1969 TURFGRASS RESEARCH SUMMARY

Michigan State University

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<u>*NOT FOR PUBLICATION*</u>

A. TURFGRASS BREEDING AND EVALUATION

A. 1. ADVANCES IN BREEDING AND GENETIC STUDIES - K. T. Payne and J. M. Vargas

Major goals of the turfgrass breeding project are resistance to Helminthosporium leafspot and strong rhizome development or creeping habit of Festuca rubra. A 15,000 plant nursery was established in 1969 representing: (1) progeny plants from two strongly creeping clones (2) selected mother plants (3) plant introductions (4) 28 varieties. Seed from selected plants from this nursery has been harvested for establishing a single plant nursery in 1970. A considerable number of vigorously creeping plants has been identified. The only survivors in a spaced plant shade nursery representing the above were those near the borders that received direct sunlight.

Sod plugs from 10 varieties were brought to the greenhouse from the field plots in January and were inoculated with Helminthosporium leaf spot using a technique which will be described in the Plant Pathology section. Inoculation was made on February 17, 1970 and readings taken on February 27 and March 13. Data are given in Table 1. The average field reading for 1969 is indicated. Two sample plugs were used for each of three replications. A rating of 0 indicates no infection, 1 is very little and 5 is 100% infection. Check plots were not inoculated but were placed in the mist chamber with the inoculated plugs.

Table 1 Helminthosporium leafspot ratings on inoculated red fescues compared to field ratings.

	2/27/70		3/13/70		Average 1969
Variety	Inoc.	Check	Inoc.	Check	Field Reading
C-26	1.7	1.0	2.8	0.3	1.0
Pennlawn	5.0	1.7	5.0	1.0	2.7
Jamestown	5.0	1.3	5.0	1.7	1.0
Wintergreen	5.0	1.0	5.0	1.7	2.0
Erika	5.0	1.0	5.0	1.7	1.0
Cottage	4.7	1.0	5.0	1.0	4.7
Dawson	3.3	0.0	4.2	1.0	1.3
Echo	4.7	0.7	5.0	2.0	4.7
MSU 18	2.8	0.0	3.8	1.0	1.0
Kg-148	5.0	0.3	5.0	1.3	1.7

The technique used appears to be more severe than field infection in 1969.

Several hundred single plant seedlings of Festuca rubra, representing nine experimental strains from Dr. C. R. Funk of New Jersey and six varieties were inoculated in the 6 to 10 leaf stage. From these, 21 plants have been isolated having a 0 reading for Helminthosporium leaf spot. These have been cloned to 15 plants each and will be transplanted to an isolated nursery for intercrossing.

Attempts to stimulate seed head formation in red fescue in the greenhouse during the winter have proven futile. Assuming that light was the key (following adequate thermal induction) a growth chamber test was run. Sod plugs from 10 varieties growing in sand and soil culture with nutrient solution applied weekly were placed under four day length regimes as described in Table 2.

Table 2. Seed induction study treatments.

Place	Hours of light	Day Temp.	Night Temp.
Greenhouse	Natural day length	70	65
Growth Chamber #1	16	60	55
Growth Chamber #2	20	70	60
Growth Chamber #3	24	60	--

The sod plugs had been taken from frozen soil in mid-January following several periods of very cold weather. They were placed in respective growth chambers on April 15. Adequate incandescent lighting was present to provide red light. Excellent vigorous foliar development occurred in all treatments. By June 15 extensive heading had developed in fescue plants in the field but no seed heads were produced on plants under test, including those in the greenhouse.

A. 2. NEW VARIETY STATUS - K. T. Payne, J. B. Beard, and L. Copeland

6,000 pounds of Foundation seed of Wintergreen red fescue was harvested in Oregon in 1969. Seed for testing in fall plantings and winter overseedings of golf greens was distributed extensively in the U.S. and abroad. Two-hundred fifty acres have been seeded in Oregon for certification in 1971. Breeder's seed of Wintergreen was produced at M.S.U. in 1969.

Twelve pounds of seed of a winterhardy fescue synthetic has been produced in 1970. This has been identified as tall fescue by the Michigan State Seed Laboratory, although plants do not have the coarse characters of F. pratense. More definite identification is pending. Two acres are being seeded in Oregon in 1970 to produce seed for further testing.

A. 3. VARIETY EVALUATIONS - J. B. Beard and K. T. Payne

Many of the turfgrass variety evaluation plots were reestablished in 1968 at East Lansing. Twenty bentgrasses, 39 fine-leafed fescues, 65 bluegrasses, 7 tall fescues, and 17 ryegrasses were established. In addition, 56 bluegrass, 37 red fescue, 5 tall fescue, and 15 ryegrass varieties were established in 1969 at Traverse City.

B. 2. SOIL MIXTURES AND MODIFICATIONS - P. E. Rieke

Forty-eight soil mixtures planted to Cohansey bentgrass are being evaluated. Ten soil cores were removed from each plot and analyzed for physical properties (infiltration, pore space distribution, water holding capacity, bulk density, and compaction) in the laboratory. One half of each plot is being compacted regularly for traffic evaluations.

B. 3. SOIL AND TISSUE TESTING - P. E. Rieke and R. N. Carrow

The influence of nitrogen carrier on the amount of leaching of nitrate nitrogen is being studied on a fine sandy loam (East Lansing) and a sand (Traverse City) Soil samples are taken at 6 inch increments to a depth of 2 feet and analyzed for nitrates every 2 weeks throughout the growing season. Data available to date reflect the influence of heavy applications of ammonium nitrate applied in April causing a high nitrate test.

Calcium arsenate (0, 5, 10, 20 and 40 pounds per 1,000 square feet) and calcium phosphate (0, 1, 2, 4, and 8 pounds of phosphorus per 1,000 square feet) were added to a phosphorus deficient sandy loam soil. The soil was incubated for 3 weeks, then four were seeded. Soil samples were saved for analysis. In addition, several soil samples were collected from golf courses with good records of arsenical application. Difficulty in arsenic determinations have been experienced utilizing the method described by J. Paul (Mikrochim. Acta. 830-835. 1965) This technique offered the advantage of simultaneous determination of arsenic and phosphorus. Presently the method adapted by Small and McCants (SSAP 25:346. 1961) is under investigation. Several extraction reagents will be used for arsenic. The objective is to determine the ratio of arsenic to phosphorus needed to control annual bluegrass but not cause injury to other grasses. This study is being coordinated with similar work at Purdue.

B. 5-a. TURFGRASS FERTILIZATION, CARRIERS - P. E. Rieke

Several nitrogen carriers were applied at 4 pounds nitrogen per 1,000 square feet on July 6, 1969. Monthly quality ratings were obtained throughout 1969 and in April, 1970. Data are shown in Table 3.

Table 3. Quality ratings for nitrogen carriers applied at 4 pounds nitrogen per 1,000 square feet July 6, 1969. Averages for 4 dates and 3 replications and April, 1970. (1=best; 9=poorest).

