	4.3	4.7	4.3	4.6
19	BR 1518[3]	5.0	3.3	4.3	4.0	4.2
20	Allure[1]	4.7	4.0	4.3	3.7	4.2
	$LSD_{(0.05)}$	1.1	1.0	1.3	1.5	0.8

[1]Tracenta and Allure are colonial 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 - 1991

N. E. Christians

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 an 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, but little irrigation was required until August because of the high rainfall in 1991. The best cultivars in 1991 were 'SR 1020', 'Putter', and 'Penneagle'. 'Penncross' quality ratings dropped from 1st place in 1990 to 12th place in 1991. This was a consistent trend during the year and the reason for it is uncertain.

Table 10. Quality ratings for the fairway height bentgrass study in 1991*.

	Cultivar	May	June	July	August	October	Mean
1	SR 1020	7.3	8.0	7.7	7.3	8.3	7.7
2	Putter	6.3	8.3	8.0	8.0	7.3	7.6
3	Penneagle	6.3	8.3	7.7	8.0	7.3	7.5
4	Providence (SR 1019)	7.7	7.7	7.0	8.0	6.7	7.4
5	J.H. Bent	6.3	7.7	7.0	7.7	7.7	7.3
6	ISI 123	6.7	7.0	7.3	7.7	7.3	7.2
7	ISI 124	7.3	6.7	7.3	7.3	7.3	7.2
8	Pennlinks	7.0	7.7	6.3	7.0	7.3	7.1
9	Cobra	6.7	7.0	6.7	7.3	6.7	6.9
10	Emerald	6.0	6.7	7.0	8.0	7.0	6.9
11	Southshore	6.7	6.7	6.7	7.3	7.3	6.9
12	Penncross	6.3	6.7	6.7	7.3	7.3	6.9
13	Carmen	7.0	7.0	6.3	7.3	6.0	6.7
14	Exeter (Colonial Bent)	6.0	5.3	5.7	6.3	6.0	5.9
15	National	4.7	5.3	5.3	6.0	6.3	5.5
16	Prominent	5.0	5.0	5.3	5.7	5.7	5.3
	$LSD_{(0.05)}$	1.0	1.8	1.0	1.1	1.5	0.8

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

Fairway Height Kentucky Bluegrass Trial - 1991

N. E. Christians and R. W. Moore

The Kentucky bluegrass plots in this trial were established in 1979 and the study was maintained at lawn height for nine seasons. In the fall of 1988, the mowing height was slowly reduced to 1 in to test the cultivars under conditions similar to a Kentucky bluegrass fairway.

The study was irrigated as needed and fertilized at a rate of 4 lb N/1000 ft^2/yr.

'Plush' performed best in 1991 (Table 11). 'Midnight' did very well, but it should be noted that this cultivar does not stand up well in dry years (see 1990 report) and develops severe powdery mildew if there is any shade in the area (the test area is in full sun).

'Majestic' was the lowest rated cultivar. This grass generally performs well at higher mowing heights, but under the low mowing heights of this study its quality deteriorated.

Table 11. The 1991 quality ratings for the fairway height Kentucky bluegrass trial established in 1978.

	Cultivar	May	June	July	August	October	Mean
1	Plush	8.0	8.7	6.7	6.3	7.3	7.4
2	Midnight	7.0	7.0	7.3	7.3	6.7	7.1
3	(WTN) I-13	7.7	7.0	7.0	7.3	6.7	7.1
4	Bristol	7.0	7.3	6.7	6.7	6.7	6.9
5	A-20-6	6.3	7.7	7.3	7.0	6.3	6.9
6	Parade	6.0	7.0	7.0	7.4	6.7	6.8
7	K3-160	6.7	7.0	7.0	6.7	6.7	6.8
8	(WTN) H-7	7.3	6.3	7.0	6.7	6.7	6.8
9	America	6.7	7.0	6.7	6.7	7.0	6.8
10	Escort	7.0	7.7	6.7	6.7	6.0	6.8
11	Aspen	7.0	7.0	6.0	6.7	6.7	6.7
12	Touchdown	7.3	6.7	5.7	7.0	7.0	6.7
13	Barbie	7.0	6.3	6.3	7.0	7.0	6.7
14	BFB-35	7.0	6.7	6.3	6.7	7.0	6.7
15	Victa	6.7	7.0	7.0	6.7	6.3	6.7
16	Rugby	6.7	6.7	6.7	6.7	6.7	6.7
17	Wabash	7.3	6.7	7.0	6.7	6.0	6.7
18	A-20	7.3	6.0	6.0	7.3	6.3	6.6
19	P-164	7.0	7.0	5.7	6.7	6.7	6.6
20	Cheri	6.7	7.0	6.3	6.7	6.3	6.6
21	Vantage	6.7	7.0	6.3	6.3	6.7	6.6
22	Bonnieblue	6.7	7.3	7.0	6.7	5.3	6.6
23	Glade	6.7	6.7	7.0	6.7	6.0	6.6
24	Common	6.7	6.7	6.3	6.3	6.7	6.5
25	N-535	6.7	7.7	6.0	6.0	6.0	6.5
26	Fanfare	6.7	7.0	6.3	6.3	6.0	6.5
27	Trenton	6.7	7.0	6.7	6.0	6.0	6.5
28	P-164B	7.0	6.7	5.7	7.0	6.0	6.5
29	Park	6.0	7.3	6.0	6.7	6.0	6.4
30	Merit	6.3	6.7	6.3	7.0	5.7	6.4

	Cultivar	May	June	July	August	October	Mean
31	Merion	6.3	6.7	5.7	6.7	6.3	6.3
32	Sving	6.3	6.7	6.0	6.3	6.0	6.3
33	Baron	6.7	7.7	6.0	6.0	5.3	6.3
34	Enmundi	6.3	6.7	6.0	6.3	6.0	6.3
35	K76-86-4	6.7	6.3	6.7	6.3	5.7	6.3
36	Sydsport	6.3	6.7	6.3	5.7	6.0	6.2
37	Senic	6.3	6.0	6.0	6.3	6.3	6.2
38	Kimono	6.7	6.3	5.7	6.3	6.0	6.2
39	SVO 1617	6.3	7.0	5.7	6.3	5.7	6.2
40	Nugget	6.0	7.0	6.0	6.3	5.3	6.1
41	Arista	6.0	6.7	6.0	6.0	6.0	6.1
42	Fylking	6.7	6.3	5.7	5.7	6.0	6.1
43	A-34	6.3	7.0	5.7	6.3	5.0	6.1
44	Columbia	5.7	6.3	6.0	6.3	5.7	6.0
45	Aquila	6.7	6.0	6.3	6.3	4.7	6.0
46	Ram I	6.0	6.3	5.3	6.3	5.7	5.9
47	Adelphi	6.0	6.3	5.3	6.0	5.3	5.8
48	Birka	6.0	6.7	5.7	5.3	5.0	5.7
49	(WTN) A-34	6.0	6.0	5.0	5.0	5.3	5.5
50	Pennstar	6.0	5.3	5.0	5.3	5.7	5.5
51	Majestic	5.7	5.7	4.7	6.0	5.3	5.5
	$LSD_{(0.05)}$	NS	NS	NS	NS	1.4	NS

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

Preemergence Annual Weed Control Study - 1991

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

The 1991 preemergence annual weed control study was conducted at the turfgrass research area on a Nicolett (fine-loamy, mixed mesic, Aquic Hapludoll) soil with a pH of 6.9 and 2.3% organic matter. The objective of the project was to evaluate the efficacy of several labeled and experimental preemergence herbicides applied to a 'Parade' 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 second week of April with a combination of large hairy and smooth crabgrass harvested from the research area. Treatments were applied on April 24. Liquids were applied with a backpack carbon-dioxide sprayer equipped with 8006 nozzles at 20 psi. Granular materials were applied with a hand-held shaker. The study was irrigated following seeding and a heavy infestation of crabgrass developed in the control plots. Heavy rains in April, May, and June kept the area well watered and no additional irrigation was necessary following germination.

The study was observed weekly for signs of phytotoxicity. No damage was observed on any of the treated plots at any time during the summer of 1991. This was true in spite of stress conditions during a dry period in late July and August. Estimates of the percentage reduction of crabgrass were made in July. Counts of crabgrass, prostrate spurge, and oxalis were made in August (Table 12).

Ronstar 2G provided excellent crabgrass control at the 4 lb a.i./A rate as did Exp 03621B 2G (an experimental formulation of the same active ingredient). The 2 lb a.i. rates of these materials were also relatively effective. Split applications of Balan were not effective in controlling crabgrass. However, when an initial application of Balan was followed by either Pre M or Team, weed control was much improved. Split applications of Team 2G at 1.5 lb a.i. were very effective in 1991. Single applications of Dimension, Pendimethalin, and Dacthal provided rather poor weed control. This was probably due to very wet weather during the early crabgrass germination period in May and early June. The results for Dimension were surprising given the good control we have seen with this material in past years. Perhaps repeat applications of Dimension would be necessary in extremely wet years.

Barricade provided reasonable crabgrass control with one application. Control was improved when Barricade was applied with Gallery. Gallery alone is not considered to be a crabgrass control. Its primary use is for control of annual broadleaf weeds. We tried it at higher than normal rates this year to determine if crabgrass control could be improved at higher rates. There was no satisfactory control of crabgrass with Gallery alone at any level used in this study.

There were no statistically significant differences in spurge and oxalis counts among treatments. The counts for these two annual species are listed in Table 12 to show the average number of plants that were observed in the three replicated plots for each treatment.

Table 12. The 1991 preemergence annual weed control study.

	Treatment	Rate (# a.i./A)	Crabgrass % Cover		Spurge Count	Oxalis Count
			July	August	August	
1	Control	---	18	65	0	0
2	Balan 60DF	2.0 + 2.0 8 wk	5	30	0	0
3	Balan 60DF, Pre M 60WP	2.0 + 1.5 8 wk	4	8	0	0
4	Balan 60DF, Team 2G	1.5 + 1.5 8 wk	3	9	1	0
5	Team 2G	1.5 + 1.5 8 wk	2	4	0	1
6	Team 2G	3.0	2	9	1	0
7	Balan 60DF	3.0	4	28	2	0
8	Gallery 75DF	.75	13	57	3	0
9	Gallery 75DF	1.0	13	60	1	0
10	Gallery 75DF	1.5	10	68	0	0
11	Gallery 75DF	.75 + .75 8 wk	12	42	0	0
12	Team 1.156G	1.5 + 1.5 8 wk	11	35	0	1
13	Pendimethalin 60WP	1.5 + 1.5 8 wk	4	28	0	0
14	Gallery/Team/ Fert. FN9064	2.72	10	38	1	0
15	Ronstar 2G	2.0	4	11	1	2
16	Ronstar 2G	4.0	0	1	3	0
17	EXPO3621B 2G	2.0	3	6	0	1
18	EXPO3621B 2G	4.0	0	1	0	1
19	EXPO4742A 4EC	6.0	8	53	1	0
20	EXP30742B 2.3G	4.0	4	23	1	0
21	EXP30742B 2.3G	6.0	1	6	1	0
22	EXP30742B 2.3G	3.0	7	28	1	0
23	EXP30832A 2.3G	4.0	5	32	2	0
24	EXP30832A 2.3G	6.0	3	14	2	2
25	EXP30833A 2.3G	4.0	3	27	1	0
26	EXP30833A 2.3G	6.0	4	31	0	0
27	Barricade 65WG	.65	2	10	2	0

	Treatment	Rate (# a.i./A)	Crabgrass % Cover		Spurge Count	Oxalis Count
			July	August	August	
28	Barricade 65WG, Gallery 75WG	.65 +.75	2	5	0	0
29	Dimension Mon15151 1EC	.38	12	40		0
30	Dimension Mon15151 1EC	.50	2	16	0	0
31	Pendimethalin 60WG	3.0	9	48	3	0
32	Dacthal 75WP	10.0	9	57	1	0
33	Scotts Fert. + Pend. 1.71G	2.6	3	27	1	0
	$LSD_{0.05}$		9	30	NS	NS

Postemergence Broadleaf Weed Control Study - 1991

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

The objective of this study was to investigate the efficacy of several herbicides currently being evaluated as postemergence controls of broadleaf weeds in turf areas. The study was conducted on a site on the northern part of the Iowa State University campus on an old lawn area established with common Kentucky bluegrass. Individual plots measured 5 ft by 10 ft. They were arranged in a randomized, complete-block design with three replications. No irrigation was available at the site. However, the spring of 1991 was very wet and there was no moisture stress on the areas before the June 6, 1991, treatment date. There was an extended drought period during July and early August when the bluegrass on the area went into summer dormancy.

The site had a good population of the following broadleaf weeds: dandelion (*Taraxacum officianale*), white clover (*Trifolium repens*), broadleaf plantain (*Plantago major*), prostrate knotweed (*Polygonum aviculare*), violet (*Viola papilionacea*), bindweed (*Convolvulus arvensis*), and ground ivy (*Glechoma hederacea*). 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 was observed on the Kentucky bluegrass. Weed counts were made on July 8 and August 21, 1991. Tables 13 and 14 list the average number of weeds in a 5 ft by 10 ft plot. Clover infestation was heavy and percent cover evaluations for this species were estimated.

Conditions were nearly perfect for weed control at the time of treatment and all materials tested provided excellent control of clover. Only Fluroxypur did not provide satisfactory dandelion control. Fluroxypur also appeared to be weak on plantain. The ground ivy population was highly variable on the plots, and this species was not observed in the control.

Confront, the new non-phenoxy substitute from DowElanco, was very effective in this test as were the standards, Trimec and Turflon.

Table 13. Weed counts conducted on July 8, 1991.

	Treatment	Rate (lb a.i./A)	Clover % Cover	Dandelion	Plantain	Knotweed	Violet	Bindweed	Ground Ivy
1	Check		32	119	19	1	2	7	0
2	Turflon II Amine	3.0 pt	0	1	2	0	1	1	1
3	Turflon D	3.0 pt	1	0	2	0	2	0	0
4	Confront	1.5 pt	0	0	2	0	1	1	1
5	XRM-5202	1.14	0	0	0	0	0	0	11
6	Fluroxypyr (XRM 5316) 1.5 lb a.i./gal	0.06	3	34	11	1	1	0	2
7	Fluroxypyr (XRM 5316) 1.5 lb a.i./gal	0.13	0	3	5	0	4	1	3
8	Fluroxypyr (XRM 5316) 1.5 lb a.i./gal	0.25	0	7	6	0	0	3	0
9	Fluroxypyr (XRM 5316) 1.5 lb a.i./gal	0.50	0	0	2	0	0	0	0
10	Fluroxypyr (XRM 5316) 1.5 lb a.i./gal	1.0	0	0	1	0	0	0	0
11	Trimec Classic	3.0 pt	0	0	11	0	0	0	0
12	Trimec Classic	4.0 pt	0	0	0	0	5	0	3
13	018847 + Lesco spreader sticker	1.1 oz/1000 ft^2 + 0.5 fl oz/gal H_2O	0	1	2	0	1	0	2
14	018847	1.1 oz/1000 ft^2	0	1	0	0	3	0	9
	$LSD_{0.05}$		7	34	9	NS	NS	3	15

Table 14. Weed counts conducted on August 21, 1991.

	Treatment	Rate (lb a.i./A)	Clover % Cover	Dandelion	Plantain	Knotweed	Violet	Bindweed	Ground Ivy	Spurge
1	Check		17	97	13	14	0	7	0	0
2	Turflon II Amine	3.0 pt	0	0	0	0	0	0	0	0
3	Turflon D	3.0 pt	1	0	1	0	2	0	0	0
4	Confront	1.5 pt	0	0	0	5	1	1	0	0
5	XRM-5202	1.14	1	0	0	0	0	0	0	0
6	Fluroxypyr (XRM 5316) 1.5 lb a.i./gal	0.06	1	22	5	2	0	1	2	2
7	Fluroxypyr (XRM 5316) 1.5 lb a.i./gal	0.13	0	8	2	2	0	1	0	0
8	Fluroxypyr (XRM 5316) 1.5 lb a.i./gal	0.25	0	25	4	0	0	2	0	0
9	Fluroxypyr (XRM 5316) 1.5 lb a.i./gal	0.50	0	1	1	0	0	0	0	0
10	Fluroxypyr (XRM 5316) 1.5 lb a.i./gal	1.0	0	1	0	0	0	1	0	1
11	Trimec Classic	3.0 pt	0	1	0	0	0	0	0	0
12	Trimec Classic	4.0 pt	0	1	0	0	1	0	0	1
13	018847 + Lesco spreader sticker	1.1 oz/1000 ft^2 + 0.5 fl oz/gal H_2O	0	1	1	0	1	0	0	0
14	018847	1.1 oz/1000 ft^2	0	0	0	0	1	0	0	0
	$LSD_{0.05}$		7	27	NS	NS	NS	3	1	NS

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

N. E. Christians and R. G. Roe

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. Trials with this compound on creeping bentgrass have been limited and little is known about the response of bentgrass to this compound at green-mowing height.

The objectives of this study were to observe rooting responses and foliar phytotoxicity to dithiopyr on creeping bentgrass mowed at 3/16-in and maintained under putting green conditions.

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 were applied on May 22, 1991, with a carbon-dioxide backpack sprayer (Table 15).

The plots were observed for signs of visible treatment differences throughout the summer. At no time were there any signs of phytotoxicity. 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 19 and August 19 to a depth of 20 cm. The diameter of the cores was 2.54 cm and six cores were collected per plot. The samples were divided into four subsamples: 0-5, 5-10, 10-15, and 15-20 cm. All soil was washed from the root samples. 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 19 and August 19, but was not affected by herbicide treatment.

Bensulide is a labeled compound for use on bentgrass greens and was used as a standard in this trial. Root weights of dithiopyr-treated bentgrass were generally similar to that of Bensulide-treated plots. This information combined with the lack of visible phytotoxicity would indicate that dithiopyr is likely safe for use on these varieties of creeping bentgrass maintained at green height.

Table 15. Response of creeping bentgrass to dithiopyr and other preemergence herbicides.

			Rooting									
			June 19, 1991					August 19, 1991				
	Treatment	Rate	1*	2	3	4	Mean	1	2	3	4	Mean
		lb a.i./A	g									
1	Control	---	0.403	0.049	0.016	0.008	0.119	1.512	0.105	0.033	0.007	0.414
2	Dithiopyr 0.10G	0.125	0.281	0.041	0.014	0.003	0.085	1.499	0.439	0.035	0.019	0.498
3	Dithiopyr 0.10G	0.250	0.372	0.062	0.012	0.007	0.113	1.103	0.104	0.042	0.020	0.317
4	Dithiopyr 0.25G	0.380	0.218	0.044	0.007	0.010	0.070	0.903	0.091	0.019	0.011	0.256
5	Dithiopyr 0.25G	0.500	0.220	0.045	0.008	0.006	0.070	1.326	0.113	0.048	0.019	0.376
6	Dithiopyr 1EC	0.250	0.203	0.076	0.006	0.003	0.072	1.100	0.085	0.029	0.013	0.307
7	Dithiopyr 1EC	0.380	0.212	0.045	0.003	0.003	0.066	1.475	0.097	0.033	0.012	0.404
8	Dithiopyr 1EC	0.500	0.196	0.041	0.009	0.006	0.063	1.293	0.113	0.036	0.016	0.365
9	Dithiopyr 1EC	0.750	0.274	0.061	0.009	0.003	0.086	1.388	0.086	0.021	0.008	0.376
10	Bensulide 4E	10.0	0.287	0.046	0.013	0.004	0.088	1.245	0.088	0.028	0.014	0.344
11	DCPA (Dacthal) 75WP	10.0	0.313	0.047	0.009	0.007	0.094	1.048	0.133	0.026	0.012	0.305
	$LSD_{0.05}$	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.

1991 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. The test was conducted on a Nicolett (fine-loamy, mixed mesic, Aquic Hapludoll) soil with a pH of 6.9 and 2.3% organic matter. Individual treatment cells measured 6 ft by 8 ft and were randomized in a complete block design with three replications. Two separate trials were conducted, one irrigated and the other on a non-irrigated area. Treatments are listed in Table 16.

The Kentucky bluegrass turf was cut at a 3/4-in depth and laid in the standard fashion on March 5. 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 for use as the point of attachment for the hydraulic lift apparatus. Check frames were pulled prior to treatment to ensure rooting. Pulling pressure exceeded 500 lbs and the sod in the area was assumed to be fully rooted at that time. Treatments were applied to the sod on May 2, 1991, with a backpack carbon-dioxide sprayer for the liquid materials and a shaker box for the granular materials (Table 16).

Rooting was measured with a technique modified from King (King & Beard, 1969). The frames were lifted vertically with a hydraulic pump apparatus. Woven steel cords were attached to each of the four screw hooks on the frame and drawn to an apex over the center of the frame (Fig. 3). The force at the point of root breakage from the soil was measured by use of a hydraulic pressure gauge. Rooting measurements were used as an indication of sod establishment. The frames were lifted on July 9 (63 days past treatment) and September 5 (126 days past treatment). 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 300 psi greater than in previous sod rooting studies. In nearly every case, pulling pressure exceeded the breaking point of the frames. There were no significant differences for irrigated and non-irrigated trials in sod pulling pressure at either the 63- or 126-day testing time (Tables 17 and 18). Root weights taken in July showed no significant difference under non-irrigated conditions. The irrigated trial showed a difference at the 0.16 level of significance.

Ronstar 2G and Pendimethalin at the split application rate showed the smallest numerical reduction in root weight. Team 2G at 3 lb a.i./A and Balan 2.5G at 2 lb a.i./A showed the greatest numerical reduction in root weight. No noticeable differences in turf quality were visible after treatment.

References

1. King, J. W. and J. P. Beard. 1969. Measuring rotting of sodded turf. Agronomy Journal 61:497-498.

Table 16. Treatments included in the 1991 rooting trial.

	Treatments	Rate/plot 6 ft x 8 ft
1	Balan 2.5G: 2.0 lb a.i./A	40 G
2	Balan 2.5G: 2.0 + 2.0 lb a.i./A - 63-day split application	40 G + 40 G
3	Team 2G: 1.5 lb a.i./A	37.5 G
4	Team 2G: 3.0 lb a.i./A	75 G
5	Team 2G: 1.5 + 1.5 lb a.i./A -- 63-day split application	37.5 G + 37.5 G
6	Pendimethalin 60DG: 2.0 lb a.i./A	1.67 G
7	Pendimethalin 60DG: 1.5 + 1.5 lb a.i./A -- 63-day split application	1.25 G + 1.25 G
8	Ronstar 2G: 3.0 lb a.i./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 17. 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]	Root Weight
			PSI	- g -
1	Balan 2.5G: 2.0 lb a.i./A	704	845	0.12
2	Balan 2.5G: 2.0 + 2.0 lb a.i./A -- 63 day split application	665	816	0.29
3	Team 2G: 1.5 lb a.i./A	673	776	0.37
4	Team 2G: 3.0 lb a.i./A	686	757	0.11
5	Team 2G: 1.5 lb a.i./A -- 63 day split application	667	746	0.23
6	Pendimethalin 60DG: 2.0 lb a.i./A	710	750	0.29
7	Pendimethalin 60DG: 1.5 + 1.5 lb a.i./A -- 63 day split application	668	782	0.45
8	Ronstar 2G: 3.0 lb a.i./A	677	789	0.44
9	Control: Sample at 63 days after first appl. (3 grids/plot) Sample at 63 days after second appl. (3 grids/plot)	741	770	0.77
	LSD	NS	NS	0.45*

*Significant at 0.16 level.

