1975 Turfgrass Research Summary

University of Illinois

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(Not for Publication)

A. 1. Indirect Effects of Thatch-Inducing Herbicides on Soil Physical Properties.
I. J. Jansen and A. J. Turgeon

Research at the University of Illinois has revealed the thatch-inducing effects of calcium arsenate and bandane herbicides. Associated with thatch development were: inhibition of earthworm activity, restriction of rooting and rhizome growth in the thatch, and greater disease incidence and higher wilting tendency in the thatchy turfs. While employing a technique involving the application of a formalin solution to cause surfacing of earthworms, reduced water infiltration into the soil underlying the thatchy turfs was observed. This led to subsequent studies on the indirect effects of thatch-inducing herbicides on soil physical properties. Measurements of water infiltration (Figure 1), soil moisture characteristic (Figure 2), hydraulic conductivity (Figure 3), bulk density (Table 1), and soil organic matter (Figure 4) showed a substantial alteration of the physical condition of the soil underlying the calcium arsenate-treated (thatchy) turf. This soil had lower water infiltration and hydraulic conductivity, less organic matter, less extractable water at various tension levels, and higher bulk density than soil from the untreated turf. Thus, treatment with calcium arsenate resulted in a series of detrimental effects within the turfgrass ecosystem that are of great concern. Consequently, the ability of the turfgrass manager to sustain acceptable turfgrass quality under conditions of stress is substantially reduced as a result of these effects due to the implementation of a program of calcium arsenate application.

A. 5. a. Evaluation of nitrogen fertilizer carriers on Kentucky bluegrass.
A. J. Turgeon

Various nitrogen carriers were applied to a 'Pennstar-Fylking-Prato' Kentucky bluegrass turf beginning in April, 1975. Rates included a total of 4 and 8 lbs N/1000 sq ft/year applied in four equal increments in April, May, August and September. Plots measured 5 by 6 ft. and each treatment was replicated three times.

The highest quality turf and lowest dollar spot incidence resulted from applications of urea, followed by Milorganite and the combination of urea and UF where the annual nitrogen application rate was 8 lbs/1000 sq. ft. (Table 2). The IBDU-treated plots were intermediate in quality while UF applications resulted in the poorest response of the turf. Dollar spot disease incidence served as a good index of turfgrass fertility response.

An additional study was conducted with Scott's Super Turf Builder and a Chevron 28-4-8 analysis material on the same Kentucky bluegrass blend beginning in April, 1975. Plots measured 10 by 6 ft. with three replications of each treatment. In May, one-half of each plot was retreated at the same rate used in April.

Turfgrass response from both fertilizers was similar at the same nitrogen application rates (Table 3). Dollar spot incidence was least in plots receiving two applications of Scott's Super Turf Builder at 1.6 lbs N/1000 sq ft.

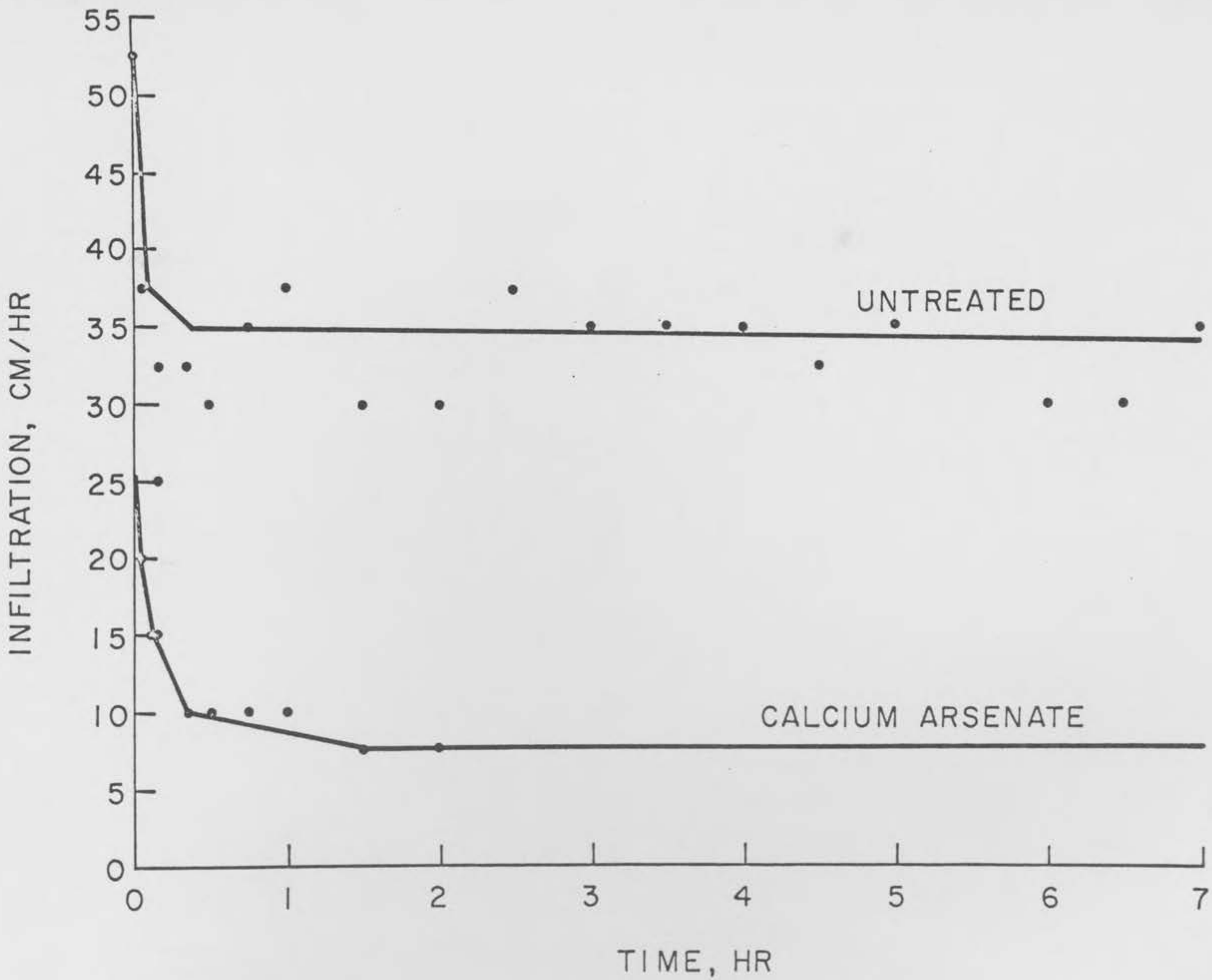

Figure 1. Effects of thatch-inducing calcium arsenate on water infiltration into a Kentucky bluegrass turf.

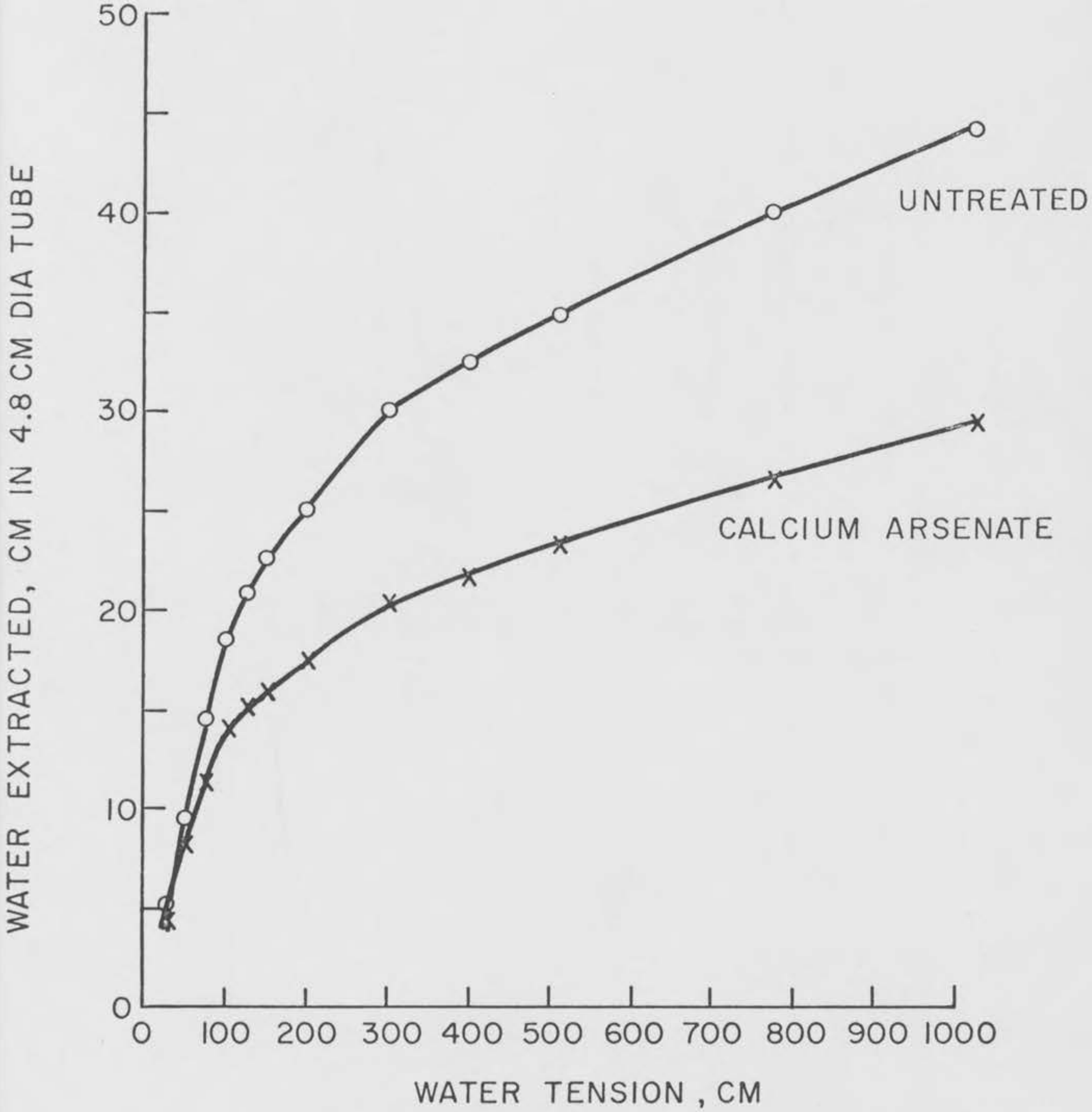

Figure 2. Effects of thatch-inducing calcium arsenate on the soil moisture characteristic of 5.3 cm dia cores taken from the surface 3 cm in a Kentucky bluegrass turf.

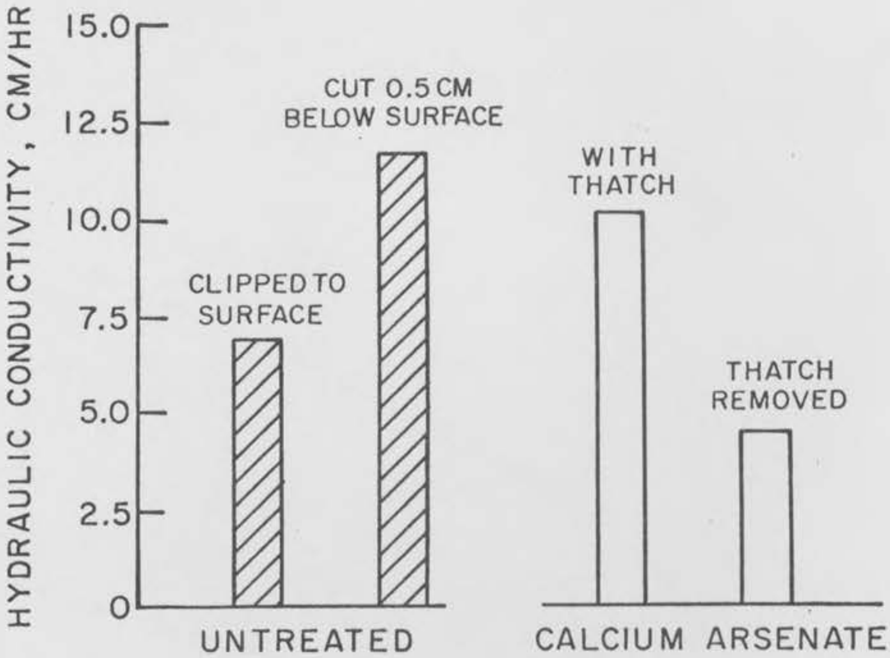

Figure 3. Effects of thatch-inducing calcium arsenate on the hydraulic conductivity of cores taken from the surface 7.6 cm in a Kentucky bluegrass turf.

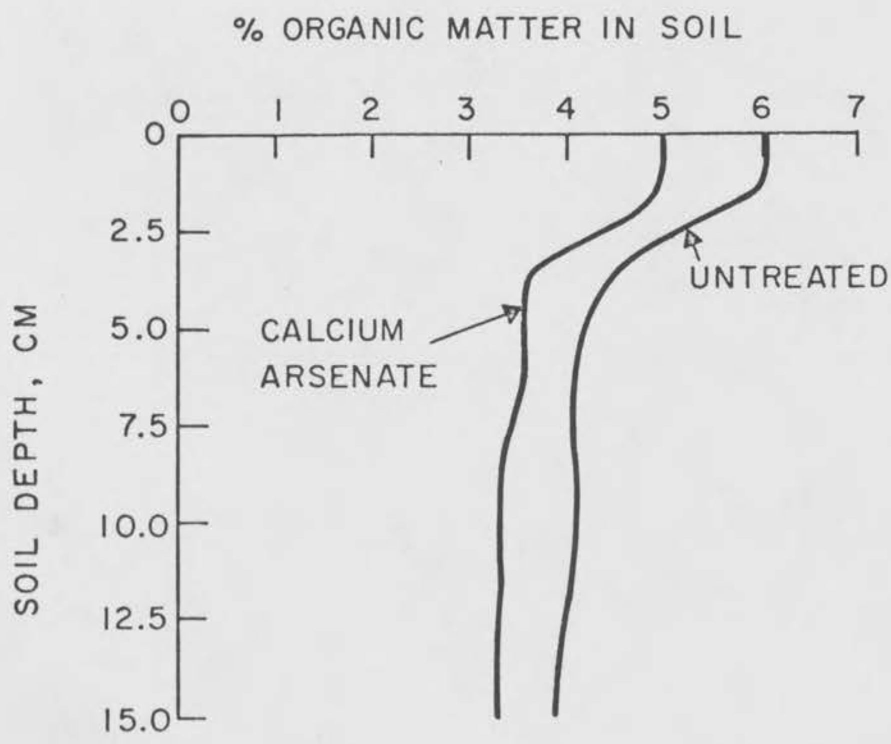

Figure 4. Effects of thatch-inducing calcium arsenate on the present organic matter of soil underlying a Kentucky bluegrass turf.

Table 1. Effects of thatch-inducing calcium arsenate on the bulk density of the surface 3 cm of soil in a Kentucky bluegrass turf.

Treatment	Bulk Density	Percent Shrinkage with Drying
	g/cm^3	%
Calcium arsenate	1.41	8.5
Untreated	1.22	16.7

Table 2. Effects of various fertilizer carriers on a 'Pennstar-Fylking-Prato' Kentucky bluegrass turf.

Fertilizer	Rate, lb N/1000 sq ft/yr	Quality[1] 5/29/75	7/13/75	8/15/75	10/16/75	Dollar Spot Disease
IBDU	4	2.7	2.7	3.7	1.3	3.7
IBDU	8	3.7	2.7	3.7	1.3	3.0
UF	4	3.3	5.7	5.3	2.0	4.7
UF	8	3.0	4.3	4.7	1.7	4.0
Urea	4	2.3	3.3	4.3	1.7	3.0
Urea	8	2.0	1.3	3.0	1.3	2.0
Urea + UF	2+2	2.7	4.7	4.0	1.7	3.7
Urea + UF	4+4	2.0	1.7	3.3	1.3	2.0
Milorganite	4	2.7	5.0	4.7	2.3	5.0
Milorganite	8	2.0	1.7	3.3	1.0	2.0

[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 severe blighting of the turf.

Table 3. Comparison of the effects of two commercial fertilizers on a 'Pennstar-Fylking-Prato' Kentucky bluegrass turf.

Fertilizer	Rate lb N/1000 sq ft		Quality[1]					Dollar Spot Disease
	4/29/75	5/21/75	5/29/75	6/30/75	7/13/75	8/15/75	10/16/75	
Scott's Super Turf Builder	1.0		4.0	6.0	4.7	5.3	2.0	4.7
	1.0	1.0	3.0	5.3	3.3	4.7	1.3	3.3
Scott's Super Turf Builder	1.6		3.3	6.3	5.0	6.0	2.0	4.7
	1.6	1.6	2.7	4.7	2.0	4.0	1.3	1.7
Chevron 28-4-8	1.0		3.7	6.0	5.0	5.3	2.0	3.7
	1.0	1.0	3.0	5.0	2.7	4.3	1.7	2.7
Chevron 28-4-8	1.4		3.7	6.0	5.3	6.0	2.3	5.0
	1.4	1.4	2.7	4.3	2.7	4.0	1.7	3.0
Chevron 28-4-8	2.0		3.3	5.7	4.0	5.3	1.7	4.0
	2.0	2.0	2.3	4.3	1.7	3.3	1.3	2.3

[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 severe blighting of the turf.