Carrier	Visual Turfgrass Quality Ratings 7/18	8/12	9/18	10/17	Average	4/29/70
Ammonium nitrate	2.7	1.7	1.8	2.8	2.25	4.8
Urea	2.5	1.7	2.0	3.3	2.38	4.5
Calcium nitrate	2.2	2.0	2.3	3.0	2.38	4.7
Ammonium sulfate	2.2	1.8	3.0	3.0	2.50	4.7
Diammonium phosphate	2.7	2.0	2.7	3.5	2.71	4.7
Ammonium chloride	2.5	2.3	3.3	4.0	3.04	5.0
Milorganite	3.8	3.2	3.5	4.0	3.63	4.3
Vertorganic	3.8	3.3	3.7	4.0	3.71	5.0
Processed poultry manure	4.0	4.0	4.5	4.3	4.21	4.7
Ureaformal dehyde	5.3	4.5	4.2	4.7	4.67	5.0
T.V.A. Sulfur coated urea	5.7	2.8	1.8	1.5	2.96	2.8
Osmocote (18-9-9)	4.5	1.7	2.5	3.2	2.96	4.2
Mag Amp	4.5	2.8	2.7	2.0	3.00	2.7
IBDU	6.3	5.0	2.8	3.0	4.29	1.7

Table 3 continued.

30-5-10 (S.D.)	2.8	1.7	2.0	2.3	2.21	4.3
12-6-6 (Sacco)	2.7	3.0	3.7	3.8	3.29	4.3
12-6-6 (Midwest)	3.0	2.7	2.5	4.0	3.04	4.7
13-3-9 (Borden)	2.3	2.8	2.7	3.5	2.83	4.7
25-5-10 (Borden)	3.2	3.0	3.7	3.5	3.34	4.3
23-7-7 (Turfbuilder)	3.3	3.2	3.7	3.7	3.46	4.2
16-4-8 (U.S.S.)	2.8	3.0	3.7	4.3	3.46	5.3
CHECK						

B. 5-b. TURFGRASS FERTILIZATION, PROGRAMS - P. E. Rieke

A summary of the 1968-69 quality ratings and dandelion counts for a series of nitrogen treatments on Merion is given in Table 4. Treatments, applied on the 15th of the month, were initiated in 1967.

Table 4. 1968-69 turfgrass quality ratings for the Merion Fertility study on fine sandy loam at East Lansing. Averages for 3 replications and 7 dates each year. Nitrogen was applied at six pounds per 1,000 square feet. Clippings are removed. (1=best; 9=poorest).

Treatment	Visual turfgrass Quality Rating	Dandelion counts per 1000 sq. ft.
33-0-0; April	3.21	63
33-0-0; May	3.28	101
33-0-0; April, August	3.18	219
33-0-0; April, May, August	2.80	66
33-0-0; April, August, September	3.10	108
33-0-0; August	3.89	143
33-0-0; May, November	3.05	133
33-0-0; May, February	3.14	82
Milorg; April	3.65	200
Milorg; April, May, August	3.40	269
UF; April	3.93	168
UF; April, May, August	4.24	272
UF: April, May, August (12)	2.34	60
CHECK	7.76	1182

B. 5-c NITROGEN STUDIES ON MERION AT TRAVERSE CITY ON 91% SAND - P. E. RIEKE and J. B. Beard

Average quality ratings for Merion are given in Table 5. In contrast to 1969 observations at East Lansing, Milorganite gave as good or better response than urea. This sandy site is irrigated heavily, receiving at least 2 inches of water per week. This may have resulted in increased leaching of the soluble nitrogen source. Table 6 gives the crabgrass density ratings for Pennlawn Red Fescue taken September 24, 1969 at the Traverse City plots.

Table 5. 1969 average visual turfgrass quality ratings for Merion Kentucky bluegrass on Grayling sand at Traverse City. Averages for 2 replications and 6 dates. (1=best; 9=poorest).

Treatment	Number of Applications*	Visual turfgrass quality rating	
		Irrigated	Unirrigated
Urea	1	2.7	3.2
	2	2.0	2.9
	3	2.3	3.3
	6	2.3	3.0
Milorganite	1	1.9	2.7
	2	1.7	2.7
	3	1.8	2.6
Ureaform	1	2.1	2.7
	2	2.2	2.8
	3	2.1	3.1
CHECK	-	5.4	6.4
½X*	6	2.8	4.0
X	6	2.3	2.9
1½X	6	2.0	2.4

*Nitrogen application rate (X) is 8 pounds per 1,000 square feet on the irrigated plots and 4 pounds on the unirrigated plots.

Table 6. 1969 crabgrass density ratings in Pennlawn Red Fescue at Traverse City. Averages of two replications. (0=none; 10=severe)

Nitrogen treatment	Number of applications*	Visual turfgrass quality ratings	
		Irrigated	Unirrigated
CHECK	-	5.0	6.5
½X *	6	4.0	5.5
X	6	0	2.0
1½X	6	0	2.0
Urea	1	1.0	1.0
	2	0.5	1.5
	3	4.5	2.5
Milorganite	1	3.0	9.0
	2	3.5	5.0
	3	3.5	4.5
Ureaform	1	5.0	5.0
	2	5.0	7.0
	3	5.0	7.0

*Nitrogen application rate (X) is 3 pounds per 1,000 square feet on the irrigated plots and 1.5 pounds on the unirrigated plots.

Sodded Merion requires about 2 pounds less nitrogen to give a significant response after three years of applications (Table 7).

Table 7. 1968-69 visual turfgrass quality ratings for seeded and sodded Mer Merion at East Lansing. Averages for 3 replications on 7 dates. (1=best; 9=poorest)

	Seeded		Sodded	
Pounds nitrogen per 1,000 sq. ft.	Quality rating	Dandelions /1000 sq. ft.	Quality rating	Dandelions /1000 sq. ft.
0	7.6	1182	6.0	1035
2	5.1	791	4.1	610
4	3.7	251	3.0	324
6	2.6	72	2.1	106
8	1.9	67	1.6	57
10	1.5	15	1.4	10
12	1.2	15	1.3	14
14	1.2	5	1.2	5

In a comparison of the nitrogen responses of Pennlawn and Wintergreen red fescues, heavy nitrogen, especially in the fall, causes decreased turf quality of the Wintergreen. This effect was particularly severe during the winter of 1968-69. Where sufficient nitrogen was applied during 1969, the Wintergreen has recovered. Quality ratings are given in Table 8.

Table 8. 1968-69 visual turfgrass quality ratings for the effect of nitrogen treatments on red fescues at East Lansing. Averages for e replications on 7 dates (1=best; 9=poorest)

Nitrogen	Pennlawn		Wintergreen	
treatment	1968	1969	1968	1969
0	6.3	6.0	6.7	7.2
1, monthly	5.1	4.6	4.5	4.8
2, monthly	4.0	2.8	3.5	3.4
3, monthly	3.5	1.9	2.4	2.6
4, monthly	2.0	1.6	2.1	2.8
6, monthly	1.3	1.3	1.8	2.8
2, April	4.0	3.2	4.0	3.5
2, August	3.9	4.0	4.6	5.1
2, April, August	3.6	3.1	3.3	3.2

C. 1. PHYSIOLOGY-GROWTH - J. Kaufmann and J. B. Beard

METABOLIC MECHANISMS OF HIGH TEMPERATURE GROWTH STOPPAGE

Leaf tissue of Toronto creeping bentgrass and Tifgreen bermudagrass was analyzed for nitrate reductase activity over a range of temperatures from 10 to 40C. The nitrate reductase enzyme isolated from the bermudagrass grown at 35 and 40C did not exhibit the significant loss of activity which was noted for bentgrass grown at 35C. When both species were grown at 25C, a nitrate reductase enzyme inactivation was found in bentgrass at an incubation temperature of 40C. The enzyme isolated from bermudagrass was not inactivated at 40C.