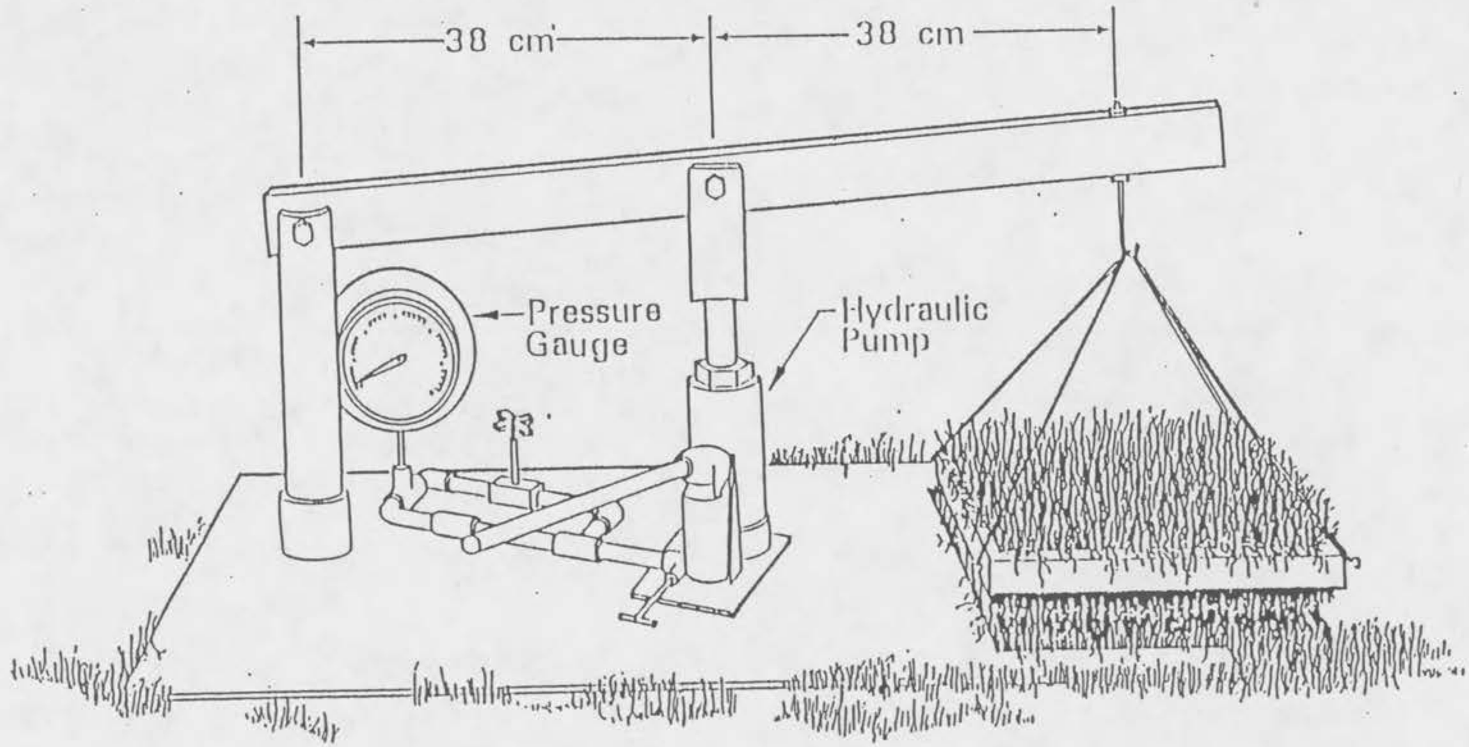
[a]Sod pulled July 9.
[b]Sod pulled September 5.

Table 18. 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]	Root Weight
		PSI		- g -
1	Balan 2.5G: 2.0 lb a.i./A	680	785	0.39
2	Balan 2.5G: 2.0 + 2.0 lb a.i./A -- 63 day split application	718	742	0.37
3	Team 2G: 1.5 lb a.i./A	741	786	0.42
4	Team 2G: 3.0 lb a.i./A	716	747	0.39
5	Team 2G: 1.5 lb a.i./A -- 63 day split application	787	742	0.40
6	Pendimethalin 60DG: 2.0 lb a.i./A	739	748	0.23
7	Pendimethalin 60DG: 1.5 + 1.5 lb a.i./A -- 63 day split application	667	767	0.25
8	Ronstar 2G: 3.0 lb a.i./A	816	795	0.49
9	Control: Sample at 63 days after first appl. (3 grids/plot) Sample at 63 days after second appl. (3 grids/plot)	804	860	0.59
	LSD	NS	NS	NS

[a]Sod pulled July 9.
[b]Sod pulled September 5.

Figure 3.



1991 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 establishment and rooting of Kentucky bluegrass (cv. 'Majestic') sod. The test was conducted on a Nicolett (fine-loamy, mixed mesic, Aquic Hapludoll) soil with a pH of 6.9 and 2.3% organic matter. Individual treatment cells measured 5 ft by 5 ft and were randomized in a complete-block design with three replications. Water was applied as needed.

The Kentucky bluegrass turf was cut at a 3/4-in depth on May 28, 1991, 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 for use as the point of attachment for the hydraulic lift apparatus. Preemergence treatments were applied to the sod on May 30, 1991, with a backpack carbon-dioxide sprayer for the liquid materials and a shaker box for the granular materials. Postemergence treatments were applied on June 18 (Table 19).

Rooting was measured with a technique modified from King (King & Beard, 1969). The frames were lifted vertically with a hydraulic pump apparatus (Fig. 3). Woven steel cords were attached to each of the four screw hooks 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 use of a hydraulic pressure gauge. Rooting measurements were used as an indication of sod establishment. The frames were lifted 10, 20, and 30 days following treatment.

There were no significant differences in sod pulling pressure at either the 10, 20, or 30 day testing time (Table 19).

Mon 15152 0.25G showed the greatest reduction in pulling pressure at the 20th day following treatment. By the 30th day, the grass on plots treated with Ronstar 2G at 4 lb a.i./A and Mon 15151 1EC at 1 lb a.i./A had numerically greater pulling pressure than the other treatments. Pendimethalin 2G at 3 lb a.i./A showed the greatest reduction in rooting, but again, these differences were not significantly different at the 0.05 level of significance.

No noticeable differences in turf quality were visible during the study.

References

1. King, J. W. and J. P. Beard. 1969. Measuring rotting of sodded turf. Agronomy Journal 61:497-498.

Table 19. Pulling pressures required to pull sod frames from Kentucky bluegrass plots treated with preemergence herbicides.

	Treatment	Rate (lb a.i./A)	10 days	20 days	30 days
1	Control	---	290.0[b]	468.3	455.0
2	Mon 15151 1EC[a]	0.5	276.6	371.6	428.3
3	Mon 15151 1EC	1.0	308.3	448.3	513.3
4	Mon 15152 .25G	0.25	283.3	366.6	444.0
5	Mon 15152 .25G	0.5	228.3	368.3	465.0
6	Mon 15151 1EC	0.5 (Post)[c]	320.0	433.3	375.0
7	Mon 15151 1EC	2.0 (Post)	285.0	493.3	453.0
8	Ronstar 2G	4.0	270.0	436.6	505.0
9	Exp 30742B 2.3G	6.0	250.0	420.0	380.0
10	Pendimethalin 2G	1.5	295.0	458.3	416.6
11	Pendimethalin 2G	3.0	291.6	456.6	336.6
	Nonrestricted $LSD_{(0.05)}$		NS	NS	NS

[a]Applied May 30, 1991.
[b]Pulling pressure psi.
[c]Post treatments were applied after the 10-day treatment on June 18.

The Effect of Prograss on the Establishment of Cool-Season Turfgrasses

J. B. Unruh and N. E. Christians

Prograss (ethofumesate) is marketed as a postemergence control of annual bluegrass *Poa annua* established in perennial ryegrass, creeping bentgrass (fairway height only), and Kentucky bluegrass turf on golf courses. The objective of this study was to observe the effects of Prograss on establishment of three cool-season turfgrass species seeded into sod previously killed with Roundup (glyphosate).

Roundup was applied to 5 ft by 5 ft plots on August 16, 1991, at a rate of 2 lb a.i./A. Two weeks after Roundup application, plots were split into three 1.67 ft by 5 ft sub-plots, verticut, and seeded with the following grasses:

Turfgrass Species	Rate (lb/1000 ft^2)
1. 'Glade' Kentucky bluegrass	1.5
2. 'Penncross' creeping bentgrass	1.0
3. 'Twilight' tall fescue	6.0

Prograss 50SC was applied three times. The first application was made at seeding, followed by a second application six weeks after emergence of tall fescue, bentgrass or bluegrass, and a final application was made twelve weeks after emergence. Prograss treatments and rates were as follows:

Table 20. List of treatments for 1991 Prograss study.

Treatment 1	Control
Treatment 2	0.5 (lb a.i./A) (3 sequential applications)
Treatment 3	0.38 (lb a.i./A) first application 0.50 (lb a.i./A) second application 0.75 (lb a.i./A) third application

Observations of percent cover were made at 28 days, 60 days, and 8 months after seeding (Table 21). Tall fescue stand was reduced by 20% and 10% by treatments 1 and 2, respectively. 'Penncross' creeping bentgrass was reduced by 39% for treatment 2, and 14% for treatment 3. Treatments 2 and 3, when applied to Kentucky bluegrass, yielded significant differences from the untreated control plots, but were not significantly different from each other.

Data from this study and an earlier study (1991 Iowa Turfgrass Research Report, p 37-38) show that seeding into a previously killed area produces much better results than seeding into bare soil.

Table 21. The percent cover of three cool-season turfgrasses treated with Prograss 50SC.

	% Cover		
	28 days	60 days	8 Months
Control			
Kentucky bluegrass	27	67	82
Creeping bentgrass	33	85	95
Tall fescue	38	90	92
Prograss (0.5 lb a.i./A)			
Kentucky bluegrass	17	43	57
Creeping bentgrass	8	43	47
Tall fescue	37	82	82
Prograss (0.38, 0.50, and 0.75 lb a.i./A)			
Kentucky bluegrass	12	40	50
Creeping bentgrass	13	63	82
Tall fescue	33	80	78

The Efficacy of Ignite (HOE-39866) as a Non-selective Herbicide

M. M. Mixdorf, D. L. Struyk, and N. E. Christians

The objective of this study was to evaluate the initial and residual efficacy of Ignite (Hoe-39866) from American Hoechst Corporation as a non-selective herbicide for the control of Kentucky bluegrass. The study was conducted on an established Kentucky bluegrass turf composed of 25% each of 'Adelphi', 'Glade', 'Parade', and 'Rugby'. The soil on the site is a Nicolett (fine-loamy, mixed mesic, Aquic Hapludoll) with a pH of 6.9 and 2.3% organic matter. Individual plots measured 5 ft by 5 ft and the study was arranged in a randomized complete-block design in three replications.

Treatments (Table 22) were applied on June 7, 1991, at a time when the grass was growing vigorously because of wet conditions during the month before treatment. All treatments were applied in the equivalent of 2 gal water/1000 ft^2 at 25 psi with a backpack carbon-dioxide sprayer equipped with 8006 nozzles.

After the June 7 application, 12 weekly ratings were made on a percent damage scale where 0 = no damage and 100% = complete kill. The study was concluded on August 30, 1991.

The best control obtained with Ignite was 90% at the 1.9 lb a.i./A rate, 3 weeks after treatment (Table 22). After the third week, grass in plots treated with Ignite, a contact herbicide, began to recover from the rhizomes. Glyphosate (Roundup), which is a systemic herbicide, maintained nearly complete control during the entire 12 weeks of the study.

The addition of Garlon, a postemergence broadleaf control, to the Ignite did not improve the control of Kentucky bluegrass beyond that obtained with Ignite alone. Ignite may have some use as a quick, 'knock down' treatment for grasses, but extended control of rhizomatous grasses requires a systemic control.

Table 22. Non-selective control of Kentucky bluegrass with Ignite and Glyphosate (Roundup).

			Weeks after Treatment (% dead tissue)											
	Treatments	Rate lb a.i./A	1	2	3	4	5	6	7	8	9	10	11	12
1	Control	0	0	0	0	0	0	0	0	0	0	0	0	0
2	HOE-39866[a]	1.5	47	50	43	40	10	8	5	5	2	0	0	0
3	HOE-39866	2.0	62	68	63	40	37	32	37	28	18	8	7	5
4	HOE-39866	3.0	82	87	90	82	78	73	77	72	57	47	55	38
5	Glyphosate[b]	2.0	90	90	93	95	97	100	100	98	100	100	98	98
6	HOE-39866 + Garlon	1.5 + 2.0	47	45	27	40	5	8	3	2	3	2	2	0
	$LSD_{(0.05)}$		26	8	16	43	18	18	26	21	20	22	13	21

[a]Ignite
[b]Roundup

The Effects of Quinclorac on the Establishment of Three Grass Species

N. E. Christians and D. L. Struyk

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 labeled.

The objectives of this study were to observe the effects of quinclorac on the establishment of 'Argyle' Kentucky bluegrass, 'Dandy' perennial ryegrass, and '82492' Chewings fescue following both pre and postapplication.

The study was conducted on newly tilled soil in a split-plot arrangement with 8 quinclorac treatments as main plots. The treatments included a control and 7 quinclorac treatments applied at 0.75 lb a.i./A at different times before and after seeding; preplant incorporated (worked with garden rake before seeding), immediately after seeding, 2 weeks after emergence, 4 weeks after emergence, 8 weeks after emergence, 12 weeks after emergence; and a combined treatment made preplant incorporated + 8 weeks after treatment (this treatment received a total of 1.5 lb quinclorac/A). BAS 0900 2S was included at 1 qt/A with all treatments applied after emergence (treatments 4-8). The three grass species were included as sub-plots. The grasses were seeded on June 3, 1991. The bluegrass was seeded at a rate of 1.5 lb/1000 ft^2, the ryegrass at 5 lb/1000 ft^2, and the Chewings fescue at 3.5 lb/1000 ft^2. The soil on the site is a Nicolett (fine-loamy, mixed mesic, Aquic Hapludoll) soil with a pH of 7.2 and 2.3% organic matter. Soil test levels on the site were 20 lb P/acre and 190 lb K/acre.

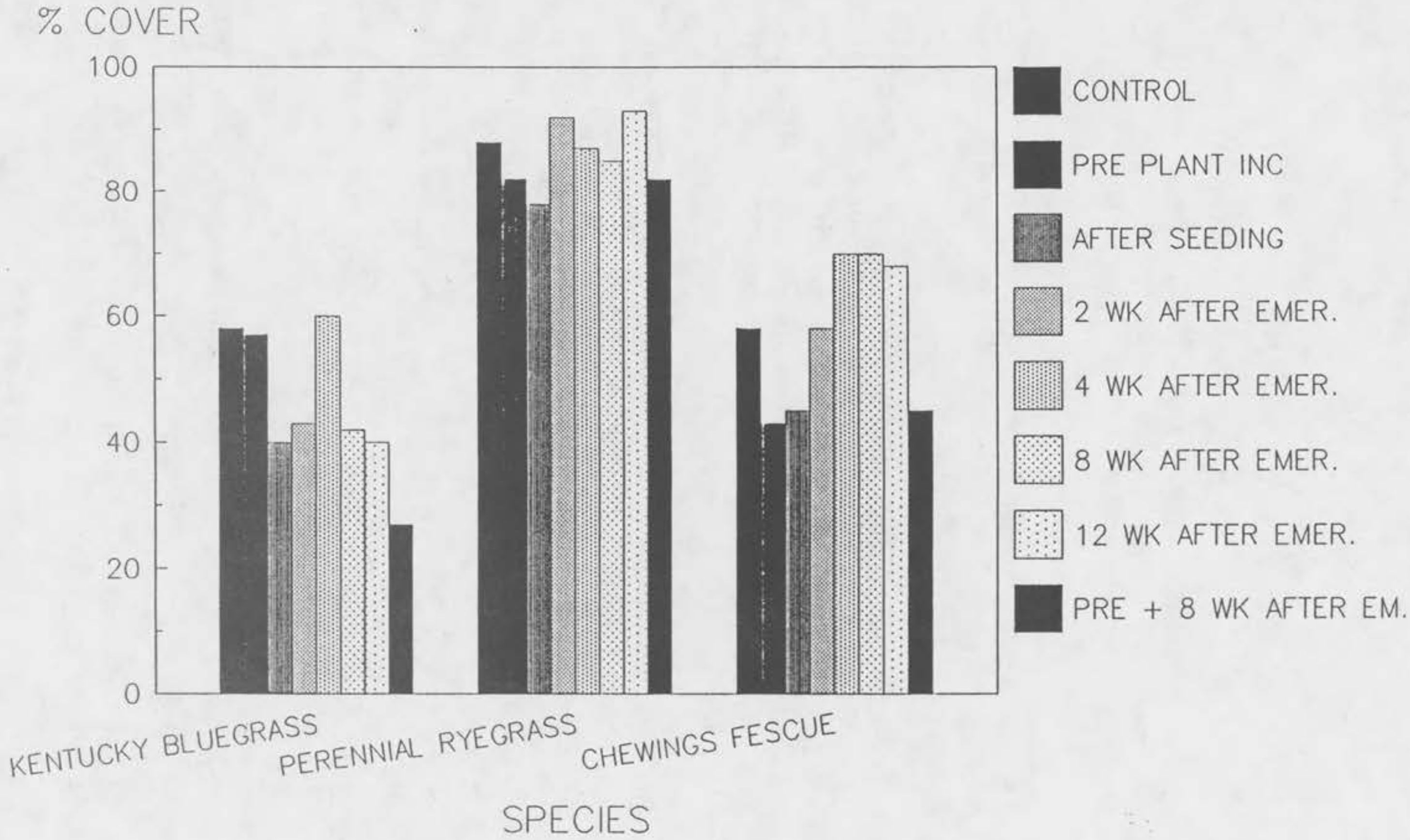
The three species germinated at different times. The last to emerge was Kentucky bluegrass on June 14. This data was taken as "date of emergence" and all following treatments were made on that basis at 2 week intervals. First data collection occurred 6 weeks after emergence. Data collection was conducted at 14-day intervals and continued for 12 weeks (Fig 4).

Preplant incorporation and the post-treatment made 4 weeks after emergence had no effect on Kentucky bluegrass. All other treatments reduced establishment. The establishment of Chewings fescue was reduced by preplant treatments (treatments 2 and 8) and by treatment immediately after establishment. Treatments beginning 2 weeks after emergence (approximately 4 weeks after seeding) were safe in this study.

The reason for the decrease in Kentucky bluegrass cover following the 8 and 12 weeks after emergence treatments is uncertain and may have been an anomaly for this study. It may also have been due to some unusual interaction with environmental conditions at the time of treatment. The effect of quinclorac on Kentucky bluegrass establishment should receive further study under a variety of environmental conditions over a wide geographical region.

Figure 4.

MEAN ESTABLISHMENT OVER THE 12 WEEK PERIOD FOR ALL THREE SPECIES



LSD (0.05) for comparison of all mean combinations = 9.7

Table 23. Mean establishment over the 12-week period for all three species.

	Control	Preplant inc	After seeding	2 wk after emer	4 wk after emer	8 wk after emer	12 wk after emer.	Pre + 8 wk after emer
Kentucky bluegrass	58	57	40	43	60	42	40	27
Perennial ryegrass	88	82	78	92	87	85	93	82
Chewings fescue	58	43	45	58	70	70	68	45

LSD for comparison of all mean combinations = 9.7 ($p = 0.05$).

Fairway Height Bentgrass Response to Postemergence Herbicides

N. E. Christians and D. L. Struyk

Creeping bentgrass is known to be quite sensitive to a number of pesticides. This sensitivity can vary with bentgrass variety, and testing of new pesticides on several bentgrasses is a very important part of the labeling process. The objectives of this trial were to study the response of 15 creeping bentgrass cultivars and one colonial bentgrass cultivar maintained at fairway height (0.5 in) to applications of 3 postemergence herbicides.

The three-year-old stand of creeping bentgrass is located at the Iowa State University Horticulture Research Station on Section 4 of the turfgrass research area. The soil is a Nicolett (fine-loamy, mixed mesic, Aquic Hapludoll) with a pH of 6.8, 2.3% organic matter, and 208 lb K/A. The area received 3 lb N/1000 ft^2 in 1991 in the form of urea. It was mowed at 0.5 in twice a week during the season. The bentgrass variety trial on which the study was conducted was replicated four times. The treatments were stripped across the replications. Treatment strips were randomized within replications.

The materials used in the study were HOE 360-18H EW (an experimental herbicide from American Hoechst) applied at 0.016 lb a.i./A, fenoxaprop (Acclaim) at 0.032 lb a.i./A, and Illoxan 3EC (another Hoechst experimental) at 1.50 lb a.i./A. Treatments were applied on the afternoon of June 19, 1991, in the equivalent of 2 gal water/1000 ft^2. The area was not watered for 24 hr following treatment. The area was then watered as needed to prevent moisture stress.

The first signs of phytotoxicity were observed on June 26, 7 days after treatment (DAT) (Table 24). The area was completely recovered by July 10, 21 DAT. Illoxan caused the greatest reduction in quality, followed by fenoxaprop and HOE 360-18H. SR 1020 showed the least damage from the treatments. 'Cobra', 'Pennlinks', and 'Prominent' showed the greatest damage.

This was the second year that we studied fairway height bentgrass response to postemergence herbicides. Results of the 1990 trial were similar (see page 40 and 41 of the 1990 turfgrass report). There are varietal differences in response to these materials that should be considered before use.

Table 24. Quality rating of 16 fairway height bentgrass cultivars treated with postemergence herbicides.

		June 26				July 3				July 10			
	Bentgrass Cultivar	0*	1	2	3	0	1	2	3	0	1	2	3
1	Cobra	9	7	7	4	9	6	7	6	9	9	9	9
2	J. H. Bent	9	7	7	5	9	7	6	7	9	9	9	9
3	ISI 123	9	7	6	5	9	7	6	7	9	9	9	9
4	ISI 124	9	7	7	5	9	7	6	7	9	9	9	9
5	Emerald	9	7	7	5	9	6	6	7	9	9	9	9
6	Southshore	9	7	7	5	9	8	7	8	9	9	9	9
7	Penncross	9	7	8	5	9	6	7	8	9	9	9	9
8	Penneagle	9	7	7	5	9	7	7	8	9	9	9	9
9	Pennlinks	9	7	6	4	9	8	7	7	9	9	9	9
10	Prominent	9	6	6	4	9	6	6	6	9	9	9	9
11	SR 1020	9	8	8	6	9	7	6	8	9	9	9	9
12	Providence (SR1019)	9	8	7	5	9	7	7	8	9	9	9	9
13	Putter	9	7	7	5	9	7	7	7	9	9	9	9
14	Carmen	9	7	7	5	9	7	6	7	9	9	9	9
15	National	9	7	7	5	9	7	7	7	9	9	9	9
16	Exeter (Colonial Bent)	9	7	6	5	9	7	7	7	9	9	9	9
	$LSD_{0.05}$	1.0(1)				1.0				NS			

*0 = control, 1 = HOE 360-18H EW at 0.016 lb a.i./A, 2 = Fenoxaprop (Acclaim) 1EC at 0.032 lb a.i./A, and 3 = Illoxan 3EC at 1.50 lb a.i./A. Treatments were applied on June 19, 1991.