A. 5. b. Effects of Timing of Fertilizer Application on Kentucky Bluegrass Turf.
A. J. Turgeon

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.

Spring green-up was best in plots receiving 2 lbs N/1000 sq ft in late October, November or December (Table 4). There was no apparent winter injury in any of the plots. Injury as fertilizer burn was evident in some plots receiving heavy nitrogen applications during late spring and summer. Although several years of testing would be necessary before definite conclusions could be reached, late fall nitrogen application did result in generally good turfgrass quality through the season with little additional fertilizer use.

Table 4. Effects of date of fertilizer application on a 'Pennstar-Fylking-Prato' Kentucky bluegrass turf.

Time of Application, month	Rate of Application lb N/1000 sq ft	Spring Green-up	Quality 6/30/75	Quality 8/15/75	Quality 10/16/75
Mar, May, Aug, Sep	1, 1, 1, 1	4.3	3.7	3.3	1.7
Mar, May, Aug, Sep	2, 2, 2, 2	4.0	6.3	3.7	1.0
Apr, May, Aug, Sep	1, 1, 1, 1	3.7	5.0	3.0	1.3
Apr, May, Aug, Sep	2, 2, 2, 2	3.3	5.3	3.3	1.0
May, Sep, Oct	1, 1, 2	2.0	5.0	3.3	1.0
May, Sep, Nov	1, 1, 2	2.0	4.0	3.7	2.0
May, Sep, Dec	1, 1, 2	2.3	4.3	3.3	1.3
May, Jun, Jul, Aug	1, 1, 1, 1	4.0	4.7	3.3	1.0
May, Jun, Jul, Aug	2, 2, 2, 2	4.0	4.3	5.3	1.7
May, Aug, Sep	1, 2, 1	3.7	4.3	3.0	1.0

A. 5. b. Effects of Fertilization and Mowing on Seven Kentucky Bluegrass Varieties.
A. J. Turgeon

Six varieties 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 varieties 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 ot two pound 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 varieties were observed at eight cultural intensities through 1974 and 1975. 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 variety.

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 variety (Table 5). Generally, close mowing and low fertility favored dollar spot incidence, especially in Nugget, while high fertility was conducive to Fusarium blight in Merion, Fylking and Pennstar. Kenblue was seriously affected by Fusarium at all cultural intensities. Previous Fusarium injury was followed by annual bluegrass invasion; thus, reduced turfgrass quality is due, in part, to the loss of annual bluegrass during the summer.

Table 5. Performance of Kentucky bluegrass varieties under different mowing and fertilization regimes.

Mowing Height, in.	Fertilization lb N/1000 sq. ft/ yr.	Dollar Spot[1] Disease	Fusarium Blight[1] Disease	Quality[2]			
				4/16/75	6/27/75	8/15/75	10/13/75
Windsor							
0.75	2	3.3	1.0	6.7	2.7	4.3	4.0
0.75	4	1.0	1.0	3.7	2.0	4.0	3.0
0.75	6	1.0	1.0	2.3	2.0	3.7	3.3
0.75	8	1.0	1.0	2.0	2.0	2.7	3.0
1.5	2	2.0	1.0	6.0	2.0	3.0	2.3
1.5	4	1.0	1.0	3.7	2.0	2.3	2.0
1.5	6	1.0	1.0	3.0	2.0	2.0	1.3
1.5	8	1.0	1.0	2.7	2.0	2.0	1.3
A-20							
0.75	2	2.7	1.0	5.3	3.0	3.7	4.0
0.75	4	2.7	1.0	3.3	2.0	3.3	4.0
0.75	6	2.0	1.0	3.0	2.0	3.0	3.7
0.75	8	1.0	1.0	3.0	2.0	3.0	4.0

Mowing Height, in.	Fertilization lb N/1000 sq. ft/yr.	Dollar Spot[1] Disease	Fusarium Blight[1] Disease	Quality[2] 4/16/75	6/27/75	8/15/75	10/13/75
A-20							
1.5	2	2.0	1.0	5.3	2.0	2.3	1.7
1.5	4	1.7	1.0	4.0	2.0	2.0	1.7
1.5	6	1.3	1.0	4.0	2.0	2.0	1.0
1.5	8	1.0	1.0	4.0	2.0	2.0	1.3
Nugget							
0.75	2	4.7	1.0	5.7	4.0	5.3	6.0
0.75	4	2.7	1.0	4.3	3.0	4.7	6.0
0.75	6	1.7	1.0	4.0	2.7	4.7	6.3
0.75	8	1.0	1.7	3.7	3.0	4.3	6.0
1.5	2	3.0	1.0	6.3	2.7	3.7	5.0
1.5	4	1.3	1.0	4.7	2.0	3.0	4.0
1.5	6	1.0	1.0	4.3	2.7	3.0	4.3
1.5	8	1.0	1.3	4.0	2.7	2.3	4.0
Merion							
0.75	2	2.3	1.3	5.7	3.7	4.7	5.3
0.75	4	2.0	1.3	4.3	3.3	4.0	5.3
0.75	6	1.7	2.0	3.7	2.7	5.0	5.3
0.75	8	1.0	4.3	3.7	2.3	5.3	6.0
1.5	2	1.7	1.3	5.0	2.3	3.3	4.0
1.5	4	1.3	1.3	3.7	2.3	2.7	4.0
1.5	6	1.0	2.0	4.0	2.0	4.3	4.0
1.5	8	1.0	4.3	4.3	2.0	5.7	4.3
Fylking							
0.75	2	3.0	1.3	6.0	3.7	5.3	6.3
0.75	4	2.0	1.7	4.0	3.0	5.0	6.3
0.75	6	1.3	4.0	4.0	3.0	5.7	6.7
0.75	8	1.0	6.0	4.0	3.0	6.7	7.0

Mowing Height, in.	Fertilization lb N/1000 Sq. ft/ yr.	Dollar Spot[1] Disease	Fusarium Blight[1] Disease	Quality[2] 4/16/75	6/27/75	8/15/75	10/13/75
1.5	2	2.0	1.0	6.7	2.7	3.7	5.0
1.5	4	1.0	1.7	4.7	2.0	4.0	4.3
1.5	6	1.0	2.7	4.7	2.0	4.7	4.3
1.5	8	1.0	5.0	4.7	2.3	5.0	4.7
Pennstar							
0.75	2	2.7	1.3	5.3	4.0	5.7	6.0
0.75	4	2.0	2.0	4.0	3.0	6.0	6.7
0.75	6	1.0	4.7	4.0	3.0	6.3	6.7
0.75	8	1.0	6.3	4.0	3.0	7.0	7.0
1.5	2	1.7	1.3	5.3	2.3	4.0	5.7
1.5	4	1.0	1.3	4.7	2.0	4.0	5.3
1.5	6	1.0	4.3	5.0	2.3	5.3	5.7
1.5	8	1.0	6.0	4.7	2.7	6.3	6.3
Kenblue							
0.75	2	3.3	5.7	4.0	4.0	6.7	6.7
0.75	4	1.0	5.7	3.7	5.0	7.0	6.3
0.75	6	1.0	6.0	4.3	6.3	7.0	7.0
0.75	8	1.0	7.0	3.7	6.3	7.3	7.0
1.5	2	1.7	6.0	4.3	2.3	6.3	6.3
1.5	4	1.0	4.7	4.7	3.0	6.3	5.7
1.5	6	1.0	5.7	5.0	3.7	6.3	6.3
1.5	8	1.0	7.0	4.3	3.7	7.0	6.3

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

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

A. 7. Effects of Thatch-Inducing Herbicides on Soil Microflora. M. A. Cole and A. J. Turgeon

Thatch development in Kentucky bluegrass turf resulting from the use of calcium arsenate and bandane was associated with the inhibitory effects of these herbicides on earthworms in the soil. Studies were undertaken to determine the effects of thatch-inducing herbicides on the activity of soil microflora (bacteria, fungi, etc.) since they are alos considered important in the decomposition of organic materials that make up thatch.

Microbial decomposition of plant residues requires a large number and variety of different microbes, and the habitat must be one in which the microbes present are active. Consequently, total numbers of bacteria and fungi and enzyme activity were examined. The data in Table 6 indicate that there was no significant reduction in total bacteria or fungi in any of the plots; on the contrary, bacteria numbers in the soil from the bandane-treated plots were higher than in the soil from the untreated control plots. The distribution of bacteria was substantially modified in both arsenate and bandane-treated plots, with proportionately more bacteria in thatch than in soil when compared to the control plots which had no thatch but in which some loose organic debris (refered to as thatch in the table) was present at the soil surface. No change in fungal distribution was observed.

Enzyme levels in thatch and soil were measured as indicators of degradative activity and as a measure of biosynthetic capabilities in the samples. Amylase, cellulase, and invertase were selected because these enzymes are required for degradation of those carbohydrates that make up a large percentage of grass residues; data are given in Table 7. Enzyme levels showed the same trend observed by total microbial counts, namely, no decline in the arsenate- or bandane-treated plots compared with control plots. Thatch from the herbicide-treated plots contained substantially more enzyme activity than in the surface debris from the control plots, but there was no significant difference in soil enzyme levels among the samples. An indeterminate but possibly large fraction of the increased enzyme levels in thatch can be attributed to plant root enzymes, but the fact remains that herbicide treatment did not result in a decrease in enzyme activity.

The abundance of bacteria producing various degradative enzymes was examined in samples from all plots (Table 8). Again, there was no decrease associated with the application of thatch-inducing herbicides. Thus, on the basis of data presented, there is no indication of a reduced ability of the microbes to degrade the major macromolecules in grass residues.

The survival of soil microorganisms requires that the cells be able to reproduce at a sufficient rate to replace cells that die and that cells are able to respond to the presence of nutrients by producing the appropriate enzymes to degrade these nutrients. Enzyme synthesis is a complex process with a number of requirements, including: 1) Metabolically active, live cells, 2) abundant energy and precursors, 3) availability of inorganic nutrients (e.g., nitrogen and phosphorous) from which precursors are synthesized, and 4) absence of toxic materials that would inhibit enzyme synthesis. Thus, if any one of the above requirements is not met, the observed results would be a decrease in the rate of enzyme synthesis or a lower total quantity of enzyme synthesized over a period of time. Amylase was chosen as the test enzyme for these experiments because a high percentage of soil bacteria produce this enzyme and because amylase activity is easily measured. Results for amylase synthesis in soil from arsenate, bandane, and control plots are presented in Table 9. The total quantity of enzyme present over the 10-day period was significantly less in arsenate and bandane soil than in control soil. The pattern of synthesis in bandane soil (rate identical to control for first 48 hr, then a decrease in rate) indicates that in some manner bandane greatly reduces the ability of soil organisms to synthesize enzymes, but that this limitation is not immediately expressed. In contrast, that rate of synthesis in arsenate-treated soil is reduced initally and at all subsequent intervals. These results provide a possible explanation for the lack of difference in enzyme levels and microbial numbers in soil and a possible basis for thatch accumulation. The normal microbial response to additional carbon and energy sources (such as grass residues) in an increase in microbial numbers and activity. The data in Table 9 strongly suggest that a major effect of both arsenate and bandane is to prevent the normal increase in soil microbial activity associated with an increased substrate availability. Consequently, the rate of decomposition is not increased in proportion to an increase in nutrient availability, with the result that the rate of disappearance of grass residue becomes proportionately less than the rate of addition. A similar lack of ability of soil bacteria to respond to additional nutrients is seen in the nitrification studies described below (Table 10).

Most of the ammonia formed in soil from organic matter or added as ammonium or urea fertilizers is converted to nitrate by nitrifying bacteria. These bacteria, like other soil organisms, respond to increased supplies of energy sources by increasing cell numbers and/or activity. When ammonium chloride was added to turfgrass soil, the initial rates (first two weeks) of NO_3^- formation were identical in all samples. However, the organisms in bandane- and arsenate-treated soil did not respond as quickly to the additional energy source as the organisms in the control soil. This inability to respond is related in both the amylase synthesis studies and nitrification studies by the relative response time of arsenate > bandane > control. This identical relationship suggests a generalized effect of arsenate and bandane upon microbial biosynthesis; the mechanism underlying this effect will be the subject of future investigations.

Table 6. Microbial numbers in thatch and underlying soil

Treatment	Viable cells/g material					
	Bacteria (x 10^{-6})		T/S[b]	Fungi (x 10^{-4})		T/S
	Thatch[a]	Soil	ratio	Thatch	Soil	ratio
Arsenate	64	9.3	6.8	13	4.2	3.1
Bandane	66	28	2.4	15	6.0	2.5
Control	46	14	3.3	12	5.0	2.4

[a]Refers to substantial thatch in bandane and arsenate-treated plots; surface debris in control plots.

[b]Ratio of viable count in thatch (T) to viable count in soil (S).

Table 7. Enzyme levels in thatch and underlying soil[a]

Treatment	Amylase			Celulase			Invertase		
	Thatch	Soil	T/S	Thatch	Soil	T/S	Thatch	Soil	T/S
Arsenate	60.5	3.9	15.5	38.6	0.6	64.3	107.8	1.6	67.4
Bandane	61.6	2.6	23.7	35.4	0.5	70.8	114.4	1.0	114.4
Control	24.6	2.5	9.8	17.9	0.4	44.8	42.9	2.6	16.5

[a]Enzyme activity in units/g thatch or soil

Table 8. Relative abundance of bacteria involved in organic decomposition in in thatch and underlying soil

	Percentage of isolates producing							
	Cellulase		Protease		Pectinase		Amylase	
Treatment	T[a]	S	T	S	T	S	T	S
Arsenate	1	<2	79	54	15	7	53	56
Bandane	1	<2	90	86	17	10	71	59
Control	9	<2	78	87	12	14	46	36

[a]T, isolates from thatch; S, isolates soil.

Table 9. Amylase synthesis in turfgrass soil

Treatment	AMYLASE SPECIFIC ACTIVITY Time (days)				
	0	1	2	6	10
Arsenate	0.36	0.67	3.37	6.60	9.58
Bandane	0.47	1.42	4.42	6.08	8.30
Control	0.50	1.38	4.71	8.88	9.17

Table 10. Nitrification rates in turfgrass soil

Treatment	NITRIFICATION RATE[a] Interval after adding NH_4Cl (days)			
	0-7	7-14	14-21	21-28
Arsenate	5.7	5.7	22.9	48.9
Bandane	3.7	4.9	25.9	79.4
Control	5.7	4.4	34.0	110.9

[a]Experimental conditions: NH_4Cl (66 μg NH_4^+/g soil) and 100 g moist soil were mixed and incubated at 25° C. Nitrate was determined on KCl extracts at 7-day intervals. Rates are given as the increase in NO_3^-/g soil/day.

B. 3. Relationship of Kentucky Bluegrass-Perennial Ryegrass Mixtures to Fusarium Blight Incidence. A. J. Turgeon

The severe incidence of *Fusarium* blight disease in susceptible cultivars of Kentucky bluegrass has caused great concern due to the efforts and expense necessary to control this disease with fungicides. Furthermore, it is questionable whether new Kentucky bluegrass cultivars will be unaffected by *Fusarium* indefinitely. The lack of *Fusarium* blight symptoms in turf-type cultivars of perennial ryegrass suggests that inclusion of some proportion of ryegrass in a seed mixture may result in little or no occurrence of *Fusarium* blight in mixed stands. However, the minimum proportion of perennial ryegrass necessary to sustain *Fusarium* blight-free turf is not known.

An experiment was initiated in May, 1975, in which all combinations of two Kentucky bluegrasses (Fylking or A-34) and two perennial ryegrasses (Pennfine or Citation) were planted at 2 lbs/1000 sq ft in soil contaminated with the *Fusarium* fungus. The ryegrass percentages were 0, 5, 10, 15, 20, 25 or 50% of the mixtures by weight. Plots measured 5 by 6 ft. and each treatment combination was replicated three times.

To date, no *Fusarium* blight has been observed in the new plantings. The plots will be monitored for several years to determine the relationship between the ryegrass percentage of mixed stands and *Fusarium* blight incidence.

B. 3. Effects of Mowing and Fertilization on Yellow Nutsedge Population Dynamics in Kentucky Bluegrass Turf. D. W. Black and A. J. Turgeon

Yellow nutsedge is a serious weed of lawns and intensively cultured turfs which has increased in occurrence and distribution during the last several years. Studies were undertaken to determine the effects of cultural practices and Kentucky bluegrass competition on the growth and development of yellow nutsedge.