D. 2-b. ENVIRONMENT, LOW TEMPERATURE - J. B. Beard

WINTER DESICCATION CONTROL. Eighteen types of covers were evaluated for effectiveness in the winter protection of a Toronto creeping bentgrass turf cut at .25 inch. Materials evaluated included polyethylene, Saran-94%, WX246, S-782-1, S-782, Soil Retention Mat, Saran-63%, Famcomat, Poly-1, topdressing, Wiltpruf, and Tufflote. The specific characteristics investigated were (a) insulating value, (b) desiccation prevention, (c) spring greenup, and (d) physical stability. Evaluations have been conducted under both controlled climate and field conditions.

WX246, S-782 and the Soil Retention Mat have given good insulation, desiccation protection and spring greenup. The spring greenup and winter dessication protection of Saran-94%, Famcomat, and the polyethylene cover were excellent but the temperature insulating value was inferior. Wiltpruf was not any better than the untreated check plot. The initial year of study indicates that it is feasible to develop a combination cover for both low temperature and desiccation protection.

E. 3 THATCH - D. P. Martin and J. B. Beard

The composition of turfgrass thatch was investigated to determine the chemical nature of thatch and possible causes for its accumulation. Analyses of total cell wall, hemicellulose, cellulose, and lignin content of Toronto creeping bentgrass, Merion Kentucky bluegrass, and Pennlawn red fescue were made. The same analyses were made on leaf, stem, and root components of these three turf species for comparative purposes.

The upper thatch layer contains a lower percentage of total cell wall than the lower layer. Lignin, the most resistant plant constituent to microbial activity, was found in greatest quantities in the thatch layer nearest the soil, decreasing upwards. Red fescue thatch had the highest percentages of lignin of the three species investigated. Total cell wall and lignin content of the roots of these three species was considerably higher than in the leaves.

A second area of this investigation was to attempt to increase biological degradation of thatch <u>in vitro</u> by addition of enzymes, a sugar, and a lignin precursor. The quantitative measurement of carbon dioxide evolved was used as an indication of increased microbial activity. A controlled environment chamber study was also completed using the more promising possibilities on intact thatch samples.

Increased carbon dioxide evolution resulted as rates of material were increased. Total cell wall determinations of thatch from the controlled environment study indicated the treated thatch was decomposing at a more rapid rate than the control.

F. 1-a BROADLEAF WEED CONTROL - A. J. Turgeon and W. F. Meggitt

EFFECTS OF SUN 11E OIL ON HERBICIDE ENHANCEMENT FOR BROADLEAVED WEED CONTROL IN TURF

Initial greenhouse tests of Sun 11E crop oil on Kentucky bluegrass and red fescue turfgrass plugs indicated that at application rates of ½, 1 and 2 gal/A, the oil is not phytotoxic. Subsequent field testing (July 23) on a clover-infested Kentucky bluegrass area showed that silvex activity increased 85 percent, at the 3/8 lb/A rate, when oil was added at 1 gal/A. Dicamba's effectiveness, however, was not significantly enhanced at the ¼ and 1/8 lb/A rate (Table 9)

Table 9. Effects of Oil-Herbicide Combinations on Clover.

Treatment	Rate lb/A	Clover Control
Silvex	3/4	95%
Silvex + Oil	3/4	95%
Silvex	3/8	87%
Silvex + Oil	3/8	94%
Dicamba	1/4	97%
Dicamba + Oil	1/4	98%
Dicamba	1/8	95%
Dicamba + Oil	1/8	96%

A second field test (August 15) involving treatments of 2,4-D, silvex, MCPP and dicamba, applied at various rates, with and without oil, was performed across alternating lanes of broadleaved weeds (buckhorn plantain, common chickweed and knotweed) and Kentucky bluegrass. Results showed that only silvex (ester formulation) activity was enhanced at the lower rate of ¼ lb/A, and only on common chickweed (Table 10).

Table 10. Effects of Oil-Herbicide Combinations on Plantain, Chickweed and Knotwood. (1= no control; 9=complete kill)

Treatment	Rate lb/A	Control		
		Plantain	Chickweed	Knotweed
2,4-D	½	7	2.7	1.0
2,4-D + Oil	½	6.7	3.3	1.3
Silvex	½	3.3	7.0	4.0
Silvex + Oil	½	3.3	7.0	4.0
Silvex	¼	1.7	3.3	1.7
Silvex + Oil	¼	2.0	6.7	1.3
MCPP	½	2.3	4	2.7
MCPP + Oil	½	2.7	4.7	3.0
MCPP	¼	1.3	2.7	1.3
MCPP + Oil	¼	1.3	2.3	1.7
Dicamba	¼	1.7	7.7	7.3
Dicamba + Oil	¼	2.0	7.7	8.0
Dicamba	1/8	2.3	6.7	6.7
Dicamba + Oil	1/8	2.0	7.3	7.3

A third field test was conducted (September 19) on Kentucky bluegrass turf infested with dandelions. Amine and ester formulations of 2,4-D were applied at $\frac{1}{2}$ and $\frac{1}{4}$ lb/A with and without Sun 11E oil (1 gal/A) and with and without X-77 surfactant (1/3 qt/A). Results showed a significant enhancement of herbicide activity of the ester formulations at the lower rate ($\frac{1}{4}$ lb/A) when oil was added to the spray mix (Table 11).

In all three field tests, the addition of oil to ester forms of herbicides (2,4-D and silvex) increased phytotoxic activity when applied at low rates to susceptible weed species. The activity of Amine-formulated herbicides, however, was not increased.

Table 11. Effects of Oil and Surfactant-Herbicide Combinations on Dandelions. (1=no control; 9=complete kill)

Treatments	Rate lbs/A	---	+ Oil	+ X-77
2,4-D amine	$\frac{1}{2}$	6.3	6.0	6.0
2,4-D amine	$\frac{1}{4}$	6.0	5.7	6.3
2,4-D ester	$\frac{1}{2}$	7.0	6.7	6.0
2,4-D ester	$\frac{1}{4}$	3.7	6.3	3.3

SUSCEPTIBILITY OF BENTGRASS VARIETIES TO BENEFIN INJURY

A greenhouse experiment was initiated June 16, 1969 in which nine bentgrass (Agrostis sp.) cultivars were treated with benefin at 0, 1.5, and 3 lb/A. The bentgrasses were taken from a one-year old planting and included: Penncross, Toronto, Cohansey, Seaside, Exeter, Highland, Holfior, Astoria and Kingston Velvet.

After three months, the plugs were rated as follows: (1) The colonial-type bentgrasses (Astoria, Holfior, Highland and Exeter) were slightly-to-moderately injured at the low rate (1.5 lb/A) of benefin application and moderately-to-severely injured at the high rate (3 lb/A). (2) The vegetative creeping bentgrasses (Toronto and Cohansey) and Seaside bentgrass were slightly injured at the low rate (1.5 lb/A) and slightly-to-moderately injured at the high rate (3 lb/A). (3) Penncross and Kingston velvet bentgrasses showed no apparent injury at the low rate (1.5 lb/A) and only very slight injury at the high rate (3 lb/A).