(1)Interaction LSD's for comparison of varieties and chemical treatments.

The Response of Kentucky Bluegrass Turf to Mefluidide Applied in Combination with Fungicides and Other Compounds

R. W. Moore and N. E. Christians

Mefluidide (Embark) is a growth regulating compound that is labeled for use on Kentucky bluegrass turf. Under some conditions its use can result in turf discoloration. In this study, two fungicides [propiconazole (Banner) and triadimefon (Bayleton)], Ferromec AC (an iron source), and BA (benzyl-adenine, a synthetic cytokinin plant hormone) were applied in combination with mefluidide.

The objectives of the study were to determine if the additives could reduce turf discoloration and observe any effects that the chemicals may have had on the turf growth response to mefluidide. The study was conducted on a 5-year-old mixed stand (25% each) of 'Parade', 'Glade', 'Rugby', and 'Adelphi' Kentucky bluegrass, established on a Nicolett (fine-loamy, mixed mesic, Aquic Hapludoll) soil with a pH of 6.9 and 2.3% organic matter. The turf was mowed at 2 1/2 in and received 1 lb of nitrogen per 1000 ft^2 in mid-April. Treatments were applied on May 10 to 5 ft x 5 ft plots and replicated three times.

Results suggest that Ferromec AC was the most effective additive at inhibiting discoloration (Table 25). The plots treated with mefluidide alone developed leafspot symptoms in May. All additives except BA were somewhat effective in reducing leafspot symptoms. None of the additives affected the growth inhibition provided by mefluidide.

Seedhead suppression was excellent on all plots treated with mefluidide and mefluidide + additives. None of the additives significantly reduced seedhead suppression.

Table 25. Turf response to mefluidide and additives.

	Treatment	Rate(oz/ 1000 ft^2)	Quality[a]				Leaf-spot[b]	Leaf Height (cm)		% Seedhead Suppression[c]
			5/23	5/31	6/6	6/21	5/31	5/31	6/6	5/23
1	Mefluidide	0.4	6.0	4.0	5.7	7.0	4.0	6.3	14.0	85%
2	Mefluidide + Ferromec AC	0.4 + 0.6	7.7	5.7	7.0	9.0	6.3	9.0	13.7	92%
3	Mefluidide + Propicanazole	0.4 + 0.046	6.3	4.7	6.3	8.0	5.0	7.0	11.7	87%
4	Mefluidide + Propicanazole	0.4 + 0.092	6.7	5.7	6.0	7.7	6.3	6.3	10.0	93%
5	Mefluidide + Triadimefon	0.4 + 0.184	6.0	5.0	6.0	7.0	5.7	7.0	13.3	80%
6	Mefluidide + Triadimefon	0.4 + 0.26	6.7	4.7	6.0	7.3	5.7	6.3	11.7	90%
7	Mefluidide + BA	0.4 + 0.6 g	5.7	4.0	5.3	8.0	3.7	6.7	12.0	78%
8	Mefluidide + BA	0.4 + 1.2 g	6.3	5.0	6.0	7.7	5.3	6.3	9.7	93%
9	Untreated Control	----	9.0	9.0	9.0	9.0	9.0	22.7	34.0	0%
	$LSD_{(0.05)}$		1.3	1.7	0.6	1.4	1.6	2.1	6.0	28.6

[a]Quality based on a scale of 9 to 1: 9 = best, 6 = acceptable, and 1 = worst.
[b]Leafspot disease ratings are based on a 9 to 1 scale: 9 = no disease, 1 = severe disease.
[c]Seedhead suppression is listed as percent inhibition of seedhead formation.

Evaluation of Fungicides for Control of Dollar Spot

in 'Emerald' Bentgrass - 1991

M. L. Gleason

Trials were conducted on the turfgrass research plots at the Horticulture Research Station of Iowa State University near Ames, Iowa. Fungicides were applied to Emerald bentgrass maintained at a 5/32-in 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.

The entire plot was inoculated with rye grain infested with the dollar spot pathogen on May 30. Fungicide applications began on June 5 and continued at recommended intervals (14, 21, or 28 days) until July 29. The number of dollar spot infection centers per plot was counted on June 19, July 4 and 17, and August 1.

Weather was relatively wet until mid-June, then unusually dry through the end of the test period. Dollar spot symptoms appeared on June 16. Disease pressure was moderate on June 19 and August 1, and severe on July 4 and July 17.

Almost all treatments suppressed dollar spot significantly (DMRT, $p>0.05$) better than the check (unsprayed) treatment on all rating dates (Table 26).

The combination of ProStar 70WG and Cyproconazole 40WG produced an enhanced green color on plots on August 1.

Table 26. Evaluation of fungicides for control of dollar spot on 'Emerald' bentgrass, 1991.

Treatment	Rate per 1000 ft^2	Timing (days)	Number of infection centers per plot[a]			
			June 19	July 4	July 17	August 1
Check	---	---	84.75 a	124.25 a	157.50 a	103.50 a
Rubigan 1AS	1.5 oz	14	0.00 c	0.50 e	1.00 d	0.00 c
Broadway 4.42AS	3.0 oz	14	5.25 c	0.00 e	1.25 d	0.00 c
Broadway 4.42AS	4.5 oz	14	0.25 c	0.00 e	0.00 d	0.00 c
Silbos DF + X-77	2.5 oz 0.25%	14	0.00 c	0.00 e	19.25 d	12.50 c
Silbos DF + X-77	2.5 oz 0.25%	28	0.00 c	24.75 cd	50.25 c	51.00 b
Silbos DF + X-77	5.0 oz 0.25%	14	0.00 c	0.00 c	6.50 d	0.00 c
Silbos DF + X-77	5.0 oz 0.25%	28	0.00 c	11.25 de	11.25 d	19.25 c
Silbos DF + X-77	7.5 oz 0.25%	14	0.00 c	0.00 e	5.00 d	0.00 c
Silbos DF + X-77	7.5 oz 0.25	28	0.00 c	3.75 e	4.50 d	6.75 c
Chipco 26019FLO	3 oz	14	0.00 c	0.00 e	0.00 d	0.00 c
Vinclozolin DF	2.0 oz	14	0.00 c	0.00 e	0.00 d	0.00 c
Vinclozolin FL	2.0 oz	14	0.00 c	0.00 e	0.00 d	0.00 c
Fungo/Vorlan WSB Premix	2.0 oz	14	0.00 c	0.00 e	0.25 d	0.00 c
Fungo/Vorlan WSB Premix	4.0 oz	14	0.00 c	0.00 e	0.00 d	0.00 c

Treatment	Rate per 1000 ft^2	Timing (days)	Number of infection centers per plot[a]			
			June 19	July 4	July 17	August 1
Fungo 85DF	0.6 oz	14	0.00 c	0.00 e	0.00 d	0.00 c
Fungo 85DF	1.2 oz	14	0.00 c	0.00 e	0.00 d	0.00 c
Vorlan FLO	1.0 oz	14	0.00 c	0.00 e	1.50 d	0.00 c
Vorlan FLO	2.0 oz	14	0.00 c	0.00 e	0.50 d	1.25 c
Duosan WSB	4.0 oz	14	0.00 c	0.00 e	0.00 d	0.00 c
Duosan WSP	6.0 oz	14	0.00 c	0.00 e	0.00 d	0.00 c
SN84364 70WG (NA 249)	1.79 oz	14	0.00 c	0.00 e	0.00 d	0.00 c
SN84364 70WG (NA 249)	1.79 oz	21	0.00 c	0.00 e	0.00 d	0.50 c
SN84364 70WP (NA 249)	1.79 oz	28	0.00 c	0.00 e	0.25 d	0.00 c
ProStar 70WG (NA 248) + Cyproconazole 40WG	1.43 oz 0.17 oz	21	0.00 c	0.00 e	0.00 d	0.00 c
Banner 1.1EC	0.5 oz	21	0.00 c	0.00 e	14.25 d	0.25 c
Banner 1.1EC + Urea (45% N)	0.5 oz 0.56 lb	21	0.00 c	0.00 e	12.25 d	4.50 c
Banner 1.1EC	1.0 oz	21	0.00 c	0.00 e	2.00 d	0.00 c
Banner 1.1EC + Urea (45% N)	1.0 oz 0.56 lb	21	0.00 c	0.00 e	0.25 d	0.75 c
Banner 1.1EC + Co. Ro. N (28% N)	1.0 oz 0.89 lb	21	0.00 c	0.00 e	1.00 d	0.00 c
Urea (45% N)	0.56 lb	21	2.00 c	46.50 b	108.50 b	77.25 b

Treatment	Rate per 1000 ft^2	Timing (days)	Number of infection centers per plot[a]			
			June 19	July 4	July 17	August 1
Co. Ro. N (28% N)	0.89 lb	21	25.25 a	38.25 bc	107.25 b	57.25 b
Sentinel 40WG	0.17 oz	28	0.00 c	0.00 e	0.00 d	0.00 c
Sentinel 40WP	0.25 oz	28	0.00 c	3.25 e	0.00 d	0.00 c
RH-3866 40WP	0.6 oz	21	0.00 c	0.00 e	0.00 d	0.00 c
TwoSome	3.0 oz	21	0.00 c	0.00 e	21.50 d	3.00 c
Touche	2.0 oz	28	0.00 c	11.00 de	3.75 d	16.50 c
Lynx 25DF + X-77	0.18 oz a.i.	21	0.00 c	0.00 e	0.50 d	0.00 c
Dyrene 4F	4.0 oz	14	0.00 c	0.00 e	0.00 d	0.50 c
Bayleton 25DF	0.25 oz a.i.	28	7.75 c	14.50 de	0.00 d	0.00 c

[a]n = 4. Means followed by the same letter are not significantly different (DMRT, $p>.05$).

Evaluation of Fungicides for Control of Brown Patch in Creeping Bentgrass - 1991

M. L. Gleason

Trials were conducted at Veenker Golf Course on the campus of Iowa State University, Ames, Iowa. Fungicides were applied to creeping bentgrass maintained at a 5/32-in 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 June 7 and continued at recommended intervals (7, 14, 21, or 28 days) until August 1. Disease development (using a qualitative rating system based on percent of a plot with brown patch symptoms) was rated on June 7, 15, and 27, and July 12 and 26.

Weather was extraordinarily wet and warm in late May, breaking all records for the period. This weather precipitated an extremely early (approximately June 3), severe outbreak of brown patch on the research plots. This outbreak occurred at least 4 weeks earlier than previous brown patch epidemics in central Iowa. The result was that the fungicide treatments were applied curatively rather than preventively. Brown patch pressure continued to be severe until mid-June, then abated as the weather became extremely dry from mid-June until the end of July.

Several treatments eradicated brown patch symptoms significantly (DMRT, $p<0.05$) better than the check (unsprayed) treatment within 20 days after initial treatment (Table 27). The most rapid eradication (within 7 days after initial treatment) was caused by Fungo/Vorlan WSB Premix at 2 or 4 oz rates.

No phytotoxicity symptoms were observed on any rating date.

Table 27. Evaluation of fungicides for control of brown patch in bentgrass, 1991.

Treatment	Rate per 1000 ft^2	Timing (days)	Disease Rating[a]				
			June 7	June 15	June 27	July 12	July 26
Check	---	---	3.67 a	3.00 a	2.00 a	0.67 ab	1.00 a
Vinclozolin DF	2 oz	14	3.33 ab	1.00 abc	0.67 abc	0.67 ab	0.33 a
Vinclozolin FL	2 oz	14	2.00 ab	0.67 abc	0.33 bc	1.33 a	1.00 a
Silbos DF + X-77	2.5 oz 0.25%	14	2.33 ab	1.00 abc	0.67 abc	1.00 ab	1.00 a
Silbos DF + X-77	2.5 oz 0.25%	28	2.00 ab	1.33 abc	0.67 abc	0.00 b	0.00 a
Silbos DF + X-77	5.0 oz 0.25%	14	3.33 ab	1.00 abc	1.00 abc	0.33 ab	0.00 a
Silbos DF + X-77	5.0 oz 0.25%	28	2.00 ab	0.67 abc	0.33 bc	0.67 ab	0.00 a
Silbos DF + X-77	7.5 oz 0.25%	14	2.00 ab	1.00 abc	0.67 abc	0.00 b	0.00 a
Silbos DF + X-77	7.5 oz 0.25%	28	2.33 ab	0.67 abc	0.00 c	0.00 b	0.00 a
Chipco 26019FLO	3 oz	14	3.33 ab	1.33 abc	1.00 abc	0.00 b	0.33 a
Broadway 4.42AS	3 oz	7	2.67 ab	0.33 bc	0.67 abc	0.33 ab	0.00 a
Broadway 4.42AS	4.5 oz	7	3.00 ab	1.33 abc	1.00 abc	0.00 b	0.00 a
Broadway 4.42AS	6 oz	7	3.50 a	2.00 abc	0.50 abc	0.00 b	0.00 a
Fungo/Vorlan WSB Premix	2 oz	14	2.33 ab	0.00 c	0.33 bc	0.00 b	0.33 a

Treatment	Rate per 1000 ft^2	Timing (days)	Disease Rating[a]				
			June 7	June 15	June 27	July 12	July 26
Fungo/Vorlan WSB Premix	4 oz	14	1.00 b	0.00 c	0.00 c	0.67 ab	0.00 a
Fungo 85DF	0.6 oz	14	3.33 ab	0.67 abc	0.67 abc	0.00 b	0.00 a
Fungo 85DF	1.2 oz	14	1.67 ab	1.00 abc	0.33 bc	0.33 ab	0.33 a
DuoSan WSB	4 oz	14	2.33 ab	1.00 abc	0.67 abc	0.00 b	0.00 a
DuoSan WSB	6 oz	14	2.33 ab	1.00 abc	0.67 abc	0.33 ab	0.00 a
ProStar 50WP (NA 211)	2 oz	21	3.33 ab	1.67 abc	1.00 abc	0.33 ab	0.00 a
ProStar 70WG (NA 211)	1.43 oz	21	2.33 ab	1.67 abc	1.33 abc	0.33 ab	0.67 a
SN84364 70WG (NA 249)	1.79 oz	14	2.33 ab	1.33 abc	1.00 abc	0.00 b	0.00 a
SN84364 70WG (NA 249)	1.79 oz	21	3.67 a	2.67 ab	1.33 abc	0.00 b	0.00 a
SN84364 70WG	1.79 oz	28	2.67 ab	0.67 abc	0.33 bc	0.00 b	0.00 a
ProStar 70WG (NA 248) + Cyproconozole 40WG	1.43 oz	21	2.00 ab	1.33 abc	1.33 abc	0.00 b	0.00 a
ASC-666518	1.9 oz	7[b]	3.33 ab	1.67 abc	1.67 ab	0.33 ac	0.67 a
ASC-66518	3.8 oz	14	2.67 ab	0.67 abc	0.33 bc	0.00 b	0.00 a
ASC-66791	2.8 oz	14	1.67 ab	0.33 bc	0.00 c	0.00 b	0.00 a

			Disease Rating[a]				
Treatment	Rate per 1000 ft^2	Timing (days)	June 7	June 15	June 27	July 12	July 26
ASC-66791	5.6 oz	14	3.00 ab	1.00 abc	0.33 bc	0.00 b	0.00 a
ASC-66608	3.75 oz	14	3.00 ab	1.00 abc	0.33 bc	0.00 b	0.00 a
ASC-66608	7.5 oz	14	3.33 ab	0.33 bc	0.00 c	0.00 b	0.00 a
ASC-66825	0.6 oz	14	2.67 ab	1.33 abc	0.00 c	0.00 b	1.00 a
ASC-66825	1.2 oz	14	1.67 ab	1.00 abc	0.33 bc	0.00 b	0.33 a
Daconil 2787 90WDG	3 oz	7[b]	2.67 ab	2.00 abc	0.33 bc	0.00 b	0.00 a
Daconil 2787 90WDG	6 oz	14	3.00 ab	1.50 abc	0.00 c	0.00 b	0.00 a
Sentinel 40WG	0.25 oz	21	2.00 ab	1.50 abc	2.00 a	0.00 b	0.00 a
Sentinel 40WG	0.16 oz	21	2.33 ab	1.33 abc	0.00 c	0.00 b	0.00 a
Sentinel 40WG + Flutolanil 50WP	0.16 oz 2 oz	21	3.33 ab	1.33 abc	0.67 abc	0.00 b	0.00 a
Banner + Daconil 2787F	1 oz 4 oz	21	2.33 ab	1.67 abc	0.33 bc	0.00 b	0.00 a
RH-3866 40WP	0.6 oz	14	3.33 ab	0.33 bc	0.67 abc	0.67 ab	0.00 a
RH-0611 62.25WP	6 oz	14	2.00 ab	1.00 abc	0.00 c	0.00 b	0.00 a
Lynx 25WP + X-77	0.18 oz a.i.	21	2.00 ab	0.67 abc	0.00 c	0.33 ab	0.00 a

[a]0 = no disease; 1 = 1-10% of plot showing symptoms; 2 = 10-25% of plots; 3 = 25-50% of plot; 4 = >50% of plot. n = 3, except n = 2 for Broadway 4.42AS at 6-oz rate, Daconil 2787 90WDG at 3-oz rate, and Sentinel 40WG at 0.25-oz rate due to carryover effects of 1990 fungicide applications. Means followed by the same letter do not differ significantly (DMRT, $p>0.05$).

[b]Changed from 14-day to 7-day schedule on June 27, 1991.

Evaluation of Fungicides for Control of Snow Molds on Creeping Bentgrass, 1990-1991

M. L. Gleason

The trial was conducted on a creeping bentgrass green (Hole #4) at the Waverly Municipal Golf Course, Waverly, Iowa. This green 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 13, 1990, using a modified bicycle sprayer at 30 psi and a dilution rate of 5 gal/1000 ft^2.

Immediately after application of fungicides, the entire plot was covered with two layers of Curlex High-Velocity excelsior mats (American Excelsior Co., St. Paul, MN). The mats were fixed in place with wire stakes. The purpose of the mats was to simulate snow cover and provide favorable conditions for the development of snow mold even in the absence of snow cover (W. Stienstra, Department of Plant Pathology, University of Minnesota, personal communication).

Snow cover persisted on the green from December 5, 1990, until March 1, 1991. Mats were removed on March 6. On that date, symptoms of gray and pink snow mold were abundant at many sites on the golf course.

Snow mold development on untreated check plots was moderate (Table 28). Symptoms of both gray and pink snow mold were evident in these plots. All fungicide treatments gave significantly better control of snow mold than the untreated check; 9 of 11 fungicide treatments were free of snow mold damage. None of the fungicide treatments was significantly different from the others in disease suppression. Treatments that had incorporated green paint were perceptibly greener in color than other treatments. No phytotoxicity symptoms were observed.

Because snow mold occurred naturally at Waverly Municipal Golf Course in 1990-91, no conclusion could be drawn about the effect of excelsior mats on disease development. However, in winters with less than three months of snow cover (a common occurrence in Iowa), the mats may provide temperature and moisture conditions favorable for snow mold development.

Table 28. Evaluation of fungicides for control of snow mold in creeping bentgrass at Waverly Municipal Golf Course, Waverly, Iowa, 1990-91.

Company	Treatment	Rate per 1000 ft^2	Percentage of Plot with Symptoms[a]
-----	Check	-----	17.5 a
ISK Biotech	Daconil 2787	16 oz	0 b
ISK Biotech	Daconil 2787 + green latex paint (67019)	16 oz 1 gal/40 gal H_2O	0 b
ISK Biotech	ASC 66791	8 oz	0 b
ISK Biotech	ASC 66791 + green latex paint (67019)	8 oz 1 gal/40 gal H_2O	0 b
DowElanco	Rubigan 1AS	8 oz	0.5 b
Nor-AM	NA249 70WDG (coformulation)	1.25 oz a.i.	0 b
Terra	Banner 1.1EC	4 oz	0 b
Terra	Banner 1.1EC + Plex	4 oz 0.25%	0 b
Terra	Rubigan 1AS + Plex	8 oz 0.25%	0.5 b
Grace-Sierra	Calo-Gran	8 lb	0 b
O. M. Scott	S-2521	2.6 Kg	0 b

[a]Means of 4 replications. Means followed by the same letter are not significantly different (DMRT, P=0.05).

Evaluation of Rubigan-Cutless Combinations for Control of Dollar Spot in Creeping Bentgrass - 1991

M. L. Gleason

Trials were conducted at Veenker Golf Course on the Iowa State University campus, Ames, Iowa. Fungicides were applied to creeping bentgrass maintained at a 5/32-in 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. Treated plots were alternated with untreated plots, so that treated plots did not adjoin each other. All plots measured 4 ft x 5 ft.

The entire plot was inoculated with rye grain infested with the dollar spot pathogen on May 30. Fungicide applications began on June 6 and were repeated on July 3 and July 29. The number of dollar spot infection centers per plot was counted on June 5, June 21, July 2, and July 17.

Weather was relatively wet until mid-June, then unusually dry through the end of the test period. Dollar spot symptoms were present at low levels on June 6; disease pressure was moderate on June 21 and severe on July 2 and July 17.

Rubigan suppressed dollar spot significantly (DMRT, $p>0.05$) better than the check (unsprayed) treatment at all concentrations on June 21 and July 17 (Table 29). All treatments were relatively ineffective on July 2, which was approximately 4 weeks after fungicides were applied. A visual examination of the data suggests that increasing the rate of Cutless in the Rubigan-Cutless combination did not enhance disease suppression. Further analysis of the Rubigan-Cutless interaction indicated that the interaction was not statistically significant (data not shown).

Table 29. Evaluation of Rubigan-Cutless combinations for control of dollar spot in creeping bentgrass, 1991.

Treatment	Rate per 1000 ft^2	Timing (days)	Number of infection centers per plot[a]			
			June 5	June 21	July 2	July 17
Check	---	---	7.00 a	91.50 a	145.00 a	173.75 a
Rubigan 1AS	0.5 oz	28	2.50 a	38.75 bcd	96.25 ab	100.75 bc
Rubigan 1AS	1.0 oz	28	5.50 a	5.75 de	72.50 b	48.25 cde
Rubigan 1AS	1.5 oz	28	7.25 a	1.50 e	51.00 b	20.75 de
Cutless 50WP	0.125 lb a.i./A	28	3.50 a	47.50 bc	94.75 ab	107.50 bc
Cutless 50WP	0.188 lb a.i./A	28	3.50 a	67.75 ab	112.75 ab	146.75 ab
Cutless 50WP	0.25 lb a.i./A	28	2.25 a	44.00 bc	91.50 ab	93.50 bc
Rubigan 1AS + Cutless 50WP	0.5 oz 0.125 lb a.i./A	28	6.75 a	25.75 cde	92.00 ab	82.75 cd
Rubigan 1AS + Cutless 50WP	1.0 oz 0.125 lb a.i./A	28	4.50 a	7.25 de	93.25 ab	55.75 cde
Rugigan 1AS + Cutless 50WP	1.5 oz 0.125 lb a.i./A	28	3.00 a	0.00 e	58.25 b	7.50 c
Rubigan 1AS + Cutless 50WP	0.5 oz 0.188 lb a.i./A	28	4.50 a	8.25 de	66.25 b	55.25 cde
Rubigan 1AS + Cutless 50WP	1.0 oz 0.188 lb a.i./A	28	5.75 a	7.50 de	103.75 ab	60.75 cde
Rubigan 1AS + Cutless 50WP	1.5 oz 0.188 lb a.i./A	28	4.25 a	1.50 e	75.75 b	12.75 e
Rubigan 1AS + Cutless 50WP	0.5 oz 0.25 lb a.i./A	28	5.25 a	13.25 cde	81.50 b	69.25 cde
Rubigan 1AS + Cutless 50WP	1.0 oz 0.25 lb a.i./A	28	3.50 a	7.75 de	87.50 ab	52.50 cde
Rubigan 1AS + Cutless 50WP	1.5 oz 0.25 lb a.i./A	28	2.50 a	1.50 c	72.50 b	11.25 e

[a]n = 4. Means followed by the same letter do not differ significantly (DMRT, p>0.05).

