Iowa Turfgrass Research Report







2000

IOWA STATE UNIVERSITY
University Extension
Ames, Iowa

FG-466/July 2000

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

In Cooperation with the
Iowa Turfgrass Institute

Field Day Program - July 13, 2000

9:00 a.m. **Introductory Remarks** - Registration Tent

9:30 a.m. **<u>CHOICE OF FOUR TOURS</u>**

All tours start from registration area. See following two pages for specific topics, speakers, times, and locations.

See following two pages

Tour #1 **Lawn Care & Grounds** -- Variety trials: bluegrass, ryegrass, fescue. Seed establishment, shade study, weed control, disease control.

Tour #2 **Golf Course** -- Bentgrass varieties, fairway height Kentucky bluegrass, weed control, sloped green study, disease control, plant growth regulators, seed establishment.

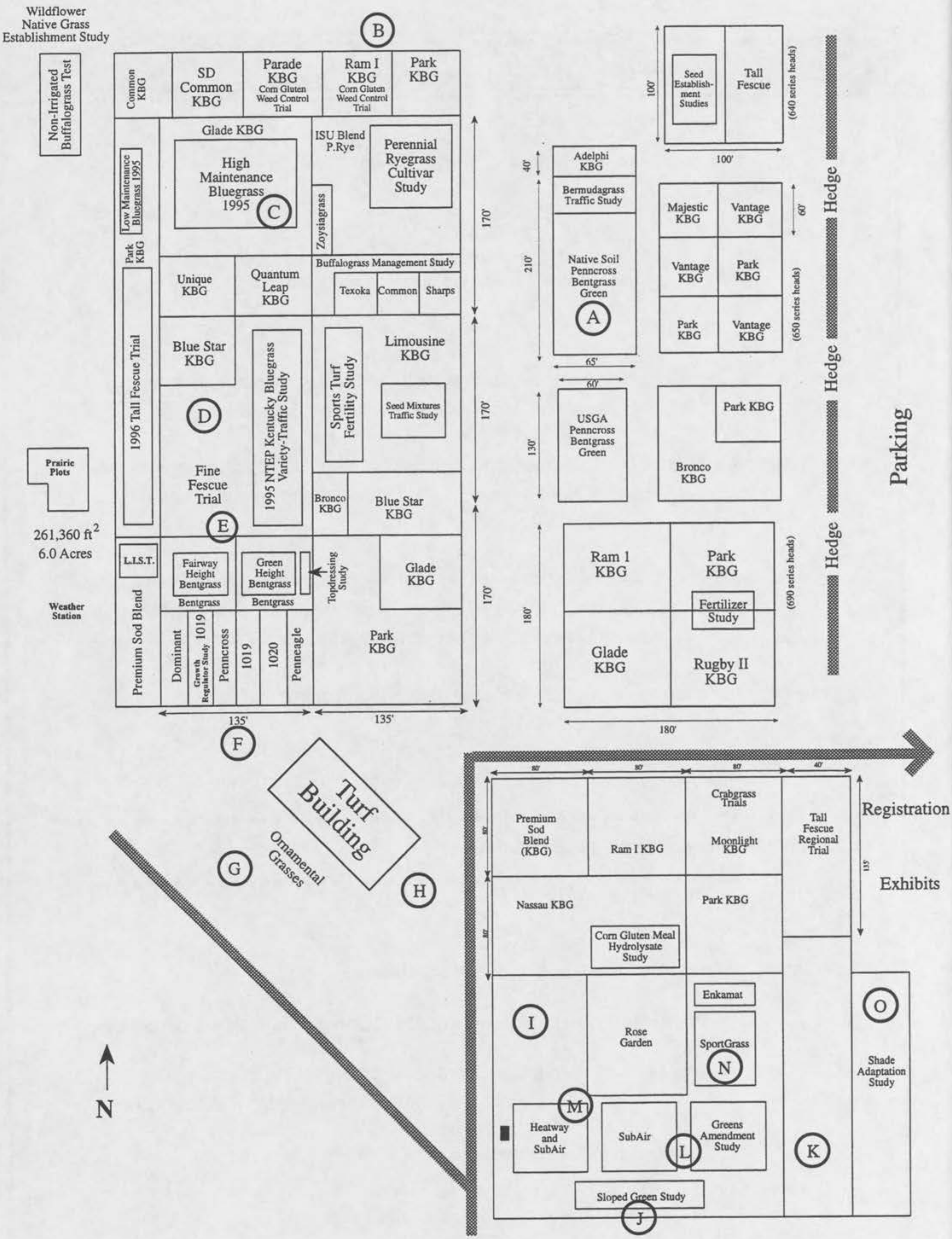
Tour #3 **Sports Turf** -- Variety trials: bluegrass, ryegrass, fescue. SportGrass and Enkamat, tarp color demonstration, bermudagrass/ryegrass, crabgrass control, disease control, seed establishment.

Tour #4 **Landscape** -- Selection and care of landscape plants for Iowa.

11:30 a.m. **Lunch (Served in Exhibit Area)**

1:00 p.m. **Educational Sessions and Demonstrations**

- **Pesticide Recertification Cont. Ed. Course (2 hours)** -- Main Building
- **Turf I.D. and Weed, Disease & Insect Control Tour** -- Dr. Dave Minner and Dr. Nick Christians
- **Vendors and Equipment** -- Exhibit Area


Wildflower
Native Grass
Establishment Study
Non-Irrigated Buffalograss Test
B
Common KBG
SD Common KBG
Parade KBG Corn Gluten Weed Control Trial
Ram I KBG Corn Gluten Weed Control Trial
Park KBG
Glade KBG
High Maintenance Bluegrass 1995
C
ISU Blend P.Rye
Perennial Ryegrass Cultivar Study
Zoysiagrass
Low Maintenance Bluegrass 1995
Park KBG
Unique KBG
Quantum Leap KBG
Buffalograss Management Study
Texoka
Common
Sharps
1996 Tall Fescue Trial
Blue Star KBG
1995 NTEP Kentucky Bluegrass Variety-Traffic Study
Sports Turf Fertility Study
Limousine KBG
Seed Mixtures Traffic Study
D
Fine Fescue Trial
E
Bronco KBG
Blue Star KBG
Prairie Plots
261,360 ft²
6.0 Acres
L.I.S.T.
Fairway Height Bentgrass
Green Height Bentgrass
Topdressing Study
Glade KBG
Bentgrass
Bentgrass
Weather Station
Premium Sod Blend
Dominant
1019
Growth Regulator Study
Penncross
1019
1020
Penneagle
Park KBG
170'
170'
170'
135'
135'
F
Turf Building
Ornamental Grasses
G
H
Seed Establishment Studies
Tall Fescue
100'
100'
(640 series heads)
Adelphi KBG
40'
Bermudagrass Traffic Study
210'
Native Soil Penncross Bentgrass Green
A
65'
Majestic KBG
Vantage KBG
60'
Vantage KBG
Park KBG
Park KBG
Vantage KBG
(650 series heads)
Hedge
Hedge
Hedge
Hedge
60'
130'
USGA Penncross Bentgrass Green
Park KBG
Bronco KBG
Parking
180'
Ram 1 KBG
Park KBG
Fertilizer Study
Glade KBG
Rugby II KBG
(690 series heads)
180'
80'
80'
80'
40'
Premium Sod Blend (KBG)
Ram I KBG
Crabgrass Trials
Moonlight KBG
Tall Fescue Regional Trial
Registration
Exhibits
135'
Nassau KBG
Park KBG
Corn Gluten Meal Hydrolysate Study
Enkamat
I
Rose Garden
SportGrass
N
O
Shade Adaptation Study
M
Heatway and SubAir
SubAir
L
Greens Amendment Study
K
Sloped Green Study
J
N

Time	Lawn Care/Grounds Tour	Golf Course Tour	Sports Turf Tour	Landscape Tour
9:30	O - Shade Adaptation Study *Troy Oster & Nick Christians*	A - Disease control *Stephen Wegulo*	N - Cool-season grasses/SportGrass *Jay Hudson*	Selection and care of landscape plants for Iowa. *Eldon Everhart* *Patrick O'Malley*
9:45	I - Crabgrass control *Barbara Bingaman*	E - Fairway grasses *Nick Christians*	M - *Poa supina*/bermudagrass *Dave Minner*	
10:00	H - Insecticides/insect update *Donald Lewis*	F - Mowing quality *Mark Howieson*	I - Crabgrass control *Barbara Bingaman*	
10:15	G - Ornamental grasses *Heather McDorman & Nick Christians*	I - Crabgrass control *Barbara Bingaman*	J - Topdressing amend./sloped green *Dave Minner*	
10:30	D - Tall and fine fescue NTEP trials *Gary Peterson*	J - Topdressing amend./sloped green *Dave Minner*	H - Insecticides/insect update *Donald Lewis*	
10:45	B - Broadleaf weed control *Barbara Bingaman*	K - Inorganic soil amendments *Deying Li*	F - Mowing quality *Mark Howieson*	
11:00	A - Disease control *Stephen Wegulo*	L - Calcium fertility/bent. greens *Rodney St. John*	B - Broadleaf weed control *Barbara Bingaman*	
11:15	C - Grass varieties for lawn care *Nick Christians*	M - *Poa supina*/bermudagrass *Dave Minner*	A - Disease control *Stephen Wegulo*	

Station	Speaker	Topic
A	Stephen Wegulo, ISU Plant Pathology	Disease control studies – pythium, dollar spot, and summer patch.
B	Barbara Bingaman, ISU Horticulture	Broadleaf weed control.
C	Nick Christians, ISU Horticulture	Grass varieties for lawn care.
D	Gary Peterson, ISU Extension	Tall fescue and fine fescue NTEP variety trials.
E	Nick Christians, ISU Horticulture	Fairway grasses.
F	Mark Howieson, ISU Horticulture	Mowing quality.
G	Heather McDorman & Nick Christians, ISU Horticulture	Ornamental grasses.
H	Donald Lewis, ISU Entomology	Insecticides/insect update.
I	Barbara Bingaman, ISU Horticulture	Pre- and postemergence control of crabgrass.
J	Dave Minner, ISU Horticulture	Topdressing amendments - sloped green.
K	Deying Li, ISU Horticulture	Inorganic soil amendments.
L	Rodney St. John, ISU Horticulture	Calcium fertility on bentgrass greens.
M	Dave Minner, ISU Horticulture	*Poa supina* and bermudagrass for athletic fields.
N	Jay Hudson, ISU Horticulture	Managing cool-season grasses as part of a SportGrass system.
O	Troy Oster & Nick Christians, ISU Horticulture	Shade adaptation study.

Introduction

Nick E. Christians and David D. Minner

The following research report is the 21st 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. This is the fourth year that the entire report is available on the Internet. This report and the 3 previous years' reports can be accessed at:

http://www.hort.iastate.edu/pages/pubs/p_frame.html

Several new projects were started in the 1999 season. The perennial ryegrass trial was replaced with a new trial that includes the latest cultivars. A new non-irrigated fairway-height Kentucky bluegrass trial was also established. This is in addition to the irrigated fairway height bluegrass study that was established in 1998. New areas of *Poa supina* and seeded bermudagrass were established for evaluation under sports turf conditions in the spring and summer of 2000. The Heatway study which was established in 1997 is also being used to evaluate bermudagrass survival in winter conditions.

We would like to acknowledge Will Emley, new superintendent of the ISU Horticulture Research Station; Rod St. John, manager of the turf research area; Barbara Bingaman, Postdoctoral researcher; Doug Campbell, research associate; Dr. Young Joo, visiting scientist; Jay Hudson, Deying Li, Mark Howieson, Troy Oster, and Melissa McDade, graduate students; and all others employed at the field research area in the past year for their efforts in building the turf program.

Special thanks to Lois Benning for her work in typing and helping to edit this publication.

Edited by Nick Christians and David Minner, Iowa State University, Department of Horticulture, Ames, IA 50011-1100.

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Weather Data for the Iowa State University Research Station January 1 to December 31, 1999

January	Rainfall (inches)	High (F°)	Low (F°)
1	0.00	12	-3
2	0.00	18	12
3	0.00	15	-2
4	0.00	-2	-25
5	0.00	21	-25
6	0.00	23	-8
7	0.00	5	-10
8	0.00	10	-5
9	0.00	10	-19
10	0.00	14	2
11	0.00	24	6
12	0.00	20	7
13	0.00	14	5
14	0.00	22	13
15	0.00	33	11
16	0.04	50	22
17	0.11	36	23
18	0.00	33	9
19	0.00	34	6
20	0.00	34	13
21	0.08	36	24
22	0.01	35	32
23	0.00	32	29
24	0.00	33	21
25	0.00	24	10
26	0.00	34	21
27	0.00	38	28
28	0.00	29	23
29	0.00	29	21
30	0.00	34	21
31	0.00	37	30

February	Rainfall (inches)	High (F°)	Low (F°)
1	0.02	36	32
2	0.02	43	27
3	0.00	48	31
4	0.00	31	17
5	0.00	57	27
6	0.00	39	26
7	0.00	50	29
8	0.00	59	36
9	0.00	55	28
10	0.00	63	37
11	0.02	60	22
12	0.00	26	19
13	0.11	36	13
14	0.00	55	28
15	0.00	56	33
16	0.00	34	25
17	0.00	32	22
18	0.02	31	25
19	0.03	33	20
20	0.00	29	23
21	0.00	37	14
22	0.00	31	20
23	0.06	31	24
24	0.00	34	17
25	0.01	46	17
26	0.00	38	30
27	0.01	46	32
28	0.00	40	29

March	Rainfall (inches)	High (F°)	Low (F°)
1	0.00	60	26
2	0.04	46	26
3	0.00	36	19
4	0.00	46	22
5	0.00	36	29
6	0.00	31	20
7	0.00	33	16
8	0.00	29	22
9	0.17	34	27
10	0.00	33	24
11	0.00	38	24
12	0.00	38	17
13	0.00	40	24
14	0.00	47	22
15	0.00	50	25
16	0.00	64	35
17	0.00	58	34
18	0.00	48	27
19	0.00	56	22
20	0.00	61	28
21	0.00	51	27
22	0.00	49	22
23	0.00	59	19
24	0.00	47	27
25	0.00	50	19
26	0.00	55	22
27	0.00	63	30
28	0.27	57	38
29	0.00	65	35
30	0.00	73	45
31	0.00	60	51

April	Rainfall (inches)	High (F°)	Low (F°)
1	0.00	71	51
2	0.03	67	38
3	0.49	73	45
4	0.00	63	35
5	0.76	55	44
6	0.01	60	38
7	0.00	75	44
8	1.77	55	45
9	0.05	50	42
10	0.02	56	41
11	0.00	51	35
12	0.00	62	31
13	0.00	64	47
14	0.01	61	45
15	0.73	48	36
16	0.15	36	31
17	0.00	49	35
18	0.00	54	31
19	0.02	64	38
20	0.01	67	38
21	0.33	62	43
22	1.51	52	42
23	0.01	57	38
24	0.00	61	42
25	0.00	63	42
26	0.02	64	49
27	0.18	56	49
28	0.00	63	48
29	0.00	68	45
30	0.00	73	36

May	Rainfall (inches)	High (F°)	Low (F°)
1	0.00	72	38
2	0.00	74	47
3	0.00	76	57
4	0.09	70	61
5	0.01	62	49
6	0.12	56	49
7	0.30	52	48
8	0.00	52	42
9	0.00	70	34
10	0.00	82	56
11	0.83	69	51
12	1.25	55	50
13	0.00	57	49
14	0.00	69	47
15	0.13	66	57
16	0.30	80	60
17	0.19	65	56
18	0.00	70	49
19	0.00	77	53
20	0.00	72	61
21	1.41	73	57
22	0.01	78	51
23	0.00	64	51
24	0.00	67	49
25	0.00	71	47
26	0.00	78	41
27	0.01	84	49
28	0.00	85	58
29	0.00	81	55
30	0.07	82	60
31	0.01	71	55

June	Rainfall (inches)	High (F°)	Low (F°)
1	0.47	72	55
2	0.00	77	51
3	0.00	78	55
4	0.88	76	62
5	0.00	87	68
6	0.00	83	73
7	0.00	90	66
8	0.11	88	68
9	0.47	89	65
10	1.54	75	65
11	0.01	78	67
12	0.00	80	54
13	0.00	77	58
14	0.00	72	52
15	0.03	61	50
16	0.00	66	48
17	0.00	74	45
18	0.00	72	54
19	0.00	74	59
20	0.00	81	64
21	0.00	84	67
22	0.15	82	68
23	1.20	82	66
24	0.00	88	63
25	0.00	88	66
26	0.00	87	67
27	0.15	80	66
28	0.00	74	59
29	0.00	73	53
30	0.11	76	59

July	Rainfall (inches)	High (F°)	Low (F°)
1	0.00	78	60
2	0.81	80	61
3	0.00	90	76
4	0.00	91	76
5	0.47	92	74
6	0.00	83	63
7	0.00	87	70
8	0.48	91	66
9	0.00	82	64
10	0.00	77	57
11	0.00	82	55
12	0.00	81	55
13	0.00	83	62
14	0.00	87	68
15	0.00	91	69
16	0.58	81	68
17	0.21	86	64
18	0.48	90	69
19	1.70	93	75
20	0.00	93	55
21	0.07	94	74
22	0.00	96	76
23	0.26	89	73
24	0.00	94	72
25	0.00	97	76
26	0.70	89	74
27	0.00	91	73
28	0.00	97	70
29	0.00	97	77
30	0.28	95	78
31	0.40	83	66

August	Rainfall (inches)	High (F°)	Low (F°)
1	0.00	78	62
2	0.00	80	58
3	0.00	81	58
4	0.05	81	60
5	0.00	84	56
6	0.93	82	60
7	0.00	78	64
8	0.00	76	59
9	0.00	83	57
10	0.00	86	64
11	0.26	79	65
12	0.02	88	66
13	0.02	71	54
14	0.00	74	49
15	0.01	81	57
16	0.00	88	63
17	1.15	89	56
18	0.68	78	65
19	0.00	76	59
20	0.00	79	55
21	0.00	82	64
22	0.75	79	63
23	0.00	79	60
24	0.00	76	59
25	0.00	85	59
26	0.00	86	62
27	0.00	88	62
28	0.00	91	66
29	0.00	80	65
30	0.00	76	57
31	0.00	81	60

September	Rainfall (inches)	High (F°)	Low (F°)
1	0.02	84	60
2	0.00	91	64
3	0.00	90	68
4	0.20	84	65
5	0.16	75	53
6	0.00	78	51
7	0.79	86	60
8	0.01	75	53
9	0.00	69	49
10	0.00	77	47
11	0.00	81	45
12	0.00	73	51
13	0.00	61	47
14	0.00	68	43
15	0.00	71	38
16	0.00	74	37
17	0.00	73	39
18	0.00	79	46
19	0.00	66	50
20	0.00	59	70
21	0.00	68	31
22	0.00	79	37
23	0.00	87	75
24	0.01	76	48
25	0.00	82	54
26	0.20	72	54
27	0.37	66	52
28	0.00	66	49
29	0.00	64	34
30	0.00	73	40

October	Rainfall (inches)	High (F°)	Low (F°)
1	0.00	58	33
2	0.00	52	35
3	0.20	46	31
4	0.00	96	27
5	0.00	72	39
6	0.00	71	34
7	0.00	77	56
8	0.03	72	46
9	0.00	77	39
10	0.00	71	46
11	0.02	71	36
12	0.00	85	53
13	0.00	58	35
14	0.00	66	34
15	0.00	82	49
16	0.01	60	42
17	0.00	53	28
18	0.00	51	26
19	0.11	50	32
20	0.00	59	26
21	0.00	77	38
22	0.07	58	36
23	0.00	48	26
24	0.00	57	20
25	0.04	71	39
26	0.00	68	30
27	0.00	80	44
28	0.00	65	41
29	0.06	77	47
30	0.00	64	41
31	0.01	70	31

November	Rainfall (inches)	High (F°)	Low (F°)
1	0.00	58	37
2	0.00	47	24
3	0.00	60	19
4	0.00	65	23
5	0.00	58	33
6	0.00	62	30
7	0.00	67	38
8	0.00	80	43
9	0.00	74	56
10	0.00	59	52
11	0.00	52	41
12	0.00	68	34
13	0.00	81	38
14	0.43	54	31
15	0.00	61	25
16	0.00	54	32
17	0.00	56	33
18	0.00	74	41
19	0.02	52	32
20	0.00	49	20
21	0.00	61	36
22	0.03	57	29
23	0.61	44	33
24	0.00	47	28
25	0.00	48	27
26	0.04	47	37
27	0.04	47	31
28	0.00	46	28
29	0.00	43	24
30	0.00	43	25

December	Rainfall (inches)	High (F°)	Low (F°)
1	0.00	51	32
2	0.00	58	44
3	0.15	57	42
4	0.00	43	34
5	0.00	34	20
6	0.00	39	16
7	0.00	50	29
8	0.00	53	48
9	0.00	43	22
10	0.00	41	14
11	0.00	43	20
12	0.00	50	21
13	0.00	46	17
14	0.00	34	22
15	0.00	34	15
16	0.00	22	5
17	0.00	23	10
18	0.02	29	5
19	0.00	32	16
20	0.00	16	-8
21	0.00	10	-13
22	0.00	9	-10
23	0.00	33	-8
24	0.00	23	-1
25	0.11	40	13
26	0.00	38	23
27	0.00	32	10
28	0.00	45	15
29	0.00	56	25
30	0.00	49	24
31	0.00	47	21

Results of Regional Kentucky Bluegrass Cultivar Trials

Rodney A. St. John, Nick E. Christians, and David D. Minner

The United States Department of Agriculture (USDA) has sponsored several regional Kentucky bluegrass cultivar trials conducted at most of the northern agricultural experiment stations. Three trials were underway at Iowa State University during the 1999 season. The first, a high-maintenance study, was established in 1995, receives 4 lb N/1000 ft^2/yr, and is irrigated as needed. The second trial established in 1995, receives 4 lb N/1000 ft^2/yr, is irrigated as needed, and receives 'traffic'. Both studies are mowed at two inches. The third trial established in the fall of 1995, is a low-maintenance study that receives 1 lb of N/1000 ft^2/yr in September and is non-irrigated. The objective of the high-maintenance, irrigated study is to investigate cultivar performance under a cultural regime similar to that used on irrigated home lawns in Iowa. The objective of the second study is to observe cultivar response under conditions similar to those found in irrigated lawns and sports fields that receive substantial traffic wear. The objective of the third study is to evaluate cultivars under conditions similar to those maintained in either a park or school ground.

The values listed under each month in Tables 1 and 2 are the averages of visual quality ratings made on three replicated plots for the three studies. Visual quality was based on a scale of 9 to 1: 9 = best quality, 6 = lowest acceptable quality, and 1 = worst quality. Yearly means of monthly data were taken and are listed in the last column. The first cultivar received the highest average rating for the entire 1999 season. The cultivars are listed in descending order of average quality.

Data for genetic color (Gcol), spring greenup (Grn), and leaf texture (Leaf) also are included for the high-maintenance and for the low-maintenance trials. Genetic color was rated using a 9 to 1 scale with 9 = dark and 1 = light green. Spring greenup was estimated using a 9 to 1 scale with 9 = green and 1 = dormant turf. Leaf texture was assessed with a 9 to 1 scale with 9 = fine and 1 = coarse texture.

Data for the high-maintenance, irrigated traffic study are included in Table 3. The cultivars are listed in descending order according to wear tolerance ratings for the 1999 season. Tolerance was assessed using a 9 to 1 scale with 9 = best and 1 = worst tolerance. The first cultivar listed was the most wear tolerant cultivar. The percentage of fall ground cover (Fcov) data also are included in Table 3.

Table 1. 1999 visual quality[1] and other ratings[2] for the High-maintenance Kentucky Bluegrass Trial.

					Turf quality					
	Cultivar	Gcol	Grn	Leaf	May	June	July	Aug	Sept	Mean
1	Liberator (ZPS-2572)	9.0	6.7	8.0	9.0	9.0	8.0	8.0	8.0	8.4
2	Total Eclipse (TCR-1738)	8.7	6.7	8.0	8.7	8.7	8.0	8.0	8.0	8.3
3	Award	9.0	7.7	7.0	8.7	8.7	7.7	7.7	8.0	8.1
4	Midnight	8.7	6.3	8.0	8.3	8.7	8.0	7.7	8.0	8.1
5	Moonlight (PST-A418)	8.3	6.0	8.0	8.3	9.0	7.7	7.7	7.7	8.1
6	Nuglade	8.3	6.7	8.0	9.0	8.7	7.3	7.7	8.0	8.1
7	Arcadia (J-1936)	8.3	6.3	8.0	8.7	8.7	7.3	7.0	7.7	7.9
8	Odyssey (J-1561)	8.0	5.7	8.3	9.0	9.0	7.0	7.0	7.7	7.9
9	PST-P46	8.0	6.3	8.0	9.0	9.0	7.0	7.0	7.3	7.9
10	Absolute (MED-1497)	8.7	7.0	8.0	9.0	9.0	7.7	6.7	6.7	7.8
11	ASP200 (HV 130)	7.0	5.7	8.0	9.0	8.7	7.3	7.0	7.0	7.8
12	Impact (J-1576)	9.0	7.0	8.0	8.7	8.3	7.0	7.0	8.0	7.8
13	NJ 1190	6.7	8.0	8.3	8.7	8.7	7.7	7.0	6.7	7.7
14	Quantum Leap (J-1567)	8.3	7.0	8.0	8.3	8.3	7.0	7.0	7.7	7.7
15	SR 2000	8.3	7.0	7.3	7.7	8.0	7.7	7.7	7.7	7.7
16	Wildwood	8.0	5.7	8.7	8.7	8.3	6.7	7.0	7.7	7.7
17	ZPS-2183	7.3	8.0	7.3	9.0	9.0	7.3	6.7	6.3	7.7
18	Rugby II (MED-18)	8.3	6.0	8.0	8.7	8.0	7.0	6.7	7.7	7.6
19	Ascot	7.7	6.3	8.0	8.3	9.0	6.3	6.3	7.3	7.5
20	BA 73-3738.3	8.3	6.3	8.0	8.3	8.3	7.0	7.0	7.0	7.5
21	BA 75-163	8.3	6.0	8.0	8.0	8.0	7.0	7.0	7.7	7.5
22	Fortuna	8.3	6.0	8.0	7.7	7.7	7.3	7.3	7.3	7.5
23	Glade	7.7	6.7	8.0	8.7	7.7	6.7	7.0	7.3	7.5
24	H86-690	8.0	7.3	8.0	8.0	7.7	7.3	7.3	7.0	7.5
25	Lipoa	7.3	6.0	8.0	8.3	8.0	7.0	7.0	7.0	7.5
26	Pick 8	7.7	7.0	8.0	8.0	8.3	7.3	7.0	7.0	7.5
27	Serene (PST-A7-245A)	7.0	6.3	7.7	8.7	8.3	6.7	6.7	7.0	7.5
28	VB 16015	8.0	6.7	8.0	7.7	8.7	7.0	7.0	7.0	7.5

	Cultivar	Gcol	Grn	Leaf	Turf quality May	June	July	Aug	Sept	Mean
29	Goldrush (BA 87-102)	7.0	6.3	8.0	7.7	8.0	7.3	7.0	7.0	7.4
30	North Star (PST-A7-60)	7.7	5.3	8.0	9.0	8.0	6.3	6.3	7.3	7.4
33	Pick-855	7.3	6.7	8.3	8.0	8.0	7.0	7.0	7.0	7.4
32	Princeton 105	7.3	7.0	8.0	8.0	8.0	7.0	7.0	7.0	7.4
33	Shamrock	7.3	8.0	8.3	8.0	8.0	7.0	7.0	7.0	7.4
34	Sodnet	8.0	7.3	8.3	8.3	8.0	7.0	6.7	7.0	7.4
35	A88-744	8.0	7.7	8.0	7.7	8.0	6.7	7.0	7.3	7.3
36	Abbey	8.0	7.0	8.0	7.3	7.7	7.7	7.0	6.7	7.3
37	BA 70-060	8.3	6.0	8.0	7.7	8.0	7.0	7.0	7.0	7.3
38	BA 77-702	7.3	6.0	8.0	7.7	7.7	7.3	6.7	7.0	7.3
39	Brilliant (PST-B2-42)	7.3	7.3	8.0	7.7	8.3	6.7	6.7	7.0	7.3
40	Cardiff	7.0	7.0	8.0	8.3	8.0	7.0	6.7	6.7	7.3
41	Challenger	8.0	7.7	8.3	8.3	7.7	6.7	6.7	7.3	7.3
42	Champagne (LTP-621)	8.0	7.0	8.0	7.7	8.0	7.0	7.0	7.0	7.3
43	Chateau	7.0	6.7	8.0	8.0	8.7	6.3	6.3	7.0	7.3
44	Dragon (ZPS-429)	8.0	6.3	7.7	7.7	7.7	7.0	7.0	7.0	7.3
45	Explorer (Pick-3561)	7.7	6.3	8.0	8.3	8.0	6.7	6.7	7.0	7.3
46	Misty (BA76-372)	7.7	6.3	8.0	8.0	8.0	6.7	6.7	7.0	7.3
47	Nustar	7.3	6.3	8.0	8.3	7.0	7.0	7.0	7.0	7.3
48	Seabring (BA 79-260)	7.7	6.7	8.0	8.0	8.3	7.0	6.3	6.7	7.3
49	Showcase (PST-BO-131)	7.7	6.3	8.0	7.0	8.0	7.0	7.0	7.7	7.3
50	SR 2100	7.7	6.7	7.7	7.3	7.3	7.3	7.0	7.3	7.3
51	BA 81-058	7.0	7.0	8.0	7.7	7.7	6.7	6.7	7.3	7.2
52	Jewel (BA 81-227)	7.3	6.3	7.7	8.3	8.0	6.3	6.3	7.0	7.2
53	LTP-620	7.3	6.7	8.0	7.7	7.3	7.0	7.0	7.0	7.2
54	SRX 2205	8.0	6.0	8.3	8.7	8.0	6.7	6.3	6.3	7.2
55	America	7.3	6.0	8.0	7.0	7.0	7.0	7.0	7.3	7.1
56	Chicago (J-2582)	6.7	6.0	8.0	7.7	7.7	6.7	6.7	7.0	7.1
57	Envicta (BA 75-173)	8.0	6.0	8.0	7.3	7.7	7.0	6.7	6.7	7.1
58	J-1555	7.7	6.7	8.0	8.0	7.7	6.3	6.3	7.0	7.1
59	NJ-GD	7.0	7.3	8.0	7.7	7.0	7.0	7.0	7.0	7.1
60	PST-BO-165	8.0	7.0	8.0	7.3	7.7	6.7	6.7	7.3	7.1
61	Raven	7.7	6.7	8.0	7.7	7.3	7.0	6.7	6.7	7.1
62	Sidekick	7.3	6.3	8.0	7.3	7.0	7.3	7.0	6.7	7.1
63	SR 2109	7.0	6.3	7.7	8.7	7.3	6.7	6.3	6.7	7.1
64	BA 81-113	7.7	6.7	8.0	7.3	7.0	7.3	6.7	6.7	7.0
65	BA 81-220	8.0	6.3	8.0	7.7	6.7	7.0	6.7	7.0	7.0
66	Coventry	7.0	7.3	7.7	8.3	8.0	6.0	6.0	6.7	7.0
67	LKB-95	7.0	6.7	8.3	8.0	7.7	6.7	6.3	6.3	7.0
68	BA 85-490	7.0	7.7	8.0	7.7	7.3	6.3	6.3	7.0	6.9
69	Blacksburg	7.7	6.0	8.3	8.3	8.0	6.7	5.7	5.7	6.9
70	Compact	6.7	5.7	7.3	7.7	6.7	6.7	6.7	6.7	6.9
71	Eclipse	7.3	6.7	8.0	7.7	7.3	6.3	6.3	7.0	6.9
72	Haga	7.0	7.3	8.0	7.7	6.7	6.7	6.7	6.7	6.9
73	Jefferson	7.0	6.3	8.0	7.3	7.0	6.7	6.7	7.0	6.9
74	MED-1580	7.3	6.3	8.0	8.3	8.0	6.7	5.7	5.7	6.9
75	NJ-54	7.3	6.3	8.0	7.7	7.7	6.3	6.3	6.7	6.9
76	Rambo (J-2579)	7.3	6.0	8.0	7.7	7.7	6.7	6.3	6.3	6.9
77	BA 76-197	7.3	6.0	8.0	7.3	7.3	6.7	6.3	6.3	6.8
78	Baron	7.7	6.7	8.0	8.0	7.0	6.3	6.3	6.3	6.8
79	Bartitia	7.7	6.3	8.3	8.7	7.0	6.3	6.0	6.0	6.8
80	Bluechip (MED-1991)	7.3	6.7	8.0	7.3	6.7	6.7	6.7	6.7	6.8
81	Conni	7.0	5.3	8.3	8.0	7.0	6.7	6.0	6.3	6.8
82	Nimbus	7.0	6.3	7.7	8.3	7.3	6.3	6.0	6.0	6.8
83	Unique	7.3	7.7	8.0	7.3	6.3	6.7	6.7	7.0	6.8
84	Apollo (PST-B3-180)	8.0	6.7	8.0	6.7	6.7	7.0	6.7	6.7	6.7
85	Baruzo	7.3	6.7	8.3	7.7	7.3	5.7	5.7	7.0	6.7

	Cultivar	Gcol	Grn	Leaf	Turf quality May	June	July	Aug	Sept	Mean
86	Classic	6.7	7.0	8.0	6.7	7.0	6.3	6.3	7.0	6.7
87	Livingston	6.7	7.0	8.0	7.0	6.7	6.7	6.3	6.7	6.7
88	Marquis	7.3	6.7	8.0	7.7	6.7	6.7	6.3	6.3	6.7
89	Pepaya (DP 37-192)	7.0	6.0	8.0	7.7	7.7	6.0	5.7	6.3	6.7
90	BA 81-270	7.0	6.7	7.7	8.3	8.0	5.7	5.3	5.7	6.6
91	BAR VB 3115B	6.3	7.0	8.7	7.3	7.3	6.0	6.0	6.3	6.6
92	Baronie	7.3	7.0	8.0	7.0	7.0	6.0	6.0	7.0	6.6
93	Allure	7.3	6.7	8.0	7.7	7.0	6.0	5.7	5.7	6.4
94	Blackstone (PST-638)	7.0	6.7	8.0	8.3	7.0	5.7	5.3	5.7	6.4
95	Kenblue	5.7	8.0	9.0	7.0	6.3	6.3	6.0	6.0	6.3
96	Caliber	6.3	8.0	8.0	7.0	6.3	5.3	5.3	5.7	5.9
97	BAR VB 5649	6.3	5.3	8.0	7.0	6.0	5.7	5.0	5.0	5.7
98	HV 242	6.3	5.0	8.0	7.7	5.7	5.0	4.7	5.0	5.6
99	ZPS-309	5.3	5.3	8.0	7.3	6.0	4.7	4.3	5.3	5.5
100	BAR VB 233	5.3	5.3	7.7	7.7	5.7	4.0	4.0	4.7	5.2
101	Limousine	6.0	6.7	8.0	7.7	5.7	4.7	4.0	4.0	5.2
102	BAR VB 6820	5.7	5.7	8.0	7.7	5.0	4.3	3.7	3.7	4.9
103	Platini	5.7	5.3	8.0	7.0	4.7	4.0	3.7	3.7	4.6
	$LSD_{(0.05)}$	1.2	1.3	0.8	1.1	1.7	1.4	1.4	1.4	1.0

[1]Visual quality was assessed using a scale of 9 to 1 with 9 = best quality, 6 = lowest acceptable quality, and 1 = worst quality.
[2]Genetic color (Gcol) was rated using a 9 to 1 scale with 9 = dark and 1 = light green. Spring greenup (Grn) was determined using a 9 to 1 scale with 9 = green and 1 = dormant. Leaf texture (Leaf) was assessed with a 9 to 1 scale with 9 = fine and 1 = coarse texture.

Table 2. 1999 visual quality[1] and other ratings[2] for the 1995 Low-maintenance Kentucky Bluegrass Trial.

	Cultivar	Gcol	Grn	Leaf	Turf quality May	June	July	Aug	Sept	Oct	Mean
1	Kenblue	5.7	6.7	7.0	6.0	6.0	5.3	6.0	4.7	5.3	5.6
2	BAR VB 3115B	7.0	6.7	6.7	6.3	6.3	6.0	5.7	3.0	5.3	5.4
3	Eagleton	6.3	5.7	6.3	4.7	5.0	4.7	6.0	4.3	4.7	4.9
4	South Dakota	5.7	6.3	7.0	6.0	6.0	6.0	4.3	2.7	4.0	4.8
5	Caliber	6.0	6.3	7.0	6.3	5.3	5.0	5.0	2.0	3.7	4.6
6	VB 16015	5.7	5.3	6.3	4.3	4.7	5.0	4.3	3.3	3.7	4.2
7	BAR VB 233	7.3	5.7	6.3	5.0	5.0	5.0	4.3	2.7	2.7	4.1
8	BH 95-199	6.0	5.7	6.7	4.3	5.0	5.0	4.7	2.0	3.0	4.0
9	Canterbury	6.7	5.3	6.7	5.3	5.3	4.3	3.7	2.7	2.0	3.9
10	Blue Star	7.0	5.7	6.7	5.0	3.7	4.0	4.0	2.7	3.3	3.8
11	Dragon (ZPS-429)	7.0	5.0	6.0	4.7	4.7	4.3	4.0	2.3	2.0	3.7
12	Bartitia	7.7	5.0	6.0	4.0	5.3	4.3	3.7	2.0	2.0	3.6
13	BAR VB 5649	6.7	5.0	5.7	4.0	4.3	3.7	3.7	2.3	2.7	3.4
14	Baruzo	6.7	5.0	6.3	4.0	4.0	3.7	4.0	2.7	2.3	3.4
15	Lipoa	5.0	5.3	6.3	3.7	4.0	4.0	3.3	2.3	3.0	3.4
16	PST-B9-196	6.3	5.3	6.3	3.3	3.3	3.3	3.7	4.0	2.7	3.4
17	MTT 683	6.7	5.0	6.0	3.3	4.0	4.0	3.7	3.0	2.0	3.3
18	North Star (PST-A7-60)	7.3	4.7	6.3	3.0	3.7	4.3	3.3	2.3	3.0	3.3
19	Baronie	5.7	5.0	6.3	3.7	3.7	3.7	3.0	3.0	2.0	3.2
20	BAR VB 6820	6.7	5.0	6.0	2.7	3.3	4.7	3.3	2.7	2.0	3.1
21	Baron	6.0	4.7	6.0	3.0	3.0	4.0	3.7	2.7	2.0	3.1
	$LSD_{0.05}$	1.3	1.4	NS	1.7	1.6	2.2	1.8	NS	2.5	1.4

[1]Visual quality was assessed using a scale of 9 to 1 with 9 = best quality, 6 = lowest acceptable quality, and 1 = worst quality.
[2]Genetic color (Gcol) was rated using a 9 to 1 scale with 9 = dark and 1 = light green. Spring greenup (Grn) was determined using a 9 to 1 scale with 9 = green and 1 = dormant. Leaf texture (Leaf) was assessed with a 9 to 1 scale with 9 = fine and 1 = coarse texture.
NS = means are not significantly different at the 0.05 level

Table 3. 1999 wear tolerance[1] and summer living ground cover[2] for the 1995 High-maintenance Kentucky Bluegrass Traffic Trial.