Table 12. Bentgrass injury from benefin. (1=no effect; 9=complete kill)

	Rate (lb/A)		
Cultivar	0	1.5	3
Penncross	1.0	1.0	2.0
Toronto	1.0	2.3	3.0
Cohansey	1.3	2.3	2.7
Seaside	1.3	2.3	2.7
Exeter	1.3	3.0	3.3
Highland	1.3	2.7	5.0
Holfior	1.3	2.7	4.0
Astoria	1.3	3.3	5.7
Kingston	1.0	1.0	1.3

CONTROL OF CREEPING SPEEDWELL (*Veronica filiformis*)

Initial greenhouse tests on speedwell-infested turfgrass plugs indicated that conventional broadleaved weed herbicides are ineffective against this weed. Herbicide treatments included 2,4-D (2 lb/A); silvex (1.5 lb/A); dicamba (1 lb/A); and picloram + 2,4-D ($\frac{1}{2}$ + 1 lb/A).

Upon collection of more plugs, endothall (3 lb/A) was applied resulting in complete kill of the weed and good turf recovery after three weeks.

Field tests were initiated July 11, 1969, on a Grand Rapids lawn, with the following treatments: endothall (2 lb/A); endothall (2 lb/A) plus vertical mowing; and vertical mowing without herbicide treatment. Nearly complete control of speedwell resulted from the herbicide treatments while verticle mowing did not give weed control nor significantly enhance the effectiveness of the herbicide.

On August 20, 1969, more treatments were applied using endothall at $\frac{1}{2}$ lb. and 1 lb/A. This was during a hot, dry period and the lawn was not receiving any artificial irrigation. The 1 lb. application rate gave nearly complete weed control while the $\frac{1}{2}$ lb. rate gave fair control averaging about 70 percent.

On September 22, 1969, endothall was applied at $\frac{1}{4}$, $\frac{1}{2}$ and 1 lb/A alone and in combination with (1 gal/A) Sun 11E nonphytotoxic oil. Both 1 lb/A rates gave nearly complete control as well as the $\frac{1}{2}$ lb. + oil treatment. The $\frac{1}{2}$ lb/A endothall treatment (without oil) gave only about 40 percent control and both $\frac{1}{4}$ lb/A treatments resulted in poor weed control. The weather, during this period, was cool and soil moisture was high.

In all tests where the herbicide was effective, weed kill was rapid leaving the turf stand thin. Other weeds did move into the area, particularly knotweed, along with some dandelions.

Table 13. Evaluation of treatments on creeping speedwell (*Veronica filiformis*)

Treatment	Rate lb/A	Date Applied	Percent Weed Control
Endothall	2	July 11	95
Endothall + vertical mowing	2	July 11	95
Vertical mowing	-	July 11	0
Endothall	1	August 20	95
Endothall	$\frac{1}{2}$	August 20	70
Endothall	1	Sept. 22	95
Endothall + oil	1	Sept. 22	95
Endothall	$\frac{1}{2}$	Sept. 22	40
Endothall + oil	$\frac{1}{2}$	Sept. 22	95
Endothall	$\frac{1}{4}$	Sept. 22	20
Endothall + oil	$\frac{1}{4}$	Sept. 22	20

EVALUATION OF HERBICIDES FOR CONTROL OF ANNUAL BLUEGRASS (Poa annua) IN CREEPING BENTGRASS (Agrostis palustris) AND MERION KENTUCKY BLUEGRASS (Poa pratensis var. Merion) TURF.

Two experiments were initiated simultaneously on golf course fairways in East Lansing and Grand Rapids, Michigan on September 10, 1969. The Grand Rapids fairway was approximately 70 percent Merion Kentucky bluegrass and 30 percent annual bluegrass. The East Lansing fairway was approximately 60 percent creeping bentgrass, 5 percent Merion Kentucky bluegrass and 35 percent annual bluegrass.

The treatments included: benefin (3 lb/A); bensulide (15 lb/A); Tri-calcium arsenate granular and wettable powder formulations (261 and 523 lb/A for each formulation); Dow's M-3251 and M-3447 (4 and 8 lb/A for each); Endothall (1 lb/A applied three times at two week intervals, 2 lb/A applied once, and 4 lb/A applied once); sodium arsenite (1 lb/A applied three times at two week intervals); Mallinckrodt's MF-415 and MF-416 (applied together at $\frac{1}{4}$ + $\frac{1}{4}$, $\frac{1}{2}$ + $\frac{1}{2}$, 1 + 1 and $1\frac{1}{2}$ + $\frac{1}{2}$ lb/A); Maintain CF-125 (2.5 lb/A); Maleic hydrazide (1 lb/A); Fison's NC-5651 (6 lb/A); DCPA (15 lb/A); Lead arsenate wettable powder (261 and 523 lb/A); and nitralin (2 lb/A).

Benefin, bensulide, Fison's NC-5651, DCPA, nitralin, the wettable powder formulations of the arsenicals, sodium arsenite and Dow's M-3447 gave no apparent postemergence activity on any of the turfgrasses tested. The granular formulation of tri-calcium arsenate gave some injury to annual bluegrass but its effects were not consistent. Dow's experimental M-3251 injured bentgrass moderately at the high rate. Endothall killed or yellowed much of the annual bluegrass at all rates but with moderate to severe injury to bentgrass, particularly at the 4 lb/A rate. Endothall appears very promising on Merion, however, providing new annual bluegrass germination is held in check by some other material. The Mallinckrodt experimental materials are highly injurious to bentgrass at the higher rates without offering adequate control of annual bluegrass. Maleic hydrazide is also injurious to bentgrass without controlling annual bluegrass. Maintain CF-125 is slightly injurious to the bluegrass but ineffective for annual bluegrass control at the rate tested.

Table 14. Evaluation of herbicides on annual bluegrass in creeping bentgrass and Merion Kentucky bluegrass turf. (1=no control; 9=complete kill)

Trmt. No.	Treatment	Rate lb/A	Bentgrass	Ky. Blue	Annual Blue
1	Benefin (2.5 g)	3	1.0	1.0	1.0
2	Bensulide (12.5 g)	15	1.0	1.0	1.0
3	Tri-calcium arsenate (48 g)	261	1.0	1.0	2.0
4	Tri-calcium arsenate (48 g)	523	1.0	1.0	3.7
5	Dow M-3251	4	1.7	1.0	1.0

Table 14 continued.

6	Dow M-3251	8	4.0	1.0	1.3
7	Dow M-3447	4	1.0	1.0	1.0
8	Dow M-3447	8	1.0	1.0	1.0
9	Endothall	1 (X3)	3.7	1.0	7.7
10	Endothall	2	3.7	1.0	7.2
11	Endothall	4	5.7	1.0	8.0
12	Sodium arsenite	1 (X3)	1.0	1.0	1.0
13	Mallinckrodt MF-415 + MF-416	$\frac{1}{4} + \frac{1}{4}$	1.0	1.0	1.0
14	" "	$\frac{1}{2} + \frac{1}{2}$	3.0	1.0	1.7
15	" "	1 + 1	5.0	2.0	4.0
16	" "	$1\frac{1}{2} + \frac{1}{2}$	6.0	1.3	2.3
17	Maintain CF-125	2.5	1.0	2.0	2.0
18	Maleic hydrazide	1	5.0	1.0	2.0
19	Fisons NC-5651	6	1.0	1.0	1.0
20	DCPA	15	1.0	1.0	1.0
21	Tri-calcium arsenate (85 wp)	261	1.0	1.0	1.0
22	" "	523	1.0	1.0	1.0
23	Lead arsenate (98 wp)	261	1.0	1.0	1.0
24	Lead arsenate "	523	1.0	1.0	1.0
25	Nitralin	2	1.0	1.0	1.3

PREEMERGENCE HERBICIDE BUILD-UP ON LAWN GRASSES

Plots of common Kentucky bluegrass, Merion Kentucky bluegrass and creeping red fescue were treated yearly, and in alternate years, with the following herbicides:

DCPA (10 lb/A); bandane (40 lb/A); terbutol (10 lb/A); bensulide (20 lb/A); benefin (1.5 lb/A); siduron (10 lb/A); tricalcium arsenate (40 lb/A); and lead arsenate (610 lb/A).