Natural Organic Trial

M. L. Agnew and S. M. Berkenbosch

A natural organic nitrogen (N) trial was established in 1989 on a four-year-old 'Park' Kentucky bluegrass (*Poa pratensis*) stand. The grass was mowed weekly with clippings removed, dried, and weights recorded. Irrigation was applied at a rate of 1 in of water/week. In 1991, rainfall was excessive from May through June.

The purpose of this study was to compare nine natural organic fertilizers to urea. Treatments included BioTurf 10-4-4, Sustane medium grade 5-2-4, Sustane fine grade 5-2-4, ISU experimental (10% N), Milorganite 6-2-0, Natures Preference 5-3-5, Ringer 10-2-6, Ringer 6-1-3, Howe 5-2-5 (added in 1990), Urea 46-0-0, and a control. All fertilizers were applied at 1 lb N/1000 ft^2 on May 15, June 15, August 15, and September 15, 1989. This study was replicated three times in a randomized complete-block design. Individual plot dimensions are 5 ft by 10 ft.

Data collected during the summer of 1991 included visual quality and clipping yields. All plots were rated weekly on a visual scale of 9 to 1. A rating of 9 is equal to a dark-green, dense turf, whereas a rating of 1 is equal to a straw-brown turfgrass stand. A rating of 6.0 was used as the minimum acceptable level of quality. Clipping yields were collected on a weekly basis or when enough grass was present to collect. Clippings were collected by removing all the leaf tissue above 2 in within a 21 in by 10 ft area (17.5 ft^2) down the center of each plot. Clippings were placed in paper sacks and dried. Weights were recorded as grams per 17.5 ft^2.

Visual quality ratings are presented in Tables 30 and 31. Urea had the overall highest quality while the control and Natures Preference had the lowest quality rating. Sustane fine had the best overall quality rating of the natural organic fertilizers. Following the May application, only plots treated with Natures Preference consistently had quality ratings at less than an acceptable level.

Clipping yield data is presented in Tables 32 and 33. Plots fertilized with urea produced the most clippings. Unfertilized control and plots fertilized with Natures Preference produced the least amount of clippings. For other fertilizers, Ringer products, Sustane fine, and ISU Experimental produced high quantities of clippings; Milorganite and BioTurf produced moderate amounts of clippings; and Sustane medium and Howe 5-2-5 produced the least amount of clippings.

Table 30. The influence of natural organic fertilizer sources on visual quality from April 16 to June 24, 1991.

	April		May				June			
Fertilizer Source	16	26	2	13	21	28	3	10	17	24
Control	2.0	3.3	3.7	5.3	4.7	5.0	5.0	5.3	5.0	5.0
Milorganite	4.0	5.3	6.3	7.0	6.0	6.3	6.7	6.7	6.3	6.0
Restore 10-2-6	4.3	5.7	7.0	7.0	7.0	7.3	7.3	6.7	6.3	7.0
Restore 6-1-3	4.0	5.3	6.3	6.7	6.3	6.7	7.0	6.3	6.0	6.0
Sustane (Fine)	4.0	5.3	6.3	6.7	7.7	7.0	7.7	6.7	7.0	7.7
Sustane (Medium)	3.7	4.3	5.7	6.0	6.3	6.3	6.7	6.0	5.7	7.0
Natures Preference	2.0	3.3	4.0	5.3	5.3	5.3	6.3	6.0	5.3	6.0
ISU Experimental	5.0	6.3	7.3	7.3	6.7	7.0	7.7	7.0	6.7	6.7
Howe	3.0	4.7	5.3	6.3	6.7	6.3	6.7	6.7	6.0	6.7
BioTurf	6.0	7.0	8.0	8.0	7.7	7.7	8.0	7.0	7.0	7.3
Urea	6.0	6.3	7.0	7.0	8.0	8.0	8.0	7.0	7.0	8.0
$LSD_{(0.05)}$	1.5	1.3	1.2	1.0	0.8	0.8	0.8	0.7	0.6	0.6

Table 31. The influence of natural organic fertilizer sources on visual quality from July 1 to October 8, 1991.

	July					August				September				October
Fertilizer Source	1	8	17	22	31	7	13	21	27	5	12	17	25	8
Control	5.0	5.0	4.7	4.0	4.7	5.0	5.3	5.3	5.0	4.7	5.0	5.0	5.0	5.0
Milorganite	7.3	7.3	7.3	6.0	6.3	6.7	6.7	7.3	6.7	7.0	7.7	6.7	7.0	7.3
Restore 10-2-6	8.7	8.7	7.7	6.7	6.3	7.0	6.7	8.0	7.7	7.7	8.7	7.0	7.0	6.7
Restore 6-1-3	7.0	7.0	6.7	6.3	6.3	6.3	7.0	7.3	7.0	7.0	7.7	6.7	6.7	7.3
Sustane (Fine)	8.0	7.7	7.7	6.7	7.0	6.7	8.0	8.3	8.0	7.0	8.0	7.0	7.7	8.7
Sustane (Medium)	7.3	7.3	7.0	6.3	6.3	6.3	6.7	7.0	6.3	7.0	6.7	6.3	6.7	7.0
Natures Preference	6.0	6.0	6.0	4.0	5.0	5.3	6.0	6.0	6.0	5.7	6.7	6.0	6.0	6.0
ISU Experimental	8.0	8.0	7.7	6.7	6.3	6.0	6.7	7.0	6.7	6.7	8.3	7.3	7.0	6.0
Howe	7.0	7.0	7.0	6.3	6.3	6.3	6.7	7.0	7.0	7.0	7.3	7.0	7.0	7.7
BioTurf	8.3	8.3	8.0	7.0	7.0	7.0	8.0	8.0	7.3	8.0	9.0	7.7	7.3	7.3
Urea	8.7	8.7	8.0	7.7	7.3	7.0	8.7	9.0	8.7	9.0	9.0	8.0	8.0	8.7
$LSD_{(0.05)}$	0.8	0.7	1.0	0.8	0.9	0.6	1.0	0.8	0.9	0.6	0.8	0.7	0.6	1.0

Table 32. The influence of natural organic fertilizer sources on clipping yields from May 3 to June 24, 1991.

	May				June			
Fertilizer Source	3	13	21	28	3	10	17	24
Control	6.9	3.1	23.6	8.9	31.7	3.0	4.6	3.9
Milorganite	28.1	18.6	51.0	25.1	65.3	8.7	10.3	11.2
Restore 10-2-6	32.7	22.5	60.4	33.8	76.1	8.7	9.9	13.8
Restore 6-1-3	39.6	22.2	56.3	28.7	75.7	10.5	9.8	10.2
Sustane (Fine)	41.2	21.1	58.7	33.4	77.2	9.6	10.1	14.5
Sustane (Medium)	20.9	16.0	56.5	25.9	70.4	8.1	9.8	12.5
Natures Preference	7.5	7.4	35.0	15.5	45.8	5.7	6.3	7.7
ISU Experimental	41.0	26.2	55.4	29.5	76.8	22.8	12.6	13.6
Howe	15.1	14.6	56.3	24.5	65.9	6.9	8.1	11.7
BioTurf	55.0	35.4	69.4	43.1	95.0	12.2	13.8	17.7
Urea	47.9	26.4	102.1	57.5	91.7	12.0	13.4	25.4
$LSD_{(0.05)}$	16.6	12.3	19.0	5.5	11.6	9.6	3.0	6.1

Table 33. The influence of natural organic fertilizer sources on clipping yields from July 1 to October 9, 1991.

	July					August				September		October
Fertilizer Source	1	8	17	22	31	7	13	20	27	12	30	9
Control	2.8	1.5	4.0	2.8	4.0	3.0	2.4	4.0	2.3	3.9	4.7	4.1
Milorganite	9.8	10.4	19.8	10.1	12.7	11.9	8.0	16.9	5.6	24.1	18.3	17.0
Restore 10-2-6	17.5	16.0	29.1	10.9	15.2	12.8	9.9	22.0	7.2	36.3	19.5	16.6
Restore 6-1-3	12.1	13.2	23.5	11.0	16.8	14.0	9.4	19.0	7.7	32.0	19.7	19.9
Sustane (Fine)	17.3	13.9	25.0	9.1	15.4	10.9	12.8	24.9	7.1	27.3	20.2	23.7
Sustane (Medium)	13.6	10.2	20.6	9.2	13.8	12.2	8.3	17.0	6.4	19.4	14.4	16.1
Natures Preference	5.2	5.3	8.4	4.5	7.7	6.5	3.9	8.0	3.3	10.4	8.2	7.7
ISU Experimental	13.2	13.6	28.5	11.5	17.8	12.9	8.3	16.1	7.2	33.7	18.7	13.3
Howe	11.9	10.8	18.3	8.1	12.9	12.1	7.7	19.0	6.9	30.0	16.3	16.6
BioTurf	20.7	18.9	36.2	13.1	22.5	17.6	13.1	25.8	9.2	48.4	24.2	21.3
Urea	35.9	23.7	37.9	12.5	23.1	20.4	18.0	42.5	12.7	69.5	27.5	27.5
$LSD_{(0.05)}$	10.7	9.4	9.6	5.5	6.6	7.1	4.6	11.8	4.0	12.8	4.0	5.5

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

M. L. Agnew and S. M. Berkenbosch

The purpose of this study was to evaluate the performance of 13 granular fertilizer sources. The treatments included urea, ammonium sulfate, sulfur-coated urea (Andersons), sulfur-coated urea (LESCO), sulfur-coated urea (Scotts), IBDU (fine), UFC ammonium sulfate, Nutralene, Scotts 41-0-0, Milorganite, Restore 10-2-6, ISU Experimental (natural organic), and a control with no fertilizer applied. All treatments were applied at 1 lb N/1000 ft^2 on May 15, June 15, August 15, and September 15, 1991, to a 'Park' Kentucky bluegrass. The study was replicated three times in a randomized complete-block design. Individual plots sizes were 4 ft by 10 ft.

All plots were mowed at a 2-in height with all clippings removed. The plots were irrigated with a minimum of 1.5 in water/growing week when sufficient rains did not occur. In 1991, rainfall was excessive from May through June.

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

Visual quality data is included in Tables 34 and 35. Average quality was determined as the means of all quality rating data. None of the fertilizer sources exhibited an average quality less than 6. Sulfur-coated urea (Scotts) had the highest average quality rating. Sulfur-coated urea (Scotts), milorganite, and Restore 10-2-6 were the only treatments to provide quality ratings above 6 during early spring.

Clipping yield data is included in Tables 36 and 37. The methylene ureas (Nutralene and Scotts 41-0-0) exhibited the lowest clipping yields, while sulfur-coated urea (Scotts and LESCO) and Restore 10-2-6 produced the greatest clipping yield.

Table 34. The effects of fertilizer sources on the visual quality[a] of 'Park' Kentucky bluegrass.

	May				June				July				
Fertilizers	2	13	21	28	3	10	17	24	1	8	17	22	30
Urea	5.0	6.3	6.3	7.0	7.0	7.3	6.7	7.7	8.0	8.0	7.0	7.0	7.0
Ammonium Sulfate	4.7	6.7	6.3	6.7	6.7	6.3	6.7	7.7	8.0	7.3	7.0	6.3	6.3
UFC Ammonium Sulfate	4.7	6.3	5.7	6.7	6.7	7.3	6.3	7.3	7.3	7.3	6.7	7.0	7.0
SCU (Andersons)	5.0	6.7	5.7	6.7	7.0	7.0	6.3	7.0	7.0	7.0	6.3	6.3	6.7
SCU (LESCO)	5.7	6.7	6.0	6.3	6.7	7.0	7.3	7.7	8.0	7.7	7.0	6.7	6.7
SCU (Scotts)	6.0	7.0	7.3	7.7	8.0	8.0	8.0	8.0	9.0	9.0	8.0	7.7	8.0
IBDU	5.7	6.7	6.0	6.0	5.7	6.3	6.7	7.0	7.0	7.7	7.0	6.3	6.0
Milorganite	6.0	6.3	5.7	6.7	6.7	7.0	6.3	7.3	7.3	7.0	6.3	6.7	6.3
Methylene Urea (Nor-Am)	4.3	6.3	5.7	6.0	6.0	6.7	6.0	7.3	7.7	7.3	6.7	6.7	6.7
Methylene Urea (Scotts)	4.7	6.3	6.7	7.0	6.7	7.0	6.7	7.7	7.7	7.3	6.7	6.3	7.0
Restore 10-2-6	6.7	7.7	6.0	7.7	7.0	6.7	7.3	7.0	7.7	7.7	7.3	7.0	6.7
ISU Experimental	5.7	6.7	6.0	7.0	7.0	7.3	6.7	8.0	8.3	7.3	6.7	6.7	6.0
Control	3.0	5.3	4.3	5.0	5.3	5.0	4.7	6.0	5.0	6.0	5.0	5.0	5.3
$LSD_{(0.05)}$	NS	NS	NS	1.2	1.0	0.8	0.9	0.9	1.1	1.2	1.0	1.1	0.9

[a]Visual quality is based on a scale of 9 to 1: 9 = dark green, dense turf, 6 = minimum acceptable quality, and 1= straw brown turf.

Table 35. The effects of fertilizer sources on the visual quality[a] of 'Park' Kentucky bluegrass.

	August				September					Means
Fertilizers	7	13	21	27	5	12	17	25	30	--
Urea	6.7	7.7	8.0	7.0	8.0	7.7	7.7	7.7	7.3	6.6
Ammonium Sulfate	6.3	7.3	7.3	7.0	7.0	7.3	7.3	7.7	7.3	6.3
UFC Ammonium Sulfate	7.0	7.7	7.7	6.7	7.3	7.7	7.7	7.7	7.7	6.4
SCU (Andersons)	6.3	7.7	7.3	7.0	8.0	7.7	8.3	8.0	7.7	6.4
SCU (LESCO)	6.7	7.7	8.0	7.0	7.3	7.3	7.7	8.0	7.7	6.5
SCU (Scotts)	8.7	9.0	9.0	8.0	9.0	8.7	9.0	8.3	8.3	7.5
IBDU	6.7	6.3	6.7	6.3	6.3	7.0	8.0	7.7	7.3	6.1
Milorganite	6.0	6.3	6.7	6.7	7.0	7.0	7.7	8.0	7.3	6.2
Methylene Urea (Nor-Am)	7.0	7.3	7.0	6.7	7.3	7.7	8.0	7.3	7.0	6.2
Methylene Urea (Scotts)	6.7	7.7	7.7	7.0	8.0	7.7	7.7	7.3	7.0	6.4
Restore 10-2-6	6.3	6.3	7.7	7.0	7.3	7.7	8.0	7.3	7.7	6.6
ISU Experimental	6.3	6.7	6.7	6.7	7.7	7.7	8.0	7.3	7.0	6.4
Control	5.0	5.0	5.0	5.0	5.0	5.0	6.0	6.3	6.0	4.7
$LSD_{(0.05)}$	1.0	1.5	1.5	1.2	0.9	1.0	1.0	NS	NS	0.7

[a]Visual quality is based on a scale of 9 to 1: 9 = dark green, dense turf, 6 = minimum acceptable quality, and 1 = straw brown turf.

Table 36. The effects of fertilizer sources on clipping yields[a] on 'Park' Kentucky bluegrass.

	May				June			
Fertilizer	3	13	21	28	3	10	17	26
Urea	28.6	14.1	26.3	28.8	31.3	14.1	9.9	26.4
Ammonium Sulfate	27.3	15.9	23.1	22.7	24.2	9.9	7.2	20.5
UFC Ammonium Sulfate	30.5	14.6	31.7	25.4	27.8	13.3	8.3	34.2
SCU (Andersons)	33.1	19.1	22.0	22.9	31.2	13.4	9.1	17.8
SCU (LESCO)	51.0	26.1	29.2	27.1	31.3	17.0	12.2	37.6
SCU (Scotts)	48.1	31.8	43.7	53.0	63.2	44.4	30.1	60.0
IBDU	25.3	18.0	19.0	21.5	27.0	14.2	8.9	13.2
Milorganite	30.1	19.1	26.5	25.8	40.1	19.1	13.7	31.8
Methylene Urea (Nor-Am)	11.0	9.5	15.7	13.1	22.7	11.4	9.2	12.4
Methylene Urea (Scotts)	19.3	13.9	24.5	22.5	26.0	13.0	9.9	20.5
Restore 10-2-6	45.0	31.1	32.5	36.6	46.0	20.1	13.4	18.4
ISU Experimental	29.7	19.5	20.1	22.4	32.8	12.9	9.6	26.6
Control	2.8	3.0	11.2	5.9	10.1	5.7	4.1	4.7
$LSD_{(0.05)}$	40.3	19.9	24.8	21.8	22.3	15.1	7.2	22.5

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

Table 37. The effects of fertilizer sources on clipping yields[a] on 'Park' Kentucky bluegrass.

	July					August			Sept		Oct	Means
Fertilizer	1	8	15	22	29	7	13	22	6	30	9	--
Urea	20.3	15.0	11.6	8.8	13.7	12.3	10.3	16.0	23.7	32.4	20.3	19.1
Ammonium Sulfate	11.5	8.2	6.5	4.7	4.6	8.5	6.6	11.9	11.0	20.1	14.5	13.6
UFC Ammonium Sulfate	14.8	10.5	8.3	6.3	7.8	11.9	11.0	17.9	20.6	43.7	25.4	19.2
SCU (Andersons)	8.2	7.7	6.8	5.0	5.6	10.1	9.4	21.4	30.8	50.7	31.0	18.7
SCU (LESCO)	20.9	16.9	14.8	10.3	11.5	15.8	15.2	20.9	28.9	47.0	35.0	24.7
SCU (Scotts)	29.9	29.4	30.7	23.8	28.1	39.1	30.7	32.7	49.5	76.1	33.5	40.9
IBDU	9.2	9.2	8.9	8.4	8.4	7.9	7.4	9.5	15.4	35.0	18.8	15.1
Milorganite	17.5	16.2	12.6	11.8	11.0	13.7	8.4	13.7	21.2	34.7	16.6	20.2
Methylene Urea (Nor-Am)	7.6	6.8	5.2	8.0	6.6	9.6	4.6	7.5	14.8	22.4	9.4	10.9
Methylene Urea (Scotts)	10.0	9.9	7.7	6.1	8.2	9.1	7.4	10.9	21.1	28.1	15.8	14.9
Restore 10-2-6	22.8	16.0	16.3	13.9	12.9	14.5	10.4	16.9	28.7	41.0	23.5	24.2
ISU Experimental	14.7	12.4	10.2	8.2	8.9	11.6	6.0	9.8	23.6	39.2	19.2	17.8
Control	2.5	2.9	1.9	2.2	2.4	3.1	1.7	2.8	3.4	6.2	3.4	4.2
$LSD_{(0.05)}$	15.3	NS	8.2	NS	NS	9.0	10.2	16.6	19.8	35.6	27.6	14.1

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

The Evaluation of Nitrogen Sources on the Quality of Bentgrass Greens

M. L. Agnew and S. M. Berkenbosch

In the spring of 1991 a study was established to evaluate the performance of 13 granular nitrogen fertilizer sources. The treatments are listed in Table 38. The treatments were applied at a 0.5 lb N/1000 ft^2 on May 25 and June 26 to a 'Penncross' creeping bentgrass/*Poa annua* green. The testing area was located at the Hyperion Field Club, Johnston, Iowa. The plot consisted of a randomized complete-block design replicated three times.

The plots were mowed daily and irrigated as needed.

Visual quality data was collected weekly. Visual quality ratings were based on a scale of 9 to 1 with 9 = dense dark green turf, 6 = acceptable quality, and 1 straw brown turf (Table 38).

The fertilizers containing higher soluble nitrogen (Coron, Country Club, Country Club + NIAD, Scotts + Minors, and Scotts + Manganese) had consistent average visual quality ratings above 6.0, dipping below 6.0 one or two times. Scotts + Manganese had the highest overall ratings and remained deep green in color during the entire 1991 testing season. The second most noticeable dark green turf was obtained by using Scotts + Minors. Both fertilizers maintained a 7.0 or above rating for most of the 1991 testing season.

The rest of the fertilizers used were slow-release nitrogen sources and showed ratings of 5.0 to 6.0 the first part of June. From mid-July through October the slow-release fertilizers showed turf with ratings of at least 6.0 or above.

Table 38. The comparison of fertilizer sources on the visual quality[a] of bentgrass.

	Date						
	May	June			July		
Fertilizer	30	6	13	20	3	12	17
Country Club 18-4-10	7.3	7.0	6.7	7.0	7.3	7.0	7.0
Nutralene 40-0-0	8.0	8.0	8.3	8.3	7.7	7.7	8.0
Scotts 26-4-13 + Minors	8.3	8.7	8.3	8.0	8.7	8.0	8.0
Scotts 22-0-12 + Manganese	7.3	7.7	8.3	8.0	8.0	8.7	8.7
Milorganite 6-2-0	6.0	6.7	6.7	6.3	6.7	7.0	7.0
Ringer Restore 10-2-6	7.7	8.0	8.0	8.3	8.3	8.7	8.7
Sustane Fine 5-2-4	7.7	7.7	7.3	7.7	7.7	7.3	7.7
IBDU Fine 31-0-0	5.3	5.3	6.3	6.7	7.0	6.7	6.7
Nutriculture 28-8-18	7.3	8.0	7.3	7.0	7.7	8.0	8.0
Andersons 22-0-22	6.7	6.7	6.7	6.7	7.0	7.0	7.0
Andersons 21-0-21	7.0	7.3	6.7	7.0	7.3	7.0	7.0
Andersons 18-6-15	7.7	7.7	7.6	7.0	7.3	7.3	7.3
Coron	8.3	8.7	9.0	9.0	9.0	9.0	8.7
$LSD_{(0.05)}$	NS	1.9	1.6	1.3	1.4	1.1	1.1

[a]Visual quality is based on a scale of 9 to 1: 9 = dense, dark green turf, 6 = minimum acceptable quality, and 1 = straw brown turf.

