PLEASE NOTE

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Table 42. Quality of Kentucky bluegrass cultivars

Please ignore the data submitted - this information is invalid. Further studies are being conducted.

Thank you,

Dr. Al Turgeon
University of Illinois

AT:dw

1976 TURFGRASS RESEARCH SUMMARY

UNIVERSITY OF ILLINOIS

AT URBANA-CHAMPAIGN

(NOT FOR PUBLICATION)

1976 Turfgrass Research Summary

University of Illinois

Urbana, Illinois

(Not for Publication)

A. 3. a. <u>Water requirement of selected turfgrass species.</u>
L. Art Spomer

Grasses contain and use more water than any other raw material required for their growth and activity. This water is more than an inert filler, probably every plant function is affected directly or indirectly by water, and a lack of water (water deficit) always reduces growth. Unlike other nutrient deficiencies, a water deficit affects growth immediately. Very little is known,however, at exactly what degree of water deficit that growth is significantly, irreversibly, and 'detrimentally' affected.

This project is trying to establish the physical and physiological water requirement of selected turfgrass species or answer the questions: How much water? What degree of water stress is detrimental? The answer to the first questions is relatively simple; however, the answer to the second question requires the examination of the effect of water deficit on several physiological processes.

The main progress on this project so far has been to develop the difficult techniques required for measuring plant water status.

B. 1. <u>Effects of fertilizations and mowing on total and nitrate nitrogen in Kentucky bluegrass leaf clippings.</u>
A. J. Turgeon, J. E. Haley and G. G. Stone

Previous studies on the levels of crude protein (total nitrogen x 6.25) is turfgrass clippings showed increased protein with increasing nitrogen fertilization and decreasing mowing height. Although mowing frequency (once, three times or five times per week) had no effect on total nitrogen in the clippings, it did affect the nitrate-nitrogen content in a single study conducted in August, 1975. Research was initiated in September, 1976, to further characterize the nitrate-nitrogen status of turfgrass clippings as affected by mowing and fertilization. An unmowed stand of 'Kenblue'-type Kentucky bluegrass was divided into two sections: an unmowed section and a section in which mowing was performed three times per week at 1.5 inches. Fertilization treatments included 0, 0.5, 1 and 2 lb N/1000 sq ft using a 10-6-4 water-soluble fertilizer on September 10 and again on September 24, 1976. Clippings from the mowed plots (and leaf material above 4 inches from the unmowed plots) were collected at 3, 7, 14, 21 and 28 days following the second fertilization. The plant material was oven-dried at 105 F for 24 hr and ground in a Wiley mill to pass through a 20 mesh screen. Total N was determined by the Kjeldahl method and nitrate-N was determined by the Phenoldisulfonic acid method.

Total nitrogen varied from 2.35 to 6.19 percent (corresponding to 14.7 to 38.7 percent crude protein) depending upon mowing, fertilization rate and time after fertilization (Table 1). The mowed plots were substantially higher in total N within fertilization level, and total N increased with increasing fertilization rate. Total N decreased after 7 days following the second fertilization at all fertilization levels. However, clippings from the unfertilized plots also had decreasing amounts of total N over time which, presumably, indicated a seasonal variation under early fall conditions. The fertilized plots maintained green color and foliar growth during the experimental period while the unfertilized plots lost color and had little growth.

Nitrate nitrogen varied from 23 to 1573 ppm. As with total N, higher fertilization rates were associated with higher nitrate-N levels in the clippings; however, the magnitude of response from fertilization was much greater. For example, in the mowed plots, the difference in nitrate-N level between the 0.5 and 2 lb N/1000 sq ft fertilization rate, 3 days after the second fertilization, was 818 ppm which was a 2.3-fold increase. Comparing these same treatments, the change in total N was 0.85 percent of dry matter, which was only a 17 percent increase. At the 0 or 0.5 lb N/1000 sq ft fertilization level, the mowed plots had higher nitrate-N than the unmowed plots; however, at the higher fertilization levels, this relationship was variable.

The highest nitrate-N level determined was less than 0.16 percent of total dry matter. Although this was substantially higher than that measured in the 1975 study, it is still considered an acceptable level in livestock feeds. (Excessive nitrate-N intake by livestock can result in methemoglobinemia or nitrite-poisoning of the blood). Further research is necessary to more accurately determine the effects of cultural practices and climatic conditions on the nitrogen status of turfgrass clippings.

Table 1. Effects of fertilization and mowing on total and nitrate nitrogen in Kentucky bluegrass leaf clippings.

Fertilization lb N/1000 sq ft	Mowing[1]	Total Nitrogen Time Aft Fert, Days					NO_3 Nitrogen Time Aft Fert, Days				
		3	7	14	21	28	3	7	14	21	28
	+	4.65	4.17	3.79	3.98	3.59	130	87	75	93	203
0	-	2.83	2.82	2.54	2.40	2.35	23	32	40	32	112
	+	5.11	4.84	4.32	4.52	3.91	355	145	152	185	248
0.5	-	3.48	3.51	3.21	3.11	2.79	73	50	53	32	150
	+	5.68	5.60	5.27	4.89	4.25	703	412	438	138	235
1.0	-	4.36	4.51	4.38	3.97	3.39	348	153	312	215	187
	+	5.96	6.19	5.67	5.85	5.05	1173	1303	1573	1192	332
2.0	-	4.91	5.18	5.07	4.67	4.19	745	1440	1460	1478	553

[1] Mowing performed 3 times/week at 1.5 in (+) or no mowing practiced (-).

B. 1. Utilization of dehydrated, pelleted turfgrass clippings as a ruminant feed.

F. C. Hinds, D. L. Arndt, M. H. Wallace, A. R. Cobb, A. J. Turgeon and J. M. Lewis

National interest in and concern about present feeding practices of meat-producing ruminants has led to renewed attention to increasing the amount of roughage used in producing acceptable market lambs and cattle. The demand for red meat is increasing and although it presently can be met by using grains, future trends in reducing the levels of grain fed will place emphasis on the quality as well as quantity of roughages. High yields of high quality forages can be obtained from well-managed stands on good farm land; however, land capable of growing grains must and will first be used for grain production. Thus, the management of present forage lands for greater production as well as the development of new sources of forages and roughages are essential. Recent studies as well as observations from research in progress clearly demonstrate that turfgrass clippings from mowing have the potential to be a valuable livestock feed.

Levels of crude protein are high enough in samples studied that turfgrass could serve as a protein supplement in many ruminant rations. A thorough understanding of the influence of cultural practices on the level and availability of important nutrients is essential to fully assess the potential benefit and ultimate acceptance of turfgrass clippings as an animal feed. In view of the vast and ever increasing land areas committed to highway rights-of-way parks, cemeteries, golf courses, lawns, sod farms and many other sites, the potential production of turfgrass clippings is truly staggering. In this respect a net of approximately 1.25 million acres per year are lost to urbanization, highway development and industrialization. The actual total loss to urbanization and development is 2.5 million acres per year but newly developed land (swamp drainage, irrigation, etc.) accounts for 1.25 million "new" farming acres per year thus the net loss to agricultural use of 1.25 million acres per year. This land that is lost represents the land resource potential to feed over one million people at today's levels of production and eating habits. The loss of the productivity of land used in urbanization, highway construction and industrialization is real under today's management and use but is not necessarily totally lost if changes in the philosophy of management and use can be instituted. A marked change in philosophy in many areas of the country to the use of clipping residues, either fresh, ensiled, or dehydrated in the feeding of cattle and sheep could in fact put many presently "unproductive" acres into a more productive role. Thus, under proper management, a valuable, renewable, presently untapped source of feed could be realized resulting in a further step forward in efficiency in Illinois and American agricultural production.

Four experiments have been initiated, two of which have been completed to evaluate the potential value of dehydrated, pelleted turfgrass (bluegrass) clippings as a source of nutrients for finishing lambs.

Experiment 1: A digestion study was conducted using 6 lambs fed a sample of dehydrated, pelleted turfgrass (Kentucky bluegrass) and as a comparison 6 similar lambs were fed a sample of pelleted, field cured second cutting alfalfa hay. During the course of the study a 21-day preliminary period was used during which time the ad libitum intake of each lamb on his respective feed was determined. Following the preliminary period feed intake was restricted to 90% of ad libitum intake and feces collected for 5 consecutive days. Appropriate samples of feed and feces were analyzed for dry matter, crude protein (CP), cell wall constituents (CWC), acid detergent fiber (ADF) and lignin (PL). From the foregoing analyses levels of cellulose and hemicellulose could be determined. The pelleted, dehydrated turfgrass was provided by Warren Turf Nursery, Suisun, California.

Experiment 2: A feeding study was conducted at the Dixon Springs Agricultural Center involving 96 lambs. Three replicates of eight lambs per lot were assigned at random within replicate to each of four treatments. The four treatments were (1) turfgrass pellets, (2) a finishing ration containing 10% alfalfa hay, (3) a finishing ration containing 20% alfalfa hay and (4) a finishing ration containing 40% alfalfa hay.

Rations used in DSAC Feeding Study (1976)

Ingredient	Percent of Ingredient by Ration			
	1	2	3	4
Dehydrated Turfgrass	100	0.0	0.0	0.0
Ground Shelled Corn	0.0	81.0	62.5	45.5
Soybean Meal (50% CP)	0.0	16.5	15.0	12.0
Ground Alfalfa Hay	0.0	10.0	20.0	40.0
Bonemeal	0.0	1.0	1.0	1.0
Feeding Grade Limestone	0.0	1.0	1.0	1.0
Trace Mineral Salt	0.0	0.5	0.5	0.5
Vitamin A, D and E	-	+	+	+
Antibiotic	-	+	+	+

All lambs were self fed their respective rations on slotted floors and provided four square feet of space per lamb. The study was conducted over a period of 83 days. At the end of the study representative lambs (3 or 4) were marketed from 11 of the 12 lots and carcass grade and observations on fat color were obtained by a federal grader. All lambs were weighed periodically and feed intake was measured on a lot basis each time lambs were weighed.

Experiment 3: A feeding study is being conducted on the Urbana campus using 12 lambs. The purpose of this study is to provide lamb carcasses from turfgrass-fed and conventionally fed lambs for taste panel evaluation. Initially the lambs were divided into two groups of 6 lambs each and one group received only turfgrass pellets and the other a conventional finishing ration (same as #2 in table). The lambs were allowed their respective rations ad libitum and were confined to slotted floors. Because of poor performance, four of the lambs initially receiving the turfgrass pellets were switched to 75% turfgrass pellets + 25% finishing pellets (2 lambs) or 50% turfgrass pellets + 50% finishing pellets (2 lambs). To date not all of the lambs have been slaughtered and thus no taste panel information is available. All lambs were weighed periodically and feed intake was measured on a group basis each time lambs were weighed. The pelleted, dehydrated turfgrass again was provided by Warren Turf Nursery but was from the northern Illinois - southern Wisconsin area.

Experiment 4: Because of the possibility of differences between the turfgrass from California and the Midwest a second digestion study is presently in progress. Six lambs are being used and digestibility of Midwest produced material is being studied at 90% of *ad libitum* intake.

The results of the digestion study are presented in Table 2. From the data it is apparent that in every respect the turfgrass was more highly digestible than a good quality alfalfa hay. Further, the voluntary intake of the turfgrass was considerably higher than for pelleted alfalfa hay. Based on the composition, digestibility, and intake of turfgrass pellets this feed merits serious evaluation as both a source of nutrients for finishing (fattening) sheep and cattle and protein supplement for ruminant livestock. Again, based on the data in Table 2 pelleted turfgrass is very close to the nutritive value of oat grain and is in fact superior in crude protein content.

As a result of the digestion study we looked forward to evaluating turfgrass pellets as the sole source of nutrients for finishing lambs. Two experiments were designed, the first one was conducted at the Dixon Agricultural Center and compared turfgrass pellets to rations containing various levels of alfalfa hay. The purpose of the first feeding experiment was to study the relative energy value of turfgrass pellets by comparing the performance of growing-finishing lambs fed turfgrass pellets to that of lambs fed conventional rations of varying digestible energy levels. Also, we wanted to obtain information on carcasses obtained the lambs fed the various rations. The second feeding experiment is being conducted in Urbana and is mainly for the purpose of obtaining lamb carcasses to be used in taste panel evaluation of lamb fed to a standard finish on conventional rations high in or totally made-up from pelleted turfgrass.

The results of the feeding study conducted at Dixon Springs are presented in Table 3. The data on gain and feed required per pound of gain are very surprising and poorer than expected. Based on the data in Table 2 the turfgrass pellets should have allowed for performance much closer to the ration containing 40% alfalfa. At this point there is no apparent reason for the poor performance except that the data in Table 2 were obtained on a sample of pellets produced in California and the data in Table 3 were obtained from pellets produced in the Midwest. Although the plant species of the parent material of both samples of pellets is the same the differences due to variations in management, fertility and climate may be substantial. Currently, experiment 4 is in progress and will obtain digestion coefficients on material similar to that used in both experiments 2 and 3. Carcass data from experiment 2 although not summarized or presented at this time indicate choice slaughter lambs can be produced on a ration of only pelleted, dehydrated turfgrass. Although turfgrass pellets produced lighter carcasses than the other dietary treatments all eight of the lambs slaughtered graded U.S.D.A. choice or better (Prime). Of the eight lambs slaughtered, five had lower than normal internal fat and only one more than normal. Of concern was the fact that two of the lamb carcasses exhibited "yellow" fat. This is uncommon in lambs whereas this would be expected if cattle were fed. The coloration was not excessive (i.e. orange fat) as found in some grass-fat beef.

Since experiment 3 has not yet ended, data will not be presented at this time. However, from the results obtained to date as was found at Dixon Springs lambs on 100% turfgrass pellets are not gaining as well as would be expected. The substitution of half of the turfgrass pellets with a conventional finishing ration greatly improves performance.

In summary the results obtained thus far suggest pelleted, dehydrated turfgrass may be a valuable feed ingredient in ruminant rations. We have a great deal yet to learn about variability in samples and the influence of management practices on nutritive value. It would appear the potential benefits from using clippings from presently unproductive areas require special attention be given to full development of the technology necessary to more efficiently utilize such a vast and valuable renewable resource.

Table 2. Composition and Digestion Coefficients for Pelleted, Dehydrated Turfgrass (Bluegrass) and Pelleted Alfalfa Hay.

	Feed	
	Turfgrass	Alfalfa
Composition: (% on DMB)		
Dry matter	88.9	90.4
Crude protein	23.7	14.9
Cell wall constituents	51.3	62.2
Acid detergent fiber	23.3	44.6
Lignin	2.8	9.4
Cellulose	17.6	31.7
Hemicellulose	28.0	17.6
Digestion Coefficients: (% on DMB)		
Dry matter	69.3	55.1
Crude protein	75.0	68.6
Cell wall constituents	70.0	47.0
Acid detergent fiber	58.4	47.0
Cellulose	55.6	41.8
Hemicellulose	80.7	53.0
Voluntary Intake:		
Grams of dry matter/Kg weight $^{3/4}$	92.2	72.2

Table 3. Gain and Feed Required Per Pound of Gain for Feeding Studies at Dixon Springs.

	Ration			
Performance	Turfgrass	10% Alfalfa	20% Alfalfa	40% Alfalfa
Average daily gain (lb/day)				
Replicate 1	.21	.48	.50	.51
Replicate 2	.25	.56	.59	.57
Replicate 3	.31	.57	.60	.58
Feed per pound of gain (lbs.)				
Replicate[a] 1	11.9	5.4	5.3	6.8
Replicate 2	14.5	6.0	6.0	6.5
Replicate 3	11.0	5.9	5.8	6.7

[a] Each replicate contained 8 lambs.

B. 1. Kentucky bluegrass mowing studies.
D. E. Brennan and A. J. Turgeon.

Studies were initiated May 17, 1976, to determine the effects of mowing height and frequency, and fertilization level on the clipping yield of a 'Pennstar-Fylking-Prato' Kentucky bluegrass turf. Increased interest in turfgrass clippings necessitates additional information on the potential yields from turfs maintained under different cultural intensities. In one study, two mowing heights (0.75 and 1.5 in) and three mowing frequencies 1, 3 and 5 mowings/week) were employed. Clippings were collected, dried and weighed during July and September. Also, density estimates were made. Plots measured 5 and 6 ft and each treatment combination was replicated 3 times in a RCB design. In a second study, two mowing heights (0.75 and 1.5 in) and four fertilization levels (0, 0.5, 1 and 2 lb N/1000 sq ft/month using 10-6-4) were employed. Clipping yield measurements were made during the last week of each month beginning in May. Ratings of stripe smut and rust diseases were made. Plots measured 10 by 6 ft and each treatment combination was replicated 3 times. Irrigation was performed to prevent wilting.

Results from the first mowing study revealed that clipping yield did not vary significantly with either mowing height or frequency in July, but a trend toward reduced yield with higher and more frequent mowing was evident in the September data (Table 4). Also, turfgrass density tended to increase with more frequent mowing.

In the second study, clipping yield did not change significantly with mowing height, but increased substantially with increasing fertilization and as the growing season progressed (Table 5). An interesting observation in this study was the distribution of clipping yield during the mowing week: in May, the lowest yields were obtained on Wednesday; in June and July, lowest yields occurred on Thursday; and in August and September, lowest yields were measured on Friday. Presumably, this reflects the carbohydrate reserve level in the plants as affected by the relatively severe Monday defoliation and prevailing climatic conditions. Further work will be necessary to adequately explain this phenomenon. Total weekly yields were highest in August except in plots maintained at the highest fertilization level. At a monthly fertilization of 2 lb N/1000 sq ft, highest yields were measured in July at both mowing heights. For the four-month period beginning in late May, total clipping yields were estimated by interpolating between monthly measurements. Results showed that total yields varied from approximately 1 to 3.2 tons per acre depending upon fertilization level. Mowing height had little effect upon total yields.

In July and August, however, highest yields did not occur at the highest fertilization level; the 1 lb N rate resulted in the same or slightly higher clipping yields than the 2 N lb rate. This is important since the severity of stripe smut disease was greatest at the highest fertilization rate in late August.

Table 4. Effects of mowing height and frequency on clipping yield and density of a 'Pennstar-Fylking-Prato' Kentucky bluegrass turf.

Mowing Height in.	Mowing Frequency	Clipping Yield, 2/60 sq ft												Visual Density[1]
		12-16 July						September						
		M	T	W	Th	F	Total	M	T	W	Th	F	Total	
0.75	1/wk	129.0					129.0	180.4					180.4	5.0
0.75	3/wk	61.0		36.6		26.0	123.6	117.8		22.2		31.0	171.0	3.9
0.75	5/wk	55.8	22.6	18.8	13.8	15.8	126.8	102.4	15.0	14.8	16.0	15.0	163.2	2.9
1.5	1/wk	119.6					119.6	127.8					127.8	4.7
1.5	3/wk	56.8		35.0		28.2	120.0	84.4		24.2		31.8	140.4	3.7
1.5	5/wk	44.6	16.0	17.4	10.4	13.4	101.8	67.8	11.2	12.0	11.6	12.0	114.6	2.9

[1] Visual density ratings were made using a scale of 1 through 9 with 1 representing best density and 9 representing poorest density.

Table 5. Effects of mowing height, fertilization and month on clipping yield of a 'Pennstar-Fylking-Prato' Kentucky bluegrass turf mowed 5 times per week.

Mowing Height in.	Fertilization lb N/M/Month	May					June					July				
		M	T	W	Th	F	M	T	W	Th	F	M	T	W	Th	F
0.75	0	8.9	5.2	3.6	4.3	4.3	10.5	6.5	5.9	4.8	5.4	30.3	19.5	12.9	10.5	21.4
0.75	0.5	14.7	8.4	5.3	6.6	6.9	23.3	13.6	11.6	8.5	11.6	60.6	35.1	24.4	19.5	36.6
0.75	1	23.4	13.2	7.9	10.7	13.2	50.1	29.4	23.3	18.9	23.7	102.3	49.6	37.9	29.0	50.4
0.75	2	36.4	18.6	9.8	15.0	20.6	68.6	34.6	29.6	25.6	29.5	105.7	49.4	38.8	29.6	46.1
1.5	0	6.3	4.7	2.8	2.9	3.4	11.8	7.0	5.8	3.9	6.1	30.6	17.8	14.5	8.3	18.0
1.5	0.5	18.2	7.3	4.9	5.3	5.8	26.0	15.5	12.5	10.6	13.2	65.2	29.3	21.8	14.3	30.9
1.5	1	28.3	11.6	8.1	9.8	12.2	59.2	32.1	24.6	21.0	28.5	106.3	43.6	39.6	22.5	40.5
1.5	2	43.7	16.8	12.1	16.0	22.1	85.1	40.9	33.1	23.3	32.7	113.5	45.9	40.0	27.6	39.9

Mowing Height in.	Fertilization lb N/M/Month	August					September					Stripe Smut[1] 27 Aug 76	Rust[1] 20 Oct 76
		M	T	W	Th	F	M	T	W	Th	F		
0.75	0	59.7	20.7	21.8	19.0	14.8	30.3	12.5	9.7	8.4	7.6	1.0	6.5
0.75	0.5	103.5	31.0	33.6	27.6	22.8	50.3	22.1	13.2	12.7	10.3	1.0	4.3
0.75	1	125.6	37.7	41.7	33.6	25.9	84.7	31.9	21.0	21.0	19.4	1.8	3.0
0.75	2	112.8	36.7	36.9	32.7	22.8	91.2	30.5	24.2	25.4	21.3	2.3	2.0
1.5	0	60.8	20.0	22.0	17.1	15.7	36.7	10.6	10.5	8.4	9.1	1.0	6.0
1.5	0.5	100.2	31.9	36.4	25.9	21.5	62.6	16.4	15.1	13.0	15.3	1.0	4.0
1.0	1	128.7	37.8	43.1	30.8	24.4	100.0	26.6	23.3	20.4	23.9	1.3	2.8
1.5	2	129.4	37.7	41.6	29.0	25.8	105.0	30.1	24.6	22.9	24.2	1.8	2.0

[1] Disease ratings were made using a scale of 1 through 9 with 1 representing no disease and 9 representing severe disease.

B. 3. Investigations of the use of Bio-dethatch in Kentucky bluegrass.
A. J. Turgeon

The recent introduction of various biological control materials for turfgrass thatch has warranted investigations to determine if these materials are actually effective.

Bio-dethatch was applied, according to the manufacturers directions, to a 'Fylking-Pennstar-Prato' Kentucky bluegrass turf on June 12, 1976. Additional treatments included: vertical mowing twice with a Ryan Ren-o-thin with knives set to penetrate to the underlying soil; coring twice with a Ryan Greensair equipped with 0.5-in tines; and applications of Bio-dethatch following cultivation by either of the two above methods. Plots measured 5 by 6 ft and each treatment was replicated three times.