The experiment was initiated in the spring, 1964, and continued through 1966. It was resumed in May of 1969.

Results to date indicate that Merion Kentucky bluegrass is slightly to moderately injured by yearly applications of bandane and bensulide. Creeping red fescue is moderately injured by all applications of DCPA, bandane and benefin. Common Kentucky bluegrass is slightly to moderately injured by yearly applications of bensulide and all applications of terbutol.

Table 15. Evaluation of preemergence herbicide injury to lawn grasses. (1=no effect; 9=complete kill)

Trmt.* No.	Treatment	Rate lbs/A	Kentucky bluegrass Common	Merion	Red Fescue
1	DCPA	10	1.3	1.3	3.0
2	DCPA	10	1.3	1.0	3.0
3	Lead arsenate	610	1.7	1.0	1.3
4	Lead arsenate	610	1.3	1.0	1.3
5	Bandane	40	1.3	3.0	3.7
6	Bandane	40	1.0	1.0	2.7
7	Terbutol	10	2.7	1.0	1.0
8	Terbutol	10	2.3	1.0	1.0
9	Bensulide	20	3.7	3.0	1.0
10	Bensulide	20	1.7	1.0	1.0
11	Benefin	1.5	1.7	1.0	4.0
12	Benefin	1.5	1.3	1.0	4.0
13	Tri-calcium arsenate	610	1.3	1.0	1.3
14	Tri-calcium arsenate	610	1.3	1.0	1.3
15	Siduron	10	1.0	1.0	1.0
16	Siduron	10	1.0	1.0	1.0

*All odd numbers treated yearly while all even numbers were treated every second year.

F. 2-a.

TYPHULA SNOW MOLD CONTROL - J. M. Vargas, Jr. and J. B. Beard

Boyne Highlands, Michigan, was again selected as the experimental site for the snow mold fungicide study, since a uniform attack of Typhula snow mold was assured on the Penncross bentgrass. The experimental area was snow covered from mid November until mid April.

Nine fungicides in 25 different treatments of three replications were applied in a randomized block design, on November 15, 1968. Variables included high and low rates of application plus fall, and fall/spring applications.

Results of the fungicide study are presented in Table 16. The percentage kill by Typhula snow mold is based on the average of individual ratings taken in the spring of 1969, after the snow melted and fungal growth ceased.

Excellent control was obtained with Demosan at the 9 oz. and Calogran at the 8 lb. rate. Adequate control was attained with Demosan at 6 oz. rate, Cadmium at the 5 and 3 oz. rates, Panogen at the 3 oz. rate and Calo clor at the 4 oz. rate. PMAS, Daconil, Tersan O.M. and Dyrene were not effective in controlling Typhula snow mold.

Table 16. 1969 SNOW MOLD FUNGICIDE STUDY. Boyne Highlands, Michigan.

Entry No.	Treatment	Rate oz./1000 sq. ft.	Application	Percent Snowmold 4/11	Percent Snowmold 4/25	Percent Snowmold Ave.	1% Comparison
24	DEMOSAN	9 + 4	Fall/Spring	1.6	5.3	3.5	a
8	CALO-GRAN	8#	Fall	3.3	6.6	5.0	a
9	CALO-GRAN	8#	Fall/Spring	3.3	7.0	5.2	a
22	DEMOSAN	9	Fall	5.6	10.0	7.8	a b
23	DEMOSAN	6 + 3	Fall/Spring	6.6	10.0	8.3	a b
5	CADMIUM	5	Fall	13.3	8.3	10.8	a b c
3	CADMIUM	3	Fall	10.0	13.3	11.6	a b c d
7	PANOGEN	3	Fall/Spring	10.0[a]	16.6	13.3	a b c d
12	CALO-CLOR	4	Fall/Spring	13.3	13.3	13.3	a b c d
4	CADMIUM	3	Fall/Spring	15.0	21.6	18.3	a b c d
6	PANOGEN	3	Fall	20.0[b]	16.6	18.3	a b c d
11	CALO-CLOR	4	Fall	21.6	16.6	19.1	a b c d
21	DEMOSAN	6	Fall	18.6	20.0	19.3	a b c d
20	DACONIL	16 + 18	Fall/Spring	23.3	30.0	26.6	a b c d
2	PMAS	2 of 10%	Fall/Spring	31.6	23.6	27.6	a b c d
14	DACONIL	8	Fall	41.6	43.3	42.5	b c d e
1	PMAS	2 of 10%	Fall	53.3	40.0	46.6	c d e
15	DACONIL	10	Fall	48.3	50.0	49.2	d e
16	DACONIL	16	Fall	45.0	53.3	49.2	d e
19	DACONIL	10 + 5	Fall/Spring	70.0	73.0	71.5	e f
13	DACONIL	6	Fall	73.3	73.0	73.2	e f
18	DACONIL	8 + 3	Fall/Spring	73.3	75.0	74.2	e f
17	DACONIL	6 + 2	Fall/Spring	71.6	78.3	75.0	e f
10	TERSAN-OM	8 + 3	Fall/Spring	85.6	86.6	86.2	f
26	CHECK	--	--	97.6	88.3	93.0	f
25	DYRENE	6 + 4	Fall/Spring	95.6	96.0	95.8	f

a - Average of 2 reps
b - Rating based on 1 rep

NOT FOR PUBLICATION

The 1969-70 snow mold study was similar to the 1968-69 study except that the spring application was omitted based on previous results. The treatments were applied on November 7 and the data were read once on April 12, 1970. The results are given in Table 17.

Calo-gran and calo clor gave excellent control along with the granular forms of Demosan (3.75 lbs and 2.5 lbs) and the 9 oz. wettable powder Demosan. Less desirable control was obtained with cadmium, Panogen, Scult, and Tersan O.M.

PMAS, Demosan 6 oz. rate (WP) and T.B.Z. were not effective in controlling the disease.

Table 17. 1969 Boyne Highlands snow mold study. Treatments were applied in November. Data expressed as percent area infested.