Yellow nutsedge was planted in May, 1974, in plots of Kentucky bluegrass turf and maintained at 3/4, 1 1/2 and 3 inches cutting height, and fertilized at 0, 1/2, 1 or 2 lbs N/1000 sq ft/month. Each plot measured 4 by 6 ft and received 6 nutsedge plants; all treatments were replicated 4 times.

The highest nutsedge density occurred in plots maintained at 3/4 inch (Figure 5). Initially, fertilization appeared to enhance nutsedge growth, but this trend was reversed by the end of four months; this was probably due to the response of the Kentucky bluegrass to fertilization during the late summer period. Thus, although mowing suppresses nutsedge growth and development, nutsedge is adapted to a mowing regime and its success as a weed in turf is apparently associated with conditions that reduce the competition from Kentucky bluegrass.

In 1975, the population density of yellow nutsedge increased dramatically in the unfertilized plots maintained under 0.75-in. cutting height. This was not true in plots maintained at intermediate fertilization rates. At the highest fertilization rate, the nutsedge population increased as *Fusarium* blight disease reduced competition from the Kentucky bluegrass.

Chemical control of yellow nutsedge was variable with MSMA, bentazon and cyperquat in field studies at numerous sites in central and southern Illinois. Generally, the best control observed from these herbicides was at sites where the nutsedge infested turf was maintained under an intensive irrigation program prior to chemical treatment. Presumably, this predisposed the nutsedge to the herbicides while stimulating more competitive growth by the adjacent turfgrasses.

C. 1. d. Shade turf adaptation. A. J. Turgeon and K. Hurto

Turfgrass adaptation to shade is a serious concern on sites where inadequate sunlight limits the growth or even threatens the survival of turf. This is especially important where poor drainage and persistently wet conditions create an unsuitable environment for fine-leaf fescues, the traditionally used shade grasses. A planting was made in September, 1974, of Kentucky bluegrasses, fine-leaf fescues and perennial ryegrasses on a wet, shaded site to determine their adaptation to these conditions. Plots measured 5 by 6 ft and each grass was replicated three times.

Initially, Nugget and A-34 were the best Kentucky bluegrasses; however, these did not persist as acceptable turfs through the summer of 1975 (Table 11). The two fine-leaf fescues deteriorated to nearly complete loss by August. The perennial ryegrasses also thinned to become very poor stands.

Table 11. Performance of turfgrass varieties in a wet, densely shaded, environment in 1975.

Variety	Quality Rating[1]	
	18 Jul 75	15 Aug 75
Kentucky bluegrasses		
A-20	6.3	7.0
A-34	4.0	6.7
Adelphi	5.3	7.0
Baron	4.7	6.3
Brunswick	6.7	9.0
Glade	5.0	6.0
Majestic	5.0	7.0
Merion	6.0	7.3
Nugget	4.0	7.0
Bonnieblue	5.7	7.7
Parade	5.0	7.3

Table 11. (Continued)

Variety	Quality Rating[1] 18 Jul 75	15 Aug 75
Victa	5.7	7.7
Vantage	6.3	7.3
Sydsport	4.7	5.7
Touchdown	5.0	6.7
Pennstar-Fylking-Prato	5.3	7.3
Adelphi-Aquilla-Parade-Nugget	4.7	7.7
Fine-leaf fescues		
Koket	7.3	9.0
Purf	7.7	8.3
Perennial ryegrasses		
Manhattan	5.3	6.0
NK-200 + Pennfine	5.3	7.3

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

D. 1. Clipping Removal and Fertilization Effects on Fusarium Blight in Kentucky Bluegrass. A. J. Turgeon

A two-year-old turf of 'Kenblue'-type Kentucky bluegrass received treatments of three fertilization schedules (2, 5 and 8 lb N/1000 sq ft/year) in a split-plot design with clippings removed versus returned in April, 1974. Plots measured 4 by 6 ft. and each treatment combination was replicated six times.

Results showed that high fertilization was conducive to *Fusarium* blight incidence except where clippings were removed (Table 12). Presumably, removal of clippings also removes an important source of inoculum for the disease.

FIGURE 5

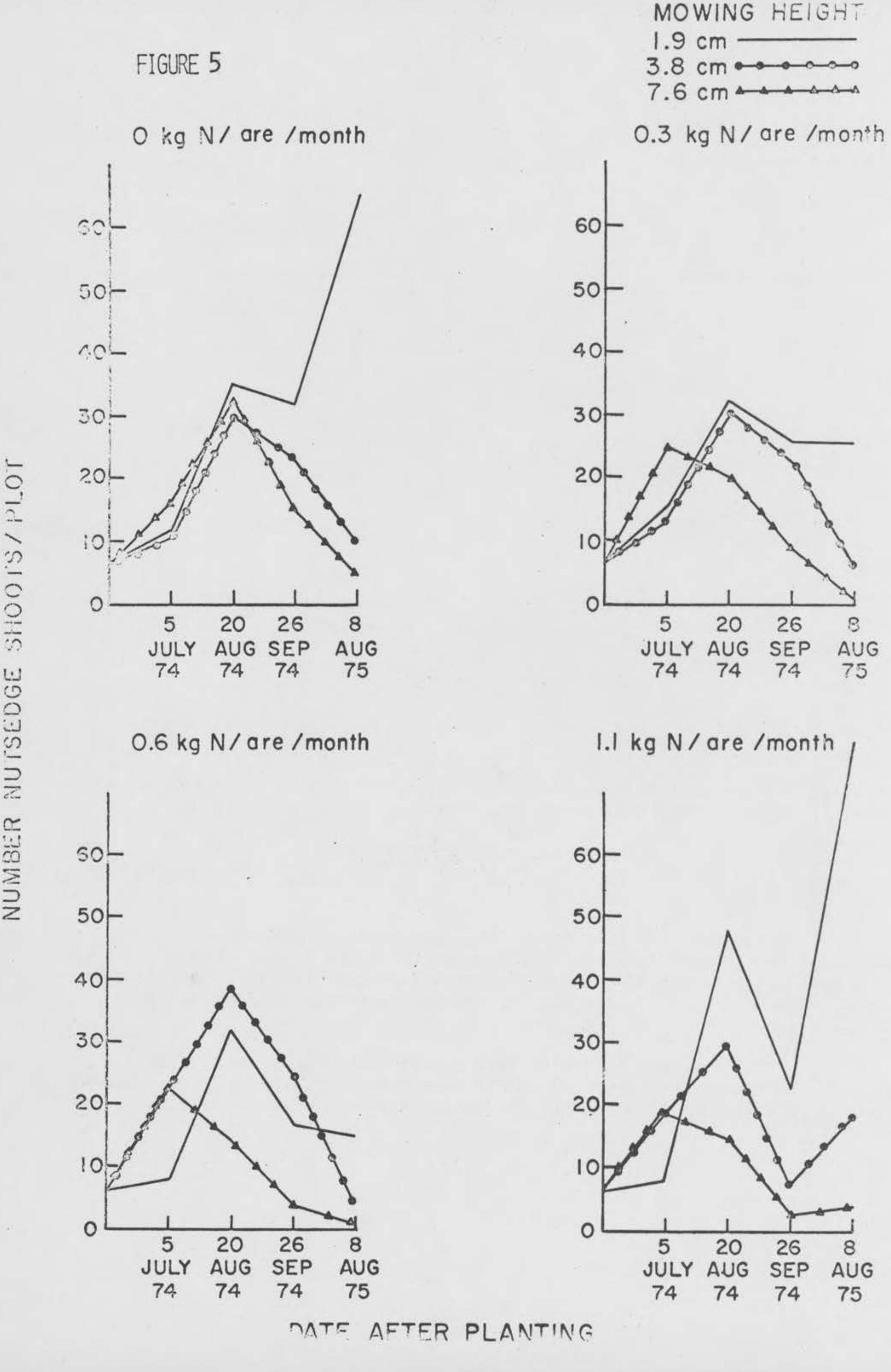
MOWING HEIGHT
1.9 cm
3.8 cm
7.6 cm
0 kg N/ are /month
0.3 kg N/ are /month
0.6 kg N/ are /month
1.1 kg N/ are /month
NUMBER NUTSEDGE SHOOTS / PLOT
0
10
20
30
40
50
60
5 JULY 74
20 AUG 74
26 SEP 74
8 AUG 75
DATE AFTER PLANTING

Table 12. Effects of clipping removal and fertilization on Fusarium blight incidence in Kentucky bluegrass turf.

Fertilization lb N/1000 sq ft/yr	Fusarium Blight Rating[1] Clippings Removed	Clippings Returned
2	1.3	1.2
5	1.5	1.7
8	1.5	3.7

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

D. 1. Potential of Turfgrass Clippings as Animal Feeds. A. J. Turgeon and Gene Lester

Mowing is one of the primary cultural practices necessary for sustaining turf. Clippings resulting from regular mowing are either picked up and discarded, or returned to the turf where they decompose. In view of the traditional use of grasses for forage, it is likely that turfgrass clippings could be successfully employed for feeding livestock and other animals. As turfgrass cultivars and cultural practices are substantially different from those employed in forage production, investigations were initiated this year to determine the relationship of turfgrass species, cultivars, mowing and fertilization to the nutritive value of clippings from these turfs. Lutein, a non-epoxide xanthophyll important as a pigmenting agent in poultry feeds, was found to occur in large quantities in Kentucky bluegrass clippings from sod farms in California. Clippings were collected from 20 Kentucky bluegrasses, four perennial ryegrasses and K-31 tall fescue in May and analyzed for lutein using an acetone extraction and thin-layer chromatographic separation of the pigments. Colorimetric determination of lutein was made from extracts from the TLC plates. Lutein levels ranged from a low of 72 mg/kg fr wt in Vantage Kentucky bluegrass to a high of 358 mg/kg in Adelphi Kentucky bluegrass (Table 13). Thus, selection of a particular turfgrass cultivar substantially affects the lutein yield from the clippings. Clippings were also collected from Kentucky bluegrass fertilized with 0, 0.25, 0.5 or 1.0 kg N/are/mo. Results showed that lutein increases significantly from increasing nitrogen fertilization, but the increases were of a relatively low magnitude (Table 14).

Turfgrass clippings offer a potentially important source of protein in animal feeds, especially for ruminants (sheep, cattle, etc.) which can digest the cellulose within the plant tissue. Crude protein levels were determined in dried clippings by Kjeldahl analysis for total nitrogen (X 6.25) in 53 Kentucky bluegrasses and 8 perennial ryegrasses. Within the Kentucky bluegrasses, crude protein levels ranged from 22 to nearly 33 percent depending upon cultivar (Table 15). The perennial ryegrasses ranged from 26.3 to 30.2 percent crude protein (Table 16).

Table 13. Lutein content in fresh clippings of various turfgrasses.

Variety	Lutein mg/kg fr wt	Variety	Lutein mg/kg fr wt
Kentucky Bluegrass			
Adelphi	358	Park	241
Warrens A-34	320	Windsor	240
Baron	287	Warrens A-20	238
Majestic	282	Victa	230
Pennstar	282	Parade	224
Merion	261	Glade	218
Fylking	260	Bonnieblue	202
Kenblue	260	Nugget	175
Sydsport	252	Touchdown	155
Brunswick	250	Vantage	72
Perennial Ryegrass			
Pennfine	347	Manhattan	250
Common	260	NK-200	241
Tall Fescue			
Kentucky-31	261		
LSD 0.5	37		
LSD .01	48		

Table 14. Effect of fertilization on lutein levels in Kentucky bluegrass clippings.

Nitrogen fertilization	Lutein
kg N/are/month	mg/kg fr wt
0	201
0.25	222
0.5	231
1.0	247
LSD .05	13
LSD .01	17

Table 15. Crude protein levels in oven-dried clippings harvested from Kentucky bluegrass varieties.

Variety	Protein	Variety	Protein
	%		%
Campina	32.7	Warrens A-34	26.4
Windsor	31.5	EVB-305	26.3
Majestic	30.0	Nugget	26.2
Sodco	30.0	Ba 61-91	26.1
Warrens A-20	28.9	Glade	25.9
Parade	28.9	K1-132	25.8
K1-138	28.9	PSU-190	25.8
K1-157	28.9	Pennstar	25.7
Adelphi	28.6	Victa	25.7
Warrens A-20-6	28.5	K1-133	25.7
NJE P-140	28.4	K1-143	25.7
Bonnieblue	28.1	RAM #1	25.6
Brunswick	27.9	Ba 62-55	25.6
Merion	27.8	EVB-282	25.5
Plush	27.7	Monopoly	25.4
PSU-197	27.5	PSU-150	25.2
Vantage	27.4	IL 38-17	25.2
Sydsport	27.2	K1-131	25.1
Galaxy	27.1	PSU-169	24.9
K1-158	27.1	RAM #2	24.7
Delft	27.1	Fylking	24.7
Baron	26.8	NJE P-59	24.6
Kenblue	26.7	EVB-391	24.4
Park	26.7	Geronimo	24.2
K1-155	26.7	Touchdown	24.1
K1-187	26.7	EVB-307	22.0
MLM 18001	26.6		
LSD	.05 = 2.8		
	.01 = 3.7		

Table 16. Crude protein levels in oven-dried clippings harvested from perennial ryegrass varieties.

Variety	Protein	Variety	Protein
	%		%
NK-101	30.2	NK-100	28.6
NK-200	29.4	K8-142	28.5
K8-137	29.4	Pennfine	28.4
Manhattan	28.7	Common	26.3

LSD .05 = 3.0
.01 = 4.1

The effects of mowing height, mowing frequency and nitrogen fertilization on the crude protein level in Kentucky bluegrass clippings were also determined. Results showed a range of crude protein levels from 20.3 to 36.8 present with the higher levels occurring in plots maintained under close mowing (1.88 cm) and high rates of nitrogen fertilization (1.1 kg N/are/month) with no significant effect from mowing frequency (Table 17). In a similar study on tall fescue, closer mowing and high nitrogen fertilization also yielded the highest crude protein levels in clippings (Table 18).

The timing of nitrogen fertilization substantially affected the crude protein levels in clippings from Kentucky bluegrass (Table 19). Clippings harvested in late May from plots receiving 1.1 kg N/are in April and again in May were highest in crude protein (33.9%). Also, late season applications of nitrogen (October, December) resulted in high crude protein levels the following May.

The nitrogen carrier used in fertilizing Kentucky bluegrass significantly affected the crude protein level in clippings (Table 20). Urea, the only soluble form used, yielded the highest level of crude protein while UF and IBDU applications resulted in the lowest crude protein yield.

Additional studies with turfgrass clippings are currently underway in the Animal Science Department under the supervision of Dr. Frank Hinds. Dehydrated clipping pellets are being fed to sheep to determine the digestibility of the pellets in ruminants. Dr. Hinds is also evaluating clippings from Kentucky bluegrass and tall fescue turfs for their energy potential through laboratory analyses.

Table 17. Effect of mowing height, mowing frequency, and nitrogen fertilization rate on crude protein level in Kentucky bluegrass clippings.

Mowing Height	Fertilization	Mowing Frequency		
		1/Wk	3/Wk	5/Wk
(cm)	kg N/are/month	% protein		
1.88	0	23.9	26.3	26.0
1.88	0.3	28.9	29.8	32.3
1.88	0.6	32.7	32.9	34.1
1.88	1.1	35.1	36.8	35.5
3.75	0	23.4	24.5	24.6
3.75	0.3	28.4	28.5	27.5
3.75	0.6	32.0	32.4	32.0
3.75	1.1	33.6	35.8	33.1
6.88	0	20.3	21.2	21.6
6.88	0.3	23.5	24.2	27.0
6.88	0.6	28.3	28.3	30.7
6.88	1.1	30.2	34.2	32.4

"F" Values For

Mowing height	61.34**
Mowing frequency	4.03
Mow ht x mow freq	1.33
Fertilization	94.86**
Mow ht x fert	1.54
Mow freq x fert	1.20
Mow ht x mow freq x fert	1.08

Table 18. Effects of mowing height and nitrogen fertilization on crude protein level in oven-dried clippings of 'Kentucky-31' tall fescue.

Mowing Height		Fertilization Rate		Protein
cm		kg N/are/year		
3.75		0		18.1
3.75		1.1		20.5
3.75		2.2		27.1
3.75		3.3		29.9
3.75		4.4		32.2
7.50		0		16.0
7.50		1.1		17.4
7.50		2.2		22.4
7.50		3.3		27.2
7.50		4.4		27.4
	LSD	.05	1.9	
	LSD	.01	2.5	

Table 19. Effects of nitrogen fertilization timing on crude protein level in oven-dried clippings of 'Pennstar-Fylking-Prato' Kentucky bluegrass on May 27, 1975.