In an adjacent area, a second experiment was initiated the same day in which a Rogers disc-seeder was used to apply Bio-dethatch into grooves resulting from two passes with the disc-seeder. For comparison, the disc-seeder was operated in an identical manner, but without applying Bio-dethatch. Plot size was 6 by 10 ft with three replications per treatment. At the time these experiments were initiated, thatch depth averaged approximately one inch.

In December, 1976, four 2-in dia cores were extracted from each plot in both experiments and thatch depth was measured on four sides of each core. Results showed no apparent difference in thatch depth from applications of Bio-dethatch; however, all cultivation methods did reduce thatch depth slightly (Table 6).

Table 6. Results from Bio-dethatch applications to Kentucky bluegrass turf.

Cultivation	Bio-dethatch[1]	Thatch Depth, in.
Vertical mowing	-	1.00
Vertical mowing	+	0.83
Coring	-	0.95
Coring	+	1.02
None	-	1.17
None	+	1.27
Disc-seeder	-	0.97
Disc-seeder	++	0.93

[1] Plus (+) indicates application of Bio-dethatch in accordance with manufacturers directions; minus (-) indicates no Bio-dethatch applied. Double plus (++) indicates application of Bio-dethatch through a Rogers disc-seeder adjusted to widest openings.

B. 3. Impact of thatch on residual activity of herbicides used in turfgrass renovation.

K. A. Hurto and A. J. Turgeon

An effective renovation program involves the eradication of undesired species and the immediate reestablishment of turf in the treated area. This practice often requires the use of a herbicide which will eliminate the existing vegetation without any residual activity which delays or prevents reestablishment. Two herbicides which meet this need are paraquat,a contact, non-selective herbicide, and glyphosate, a systemic, non-selective herbicide. Both of these herbicides are reported to be rapidly inactivated in the soil thus allowing for quick replanting of the treated area. While studies have shown that these herbicides lack any residual activity within the soil, no study to date has reported the impact of thatch on the residual activity of these two herbicides. The purpose of this study was to investigate the effects of thatch on the residual activity of glyphosate or paraquat.

Field studies were initiated April 29, and August 9, 1976 to determine the effects of thatch and cultivation methods on herbicide activity as they affect germination and subsequent growth of perennial ryegrass. April 29 studies consisted of herbicide applications to a mature Kentucky bluegrass turf growing on a Flanagan silt loam soil at two sites: one site had a thatch layer 0.75 to 1.0 inches thick; and the other site was free of thatch. Applications of paraquat at 1 and 2 lbs a.i./acre and glyphosate at 2, 4 and 8 lbs a.i./acre were made to 5 by 6 ft plots in a spray volume of 28 gpa. Four days later, the treated sites were reestablished in the following manner: core cultivation plus vertical mowing to break up the soil cores, and broadcast seeding at 6 lbs/1000 sq ft; vertically mowed and broadcast seeded; or disc-seeded with a Rogers seeder at 1.9 lbs/1000 sq ft. Prior to seeding, the areas were swept free of loose debris. Treatment combinations were replicated three times in a randomized complete block design. Studies initiated August 9, 1976 were identical to earlier studies except that only a thatchy site was used. Plots were monitored for injury, and percent cover was visually estimated six weeks after planting.

Greenhouse studies were also conducted to evaluate the effects of herbicide residues in grass clippings on the germination of Kentucky bluegrass and perennial ryegrass. Twenty-five seeds of 'Kenblue' Kentucky bluegrass or 'Epic' perennial ryegrass were spread on the surface of a 2:1 (sand:soil) potting soil contained in 6 oz styrofoam cups. Grass clippings, removed four days after herbicide treatment from the August 9, 1976 field studies, were then spread on the surface of the soil. Pots were placed under a mist sprayer for three days to assure germination. Subsequent irrigation was provided as needed. Treatments were replicated three times in a completely randomized design. Percent emergence was recorded three weeks after seeding.

April 29 field study results:

Differences in percent coverage were observed between herbicide treatments and reestablishment methods (Table 7). Reestablishment of the thatch-free site showed comparable coverage from either vertical mowing and seeding or from core cultivation plus vertical mowing and seeding. Disc seeding resulted in less coverage. Herbicide treatment had no adverse affect on stand coverage. However, on thatchy turf, disc seeding into plots previously treated with paraquat at 2 lb/acre resulted in a severe reduction of stand coverage. No injury was apparent in the paraquat-treated plots which were planted following core cultivation or vertical mowing.

August 9 field study results:

Reduction in percent coverage of paraquat treated plots was observed with all cultivation methods (Table 8). Reduction was most severe in disc seeded plots. Removal of thatch (vertical mowing) or introduction of soil at the seed germination site (core cultivation) have a mitigating effect on paraquat residual activity. No differences in percent coverage of glyphosate-treated plots were observed within establishment method. Vertical mowing to remove the thatch layer prior to seeding resulted in better cover.

Greenhouse study results:

Placement of paraquat-treated grass clippings on top of surface seeded Kentucky bluegrass or perennial ryegrass suppressed seedling emergence (Table 9). Comparable results were obtained between glyphosate-treated clippings and untreated clipping studies.

These studies indicate that although paraquat has no residual activity in soil, where thatch is present, or where clippings from herbicide treated turf may come into contact with seeded areas, there may be an inhibition of seedling emergence. Removal of thatch by vertical mowing, or the introduction of soil at the site of seed germination by core cultivation, tend to mitigate paraquat injury. Differences in magnitude of paraquat injury between spring and late summer studies suggest that environmental factors may also affect residual activity of paraquat in thatch.

Table 7. The effects of herbicide treatment, reestablishment method and thatch on the percent cover of 'Pennfine' perennial ryegrass six weeks after seeding on May 3, 1976.

Herbicide Treatment	Rate lb/acre	Thatchy DS[1]	Thatchy CVB	Thatchy VB	Thatch-free DS	Thatch-free CVB	Thatch-free VB
		(% cover)			(% cover)		
glyphosate	2	53	77	57	40	60	57
	4	50	70	70	42	53	57
	8	55	82	77	35	58	57
paraquat	1	55	78	73	50	67	80
	2	8	63	50	38	62	68
LSD .05		10	NS	15	NS	NS	8
.01		15	NS	22	NS	NS	12

[1] Reestablishment Methods: (DS) disc seeding; (CVB) core cultivation, vertical mowing and broadcast seeding; (VB) vertical mowing and broadcast seeding.

Table 8. The effect of herbicide treatment and reestablishment method on the percent cover of 'Pennfine' perennial ryegrass six weeks after treatment as affected by the presence of thatch. (August 9, 1976).

Establishment Method	Herbicide Treatment, lb/acre glyphosate 2	glyphosate 4	glyphosate 8	paraquat 1	paraquat 2	LSD .05	LSD .01
	(% cover)						
Disc seeding	47	47	45	1	1	14	21
Core cultivation, vertical mowing and broadcast seeding.	67	67	75	57	55	NS	NS
Vertical mowing and broadcast seeding.	90	83	90	80	63	10	NS

Table 9. Percent germination of two turfgrass species as affected by herbicide residues in grass clippings.

Herbicide Treatment	Rate lb/acre	'Kenblue' Kty Bluegrass	'Epic' Per Ryegrass
		(%)	(%)
glyphosate	2	39.0 b	56.0 a
	4	55.0 a	59.6 a
	8	43.3 b	57.3 a
paraquat	1	2.6 c	14.3 b
	2	0.0 d	2.0 c
untreated	-	37.6 b	67.0 a

Means within columns followed by unlike letters are statistically significant at the 5% level by Duncan's Multiple Range Test.

B. 3. Injury of thatchy Kentucky bluegrass turf from preemergence herbicides.
K. A. Hurto and A. J. Turgeon

Research at the University of Illinois has shown that successive applications of some preemergence herbicides can induce thatch development in Kentucky bluegrass turf. Yet, no studies have been reported of the impact of thatch on the activity of preemergence herbicides. Thus, a series of investigations were undertaken to determine the effects of a thatch layer on the persistence, mobility, efficacy and selectivity of preemergence herbicides in turf. In this study, the relative phytotoxicity of several preemergence herbicides in thatch-free and thatchy turfs of Kentucky bluegrass were compared.

Preemergence herbicides were applied April 24 to an established Kentucky bluegrass turf located at two sites: one site had a thatch layer 3/4-1 inch thick and the other site had no thatch. Treatments were made as indicated in Table 10, and then overseeded with crabgrass. Plots measured 5 by 6 feet and each treatment was replicated three times. Treatments were monitored for crabgrass germination and turfgrass injury with data taken several times during the summer.

Results showed good to excellent crabgrass control and no injury of thatch-free sites with: all Dacthal formulations, Balan at 4 lb a.i./acre, all Betasan formulations and Ronstar treatments (Table 10). Crabgrass control in thatchy plots was excellent with all treatments, although weed pressure was not as severe as in thatch-free sites. Injury was evident in thatchy sites, and was moderate to severe from Balan, EL-131, Betasan 3.6 G at 20 lb a.i./acre, and Ronstar treatments. Injury was more pronounced under mid-summer stress.

Additional laboratory studies are underway to determine the cause of higher injury from preemergence herbicides in the thatchy plots. Our current hypothesis is that, compared to soil, thatch is a more porous medium that allows greater downward mobility of the herbicides; thus, as more of the herbicides enters the turfgrass root zone, more injury results. In contrast, the root system of a thatch-free turf is below the soil surface and, presumably, the concentrated herbicide layer. Consequently, the turfgrass root zone is separated and "protected" from the potentially injurious herbicides.

Table 10. Preemergence crabgrass control with herbicides on thatchy and thatch-free Kentucky bluegrass turf.

			Thatch-free Turf						Thatchy-turf					
			Phytotoxicity[3]						Phytotoxicity					
Treatments	Form[1]	Rate lb a.i./acre[2]	5 June 1976	7 July 1976	21 July 1976	13 Aug 1976	% Crabgrass	% Control	5 June 1976	7 July 1976	21 July 1976	13 Aug 1976	% Crabgrass	% Control
Dacthal	75WP	10.5	1.0	1.0	1.0	1.0	4	87	1.0	1.0	1.0	1.0	2	85
"		21.0	1.0	1.0	1.0	1.0	1	97	1.0	1.0	1.0	1.0	2	85
"	5G16/30	10.5	1.0	1.0	1.0	1.0	4	87	1.0	1.0	1.0	1.0	2	85
"		21.0	1.0	1.0	1.0	1.0	5	81	1.0	1.0	1.0	1.0	2	85
"	5G24/48	10.5	1.0	1.3	1.0	1.0	1	97	1.0	1.0	1.0	1.0	1	92
"		21.0	1.0	1.0	1.0	1.0	2	94	1.0	1.0	1.0	1.0	5	63
"	6F	10.5	1.0	1.0	1.0	1.0	0	100	1.0	1.0	1.0	1.0	1	92
"		21.0	1.0	1.0	1.0	1.0	1	97	1.0	1.0	1.0	1.0	1	100
"		10.5 + 5.3	1.0	1.3	1.0	1.0	0	100	1.0	1.0	1.0	1.0	0	100
"		10.5 + 7.3	1.0	1.0	1.0	1.0	0	100	1.0	1.3	1.0	1.0	0	100
"		10.5 + 10.5	1.0	1.0	1.0	1.0	0	100	1.0	1.0	1.0	1.0	0	100
Balan	2.5G	2	1.0	1.0	1.0	1.0	7	76	2.0	2.6	4.0	1.3	1	92
"		3	1.0	1.0	1.0	1.0	8	70	2.0	3.6	3.7	2.0	1	92
"		4	1.0	2.0	1.0	1.0	2	94	2.3	4.3	5.3	1.6	0	100
Betasan	4E	10	1.0	1.0	1.0	1.0	0	100	1.0	1.0	1.3	1.0	0	100
"		20	1.0	1.0	1.0	1.0	0	100	1.3	1.6	2.0	1.0	0	100
"	3.6G	10	1.3	1.0	1.0	1.0	2	94	1.0	1.3	2.0	1.0	0	100
"		20	1.0	1.0	1.0	1.0	0	100	1.3	3.6	3.0	1.3	1	92
"	12.5G	10	1.0	1.3	1.0	1.0	2	94	1.0	1.0	1.0	1.0	1	92
"		20	1.0	1.0	1.0	1.0	2	94	1.0	1.3	1.7	1.0	0	100
EL-131	50WP	2	1.0	2.0	2.0	1.3	10	63	1.3	1.6	2.3	1.0	0	100
"		3	1.0	3.0	3.0	1.0	9	67	5.6	7.0	7.3	4.0	1	92
Ronstar	2G	2	1.0	1.0	1.0	1.0	4	87	2.3	4.3	5.0	1.6	4	69
"		3	1.0	1.3	1.0	1.0	2	94	3.0	5.0	4.7	1.3	3	74
"		4	1.0	1.0	1.0	1.0	1	97	4.6	5.3	6.0	2.6	0	100
Untreated	--	--	1.0	1.0	1.0	1.0	27	0	1.0	1.0	1.0	1.0	13	0

1 Formulations include: wettable powders (WP), flowables (F), granules (G) and emulsifiable concentrates (E).

2 Initial applications were made on April 24, 1976 and second applications were made June 15, 1976.

3 Phytotoxicity ratings were made using a scale of 1 through 9 with 1 representing no injury and 9 representing complete necrosis of the turf.

B. 3. Characterization of thatch as a turfgrass growing medium.
K. A. Hurto and A. J. Turgeon

Thatch is a tightly intermingled layer of living and dead stems, roots and leaves of grass located between the soil surface and the green vegetation above it. Where a substantial thatch layer exists, turfgrass roots and rhizomes may be essentially confined to the thatch. Thus, the thatch functions as the primary growing medium for the turf while the underlying soil may be of only secondary importance. Using standard soil testing procedures, studies were undertaken to accurately characterize thatch as a growing medium.

Chemical measurements were made of thatch from different turfgrass species and cultivars, as presented in Tables 11-19. Plots from which samples were removed measured 6 by 8 ft and each treatment was replicated three times. Fertilizer was applied 4 times per year to supply a total of 4 lbs of nitrogen per 1000 sq ft using a 10-6-4 analysis water-soluble fertilizer. Mowing was performed 2 or 3 times a week at 1.5 inches. Irrigation was provided as needed to prevent wilting. Samples removed from the plots were measured for thatch accumulation and then air-dried. The thatch layer was separated from the underlying soil and ground to pass a 40 mesh screen. The one inch soil underlying the thatch was subsequently pulverized prior to chemical analysis.

Chemical characterization of thatch revealed that its ability to retain and supply nutrients essential to plant growth was substantially higher than soil when expressed on a weight basis. However, on a volume basis, values are comparable or slightly higher (Table 18). Values varied between species, but were comparable among cultivars irrespective of thatch depth. Cation exchange capacity was highest for pesticide-induced thatch samples (Table 17). CEC did not change much between sampling dates. Analysis of upper and lower thatch profiles indicate a trend towards higher nutrient values in the upper profile (Tables 13 & 16). This suggests a greater degree of decomposition in the upper thatch layer presumably due to the addition of leaf tissue from clippings and senescing leaves. Base saturation was variable between sampling dates, but generally was higher in thatch than in soil (on a weight basis). Soil content of thatch was also observed to vary among cultivars; P-140 and touchdown had less soil intermingled with the thatch than did either Kenblue, Merion, or Nugget. Thus, the differences in physical composition may also affect the nutrient retention capacity of thatch. Measurements of pH revealed that thatch was not more acidic than soil, generally, but that it probably reflects the presence of materials supplied through irrigation, fertilization and other cultural practices.

Physical measurements included: Bulk density; total porosity; aeration porosity; and moisture characteristics. Bulk density of thatch was variable depending on the soil content of the thatch sample (Table 19). However, total porosity did not appear to be affected by inclusion of soil in the thatch layer. In contrast, total porosity of soil underlying thatch decreased as soil bulk density increased. At equivalent water content, thatch had greater aeration porosity (Figure 1). At low matric potential, more water was extracted from thatch than the underlying soil (Figure 2). Within the thatch, more large-size pores were distributed in the upper layer.

Table 11. Chemical characterization of thatch from 5 Kentucky bluegrass cultivars and the 0-2.5 cm soil underlying them. (October 25, 1975 sampling date).

Cultivar	Thatch Depth	pH	CEC	Base Saturation	K	Na	Mg	Ca	P_1	P_2
	cm		meq/100g	%	meq/100g				Kg/ha	% P
Kenblue	1.0	6.2 d-g	26.4 bc	41.4 de	1.2 bc	0.4 a	2.9 c	6.5 bc	184 a	1.1 b
soil		5.6 a-b	18.9 a	31.8 f	0.4 d	0.2 b	1.5 e	4.2 d	130 a	0.7 a
Mevion	1.1	6.1 c-f	25.3 bc	45.2 cd	1.4 bc	0.4 a	2.8 c	6.8 bc	208 a	1.0 b
soil		5.8 b-d	18.8 a	32.3 f	0.5 d	0.2 b	1.3 e	3.9 d	169 a	0.7 a
Nugget	1.5	6.3 e-h	30.3 c	42.1 cde	1.5 a	0.4 a	3.6 b	7.4 b	199 a	1.3 b
soil		5.7 a-c	20.1 a	32.5 f	0.5 d	0.2 b	1.5 e	4.4 d	168 a	0.7 a
P-140	1.8	6.2 d-g	26.4 bc	40.4 de	1.3 b	0.4 a	2.9 c	6.1 c	193 a	1.2 b
soil		5.8 b-d	18.7 a	65.4 a	1.0 c	0.4 a	2.5 cd	8.3 a	193 a	0.8 a
Touchdown	2.0	6.0 b-e	30.3 c	45.4 c	1.9 a	0.5 a	4.0 a	7.4 b	195 a	1.3 b
soil		5.3 a	18.3 a	54.6b	0.8 cd	0.4 a	2.2 d	6.6 bc	148 a	0.7 a

Means within columns followed by unlike letters are significantly different at the 5% level by Duncan's multiple range test.

Table 12. Chemical characterization of thatch from 5 Kentucky bluegrass cultivars and the 0-2.5 cm soil underlying them. (July 8, 1976 sampling date.)

Cultivar	Thatch Depth	pH	CEC	Base Saturation	K	Na	Mg	Ca	P_1	P_2
	cm		meq/100g	%	meq/100g				Kg/ha	% P
Kenblue	1.3	6.7 a	28.1 a	38.0 ab	1.2 b	0.2 a	2.9 b	6.4 a	216 ab	1.0 a
soil		6.6 a	21.1 b	28.8 c	0.4 c	0.1 b	1.5 c	4.1 b	136 c	0.6 b
Merion	1.7	6.7 a	26.0 a	37.0 ab	1.2 b	0.2 a	2.5 b	5.7 a	249 a	1.0 a
soil		6.5 a	17.5 b	33.0 c	0.4 c	0.1 b	1.3 c	3.7 b	167 bc	0.7 b
Nugget	1.7	6.6 a	29.1 a	39.6 ab	1.5 b	0.2 a	2.9 b	6.9 a	255 a	1.1 a
soil		6.3 a	20.1 b	30.5 c	0.4 c	0.2 a	1.5 c	4.1 b	189 abc	0.7 b
P-140	2.2	6.5 a	26.9 a	39.6 ab	1.5 b	0.2 a	3.2 ab	5.8 a	246 a	1.1 a
soil		6.5 a	17.7 b	30.4 c	0.4 c	0.2 a	1.2 c	3.6 b	189 abc	0.7 b
Touchdown	2.5	6.6 a	29.8 a	42.6 a	2.0 a	0.2 a	3.4 a	6.9 a	243 a	1.1 a
soil		6.5 a	18.7 b	26.8 c	0.3 c	0.2 a	1.2 c	3.3 b	166 bc	0.7 b

Means within columns followed by unlike letters are significantly different at the 5% level by Duncan's multiple range test.

Table 13. Chemical characterization of the thatch profile of 2 Kentucky bluegrass cultivars and the 0-2.5 cm soil underlying them. (July 8, 1976 sampling date).

Cultivar	Sampling Profile[1]	pH	CEC	Base Saturation	K	Na	Mg	Ca	P_1	P_2
			meq/100g	%	meq/100g				Kg/ha	% P
P-140	U	6.4 a	29.5 a	40 a	2.3 b	2.0 a	3.3 a	6.0 bc	264 a	1.3 a
	L	6.6 a	24.3 b	37 a	0.9 c	0.2 a	2.2 b	5.6 c	229 ab	0.9 b
	S	6.5 a	17.7 c	30 b	0.4 cd	0.2 a	1.2 c	3.6 d	188 bc	0.7 b
Touchdown	U	6.6 a	31.0 a	46 a	3.0 a	0.2 a	3.6 a	7.3 a	269 a	1.3 a
	L	6.6 a	286 ab	38 a	1.0 c	0.2 a	3.0 a	6.6 b	216 abc	0.9 b
	S	6.5 a	18.7 c	27 b	0.3 d	0.2 a	1.2 c	3.3 d	166 c	0.7 b

[1] Sampling profile: (U) upper thatch layer; (L) lower thatch layer; (S) 0-2.5 cm soil.

[2] Means within columns followed by unlike letters are significantly different at the 5% level by Duncan's multiple range test.

Table 14. Chemical characterization of thatch from 3 red fescue cultivars and underlying 0-2.5 cm soil. (July 8, 1976 sampling date.)

Cultivar	Thatch Depth	pH	CEC	Base Saturation	K	Na	Mg	Ca	P_1	P_2
	cm		meq/100g	%	meq/100g				Kg/ha	% P
C-26	2.0	6.6 a	37.4 a	36.8 a	1.1 a	0.2 ab	3.7 b	8.7 b	149 a	1.1 a
soil		6.5 ab	19.5 b	25.6 b	0.3 b	0.1 b	1.2 c	3.0 c	85 b	0.5 b
Menuet	1.8	6.7 a	45.7 a	37.5 a	1.4 a	0.3 a	4.9 a	10.5 a	167 a	1.3 a
soil		6.5 ab	18.3 b	27.1 b	0.3 b	0.2 ab	1.2 c	3.3 c	77 b	0.6 b
Pennlawn	1.7	6.7 a	39.8 a	38.0 a	1.7 a	0.3 a	4.3 ab	8.9 b	173 a	1.2 a
soil		6.3 b	19.1 b	26.3 b	0.3 b	0.2 ab	1.3 c	3.3 c	74 b	0.6 b

Means within column followed by unlike letters are significantly different at the 5% level by Duncan's multiple range test.

Table 15. Chemical characterization of pesticide-induced thatch of 'Kenblue' Kentucky bluegrass. (October 25, 1975 sampling date.)

Treatment	Thatch Depth	pH	CEC	K	Na	Mg	Ca	Base Saturation	P_1	Total P
	cm		meq/100g					%	Kg/ha	%
Bandane	1.8	5.9 a	46.4 a	1.5 a	0.7 a	4.3 c	14.4 a	45.0 b	182 a	2.2 a
soil		5.3 b	25.2 b	.5 c	0.2 c	1.9 d	6.4 c	37.4 bc	182 a	0.9b
CaAs	1.9	6.1 a	46.4 a	1.8 a	0.7 a	4.8 b	11.0 b	39.6 bc	169 a	2.0 a
soil		6.1 a	25.3 b	.5 c	0.2 c	2.0 d	5.6 c	32.9 c	136 a	0.9 b
Thatch-free		6.1 a	28.9 b	1.2 b	0.5 b	5.9 a	12.2 b	68.9 a	150 a	1.1 b

Means within columns followed by unlike letters are significantly different at the 5% level using Duncan's multiple range test.