Treatment	Rate/1000 ft^2	Replication I	II	III	Average	1% Comparison
Calo-gran	8 lbs.	0	0	0	0	a
Demosan	3.75 lbs.	5	5	2	4	a
Calo-clor	4 oz.	1	2	10	4.3	a
Demosan	2.5 lbs.	10*	10*	2	7.3	a
Demosan	9 oz.	15	10	10	11.6	a
Scutl	---	25	20	15	20.0	a b
Cadmium	3 oz.	10	25	35	23.3	a b c
Panogen	3 oz.	30	50	15	31.6	a b c
Cadmium	5 oz.	10	30	60	33.3	a b c
Tersan O.M.	8 oz.	30	30	50	36.7	a b c
PMAS	2 oz.	60	45	45	50.0	b c d
Demosan	6 oz.	60	80	20	53.0	c d e
T.B.Z.	4 oz.	80	95	50	75.0	d e
Check	---	95	90	75	86.0	e

*appears to be spring infection

F. 2-b. SYSTEMIC FUNGICIDES CONTROL OF DOLLAR SPOT - J. M. Vargas, Jr.

The tests were run on Toronto bentgrass at the M.S.U. Crop Science Field Laboratory. The plots were inoculated with Sclerotinia homeocarpa and the disease was allowed to develop before the first applications were made.

Three different formulations of Thiabendazole were included in the study a 60% formulation from Merck & Company (TBZ) and two 25% formulations from Mallinckrodt, MF 443 and MF 444. TBZ and MF 443 were applied both once and twice a month at various rates while MF 444 and a standard check Phenmad and Thirmad were applied only every two weeks. The plots were 5' x 10' and each treatment was replicated 3 times in a random block design.

The results are given in Table 18 TBZ at the 1 and 2 oz. rate, MF 443 at the 4 oz. rates, MF 444 at the 1 oz. rate all gave excellent control when applied every two weeks. No material was effective in controlling the disease when applied only once a month.

NOT FOR PUBLICATION

Table 18. 1969 Sclerotinia Dollar Spot Study

on Toronto Bentgrass at East Lansing. Averages of 3 replications.

Treatments applied July 22, August 19, and September 16

Chemicals	Rate oz./1000 sq. ft.	Total number of spots					
		7/22	8/5	8/19	9/2	9/16	9/30
TBZ	1 oz.	143	87	28	2	8	0
TBZ	2 oz.	246	92	47	11	0	0
TBZ	1 oz./mo.	268	184	184	103	735	214
TBZ	2 oz./mo.	248	104	144	26	188	24
MF 443	1 oz.	286	101	74	118	222	67
MF 443	2 oz.	171	64	129	26	18	0
MF 443	4 oz.	214	33	0	4	4	0
MF 443	1 oz./mo.	225	159	267	127	619	269
MF 443	2 oz./mo.	237	117	186	120	582	211
MF 443	4 oz./mo.	148	31	76	53	276	54
MF 444	1 oz.	186	42	14	4	0	0
Phenmad + Thirmad	1 oz. + 2-1/2 oz.	299	367	255	110	56	3
Check	---	285	486	595	615	1625*	1925*

*Estimations

NOT FOR PUBLICATION

F. 2. FUSARIUM BLIGHT CONTROL - J. M. Vargas, Jr.

Nine materials were tested in various combination for the control of Fusarium blight. Fore, Daconil 2787, Benlate, Actidione-Thiram, Chlordane, Sevin, TBZ, MF 443 and MF 444. Of these materials only Benlate showed any promise.

We were able to prevent the symptoms from occurring in previously infected areas by keeping the top inch of soil moist during the growing season. This required daily watering of disease areas during the hot dry weather.

G. 2. ESTABLISHMENT, SODDING - J. W. King and J. B. Beard

The vertical lifting technique for evaluation of rooting of sod was used in comparing sod grown on mineral and organic soils. After 2 years there have been no consistent differences between the two sources (Table 19).

Table 19. Vertical lifting force (lbs/sq. ft.) required to lift sod. Averages of 4 replications. East Lansing, Michigan.

Sod Type	Dates 1968					1969		
	8/20	8/27	9/03	10/7	11/6	5/05	7/08	8/11
Mineral	18.7	27.5	32.8	37.8	45.2	110.5	88.8	91.5
Organic	20.0	42.0	37.2	42.0	41.2	85.0	90.8	124.5

G. 4. SOD HEATING - J. W. King and J. B. Beard

The effects of cutting height, nitrogen rates, and N^6 benzyladenine treatments on sod heating and damage were investigated under simulated shipping conditions in a series of experiments. Shipping conditions were simulated by stacking 12 sod pieces in insulated plywood boxes (20 inches square by 30 inches deep) and placing 255 lb. of weight over the sod. Temperature, carbon dioxide, oxygen, and ethylene levels within the sod stacks were measured. Sod pieces were removed from the boxes at 24 hour intervals. Six inch diameter plugs were transplanted to pots in the greenhouse. Percent leaf kill, percent leaf cover, and root organic matter production data were obtained.

The effects of carbon dioxide, oxygen, and ethylene were investigated in controlled atmosphere studies. Sod pieces were removed from the chambers at 24 hour intervals and transplanted to pots in the greenhouse. Percent leaf kill, percent leaf cover, and root production data were obtained.

Inhibition of respiration from oxygen starvation or from high carbon dioxide levels was not a cause of sod injury. Carbon dioxide levels increased to 13 to 19% and oxygen levels decreased to 2 to 5% during storage under simulated shipping conditions. Controlled atmosphere studies showed that sod survived longest when stored at 18% carbon dioxide and 2% oxygen. The respiration rate of sod cut at 2 inches averaged 74 ml CO_2/kg/hr.

The decreases in total available carbohydrate levels were well correlated with increases in percent leaf kill and decreases in root production for a sod heating box experiment conducted late in the season. Carbohydrate levels were not reduced to a consistent low level before sod death occurred for sod stored in controlled atmospheres at 104 and 83°F. Available carbohydrates were not exhausted in either experiment. Direct high temperature injury occurred at 104°F.

Ethylene production is not a factor affecting sod injury in commercial sod loads. High ethylene production (2 to 5 ppm) occurred where high rates of nitrogen were applied. The ethylene production was usually less than 2 ppm where normal levels of nitrogen (150 lb/A/yr) were applied. Controlled atmosphere studies showed that a sharp decrease in root production occurred between 2 and 4 ppm of ethylene. Ethylene production was independent of temperature.

N^6 benzyladenine, a respiration inhibitor, did not affect carbon dioxide and oxygen levels, temperature, or injury of sod during storage.

Root production was higher for sod produced with below normal nitrogen fertilization. The application of a very high rate of nitrogen (215 lb/A) within a few days before harvest resulted in more injury and less root production than for sod produced with normal (150 lb/A/yr) nitrogen fertilization.

Sod cut at 0.75 inch within a few days before harvest survived storage longer than sod cut at 2 inches. The low cutting treatment reduced respiration rate and temperature levels during storage and resulted in reduced percent leaf kill and increased root production.

Sod injury increased progressively in relation to increased temperature levels occurring during storage. Sod survived 5 days with less than 10% leaf kill where storage temperature reached only 87°F. The percent leaf kill reached 80 to 90% after 3 to 4 days of storage where storage temperatures reached 95 F. The rate of sod injury was greater relative to temperature in early June when maximum seedhead production occurred and in early August when soil temperatures were higher. Ventilation tubes inserted into commercial sod loads did not reduce temperature effectively. High temperature was the most important cause of sod injury.

G. 4. ROADSIDE ESTABLISHMENT - J. Kaufmann and J. B. Beard

The research work on roadside establishment was terminated on July 1, 1970. A final report covering all investigations since 1963 will be prepared and published in the near future.