Fertilization Date	Fertilization Rate	Protein
	kg N/are	%
APR, MAY, AUG, SEP	0.6, 0.6, 0.6, 0.6	30.8
APR, MAY, AUG, SEP	1.1, 1.1, 1.1, 1.1	33.9
MAY, JUN, JUL, AUG	0.6, 0.6, 0.6, 0.6	26.7
MAY, JUN, JUL, AUG	1.1, 1.1, 1.1, 1.1	29.0
MAY, SEP, OCT	0.6, 0.6, 1.1	30.5
MAY, SEP, DEC	0.6, 0.6, 1.1	31.1
MAY, SEP	0.6, 0.6	26.9
LSD .05		2.7
LSD .01		3.8

Table 20. Effects of nitrogen source on crude protein level in oven-dried clippings of 'Pennstar-Fylking-Prato' Kentucky bluegrass.

Fertilizer Date	Rate	Protein
	kg N/are/year	%
Urea	2.2	27.6
Urea	4.4	32.0
UF	2.2	22.5
UF	4.4	24.6
IBDU	2.2	22.6
IBDU	4.4	23.3
Act. sew. sludge	2.2	25.0
Act. sew. sludge	4.4	28.0
LSD .05		1.3
.01		1.8

D. 5. Effects of Chemical Growth Retardants on Tall Fescue Turf. A. J. Turgeon

Chemical agents for reducing trufgrass mowing requirements have been investigated for over two decades; yet, chemical growth retardents have not been extensively used on turf because of their phytotoxic effects on the grass, ineffectiveness in slowing vertical growth, or both. The search for new materials has yielded many candidate growth retardents that offer promise for reducing the mowing requirements of turf. Two experimental growth-retarding chemicals were applied to a mature stand of tall fescue on March 21, April 30 and May 25, 1975, at 2.5, 5.0 and 7.5 lb/acre. MH plus chlorflurenol (2+2 lb/acre) were also applied as standards for comparison. Plots measured 10 by 10 ft. and each treatment was replicated three times.

Foliar height and seedhead height were not substantially reduced from the March applications of CGA-17020, CGA-24705 or the MH + chlorflurenol combination; however, seedhead density of the treated turfs was reduced from 53 to 99 percent depending upon the chemical used and its rate of application (Table 21). Apparent phytotoxicity from use of the growth retardents was moderate to severe two months after applications but disappeared by summer. However, the phytotoxicity observation may have been partly due to a failure of these plots to green up as well as the untreated plots rather than from chemical injury following treatment.

Following April applications of the growth retardents to previously untreated turf, the reduction of seedhead density was nearly complete in plots treated with CGA-24705 (Table 22). CGA-17020 was considerably less effective than CGA-24705, and MH + chlorflurenol was essentially ineffective. Phytotoxicity was only slight from these treatments. Since the April applications were followed by a single mowing at three inches after six days, the impressive results from CGA-24705 treatments may have been due to a chemical application mowing interaction. This suggests that these two factors should be explored further in future research.

Results from the May applications to turf that had been mowed four times were negative since no seedheads developed in these plots and foliar growth was uniform throughout the test area (Table 23).

In conclusion, turfgrass response to treatment with chemical growth retardents varied widely depending upon the chemical used and the timing of application. Late April appeared to be optimum for suppressing seedhead formation with little turfgrass injury. The possible interaction between the use of CGA-24705 and subsequent mowing requires additional study.

Table 21. Effects of chemicals applied March 21, 1975 to tall fescue

TREATMENT	RATE (lb/A)	FOLIAR HEIGHT, in 5/26	FOLIAR HEIGHT, in 7/30	SEEDHEAD HEIGHT, in 5/26	SEEDHEAD HEIGHT, in 7/30	SEEDHEAD REDUCTION, % 5/26	SEEDHEAD REDUCTION, % 7/30	PHYTO-TOXICITY 5/26	PHYTO-TOXICITY 7/30
1 CGA-17020	2.5	11	21	24	40	55	70	4.0	1.0
2 CGA-17020	5.0	10	23	23	40	68	73	5.7	1.0
3 CGA-17020	7.5	8	19	16	—	88	99	6.7	1.0
4 CGA-24705	2.5	13	22	26	37	33	60	2.0	1.0
5 CGA-24705	5.0	10	15	24	34	67	75	4.3	1.0
6 CGA-24705	7.5	11	17	23	33	80	88	4.7	1.0
7 MH + Chlor-flurenol	2 + 2	14	23	30	39	17	53	2.7	1.0
8 Untreated	—	15	23	31	41	0	0	1.0	1.0

Table 22. Effects of chemicals applied April 30, 1975 to tall fescue followed by one mowing after six days

TREATMENT	RATE lb/A	FOLIAR HEIGHT, in 5/26	FOLIAR HEIGHT, in 7/30	SEEDHEAD HEIGHT, in 5/26	SEEDHEAD HEIGHT, in 7/30	SEEDHEAD REDUCTION, % 5/26	SEEDHEAD REDUCTION, % 7/30	PHYTO-TOXICITY 5/26	PHYTO-TOXICITY 7/30
1 CGA-17020	2.5	9	17	23	35	21	13	3.0	1.0
2 CGA-17020	5.0	9	18	23	35	37	30	3.0	1.0
3 CGA-17020	7.5	10	16	23	34	27	45	3.0	1.0
4 CGA-24705	2.5	8	15	14	—	90	96	3.0	1.0
5 CGA-24705	5.0	8	16	—	—	95	99	3.0	1.0
6 CGA-24705	7.5	6	17	—	—	98	99	3.0	1.0
7 MH + Chlor-flurenol	2 + 2	11	18	25	37	3	10	1.7	1.0
8 Untreated	—	12	19	25	37	0	0	1.0	1.0

Table 23. Effects of chemicals applied May 25, 1975 to tall fescue following four mowings, and measured July 30, 1975

TREATMENTS	RATE, lb/A	FOLIAR HEIGHT,in	PHYTOTOXICITY
1 CGA-17020	2.5	12	1.0
2 CGA-17010	5.0	12	1.0
3 CGA-17020	7.5	11	1.0
4 CGA-24705	2.5	12	1.0
5 CGA-24705	5.0	12	1.0
6 CGA-24705	7.5	12	1.0
7 MH + Chlor-flurenol	2 + 2	12	1.0
8 Untreated	—	12	1.0

[1]Phytotoxicity was measured using a scale of 1 through 9 with 1 representing no injury and 9 representing complete necrosis of the turf.

D. 2. Effects of Aquatic Herbicides Applied in Irrigation Water to Creeping Bentgrass Turf. R. C. Hiltibran and A. J. Turgeon

Ponds, lakes and other water bodies are important features of the golf course landscape because of their aesthetic value and the hazard that they present to play. They also serve as sources of water for irrigating the turf. Since water bodies are susceptible to invasion by algae and aquatic weeds, herbicides are sometimes used to control this unwanted vegetation. However, a major concern is the effects of these herbicides on the turf when applied with the irrigation water. An exploratory study was undertaken in 1973 to determine the potential phytotoxicity associated with the application of aquatic herbicides in irrigation water. This led to a major study in 1974 to accurately determine the importance of aquatic herbicide type, formulation, concentration, timing, and application frequency in the injury and subsequent recovery of treated turf. In 1975, two of the aquatic herbicides which had caused extensive turfgrass injury in previous investigations,simazine and dichlobenil,were applied with irrigation water in decreasing concentration corresponding to the usual rates of their decomposition in the aquatic environment. The rates of simazine application for each week are summarized in Table 26. Also, pond water treated with 0.5 ppm simazine was used for irrigating turf each week for comparison. The results from the 1974 and 1975 studies are presented herein.

The herbicides, formulations and application rates used in the 1974 study are reported in Table 24. The number and dates of application are in Table 25.

No injury to Penncross creeping bentgrass resulted from applications of the copper compounds, 2, 4-D amine, diuron, fenac or the endothall formulations in any of the application sequences given in Table 25. Diquat caused slight-moderate injury in August from the spring-summer (Figure 6) and summer-summer (Figure 7) application sequences. The diquat and diquat + cutrine applications made in the multiple summer sequence caused increasing injury with successive applications from mid-August through September (Figure 8).

Dicholobenil was moderately to severely injurious in all of the 1974 application sequences; however, the plots did recover from the spring-summer (Figure 6) and summer-summer (Figure 7) application sequences by late September. In the multiple summer study, virtually complete necrosis of the plots resulted from dichlobenil applications (Figure 8). In the 1975 study in which decreasing concentrations of dichlobenil were applied, no injury resulted (Figure 9).

Simazine applications caused no damage in the spring-summer and summer-summer tests, but severe injury resulted from the twelve applications in the multiple summer study (Figure 8). In the 1975 study in which simazine was applied in decreasing concentration and from treated pond water, moderate turfgrass injury resulted in both cases (Figure 9). This clearly indicates that simazine should not be used for aquatic weed control in water bodies that are used as a source of turfgrass irrigation water.

The emulsifiable concentrate of silvex was only slightly injurious in the summer-summer application sequence (Figure 7) while severe injury to the turf resulted in the multiple summer study (Figure 8). However, the combination of the soluble salts of silvex and endothall caused only moderate turfgrass injury when applied in the multiple summer application sequence (Figure 8).

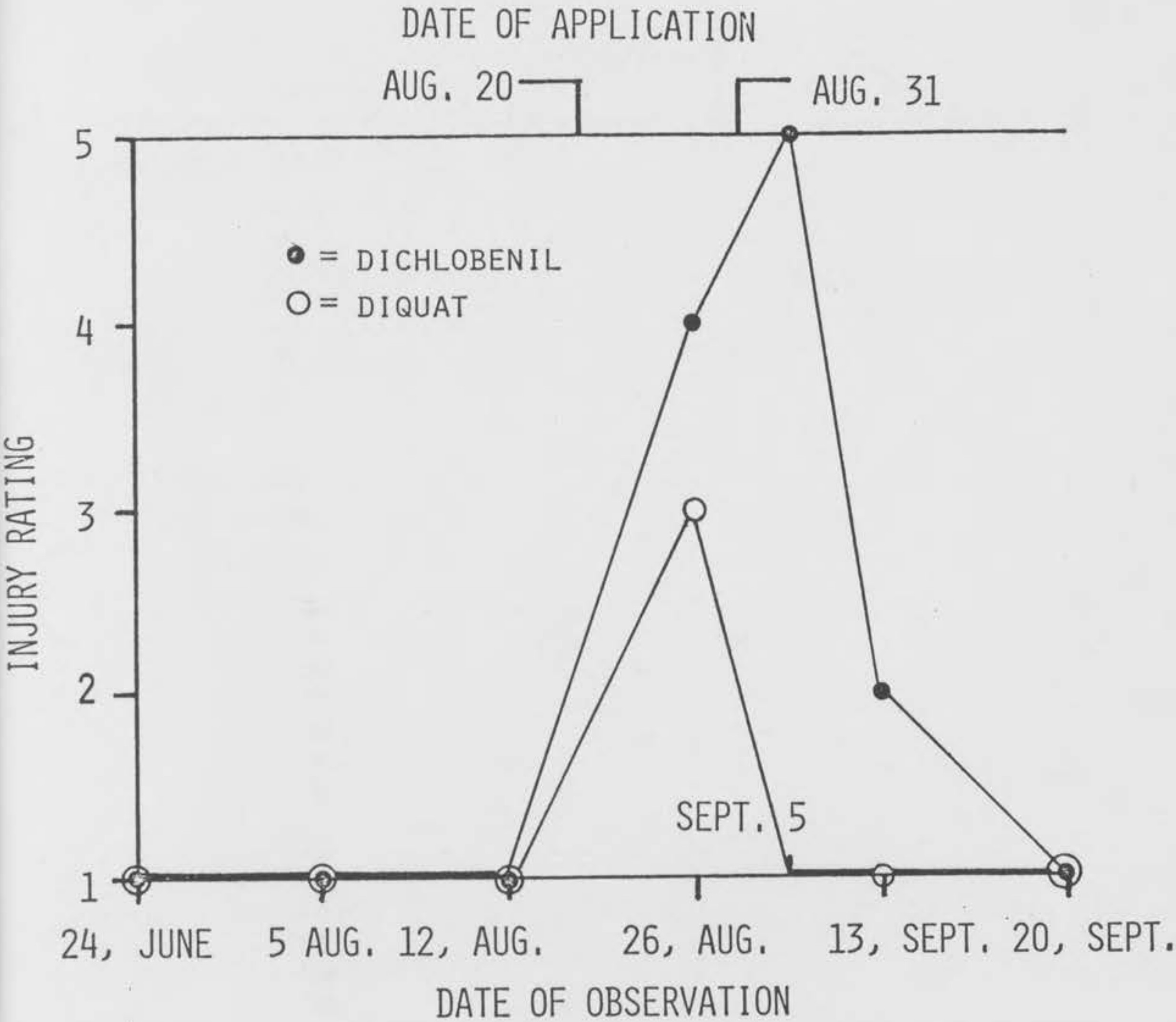

Figure 6. Injury from two spring (30 May and 6 June) and two summer (20 and 31 August) applications of aquatic herbicides in 1.3 cm of irrigation water to Penncross creeping bentgrass.

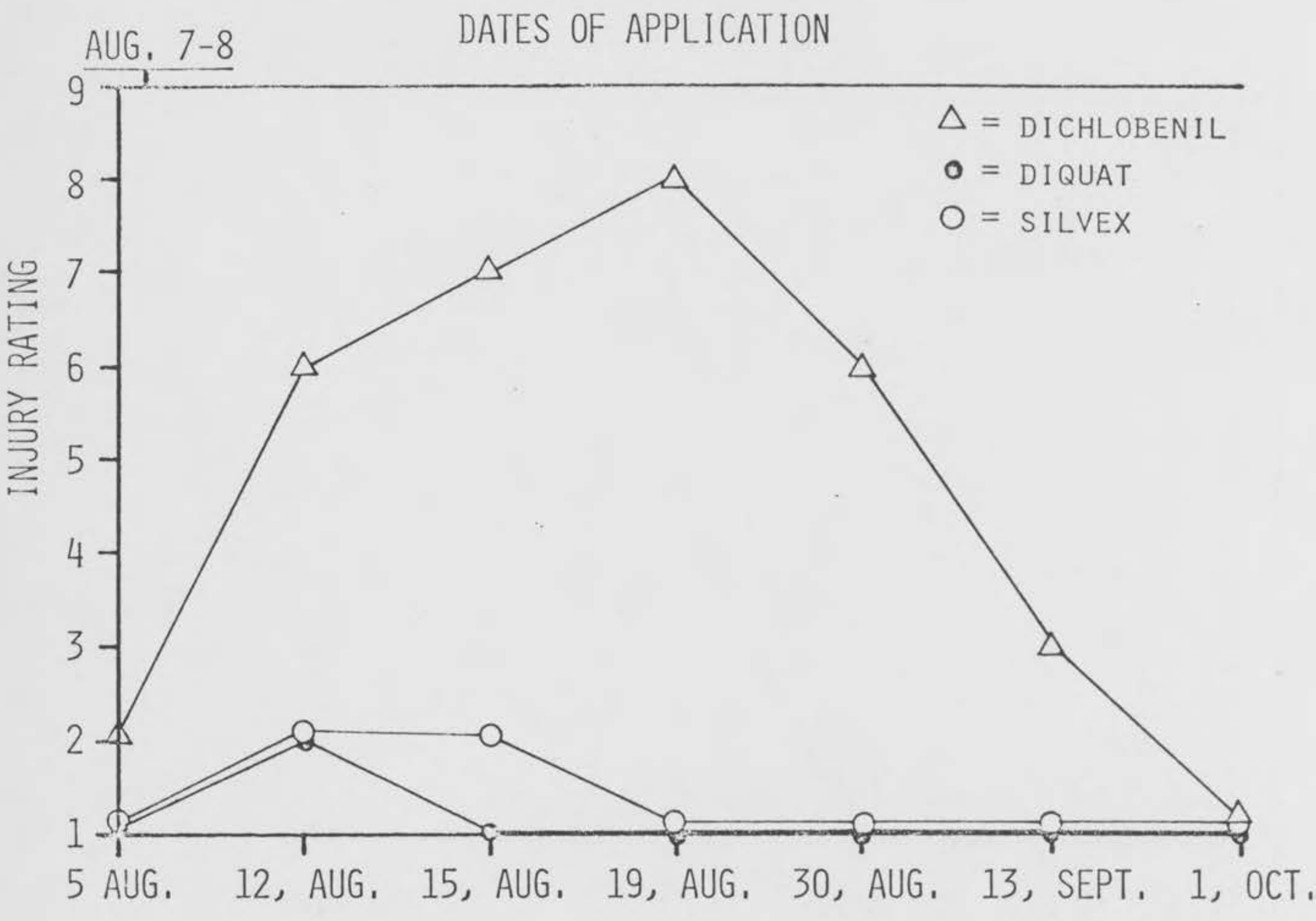

Figure 7. Injury from four summer (29 July, 1, 7, and 8 August) applications of aquatic herbicides in 1.3 cm of irrigation water to Penncross creeping bentgrass.