	Cultivar	Summer ground cover (%)	Wear tolerance
1	BAR VB 3115B	90.0	8.0
2	Ba 81-270	70.0	6.7
3	Serene (PST-A7-245A)	73.3	6.7
4	Coventry	68.3	6.3
5	Kenblue	73.3	6.3
6	LKB-95	65.0	6.0
7	America	65.0	6.0
8	Champagne (LTP-621)	60.0	6.0
9	Rugby II (MED-18)	61.7	6.0
10	Sidekick	63.3	6.0
11	MED-1580	68.3	5.7
12	Bluechip (MED-1991)	58.3	5.7
13	Classic	68.3	5.7
14	Odyssey (J-1561)	60.0	5.7
15	Eclipse	53.3	5.7
16	NuStar	66.7	5.7
17	NJ 1190	63.3	5.7
18	Unique	60.0	5.7
19	Chateau	70.0	5.3
20	Haga	55.0	5.3
21	Ba 75-163	65.0	5.3
22	ASP200 (HV 130)	56.7	5.3
23	NuGlade	56.7	5.3
24	Pick-855	71.7	5.3
25	Ba 70-060	65.0	5.3
26	Ba 75-490	60.0	5.3
27	Seabring (Ba 79-260)	63.3	5.3
28	Ba 81-227	63.3	5.3
29	PST-P46	61.7	5.3
30	PST-B2-42	61.7	5.3
31	Compact	58.3	5.3
32	VB 16015	58.3	5.3
33	Princeton 105	61.7	5.0
34	A88-744	56.7	5.0
35	Wildwood	61.7	5.0
36	Total Eclipse (TCR-1738)	58.3	5.0
37	Rambo (J-2579)	61.7	5.0
38	Chicago (J-2582)	61.7	5.0
39	Quantum Leap (J-1567)	56.7	5.0
40	Liberator (ZPS-2572)	55.0	5.0
41	Ba 75-173	61.7	5.0
42	Moonlight (PST-A418)	53.3	5.0
43	Glade	58.3	5.0
44	Jefferson	53.3	5.0
45	Allure	63.3	5.0
46	Baronie	51.7	5.0
47	Baruzo	45.0	5.0
48	Apollo (PST-B3-180)	55.0	5.0
49	Shamrock	51.7	4.7
50	Ba77-702	43.3	4.7
51	Award	55.0	4.7
52	Limousine	55.0	4.7
53	Explorer (Pick-3561)	56.7	4.7
54	Abbey	46.7	4.7
55	Sodnet	61.7	4.7
56	PST-BO-141	60.0	4.7

	Cultivar	Summer ground cover (%)	Wear tolerance
57	Challenger	46.7	4.7
58	Midnight	55.0	4.7
59	Nimbus	55.0	4.7
60	Cardiff	58.3	4.7
61	Ba 76-197	45.0	4.3
62	Baron	45.0	4.3
63	NJ-GD	55.0	4.3
64	Caliber	51.7	4.3
65	Impact (J-1576)	45.0	4.3
66	Arcadia (J-1936)	56.7	4.3
67	SR 2100	50.0	4.3
68	SR 2109	53.3	4.3
69	SRX 2205	43.3	4.3
70	Ascot	51.7	4.3
71	Ba 73-373	55.0	4.3
72	Misty (Ba 76-372)	48.3	4.3
73	Ba 81-058	45.0	4.3
74	North Star (PST-A7-60)	48.3	4.3
75	Conni	53.3	4.3
76	Fortuna	53.3	4.3
77	NJ-54	51.7	4.3
78	Lipoa	46.7	4.0
79	BAR VB 6820	48.3	4.0
80	Marquis	50.0	4.0
81	HV 242	43.3	4.0
82	Raven	45.0	4.0
83	Pick 8	45.0	4.0
84	J-1555	48.3	4.0
85	Ba 81-220	45.0	4.0
86	H86-690	41.7	4.0
87	LTP-620	46.7	4.0
88	Dragon (ZPS-429)	46.7	4.0
89	Livingston	43.3	4.0
90	Absolute (MED-1497)	43.3	3.7
91	Goldrush (Ba 87-102)	41.7	3.7
92	Ba 81-113	41.7	3.3
93	PST-BO-165	31.7	3.3
94	Blacksburg	36.7	3.3
95	ZPS-2183	40.0	3.3
96	Bartitia	40.0	3.3
97	Blackstone (PST-638)	31.7	3.0
98	SR 2000	33.3	2.7
99	Platini	28.3	2.3
100	Pepaya (DP 37-192)	18.3	2.0
101	BAR VB 233	18.3	2.0
102	BAR VB 5649	21.7	2.0
103	ZPS-309	15.0	1.0
	$LSD_{0.05}$	20.9	1.7

[1]Wear tolerance was assessed using a 9 to 1 scale with 9 = best and 1 = worst wear tolerance.
[2]These values represent the percentage of area per plot covered by turf in summer 1999.

Fairway Height Kentucky Bluegrass Cultivar Trial - Established 1998

Nick E. Christians and Barbara R. Bingaman

This is the second year of data from the Fairway Height Kentucky Bluegrass Cultivar Trial established in the fall of 1998. Data collection began after the cultivars were fully established in April, 1999. The area was maintained at a 0.5 in. mowing height. Four bluegrass cultivars were included. The cultivars were maintained with 4 lbs of N/1000 ft^2/growing season. Fungicides are used as needed in a preventative program. Herbicides and insecticides were applied as needed.

Visual quality ratings were taken from April through October 1999 (Table 1). Visual quality was assessed using a 9 to 1 scale with 9 = best, 6 = lowest acceptable, and 1 = worst quality.

Table 1. 1999 Visual quality data of Kentucky bluegrass maintained at fairway height for the 1998 Fairway height Kentucky bluegrass cultivar trial.

Cultivar	April	May	June	July	Aug	Sept	Oct	Mean
1. Bluemoon	6.3	5.7	6.7	6.7	7.3	6.7	7.3	6.7
2. Nuglade	6.3	6.7	5.7	6.7	7.3	7.0	6.3	6.6
3. Award	5.3	5.7	5.3	7.0	7.3	6.3	6.7	6.2
4. Rambo	6.0	6.0	6.0	6.0	6.7	5.7	7.0	6.2
$LSD_{(0.05)}$	0.6	NS	NS	NS	NS	NS	NS	NS

NS = means are not significantly different at the 0.05 level.
Visual quality was assessed using a 9 to 1 scale with 9 = best, 6 = lowest acceptable, and 1 = worst quality.

Regional Tall Fescue Cultivar Evaluation - Established 1996

Nick E. Christians and Rodney A. St. John

This was the third year of data collection from the new tall fescue trial. This is a National Turfgrass Evaluation Program (NTEP) trial. It is being conducted at many locations around the U.S. The purpose of the trial is to study the regional adaptation of 129 tall fescue cultivars. Cultivars were evaluated for seedling vigor in October. The study is established in full sun. Three replications of the 3 x 5 ft (15 ft^2) plots were established for each cultivar in the spring of 1996. The trial is maintained at a 3-inch mowing height, 3.5 lbs N/1000 ft^2 were applied during the growing season, and the area was irrigated when needed to prevent drought. Preemergence herbicide was applied once in the spring.

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

Data for genetic color (Gcol), spring greenup (Grn), and leaf texture (Leaf) also are included. Genetic color was rated using a 9 to 1 scale with 9 = dark and 1 = light green. Spring greenup was estimated using a 9 to 1 scale with 9 = green and 1 = dormant turf. Leaf texture was assessed with a 9 to 1 scale with 9 = fine and 1 = coarse texture.

Table 1. 1999 visual quality[1] and other ratings[2] for the 1996 National Tall Fescue regional cultivar trial.

					Turf quality						
	Cultivar	Gcol	Grn	Leaf	May	June	July	Aug	Sept	Oct	Mean
1	Crossfire II	6.7	6.0	7.3	6.7	6.3	6.7	7.3	8.0	7.0	7.0
2	Wolfpack (PST-R5TK)	7.3	6.3	6.7	6.0	6.3	7.0	7.3	7.3	7.3	6.9
3	Brandy (J-101)	7.3	5.7	6.3	6.0	6.7	6.7	7.3	7.0	7.0	6.8
4	Pixie E+	6.7	5.7	7.3	6.7	6.7	6.3	7.0	6.7	7.3	6.8
5	Regiment	6.0	6.0	6.0	6.0	6.0	6.3	7.3	7.3	7.7	6.8
6	Titan 2	5.3	6.0	6.0	6.3	6.7	6.7	7.3	7.0	7.0	6.8
7	Masterpiece (LTP-SD-TF)	7.0	6.0	7.7	6.7	6.0	6.0	7.0	7.3	7.3	6.7
8	Millennium (TMI-RBR)	6.7	5.0	6.0	5.7	5.3	6.7	7.3	7.7	7.7	6.7
9	Rebel Sentry (AA-A91)	7.0	5.7	6.3	6.7	6.0	6.7	7.0	6.7	7.0	6.7
10	Tar Heel	6.3	5.7	6.3	6.0	5.3	6.7	7.3	7.0	7.7	6.7
11	Rembrandt (LTP-4026 E+)	6.7	5.0	6.3	5.7	5.7	6.0	7.0	7.7	7.7	6.6
12	Watchdog (PICK FA B-93)	6.0	5.7	6.3	6.0	6.3	6.7	6.3	7.0	7.0	6.6
13	ZPS-2PTF	6.7	5.0	7.0	6.3	6.3	6.0	7.0	7.0	6.7	6.6
14	Duster	6.7	5.7	6.3	6.0	6.0	7.0	6.7	6.3	6.3	6.4
15	ISI-TF11	6.3	5.3	6.0	6.0	6.0	6.0	6.3	7.0	7.0	6.4
16	PRO 8430	6.0	5.7	6.7	5.3	6.0	6.7	7.3	7.0	6.3	6.4
17	Renegade	6.7	7.0	6.3	6.3	6.0	6.7	6.7	6.7	6.0	6.4
18	Bravo (RG-93)	6.3	5.7	6.0	6.3	5.7	5.7	6.3	6.7	7.0	6.3
19	Coyote	6.3	5.3	6.3	5.7	4.7	7.0	5.3	7.7	7.7	6.3
20	Gazelle	7.0	6.7	8.0	6.3	5.7	6.0	6.7	6.0	7.3	6.3
21	Jaguar 3	6.7	6.3	6.0	5.7	5.7	6.0	6.7	6.7	7.0	6.3
22	MB 213	7.0	5.7	7.7	6.0	6.0	6.0	6.7	6.0	7.0	6.3
23	PICK RT-95	6.7	5.7	6.7	5.7	6.3	6.0	7.3	6.0	6.3	6.3
24	Safari	5.7	6.0	5.3	6.0	5.7	6.3	6.3	6.7	7.0	6.3
25	Shenandoah	6.0	5.7	6.0	6.3	6.0	6.0	7.0	6.0	6.7	6.3
26	Shenandoah II (WRS2)	6.7	6.0	6.7	6.3	5.7	6.3	6.0	6.3	7.0	6.3
27	Anthem II (TMI-FMN)	5.3	5.3	6.3	5.7	6.0	6.3	6.3	5.7	7.0	6.2
28	ATF-253	5.7	4.7	5.7	5.7	5.3	6.0	7.0	6.3	7.0	6.2
29	Aztec II (TMI-AZ)	6.3	5.3	6.0	6.0	5.7	5.0	7.0	7.0	6.3	6.2
30	Coronado	7.0	5.3	7.0	5.3	6.3	6.7	6.0	6.0	6.7	6.2
31	DP 7952	5.0	6.0	6.0	6.3	6.0	6.0	6.7	6.7	5.7	6.2

	Cultivar	Gcol	Grn	Leaf	Turf quality May	June	July	Aug	Sept	Oct	Mean
32	Empress	6.7	6.0	6.3	6.0	6.3	5.7	6.0	6.7	6.7	6.2
33	Genesis	7.0	5.7	6.0	6.0	6.0	6.0	5.7	6.7	7.0	6.2
34	MB 216	7.0	6.7	6.0	6.0	6.3	6.3	6.7	5.3	6.3	6.2
35	Red Coat (ATF-038)	6.7	5.7	6.0	6.3	5.7	5.7	6.3	6.3	6.7	6.2
36	SR 8210	5.7	5.7	6.0	5.7	5.7	6.0	6.7	6.0	7.0	6.2
37	Arid	5.7	5.3	5.7	6.0	6.0	5.7	6.0	6.3	6.3	6.1
38	Arid 2 (J-3)	8.0	5.3	6.7	5.7	6.0	6.3	6.7	5.7	6.0	6.1
39	ATF-257	5.3	5.0	6.3	5.0	6.0	5.3	6.7	6.7	6.7	6.1
40	Bonsai 2000 (Bullet)	6.0	5.0	5.7	6.0	5.3	6.0	6.3	6.3	6.7	6.1
41	CU9501T	6.3	6.3	5.7	6.0	6.0	6.0	6.0	6.3	6.3	6.1
42	Marksman	6.3	6.3	6.3	5.7	5.3	6.0	7.0	6.0	6.7	6.1
43	MB 212	7.0	5.3	6.3	6.0	6.0	6.3	6.0	5.3	6.7	6.1
44	Plantation (Pennington-1901)	7.0	5.0	5.7	6.3	6.0	5.0	6.3	6.7	6.0	6.1
45	PST-523	5.3	4.7	5.7	6.0	5.3	6.3	6.3	6.0	6.7	6.1
46	WPEZE (WVPB-1C)	6.7	6.3	6.3	6.3	6.0	6.7	6.0	5.3	6.3	6.1
47	Alamo E	6.7	5.7	6.0	5.7	5.3	6.3	6.0	6.3	6.3	6.0
48	Apache II	6.7	5.7	5.7	5.0	5.3	6.0	6.7	6.3	6.7	6.0
49	Bandana (PST-R5AE)	6.7	5.7	6.7	6.0	5.3	6.3	6.3	5.7	6.3	6.0
50	Chapel Hill (TA-7)	6.7	6.0	6.0	6.0	6.3	5.7	6.3	6.0	5.7	6.0
51	Falcon II	7.3	7.0	5.7	5.7	5.7	6.0	6.3	6.0	6.3	6.0
52	OFI-96-31	7.3	5.0	6.0	5.7	6.0	6.3	6.0	6.0	6.0	6.0
53	R5AU	6.0	5.7	6.0	5.7	6.0	6.3	6.7	5.7	5.7	6.0
54	ATF-188	6.0	5.7	6.3	4.7	5.0	6.3	5.7	7.0	6.7	5.9
55	ATF-196	5.3	6.3	7.0	6.0	5.3	6.3	6.0	5.3	6.3	5.9
56	PSII-TF-9	5.3	6.3	5.3	6.0	5.7	5.7	6.7	6.0	5.7	5.9
57	SRX 8084	5.7	5.3	6.7	5.3	6.0	6.3	6.3	5.3	6.0	5.9
58	Sunpro	7.3	5.7	7.3	5.7	5.7	6.7	6.3	6.0	5.3	5.9
59	ATF-022	5.7	5.7	6.7	5.7	5.7	6.0	6.0	5.7	6.0	5.8
60	Coronado Gold (PST-5RT)	7.0	5.0	6.3	5.3	5.3	5.7	6.0	6.0	6.3	5.8
61	EC-101	5.7	5.3	5.3	6.7	5.7	5.7	6.3	5.0	5.3	5.8
62	ISI-TF9	6.7	5.3	5.7	5.0	5.7	7.0	5.7	5.3	6.3	5.8
63	Leprechaun	5.3	6.0	5.0	5.3	5.0	6.3	6.3	6.0	6.0	5.8
64	Lion	7.3	5.7	6.7	6.3	6.0	5.7	6.3	5.3	5.3	5.8
65	MB 28	7.3	5.7	6.0	6.0	6.3	5.3	5.3	5.7	6.0	5.8
66	Mustang II	5.3	5.3	6.7	5.3	4.7	5.7	6.3	6.0	6.7	5.8
67	OFI-FWY	7.0	5.7	5.7	5.7	6.0	5.7	6.3	6.0	5.3	5.8
68	PST-5M5	6.7	5.7	6.3	6.0	5.3	5.7	6.0	6.0	6.0	5.8
69	Tulsa	5.7	4.7	7.0	6.0	5.7	5.7	6.0	5.3	6.0	5.8
70	Arid 3 (J-98)	6.7	5.0	7.0	5.7	5.7	5.7	6.7	5.3	5.0	5.7
71	CU9502T	6.3	5.3	7.3	6.7	6.7	5.7	5.0	4.3	5.7	5.7
72	Finelawn Petite	5.7	5.3	6.3	6.3	6.0	4.7	5.7	5.3	6.0	5.7
73	JSC-1	5.7	6.0	5.7	5.7	5.3	6.0	6.0	5.7	5.7	5.7
74	JTTFC-96	5.7	6.3	6.0	6.3	6.0	5.3	5.7	5.3	5.7	5.7
75	Kitty Hawk S.S.T. (SS45DW)	6.7	5.3	7.0	5.7	5.3	6.3	6.0	5.3	5.7	5.7
76	Pick FA XK-95	7.0	5.7	7.0	7.0	6.3	5.3	5.3	5.3	5.0	5.7
77	Southern Choice	7.3	5.7	5.7	5.3	5.3	6.3	5.7	5.3	6.0	5.7
78	WX3-275	6.0	5.0	6.7	6.0	5.7	6.0	6.0	5.0	5.7	5.7
79	AV-1	5.3	5.7	5.3	5.0	6.0	5.7	5.7	5.7	5.7	5.6
80	BAR FA6 US2U	7.7	5.7	7.0	6.3	5.7	5.3	5.3	5.3	5.7	5.6
81	Comstock (SSDE31)	6.0	5.7	5.3	5.3	4.7	6.3	5.7	5.0	6.3	5.6
82	EA 41	6.7	4.7	6.7	5.7	5.0	6.0	5.3	5.3	6.3	5.6
83	MB 29	7.0	5.3	6.0	6.0	5.0	5.0	5.7	5.7	6.0	5.6

	Cultivar	Gcol	Grn	Leaf	Turf quality May	June	July	Aug	Sept	Oct	Mean
84	OFI-96-32	5.7	4.7	5.7	5.3	5.7	6.0	6.7	5.0	5.0	5.6
85	Olympic Gold (PST-5E5)	5.7	5.7	5.7	5.7	5.7	5.0	5.0	5.7	6.3	5.6
86	Pick FA 15-92	7.3	5.7	7.3	5.7	5.3	6.0	5.3	5.3	5.7	5.6
87	Pick FA 20-92	7.0	6.3	6.3	5.3	5.7	5.3	6.0	6.0	5.3	5.6
88	Rebel 2000 (AA-989)	6.7	5.0	6.0	6.3	5.3	5.7	5.3	5.3	5.3	5.6
89	Shortstop II	6.7	6.3	6.7	6.3	5.7	5.3	5.7	5.0	5.3	5.6
90	WVPB-1D	5.7	6.0	5.3	5.0	5.3	6.0	5.7	5.7	6.0	5.6
91	ZPS-5LZ	6.3	5.7	6.0	6.0	6.0	6.0	4.3	5.7	5.7	5.6
92	Axiom (ATF-192)	5.7	4.7	6.0	5.3	5.3	5.0	6.0	5.3	6.0	5.5
93	DLF-1	5.0	6.0	5.7	5.3	5.3	6.0	5.3	5.0	6.0	5.5
94	MB 210	7.0	5.0	7.0	5.7	5.3	5.7	5.7	4.7	6.0	5.5
95	MB211	7.0	6.0	6.7	5.3	5.0	6.0	5.7	5.3	5.7	5.5
96	MB 215	6.7	5.7	5.7	5.7	6.0	5.0	5.3	5.3	5.7	5.5
97	SRX 8500	6.7	5.3	6.7	6.0	5.7	5.0	5.3	5.7	5.3	5.5
98	Twilight II (TMI-TW)	6.7	5.0	6.7	5.7	5.3	6.3	5.0	5.7	5.0	5.5
99	BAR FA6 US3	7.7	5.3	6.3	5.7	5.3	5.7	5.3	5.0	5.3	5.4
100	BAR FA6 US6F	7.0	5.3	6.0	5.7	5.7	4.7	5.7	5.7	5.0	5.4
101	JTTFA-96	5.0	7.0	5.7	5.0	5.3	5.7	5.3	5.7	5.7	5.4
102	MB 26	7.3	4.7	5.7	5.0	5.3	5.3	6.0	5.0	5.7	5.4
103	OFI-931	6.7	5.3	6.7	5.7	6.0	5.3	5.0	5.3	5.3	5.4
104	Bulldawg (PICK GA-96)	7.0	5.3	6.7	5.7	5.0	5.3	5.3	5.3	5.3	5.3
105	Cochise II	5.7	4.7	6.7	5.3	5.7	5.3	5.3	5.0	5.3	5.3
106	Good-En (KOOS 96-14)	6.0	5.7	5.3	5.3	5.0	5.7	5.3	5.0	5.3	5.3
107	ISI-TF10	6.7	5.0	6.0	5.3	5.7	5.0	5.7	5.0	5.0	5.3
108	Kentucky-31 W/Edno	4.3	6.0	4.0	5.0	5.7	6.0	5.0	4.7	5.0	5.3
109	OFI-951	6.3	6.0	6.7	4.7	5.3	5.7	5.7	4.7	5.7	5.3
110	Bonsai	6.0	5.7	6.0	5.3	5.7	5.3	5.0	4.7	5.0	5.2
111	DP 50-9011	6.3	5.3	7.0	5.7	5.7	5.3	5.0	4.7	5.0	5.2
112	Equinox (TMI-N91)	5.7	5.7	5.3	5.3	5.3	5.0	5.0	5.0	5.7	5.2
113	MB 214	6.7	5.7	6.0	6.0	5.7	5.0	4.7	4.3	5.7	5.2
114	Pedestal (PC-AO)	6.3	6.0	6.0	5.3	5.0	4.7	5.0	5.3	5.7	5.2
115	WVPB-1B	6.0	5.0	5.7	5.0	5.0	5.3	5.3	5.3	5.0	5.2
116	Arabia (J-5)	6.7	6.0	6.3	5.3	5.3	4.7	5.3	5.0	5.0	5.1
117	BAR FA 6D	6.3	4.7	6.3	5.0	5.0	5.0	5.0	4.3	6.0	5.1
118	BAR FA6D USA	6.3	5.7	7.3	4.7	5.0	5.3	5.3	5.0	5.3	5.1
119	PSII-TF-10	6.3	6.0	6.0	5.3	5.0	5.0	5.3	5.0	5.0	5.1
120	PST-5TO	6.3	5.7	7.0	5.0	4.3	5.0	5.7	5.7	4.7	5.1
121	Tomahawk-E	6.0	5.7	6.0	5.7	5.0	5.0	5.0	4.7	5.3	5.1
122	BAR FA6 US1	6.7	6.0	6.7	5.7	5.0	4.7	5.0	4.7	5.0	5.0
123	BAR FA 6LV	6.3	5.7	6.3	5.7	5.0	5.0	5.0	4.0	4.7	4.9
124	Pick FA N-92	6.3	5.0	7.7	5.0	5.0	5.0	5.0	4.3	5.0	4.9
125	ATF-020	5.0	4.7	6.0	5.0	5.0	4.7	5.0	4.3	4.7	4.8
126	Pick FA 6-91	6.3	5.0	7.0	5.7	5.0	4.7	4.7	4.3	4.3	4.8
127	Velocity (AA-983)	6.3	5.3	6.0	5.3	5.0	4.3	4.7	4.3	5.3	4.8
128	Reserve (ATF-182)	6.3	5.0	6.0	5.0	5.0	5.0	4.3	4.3	4.7	4.7
129	Pick FA UT-93	7.3	5.3	7.0	5.0	4.7	4.3	4.7	3.7	4.7	4.5
	$LSD_{0.05}$	1.6	3.6	2.0	2.8	3.3	2.7	2.1	1.9	1.5	1.2

[1]Visual quality was assessed using a 9 to 1 scale with 9 = best, 6 = lowest acceptable, and 1 = worst quality.
[2]Genetic color (Gcol) was rated using a 9 to 1 scale with 9 = dark and 1 = light green. Spring greenup (Grn) was determined using a 9 to 1 scale with 9 = green and 1 = dormant. Leaf texture (Leaf) was assessed with a 9 to 1 scale with 9 = fine and 1 = coarse texture.

Regional Fine Fescue Cultivar Trial - Established 1998

Nick E. Christians and Rodney A. St. John

This was the second year of data from the 1998 Fineleaf Fescue National Turfgrass Evaluation Program (NTEP) trial. It is being conducted at many locations around the U.S. The purpose of the trial is to study the regional adaptation of 79 fineleaf fescue selections. Cultivars are evaluated for quality each month of the growing season through October. The study is conducted in full sun. Three replications of the 3 x 5 ft (15 ft^2) plots were established for each cultivar in October 1998. The trial has been maintained at a 2-inch mowing height, fertilized with 3.5 lbs N/1000 ft^2 during the growing season, and has been irrigated when needed to prevent drought. Preemergence herbicide was applied once in the spring.

Visual quality was evaluated monthly in 1999 from May through October (Table 1). Quality was assessed using a 9 to 1 scale with 9 = best , 6 = lowest acceptable, and 1 = worst quality. The values listed under each month in Table 1 are the averages of visual quality ratings made on three replicated plots for the three studies. Yearly means of monthly data were taken and are listed in the last column. The first cultivar received the highest average rating for the entire 1999 season. The cultivars are listed in descending order of average quality.

Data for genetic color (Gcol), spring greenup (Grn), and leaf texture (Leaf) also are included for the high-maintenance, irrigated and for the low-maintenance trials. Genetic color was rated using a 9 to 1 scale with 9 = dark and 1 = light green. Spring greenup was estimated using a 9 to 1 scale with 9 = green and 1 = dormant turf. Leaf texture was assessed with a 9 to 1 scale with 9 = fine and 1 = coarse texture.

Table 1. The 1999 visual quality[1] and other turf attribute ratings[2] for cultivars in the 1998 Fineleaf Fescue Cultivar Trial.

	Cultivar	Species[3]	Gcol	Grn	Leaf	May	June	July	Aug	Sept	Oct	Mean
1	SRX 52961	SCF	7.0	7.3	6.7	6.0	7.0	6.7	6.3	7.7	7.0	6.8
2	ABT-CR-2	SCF	7.7	7.3	7.0	7.0	6.7	7.3	5.3	7.3	6.3	6.7
3	ABT-CR-3	SCF	8.3	7.3	7.3	7.0	7.0	6.7	6.3	6.7	6.3	6.7
4	ASR 049	SLF	7.0	5.7	7.7	6.3	6.0	6.7	6.0	7.0	8.0	6.7
5	PST-EFL	SCF	6.3	8.0	6.3	6.0	6.3	6.3	7.0	7.0	6.7	6.6
6	ISI FRR 7	SCF	7.0	7.3	7.3	6.7	5.7	6.7	6.3	6.3	7.3	6.5
7	Salsa	SCF	6.3	8.0	7.3	5.3	6.0	6.3	6.0	7.7	7.7	6.5
8	Intrigue	CF	7.3	6.7	7.7	6.7	7.0	6.0	6.3	6.7	6.0	6.4
9	Jasper II	SCF	7.0	7.0	6.7	5.7	6.0	6.7	6.3	6.7	7.3	6.4
10	Longfelow II	CF	8.0	7.0	7.7	6.3	6.7	6.3	5.0	7.3	7.0	6.4
11	Florentine	SCF	7.0	7.7	6.7	6.3	6.3	6.0	5.3	6.7	7.0	6.3
12	Shadow II	CF	7.0	6.7	7.0	6.7	7.0	6.7	4.7	6.0	6.7	6.3
13	ABT-CHW-2	CF	6.0	6.7	7.7	6.3	6.3	5.7	5.3	6.7	6.7	6.2
14	ABT-CHW-3	CF	7.3	7.0	6.7	6.3	6.0	6.7	5.3	6.0	7.0	6.2
15	BAR CHF 8 FUS2	CF	7.7	7.3	7.0	5.7	6.3	6.7	5.3	6.0	7.0	6.2
16	BAR SCF 8 FUS3	SLF	7.7	6.7	6.7	6.7	6.7	6.3	5.7	6.0	6.0	6.2
17	Culombra	CF	7.0	7.7	7.3	5.7	7.0	6.3	5.7	5.7	6.7	6.2
18	Seabreeze	SLF	5.7	7.3	7.0	5.3	5.3	5.3	5.7	7.0	8.3	6.2
19	Tiffany	CF	8.0	6.7	8.0	6.0	6.7	6.3	5.3	6.3	6.7	6.2
20	4001	HF	7.0	5.7	7.3	6.7	6.0	6.0	5.7	6.3	5.7	6.1
21	ABT-HF1	HF	6.3	6.0	7.7	6.3	5.3	6.3	6.3	6.0	6.3	6.1
22	BAR CF 8 FUS1	SCF	6.7	8.0	6.7	5.7	6.0	6.3	5.7	6.0	6.7	6.1
23	ISI FRR 5	SCF	7.0	7.3	6.0	6.0	6.0	5.3	5.7	7.0	6.3	6.1
24	PST-47TCR	SCF	7.0	7.0	7.0	6.0	5.3	6.3	6.0	6.0	6.7	6.1
25	ASC 087	SCF	6.0	7.7	6.7	5.7	5.7	6.7	5.7	6.0	6.3	6.0
26	Brittany	CF	7.7	7.0	7.7	6.0	6.0	6.0	5.3	6.0	6.7	6.0
27	Shademaster II	SCF	6.3	5.0	6.3	6.0	5.3	6.0	5.3	6.3	7.0	6.0
28	ACF 083	CF	6.3	7.7	7.0	5.7	5.3	5.3	5.3	6.0	7.7	5.9
29	AHF 009	HF	6.3	5.7	7.0	6.0	5.7	6.3	6.0	6.0	5.7	5.9
30	Ambassador	CF	7.0	6.3	7.3	6.7	5.7	6.0	5.0	6.0	6.3	5.9
31	Banner III	CF	7.0	6.3	7.0	6.7	6.7	5.7	4.7	5.3	6.3	5.9
32	Oxford	HF	7.0	6.0	7.7	6.7	6.3	7.0	5.7	4.3	5.7	5.9

	Cultivar	Species[3]	Gcol	Grn	Leaf	May	June	July	Aug	Sept	Oct	Mean
33	PST-4FR	SCF	7.0	7.3	6.0	6.0	5.0	7.0	5.0	6.3	6.0	5.9
34	PST-4MB	BHF	6.0	5.3	6.3	6.0	6.0	6.3	5.3	5.7	6.0	5.9
35	ABT-CHW-1	CF	7.0	6.7	7.3	6.7	6.3	5.7	5.3	5.3	5.7	5.8
36	ABT-HF-4	HF	6.0	5.0	6.0	6.3	5.3	5.7	5.7	5.7	6.3	5.8
37	ACF 092	CF	6.7	7.3	7.0	5.0	5.3	6.0	5.0	6.3	7.0	5.8
38	Bridgeport	CF	6.7	7.0	7.7	6.3	5.7	5.3	5.0	6.0	6.3	5.8
39	DGSC 94	SCF	5.7	8.0	6.7	5.3	5.7	6.3	5.0	5.7	6.7	5.8
40	Pathfinder	SCR	6.3	8.0	6.3	5.3	6.0	5.7	5.3	6.0	6.7	5.8
41	Pick FRC 4-92	CF	7.0	7.3	7.3	6.3	6.7	5.7	4.7	5.0	6.7	5.8
42	SRX 3961	HF	7.3	5.7	8.0	6.7	6.0	6.3	5.0	6.0	5.0	5.8
43	SRX 52LAV	SCF	6.3	7.3	6.3	5.7	5.3	5.7	5.0	6.3	7.0	5.8
44	Treazure (E)	CF	6.0	7.3	8.0	6.0	6.3	5.3	5.3	6.3	5.7	5.8
45	ASC 082	SCF	6.7	7.7	6.7	6.0	5.7	5.7	5.0	6.0	6.0	5.7
46	SR 5100	CF	7.0	7.0	6.7	6.0	6.3	5.7	4.7	5.3	6.3	5.7
47	ABT-HF-3	HF	6.0	5.3	6.7	6.7	6.0	6.0	5.0	4.7	5.3	5.6
48	Bighorn	HF	6.0	5.0	6.7	6.3	5.3	5.7	6.0	5.0	5.0	5.6
49	Boreal	SCF	5.7	7.7	6.3	5.0	5.3	5.3	5.7	5.7	6.3	5.6
50	Dawson E+	SLF	6.0	6.3	7.0	5.0	5.7	6.0	5.3	5.0	6.7	5.6
51	Jamestown II	CF	6.0	7.0	6.7	5.0	5.3	5.7	5.7	6.0	5.7	5.6
52	Sandpiper	CF	6.7	7.0	7.7	5.0	5.7	5.3	5.3	6.0	6.0	5.6
53	SR 3200	BF	5.7	5.3	6.7	6.0	5.3	5.7	5.7	5.0	5.7	5.6
54	ASC 172	SCF	7.0	7.0	6.0	5.7	5.7	6.0	4.3	5.0	6.3	5.5
55	Heron	CF	6.0	5.7	7.7	6.3	5.7	5.7	5.0	5.3	5.0	5.5
56	Magic	CF	6.7	6.0	7.3	6.0	6.7	5.0	4.3	5.7	5.3	5.5
57	Nordic (E)	HF	6.7	5.7	7.0	5.0	5.7	6.3	5.7	5.3	5.0	5.5
58	Pick FRC A-93	CF	7.3	6.7	8.0	6.0	6.7	5.7	4.0	4.7	6.0	5.5
59	PST-4HM	CF	6.3	5.3	7.3	5.3	5.3	6.0	5.7	5.0	5.7	5.5
60	MB-63	CF	6.7	6.7	7.3	6.0	5.7	5.0	4.3	5.7	6.0	5.4
61	Minotaur	HF x BF	6.0	5.3	6.3	6.3	5.3	6.3	5.0	4.7	5.0	5.4
62	Scaldis	HF	6.3	5.0	7.0	6.7	5.7	6.3	5.0	4.3	4.3	5.4
63	Attila E	HF	6.7	5.7	7.3	5.7	5.7	5.3	5.3	5.0	4.7	5.3
64	BAR HF 8 FUS	HF	6.7	6.0	6.7	5.7	5.3	5.7	5.0	4.7	5.7	5.3
65	Common Creeping Red	SCF	5.7	7.0	6.7	5.0	5.7	5.3	5.0	5.0	6.0	5.3
66	Defiant	HF	6.7	6.3	7.3	5.3	5.3	6.3	4.7	4.7	5.7	5.3
67	MB-82	HF	6.7	6.7	7.0	6.3	6.0	6.3	5.0	4.0	4.3	5.3
68	AHF 008	HF	6.3	6.0	6.3	5.7	5.3	5.0	4.7	5.7	4.7	5.2
69	ISI FL 11	HF	7.3	5.3	7.0	6.0	5.3	5.0	5.0	4.7	5.0	5.2
70	Pick FF A-97	HF	6.0	5.7	7.3	5.3	5.0	6.0	4.7	5.0	5.0	5.2
71	Quatro	SF	5.7	6.0	7.3	6.0	5.3	4.7	5.3	5.0	5.0	5.2
72	Rescue 911	HF	8.0	5.3	7.0	7.0	6.3	6.0	4.3	3.7	3.7	5.2
73	Shademark	SCF	5.7	8.0	7.0	4.7	4.7	5.3	5.0	5.3	6.0	5.2
74	Discovery	HF	7.0	5.7	7.0	6.3	5.3	5.7	4.0	4.3	5.0	5.1
75	Reliant II	HF	6.7	5.3	6.0	6.0	5.3	5.3	4.0	4.7	5.3	5.1
76	ABT-HF-2	HF	7.0	5.0	7.3	6.0	5.0	5.3	5.0	4.0	4.0	4.9
77	ISI FL 12	HF	6.3	5.3	6.3	5.7	5.0	5.7	5.0	4.0	4.3	4.9
78	Osprey	HF	6.7	5.3	7.7	6.3	5.3	5.7	3.0	2.7	2.7	4.3
79	SR 6000	TH	4.7	4.3	4.7	4.7	4.3	4.0	3.7	4.0	4.0	4.1
	$LSD_{0.05}$		1.4	1.2	1.0	1.9	1.2	2.2	3.8	2.0	2.1	1.2

[1]Visual quality was assessed using a scale of 9 to 1 with 9 = best quality, 6 = lowest acceptable quality, and 1 = worst quality.
[2]Genetic color (Gcol) was rated using a 9 to 1 scale with 9 = dark and 1 = light green. Spring greenup (Grn) was determined using a 9 to 1 scale with 9 = green and 1 = dormant. Leaf texture (Leaf) was assessed with a 9 to 1 scale with 9 = fine and 1 = coarse texture.
[3]BF = blue fescue, BHF = blue hard fescue, CF = creeping fescue, HF = hard fescue, SF = sheep fescue, SLF = slender creeping fescue, SCF = strong creeping fescue, TH = tufted hairgrass.

Perennial Ryegrass Studies - Established 1994 and 1999

Rodney A. St. John and Nick E. Christians

This was the final year of the trial that began in the fall of 1994 with the establishment of 96 cultivars of perennial ryegrass at the Iowa State University Horticulture Research Station. The study was established on an irrigated area that was maintained at a 2-inch mowing height and fertilized with 3 to 4 lb N/1000 ft^2/yr. The area received herbicide treatments as required.

Cultivars were evaluated for turf quality May through August of 1999. Visual quality was assessed using a 9 to 1 scale with 9 = best, 6 = lowest acceptable, and 1 = worst quality. The values listed under each month in Table 1 are the averages of ratings made on three replicated plots for the three studies. Yearly means of data from each month are listed in the last column. The cultivars are listed in descending order of average quality.

Data for genetic color (Gcol), spring greenup (Grn), and leaf texture (Leaf) also are included. Genetic color was rated using a 9 to 1 scale with 9 = dark and 1 = light green. Spring greenup was estimated using a 9 to 1 scale with 9 = green and 1 = dormant turf. Leaf texture was assessed with a 9 to 1 scale with 9 = fine and 1 = coarse texture (Table 1).

A new Perennial ryegrass trial was initiated in Fall 1999 with the establishment of 134 cultivars at the research station. The experimental area was prepared and maintained under the same guidelines as the previous study.

Seedling vigor and percentage living ground cover data were taken in October 1999. Seedling vigor was measured using a 9 to 1 scale with 9 = most vigorous and 1 = worst. Percentage living ground cover values represent the percentage area per plot covered by ryegrass. The cultivars are presented in descending order of percentage living ground cover (Table 2).

Table 1. 1999 visual quality[1] and other ratings[2] for the 1994 National Perennial Ryegrass Study.