Plot areas were established, observed and evaluated on three specific types of roadside sites: (a) a clay loam cut (b) a clay loam fill, and (c) a sandy cut. The areas of investigation included: (1) fertility practices (2) seed mixture composition (3) mulching materials (4) seedbed preparation and (5) seeding methods, rates and dates. Related studies included investigations into the use of chemical growth retardants for controlling excessive growth of roadside turf, and demonstration areas of sod versus seed establishment on steep slopes and ditch bottoms.

In the fertility studies exceptional turf establishment was noted with an initial application of 2#/1000 sq. ft. each of actual N, P_2O_5 and K_2O, plus a follow-up application of 1#/1000 sq. ft. N. Variation in the carrier and ratio of the fertilizer had little long term effect on turf establishment on any of the sites.

In the seed mixture studies, the most rapid establishment was achieved with mixtures containing a minimum of 20% each of perennial rye grass, Kentucky bluegrass, and red fescue on a seed number basis. The inclusion of cereal grain was detrimental on the clay loam sites, but was beneficial in the establishment of red fescue on the sandy site.

After four growing seasons Kentucky bluegrass had become dominant on the clay loam sites, while red fescue was the primary species on the sandy site.

In considering overall cost and roadside turf establishment factors, straw (2 T/A) plus asphalt (150 gal/A) continued to rate superior to manufactured mulches in all plot areas under investigation. Jute net and soil retention mat were comparable for erosion control and turf establishment.

The application of a 2" layer of topsoil on the sandy site was the superior seedbed preparation method in terms of turf establishment. Various methods of tilling did not appear to improve the establishment of turf on this sandy site.

The data from both of the clay loam sites and the sandy site suggests that a practical seeding rate is 80#/A, and acceptable seeding dates are from May 1 throughout the entire summer to October 1.

G. 3. SOD PRODUCTION - J. B. Beard and P. E. Rieke

MOWING HEIGHT AND FREQUENCY. The influence of five cutting heights (0.5, 1.0, 1.5, 2.0, and 2.5 inches) and two cutting frequencies (one and two times per week) were evaluated for the effect on the sod strength of Merion Kentucky bluegrass. The effect of cutting height was evaluated in terms of sod strength and is presented in Table 20. Most cutting height and frequency treatments resulted in an acceptable level of sod strength with the highest levels achieved at the 2.5 inch height cut once per week. The visual turfgrass quality on all treatments has been acceptable throughout the experimental period.

Table 20. The Effect of Cutting Height and Frequency on Sod Strength, MSU Muck Experimental Farm. 3 replications.

Cutting Height (Inches)	Cutting Frequency (times /wk)	(Pounds Required to Tear Sod) 7/8	8/14	Ave.
2.5	1	140	182	161
2.0	1	113	177	145
2.0	2	152	137	144
2.5	2	120	160	140
1.5	1	107	173	140

NOT FOR PUBLICATION

Table 20 continued.

1.0	1	92	170	131
1.5	2	125	117	121
1.0	2	92	115	103
0.5	1	88	118	103
0.5	2	80	73	76

DATE OF SEEDING SURVEY. The date of seeding study was initiated on September 26, 1968, with seedings made at approximately fifteen day intervals through November 8, 1968, and starting again on May 15, 1969. In the comparison of initial establishment of the fall seedings all plantings made after October 15 were quite thin and subject to extensive weed invasion.

SOD VARIETY EVALUATIONS. Twenty-two Kentucky bluegrass varieties and three red fescue varieties are under evaluation. The experimental area was seeded August 25, 1968. Data is presented on establishment rate, visual density, fall color and sod strength. The sod strength measurement would be one of the major criteria of concern to the commercial sod grower.

Park, Delta, and Pp-1 exhibit the most rapid rate of establishment (Table 21), followed by South Dakota Common, Windsor, and Fylking. Captan, Park, Kenblue, Delta and Pp-1 ranked high in terms of the visual density rating.

Table 21. Sod Variety Evaluations, MSU Muck Experimental Farm. 3 replications. Sod strengths taken June 27 and August 12, 1969. (1=best; 9=poorest)

Variety	Establishment Rate (2 dates)	Visual Density Oct. 25, 1969	Fall Color	Sod strength, lbs.
Nuggett	4.1	3.5	1.7	168
Pennstar	3.8	4.0	2.0	167
Fylking	2.8	3.1	2.7	158
Pp-1*	2.0	2.9	2.0	155
A-34	3.4	4.2	3.3	146
Belturf	4.0	4.5	1.0	142
Merion	3.0	4.4	1.3	141
Captan*	2.9	2.1	2.0	140
PSU-K-107*	3.8	3.3	2.3	140
Jamestown	2.2	1.4	2.3	140
Cougar	3.6	3.9	2.7	135
76G22-986*	3.4	3.7	3.0	131
Pennlawn	1.3	1.0	4.0	131
S-59*	3.4	3.3	4.7	131
59*	3.5	3.7	4.7	126
Campus*	5.9	6.2	2.3	126
NJE-27*	4.4	5.4	1.3	114

Table 21 continued.

Arboretum	2.9	3.2	4.7	110
Windsor	2.6	3.1	3.3	110
Prato**	7.4	8.5	2.7	98
Delta	1.9	2.9	4.3	88
Kenblue	3.0	2.8	4.0	86
Park	1.9	2.5	4.3	65
Newport	3.0	3.5	4.3	56
S. Dakota Common	2.5	3.4	3.3	35

* Not commercially available in U.S.
**Seed lot had very low germination.

BLENDS FOR SOD PRODUCTION. Six Kentucky bluegrass varieties were utilized in this study in eleven different combinations. Sod strength data are presented in Table 22. No great differences were observed between most of the Kentucky bluegrass blends included in this study. Blends containing Fylking tended to rank higher in terms of sod strength.

Table 22. Sod Strength Evaluation of Bluegrass Blends, MSU Muck Experimental Farm. 3 replications.

Percent Composition						Sod Strength (Pounds Required to Tear Sod)		
Merion	Newport	Park	Fylking	Windsor	Prato	6/26	8/14	Ave.
%	%	%	%	%	%			
			33	33	33	108	147	127
	33	33	33			98	130	114
50			50			95	123	109
33		33	33			105	107	106
	33			33	33	93	107	100
50					50	87	100	93
50				50		68	117	92
33			33	33		85	100	92
50	50					78	103	90
50		50				72	93	82
33	33	33				58	103	80

AN EVALUATION OF THE RELATIVE SOD STRENGTH OF TEN MERION KENTUCKY BLUEGRASS-PENNLAWN RED FESCUE MIXTURES is presented in Table 23. These data indicate that mixtures containing as little as 30% Merion Kentucky bluegrass on a seed number basis gave comparable sod strength to the other five highest ranking mixtures. Similar results were also observed in terms of a minimum percentage of Merion in a previous preliminary study in 1967.

Table 23. Sod Strength Evaluations of Merion Kentucky Bluegrass-Pennlawn Red Fescue Mixture, MSU Muck Experimental Farm. 3 replications.

MIXTURE COMPOSITION (Percent on Seed Number Basis)*		SOD STRENGTH (Pounds Required to tear sod)		
Merion	Pennlawn	6/26	8/14	Ave.
40 (15)	60 (85)	162	135	148
70 (44)	30 (59)	133	145	139
60 (28)	40 (72)	150	122	136
30 (10)	70 (90)	167	103	135
80 (50)	20 (50)	132	130	131
50 (22)	50 (79)	128	120	124
90 (70)	10 (30)	103	143	123
100 (100)	0 (0)	108	127	117
10 (3)	90 (97)	152	65	108
0 (0)	100 (100)	137	80	108
20 (6)	80 (94)	123	92	107

*Percentages in parenthesis are on a weight basis.