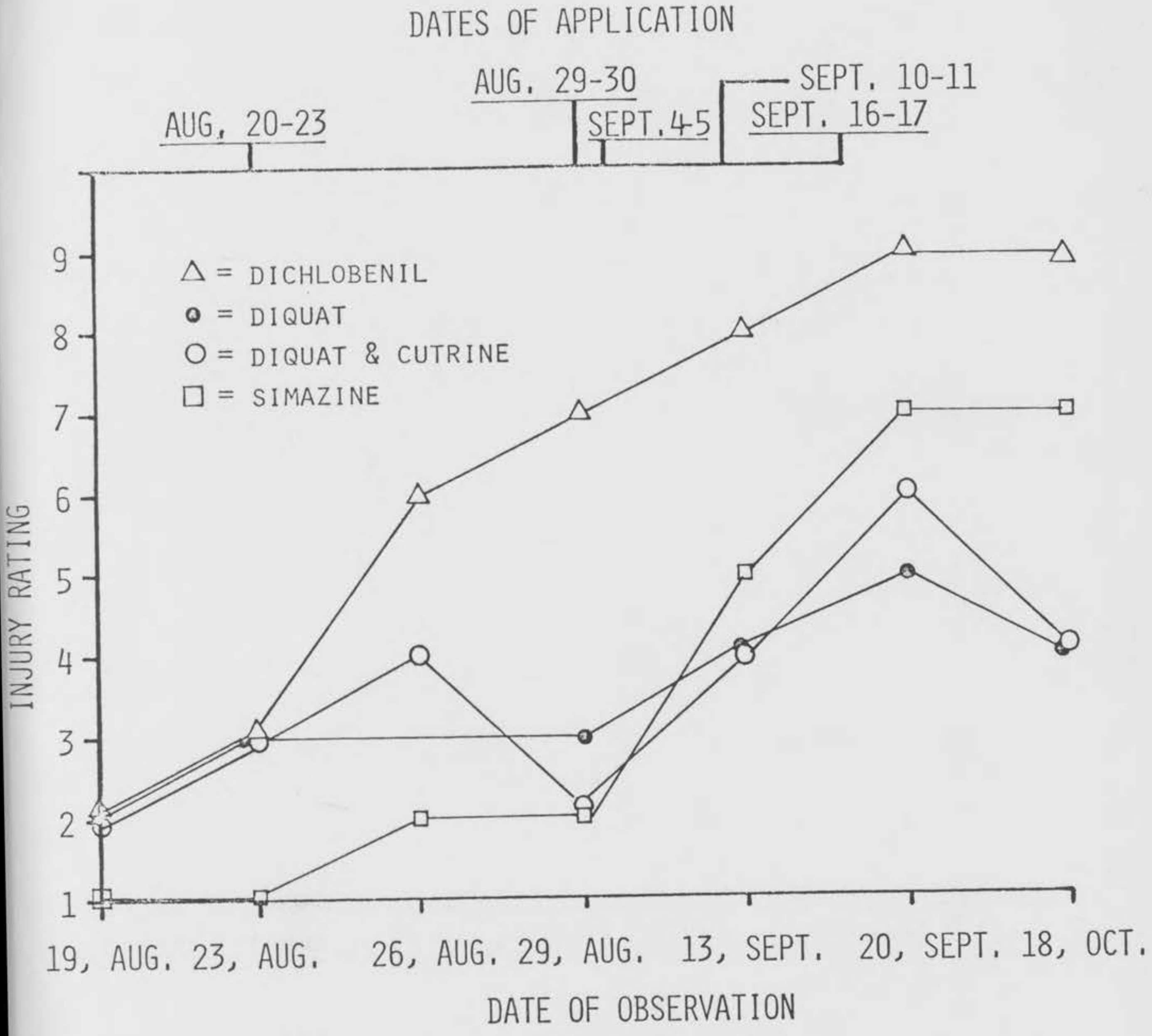

Figure 8a. Injury from twelve summer (14, 16, 20, 23, 29, and 30 August, 4, 5, 10, 11, 16, and 17 September) applications of dichlobenil, diquat, and simezine formulations in 1.3 cm of irrigation water to Penncross creeping bentgrass.

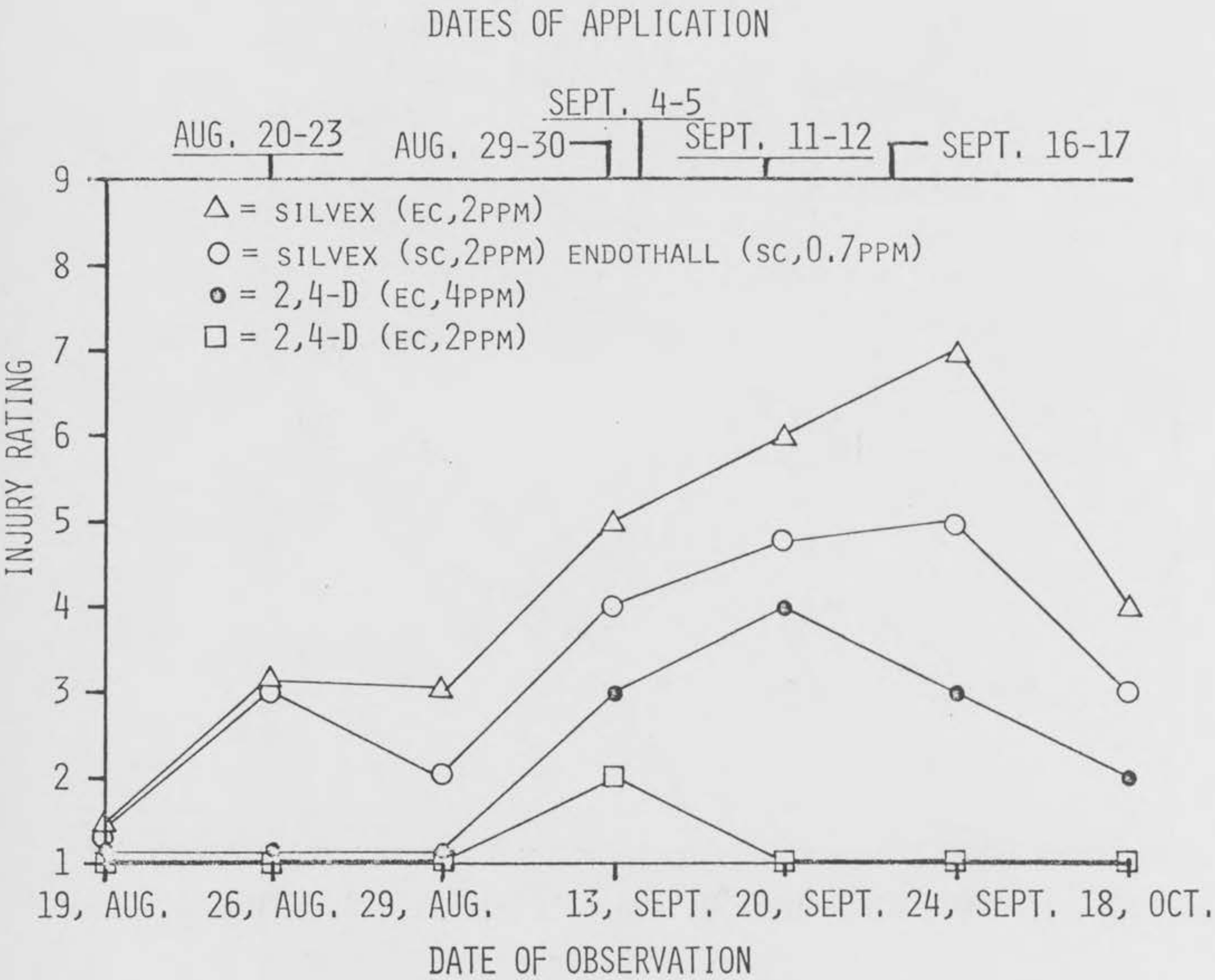

Figure 8b. Injury from twelve summer (14, 16, 20, 23, 29, and 30 August, 4, 5, 10, 11, 16, and 17 September) applications of 2,4-D and silvex formulations in 1.3 cm of irrigation water to Penncross creeping bentgrass.

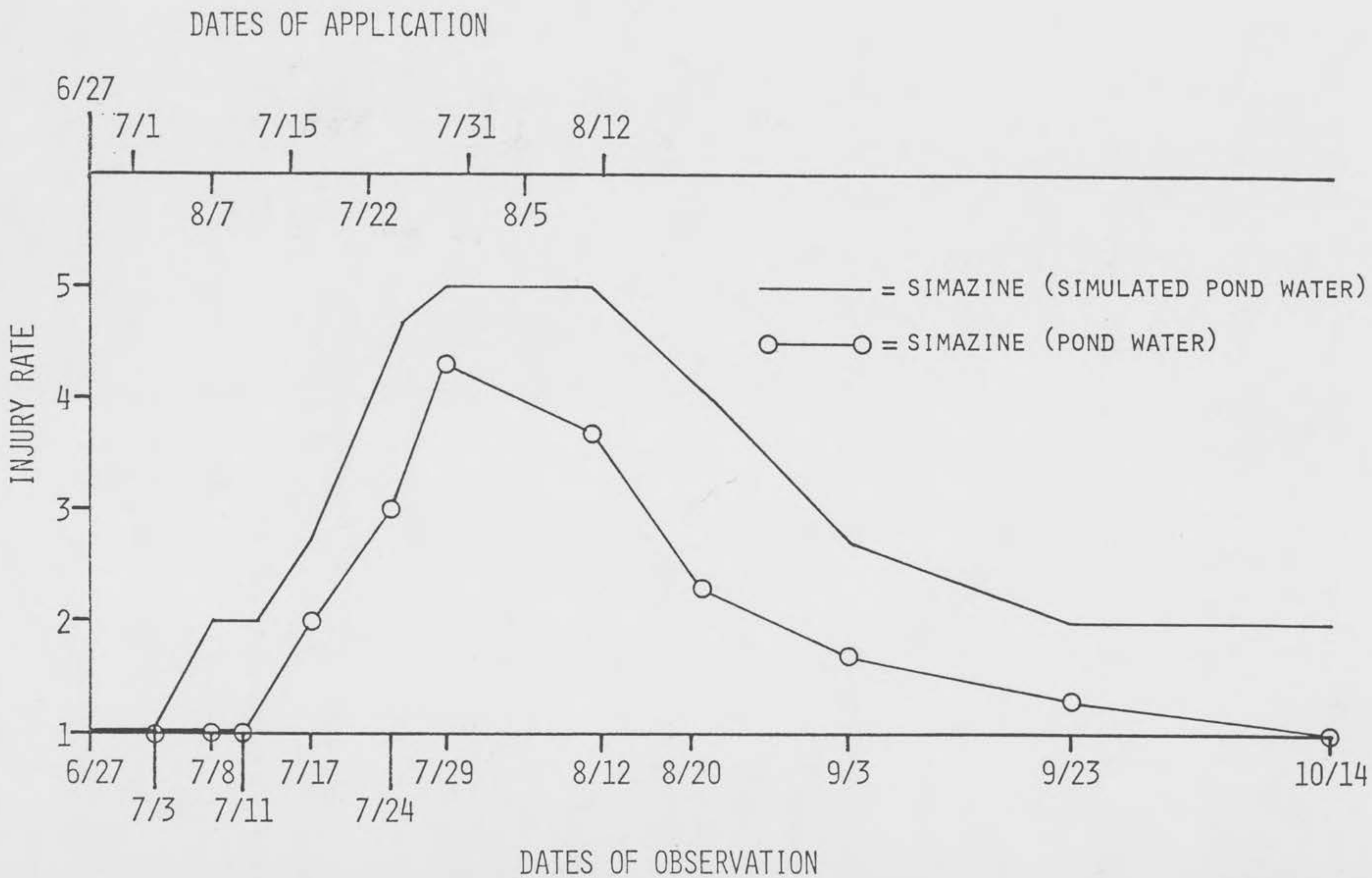

Figure 9. Injury from eight weekly applications of simazine at decreasing concentrations in 74.2 liters of water.

Since endothall caused no injury by itself, the formulation of silvex seems to be an important factor affecting the extent of injury caused by this herbicide. This same relationship was observed with applications of 2, 4-D. Slight injury resulted from multiple summer applications of the emulsifiable concentrate of 2, 4-D at 2 ppm while none was observed to occur where the amine salt formulation was used (Figure 8). Increasing the concentration to 4 ppm resulted in moderate injury to the turf.

Table 24. Aquatic herbicides applied to penncross creeping bentgrass

Active ingredient	Formulation % of	Rate of application a/8 mg/l
Copper sulfate pentahydrate	25 Analytical reagent	1 (Cu)
Copper-triethanolamine	7.1	1 (Cu)
Dichlobenil	50-WP	2
Diquat cation	35.3	1
Diquat-copper triethanolamine	35.3 7.1	1 (diquat) 1 (copper)
Diuron	80-WP	0.25
Endothall		
Potassium salt	40.3	1
di-N,Ndi methylalkyl- amine salt	5 endothall acid equivalent	1 (endothal-acid)
di-(dimethyltri- deerl. amine) oxide	16.8	1 endothall acid
Mono-(dimethyltridecyl amine) oxide	23.8	1.0 (endothall acid)
Endothall + silvex potassium endothal potassium silvex	 22.1 25.3	 0.7 2.0
Fenac, Na	16.8	2.0
Silvex butoxyethanol ester	42.9 58.9	2.0
Simazine	80-WP	

Active ingredient	Formulation % of	Rate of application a/8 mg/l
2,4-D		
dimethyl amine salt	41.2	2.0
butoxy-ethanol ester		2.0
butoxy ester ethanol	68.1	4.0

Table 25. Summary of application dates of aquatic herbicides in 1.27 centimeters of water applied to penncross creeping bentgrass during 1974

Application	Dates
Spring	29, 30 May and 3, 4 June
Spring-Summer	29, 30 May and 3, 4 June 29 July and 30 July
Summer-Summer	29, 30 July and 30 July, 1 August 7 August and 8 August
Multiple-Summer	14, 15 August and 15, 16 August 20, 21 August and 22, 23 August 29 August and 30 August 4 September and 5 September 11 September and 11 September 16 September and 17 September

Table 26. Concentrations of simazine and dichlobenil in 74.2 liters of irrigation water applied to penncross creeping bentgrass

Application week	Aquatic herbicides	
	Simazine	Dichlobenil
	mg/l	
1	0.50	0.18
2	0.43	0.26
3	0.36	0.18
4	0.30	0.13
5	0.25	0.09
6	0.21	0.06
7	0.17	0.04
8	0.14	0.03

D. 3. Effectiveness Biodethatch in Reducing Thatch Development in Kentucky Bluegrass. A. J. Turgeon

Two field studies were initiated in June, 1975, to determine whether a commercial material, Biodethatch, was effective in reducing thatch development in Kentucky bluegrass turfs. A split-plot design was used in which Biodethatch was applied to half of the plots maintained with clippings removed versus returned during mowing. Plots measured 4 by 6 ft. and each treatment combination was replicated four times in each of two studies.

To date, no positive effects from the Biodethatch applications have been observed.

E. 1. b. <u>Preemergence Crabgrass Herbicide Evaluation</u>. A. J. Turgeon

Preemergence herbicides were applied in early May to established Kentucky bluegrass that had been spiked and overseeded with crabgrass and goosegrass. Subsequent treatments were made as indicated in Table 27. Plots measured 5 by 6 ft. and each treatment was replicated three times. The plots were monitored for crabgrass germination and turfgrass injury with data taken several times during the season.

Results showed good to excellent control of crabgrass and no injury from the May treatments with: all Dacthal formulations, Balan at 3 lb a.i./acre followed by 1 lb in June, Ronstar, Betasan at 10 lb a.i./acre, and Terbutol at the higher rates of application (Table 27). Unacceptable injury resulted from the dinitroaniline herbicides: EL-131, Tolban and Balan at 4 lb a.i./acre. Injury was more prominent in late June under severe climatic stress.

Table 27. Preemergence crabgrass and silver crabgrass control with herbicides

Treatments	Form[1]	Rate, lb a.i./acre[2]	Phytotoxicity[3] 29 May 75	Phytotoxicity[3] 24 June 75	% Crabgrass 15 Aug	% Crabgrass 10 Sept	% Control 15 Aug	% Control 10 Sept
Dacthal	75 WP	10	1.0	1.0	2	4	97	92
Dacthal	75 WP	15	1.0	1.0	2	5	97	91
Dacthal	75 WP	10+7.5	1.0	1.0	0	4	100	92
Dacthal	75 WP	10+15	1.0	1.0	0	3	100	94
Dacthal	75 WP	10+5	1.0	1.0	2	4	97	92
Dacthal	4 F	10	1.0	1.0	5	6	92	89
Dacthal	6 F	10	1.0	1.0	4	11	93	79
Dacthal	6 F	15	1.0	1.0	3	5	95	91
Dacthal	6 F	20	1.0	1.0	3	5	95	91

[1] Formulations include: wettable powders (WP), flowables (F), granules (G), emulsifiable consentrates (E) and solutions(S).