					Quality				
	Cultivar	Gcol	Grn	Leaf	May	June	July	Aug	Mean
1	Brightstar II (PST-2M3)	9.0	6.7	8.3	9.0	9.0	7.0	7.0	8.0
2	MB 44	9.0	7.0	8.7	9.0	9.0	7.0	6.7	7.9
3	Roadrunner (PST-2ET)	8.0	7.0	8.0	7.0	7.7	6.0	6.3	7.8
4	Prelude III (LRF-94-B6)	8.7	7.0	8.0	8.3	9.0	7.0	6.7	7.8
5	Palmer III (LRF-94-MPRH)	9.0	6.7	8.0	8.3	9.0	7.0	6.7	7.8
6	Pennant II (MB 42)	9.0	6.7	8.0	8.3	8.7	6.7	6.7	7.6
7	MB 45	9.0	7.0	8.0	8.3	9.0	6.7	6.3	7.6
8	Wind Dancer (MB 46)	8.7	7.0	8.0	8.3	8.7	6.7	6.7	7.6
9	Catalina (PST-GH-94)	9.0	7.7	8.3	8.3	8.3	6.7	6.7	7.5
10	Advantage	8.7	7.3	8.0	8.0	8.7	6.7	6.7	7.5
11	Premier II (BAR USA 94-11)	8.3	7.0	8.0	8.0	8.7	6.3	7.0	7.5
12	Chaparral (PST-2DLM)	8.0	7.0	7.7	8.0	8.3	6.3	7.0	7.4
13	Repell III (LRF-94-C7)	8.7	7.7	8.0	7.7	8.7	6.7	6.7	7.4
14	Calypso II	8.3	7.3	8.0	8.3	8.3	6.3	6.3	7.3
15	J-1706	8.0	6.0	8.0	7.7	8.7	6.7	6.0	7.3
16	LRF-94-CB	8.3	6.7	8.0	8.0	8.3	6.3	6.7	7.3
17	Excel (MB 1-5)	8.3	8.0	8.3	8.0	8.7	6.0	6.3	7.3
18	Majesty (MB 43)	8.3	7.3	8.0	8.0	8.3	6.3	6.3	7.3
19	Line Drive (MB 47)	9.0	8.0	8.0	8.0	8.3	6.3	6.7	7.3
20	Elf	8.3	7.7	7.7	7.7	8.3	6.3	6.3	7.2
21	Citation III (PST-2DGR)	8.3	8.0	8.0	8.0	8.0	6.3	6.3	7.2
22	Secretariat (RPBD)	8.7	7.7	8.0	8.0	8.3	6.3	6.0	7.2
23	Imagine	8.3	7.3	8.0	8.3	8.3	6.0	6.0	7.2
24	Divine	9.0	7.7	8.3	8.0	8.3	6.3	6.0	7.2
25	Dancer	8.0	7.0	8.0	7.7	8.0	6.3	6.3	7.1
26	Sonata (PST-2R3)	8.3	7.0	8.0	7.7	8.3	6.3	6.0	7.1
27	MardiGras (ZPS-2NV)	8.7	7.0	8.0	8.3	8.0	6.0	6.0	7.1
28	Legacy II (Lesco-TWF)	8.3	6.0	8.0	8.0	8.0	6.0	6.3	7.1
29	Panther (ZPS-PR1)	8.3	6.7	8.0	7.7	8.0	6.3	6.3	7.1
30	Wizard (MB 41)	8.0	9.0	8.0	7.3	8.0	6.3	6.7	7.1

	Cultivar	Gcol	Grn	Leaf	Quality May	June	July	Aug	Mean
31	Precision	7.7	7.0	8.0	8.0	7.7	6.3	6.0	7.0
32	Esquire	7.7	7.3	8.0	8.3	8.0	5.7	6.0	7.0
33	Omega 3 (ZPS-2DR-94)	8.7	7.3	8.3	8.0	8.0	6.0	6.0	7.0
34	Quickstart	8.0	6.3	8.0	7.3	8.3	6.3	6.0	7.0
35	Brightstar	7.7	7.0	8.0	8.0	7.7	6.0	6.3	7.0
36	Head Start (Pick PR 84-91)	8.0	6.0	7.3	8.0	7.7	6.0	6.3	7.0
37	Koos 93-6	8.0	7.0	8.0	7.3	8.3	6.3	6.0	7.0
38	Pick Lp 102-92	8.7	7.0	8.0	7.3	8.3	6.3	6.0	7.0
39	Bar Er 5813	8.0	7.3	8.0	7.7	8.0	6.0	6.0	6.9
40	APR 124	8.0	6.3	8.0	7.7	8.0	6.0	6.0	6.9
41	Cutter	7.7	8.0	8.0	7.3	8.0	6.3	6.0	6.9
42	WX3-91	8.3	7.0	8.0	7.7	7.7	6.0	6.3	6.9
43	WX3-93	8.0	6.7	8.0	7.7	8.0	6.0	6.0	6.9
44	Wind Star (PST-28M)	8.3	6.3	8.0	7.7	8.0	6.0	6.0	6.9
45	Prizm	8.3	7.3	8.0	7.7	8.0	6.0	6.0	6.9
46	Assure	7.3	7.3	8.0	7.7	7.7	6.0	6.3	6.9
47	Nine-O-One	8.0	7.3	8.0	7.7	8.0	6.0	6.0	6.9
48	Night Hawk	8.3	7.0	8.0	8.0	7.7	6.0	6.0	6.9
49	PS-D-9	8.3	7.3	8.0	8.0	7.7	6.0	6.0	6.9
50	CAS-LP23	7.7	7.7	8.0	7.3	8.0	6.3	6.0	6.9
51	APR 131	8.3	7.3	8.0	7.0	7.7	6.3	6.0	6.8
52	Laredo	8.0	7.3	8.0	7.7	8.0	5.7	6.0	6.8
53	Accent	8.0	7.7	8.0	7.3	8.0	6.0	6.0	6.8
54	Top Gun (J-1703)	8.0	6.7	8.0	7.3	7.7	6.0	6.0	6.8
55	Vivid	8.3	7.0	8.0	7.0	8.0	6.0	6.0	6.8
56	Stardance (PST-2FE)	8.3	6.7	8.0	7.3	8.0	6.0	6.0	6.8
57	Manhattan 3	8.0	7.0	8.0	7.3	8.0	6.0	6.0	6.8
58	Saturn II (ZPS-2ST)	8.3	7.0	8.0	7.0	8.0	6.0	6.0	6.8
59	Academy (PC-93-1)	7.7	7.0	8.0	7.7	7.7	6.0	6.0	6.8
60	ISI-MHB	7.7	6.7	8.0	7.3	7.7	6.0	6.0	6.8
61	R2 (ISI-R2)	8.7	7.0	8.3	7.3	7.7	6.0	6.0	6.8
62	Top Hat	8.0	7.3	8.0	7.7	7.7	6.0	6.0	6.8
63	Blazer III (Pick 928)	7.7	7.3	8.0	7.7	7.7	6.0	6.0	6.8
64	Williamsburg	7.7	7.0	8.0	7.3	7.7	6.3	6.0	6.8
65	Riviera II	7.3	7.3	8.0	7.7	7.3	6.0	6.0	6.8
66	DLP 1305	8.0	7.0	8.0	8.3	7.0	6.0	6.0	6.8
67	SR 4010 (SRX 4010)	8.0	6.7	8.0	7.3	7.7	6.0	6.0	6.8
68	SR 4200	7.3	6.7	8.0	7.3	7.7	6.0	6.0	6.8
69	SR 4400 (SRX 4400)	7.3	8.3	8.0	7.3	7.7	6.0	6.0	6.8
70	Omni	7.7	7.0	8.0	7.3	7.7	6.0	6.0	6.8
71	Morning Star	7.7	7.3	8.0	7.7	7.7	6.0	6.0	6.8
72	Pegasus	7.7	7.7	8.0	7.3	7.7	6.0	6.0	6.8
73	Blackhawk (TMI-EXFLP94)	7.3	7.0	8.0	7.3	7.7	6.0	6.0	6.8
74	Caddieshack (MED 5071)	7.7	7.3	8.0	7.0	8.0	5.7	6.0	6.7
75	Navajo	7.7	6.7	8.0	7.3	7.3	6.0	6.0	6.7
76	Stallion Supreme (PSI-E-1)	8.0	8.0	8.0	7.0	7.7	6.0	6.0	6.7
77	WVPB-93-KFK	7.3	6.7	8.0	7.3	7.7	5.7	6.0	6.7
78	Passport (PST-2FF)	7.7	6.7	8.0	7.3	7.3	6.0	6.0	6.7
79	Koos 93-3	8.0	6.0	8.0	7.0	7.7	6.0	6.0	6.7
80	Stallion Select	7.7	7.3	7.7	7.3	7.3	6.0	6.0	6.7
81	PST-2CB	8.0	7.3	7.7	7.3	7.3	6.0	6.0	6.7
82	Edge	7.3	6.7	8.0	7.0	7.7	6.0	5.7	6.6
83	WVPB-PR-C-2	6.7	6.7	8.0	7.0	8.0	5.7	5.7	6.6

	Cultivar	Gcol	Grn	Leaf	Quality May	June	July	Aug	Mean
84	DSV NA 9402	7.0	7.0	7.7	8.3	6.7	5.7	5.3	6.5
85	APR 066	6.7	7.0	7.7	6.7	7.3	6.0	6.0	6.5
86	Express	7.7	8.3	8.0	7.0	7.3	6.0	5.7	6.5
87	MVF-4-1	7.0	6.7	8.0	6.7	7.3	6.0	6.0	6.5
88	Figaro	7.0	6.0	7.3	7.7	6.7	6.0	5.7	6.5
89	Nobility	7.0	7.3	7.7	6.7	7.3	6.0	6.0	6.5
90	Achiever	7.7	7.7	8.0	7.0	7.3	5.7	5.7	6.4
91	APR 106	7.0	7.0	8.0	7.7	7.0	5.3	5.7	6.4
92	WVPB 92-4	7.3	6.7	8.0	6.7	7.0	6.0	6.0	6.4
93	Saturn	6.7	6.3	8.0	7.0	7.0	6.0	5.7	6.4
94	DSV NA 9401	6.3	7.0	8.0	7.3	6.3	5.7	5.3	6.2
95	Pennfine	6.3	7.7	7.0	6.0	6.3	5.7	5.0	5.8
96	Linn	5.3	6.3	6.3	6.0	5.0	5.0	5.3	5.3
	$LSD_{(0.05)}$	1.0	NS	0.4	1.0	0.9	0.6	0.5	0.5

[1]Visual quality was assessed using a 9 to 1 scale with 9 = best quality, 6 = lowest acceptable quality, and 1 = worst quality.
[2]Genetic color (Gcol) was rated using a 9 to 1 scale with 9 = dark and 1 = light green. Spring greenup (Grn) was determined using a 9 to 1 scale with 9 = green and 1 = dormant. Leaf texture (Leaf) was assessed with a 9 to 1 scale with 9 = fine and 1 = coarse texture.
NS = means are not significantly different at the 0.05 level.

Table 2. 1999 seedling vigor and percentage living cover[1] for the 1999 National Perennial Ryegrass Study.

	Cultivar	Seedling vigor	Percentage (%) living cover
1	Majesty	8.3	73.3
2	Affirmed	8.3	73.3
3	JR-151	8.3	73.3
4	DP 17-9391	8.7	73.3
5	Passport	8.0	70.0
6	APR 1233	8.0	70.0
7	Exacta	8.0	70.0
8	JR-187	8.0	70.0
9	Line Drive	8.7	70.0
10	Linn	9.0	66.7
11	Buccaneer	8.7	66.7
12	YatsuGreen	8.7	66.7
13	Affinity	8.3	66.7
14	Roberts-627	8.0	66.7
15	Barlennium	8.0	66.7
16	JR-128	8.0	66.7
17	Pick PRNGS	8.0	66.7
18	PST-2BR	8.0	66.7
19	Palmer III	8.0	66.7
20	SRX 4801	8.0	66.7
21	Calypso	8.3	63.3
22	Racer	8.3	63.3
23	Fiesta III	8.0	63.3
24	Headstart	8.0	63.3
25	Paragon	8.0	63.3
26	WVPB-R-84	8.0	63.3
27	Nexus	8.3	63.3
28	LTP 98-501	8.0	63.3
29	CIS-PR-85	8.0	63.3
30	Ascend	7.7	63.3
31	Pleasure XL	8.3	63.3
32	APR 1235	8.0	63.3

	Cultivar	Seedling vigor	Percentage (%) living cover
33	Premier II	8.0	63.3
34	APR 1231	8.0	63.3
35	ABT-99-4.629	8.0	63.3
36	BY-100	8.3	63.3
37	Pick RC2	8.0	60.0
38	Koos R-71	8.0	60.0
39	WVPB-R-82	8.3	60.0
40	R8000	7.7	60.0
41	Divine	7.7	60.0
42	Premier	8.7	60.0
43	PST-2RT	7.7	60.0
44	PST-CATS	8.0	60.0
45	Manhattan 3	7.7	60.0
46	Phantom	7.7	60.0
47	Cathedral II	7.7	60.0
48	Pennant II	7.7	60.0
49	Allsport	8.0	60.0
50	Wilmington	7.7	60.0
51	6011	7.7	60.0
52	APR 1232	7.3	60.0
53	Elfkin	7.3	60.0
54	SRX 4820	8.0	60.0
55	ABT-99-4.633	8.0	60.0
56	ABT-99-4.753	8.0	60.0
57	ABT-99-4.903	7.7	60.0
58	Jet	8.0	60.0
59	LPR 98-143	8.0	56.7
60	LPR 98-144	7.7	56.7
61	Secretariat	8.0	56.7
62	Promise	7.0	56.7
63	APR 1234	7.7	56.7
64	APR 1236	7.7	56.7
65	DLF-LDD	7.7	56.7
66	NJ-6401	8.0	56.7
67	CIS-PR-69	7.7	56.7
68	CIS-PR-78	7.7	56.7
69	CIS-PR-80	8.0	56.7
70	APR 1237	7.7	56.7
71	Churchill	7.7	56.7
72	BAR 9 B2	7.7	56.7
73	JR-317	8.0	56.7
74	Edge	8.0	56.7
75	Pick PR B-97	7.3	56.7
76	ABT-00-4.339	7.0	56.7
77	ABT-99-4.464	7.3	56.7
78	Panther	7.7	56.7
79	DP LP-1	7.7	56.7
80	SRX 4120	8.0	56.7
81	ABT-99-4.115	7.7	56.7
82	ABT-99-4.560	7.7	56.7
83	PST-2JH	7.7	56.7
84	ABT-99-4.461	7.3	56.7
85	Pick PR 1-94	7.7	53.3
86	Pizzazz	7.7	53.3

	Cultivar	Seedling vigor	Percentage (%) living cover
87	Pick EX2	8.0	53.3
88	Pennington-11301	7.7	53.3
89	CIS-PR-75	7.3	53.3
90	CIS-PR-84	7.7	53.3
91	PST-2SLX	7.3	53.3
92	PST-2CRL	7.3	53.3
93	PST-2LA	7.7	53.3
94	Carger II	8.0	53.3
95	ABT-99-4.600	7.7	53.3
96	ABT-99-4.815	7.7	53.3
97	Seville II	8.0	53.3
98	DP 17-9069	7.7	53.3
99	AG-P981	7.3	53.3
100	APR 776	7.3	53.3
101	SRX 4RHT	7.3	53.3
102	CAS-LP84	7.3	53.3
103	EP57	7.3	53.3
104	ABT-99-4.709	7.3	53.3
105	CIS-PR-72	7.7	53.3
106	B1	7.7	50.0
107	Pick PR QH-97	7.3	50.0
108	Pick MDR	7.7	50.0
109	PST-2CRR	8.0	50.0
110	PST-2M4	7.7	50.0
111	Brightstar II	7.3	50.0
112	Catalina	7.3	50.0
113	ABT-99-4.721	6.7	50.0
114	DP 17-9496	8.3	50.0
115	MP58	7.7	50.0
116	MP103	7.3	50.0
117	PST-2L96	7.0	50.0
118	Radiant	7.3	50.0
119	PST-2A6B	7.3	46.7
120	PST-2SBE	7.7	46.7
121	APR 777	7.0	46.7
122	SR 4500	7.3	46.7
123	Skyhawk	7.3	46.7
124	MEPY	7.0	46.7
125	ABT-99-4.834	7.3	43.3
126	MDP	6.7	43.3
127	EPD	6.7	43.3
128	EP53	7.0	43.3
129	ABT-99-4.960	7.0	43.3
130	ABT-99-4.625	7.0	40.0
131	ABT-99-4.965	7.3	40.0
132	MP108	7.0	36.7
133	ABT-99-4.724	6.7	33.3
134	LTP-ME	1.0	10.0
	$LSD_{(0.05)}$	0.8	15.0

[1]Seedling vigor was rated using a 9 to 1 scale with 9 = best and 1 = worst vigor. Percentage living ground cover values represent the percentage area per plot covered by ryegrass.

Shade Adaptation Study

Nick E. Christians, Barbara R. Bingaman, and Gary M. Peterson

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

A second shade trial was added in the fall of 1994 to evaluate the performance of cultivars of chewings fescue (C.F.), creeping red fescue (C.R.F.), hard fescue (H.F.), tall fescue (T.F.), Kentucky bluegrass (K.B.), rough bluegrass (*Poa trivialis*), and *Poa supina*.

The trials are located under the canopy of a mature stand of Siberian elm trees (Ulmus pumila) at the Iowa State University Horticulture Research Station north of Ames, Iowa. Grasses are mowed at a 2-inch height and receive 2 lb N/1000 ft^2/year. No weed control has been required on the area, but the grass has been irrigated during extended droughts.

Monthly quality data are collected from May through October (Table 1 and 2). Visual quality is based on a scale of 9 to 1: 9 = best quality, 6 = lowest acceptable quality, and 1 = worst quality.

Table 1. 1999 Visual quality[1] data for turfgrass culitvars in the 1987 Shade Trial in descending order for mean quality.

	Cultivar	May	June	July	August	September	October	Mean quality
1	Victor (C.F.)	8.0	6.7	5.7	7.0	7.0	6.7	6.8
2	Waldina (H.F.)	5.7	6.3	6.7	7.0	7.0	6.7	6.6
3	Bar Fo 81-225 (H.F.)	6.0	6.7	7.0	5.7	7.3	6.7	6.6
4	Jamestown (C.F.)	7.0	5.7	5.0	6.3	6.7	5.7	6.1
5	Atlanta (C.F.)	6.3	6.7	5.3	6.3	6.0	6.0	6.1
6	Shadow (C.F.)	7.0	6.0	5.0	5.0	6.3	6.7	6.0
7	Agram (C.F.)	6.7	6.3	4.3	6.0	6.3	6.3	6.0
8	Waldorf (C.F.)	6.7	6.0	5.7	6.0	6.0	5.7	6.0
9	Mary (C.F.)	6.3	6.0	4.7	5.7	6.3	6.3	5.9
10	Banner (C.F.)	7.0	6.3	4.3	5.0	6.0	6.0	5.8
11	St-2 (SR3000) (H.F.)	5.3	5.7	5.3	5.3	6.3	6.0	5.7
12	Pennlawn (C.R.F.)	6.7	5.0	4.3	5.0	5.0	5.7	5.3
13	Wintergreen (C.F.)	6.0	5.3	4.7	4.7	5.7	5.3	5.3
14	Ensylva (C.R.F.)	6.0	4.7	4.3	5.7	5.7	5.7	5.3
15	Reliant (H.F.)	4.3	5.0	5.0	6.0	6.3	5.3	5.3
16	Rebel II (T.F.)	5.0	4.7	4.7	5.3	6.0	5.0	5.1
17	Koket (C.F.)	6.0	5.7	3.3	4.0	5.3	5.0	4.9
18	Estica (C.R.F.)	5.0	4.7	4.3	5.0	5.7	5.0	4.9
19	Sabre (P.T.)	6.7	6.0	4.3	4.3	4.3	4.0	4.9
20	Biljart (H.F.)	4.7	5.0	4.7	3.7	5.3	5.7	4.8
21	Rebel (T.F.)	5.3	4.7	4.3	3.7	6.0	4.7	4.8
22	Highlight (C.F.)	5.0	4.0	3.0	5.3	4.3	4.7	4.4
23	Arid (T.F.)	4.3	4.3	3.7	4.7	4.7	4.3	4.3
24	Spartan (H.F.)	4.0	4.3	3.3	3.7	4.7	5.0	4.2
25	Midnight (K.B.)	3.3	3.7	3.7	5.0	4.3	3.3	3.9
26	Scaldis (H.F.)	3.7	4.3	3.7	2.7	4.3	4.0	3.8
27	Apache (T.F.)	3.7	3.3	4.0	5.0	3.3	3.7	3.8
28	Bonanza (T.F.)	4.3	3.0	3.3	4.3	3.7	4.3	3.8
29	Falcon (T.F.)	4.3	4.0	3.3	3.3	3.7	3.3	3.7
30	Coventry (K.B.)	3.0	3.3	3.3	2.7	2.3	2.7	2.9
31	Ram I (K.B.)	3.0	3.3	2.3	3.7	3.0	2.0	2.9
32	Chateau (K.B.)	1.7	2.3	2.0	2.0	2.7	2.3	2.2
33	Nassau (K.B.)	2.3	2.0	1.0	3.3	2.0	2.3	2.2
34	Bristol (K.B.)	2.0	2.0	1.7	3.7	1.7	2.0	2.2
35	Glade (K.B.)	2.0	2.0	1.3	1.7	1.7	2.3	1.8
	$LSD_{0.05}$	1.9	1.7	2.1	2.3	1.6	1.9	1.4

[1]Visual quality was assessed using a scale of 9 to 1 with 9 = best, 6 = lowest acceptable, and 1 = worst turf quality.

Table 2. 1999 Visual quality[1] data for turfgrass culitvars in the 1994 Shade Trial in descending order for mean quality.

	Cultivar	May	June	July	August	September	October	Mean quality
1	Sabre (P.T.)	6.3	6.0	4.3	3.0	5.7	4.7	5.0
2	Polder (P.T.)	4.7	4.7	4.0	4.0	6.0	5.0	4.7
3	Banner (C.F.)	5.7	4.0	4.0	3.3	5.3	5.7	4.7
4	SR5100 (C.F.)	4.3	4.3	4.3	3.7	5.7	4.7	4.5
5	Southport (C.F.)	4.7	4.0	4.3	3.7	5.7	4.3	4.4
6	Victory (C.F.)	5.0	4.7	3.3	3.7	4.7	5.0	4.4
7	Banner II (C.F.)	4.3	4.3	4.0	4.0	6.0	3.7	4.4
8	Bridgeport (C.F.)	4.7	4.7	3.0	3.7	5.0	4.0	4.2
9	Midnight (K.B.)	4.7	5.0	3.7	3.0	4.7	3.7	4.1
10	Cypress (P.T.)	5.3	5.0	3.3	3.0	3.3	4.0	4.0
11	Silvana (H.F.)	3.3	4.3	4.3	3.0	4.7	4.3	4.0
12	Molinda (C.F.)	4.7	4.3	3.0	3.3	4.3	4.0	3.9
13	Waldina (H.F.)	3.3	3.7	3.7	4.0	3.7	4.3	3.8
14	Shadow (C.F.)	4.7	3.0	3.3	3.0	3.3	5.7	3.8
15	Shenandoah (T.F.)	3.0	3.7	3.7	3.0	4.0	4.7	3.7
16	Nordic (H.F.)	3.7	3.0	3.3	3.3	4.3	4.0	3.6
17	Flyer (C.R.F.)	3.3	4.3	3.0	3.3	4.0	3.7	3.6
18	Bonanza (T.F.)	4.3	4.3	2.3	2.3	4.0	4.0	3.6
19	Arid (T.F.)	3.3	3.0	2.3	3.3	3.7	4.3	3.3
20	Bonanza II (T.F.)	2.7	3.7	3.3	2.7	3.3	3.3	3.2
21	Glade (K.B.)	4.0	3.7	2.3	2.0	2.0	4.0	3.0
22	Mirage (T.F.)	4.0	2.7	2.0	1.7	3.3	3.7	2.9
23	Coventry (K.B.)	3.0	3.3	3.0	2.3	2.7	2.7	2.8
24	Rebel II (T.F.)	3.0	3.7	2.3	2.0	2.0	3.0	2.7
25	Adobe (T.F.)	2.3	3.7	2.3	2.7	2.7	2.7	2.7
26	Ascot (K.B.)	3.0	2.7	2.3	2.7	2.3	2.7	2.6
27	Aztec (T.F.)	3.3	2.0	2.3	2.0	2.3	2.7	2.4
28	Spartan (H.F.)	2.3	1.7	2.0	2.0	3.7	2.3	2.3
29	Falcon II (T.F.)	2.0	2.0	1.7	1.3	2.0	2.3	1.9
30	Buckingham (K.B.)	1.7	1.7	1.7	1.7	1.7	1.7	1.7
31	Bristol (K.B.)	2.0	2.0	1.3	1.3	1.7	2.0	1.7
32	Rebel (T.F.)	2.0	1.7	1.0	1.7	1.7	2.3	1.7
33	Bonsai (T.F.)	2.0	1.7	1.0	1.7	2.7	1.3	1.7
34	Brigade (H.F.)	1.7	1.3	1.0	1.3	1.3	2.0	1.4
35	Supranova (P.S.)	1.3	1.3	1.0	1.0	1.7	1.7	1.3
	$LSD_{0.05}$	2.3	2.1	1.7	1.9	1.9	2.1	1.6

[1]Visual quality was assessed using a scale of 9 to 1 with 9 = best, 6 = lowest acceptable, and 1 = worst turf quality.

Table 3. The average quality ratings for grasses in the 1987 Shade Trial: 1992 - 1999.

	Cultivar	1992	1993	1994	1995	1996	1997	1998	1999	Ave.*
1	Victor (C.F.)	5.9	7.2	7.1	6.6	6.6	7.1	7.0	6.8	6.53
2	Waldorf (C.F.)	7.3	5.9	6.2	5.8	6.1	6.6	6.1	6.0	6.17
3	ST-2 (SR 3000) (H.F.)	6.3	5.7	6.1	6.1	5.5	5.8	5.1	5.7	6.11
4	Mary (C.F.)	6.4	6.7	6.6	6.7	6.3	6.2	5.8	5.9	6.11
5	BAR FO 81-225 (H.F.)	6.5	5.5	6.1	6.5	5.7	5.9	5.8	6.6	6.10
6	Jamestown (C.F.)	6.0	6.5	6.6	6.2	5.9	6.1	6.1	6.1	6.03
7	Shadow (C.F.)	6.0	6.6	6.6	5.9	5.9	6.6	6.3	6.0	6.02
8	Waldina (H.F.)	5.5	5.5	5.8	5.8	5.1	5.9	6.4	6.6	5.95
9	Atlanta (C.F.)	6.1	5.8	5.7	5.5	6.7	6.6	5.9	6.1	5.94
10	Pennlawn (C.R.F.)	6.2	6.3	5.5	5.5	5.9	6.2	5.8	5.3	5.79
11	Rebel (T.F.)	6.0	6.9	5.9	5.7	4.6	4.5	5.3	4.8	5.74
12	Banner (C.F.)	5.0	6.0	5.6	5.3	6.2	6.3	5.7	5.8	5.74
13	Sabre (P.T.)	6.4	7.4	6.2	4.8	4.9	5.0	5.4	4.9	5.73
14	Estica (C.R.F.)	5.6	6.6	6.1	5.6	4.3	4.3	5.2	4.9	5.70
15	Biljart (H.F.)	6.1	5.0	5.1	5.1	4.8	5.1	4.4	4.8	5.56
16	Rebel II (T.F.)	5.6	6.1	6.2	5.1	4.3	4.1	5.4	5.1	5.55
17	Agram (C.F.)	5.9	5.4	5.3	5.1	5.5	5.6	6.0	6.0	5.53
18	Bonanza (T.F.)	6.9	6.3	6.2	5.2	4.2	4.1	4.2	3.8	5.49
19	Wintergreen (C.F.)	5.9	5.0	5.0	5.0	6.0	5.9	5.3	5.3	5.43
20	Falcon (T.F.)	6.0	6.5	6.3	5.2	4.2	4.2	4.2	3.7	5.41
21	Apache (T.F.)	6.0	6.3	5.4	5.3	3.7	3.2	4.2	3.8	5.33
22	Ensylva (C.R.F.)	5.1	5.9	5.4	4.4	5.3	4.9	5.2	5.3	5.27
23	Spartan (H.F.)	4.2	4.7	5.1	4.9	5.0	4.8	4.6	4.2	5.23
24	Arid (T.F.)	7.1	6.7	5.6	4.7	2.9	2.7	4.0	4.3	5.20
25	Koket (C.F.)	5.2	5.2	5.7	4.6	4.6	5.4	5.6	4.9	5.17
26	Scaldis (H.F.)	5.2	4.6	4.4	4.8	4.1	4.6	3.7	3.8	4.81
27	Highlight (C.F.)	4.6	5.0	4.8	4.7	4.9	5.1	5.2	4.4	4.75
28	Coventry (K.B.)	5.4	6.0	4.7	3.8	3.9	3.5	3.4	2.9	4.57
29	Midnight (K.B.)	5.5	6.4	4.6	4.4	4.0	3.9	4.6	3.9	4.51
30	Reliant (H.F.)	3.5	4.2	4.9	4.8	4.9	5.0	5.4	5.3	4.50
31	RAM I (K.B.)	5.0	5.9	4.3	3.3	2.8	2.7	3.2	2.9	4.38
32	Chateau (K.B.)	5.5	5.2	4.1	3.0	2.2	1.9	2.1	2.2	4.09
33	Glade (K.B.)	4.8	5.3	3.3	2.8	2.8	2.3	2.7	1.8	3.93
34	Bristol (K.B.)	3.9	5.0	4.1	3.6	2.8	2.4	3.1	2.2	3.73
35	Nassau (K.B.)	3.8	4.3	3.3	2.4	2.1	2.0	2.4	2.2	3.17

Quality Based on a 9 to 1 scale: 9 = best quality, 6 = lowest acceptable quality, and 1 = poorest quality.
*Average includes 1988, 1989, 1990, and 1991 data (not listed).
C.F. = chewings fescue, C.R.F. = creeping red fescue, H.F. = hard fescue, K.B. = Kentucky bluegrass, P.T. = *Poa trivialis* , T.F. = tall fescue. P.S. = *Poa supina*.

Fairway Height Bentgrass Cultivar Trials - Established 1998

Nick E. Christians and Rodney A. St. John

This is the first full year of data from the Fairway Height Bentgrass Cultivar trial established in the fall of 1998. The area was maintained at a 0.5 in. mowing height. This is a National Turfgrass Evaluation (NTEP) trial and is being conducted at several research stations in the U.S. It contains 26 of the newest seeded cultivars and a number of experimentals. The cultivars are maintained with 4 lbs of N/1000 ft^2/growing season. Fungicides are used as needed in a preventative program. Herbicides and insecticides also are applied as needed.

Visual quality ratings were taken from May through October 1999 (Table 1). Visual quality was assessed using a 9 to 1 scale with 9 = best, 6 = lowest acceptable, and 1 = worst quality. Spring greenup (Green) was evaluated in April 1999 using a 9 to 1 scale with 9 = best and 1 = worst greenup. Genetic color (Color), leaf texture (Leaf), and spring density (dense) were evaluated in June 1999. Genetic color was based on a 9 to 1 scale with 9 = dark green and 1 = light green. Leaf texture was estimated using a 9 to 1 scale with 9 = fine and 1 = coarse texture. Spring density values represent the percentage area per plot covered by bentgrass.

Table 1. 1999 Visual turf quality data and other physical ratings for cultivars in the 1998 Fairway Height Bentgrass Trial.

						Quality						
	Cultivar	Color	Green	Leaf	Dense	May	June	July	Aug	Sept	Oct	Mean
1	Century	7.0	5.7	6.7	7.3	6.0	6.3	6.3	7.3	7.3	7.0	6.7
2	Imperial	7.0	6.0	7.0	6.7	5.7	5.3	7.0	7.3	8.0	7.0	6.7
3	Backspin	7.0	6.0	7.0	7.3	5.7	6.3	6.3	6.7	7.3	7.0	6.6
4	Seaside II	6.7	6.0	6.7	6.0	5.7	6.0	6.3	6.3	7.3	6.7	6.4
5	Penn G-6	6.7	5.7	6.7	6.3	5.3	6.0	6.0	6.7	6.7	7.0	6.3
6	Grand Prix	6.3	6.0	6.0	5.7	4.7	6.0	6.0	6.7	7.0	6.7	6.2
7	Providence	6.3	6.3	7.0	7.0	5.3	5.7	6.0	6.3	7.0	7.0	6.2
8	PST-OVN	6.3	6.3	6.3	6.3	6.0	5.7	6.0	6.3	6.3	6.3	6.1
9	SR 1119	6.0	6.7	6.0	6.0	5.3	5.3	6.0	6.7	6.7	6.3	6.1
10	SRX 1120	6.7	6.0	6.7	5.7	4.7	4.7	6.0	7.0	7.0	6.3	5.9
11	Penncross	6.0	6.0	6.0	6.3	5.3	5.7	5.7	6.7	5.7	5.7	5.8
12	SRX 1BPAA	6.3	6.0	5.7	5.3	4.3	4.7	6.3	6.3	6.3	6.7	5.8
13	Trueline	6.3	6.3	6.3	5.7	5.3	5.0	6.0	6.0	6.3	6.3	5.8
14	L-93	7.3	6.0	6.0	6.0	5.0	5.3	5.3	6.0	6.0	6.7	5.7
15	Penneagle	7.0	5.3	7.0	5.0	5.3	6.0	5.7	6.0	5.7	5.3	5.7
16	Princeville	5.7	6.0	5.3	5.7	4.7	5.3	5.0	5.3	5.7	5.7	5.3
17	PST-9HG*	7.0	6.0	6.0	5.3	4.3	4.7	4.3	4.7	5.0	6.0	4.8
18	Seaside	5.3	6.3	5.3	5.3	4.7	4.7	4.7	4.7	4.3	4.7	4.6
19	SR 7100*	7.7	5.7	7.0	5.3	3.7	5.0	4.3	4.7	4.3	5.3	4.6
20	ISI AT-5*	7.0	6.0	6.3	4.3	3.7	4.0	4.7	4.3	3.7	5.7	4.3
21	PST-9PM*	7.0	5.7	5.3	5.3	4.3	4.7	3.7	3.7	3.7	5.0	4.2
22	Tiger	7.7	5.7	7.3	4.7	4.0	4.3	4.3	4.7	3.3	4.7	4.2
23	SRX 7 MOBB*	7.7	6.7	7.0	5.3	4.0	4.7	4.3	4.0	3.3	4.3	4.1
24	ABT-COL-2*	6.7	5.7	6.3	4.3	3.7	4.3	3.7	3.3	3.3	4.7	3.8
25	SRX 7 MODD*	7.3	6.3	6.0	4.7	3.7	3.7	3.7	3.7	3.7	4.3	3.8
26	Golfstar**	6.7	6.0	6.0	4.0	3.3	3.7	3.7	3.7	3.3	4.3	3.7
	$LSD_{(0.05)}$	2.0	NS	NS	1.8	1.1	1.1	1.0	0.8	1.0	1.0	0.6

*Colonial bentgrass
**Idaho bentgrass
Color (Genetic color): 9 = dark green and 1 = light green. Green (Greenup): 9 = best and 1 = worst greenup. Leaf (Leaf texture): 9 = fine and 1 = coarse. Spring density (dense) represents the percentage area per plot covered by bentgrass.
Visual quality was assessed with a 9 to 1 scale with 9 = best, 6 = lowest acceptable, and 1 = worst quality.
NS = means are not significantly different at the 0.05 level.

Green Height Bentgrass Cultivar Trials - Established 1998

Nick E. Christians and Rodney A. St. John

This was the first full year of data collection from the Green Height Bentgrass Cultivar trial established in the fall of 1998. The area is maintained at a 3/16-inch mowing height. This is a National Turfgrass Evaluation Program (NTEP) trial and is being conducted at several research stations in the U.S. It contains 29 seeded cultivars, including a number of experimentals. The cultivars are maintained with a fertilizer program of 1/4 lb N applied at 14-day intervals with a total of 4 lb of N/1000 ft^2/growing season. Fungicides are used as needed in a preventive program. Herbicides and insecticides are applied as needed.

Visual quality ratings were taken from May through October 1999 (Table 1). Visual quality was assessed using a 9 to 1 scale with 9 = best, 6 = lowest acceptable, and 1 = worst quality. Spring greenup (Green) was evaluated in April 1999 using a 9 to 1 scale with 9 = best and 1 = worst greenup. Genetic color (Color), leaf texture (Leaf), and spring density (dense) were evaluated in June 1999. Genetic color was based on a 9 to 1 scale with 9 = dark green and 1 = light green. Leaf texture was estimated using a 9 to 1 scale with 9 = fine and 1 = coarse texture. Spring density values represent the percentage area per plot covered by bentgrass.

Table 1. 1999 visual turf quality data and other physical ratings for cultivars in the 1998 Green Height Bentgrass Trial.

						Quality						
	Cultivar	Color	Green	Leaf	Dense	May	June	July	Aug	Sept	Oct	Mean
1	SYN 96-2	7.7	6.7	7.0	7.7	5.7	5.7	7.7	7.3	7.7	7.0	6.8
2	Century	7.0	6.3	6.0	7.0	6.0	6.0	6.7	7.0	7.7	7.0	6.7
3	Imperial	7.3	6.0	7.0	7.0	6.0	5.7	6.7	7.0	7.7	7.0	6.7
4	Bar AS 8FUS2	8.0	6.3	7.3	7.7	6.0	5.7	6.7	6.7	7.0	7.0	6.5
5	ABT-CRB-1	7.3	6.0	7.0	6.0	5.7	6.0	6.3	6.7	7.0	7.0	6.4
6	Penn A-1	7.3	6.7	7.7	6.3	5.7	5.7	6.7	6.7	7.3	6.3	6.4
7	Penn A-4	7.0	6.3	7.0	6.7	6.0	5.3	7.0	6.7	6.7	7.0	6.4
8	Penn G-1	7.0	6.0	7.0	7.3	5.7	6.0	6.3	6.3	7.0	7.0	6.4
9	Penn A-2	7.3	5.7	6.7	6.7	5.7	6.0	6.3	6.7	6.7	6.7	6.3
10	Providence	7.7	6.3	7.0	7.0	6.0	5.3	7.0	7.0	6.7	6.0	6.3
11	PST-A2E	6.7	6.3	7.0	6.3	5.3	5.0	6.0	6.7	7.3	7.7	6.3
12	SYN 96-1	7.7	5.7	7.7	7.0	5.3	5.3	6.3	6.3	8.0	6.7	6.3
13	SYN 96-3	7.3	6.0	7.7	6.7	5.0	5.7	6.3	6.7	7.0	7.0	6.3
14	Crenshaw	7.0	6.3	6.7	5.7	5.3	5.0	6.3	6.3	7.0	7.0	6.2
15	ISI AP-5	7.3	6.0	7.0	6.7	5.3	5.7	6.3	6.3	6.3	7.0	6.2
16	L-93	7.7	6.0	7.3	7.3	6.0	5.7	6.3	6.7	6.7	6.0	6.2
17	SRX 1NJH	7.3	6.7	6.0	6.3	5.3	5.7	6.7	6.3	6.7	6.3	6.2
18	Backspin	8.0	5.7	7.3	6.7	5.7	5.3	6.7	6.7	6.3	6.0	6.1
19	Pick CB 13-94	6.7	6.7	6.0	6.7	6.0	5.3	6.7	6.0	6.3	6.0	6.1
20	Penn G-6	7.0	6.0	6.3	6.7	5.7	5.3	6.3	6.0	6.3	6.3	6.0
21	Bar CB 8US3	7.3	6.0	7.3	6.3	5.3	5.7	5.7	6.0	6.0	6.7	5.9
22	SR 1119	7.3	6.3	7.3	6.7	5.3	5.7	6.3	6.0	5.7	6.3	5.9
23	Pennlinks	7.0	6.3	6.0	6.7	5.7	5.7	6.3	5.7	5.7	5.7	5.8
24	Penncross	7.7	6.3	7.0	6.3	5.7	5.7	5.7	5.3	5.3	6.0	5.6
25	SRX 1BPAA	6.3	6.3	6.3	6.0	5.3	5.3	6.0	5.7	5.7	5.3	5.6
26	SRX 1120	7.0	6.0	6.7	6.0	5.3	5.0	6.0	5.7	5.7	5.3	5.5
27	Pick MVB*	7.3	6.0	8.7	5.7	4.3	5.0	5.0	4.3	4.3	6.3	4.9
28	SR 7200*	7.3	6.3	8.7	5.7	4.3	4.3	5.0	4.0	4.3	7.0	4.8
29	Bavaria*	6.7	6.3	9.0	6.3	4.0	4.3	5.0	3.7	4.3	5.3	4.4
	$LSD_{(0.05)}$	NS	NS	1.2	NS	0.9	NS	1.0	1.0	1.0	1.0	0.4

*Velvet bentgrass

Color (Genetic color): 9 = dark green and 1 = light green. Green (Greenup): 9 = best and 1 = worst greenup. Leaf (Leaf texture): 9 = fine and 1 = coarse. Spring density (dense) represents the percentage area per plot covered by bentgrass. Visual quality was assessed with a 9 to 1 scale with 9 = best, 6 = lowest acceptable, and 1 = worst quality.

NS = means are not significantly different at the 0.05 level.

Overseeding of Northern Turfgrass Sports Fields with Bermudagrass

David D. Minner, Roch Gaussoin, and Steve Keeley

Objective:
To determine if seeded bermudagrass can be established in the summer and then used for intensely trafficked sport fields in late summer/early fall.

Procedure:

1998

This is a cooperative research project with Dr. Roch Gaussoin, University of Nebraska, and Dr. Steve Keeley, Kansas State University. Field plots were also established in Kansas and Nebraska, but only the Iowa data is reported at this time. This field research project was established at the Iowa State University Horticulture Research Station, Ames, IA. On 19 June 1998 the study area was prepared by treating the existing stand of grass and weeds with glyphosate. Eleven days later all of the vegetation was dead and approximately 50 percent of the area was showing exposed soil. On 2 July 1998 the test area was verticut in two directions to a depth of 0.5 inches. The area was immediately fertilized, seeded, and watered. One pound of N, P_2O_5, and K_2O was applied per 1000 sq. ft. Six bermudagrass varieties (3 lbs. seed /1000 sq. ft.) and Bright Star perennial ryegrass (15 lbs. seed/1000 sq. ft.) were established in 8 foot by 15 foot whole-plots. Grass was watered and mowed to a two-inch cutting height. Plots were rated on 24 August and then half of each bermudagrass whole-plot was slit seeded with Bright Star perennial ryegrass (10 lbs/1000 sq. ft.) to provide a 4-foot by 15-foot split-plot. The experimental design was a randomized complete block with seven whole-plot treatments (bermudagrasses: Sultan, Numex Sahara, SWI-10, Blend C, Mirage, and Pyramid), two split-plot treatments (with or without perennial ryegrass), and three replications.