The Effects of Synthetic and Natural Organic Nitrogen Source and Core Cultivation on Turfgrass Growth under Traffic Stress

M. L. Agnew

This study was initiated at the Iowa State University Horticulture Research Station in Ames, Iowa, during the spring of 1989. The objective of this study was to observe the effects of six fertilizer sources and core cultivation on turfgrass quality, clipping production, root density, and physical soil properties.

The six fertilizer sources include:

1.	Urea 46-0-0	(Synthetic fast-release organic)
2.	IBDU 31-0-0	(Synthetic slow-release organic)
3.	Ringer Turf Restore 10-2-6	(Natural organic)
4.	Ringer Greens Restore 6-1-3	(Natural organic)
5.	Milorganite 6-2-0	(Natural organic)
6.	Ureaform (Blue Chip) 38-0-0	(Synthetic slow-release organic)

Urea was applied at 1 lb N/1000 ft^2 on May 15, June 15, August 15, and September 15, 1990. All other fertilizers were applied on May 15 and August 15 at a 2 lb N/1000 ft^2 rate.

Core cultivation treatments consisted of two passes with a Ryan Lawn-Aire 28 just before fertilization on May 15 and August 15. This resulted in approximately 20 holes/ft^2/treatment.

Traffic stress was initiated on May 15 and consisted of five passes each Friday with a water-filled smooth roller. Traffic stress resulted in a combination of wear and soil compaction.

One undisturbed soil sample was collected from each plot on October 15. Total porosity, air-filled porosity, bulk density, and soil strength were determined on each sample.

Fertilizer source demonstrated some effects on soil physical properties (Table 39). Bulk densities ranged from 1.30 for Ringer 6-1-3 to 1.38 for urea-treated plots. Total porosity ranged from 34.4% for Ringer 10-2-6 to 36.7% for urea-treated plots.

The effects of core cultivation were not as noticeable in 1991. However, traffic had a significant effect on soil physical properties. Soils receiving traffic had a soil strength of 3.2 versus 2.4 for non-traffic treatments. The bulk density of traffic treatments averaged 1.4 versus 1.28 for non-traffic treatments. Total and air-filled porosity at (0.01 mPa) for traffic treatments were 36.7% and 15.7% versus 34.4% and 12.4% for non-traffic treatments.

Visual quality ratings and clipping yield samples were collected on a weekly basis. Visual ratings were based on a visual scale of 9 to 1. A rating of 9 equals a dark green, dense turfgrass, whereas a rating of 1 equals a straw brown turfgrass stand. A rating of 6 was used as the minimum acceptable level of quality. Clippings were collected by removing all leaf tissue above 2 in within a 21 in by 5 ft area (8.75 ft^2) down the center of each plot. Clippings were placed in paper bags and dried. Weights were recorded as g/8.75 ft^2.

The effect of fertilizer source on visual quality is presented in Table 40. Urea-treated plots had the highest average quality ratings of 7.7 followed by Blue Chip (6.5), Ringer Turf Restore 10-2-6 (6.4), Milorganite (6.2), Ringer Green Restore 6-1-3 (6.1), and IBDU (6.1).

The effect of fertilizer source on clipping yields is presented in Table 41. Urea produced the greatest amount of clippings (163.4 g), followed by Restore 10-2-6 (88.7 g), Restore 6-1-3 (82.3 g), Milorganite (74.2 g), and IBDU (62.7 g). Treatments with higher yields corresponded to the better quality ratings.

The effects of core cultivation on visual quality were evident on one date (Table 40). The effect of core cultivation on clipping yields was evident on several dates. Core-cultivated plots had a total of 102.8 g of clippings compared to 86.4 g for non-cored plots.

Traffic affected visual quality of Kentucky bluegrass on several dates (Table 40). Traffic improved quality on May 13 and June 24, while decreasing quality on May 13, June 3, June 10, August 7, and September 30. Plots receiving traffic produced 86.6 g of dried clippings versus 103 g of dried clippings for the non-treated control.

Table 39. The effects of fertilizer, core cultivation, and traffic on soil properties.

Fertilizer Source	Core	Traffic	Soil Strength	Bulk Density	Total Pore Space	Air Filled Pores
Urea	Yes	Yes	3.3	1.49	35.0	12.2
Urea	Yes	No	2.4	1.30	38.2	15.7
Urea	No	Yes	2.9	1.48	36.8	12.9
Urea	No	No	2.2	1.26	36.9	16.0
IBDU	Yes	Yes	3.0	1.41	34.3	12.4
IBDU	Yes	No	2.3	1.27	37.3	16.3
IBDU	No	Yes	3.6	1.47	34.9	13.2
IBDU	No	No	2.5	1.32	36.8	16.5
Restore 10-2-6	Yes	Yes	3.4	1.38	33.7	12.2
Restore 10-2-6	Yes	No	2.4	1.30	35.5	14.1
Restore 10-2-6	No	Yes	3.7	1.45	32.8	12.4
Restore 10-2-6	No	No	2.7	1.34	35.5	14.7
Milorganite	Yes	Yes	3.0	1.38	34.3	11.5
Milorganite	Yes	No	2.1	1.30	35.6	15.1
Milorganite	No	Yes	2.9	1.42	34.0	12.8
Milorganite	No	No	2.3	1.28	36.2	15.4
Restore 6-1-3	Yes	Yes	2.6	1.35	34.4	12.1
Restore 6-1-3	Yes	No	2.4	1.31	37.4	16.1
Restore 6-1-3	No	Yes	3.1	1.30	35.7	14.0
Restore 6-1-3	No	No	2.6	1.25	37.4	16.0
Blue Chip	Yes	Yes	3.3	1.46	33.1	10.9
Blue Chip	Yes	No	2.3	1.19	36.6	16.6
Blue Chip	No	Yes	2.9	1.42	34.2	12.6
Blue Chip	No	No	2.3	1.24	37.2	15.7
$LSD_{(Fert)}$			NS	0.05	1.5	NS
$LSD_{(Core)}$			NS	NS	NS	NS
$LSD_{(Comp)}$			0.2	0.03	0.9	0.7

Table 40. Visual quality.

Treatments			May				June				July					August			September				Oct
Fertilizer	Core	Comp	2	13	21	28	3	10	17	24	1	8	17	22	30	7	13	21	5	12	17	30	8
Urea	No	No	6.7	6.7	8.0	8.0	8.0	8.0	7.0	7.7	9.0	9.0	7.7	8.0	7.7	7.7	8.0	8.7	8.3	9.0	8.0	8.0	8.3
Urea	No	Yes	7.0	7.7	7.7	7.7	7.3	7.3	6.7	8.0	9.0	9.0	7.7	7.3	7.3	7.7	8.0	9.0	8.7	9.0	7.7	8.0	8.0
Urea	Yes	No	6.7	7.0	7.7	7.7	8.0	8.0	7.0	8.0	8.7	9.0	7.7	7.7	7.7	8.0	8.0	9.0	7.3	8.3	8.0	8.0	8.3
Urea	Yes	Yes	6.0	7.3	7.04	7.3	7.3	7.0	6.7	8.0	8.7	9.0	7.7	7.3	7.0	7.7	8.0	8.7	7.7	8.0	7.7	7.7	8.0
IBDU	No	No	5.3	5.3	6.7	6.7	6.3	6.3	6.0	6.0	7.0	7.0	5.7	5.7	5.7	6.3	6.0	6.0	6.7	6.7	7.3	7.0	7.0
IBDU	No	Yes	5.0	6.3	6.0	6.7	6.0	6.3	6.0	6.3	7.0	7.0	5.7	5.7	5.7	6.0	6.0	6.0	6.3	7.3	7.3	6.3	7.0
IBDU	Yes	No	5.0	5.7	6.3	6.7	7.0	6.7	6.4	5.7	6.3	6.4	5.7	6.0	6.0	6.3	6.7	6.0	7.0	7.7	7.3	7.0	7.3
IBDU	Yes	Yes	5.3	6.3	6.3	6.7	6.3	6.3	6.3	6.7	6.3	6.3	5.7	5.7	5.3	6.0	6.3	6.0	7.7	8.0	7.3	6.7	7.0
Restore 10-2-6	No	No	5.7	5.7	6.7	7.7	7.7	7.0	6.7	6.3	6.7	7.0	6.0	5.7	5.7	6.3	6.7	6.0	7.7	8.3	7.3	7.0	6.3
Restore 10-2-6	No	Yes	5.7	6.3	6.3	7.0	7.0	6.3	6.4	6.7	6.7	7.0	5.7	6.0	5.3	5.7	6.7	6.0	7.3	8.3	7.3	7.0	6.7
Restore 10-2-6	Yes	No	6.0	6.0	6.0	6.3	7.0	7.0	6.3	5.7	6.7	7.0	5.7	6.7	6.0	7.0	6.0	6.7	8.0	8.3	7.3	7.0	6.7
Restore 10-2-6	Yes	Yes	5.7	6.3	6.0	6.3	6.7	6.0	6.7	6.7	6.7	7.0	5.3	6.0	6.0	6.3	6.0	6.3	8.0	8.3	7.3	6.0	7.0
Milorganite	No	No	5.7	6.0	6.0	6.3	6.0	6.3	6.3	5.7	6.7	7.0	6.0	6.0	5.7	6.3	6.0	6.0	6.3	6.7	6.3	6.7	6.3
Milorganite	No	Yes	5.0	6.3	6.0	6.0	6.0	6.7	7.0	6.0	6.7	7.3	5.3	6.3	6.3	6.0	6.3	6.3	7.0	7.7	7.0	7.0	6.3
Milorganite	Yes	No	5.7	6.0	6.3	6.3	7.0	6.7	6.3	6.3	7.0	7.7	6.0	6.3	6.0	6.7	6.3	6.3	7.0	7.3	7.3	7.0	6.7
Milorganite	Yes	Yes	5.7	6.3	6.3	6.0	6.3	6.0	6.7	6.3	7.7	7.3	5.7	5.7	6.3	6.3	6.3	6.7	7.0	7.7	7.0	6.7	6.3
Restore 6-1-3	No	No	5.7	6.0	6.7	6.7	6.7	6.3	6.0	6.0	6.3	6.7	5.7	5.7	6.3	6.3	6.7	6.0	6.0	7.0	7.0	6.7	6.7
Restore 6-1-3	No	Yes	6.0	6.7	6.0	6.3	6.3	6.3	6.0	6.0	6.7	7.0	5.7	5.7	6.3	6.3	6.7	7.0	6.3	8.0	6.7	6.3	6.7
Restore 6-1-3	Yes	No	6.0	6.3	6.0	6.0	6.3	6.3	6.3	6.3	6.7	6.7	6.3	6.0	6.3	6.0	6.0	6.0	6.3	7.3	6.7	7.0	6.7
Restore 6-1-3	Yes	Yes	6.0	6.7	6.0	5.7	6.0	6.0	6.0	6.0	6.3	6.7	5.3	6.3	6.0	6.0	6.3	6.0	6.7	7.3	6.7	6.7	6.7
Blue Chip	No	No	5.7	6.3	7.3	6.7	6.7	7.0	6.3	6.3	7.0	7.7	6.3	6.0	6.7	6.7	7.0	7.0	7.3	8.0	7.0	7.0	6.3
Blue Chip	No	Yes	5.3	6.7	7.0	7.0	6.7	6.0	6.7	7.0	7.7	7.7	6.7	6.3	7.0	7.0	7.0	6.7	7.3	8.0	7.0	6.3	6.3
Blue Chip	Yes	No	5.3	6.7	7.3	6.3	6.7	7.3	6.7	6.3	7.3	8.0	6.7	6.3	6.7	6.7	7.0	7.0	7.3	7.3	7.7	7.0	6.7
Blue Chip	Yes	Yes	5.3	6.7	7.0	5.7	6.3	6.7	6.0	6.7	7.3	8.0	6.7	6.3	6.3	6.3	6.7	6.7	7.3	8.0	7.0	6.0	6.3

Table 41. Clipping height .

Treatments			May				June				July				August				September	
Fertilizer	Core	Comp	7	13	21	28	7	10	17	24	1	8	17	24	2	8	13	22	13	30
Urea	No	No	12.1	9.5	20.6	13.6	14.1	9.2	5.7	9.26	1.0	6.2	6.1	7.6	7.5	5.5	4.6	7.4	16.5	13.0
Urea	No	Yes	16.2	11.5	22.3	17.8	10.4	9.8	5.5	11.6	1.0	6.6	13.1	9.6	8.7	5.5	4.0	7.1	20.5	7.5
Urea	Yes	No	14.7	11.3	13.2	11.2	13.1	8.0	3.8	8.5	1.6	5.7	5.6	7.3	7.5	5.3	5.0	6.4	16.8	10.2
Urea	Yes	Yes	14.4	8.0	10.4	9.0	8.7	5.6	3.7	9.6	1.7	5.6	9.8	8.2	6.8	4.9	4.8	6.5	17.2	6.8
IBDU	No	No	3.0	2.9	9.8	9.0	8.7	5.6	3.2	3.9	0.4	1.5	2.7	2.9	3.3	2.6	1.4	5.8	6.3	6.9
IBDU	No	Yes	2.0	1.9	8.3	7.5	7.9	5.2	3.0	3.4	0.2	1.5	1.6	2.2	2.3	1.7	1.2	1.1	4.9	3.5
IBDU	Yes	No	2.7	2.4	5.4	6.5	7.6	4.5	3.0	3.4	0.1	1.2	1.1	2.7	3.2	2.5	1.9	1.4	5.6	5.9
IBDU	Yes	Yes	2.4	1.9	8.3	5.8	5.2	3.6	2.6	2.7	0.2	1.3	1.1	2.5	2.4	1.9	2.2	1.3	6.7	3.4
Restore 10-2-6	No	No	4.6	4.7	11.6	12.8	12.7	8.4	4.4	5.0	0.2	1.6	2.6	3.1	4.3	3.6	1.5	2.2	12.4	10.0
Restore 10-2-6	No	Yes	3.5	4.1	9.8	10.4	10.2	8.8	3.6	5.5	0.3	1.7	2.5	2.3	3.7	2.3	1.5	2.1	10.5	5.4
Restore 10-2-6	Yes	No	5.6	4.6	5.9	8.9	11.0	7.1	4.2	4.1	0.3	2.3	3.1	4.3	5.0	3.4	2.1	2.4	15.0	8.9
Restore 10-2-6	Yes	Yes	4.0	2.8	3.6	5.1	7.0	5.3	3.0	3.7	0.3	1.9	1.8	3.0	3.2	1.7	1.2	1.7	10.4	3.0
Milorganite	No	No	4.2	3.4	7.8	7.2	8.4	5.8	3.7	3.9	0.2	1.7	2.0	2.5	3.5	2.5	1.3	1.8	9.7	7.0
Milorganite	No	Yes	2.5	2.2	6.1	5.4	7.1	6.8	3.3	4.0	0.2	1.7	1.8	2.8	3.2	2.3	1.9	1.6	7.7	4.0
Milorganite	Yes	No	5.1	4.8	7.6	8.0	10.2	7.5	4.5	4.4	0.5	1.9	2.7	4.1	5.1	3.6	2.5	2.3	13.1	7.2
Milorganite	Yes	Yes	3.1	2.1	4.0	4.4	4.7	4.0	2.9	3.7	0.3	2.1	1.9	3.5	3.8	2.2	1.5	1.9	11.4	3.5
Restore 6-1-3	No	No	5.8	5.9	11.5	11.5	11.7	7.3	4.2	4.1	0.3	2.4	2.2	3.4	4.3	3.6	1.7	2.3	11.9	8.6
Restore 6-1-3	No	Yes	4.4	5.2	10.1	8.8	11.1	8.2	4.9	4.9	0.4	2.7	2.5	3.8	4.1	2.8	1.7	2.3	8.2	3.0
Restore 6-1-3	Yes	No	4.3	4.6	6.1	6.9	9.3	6.4	2.6	3.1	0.2	1.7	1.3	2.8	4.0	2.8	1.2	2.0	10.9	7.6
Restore 6-1-3	Yes	Yes	3.7	3.7	4.2	5.7	5.7	4.8	2.6	3.1	0.3	1.9	1.1	3.5	3.2	1.8	0.9	1.5	7.2	2.6
Blue Chip	No	No	4.7	6.6	15.9	11.3	10.8	8.2	5.0	5.2	0.2	3.0	2.8	4.7	5.2	4.3	2.4	3.1	12.7	7.7
Blue Chip	No	Yes	2.7	3.7	12.2	9.1	9.5	7.9	4.3	5.5	0.5	3.6	5.2	5.1	5.6	3.3	2.0	2.7	10.3	3.1
Blue Chip	Yes	No	3.8	5.1	10.3	12.7	9.9	6.7	4.2	4.6	0.4	3.4	2.9	3.7	5.1	4.0	1.8	2.4	11.4	7.3
Blue Chip	Yes	Yes	3.8	3.6	7.7	7.0	6.7	5.5	3.2	3.7	0.4	3.4	4.0	3.9	3.8	2.8	1.2	1.9	10.6	2.9

MURP Studies

M. L. Agnew and S. M. Berkenbosch

In the spring of 1990 a study was established in cooperation with O. M. Scott & Sons Company to compare the effects of four nitrogen formulations on a four-year-old stand of 'Ram I' Kentucky bluegrass. Individual plots measured 3 ft x 10 ft and the treatments were replicated 3 times in a randomized complete-block design. The plots were mowed weekly with one mower pass and all leaf tissue above 1 1/2-in collected. Irrigation was added to reduce plant stress.

Nitrogen fertilizers used in this study include: three methylene urea formulations (39-0-0, 41-0-0, and 42-0-0) and urea (46-0-0). The fertilizers were applied at a rate of 1 lb N/1000 ft^2 on May 10, June 20, and August 10.

Data collected included fresh clipping weight and visual quality rating. Clippings were collected each week or when growth warranted clipping removal. Clippings were collected with a Toro rotary mower and placed in bags. Fresh weights were recorded immediately after mowing. Visual quality ratings were collected weekly prior to clipping removal. Ratings are based on a scale of 9 to 1: 9 = a dark green turfgrass stand, 6 = a minimum acceptable level, and 1 = dead, straw brown turf.

Spring green-up data is presented in Table 42. In April, plots treated with 46-0-0 and 42-0-0 greened up quicker than other plots. Following each fertilizer treatment, 46-0-0 demonstrated higher quality (Tables 42 and 43). Interestingly, this quality did not diminish over time. Plots treated with 42-0-0 and 41-0-0 provided the best quality among the methylene ureas.

The high quality ratings of 46-0-0 can be explained in part by the clipping data. Plots treated with 46-0-0 consistently had higher clipping yields (Tables 44 and 45). For example, plots treated with 46-0-0 produced in excess of 2 times the clippings of plots treated with 42-0-0. This type of growth could create problems associated with everyday maintenance, such as mowing and disease activity.

Table 42. The influence of methylene urea sources on visual quality ratings[a] form April 16 to July 30, 1991.

	April		May				June				July				
Fertilizer	16	26	2	13	21	28	3	10	17	24	1	8	15	22	30
42-0-0	4.0	4.7	5.7	6.7	7.3	7.0	7.7	7.0	6.7	6.7	8.0	7.7	7.3	6.0	6.7
41-0-0	3.3	4.3	5.3	6.3	7.0	6.7	7.0	7.0	7.0	7.0	8.0	8.3	7.3	6.7	6.7
39-0-0	2.3	3.3	4.7	6.0	6.3	5.7	7.0	6.3	6.0	6.0	7.0	7.0	6.3	5.3	5.7
46-0-0	5.0	6.0	7.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	9.0	9.0	8.0	7.3	8.0
Control	1.0	2.3	3.0	5.0	5.0	4.7	5.7	6.0	5.0	5.0	6.0	6.0	5.0	4.0	5.0
$LSD_{(0.05)}$	0.6	1.1	0.8	0.6	0.7	0.6	1.0	0.5	0.5	0.5	0.6	0.6	0.6	2.0	0.8

Table 43. The influence of methylene urea sources on visual quality ratings[a] from August 7 to October 8, 1991.

	August				September					October
Fertilizer	7	13	21	27	5	13	17	25	30	8
42-0-0	6.3	8.0	8.0	8.0	8.0	8.3	7.7	7.7	8.0	8.0
41-0-0	7.0	8.0	8.0	8.0	8.3	9.0	8.3	8.3	7.7	7.7
39-0-0	6.3	7.0	7.0	7.0	7.0	7.3	8.0	7.7	7.3	7.0
46-0-0	8.0	9.0	9.0	9.0	9.0	9.0	8.7	8.3	8.7	9.0
Control	5.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
$LSD_{(0.05)}$	0.6	0.6	0.6	0.6	0.9	0.6	1.0	1.0	0.9	0.5

[a]Visual quality is based on a scale of 9 to 1: 9 = dense, dark green turf, 6 = minimum acceptable quality, and 1 = straw brown turfgrass sod.

Table 44. The influence of methylene sources on clipping yields[a] from May 7 to June 24, 1991.

	May				June			
Fertilizer	7	13	22	28	3	11	17	24
42-0-0	5.9	12.2	30.4	73.2	224.8	16.2	19.2	24.2
41-0-0	4.7	9.0	34.6	55.9	209.9	26.2	13.7	23.1
39-0-0	3.6	7.2	27.4	36.8	176.5	10.4	14.8	15.9
46-0-0	19.5	41.0	129.5	156.3	352.7	34.7	36.6	51.8
Control	2.7	2.4	7.4	13.5	75.1	3.0	36.3	6.1
$LSD_{(0.05)}$	3.7	13.6	24.3	37.8	64.7	9.2	NS	7.3

Table 45. The influence of methylene urea sources on clipping yields[a] from July 1 to September 19, 1991.

	July			August				September	
Fertilizer	1	8	15	7	13	21	27	13	19
42-0-0	20.9	14.8	20.6	23.4	28.6	45.7	24.8	128.6	64.5
41-0-0	20.0	14.8	22.4	31.7	30.4	49.4	34.6	199.8	87.6
39-0-0	12.1	10.3	14.0	13.9	17.2	20.2	10.9	108.8	60.1
46-0-0	66.3	27.3	37.8	51.8	67.0	96.0	56.5	313.3	116.2
Control	2.5	2.1	2.6	6.3	5.0	9.2	6.1	40.6	24.8
$LSD_{(0.05)}$	21.9	8.6	9.9	25.0	18.3	35.3	29.2	41.1	16.6

[a]Fresh weights of clippings.

Plant and Soil Response to Nitrogen Fertilizer Sources

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. 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 10-1-0
(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 measurementss 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 Tables 46 and 47. All fertilizer sources provided acceptable quality. However, urea-treated plots consistently had the darkest green color.

Dried clipping weights are presented in Tables 48 and 49. Urea-treated plots produced a high of 414.9 g/17.5 ft^2/season whereas Nutralene-treated plots produced a low of only 312.8 g/17.5 ft^2/season. Only the non-treated control produced less clippings.

Total chlorophyll content data is presented in Tables 50 and 51. Total chlorophyll is a quantitative measure of plant color. Fertilizers that contained water-soluble nitrogen (urea, N-Sure, Coron) tended to have higher chlorophyll content.

Root data is presented in Table 52. All fertilizer sources had less total root growth than the non-fertilized control. Urea-treated plants had 46% less roots than the control, while the Coron-treated plants had only 21% less roots than the control.

Soil nitrate data is presented in Tables 53 and 54. There were no differences between fertilizer treatments in 1991.