Table 16. Chemical characterization of the thatch profile and the underlying soil of 2 pesticide-induced thatch in Kentucky bluegrass, and the 0-2.5 cm soil from a thatch-free Kentucky bluegrass turf. (July 8, 1976 sampling date.)

	Sampling[1] Profile	pH	CEC	Base Saturation	K	Na	Mg	Ca	P_1	P_2
			meq/100g	%	meq/100g				Kg/ha	% P
Bandane	U	6.6 bc	43.1 a	42 a	2.8 a	0.4 a	5.1 a	4.9 a	255 a	2.1 a
	L	6.5 c	43.6 a	40 a	0.9 b	0.4 a	5.1 a	4.5 a	140 b	1.5 b
	S	6.7 b	26.0 b	31 c	0.5 c	0.2 b	2.2 b	2.1 b	180 a	0.9 c
Calcium As	U	6.7 b	49.5 a	37 ab	2.9 a	0.4 a	4.8 a	4.9 a	249 a	2.1 a
	L	7.0 a	44.3 a	37 ab	0.6 c	0.4 a	4.1 a	3.7 ab	249 a	1.6 a
	S	6.7 b	25.2 b	33 bc	0.4 c	0.2 b	2.0 b	2.1 b	240 a	0.9 c
Untreated	S	6.9 a	28.6 b	29 c	0.4 c	0.2 b	2.1 b	5.5 a	166 b	0.9 c

[1] Sampling profile: (U) upper thatch layer; (L) lower thatch layer; (S) 0-2.5 cm soil.

[2] Means within columns followed by unlike letters are significantly different at the 5% level by Duncan's multiple range test.

Table 17. Comparison of chemical characteristics of thatch and the 0-2.5 cm soil underlying them of severalturfgrass species, or pesticide-induced thatch. (July 8, 1976 sampling date.)

		Test Results[4]								
Species	Thatch Depth	pH	CEC	K	Na	Mg	Ca	Base Saturation	P_1	Total P
	cm		meq/100g					%	Kg/ha	%
Bentgrass	3.1	7.2 b	25.3 c	0.4 c	0.7 d	2.1 d	9.4 b	47.4 a	240 a	1.6 a
soil		7.4 a	19.9 d	0.1 d	0.9 d	1.4 e	8.5 c	50.3 a	190 cd	1.2 b
Red fescue[1]	1.8	6.7 d	40.1 b	1.4 b	0.3 bc	4.3 a	9.4 b	37.4 b	163 e	1.2 b
soil		6.4 f	19.0 d	0.3 cd	0.1 a	1.2 e	3.2 e	26.3 d	79 f	0.6 d
Kentucky bluegrass[2]	2.3	6.6 d	28.0 c	1.5 ab	0.2 ab	3.0 c	6.4 d	39.4 b	242 a	1.1 b
soil		6.4 f	19.0 d	0.4 c	0.2 ab	1.3 e	3.8 e	29.9 cd	169 de	0.7 d
Pesticide[3]	1.9	6.6 d	45.1 a	1.7 a	0.4 c	4.9 a	10.6 a	39.8 b	223 ab	1.7 a
soil		6.7 d	25.6 c	0.4 c	0.2 ab	2.1 d	5.6 d	33.2 c	210 bc	0.9 c
Thatch-free		6.9 c	28.6 c	0.5 c	0.2 ab	2.5 d	6.1 d	30.8 c	166 de	0.9 c

1 Red fescue data is an average of three cultivars.

2 Kentucky bluegrass data is an average of five cultivars.

3 Pesticide induced thatch data is an average of bandane and calcium arsenate treated Kentucky bluegrass plots.

4 Means within columns followed by unlike letters are significantly different at the 5% level by Duncan's multiple test.

Table 18. Comparison of cation exchange capacity of thatch from 5 Kentucky bluegrass cultivars expressed on a weight and a volume basis, to the 0-2.5 cm soil underlying them.

Cultivar	Thatch Depth cm	Thatch		Soil
		meq/100g	meq/adj vol*	meq/100g
Kenblue	1.2	26.4	19.8	18.9
Merion	1.7	25.3	21.8	18.8
Nugget	1.7	30.3	18.8	20.1
P-140	2.2	26.4	15.6	18.7
Touchdown	2.5	30.3	16.1	18.3

* CEC values of thatch expressed on a volume of thatch equivalent to the volume of soil at 100 grams.

Table 19. Physical characteristics of several thatch-types, the 0-2.5 cm soil underlying them, and the 0-2.5 cm soil from a thatch-free site.

Source	Bulk Density g/cc	Total Porosity %
Natural 'Mor'	0.22	64
0-2.5 cm soil	1.47	32
Induced 'Mor'	0.26	68
0-2.5 cm soil	1.06	48
Natural 'Mull'	0.63	66
0-2.5 cm soil	1.25	40
Thatch-free	0.88	54

Thatch types include: (natural 'Mor') thatch relatively free of soil occurring at the soil surface; (induced 'Mor') thatch relatively free of soil occurring at the soil surface as a result of successive applications of calcium arsenate at 439 kg/ha yearly; (Natural 'Mull') intermingling of soil and thatch occurring at the soil surface.

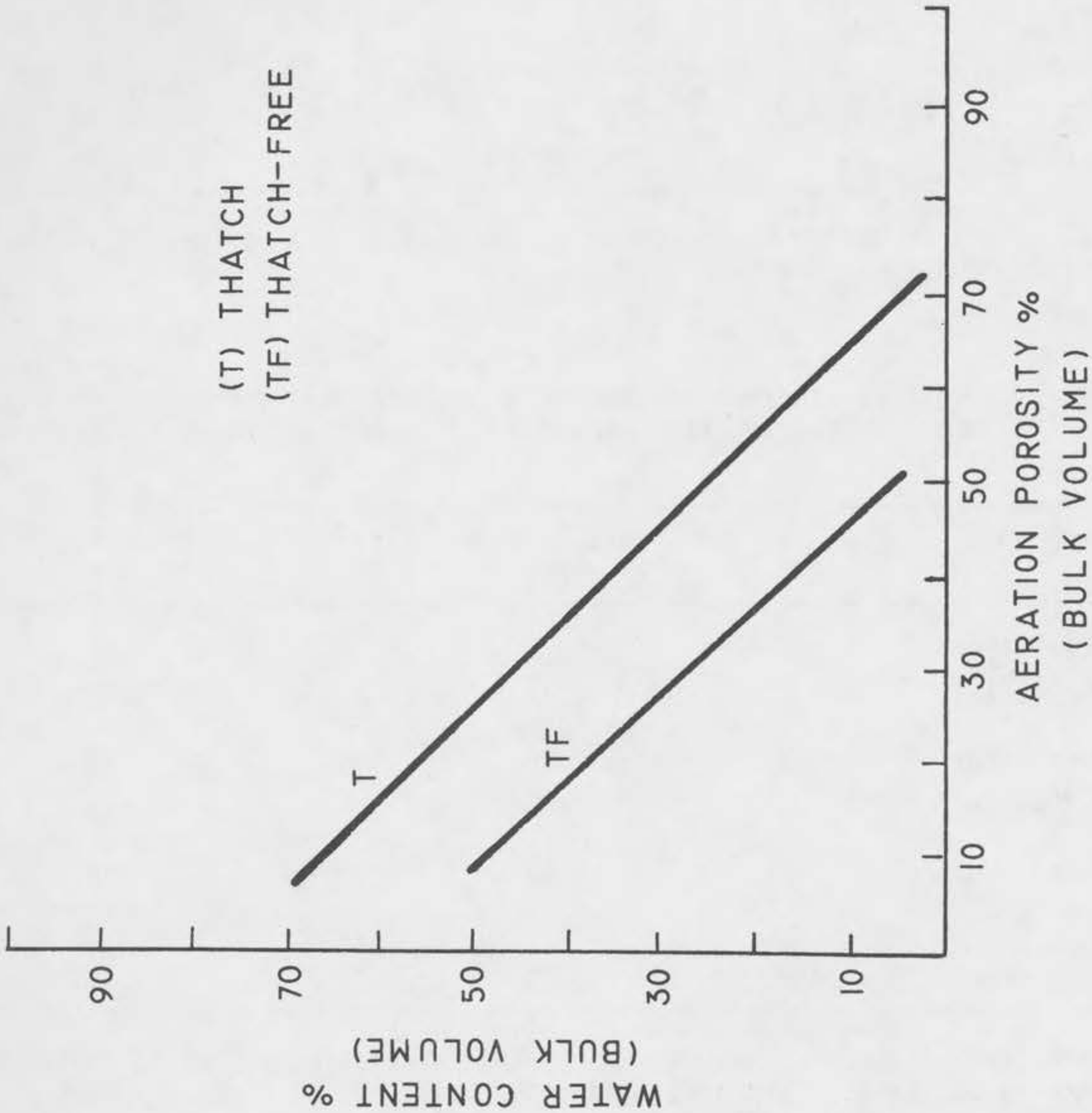

Figure 1. Comparison of aeration porosity of a Kentucky bluegrass thatch and the surface soil of a thatch-free Kentucky bluegrass turf as affected by water content.

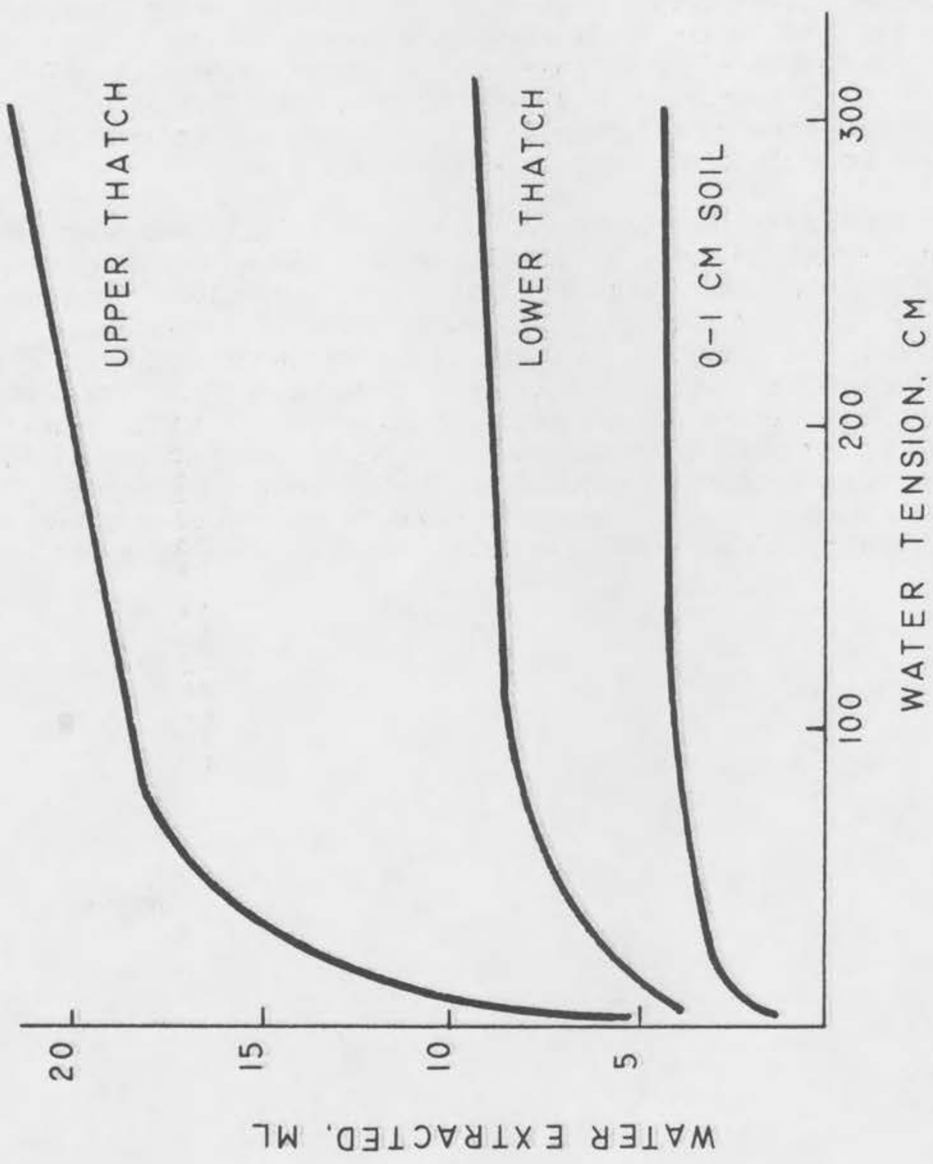

Figure 2. Comparison of moisture characteristics of 5.3 cm diameter cores of the upper and lower profiles of a 2 cm thich Kentucky bluegrass thatch and the surface 1 cm soil underlying it.

B. 5. <u>Kentucky bluegrass cultivar management study</u>.
A. J. Turgeon and J. E. Haley

Six cultivars of Kentucky bluegrass, including: Windsor, Nugget, Merion, Fylking, Pennstar and Kenblue, were planted in 1972 and maintained at 1 3/4 inch height through the season. In April of 1973, all of the cultivars except Windsor were clipped at 1 1/2 or 3/4 inch three times per week, and fertilized at an annual rate of 2, 4, 6 or 8 pounds of nitrogen per 1000 sq. ft., applied in one or two pounds increments in May, June, August and September. In the fall of 1973, A-20 sod was planted in an adjacent area and included in the study along with Windsor. Thus, seven cultivars were observed at eight cultural intensities through 1974, 1975 and 1976. The nitrogen source was a 10-6-4 water-soluble fertilizer. Each treatment combination (mowing height x fertility level) was replicated three times with 4 by 6 ft plots within each cultivar block.

Results indicate that turfgrass quality is largely dependent upon disease incidence which, in turn, is associated with the mowing height and fertilization rate within each cultivar (Table 20). Generally, close mowing and low fertility favored dollar spot incidence, especially in Nugget, while high fertility was conducive to <u>Fusarium</u> blight in Merion, Fylking and Pennstar. Kenblue was seriously affected by <u>Fusarium</u> at all cultural intensities. Previous <u>Fusarium</u> injury was followed by annual bluegrass invasion; thus, reduced turfgrass quality is due, in part, to the loss of annual bluegrass during the summer. For the first time, stripe smut disease was observed in all cultivars except A-20. The severity of this disease was greatest where higher mowing and more intensive fertilization were practiced.

Table 20. Quality of Kentucky bluegrass cultivars under different mowing and fertilization regimes.

Mowing Height in.	Fertilization lb N/1000 sq. ft/yr	Dollar Spot[1] 8/13/76	Stripe Smut[1] 8/27/76	Thatch Depth in.	% Annual Bluegrass	Quality[2]				
						5/18/76	7/13/76	8/13/76	9/17/76	10/18/76
Windsor										
0.75	2	3.0	1.0	1.6	0.3	3.0	3.3	3.3	3.3	3.7
0.75	4	2.0	1.3	1.7	2.0	4.0	3.0	3.7	2.3	3.0
0.75	6	1.0	2.0	1.5	3.3	4.0	3.0	3.3	2.3	3.0
0.75	8	1.0	1.7	1.4	5.7	4.0	3.3	3.3	2.3	3.0
1.50	2	2.3	1.0	2.0	0	3.7	3.7	3.3	3.3	3.7
1.50	4	1.3	1.7	2.0	0	4.0	2.3	3.3	1.3	2.7
1.50	6	1.0	2.7	2.2	0	3.3	3.0	3.3	2.0	2.7
1.50	8	1.0	3.0	2.2	0.3	3.0	3.3	3.7	2.7	3.0
A-20										
0.75	2	3.7	1.0	2.5	8.7	3.3	4.7	4.7	3.3	3.7
0.75	4	2.3	1.0	2.5	6.7	3.3	3.0	3.3	2.7	3.0
0.75	6	1.3	1.0	2.4	7.0	3.0	3.3	3.0	2.0	3.0
0.75	8	1.7	1.0	2.6	13.3	3.0	3.3	4.0	4.0	4.0
1.50	2	2.3	1.0	3.3	0	4.0	4.0	4.3	2.7	3.0
1.50	4	1.7	1.0	3.0	0	4.0	4.0	3.7	1.7	2.3
1.50	6	1.0	1.0	2.9	0	3.3	4.0	2.0	1.0	2.3
1.50	8	1.3	1.0	2.9	0	3.3	3.7	3.0	1.0	2.3
Nugget										
0.75	2	5.7	1.0	1.4	2.3	2.7	3.7	5.3	4.3	4.3
0.75	4	2.3	1.0	1.7	12.0	2.3	3.3	5.3	3.7	4.3
0.75	6	2.7	1.3	1.5	30.0	1.3	4.0	5.7	4.7	5.0
0.75	8	3.3	1.7	1.6	26.7	2.0	4.7	5.0	5.3	5.0
1.50	2	4.3	1.3	2.1	0	4.7	4.3	5.3	2.7	3.0
1.50	4	1.7	2.3	2.2	0	4.7	3.7	5.3	2.3	3.0
1.50	6	2.7	2.3	2.2	0	5.3	3.3	4.0	2.0	3.0
1.50	8	2.7	2.7	2.1	3.3	5.3	3.3	4.0	1.3	3.3

Table 20. continued.

Mowing Height in.	Fertilization lb N/1000 sq. ft/yr	Dollar Spot[1] 8/13/76	Stripe Smut[1] 8/27/76	Thatch Depth in.	% Annual Bluegrass	Quality[2] 5/18/76	7/13/76	8/13/76	9/17/76	10/18/76
Merion										
0.75	2	3.0	1.0	1.5	12.0	3.3	4.7	5.0	4.0	4.3
0.75	4	1.3	1.0	1.7	26.7	3.0	4.0	4.7	3.7	4.7
0.75	6	1.7	1.3	1.8	32.7	2.7	5.0	5.3	5.3	4.7
0.75	8	1.3	1.7	1.6	40.0	3.0	5.0	5.7	5.3	5.3
1.50	2	2.0	1.3	1.9	3.7	4.0	4.0	4.0	2.7	3.0
1.50	4	1.0	2.3	2.0	2.3	4.3	3.0	3.7	2.7	3.0
1.50	6	2.0	2.3	1.9	6.7	4.0	3.0	3.3	2.7	2.7
1.50	8	1.0	2.7	2.1	12.0	4.3	3.0	3.3	3.0	3.7
Fylking										
0.75	2	4.3	1.0	1.9	16.7	3.7	4.0	6.3	5.3	5.0
0.75	4	2.0	1.3	1.9	40.0	3.0	4.7	5.3	5.0	5.7
0.75	6	1.3	1.7	1.8	68.3	3.3	5.7	7.3	7.0	6.7
0.75	8	1.0	1.3	1.9	81.6	3.3	6.0	7.3	7.3	7.3
1.50	2	1.7	1.7	2.3	16.7	4.7	3.0	4.0	3.7	3.7
1.50	4	1.3	2.0	2.2	16.7	5.0	3.0	4.3	3.3	4.7
1.50	6	1.3	1.7	2.1	20.0	5.3	3.0	4.0	3.0	4.7
1.50	8	1.0	2.0	2.3	33.3	5.3	4.0	4.3	3.7	4.7
Pennstar										
0.75	2	3.3	1.0	1.6	43.3	3.7	4.0	5.7	5.3	6.0
0.75	4	1.7	1.0	1.9	68.3	3.0	4.7	6.7	7.0	7.0
0.75	6	1.0	1.0	1.8	68.3	3.3	6.0	7.3	7.7	8.0
0.75	8	1.0	1.0	1.6	85.0	3.3	6.0	8.0	8.7	8.3
1.50	2	2.3	1.0	2.2	26.7	5.0	3.7	4.3	4.3	4.0
1.50	4	1.3	1.3	2.2	23.3	5.3	4.0	4.7	5.0	4.7
1.50	6	1.3	1.3	2.1	30.0	6.0	3.7	4.3	4.7	4.7
1.50	8	1.0	1.0	2.2	36.7	6.0	4.7	5.7	6.0	6.0

Table 20. continued.

Mowing Height in.	Fertilization lb N/1000 sq. ft/yr	Dollar Spot[1] 8/13/76	Stripe Smut[1] 8/27/76	Thatch Depth in.	% Annual Bluegrass	Quality[2] 5/18/76	7/13/76	8/13/76	9/17/76	10/18/76
Kenblue										
0.75	2	2.7	1.0	0.3	55.0	5.3	7.0	6.3	7.3	6.7
0.75	4	1.3	1.0	0.8	71.7	5.7	8.3	8.0	8.0	8.3
0.75	6	1.0	1.0	0.6	81.7	6.3	8.3	9.0	9.0	8.7
0.75	8	1.0	1.0	0.2	97.7	6.7	9.0	9.0	9.0	9.0
1.50	2	2.3	2.0	0.6	25.0	7.3	5.0	4.7	6.0	4.7
1.50	4	1.7	2.0	0.4	36.7	7.3	7.0	6.3	6.3	5.3
1.50	6	1.0	2.0	0.5	43.3	7.7	7.0	7.0	6.3	6.3
1.50	8	1.0	1.0	0.3	50.0	8.0	7.7	7.7	7.0	7.0

[1] Disease severity was rated using a scale of 1 through 9 with 1 representing no disease and 9 representing complete necrosis of the plot.

[2] Quality ratings were made using a scale of 1 through 9 with 1 representing perfect quality and 9 representing very poor quality.

B. 5. Expanded Kentucky bluegrass cultivar management study.
A. J. Turgeon and J. E. Haley

Twenty-one cultivars of Kentucky bluegrass were planted in 15 replicate plots in September, 1974. Twelve replications of the cultivars were planted in the northwest section of the OHRC turfgrass experimental site and 3 replications were located north of the east-west road leading into the OHRC. In 1975, five different cultural intensities were imposed so that 3 replications of each cultivar were maintained under one of the following programs: 0.75-in mowing with 4 lb N/1000 sq ft/yr, 0.75-in mowing with 8 lb N/1000 sq ft/yr, 1.5-in mowing with 4 lb N/1000 sq ft/yr, 1.5-in mowing with 8 lb N/1000 sq ft/yr, and 3-in mowing with 1 lb N/1000 sq ft/yr. Mowing was performed 2 or 3 times per week at 0.75 or 1.5 in, and once per week at 3 in. Fertilization was performed in 1 or 2 lb N increments in April, May, August and September. The 3-in plots were fertilized in April. Irrigation was performed as needed to prevent wilting. Plots measured 5 by 6 ft and cultivars within cultural level were arranged in a randomized complete block design.