[2] Initial applications were made on May 3, 1975; in some cases, second applications were made on June 27, 1975, unless indicated otherwise; and third applications were made on August 15, 1975.

[3] Phytotoxicity ratings were made using a scale of 1 through 9 with 1 representing complete necrosis of the turf.

Treatments	Form[1]	Rate, lb	Phytotoxicity[3] 29 May 75	24 June 75	% Crabgrass 15 Aug	10 Sept	% Control 15 Aug	10 Sept
Dacthal	6 F	5+5+5	1.0	1.0	4	6	93	89
Dacthal	6 F	10+10+10	1.0	1.0	2	7	96	87
Dacthal	6 F	10+5	1.0	1.0	2	5	96	91
Dacthal	6 F	5	1.0	1.0	5	10	92	81
Dacthal	6 F	0+5	1.0	1.0	35	55	38	0
Dacthal	6 F	10+7.5	1.0	1.0	1	3	98	94
Dacthal	6 F	10+15	1.0	1.0	1	2	98	96
Dacthal	6 F	15 (May 20)	1.0	1.0	2	4	97	92
Dacthal	6 F	15 (June 3)	1.0	1.0	3	4	95	92
Dacthal	6 F	15 (June 23)	1.0	1.0	50	57	11	0
Balan	2.5 G	2	1.0	1.0	14	19	76	64
Balan	2.5 G	3	1.3	1.0	7	15	88	72
Balan	2.5 G	4	1.7	2.7	11	3	80	94
Balan	2.5 G	2+2+2	1.0	1.0	5	6	91	89
Balan	2.5 G	3+1	1.0	1.0	2	5	96	91
EL-131	50 WP	2	2.3	2.7	23	22	58	58
EL-131	50 WP	3	3.0	4.7	24	25	57	53
EL-131	50 WP	4	3.3	4.7	25	22	55	58
EL-131	50 WP	2+2+2	2.0	2.3	6	8	89	85
EL-131	50 WP	3+1	3.7	4.3	8	8	85	85
EL-131	50 WP	2+1	2.7	3.3	9	20	84	62
EL-131	50 WP	4+4	3.7	5.0	4	3	93	94
Tolban	2 G	2	2.0	3.7	2	3	97	94
Ronstar	2 G	1	1.0	1.0	9	20	83	62
Ronstar	2 G	2	1.0	1.0	2	6	97	89
Ronstar	2 G	3	1.0	1.0	4	6	93	89
Betasan	4 E	5	1.0	1.0	9	17	84	68
Betasan	4 E	7.5	1.0	1.0	5	8	92	85
Betasan	4 E	10	1.0	1.0	2	5	97	91
Betasan	4 E	3.8+3.8	1.0	1.0	9	11	84	79
Betasan	3.6 G	5	1.0	1.0	11	8	80	85
Betasan	3.6 G	7.5	1.0	1.0	7	9	88	83

Treatments		Rate, lb a.i./acre[2]	Phytotoxicity[3] 29 May 75	24 June 75	% Crabgrass 15 Aug	10 Sept	% Control 15 Aug	10 Sept
Betasan	3.6 G	10	1.0	1.0	6	6	89	89
Betasan	3.6 G	3.8+3.8	1.0	1.0	15	21	73	64
VEL-4207	2 E	0.5	1.0	1.0	54	82	0	0
VEL-4207	2 E	1.0	1.0	1.0	60	54	0	0
VEL-4207	2 E	1.5	1.0	1.0	58	72	0	0
VEL-4207	2 E	2.0	1.0	1.0	60	75	0	0
VEL-4207	2 E	2.5	1.0	1.0	33	52	41	0
Banvel	4 S	0.3	1.0	1.0	50	67	1	0
Banvel	4 S	0.5	1.0	1.0	50	52	1	0
Banvel	4 S	1	1.0	1.0	55	63	0	0
Banvel	4 S	2	1.0	1.0	40	53	29	0
Terbutol	80 WP	10	1.0	1.0	11	14	80	74
Terbutol	80 WP	15	1.3	1.0	6	8	89	85
Terbutol	80 WP	20	1.7	1.0	3	4	95	92
Untreated	—	—	1.0	1.0	55	53	0	0

E. 1. b. Effects of Herbicides on Annual Bluegrass Control and the Recuperative Ability of Kentucky Bluegrass Turf. A. J. Turgeon

Control of annual bluegrass with herbicides does not necessarily guarentee satisfactory turfgrass quality unless the desirable turfgrass species are tolerant of the herbicides, and voids resulting from the death of annual bluegrass fill in from adjacent turf. An experiment was initiated in August, 1975, to determine the effect of mowing height and herbicide application on the recuperative potential of Kentucky bluegrass. Plots measuring 5 by 6 ft. were maintained under 0.75-in. and 1.5-in. cutting heights beginning in June, 1975. In August, circular areas of dead turf measuring 12, 8 and 4 inches in diameter were developed in each plot from a single application of glyphosate at 4 lb/acre. After one week, all plots except three were overseeded with annual bluegrass at the rate of 1 lb/1000 sq. ft. and treated with various herbicides including: Betasan @ 10 lb/acre; Dacthal @ 12 lb/acre, Balan @ 2 lb/acre, Terbutol @ 10 lb/acre, EL-131 @ 2 lb/acre, liquid and granular formulations of endothall @ 4 lb/acre and Ronstar @ 2 lb/acre. Additional treatments included a seeded and a nonseeded check which did not receive herbicides.

The plots are being observed for annual bluegrass control and recovery of Kentucky bluegrass in the circular voids resulting from glyphosate treatment.

E. 1. c. Studies on the Use of Glyphosate for Turfgrass Renovation.
A. J. Turgeon

A field study was initiated July 31, 1975, on a Flanagan silt loam soil to determine the effects of preplant incorporated and preemergence applications of glyphosate on germination and subsequent growth of 'A-34' Kentucky bluegrass and 'Pennfine' perennial ryegrass. Seeding rates were 1 and 3 kg/are for the A-34 and Pennfine, respectively. Glyphosate was applied at 0, 1.12, 2.24, 4.48, 8.96 and 17.92 kg/ha prior to seeding, and lightly raked into the top 2.5 cm of soil, or immediately after seeding. Plots measured 1.52 m by 1.82 m with seeded strips of each grass measuring 0.61 m by 1.82 m within each plot. Irrigation was performed as needed to encourage germination. Treatment combinations were replicated three times in a randomized complete block design. After five weeks, clipping yields were measured using a 2.5-cm cutting height. Afterward, the plots were mowed twice weekly at 3.8 cm. Stand counts were made eight weeks after planting from two 25-cm^2 plugs taken from both grasses in each plot.

A second study was initiated on August 4, 1975, to determine the relative effectiveness of different turfgrass establishment methods following glyphosate treatment at 2.7 lb/acre of a mature stand of tall fescue. The herbicide was applied using a Chevron Sprayette. After six days, the following establishment methods were employed: core cultivation, seeding at 2 lbs/1000 sq. ft., and vertical mowing to break up the soil cores; disc seeding with a Rogers Seeder to incorporate 20 lbs of seed/acre directly into grooves resulting from vertical mowing; broadcast seeding at 2 lbs/1000 sq. ft.; and vertical mowing followed by broadcast seeding at 2 lbs/1000 sq. ft. The seed mixture was a 1:1 combination by weight of A-20 Kentucky bluegrass and Pennfine perennial ryegrass. Plots measured 8 by 10 ft. and each establishment method was replicated three times in a randomized complete block design. After one month, the present turfgrass cover was estimated.

No significant reductions in clipping yield or stand density of 'A-20' Kentucky bluegrass or 'Pennfine' perennial ryegrass resulted from preplant incorporated or preemergence applications of glyphosate (Tables 28 and 29). However, a trend toward higher density and yield was observed with increasing rates of glyphosate. With the implementation of different establishment methods following treatment with glyphosate, the best turfgrass cover resulted in plots that had been core cultivated prior to seeding (Table 30). Results from disc seeding and vertical mowing plus broadcast seeding were comparable; however, much less seed was used in disc seeding due to the selective placement of seed into the grooves developed by the vertical mowing component of the apparatus. Also, the pattern of turfgrass cover differed in that, following disc seeding, parallel lines of turfgrass seedlings developed while a more random seedling stand resulted from vertical mowing plus broadcast seeding. The poorest turfgrass cover was observed in plots that had no cultivation prior to broadcast seeding. In conclusion, disc seeding was the most efficient method of turfgrass establishment in terms of the labor-time requirement and quantity of seed used while the most effective method was the combination of core cultivation, broadcast seeding and vertical mowing.

Table 28. Effects of preplant incorporated and preemergence applications of glyphosate on clipping yield of two turfgrass species five weeks after planting.*

GLYPHOSATE	A-20 Kentucky bluegrass		Pennfine perennial ryegrass	
	PPI	PRE	PPI	PRE
Kg a.i./ha	g clipping dry wt/56 dm^2			
0	1.29	1.29	28.25	27.53
1.12	1.62	1.39	31.75	24.67
2.24	1.77	1.80	30.98	28.47
4.48	2.66	1.51	28.57	28.28
8.96	2.05	1.23	38.14	30.60
17.92	2.40	1.75	34.72	31.67
LSD .05	1.33	0.98	8.63	9.17
LSD .01	1.89	1.39	12.28	13.05

*Table values are the means of three replications.

Table 29. Effects of preplant incorporated and preemergence applications of glyphosate on stand density of two turfgrass species eight weeks after planting.*

GLYPHOSATE	A-20 Kentucky bluegrass		Pennfine perennial ryegrass	
	PPI	PRE	PPI	PRE
Kg a.i./ha	No shoots/25-cm^2 plug			
0	25.66	26.50	19.83	24.33
1.12	25.33	31.83	23.16	27.16
2.24	33.66	29.00	27.83	22.16
4.48	17.50	28.83	15.50	34.83
8.96	36.50	29.00	28.50	23.33
17.92	30.66	20.33	27.33	15.16
LSD .05	9.70	11.60	12.20	11.63
LSD .01	13.12	15.70	16.50	15.73

*Table values are the means of six replications.

Table 30. Effects of establishment method in the development of turfgrass cover following glyphosate treatment at 2.7 lb/acre of a mature stand of tall fescue.

Establishment method	Percent stand[1]
Core cultivation, seeding, and vertical mowing	81.6
Disc seeding	66.6
Broadcast seeding	48.3
Vertical mowing, and broadcast seeding	70.0

[1]One month after seeding a mixture of A-34 Kentucky bluegrass and Pennfine perennial ryegrass (1:1).

E. 2. b. <u>1975 Fungicide Evaluation for the Control of Sclerotinia Dollar Spot and Rhizoctonia Brown Patch on Creeping Bentgrass</u>. G. W. Simone and M. C. Shurtleff

Fungicide evaluations are part of the continuing turfgrass research program at the University of Illinois. This experiment (Table 31) was designed to compare the effectiveness of several experimental and commercial fungicides (at differing rates and application intervals) in controlling two of the most common diseases of bentgrass in Illinois -- Schlerotinia dollar spot and Rhizoctonia brown patch. The experimental design was completely randomized with four replications. Fungicide application commenced on June 20 and were continued through the end of September. Ratings were conducted during the period of August 3 through September 26, at two week intervals for Sclerotinia dollar spot.Rhizoctonia brown patch ratings were conducted between August 16 and September 12 (corresponding to disease appearance in the checks) at two week intervals also.

Companies contributing fungicides and professioanl assistance were: Diamond Shamrock Corporation (Daconil 2787); E. I. duPont de Nemours and Company (DPX164 and Tersan 1991); and Rhodia Incorporated (RP 26019); and Rohm and Haas Company (Rh 3928A and Exp 42252).

Incidence of both diseases was light during this evaluation. All entry fungicides provided excellent control of Sclerotinia dollar spot during the rating periods. Rhizoctonia brown patch control was slightly more variable among entry fungicides. The Exp. 42252 entry (0.2 lb a.i. at 14 day intervals) and the RH 3928A entry (14 day intervals) had numerically larger disease ratings than the water check. However, no disease severety rating for any fungicide entry was significantly greater than the water check. Without greater disease pressure, more effective rates or application intervals could not be validly assessed.

Final inspection of these bentgrass plots one month after suspension of fungicide application did not reveal any new incidence of either disease. All entry fungicides appeared equally effective in suppressing a mid fall incidence of dollar spot that has been observed in previous years.

Table 31. Fungicide evaluation for control of sclerotinia dollar spot and rhizoctonia brown patch on creeping bentgrass

Fungicide	Rate[1] (oz/1000 sq. ft.)	Application[1] Interval (days)	Scerotinia D. S.[2] 8/3	8/16	8/29	9/12	9/26	Overall Mean	Rhizoctonia B.P.[3] 8/16	8/29	9/12	Overall Mean
Daconil 2787	1/4 pt.	10	.25	.25	.00	.00	.00	.10	.00	.00	.00	.00
Daconil 2787 & Terson 1991	1/8 pt +2	14	.00	.25	.00	.00	.00	.05	2.5	2.5	2.5	2.5
DPX 164	4	7	.00	.00	.00	.00	.00	.00	.00	2.5	2.5	1.66
DPX 164	4	14	.00	.00	.00	.00	.00	.00	.00	0.0	2.5	.83
Exp 42252	.01 lb a.i.	7	.25	.25	.25	.25	.25	.25	.00	2.5	5.0	2.5
Exp 42252	.02 lb a.i.	14	.25	.75	.5	.25	.00	.35	5.0	7.5	12.5	8.3
RH 3928A	.06 lb	7	.25	.00	.00	.00	.00	.05	0.0	7.5	7.5	5.0
RH 3928A	.06 lb	14	.25	.25	.25	.25	.00	.20	2.5	5.0	15	7.5
RP 26019	2 a.i.	10	.00	.00	.00	.00	.00	.00	2.5	2.5	2.5	2.5
RP 26019	4 a.i.	10	.00	.00	.00	.00	.00	.00	2.5	2.5	7.5	4.16
Tersan 1991	2	14	.00	.25	.25	.00	.00	.10	.00	0.0	7.5	2.5
Water (check)	—	—	.5	.75	.5	.25	.25	.45	7.5	5.0	7.5	6.66

[1]Application rates and intervals determined by label instructions or manufacturer's suggestions.

[2]Dollar spot ratings were based on a scale of 0-5 (0=no dollar spot; 5=severe dollar spot). Ratings are expressed as the mean of 4 replications.

[3]Brown patch ratings were based on percent plot area diseased. Ratings are expressed as the mean of 4 replications.

E. 2. b. Fusarium Blight Control Study. M. C. Shurtleff and A. J. Turgeon

One of the most important diseases of lawns and fine turfs is Fusarium blight. It may appear with the beginning of hot weather, it continues through much of the growing season, and it is frequently confused with other diseases, insect injury and other types of damage. Early diagnosis and implementation of effective control measures are essential for sustaining acceptable turfgrass quality in affected turfs.

An evaluation of several commercial fungicides applied with and without fertilizer was initiated August 18, 1975, on a severely diseased Kentucky bluegrass turf. The area had been severely affected by Fusarium blight in previous years. Table 32 indicated the fungicides and thier rates of application. Plots measured 5 by 6 ft. and each treatment was replicated six times with one-half of the plots receiving 1.5 lb of nitrogen (using a 10-6-4 analysis water-soluble fertilizer) per 1000 sq. ft. on September 4, 1975. The fungicides were applied to turf that was wet from several days of rain. Immediately after spraying, the fungicides were drenched into the rootzone using one inch of water.

The percent area of each plot covered with healthy turf was recorded on October 9, 1975 (Table 32). The data confirmed that the three systemic fungicides used (Cleary 3336, Fungo and Tersan 1991) are effective in controlling Fusarium blight. Surprisingly, the 4-oz rates were about as effective as the 8-oz rates. The fertilized plots recovered more rapidly than did those that received no fertilizer. As expected, PCNB (Terraclor) was ineffective in controlling Fusarium blight.

Since the fungicides were applied long after the initial Fusarium blight symptoms were evident, prompt spraying at the first signs of the disease would probably have resulted in a more rapid and complete recovery of the turf.

Table 32. Eradicative control of Fusarium blight in Kentucky bluegrass with fungicides and the effect of nitrogen fertilization on recovery.

FUNGICIDE	RATE oz/1000 sq ft	Percent turfgrass coverage	
		Fertilized	Unfertilized
Fungo	4	86.7	78.3
Fungo	8	88.3	80.0
Cleary 3336	4	78.3	76.7
Cleary 3336	8	86.0	73.3
Tersan 1991	4	80.0	63.3
Tersan 1991	8	72.7	66.7
PCNB	8	51.7	51.7
Untreated	—	56.7	46.7

E. 3. Annual White Grub Control Trial. Roscoe Randell

Various experimental and commercial insecticides were applied to Kentucky bluegrass plots measuring 1000 sq. ft. at Decatur Country Club on September 2, 1975. The granular materials were applied through a gravity-flow spreader and liquid concentrates were mixed with one gallon of water for application to 1000 sq. ft. plots. All plots were irrigated immediately after application of the insecticides. Precounts made on grub populations prior to treatment yielded 8 to 9 grubs per sq. ft. Control data were taken September 22, 1975.