This study will be carried on through 1992.

Table 46. The effects of fertilizer source on the visual quality[(a)] of Kentucky bluegrass during 1991.

	May			June				July		
Fertilizer Source	15	22	28	3	11	18	25	2	15	30
Coron 28-0-0	8.0	7.7	8.7	8.3	8.7	8.3	8.7	7.3	8.0	7.3
Nutralene 40-0-0	6.7	7.0	7.7	7.7	7.3	8.0	7.7	8.0	8.3	7.3
Sulfur Coated Urea 37-0-0	7.0	7.0	7.7	7.7	7.7	8.7	8.7	8.3	8.3	8.3
Urea 46-0-0	8.7	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.0	7.7
Ringer Restore 10-2-6	6.3	7.3	8.0	8.7	7.7	8.7	8.7	8.3	8.7	8.3
Ureaform 38-0-0	6.7	6.7	7.3	7.3	6.7	7.3	7.0	7.0	7.7	6.7
N-Sure 28-0-0	8.0	7.7	8.3	8.3	8.3	8.3	8.3	7.3	8.0	6.7
Corn Gluten Meal 10-1-0	6.0	6.3	8.0	8.7	7.7	8.0	8.0	8.7	9.0	8.3
Control -- no fertilizer	5.7	6.0	6.3	7.3	6.0	6.0	6.3	6.0	6.7	5.7
$LSD_{(0.05)}$	1.3	1.1	NS	1.0	0.8	0.8	0.8	1.0	1.2	1.0

Table 47. The effects of fertilizer source on the visual quality[(a)] of Kentucky bluegrass during 1991.

	August		September					October
Fertilizer Source	12	21	4	10	17	24	30	8
Coron 28-0-0	7.0	8.7	8.3	7.7	8.0	8.0	8.0	8.7
Nutralene 40-0-0	7.3	7.3	7.7	8.0	7.7	8.0	8.3	9.0
Sulfur Coated Urea 37-0-0	8.3	8.3	8.0	8.0	8.0	8.0	8.0	8.3
Urea 46-0-0	7.0	9.0	9.0	9.0	8.7	8.7	8.7	9.0
Ringer Restore 10-2-6	7.3	7.7	7.3	8.0	7.7	7.3	7.3	7.7
Ureaform 38-0-0	7.3	7.3	7.3	7.0	7.3	7.0	7.3	7.3
N-Sure 28-0-0	7.0	9.0	8.0	8.7	8.0	7.7	8.0	8.3
Corn Gluten Meal 10-1-0	7.3	6.7	7.3	8.0	8.0	8.0	7.7	7.7
Control -- no fertilizer	6.0	6.3	6.3	5.7	5.7	5.7	6.0	6.0
$LSD_{(0.05)}$	0.8	0.7	0.7	1.2	1.4	1.1	1.0	0.8

[(a)]Quality is based on a scale of 9 to 1: 9 = dense, dark green turf, 6 = minimum acceptable quality, and 1 = straw brown turf.

Table 48. The effects of fertilizer source on dried clipping weights[a] of Kentucky bluegrass for 1991.

	May		June			
Fertilizer Source	22	28	3	11	18	25
Coron 28-0-0	37.6	39.6	39.3	39.1	25.8	27.6
Nutralene 40-0-0	25.3	29.0	31.3	28.0	18.9	18.1
Sulfur Coated Urea 37-0-0	27.0	36.1	36.2	31.4	25.1	23.5
Urea 46-0-0	40.0	44.2	34.9	40.0	30.3	21.5
Ringer Restore 10-2-6	26.8	39.3	35.0	30.3	30.3	21.5
Ureaform 38-0-0	27.8	33.8	32.4	28.7	19.6	18.9
N-Sure 28-0-0	36.2	36.1	38.6	37.3	24.1	27.8
Corn Gluten Meal 10-1-0	23.0	34.3	34.7	27.7	22.3	26.0
Control -- no fertilizer	20.7	25.5	26.1	20.1	13.8	14.4
$LSD_{(0.05)}$	NS	9.8	6.3	7.4	5.2	NS

Table 49. The effects of fertilizer source on dried clipping weights[a] of Kentucky bluegrass for 1991.

	July		August		September		
Fertilizer Source	2	15	12	21	4	10	17
Coron 28-0-0	18.3	28.6	22.3	32.9	41.0	22.1	35.2
Nutralene 40-0-0	15.3	24.7	20.4	24.8	24.3	17.5	35.2
Sulfur Coated Urea 37-0-0	18.6	35.7	31.1	28.8	33.0	19.9	37.3
Urea 46-0-0	17.0	25.4	23.9	35.7	39.6	23.8	38.6
Ringer Restore 10-2-6	22.8	33.7	22.5	23.6	34.9	20.1	38.3
Ureaform 38-0-0	11.9	22.5	22.8	23.6	27.5	17.5	30.7
N-Sure 28-0-0	15.1	23.9	18.9	31.0	42.3	18.2	37.5
Corn Gluten Meal 10-1-0	22.1	33.6	21.0	21.8	29.8	18.0	38.8
Control -- fertilizer source	9.5	18.5	13.8	16.9	21.2	11.7	23.3
$LSD_{(0.05)}$	7.0	NS	5.8	6.2	9.2	4.8	NS

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

Table 50. The effects of fertilizer source on total leaf chlorophyll content of Kentucky bluegrass for 1991.

	May			June				July		
Fertilizer Source	15	22	28	3	11	18	25	2	15	30
Coron 28-0-0	16.2	12.7	12.3	11.9	13.1	8.2	12.1	10.5	11.2	11.2
Nutralene 40-0-0	14.6	13.5	12.9	11.7	12.8	11.9	12.1	11.3	11.5	11.4
Sulfur Coated Urea 37-0-0	16.1	14.6	12.9	11.8	13.5	12.6	12.4	12.1	11.9	12.6
Urea 46-0-0	17.5	15.9	14.0	12.3	14.3	13.1	13.0	11.4	11.2	11.2
Ringer Restore 10-2-6	15.9	13.7	12.7	11.9	12.6	13.6	11.9	11.5	11.8	11.2
Ureaform 38-0-0	15.2	13.4	12.7	11.9	22.7	11.4	11.9	10.8	13.4	11.5
N-Sure 28-0-0	17.2	14.4	13.5	11.9	14.1	12.2	12.5	10.8	15.8	11.9
Corn Gluten Meal 10-1-0	14.8	14.0	13.2	11.9	12.3	11.8	12.9	11.7	11.9	11.3
Control -- fertilizer source	14.7	12.4	11.4	10.5	10.5	10.2	10.3	9.6	11.6	10.5
$LSD_{(0.05)}$	1.7	1.5	0.9	0.9	NS	1.3	0.9	0.9	NS	1.0

Table 51. The effects of fertilizer source on total leaf chlorophyll content of Kentucky bluegrass for 1991.

	August		September				October
Fertilizer Source	12	21	4	10	17	24	8
Coron 28-0-0	10.5	11.9	14.6	12.6	12.6	15.5	13.0
Nutralene 40-0-0	11.1	11.1	12.5	12.3	13.4	14.5	12.9
Sulfur Coated Urea 37-0-0	12.7	11.9	13.2	12.9	13.4	14.4	13.1
Urea 46-0-0	11.7	11.5	12.5	15.1	13.3	12.8	14.7
Ringer Restore 10-2-6	11.7	10.6	13.2	12.6	12.9	13.9	12.2
Ureaform 38-0-0	11.5	11.5	13.4	12.1	13.0	15.0	13.2
N-Sure 28-0-0	10.9	12.1	15.8	12.6	13.3	15.2	13.5
Corn Gluten Meal 10-1-0	11.3	10.8	13.2	12.4	12.8	16.4	12.9
Control -- fertilizer source	10.0	9.7	11.6	10.8	11.1	12.3	11.7
$LSD_{(0.05)}$	1.0	1.0	1.3	NS	1.3	NS	1.4

Table 52. The effects of fertilizer source on the rooting[a] of Kentucky bluegrass on October 17, 1992.

	Rooting Depth (cm)				
Fertilizer Source	0-5	5-10	10-15	15-20	Total
Coron 28-0-0 (liquid)	91.9	22.9	11.8	10.1	136.7
Nutralene 40-0-0 (granular)	109.7	19.6	4.1	1.2	134.6
Sulfur Coated Urea 37-0-0 (granular)	95.0	18.5	5.7	3.5	122.7
Urea 46-0-0 (granular)	63.6	14.6	8.8	7.0	94.0
Ringer Lawn Restore 10-2-6 (granular)	81.4	30.7	11.4	5.8	129.3
Ureaform 38-0-0 (granular)	90.1	18.5	9.7	6.6	124.9
N-Sure 28-0-0 (liquid)	83.3	15.4	7.5	7.2	113.4
Corn Gluten Meal (10-1-0) (granular)	77.1	20.2	13.8	8.3	119.4
Control -- no fertilizer	117.4	34.2	14.5	7.7	173.8
$LSD_{(0.05)}$	NS	0.012	NS	NS	

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

Table 53. The effects of fertilizer source on soil nitrate content[a] on July 17, 1991.

	Nitrate Depth (cm)						
Fertilizer Source	0-5	5-10	10-15	15-20	30-35	60-65	90-95
Coron 28-0-0 (liquid)	10.2	10.5	5.1	4.1	2.0	2.0	2.1
Nutralene 40-0-0 (granular)	9.8	6.0	3.6	2.6	1.1	2.3	1.9
Sulfur Coated Urea 37-0-0 (granular)	7.2	4.3	3.6	4.4	1.6	1.5	1.3
Urea 46-0-0 (granular)	10.5	6.0	4.3	3.7	1.5	1.7	2.4
Ringer Lawn Restore 10-2-6 (granular)	7.0	3.0	7.4	5.0	2.0	3.2	2.9
Ureaform 38-0-0 (granular)	8.1	6.4	5.0	3.9	2.0	1.8	4.8
N-Sure 28-0-0 (liquid)	3.7	6.4	6.6	5.1	3.1	1.9	4.4
Corn Gluten Meal 10-1-0 (granular)	6.4	7.3	4.9	4.8	2.7	2.9	3.6
Control -- no fertilizer	8.0	7.0	1.9	2.6	0.7	1.4	0.6
$LSD_{(0.05)}$	NS	NS	NS	NS	NS	NS	NS

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

Table 54. The effects of fertilizer source on soil nitrate content[a] on October 15, 1991.

	Nitrate Depth (cm)						
Fertilizer Source	0-5	5-10	10-15	15-20	30-35	60-65	90-95
Coron 28-0-0 (liquid)	8.7	10.1	7.4	5.8	3.9	3.9	3.6
Nutralene 40-0-0 (granular)	9.3	7.8	5.6	4.9	3.8	3.9	3.5
Sulfur Coated Urea 37-0-0 (granular)	6.0	9.7	7.6	9.6	6.1	5.3	5.3
Urea 46-0-0 (granular)	12.9	10.5	8.7	7.1	5.2	6.2	5.1
Ringer Lawn Restore 10-2-6 (granular)	9.3	8.7	9.2	7.6	5.8	4.6	5.1
Ureaform 38-0-0 (granular)	8.4	7.9	9.5	8.5	9.9	4.7	8.1
N-Sure 28-0-0 (liquid)	12.5	10.9	6.6	4.9	4.4	5.4	12.2
Corn Gluten Meal 10-1-0 (granular)	9.5	5.6	6.4	5.2	10.5	4.9	----
Control -- no fertilizer	8.4	7.9	9.4	7.0	5.8	6.8	6.7
$LSD_{(0.05)}$	NS	NS	NS	NS	NS	NS	NS

[a]Soil nitrate is reported as ppm.

1991 Comparison of Kentucky Bluegrass Response to ONCE and Methylene Urea

R. W. Moore and N. E. Christians

Two nitrogen (N) sources were evaluated for maintenance fertilization of Kentucky bluegrass. The evaluation included Scotts 41-0-0 methylene urea which contains 77% WSN and 23% CWIN and Grace/Sierra's ONCE fertilizer in two formulations (25-0-18 and 35-0-6). The N source in ONCE is a blend of 70%-coated and 15%-uncoated urea. The coated fraction is a 5- to 6-month resin-coated urea. The balance of this fertilizer is an uncoated potassium sulfate.

The turfgrass used in this study was 'Park' Kentucky bluegrass, which was maintained at a 2-in cutting height. The plots were irrigated with 1 in of moisture/week when needed. A randomized complete-block design with three replications was used. Each plot measured 5 ft by 5 ft, and each replication was separated by a 2-ft border. The soil is a Nicolett (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.

ONCE was applied at two application levels (Table 55). The 25-0-18 and 35-0-6 were each applied at 3 and 4 lb N/1000 ft^2 with one application in early May. The 41-0-0 was applied at two rates, one at 3 lb N/1000 ft^2, split evenly at 1 lb N each in May, August, and September. The second rate was 4 lb N/1000 ft^2 in a split application of 1.5 lb N/1000 ft^2 in May, 1 lb N/1000 ft^2 in August, and 1.5 lb N/1000 ft^2 in September. Potassium sulfate was applied to the 41-0-0 treated plots at a rate equivalent to that provided by the 25-0-18. The 35-0-6 treated plots did not receive additional potassium.

Data taken included visual quality and clipping yields (fresh weight). The visual quality was based on a 9 to 1 scale: 9 = best quality, 6 = acceptable, and 1 = no live grass. Clipping yields were obtained using a 21-in push mower and taking one swath through the 5 ft length of each plot. This resulted in a 8.75 ft^2 area in which clippings were sampled.

The spring and early summer were very wet, and were followed by an extended drought in mid to late summer. The grass that received ONCE 25-0-18 at 4 lb N/1000 ft^2 in May (Table 56) had higher quality ratings than the other treatments until mid September. The 25-0-18 at 3 lb N and the 35-0-6 at 4 lb N/1000 ft^2 showed lower quality than the 25-0-18, but still maintained an acceptable quality level for most of the season. The 35-0-6 at 3 lb N and 41-0-0 at 3 lb and 4 lb N/1000 ft^2 had lowest quality ratings during the early to midsummer time period. The 25-0-18 at the 4 lb N/1000 ft^2 rate showed reduced quality after the first of September while the 41-0-0 at the 3 and 4 lb levels increased in quality during this time period.

Overall, clipping yields (Table 57) were greater for the plots treated with 25-0-18 at the 4 lb N/1000 ft^2 rate. This was followed closely by 25-0-18 at the 3 lb N rate and 35-0-6 at the 4 lb N rate. The grass in plots treated with 41-0-0 at both the 3 and 4 lb N/1000 ft^2 rates had significantly lower clipping yields.

The 25-0-18 applied at 4 lb N/1000 ft^2 in one application had more consistent quality ratings than any other treatment. This was probably due to the higher rate of nitrogen and the blend of quick and slow-release (resin-coated) urea used.

The 25-0-18 at 3 lb N and 35-0-6 at both the 3 lb and 4 lb N/1000 ft^2 rates did not maintain quality as long as did the 25-0-18 at the 4 lb N rate. This may be due to subtle differences in the amount of resin-coated urea in the 35-0-6 and the wet spring conditions which could have caused the 35-0-6 to be depleted before the end of the growing season. The 3 lb rate of both fertilizers provided less nitrogen per given area. The 25-0-18 was applied with an amount of potassium almost four times greater than was applied with the 35-0-6. This may have contributed to the differences in quality, even at the same nitrogen levels. The 41-0-0 methylene urea had lower overall quality but did have higher quality ratings after the first of September. This was probably due to the type of slow-release nitrogen and split applications used. The very wet conditions following the first application probably removed the water soluble N from this material very quickly.

Table 55. Treatments in the 1991 Grace/Sierra fertilizer trial.

	Treatment	Rate (lb N/1000 ft^2)	Applied
1	ONCE 25-0-18	3	May
2	ONCE 25-0-18	4	May
3	ONCE 35-0-6	3	May
4	ONCE 35-0-6	4	May
5	Scotts 41-0-0	1	May
	Scotts 41-0-0	1	August
	Scotts 41-0-0	1	September
6	Scotts 41-0-0	1.5	May
	Scotts 41-0-0	1	August
	Scotts 41-0-0	1.5	September

Table 56. The 1991 Grace/Sierra trial -- quality ratings.

	Date										
Treatment	6/13	6/27	7/12	7/23	8/7	8/20	9/3	9/17	10/1	10/22	Mean
ONCE 25-0-18 3 lb rate	7.0	7.0	7.0	7.0	6.7	7.0	6.3	6.0	6.0	5.0	6.5
ONCE 25-0-18 4 lb rate	8.0	8.0	8.0	8.0	8.0	8.0	8.0	7.0	6.3	6.0	7.5
ONCE 35-0-6 3 lb rate	7.0	6.0	6.0	6.0	5.3	6.0	5.3	5.0	5.3	5.3	5.7
ONCE 35-0-6 4 lb rate	8.0	7.0	7.7	7.7	6.7	7.0	6.3	5.3	5.0	4.7	6.5
Scotts 41-0-0 3 lb split rate	5.0	4.0	4.0	4.0	3.0	4.3	6.3	7.0	7.7	7.0	5.2
Scotts 41-0-0 4 lb split rate	5.7	5.0	5.0	5.0	4.0	4.7	7.0	8.0	8.0	8.0	6.0
$LSD_{(0.05)}$	0.4	0.1	0.4	0.4	0.7	0.7	1.2	0.4	1.1	0.7	0.3

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

Table 57. The 1991 Grace/Sierra trial -- clipping yield (g).

	Date														
Treatment	6/11	6/17	6/24	7/1	7/8	7/15	7/22	7/30	8/7	8/13	8/22	9/6	9/19	10/22	Mean
ONCE 25-0-19 3 lb rate	25.8	46.9	69.5	35.8	36.8	37.3	36.7	31.8	34.6	18.4	18.0	38.3	48.0	1.1	34.2
ONCE 25-0-18 4 lb rate	28.3	55.1	89.0	46.6	41.3	44.1	45.5	38.8	56.4	30.9	21.1	47.3	63.5	1.5	43.5
ONCE 35-0-6 3 lb rate	33.2	44.7	64.2	36.0	32.0	26.8	26.5	26.6	32.3	17.0	17.3	29.1	43.1	0.8	30.7
ONCE 35-0-6 4 lb rate	49.6	46.5	81.7	39.4	36.6	38.7	34.5	27.6	33.9	18.4	17.2	36.6	31.1	0.8	35.6
Scotts 41-0-0 3 lb split rate	24.1	21.4	28.4	11.3	9.8	6.4	7.1	8.9	10.4	5.2	6.8	26.5	43.1	1.4	15.0
Scotts 41-0-0 4 lb split rate	35.2	29.8	29.4	17.5	14.3	11.0	10.9	8.5	10.1	5.5	8.0	28.9	49.2	3.1	18.7
$LSD_{(0.05)}$	NS	18.0	22.1	10.0	16.5	16.0	14.0	11.9	7.0	4.0	6.0	NS	NS	0.9	10.0

1991 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 58). 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 Nicolett (fine-loamy, mixed mesic, Aquic Hapludoll) with a pH of 6.8 and 2.3% organic matter, a P content of 29 lb/A, and a K content of 216 lb/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 June, August, and September. The Harmony program (Table 58) consisted of a Microbial Soil Activator applied at 1.6 oz/1000 ft^2 on June 15 and October 1; a 25-15-10-3S turf food applied at 0.25 lb/1000 ft^2 on June 25, July 15, August 15, and September 15; and a 3-4-3 organic fertilizer applied at 40 lb/1000 ft^2 on June 15 and October 1. The total N applied was 2.49 lb N/1000 ft^2 from June 15 to September 15 in the Scotts program and 2.65 lb N/1000 ft^2 in the Harmony program.

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 using a 21-in push mower and taking one swath through the 5 ft length of each plot (8.75 ft^2) at a 2-in cutting height.

The grass in the control plots received an acceptable quality rating of 6 at the first data collection date of June 26 (Table 59). After that date, only unacceptable levels were observed. The Scotts plots received higher initial quality ratings, but were lower from August through October. The Harmony treatments showed consistent quality ratings throughout the season. The low quality ratings for all three treatments in August were due to several weeks of drought conditions that caused the turf to go into dormancy.

There were no significant differences in clipping yields (Table 60). The Scotts plots had numerically higher clipping yields in June and July than the Harmony plots, but about the same in September and October. The control showed less clipping yield than the treated plots. No clippings were taken in August because of the dormancy of the grass at that time.

Quality ratings for the plots treated with the Harmony soil activator program were higher than the control and showed a slight advantage over the Scotts program in 1991. The consistency in the Harmony program is probably due to the monthly feeding of nutrients to the plots. The grass in the Scotts plots had better quality early, but didn't maintain that quality. This may have been due to good initial release of nitrogen and slower recovery after the summer dormancy.

There were no significant differences in clipping yields among treatments and control. The lower yields in late September were due to lack of moisture on this non-irrigated site, causing a reduction in grass growth.

Table 58. Treatments in the 1991 soil activator fertilizer study.

Treatment		When Applied
1.	Control	
2.	Harmony Program	
	Microbial Soil Activator @ 1.6 oz/1000 ft^2	June 15, 1991
	25-15-3 organic fertilizer @ 40 lb/1000 ft^2	June 15, 1991
	25-15-10-3S Turf Food @ 0.25 lb/1000 ft^2	June 25, 1991
	25-15-10-3S Turf Food @ 0.25 lb/1000 ft^2	July 15, 1991
	25-15-10-3S Turf Food @ 0.25 lb/1000 ft^2	August 15, 1991
	25-15-10-3S Turf Food @ 0.25 lb/1000 ft^2	September 15, 1991
	Microbial Soil Activator @ 1.6 oz/1000 ft^2	October 1, 1991
	3-4-3 organic fertilizer @ 40 lb/1000 ft^2	October 1, 1991
3.	Scotts 32-3-10 applied @ 0.83 lb N/1000 ft^2	June 15, 1991
	Scotts 32-3-10 applied @ 0.83 lb N/1000 ft^2	August 15, 1991
	Scotts 32-3-10 applied @ 0.83 lb N/1000 ft^2	September 15, 1991

Table 59. The 1991 soil activator trial -- quality ratings.

	Date								
Treatment	6/26	7/12	7/18	7/23	8/1	8/28	9/27	10/22	Mean
Control	6.0	5.0	5.0	5.0	5.0	3.0	5.0	4.0	4.8
Harmony Program	7.0	7.0	7.0	8.0	7.0	5.0	8.0	6.7	7.0
Scotts 32-3-10	8.0	8.0	7.0	7.0	6.0	4.7	7.0	5.3	6.6
$LSD_{(0.05)}$	0.1	0.1	0.1	0.1	0.1	0.8	0.1	0.9	0.2

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

Table 60. The 1991 soil activator trial -- clipping yields (g).

Treatment	Date					Mean
	6/27	7/23	9/6	9/27	10/22	
Control	34.0	39.9	12.2	9.4	13.4	21.8
Harmony Program	45.3	78.0	33.5	17.8	18.9	38.7
Scotts 32-3-10	70.7	90.3	33.1	12.3	21.2	45.5
$LSD_{(0.05)}$	NS	NS	NS	NS	NS	NS

Micronutrient Study on Putting Greens

M. L. Agnew and J. L. Schmidt

In Iowa the pH of sand-based golf greens ranges from 7.8 to 8.3. The availability of micronutrients, especially iron and manganese, 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 and growth of creeping bentgrass when treated with seven micronutrient sources applied with and without nitrogen.