Observations during 1976 revealed the impact of fertilization and mowing on the susceptibility of the cultivars to dollar spot and *Fusarium* blight diseases and annual bluegrass invasion (Table 21). Generally, close mowing (0.75 in) and high fertilization levels (8 lb N/1000 sq ft/yr) were most conducive to *Fusarium* blight disease and annual bluegrass invasion. However, annual bluegrass coverage varied from 8.7 to 50 percent depending upon cultivar. The lower fertilization level (4 lb N/1000 sq ft/yr) on the 0.75-in plots resulted in considerably less annual bluegrass invasion. Essentially no annual bluegrass invaded plots maintained at the higher mowing heights. Dollar spot pressure was severe, especially in plots maintained at the lower fertilization levels.

Although insufficient data have been gathered to accurately determine the adaptation of the cultivars to the different cultural intensities, it is clear that the cultivars vary widely in their persistence and quality under the highest cultural intensity. Of the 21 cultivars, A-34, Brunswick, and Touchdown appear best adapted to conditions under which annual bluegrass is most likely to invade. At the lowest cultural intensity (3 in, 1 lb N), Birka and Code 95 appear to be slightly above average in quality.

Table 21. New Kentucky bluegrass cultivar management study.[1]

Cultivar	Cultural Intensity[2]	Dollar Spot[3] 8/13/76	Fusarium Blight[3] 8/13/76	% Annual Bluegrass	Quality[4] 7/14/76	Quality[4] 8/13/76	Quality[4] 9/21/76	Quality[4] 10/19/76
A-20	M .75, F4	4.3	2.7	6.7	4.0	5.0	7.3	7.0
	M .75, F8	1.3	4.7	25.0	3.7	5.0	8.7	8.3
	M 1.5, F4	2.7	2.0	0	3.7	4.7	6.0	6.3
	M 1.5, F8	3.0	3.0	0	4.0	4.7	6.0	5.7
	M 3.0, F1	1.3	1.0	0	4.3	4.7	5.0	5.3
A-34	M .75, F4	2.3	1.0	1.0	3.0	3.7	4.0	4.7
	M .75, F8	1.0	3.3	8.7	3.7	3.3	6.3	5.3
	M 1.5, F4	2.7	1.3	0	3.0	3.7	4.3	4.7
	M 1.5, F8	1.3	1.0	0	3.7	4.0	5.0	4.0
	M 3.0, F1	3.7	1.0	0	4.7	5.0	5.7	5.7
Adelphi	M .75, F4	2.7	2.7	5.0	3.3	5.0	6.0	6.3
	M .75, F8	1.0	4.3	36.7	3.7	6.0	8.0	7.3
	M 1.5, F4	2.0	2.3	0	3.3	4.3	5.7	5.7
	M 1.5, F8	1.3	2.7	0	4.0	4.7	6.0	5.0
	M 3.0, F1	1.3	1.0	0	4.7	4.3	5.3	5.7
Aquilla	M .75, F4	4.3	1.3	3.3	3.7	5.0	5.0	5.7
	M .75, F8	1.0	4.0	26.7	3.0	3.7	8.0	8.0
	M 1.5, F4	5.3	1.0	0	3.7	5.7	6.0	5.3
	M 1.5, F8	2.0	2.7	0	3.3	4.0	6.7	5.3
	M 3.0 F1	4.0	1.0	0	4.3	4.3	4.0	4.3
Baron	M .75, F4	3.7	1.0	1.0	4.3	4.7	5.3	5.7
	M .75, F8	1.3	5.0	30.0	4.0	5.0	7.7	7.7
	M 1.5, F4	2.7	1.0	0	3.0	4.3	5.0	5.0
	M 1.5, F8	1.3	2.7	0	3.0	3.7	7.0	5.7
	M 3.0, F1	2.0	1.0	0	5.0	4.0	5.0	5.0

Table 21. continued.

Cultivar	Cultural Intensity[2]	Dollar Spot[3] 8/13/76	Fusarium Blight[3] 8/13/76	% Annual Bluegrass	Quality[4] 7/14/76	Quality[4] 8/13/76	Quality[4] 9/21/76	Quality[4] 10/19/76
Birka	M .75, F4	4.0	1.7	0.3	3.3	5.0	6.0	6.0
	M .75, F8	1.0	4.7	23.3	2.7	4.3	8.3	8.0
	M 1.5, F4	3.7	2.0	0	3.0	4.7	5.3	5.7
	M 1.5, F8	1.0	2.0	0	3.0	4.0	7.3	6.3
	M 3.0, F1	2.7	1.0	0	4.0	3.7	4.3	4.0
Bonnieblue	M .75, F4	2.7	2.0	7.0	3.3	4.7	5.7	5.7
	M .75, F8	1.3	4.0	28.3	3.3	4.7	7.7	6.7
	M 1.5, F4	3.3	2.0	0	3.3	4.7	5.3	5.3
	M 1.5, F8	1.7	3.0	0	3.7	4.7	5.3	4.7
	M 3.0, F1	1.3	1.0	0	4.7	4.0	4.7	5.0
Brunswick	M .75, F4	2.0	1.0	1.0	2.7	3.7	3.7	5.3
	M .75, F8	1.0	3.0	8.7	3.0	3.3	5.3	4.7
	M 1.5, F4	2.3	1.0	0	3.0	4.7	4.0	5.3
	M 1.5, F8	1.3	2.0	0	3.0	4.0	3.7	4.0
	M 3.0, F1	2.0	1.0	0	4.0	4.7	5.7	6.3
Cheri	M .75, F4	3.3	2.3	13.7	4.0	4.7	6.0	6.0
	M .75, F8	2.0	5.3	30.0	4.3	5.3	7.3	6.7
	M 1.5, F4	3.3	1.7	0	3.3	4.3	4.7	5.3
	M 1.5, F8	1.7	1.3	0	3.3	4.0	5.3	5.0
	M 3.0, F1	2.0	1.0	0	5.0	4.7	5.0	5.0
Code 95	M .75, F4	2.0	2.7	1.0	4.3	4.7	6.7	6.3
	M .75, F8	1.0	4.3	18.3	3.7	5.0	8.0	7.7
	M 1.5, F4	1.7	4.0	0	3.7	4.3	5.7	5.7
	M 1.5, F8	1.3	4.7	0	3.3	5.7	6.3	5.3
	M 3.0, F1	1.3	1.0	0	3.7	4.7	5.0	6.0
Glade	M .75, F4	3.7	1.0	0.7	3.7	5.0	5.0	5.0
	M .75, F8	1.0	3.7	33.3	4.3	3.7	7.7	7.0
	M 1.5, F4	3.0	1.0	0	3.0	4.3	5.0	4.7
	M 1.5, F8	1.3	1.0	0	2.7	4.0	6.7	5.0
	M 3.0, F1	1.3	1.0	0	4.3	4.3	4.3	4.0

Table 21. continued.

Cultivar	Cultural Intensity[2]	Dollar Spot[3] 8/13/76	Fusarium Blight[3] 8/13/76	% Annual Bluegrass	Quality[4] 7/14/76	Quality[4] 8/13/76	Quality[4] 9/21/76	Quality[4] 10/19/76
Majestic	M .75, F4	4.3	3.0	23.3	5.0	6.0	7.7	7.3
	M .75, F8	1.3	5.0	40.0	4.7	5.7	8.7	8.0
	M 1.5, F4	2.7	2.0	1.0	4.3	5.7	7.0	7.0
	M 1.5, F8	1.7	2.3	0	3.7	5.0	6.3	6.0
	M 3.0, F1	2.0	1.0	0	5.7	5.3	5.7	5.7
Merion	M .75, F4	3.3	1.7	2.3	3.7	4.3	5.7	5.7
	M .75, F8	1.7	3.3	26.7	4.7	4.3	5.3	5.0
	M 1.5, F4	4.0	1.3	0	3.3	4.7	5.0	5.3
	M 1.5, F8	1.3	3.0	0	3.3	4.3	5.3	3.7
	M 3.0, F1	2.3	1.0	0	5.0	5.3	5.3	6.0
Nugget	M .75, F4	4.7	2.3	2.0	4.3	4.7	6.3	6.0
	M .75, F8	1.3	4.3	40.0	4.0	4.7	7.7	8.0
	M 1.5, F4	6.0	2.0	0	4.0	7.0	7.0	6.7
	M 1.5, F8	1.7	3.3	0	4.0	5.0	7.0	6.3
	M 3.0, F1	3.0	1.0	0	4.3	4.7	4.7	5.3
Parade	M .75, F4	3.0	2.0	2.3	4.0	5.0	6.0	6.0
	M .75, F8	1.7	3.0	23.3	4.0	4.3	7.0	6.0
	M 1.5, F4	2.7	1.0	0	4.0	5.0	5.7	5.7
	M 1.5, F8	1.3	2.7	0	3.7	4.7	5.3	5.0
	M 3.0, F1	2.0	1.0	0	4.3	5.0	5.0	5.0
Pennstar	M .75, F4	4.0	2.0	2.3	4.0	5.3	6.3	6.0
	M .75, F8	1.0	4.7	21.7	3.3	5.0	9.0	9.0
	M 1.5, F4	4.3	1.7	0	3.3	5.7	5.7	6.0
	M 1.5, F8	2.3	4.7	0	3.7	6.0	7.3	6.3
	M 3.0, F1	2.3	1.0	0	4.7	4.0	4.3	4.3
Rugby	M .75, F4	2.7	2.0	3.7	4.3	4.7	5.0	5.7
	M .75, F8	1.3	4.0	40.0	5.0	5.0	7.7	6.3
	M 1.5, F4	2.3	1.0	0	3.3	4.0	4.7	4.3
	M 1.5, F8	1.7	1.3	0	4.0	4.0	5.3	3.7
	M 3.0, F1	1.0	1.0	0	5.0	5.3	5.3	5.0

Table 21. continued.

Cultivar	Cultural Intensity[2]	Dollar Spot[3] 8/13/76	Fusarium Blight[3] 8/13/76	% Annual Bluegrass	Quality[4] 7/14/76	Quality[4] 8/13/76	Quality[4] 9/21/76	Quality[4] 10/19/76
Sydsport	M .75, F4	4.0	1.7	0.7	4.3	4.3	5.3	5.3
	M .75, F8	1.3	4.0	11.7	4.0	4.3	6.7	6.3
	M 1.5, F4	4.3	1.0	0	3.3	5.3	5.3	4.7
	M 1.5, F8	1.0	1.7	0	3.3	4.0	5.0	3.3
	M 3.0, F1	2.3	1.0	0	4.3	4.7	4.7	5.3
Touchdown	M .75, F4	3.3	1.7	1.0	3.0	4.3	4.3	5.3
	M .75, F8	1.0	2.0	8.7	3.0	3.0	6.0	5.3
	M 1.5, F4	4.0	1.7	0	3.3	5.0	4.3	5.0
	M 1.5, F8	1.0	1.0	0	2.7	3.0	3.0	3.7
	M 3.0, F1	1.3	1.0	0	4.7	5.0	5.0	5.0
Vantage	M .75, F4	4.7	2.7	1.0	4.7	5.7	7.3	6.3
	M .75, F8	1.3	4.7	50.0	4.7	5.3	8.7	8.3
	M 1.5, F4	3.0	2.3	0	4.3	5.0	6.0	5.3
	M 1.5, F8	1.3	3.7	0	3.7	5.3	7.7	6.0
	M 3.0, F1	2.3	1.0	0	4.3	4.7	5.0	4.7
Victa	M .75, F4	4.7	2.3	1.0	4.3	5.0	6.3	6.3
	M .75, F8	1.0	4.3	28.3	4.7	4.7	7.7	7.3
	M 1.5, F4	3.7	4.0	0	3.7	5.0	5.3	5.7
	M 1.5, F8	1.3	3.3	0	3.3	4.3	6.0	5.7
	M 3.0, F1	2.0	1.0	0	4.0	4.0	4.0	4.7

1 Planted September, 1974.

2 Cultural intensities: mowing at 0.75 in (M .75), 1.5 in (M 1.5), and 3.0 in (M 3.0); fertilization with 10-6-4 to supply an annual total of 4 lb N/1000 sq ft (F4), or 8 lb N/1000 sq ft (F8), with equal increments applied in April, May, August and September. F1 equals 1 lb N/1000 sq ft applied in May.

3 Dollar spot and Fusarium blight diseases rated using a scale of 1 through 9, with 1 representing no disease and 9 representing complete necrosis of the plot.

4 Quality ratings were made using a scale 1 through 9, with 1 representing perfect quality and 9 representing very poor quality.

B. 5. Tall fescue management study.
A. J. Turgeon and J. E. Haley

Tall fescue is a unique turfgrass that has been planted extensively along Illinois roadsides and for "low-maintenance" turfs. Its midsummer stress tolerance, adaptation to low intensities of culture, and excellent wear tolerance make tall fescue a suitable grass for some heavily trafficked sites where maintenance funds are limited. It is well adapted to climatic conditions in southern Illinois; however, its lack of cold tolerance frequently results in poor turfgrass quality in northern Illinois. Results from research at Beltsville, Maryland, indicated that tall fescue responds well to relatively high fertilization levels and, therefore, it may not be a strictly low-maintenance turfgrass.

Tall fescue was planted at the OHRC in August, 1972, at the seeding rate of 6 lb/1000 sq ft. It was maintained through 1973 at a mowing height of 1.5 inches and received an annual total of 4 lb N/1000 sq ft/yr using a 10-6-4 analysis fertilizer. In early 1974, an experiment was initiated in which the tall fescue was subjected to three mowing heights (0.75, 1.5 and 3.0 in) and five fertilization levels (0, 2, 4, 6 and 8 lb N/1000 sq ft/yr) with a 10-6-4 fertilizer applied in equal increments in April, May, August and September. Irrigation was performed to prevent wilting of the turf. Plots measured 4 by 6 ft and each treatment combination was replicated four times in a randomized complete block design.

During the next two growing seasons, annual bluegrass invaded the 0.75-in plots and Kentucky bluegrass developed in the plots maintained at the higher mowing heights. On July 16, 1976, the percent species compositions of each plot was determined. The amount of annual bluegrass in the plots varied with mowing height and fertilization level (Table 22). Under the 0.75-in mowing height, annual bluegrass averaged between 82.5 and 99.0 percent with increasing amounts associated with increasing fertilization. At the 1.5-in mowing height, Kentucky bluegrass and annual bluegrass increased with increasing fertilization level. No annual bluegrass occurred in the 3-in plots; however, Kentucky bluegrass composed slightly over half of the turf as long as some fertilizer was applied. Thus, although tall fescue may respond to increasing fertilization, the regular application of fertilizer apparently favors Kentucky bluegrass and annual bluegrass more than tall fescue in central Illinois. Presumably, regular irrigation was also highly favorable for sustaining the bluegrasses as competing turfgrass species.

Table 22. Effects of mowing height and fertilization on the percent species composition of a site planted initially to tall fescue.

Mowing Height, in.	Fertilization lb N/M/Yr	% Composition		
		Tall fescue	Kentucky bluegrass	Annual bluegrass
0.75	0	17.5	0	82.5
0.75	2	6.5	0	93.5
0.75	4	3.0	0	97.0
0.75	6	1.0	0	99.0
0.75	8	1.0	0	99.0
1.50	0	60.0	40.0	0
1.50	2	36.3	60.0	3.8
1.50	4	17.5	72.5	10.0
1.50	6	17.5	71.2	11.3
1.50	8	16.5	72.5	11.3
3.00	0	62.5	37.5	0
3.00	2	47.5	52.5	0
3.00	4	42.5	57.5	0
3.00	6	45.0	55.0	0
3.00	8	47.5	52.5	0

B. 6. Chemical growth retardation of tall fescue.
A. J. Turgeon and J. E Haley

Chemical growth retardants are used on low maintenance turfs in order to reduce the mowing requirement. Their use has been limited in the past by inadequate control of vertical growth, and by unacceptable phytotoxicity in treated turfs. Consequently, evaluations are conducted to find new materials that may offer better efficacy without seriously reducing turfgrass quality.

Several materials were applied to a mature stand of tall fescue on May 14, 1976. Although mowing was performed during previous seasons, none was practiced in 1976 until conclusion of this experiment. No fertilization or irrigation were performed either. Applications were made in 28.8 gal of water per acre using a CO_2-propelled small-plot sprayer. At 27 and 53 days following treatment, measurements were made of foliar and seedhead height, seedhead density as a percent of those in untreated plots, and phytotoxicity.

None of the materials produced satisfactory results at any of the application rates employed (Tables 23 and 24). The most effective of the materials was Vernam at 6 lb/acre which provided approximately 65 percent reduction in foliar height, 70 to 90 percent seedhead reductions, and moderate-to-severe phytotoxicity. SN-49537 was slightly less effective than Vernam in retarding growth but comparable in its phytotoxic effects on the turf at the highest rate (2 lb/acre) applied. Sutan was essentially ineffective except for the moderate amount of phytotoxicity resulting from all rates of application.

Table 23. Effects of chemical growth retardants applied May 14, 1976 to tall fescue turf 27 days after treatment[1].

Treatment	Rate, lb/a	Foliar Height, in	Seedhead Height, in	% Seedheads[2]	Phytotoxicity[3]
Sutan 4S	2	7.3	16.3	30.0	3.3
Sutan 4S	4	5.8	16.7	48.3	3.7
Sutan 4S	6	6.5	16.7	39.0	4.7
Vernam 4S	2	6.7	15.7	28.3	4.0
Vernam 4S	4	6.5	14.0	33.3	4.7
Vernam 4S	6	5.0	13.0	11.7	7.7
SN-49537 50W	0.5	6.5	15.7	28.3	4.0
SN-49537 50W	1	6.8	15.2	36.7	3.0
SN-49537 50W	2	5.8	15.0	16.7	8.3
Untreated	-	8.0	16.7	100.0	1.0

[1] Table values are the means of three replications.

[2] Seedheads were estimated as a percent of the untreated plots.

[3] Phytotoxicity ratings were made using a scale of 1 through 9 with 1 representing no injury and 9 representing complete necrosis of the turf.

Table 24. Effects of chemical growth retardants applied May 14, 1976, to tall fescue turf 53 days after treatment[1].

Treatment	Rate, lb/a	Foliar Height, in	Seedhead Height, in	% Seedheads[2]	Phytotoxicity[3]
Sutan 4S	2	8.7	11.8	35.3	2.7
Sutan 4S	4	9.5	12.0	36.7	3.0
Sutan 4S	6	7.7	11.3	53.7	4.0
Vernam 4S	2	9.0	9.8	54.7	3.0
Vernam 4S	4	8.2	10.0	61.0	2.0
Vernam 4S	6	6.7	6.5	30.3	4.0
SN-49537 50W	0.5	8.3	12.2	72.3	2.7
SN-49537 50W	1	10.2	12.5	66.7	2.3
SN-49537 50W	2	6.8	10.5	41.3	4.0
Untreated	-	10.3	13.5	100.0	1.0

[1] Table values are the means of three replications.

[2] Seedheads were estimated as a percent of the untreated plots.

[3] Phytotoxicity ratings were made using a scale of 1 through 9 with 1 representing no injury and 9 representing complete necrosis of the turf.

C. 1. a. Broadleaf weed control study.
K. A. Hurto and A. J. Turgeon

Several phenoxyalkanoic and benzoic acid herbicides are used for controlling broadleaf weeds in turf. Each herbicide is highly effective on certain weeds, marginally effective on others, and ineffective on still others. Thus,combinations of two or three herbicides provide broad -spectrum control that is necessary where several weed species are present. Combinations of 2,4-D with silvex, mecroprop or dicamba are typical of many commercial formulations. Regardless of the specific herbicides applied, efficacy can vary widely depending upon enviromental and turfgrass conditions. Two methods for improving the efficacy of these herbicides include: (a) combining them at a proportion designed to optimize performance, and (b) include adjuvants to enhance herbicide activity without serious loss of selectivity. The purpose of this study was to evaluate the effects of the adjuvant-Exhalt 800 - in herbicide combinations for controlling broadleaf weeds in Kentucky bluegrass.

Treatments were made on August 13, 1976, to a 'Pennstar-Fylking-Prato' Kentucky bluegrass turf uniformly infested with white clover and dandelions. Plots measured 5 by 6 ft and each treatment was replicated three times. Evaluations were made August 31, 1976.

The 2,4-D and dicamba combinations was effective in controlling the weeds at all rates of application (Table 25). The 2,4-D and silvex combinations was less effective but enhanced by addition of Exhalt 800. Application of Exhalt 800 alone produced no apparent effect on the weeds or turfgrasses. Thus, inclusion of Exhalt 800 can improve broadleaf weed control with marginally effective herbicides.

Table 25. Broadleaf weed control in Kentucky bluegrass from postemergence applications of herbicides made August 13, 1976.

Treatments	Rate lb/a	Weed Control[1]	
		White Cover	Dandelion
2,4-D + silvex	1.0 + 0.5	6.3	7.0
2,4-D + silvex + Exhalt 800[2]	1.0 + 0.5	9.0	9.0
2,4-D + silvex	0.5 + 0.25	5.3	8.3
2,4-D + silvex + Exhalt 800[2]	0.5 + 0.25	6.7	8.7
2,4-D + dicamba	1.0 + 0.25	9.0	9.0
2,4-D + dicamba + Exhalt 800[2]	1.0 + 0.25	9.0	9.0
2,4-D + dicamba	0.5 + 0.13	8.3	9.0
2,4-D + dicamba + Exhalt 800[2]	0.5 + 0.13	9.0	9.0
Exhalt 800	-	1.0	1.0
Untreated	-	1.0	1.0

[1] Weed control ratings were made using a scale of 1 through 9 with 1 representing no control and 9 representing complete control.

[2] Exhalt 800 (surfactant) added to make 0.125% of total spray volume.

C. 1. b. Crabgrass control study.
K. A. Hurto and A. J. Turgeon

Postemergence control of crabgrass and other summer annual weeds is accomplished with organic arsenical herbicides (DSMA, MSMA, MAMA) applied two or three times at weekly intervals. The potential for turfgrass injury is very high from these herbicides, especially under high temperature conditions. This experiment was performed to evaluate combinations of organic arsenicals with phenoxyalkanoic acid (2,4-D, MCPP) herbicides, and the adjuvant-Exhalt 800, to determine if crabgrass control could be improved. Also, an experimental herbicide - Dowco 356 - was compared with the arsenicals for controlling crabgrass. Plots measured 5 by 6 ft and each treatment was replicated three times. The site was a 'Kenblue'-type Kentucky bluegrass turf. Chemical applications were made August 13 and, again, August 20, 1976. Spray volume was 10 gal of water per 1000 sq ft. Control ratings were made August 31, 1976.

None of the treatments resulted in complete crabgrass control; however, the most effective treatment was Dowco 356 at the higher (2 lb/acre) application rate (Table 26). Both Exhalt 800 ahd mecoprop improved crabgrass control where mixed with an organic arsenical herbicide (DSMA, MAMA) plus 2,4-D.

Table 26. Crabgrass control from postemergence applications of herbicides made August 13 and 20, 1976.