NITROGEN EFFECTS ON SOD DEVELOPMENT

Excessive nitrogen applications decrease root and rhizome growth and sod strength measurements. Initial soil nitrogen level is important in the response as well (Table 24).

Table 24. Influence of soil nitrogen level and nitrogen fertilization on sod strength of Merion. MSU Muck Experimental Farm. 4 replications.

	Initial soil nitrogen level	
Nitrogen treatment	High	Low
0	84	43
15, monthly	109	77
30, monthly	79	113
60, monthly	72	104
120, monthly	58	78
30, spring	109	123
60, spring	94	111
120, spring	70	79
30, fall	68	75
60, fall	75	84
120, fall	71	84

SOIL LOSS WITH SOD. Plots established in 1963 have soil levels which indicate the soil has subsided 2.4 inches under permanent grass, 3.4 inches under onion cropping, and 5.2 inches after 5 sod crops have been harvested. About 0.5 inches of soil is lost per crop with .35 inches more lost than with onions.

SOD CLIPPING UTILIZATION. Proper mowing practices are required to maintain sod quality. Considerable leaf growth is removed in this operation. These clippings have not been utilized in the past. Techniques have been developed in the past year for collecting and pelletizing the clippings. Approximately two tons of pelletized sod clippings have now been obtained and analyzed for total digestible nutrients, essential element content, protein content and rate of digestibility. Feeding studies are in progress on several types of animals to determine how such clippings might be best utilized. The pellets offer promise as bedding for lab animals as well.

H. 1. EXTENSION REPORT - Bob Shearman

The three-quarter time graduate assistant position in turfgrass extension established in 1968 at Michigan State University has recently been structured to facilitate two half-time appointments. The program has developed well over the past two years with responsibilities primarily in the area of advising professional turfmen, teaching extension classes, and coordinating writing and publication of turfgrass extension bulletins. Two bulletins were released in the spring of 1970: (1) Lawn Establishment and (2) Lawn Care. In addition to these bulletins, three others are being prepared including (1) Weed Identification and Control, (2) Lawn Diseases and Insects, and (3) Sod Production.

The 40th Annual Michigan Turfgrass Conference was held January 27-28, 1970, in the Kellogg Center. This is the second oldest state turfgrass conference in the nation. There were 512 registered for the conference, the largest number ever to attend. Visiting speakers appearing on the program were Dr. Paul Alexander, Educational Director for the Golf Course Superintendents' Association of America; Jim Latham, Chief Field Agronomist for the Milwaukee Sewage Commission; Dr. Robert Miller, Turfgrass Specialist, Ohio State University; and Dr. Mel Shurtleff, Turfgrass Pathologist, University of Illinois. In addition to the MSU turfgrass research reports, topics emphasized included (a) golf course irrigation, (b) turfgrass cultivation, (c) putting green establishment and maintenance, (d) sod heating, (e) drainage for sod fields, (f) spraying equipment, (g) turfgrass diseases, (h) pesticide safety and compatibility, and (i) helicopter application of pesticides. The 41st Annual Michigan Turfgrass Conference has been scheduled for January 26-27, 1971, at the Kellogg Center on the MSU Campus.

The East Lansing Michigan Turfgrass Field Day was held on September 4, 1969, with some 300 professional turfgrass managers participating in the biennial event. In addition to the turfgrass research plots at MSU, the newly installed synthetic turf at Spartan Stadium was viewed. Last September 10 was the date that the First Sod Producers' Field Day at the MSU Muck Experimental Farm northeast of East Lansing was held. Sod growers had the opportunity to observe rates of sod strength formation of 36 Kentucky bluegrass varieties, as well as mixtures and blends. Dates of seeding, fertilization, mowing height and frequency, and subsidence studies were also discussed.

The Biennial Northern Michigan Turfgrass Field Day will be held September 9, 1970, at Traverse City, Michigan. The tentative program will consist of viewing the experimental plots, equipment demonstrations, and a series of research reports.

H. 2-a. TWO YEAR TURFGRASS MANAGEMENT TECHNICAL TRAINING PROGRAM - K. T. Payne

Twenty-two students graduated from the Turfgrass Management program in March 1970. Average starting salary was $8500 and the highest was $10,500. Twenty-three students are on summer placement training in 1970.

Applications for entrance in the fall of 1970 have been limited to 40. Additional applicants may come on a no-preference status with the opportunity to enter the program after one term in the place of any who may fail the first term or withdraw for other reasons.

John King, coordinator of the program since its inception, withdrew to complete graduate study and K. T. Payne assumed the responsibility in February 1970.

H. 2-b. UNDERGRADUATE AND GRADUATE TURFGRASS MANAGEMENT PROGRAM - J. B. Beard and P. E. Rieke

A four year undergraduate curriculum leading to a B.S. degree in turfgrass management was initiated 4 years ago at Michigan State University. Eighteen students are now enrolled in this program.

Graduate study is offered at the M.S. and Ph.D. level in all phases of turfgrass science. Turfgrass students enrolled for graduate study during 1969-70 were as follows:

Name	Degree	Appointment	B.S. Degree (from)
English, K.	M.S.	1/2 - Soils	Michigan State University
Carrow, R.	Ph.D.	1/2 - Soils	Michigan State University
Hogart, J.	M.S.	1/2 - Physiology	Michigan State University
Kaufmann, J.	Ph.D.	3/4 - Roadsides	Goshen College
Martin, D.	Ph.D.	1/2 - Physiology	Michigan State University
Shearman, B.	M.S.	1/2 - Extension	Oregon State University
Turgeon, A.	Ph.D.	3/4 - Weeds	Rutgers University
King, J.	Ph.D.	3/4 - Teaching	Purdue University

RECENT PUBLICATIONS

1. Beard, J. B. and P. E. Rieke. 1969. Producing Quality Sod. In Turfgrass Science. A. A. Hanson and F. V. Juska, editors. Agron. Monograph 14: 442-461.

2. Beard, J. B. and D. P. Martin. 1970. Influence of water temperature on submersion tolerance of four grasses. Agron. Journal 62:257-259.

3. Green, D. G. and J. B. Beard. 1969. Seasonal relationships between nitrogen nutrition and soluble carbohydrates in the leaves of *Agrostis palustris* Huds. and *Poa pratensis* L. Agron. Journal 61:107-111.

4. Kaufmann, John E. 1970. The influence of temperature and other environmental factors on nitrate reductase activity of *Agrostis palustris* Huds. and *Cynodon dactylon* L. M.S. thesis.

5. King, John W. 1970. Factors affecting the heating and damage of Merion Kentucky bluegrass (Poa pratensis L.) sod under simulated shipping conditions. Ph.D. thesis.

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

7. Martin, David P. 1970. The composition of turfgrass thatch and the influence of several materials to increase thatch decomposition. M.S. thesis.

8. Rieke, P. E., J. B. Beard, and R. E. Lucas. 1968. Grass sod production on organic soils in Michigan. Proc. Third Int. Peat Congress 350-354.