Treatments included 7 micronutrient sources applied with and without nitrogen. The micronutrient treatments and rates included:

1. Agri-Plex For-X (1.5 fl oz/1000 ft^2)
2. Agri-Plex Fe 8% (1 fl oz/1000 ft^2)
3. Agri-Plex Fe 8%, Mn 2% (1 fl oz/1000 ft^2)
4. Sprint 138 Fe (1.8 oz/1000 ft^2)
5. Sprint 330 Fe (3.7 oz/1000 ft^2)
6. Iron sulfate (1.5 oz/1000 ft^2)
7. Manganese sulfate (1.5 oz/1000 ft^2)
8. Control (none)

The nitrogen treatments and rates included:

1. Coron 29-0-0 (0.3 lb/1000 ft^2/application)
2. Control (none)

Treatments were replicated three times in an 8 by 2 factorial in a randomized complete-block design. Data collected included visual quality (sites 1 and 2) and putting green speed (site 1). Visual quality was based on a scale of 9 to 1: 9 = dark green turf, 6.5 = minimum acceptable quality, and 1 = dead turf. Putting green speed was measured using a USGA stimpmeter.

Two sites were selected for this study.

<u>Site 1</u>: ISU Horticulture Research Station

Soil type:	Modified sand green constructed with 80% sand, 10% hypnum peat, and 10% soil
pH = 8.1	
Grass species:	'Penncross' creeping bentgrass established in 1984.
Treatment dates:	May 21, 1991 August 7, 1991 September 6, 1991
Data collected:	Visual quality (1-9) Stimpmeter (inches)

Site 2: Hyperion Field Club lower practice green

Soil type:	Native soil base with 100% sand topdress. Sand layer depth was measured as 6 cm.
pH = 7.9 (sand = 8.3, soil = 7.4)	
Grass species:	'Penncross' creeping bentgrass *Poa annua*
Treatment dates:	May 22, 1991 June 27, 1991
Data collected:	Visual quality (1-9)

Site 1

Plots treated with nitrogen exhibited consistently better quality (Table 61). The distance of ball roll on plots treated with nitrogen averaged 3.2 in less than on plots not treated with nitrogen (Table 62).

Table 63 averages quality ratings for micronutrient treatments by nitrogen treatment. Chelated micronutrients (Agri-Plex For-X, Agri-Plex Fe 8%, Sprint 138 Fe, and Sprint 330 Fe) provided enhanced quality one week after application in May and September. All treatments enhanced initial quality on May 28 over the non-fertilized control.

Table 64 averages green speed for micronutrient treatments regardless of nitrogen treatment. It was our attempt to correlate speed with growth rate of grass. However, after reviewing the literature, factors such as grain may influence ball speed. Fortunately, the grain should have been consistent throughout an entire replication, but most likely differed between replications. When significant differences occurred, the Agri-Plex For-X treated bentgrass had speeds equivalent to non-treated controls. The Agri-Plex For-X treated plots had better quality without the usual excessive growth. Plots treated with Sprint 138 Fe had similar results.

Site 2

As in Site 1, plots treated with nitrogen had significantly better quality (Table 65). There was an effect of micronutrients following the May treatment but not the June 27 treatment. The combined effect of nitrogen and micronutrients was more pronounced on Site 2. The topdress mix is 100% sand and most likely more deficient than the Site 1 mix. The chelated micronutrient treated areas generally retained their color for longer periods of time. Green speed was not measured due to slope effects of the site.

While the effect of nitrogen was significant, the addition of selected chelated micronutrients can provide enhanced growth on healthy turfgrass. Further research on rates should be conducted to identify optimal levels on typical Iowa greens. It is obvious that responses will vary by soil mix.

Table 61. The influence of nitrogen added to micronutrients on creeping bentgrass visual quality[a]. (Horticulture Station)

	May	June			August			September		
	28	5	11	19	13	21	28	13	20	25
Treatments with Nitrogen	7.7	8.1	8.1	8.3	8.4	8.4	8.3	8.4	8.3	8.0
Treatments without Nitrogen	6.3	6.8	6.8	6.8	7.3	6.9	6.9	6.8	7.1	6.8
$LSD_{(nitrogen)}$	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.3	0.4	0.6

[a]Visual quality is based on a rating of 9 to 1: 9 = dark green, dense turf, 6 = minimum acceptable quality, 1 = dead turf.

Table 62. The influence of nitrogen added to micronutrients on creeping bentgrass. stimpmeter readings[a]. (Horticulture Station)

	May	June			August			September		
	28	5	11	19	13	21	28	13	20	25
Treatments with Nitrogen	67.5	66.7	72.3	77.3	67.0	79.7	75.4	61.3	72.3	65.3
Treatments without Nitrogen	69.0	68.5	75.6	81.1	72.3	82.3	79.6	65.1	75.5	68.6
$LSD_{(nitrogen)}$	NS	NS	2.0	2.6	2.5	NS	2.6	2.4	NS	2.2

[a]Stimpmeter reading is the distance (inches) a golf ball rolls on a green when using a USGA stimpmeter.

Table 63. The influence of micronutrients and nitrogen fertilization on the visual quality[a] of bentgrass greens. (Horticulture Station)

		May	June			August			September		
Iron Source	Nitrogen Added	28	5	11	19	13	21	28	13	20	25
Agri-Plex For-X	Yes	8.0	8.3	8.0	8.0	8.3	8.7	8.7	8.7	8.3	8.0
Agri-Plex For-X	No	7.0	7.0	6.7	6.7	7.0	7.0	6.7	6.7	7.3	7.0
Agri-Plex Fe 8%	Yes	8.0	8.3	8.0	8.3	8.3	8.3	8.3	8.3	8.3	8.7
Agri-Plex Fe 8%	No	7.0	7.0	7.0	6.7	7.7	7.3	7.0	7.3	7.3	6.3
Agri-Plex Fe 8% Mn 2%	Yes	6.3	7.0	7.7	8.0	8.0	8.3	8.7	7.7	7.7	7.0
Agri-Plex Fe 8% Mn 2%	No	6.7	7.3	6.7	7.0	7.0	7.0	7.0	7.0	7.0	7.3
Sprint 138 Fe	Yes	8.7	9.0	9.0	9.0	8.7	8.7	8.7	9.0	8.7	8.0
Sprint 138 Fe	No	6.7	6.3	7.0	6.3	7.3	7.0	7.3	7.0	7.3	7.3
Sprint 330 Fe	Yes	9.0	9.0	9.0	8.7	9.0	8.7	8.7	8.7	8.7	8.3
Sprint 330 Fe	No	5.7	6.3	6.3	7.0	7.7	7.3	7.0	7.3	7.3	7.0
$FeSO_3$	Yes	7.0	7.7	7.7	8.0	8.3	8.0	7.3	8.7	8.7	8.3
$FeSO_3$	No	7.0	8.0	7.7	7.7	7.3	6.7	6.7	7.0	7.0	7.3
$MnSO_3$	Yes	7.0	7.7	7.3	8.3	8.0	8.0	7.7	8.7	8.7	7.7
$MnSO_3$	No	6.0	7.0	7.3	6.7	7.3	6.7	6.7	6.3	6.7	6.3
Control	Yes	7.3	8.0	8.0	8.0	8.3	8.3	8.7	7.7	7.0	8.0
Control	No	4.7	5.7	6.0	6.7	6.7	6.3	6.7	6.0	6.7	6.0
$LSD_{(micro)}$		0.8	NS	NS	NS	NS	NS	0.6	0.7	NS	NS
$LSD_{(mxn)}$		*	*	*	NS	NS	NS	NS	NS	NS	NS

*Significant interaction between micronutrient and nitrogen.

[a]Visual quality is based on a rating of 9 to 1: 9 = dark green turf, 6.0 = minimum acceptable quality, and 1 = dead turf.

Table 64. The influence of micronutrients and nitrogen fertilizer on creeping bentgrass quality Stimpmeter ratings[a]. (Horticulture Station)

	May	June			August			September		
Iron Source	28	5	11	19	14	21	28	13	20	25
Agri-Plex-For-X	70.2	71.0	75.7	80.7	74.9	84.5	81.1	69.3	78.2	70.8
Agri-Plex-Fe 8%	69.0	67.1	74.4	79.4	69.3	79.5	77.2	61.5	72.5	66.3
Agri-Plex-Fe 8% Mn 2%	67.9	65.5	70.3	78.6	69.0	79.2	73.8	61.6	73.6	65.5
Sprint 138 Fe	66.1	65.2	74.4	80.1	69.9	79.7	77.9	60.3	70.8	65.7
Sprint 330 Fe	64.9	67.1	70.8	76.5	66.5	76.5	75.4	59.9	71.9	64.3
$FeSO_3$	68.6	65.7	72.1	76.4	69.8	81.0	76.1	61.5	71.1	64.6
$MnSO_3$	69.5	69.5	76.2	81.1	72.5	84.3	80.1	65.7	76.6	68.9
Control	69.9	69.9	77.8	80.6	73.2	83.2	78.5	65.7	76.5	69.8
$LSD_{(micro)}$	NS	NS	4.1	NS	5.0	NS	NS	4.9	NS	4.5

[a]Stimpmeter reading is the distance (inches) a golf ball rolls on a green when using a USGA stimpmeter.

Table 65. The influence of micronutrients and nitrogen fertilization on visual quality[a] of greens at the Hyperion Field Club.

		May	June			July		
Iron Source	Nitrogen Added	30	6	13	20	3	12	17
Agri-Plex For-X	Yes	8.3	8.7	8.7	8.0	8.3	8.3	8.0
Agri-Plex For-X	No	6.0	7.0	6.0	6.3	6.0	6.3	6.7
Agri-Plex Fe 8%	Yes	8.3	8.3	7.7	7.3	8.0	7.7	7.7
Agri-Plex Fe 8%	No	6.7	7.3	7.0	7.0	6.3	6.3	6.7
Agri-Plex Fe 8% Mn 2%	Yes	7.7	8.0	7.3	7.3	7.7	7.7	7.7
Agri-Plex Fe 8% Mn 2%	No	7.3	7.3	6.7	7.3	6.7	7.3	7.3
Sprint 138 Fe	Yes	8.7	8.7	8.0	7.7	8.3	7.7	7.7
Sprint 138 Fe	No	6.0	6.3	6.3	6.0	6.7	6.7	6.7
Sprint 330 Fe	Yes	9.0	8.7	7.3	7.0	8.7	7.7	7.3
Sprint 330 Fe	No	6.7	6.3	6.7	6.3	6.0	6.3	6.0
$FeSO_3$	Yes	7.7	7.3	7.3	7.3	7.3	7.3	7.0
$FeSO_3$	No	7.7	7.0	7.0	7.0	6.7	6.7	6.3
$MnSO_3$	Yes	6.7	6.7	6.3	6.3	7.0	7.3	7.7
$MnSO_3$	No	6.7	7.0	6.7	6.7	6.0	6.7	7.0
Control	Yes	7.3	7.7	8.0	7.7	8.0	8.0	8.0
Control	No	6.0	6.3	6.0	6.0	6.3	6.7	6.7
$LSD_{(micro)}$		0.6	NS	NS	NS	NS	NS	NS
$LSD_{(nitrogen)}$		0.3	0.5	0.5	0.5	0.5	0.4	0.4

[a]Visual quality is based on a rating of 9 to 1: 9 = dark green turf, 6.0 = minimum acceptable quality, and 1 = dead turf.

Clipping Reduction of Kentucky Bluegrass with Growth Regulators

N. E. Christians and T. R. Bormann

The disposal of grass clippings in landfills is no longer allowed in many parts of the country. One potential method of reducing clipping production on lawn areas is the use of growth-regulating compounds to slow growth of the grass. In this trial an experimental growth regulator known as Primo was compared to an industry standard, Limit.

The treatments included an untreated control, Primo at 300 g active ingredient a.i./hectare (0.27 lb a.i./A), Primo at 400 g a.i./hectare (0.36 lb a.i./A), and Limit at 2749 g a.i./hectare (2.5 lb a.i./A). The treatments were applied on May 8, 1991, to 10 ft by 10 ft plots of 'Majestic' Kentucky bluegrass. The treatments were replicated three times. The entire test area was mowed at a 2 in mowing height twice after treatment. Quality ratings based on color, uniformity, and density were made on a scale of 9 to 1: 9 = best, 6 = acceptable, and 1 = worst, beginning 14 days after treatment (DAT).

Beginning 21 days after treatment, one-half of each treated plot was mowed and fresh weight of clippings was determined. Height of growth from the newly mowed area to the top of the unmowed canopy was measured following each weekly mowing. Quality ratings, height measurements, and clipping weights were taken weekly through the 49th day after treatment.

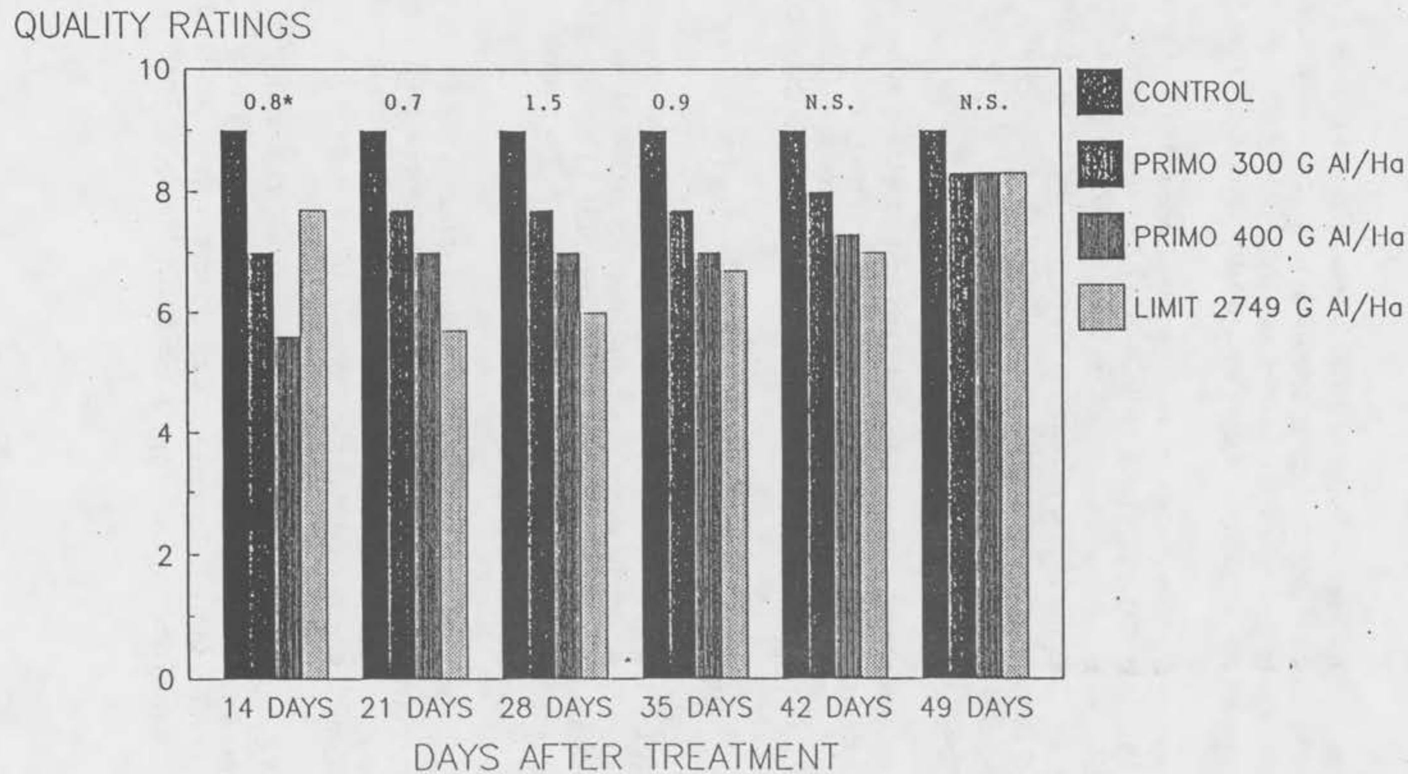
The three treated plots were observed to have lower quality ratings than the control up to the beginning of the study (Fig. 5). Clipping weight (Fig. 6) was reduced by the treatments through the 28th DAT, but by the 35th day the clipping weights from treated plots exceeded that of the control. This type of slight post-inhibition growth is often observed on grasses that have been treated with growth-regulating compounds. The high clipping yield for the plot treated with the higher rate of Primo at the 49th day is likely due to a higher rate of moisture in one of the replications.

Height of the canopy was reduced by the treatments through the 49 days of the study (Fig. 7). This, combined with the fact that clipping weight increased after day 35, would indicate that the post-inhibition growth stimulation was due to an increase in density of the stand, and not to an increase in the vertical growth of the leaf blades.

Both Primo and Limit were effective in reducing clipping yields through the 28th DAT. Grass in the plots treated with Primo generally had higher quality ratings than Limit plots, although the differences in quality ratings were generally quite small. Both products would have the potential for reducing clippings in Kentucky bluegrass lawns.

Figure 5.

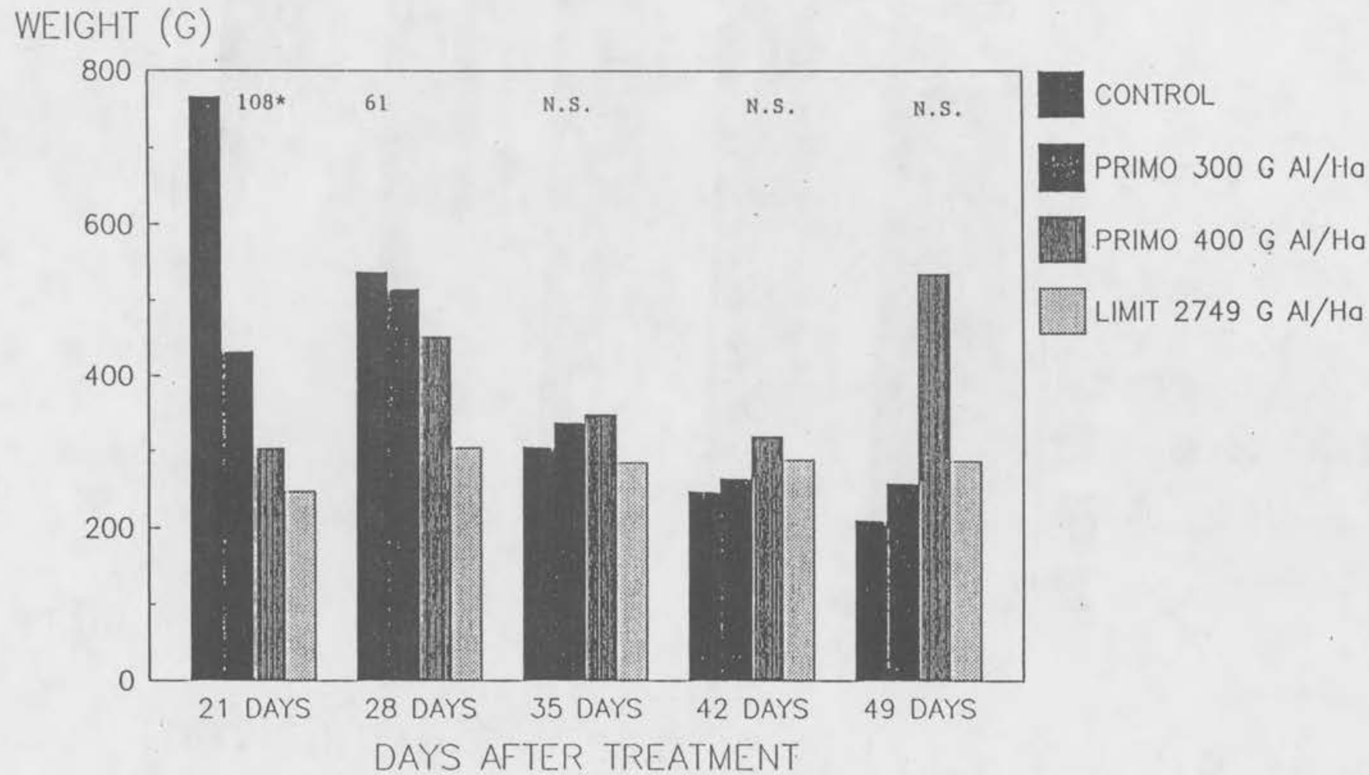
1991 PRIMO GROWTH REGULATOR STUDY



* LSD at the 0.05 level; N.S. = not significant

Figure 6.

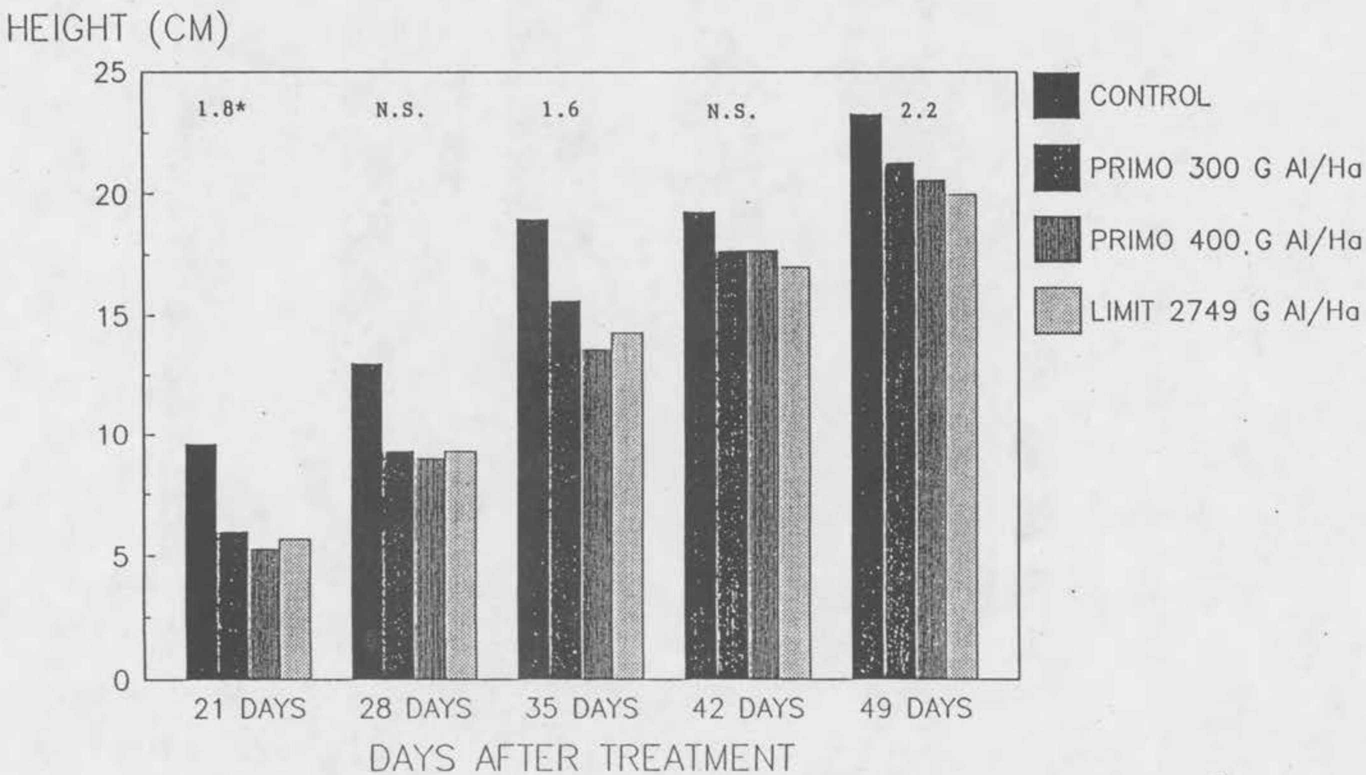
1991 PRIMO GROWTH REGULATOR STUDY



* LSD at the 0.05 level; N.S. = not significant

Figure 7.