Treatments	Rates[1] (lb a.i./acre)	Crabgrass Control[2]
DSMA + 2,4-D	3.0 + 0.5	2.7
DSMA + 2,4-D + MCPP	3.0 + 0.5 + 1.0	5.7
MAMA + 2,4-D	3.0 + 0.5	2.7
MAMA + 2,4-D + Exhalt 800[3]	3.0 + 0.5	6.0
Dowco 356	1.0	3.7
Dowco 356	2.0	6.3
Untreated	-	1.0

[1] Applied with a spray volume of 10 gal water/1000 sq ft.

[2] Crabgrass control ratings were made using a scale of 1 through 9 with 1 representing no control and 9 representing complete control.

[3] Exhalt 800 (surfactant) added to make 0.125% of total spray volume.

C. 1. c. Selective control of creeping bentgrass.
J. E. Haley and A. J. Turgeon

Creeping bentgrass is a serious weed in Kentucky bluegrass turf because of the difficulty in controlling it with selective herbicides. Two herbicides which have caused extensive injury to bentgrass are endothall and silvex. Our hypothesis was that a combination of these herbicides might be more effective in selectively controlling bentgrass than either herbicide applied alone. Plots of Kentucky bluegrass, measuring 5 by 6 ft, were planted with 2 plugs (4 in dia) of creeping bentgrass in June. On July 13, 1976, the plots were sprayed with endothall and silvex alone and in combination at various rates and proportions using a spray volume of 28.8 gallons per acre. The plots were monitored for injury to the bentgrass plugs and the Kentucky bluegrass turf.

Endothall caused temporary injury to both grasses and silvex was highly injurious to the bentgrass; however, the combination of endothall and silvex at 1 and 2 lb/acre, respectively, provided complete control of bentgrass with moderate but temporary injury to Kentucky bluegrass (Table 27). Thus, where temporary turfgrass injury can be tolerated, the endothall-silvex combination offers considerable promise for controlling this serious weed.

Table 27. Selective control of bentgrass in Kentucky bluegrass turf.

Treatment	Rate, lb/acre	Bentgrass control[1]					Turfgrass injury[1]					
		Days after treatment										
		6	10	16	23	34	3	6	10	16	23	34
Endothall[2]	1	5.7	3.0	1.7	1.7	1.0	1.7	2.7	2.3	1.3	1.3	1.0
"	2	7.3	5.7	4.0	3.3	1.0	2.0	3.7	2.0	1.3	1.3	1.0
"	4	8.0	7.7	7.0	5.3	2.0	2.7	5.3	4.0	2.7	1.7	1.0
Silvex[3]	1	5.0	6.0	6.3	5.7	2.7	1.3	1.7	1.0	1.0	1.0	1.0
"	2	6.7	7.0	8.3	7.7	5.7	1.0	1.3	1.3	1.3	1.3	1.0
"	4	7.3	7.7	8.3	8.0	8.0	1.0	2.0	2.0	2.0	1.3	1.0
Endothall + Silvex	1 + 1	8.7	8.7	9.0	8.3	8.3	2.0	4.0	3.0	2.3	1.3	1.3
"	2 + 2	8.7	9.0	9.0	8.7	8.7	3.0	6.0	5.0	4.0	2.7	1.0
"	1 + 2	8.7	9.0	9.0	9.0	9.0	2.3	4.0	3.7	2.3	2.7	1.0
"	2 + 1	9.0	9.0	9.0	9.0	7.3	2.0	5.3	4.3	3.3	2.0	1.7
Untreated	-	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

[1] Bentgrass control and turfgrass injury were rated using a scale of 1 through 9 with 1 representing no injury or control, and 9 representing complete control or necrosis of the turf.

[2] The endothall formulation was a 1.5 lb/gallon disodium salt.

[3] The silvex formulation was a 4 lb/gallon low volatile ester.

C. 1. c. Perennial grass control with glyphosate.
K. A. Hurto and A. J. Turgeon

Perennial weedy grasses such as nimblewill, bentgrass, bermudagrass and tall fescue can invade and disrupt the uniform appearance of a Kentucky bluegrass turf. They are especially problematic since they are difficult or impossible to control selectively with existing herbicides. Thus, control procedures usually involve mechanical removal of the perennial grasses or spot-treatment of the clumps or patches with non-selective, systemic herbicides. Furthermore, residual activity of the traditionally used herbicides, dalapon and amitrole, precludes immediate replanting or inhibits lateral growth from surrounding turfgrasses into the voids resulting from the death of the weedy grasses. The introduction of glyphosate (Monsanto's Roundup) - a non-residual, systemic, non-selective herbicide - has provided the turfgrass manager with a unique tool for controlling these undesired grasses. Small treated areas can quickly fill in from surrounding turfgrasses, and larger treated areas can be replanted after just a few days (a minimum of three days is necessary to allow for adequate translocation of the herbicide within treated plants).

A study was initiated to compare the efficacy of two concentrations of glyphosate applied as a spray (to runoff) or by brush to transplanted plugs of creeping bentgrass, tall fescue, nimblewill and bermudagrass in a Kentucky bluegrass turf. Plugs measured 4 inches in diameter and each of the four weed grasses was planted in 2 by 2 ft plots of Kentucky bluegrass. Glyphosate concentrations of 0.5 and 0.25 percent were applied August 13, 1976 to four replicate plots arranged in a randomized complete block design. Sufficient plots were established for three subsequent tests.

Results showed good control from glyphosate, especially at the higher (0.5%) concentration regardless of application method (Table 28). Recovery from adjacent Kentucky bluegrass was faster where glyphosate was applied by brush.

Table 28. Control of perennial grass species with glyphosate applied as a spray or by brush.

Glyphosate		Grass Species			
Application	Conc., %	Tall fescue	Bentgrass	Bermudagrass	Nimblewill
Spray	0.25	9.3	9.5	8.8	10.0
Spray	0.50	10.0	8.8	9.5	9.3
Brush	0.25	8.5	9.5	9.0	9.5
Brush	0.50	9.5	9.8	9.8	9.8

[1] Control ratings were made using a scale of 0 to 10 with 0 representing no control and 10 representing complete control.

[2] Spray applications were made using a B & G Super Surge Sprayer; spray solutions were applied to runoff. Brush applications were made with a 3-inch paint brush to completely cover the leaves.

C. 2. b. Red leaf spot control in Toronto creeping bentgrass.
F. H. Berns, M. C. Shurtleff and A. J. Turgeon

Red leaf spot, caused by the fungus Helminthosporium erythrospilum was first observed infecting bentgrass species around 1920 in the New York City area. By 1923, it had been observed throughout the more humid areas of the United States from Massachusetts to Virginia and west to Ohio, Indiana, Michigan and Wisconsin, attacking redtop and creeping bentgrass and to a lesser extent Colonial bentgrass, and velvet bentgrass. The casual fungus was described in 1935 as an important pathogen causing leaf spot and crown rot of redtop and most cultivated bentgrasses during prolonged periods of warm, wet weather.

Starting in 1973, or perhaps earlier, numerous golf courses in the Chicago, Illinois area experienced a severe disease on 'Toronto' (C-15) and 'Washington' (C-50) creeping bentgrass putting greens in spite of applying regular preventive fungicide spray programs. Many of the fungicides known to effectively control diseases incited by species of Helminthosporium did little to improve the condition of the diseased greens. Meyer and Turgeon made numerous isolations from the leaves, crowns and roots of diseased plants and obtained H. erythrospilum from 80 to 85 percent of the samples.

The initial symptoms observed on 'Toronto' putting greens in the Chicago area usually consist of small spots of dead grass plants one-half to one inch in diameter, which appear orange to reddish-brown in color; or individual leaves are found that are completely withered or bleached. As the disease progresses during the season, the spots increase in number and merge to cause extensive thinning of the turf.

A uniformly and severely diseased 'Toronto' creeping bentgrass nursery, located in a southwest suburb of Chicago, was used to conduct the following studies. The nursery had been severely damaged by Helminthosporium erythrospilum during the 1973-75 seasons. The turf was mowed at 1/4 inch five times per week and irrigation was performed as needed to maintain normal color and growth. The fungicides used were chlorothalonil (Daconil 2787) and an alternating schedule of Daconil and anilazene (Dyrene). The plots to be treated were arranged in a completely randomized block design. All plots measured 6 by 10 ft with three replications per treatment and a foot untreated strip between plots. The fungicides used, application rates, spray interval and timing are given in Table 29. Fungicide treatments were started on May 4 on most plots and continued to September 28 at weekly or 14-day intervals. A spray volume of 5, 10 or 20 gallons of water per 1000 ft^2 were used to apply the fungicides.

Fertilizer treatments were made in 5-foot strips across each plot using a water-soluble 10-8-4 fertilizer. Applications were made on May 7, June 25, August 13 and September 10. The south half of all plots was given an equivalent of 10 pounds of nitrogen (high N) per season; the north half of the plots received 5 pounds of nitrogen for the season (low N) as indicated in Table 1.

Plots were rated as a percentage of healthy turfgrass cover on April 28 before the start of the experiment and on May 18 and 25; June 1, 8 and 15; July 6, 20 and 27; August 3, 17, 24 and 31; and September 7, 13, 21 and 28.

When the fungicide treatments were rated on April 28, the healthy turfgrass cover was approximately 40 to 45 percent. Red leaf spot, primarily as a crown-root rot, was the only disease observed during the course of the experiment. The percent healthy turfgrass cover ratings are considered an index of red leaf spot control.

Daconil applied at 3 or 6 oz of formulated produce in 5, 10 or 20 gallons of water/1000 ft^2 on a weekly basis throughout the season (May 4 to September 28) provided excellent control (Table 29). All plots were essentially 100 percent covered by healthy turfgrass by August 24. Plots receiving 20 gallons of water were a denser and healthier green than those plots receiving 10 or 5 gallons of water. The Daconil-Dyrene rotation treatments on a weekly basis were only slightly less effective than the Daconil alone. The Daconil treatment commencing on June 29 was not significantly better than the untreated controls until early August while the Daconil treatment commencing on September 7 was totally ineffective. This is essentially what Meyer and Turgeon found; once the red leaf spot fungus infects the crown-root area of plants during the warmer periods of late spring and summer, fungicide applications are of little value in speeding turfgrass recovery. The half of all plots receiving the high rate of nitrogen (10 lb N/season) had a consistently higher healthy turfgrass cover than the half containing the low rate of nitrogen (5 lb N/season).

Table 29. Effect of fungicide, rate, spray interval/timing, gallonage, and fertilization in controlling red leaf spot disease on 'Toronto' creeping bentgrass.

Fungicide	Rate of formulation/ gallonage ($oz/1000\ ft^2$)	Spray interval (days)[a]	Fertil-ization[b]	Percentage healthy turfgrass cover[c] April 28	May 25	June	July	Aug.	Sept.	Average[d] (May-Sept.)
Daconil	3/5 gal	7	high N	40.0	78.3	91.0	95.7	94.6	99.6	91.8
			low N		73.3	78.0	96.3	93.7	99.4	88.1
	6/5 gal	7	high N	45.0	75.0	86.6	95.6	94.0	99.6	90.2
			low N		71.7	74.4	96.0	94.7	98.0	87.0
	3/10 gal	7	high N	46.7	80.0	90.6	93.9	89.3	96.5	90.1
			low N		72.8	76.1	94.6	94.4	99.0	87.4
	6/10 gal	7	high N	45.0	73.3	87.2	93.8	92.6	98.6	89.1
			low N		68.3	66.0	92.0	90.2	98.8	83.1
	3/20 gal	7	high N	45.0	80.0	91.7	95.8	96.2	99.9	92.7
			low N		78.3	81.1	83.3	94.7	99.1	87.3
	6/20 gal	7	high N	40.0	73.3	93.3	96.8	94.7	100.0	91.6
			low N		66.7	71.7	91.4	93.6	98.8	84.4
Daconil	3/5 gal	2 wks	high N	40.0	75.0	85.0	95.9	94.7	95.3	89.2
Dyrene	3/5 gal	2 wks	low N		71.7	72.2	94.2	95.1	91.5	84.9
Daconil	6/5 gal	2 wks	high N	42.0	75.0	86.1	94.6	95.5	96.7	89.6
Dyrene	6/5 gal		low N		70.0	71.7	93.5	95.6	95.7	85.3
Daconil	6/5 gal	late June	high N	41.7	76.7	87.7	84.6	74.9	87.3	83.5
			low N		71.7	66.1	79.7	75.3	86.2	75.8
Daconil	6/5 gal	early Sept.	high N	41.7	76.7	88.3	85.9	67.1	64.8	76.6
			low N		68.3	63.9	81.1	68.9	61.3	68.7
Untreated	--	--	high N	40.0	76.7	87.8	77.7	67.1	66.7	75.2
			low N		71.7	67.2	79.4	63.2	55.0	68.6
Untreated	--	--	high N	41.3	75.0	86.9	89.6	68.3	74.7	78.9
			low N		70.0	68.9	81.3	61.3	64.2	69.1

a/ All fungicides were applied weekly starting May 4 with the exception of the late June treatment (first applied on June 28) and the early September treatment (first applied on September 7) and the rotations of Daconil and Dyrene which were put on at 2-week intervals.

b/ A water-soluble 10-8-4 fertilizer was applied to all plots on May 7, June 24, August 13, and September 10. One half of each plot received an equivalent of 10 pounds of nitrogen (high N) for the season while the other half received 5 pounds of nitrogen (low N) for the season.

Table 29. footnotes continued.

c/ The percentage healthy turfgrass cover was estimated by recording the dead or discolored turf and subtracting from 100. Visual estimations were made on each plot on April 28 and May 18 and for each sub-plot on May 25; June 1, 8 and 15; July 6, 20 and 27; August 13, 17, 24 and 31; and September 7, 13, 23 and 28 when the experiment was terminated.

d/ The figures given are the average of all visual estimations made between May 25 and September 28.

C. 2. b. Fungicide evaluation for sclerotinia dollar spot control on penncross creeping bentgrass.

G. W. Simone, K. J. Hermann, T. M. Sjulin and M. C. Shurtleff

A continuing part of the turfgrass research program at the University of Illinois is fungicide evaluation for disease control. Commercial and experimental fungicides are annually screened for their effectiveness in controlling natural occurrences of Sclerotinia Dollar Spot and Rhizoctonia Brown Patch diseases on bentgrass. Due to the unfavorably dry summer season, only a low incidence of Dollar Spot was observed on the Penncross plots. No Brown Patch was observed during the testing period.

Fungicides for evaluation of the technical assistance were contributed by the following chemical companies: W. A. Cleary Corp. (Thiram Flowable, MBC, and Maneb-Zinc Flowable); Diamond Shamrock Corp. (Daconil 2787); E. I. Du Pont de Nemours & Co. (Tersan 1991); Elanco (EL-222); Rhodia Inc. (RP 26019); and Rohm & Haas Co. (RH 2161 and Fore).

All fungicides were tested on a Penncross creeping bentgrass plot in a randomized complete block design. Each plot measured 6 by 10 ft and all treatments were replicated 4 times. One-ft check strips running the length of the experiment were left between plots to allow disease spread into the treatment plots. All plots were inoculated with infected turfgrass clippings on August 2 and August 9, followed by nightly irrigation. Turfgrass clipping collection from the green was suspended during August to further encourage disease development. No fungicides were applied to the test area prior to fungicide evaluation.

Fungicide applications commenced on August 16 and continued until Sept. 28 according to the rates and intervals presented in Table 30. All materials were applied with a Hudson Matador tank sprayer and Spray Hawk spray boom combination at 25 lbs/square inch pressure. Dollar Spot ratings were made at 2 week intervals, on Aug. 31, Sept. 15 and Sept. 28 based on a percent plot area infection.

Thiram Flowable and RP 26019 (1.0 oz a.i., 14 day) were less effective in controlling the initial disease outbreak than the rest of the fungicide entries as of the Aug. 31 rating (Table 30). The subsequent two ratings demonstrated equal disease control by all entry fungicides and rates except the RH 2161 with poorly controlled Dollar Spot disease. Higher amounts of active material per application interval resulted in less disease control in this experiment. This experimental fungicide may affect the turf plant more severely at higher rates than the target disease organism.

Phytotoxicity, as footnoted for RH 2161 in Table 30, was the result of rate misinformation supplied by the manufacturer. When the correct rate was applied, no further phytotoxicity was observed. The Elanco EL-222 induced some phytotoxic response. At the first two rating periods, all rates of EL-222 resulted in a bluish-green cast to the Penncross plots. This effect was not evident during the cooler weather of the final rating period on Sept. 28. Disease control by EL-222 was comparable to such labelled products as Tersan 1991 and Daconil 2787.

Table 30. Fungicide evaluation for control of sclerotinia dollar spot disease on penncross creeping bentgrass at Urbana, Illinois in 1976

			Sclerotinia Dollar Spot Ratings[2]		
Fungicide	Rate/1000 sq ft[1]	Interval Days[1]	Aug. 31[3]	Sept. 15[3]	Sept. 28[3]
Thiram flowable	3.0 fl oz a.i.	7	2.0 b	0.25 a	1.75 a
MBC	0.5 oz a.i.	14	0.5 a	0.0 a	0.0 a
MBC	1.0 "	14	0.0 a	0.0 a	0.0 a
Maneb-Zinc flowable	4.0 "	7	0.5 a	0.0 a	0.0 a
Daconil 2787	4.0 fl oz	7	0.0 a	0.0 a	0.25 a
Tersan 1991	1.0 oz	14	0.0 a	0.0 a	0.0 a
EL-222	0.75 fl oz	14	1.0 a	0.5 a	0.0 a
EL-222	1.5 "	14	0.5 a	0.25 a	0.0 a
EL-222	3.0 "	7	0.0 a	0.0 a	0.5 a
EL-222	3.0 "	14	0.0 a	0.5 a	0.5 a
RP-26019	2.0 oz a.i.	7	0.0 a	0.0 a	0.0 a
RP-26019	1.0 "	7	0.75 a	0.25 a	0.0 a
RP-26019	4.0 "	7	0.25 a	0.25 a	0.0 a
RP-26019	1.0 "	14	2.25 b	0.25 a	0.0 a
RP-26019	8.0 "	7	0.0 a	0.0 a	0.0 a
RP-26019	2.0 "	14	1.0 a	0.25 a	0.0 a
RH 2161[4]	0.5 oz a.i.	7	--	5.87 c	15.0 d
RH 2161	0.5 "	14	--	4.1 b	5.45 b
RH 2161	1.0 "	7	--	12.3 e	10.1 c
RH 2161	1.0 "	14	--	3.13 b	7.4 bc
Fore	4.0 oz	7	1.25 a	0.5 a	5.25 b
Water control	--	--	8.75 c	9.25 d	15.0 d

1 All rates and spray intervals were either manufacturer suggestions or label directions.

2 Dollar Spot ratings were based on percent plot area infected.

3 All treatment means followed by different letters are significantly different at the .05 level of probability as determined by the F LSD test within each rating period.

4 Ratings for RH 2161 are missing on Aug. 31 due to manufacturer error in suggested application rates. Subsequent ratings are based on 1-2 less fungicide application than other treatments. Both RH 2161 and Fore were applied with Triton CS-7 spreader sticker at 1 pt/100 gal.

C. 3. Insecticide evaluation for white grub control.
Roscoe Randell

Atenius spretulus grubs were found in damaging numbers in golf course fairways and greens feeding on roots of Poa annua and bentgrass. Diazinon applied as granules or spray at a rate of 5 pounds of active ingredient gave effective control when watered into the root zone after application (Table 31). Trichlorfon (Dylox or Proxol) applied as a spray at 6 to 8 pounds of active ingredient gave acceptable control.

Annual white grubs, Cyclocephla immaculata damaged many areas of turfgrass in a 50 to 75 mile area across central Illinois. Counts up to 50 to 55 grubs per square foot were observed with most areas averaging about 12 to 15 per square foot. Some of the labeled and experimental chemicals that proved to be effective in 1977 tests included diazinon, either as a spray or granules; trichlorfon (Dylox or Proxol) as a spray; Ficam, Ciba-Geigy 12223, Velsicol 4283 and Dyfonate.

Table 31. Annual white grub control results.

	Grub Counts Per Square Foot[1]							
		Plot Number						
Insecticide	Rate a.i/a	1	2	3	4	5	6	7
Diazinon E.C.	5 lb/a	6.2	1.0	1.2	2.0	0.8	1.8	2.0
G.		-	-	-	-	-	-	-
Ficam W.P.	1.5 lb	0.8	0.2	0.0	0.2	0.0	0.8	0.4
G.		-	0.2	-	-	-	0.0	-
CGA-122223 E.C.	2.0 lb	2.2	0.4	0	0	1.2	0.4	1.0
G.		1.8		-		-	-	1.2
Dursban	4.0 lb	-	-	9.4	-	8.6	10.2	7.2
Vel 4283 E.C.	2 lb	-	-	0.4	0.4	1.0	1.8	2.4
Proxol W.P.		-	-	-	-	0.6	0.6	0.8
Dyfonate G.	6 lb	1.4	-	-		-	-	-
Untreated	-	12.53	14.2	10.2	12.0	13.6	14.4	12.6

[1] Table values are the means of five replications.

D. 2. Vertical soil water retention in newly sodded, drained turfgrass sites.
L. Art Spomer and A. J. Turgeon

Drained golf greens, athletic fields, and various other turfgrass planting sites are frequently backfilled with specially-prescribed coarse or very coarse-textured root growth media to compensate for the effects of the shallow (20 to 50 cm deep), perched water table which forms at the drainage level. These areas are often planted with sod grown on much finer-textured soils. This study examined the water retention in such unhomogenous soil profiles following irrigation and drainage.

Water retention in such a drained soil profile were predicted from moisture characteristics of a backfill medium (5 parts very coarse-textured river sand plus 1.25 parts silty clay loam soil), a muck soil, and Drummer silty clay loam and confirmed by water content measurements on laboratory columns duplicating drained, sodded turfgrass sites where the sod was grown on a muck or silty clay loam soil.

Figure 3 illustrates the moisture characteristics (water content as a function of pressure potential) over the pressure potential range of 0 to -50 cm water for a typical GM consisting of five parts washed, very coarse-textured river sand plus 1.25 parts silty clay loam and two typical Illinois sod producing soils: Drummer silty clay loam (SCL) and a muck soil (M). A suction plate apparatus was used for these measurements. Dry, homogeneous samples of each medium were carefully compacted until negligible bulk volume changes occurred and then vacuum-saturated with tap water prior to analysis. Total porosity was determined by liquid and gas pycnometric techniques. Since a perched water table (pressure potential = 0) forms at the drainage level in a drained turf profile (DTP) following irrigation and drainage, Figure 3 also predicts water retention as a function of height above the drainage level for each medium. Since most DTP are 20 to 40 cm deep, these moisture characteristics predict that both the SCL and M would remain essentially saturated in a DTP even though the underlying GM is only about 40% saturated following irrigation and drainage. The SCL and M sod-soil layers should therefore remain saturated even if a perched water table doesn't form at the sod GM interface.