Control was excellent with Furadan, CGA-12223 and the Dyfonate 2G formulation (Table 33). The more concentrated 5G formulation of Dyfonate was not as effective in controlling grubs; presumably, the uniformity of distribution with this carrier was substantially less than that from the less concentrated 2G material. Spectracide provided good grub control while results from Orthene applications were fair to poor.

Table 33. 1975 Annual white grub control

Insecticide	Lb ai/acre	No. of grubs/5 sq ft		
		Alive	Mor	Dead
Spectracide 5%G	5 lb	7	14	15
Spectracide 25% E.C.	5 lb	2	6	9
CGA-12223 1%G	1 lb	1	5	12
CGA-12223 1%G	2 lb	0	0	6
Dyfonate 2G	6 lb	1	5	16
Dyfonate 5G	6 lb	18	12	11
Orthene 1.35 lb/gal	2.5 lb	34	7	0
Orthene 1.35 lb/gal	5 lb	19	20	10
Furadan 10G	2 lb	0	1	8
Untreated	—	41	0	0

F. 2. Comparison of Washed (Soil-Less) and Unwashed Sod. J. E. Renaud and A. J. Turgeon

Sodding has become a very popular method of turfgrass propagation for sites where it is desirable to obtain quality turf quickly. A new approach to sodding was introduced by Warren's Turf Nursery with the development of soil-less sod from automated washing of the sod strips. Obvious advantages of soil-less sod include: lower shipping cost, easier handling of the sod at the transplant site, and elimination of the potentially troublesome interface between the soil carried with the sod and the soil at the transplant site. This latter advantage may be especially important where sod is laid on top of a sand growing medium such as in PAT football field construction or in development of new greens employing essentially pure sand in the root zone.

Sod sections measuring 9 by 11 inches were washed free of soil and planted in root observation boxes containing soil or sand. Unwashed sod sections were also planted for comparison. The experiment was conducted in late May and in late July, and root development was measured at three soil depths after 13 days. Each treatment was replicated three times.

Sod rooting from washed sod was substantially better than that observed from the unwashed sod following the May planting (Figure 10a). This rooting difference was more pronounced in sand than in the soil medium. When the same experiment was conducted in July, under appreciably higher temperatures, the results were reversed (Figure 10b). Apparently, the absence of soil in the washed sod reduces the stress tolerance of the grass and, thus, results in poorer establishment under conditions of climatic stress. In the absence of climatic stress, elimination of the soil interface under the planted washed sod allows for faster root development.

Washed and unwashed sod sections measuring 12 by 12 inches were placed on top of rooting screens which were, in turn, placed on top of soil or on sand for subsequent determination of sod rooting strength. Muck-grown sod was used, and each treatment was replicated six times. After three weeks, hooks were attached to the screens and the force required to extract the sod sections from the underlying growing media was measured. Careful attention was paid to the water requirements of the grass to prevent injury from desiccation. Sod rooting strength was the same or higher with the washed sods compared to the unwashed sod sections (Figure 11).

The contribution of sod moisture to the weight and surface area of the sod was measured by saturating 12 by 12 inch sections of washed and unwashed sod, and then determining weight and area losses after air drying the sod sections for several days. Results showed that moisture loss and shrinkage were greatest in the washed (soil-less) sod (Table 34). Since sod shrinkage at the planting site is an important factor affecting the establishment and appearance of the new turf, it is apparent that irrigation practices are more critical where soil-less sod is planted.

The effects of automated washing on sod weight and sod strength were studied using an apparatus designed and constructed by Warren's Turf Nursery. Sod sections measuring 1.5 by 6 ft. were run through the washing apparatus 1, 2, 3, 4 or 5 times; then, each section was immediately weighed and tested

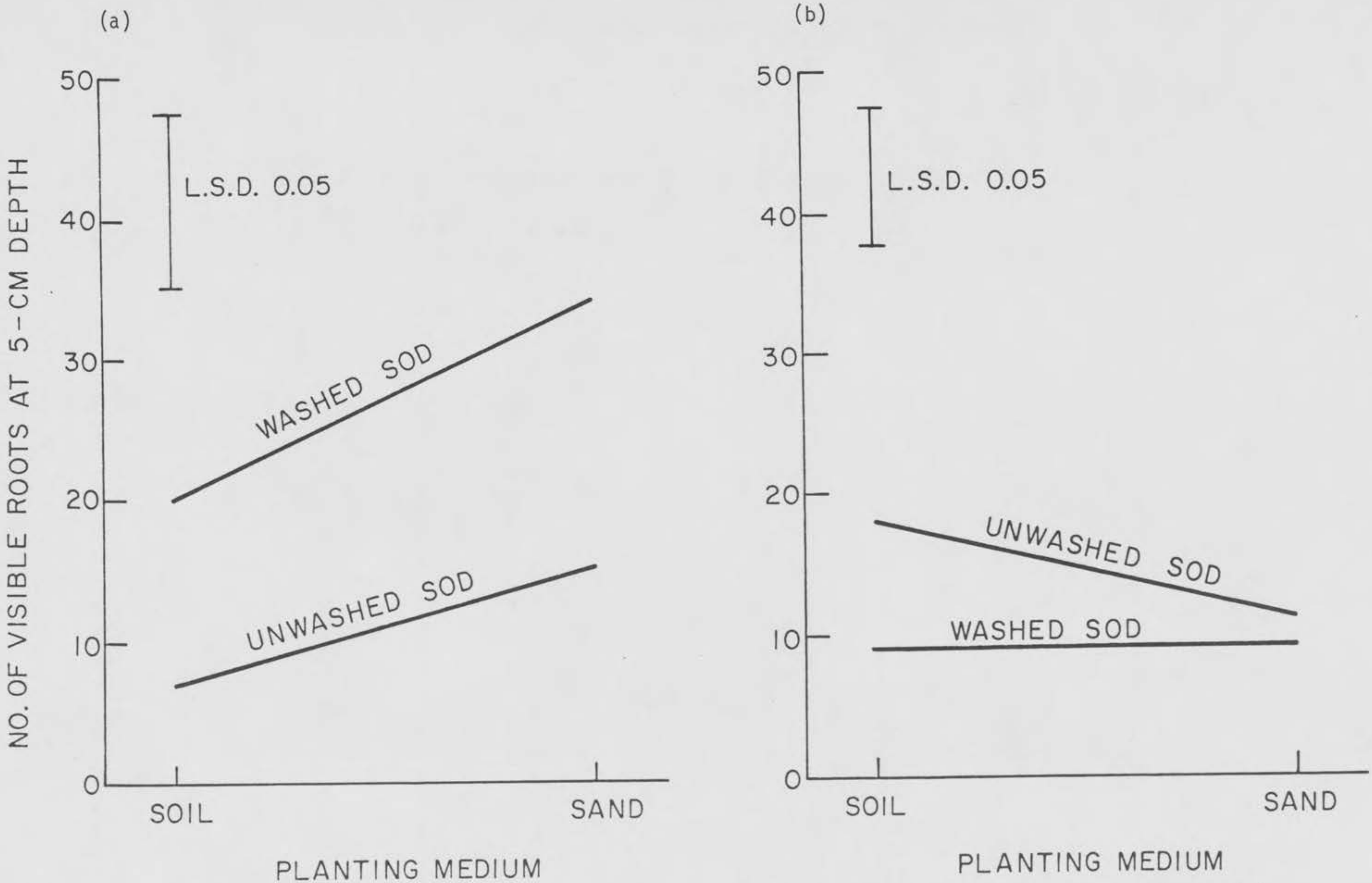

Figure 10. Sod rooting from washed versus unwashed A-20 sod sections planted in spring (a) and summer (b) in soil and in sand.

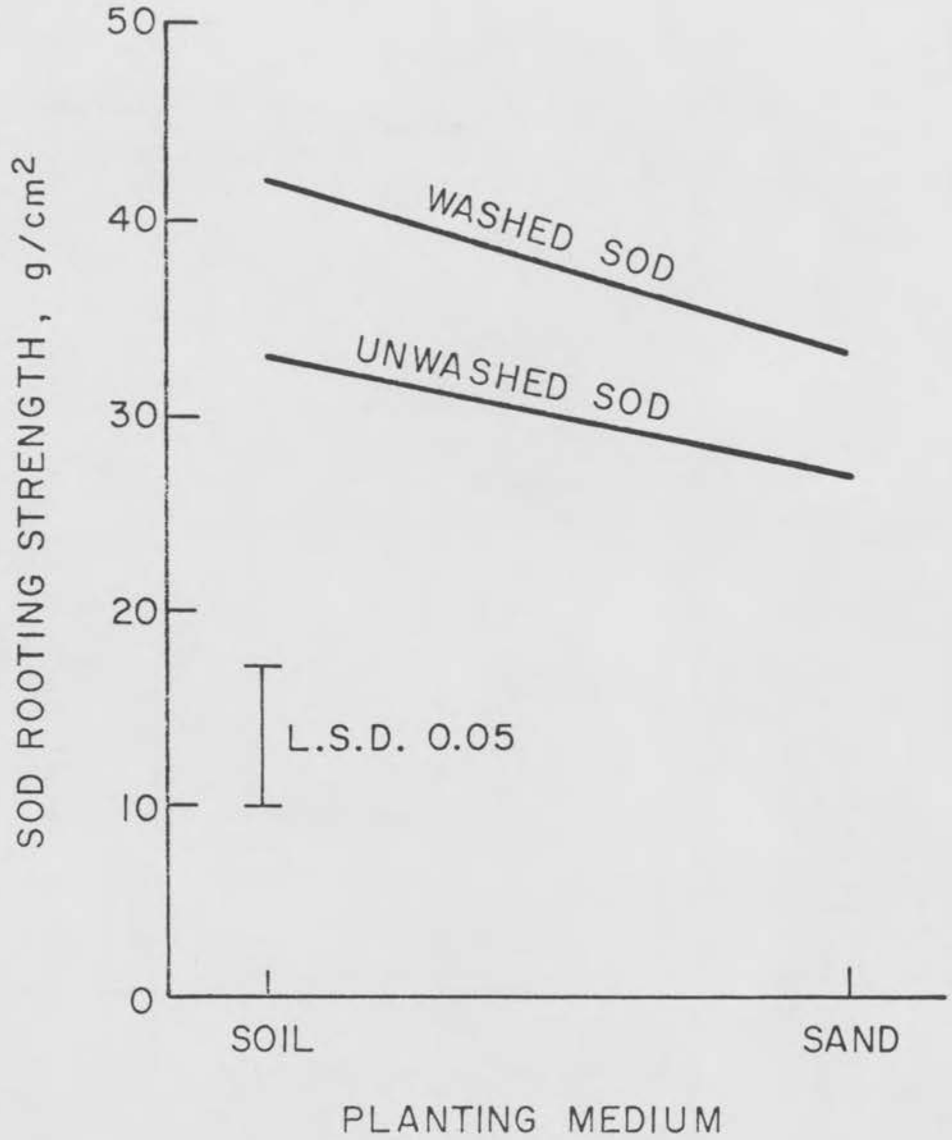

Figure 11. Sod rooting strength of washed versus unwashed A-20 sod sections planted in summer in soil and in sand.

for sod strength using a sod pulling device constructed at the University of Illinois. Results were compared with those from unwashed sod. In addition, unwashed sod sections were saturated with water by careful soaking to avoid soil loss, and these were also weighed and tested for sod strength. Results showed a dramatic loss of sod strength with the first washing but no significant reduction in sod strength from successive washings (Figure 12). However, saturation of unwashed sod with water also resulted in a substantial loss in sod strength. Thus, the loss of sod strength from washing was not due to soil removal but, rather, from the addition of moisture to the sod. Presumably, the water addition has a lubricating effect on the intermingled roots and rhizomes that provide sod strength.

At least three washings were necessary to satisfactorily remove soil from the sod sections as indicated by the loss in sod weight from successive washings. The weight loss is partially offset, however, by the weight of water added to the sod from washing. A more effective means of reducing sod moisture after washing would be desirable by order to optimize the advantage of reduced sod weight from the removal of soil in the sod.

Table 34. Effects of drying on weight and area losses in washed versus unwashed muck-grown A-20 sod sections

Sod type	Sat. Wt., oz.	Dry Wt., oz.	Loss, %	Sat. Area, in^2	Dry Area, in^2	Loss %
Unwashed	72	29	59	142	122	14.0
Washed	36	7	82	139	116	17.0

F. 4. Vegetative Establishment of Kentucky Bluegrass and Creeping Bentgrass Turf. A. J. Turgeon and E. G. 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

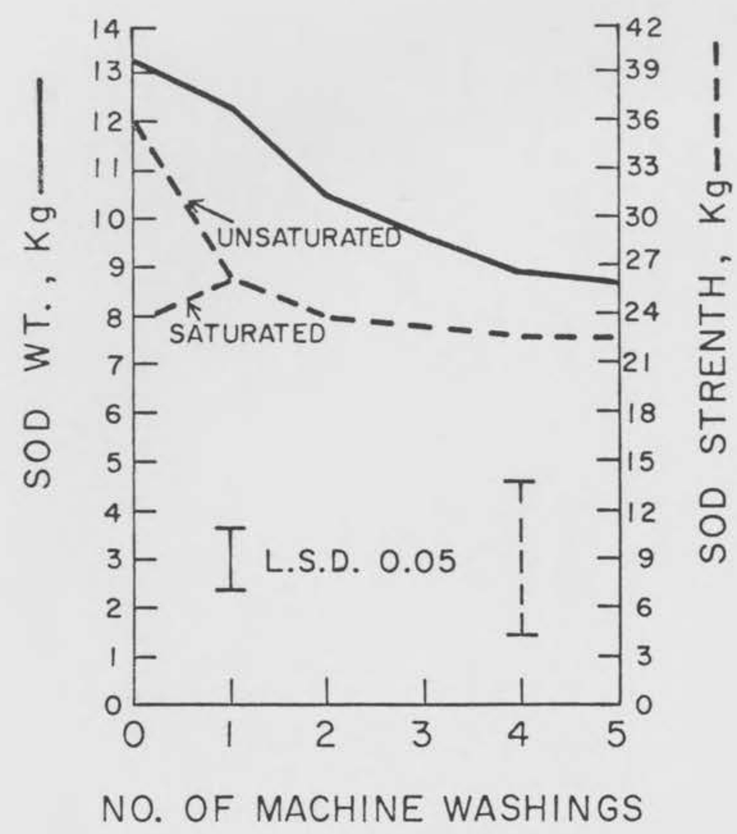

Figure 12. Effects of successive machine washings on the weight and strength of 6 by 1.5 ft. strips of A.20 sod.

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.

Plugs of three creeping bentgrass varieties (Toronto, Pennpar, and Cohansey) were machine-planted and treated with several preemergence herbicides in June to determine the feasibility of this establishment method for bentgrass. Plots measured 5 by 6 ft. and each treatment was replicated three times.

The fastest rate of coverage by A-20 occurred in the unmowed plots, or under a 3-in mowing height and a minimum of 1 lb N/1000 sq ft/month (Table 35). Unacceptably slow lateral growth of the plugs occurred under the 0.75-in mowing height regardless of fertilization level.

The condition of plugs of the Kentucky bluegrasses treated with Ronstar ranged from good to complete necrosis depending upon variety (Table 36). 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 varieties shown to be injured from Ronstar (i.e. Campina, Merion, Parade, Park, Pennstar, etc.).

The results from the bentgrass study indicate that Ronstar and Balan are too injurious to be practical for this use, and that Betasan offers the best potential for controlling weeds during vegetative establishment of creeping bentgrass turf from plugs (Table 37). This latter conclusion is tentative, and depends upon further evaluation of the treated plots.

Table 35. Effects of mowing and fertilization on the rate of coverage by A-20 Kentucky bluegrass planted from plugs.

Mowing Height	Fertilization	Time After Planting, Weeks	
		14	22
in.	lb N/1000 sq ft/mo	% cover	
0.75	0	20.0	38.3
0.75	0.5	28.3	48.3
0.75	1	23.3	41.6
0.75	2	23.3	43.3
1.5	0	31.7	48.3
1.5	0.5	43.3	63.3
1.5	1	40.0	63.3
1.5	2	38.3	63.3
3.0	0	46.7	66.7
3.0	0.5	43.3	70.0
3.0	1	60.0	73.3
3.0	2	56.7	85.0
none[1]	0	58.3	61.6
none[1]	0.5	50.0	68.3
none[1]	1	61.7	75.0
none[1]	2	65.0	78.3

[1]Mowing at 3 inches was initiated on these plots in September 20, 1975, 17 weeks after planting.