1999

In 1999 treatments were established on the same plots that were used in 1998. The intent was to keep any existing vegetation (bermudagrass or perennial ryegrass) that may have overwintered in the plots. Sports field managers are reluctant to kill any vegetation in high traffic areas and re-establishing into the existing vegetation in this manner provided a realistic approach to providing maximum cover during the summer. By mid-June it was evident that no bermudagrass had survived the winter and the split plots containing only bermudagrass contained about 50% *Poa annua*. To maximize desirable turf cover the only plots treated with Round-up were those that received 100% bermudagrass. The 100% perennial ryegrass plots and the bermudagrass plots overseeded with perennial ryegrass were not treated with Round-up. Round-up was applied on 10 June and all plots were seeded on 15 June 1999. Seeding and fertility rates were the same as in 1998.

Traffic was applied with a Brouwer roller that was modified with football cleats to supply differential-slip-type traffic. Fifteen passes over the test area were made with the traffic simulator between 27 August and 15 September 1998 and 60 passes were made between 16 September and 24 October in 1999

Results and Discussion:

1998

Table 1 shows the advantage of establishing a warm season grass like bermudagrass during the summer compared with perennial ryegrass. On 24 August all of the bermudagrass selections had greater than 90% turf cover, while perennial ryegrass had only 23% turf cover. This resulted in a substantial advantage that would coincide with the beginning of a normal fall football season. Even with an additional perennial ryegrass seeding on 24 August, the bermudagrasses provided more turf cover than perennial ryegrass at the end of the football season. Bermudagrass cover was approximately 75% compared with 52% for perennial ryegrass (Table 2).

All of the bermudagrass varieties retained 100% of their green color on 15 September. By 1 October the bermudagrasses were showing signs of winter dormancy and green color retention was approximately 60 percent. By 16 October 1998 bermudagrass leaves were mostly brown with only about 30% green tissue present. Table 2 shows that there was a slight improvement in turf color on 16 October when bermudagrass was overseeded with perennial ryegrass. By 16 October the perennial ryegrass only treatment had much better color than the bermudagrass or the bermudagrass/overseeded with rye treatments.

1999

In mid-June 1999 it was evident that no bermudagrass survived the winter and the plots seeded with only bermudagrass had approximately 50% cover by *Poa annua*. The winter-killed bermudagrass plots that were contaminated with *Poa annua* were treated with Round-up on 18 June in preparation for seeding. Just as in 1998, all the plots were again seeded in early July 1999. The difference in 1999 was that the perennial ryegrass and ryegrass plus bermudagrass treatments already had some residual established turf from the previous 1998 season. Any treatments that received perennial ryegrass in 1998 had approximately 50% perennial ryegrass at time of seeding on 1 June 1999. Table 3 shows the effect of interseeding bermudagrass and perennial ryegrass into this situation. The residual perennial ryegrass from 1998 combined with the additional seeding in 1999 resulted in a 90% turf cover stand. In 1998 the summer seeding of perennial ryegrass on bare ground only produced 23% turf cover. This is a good indication of why athletic field managers do not like to start over by killing existing vegetation, even though it may be sparse. When the mixture of bermudagrass and perennial ryegrass was seeded into the existing 50% stand of perennial ryegrass, it appeared that the bermudagrass would only establish where there was bare ground or exposed soil. This resulted in a stand of approximately 25% bermudagrass and 75% perennial ryegrass at the beginning of the fall traffic period compared to the bare ground plots that when seeded with 100% bermudagrass resulted in 100% turf cover (Tables 1 and 3).

There was very little difference among bermudagrass varieties in terms of turf quality or cover as it relates to traffic. The most compelling result for using bermudagrass for summer overseeding in the north is evident from the amount of bare ground or exposed soil data (Table 3). At the end of the fall traffic period perennial ryegrass alone resulted in 37% of the ground having exposed soil, while bermudagrass alone or mixed with perennial rye had less than 10% exposed soil.

This study has shown that seeded bermudagrass can be used to quickly establish grass on intensely trafficked cool-season fields. While it does not over winter, it has provided better turf cover and less exposed soil compared to conventional overseeding only with perennial ryegrass. Turf quality in terms of color and texture are of little importance to the athletic field manager who is battling excessive traffic. Germplasm that specifically addresses the issue of turf cover should not be overlooked just because it has less appeal from a visual quality basis.

Listed below are some of the desirable characteristics for selecting seeded bermudagrasses that could be used for annual overseeding of cool season grasses in northern climates.

- *Winter hardy* – obviously, a bermudagrass that overwinters in northern climates would be very desirable.
- *Biomass* – The goal is to prevent exposed soil. Varieties that rapidly produce thatch or mat to provide a protective cushion over the soil are very desirable.
- *Extended growing season* – We are looking for varieties that germinate and start growing at lower temperatures in the spring/summer and continue to produce growth longer into the fall before dormancy. A variety that continues to actively produce vegetation during the 45 day period before the first frost would be very desirable.
- *Competitor* – When a thin stand of perennial ryegrass is overseeded with bermudagrass, the bermudagrass only establishes in the areas where the soil has been exposed by traffic. We would like to have a bermudagrass that is more competitive and has better establishment characteristics when it is drill seeded into an established stand of perennial ryegrass.

Table 1. Percent turf cover for six bermudagrass selections and one perennial ryegrass. Grass was seeded on 2 July and evaluated on 24 August 1998.

Grass	% Turf Cover
Sultan	95
NuMex Sahara	95
Mohawk	98
Blend C[z]	93
Mirage	95
Pyramid	96
Bright Star	23

[z] Blend C contains Princess 50%, SWI-10 25%, and Sultan 25%.

Table 2. Turfgrass color, quality, and % cover on 16 Oct 1998 at the end of the simulated traffic season.

Grass	Color	Quality	% Cover
Sultan	3	6	75
Sultan + PR	4	6	73
NuMex Sahara	3	6	73
NuMex Sahara + PR	4	6	72
Mohawk	3	6	75
Mohawk + PR	4	6	73
Blend C	3	6	73
Blend C + PR	4	6	73
Mirage	3	6	72
Mirage + PR	4	6	73
Pyramid	3	6	72
Pyramid + PR	4	6	75
Bright Star PR	8	5	52

Table 3. Turfgrass quality and cover rated on 16 September 1999 before traffic and 12 December 1999 at the end of the simulated traffic season. Turf quality rated on a scale of 1 to 10, 10 = best and 1 = worst. Turfgrass cover rated as percent of plot area covered with either bermudagrass, perennial ryegrass, or exposed soil (grass completely worn away).

Grass	Quality	% Cover		% Cover		
		Bermuda	Per rye	Bermuda	Per rye	Exposed soil
	16 September 1999 (before traffic)			12 December 1999 (after traffic)		
Sultan	5.7	100	-	83	-	17
Sultan + PR	5.3	12	88	8	82	10
NuMex Sahara	7.3	100	-	95	-	5
NuMex Sahara + PR	6.3	28	72	42	62	8
SWI-10	7.3	100	-	95	-	5
SWI-10 + PR	6.0	28	72	25	65	10
Blend C	6.0	100	-	85	-	15
Blend C + PR	5.7	25	75	23	67	10
Mirage	7.0	100	-	88	-	12
Mirage + PR	5.7	20	80	17	73	10
Pyramid	6.3	100	-	90	-	10
Pyramid + PR	5.7	10	90	12	78	10
Bright Star PR	4.0	-	90	-	63	37

Ornamental Grasses Renovation Project 1999-2000

Heather McDorman and Nick Christians

Purpose:
The purpose of the ornamental grasses renovation project is to "revamp" a site consisting of 34 different ornamental grasses on each side, within a 270-foot garden bed. Originally, the site was used for an ornamental grass study relating to the "suitability of 19 species of ornamental grass to the Iowa climate" (Roe and Christians). Many changes in the arrangement of these grasses have occurred since the project first began in 1989, resulting in the need for renovation.

The beginning of renovation:
Today there are many species and varieties that still exist on the site. However, some of the grasses have transferred on their own to other plots, some stayed where they were planted, and others have faded away. In this project, there is a list including 19 proposed grasses to be introduced, eight to be transplanted, and approximately seven to stay where they currently are. These numbers may vary since each side, though planted with the same species, has evolved differently.

The spacing and overall design will remain the same for the renovation as it was for the original design. Each plot on this site consists of a four to five foot by five foot spacing. The sizes allow adequate room for healthy growth and for a good specimen.

The grasses will descend in height from number one in the center, to 34 on each of the ends. One of the difficulties in planning this (with the heights), is that some of the grasses form clumps at a certain height, but flower maybe two feet higher. Other grasses may have foliage and flowering at one approximate height. Variation to some extent may occur, but hopefully the species are arranged in such a way to be complimentary to each other.

Difficulties in research findings:
After reading about many of the different species, as well as the many descriptions from various sources, it was evident how critical genus-species names can be. It is important to know one species from another so that the information can be more useful and unwanted species are not accidentally introduced.

Some sources indicated how certain species could become confused with another, whether through catalogs, the names, hybrids, etc. One example by Darke was used in the description for *Elymus glaucus*. It stated that "the name *Elymus glaucus* hort. is often used in error in nursery catalogs and garden books to refer to *Leymus arenarius*, a running species with strongly glaucous foliage" (190). Another example in the same book stated for *Miscanthus* 'Purpurascens', "Does not belong to *Miscanthus sinensis*, although often listed as such. Possibly a hybrid involving *M. oligostachyus*, but ultimate origin is obscure" (225). These examples show how easy an unwanted species can be mistaken for another species.

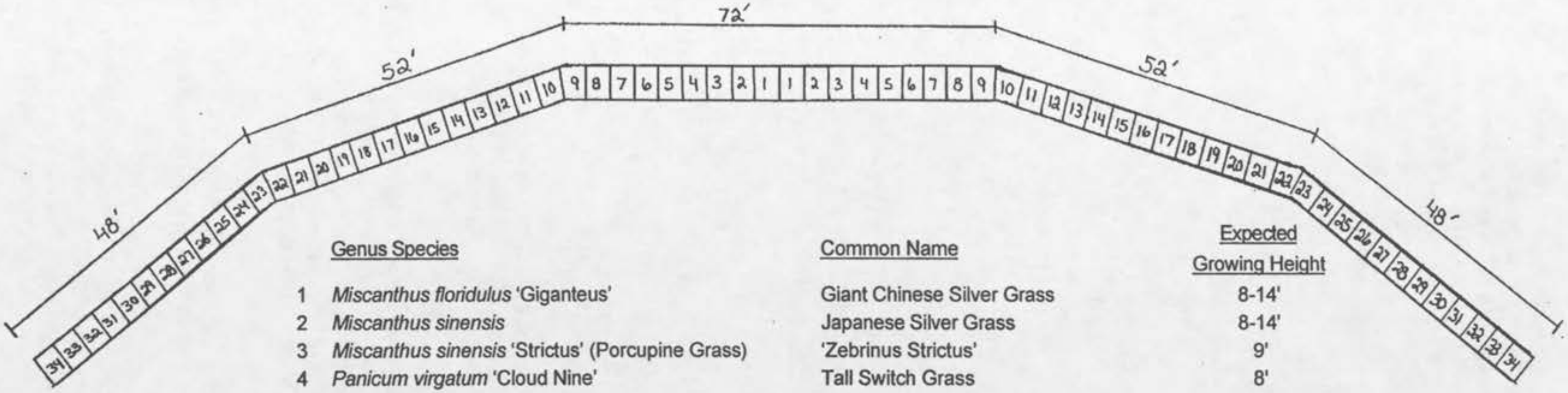
Choosing the species:
Ornamental grasses have numerous characteristics, each of which could make a difference in what species is chosen for a particular landscape. For the plots at the Horticulture Research Station, the new species have general characteristics of being bunch type, non-aggressive, varying in color, form and shape, in addition to being able to grow in the zones 4 and/or 5. Species that have survived over the years and are still standing, plus leave room for the other grasses to grow were the species that remained on the list from the previous years.

Locating and Ordering the Grasses:
In the search for locating particular grasses, there were many sources available, although sometimes limiting. The Internet provided pictures, descriptions, and availability for purchasing. Local nurseries were another beneficial source.

Overall, the search went well even though a few species and varieties proved difficult to find. The result was a few changes in the list of grasses. One change was made with the *Helictotrichon sempervirens* (Blue oat grass). The variety 'Robust' was unavailable and was replaced with 'Saphirsprudel'. The same kind of change was made for the *Panicum virgatum* 'Strictum' which was replaced by the 'Prairie Sky' variety. These are only a few of the changes.

Planting:
On May 12, 2000 the new grasses that had arrived were planted in their proper location. The existing grasses previously in those places were divided into small sections and placed in pots to be transplanted later. All of the grasses were thoroughly watered. Competing vegetation or unwanted varieties would later be sprayed with Round-up for control.

Conclusion:
Every ornamental grass has a uniqueness to itself. Even the many varieties of *Molinia caerulea ssp. arundinacea*, *Miscanthus sinensis*, or *Deschampsia caespitosa*. In the study of ornamental grasses, one can quickly learn to see these unique properties and understand the benefits of having ornamental grasses. They not only provide a source of aesthetics, habitat for wildlife, and interesting specimens, but also provide a source that enriches the senses.



	Genus Species	Common Name	Expected Growing Height
1	*Miscanthus floridulus* 'Giganteus'	Giant Chinese Silver Grass	8-14'
2	*Miscanthus sinensis*	Japanese Silver Grass	8-14'
3	*Miscanthus sinensis* 'Strictus' (Porcupine Grass)	'Zebrinus Strictus'	9'
4	*Panicum virgatum* 'Cloud Nine'	Tall Switch Grass	8'
5	*Miscanthus sinensis* 'Graziella'	Japanese Silver Grass	7'
6	*Miscanthus sinensis* 'Silberfeder'	Silver Feather	7'
7	*Molinia caerulea ssp. arundinacea* 'Transparent'	Tall Purple Moor Grass	6-8'
8	*Molinia caerulea ssp. arundinacea* 'Skyrace'	Tall Purple Moor Grass	6'
9	*Molinia caerulea ssp. arundinacea* 'Windspiel'	Tall Purple Moor Grass	6'
10	*Molinia litorialis* 'Fontaene'	Tall Purple Moor Grass	6'
11	*Calamagrostis* x *acutiflora* 'Karl Foerster'	Karl Foerster's Feather Reed Grass	6'
12	*Miscanthus sinensis* 'Variegatus'	Variegated Miscanthus	6'
13	*Miscanthus sinensis* 'Silberspinne'	Japanese Silver Grass	6'
14	*Panicum virgatum* 'Prairie Sky'	Switch Grass	6'
15	*Panicum virgatum* 'Heavy Metal'	Blue Switch Grass	5'
16	*Panicum virgatum*	Switch Grass	5'
17	*Miscanthus sinensis* 'Purpurascens'	Autumn Red	5'
18	*Sorghastrum nutans*	Indian Grass	3-8'
19	*Andropogon gerardii*	Big bluestem	5'
20	*Calamagrostis arundinacea* var. *brachytricha*	Fall Blooming Reed Grass	3-4'
21	*Panicum virgatum* 'Haense Herms'	Red Switch Grass	4'
22	*Panicum virgatum* 'Rehbrun'	Red Switch Grass	4'
23	*Panicum virgatum* 'Rotstrahlbusch'	Red Switch Grass	4'
24	*Spodiopogon sibiricus*	Siberian graybeard	4'
25	*Bouteloua curtipendula*	Side-oats grama	3'
26	*Molinia caerulea* 'Moorhexe'	Purple Moor Grass	3'
27	*Schizachyrium scoparium* 'Blaze'	Little Bluestem	2-3'
28	*Deschampsia cespitosa* 'Bronzeschleier'	Tufted Hair Grass	2-3'
29	*Deschampsia cespitosa* 'Tautraeger'	Tufted Hair Grass	2-3'
30	*Helictotrichon sempervirens* 'Saphirsprudel'	Blue-oat grass	2 - 4 1/2'
31	*Festuca mairei*	Atlas Mountain Fescue	2 - 2 1/2'
32	*Molinia caerulea* 'Variegata'	Variegated Moor Grass	1 - 2 1/2'
33	*Festuca glauca* 'Superba'	Large Blue Fescue	1-2'
34	*Festuca glauca* 'Elijah Blue'	'Elijah Blue' Fescue	8"

1999 Preemergent Annual Weed Control Study

Barbara R. Bingaman, Mark J. Howieson, and Nick E. Christians

Various formulations of Barricade on a fertilizer carrier were screened to determine the lowest herbicide rate that would provide an acceptable level of crabgrass control. This study was conducted at Iowa State University Horticulture Research Station. The experimental area was seeded in Fall 1998 with 'Moonlight' Kentucky bluegrass. The soil in this area was a Nicollet (fine-loamy, mixed, mesic Aquic Hapludoll) with an organic matter content of 3.8%, a pH of 7.1, 12 ppm P, and 128 ppm K. In the spring of 1999, the plot had approximately 50% bluegrass cover. This area had a history of heavy crabgrass infestations so no overseeding of crabgrass was performed.

The experimental design was a randomized complete block. Individual plot size was 5 x 5 ft with three replications. There were a total of 19 treatments including Dimension 1EC and experimental formulations of Dithiopyr. Dimension, Team Pro, Pendimethalin, and Barricade were screened in formulations on fertilizer. Other experimental formulations also were included with an untreated control (Table 1).

Table 1. Products and application rates for the 1999 Preemergent Annual Grass Study.

	Material	Rate lb a.i./A	Rate lb fertilizer/1000 ft^2
1	Untreated control	N/A	N/A
2	Dimension 1EC	0.18	3.5
3	Dimension 1EC	0.25	3.5
4	Dimension 0.072FG AD442	0.18	5.76
5	Dimension 0.164FG AD445	0.25	5.76
6	Dithiopyr PED 2.32XF 99006	0.18	3.5
7	Dithiopyr PED 2.32XF 99006	0.25	3.5
8	Dithiopyr PED 2.52XF 99007	0.18	3.5
9	Dithiopyr PED 2.52XF 99007	0.25	3.5
10	Dimension 40WP	0.18	3.5
11	Dimension 40WP	0.25	3.5
12	Fertilized control	N/A	3.5

	Material	Initial application Rate lb a.i./A	Sequential application Rate lb a.i./A
13	Team Pro NAF-324 0.86GR	1.50	1.5
14	Team Pro NAF-324 0.86GR	2.00	none
15	Pendimethalin 0.86GR	1.50	1.5
16	Pendimethalin 0.86GR	2.00	none
17	Dimension 0.09 GR	0.38	none
18	Barricade 0.22 GR	0.50	none
19	AND 674.99	1.24	none

Treatments 2 - 12 and initial applications of 13-18 were made April 30 before crabgrass germination.
Sequential applications of treatments 13 and 15 were made on June 24, 8 to 10 weeks after the initials.

All materials were applied on April 30. Granular treatments were made using cardboard cartons as 'shaker dispensers' to ensure even distribution of product. Liquid materials were dissolved in 283 ml water (which is equivalent to a rate of 3 gal/1000 ft^2) and were applied at 30-35 psi using a carbon dioxide backpack sprayer equipped with TeeJet #8006 flat fan nozzles.

The plot was checked May 3 for phytotoxicity and none was observed. Visual quality ratings were made weekly from May 10 through September 14 (Tables 2 and 3). Quality was assessed using a 9 to 1 scale with 9 = best, 6 = lowest acceptable, and 1 = worst quality. Crabgrass count data were taken weekly from May 10 through September 14 (Table 4). In addition, data were taken for all weed species present on September 1, 9, and 14 (Table 5). Data were analyzed with the Statistical Analysis System (SAS, version 6.12) and the Analysis of Variance (ANOVA) procedure. Means were compared with Fisher's Least Significant Difference (LSD) tests.

The quality of the 'Moonlight' bluegrass was not affected by any of the treatments. Even the herbicide plus fertilizer formulations had no effect on quality. This bluegrass cultivar has a dark, blue-green color and differences in color were not detectable. Thickness and uniformity also were similar for untreated and treated bluegrass.

There were very few crabgrass plants in the experimental area even in the surrounding fringe areas. This can probably be explained by a low germination rate of crabgrass and/or the aggressive nature of this bluegrass cultivar. It has been noted from other studies that crabgrass populations are low in bluegrass plots during the establishment year. This study area will be monitored spring and summer 2000 for differences in quality and crabgrass numbers. In addition, another area was planted with 'Moonlight' and other standard bluegrass cultivars so crabgrass populations within the establishment year can be monitored.

Broadleaf weed species were prevalent within this test area early spring 1999. As the bluegrass filled in the area, the weeds were outcompeted and by September their numbers were very low. Dandelion was the only species that was found in more than two individual plots.

Table 2. Visual quality[1] of 'Moonlight' Kentucky bluegrass treated for the 1999 Preemergent Annual Weed Control Study (May 10 through July 14).

	Material	Rate lb a.i./A	May 10	May 20	May 26	June 2	June 11	June 15	June 24	July 1	July 7	July 14
1	Untreated control	N/A	9	9	9	9	9	9	9	9	9	9
2	Dimension 1EC	0.18	9	9	9	9	9	9	9	9	9	9
3	Dimension 1EC	0.25	9	9	9	9	9	9	9	9	9	9
4	AD442	0.18	9	9	9	9	9	9	9	9	9	9
5	AD445	0.25	9	9	9	9	9	9	9	9	9	9
6	PED #99006	0.18	9	9	9	9	9	9	9	9	9	9
7	PED #99006	0.25	9	9	9	9	9	9	9	9	9	9
8	PED #99007	0.18	9	9	9	9	9	9	9	9	9	9
9	PED #99007	0.25	9	9	9	9	9	9	9	9	9	9
10	Dimension 40WP	0.18	9	9	9	9	9	9	9	9	9	9
11	Dimension 40WP	0.25	9	9	9	9	9	9	9	9	9	9
12	Fertilized control	N/A	9	9	9	9	9	9	9	9	9	9
13	NAF-324	1.50	9	9	9	9	9	9	9	9	9	9
14	NAF-324	2.00	9	9	9	9	9	9	9	9	9	9
15	Pendimethalin 0.86GR	1.50	9	9	9	9	9	9	9	9	9	9
16	Pendimethalin 0.86GR	2.00	9	9	9	9	9	9	9	9	9	9
17	Dimension 0.09GR	0.38	9	9	9	9	9	9	9	9	9	9
18	Barricade 0.22GR	0.50	9	9	9	9	9	9	9	9	9	9
19	AND 674.99	1.24	9	9	9	9	9	9	9	9	9	9
	$LSD_{0.05}$		--	--	--	--	--	--	--	--	--	--

[1]Visual quality was assessed using a 9 to 1 scale with 9 = best, 6 = lowest acceptable, and 1 = worst quality.

Table 3. Visual quality[1] of 'Moonlight' Kentucky bluegrass treated for the 1999 Preemergent Annual Weed Control Study (June 21 through September 14).

	Material	Rate lb a.i./A	July 21	July 27	Aug 3	Aug 10	Aug 17	Aug 26	Sept 1	Sept 9	Sept 14	Mean
1	Untreated control	N/A	9	9	9	9	9	9	9	9	9	9
2	Dimension 1EC	0.18	9	9	9	9	9	9	9	9	9	9
3	Dimension 1EC	0.25	9	9	9	9	9	9	9	9	9	9
4	AD442	0.18	9	9	9	9	9	9	9	9	9	9
5	AD445	0.25	9	9	9	9	9	9	9	9	9	9
6	PED #99006	0.18	9	9	9	9	9	9	9	9	9	9
7	PED #99006	0.25	9	9	9	9	9	9	9	9	9	9
8	PED #99007	0.18	9	9	9	9	9	9	9	9	9	9
9	PED #99007	0.25	9	9	9	9	9	9	9	9	9	9
10	Dimension 40WP	0.18	9	9	9	9	9	9	9	9	9	9
11	Dimension 40WP	0.25	9	9	9	9	9	9	9	9	9	9
12	Fertilized control	N/A	9	9	9	9	9	9	9	9	9	9
13	NAF-324	1.50	9	9	9	9	9	9	9	9	9	9
14	NAF-324	2.00	9	9	9	9	9	9	9	9	9	9
15	Pendimethalin 0.86GR	1.50	9	9	9	9	9	9	9	9	9	9
16	Pendimethalin 0.86GR	2.00	9	9	9	9	9	9	9	9	9	9
17	Dimension 0.09GR	0.38	9	9	9	9	9	9	9	9	9	9
18	Barricade 0.22GR	0.50	9	9	9	9	9	9	9	9	9	9
19	AND 674.99	1.24	9	9	9	9	9	9	9	9	9	9
	$LSD_{0.05}$		--	--	--	--	--	--	--	--	--	--

[1]Visual quality was assessed using a 9 to 1 scale with 9 = best, 6 = lowest acceptable, and 1 = worst quality.

Table 4. Crabgrass counts[1] in 'Moonlight' Kentucky bluegrass treated for the 1999 Preemergent Annual Weed Control Study.

	Material	Rate lb a.i./A	July 7	July 14	July 21	July 27	Aug 3	Aug 10	Aug 17	Aug 26	Sept 1	Sept 9	Sept 14	Mean
1	Untreated control	N/A	0.3	0.7	1.3	1.3	2.7	3.0	3.7	3.7	3.7	4.0	5.0	2.7
2	Dimension 1EC	0.18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	Dimension 1EC	0.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	AD442	0.18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	AD445	0.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	PED #99006	0.18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	PED #99006	0.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	PED #99007	0.18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	PED #99007	0.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	Dimension 40WP	0.18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	Dimension 40WP	0.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	Fertilized control	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	NAF-324	1.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	NAF-324	2.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	Pendimethalin 0.86GR	1.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	Pendimethalin 0.86GR	2.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	Dimension 0.09GR	0.38	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	Barricade 0.22GR	0.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	AND 674.99	1.24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	$LSD_{0.05}$		NS	0.2	0.4	0.4	0.6	0.7	1.0	1.0	1.0	1.1	1.7	0.7

[1]These figures represent the number of crabgrass plants per plot.

Table 5. Dandelion counts[1] in 'Moonlight' Kentucky bluegrass treated for the 1999 Preemergent Annual Weed Control Study.

	Material	Rate lb a.i./A	Sept 1	Sept 9	Sept 14	Mean count
1	Untreated control	N/A	0.0	0.7	0.7	0.4
2	Dimension 1EC	0.18	0.3	0.0	0.3	0.2
3	Dimension 1EC	0.25	0.0	0.0	0.0	0.0
4	AD442	0.18	0.0	0.0	0.0	0.0
5	AD445	0.25	0.4	1.0	1.0	0.9
6	PED #99006	0.18	0.0	0.3	0.4	0.3
7	PED #99006	0.25	0.3	0.3	0.3	0.3
8	PED #99007	0.18	0.3	1.0	1.0	0.8
9	PED #99007	0.25	0.0	0.3	0.3	0.2
10	Dimension 40WP	0.18	1.7	1.7	1.7	1.7
11	Dimension 40WP	0.25	0.7	1.0	1.0	0.9
12	Fertilized control	N/A	0.7	1.0	1.0	0.9
13	NAF-324	1.50	0.3	0.3	0.3	0.3
14	NAF-324	2.00	0.7	0.3	1.0	0.7
15	Pendimethalin 0.86GR	1.50	1.3	0.4	0.4	0.9
16	Pendimethalin 0.86GR	2.00	0.3	0.3	0.3	0.3
17	Dimension 0.09GR	0.38	0.0	0.3	0.4	0.3
18	Barricade 0.22GR	0.50	0.7	1.0	1.0	0.9
19	AND 674.99	1.24	1.3	1.0	1.3	1.2
	$LSD_{0.05}$		NS	NS	NS	NS

[1]These figures represent the number of dandelion plants per plot.

1999 Postemergent Annual Grass Control Study

Barbara R. Bingaman, Mark J. Howieson, and Nick E. Christians

Herbicides applied postemergently were screened for efficacy in controlling crabgrass in established turfgrass. The study was located at the Iowa State University Horticulture Research Station north of Ames, IA. The experimental plot was in established 'Common' Kentucky bluegrass with a heavy crabgrass infestation. The soil in this area was a Nicollet (fine-loamy, mixed, mesic Aquic Hapludoll) with 2.4% organic matter, 14 ppm P, 66 ppm K, and a pH of 7.8. The study was arranged as a randomized complete block. Individual plots were 5 x 5 ft with three replications. Preclaim 3.09EC, Drive 75DF, and Acclaim Extra 0.57EW were included with an untreated control. Preclaim 3.09EC and Drive 75DF were applied early and mid-postemergent. Drive 75DF and Acclaim Extra 0.57EW were applied late postemergent.

Early post treatments were applied on June 24 when the crabgrass was in the 1-4 leaf stage. Mid-post treatments were made on July 8 when the crabgrass had 1-2 tillers and the late-post treatments were applied on August 5 when the crabgrass had 3 or more tillers. Estimations of crabgrass density were made weekly from June 29 through September 7 (Table 1). These data represent the percentage of area per plot covered by green, healthy crabgrass. Percentage crabgrass cover data were transposed to express percentage cover reductions as compared with the untreated controls (Table 2). Visual quality was monitored over this same period. Quality was assessed using a 9 to 1 scale with 9 = best, 6 = lowest acceptable, and 1 = worst quality (Table 3). The bluegrass also was checked for phytotoxicity following each set of treatments. Data were analyzed with the Statistical Analysis System (SAS, Version 6.12) and the Analysis of Variance procedure (ANOVA). Means were compared with Fisher's Least Significant Difference test (LSD).

The early-post treatments provided nearly total crabgrass control from July 7 through July 14 (Table 1). Reductions in crabgrass cover remained ≥ 90% in Preclaim 3.09EC treated grass until August 26 and in Drive 75DF treated through September 7 (Table 2). Preclaim 3.09EC applied mid-postemergently provided > 88% crabgrass control from July 21 through September 7 (Tables 1 and 2). The mid-post application of Drive 75DF reduced crabgrass by 60.7% on July 26 but the crabgrass seemed to recover. By August 19, percentage crabgrass cover in the untreated control was similar to cover in grass treated with Drive 75DF mid-post. Both Acclaim Extra 0.57EW and Drive 75DF were effective when applied as late-post materials (Tables 1 and 2). By August 11, Drive 75DF reduced crabgrass by ≥ 88% as compared to the untreated controls. After August 19, Acclaim Extra 0.57EW provided > 80% crabgrass control.

No phytotoxic symptoms were observed. There was some slight yellow coloration on the turf following the Preclaim 3.09EC applications. This color was gone after 48 hours with no turfgrass damage visible. There were no statistical reductions in the quality of treated grass as compared with the untreated controls (Table 3).

Table 1. Percentage undamaged crabgrass cover[1] in turf treated for the 1999 Postemergence Annual Weed Control Study.

	Materials	Rate lb a.i./A	Timing	June 29	July 7	July 9	July 14	July 21	July 26	Aug 3
				%						
1	Untreated control	N/A	N/A	81.7	73.3	76.7	68.3	91.7	93.3	90.0
2	Preclaim 3.09 EC	2.06	Early Post	68.3	0.3	0.0	0.0	1.7	3.7	6.7
3	Drive 75DF	0.75	Early Post	1.0	0.0	0.0	0.0	0.0	3.7	5.0
4	Preclaim 3.09 EC	2.06	Mid Post	63.3	66.7	75.0	43.3	6.7	10.3	6.7
5	Drive 75DF	0.75	Mid Post	68.3	68.3	60.0	38.3	53.3	36.7	55.0
6	Acclaim Extra 0.57EW	0.12	Late Post	61.7	68.3	68.3	58.3	90.0	88.3	85.7
7	Drive 75DF	0.75	Late Post	73.3	70.0	68.3	63.3	83.3	91.7	90.0
	$LSD_{0.05}$			38.0	24.9	20.3	25.5	18.3	11.3	18.9

	Materials	Rate lb a.i./A	Timing	Aug 11	Aug 19	Aug 26	Aug 31	Sept 7	Mean[2]
				%					
1	Untreated control	N/A	N/A	83.3	83.3	86.7	90.0	71.7	82.5
2	Preclaim 3.09 EC	2.06	Early Post	8.3	5.3	11.7	10.0	10.0	10.5
3	Drive 75DF	0.75	Early Post	6.7	3.7	5.3	5.3	6.7	3.1
4	Preclaim 3.09 EC	2.06	Mid Post	6.7	6.7	5.0	3.7	8.3	17.2
5	Drive 75DF	0.75	Mid Post	55.0	83.3	81.7	78.3	81.7	62.3
6	Acclaim Extra 0.57EW	0.12	Late Post	80.0	15.0	16.7	10.0	10.0	24.4
7	Drive 75DF	0.75	Late Post	10.0	5.0	5.3	8.3	6.7	6.7
	$LSD_{0.05}$			27.8	10.4	12.9	14.4	7.7	10.4

[1]These data represent the percentage cover of healthy crabgrass per plot.

[2]Mean cover for early post treatments includes data for the entire season, for mid post only data after July 8, and for late post only data after Aug. 5.

Early post materials were applied June 24 when the crabgrass was in the 1-4 leaf stage. Mid-post applications were made on July 8 when the crabgrass had 1 to 2 tillers and late post applications on Aug. 5 when the crabgrass had > 3 tillers.

Table 2. Reductions in percentage crabgrass cover[1] in turf treated for the 1999 Postemergence Annual Weed Control Study .

	Materials	Rate lb a.i./A	Timing	June 29	July 7	July 9	July 14	July 21	July 26	Aug 3
				%						
1	Untreated control	N/A	N/A	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Preclaim 3.09 EC	2.06	Early Post	16.4	99.5	100.0	100.0	98.2	96.1	92.6
3	Drive 75DF	0.75	Early Post	98.8	100.0	100.0	100.0	100.0	96.1	94.4
4	Preclaim 3.09 EC	2.06	Mid Post	22.5	9.0	2.2	36.6	92.7	88.9	92.6
5	Drive 75DF	0.75	Mid Post	16.4	6.8	21.8	43.9	41.8	60.7	38.9
6	Acclaim Extra 0.57EW	0.12	Late Post	24.5	6.8	10.9	14.6	1.9	5.3	3.7
7	Drive 75DF	0.75	Late Post	10.2	4.5	10.9	7.3	9.1	1.8	0.0
	$LSD_{0.05}$			46.5	33.9	26.5	37.3	19.9	12.1	21.0

	Materials	Rate lb a.i./A	Timing	Aug 11	Aug 19	Aug 26	Aug 31	Sept 7	Mean[2]
				%					
1	Untreated control	N/A	N/A	0.0	0.0	0.0	0.0	0.0	0.0
2	Preclaim 3.09 EC	2.06	Early Post	90.0	93.6	86.5	88.9	86.1	87.3
3	Drive 75DF	0.75	Early Post	92.0	95.6	93.8	94.1	90.7	96.2
4	Preclaim 3.09 EC	2.06	Mid Post	92.0	92.0	94.2	95.9	88.4	79.4
5	Drive 75DF	0.75	Mid Post	34.0	0.0	5.8	13.0	0.0	25.3
6	Acclaim Extra 0.57EW	0.12	Late Post	4.0	82.0	80.8	88.9	86.1	70.6
7	Drive 75DF	0.75	Late Post	88.0	94.0	93.8	90.7	90.7	91.9
	$LSD_{0.05}$			33.3	12.4	14.9	16.0	10.8	11.1

[1]These data represent percentage reductions in cover as compared to the untreated controls.

[2]Mean cover for early post treatments includes data for the entire season, for mid post only data after July 8, and for late post only data after Aug. 5.

Early post materials were applied June 24 when the crabgrass was in the 1-4 leaf stage. Mid Post applications were made on July 8 when the crabgrass had 1 to 2 tillers and late post applications on Aug. 5 when the crabgrass had > 3 tillers.

Table 3. Visual quality[1] of turf treated for the 1999 Postemergence Annual Weed Control Study.

	Materials	Rate lb a.i./A	Timing	June 29	July 7	July 9	July 14	July 21	July 26	Aug 3
1	Untreated control	N/A	N/A	9.0	9.0	8.0	8.7	9.0	9.0	9.0
2	Preclaim 3.09 EC	2.06	Early Post	8.3	9.0	9.0	7.0	9.0	9.0	9.0
3	Drive 75DF	0.75	Early Post	8.7	9.0	9.0	8.0	9.0	9.0	9.0
4	Preclaim 3.09 EC	2.06	Mid Post	9.0	9.0	8.0	8.0	9.0	9.0	9.0
5	Drive 75DF	0.75	Mid Post	9.0	9.0	8.0	8.0	9.0	9.0	9.0
6	Acclaim Extra 0.57EW	0.12	Late Post	9.0	9.0	8.0	8.7	9.0	9.0	9.0
7	Drive 75DF	0.75	Late Post	9.0	9.0	8.0	8.7	9.0	9.0	9.0
	$LSD_{0.05}$			NS	--	--	1.0	--	--	--

	Materials	Rate lb a.i./A	Timing	Aug 11	Aug 19	Aug 26	Aug 31	Sept 7	Mean
1	Untreated control	N/A	N/A	9.0	9.0	9.0	9.0	9.0	8.9
2	Preclaim 3.09 EC	2.06	Early Post	9.0	9.0	9.0	9.0	9.0	8.8
3	Drive 75DF	0.75	Early Post	9.0	9.0	9.0	9.0	9.0	8.9
4	Preclaim 3.09 EC	2.06	Mid Post	9.0	9.0	9.0	9.0	9.0	8.8
5	Drive 75DF	0.75	Mid Post	9.0	9.0	9.0	9.0	9.0	8.8
6	Acclaim Extra 0.57EW	0.12	Late Post	9.0	9.0	9.0	9.0	9.0	8.9
7	Drive 75DF	0.75	Late Post	9.0	9.0	9.0	9.0	9.0	8.9
	$LSD_{0.05}$			--	--	--	--	--	NS

[1]Visual quality was assessed using a 9 to 1 scale with 9 = best, 6 = lowest acceptable, and 1 = worst quality.

Early post materials were applied June 24 when the crabgrass was in the 1-4 leaf stage. Mid Post applications were made on July 8 when the crabgrass had 1 to 2 tillers and late post applications on August 5 when the crabgrass had > 3 tillers.

NS = means are not significantly different at the 0.05 level.

-- = means comparisons tests can not be applied to these data.

Poa annua Control With Prograss — 1999-2000

Nick Christians

The 1999-2000 *Poa annua* control trial included two parts. The first part involved application of Prograss (ethofumesate) 1.5 EC to golf course fairways on three golf courses in central Iowa by the course superintendents. The second part involved a replicated field trial conducted on the 14th fairway at Ames Golf and Country Club north of Ames, IA.

FAIRWAY APPLICATIONS

The courses involved in the fairway treatment study included the following locations and superintendents:

Don Portwine Ames Golf and Country Club 5752 G.W. Carver Ames, IA 50010	Bill Barker Terrace Hills Golf Course 8700 NE 46th Ave., PO Box 425 Altoona, IA 50009	John Ausen Hyperion Field Club 7390 NW Beaver Drive Johnston, IA 50131

AMES GOLF AND COUNTRY CLUB

At Ames Golf and Country Club, superintendent Don Portwine treated the north one-half of the 14th fairway with Prograss on the following schedule: May 20-3 oz, June 17-1.5 oz, July 13- 1.5 oz, August 16-1.5 oz, September 24-1.5 oz, and October 18-1.5 oz/1000 ft^2. The total application rate for the season was 10.5 oz/1000 ft^2. The fairway was estimated to have a 60% cover of *Poa annua* and 40% Kentucky bluegrass at the initiation of treatments. Each application was combined in a tank mix with Sprint 330, an iron source containing 10% Fe by weight, at 3 oz product/1000 ft^2, and urea at 0.1 lb N/1000 ft^2. Parts of the treated area that had been infested with creeping bentgrass were killed with Roundup on August 27 and seeded with a combination of Newglade, Bluemoon, Award, Rugby II, and Rambo Kentucky bluegrass.

At no time during the season were any signs of phytotoxicity observed on the Kentucky bluegrass. Observations on Oct. 12 indicated no significant loss of *Poa annua* in the treated area and there was no apparent damage to the germinating Kentucky bluegrass seedlings. Parts of the seeded area are split into treated and non-treated areas and observations of seedling survival and *Poa annua* control were made in the spring on April 17, 2000.

The area seeded with Kentucky bluegrass in the fall showed no reduction of germination in areas treated with Prograss during the 1999 season. *Poa annua* reduction was hard to determine in treated areas. The section of the fairway that had been estimated to have a 60% *Poa annua* population in the spring of 1999, had an approximate 25 to 30% infestation in the spring of 2000. However, the areas that were killed with Roundup and seeded to Kentucky bluegrass had at least 60% *Poa annua* and in some areas more than 60%. The population in these fall-seeded sections of the fairway was the same in areas treated with Prograss in 1999 as it was in areas that had not received the Prograss.