Figure 4 illustrates water retention in 10 cm dia, drained laboratory columns consisting of 27.5 cm GM overlain by 2.5 cm SCL or M. Water was applied to the top of each column until drainage from the bottom equaled application for a period of about 10 minutes. One-cm-thick sections were then removed for gravimetric water content measurements 48 hours following wetting. Total porosity was determined by liquid and gas pycnometric techniques. Observed water retention in these columns confirm the predicted saturated sod-soil layer and unsaturated GM.

The results of this study indicate that sod grown on fine or medium-textured natural soils and planted on very coarse-textured backfill in drained turfgrass sites may remain saturated following irrigation and drainage even though the underlying backfill drains adequately. This may

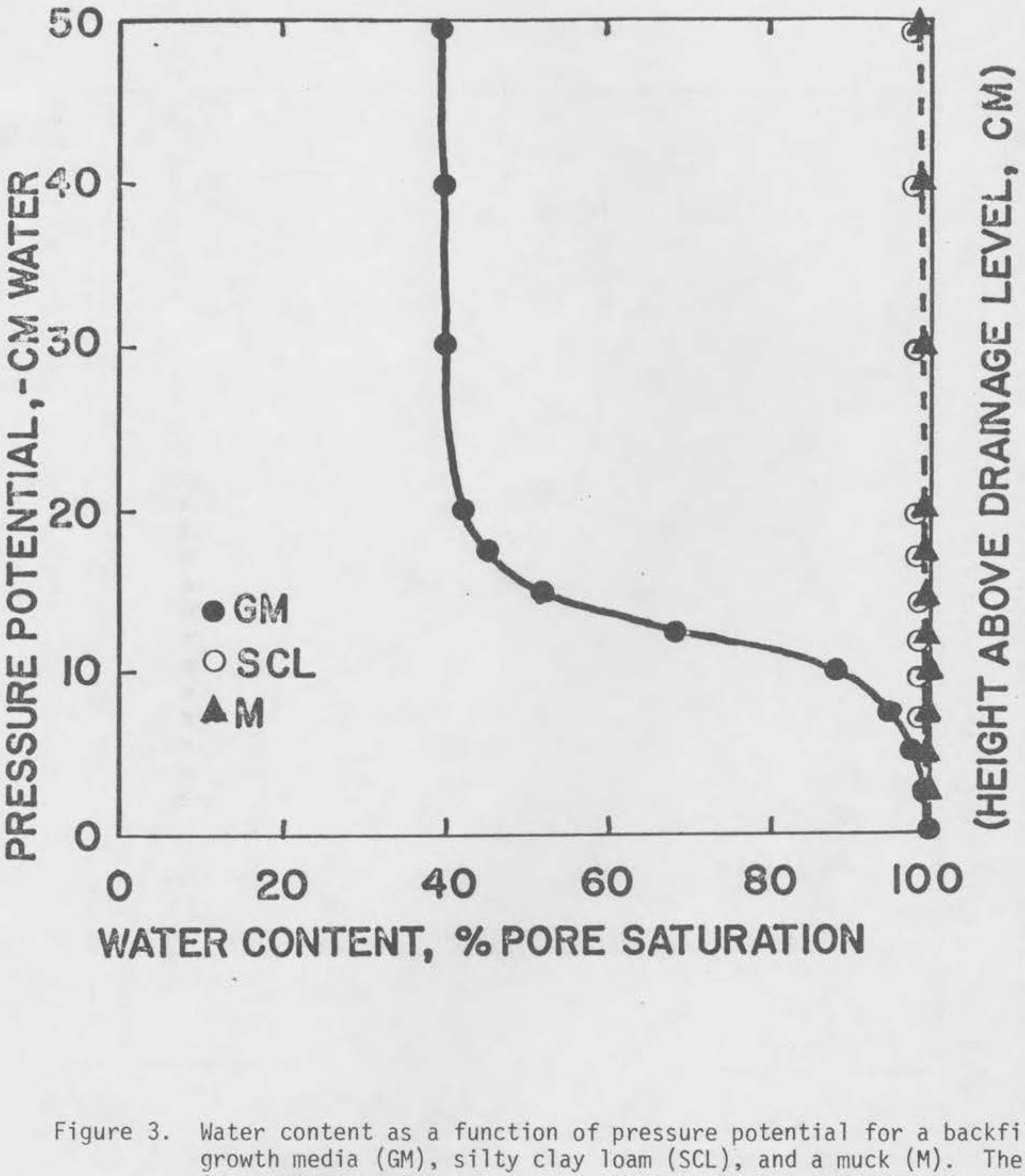

Figure 3. Water content as a function of pressure potential for a backfill growth media (GM), silty clay loam (SCL), and a muck (M). The GM consists of 5 parts washed, very coarse river sand plus 1.25 parts SCL.

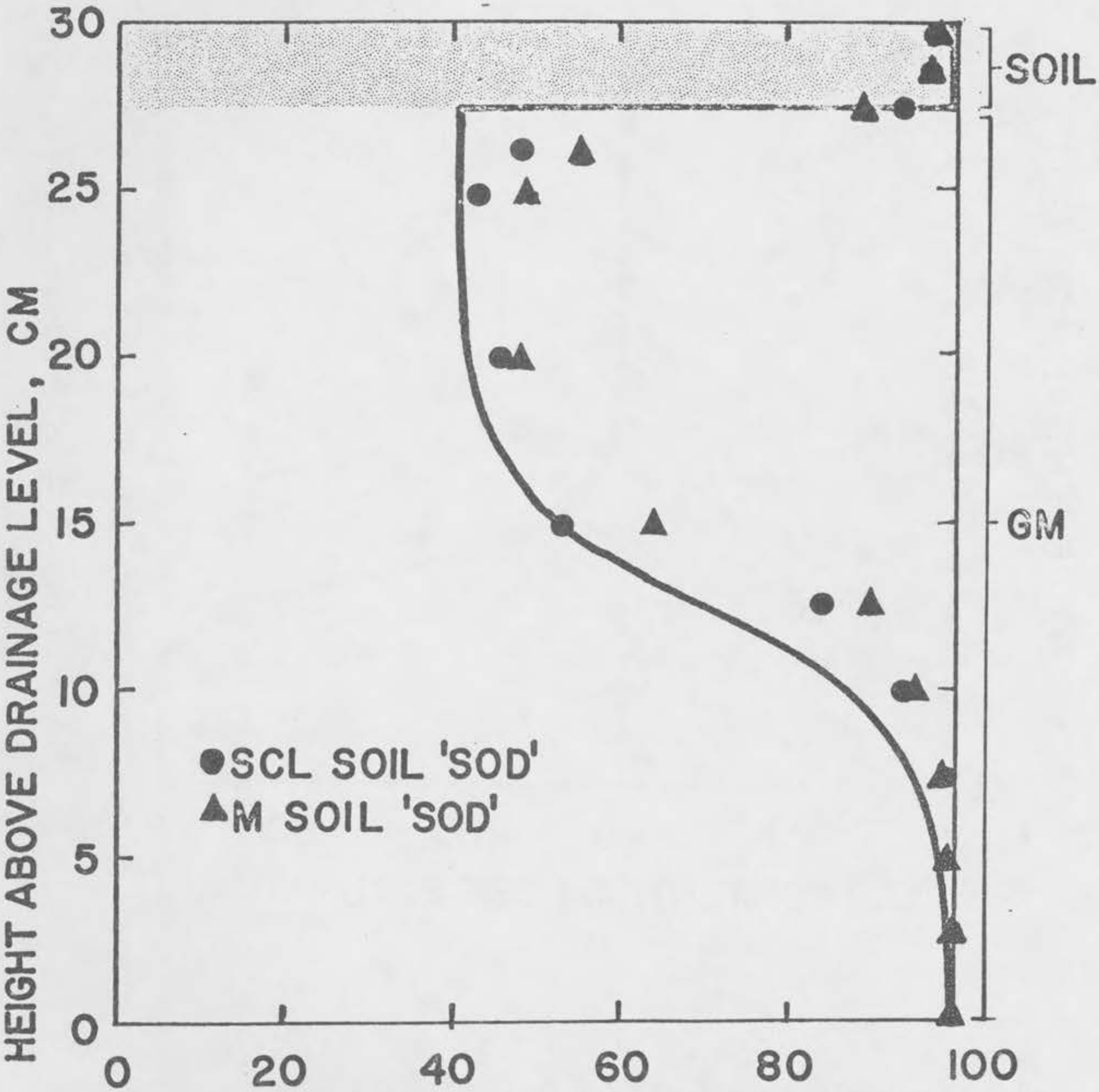

Figure 4. Water content as a function of soil height above the drainage level. The line indicates that predicted from Figure 3 data and the points indicate that observed in laboratory columns overlain with SCL or M soil layers.

retard sod rooting and affect subsequent turf growth. The significance of this effect is the subject of continued study. Possible ways of avoiding this problem are to use sod grown on soil similar to the backfill, use "soil-less sod", or use alternative methods of propagation.

D. 2. Effects of Exhalt 4-10 anti-desiccant on sod rooting.
A. J. Turgeon

Previous research at the University of Illinois has shown that soil-less (washed) sod can root faster than conventional (unwashed) sod providing midsummer stress does not cause desiccation of the sod. An evaluation was performed to determine if Exhalt 4-10 effectively reduces desiccation following planting of soil-less sod.

Sections of 'Fylking-Pennstar-Prato' Kentucky bluegrass sod, measuring 1 by 1 ft, were washed free of soil and planted in rooting screens on a sand medium in mid-August, 1976. Five replications of each treatment were used. Irrigation was performed twice daily during the experimental period. After three weeks, sod rooting strength was determined with an apparatus designed to measure the force required to lift the sod screens free from the planting medium.

Results showed no apparent benefit from the use of Exhalt 4-10; sod rooting strength did not increase (Table 32) and desiccation injury appeared slightly greater in the Exhalt 4-10-treated sod sections.

Table 32. Effects of an anti-desiccant on rooting strength of washed soil-less Kentucky bluegrass sod sections three weeks after planting in sand.

Treatment	Sod Rooting Strength[1]	
	Total	"Corrected"
	lb force/ sq ft	
Exhalt-4-10	51	30
Untreated	56	34

[1] Sod rooting strength was measured with a device designed to determine the total force required to extract 1 by 1 ft sod sections from the sand medium. The "corrected" strength is total minus the weight of the sod, planting screen (4 lb), and soil adhering to the roots after lifting.

D. 4. Kentucky bluegrass establishment with industrial sludge.
B. A. Fritz and A. J. Turgeon

The disposal of industrial wastes is a serious problem for commercial manufacturers. Suitable receptor sites for a wide assortment of waste materials are limited in the vicinity of industrial centers. Furthermore, the cost of disposal may represent a significant percentage of overall production costs. Thus, there is a growing need to identify suitable receptor sites for industrial wastes and to determine their impact at these sites. Because of their chemical and physical composition, some waste materials may actually have a beneficial effect on plant growth. The purpose of this research is to determine whether turfgrass planting sites can be used for the disposal of a waste material from a pigment manufacturing plant in Illinois. After drying and grinding, the material is a fine-textured brown powder with a density of 1 g/ml. Chemical analysis reveals that it is composed of iron oxides (ca. 40%), barium sulfate (ca. 11%) and calcium sulfate (ca. 49%).

The processed sludge was applied at the rate of 0, 50, 250 and 1250 lb/1000 sq ft to the surface of a Flanagan silt loam soil in root observation boxes and worked into the surface inch. Kentucky bluegrass was seeded on June 14, 1976, at the rate of 2 lb/1000 sq ft, and the seedbeds were irrigated twice daily to promote germination. The boxes were planted outside in order to expose the plants to normal growing conditions encountered during the summer and fall seasons. Shoot density, rooting, color, and clipping yields were measured at various intervals after planting.

Shoot density increased with increasing rates of sludge up to 250 lb/1000 sq ft, then decreased to the same level as the untreated boxes at the 1250 lb rate (Table 33). Rooting was highly variable but appeared to decrease slightly because of the sludge applications. After 49 days, a marked difference in leaf color was observed; the plants growing in soil treated with 50 and 250 lbs sludge were slightly to moderately chlorotic while the 1250 lb sludge application resulted in plants slightly darker than the plants growing in the untreated soil. After 73 days, clipping yields were taken for the first time, and values were comparable at all but the highest sludge rate; at 1250 lb/1000 sq ft, the sludge treatment resulted in a nearly five-fold increase in clipping yield over the other treatments. After allowing regrowth during the fall months, clipping yields again were highest at the highest sludge application rate.

On September 3, 1976, field plots were planted with Kentucky bluegrass after soil incorporation of dried industrial sludge at 0, 50, 250 and 1000 lb/1000 sq ft. Seedling density was measured 35 and 100 days following planting, and turfgrass cover was also estimated at the latter date. Density and cover both declined as the sludge application rate increased (Table 34). This study will be continued until the sod is sufficiently mature for harvesting.

A third study was initiated on September 6, 1976, to determine the effects of soil-incorporated sludge on sod rooting. Sections of sod measuring 1 by 1 ft were placed in rooting screens and planted on top of soil receiving 0, 50, 250 and 1250 lb sludge/1000 sq ft that was incorporated into the top inch. After three weeks, sod rooting strength was measured by determining the force required to extract the sod sections from the underlying soil. Turfgrass color was also rated at this time. Sod rooting strength declined slightly as the sludge application rate increased; however, foliar color increased (Table 35).

These studies have shown both positive and negative effects from sludge. A decline in rooting was evident from various measurements, but turfgrass density either increased or decreased depending upon where the plantings were made. In the soil contained within root observation boxes, moderate rates of sludge yielded higher density than the untreated soil while, in the field, these rates resulted in slight decreases in density and turfgrass cover. Presumably, sludge can predispose turfgrass plants to injury from climatic stress unless adequate precautions are taken to protect the plants (via enclosure within the root observation boxes or more intensive irrigation at field sites). The substantial increases in topgrowth observed in the root observation boxes where the highest (1250 lb/1000 sq ft) sludge rates were applied suggest that the sludge directly or indirectly provides nutrients important for plant growth. Sludge components include: calcium, sulfur, iron and barium. The oxides and sulfates of the sludge may also affect the availability of other nutrients contained within the soil.

Table 33. Effects of soil-incorporated industrial sludge on establishment of Kentucky bluegrass seeded in root-observation boxes.

Sludge Rate	Color[1] 2 Aug 76	Density 9 Jul 76	Density 2 Aug 76	Rooting 9 Jul 76	Rooting 2 Aug 76	Clipping dry wt 26 Aug 76	Clipping dry wt 17 Dec 76
lb/1000 sq ft		no. shoots/12.6 sq cm		no. roots @ 5-cm depth		g/639 sq cm	
0	1.5	61.3	57.7	29.3	41.7	2.5	1.5
50	2.2	100.2	64.0	19.3	39.7	2.1	0.5
250	4.5	137.3	141.7	22.7	37.0	2.5	0.5
1250	1.0	61.8	60.0	23.3	33.0	12.0	4.4

[1] Color was rated using a scale of 1 through 9 with 1 representing dark green, 5 for yellow-green, and 9 representing a complete lack of green color.

Table 34. Effects of soil-incorporated industrial sludge on establishment of Kentucky bluegrass seeded on a Flanagan silt loam field soil.[1]

Sludge Rate	Shoot Density		Turfgrass Cover
	14 Oct 76	17 Dec 76	17 Dec 76
lb/1000 sq ft	no. shoots/25 sq cm		%
0	28.0	20.2	72.5
50	25.3	18.2	72.0
250	18.4	15.0	64.2
1000	15.3	11.2	32.0

[1] Sludge surface applied and raked into top inch of soil. Kentucky bluegrass seeded at 2 lb/1000 sq ft.

Table 35. Effects of soil-incorporated industrial sludge on color and rooting strength of Kentucky bluegrass sod sections three weeks after planting in a Flanagan silt loam soil.[1]

Sludge Rate	Color[2] 27 Sep 76	Sod Strength[3]	
		Total	"Corrected"
lb/1000 sq ft		lb force/sq ft	
0	3.1	72.5	43.5
50	2.9	71.7	43.0
250	2.5	66.2	39.7
1000	1.5	60.5	36.3

[1] Sludge surface-applied and raked into top inch of soil.

[2] Color was rated using a scale of 1 through 9 with 1 representing dark green, 5 for yellow green, and 9 representing a complete lack of green color.

[3] Sod rooting strength was measured with a device designed to determine the total force required to extract 1 by 1 ft sod sections from the underlying soil. The "corrected" strength is total minus the weight of the sod, planting screen (4 lb), and soil adhering to the roots after lifting.

D. 4. Vegetative establishment of Kentucky bluegrass from plugs.
A. J. Turgeon and Edwin Solon

Research at the University of Illinois has shown that vegetative establishment of weed-free A-20 Kentucky bluegrass turf can be accomplished using closely-spaced plugs of sod in conjunction with oxadiazon (Ronstar) herbicide application to a prepared soil. Studies were undertaken in May, 1975, to determine the effects of mowing height (0.75, 1.5, 3 in.; no mowing) and fertilization level (0, 0.5, 1,2 lb N/1000 sq ft/month) on the rate of coverage by a planting of A-20 plugs subsequently treated with Ronstar 2G at 3 lb a.i./acre. Plots measured 12 by 6 ft and each treatment combination was replicated three times.

Since all previous studies were performed with A-20 Kentucky bluegrass, a study was undertaken in May, 1975, to determine the adaptability of other varieties to this method of establishment. Three replications of 2 by 2 ft plots were planted with four 2-in plugs each of 48 Kentucky bluegrass varieties. Ronstar 2G was then applied at 3 lb a.i./acre.

During the first 14 weeks, the fastest rate of coverage by A-20 occurred in the unmowed plots, or under a 3-inch mowing height and minimum of 1 lb N/1000 sq ft/month (Table 36). After 22 weeks, the plots mowed at 1.5 inches had over 60 percent cover where a minimum of 0.5 lb N/1000 sq ft/month was applied. This was comparable to many of the plots mowed at 3 inches. At 60 weeks following planting, all fertilized plots had over 90 percent cover. Nearby complete cover was observed in the fertilized plots mowed at 3 inches.

The condition of plugs of the Kentucky bluegrasses treated with Ronstar ranged from good to nearly complete necrosis depending upon variety (Table 37). Thus, plugging in conjunction with Ronstar application is not a feasible establishment method for all varieties, and careful attention should be paid to the type of sod used. Furthermore, the implication of these results is that this herbicide should not be used on those turfs composed of cultivars shown to be injured from Ronstar (i.e. Campina, Merion, Parade, Park, Pennstar, etc.). However, application of this herbicide to established plots of these same cultivars in 1976 resulted in only slight injury to Campina, EVB-305 and K1-138 (Table 42).

Table 36. Effects of mowing and fertilization on the rate of coverage by A-20 Kentucky planted from plugs in May, 1975.

Mowing[1] Height, in.	Fertilization lb N/1000 sq ft/month	Time After Planting, Weeks		
		14	22	60
0.75	0	20.0	38.3	81.7
0.75	0.5	28.3	48.3	93.3
0.75	1	23.3	41.6	91.7
0.75	2	23.3	43.3	93.3
1.5	0	31.7	48.3	83.3
1.5	0.5	43.3	63.3	96.0
1.5	1	40.0	63.3	96.3
1.5	2	38.3	63.3	94.3
3.0	0	46.7	66.7	83.3
3.0	0.5	43.3	70.0	97.7
3.0	1	60.0	73.3	97.7
3.0	2	56.7	85.0	99.0
none	0	58.3	61.6	88.3
none	0.5	50.0	68.3	97.7
none	1	61.7	75.0	99.0
none	2	65.0	78.3	99.0

[1] Mowing of the unmowed (none) plots at 3 inches was initiated in September, 1975. In July, 1976, the mowing height of all plots was adjusted to 1.5 inches.

Table 37. Effects of oxadiazon applied at 3 lb/acre in May, 1975, to field-planted plugs of Kentucky bluegrass cultivars.

CULTIVAR	Phyto toxicity[1] 7/18/75	% Cover 10/16/75	% Cover 7/14/76	CULTIVAR	Phyto- toxicity[1] 7/18/75	% Cover 10/16/75	% Cover 7/14/76
A-20	2.3	25	98	Kenblue	4.3	25	81
A-34	1.0	23	96	Majestic	3.0	22	95
Adelphi	4.3	25	87	Merion	7.7	4	30
BA 61-91	4.3	25	70	Monopoly	3.7	28	98
BA 62-55	2.3	35	78	Nugget	4.3	14	70
Baron	3.0	20	77	P-59	6.3	13	70
Bonnieblue	3.7	31	87	P-140	4.0	18	90
Brunswick	1.0	27	96	Parade	7.3	7	72
Campina	7.7	8	40	Park	6.3	17	57
Cheri	4.3	18	73	Pennstar	6.3	9	77
EVB-282	2.7	25	88	Plush	2.3	37	93
EVB-305	9.0	0	12	PSU-150	1.0	43	98
EVB-307	2.7	18	78	PSU-169	1.0	52	100
EVB-391	4.7	14	78	PSU-190	5.0	8	73
FYLKING	5.0	11	72	PSU-197	1.7	50	93
Galaxy	2.3	25	88	RAM #1	2.3	27	98
Geronimo	3.0	35	93	RAM #2	2.3	37	98
Glade	1.0	28	96	Rugby	4.3	38	93
K1-131	3.0	32	96	Sodco	1.7	37	98
K1-132	1.7	35	97	Sydsport	4.3	11	72
K1-133	2.3	18	93	Touchdown	4.3	20	83
K1-138	5.0	5	58	Vantage	2.3	35	83
K1-143	2.3	13	92	Victa	3.0	28	83
K1-157	6.3	29	70	Windsor	1.0	50	98

[1] Phytotoxicity were made using a scale of 1 through 9 with 1 representing no injury and 9 representing complete necrosis of the plugs.

D. 4. Effects of activated charcoal on turfgrass establishment.
Sherry Roethe and A. J. Turgeon

Activated charcoal has been used to adsorb residual pesticides in soil prior to planting, or to reduce turfgrass injury from inadvertent pesticide applications. There is some evidence that activated charcoal may aid turfgrass establishment on sites where there are no pesticide residues. The reasons for this are not clear, but some authors have attributed it to enhanced nutrient uptake.

Studies were conducted in the field and greenhouse to determine the effects of activated charcoal soil-treatment on seed germination, seedling vigor and sod rooting. In the greenhouse, 50 seeds each of Pennfine perennial ryegrass or A-34 Kentucky bluegrass were planted on Flanagan silt loam soil in six-inch pots. About 1 tablespoon (336 lb/acre) of dry activated charcoal (Gro-Safe) was worked into the top 1.5 inches of soil prior to seeding. Periodic counts of germinating seed and seedling height were made and, at the conclusion of the experiment, dry weights of shoots and roots were taken. Each treatment was replicated six times in a completely randomized design.

Results showed no effects of activated charcoal on percent germination, or root and shoot weight, of Pennfine and A-34 (Table 38).