Table 36. Effects of Ronstar applied at 3 lb a.i./acre to field-planted plugs of Kentucky bluegrass varieties.

Variety	Phytotoxicity[1]	% Cover[2]	Variety	Phytotoxicity[1]	% Cover[2]
A-20	2.3	25	KENBLUE	4.3	25
A-34	1.0	23	MAJESTIC	3.0	22
ADELPHI	4.3	25	MERION	7.7	4
BA 61-91	4.3	25	MLM-18001	4.3	18
BA 62-55	2.3	35	MONOPOLY	3.7	28
BARON	3.0	20	NUGGET	4.3	14
BONNIEBLUE	3.7	31	P-59	6.3	13
BRUNSWICK	1.0	27	P-140	4.0	18
CAMPINA	7.7	8	PARADE	7.3	7
EVB-282	2.7	25	PARK	6.3	17
EVB-305	9.0	0	PENNSTAR	6.3	9
EVB-307	2.7	18	PLUSH	2.3	37
EVB-391	4.7	14	PSU-150	1.0	43
FYLKING	5.0	11	PSU-169	1.0	52
GALAXY	2.3	25	PSU-190	5.0	8
GERONIMO	3.0	35	PSU-197	1.7	50
GLADE	1.0	28	RAM #1	2.3	27
K1-131	3.0	32	RAM #2	2.3	37
K1-132	1.7	35	SODCO	1.7	37
K1-133	2.3	18	SYDSPORT	4.3	11
K1-138	5.0	5	TOUCHDOWN	4.3	20
K1-143	2.3	13	VANTAGE	2.3	35
K1-155	4.3	38	VICTA	3.0	28
K1-157	6.3	29	WINDSOR	1.0	50

[1]Phytotoxicity ratings were made on July 18, 1975, using a scale of 1 through 9 with 1 representing no injury and 9 representing complete necrosis of the plugs.

[2]Percent cover readings were made on October 16, 1975.

Table 37. Effects of preemergence herbicides used in conjunction with plugging for creeping bentgrass establishment.

Treatment	Rate, lb a.i./acre	Bentgrass Vigor[1]	Weed Control[2]	Percent Cover[3]
1. Betasan 3.6 G	10	2.7	3.3	58.3
2. Betasan 3.6 G	20	4.0	3.0	50.0
3. Ronstar 2 G	2	4.7	2.0	48.3
4. Ronstar 2 G	4	7.3	1.7	21.7
5. Balan 2.5 G	3	4.7	4.0	16.7
6. Dacthal 5 G	12	3.0	5.3	33.3
7. Dacthal 5 G	24	4.3	4.0	28.3
8. Untreated	--	1.0	9.0	16.7

[1]Bentgrass vigor ratings were made on July 18, 1975, using a scale of 1 through 9 with 1 representing best growth and 9 representing complete necrosis of the plugs.

[2]Weed control ratings were made on August 8, 1975, using a scale of 1 through 9 with 1 representing complete control of weeds and 9 representing no weed control.

[3]Percent cover readings were made on October 13, 1975.

G. 3. a. Kentucky Bluegrass Variety, Blend and Mixture Evaluation. A. J. Turgeon

The intraspecific variability of Kentucky bluegrass has allowed the development of many varieties 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 a 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 diseases of principal importance this year were *Helminthosporium* leaf spot, *Sclerotinia* dollar spot and *Fusarium* blight (Table 38). Those varieties showing the least injury from these diseases were: A-20, A-34, Adelphi, Baron, Bonnieblue, EVB-282, EVB-391, Galaxy, Glade, K1-131, K1-132, K1-143, K1-155, Majestic, MLM-18001, Monopoly, P-59, P-140, Parade, PSU-150, Sodco, Touchdown, Victa and Windsor. The summer quality data reflect both disease incidence and summer stress tolerance. Thatch development varied from 0.71 to 1.91 cm thick, depending upon variety. There is reason to believe that thatch has an important effect on summer stress tolerance since Nugget typically declines as summer temperatures rise while, at the Belleville site in southern Illinois, the absence of thatch in Nugget is associated with substantially better summer quality.

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 not been good turfs due to the poor adaptation and high disease susceptibility of the fescues. The Fylking-Pennfine (perennial ryegrass) mixture is predominantly perennial ryegrass and its quality through the season is similar to that of Pennfine alone.

Table 38. Performance of Kentucky bluegrass varieties, blends and mixtures in 1975.

Variety	Spring Green-up[1]	Leaf Spot Disease[2]	Fusarium Blight[2]	Dollar Spot Disease	Thatch Depth, cm.	Quality[1] 7/11/75	8/15/75	10/9/75
A-20 (seeded)	3.3	2.0	1.0	1.0	1.39	2.7	2.0	3.7
A-20 (veg)	4.0	2.0	1.0	1.0	1.24	3.7	2.3	2.7
A-34	3.0	2.7	1.3	1.0	1.11	5.0	2.3	3.0
A-20-6	4.0	2.0	1.0	1.0	0.99	2.7	2.0	2.0
Adelphi	2.7	2.0	1.0	1.0	1.25	4.0	2.3	3.0
Ba 61-91	4.3	2.7	2.0	1.3	1.05	3.7	3.7	4.7
Ba 62-55	4.0	2.3	1.3	2.0	1.50	3.3	3.3	3.3
Baron	5.3	2.7	1.3	1.0	1.37	3.7	3.0	3.0
Bonnieblue	3.0	2.3	1.3	1.0	1.01	3.7	2.3	3.3
Brunswick	2.0	3.0	2.3	1.7	1.54	2.3	3.7	4.7
Campina	2.3	7.0	1.0	1.3	1.06	4.0	3.3	3.3
Delft	2.3	3.7	5.0	1.0	1.04	3.7	5.7	6.3
EVB-282	3.3	3.0	1.0	1.0	1.14	2.7	2.7	3.0
EVB-305	4.7	2.0	4.3	1.3	1.52	5.3	4.3	5.7
EVB-307	3.7	2.0	2.0	1.7	1.19	4.0	4.0	4.3
EVB-391	5.7	2.7	1.3	1.0	1.26	4.0	3.0	3.0
Fylking	4.3	2.3	2.3	1.3	1.30	3.3	3.3	4.7
Galaxy	3.7	2.0	1.3	1.0	1.17	3.7	2.3	3.3
Geronimo	3.0	3.3	2.0	2.0	1.25	3.3	4.0	4.3
Glade	3.7	2.7	1.0	1.7	1.54	3.7	3.3	3.0
K1-131	3.3	2.7	1.3	1.0	1.41	3.3	2.7	3.3
K1-132	3.3	3.0	1.0	1.0	1.27	3.3	3.0	3.0
K1-133	3.0	2.7	1.7	1.0	1.20	3.0	3.0	4.0
K1-138	3.0	4.0	5.7	1.0	1.21	3.7	6.3	5.7
K1-143	3.0	2.7	1.0	1.3	1.32	3.0	2.3	3.0
K1-155	2.7	2.0	1.3	1.0	1.21	4.0	2.7	3.3
K1-157	2.3	5.3	3.0	1.0	1.13	3.7	3.3	5.0
K1-158	2.0	5.3	1.7	1.0	1.22	3.0	1.7	2.7
K1-187	3.0	2.7	2.0	1.0	1.45	3.0	3.3	4.7
Kenblue	3.0	5.0	2.0	1.3	0.96	3.7	3.3	4.0
1L-3817	4.3	2.3	2.7	1.3	1.13	4.3	4.3	4.3

Majestic	2.7	2.0	1.0	1.0	1.41	4.0	2.3	2.7
Merion	3.0	2.0	1.7	1.3	1.02	2.3	3.0	4.0
MLM 18001	3.3	3.0	1.3	1.0	1.58	3.7	2.7	2.7
Monopoly	2.7	2.7	1.0	1.0	1.06	2.3	2.0	2.7
Nugget	7.7	1.0	2.7	3.3	1.52	4.7	5.3	5.3
P-59	2.0	2.3	1.0	1.0	1.33	4.7	2.7	2.7
P-140	2.3	2.7	1.0	1.7	1.76	2.3	2.3	2.7
Parade	2.3	2.3	1.3	1.7	1.01	4.3	3.0	2.7
Park	2.3	5.3	2.0	1.0	0.71	2.7	3.3	5.0
Pennstar	4.0	2.0	2.0	1.0	1.22	3.3	3.3	4.0
Plush	3.7	3.0	1.7	1.0	1.33	2.3	2.3	3.7
PSU-150	3.3	2.0	1.0	1.0	1.17	3.0	3.3	3.7
PSU-169	3.0	2.3	1.7	1.0	1.13	4.3	3.3	4.0
PSU-190	3.7	2.7	1.7	1.0	1.29	3.0	3.3	4.0
PSU-197	3.7	2.7	2.7	1.0	0.97	3.0	4.0	5.3
RAM #1	4.3	2.7	1.3	2.7	1.68	3.7	3.7	3.7
RAM #2	3.0	2.7	3.0	1.3	1.37	3.7	4.3	4.3
Sodco	3.0	3.0	1.0	1.0	1.37	3.0	2.7	2.3
Sydsport	4.0	2.0	1.7	1.0	1.22	5.0	3.0	3.0
Touchdown	3.3	2.3	1.0	1.0	1.91	4.3	3.0	2.7
Vantage	3.0	3.7	1.7	1.0	1.02	2.7	2.7	3.3
Victa	5.0	2.7	1.0	1.0	1.47	3.0	3.0	3.3
Windsor	3.0	3.0	1.0	1.0	1.22	2.7	2.0	3.0
.... Blends								
Merion + Kenblue	3.0	3.0	1.7	1.0	1.22	3.0	3.3	4.3
Merion + Pennstar	2.3	2.0	1.0	1.0	1.19	2.3	3.0	4.0
Merion + Baron	3.3	2.3	2.0	1.0	1.30	3.7	3.3	4.0
Nugget + Pennstar	7.0	1.3	2.0	1.0	1.28	4.3	4.0	4.3
Nugget + Park	3.0	2.3	3.7	1.0	1.10	3.7	5.0	6.0
Nugget + Glade	4.7	2.0	1.3	1.0	1.42	3.7	2.7	3.7
Nugget + Adelphi	4.3	1.7	1.3	1.0	1.27	4.3	2.7	3.3
Victa + Vantage	3.7	2.7	1.7	1.0	1.40	3.3	3.0	3.3

P-59 + Brunswick	2.3	2.7	3.3	1.0	1.41	3.3	4.3	5.3
Blend 38	3.3	3.0	1.7	1.0	1.51	3.3	3.0	3.3
			.... Mixtures					
Fylking + Jamestown (RF)	4.0	2.3	5.0	1.0	1.36	4.7	4.3	6.0
Fylking + Pennlawn (RF)	3.3	2.3	5.3	1.0	1.24	3.7	5.7	6.0
Fylking + C-26 (HF)	3.7	2.0	3.3	1.3	1.31	3.7	4.3	5.7
Fylking + Pennfine (PR)	1.0	2.0	1.0	1.3	0.72	2.7	3.3	2.7

[1] Spring green-up and 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 blighting of the turf.

G. 3. b. Fine-fescue Variety Evaluation. A. J. Turgeon

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

The fine-leaf fescue varieties were planted in April, 1972. Plots measure 6 by 8 ft. and each is replicated three times. Fertilizer is applied twice yearly to supply a total of 2 pounds of nitrogen per 1,000 sq. ft.

None of the varieties provided high-quality turf under the experimental conditions (Table 39). Those least affected by disease and summer stress include: Barfalla, Jade (formerly Horritine), Koket, Scaldis and C-26. Dollar spot disease was evident in most of the plots and definite symptoms of *Fusarium* blight were observed in many plots that were not weed-infested or substantially deteriorated.

Table 39. Performance of fine-leaf fescue varieties in 1975.

Variety	Quality Rating[1] 4/16/75	6/27/75	8/15/75	10/9/75	Dollar Spot Disease[2]
Barfalla	4.7	4.3	5.0	5.3	4.7
Dawson	7.0	6.3	7.0	6.3	6.7
Encota	5.7	5.0	6.3	6.3	4.0
Flavo	6.0	5.0	6.3	6.7	4.7
Highlight	7.0	6.0	7.3	8.0	3.3
Jade	3.7	5.0	4.0	4.3	2.7
Jamestown	5.3	4.3	5.0	6.0	3.0
Koket	4.0	4.7	5.0	4.3	3.3
Menuet	4.7	5.0	6.0	5.3	5.3
Oregon-K	4.7	4.7	5.0	6.3	4.3
Pennlawn	4.3	4.3	6.0	6.3	5.0
Polar	5.7	5.7	7.7	7.3	6.3
Roda	7.0	6.7	7.3	6.7	7.0
Scaldis	4.3	4.7	4.7	5.0	4.0
Waldorf	5.0	3.7	5.0	6.7	2.0
C-26	4.7	4.0	5.0	5.0	2.7
CEBECO S70-2	7.0	6.3	7.0	7.0	5.0
CEBECO Hz71-4	7.0	6.7	6.7	7.3	3.7
ERG-11	7.0	6.3	7.0	7.3	5.3
Scarlet	5.7	5.0	6.3	7.3	5.0
HF-11	6.7	6.0	7.0	7.3	6.0
Durlawn	7.3	6.0	7.0	6.7	5.7
Novarubra	5.7	7.0	7.3	6.0	6.7
Barok	7.0	5.3	7.0	6.3	5.0
RU-45C	5.0	4.3	5.7	6.7	2.7
C-26 + Jamestown	5.7	5.0	6.0	6.0	3.3

[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.

G. 3. c. Creeping Bentgrass Variety Evaluation. A. J. Turgeon

Creeping bentgrass varieties 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. Small sections of each plot were treated with 12 or 24 lb Tupersan 50 WP in May, 1975, to determine the tolerance of the bentgrasses to this herbicide.

The most outstanding variety was Penncross while Toronto was the poorest due to a severe incidence of red leaf spot disease followed by considerable crabgrass and annual bluegrass invasion (Table 40). In terms of color, density and growth habit, Metropolitan was the least attractive variety.

Tupersan injury was evident in the following varieties: Washington, Old Orchard, Collins, Nimisilla, MSU-Ap-18 and MSU-Ap-38.

Table 40. Performance of creeping bentgrass varieties in 1975.

Variety	Quality Ratings[1]				Tupersan Phytotoxicity[2]	
	4/16/75	6/24/75	8/5/75	10/13/75	12 lb/A	24 lb/A
Seaside	6.0	3.7	6.3	5.7	1.0	1.0
Penncross	3.3	2.7	3.3	3.7	1.0	1.0
Washington	4.3	3.0	4.7	3.3	2.3	3.0
Toronto	7.7	5.3	7.3	7.3	1.0	1.0
Cohansey	3.7	3.3	4.0	4.0	1.0	1.0
Pennpar	4.0	2.0	3.3	3.0	1.0	1.0
Pennlu	6.0	3.3	5.7	5.0	1.0	1.0
Arlington	5.3	3.0	5.7	4.7	1.0	1.0
Emerald	4.0	3.0	3.7	3.7	1.0	1.0
Congressional	3.7	3.0	4.7	4.3	1.0	1.0
Old Orchard	4.7	3.0	4.3	3.0	2.0	2.7
Metropolitan	6.3	3.7	6.3	5.0	1.0	1.0
Collins	5.3	3.0	5.3	4.3	1.7	2.0
Nimisilla	5.7	2.7	4.0	4.0	1.7	2.0
Morrissey	4.3	3.0	3.7	3.7	1.0	1.0
MSU-Ap-18	6.3	2.3	4.0	4.0	3.3	4.3
MSU-Ap-28	5.3	2.3	3.3	4.0	1.0	1.0
MSU-Ap-38	5.0	2.0	2.3	2.7	2.0	3.0

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

[2] Phytotoxicity was rated using a scale of 1 through 9 with 1 representing no injury and 9 representing complete necrosis of the treated turf.

G. 3. d. Perennial Ryegrass Variety Evaluation. A. J. Turgeon

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 early spring, Manhattan was the best variety while Pennfine was one of the worst due to some winter injury (Table 41). By early summer, Pennfine was the outstanding variety, and it provided the best appearing turf through the summer. The seasonal performance of Pennfine and Manhattan suggest that a blend of these two ryegrass varieties may provide good trufgrass quality through the growing season.

Table 41. Performance of perennial ryegrass varieties in 1975

Variety	Quality Rating[1]			
	4/16/75	6/27/75	8/5/75	10/9/75
Pelo	5.0	4.7	6.0	4.7
NK-100	5.7	5.3	5.3	5.0
KN-100	5.0	5.7	6.3	5.3
KN-200	3.3	4.3	5.3	4.7
Manhattan	2.7	4.3	4.3	4.0
Pennfine	6.7	2.0	2.3	2.7
Common	7.7	6.7	5.0	5.3
K8-137	5.3	3.7	3.7	3.7
K8-142	4.7	5.3	4.3	4.3

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