TERRACE HILLS GOLF COURSE

At Terrace Hills Golf Course, superintendent Bill Barker treated the 11th fairway with Prograss on the following schedule: May 10-3 oz, June 3-1.5 oz, July 13-1.5 oz, August 10-1.5 oz, August 31-1.5 oz, October 8-1.5 oz, and October 29-1.5 oz/1000 ft^2. The total application rate for the season was 12 oz/1000 ft^2. Each application was combined in a tank mix with Sprint 330 at 3 oz product/1000 ft^2, and urea at 0.1 lb N/1000 ft^2. The fairway was estimated to have a 35 to 40% *Poa annua* at the initiation of treatments with the rest of the fairway covered with a combination of Kentucky bluegrass and Perennial ryegrass.

No phytotoxicity was observed on the bluegrass/ryegrass turf during the season. Most of the *Poa annua* died during a high stress period in late July on both treated and untreated areas. At the end of the season, *Poa annua* was germinating back into various areas on the course, but it was not possible to make an accurate estimate of *Poa annua* reduction in treated areas.

In April of 2000, the *Poa annua* population on the treated fairway had been reduced to less than 5%.

Bill also treated the collar areas of several greens with 3 oz Prograss on Oct. 8 and again on Oct. 29, 1999. All *Poa annua* in the treated areas died during the winter and he plans to overseed the areas with perennial ryegrass in April 2000.

HYPERION FIELD CLUB

At Hyperion Field Club, superintendent John Ausen began treatments on the fairway with Prograss on the following schedule: April 28-1.5 oz, May 20-1.5 oz, June 11-1.5 oz, June 29-1.5 oz/1000 ft^2. Each application was combined in a tank mix with Sprint 330 at 3 oz product/1000 ft^2, and urea at 0.1 lb N/1000 ft^2. The fairway is Penneagle creeping bentgrass with approximately 60% *Poa annua*. He suspended treatments in July when severe loss of Creeping bentgrass began to occur in the clean-up round on the outer edge of the fairway during a high-temperature stress period. The treatments were not resumed.

REPLICATED FIELD TRIAL

The replicated field trial was conducted on the 14th fairway at Ames Golf and Country Club, adjacent to the fairway area treatment conducted by Don Portwine. The Kentucky bluegrass fairway was estimated to have a 60% *Poa annua* cover in the area where the trial was conducted at the initiation of treatments. The study was arranged as a randomized complete block with 3 replications. Prograss was applied at rates of 0, 0.75, 1.5, and 3 oz/1000 ft^2 to plots measuring 5 ft x 5 ft on the following dates; May 14, June 7, June 29, August 1, September 16, and October 12. Data were collected on percentage *Poa annua* control on September 16 and October 12. Each application was combined in a tank mix with Sprint 330 at 3.5 oz product/1000 ft^2, and urea at 0.1 lb N/1000 ft^2. Prior to September 16, no reduction in *Poa annua* was observed at any of the application rates. No phytotoxicity was observed on the Kentucky bluegrass at any time during the season.

The cumulative rate of application on the plots by September 16 was 0, 3.75, 7.5, and 15 oz/1000 ft^2. The cumulative rate at October 12 was 0, 4.5, 9, and 18 oz/1000 ft^2, and the total application rate for the season was 0, 5.25, 10.5, and 21 oz/1000 ft^2.

On September 16, *Poa annua* was observed to have been reduced by 0, 0, 43, and 88% in response to cumulative rates of 0, 3.75, 7.5, and 15 oz/1000 ft^2, respectively (Table 1). By October 12, *Poa annua* reduction was observed to be 0, 25, 52, 93% in response to cumulative rates of 0, 5.25, 10.5, and 21 oz/1000 ft^2 Prograss. A final treatment for the season was made on October 12 which resulted in cumulative rates of 0, 5.25, 10.5, and 21 oz/1000 ft^2 Prograss for the season.

On April 17, 2000, *Poa annua* reduction was 39, 72, and 97% in response to the cumulative Prograss applications of 5.25, 10.5, and 21 oz/1000 ft^2, respectively.

We plan to continue this study by applying Bensulide, a preemergence herbicide that will reduce germination of *Poa annua* back into the plots, in the spring of 2000 to one-half of each of the treated plots. A report on the results of that trial will appear in next year's research report.

Table 1. Poa annua reduction in response to Prograss in the replicated trial conducted at Ames Golf and Country Club.

Prograss Treatment	Sept. 16, 1999	Oct. 12, 1999	April 17, 2000
	Percentage Reduction in *Poa annua*		
1. Control	00	00	00
2. O.75 oz/1000 ft^2/app	00	25	39
3. 1.50 oz/1000 ft^2/app	43	52	72
4. 3.00 oz/1000 ft^2/app	88	93	97
LSD 0.05	16	19	26

By September 16, 5 treatments had been applied for a cumulative rate of 0, 3.75, 7.5, and 15 oz/1000 ft^2. By October 12, 6 treatments had been applied for a total of 0, 4.5, 9, and 18 oz/1000 ft^2. A seventh treatment was made on October 12 for a season total of 0, 5.25, 10.5, and 21 oz/1000 ft^2. No phytotoxicity was observed on treated Kentucky bluegrass at any time during the season.

1999 Alldown™ Natural Herbicide Study

Barbara R. Bingaman, Mark J. Howieson, & Nick E. Christians

Alldown™, a natural organic non-selective herbicide, was screened for efficacy in turfgrass and compared to Roundup. Three studies with this material were conducted at the Iowa State University Horticulture Research Station north of Ames, IA. The experimental area for Study I was established 'Majestic' Kentucky bluegrass. Studies II and III were conducted in the same plots in established 'Vantage' bluegrass. The soil in these areas was a Nicollet (fine-loamy, mixed, mesic Aquic Hapludoll) with an organic matter content of 3.9%, a pH of 6.5, 3 ppm P, and 77 ppm K.

The experimental design for all studies was a randomized complete block. There were three replications with no barrier rows between replications. Individual plot size was 5 x 5 ft and there were six treatments including an untreated control. For Study I, Alldown™ was applied at the label rate of 22 ml product/25 ft^2 (10 gal/A) and at 22, 44, 66, and 88 ml/plot (Table 1). Alldown™ application rates were increased to 88, 110, 132, and 154 ml product/plot for Studies II and III (Tables 2 and 3). Roundup was applied at the label rate for comparisons in all three studies.

The two lowest rates of Alldown™ for Study I were applied with a boom equipped with a single #8500 TeeJet flat fan nozzle because of the low volume of liquid. All other materials were applied using a boom equipped with three TeeJet #8006 flat fan nozzles. A carbon dioxide backpack sprayer was used at 30-35 psi.

Treatments for Study I were applied on May 26. It was 70° F and sunny with no wind. Study II was begun on June 24 under sunny skies with no wind and a temperature in the mid 80's. Conditions were ideal for application of materials for Study III on July 27. It was 85° F and partly sunny with a light southeast wind.

Efficacy of the materials was recorded as the percentage of dead turf per plot. The first data were taken 24 hours post treatment and subsequent data were taken weekly until Alldown™ -treated turf had recovered (Tables 1-3).

Data were analyzed using the Statistical Analysis System (SAS, Version 6.12) and the Analysis of Variance (ANOVA) procedure. Means were compared with Fisher's Least Significant Difference (LSD) test.

Twenty-four hours post application, turf treated with the highest rate of Alldown™ in Study I was > 70% dead (Table 1). By June 2, the Alldown™-treated turf was beginning to recover while the Roundup-treated turf was >85% dead.

Less than 30 minutes post application, Alldown™ -treated turf in Study II was turning brown and dying. On June 25, twenty-four hours post application >95% of Alldown™ -treated turf was dead (Table 2). By July 7, Alldown™ -treated turf was beginning to recover while the Roundup-treated turf was 85% dead. After July 14, Alldown™ -treated turf had recovered and was indistinguishable from untreated turf.

Similar results were observed following treatment for Study III. The Alldown™ -treated turf began to brown within 30 minutes following application. Data taken on July 28, show that at 24 hours post treatment turf treated with Alldown™ at 110, 132, and 154 ml was ≥95% dead (Table 3). By August 24, the Alldown™ -treated turf had recovered.

Table 1. Percentage dead turfgrass cover[1] in Kentucky bluegrass treated for the 1999 Alldown™ Natural Herbicide Study I.

	Material	Rate ml /plot	May 27	June 2	Mean
			%		
1.	Untreated control	NA	0.0	0.0	0.0
2.	Alldown™	22.0	13.3	6.7	10.0
3.	Alldown™	44.0	28.3	16.7	22.5
4.	Alldown™	66.0	43.3	31.7	37.5
5.	Alldown™	88.0	73.3	43.3	58.3
6.	Roundup (label rate)	1.0	0.0	86.7	43.3
	$LSD_{0.05}$		6.1	12.5	7.9

[1]These figures represent the percentage area per plot covered by dead turfgrass.
Materials applied on May 26, 1999

Table 2. Percentage dead turfgrass cover[1] in Kentucky bluegrass treated for the 1999 Alldown™ Natural Herbicide Study II.

	Material	Rate ml /plot	June 25	June 30	July 7	July 14	July 21	July 27	Mean
			%						
1.	Untreated control	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.	Alldown™	88.0	96.7	95.0	73.3	10.0	0.0	0.0	45.8
3.	Alldown™	110.0	98.3	96.7	80.0	10.0	0.0	0.0	47.5
4.	Alldown™	132.0	96.7	95.0	80.0	10.0	0.0	0.0	46.9
5.	Alldown™	154.0	100.0	100.0	80.0	10.0	0.0	0.0	48.3
6.	Roundup	1.0	0.0	10.0	85.0	98.3	98.3	93.3	64.2
	$LSD_{0.05}$		4.0	6.1	10.5	2.1	2.1	4.3	3.7

[1]These figures represent the percentage area per plot covered by dead turfgrass.
Materials applied on June 24, 1999

Table 3. Percentage dead turfgrass cover[1] in Kentucky bluegrass treated for the 1999 Alldown™ Natural Herbicide Study III.

	Material	Rate ml /plot	July 28	August 3	August 11	August 19	August 24	Mean
			%					
1.	Untreated control	NA	0.0	0.0	0.0	0.0	0.0	0.0
2.	Alldown™	88.0	81.7	81.7	50.0	13.3	0.0	45.3
3.	Alldown™	110.0	95.0	95.0	58.3	13.3	0.0	52.3
4.	Alldown™	132.0	96.7	96.7	56.7	21.7	0.0	54.3
5.	Alldown™	154.0	95.0	95.0	65.0	16.7	0.0	54.3
6.	Roundup	1.0	96.7	96.7	96.7	93.3	93.3	95.3
	$LSD_{0.05}$		7.0	7.0	18.4	6.1	2.1	5.5

[1]These figures represent the percentage area per plot covered by dead turfgrass.
Materials applied on July 27, 1999

1999 Postemergent Broadleaf Herbicide Study

Barbara R. Bingaman, Mark J. Howieson, and Nick E. Christians

The efficacy of Millennium Ultra and numbered research compounds were compared to traditional 3-way herbicides (i.e. Riverdale's Triplet) in this study. It was conducted at the Iowa State University Horticulture Research Station north of Ames, IA in an area of common bluegrass with a heavy infestation of red clover, white clover, dandelions, Canada thistle, and other broadleaf weed species. The soil in this area was a Nicollet (fine-loamy, mixed, mesic Aquic Hapludoll) with 3.5% organic matter content, pH of 7.3, 6 ppm P, and 130 ppm K. The experimental design was a randomized complete block with 5 x 10 ft plots and three replications.

Triplet, Millennium Ultra, Super Trimec, Trimec Classic, and three experimental products (RDL 211, RDL 343, and RDL 414) were screened against an untreated control (Table 1). The materials were diluted into 567 ml of water. This translates to an application rate of 3 gal/1000 ft^2. Sprayables were applied at 30-35 psi using a carbon dioxide backpack sprayer equipped with TeeJet #8006 flat fan nozzles.

All products were applied postemergently after dandelions, clover, and other broadleaf species were well established. Applications were made on June 9. It was 86° F and partly sunny with a SW wind at 10-15 mph. There was no drift of the materials. The plot was neither irrigated nor mowed for 24 hours following application.

Weed damage data were taken on June 15 and June 18. Damage was assessed using a 0 to 9 scale with 0 = no damage, 5 = individual plants 50% dead and 9 = 100% dead (Tables 2-4). After June 18, it was assumed that all remaining damaged and undamaged weeds would survive so no additional damage data were taken. Beginning on June 24, weed population data were taken. Subsequent data were taken on June 29, July 9, July 15, July 21, July 27, and August 4. Dandelion and thistle numbers were counted per plot and clover numbers were estimated as percentage cover per plot (Tables 5,7, & 9). To better reflect weed control, weed population data were converted to percentage reductions as compared with the untreated controls (Tables 6, 8, & 10). Percentage crabgrass cover was estimated on July 27 and August 4 (Table 11). On August 4, all other weed species within the study were surveyed. Oxalis and crabgrass populations were large enough to collect data (Tables 11 and 12).

Data were analyzed with the Statistical Analysis System (SAS, Version 6.12) and the Analysis of Variance procedure (ANOVA). Treatment effects were tested using Fisher's Least Significant Difference (LSD) mean separation test.

The plot was examined for phytotoxicity periodically and no phytotoxic symptoms were found. Herbicide treatment did not cause any deterioration in turf quality as compared with the untreated control throughout the study (Table 1). Visual quality remained good throughout the duration of the study.

There was significant damage to dandelions, clover, and Canada thistle on June 15 and June 18 as compared with the untreated controls (Tables 2, 3, and 4). There were some significant differences in the level of clover damage among the herbicide treatments on June 15 and June 18. Differences in thistle damage were significant among the herbicides on June 18.

By June 29, all herbicide-treated dandelion populations were significantly reduced as compared with the untreated controls (Tables 5 and 6). The best control was observed on July 9 when all herbicides reduced dandelion numbers by at least 70%. Mean reductions show that all herbicides significantly reduced dandelion populations as compared to the untreated controls.

Clover control was highly significant from June 24 through the end of the study (Tables 7 and 8). By July 9, clover cover was reduced at least 80% in all treated turf and reductions were > 95% in turf treated with four of the herbicide formulations. Reductions were numerically greater for some herbicides from June 29 through August 4, but the differences among herbicide treatments were not significant.

Canada thistles were initially severely damaged by some of the herbicides but the plants were not killed as shown by the data (Tables 9 and 10). There were no significant differences in thistle numbers among the treatments as compared with the controls. All herbicides reduced thistle counts through June 29 as compared with the control but after this date most treated turf contained more thistles than the untreated.

Because of decreased competition from dandelion and clover, oxalis and crabgrass populations were generally larger in treated turf than in untreated (Tables 11 and 12). Differences in oxalis counts were not significant but differences were significant in percentage crabgrass cover.

Table 1. Visual quality[1] of turf treated for the 1999 Riverdale Postemergent Broadleaf Herbicide Study.

	Material	Rate product /1000 ft^2	June 24	June 29	July 9	July 15	July 21	July 27	Aug 4	Mean
1	Untreated control	NA	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
2	Triplet 49.7%	1.29 oz	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
3	Millennium Ultra 47.1%	0.92 oz	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
4	RDL 211 47.4%	1.10 oz	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
5	RDL 343 46.0%	1.17 oz	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
6	RDL 414 59.1%	1.10 oz	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
7	Super Trimec	1.10 oz	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
8	Trimec Classic 3.4 SL	1.50 oz	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
	$LSD_{0.05}$		--	--	--	--	--	--	--	--

[1]Visual quality was assessed using a 9 to 1 scale with 9 = best, 6 = lowest acceptable, and 1 = worst quality.

Table 2. Damage[1] to dandelions in turf plots treated for the 1999 Riverdale Postemergent Broadleaf Herbicide Study.

	Material	Rate product /1000 ft^2	June 15	June 18	Mean
1	Untreated control	NA	0.0	0.0	0.0
2	Triplet 49.7%	1.29 oz	7.3	5.7	6.5
3	Millennium Ultra 47.1%	0.92 oz	7.0	6.3	6.7
4	RDL 211 47.4%	1.10 oz	6.7	6.3	6.5
5	RDL 343 46.0%	1.17 oz	7.0	5.3	6.2
6	RDL 414 59.1%	1.10 oz	7.7	6.0	6.8
7	Super Trimec	1.10 oz	8.3	7.0	7.7
8	Trimec Classic 3.4 SL	1.50 oz	8.0	7.3	7.7
	$LSD_{0.05}$		1.6	2.2	1.5

[1]These figures represent the degree of damage observed on dandelions. Damage was assessed using a 0 to 9 scale with 0 = no damage, 5 = plants 50% dead, 9 = plants 100% dead.

Table 3. Damage[1] to clover in turf plots treated for the 1999 Riverdale Postemergent Broadleaf Herbicide Study.

	Material	Rate product /1000 ft^2	June 15	June 18	Mean
1	Untreated control	NA	0.0	0.0	0.0
2	Triplet 49.7%	1.29 oz	5.7	5.7	5.7
3	Millennium Ultra 47.1%	0.92 oz	5.0	6.7	5.8
4	RDL 211 47.4%	1.10 oz	6.7	6.3	6.5
5	RDL 343 46.0%	1.17 oz	6.0	5.7	5.8
6	RDL 414 59.1%	1.10 oz	6.3	5.3	5.8
7	Super Trimec	1.10 oz	7.0	7.3	7.2
8	Trimec Classic 3.4 SL	1.50 oz	5.3	6.3	5.8
	$LSD_{0.05}$		1.1	1.6	1.1

[1]These figures represent the degree of damage observed on clover. Damage was assessed using a 0 to 9 scale with 0 = no damage, 5 = plants 50% dead, 9 = plants 100% dead.

Table 4. Damage[1] to Canada thistle in turf plots treated for the 1999 Riverdale Postemergent Broadleaf Herbicide Study.

	Material	Rate product /1000 ft^2	June 15	June 18	Mean
1	Untreated control	NA	0.0	0.0	0.0
2	Triplet 49.7%	1.29 oz	5.3	5.3	5.3
3	Millennium Ultra 47.1%	0.92 oz	4.7	4.3	4.5
4	RDL 211 47.4%	1.10 oz	4.7	8.0	6.3
5	RDL 343 46.0%	1.17 oz	8.7	8.0	8.3
6	RDL 414 59.1%	1.10 oz	8.3	8.0	8.2
7	Super Trimec	1.10 oz	8.0	9.0	8.5
8	Trimec Classic 3.4 SL	1.50 oz	9.0	7.7	8.3
	$LSD_{0.05}$		5.1	4.3	4.5

[1]These figures represent the degree of damage observed on thistle. Damage was assessed using a 0 to 9 scale with 0 = no damage, 5 = plants 50% dead, 9 = plants 100% dead.

Table 5. Dandelion populations[1] in turf plots treated for the 1999 Riverdale Postemergent Broadleaf Herbicide Study.

	Material	Rate product /1000 ft^2	June 24	June 29	July 9	July 15	July 21	July 27	Aug 4	Mean
1	Untreated control	NA	40.3	55.3	56.7	23.3	26.7	31.3	30.3	37.7
2	Triplet 49.7%	1.29 oz	20.7	32.7	16.7	14.7	15.0	14.3	21.7	19.4
3	Millennium Ultra 47.1%	0.92 oz	31.7	35.7	7.7	6.7	6.0	5.3	13.0	15.1
4	RDL 211 47.4%	1.10 oz	17.7	23.0	7.0	10.7	13.3	13.0	8.3	13.3
5	RDL 343 46.0%	1.17 oz	18.7	32.3	16.3	16.0	16.7	22.7	15.3	19.7
6	RDL 414 59.1%	1.10 oz	22.3	31.0	7.7	22.3	11.7	10.7	11.3	16.7
7	Super Trimec	1.10 oz	19.3	24.0	1.3	5.0	6.3	6.0	6.0	9.7
8	Trimec Classic 3.4 SL	1.50 oz	15.3	24.7	7.7	10.0	8.3	6.0	7.3	11.3
	$LSD_{0.05}$		15.1	15.9	12.8	11.3	10.4	P>F = 0.06 17.3	13.0	10.8

[1]These figures represent the number of dandelions per plot.

Table 6. Percentage reductions[1] in dandelion populations in turf plots treated for the 1999 Riverdale Postemergent Broadleaf Herbicide Study.

	Material	Rate product /1000 ft^2	June 24	June 29	July 9	July 15	July 21	July 27	Aug 4	Mean
			Percentage reduction (%)							
1	Untreated control	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Triplet 49.7%	1.29 oz	48.7	40.9	70.6	37.1	43.8	54.2	28.5	48.6
3	Millennium Ultra 47.1%	0.92 oz	21.4	35.5	86.5	71.4	77.5	83.0	57.1	59.8
4	RDL 211 47.4%	1.10 oz	56.2	58.4	87.7	54.2	50.1	58.5	72.5	64.8
5	RDL 343 46.0%	1.17 oz	53.7	41.5	71.2	31.3	37.6	27.6	49.4	47.7
6	RDL 414 59.1%	1.10 oz	44.6	43.9	86.5	4.1	56.3	65.9	62.6	55.7
7	Super Trimec	1.10 oz	52.0	56.6	97.6	78.5	76.3	80.8	80.2	74.2
8	Trimec Classic 3.4 SL	1.50 oz	62.0	55.4	86.5	57.1	68.8	80.8	75.8	69.9
	$LSD_{0.05}$		37.4	28.7	22.6	48.4	38.9	P>F = 0.06 55.3	42.9	28.6

[1]These figures represent percentage reductions in dandelion counts per plot as compared to dandelion populations in the untreated controls.

Table 7. Percentage clover cover[1] in turf plots treated for the 1999 Riverdale Postemergent Broadleaf Herbicide Study.

	Material	Rate product /1000 ft^2	June 24	June 29	July 9	July 15	July 21	July 27	Aug 4	Mean cover
			(%)							
1	Untreated control	NA	65.0	88.3	56.7	56.7	66.7	70.0	71.7	67.9
2	Triplet 49.7%	1.29 oz	20.0	26.7	3.7	10.3	11.7	16.7	9.0	14.0
3	Millennium Ultra 47.1%	0.92 oz	15.0	10.0	0.7	0.7	0.7	0.3	1.0	4.0
4	RDL 211 47.4%	1.10 oz	16.7	13.3	6.7	2.0	5.0	8.7	6.7	8.4
5	RDL 343 46.0%	1.17 oz	33.3	26.7	8.3	6.7	8.3	13.3	8.3	15.0
6	RDL 414 59.1%	1.10 oz	16.7	11.7	2.3	1.0	1.0	1.0	1.0	5.0
7	Super Trimec	1.10 oz	18.3	13.3	0.7	0.0	0.7	1.0	0.7	5.0
8	Trimec Classic 3.4 SL	1.50 oz	26.7	25.0	10.0	8.3	11.7	16.7	8.3	15.2
	$LSD_{0.05}$		24.2	22.0	11.0	16.9	14.1	20.1	11.4	12.7

[1]These figures represent the area per plot covered by clover.

Table 8. Percentage reductions[1] in clover cover in turf plots treated for the 1999 Riverdale Postemergent Broadleaf Herbicide Study.

	Material	Rate product /1000 ft^2	June 24	June 29	July 9	July 15	July 21	July 27	Aug 4	Mean
			(%)							
1	Untreated control	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Triplet 49.7%	1.29 oz	69.2	69.8	93.5	81.8	82.5	76.2	87.4	79.4
3	Millennium Ultra 47.1%	0.92 oz	76.9	88.7	98.8	98.8	99.0	99.5	98.6	94.0
4	RDL 211 47.4%	1.10 oz	74.4	84.9	88.2	96.5	92.5	87.6	90.7	87.6
5	RDL 343 46.0%	1.17 oz	48.7	69.8	85.3	88.2	87.5	81.0	88.4	77.9
6	RDL 414 59.1%	1.10 oz	74.4	95.8	95.9	98.2	98.5	98.6	98.6	92.7
7	Super Trimec	1.10 oz	71.8	84.9	98.8	100.0	99.0	98.6	99.1	92.7
8	Trimec Classic 3.4 SL	1.50 oz	59.0	71.7	82.4	85.3	82.5	76.2	88.4	77.5
	$LSD_{0.05}$		37.2	24.9	19.4	29.8	21.2	28.7	15.9	18.7

[1]These figures represent percentage reductions in clover cover per plot as compared to clover populations in the untreated controls.

Table 9. Canada thistle populations[1] in turf plots treated for the 1999 Riverdale Postemergent Broadleaf Herbicide Study.

	Material	Rate product /1000 ft^2	June 24	June 29	July 9	July 15	July 21	July 27	Aug 4	Mean count
1	Untreated control	NA	11.0	15.7	5.0	6.7	4.3	5.0	6.3	7.7
2	Triplet 49.7%	1.29 oz	4.0	4.3	5.7	6.3	6.7	8.0	8.7	6.2
3	Millennium Ultra 47.1%	0.92 oz	3.7	9.0	5.7	11.3	11.3	12.3	12.7	9.4
4	RDL 211 47.4%	1.10 oz	4.0	10.0	6.0	7.7	7.7	7.7	10.0	7.6
5	RDL 343 46.0%	1.17 oz	2.7	5.3	2.7	6.0	6.0	6.0	6.0	5.0
6	RDL 414 59.1%	1.10 oz	5.0	7.3	5.3	6.7	9.7	11.7	14.3	8.6
7	Super Trimec	1.10 oz	3.0	12.3	8.7	11.7	13.7	19.0	18.0	12.3
8	Trimec Classic 3.4 SL	1.50 oz	5.3	13.3	11.0	12.3	13.0	17.0	13.3	12.2
	$LSD_{0.05}$		NS	NS	NS	NS	NS	NS	NS	NS

[1]These figures represent the number of thistles per plot.

Table 10. Percentage reductions[1] in Canada thistle populations in turf plots treated for the 1999 Riverdale Postemergent Broadleaf Herbicide Study.

	Material	Rate product /1000 ft^2	June 24	June 29	July 9	July 15	July 21	July 27	Aug 4	Mean
			(%)							
1	Untreated control	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Triplet 49.7%	1.29 oz	63.6	72.4	0.0	5.5	0.0	0.0	0.0	19.0
3	Millennium Ultra 47.1%	0.92 oz	66.7	42.7	0.0	0.0	0.0	0.0	0.0	0.0
4	RDL 211 47.4%	1.10 oz	63.6	36.3	0.0	0.0	0.0	0.0	0.0	1.7
5	RDL 343 46.0%	1.17 oz	75.8	66.0	46.7	10.4	0.0	0.0	4.8	35.7
6	RDL 414 59.1%	1.10 oz	54.5	53.3	0.0	0.5	0.0	0.0	0.0	0.0
7	Super Trimec	1.10 oz	72.7	21.4	0.0	0.0	0.0	0.0	0.0	0.0
8	Trimec Classic 3.4 SL	1.50 oz	51.5	15.1	0.0	0.0	0.0	0.0	0.0	0.0
	$LSD_{0.05}$		NS	NS	NS	NS	NS	NS	NS	NS

[1]These figures represent percentage reductions in thistle counts per plot as compared to thistle populations in the untreated controls.

Table 11. Oxalis populations[1] in turf plots treated for the 1999 Riverdale Postemergent Broadleaf Herbicide Study.

	Material	Rate product /1000 ft^2	August 4
1	Untreated control	NA	1.3
2	Triplet 49.7%	1.29 oz	3.7
3	Millennium Ultra 47.1%	0.92 oz	4.3
4	RDL 211 47.4%	1.10 oz	1.7
5	RDL 343 46.0%	1.17 oz	3.0
6	RDL 414 59.1%	1.10 oz	2.0
7	Super Trimec	1.10 oz	2.0
8	Trimec Classic 3.4 SL	1.50 oz	2.7
	$LSD_{0.05}$		NS

[1]These figures represent the number of oxalis per plot.

Table 12. Percentage crabgrass cover[1] in turf plots treated for the 1999 Riverdale Postemergent Broadleaf Herbicide Study.

	Material	Rate product /1000 ft^2	July 27	August 4	Mean
			(%)		
1	Untreated control	NA	5.3	5.3	5.3
2	Triplet 49.7%	1.29 oz	8.3	3.3	5.8
3	Millennium Ultra 47.1%	0.92 oz	23.3	25.0	24.2
4	RDL 211 47.4%	1.10 oz	18.3	11.7	15.0
5	RDL 343 46.0%	1.17 oz	16.7	25.0	20.8
6	RDL 414 59.1%	1.10 oz	18.3	15.0	16.7
7	Super Trimec	1.10 oz	7.0	8.3	7.7
8	Trimec Classic 3.4 SL	1.50 oz	30.0	28.3	29.2
	$LSD_{0.05}$		11.9	14.2	11.1

[1]These figures represent percentage reductions in percentage crabgrass cover per plot as compared to populations in the untreated controls.

Effects of Drive on Turfgrass Seeding

Barbara R. Bingaman, Mark. J. Howieson, and Nick E. Christians

Evaluations of the effects of Drive 75DF and Drive 0.43GR herbicides on newly seeded turfgrass were made as compared to the industry standard herbicide. The study was conducted at the Iowa State University Horticulture Research Station. Individual 5 x 5 ft plots in a prepared bare soil area were seeded with either 'Quantum Leap' Kentucky bluegrass, or 'Brightstar II' perennial ryegrass, or 'Penncross; creeping bentgrass. The soil in this area was a Nicollet (fine-loamy, mixed, mesic Aquic Hapludoll) with an 3.8% organic matter, pH of 6.5, 3 ppm P, and 77 ppm K. Three replications were performed.

There were multiple applications of some materials with the timing dependent on days before seeding and after emergence (Table 1). A control treated with starter fertilizer and an untreated control were included for each grass species.

Treatment with granular materials was made using cardboard cartons as 'shaker dispensers' to ensure uniform distribution of product. Liquid materials were diluted into 287 ml of water. This translates to an application rate of 3 gal/1000 ft^2. Sprayables were applied at 30-35 psi using a carbon dioxide backpack sprayer equipped with TeeJet #8006 flat fan nozzles.

Drive 75DF at 0.75 lb a.i./A was applied 7 days prior to seeding, at seeding, 14 days after emergence, and 28 days after emergence (Table 1). Emergence was defined as the date when approximately 50% germination had occurred. Drive 0.43GR with starter fertilizer was applied at seeding, 14 days after emergence, and 28 days after emergence. Seven days before seeding and at seeding treatments were made with Siduron 50WP.

The '7 days before seeding' treatments were made on June 3 and seeding was performed on June 10. Following seeding, there was a substantial rainfall (Table 6). On June 11, the plots were lightly raked and the 'at seeding' applications were made. The '14 days post-emergence' treatments were applied on July 8 and the '14 days post-emergence' on July 21. Twenty-four hours following herbicide treatments the plot was irrigated with 0.5 inch of water.

Turf quality ratings were taken weekly beginning June 30. Visual quality was assessed using a 9 to 1 scale with 9 = best, 6 = lowest acceptable, and 1 = worst quality (Table 2). The plot was surveyed for phytotoxicity when quality ratings were taken. Phytotoxicity was rated using a 9 to 1 scale with 9 = healthy turf and 1 = dead turf. Turf density data were recorded weekly from June 30 through September 14 (Table 3). Density was estimated as the percentage of area per plot covered by turf species. Weed population data were taken weekly from July 14 through September 14 (Table 4). Populations were estimated as the percentage of area per plot covered by weed species. Grass and broadleaf weed species data were combined because crabgrass was the predominate species with a small number of broadleaf species present. On September 7 and 14, determinations of percentage cover were made for crabgrass, spurge, and witchgrass (Table 5). Counts per plot were made for plantain and oxalis.

Data were analyzed with the Statistical Analysis system (SAS, Version 6.12) and the Analysis of Variance procedure (ANOVA). Treatment effects on turfgrass cover, weed cover, and turf quality were compared with Fisher's Least Significant Difference (LSD) test.

There were no phytotoxic symptoms observed following treatment. The quality of herbicide treated turf was similar to fertilized and untreated turf of all three grass species (Table 2).

In this study, Drive 75DF and Drive 0.43GR were applied at approximately four times the recommended rate for newly seeded areas. At the termination of this study, percentage cover of turf treated with the Drive formulations was at least 70% for creeping bentgrass and perennial ryegrass.

Percentage cover for Kentucky bluegrass was very low. Typically establishment of bluegrass in the spring is difficult but in this study, germination rates were especially low. Data before September 14, include percentage cover for all turf species present in the bluegrass plots. In most of these, creeping bentgrass from adjacent plots had moved in.

Data from September 14 do not reflect any differences in Kentucky bluegrass cover between the treated and untreated turf (Table 3). The cover figures from the preceding weeks suggest that other turf species 'invaded' the fertilized bluegrass plots at a much higher rate than the other plots. Percentage cover data for the treated and untreated bluegrass are similar for much of the duration of the study, excluding the data for the fertilized bluegrass.

Mean percentage turfgrass cover figures show that the Drive formulations did cause significant reductions in creeping bentgrass cover as compared with untreated, Siduron treated, and fertilized turf (Table 3). For four of the final five weeks of the study, however, there were no differences in treated bentgrass cover as compared with untreated and fertilized turf.

Mean percentage turfgrass cover figures for the entire study show that none of the treatments significantly reduced ryegrass cover (Table 3). On September 7 and 14, percentage ryegrass cover for herbicide treated turf was significantly higher than untreated turf.

Significant differences in percentage weed cover occurred for all three turf species during the study (Table 4). Drive 75DF and Drive 0.43GR provided excellent weed control in bluegrass, bentgrass, and ryegrass. In most cases, control with Drive 75DF in all turf species tested was better than with Drive 0.43GR and Siduron 50WP. Mean weed cover data show highly significant reductions in weed cover for all three turf species treated with Drive 75DF, Drive 0.43GR, and Siduron 50WP as compared with untreated and fertilized turf.

Crabgrass cover was significantly reduced in bluegrass, bentgrass, and ryegrass treated with either Drive 75DF, or Drive 0.43GR, or Siduron 50WP as compared with fertilized and untreated turf (Table 5). The level of crabgrass control was similar for the three herbicides in all turf species. Population distributions of plantain, spurge, oxalis and witchgrass were not widespread enough to show any significant differences due to treatment.

Table 1. Materials and application instructions for the 1999 Micro-Flo Drive Seeding Study.

						Timing of Application[1]			
						Before seeding		After emergence	
	Material	Rate lb a.i./A	Turf Species	Seed Rate lb/ 1000 ft^2	Fertilizer rate lb/ 1000 ft^2	7 days	0 days	14 days	28 days
1	Untreated control	NA	Kentucky bluegrass	1.5	NA	NA	NA	NA	NA
2	Drive 75DF	0.75	Kentucky bluegrass	1.5	NA	yes	yes	yes	yes
3	Drive 0.43GR	0.75	Kentucky bluegrass	1.5	NA	no	yes	yes	yes
4	Siduron 50WP	5.00	Kentucky bluegrass	1.5	NA	yes	yes	no	no
5	Fertilized control (18-24-12)	NA	Kentucky bluegrass	1.5	4.0	no	yes	yes	yes
6	Untreated control	NA	creeping bentgrass	1.0	NA	NA	NA	NA	NA
7	Drive 75DF	0.75	creeping bentgrass	1.0	NA	yes	yes	yes	yes
8	Drive 0.43GR	0.75	creeping bentgrass	1.0	NA	no	yes	yes	yes
9	Siduron 50WP	5.00	creeping bentgrass	1.0	NA	yes	yes	no	no
10	Fertilized control (18-24-12)	NA	creeping bentgrass	1.0	4.0	no	yes	yes	yes
11	Untreated control	NA	perennial ryegrass	4.0	NA	NA	NA	NA	NA
12	Drive 75DF	0.75	perennial ryegrass	4.0	NA	yes	yes	yes	yes
13	Drive 0.43GR	0.75	perennial ryegrass	4.0	NA	no	yes	yes	yes
14	Siduron 50WP	5.00	perennial ryegrass	4.0	NA	yes	yes	no	no
15	Fertilized control (18-24-12)	NA	perennial ryegrass	4.0	4.0	no	yes	yes	yes

[1]Timing of application is based on seeding and emergence. Emergence is defined as the date that 50% of the seedlings have emerged. 'Seven days before seeding' applications were made on June 3. Seeding was done on June 10 'At seeding applications' were made on June 11. 'Fourteen days after emergence' applications were made on July 8 and 'twenty-eight days after emergence' on July 21.

Table 2. Visual quality[1] of Kentucky bluegrass (KB), creeping bentgrass (CB), and perennial ryegrass (PR) seeded in the 1999 Micro-Flo Drive Seeding Study.

	Material	Turf Species	June 30	July 7	July 14	July 20	July 27	Aug 3	Aug 11	Aug 19	Aug 24	Aug 31	Sept 7	Sept 14	Mean
1	Untreated control	KB	9	9	9	9	9	9	9	9	9	9	9	9	9
2	Drive 75DF	KB	9	9	9	9	9	9	9	9	9	9	9	9	9
3	Drive 0.43GR	KB	9	9	9	9	9	9	9	9	9	9	9	9	9
4	Siduron 50WP	KB	9	9	9	9	9	9	9	9	9	9	9	9	9
5	Fertilized control (18-24-12)	KB	9	9	9	9	9	9	9	9	9	9	9	9	9
	$LSD_{0.05}$		–	–	–	–	–	–	–	–	–	–	–	–	–
6	Untreated control	CB	9	9	9	9	9	9	9	9	9	9	9	9	9
7	Drive 75DF	CB	9	9	9	9	9	9	9	9	9	9	9	9	9
8	Drive 0.43GR	CB	9	9	9	9	9	9	9	9	9	9	9	9	9
9	Siduron 50WP	CB	9	9	9	9	9	9	9	9	9	9	9	9	9
10	Fertilized control (18-24-12)	CB	9	9	9	9	9	9	9	9	9	9	9	9	9
	$LSD_{0.05}$		–	–	–	–	–	–	–	–	–	–	–	–	–
11	Untreated control	PR	9	9	9	9	9	9	9	9	9	9	9	9	9
12	Drive 75DF	PR	9	9	9	9	9	9	9	9	9	9	9	9	9
13	Drive 0.43GR	PR	9	9	9	9	9	9	9	9	9	9	9	9	9
14	Siduron 50WP	PR	9	9	9	9	9	9	9	9	9	9	9	9	9
15	Fertilized control (18-24-12)	PR	9	9	9	9	9	9	9	9	9	9	9	9	9
	$LSD_{0.05}$		–	–	–	–	–	–	–	–	–	–	–	–	–
	$LSD_{0.05}$ (all turf species)		–	–	–	–	–	–	–	–	–	–	–	–	–

[1]Quality was assessed using a 9 to 1 scale with 9 = best, 6 = lowest acceptable, and 1 = worst quality.

Table 3. Percentage turfgrass cover[1] for Kentucky bluegrass (KB), creeping bentgrass (CB), and perennial ryegrass (PR) seeded in the 1999 Micro-Flo Drive Seeding Study.