In a field study, Pennfine or A-34 were seeded at 6 and 2 lb/1000 sq ft, respectively, to untreated and charcoal-treated (300 lb/acre) plots. The charcoal was applied as a slurry and incorporated into the top 1.5 inches of soil after drying. Plots measured 2 by 2 ft and each treatment was replicated five times. After 10 weeks, 2-in plugs were taken from each plot for density counts, and root and shoot dry weights.

Again, no significant effects on seedling density, or root and shoot weights, resulted from activated charcoal soil-treatment (Table 39).

In the greenhouse, 6-in pots were seeded with A-34 and Pennfine in untreated and activated charcoal-treated soil as in the first study. Foliar height of seedlings was measured over a 49-day experimental period.

No significant effects on top growth were observed from soil-incorporation of activated charcoal in this study (Table 40). Thus, from these studies, it appears unlikely that activated charcoal enhances germination or seedling growth of Kentucky bluegrass or perennial ryegrass in soil free of pesticide residues.

A series of field experiments were initiated in the fall of 1975 to determine if activated charcoal soil-treatment would enhance rooting from freshly plant sod. A-34 Kentucky bluegrass sod was cut into 1 by 1 ft sections and planted in rooting screens on both sand and Flanagan silt loam soil media. Under one-third of the sod sections, activated charcoal was applied at 300 lb/acre and incorporated into the top 1.5 inches of planting medium. In a second treatment, activated charcoal was applied to the sod surface after planting. Treatments including controls, were replicated five times in each of three experiments. After three weeks, the sod sections were extracted from their media to measure rooting strength.

Results showed significant enhancement of sod rooting in two of the three experiments from both soil-applied and sod-applied activated charcoal treatments to the soil media (Table 41). The lack of significant differences in the October 31 study was probably due to the unfavorable growing conditions existing at that time. The reason for these positive results is not known since pesticide residues did not exist on the experimental site. Activated charcoal did not induce greater sod rooting strength whose sod sections were planted on sand; however, root growth was much less in the sand, compared to the soil, in the September study. Additional research is necessary to adequately explain these results.

Table 38. Effects of activated charcoal (336 kg/ha) on germination 26 days after seeding, and shoot and root growth two months after seeding 'Pennfine' perennial ryegrass and 'A-34' Kentucky bluegrass in the greenhouse.[1]

Treatment	Pennfine			A-34		
	Germination	Shoot wt	Root wt	Germination	Shoot wt	Root wt
	%	$g/75cm^2$	$g/75\ cm^2$	%	$g/75\ cm^2$	$g/75\ cm^2$
Charcoal	86.4	2.23	1.30	52.4	0.22	0.14
Untreated	86.7	1.75	1.22	53.0	0.24	0.14

[1] No significant difference between means in column at the 5 percent level.

Table 39. Effects of activated charcoal (336 kg/ha) on shoot and root growth of 'Pennfine' perennial ryegrass and 'A-34' Kentucky bluegrass ten weeks after seeding in the field.[1]

Treatment	Pennfine			A-34		
	Shoot density	Shoot wt	Root wt	Shoot density	Shoot wt	Root wt
	$No./20\ cm^2$	$g/20\ cm^2$	$g/20\ cm^2$	$No./20\ cm^2$	$g/20\ cm^2$	$g/20\ cm^2$
Charcoal	31.3	0.50	0.68	34.3	0.10	0.13
Untreated	27.7	0.25	0.75	41.0	0.13	0.20

[1] No significant difference between means in column at the 5 percent level.

Table 40. Effects of activated charcoal (336 kg/ha) on foliar height of 'Pennfine' perennial ryegrass and 'A-34' Kentucky bluegrass established from seed in the greenhouse.[1]

Treatment	Pennfine Days After Planting					A-34 Days After Planting				
	19	26	33	40	49	19	26	33	40	49
					mm					
Charcoal	88	131	150	170	154	20	30	41	56	82
Untreated	93	123	150	165	160	24	39	60	76	101

[1] No significant difference between means in column at the 5 percent level.

Table 41. Effects of activated charcoal (336 kg/ha) on sod rooting strength of 'A-34' Kentucky bluegrass in sand and soil three weeks after planting at three dates.

Treatment	Exp I - 9/29/75				Exp II - 10/31/75				Exp III - 4/19/76	
	Total SRS		"Corrected" SRS		Total SRS		"Corrected" SRS		Total SRS	"Corrected" SRS
	Sand	Soil	Sand	Soil	Sand	Soil	Sand	Soil	Soil	Soil
	kg/900 sq cm									
Charcoal applied to rooting media	53.4	113.0*	29.9	80.8*	28.4	36.4	20.0	21.2	71.7*	47.5*
Charcoal applied to sod surface	53.8	116.0*	29.6	77.3*	28.8	42.0	19.2	24.8	71.2*	47.8*
Untreated	54.3	89.0	29.0	51.8	27.3	31.3	18.5	18.5	50.5	30.5

* Means in column significantly different at the 5% level.

E. 3. a. Kentucky bluegrass cultivar, blend and mixture evaluation.
A. J. Turgeon and J. E. Haley

The intraspecific variability of Kentucky bluegrass has allowed the development of many cultivars and experimental selections that differ widely in their color, texture, density, environmental adaptation, disease susceptibility, and other factors. There are 52 varieties plus 10 blends and 4 mixtures from an April, 1972 planting under test at this station. Plots measure 6 by 8 ft and each variety is replicated three times. Fertilizer is applied 4 times per year to supply a total of 4 pounds of nitrogen per 1000 sq ft, using 10-6-4 analysis fertilizer. Mowing is performed 2 or 3 times per week at 1.5 inches. The turf is irrigated as needed to prevent wilt. The basis for these efforts is that improvements in the characteristics and adaptation of a turfgrass reduce its dependency on cultural practices designed to compensate for its weaknesses. Thus, turfgrass management is made simpler and higher turfgrass quality is obtainable with the use of improved varieties.

The disease of principal importance this year was *Helminthosporium* leaf spot during April and May. This is reflected in the May quality data (Table 42). Unlike the 1974 and 1975 seasons, *Fusarium* blight disease did not occur extensively in the plots. Presumably, the lack of *Fusarium* blight was associated with relatively mild weather during August. Stripe smut disease symptoms were evident in late August, but they did not occur uniformly over the experimental site.

The blends reflect disease and quality levels that represent compromises between the two component varieties. Considering the fact that no variety is perfect, blending superior varieties allows for incorporating the desirable features of each component while reducing the impact of a specific weakness on general turfgrass quality. The Kentucky bluegrass (Fylking)-fine fescue mixtures have been higher quality turfs than in previous years. Again, this is probably due to the more favorable growing conditions for red fescue during mid-1976.

Table 42. Quality of Kentucky bluegrass cultivars in 1976.

Cultivar	Stripe Smut 8/27/76	Oxadiazon Phytotox-icity[1]	Fall Color 12/17/76	Quality[2]				
				5/18/76	7/12/76	8/13/76	9/16/76	10/18/76
A-20 (seeded)	2.3	1.0	4.7	2.7	2.3	2.0	1.3	2.7
A-20 (veg)	1.7	1.0	4.7	2.7	2.7	2.7	1.7	3.0
A-34	1.0	1.0	4.0	3.0	2.7	2.7	2.0	2.0
A-20-6	1.3	1.0	5.3	2.7	2.0	2.7	1.3	2.0
Adelphi	1.7	1.0	4.0	2.7	3.0	3.3	2.3	3.0
Ba 61-91	2.3	1.0	4.7	3.7	3.0	3.3	1.7	2.3
Ba 62-55	1.7	1.0	4.0	3.3	2.3	3.7	2.3	3.3
Baron	2.7	1.0	4.0	3.3	3.0	3.3	1.0	3.3
Bonnieblue	1.3	1.0	4.3	2.3	3.0	4.0	3.7	3.7
Brunswick	1.7	1.0	4.0	3.7	2.7	3.3	2.0	2.0
Campina	1.3	2.7	4.3	6.7	4.0	3.7	3.7	3.7
Cheri	1.7	1.0	5.0	3.7	2.7	2.7	1.7	2.7
Delft	3.0	1.0	4.0	3.3	2.7	3.0	3.0	3.7
Enmundi	1.7	1.0	4.3	3.0	2.7	2.7	2.0	3.0
EVB-305	1.3	2.7	4.0	3.0	3.7	3.0	3.0	2.7
Entopper	1.7	1.0	5.0	3.7	3.0	3.0	3.0	3.3
Enoble	1.0	1.0	5.3	3.0	3.0	2.7	2.0	2.7
Fylking	1.3	1.0	4.0	2.3	3.0	3.3	3.0	3.3
Galaxy	1.7	1.0	4.0	3.0	3.0	3.0	2.0	3.0
Geronimo	1.3	1.0	5.7	3.7	3.3	3.3	2.3	3.0
Glade	1.3	1.0	4.7	3.0	2.7	3.3	1.7	3.0
K1-131	1.3	1.0	5.0	3.3	3.0	3.3	2.3	3.7
K1-132	2.7	1.0	5.3	3.3	3.0	4.0	2.0	3.3
K1-133	4.0	1.0	5.0	3.3	2.7	3.3	4.0	4.0
K1-138	2.0	2.0	4.0	5.0	4.0	3.7	4.7	5.0
K1-143	4.0	1.0	4.3	3.0	2.3	2.7	2.7	3.3
K1-157	1.7	1.0	6.0	4.7	3.0	3.0	3.3	3.3
K1-158	1.3	1.0	6.3	5.3	3.0	3.0	3.0	3.7
K1-187	2.7	1.0	5.0	3.0	3.3	3.3	3.3	3.3

Table 42 (Continued)

Cultivar	Stripe Smut 8/27/76	Oxadiazon Phytotox-icity[1]	Fall Color 12/17/76	Quality[2]				
				5/18/76	7/12/76	8/13/76	9/16/76	10/18/76
Kenblue	1.0	1.0	4.7	5.0	3.3	3.7	3.3	3.3
IL-3817	1.7	1.0	5.0	3.7	3.7	3.7	4.3	3.7
Majestic	1.3	1.0	4.3	2.7	2.7	3.3	3.0	3.7
Merion	1.0	1.0	4.0	3.3	3.3	3.0	3.0	3.0
Monopoly	3.7	1.0	4.7	2.7	2.0	3.3	2.0	3.0
Nugget	1.0	1.0	4.7	2.7	3.7	4.0	3.3	3.7
P-59	1.3	1.0	3.7	2.7	3.0	2.7	1.7	2.0
P-140	1.0	1.0	6.0	3.7	2.7	2.3	2.3	2.3
Parade	1.3	1.0	4.0	3.0	3.0	2.3	2.0	2.7
Park	1.7	1.0	4.3	5.3	3.0	3.7	3.7	3.7
Pennstar	2.0	1.0	4.0	2.7	2.7	3.0	2.7	3.0
Plush	1.7	1.0	4.0	3.3	2.3	2.3	2.3	2.3
PSU-150	1.3	1.0	5.0	2.7	2.7	2.3	1.0	2.7
PSU-169	3.3	1.0	5.0	3.0	2.7	3.0	2.0	3.0
PSU-190	1.3	1.0	4.7	3.0	2.7	2.7	2.3	3.0
PSU-197	1.3	1.0	4.7	3.7	3.0	3.3	2.7	3.3
RAM #1	1.0	1.0	4.7	3.7	3.3	3.7	1.7	3.0
RAM #2	2.3	1.0	5.0	3.0	2.7	3.0	2.7	3.7
Rugby	1.3	1.0	4.0	3.0	3.3	2.7	1.7	3.0
Sodco	1.3	1.0	5.0	3.0	2.7	2.3	1.7	2.7
Sydsport	1.0	1.0	4.7	3.0	3.0	3.0	1.3	2.7
Touchdown	1.7	1.0	4.7	2.3	2.7	3.3	1.7	3.0
Vantage	1.3	1.0	4.0	4.0	3.0	3.3	2.7	2.7
Victa	4.3	1.0	4.0	3.7	2.3	3.7	2.3	3.7
Windsor	1.0	1.0	5.3	3.3	3.0	3.0	2.0	2.7

Table 42 (Continued)

Cultivar	Stripe Smut 8/27/76	Oxadiazon Phytotoxicity[1]	Fall Color 12/17/76	5/18/76	7/12/76	8/13/76	9/16/76	10/18/76
. . . . Blends								
Merion + Kenblue	1.0		4.0	3.7	3.0	3.0	2.7	3.0
Merion + Pennstar	1.0		4.7	3.0	2.7	2.7	2.3	3.0
Merion + Baron	1.7		4.0	3.3	3.0	3.0	1.7	3.0
Nugget + Pennstar	2.0		5.0	2.3	3.0	3.7	2.3	3.0
Nugget + Park	1.7		4.3	4.3	3.7	3.3	2.0	3.0
Nugget + Glade	1.7		4.3	3.0	3.0	3.3	2.0	3.0
Nugget + Adelphi	2.0		4.0	2.7	3.7	3.0	2.3	3.0
Victa + Vantage	2.3		4.7	3.0	2.7	3.3	2.0	3.0
P-59 + Brunswick	2.7		4.0	3.7	2.3	2.7	2.3	2.3
Blend 38	2.3		4.7	3.0	3.0	3.0	1.7	2.7
. . . . Mixtures								
Fylking + Jamestown RF	1.0		4.0	3.3	3.0	3.7	3.7	3.7
Fylking + Pennlawn RF	1.3		4.7	4.0	3.0	3.7	4.7	3.7
Fylking + C-26 RF	1.0		4.0	3.7	2.7	3.7	4.0	4.0
Fylking + Pennfine PR	1.0		7.0	3.0	3.0	3.7	3.3	3.7

[1] Phytotoxicity from oxadiazon (Ronstar 26) herbicide applied at 3 lb/acre was rated using a scale of 1 through 9 with 1 representing no injury and 9 representing complete necrosis of the treated turf.

[2] Quality was rated using a scale of 1 through 9 with 1 representing perfect quality and 9 representing very poor quality.

E. 3. a. Expanded Kentucky bluegrass selection evaluation.
A. J. Turgeon and J. E. Haley

With the introduction of many new experimental selections, a new series of Kentucky bluegrass plots were planted in September, 1974, to determine their performance in central Illinois. Plot size was 5 by 6 ft and each selection was planted at 2 lb/1000 sq ft in three replicate plots. Cultural practices are conducted as in the Kentucky bluegrass cultivar evaluation.

The principal diseases evident in these plots were dollar spot and rust (Table 43). Quality level varied with Kentucky bluegrass selection and time during the growing season. Data collected during subsequent seasons will be needed before these selections can be adequately characterized in terms of their likely performance under our conditions.

Table 43. Kentucky bluegrass experimental selection evaluation.[1]

Selection	Rust Disease[2] 20 Oct 76	Dollar Spot[2] 11 Aug 76	Quality[3] 15 Jul 76	Quality[3] 10 Aug 76	Quality[3] 21 Sep 76	Quality[3] 20 Oct 76
Adiker A214	4.0	4.3	3.3	4.7	6.0	5.7
Adiker K1096	4.0	3.3	3.3	4.0	5.3	5.3
Burl D517	4.0	4.3	3.7	4.3	5.0	6.0
Burl F1086	3.0	3.3	3.7	3.7	4.3	4.7
Burl F1145	3.0	3.0	3.0	3.3	4.7	4.3
Burl F2039	3.7	3.3	4.0	4.3	5.0	5.3
Calturf P143	4.0	3.3	4.0	4.0	5.7	5.3
Grun K860	3.0	4.3	3.7	4.3	5.3	5.3
GWSH #2	4.3	4.3	4.0	4.7	5.0	5.3
NK-P154	4.0	3.0	3.3	3.3	4.0	3.7
P-3N	3.3	3.0	3.0	3.7	4.3	4.3
P-167	3.7	4.3	4.0	4.7	6.0	5.7
Princeton 104	3.7	4.3	3.3	3.7	4.3	3.7
Princeton 164	3.3	4.0	4.0	4.0	5.0	4.3
K1-80	4.3	5.0	4.0	5.7	6.0	5.7
K1-88	5.0	3.3	4.3	4.0	5.7	5.3
K1-121	4.0	4.3	4.0	5.0	5.3	5.0
K1-122	4.7	4.7	4.7	5.3	6.0	5.7
K1-136	3.3	4.3	4.0	4.0	5.7	5.7
K1-140	3.0	4.7	3.7	5.7	5.3	4.7
K1-144	2.3	3.7	3.0	4.0	5.0	4.7
K1-152	5.3	3.7	4.0	3.7	4.0	5.0
K1-153	4.0	4.3	4.3	5.3	6.0	5.3
K1-154	3.7	4.0	4.0	4.3	5.7	5.3
K1-159	3.3	3.3	4.0	3.7	5.3	5.3
K1-165	5.3	5.7	4.7	6.0	6.0	6.7
K1-189	3.3	3.7	3.7	4.7	5.3	6.0
K2-200	3.3	3.7	4.3	4.7	5.7	5.7
K3-162	2.7	3.0	4.0	3.7	4.3	4.0
K3-164	3.0	3.3	4.0	4.0	5.0	5.0

Table 43 (Continued)

Selection	Rust Disease[2] 20 Oct 76	Dollar Spot[2] 11 Aug 76	Quality[3] 15 Jul 76	10 Aug 76	21 Sep 76	20 Oct 76
K3-166	3.3	3.7	3.7	4.0	4.0	4.0
K3-168	3.3	3.3	3.7	4.0	5.3	5.0
K3-169	3.3	4.0	4.0	4.0	5.0	5.3
K3-170	4.3	3.7	3.7	4.7	5.3	6.0
K3-171	5.0	4.0	3.7	4.7	5.3	6.0
K3-172	3.3	3.3	4.3	4.3	5.3	4.7
K3-174	3.7	4.0	3.7	5.0	5.0	5.7
K3-178	3.3	3.7	4.0	4.7	4.7	5.0
K3-179	3.3	4.0	4.3	5.0	5.3	6.0
K3-180	3.7	3.7	3.7	4.0	4.7	5.0
K3-181	2.7	3.3	3.7	5.0	5.0	5.0
K3-182	3.3	4.3	3.7	5.7	5.7	5.3
K3-222	3.3	4.0	4.3	5.3	5.7	5.3
K8-176	3.3	2.7	4.0	3.7	4.3	5.3
WTN-A20-6	5.3	4.3	3.7	4.7	5.0	5.3
WTN-A29-10	5.0	4.3	3.0	4.3	4.3	5.3
WTN-H-11	5.0	4.0	3.3	4.0	4.3	4.3
WTN-I-13	4.7	4.7	3.7	4.7	4.7	4.3
WTN-N-1	5.0	3.3	2.7	4.0	4.7	5.0
WTN-N-37	4.3	4.0	3.0	4.0	4.7	5.3
WTN-0-59	3.0	3.7	3.7	3.7	4.0	3.3
WTN-0-758	3.0	2.7	2.3	3.3	3.7	4.7
Newport	3.3	3.3	3.3	4.3	5.3	4.7
Park	5.3	3.3	3.3	3.3	5.3	5.7
Aquilla	2.7	4.0	2.7	4.3	4.3	4.0

Table 43 (Continued)

Selection	Rust Disease[2] 20 Oct 76	Dollar Spot[2] 11 Aug 76	Quality[3] 15 Jul 76	10 Aug 76	21 Sep 76	20 Oct 76
. . . . Combinations						
WTN #1	3.7	3.3	3.0	4.0	3.7	4.7
WTN #2	5.0	4.3	3.3	4.3	3.7	4.7
Prato-Fylking-Ronstar	3.7	4.0	3.3	4.7	4.7	4.0
Adelphi-Aquilla-Parade-Nugget	3.3	5.3	4.3	5.3	5.0	4.3
Adelphi-Aquilla-Parade	3.0	5.0	4.0	4.7	5.0	4.3
Majestic-Nugget	3.3	4.3	3.0	4.0	5.3	5.0
Adelphi-Baron-Bonnieblue	3.7	4.0	3.3	4.0	5.0	5.3
Brunswick-Parade	5.3	3.3	3.0	3.3	4.3	5.7
Baron-Nugget	4.0	5.3	4.0	6.0	5.3	5.3
Pennfine-Majestic	4.7	6.0	6.7	6.7	6.3	6.0
Sydsport-Majestic	4.7	3.3	3.3	3.7	4.0	4.3

[1] Planted September, 1974.

[2] Disease ratings were made using a scale of 1 through 9 with 1 representing no disease and 9 representing complete necrosis.

[3] Quality ratings were made using a scale of 1 through 9 with 1 representing perfect quality and 9 representing very poor quality.

E. 3. b. Fine fescue cultivar evaluation
A. J. Turgeon and J. E. Haley

Fine-leaf fescues (creeping red, Chewings, hard and sheep) have traditionally been used as shade grasses or for drouthy, sandy sites. Their performance in sunny locations on fine-textured Illinois soils has generally been unsatisfactory.

The fine-leaf fescue cultivars were planted April, 1972. Plots measured 6 by 8 ft and each is replicated three times. Fertilizer is applied twice yearly to supply a total of 2 lb N/1000 sq ft.

None of the cultivars provided high quality turf under the experimental conditions (Table 44). Of the group, Jade, Scaldis and C-26 ranked best; however, turfgrass quality deteriorated substantially during the summer months.

Table 44. Performance of fine-leaf fescue cultivars in 1976.

Cultivar	Quality Rating[1]				
	5/18/76	7/12/76	8/13/76	9/23/76	10/18/76
Barfalla	4.7	4.3	5.3	5.7	4.7
Dawson	6.0	4.3	5.3	7.3	6.3
Encota	6.0	5.0	6.3	6.7	6.7
Flavo	5.7	4.3	6.0	6.3	6.3
Highlight	7.7	7.7	7.0	8.3	7.3
Jade	3.0	4.7	6.0	4.7	4.7
Jamestown	4.3	4.7	5.3	6.3	4.7
Koket	3.3	6.0	6.0	6.3	4.7
Menuet	3.7	4.7	6.0	5.7	5.0
Oregon-K	4.7	3.7	5.7	6.0	5.7
Pennlawn	4.7	4.3	6.7	6.3	5.7
Polar	5.7	3.0	5.7	5.3	5.7
Roda	5.3	6.7	7.3	7.3	5.7
Scaldis	3.0	3.3	6.0	6.0	5.3
Waldorf	5.7	6.0	7.0	6.7	6.7
C-26	3.0	3.7	6.0	6.0	5.0
CEBECO S70-2	6.0	7.7	6.3	8.3	7.7
CEBECO Hz71-4	6.3	7.7	7.3	8.3	7.3

Table 44 (Continued)

Cultivar	Quality Rating[1]				
	5/18/76	7/12/76	8/13/76	9/23/76	10/18/76
ERG-11	7.0	7.0	7.0	7.7	7.3
Scarlet	6.0	6.0	7.0	7.7	6.7
Hf-11	6.3	6.7	7.0	7.0	5.3
Durlawn	6.7	4.0	6.7	6.7	7.3
Novarubra	5.0	3.7	5.7	6.0	5.3
Barok	5.7	4.7	6.7	6.7	6.0
RU-45C	4.7	5.7	6.3	7.0	6.3
C-26 + Jamestown	4.0	4.3	6.3	6.7	5.7

[1] Quality ratings were made using a scale of 1 through 9 with 1 representing best quality and 9 representing poorest quality.