1991 PRIMO GROWTH REGULATOR STUDY



* LSD at the 0.05 level; N.S. = not significant

Pesticide and Fertilizer Fate in Turfgrasses

Managed under Golf Course Conditions

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

Various chemicals and nutrients are widely use by the turfgrass industry to maintain a high quality stand of turf. Runoff and leaching of fertilizers and pesticides from golf courses and recreational, agricultural, municipal, and industrial operations are perceived by the public to have possible detrimental effects on the environment. The first phase of this research project was to study the fate of nitrogen and phosphorus when applied to a golf course fairway. This three-year project is being funded by the United States Golf Association (USGA).

The objectives this study were to (1) investigate the hydrology of an undisturbed soil column under a heavy and light irrigation scheme; (2) quantify the fate of nitrogen when it is applied to an undisturbed soil column covered with turf, using nitrogen with an atomic weight of 15, nitrogen-15, (99.6% of naturally occurring nitrogen has an atomic weight of 14) as a tracer; and (3) to study the movement of phosphorus when applied to an undisturbed soil column.

Undisturbed (macropores still intact, worm holes, soil cracks, etc.) soil columns were collected at the Horticulture Station. An area with a well-established stand of turf grown to fairway height was used for the collection of the soil columns. The undisturbed soil columns were brought into the greenhouse in November, 1990, and testing started in February, 1991.

The one-week testing procedure started with an application of nitrogen and phosphorous to the turf. The source of nitrogen was urea and the phosphorous source was calcium phosphate. To distinguish between nitrogen that was stored in the soil and nitrogen that was applied, the urea was labeled with nitrogen-15. To determine the effects of irrigation rates, two watering schemes were used. Treatment 1 was an application of 1 in of water immediately after the nutrients were applied and treatment 2 was 4 separate 1/4-in applications distributed throughout the one-week test period. Volatilized ammonia was collected. Soil water that leached through the column was collected and tested for nitrogen and phosphorus at the end of the test period. The soil and vegetative materials were dried and sent to the analytical lab for testing.

Fig. 8 shows the fractions of applied nitrogen found for each individual column. The average total nitrogen recovery was 75%. Denitrification was not determined due to complexity of determination. A comparison between the two treatments is shown in Fig. 9. The majority of the applied nitrogen was found in the 0-10 cm soil layer. Treatment 1 contains considerably more nitrogen below 30 cm compared to treatment 2. Figs. 10 and 11 represent the nitrogen found in the form of nitrate. A similar trend of more nitrate nitrogen being transported below 30 cm was evident in columns receiving irrigation treatment 1.

Fig. 12 represents the phosphorus found in the soil for the two treatments. Some phosphorus was transported below 20 cm. Phosphorus is considered relatively immobile in soil, but phosphorus was found in the leachate for 5 of the 7 soil columns under treatment 1. This shows the importance of properly controlled irrigation.

Summarizing the results of this project:

- *** Volatilization is negligible if irrigation is applied immediately.
- *** Macropores play a major role in transport of surface-applied chemicals through the soil profile
- *** One 1-in application of irrigation significantly increases the transport of N below 12 in compared to four 1/4-in applications.
- *** P is transported below 8 in with heavy irrigation after application.

A second set of columns were collected in October, 1991. The fate of Trimec, pendimethalin, Subdue, Triumph, and Dursban will be included during 1992-1993. Field studies are being performed to study the fate of nitrogen and pesticides when applied to turfgrass.

Figure 8.

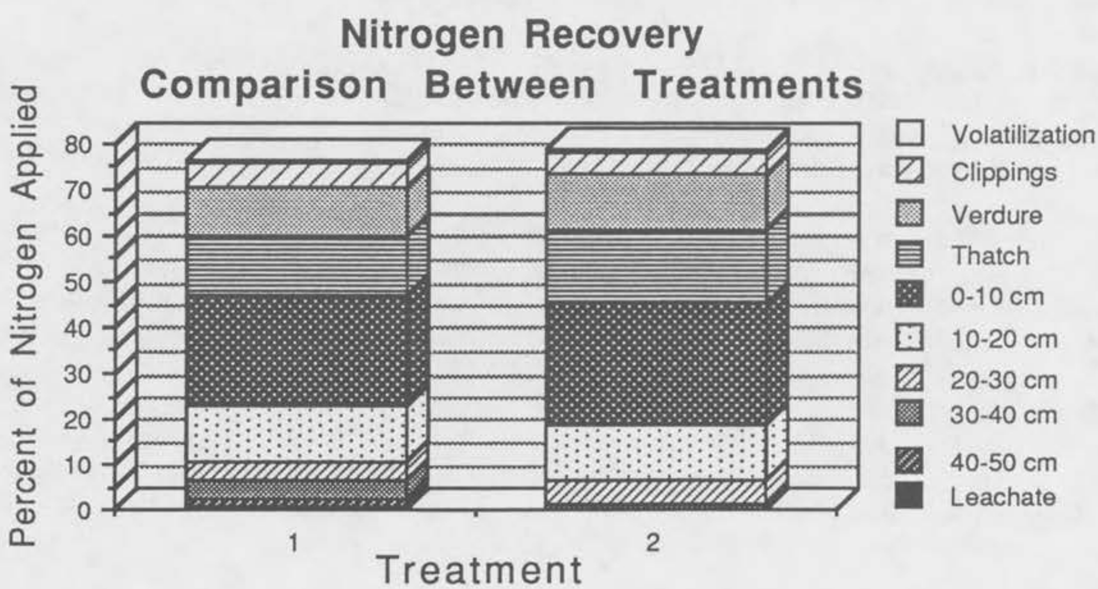


Figure 9.

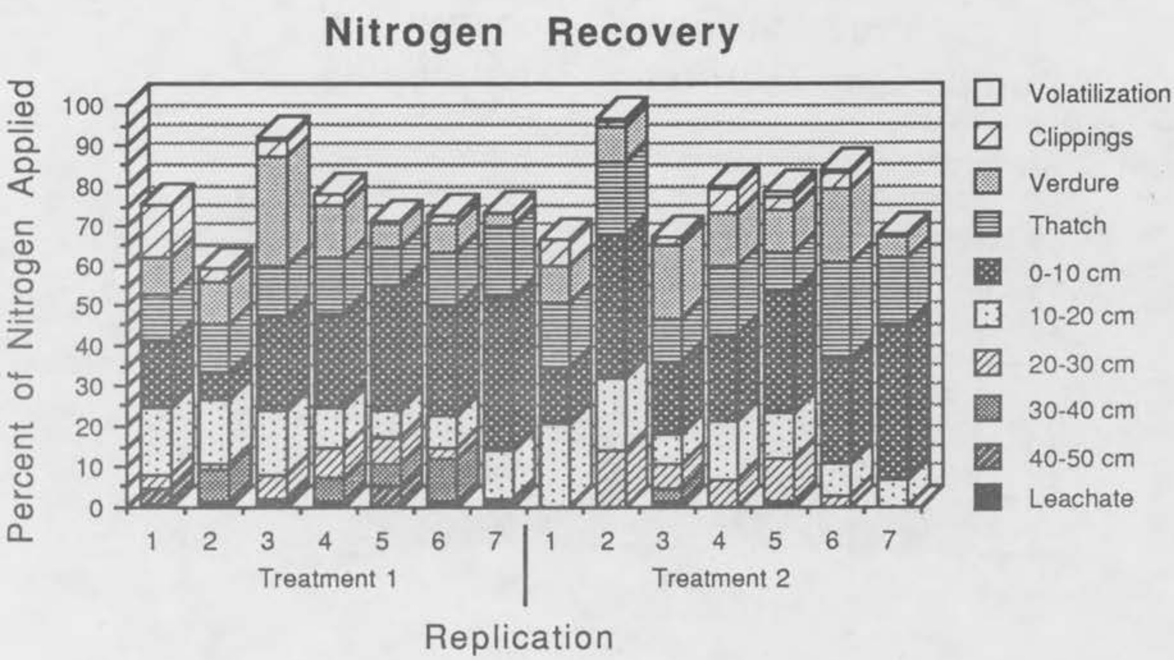


Figure 10.

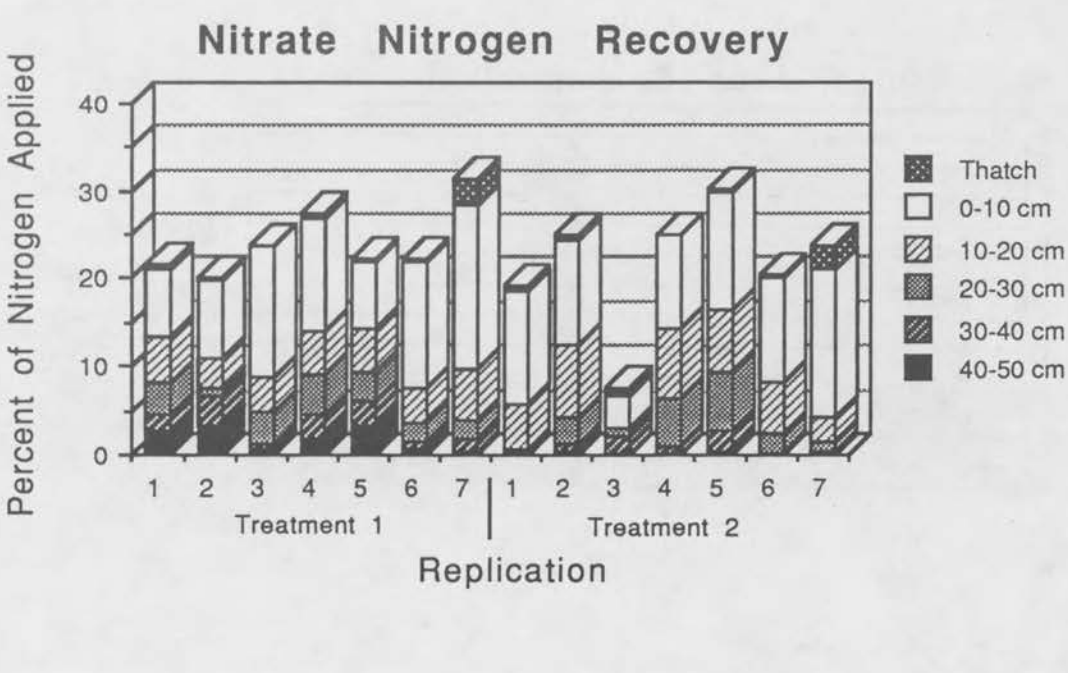


Figure 11.

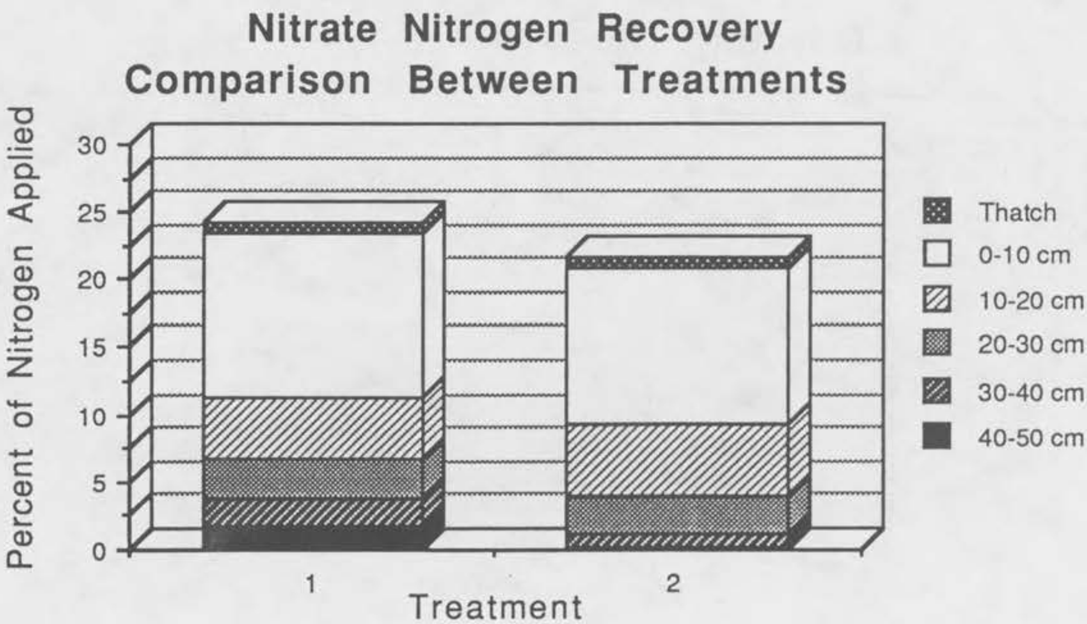
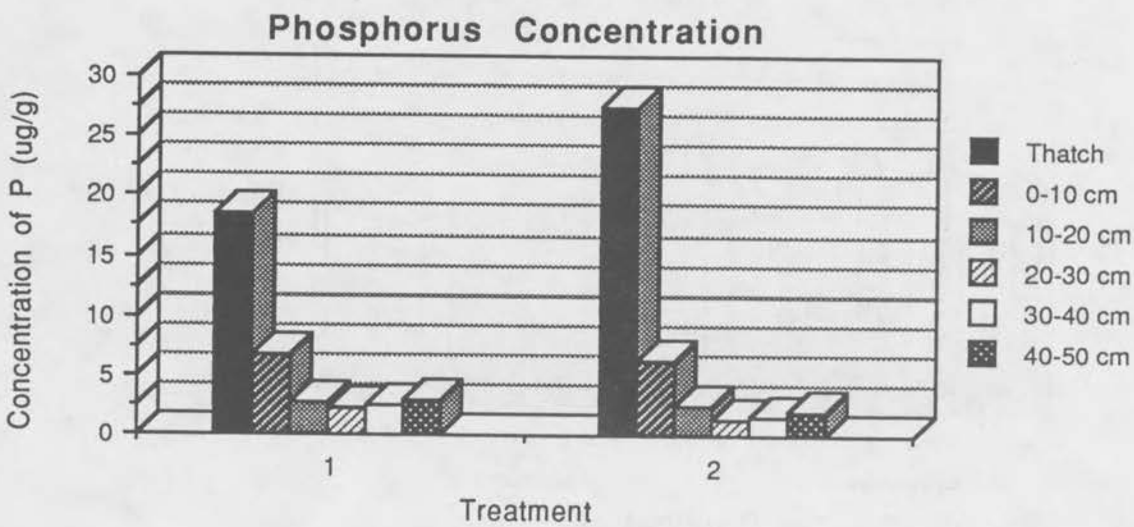


Figure 12.



Drift of Postemergence Herbicide Spray during a Turfgrass Application

H. Hatterman-Valenti, M. Owen, and N. 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 residental 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 were 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 66). 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 67, 68 and 69). 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 66. Percent of application volume lost to drift.

Nozzle Type	Distance Downwind 30 cm	90 cm	150 cm	210 cm
Fluorescein Dye Collected on Tomato				
Flat fan	5.63	1.83	0.72	0.69
Swirl chamber	4.37	0.61	0.49	0.31
Spray gun	1.03	0.17	0.15	0.08
Fluorescein Dye Collected on Mylar				
Flat fan	27.91	4.83	4.02	2.77
Swirl chamber	21.13	2.75	1.41	0.91
Spray gun	10.24	0.49	0.30	0.25

Table 67. Mean increase in tomato height 4 weeks after treatment.

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

[a]$LSD_{(0.05)} = 5.1$
*$LSD_{(0.05)} = 3.1$

Table 68. Mean increase in tomato weight 4 weeks after treatment.

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

[a]$LSD_{(0.05)} = 17.5$
*$LSD_{(0.05)} = 16.7$

Table 69. Mean percent injury to tomato 4 weeks after treatment.

	Distance Downwind			
Nozzle Type	30 cm	90 cm	150 cm	210 cm
Flat fan	61.11	41.11	26.39	14.78
Swirl chamber	61.38	7.50	2.22	0.28
Spray gun	8.61	2.50	0.01	0.28

Isolation and Identification of Allelopathic Compounds from Wet Milling Corn By-products

D. L. Liu and N. E. Christians

Allelopathy is a term used to describe a chemical interaction among plants. It refers to the effects of higher plants of one species (the donor) on the germination, growth, or development of plants of another (receptor) species. The effect which includes both inhibitory and stimulatory influences is exerted through release of a chemical by the donor. Several chemical groups have been implicated as allelopathic agents. They have an important role in crop production and crop protection. To access the chemical specificity for allelopathy, identification of the causal agents is required.

Based on earlier studies, there is a possibility that allelopathic compounds exist in corn that inhibit the establishment of a variety of plant species by inhibiting root formation during germination. It will be environmentally and economically desirable to exploit the phenomenon of allelopathy in corn products as a potential alternative to conventional herbicides. If the purification method of extracting the allelopathic compounds can be established, it could potentially be marketed as a naturally occurring, environmentally safe herbicide and produced in large quantities. This could lead to the development of other related compounds.

The purposes of this study are to evaluate the phytotoxicity of various corn by-products, to extract and purify the allelopathic compound(s) from the selected products, and to identify the chemical structure(s) of the allelopathic compound(s).

Ground Ivy Control with Borax

H. Hatterman-Valenti and N. Christians

Borax (sodium tetraborate) has been used as an herbicide since the 1950s. Its general herbicidal use is non-selective vegetation control under asphalt or spot treatment of johnsongrass in cotton. For these uses, the application rate ranges from 5 to 15 lb/100 ft^2, depending on which form (i.e. anhydrous, pentahydrate, or decahydrate) is used. The element in borax which is responsible for the physiological action in higher plants is boron. Boron is an essential mineral element for all vascular plants. It is absorbed by plant roots and functions in lignification and xylem differentiation. A rapid response to boron deficiency is the inhibition of primary and lateral root growth. Boron deficiency can also cause a number of other symptoms. However, it is the toxicity from high levels of boron that has an herbicidal effect. Sensitivity to boron varies greatly between species, and there is often a narrow concentration range between boron deficiency and toxicity. Typical toxicity symptoms on mature leaves are marginal and/or tip chlorosis and necrosis. Dicots are generally more sensitive to boron than monocots, yet many exceptions have been reported in plant nutrition textbooks. This study was conducted in order to investigate the use of borax to selectively control ground ivy in a cool-season lawn.

Twenty MuleTeam Borax® was used for the boron source in the study. A weedy control and 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. The experimental design was a randomized complete-block with three replications. Individual plot dimensions were 5 ft 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

Herbicide applications were made June 18, 1991. Control and injury ratings were taken June 27, July 17, and finally on October 3, 1991. One week after the applications, visual injury symptoms to the ground ivy were evident with the 10 and 20 oz borax solutions, on both the ground ivy and turfgrass. As time progressed, ground ivy control improved so that by October 3 all borax applications and the Super Trimec® provided at least 93% control. Ground ivy within the control plots also decreased over the summer either due to environmental stress or the lateral movement of the borax during heavy rains. Injury to the turfgrass was observed with most of the borax treatments. However, turfgrass injury did diminish with time.

Table 70. Ground ivy control in a cool-season turfgrass.

Treatment[a]	% Ground Ivy Reduction			% Injury to Turf		
	6/27	7/17	10/3	6/27	7/17	10/3
5 oz L. Borax	68	73	98	10	3	5
10 oz L. Borax	93	80	93	30	18	12
20 oz L. Borax	97	92	100	40	13	10
Super Trimec	72	95	100	8	10	2
20 oz D. Borax	52	57	94	18	13	12
Sharpshooter	17	30	63	17	10	8
Weedy Control	0	0	45	0	0	0
$LSD_{(0.05)}$	18	24	47	NS*	22	20

[a]L. Borax = Liquid borax solution; D. Borax = Dry borax.
*NS = Not significant

Organic Lawn Care Trial

S. M. Berkenbosch, N. E. Christians, and M. L. Agnew

This was the second year for this trial located in Ames on the corner of 13th Street and Haber Road. The study was established in 1990 with the objective to observe the effects of two "no pesticide" natural organic fertilizer products at split rates and one complete fertilizer system, using a home-lawn scenario including herbicides and insecticides. This study is being conducted under non-irrigated conditions.

The treatments included:

- Scotts Complete 4-Step Program (4 lb N/1000 ft^2)
- Corn gluten meal -- 4 lb N/1000 ft^2 applied in spring
- Corn gluten meal -- split treatments of 2 lb N spring and 2 lb N late summer
- Ringer 10-2-6 -- 4 lb N/1000 ft^2 applied in spring
- Ringer 10-2-6 -- split treatment of 2 lb N spring and 2 lb N late summer

The study contained three control plots and was replicated three times in a randomized complete-block design. All plots were mowed weekly by University Student Housing Department maintenance personnel.

The study went into partial dormancy during midsummer. When the data was averaged, it was found that corn gluten meal applied at a 4 lb spring application and Scotts 4-Step Complete Program had the best weed control and green-up response. Ringer 10-2-6 applied at the 4 lb N rate and split application of 2 lb spring and fall showed good green-up response but had no weed control. Corn gluten meal applied at a split 2 lb N rate had less green-up but still had above average weed control. Visual quality ratings were based on a visual scale of 9 to 1: 9 = dense, dark green turf, 6 = minimum acceptable quality, and 1 = straw brown turfgrass.

Table 71. Natural organic fertilizer trial results, 1991.

	Fertilizer Source	Spring	Summer	Fall	Mean
1	Corn gluten meal (4 lb spring)	6.7	8.0	6.3	7.0
2	Scotts Complete	7.0	6.7	5.7	6.4
3	Ringer (4 lb spring)	6.7	7.0	5.3	6.3
4	Ringer (split application)	6.0	6.3	5.7	6.0
5	Corn gluten meal (split application)	6.0	6.0	5.7	5.9
6	Control	5.0	5.3	5.0	5.1

Introducing

Iowa State University Personnel
Affiliated with the Turfgrass Research Program

Dr. Michael Agnew	Associate Professor, Extension Turfgrass Specialist Horticulture Department
Mr. Dave Anderson	Graduate Student and Research Associate Horticulture Department M.S. (Agnew, M)
Ms. Susan Berkenbosch	Extension Associate, Horticulture Department
Mr. Tim Bormann	Field Technician, Horticulture Department
Mr. Doug Campbell	Research Associate, Horticulture Department
Dr. Nick Christians	Professor, Turfgrass Science Research and Teaching Horticulture Department
Ms. Kathy Eldridge	Field Technician, Horticulture Department
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Companies and Organizations That Made Donations

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