	Material	Turf Species	June 30	July 7	July 14	July 20	July 27	Aug 3	Aug 11	Aug 19	Aug 24	Aug 31	Sept 7	Sept 14[2]	Mean[3]
			%												
1	Untreated control	KB	3.7	10.0	10.3	16.7	18.3	13.3	13.3	20.0	20.0	18.3	23.3	3.7	14.3
2	Drive 75DF	KB	5.0	5.0	11.7	18.3	18.3	11.7	11.7	20.0	33.3	40.0	43.3	3.7	18.5
3	Drive 0.43GR	KB	5.0	5.0	8.3	8.3	11.7	6.7	13.3	18.3	23.3	25.0	35.0	5.0	13.8
4	Siduron 50WP	KB	5.0	11.7	13.3	21.7	25.0	20.0	23.3	33.3	43.3	41.7	53.3	2.3	24.5
5	Fertilized control (18-24-12)	KB	6.7	15.0	23.3	33.3	31.7	33.3	31.7	65.0	56.7	65.0	58.3	0.3	35.0
	$LSD_{0.05}$		NS	7.4	10.2	NS	NS	12.4	15.5	17.5	NS	27.5	NS	NS	14.0
6	Untreated control	CB	11.7	30.0	45.0	60.0	66.7	66.7	68.3	70.0	78.3	83.3	80.0	75.0	61.3
7	Drive 75DF	CB	6.7	11.7	26.7	45.0	43.3	40.0	43.3	58.3	61.7	66.7	75.0	76.7	46.3
8	Drive 0.43GR	CB	6.7	10.0	20.0	36.7	41.7	26.7	38.3	51.7	60.0	60.0	68.3	70.0	40.8
9	Siduron 50WP	CB	5.0	18.3	33.3	61.7	75.0	68.3	83.3	83.3	85.0	81.7	85.0	90.0	64.2
10	Fertilized control (18-24-12)	CB	13.3	30.0	46.7	58.3	56.7	60.0	75.0	61.7	75.0	73.0	75.0	68.3	57.8
	$LSD_{0.05}$		NS	14.3	14.8	NS	16.4	27.3	19.7	NS	NS	14.8	NS	NS	12.9
11	Untreated control	PR	33.3	41.7	41.7	41.7	43.3	40.0	36.7	46.7	43.3	45.0	40.0	35.0	40.7
12	Drive 75DF	PR	23.3	23.3	38.3	61.7	56.7	48.3	48.3	58.3	68.3	58.3	65.0	70.0	51.7
13	Drive 0.43GR	PR	43.3	38.3	58.3	75.0	58.3	41.7	46.7	58.3	68.3	66.7	75.0	71.7	58.5
14	Siduron 50WP	PR	26.7	31.7	40.0	56.7	61.7	61.7	65.0	75.0	78.3	68.3	71.7	70.0	58.9
15	Fertilized control (18-24-12)	PR	53.3	58.3	65.0	70.0	51.7	56.7	50.0	61.7	70.0	55.0	51.7	58.3	58.5
	$LSD_{0.05}$		NS	19.7	19.8	NS	NS	NS	NS	NS	NS	NS	18.9	21.7	NS
	$LSD_{0.05}$ (all turf species)		14.0	13.5	15.5	21.0	16.8	19.7	22.2	22.2	25.1	21.3	25.2	20.0	14.4

[1]These figures represent the area per plot covered by green turf. For treatments 1 - 5 these numbers include the area covered by all turf species including CB and PR that established in the plots due to poor KB germination.
[2]The figures for KB cover on Sept 14 include only the area per plot covered by KB and are not included in the mean.
[3]The means for KB cover include data through September 7.

Table 4. Percentage weed cover[1] in Kentucky bluegrass (KB), creeping bentgrass (CB), and perennial ryegrass (PR) seeded for the 1999 Micro-Flo Drive Seeding Study.

	Material	Turf Species	July			Aug					Sept		
			14	20	27	3	11	19	24	31	7	14	Mean
			%										
1	Untreated control	KB	20.0	36.7	45.0	53.3	61.7	63.3	66.7	63.3	56.7	53.3	52.0
2	Drive 75DF	KB	2.3	3.7	7.0	7.0	6.7	6.7	3.7	2.3	2.3	3.7	4.5
3	Drive 0.43GR	KB	3.7	6.7	13.3	10.0	10.0	11.7	8.3	6.7	13.3	13.3	9.7
4	Siduron 50WP	KB	1.0	2.3	6.7	11.7	21.7	18.3	16.7	23.3	18.3	23.3	14.3
5	Fertilized control (18-24-12)	KB	36.7	61.7	60.0	58.3	68.3	33.3	43.3	35.0	41.7	41.7	48.0
	$LSD_{0.05}$		14.0	15.6	12.0	13.3	16.9	15.0	23.2	22.2	14.3	14.5	11.7
6	Untreated control	CB	18.3	16.7	31.7	25.0	28.3	28.3	21.7	16.7	20.0	25.0	23.2
7	Drive 75DF	CB	2.3	5.3	8.7	5.3	8.3	6.7	5.0	6.7	5.0	2.0	5.2
8	Drive 0.43GR	CB	4.0	8.7	13.3	9.0	7.0	12.0	10.3	12.0	8.7	10.0	9.0
9	Siduron 50WP	CB	2.3	4.0	10.3	13.3	10.0	11.7	10.0	11.7	15.0	10.0	9.8
10	Fertilized control (18-24-12)	CB	35.0	38.3	40.0	33.3	25.0	38.3	25.0	38.3	25.0	31.7	31.8
	$LSD_{0.05}$		16.8	NS	14.8	18.5	15.5	NS	13.0	13.2	NS	17.8	14.7
11	Untreated control	PR	23.3	35.0	53.3	50.0	53.3	45.0	53.3	48.3	60.0	66.7	48.8
12	Drive 75DF	PR	1.0	1.0	2.3	2.3	3.7	3.7	3.3	2.0	2.3	2.3	2.4
13	Drive 0.43GR	PR	5.3	2.3	10.0	7.0	6.7	11.7	7.0	7.0	5.7	5.3	6.8
14	Siduron 50WP	PR	1.0	1.0	5.3	4.0	8.3	6.7	6.7	5.0	10.0	10.0	5.8
15	Fertilized control (18-24-12)	PR	21.7	18.3	48.3	33.3	41.7	33.3	26.7	41.7	45.0	48.3	35.8
	$LSD_{0.05}$		13.8	NS	21.1	27.0	26.0	29.5	22.2	32.3	22.4	22.3	23.0
	$LSD_{0.05}$ (all turf species)		13.4	20.7	16.0	18.7	17.8	21.0	17.1	21.4	16.9	16.7	15.4

[1]These figures represent the percentage area per plot covered by green, healthy weeds (predominately crabgrass with only a few broadleaf species).

Table 5. Weed populations by species[1] in Kentucky bluegrass (KB), creeping bentgrass (CB), and perennial ryegrass (PR) seeded for the 1999 Micro-Flo Drive Seeding Study.

	Material	Turf Species	Percentage crabgrass cover	Plantain counts	Percentage spurge cover	Oxalis counts	Percentage witchgrass cover
1	Untreated control	KB	31.7	0.0	10.3	0.0	11.7
2	Drive 75DF	KB	1.7	1.0	0.0	0.0	0.3
3	Drive 0.43GR	KB	10.0	2.3	0.0	2.0	0.0
4	Siduron 50WP	KB	6.7	0.3	10.0	0.0	0.0
5	Fertilized control (18-24-12)	KB	38.3	0.0	3.3	0.3	0.0
	$LSD_{0.05}$		15.9	NS	NS	NS	8.7
6	Untreated control	CB	23.3	0.0	0.3	0.0	1.7
7	Drive 75DF	CB	0.0	0.3	0.0	0.7	0.0
8	Drive 0.43GR	CB	10.0	0.3	0.0	0.3	0.0
9	Siduron 50WP	CB	10.0	0.0	0.0	0.0	0.0
10	Fertilized control (18-24-12)	CB	31.7	0.0	0.0	0.0	0.0
	$LSD_{0.05}$		17.8	NS	NS	NS	NS
11	Untreated control	PR	63.3	0.0	1.7	0.7	1.7
12	Drive 75DF	PR	0.3	0.0	1.0	0.3	0.3
13	Drive 0.43GR	PR	5.0	0.0	0.0	0.3	0.0
14	Siduron 50WP	PR	6.7	0.0	3.3	0.3	0.0
15	Fertilized control (18-24-12)	PR	41.7	0.0	0.0	0.0	6.7
	$LSD_{0.05}$		23.5	–	NS	NS	NS
	$LSD_{0.05}$ (all turf species)		17.3	1.1	NS	NS	6.7

[1]These figures represent the area per plot covered by crabgrass, spurge, and witchgrass and the number of weeds per plot for plantain and oxalis.

USGA Sand-based Green Novex Fertilizer Trial

Mark J. Howieson and Nick E. Christians

Proxy 2SL (ethephon) is a plant growth regulator that has been shown to limit the vertical growth of various turfgrass species. This study was conducted to determine the effects that Proxy applications would have on the visual quality, e.g., the color, density, and uniformity of creeping bentgrass maintained at fairway height. An area of '1019' creeping bentgrass located at the Iowa State University Horticulture Research Station was treated with Proxy 2SL and evaluated as follows.

The study was organized as a completely randomized block design, which was replicated three times. Each replication consisted of five treatments - four Proxy treatments and one untreated control - that were randomly assigned to an individual 5 X 5 ft plot within the block. Proxy 2SL treatments consisted of the following application rates: 0,1.5, 3.0, 5.0 and 10.0 fl oz of Proxy/1000 ft^2.

All treatments were applied before the onset of warm summer temperatures; however, the application frequency and date of application differed among the treatments. The 3.0, 5.0 and 10.0 fl oz of Proxy/1000 ft^2 treatments were applied just once. The aforementioned treatments were applied on June 24. The 1.5 fl oz of Proxy/1000 ft^2 treatment was applied multiple times at an interval of 14 days. The first of the multiple application treatments was made on May 26, 1999 – eight applications of the 1.5 fl oz of Proxy/1000 ft^2 treatment were made over the duration of the study.

Treatment applications were made using a $C0_2$ powered backpack sprayer calibrated to apply 3.0 gallons of material/1000 ft^2. The turfgrass utilized in this study was established on a growth medium consisting of 1/3 Nicollet soil, 1/3 peat, and 1/3 sand. The growth medium had a pH of 8.05, an organic matter composition of 3.04%, 3 ppm of nitrogen, 2 ppm of phosphorus and 41 ppm of potassium.

Turf evaluations of color, density, uniformity, and phytotoxicity were made on a weekly basis following chemical treatment. Phytotoxicity was noted as either absent or present while color, density, and uniformity were ranked on a scale of 1 to 9; with 9=best, 5=lowest acceptable and 1=worst.

The weekly evaluations for color are located in Table 1. Statistically significant differences in color occurred on June 30, July 7, August 11, August 25, September 1, September 9, and September 15. Beginning approximately two weeks after chemical application, the Proxy-treated plots began to appear a lighter shade of green, a yellow-green color. Four weeks after the chemical application, however, the Proxy-treated plots began to turn a brilliant green color. A notable exception was the 1.5 fl oz/1000 ft^2 treatments. The repeated applications of Proxy resulted in a continuous, but acceptable, reduction in color quality when compared to the controls and other Proxy treatments. No observable color differences existed on July 21, July 28, and August 18, however. This color discrepancy became even more pronounced during August when the other treated plots were darkening in color. As an additional note, the only observed phytotoxicity occurred with the 10.0 fl oz/1000 ft^2 treatment the week following the chemical application, June 30. No browning of the leaf tissue occurred – only a minimal yellowing of the treated area.

The Proxy treatments improved the density of the creeping bentgrass at all rates (Note Table 2). Beginning July 7 with the 10.0 fl oz/1000 ft^2 treatments and July 14 with the remaining treatments, numerous finer textured leaf blades began to appear within the individual plots. Density was not significantly affected until July 21, however. The Proxy treated plots were much shorter, tighter, and denser than the turf found in the untreated controls. It was quite difficult to discern density differences between treated plots during the early stages of the study, but during mid-August, the 1.5 fl oz of Proxy/1000 ft^2 treatments eclipsed the other treatments – clearly due to the continuing application of product.

The uniformity of the grass plots was also influenced by the Proxy treatments. Significant differences occurred on July 21, July 28, August 11, August 25, September 1, September 9, and September 15 (Note Table 3). The treated plots produced a grass stand that was far less "grainy" with a more consistent color and density than the untreated controls. As mentioned earlier, the chemical treated plots appeared to be much shorter, tighter and denser – more uniform.

Table 1. Visual assessment[1] regarding the color of '1019' creeping bentgrass treated with the following rates of Proxy 2SL plant growth regulator[2].

Treatment	June 2	June 9[3]	June 16	June 24[4]	June 30	July 7[3]	July 14	July 21[3]	July 28
Untreated Control	7.0	7.0	7.0	7.0	7.0	6.0	8.7	9.0	9.0
1.5 fl oz/1000 ft^2	7.0	7.0	7.0	7.0	7.0	6.0	8.3	9.0	9.0
3.0 fl oz/1000 ft^2	7.0	7.0	7.0	7.0	7.0	6.0	8.0	9.0	9.0
5.0 fl oz/1000 ft^2	7.0	7.0	7.0	7.0	7.0	6.0	8.0	9.0	9.0
10.0 fl oz/1000 ft^2	7.0	7.0	7.0	7.0	6.0	5.0	7.3	9.0	9.0
LSD $_{0.05}$	NA	NA	NA	NA	0.00	0.00	NA	NA	NA

Treatment	Aug 4[3]	Aug 11	Aug 18[3]	Aug 25	Sept 1[3]	Sept 9	Sept 15
Untreated Control	8.7	9.0	9.0	9.0	9.0	9.0	9.0
1.5 fl oz/1000 ft^2	8.0	8.0	9.0	8.0	8.0	8.0	8.0
3.0 fl oz/1000 ft^2	8.0	9.0	9.0	9.0	9.0	9.0	9.0
5.0 fl oz/1000 ft^2	8.0	9.0	9.0	9.0	9.0	9.0	9.0
10.0 fl oz/1000 ft^2	8.0	9.0	9.0	9.0	9.0	9.0	9.0
LSD $_{0.05}$	NA	0.00	NA	0.00	0.00	0.00	0.00

[1]Visual quality ratings were assigned using a 9 to 1 scale with 9=best and 1=worst.
[2]The initial application of the 1.5 fl oz of Proxy/1000 ft^2 treatment was made on May 26.
[3]An application of the 1.5 fl oz of Proxy/1000 ft^2 treatment was made on this date.
[4]The single application treatments of 3.0, 5.0 and 10.0 fl oz of Proxy/1000 ft^2 and the multiple application treatment of 1.5 fl oz of Proxy/1000 ft^2 were applied on this date.
NA –The LSD test is not applicable, the differences between means are not significantly different when α=0.05

Table 2. Visual assessment[1] regarding the density of '1019' creeping bentgrass treated with the following rates of Proxy 2SL plant growth regulator[2].

Treatment	June 2	June 9[3]	June 16	June 24[4]	June 30	July 7[3]	July 14	July 21[3]	July 28
Untreated Control	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	6.0
1.5 fl oz/1000 ft^2	7.0	7.0	7.0	7.0	7.0	7.0	7.0	9.0	8.7
3.0 fl oz/1000 ft^2	7.0	7.0	7.0	7.0	7.0	7.0	7.0	8.3	7.3
5.0 fl oz/1000 ft^2	7.0	7.0	7.0	7.0	7.0	7.0	7.0	8.7	8.0
10.0 fl oz/1000 ft^2	7.0	7.0	7.0	7.0	7.0	7.0	7.0	8.0	8.0
LSD $_{0.05}$	NA	NA	NA	NA	NA	NA	NA	0.77	0.77

Treatment	Aug 4[3]	Aug 11	Aug 18[3]	Aug 25	Sept 1[3]	Sept 9	Sept 15
Untreated Control	7.0	7.0	7.0	7.0	7.0	7.0	7.0
1.5 fl oz/1000 ft^2	9.0	9.0	9.0	9.0	9.0	9.0	9.0
3.0 fl oz/1000 ft^2	7.7	8.7	7.7	7.7	7.7	7.3	8.3
5.0 fl oz/1000 ft^2	8.0	9.0	8.0	8.0	7.7	7.3	8.0
10.0 fl oz/1000 ft^2	8.0	9.0	8.0	7.7	7.3	7.3	8.0
LSD $_{0.05}$	0.45	0.49	0.49	0.73	0.81	0.84	0.49

[1]Visual quality ratings were assigned using a 9 to 1 scale with 9=best and 1=worst.
[2]The initial application of the 1.5 fl oz of Proxy/1000 ft^2 treatment was made on May 26.
[3]An application of the 1.5 fl oz of Proxy/1000 ft^2 treatment was made on this date.
[4]The single application treatments of 3.0, 5.0 and 10.0 fl oz of Proxy/1000 ft^2 and the multiple application treatment of 1.5 fl oz of Proxy/1000 ft^2 were applied on this date.
NA –The LSD test is not applicable, the differences between means are not significantly different when α=0.05.

Table 3. Visual assessment[1] regarding the uniformity of '1019' creeping bentgrass treated with the following rates of Proxy 2SL plant growth regulator[2].

Treatment	June 2	June 9[3]	June 16	June 24[3]	June 30	July 7[3]	July 14	July 21[3]	July 28
Untreated Control	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
1.5 fl oz/1000 ft^2	7.0	7.0	7.0	7.0	7.0	7.0	7.0	9.0	8.7
3.0 fl oz/1000 ft^2	7.0	7.0	7.0	7.0	7.0	7.0	7.0	8.3	7.7
5.0 fl oz/1000 ft^2	7.0	7.0	7.0	7.0	7.0	7.0	7.0	8.7	8.3
10.0 fl oz/1000 ft^2	7.0	7.0	7.0	7.0	7.0	7.0	7.0	8.0	8.3
$LSD_{0.05}$	NA	NA	NA	NA	NA	NA	NA	0.77	0.81

Treatment	Aug 4[3]	Aug 11	Aug 18[3]	Aug 25	Sept 1[3]	Sept 9	Sept 15
Untreated Control	7.7	7.0	8.0	7.0	7.0	7.0	7.3
1.5 fl oz/1000 ft^2	7.3	8.7	8.3	9.3	9.0	9.0	9.0
3.0 fl oz/1000 ft^2	8.0	8.7	8.0	8.0	7.3	7.7	8.0
5.0 fl oz/1000 ft^2	8.0	9.0	8.0	8.0	7.7	8.0	8.0
10.0 fl oz/1000 ft^2	8.0	9.0	8.0	8.0	7.0	8.0	8.0
$LSD_{0.05}$	NA	0.73	NA	0.00	0.77	0.49	0.49

[1]Visual quality ratings were assigned using a 9 to 1 scale with 9=best and 1=worst.
[2]The initial application of the 1.5 fl oz of Proxy/1000 ft^2 treatment was made on May 26.
[3]An application of the 1.5 fl oz of Proxy/1000 ft^2 treatment was made on this date.
[4]The single application treatments of 3.0, 5.0 and 10.0 fl oz of Proxy/1000 ft^2 and the multiple application treatment of 1.5 fl oz of Proxy/1000 ft^2 were applied on this date.
NA –The LSD test is not applicable, the differences between means are not significantly different when α=0.05.

Morphological Changes of Tall Fescue in Response to Saturated Soil Conditions

Deying Li, Lei Han, Nick E. Christians, and David D. Minner

Low oxygen (hypoxia) is one of the soil-related stresses that affect grasses. Understanding physiological responses of grasses to hypoxia is an important part of their management. The objectives of these studies were to observe morphological changes and aerenchyma formation of tall fescue (*Festuca arundinacea* Schreb.) subjected to hypoxic conditions and to investigate the role of ethylene in these morphological and anatomical responses. 'Finelawn' tall fescue was subjected to water-saturated condition to induce hypoxia. Tall fescue growing in well drained soil was subjected to 1.5, 2.5, and 4 $\mu L\ L^{-1}$ ethylene, and 0.3, 0.45, and 0.6 mM 2-chloroethyl phosphonic acid (ethephon). A second study involved the application of 0.1, 0.5, and 1 mM Ag^{+} and 1, 5, and 10 µM Co^{++} to 'Finelawn' tall fescue subjected to water saturation. In the third study, 'Finelawn' tall fescue was treated with 0.3 mM ethephon and then treated with 0.01, 0.05, and 0.1 mM Indole Acetic Acid (IAA). Aerenchyma formed in the cortical tissue of the root- enlongation zone when the plants were kept under water-saturated conditions and when they were treated with exogenous ethylene. Internal atmosphere ethylene levels increased in plants under water-saturated condition. Ag^{+} and Co^{++} applications inhibited the formation of aerenchyma in plants subjected to water saturated conditions. The results indicate that internal ethylene was responsible for the aerenchyma formation. Increased adaxial leaf angle was observed in plants grown under hypoxic conditions and in plants treated with exogenous ethylene. Ag^{+} and Co^{++} did not change leaf adaxial angle, whereas IAA inhibited it in plants treated with exogenous ethylene or maintained under hypoxic conditions.

Table 1. Morphological response of 'Finelawn' tall fescue plants subjected to water-saturated conditions.

Treatment	Leaf angle 1st leaf	Leaf angle 2nd leaf	Leaf angle 3rd leaf†	Root dry weight
	------------ Degree ------------			mg pot^{-1}‡
Unsaturated control	21.7	19.6	15.8	14.2
Water saturation	30.7	26.1	16.6	18.5
Ethylene + 1.5 $\mu L\ L^{-1}$	33.2	31.6	19.9	6.5
Ethylene + 2.5 $\mu L\ L^{-1}$	30.8	31.6	17.5	8.6
Ethylene + 4.0 $\mu L\ L^{-1}$	28.2	31.0	20.7	9.8
Ethephon + 0.3 mM	41.2	36.0	28.5	7.0
Ethephon + 0.4 mM	37.8	29.2	25.4	9.4
Ethephon + 0.7 mM	33.1	26.4	23.2	10.3
$LSD_{0.05}$	5.6	5.2	5.6	3.0

† Leaves are numbered from the bottom upward.
‡ Three plants per pot.

Table 2. Morphological change of 'Finelawn' tall fescue plants subjected to water-saturated conditions, exogenous ethylene, and ethylene function inhibitors.

Treatment	Adaxial leaf angle		Root diam		Root dry weight
	2nd leaf	3rd leaf†	Seminal	Adventitious	
	---- Degree ----		---- mm ----		mg pot^{-1}‡
Unsaturated control	23.4	17.4	0.43	0.21	10.0
WS§	37.2	25.3	0.50	0.17	12.3
WS + 0.1 mM Ag^{+1}	32.4	25.0	0.46	0.18	12.1
WS + 0.5 mM Ag^{+1}	38.4	26.7	0.52	0.18	11.5
WS + 1 mM Ag^{+1}	40.6	26.7	0.51	0.19	9.5
WS + 1 µM Co^{++}	33.6	24.8	0.44	0.21	12.4
WS + 5 µM Co^{++}	38.5	24.9	0.47	0.18	11.6
WS + 10 µM Co^{++}	36.4	26.0	0.57	0.21	11.2
0.35 mM ethephon	31.8	25.4	0.58	0.22	10.8
0.35 mM ethephon + 1 mM Ag^{+1}	34.6	24.7	0.56	0.24	12.9
0.35 mM ethephon + 10 µm Co^{++}	33.8	28.8	0.54	0.20	13.3
$LSD_{0.05}$	4.8	3.7	0.07	0.03	2.7

† Leaves are numbered from the bottom upward.
‡ Three plants per pot.
§ Water saturation.

Table 3. Interaction between the effects of IAA and ethephon in the morphological changes of 'Finelawn' tall fescue plants subjected to water-saturated conditions.

Treatment	Adaxial leaf angle		Root dry weight
	2nd leaf	3rd leaf†	
			mg pot^{-1}‡
Control	22.7	21.0	22.2
0.01 mM IAA	25.9	25.5	19.5
0.05 mM IAA	25.0	22.5	20.8
0.1 mM IAA	24.5	21.5	23.1
Water saturation	49.9	28.0	29.3
Water saturation + 0.01 mM IAA	53.2	28.7	36.7
Water saturation + 0.05 mM IAA	45.8	23.2	29.8
Water saturation + 0.1 mM IAA	35.4	19.2	27.0
0.3 mM ethephon	35.2	28.3	25.8
0.3 mM ethephon + 0.01 mM IAA	25.7	24.0	22.4
0.3 mM ethephon + 0.05 mM IAA	27.2	25.5	20.1
0.3 mM ethephon + 0.1 mM IAA	29.2	21.0	21.4
$LSD_{0.05}$	1.9	NS	10.0

† Leaves are numbered from the bottom upward. First leaf is not included because the first tiller emerged.
‡ Three plants per pot.

Evaluation of Fungicides for Control of Dollar Spot in Creeping Bentgrass, 1999

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Trials were conducted at the Iowa State University Horticulture Research Farm near Gilbert, Iowa. Fungicides were applied to 'Penncross' creeping bentgrass maintained at 5/32-inch cutting height, using a modified bicycle sprayer at 30 psi and a dilution rate of 5 gal/1,000 ft^2. The experimental design was a randomized complete block with four replications. All plots measured 4 ft x 5 ft. Four days after inoculation of the entire plot with rye grain infested with the dollar spot pathogen, fungicide applications began on 14 Jun. Subsequent applications were made on 28 Jun, 5, 12, and 26 Jul, and 9 Aug. The plot was re-inoculated with infested rye grain on 10 Jul.

Dollar spot symptoms appeared in the plot within 2 weeks after the first spray application. Disease development was slight in early July, which prompted re-inoculation. Disease pressure did not subsequently increase above the level of early July, however. Most treatments on 1 Jul, and all treatments on 19 Jul and 18 Aug, exhibited significantly less disease than the untreated check. No phytotoxicity symptoms were observed during the trial.

		% plot diseased*		
Product, Rate/1,000 ft^2	Interval (days)	1 Jul	19 Jul	18 Aug
Untreated check	——	4.03	3.00	1.42
Spectro 90WDG, 2 oz	14	0.00	0.00	0.00
Spectro 90WDG, 4 oz	14	0.00	0.00	0.00
Spectro 90WDG, 8 oz	14	0.00	0.00	0.00
Bayleton 50DF, 0.25 oz +Daconil Ultrex 82.5 WDG, 1.82 oz	14	0.65	0.00	0.00
Lynx 45 WP, 0.28 oz +Daconil Ultrex 82.5 WDG, 1.82 oz	14	0.18	0.00	0.00
Bayleton 50 DF, 0.25 oz	14	0.08	0.00	0.00
Lynx 45WP, 0.28 oz	14	0.50	0.00	0.00
DAS0076	Confidential	1.75	0.00	0.03
DAS0076	Confidential	2.50	0.00	0.00
DAS0076	Confidential	0.80	0.00	0.00
DAS0076	Confidential	1.25	0.00	0.88
Eagle 50WP, 0.5 oz	14	0.00	0.00	0.00
Chipco 26GT 2SC, 4 fl oz	14	0.38	0.00	0.00
Chipco Signature 80WG, 4 oz	14	3.50	0.50	0.68
Chipco 26GT 2SC, 4 oz +Chipco Signature 80WG, 8 oz	14	0.20	0.00	0.00
TM-41702 40WP, 1.88 lb/A	14	0.50	0.00	0.13
TM-41702 40WP, 1.88 lb/A	21	0.90	0.13	0.50
TM-41702 40WP, 1.25 lb/A	14	0.75	0.25	0.18
TM-41702 40WP, 2.5 lb/A	14	1.28	0.13	0.08
LEAST SIGNFICANT DIFFERENCE**		1.81	1.16	0.50

*Mean of 4 subplots
**P = 0.05

Evaluation of Fungicides for Control of Brown Patch in Creeping Bentgrass, 1999

Mark L. Gleason and John P. Newton
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Trials were conducted at Veenker Memorial Golf Course on the campus of Iowa State University. Fungicides were applied to creeping bentgrass maintained at 5/32-inch cutting height, using a modified bicycle sprayer at 30 psi and a dilution rate of 5 gal/1,000 ft^2. The experimental design was a randomized complete block with four replications. All plots measured 4 ft x 5 ft. Fungicide treatments were all applied on 9 Jun, then re-applied at recommended intervals on 23 Jun, 7 and 21 Jul, and 4 Aug.

Brown patch symptoms were first observed on 30 Jun. Disease development on untreated check plots was light on 1 Jul and moderate or severe on 19 and 30 Jul and 20 Aug. Most, but not all, fungicide treatments exhibited significantly less disease than the untreated check. No phytotoxicity symptoms were observed during the trial.

		Disease Severity Rating*			
Product, Rate/1,000 ft^2	Interval (days)	1 Jul	19 Jul	30 Jul	20 Aug
Untreated check	—	1.75	5.00	3.50	3.50
Heritage 50WG, 0.2 oz	14	0.25	0.00	0.00	1.00
Heritage 50WG, 0.4 oz	28	0.00	0.00	0.75	0.25
Spectro 90WDG, 2 oz	14	0.00	1.25	0.00	1.50
Spectro 90WDG, 4 oz	14	0.00	0.75	0.25	1.00
Spectro 90WDG, 8 oz	14	0.00	0.00	0.00	2.75
Compass 50WG, 0.1 oz +Banner MAXX 0.5 fl oz	14	0.00	0.00	0.00	0.25
Compass 50 WG, 0.15 oz +Banner MAXX 0.5 fl oz	14	0.00	0.00	0.00	0.00
Eagle 50 WP, 0.6 oz	14	0.00	1.00	0.50	0.00
LEAST SIGNIFICANT DIFFERENCE**		0.68	0.81	0.86	1.09

*Rating scale: 0 = no disease; 1 = 1-5%; 2 = 5-10%; 3 = 10-25%; 4 = 25-50%; 5 = >50% of plot area diseased
**P = 0.05. n = 4.

Spoon-feeding Creeping Bentgrass Greens With Granular Fertilizers

Mark J. Howieson and Nick E. Christians

The proliferation in the use of sand-based greens presents a unique maintenance problem to a growing number of turfgrass managers. The low nutrient holding capacity inherent with sand-based systems makes it difficult to provide adequate nutrition to turf while minimizing fertilizer leaching and runoff. Frequent applications of liquid fertilizers at low rates have become the standard means by which to supply nutrients to sand-based greens. This "spoon-feeding" approach affords great versatility in a fertility program – allowing turfgrass managers to rectify nutrient deficiencies quickly while providing just enough nutrition to promote healthy, but not excessive, turf growth. Historically, "spoon-feeding" has required the use of liquid fertilizers, as granular materials contain high nitrogen concentrations that, when applied at low rates, would result in irregular green dots over stimulated turf. The objective of this study was to screen the efficacy of the new Lesco Matrix granular fertilizers – an improved methylene urea technology - as a dry "spoon-feeding" fertilizer material. Matrix fertilizers can be produced in low nitrogen concentration formulations with other nutrients incorporated into the fertilizer, such as iron and magnesium. These traits make Matrix fertilizers a useful product for use as a sand-based green fertilizer material.

The trial was arranged on the 'Penncross' creeping bentgrass USGA green at the Iowa State University Research Station and organized as a randomized complete block design with three replications. Each individual block consisted of five 5x5 ft treatment plots. The five fertilizers utilized in the study included granular Lesco Matrix fertilizers with analyses of 5-0-28, 12-0-22 and 17-3-18, a standard 17-3-17 Lesco granular fertilizer and a liquid fertilizer composed of urea and potassium sulfate (46-0-0 and 0-0-50, respectively).

Application timing and rate differed between the fertilizer treatments. The three Matrix fertilizers and the liquid fertilizer treatments were applied at a rate of 0.25 lbs of N/1000 ft^2 every ten days – a "spoon-feeding" fertilization program. The solid 17-3-17 standard Lesco fertilizer was applied at a rate of 0.75 lbs N/1000 ft^2 every 30 days. All treatments received a total of 0.75 lbs of N/1000 ft^2 over a period of 30 days. The initial fertilizer application was made on June 17 and the last on September 15. Table 1 lists all fertilizer application dates of the study. Granular fertilizers were applied to each individual 5x5 ft plot by hand, and in two different directions, to ensure uniform coverage. The liquid fertilizer applications were made using a CO_2 powered backpack sprayer calibrated to deliver 3.0 gallons of solution/1000 ft^2.

Table 1. Application dates[1] of fertilizer treatments.

	17-Jun	27-Jun	07-Jul	17-Jul	27-Jul
Treatments Applied	All	Matrix 5-0-28 Matrix 12-0-22 Matrix 17-3-18 Liquid Fertilizer[2]	Matrix 5-0-28 Matrix 12-0-22 Matrix 17-3-18 Liquid Fertilizer[2]	All	Matrix 5-0-28 Matrix 12-0-22 Matrix 17-3-18 Liquid Fertilizer[2]

	06-Aug	14-Aug	26-Aug	06-Sep	15-Sep
Treatments Applied	Matrix 5-0-28 Matrix 12-0-22 Matrix 17-3-18 Liquid Fertilizer[2]	All	Matrix 5-0-28 Matrix 12-0-22 Matrix 17-3-18 Liquid Fertilizer[2]	Matrix 5-0-28 Matrix 12-0-22 Matrix 17-3-18 Liquid Fertilizer[2]	All

[1] The Matrix and 46-0-54 liquid fertilizers were applied at an interval of ten days, while the standard 17-3-17 fertilizer was applied every 30 days.
[2] Comprised of urea (46-0-0) and potassium sulfate (0-0-50).

Turf evaluations of color and uniformity were made on a weekly basis and ranked on a scale of 1 to 9 with 9=best, 5=lowest acceptable and 1=worst. Table 2 lists the weekly color evaluations for each treatment. Uniformity assessments can be found in Table 3. Statistically significant differences in color occurred on July 1, July 14, July 21, July 28, August 4, August 11, August 18, August 25, September 1, September 9, September 15, and September 23. In general, the 5-0-28 Matrix fertilizer produced the best color, until the beginning of August. At this point, the 5-0-28 and 12-0-22 Matrix fertilizers became indistinguishable from one another – and superior in color to all other fertilizer treatments. The standard solid 17-3-17 and liquid fertilizer's color fluctuated greatly over the course of the study, but were of higher quality than the 17-3-18 Matrix fertilizer. The 17-3-18 Matrix fertilizer produced the lowest color rating at all data collection dates except August 11.

Table 2. Color[1] of 'Penncross' creeping bentgrass treated with the following fertilizers.

Treatment	24-Jun	01-Jul	07-Jul	14-Jul	21-Jul	28-Jul	04-Aug
Matrix 5-0-28	7.0	8.7	8.7	8.3	9.0	9.0	9.0
Matrix 12-0-22	5.7	7.0	8.3	7.7	8.7	8.3	8.7
Matrix 17-3-18	5.3	6.7	7.0	6.0	7.0	6.0	7.0
Liquid[2]	5.7	7.3	7.7	8.3	8.0	7.0	8.3
Standard 17-3-17	7.3	8.3	8.3	6.3	7.7	7.3	8.3
$LSD_{0.05}$	NA	1.2	NA	1.4	0.6	0.6	0.7

Treatment	11-Aug	18-Aug	25-Aug	01-Sep	09-Sep	15-Sep	23-Sep
Matrix 5-0-28	9.0	8.7	9.0	9.0	9.0	9.0	9.0
Matrix 12-0-22	9.0	8.7	9.0	9.0	9.0	9.0	9.0
Matrix 17-3-18	8.7	7.0	7.3	7.0	7.3	7.7	7.3
Liquid[2]	8.7	8.0	8.3	8.3	8.7	8.7	9.0
Standard 17-3-17	7.3	8.3	9.0	7.7	7.7	7.7	8.0
$LSD_{0.05}$	0.9	0.8	0.6	0.6	0.9	0.8	0.5

[1] Color ratings were assigned using a 1 to 9 scale, with 9=best, 5=lowest acceptable and 1=worst.
[2] Comprised of urea (46-0-0) and potassium sulfate (0-0-50)
NA - means between treatments are not statistically significant per Fischer's LSD test.

Statistically significant differences in uniformity occurred on July 21, July 28, August 11, August 18, and September 1. Note Table 3. The 5-0-28 Matrix fertilizer resulted in excellent uniformity throughout the study and, once again, became virtually indistinguishable from the 12-0-22 matrix fertilizer treatments after July 28. As expected, the liquid fertilizer treatment demonstrated high levels of uniformity, especially after July 14 - although not to as high of a degree as the 5-0-28 and 12-0-22 Matrix fertilizer treatments. The Lesco standard solid fertilizer also produced excellent uniformity. The 17-3-18 Matrix fertilizer, however, did not result in an even nitrogen response – especially early in the study. Areas of the treated plots were often irregular in color and appearance and were of lesser quality than the other treatments. The high nitrogen concentration of the fertilizer and the low application rate most likely resulted in non-uniform distribution of the nitrogen over the treated plot.

Table 3. Uniformity[1] of 'Penncross' creeping bentgrass treated with the following fertilizers.

Treatment	24-Jun	01-Jul	07-Jul	14-Jul	21-Jul	28-Jul	04-Aug
Matrix 5-0-28	6.7	8.0	7.7	8.3	9.0	9.0	9.0
Matrix 12-0-22	5.3	6.7	7.7	7.3	7.7	9.0	9.0
Matrix 17-3-18	4.7	6.0	6.7	6.0	8.0	8.0	7.7
Liquid[2]	4.7	6.3	6.3	8.3	8.0	9.0	8.7
Standard 17-3-17	6.7	8.0	8.0	7.3	8.7	9.0	8.7
$LSD_{0.05}$	NA	NA	NA	NA	0.7	0.01	NA

Treatment	11-Aug	18-Aug	25-Aug	01-Sep	09-Sep	15-Sep	23-Sep
Matrix 5-0-28	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Matrix 12-0-22	9.0	9.0	9.0	9.0	9.0	8.7	9.0
Matrix 17-3-18	6.7	7.3	8.0	7.0	8.3	8.3	9.0
Liquid[2]	9.0	9.0	8.7	8.3	9.0	9.0	9.0
Standard 17-3-17	7.7	8.7	8.7	8.0	8.7	8.7	9.0
$LSD_{0.05}$	1.2	0.6	NA	0.9	NA	NA	NA

[1] Visual Quality ratings were assigned using a 1 to 9 scale, with 9=best, 5=lowest acceptable and 1=worst.
[2] Comprised of urea (46-0-0) and potassium sulfate (0-0-50)
NA- means between treatments are not statistically significant per Fischer's LSD test.

At the conclusion of the study, September 23, tissue samples were taken from each treatment plot and analyzed for total nitrogen content. The Iowa State University Horticulture Plant Nutrition Laboratory performed the tests using the TKN for plant digests method. The results are listed in Table 4. Notice that all the solid fertilizer treatments have total nitrogen contents higher than the liquid fertilizer treatment. Mowing results in tissue loss from the grass plant - and the main source of nitrogen for liquid fertilized turf. While turf grown in the solid fertilizer treatment plots can take up more nitrogen from the rootzone, no nitrogen will be made available to the turf grown in the liquid fertilizer plots until subsequent applications of foliar sprays are made.

Table 4. Total Nitrogen Content[1] of tissue collected from each treatment

	Matrix 5-0-28	Matrix 12-0-22	Matrix 17-3-18	Liquid[2]	Standard 17-3-17	$LSD_{0.05}$
Total Nitrogen Content	3.5	3.2	3.2	3.0	3.4	0.2

[1] Measured in % nitrogen of the dry weight
[2] Comprised of urea (46-0-0) and potassium sulfate (0-0-50)

The 5-0-28 and 12-0-22 Matrix fertilizers clearly have potential for use in dry "spoon-feeding" fertilizer programs. The color and uniformity ratings achieved by these treatments met or exceeded the results produced by the liquid fertilizer – the current fertilizer standard in a "spoon-feeding" program. The ability to incorporate other nutrients such as iron or magnesium into a low nitrogen fertilizer would allow for great flexibility in a sand-based green fertility program. Custom formulations of the granular Matrix fertilizers could be created to meet the needs of high maintenance turf at all stages of growth and development, making these fertilizers valuable assets in a fertilizer regimen.

1991 Corn Gluten Meal Crabgrass Control Study - Year 9

Barbara R. Bingaman, Melissa C. McDade, and Nick E. Christians

A study screening corn gluten meal (CGM) for efficacy as a natural product herbicide and fertilizer in turf has been continued on the same plot at the Iowa State University Research Station north of Ames, IA since 1991. The experimental area is established 'Parade' Kentucky bluegrass and the soil is a Nicollet (fine-loamy, mixed, mesic Aquic Hapludoll) with organic matter of 4.0%, pH of 7.2, 4.5 ppm P, and 107 ppm K. Individual experimental plots are 5 x 5 ft and there are five treatments with three replications. The experimental design is a randomized complete block. Corn gluten meal is applied each year to the same plots at 0, 20, 40, 60, 80, 100, and 120 lb/1000 ft^2 (Table 1). Because CGM is 10% N, these rates are equivalent to 0, 2, 4, 6, 8, 10, and 12 lb N/1000 ft^2. The CGM is applied each year in a single early-spring preemergence application using 'shaker dispensers'. The materials are watered-in with the irrigation system. Supplemental irrigation is used to provide adequate moisture to maintain the grass in good growing condition. In 1999, applications were made on April 30.

The plot was monitored throughout the season for turf quality. Visual turf quality was assessed using a 9 to 1 scale with 9 = best, 6 = lowest acceptable, and 1 = worst turf quality. Quality data were taken on April 21, May 10, May 26, June 2, June 8, June 15, June 24, July 1, July 7, July 14, July 22, July 27, August 3, August 11, August 19, August 24, August 31, September 7, and September 14 (Tables 1 and 2).

Weed populations were measured by either counting the number of plants or estimating the percentage cover per individual plot. Percentage weed cover data (including all broadleaf weed species) were taken early in the season. Weed cover data were recorded on April 21, April 28, and June 2 and represent the area covered by broadleaf weeds in each plot (Tables 3 and 4). Beginning on July 1, separate weed data were taken for clover and dandelion. Clover populations were assessed by estimating the percentage clover cover per plot (Tables 9 and 10). Dandelion plants were counted in each plot (Tables 7 and 8).