[2] Disease ratings were made using a scale of 1 through 9 with 1 representing no disease and 9 representing complete necrosis of the turf.

E. 3. c. Creeping bentgrass cultivar evaluation.
A. J. Turgeon and J. E. Haley

Creeping bentgrass cultivars were established in May, 1973, in plots measuring 6 by 8 ft with three replications of each variety. Mowing height is 0.25 in. and the plots receive a total of 4 lb N/1000 sq ft annually. Irrigation is performed as needed to prevent wilting. Fungicides were not applied in 1976 in order to differentiate disease incidence in the cultivars.

The cultivars varied widely in their quality ratings due to differences in texture, color, density, annual bluegrass invasion and disease incidence (Table 45). The poorest cultivar was Toronto which deteriorated severely in 1974 due to red leaf spot disease and, now, annual bluegrass covers over 50 percent of the plot areas. In contrast, the Toronto plots at the two satellite stations (Scott Air Force Base, Chicago Botanic Garden) have been good quality turfs since red leaf spot disease did not occur at those locations. Good turfgrass quality has been observed with Washington, Cohansey, Pennpar, Old Orchard, Nimisilla, and the experimental selections: Morrissey, MSU-Ap-28 and MSU-Ap-38. Annual bluegrass invasion varied from 0 to 53 percent among 18 cultivars.

Table 45. Creeping bentgrass cultivar evaluation.[1]

Cultivar	Dollar Spot[2] 8/13/76	Brown Patch[2] 8/13/76	% Annual Bluegrass 7/14/76	Quality[3] 5/18/76	7/14/76	8/13/76	10/4/76
Seaside	2.3	1.3	25.0	5.7	5.0	4.7	4.7
Penncross	2.7	1.3	10.0	5.0	3.3	4.0	4.7
Washington	2.7	1.7	11.7	4.3	3.7	4.0	6.7
Toronto	4.3	1.0	53.3	8.0	7.3	6.7	6.0
Cohansey	2.7	3.0	15.0	4.7	3.3	4.3	6.7
Pennpar	1.7	1.7	8.3	5.3	3.0	3.3	3.3
Pennlu	2.0	2.7	31.6	7.0	6.7	6.0	4.7
Arlington	2.0	3.3	18.3	6.7	5.0	5.3	5.0
Emerald	3.0	2.7	26.7	6.0	4.3	5.3	6.7
Congressional	2.7	2.0	16.7	5.7	5.0	4.7	6.3
Old Orchard	3.0	1.7	7.6	4.7	4.0	4.7	6.3
Metropolitan	1.7	2.0	16.6	6.0	6.0	5.7	2.7
Collins	2.0	2.3	15.0	5.7	4.3	4.7	4.0
Nimisilla	3.0	1.0	3.3	4.7	3.3	4.3	7.7
Morrissey	2.3	1.0	10.0	4.3	3.3	4.0	4.3
MSU-Ap-18	2.7	1.0	3.7	5.0	3.3	4.7	7.7
MSU-Ap-28	4.0	1.0	1.7	4.7	2.3	4.3	7.0
MSU-Ap-38	2.7	1.0	0	4.3	2.3	4.0	6.7

[1] Planted May 18, 1973.

[2] Disease ratings were made using a scale of 1 through 9 with 1 representing no disease and 9 representing complete necrosis.

[3] Quality ratings were made using a scale of 1 through 9 with 1 representing perfect quality and 9 representing very poor quality.

E. 3. d. Perennial ryegrass cultivar evaluation.
A. J. Turgeon and J. E. Haley

Perennial ryegrass is usually considered a temporary lawn grass, or a nurse grass in seed mixtures. In Illinois, deterioration during the summer months has prevented perennial ryegrass from becoming an important permanent turfgrass. Improved varieties with better color, density, mowing quality and disease resistance have challenged the traditional image of perennial ryegrass.

In mid-March, most of the ryegrasses reflected moderate to severe winter injury; however, the condition of Manhattan and NK-200 indicated superior cold hardiness for these cultivars (Table 46). By mid-May, all cultivars had recovered completely; quality differences were a reflection of density, color and mowability. In July, the superior quality of Pennfine was due to its outstanding midsummer stress tolerance. Manhattan had the best quality under cool, fall conditions.

Table 46. Quality of perennial ryegrass cultivars.

Cultivar	Quality[1]					
	3/15/76	5/18/76	7/12/76	8/13/76	9/21/76	10/18/76
Common	7.7	6.0	6.3	5.3	4.3	4.3
K8-137	5.7	2.7	4.0	4.0	2.3	3.3
K8-142	4.3	3.0	3.7	4.0	3.3	4.0
Manhattan	3.3	2.0	3.7	3.3	1.3	2.7
NK-100	6.7	3.3	3.7	4.7	3.3	3.7
NK-101	4.7	4.0	4.3	4.3	3.3	3.3
NK-200	3.3	2.7	3.7	4.7	3.7	4.0
Pelo	7.0	3.7	4.3	4.0	3.3	3.7
Pennfine	5.0	2.3	2.0	3.3	2.3	3.3

[1] Quality ratings were made using a scale of 1 through 9 with 1 representing perfect quality and 9 representing very poor quality.

E. 3. e. Coarse fescue cultivar evaluation.
A. J. Turgeon and J. E. Haley

Coarse fescues include tall fescue (Festuca arundinacea) and meadow fescue (Festuca elatior). These are similar species that are very difficult to distinguish from each other based on vegetative features. Although tall fescue is the principal turfgrass species, the recent introduction of a meadow fescue selection from the Michigan State University experiment station necessitates the use of the collective reference - coarse fescue.

Plots were established in September, 1974, measuring 5 by 6 ft in three replications. The plots are mowed two or three times per week at 1.5 inches. Total annual fertilization is 4 lb N/1000 sq ft applied in 1 lb increments in April, May, August and September with a 10-6-4 water-soluble fertilizer. Irrigation is conducted as needed to prevent wilting.

In March, 1976, turfgrass quality varied widely among the selections due to their differential winter hardiness; Maris Kasbah, Maris Jebal and KO-103 were moderately-to-severely injured while the other selections exhibited good cold hardiness (Table 47). Quality of the MSU meadow fescue deteriorated substantially during late summer due, presumably, to its poor heat tolerance. A non-replicated plot of Kentucky-31 tall fescue, which is widely used in southern Illinois, appeared as good as any of the experimental selections.

Table 47. Coarse fescue cultivar evaluation.

Cultivar	Quality				
	3/15/76	7/15/76	8/10/76	9/21/76	10/20/76
MSU MF	4.3	4.0	5.3	8.0	6.7
Maris-Kasbah TF	6.3	7.0	6.3	7.3	6.0
Maris-Jebal TF	8.7	8.3	8.0	8.0	7.7
KO-103	7.7	8.0	7.3	7.3	7.3
KO-111	3.7	5.3	5.0	5.0	5.7
K4-204	3.7	4.7	4.3	4.0	5.3
K8-108	5.0	6.0	5.0	5.3	6.0

G. 2. Soil physical amendment for golf greens and other drained soils.
L. Art Spomer

A perched water table forms at the drainage level following the irrigation and drainage of a drained soil such as a golf green. Since these soils are typically relatively shallow (25-35 cm), most natural soils would remain saturated under the influence of the perched water table and plant growth would likely be adversely affected by the poor soil aeration conditions which result. This problem is solved in practice by developing special media consisting of sufficient very coarse-textured media to provide adequate small, water retention pores (which remain saturated following drainage). Unfortunately most of the development of these media has consisted of "trial-and-error studies" rather than systematic physical examinations of how aeration and water retention are affected by different proportions of components.

This project has developed a simple physical model which can be used to predict the total, aeration, and water retention porosity of any mixture of very coarse-textured and fine-textured components (Figure 5). This model has been thoroughly tested in the lab and was found to be an accurate predictor of mixture physical properties (Figure 6).

The final stages in this project is to determine plant requirements for water and aeration and "field testing" of the model.

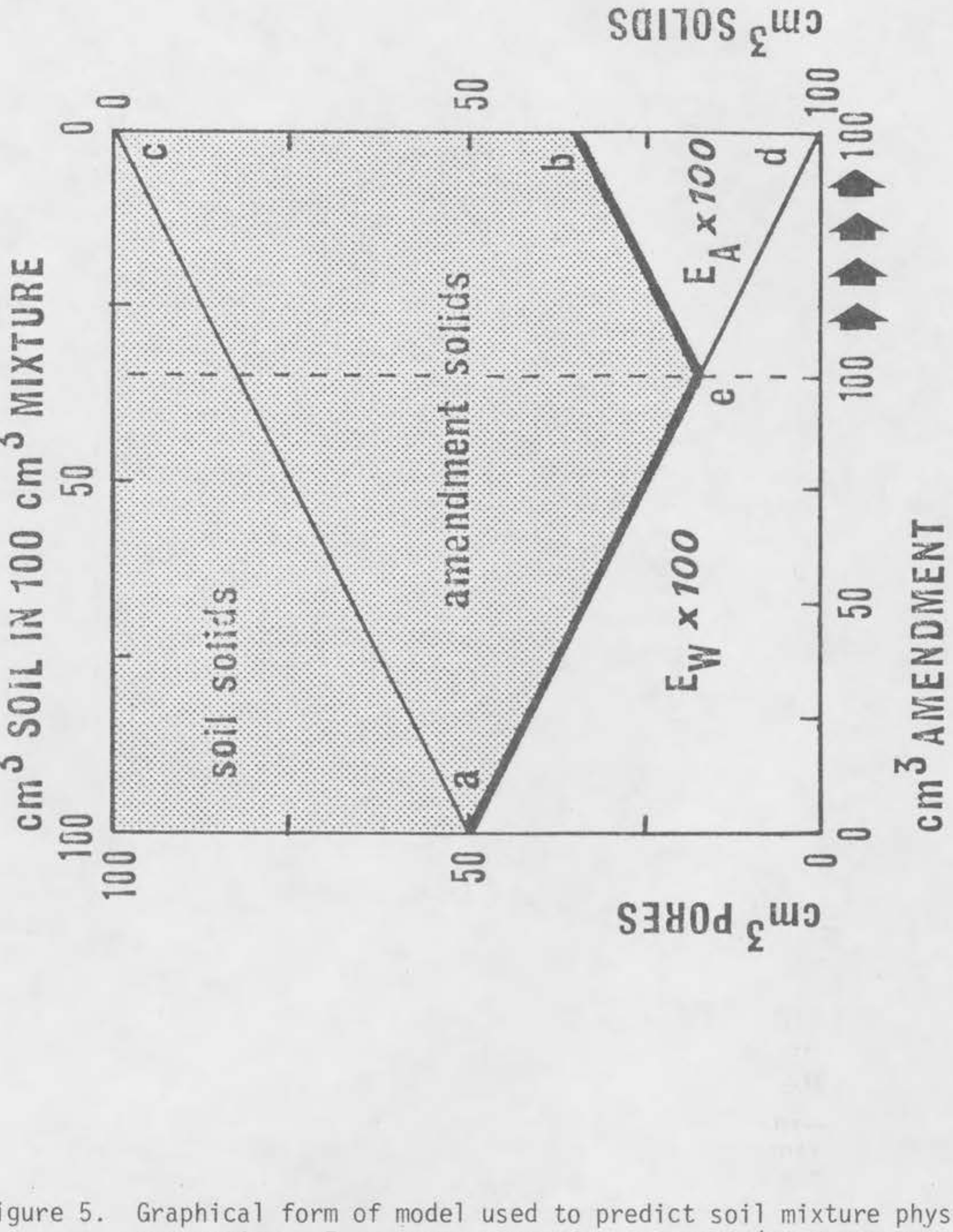

Figure 5. Graphical form of model used to predict soil mixture physical properties. E_W = water retention porosity (in drained golf green) and E_A = aeration porosity, a = soil porosity and b = amendment porosity. The dashed line (e) is the threshold proportion. The amount of soil in the mix decreases from left to right (proportion of amendment increases). Total porosity = $E_W + E_A$.

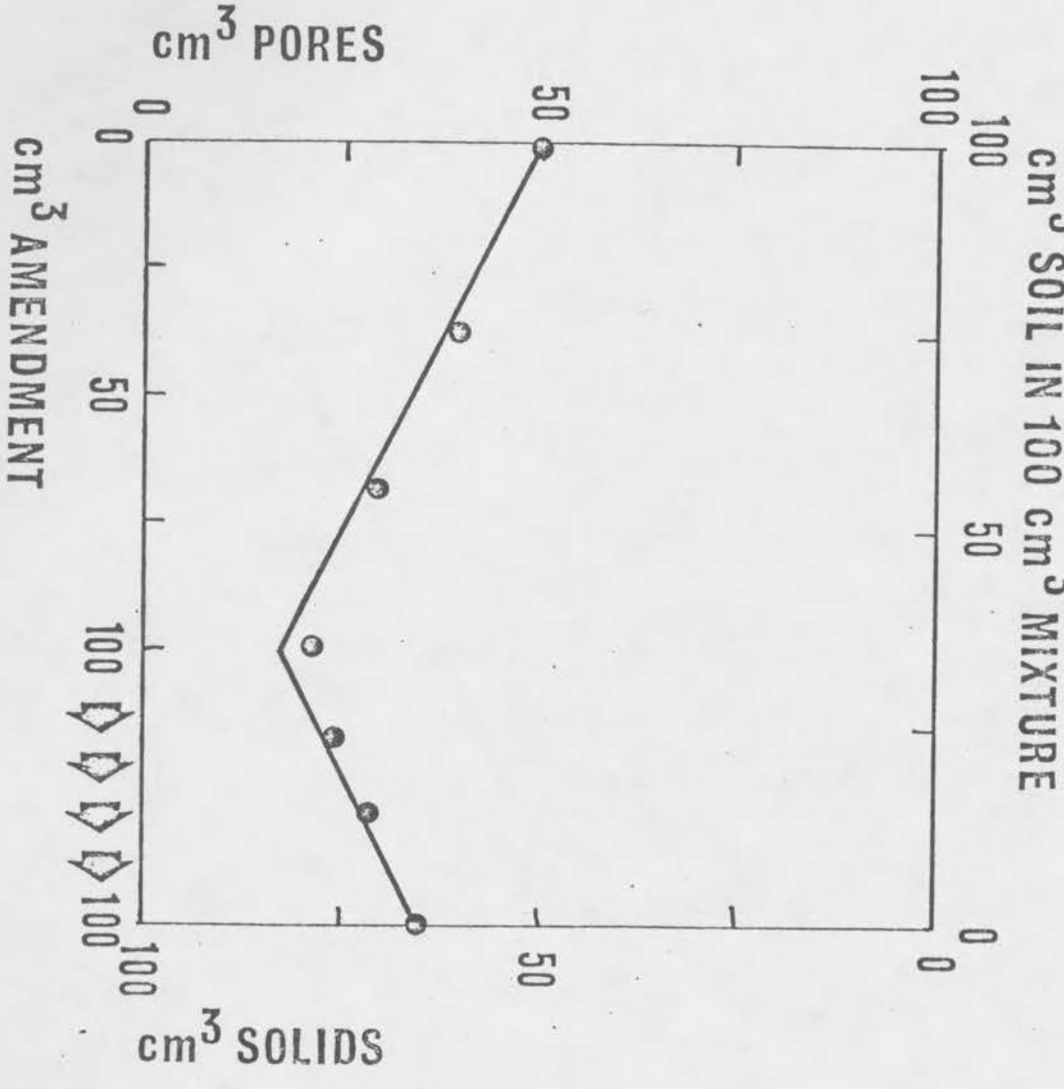

Figure 6. Comparison of actual (dots) with theoretical (line) total porosity in 7 different golf green media. Theoretical porosities were predicted from the model.

G. 5. a. Evaluation of UF and IBDU fertilizers.
J. R. Street and A. J. Turgeon

A number of nitrogen-containing fertilizers are presently available on the market for turfgrass fertilization. These materials vary considerably in their chemical and physical properties. Some products contain a high percentage of soluble nitrogen, others consist primarily of slowly-soluble components, whereas certain products are formulated to consist of soluble and slowly-soluble components in specific proportions. The nitrogen release pattern and, consequently, turfgrass response depend upon the fertilizer material chosen and the particular fertilization program instituted.

Several UF (methylene urea) and IBDU (isobutylidiene diurea) type fertilizers are presently under evaluation on a mature 'Pennstar-Fylking-Prato' Kentucky bluegrass turf at the OHRC turfgrass facility. The Kentucky bluegrass area was maintained at 4 lb N/1000 sq ft/yr and a 1.5-in mowing height prior to initiation of treatments in May, 1976. The entire area received 1 lb N/1000 sq ft using a 10-6-4 analysis fertilizer, in April, 1976. Treatments consist of 9 nitrogen carriers applied at various rates and dates under either a spring or fall initiation program (Table 48). Each treatment was replicated three times with 6 by 10 ft plots. Mowing was performed 2 or 3 times weekly at 0.75 in. Irrigation was performed as needed to prevent wilting.

Fertilizer materials were evaluated on the basis of turfgrass color and visual density ratings at various times following treatment. Observations during 1976 revealed no differences among fertilizer treatments (Table 49). A moderate level of fertility was maintained on the Kentucky bluegrass site for several years prior to treatment initiation. Thus, differences among fertilizer treatments were not as readily observable as might be expected on a more nitrogen deficient turf. Presumably residual nitrogen in the soil masked differences among treatments that might have occurred. However, unfertilized plots consistently showed slightly poorer color and visual density ratings than fertilized plots. Evaluation of density, spring green-up, disease incidence and other quality factors will be monitored during the 1977 growing season.

Table 48. Evaluation of UF fertilizers and IBDU fertilizers.

Fertilizer	Analysis	% WIN	Lb N/M	Application Dates: Spring Initiation	Application Dates: Fall Initiation
1. Proturf Super Fairway	34-3-7	5.2	1.0	May, June, Sept.	Sept, April[1/], June[1/]
2. ProTurf Fairway	30-3-10	8.8	1.0	" " "	" " "
3. ProTurf N-O-K	28-0-14	9.4	1.0	" " "	" " "
4. ProTurf Super Fert.	31-5-3	15.6	2.0	May, September	September, April[1/]
5. Par Ex IBDU Coarse	31-0-0	27.9	2.0	" "	" "
6. Par Ex	24-4-12	10.8	1.0	May, June, Sept.	Sept. April[1/], June[1/]
7. Par Ex	20-0-16	14.8	1.0	" " "	" " "
8. Par Ex	27-3-9	18.0	1.0	" " "	" " "
9. Hercules U/F	38-0-0	28.0	2.0	May, September	September, April[1/]
10. Check					

[1/] Only 1/2 of plot scheduled for retreatment at times indicated.

Table 49. Density and color ratings for UF and IBDU fertilizers under spring and fall initiation programs.[1]

Fertilizer	Spring Initiation							Fall Initiation			
	Color			Visual Density				Color		Visual Density	
	7/13/76	10/1/76	10/15/76	7/13/76	8/26/76	10/1/76	10/15/76	10/1/76	10/15/76	10/1/76	10/15/76
ProTurf Super Fairway	2.7	2.0	3.0	3.7	3.0	1.3	2.0	2.0	3.0	2.3	2.0
ProTurf Fairway	3.0	2.0	3.0	3.3	3.0	1.3	2.0	2.0	3.0	2.3	2.3
ProTurf N-O-K	3.0	2.0	3.0	3.7	3.5	2.0	3.3	2.0	3.0	1.7	2.0
ProTurf Super Fert.	3.3	2.0	2.7	3.7	3.0	1.0	2.0	2.0	3.0	2.0	2.0
Par Ex IBDU Coarse	2.3	2.3	3.0	3.7	2.8	2.0	2.0	2.3	3.0	1.7	2.3
Par Ex	3.5	2.3	3.0	3.3	3.5	1.7	2.0	2.3	3.3	2.3	2.0
Par Ex	3.3	2.3	3.0	3.0	3.2	1.7	2.0	2.0	3.3	2.3	2.0
Par Ex	2.7	3.0	3.3	3.7	3.5	3.0	3.0	2.0	3.0	2.0	2.0
Hercules U/F	3.7	2.0	3.3	3.7	3.3	2.0	2.3	2.0	3.3	2.0	2.0
Check	5.0	4.0	4.0	4.3	4.0	3.0	3.3	2.3	4.0	3.7	3.3

[1] See Table 1 for treatment schedules; color and visual density ratings were made on a scale of 1 through 9 with 1 representing best and 9 representing poorest.

G. 5. b. Fertilization timing study on Kentucky bluegrass.
A. J. Turgeon, J. R. Street and J. E. Haley

A water-soluble form of nitrogen (10-6-4) was applied to a 'Pennstar-Fylking-Prato' Kentucky bluegrass turf on various dates beginning in April, 1974, to determine the fertilization program for best turfgrass quality. Plots measured 5 by 6 ft and each treatment was replicated three times.

With the absence of *Fusarium* blight and dollar spot diseases this year in these plots, turfgrass quality in early summer was generally better in plots receiving heavy spring fertilization (Table 50). However, stripe smut incidence in late August was most severe in plots heavily fertilized during the summer months. Disease symptoms which persisted for approximately one month were: general chlorosis of the plots and a nearly vertical orientation of the leaf blades. Thus, an important relationship between strip smut severity and the timing and amount of nitrogen fertilizer application was established.

Table 50. Effects of fertilization timing on turfgrass quality and stripe smut incidence in 'Pennstar-Fylking-Prato[1] Kentucky bluegrass.

Time of Application Month	Rate of Application lb N/1000 sq ft	Stripe Smut[1] 8/27/76	Quality[2]	
			7/16/76	8/26/76
Mar, May, Aug, Sep	1, 1, 1, 1	1.3	3.3	3.0
Mar, May, Aug, Sep	2, 2, 2, 2	1.3	2.3	3.3
Apr, May, Aug, Sep	1, 1, 1, 1	1.0	2.0	3.0
Apr, May, Aug, Sep	2, 2, 2, 2	2.7	2.7	3.0
May, Sep, Oct	1, 1, 2	1.0	3.3	3.0
May, Sep, Nov	1, 1, 2	1.0	3.7	3.3
May, Sep, Dec.	1, 1, 2	1.0	3.3	3.0
May, Jun, Jul, Aug	2, 2, 2, 2	4.0	3.7	4.7
May, Jun, Jul, Aug	1, 1, 1, 1	2.3	2.7	3.3
May, Aug, Sep	1, 2, 1	1.3	3.7	3.0

[1] Stripe smut disease ratings were made using a scale of 1 through 9 with 1 representing no disease and 9 representing severe disease incidence.

[2] Quality ratings were made using a scale of 1 through 9 with 1 representing best quality and 9 representing poor quality.