Crabgrass plants in the 1- to 3-leaf growth stage were found late in June and they were large enough by July 22 to count. Subsequent counts were made on July 27, August 3, August 11, August 19, August 24, August 31, September 7, and September 14 (Tables 5 and 6).

Data were analyzed with the Statistical Analysis System (SAS, Version 6.12) and the Analysis of Variance (ANOVA) procedure. Effects of CGM on bluegrass quality and weed control were examined using Fisher's Least Significant Difference (LSD) means comparison tests. To better express weed control, weed population data were converted to percentage reductions as compared to the untreated controls.

At spring greenup in April, there were no quality differences between treated and untreated turf (Table 1). By late May, the quality of CGM treated grass was significantly better than untreated grass. The improved quality of treated bluegrass lasted for much of the season. During the hottest and driest period in mid- to late July, the quality of treated and untreated grass deteriorated (Tables 1 and 2). Once the temperatures moderated, CGM-treated grass exhibited better quality than untreated and the quality differences were still evident in September.

Percentage weed cover was significantly decreased by all CGM rates except 20 lb/1000 ft^2 as compared with the untreated controls (Tables 3 and 4). On June 2, reductions were at least 62% for CGM rates above 20 lb/1000 ft^2 and were ≥ 80% for the 80 and 120 lb rates.

Crabgrass populations were drastically reduced by CGM from July through September at all rates except 20 lb/1000 ft^2 (Tables 5 and 6). Mean crabgrass reductions for the entire season were ≥ 95% for all CGM rates except 20 lb/1000 ft^2 (Table 6). There were more crabgrass plants in turf treated with CGM at 20 lb/1000 ft^2 than in untreated turf for much of the season (Table 5). In 1997 and 1998, there also were more crabgrass plants in turf treated with CGM at 20 lb/1000 ft^2 as compared with the untreated control (Table 11). Crabgrass control at all CGM levels was better in 1999 than in previous years.

Dandelion counts were significantly reduced by CGM at all levels except 20 lb/1000 ft^2 as compared with the untreated controls (Tables 7 and 8). Mean reductions were at least 77% for CGM at 40 lb and higher and greater than 92% for CGM at 60 lb and higher. Dandelion control in 1999 was better than either 1998 or 1997 except at the 20 lb/1000 ft^2 level (Table 13).

Percentage clover cover was significantly reduced in turf treated with CGM as compared with the untreated controls (Tables 9 and 10). Mean reductions in clover cover were > 81% as compared with the untreated controls in turf treated with CGM at all levels except 20 lb (Table 10). Clover control in 1999 was similar to that in previous years except at 20 lb/1000 ft^2. At this rate, the level of clover control was higher in 1999 than 1998 but still lower than in previous years (Table 12).

Table 1. Visual quality[1] of Kentucky bluegrass treated in the 1991 Corn Gluten Meal Weed Control Study (April 22 through July 7).

	Material	lbs CGM /1000 ft^2	lbs N /1000 ft^2	April 22	April 28	May 10	May 20	May 26	June 8	June 15	June 24	July 1	July 7
1	Untreated control	0	0	6.0	7.0	6.7	6.0	5.0	5.0	6.0	5.0	5.3	5.3
2	Corn gluten meal	20	2	6.0	7.0	6.7	7.3	6.3	5.7	6.7	6.3	6.3	6.0
3	Corn gluten meal	40	4	6.0	7.0	7.3	7.3	7.3	7.0	8.0	7.3	7.3	7.3
4	Corn gluten meal	60	6	6.0	7.0	8.0	6.7	8.3	8.3	8.3	7.7	7.3	7.3
5	Corn gluten meal	80	8	6.0	7.0	8.0	6.3	8.7	8.7	9.0	9.0	8.3	8.7
6	Corn gluten meal	100	10	6.0	7.0	8.3	6.7	7.7	8.0	8.3	9.0	8.3	8.7
7	Corn gluten meal	120	12	6.0	7.0	8.0	6.7	7.7	9.0	9.0	9.0	8.7	9.0
	$LSD_{0.05}$			--	--	0.9	NS	1.2	0.9	0.7	0.7	1.3	1.1

[1]Visual quality was assessed using a 9 to 1 scale with 9 = best, 6 = lowest acceptable, and 1 = worst turf quality.
NS = means are not significantly different at the 0.05 level.

Table 2. Visual quality[1] of Kentucky bluegrass treated in the 1991 Corn Gluten Meal Weed Control Study (July 14 through Sept. 14).

	Material	lbs CGM /1000 ft^2	July 14	July 27	Aug 3	Aug 11	Aug 19	Aug 24	Aug 31	Sept 7	Sept 14	Mean
1	Untreated control	0	5.3	5.7	6.0	6.0	5.7	5.3	5.3	5.3	5.3	5.6
2	Corn gluten meal	20	5.7	5.3	6.0	6.3	5.7	6.0	6.3	6.3	6.3	6.2
3	Corn gluten meal	40	7.0	7.3	7.3	6.7	6.7	7.0	6.3	6.3	6.7	7.0
4	Corn gluten meal	60	7.3	7.3	7.0	7.3	7.0	7.3	6.3	7.0	7.0	7.3
5	Corn gluten meal	80	8.0	7.7	8.3	8.0	8.0	7.3	8.0	7.0	7.7	7.9
6	Corn gluten meal	100	8.7	7.7	9.0	8.3	8.3	8.7	8.3	7.7	8.7	8.1
7	Corn gluten meal	120	8.7	8.0	8.3	8.3	8.3	8.3	8.7	7.7	8.3	8.2
	$LSD_{0.05}$		1.4	1.7	1.2	1.2	1.1	0.9	1.2	0.8	1.3	0.5

[1]Visual quality was assessed using a 9 to 1 scale with 9 = best, 6 = lowest acceptable, and 1 = worst turf quality.
NS = means are not significantly different at the 0.05 level.

Table 3. Percentage weed cover[1] in Kentucky bluegrass treated in the 1991 Corn Gluten Meal Weed Control Study.

	Material	lbs CGM/1000 ft^2	April 21	April 28	June 2	Mean cover
1	Untreated Control	0	60.0	81.7	86.7	76.1
2	Corn gluten meal	20	55.0	65.0	76.7	65.6
3	Corn gluten meal	40	12.3	25.0	25.0	20.8
4	Corn gluten meal	60	20.0	30.0	18.3	22.8
5	Corn gluten meal	80	11.7	16.7	16.7	15.0
6	Corn gluten meal	100	27.3	35.0	32.7	31.7
7	Corn gluten meal	120	18.3	21.7	15.0	18.3
	$LSD_{0.05}$		14.0	13.9	12.0	11.2

[1]These values represent the area per plot covered by grass and broadleaf weed species.
NS = means are not significantly different at the 0.05 level.

Table 4. Percentage weed cover reductions[1] in Kentucky bluegrass treated in the 1991 Corn Gluten Meal Weed Control Study.

	Material	lbs CGM/1000 ft^2	April 21	April 28	June 2	Mean cover
1	Untreated Control	0	0.0	0.0	0.0	0.0
2	Corn gluten meal	20	8.3	20.4	11.6	13.9
3	Corn gluten meal	40	79.4	69.4	71.2	72.7
4	Corn gluten meal	60	66.7	63.3	78.9	70.1
5	Corn gluten meal	80	80.6	79.6	80.8	80.3
6	Corn gluten meal	100	54.4	57.2	62.3	58.4
7	Corn gluten meal	120	69.4	73.5	82.7	75.9
	$LSD_{0.05}$		23.3	17.1	13.8	14.7

[1]These values represent reductions in the area per plot covered by grass and broadleaf weed species as compared to the untreated.
NS = means are not significantly different at the 0.05 level.

Table 5. Crabgrass counts[1] in Kentucky bluegrass treated in the 1991 Corn Gluten Meal Weed Control Study.

	Material	lbs CGM/1000 ft^2	July 22	July 27	Aug 3	Aug 11	Aug 19	Aug 24	Aug 31	Sept 7	Sept 14	Mean
1	Untreated control	0	1.7	40.3	45.0	34.0	32.3	23.7	30.7	24.7	26.7	28.8
2	Corn gluten meal	20	0.3	50.0	38.3	30.0	40.3	27.3	31.0	27.3	21.3	29.6
3	Corn gluten meal	40	0.0	0.0	0.0	0.3	0.7	0.7	0.3	1.0	0.0	0.3
4	Corn gluten meal	60	0.0	0.0	0.3	0.7	0.3	0.3	0.0	0.7	0.0	0.3
5	Corn gluten meal	80	0.0	0.7	3.3	1.0	2.7	0.7	1.3	0.7	2.3	1.4
6	Corn gluten meal	100	0.0	0.3	2.3	0.7	1.0	1.0	1.7	2.0	0.7	1.1
7	Corn gluten meal	120	3.3	0.0	2.0	0.0	0.7	1.0	0.3	0.0	0.0	0.8
	$LSD_{0.05}$		NS	35.8	31.8	23.5	23.4	16.8	20.0	14.1	14.5	19.5

[1]These values represent the number of crabgrass plants per plot.
NS = means are not significantly different at the 0.05 level.

Table 6. Crabgrass count reductions[1] in Kentucky bluegrass treated in the 1991 Corn Gluten Meal Weed Control Study.

	Material	lbs CGM/1000 ft^2	July 22	July 27	Aug 3	Aug 11	Aug 19	Aug 24	Aug 31	Sept 7	Sept 14	Mean
1	Untreated control	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Corn gluten meal	20	80.4	0.0	14.8	11.8	0.0	0.0	0.0	0.0	20.1	0.0
3	Corn gluten meal	40	100.0	100.0	100.0	99.0	97.9	97.2	98.9	96.0	100.0	98.8
4	Corn gluten meal	60	100.0	100.0	99.3	98.0	99.0	98.6	100.0	97.3	100.0	99.1
5	Corn gluten meal	80	100.0	98.3	92.6	97.1	91.7	97.2	95.7	97.3	91.3	95.1
6	Corn gluten meal	100	100.0	99.2	94.8	98.0	96.9	95.8	94.6	91.9	97.5	96.3
7	Corn gluten meal	120	0.0	100.0	95.6	100.0	97.9	95.8	98.9	100.0	100.0	97.2
	$LSD_{0.05}$		NS	88.8	70.6	69.1	72.5	70.8	65.3	57.0	54.5	67.9

[1]These values represent reductions in the number of crabgrass plants per plot as compared to the untreated control.
NS = means are not significantly different at the 0.05 level.

Table 7. Dandelion counts[1] in Kentucky bluegrass treated in the 1991 Corn Gluten Meal Weed Control Study.

	Material	lbs CGM /1000 ft^2	July 1	July 14	July 22	July 27	Aug 3	Aug 11	Aug 19	Aug 24	Aug 31	Sept 7	Sept 14	Mean
1	Untreated control	0	11.0	31.7	24.0	27.0	32.7	27.0	32.3	38.0	33.7	36.3	39.7	30.3
2	Corn gluten meal	20	11.0	30.0	20.0	38.0	40.0	29.7	30.0	31.3	30.0	40.3	30.0	30.0
3	Corn gluten meal	40	2.0	7.7	4.0	2.7	5.3	7.0	9.7	13.0	10.0	7.0	8.3	7.0
4	Corn gluten meal	60	1.3	2.3	0.3	1.7	3.3	2.3	3.3	3.3	2.0	3.0	3.0	2.4
5	Corn gluten meal	80	0.7	1.7	1.0	1.3	1.7	1.7	3.0	2.7	2.0	1.3	3.0	1.8
6	Corn gluten meal	100	1.3	1.0	0.0	0.7	1.0	0.7	0.7	1.7	0.7	1.7	0.0	0.8
7	Corn gluten meal	120	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.3	1.0	0.7	0.3
	$LSD_{0.05}$		3.4	8.9	6.6	8.8	8.1	7.6	7.8	14.0	7.4	10.6	13.2	7.5

[1]These values represent the number of crabgrass plants per plot. NS = means are not significantly different at the 0.05 level.

Table 8. Dandelion count reductions[1] in Kentucky bluegrass treated in the 1991 Corn Gluten Meal Weed Control Study.

	Material	lbs CGM /1000 ft^2	July 1	July 14	July 22	July 27	Aug 3	Aug 11	Aug 19	Aug 24	Aug 31	Sept 7	Sept 14	Mean
1	Untreated control	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Corn gluten meal	20	0.0	5.4	16.7	0.0	0.0	0.0	7.1	17.5	11.0	0.0	24.4	0.9
3	Corn gluten meal	40	81.8	75.8	83.3	90.1	83.7	74.1	70.1	65.8	70.3	80.7	79.0	77.0
4	Corn gluten meal	60	87.9	92.6	98.6	93.8	89.8	91.4	89.7	91.2	94.1	91.7	92.4	92.2
5	Corn gluten meal	80	93.9	94.7	95.8	95.1	94.9	93.8	90.7	93.0	94.1	96.3	92.4	94.0
6	Corn gluten meal	100	87.9	96.8	100.0	97.5	96.9	97.5	97.9	95.6	98.0	95.4	100.0	97.2
7	Corn gluten meal	120	97.0	100.0	100.0	100.0	100.0	100.0	100.0	98.2	99.0	97.2	98.3	99.1
	$LSD_{0.05}$		30.6	28.2	27.7	32.6	24.9	28.2	24.2	36.8	22.0	29.3	33.2	24.7

[1]These values represent reductions in the number of dandelion plants per plot as compared to the untreated control.
NS = means are not significantly different at the 0.05 level.

Table 9. Percentage clover cover[1] in Kentucky bluegrass treated in the 1991 Corn Gluten Meal Weed Control Study.

	Material	lbs CGM /1000 ft^2	July 1	July 14	July 22	July 27	Aug 3	Aug 11	Aug 19	Aug 24	Aug 31	Sept 7	Sept 14	Mean
1	Untreated control	0	71.7	58.3	55.0	48.3	28.3	21.7	20.0	30.0	20.0	31.7	25.0	37.3
2	Corn gluten meal	20	48.3	50.0	30.0	30.0	13.3	13.3	3.0	18.3	12.3	12.3	15.0	22.4
3	Corn gluten meal	40	25.0	10.0	10.0	7.3	2.3	5.3	2.0	2.0	5.3	3.0	3.0	6.8
4	Corn gluten meal	60	11.7	10.0	13.3	11.7	6.7	3.7	2.3	2.3	5.3	3.7	5.3	6.9
5	Corn gluten meal	80	3.3	3.3	3.7	12.0	1.0	2.3	1.0	1.0	1.0	2.3	2.3	3.0
6	Corn gluten meal	100	12.3	5.0	5.0	5.3	1.0	2.3	1.0	2.3	1.0	3.0	2.3	3.7
7	Corn gluten meal	120	5.0	6.7	3.7	2.3	5.0	5.0	5.0	2.3	5.0	3.7	6.7	4.6
	$LSD_{0.05}$		18.5	10.8	13.9	19.1	14.3	7.1	6.2	14.1	6.8	12.2	13.8	10.0

[1]These values represent the area per plot covered by clover. NS = means are not significantly different at the 0.05 level.

Table 10. Percentage clover cover reductions[1] in Kentucky bluegrass treated in the 1991 Corn Gluten Meal Weed Control Study.

	Material	lbs CGM /1000 ft^2	July 1	July 14	July 22	July 27	Aug 3	Aug 11	Aug 19	Aug 24	Aug 31	Sept 7	Sept 14	Mean
1	Untreated control	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Corn gluten meal	20	32.6	14.2	45.5	37.9	52.9	38.6	85.0	38.9	38.3	61.1	40.0	40.0
3	Corn gluten meal	40	65.1	82.8	81.8	84.8	91.8	75.4	90.0	93.3	73.3	90.5	88.0	81.6
4	Corn gluten meal	60	83.7	82.8	75.8	75.8	76.4	83.1	88.3	92.2	73.3	88.4	78.7	81.5
5	Corn gluten meal	80	95.4	94.3	93.3	75.2	96.5	89.2	95.0	96.7	95.0	92.6	90.7	91.9
6	Corn gluten meal	100	82.8	91.4	90.9	89.0	96.5	89.2	95.0	92.2	95.0	90.5	90.7	90.1
7	Corn gluten meal	120	93.0	88.6	93.3	95.2	82.3	77.0	75.0	92.2	75.0	88.4	73.3	87.7
	$LSD_{0.05}$		25.8	18.5	25.3	39.5	50.5	32.6	30.8	47.0	34.2	38.4	55.1	26.8

[1]These values represent reductions in the number of dandelion plants per plot as compared to the untreated control.
NS = means are not significantly different at the 0.05 level.

Table 11. Comparisons of the mean crabgrass count reductions[1] in Kentucky bluegrass treated in the 1991 Corn Gluten Meal Weed Control Study for 1991 through 1999.

	Material	lbs CGM /1000 ft^2	1991	1992	1993	1994	1995	1996	1997	1998	1999
			%								
1	Untreated control	0	0	0	0	0	0	0	0	0	0
2	Corn gluten meal	20	58	85	91	70	36	15	0	0	0
3	Corn gluten meal	40	86	98	98	97	88	97	79	91	99
4	Corn gluten meal	60	97	98	93	98	93	85	82	92	99
5	Corn gluten meal	80	87	93	93	87	75	69	54	56	95
6	Corn gluten meal	100	79	94	95	86	75	87	79	83	96
7	Corn gluten meal	120	97	100	100	98	84	97	82	76	97
	$LSD_{0.05}$		26	44	31	39	40	60	NS	NS	68

[1]These values represent reductions in crabgrass plants per plot as compared with the untreated controls.
NS = means are not significantly different at the 0.05 level.

Table 12. Comparisons of the mean percentage clover cover reductions[1] in Kentucky bluegrass treated in the 1991 Corn Gluten Meal Weed Control Study for 1994 through 1999.

	Material	lbs CGM /1000 ft^2	1994	1995	1996	1997	1998	1999
			%					
1	Untreated control	0	0	0	0	0	0	0
2	Corn gluten meal	20	81	56	71	63	27	40
3	Corn gluten meal	40	90	64	82	87	84	82
4	Corn gluten meal	60	98	93	93	95	85	82
5	Corn gluten meal	80	100	76	90	95	93	92
6	Corn gluten meal	100	94	84	92	76	90	90
7	Corn gluten meal	120	90	93	93	93	90	88
	$LSD_{0.05}$		NS	48	29	26	21	27

[1]These values represent reductions in percentage clover cover per plot as compared with the untreated controls.
NS = means are not significantly different at the 0.05 level.

Table 13. Comparisons of the mean percentage dandelion count reductions[1] in Kentucky bluegrass treated in the 1991 Corn Gluten Meal Weed Control Study for 1994 through 1998.

	Material	lbs CGM /1000 ft^2	1994	1995	1996	1997	1998	1999
			%					
1	Untreated control	0	0	0	0	0	0	0
2	Corn gluten meal	20	71	49	33	24	5	1
3	Corn gluten meal	40	100	77	75	76	72	77
4	Corn gluten meal	60	100	89	79	84	83	92
5	Corn gluten meal	80	98	96	95	93	91	94
6	Corn gluten meal	100	100	98	96	88	89	97
7	Corn gluten meal	120	100	100	100	97	97	99
	$LSD_{0.05}$		50	65	60	61	37	25

[1]These values represent the reductions in dandelion counts per plot as compared with the untreated controls.

1995 Corn Gluten Meal Rate Weed Control Study - Year 5

Barbara R. Bingaman, Melissa C. McDade, and Nick E. Christians

Corn gluten meal (CGM) is being screened for efficacy as a natural product herbicide in turf. This long-term study was begun in 1995 at the Iowa State University Horticulture Research Station north of Ames, IA. The experimental area is established 'Ram 1' Kentucky bluegrass. The soil is a Nicollet (fine-loamy, mixed, mesic Aquic Hapludoll) with an organic matter content of 3.9%, a pH of 7.2, 4.5 ppm P, and 107 ppm K. Prior to treatment in 1995, the percentage broadleaf weed cover within the study perimeter exceeded 50%.

Individual experimental plots are 10 x 10 ft with three replications. The experiment is arranged in a randomized complete block design. Each year corn gluten meal is applied to the same plots at a yearly rate of 40 lb CGM/1000 ft^2 (equivalent to 4 lb N/1000 ft^2) using four different regimes of single and split applications for a total of five treatments (Table 1). Four applications of 10 lb/1000 ft^2, split applications of 20 lb/1000 ft^2, an initial application of 30 lb plus a sequential of 10 lb/1000 ft^2, and a single application of 40 lb/1000 ft^2 are included with an untreated control.

Initial applications of all treatments for 1999 were made on April 30 before crabgrass germination. The second application of treatment 2 was made on June 7, the third on July 21, and the final on August 26. Sequential applications of treatments 3 and 4 were made on July 21.

The experimental plot was checked for phytotoxicity after each treatment. Turf quality data were taken weekly from April 28 through September 24. Visual quality was measured using a 9 to 1 scale with 9 = best and 6 = lowest acceptable, and 1 = worst quality (Table 1 and 2).

Crabgrass was first observed on July 27. Population data were recorded on August 3, August 11, August 19, August 24, August 31, September 7, and September 14 (Table 3).

Broadleaf herbicide was applied to this study in Fall 1999 in error. Data for broadleaf weed populations, therefore, are probably not accurate reflections of levels of control provided by corn gluten meal. Clover infestations were estimated by determining the percentage of each individual plot covered by clover. Data were taken on July 1, August 31, September 7, and September 14 (Table 7). Dandelion populations were measured on these same dates by counting the number of plants per plot (Table 5).

Data were analyzed with the Statistical Analysis System (SAS, Version 6.12) and the Analysis of Variance (ANOVA) procedure. Means comparisons were made with Fisher's Least Significant Difference test (LSD). Crabgrass, clover, and dandelion population data were converted to represent percentage reductions as compared with the untreated controls (Table 4, 6, and 8).

There were no phytotoxic symptoms detected on the treated bluegrass. Visual turf quality was significantly better in bluegrass treated with CGM than in the untreated control from April 28 through August 3 except on June 2 (Tables 1 and 2). After August 3, there were significant differences in quality between treated and untreated turf but the quality of grass treated with 40 lb CGM in the spring deteriorated and was not different than the untreated control on August 11 and August 31. Mean visual quality for the entire season was better for bluegrass treated with CGM than the untreated grass.

Crabgrass populations were lower in turf treated with CGM than in untreated turf but the counts were not statistically different (Table 3). Crabgrass numbers were low in the untreated controls. Broadleaf weed species were well established when the crabgrass was emerging especially in the untreated controls and the competition from the broadleaves and the mature turf probably prevented the establishment of large crabgrass populations within the untreated plots. Because of large differences in crabgrass populations among the treatments in each replication, reductions in crabgrass populations were not statistically different at the 0.05 level on any of the collection dates (Tables 3 and 4). Populations were, however, reduced by as much as 97.9% in CGM treated turf as compared with untreated turf. Bluegrass treated with split applications of 20 lb CGM reduced crabgrass counts by at least 92.0% from August 3 through September 14.

In 1999, crabgrass control was much better at all CGM levels than in 1995 through 1998 (Tables 9 and 10). In contrast to previous years, crabgrass populations in the untreated controls were greater than in treated grass. Split applications of 20 lb CGM provided 95% crabgrass reductions in 1999 as compared to 45, 33, 50, and 86% in 1995, 1996, 1997, and 1998, respectively. A single 40 lb CGM application did not reduce crabgrass numbers in 1996 and 1997 and provided only 54 and 53% reductions in 1995 and 1998, respectively. In 1999, the 40 lb application reduced crabgrass numbers by 90%.

Corn gluten meal significantly reduced dandelion numbers as compared with the untreated controls on all data collection dates (Table 5). Mean crabgrass reductions were similar for all CGM treatments and ranged from 68.9 to 84.8% (Table 6).

Clover populations were very low in all treated and untreated turf (Table 7). This is probably due to the application of broadleaf herbicide in Fall 1998. Mean clover cover for the untreated controls was only 5.7%. All CGM treatments provided similar levels of clover cover reductions according to the mean reductions and all were statistically different from the untreated controls (Table 8).

Because this study was mistakenly treated with 2,4-D in late fall 1998, comparisons of dandelion and clover data with those of previous years may not be valid. Dandelion control in 1999 was better than in previous years especially in grass treated with the 20 lb CGM split treatments (Table 11). Clover control was much better in 1999 than in past years but the percentage clover cover in the entire study area including the untreated controls was much lower.

Table 1. Visual quality[1] of Kentucky bluegrass treated with corn gluten meal in the 1995 Corn Gluten Meal Rate Weed Control Study (April 28 - July 14).

	Material	Rate lb product/1000 ft^2	April 28	May 10	May 26	June 2	June 8	June 15	June 24	July 1	July 7	July 14
1	Untreated control	NA	5.7	7.0	5.3	5.3	5.0	6.0	6.0	6.0	6.0	6.0
2	Corn gluten meal	10 fb 10 fb 10 fb 10	8.3	8.0	7.3	6.0	6.0	7.0	7.7	8.0	8.3	7.7
3	Corn gluten meal	20 fb 20	7.3	8.0	7.3	7.0	7.3	7.3	7.0	7.3	7.0	7.0
4	Corn gluten meal	30 fb 10	8.7	8.3	8.3	8.3	8.0	8.0	8.0	8.3	8.0	7.7
5	Corn gluten meal	40	7.0	8.7	8.3	8.7	9.0	9.0	8.7	8.7	8.7	8.0
	$LSD_{0.05}$		1.5	0.8	1.5	0.9	0.5	0.5	1.2	1.3	0.8	0.7

[1]Visual quality was assessed using a 9 to 1 scale with 9 = best, 6 = lowest acceptable, and 1 = worst turf quality.

Table 2. Visual quality[1] of Kentucky bluegrass treated with corn gluten meal in the 1995 Corn Gluten Meal Rate Weed Control Study (July 21 - September 24).

	Material	Rate lb product/1000 ft^2	July 21	July 27	Aug 3	Aug 11	Aug 19	Aug 24	Aug 31	Sept 7	Sept 14	Sept 24	Mean quality
1	Untreated control	NA	6.0	6.0	5.3	5.0	5.0	5.0	6.0	5.7	5.0	6.0	5.7
2	Corn gluten meal	10 fb 10 fb 10 fb 10	8.7	8.0	7.7	7.3	7.7	8.0	8.0	5.7	8.7	9.0	7.7
3	Corn gluten meal	20 fb 20	7.0	7.7	7.7	8.7	8.7	8.7	8.3	5.0	8.3	7.7	7.5
4	Corn gluten meal	30 fb 10	8.3	7.3	7.0	8.0	7.7	8.0	8.3	5.0	7.0	7.7	7.8
5	Corn gluten meal	40	8.3	7.7	7.3	6.0	6.3	6.3	7.0	4.3	6.3	7.0	7.6
	$LSD_{0.05}$		0.9	1.2	1.0	1.2	0.6	1.1	1.2	NS	1.2	0.7	0.5

[1]Visual quality was assessed using a 9 to 1 scale with 9 = best, 6 = lowest acceptable, and 1 = worst turf quality.
NS = means are not significantly different at the 0.05 level

Table 3. Crabgrass counts[1] in Kentucky bluegrass treated with corn gluten meal (CGM) in the 1995 Corn Gluten Meal Rate Weed Control Study.

	Material	Rate lb product/1000 ft^2	Aug 3	Aug 11	Aug 19	Aug 24	Aug 31	Sept 7	Sept 14	Mean
1	Untreated control	NA	114.7	80.7	87.0	95.0	113.0	109.0	112.3	101.7
2	Corn gluten meal	10 fb 10 fb 10 fb 10	34.3	34.0	28.7	26.7	41.0	35.0	33.3	33.3
3	Corn gluten meal	20 fb 20	5.0	5.0	4.7	6.3	9.0	5.0	2.3	5.3
4	Corn gluten meal	30 fb 10	23.0	14.3	15.7	14.7	15.3	16.0	18.7	16.8
5	Corn gluten meal	40	7.7	9.3	8.7	10.7	14.7	11.3	9.7	10.3
			P>F=0.09						P>F=0.08	
	$LSD_{0.05}$		85.9	NS	NS	NS	NS	NS	82.8	NS

[1]These values represent the number of crabgrass plants per plot.
NS = means are not significantly different at the 0.05 level.

Table 4. Crabgrass counts[1] in Kentucky bluegrass treated with corn gluten meal (CGM) in the 1995 Corn Gluten Meal Rate Weed Control Study.

	Material	Rate lb product/1000 ft^2	Aug 3	Aug 11	Aug 19	Aug 24	Aug 31	Sept 7	Sept 14	Mean
1	Untreated control	NA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	Corn gluten meal	10 fb 10 fb 10 fb 10	70.1	57.9	67.0	71.9	63.7	67.9	70.3	67.3
3	Corn gluten meal	20 fb 20	95.6	93.8	94.6	93.3	92.0	95.4	97.9	94.8
4	Corn gluten meal	30 fb 10	80.0	82.2	82.0	84.6	86.4	85.3	83.4	83.5
5	Corn gluten meal	40	93.3	88.4	90.0	88.8	87.0	89.6	91.4	89.9
			P>F=0.09						P>F=0.08	
	$LSD_{0.05}$		85.9	NS	NS	NS	NS	NS	82.8	NS

[1]These values represent the percentage reduction in crabgrass plants per plot as compared with the untreated control.
NS = means are not significantly different at the 0.05 level.

Table 5. Dandelion counts[1] in Kentucky bluegrass treated with corn gluten meal in the 1995 Corn Gluten Meal Rate Weed Control Study.

	Material	Rate lb product/1000 ft^2	July 1	Aug 31	Sept 7	Sept 14	Mean
1	Untreated control	NA	23.3	79.0	63.3	67.3	58.3
2	Corn gluten meal	10 fb 10 fb 10 fb 10	12.3	24.7	17.3	18.3	18.2
3	Corn gluten meal	20 fb 20	8.3	10.3	8.7	8.0	8.8
4	Corn gluten meal	30 fb 10	6.0	17.0	18.3	15.7	14.3
5	Corn gluten meal	40	7.0	16.3	12.3	14.3	12.5
	$LSD_{0.05}$		7.0	32.2	25.5	28.4	21.9

[1]These data represent the number of dandelion plants per plot.

Table 6. Dandelion count reductions[1] in Kentucky bluegrass treated with corn gluten meal in the 1995 Corn Gluten Meal Rate Weed Control Study.

	Material	Rate lb product/1000 ft^2	July 1	Aug 31	Sept 7	Sept 14	Mean
			%				
1	Untreated control	NA	0.0	0.0	0.0	0.0	0.0
2	Corn gluten meal	10 fb 10 fb 10 fb 10	47.1	68.8	72.6	72.8	68.9
3	Corn gluten meal	20 fb 20	64.2	86.9	86.3	88.1	84.8
4	Corn gluten meal	30 fb 10	74.2	78.5	71.0	76.7	75.6
5	Corn gluten meal	40	70.0	79.3	80.5	78.7	78.6
	$LSD_{0.05}$		29.9	40.8	40.3	42.2	37.5

[1]These values represent the percentage reductions in dandelion counts per plot as compared with the untreated control.

Table 7. Percentage clover cover[1] in Kentucky bluegrass treated with corn gluten meal in the 1995 Corn Gluten Meal Rate Weed Control Study.

	Material	Rate lb product/1000 ft^2	July 1	Aug 31	Sept 7	Sept 14	Mean
			%				
1	Untreated control	NA	6.6	3.7	2.3	10.0	5.7
2	Corn gluten meal	10 fb 10 fb 10 fb 10	0.0	0.3	0.3	0.3	0.3
3	Corn gluten meal	20 fb 20	0.0	0.3	0.0	0.0	0.1
4	Corn gluten meal	30 fb 10	0.0	0.3	0.0	0.0	0.1
5	Corn gluten meal	40	0.0	0.0	0.0	0.0	0.0
						P>F=0.09	
	$LSD_{0.05}$		NS	2.2	NS	8.3	4.1

[1]These figures represent the area per plot covered by dandelions.
NS = means are not significantly different at the 0.05 level.

Table 8. Percentage reductions in clover cover[1] in Kentucky bluegrass treated with corn gluten meal in the 1995 Corn Gluten Meal Rate Weed Control Study.

	Material	Rate lb product/1000 ft^2	July 1	Aug 31	Sept 7	Sept 14	Mean
			%				
1	Untreated control	NA	0.0	0.0	0.0	0.0	0.0
2	Corn gluten meal	10 fb 10 fb 10 fb 10	100.0	91.0	85.5	96.7	95.6
3	Corn gluten meal	20 fb 20	100.0	91.0	100.0	100.0	98.5
4	Corn gluten meal	30 fb 10	100.0	91.0	100.0	100.0	98.5
5	Corn gluten meal	40	100.0	100.0	100.0	100.0	100.0
						P>F=0.09	
	$LSD_{0.05}$		NS	58.4	NS	83.3	71.2

[1]These figures represent the percentage reductions in clover cover per plot as compared to the untreated control.
NS = means are not significantly different at the 0.05 level.

Table 9. Crabgrass counts[1] in Kentucky bluegrass treated in the 1995 Corn Gluten Meal Rate Weed Control Study for 1996 through 1999.

	Material	Rate lb product/1000 ft^2	1996	1997	1998	1999
1	Untreated control	NA	4	36	19	102
2	Corn gluten meal	10 fb 10 fb 10 fb 10	7	19	11	33
3	Corn gluten meal	20 fb 20	3	18	3	5
4	Corn gluten meal	30 fb 10	1	14	4	17
5	Corn gluten meal	40	5	37	9	10
	$LSD_{0.05}$		NS	NS	NS	NS

[1]These values represent the number of crabgrass plants per plot.
NS = means are not significantly different at the 0.05 level.

Table 10. Percentage crabgrass count reductions[1] in Kentucky bluegrass treated in the 1995 Corn Gluten Meal Rate Weed Control Study for 1995 through 1999.

	Material	Rate lb product/1000 ft^2	1995	1996	1997	1998	1999
					%		
1	Untreated control	NA	0	0	0	0	0
2	Corn gluten meal	10 fb 10 fb 10 fb 10	28	0	48	42	67
3	Corn gluten meal	20 fb 20	45	33	50	86	95
4	Corn gluten meal	30 fb 10	44	67	61	78	86
5	Corn gluten meal	40	54	0	0	53	90
	$LSD_{0.05}$		NS	NS	NS	NS	NS

[1]These values represent the percentage reductions in crabgrass plants per plot as compared with the untreated controls.
NS = means are not significantly different at the 0.05 level.

Table 11. Percentage dandelion count reductions[1] in Kentucky bluegrass treated in the 1995 Corn Gluten Meal Rate Weed Control Study for 1996 through 1999.

	Material	Rate lb product/1000 ft^2	1996	1997	1998	1999
				%		
1	Untreated control	NA	0	0	0	0
2	Corn gluten meal	10 fb 10 fb 10 fb 10	48	50	66	69
3	Corn gluten meal	20 fb 20	50	60	59	85
4	Corn gluten meal	30 fb 10	28	28	69	76
5	Corn gluten meal	40	50	58	62	79
	$LSD_{0.05}$		NS	NS	21	38

Table 12. Percentage clover cover reductions[1] in Kentucky bluegrass treated in the 1995 Corn Gluten Meal Rate Weed Control Study for 1996 through 1999.

	Material	Rate lb product/1000 ft^2	1996	1997	1998	1999
				%		
1	Untreated control	NA	0	0	0	0
2	Corn gluten meal	10 fb 10 fb 10 fb 10	45	65	74	96
3	Corn gluten meal	20 fb 20	69	82	72	99
4	Corn gluten meal	30 fb 10	90	92	64	99
5	Corn gluten meal	40	92	83	93	100
	$LSD_{0.05}$		NS	58	49	71

Managing Cool-season Grasses as Part of a SportGrass® System

David D. Minner and Jay S. Hudson

New and innovative systems are being developed for natural grass fields. Coaches, athletes, and trainers prefer natural grass to reduce physical stress on players. Artificial surfaces are known for their durability and infrequent need for maintenance. SportGrass is the first product that combines the playability of natural grass with some of the more durable characteristics of synthetic turf.

The SportGrass system is a synthetically-reinforced layer of grass that is grown on a sand-based rootzone. The system consists of natural grass growing in a synthetic matrix containing fibrillated fibers (polypropylene blades) attached to a backing. Within the layer of sand are polypropylene grass blades tufted into a woven backing (www.sportgrass.com). Roots can grow through the woven backing and into the sand below. Since grass roots grow down through the synthetic fibers and backing, the crown and roots of the plant are protected. SportGrass is horizontally and vertically stabilized by the combination of the polypropylene blades and the backing material. Grass can be established by seeding or sprigging. Specialized methods have been developed to produce, harvest, and install large-roll SportGrass sod.

The SportGrass system was designed to reduce divots, ruts, and bare spots due to heavy traffic. The product claims to reduce the need for renovation and frequent repairs. Cool-season and warm-season turfgrasses can be grown in the SportGrass system. If the natural grass is briefly worn away, the synthetic and sand portions of the SportGrass system maintain a stable playing surface. SportGrass also aids in a quicker recovery of the turfgrass.

The SportGrass synthetic material is typically produced in 15 ft by 100 ft rolls. The synthetic turf material is laid on top of the sand-based root zone. During installation, the seams of the synthetic material are temporarily held to the rootzone with metal sod staples. Sand that matches the root zone is then topdressed and brushed into the 3/4-inch polypropylene blade matrix. As an alternative, a gunit gun has been used to blow dry sand into the polypropylene fibers. Once the matrix has been filled, seeding or sprigging can take place. The seed is typically sliced into the surface so that the plant crown develops within the sand/fiber matrix. SportGrass can also be installed as sod. SportGrass sod is grown over a plastic sheet to impede root penetration. The sod is then sliced into appropriate sizes in the sod field (usually 42 inches by 40 feet). A large roll harvester is used to roll up the sod. SportGrass has been used on football, baseball, and soccer fields and golf courses.

Most natural grass systems tend to become elevated above the surface where the grass was first established. Over time the accumulation of thatch and the process of topdressing can add as much as 0.5 to 2.0 inches of material above the original soil line where the grass was first started. Stabilizing materials that were once near the surface can be lowered in the profile as organic and mineral material accumulates above the synthetic stabilizer. We are interested in finding out if this "burying" of the stabilizer material reduces their effectiveness. We also want to know if current management practices can be used to prevent accumulation of thatch above the synthetic stabilizer. Stabilizers also tend to reduce surface resilience and increase surface hardness (as measured by Gmax). Two separate studies were established in the fall of 1996 to evaluate mat management above the surface of the stabilizers and to evaluate field hardness.

Methods:

Study # 1 - Mat Management

The objective was to evaluate conventional methods of turfgrass management as they apply to SportGrass. Of particular interest is how grass management practices influence the accumulation of organic matter within and above the synthetically reinforced zone. Most grass systems tend to increase in elevation as topdressing, thatch, and mat accumulate above the original surface where the grass was first established. Moderate accumulation of thatch may improve surface characteristics by increasing cushion and biomass cover. Eight treatments including two non-SportGrass controls were used to evaluate mat management in the SportGrass System (Table 1a). The six SportGrass treatments consisted of catching clippings, returning clippings, verticutting, solid coring, Primo plant growth regulator, and verticutting after thatch accumulation. Verticutting was applied on 4 May 1998 and 6 May 1999. Solid tine aerification was applied on 4 May and 25 August 1998 and on 6 May and 25 August. Primo treatments were applied on 23 May, 27 June, and 29 July 1998 and on 20 May, 28 June, and 27 July 1999. Verticutting was applied by making two passes over the plot in opposite directions using a Bluebird vertical mower. The verticut depth was set so that it just touched the top of the synthetic grass blades. The thatch litter was hand raked and removed from the surface. Hollow tine coring with 5/8-inch tines was attempted on a border area containing SportGrass. The GA30 Cushman aerifyer with 5/8-inch hollow tines did not adequately penetrate the synthetic backing of the SportGrass material. Pointed 3/8-inch solid tines easily penetrated the backing and were used in the study. Holes were punched on 2-inch centers at a rate of 36 holes/sq ft. Heavier coring equipment such as the Cushman GA60 have successfully hollow cored through the SportGrass backing using 3/4-inch tines.

Study #2 - Grass Species
The objective was to evaluate how grass species, seeding rates, and traffic intensity influence the performance of the natural grass and synthetic turf combination. (Tables 2a and 2b). Synthetically stabilizing sand surfaces typically increases surface hardness. In some situations synthetic stabilizers have been perceived as making fields too hard. When cleat penetration and traction are reduced the field appears slippery. Fields dominated by a thick stand of perennial ryegrass have been described as being more slippery than other types of grass. This study evaluates the performance of a SportGrass system with respect to hardness and footing.

Studies were evaluated for turf appearance, surface hardness, and traction measurements. Surface hardness was measured with a 2.25-kg hammer attached to the Bruel and Kjaer 2515 Vibration Analyzer. The hammer was dropped from a height of 18 inches. Traction was conducted with a torque wrench apparatus attached to a cleated plate that was developed by Canaway and Bell, 1986. One hundred pounds was the load bearing weight of the torque device and the weight was dropped from a height of 2 inches. Traction was assessed as the amount of torque (N·m) required to tear the underlying sod. Traction data represent the average of three individual measurements per plot. Traffic was applied during the spring and fall to simulate athletic activity. A model T224 Brouwer roller that has been converted into a riding traffic simulator was used. Both of the two-foot-wide rollers on the traffic simulator are fitted with 5/8-inch football cleats on 2-inch centers. The rollers are attached by chain and sprocket to supply a differential-slip-type of traffic that produces a tearing action of the grass surface.

The Statistical Analysis System version 6.12 (SAS Institute, 1996) and Analysis of Variance (ANOVA) were used to analyze the data. Least Significant Difference (LSD) means comparisons were made to test between treatments effects on surface hardness (Tables 3) and traction (Table 4).

1999 Results:

At this time, results from only the mat management study will be presented. Surface hardness for treatments with SportGrass were significantly harder than the seeded and sodded control (Table 3). The only exception was that the use of solid tine aerification produced similar results to the seeded control on 14 June and 22 July (Table 3). Traction increased for all treatments with SportGrass compared to the seeded and sodded control on 6 May and 22 July (Table 4). Vertical mowing provided similar traction compared to the seeded and sodded controls (Table 4). No differences were seen on 7 Dec. for surface hardness and traction (Table 3 and Table 4)

Literature Cited
Canaway, P.M. and M.J. Bell. 1986. Technical note: An apparatus for measuring traction and friction on natural and artificial playing surfaces. J. Sports Turf Res. Inst. 62:211-214.

Table 1a. Treatments used to evaluate management of the grass mat within the SportGrass system.

Trt	Clippings	Cultivation	PGR	Other	with SportGrass
1.	Catch	none	none	none	yes
2.	Return	none	none	none	yes
3.	Return	Verticut	none	none	yes
4.	Return	Solid core	none	none	yes
5.	Return	none	Primo	none	yes
6.	Return	none	none	after thatch accumulates, begin thatch reduction treatment	yes
7.	Return	none	none	Seeded control	no
8.	Return	none	none	Sodded control	no

Table 1b. Plot layout for mat management study.

extra plot	extra plot	6	2	4
3	5	2	5	1
4	6	1	3	6
1	3	2	5	4
7	8	7	8	7

GRASS SPECIES STUDY AREA
North «

Rep 1	Rep 2	Rep 3

Table 2a. Species layout for grass species study.

Trt	Grass species (whole plot trt)	Seeding rate lb/1000 ft^2	Traffic Intensity (Split plot)	
			Low	High
1.	Kentucky bluegrass[1]	2	yes	
2.	Kentucky bluegrass	2		yes
3.	Kentucky bluegrass	4	yes	
4.	Kentucky bluegrass	4		yes
5.	Perennial ryegrass[2]	7	yes	
6.	Perennial ryegrass	7		yes
7.	Perennial ryegrass	14	yes	
8.	Perennial ryegrass	14		yes
9.	KB & PR	2 & 7	yes	
10.	KB & PR	2 & 7		yes
11.	KB & PR	4 & 14	yes	
12.	KB & PR	4 & 14		yes

[1] 'Limousine' Kentucky bluegrass
[2] 'Pinnacle' Perennial ryegrass

Table 2b. Plot plan of treatment arrangements for the grass species study.

MAT MANAGEMENT STUDY AREA

North «

REP 1						REP 2		
1	2	3	4	5	6	7	8	9
1 (1a)	**3 (2a)**	**5 (3a)**	**7 (4a)**	**9 (5a)**	**11 (6a)**	**1 (1a)**	**7 (4a)**	**9 (5a)**
10	11	12	13	14	15	16	17	18
2 (1b)	**4 (2b)**	**6 (3b)**	**8 (4b)**	**10 (5b)**	**12 (6b)**	**2 (1b)**	**8 (4b)**	**10 (5b)**
REP 3								
19	20	21	22	23	24	25	26	27
7 (4a)	**5 (3a)**	**11 (6a)**	**3 (2a)**	**1 (1a)**	**9 (5a)**	**5 (3a)**	**11 (6a)**	**3 (2a)**
28	29	30	31	32	33	34	35	36
8 (4b)	**6 (3b)**	**12 (6b)**	**4 (2b)**	**2 (1b)**	**10 (5b)**	**6 (3b)**	**12 (6b)**	**4 (2b)**

Table 3. Surface hardness (g_{max}) of eight treatment in the mat management study on six dates during 1999. Surface hardness was measured as the peak deceleration of five separate location drops with a 2.25-kg hammer.

Treatments	Dates					
	May 6	June 14	July 22	Aug 25	Sept 26	Dec 7
1. Catch Clippings	86.0	106.4	104.2	105.3	105.7	120.3
2. Return Clippings	79.5	102.4	102.8	102.4	93.6	117.4
3. Verticut (prevent thatch)	83.9	108.9	105.4	105.3	105.6	122.2
4. Solid tine aerify	75.8	90.8	94.2	96.0	95.1	112.8
5. PGR (Primo)	85.0	104.2	104.5	104.6	104.0	116.5
6. Verticut (after accumulation)	82.8	106.1	105.7	106.2	104.0	112.1
7. Control seeded	67.5	91.0	92.1	90.9	80.2	111.3
8. Control sodded	64.4	80.8	83.9	87.7	86.0	108.1
$LSD_{0.05}$	8.2	5.6	3.8	3.8	7.5	NS

Table 4 Traction measurements (N·m) of eight treatments in the mat management study on six dates during 1999. Traction was measured two times in each plot.

Treatments	Dates					
	May 6	June 14	July 22	Aug 25	Sep 26	Dec 7
1. Catch Clippings	88.0	69.8	64.3	66.7	64.2	59.0
2. Return Clippings	87.7	72.8	67.3	64.2	57.8	57.5
3. Verticut (prevent thatch)	93.7	62.5	64.7	57.0	57.2	56.3
4. Solid tine aerify	84.2	70.7	63.0	59.8	62.2	59.2
5. PGR (Primo)	85.3	66.8	65.7	66.8	65.0	61.2
6. Verticut (after accumulation)	89.0	67.0	68.8	62.0	62.2	57.3
7. Control seeded	70.7	65.5	55.2	55.5	59.0	60.2
8. Control sodded	61.2	62.2	58.0	55.0	57.5	57.8
$LSD_{0.05}$	4.6	4.6	5.0	4.4	5.2	NS

Managing Bentgrass Stress on Putting Green Slopes –1999 Report

David D. Minner, Nick E. Christians, Deying Li, Iowa State University, and
Dennis Watters, CGCS, Fort Dodge Country Club
Sponsered by:
Iowa Golf Course Superintendents Association and Golf Course Superintendents Association of America

A sloped research green (SRG) was constructed and established with Crenshaw creeping bentgrass at the Horticulture Research Center, Ames, IA in July 1997 to evaluate bentgrass management under difficult and variable growing conditions. The objective of this project was to evaluate organic and inorganic amendments applied as topdressing. Iowa State University, Iowa Golf Course Superintendents Association and the Golf Course Superintendents Association of America fund this project. The SRG was erected to simulate the undulating topography that occurs on many putting greens - as opposed to a typical flat research green. The sand based portion of the SRG is 100 ft by 40 ft by 1 ft. The subgrade, gravel blanket, and sand rootzone all follow the same contour. The 12-inch sand rootzone contains no amendment and is positioned over a 4-inch gravel blanket with 4-inch drain lines. The SRG has four distinct micro-environments that will be simultaneously evaluated for nine different treatments. The micro-environments are: 1) cool slope - this 7.0% slope faces north and should be cooler in the summer but also colder in the winter, 2) knoll - the crown of the green is expected to have the most potential for scalping and dry spot injury in the summer, 3) hot slope - this 6.6% slope faces south and is expected to generate high surface temperatures, and 4) swale - the low portion of the green is expected to have excessively wet conditions. No amendments, organic or inorganic, were used to construct the 12-inch rootzone. The sand has a pH of 8.2 and is calcareous. Topdressing treatments will be routinely applied to 40 ft. by 6 ft. plots. The long and narrow plots are situated so that each treatment covers all four distinct micro-environments on the green. The five topdressing treatments are listed in Table 1. Axis, Profile, Zeolite, and Zeopro are inorganic amendments that will be compared with the organic amendment Dakota Peat. Axis is a diatomaceous earth, Profile is a porous ceramic clay, Zeolite is an aluminosilicate mineral, and Zeopro is a nutrient loaded Zeolite. All of the products claim to improve cation exchange, and nutrient and water holding capacity.

The sloped green matured and filled in during the summer of 1998. By August there was 100 percent turf cover and approximately 0.5-cm of thatch. On 25 September 1998 the green was severely verticut. A 0.5-cm depth of topdressing material was immediately applied for each treatment following verticutting. The green was mowed at 0.25 inches during the fall and was covered on 1 December 1998 with an Evergreen Grow Blanket for winter protection. The green was showing signs of winter desiccation by late January, but there were no visible differences among treatments. By 1 April it was apparent that the turf was severely damaged by winter desiccation and there were still no differences among treatments from winter injury or spring green-up. On 1 April 1999 the green was verticut, reseeded, and plugs moved, within treatments, into the most severely damaged knoll areas of the green. Mowing height was raised to 0.45 inches and gradually lowered to 0.2 inches by 23 August 1999. Treatments were topdressed with 0.2 inches of material on 26 September 1998. Topdressing treatments were applied every two weeks from 14 May to 30 September for a total of 1.0 inch of topdressing in 1999. To smooth the green's surface and depressions between plots, the entire green was topdressed with 0.1 inches of the original sand and drug across all plots on 25 Oct 1999. The entire green was fertilized with a total of 4.4 lb N/1000sq.ft., 2.5 lb P_2O_5/1000sq.ft., and 3.6 lb K_20/1000sq.ft. Since Zeopro contains additional nutrients it received an additional 1 lb N/1000sq.ft., 0.5 lb P_2O_5/1000sq.ft., and 6 lb K_20/1000sq.ft. Turf quality, color, and dry spots were rated throughout the summer on a scale of 0-9, 9=best turf.

Table 1. Organic and inorganic amendments applied to the sloped putting green as topdressing treatments.

Topdressing Treatment		Calcareous Sand	Inorganic Amendment	Organic Amendment
		% by volume		
1	sand + Dakota peat (control)	90	-	10
2	sand + Axis	80	20	-
3	sand + Profile	80	20	-
4	sand + Zeolite	80	20	-
5	sand + Zeopro	80	20	-

Table 2 shows the quality ratings for 1999. During most of the growing season Zeopro showed better turf quality than all other topdressing treatments because of the improved turf color that was associated with the additional nitrogen in this "loaded product". Also under more favorable conditions, i.e. swale and cool areas, Zeopro produced better turf quality.

In the knoll area, where stress increased, turf performance among treatments would change as the result of two planned dry down periods. During the first stress period Zeopro had significantly better quality than Zeolite and the control. At this same time Axis was better than Profile. During the second water stress period turf was showing considerable wilt with no differences between treatments. Nine days into the irrigated recovery period, 16 September 1999, Axis was better than Profile, Zeopro, and the control. Profile and Zeopro had significantly lower quality than all other treatments. The advantage in turf quality gained under non-stress conditions by Zeopro was lost during the irrigated recovery period that followed two periods of moisture stress. The Zeopro treatment totaled 5.4 lb N/1000sq.ft. while all other treatments had only 4.4 lb N/1000sq.ft. It is possible that the extra 1 lb N/1000sq.ft. could have made turf appear better during most of the summer, but also predisposed the grass to more injury as evident from the lower quality ratings following the dry down and recovery period. On 14 October 1999, 37 days into the recovery period Profile had recovered to have the best turf quality although the differences among treatments were not significant.

The realistic conditions of the SRG have demonstrated treatment differences that may not have been apparent on a flat research green. It is important to simulate realistic conditions whenever possible in our turfgrass research programs.

Fig 1. Sloped Research

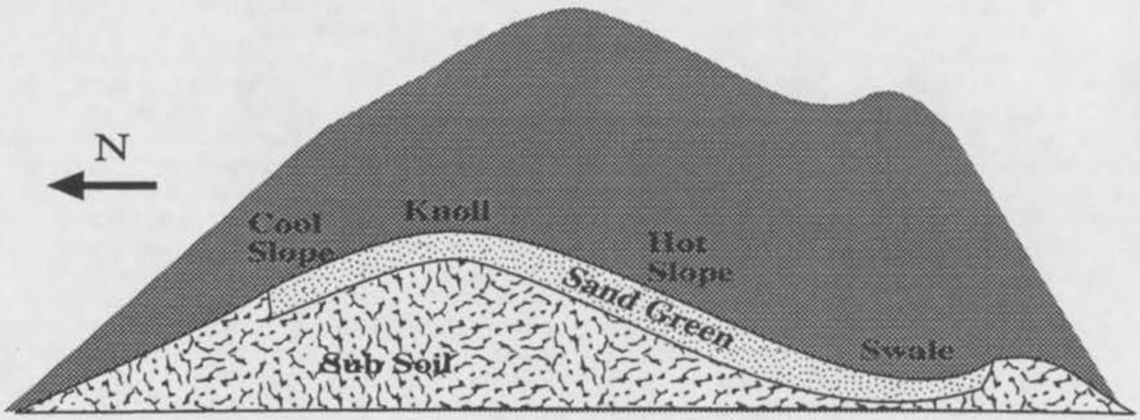

Table 2. Turfgrass visual quality in four microenvironments of a sloped green treated with inorganic amendments in 1999.

Treatment	Before water stress	After 1st water stress	After 2nd water stress	Recovery period		
	7-15-99	8-2-99	9-7-99	9-16-99	10-14-99	11-11-99
			Cool area			
Control	6.67	6.67	6.17	7.50	8.67	6.00
Axis	6.50	6.33	6.50	7.50	8.17	6.00
Profile	6.50	6.17	5.83	7.17	8.67	6.00
Zeolite	6.67	6.17	5.67	7.17	8.50	6.00
Zeopro	7.00	7.50	6.00	7.17	8.50	6.00
$LSD_{0.05}$	NS	0.38	NS	NS	NS	NS
			Knoll area			
Control	7.00	6.50	5.67	4.50	6.17	7.33
Axis	7.00	6.00	4.33	7.00	7.33	5.67
Profile	7.00	5.17	4.83	5.17	7.83	5.83
Zeolite	7.00	5.50	4.67	6.50	6.33	5.50
Zeopro	7.00	6.50	5.00	4.83	7.00	5.67
$LSD_{0.05}$	NS	0.60	NS	0.65	NS	NS
			Hot area			
Control	7.00	6.00	4.33	7.00	8.33	6.33
Axis	7.00	6.17	5.67	7.67	7.17	6.67
Profile	7.00	6.00	4.83	6.00	7.00	6.00
Zeolite	7.00	6.00	4.67	6.67	7.33	6.83
Zeopro	7.00	6.67	4.67	5.50	7.00	6.33
$LSD_{0.05}$	NS	NS	0.76	1.03	0.83	NS
			Swale area			
Control	6.00	6.67	6.00	8.17	8.67	7.50
Axis	6.33	6.67	6.50	7.83	8.33	7.33
Profile	5.83	6.17	6.00	8.00	8.50	7.50
Zeolite	5.83	6.50	6.33	8.00	8.17	7.67
Zeopro	6.50	7.16	6.17	8.00	8.17	7.50
$LSD_{0.05}$	NS	0.53	NS	NS	NS	NS

*0-9 scale, 9 = best.

The Effect of Tarp Color on Turfgrass Growth

David D. Minner, Deying Li, Vince Patterozzi, and Jeffrey J. Salmond,

Many of our research ideas come from inventive grounds managers in the turfgrass industry. This project is a good example. Vince Patterozzi, Head Grounds Manager Baltimore Ravens, noticed that there was a difference in turf appearance when he used different color rain tarps. After two years of hearing this comment, Vince put it to me like this, "There is something going on with tarp color, you figure it out". He arranged with M Putterman & Company Inc. (800-621-0146) to send us several different samples of tarp colors. The study below is what developed from a very astute observation.

Objective: To determine if tarp color has any effect on turf growth and color.

Method:

The Putterman Rain Buster Athletic Field tarps used in this study were vinyl-coated polyester. These tarps are generally placed on the field temporarily and then removed when the rain event ends. Fields are generally covered for only a few hours, but in some cases a tarp may be left on the field for three days or longer. In 1999 two different studies were conducted on a mature stand of 'Midnight' Kentucky bluegrass. Five-foot by five-foot tarps of each tarp color were pinned to the ground in a randomized block design with 3 replications. Tarps were left in place for 105 consecutive days from 2 Dec 1999 to 17 March 2000 (Table 1). In a second study and a separate area, the tarps were placed for 35 consecutive days during spring green-up from 17 March to 20 April 2000 (Table 2.) Five-foot by five-foot tarps of each tarp color were pinned to the ground in a randomized block design with 3 replications. Turf color was rated on a scale of 1-10, 10 = darkest green and 1 = no green color, white/brown, and 6 = lowest acceptable color. Turf growth was rated on a scale of 1–10, 10 = most growth and 1 = no growth.

Results:

In all studies, tarp color had a dramatic effect on turf color. Yellow, orange, red, and white tarps produced the best turf color with ratings ranging between 6.5 and 10. When compared to the control, turf color was generally enhanced by tarp colors yellow, orange, red, and white. Tarp colors light blue, blue, and purple produced some yellowing that made them inferior to yellow, orange, red, and white. Tarp colors gray, light-green, dark-green, and black produce the most decrease in turf color and they were considered unacceptable. A Covermaster grow tarp and Enkamat were also included in the study even though they are not moisture prevention tarps. Both Covermaster and Enkamat improved turf color compared to the non-covered control plots. Enkamat and Covermaster also increased turf color with the least amount of growth.

Table 1. Turf quality after covered for 105 consecutive days from December 2, 1999 to March 17, 2000.

Treatment		Color		Growth	
		Feb 25	Mar 17	Feb 25	Mar 17
Red	V 10 oz.	4.3	8.7	1.7	7.3
Yellow	V 10 oz.	5.3	8.3	2.0	7.7
Orange	V 10 oz.	4.0	9.0	2.0	8.0
Light green	V 10 oz.	3.7	4.0	1.3	6.7
Light blue	V 13 oz.	3.0	5.0	1.5	6.0
Blue	V 13 oz.	4.5	7.0	2.0	6.5
Purple	V 13 oz.	3.7	6.0	1.3	7.7
Dark green	V 13 oz.	2.7	2.0	2.0	8.3
White	P 7 oz.	3.0	6.3	1.0	5.0
Gray/white	P 7 oz.	2.3	3.3	1.7	8.0
White/black	P 7 oz.	2.0	2.0	1.0	7.0
Black/white	P 7 oz.	2.5	2.0	1.5	8.0
Enkamat		3.0	6.7	1.0	5.0
Covermaster		2.0	5.0	2.0	4.0
Control		1.0	1.0	1.0	1.0

V - Vinyl-coated polyester
P - Polyethylene

Table 2. Turf quality after covered 35 consecutive days from March 17 to April 20, 2000.

Treatment		Color		Growth	
		Mar 31	Apr 20	Mar 31	Apr 20*
Red	V 10 oz.	9.7	8.7	9.3	8.3
Yellow	V 10 oz.	10.0	9.0	8.0	8.7
Orange	V 10 oz.	10.0	8.5	9.0	8.0
Light green	V 10 oz.	5.7	3.0	8.0	7.0
Light blue	V 13 oz.	7.0	5.0	6.5	6.5
Blue	V 13 oz.	7.0	5.0	8.5	6.5
Purple	V 13 oz.	6.0	4.3	7.3	7.7
Dark green	V 13 oz.	3.7	1.0	7.0	6.7
white	P 7 oz.	8.0	9.7	4.7	4.7
Gray/white	P 7 oz.	4.7	2.3	7.0	6.7
white/black	P 7 oz.	4.0	1.0	6.0	6.0
Black/white	P 7 oz.	3.0	1.0	7.5	6.5
Enkamat		8.0	10.0	5.3	5.0
Covermaster		8.0	9.0	4.0	4.0
Control		6.7	6.0	3.0	2.0

* Actual height of plant in inches.

Applying Calcium to Turfgrass Grown on Calcareous Sand

Rodney A. St. John, Nick E. Christians, and Henry G. Taber

ABSTRACT. Athletic fields and golf course greens often are constructed of calcareous sands. Supplemental calcium (Ca) applications are frequently recommended to these areas based on the results of Basic Cation Saturation Ratio (BCSR) soil testing and on the belief that the Ca in the $CaCO_3$ has limited availability to the plant. Our objective was to determine if additional Ca applications to grass grown on calcareous sand are beneficial to the plant. 'Midnight' Kentucky bluegrass (*Poa pratensis* L.) and 'Penncross' creeping bentgrass (*Agrostis palustris* Huds.) were grown on either calcareous or silica sand in a two-year greenhouse study. Treatments included a control, calcium sulfate [gypsum] ($CaSO_4$), calcium carbonate [lime] ($CaCO_3$), calcium nitrate [$Ca(NO_3)_2 \cdot H_2O$], and calcium chelate (8% Ca, 6% N) incorporated into the media at a level of 23 $g \cdot m^{-2}$ Ca. Because Ca nitrate and Ca chelate contain N, ammonium nitrate (NH_4NO_3) was added to the other treatments to equal the amount of N derived from these sources. Results included in this interim report are for the first year only. The Ca treatments did not affect the clipping weights of Kentucky bluegrass grown on calcareous sand. Of the five Ca treatments applied to creeping bentgrass grown on calcareous sand, only $CaCO_3$ increased total clipping weight. There were no differences in Ca tissue content in response to Ca treatment for either species grown on calcareous sand. On the silica sand, all treatments increased tissue Ca content for both species compared to the control. Calcium nitrate added to creeping bentgrass grown on calcareous sand resulted in lower amounts of magnesium (Mg) in the plant. A two-year field study was also started on a 'Crenshaw' creeping bentgrass green using the same treatments. The rate of 23 $g \cdot m^{-2}$ Ca was divided into 5 monthly applications. Calcium applications to the green did not increase the Ca content of the leaf tissue or clipping yield in the first year.

RESULTS & DISCUSSION

Greenhouse Study

Adding Ca to the calcareous sand did not increase the concentration of Ca in the leaf tissue of either species (Table 1). Adding Ca to Kentucky bluegrass on calcareous sand did not increase the clipping yield, but adding $CaCO_3$ to creeping bentgrass on calcareous sand increased clipping yield by 18% (Table 1). Adding any Ca source to creeping bentgrass grown on silica sand increased the concentration of Ca measured in the leaf tissue. Only $CaCO_3$ and calcium chelate increased the leaf Ca concentration of Kentucky bluegrass grown on silica sand. But, these increased Ca concentrations did not exceed the amount of Ca found in grasses growing on the calcareous sand control (Table 1). Adding gypsum to grasses grown on silica sand increased the clipping weight of Kentucky bluegrass by 22% and creeping bentgrass by 32% (Table 1). This indicates the calcareous sand is supplying the amount of Ca required for plant growth and that Kentucky bluegrass and creeping bentgrass grown on silica sand would benefit from additional applications of Ca.

Creeping bentgrass leaf Mg concentration was greatest for grass that was grown on the calcareous control. Calcium nitrate applications to creeping bentgrass reduced Mg levels on both silica sand and calcareous sand. This effect was not noticed on Kentucky bluegrass. Due to the fact that sand has a limited cation exchange capacity, additional Ca may cause the other basic cations, like Mg, to be removed from exchange sites. In solution, Mg could be readily lost either by leaching out of the soil profile or by precipitation into insoluble forms, which may cause the plants to have lower tissue Mg levels.

Field Study

The $CaCO_3$ and gypsum were applied granularly using "SuperCal 98-G" $CaCO_3$ and "SuperCal SO_4" gypsum from Calcium Products, Inc., Gilmore City, IA 50541. Both sources are finely ground to increase reactivity and re-pelletized to aid in handling and distribution. The $Ca(NO_3)_2$ and the calcium chelate were sprayed onto the plots. Liquid urea was also sprayed at a N rate of 3.7 $g \cdot m^{-2}$ to balance the amount of N that the $Ca(NO_3)_2$ and the calcium chelate contain. Calcium was applied five times at a rate of 4.6 $g \cdot m^{-2}$ per month for a total of 23 $g \cdot m^{-2}$ Ca.

Throughout the first year of the study there were no leaf color or texture differences between the treatments. Adding Ca to the creeping bentgrass did not increase the concentration of Ca in the leaf tissue (Table 2). This field study is being repeated again in 2000 and more detailed results will be presented next year.

Table 1. Total clipping dry weight (g) and nitrogen (N), calcium (Ca), magnesium (Mg), potassium (K), and phosphorus (P) concentrations ($g \cdot kg^{-1}$) for two grass species grown in a greenhouse during 1998. The grasses were grown on silica sand (S) (pH=7.2), and calcareous sand (C) (pH=8.2). Clipping dry weights are the average total accumulation of clippings over 10 weeks. Nutrient concentrations are from Inductive Coupled Argon Plasma (ICAP) and Total Kjeldahl Nitrogen (TKN) analysis performed on the clippings collected during the first eight weeks. The bottom columns are the General Linear Model Procedure P > F results; and G is the Grass, S is the Sand type, and Trt is the calcium treatment.

Creeping Bentgrass

	Clip wt.		N		Ca		Mg		K		P	
Treatments	S	C	S	C	S	C	S	C	S	C	S	C
	— g —		$g \cdot kg^{-1}$									
No Ca	1.80	1.97	41.4	41.6	5.7	10.1	3.1	3.4	27.0	29.8	5.5	4.4
Gypsum	2.38	2.14	45.8	43.5	9.3	11.6	3.0	3.3	28.8	29.5	6.1	4.1
$CaCO_3$	1.96	2.32	44.2	44.8	9.5	10.3	3.1	3.3	26.3	31.6	5.0	4.6
$Ca(NO_3)_2 \cdot H_2O$	1.72	2.15	39.6	42.6	9.9	9.1	2.3	2.9	32.3	30.9	4.5	4.1
Ca Chelate	2.10	2.23	43.5	43.5	11.9	10.7	3.0	3.1	30.2	29.8	4.7	4.4
$LSD_{0.05}$	0.32		NS		2.3		0.4		2.3		0.8	

Kentucky Bluegrass

	Clip wt.		N		Ca		Mg		K		P	
Treatments	S	C	S	C	S	C	S	C	S	C	S	C
	— g —		$g \cdot kg^{-1}$									
No Ca	1.38	1.61	33.1	33.9	3.3	5.2	1.8	2.3	21.2	29.0	5.0	3.7
Gypsum	1.68	1.72	34.3	33.3	4.2	5.7	1.8	2.1	29.2	27.7	5.8	3.4
$CaCO_3$	1.33	1.65	33.0	33.1	4.6	4.8	1.6	2.1	28.6	29.1	4.2	3.8
$Ca(NO_3)_2 \cdot H_2O$	1.47	1.62	33.0	33.9	4.2	5.3	1.6	2.2	29.8	28.3	4.3	3.7
Ca Chelate	1.61	1.55	35.0	35.0	5.6	5.9	1.9	2.3	30.6	27.8	5.1	3.9
$LSD_{0.05}$	0.28		NS		1.1		0.3		7.2		0.5	

General Linear Models Procedure Pr>F

	Clip wt.	N	Ca	Mg	K	P
Grass type	0.0004	0.0003	0.0006	0.0003	0.018	0.032
Sand type	0.0020	0.73	0.0005	0.0001	0.25	0.0001
G*S	0.72	0.92	0.85	0.11	0.60	0.10
Trt	0.0023	0.14	0.0001	0.0019	0.095	0.0008
Sand*Trt	0.026	0.52	0.0009	0.32	0.039	0.0001
Grass*Trt	0.27	0.21	0.19	0.02	0.71	0.26
G*S*Trt	0.37	0.94	0.10	0.87	0.41	0.62

Table 2. Nitrogen (N), calcium (Ca), magnesium (Mg), and potassium (K), concentrations ($g \cdot kg^{-1}$) for 'Crenshaw' creeping bentgrass established on a pure sand-based green (pH=8.2). Results are from the first year of a two-year field experiment. Nutrient concentrations are from Inductive Coupled Argon Plasma (ICAP) and Total Kjeldahl Nitrogen (TKN) analysis performed on the clippings collected immediately before the 4th and 5th treatment applications. The table is formed from the averages of the two testing dates.

	Nutrient Concentrations			
	N	Ca	Mg	K
Treatments	$g \cdot kg^{-1}$			
No Ca	25.7	5.4	2.0	15.8
Gypsum	25.7	5.6	1.8	16.0
$CaCO_3$	25.8	5.6	2.0	15.8
$Ca(NO_3)_2 \cdot H_2O$	25.4	5.6	1.9	16.2
Ca Chelate	27.0	5.8	1.9	16.5
$LSD_{0.05}$	1.5	NS	NS	NS

Freezing and Thawing Effects on Sand-based Media Modified with Inorganic Amendments

Deying Li, Marco Volterrani, Nick E. Christians, David D. Minner and Simone Magni

This is a joint project with Marco Volterrani of the University of Pisa, Italy. The full text will be published in the International Turfgrass Research Journal in 2001.

ABSTRACT. Many inorganic amendments have been suggested for use in sand-based systems to increase nutrient and water holding capacity, but little is known about their long-term effects on the physical properties of the media. The objectives of this study were to investigate the effects of freezing-and-thawing on the particle integrity, soil bulk density, and saturated hydraulic conductivity (K_{sat}) of a sand-based media amended with inorganic materials and to measure the particle stability of these sand and inorganic amendment mixtures when subjected to compaction. The amendments included porous ceramic clay (PCC), calcined diatomaceous earth (CDE), zeolite clinoptilolite, zeolite chabasite, a polymer coated clay with a kelp material incorporated on the exterior of the polymer coating (PC), lapillus , and pumice. A mixture of 85% sand and 15% (v/v) of the soil amendments was prepared in the laboratory. After 20 freeze/thaw cycles, sand amended with PC had a 7.6% decrease in bulk density from the compacted sample. The percentage weight of the finest fraction that passed through to the 0.053-mm sieve to the bottom pan increased in all treatments except the control and PC. The fine particles collected in the pan increased by 124% for sand amended with zeolite clinoptilolite. After 20 cycles of freeze/thaw, K_{sat} values of sand amended with PCC and CDE were 25 and 33% higher than the control, respectively. Twenty freeze/thaw cycles resulted in a 219, and 101% increase in K_{sat} of the sand amended with PC and peat, respectively. The increases of K_{sat} by PC and peat are likely due to their particle stability during freezing and thawing. Dynamic compaction caused breakdown of 1.2 to 3.3% of the particles retained on the 0.5-mm sieve.

Table 1. Physical properties of the inorganic materials used in the freezing-and-thawing study.

Property	Inorganic materials							
	Sand	Zeolite 1†	Zeolite 2‡	PCC§	CDE¶	PC#	Lapillus	Pumice
Gravel (>2 mm), g kg^{-1}	1.0	2.0	437.7	0.0	0.0	25.3	100.0	158.7
Very coarse (1.0-2.0 mm), g kg^{-1}	4.7	128.3	376.7	0.0	249.7	81.7	169.7	357.0
Coarse (0.5-1.0 mm), g kg^{-1}	123.0	574.3	23.7	596.0	501.7	490.0	143.3	239.3
Medium (0.25-0.5 mm), g kg^{-1}	770.7	243.3	30.3	401.0	215.3	326.3	149.0	114.0
Fine (0.15-0.25 mm), g kg^{-1}	89.3	15.0	26.7	3.3	17.3	41.7	114.7	44.3
Very fine (0.106-0.15 mm), g kg^{-1}	6.3	11.7	23.0	0.0	6.7	10.0	75.3	21.7
Silt (0.05-0.106 mm), g kg^{-1}	4.0	13.7	32.7	0.0	9.3	14.3	133.7	30.7
Clay (<0.05 mm), g kg^{-1}	2.3	11.0	50.3	0.0	0.0	8.3	114.0	35.0
pH (1:1 water/material)	6.8	7.8	8.0	6.3	7.0	6.4	7.0	6.8

† Zeolite clinoptilolite.
‡ Zeolite chabasite.
§ PCC, porous ceramic clay.
¶ CDE, calcined diatomaceous earth.
# PC, polymer coated clay with a kelp material incorporated on the exterior of the polymer coating.

Table 2. The effect of freezing and thawing on the change in bulk density of the mixtures including 85% sand/15% amendment (v/v).

Treatment	Bulk density compacted	Bulk density decrease					
	g cm^{-1}	Saturated	Frozen	1-cycle	5-cycle	10-cycle	20-cycle
		%					
Peat	1.47	1.7	8.4	1.9	1.7	0.9	0.3
Zeolite1†	1.51	0.2	7.7	1.0	0.6	1.0	2.1
Zeolite2‡	1.54	0.2	5.7	0.6	1.0	1.2	1.8
PCC§	1.46	0.6	7.9	1.4	1.0	0.6	1.7
CDE¶	1.45	-0.2	7.6	1.0	1.5	3.6	2.8
PC#	1.61	16.1	18.4	15.6	11.5	9.5	7.6
Lapillus	1.59	0.0	8.2	2.0	1.6	3.4	1.9
Pumice	1.50	0.2	7.8	1.0	0.8	2.1	1.5
$LSD_{0.05}$	0.02	1.0	1.6	0.9	1.0	1.2	1.7

† Zeolite clinoptilolite.
‡ Zeolite chabasite.
§ PCC, porous ceramic clay.
¶ CDE, calcined diatomaceous earth.
# PC, polymer coated clay with a kelp material incorporated on the exterior of the polymer coating.

Table 3. Freezing and thawing effects on particle integrity of the mixtures containing 85% sand/15% amendment (v/v).

Treatment	Sieve aperture (mm) 4	2	1	0.5	0.25	0.15	0.106	0.053	pan
	Percentage weight retained on the sieve before freezing-and-thawing								
Peat	0.0	0.1	0.7	13.2	75.6	8.3	0.8	0.8	0.5
Zeolite1†	0.0	0.0	1.9	18.5	71.7	7.2	0.4	0.2	0.1
Zeolite2‡	0.2	2.1	5.0	12.2	70.9	7.5	0.7	0.6	0.8
PCC§	0.0	0.0	0.5	15.5	74.6	8.2	0.6	0.3	0.4
CDE¶	0.0	0.1	1.3	13.6	74.8	8.9	0.7	0.5	0.1
PC#	0.1	0.3	1.4	16.6	71.2	8.7	0.8	0.6	0.3
Lapillus	0.0	1.3	2.2	13.0	69.7	8.8	1.6	2.0	1.4
Pumice	0.0	0.9	2.8	14.9	72.5	7.2	0.6	0.5	0.5
$LSD_{0.05}$	0.0	0.2	0.4	1.3	1.2	0.9	0.2	0.1	0.3
	Percentage decreased after 20 cycles of freezing-and-thawing								
Peat	33.3	26.0	14.7	6.3	-2.7	3.0	-3.7	4.7	1.7
Zeolite1	0.0	0.0	-2.0	-3.0	2.0	-7.3	-36.7	-98.7	-124.3
Zeolite2	54.7	20.3	11.0	0.3	-1.0	-3.7	-15.7	-9.0	-16.7
PCC	0.0	9.7	-16.7	-19.0	2.7	15.0	14.0	3.0	-6.0
CDE	33.3	18.3	-27.7	-8.0	0.3	12.0	13.7	20.3	-25.3
PC	100.0	21.3	-10.7	-12.3	0.3	15.3	25.3	32.0	13.0
Lapillus	0.0	8.7	-12.3	4.0	2.0	-4.3	-13.7	-22.7	-34.0
Pumice	33.3	12.0	10.0	5.0	0.0	-10.0	-24.7	-22.3	-39.3
$LSD_{0.05}$	NS	NS	19.0	8.7	NS	14.3	26.9	57.8	70.8

† Zeolite clinoptilolite.
‡ Zeolite chabasite.
§ PCC, porous ceramic clay.
¶ CDE, calcined diatomaceous earth.
\# PC, polymer coated clay with a kelp material incorporated on the exterior of the polymer coating.

Table 4. Changes in saturated hydraulic conductivity (K_{sat}) caused by freezing and thawing of the mixtures containing 85% sand/15% amendment (v/v).

Treatment	K_{sat}† 0-cycle	20-cycle	K_{sat} increase
	.... cm h^{-1}	....	%
Control	20.13	30.34	50.13
Peat	9.54	19.20	101.21
Zeolite 1‡	23.59	26.20	11.04
Zeolite 2§	10.95	15.88	44.71
PCC¶	31.67	38.03	20.16
CDE#	24.21	40.38	66.63
PC††	11.21	35.89	219.27
$LSD_{0.05}$	1.19	5.86	28.49

† K_{sat}, saturated hydraulic conductivity.
‡ Zeolite clinoptilolite.
§ Zeolite chabasite.
¶ PCC, porous ceramic clay.
\# CDE, calcined diatomaceous earth.
†† PC, polymer coated clay with a kelp material incorporated on the exterior of the polymer coating.

Table 5. Particle-size distribution after by mechanical compaction in the mixtures containing 85% sand/15% amendment (v/v) which has passed 1-mm sieve and retained on 0.5-mm sieve.

Treatment	Sieve aperture (mm) 0.5	0.25	0.15	0.106	0.053	Pan
	Percentage weight retained					
Zeolite 1†	98.75	1.00	0.25	0.00	0.00	0.00
Zeolite 2‡	97.98	1.68	0.25	0.00	0.09	0.00
PCC§	98.64	1.11	0.26	0.00	0.00	0.00
CDE¶	98.34	1.48	0.17	0.00	0.00	0.00
PC#	98.21	1.56	0.23	0.00	0.00	0.00
Lapillus	96.74	2.34	0.59	0.08	0.17	0.14
Pumice	97.61	1.56	0.33	0.08	0.25	0.14
$LSD_{0.05}$	0.95	0.55	0.15	NS	NS	NS

† Zeolite clinoptilolite.
‡ Zeolite chabarite.
§ PCC, porous ceramic clay.
¶ CDE, calcined diatomaceous earth.
\# PC, polymer coated clay with a kelp material incorporated on the exterior of the polymer coating.

Introducing

Iowa State University Personnel Affiliated with the Turfgrass Research Program

Barbara Bingaman, Ph.D.	Postdoctoral Research Associate, Horticulture Dept.
Doug Campbell	Research Associate, Horticulture Department
Nick Christians, Ph.D.	Professor, Turfgrass Science Research and Teaching, Horticulture Dept.
Will Emley	Superintendent, Horticulture Research Station
Mark Gleason, Ph.D.	Professor, Extension Plant Pathologist, Plant Pathology Dept.
Mark Helgeson	Field Technician, Horticulture Dept.
Clinton Hodges, Ph.D.	Professor, Turfgrass Science Research and Teaching, Horticulture Dept.
Mark Howieson	Graduate Student, M.S. (Christians)
Jay Hudson	Graduate Student, M.S. (Minner)
Jeff Iles, Ph.D.	Associate Professor, Extension, Nursery Crops/Ornamentals, Horticulture Dept.
Young K. Joo, Ph.D.	Visiting Scientist from Korea
Kevin Knudston	Field Technician, Horticulture Dept.
Donald Lewis, Ph.D.	Professor, Extension Entomologist, Entomology Department
Deying Li	Graduate Student, Ph.D. (Christians and Minner)
Melissa McDade	Graduate Student, M.S. (Christians - Graduated 1999)
David Minner, Ph.D.	Associate Professor, Turfgrass Science Research and Extension, Horticulture Dept.
Josh Olson	Field Technician, Horticulture Dept.
Troy Oster	Graduate Student, M.S. (Christians - starting Fall 2000)
Rodney St. John	Superintendent, Turfgrass Research Station, Horticulture Dept.
Brad Sanders	Field Technician, Horticulture Dept.
Joe Stoeffler	Field Technician, Horticulture Dept.
Scott Thayer	Field Technician, Horticulture Dept.
Brian Wehner	Field Technician, Horticulture Dept.

Companies and Organizations That Made Donations or Supplied Products to the Iowa State University Turfgrass Research Program

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