1968 TURFGRASS RESEARCH SUMMARY

Michigan State University

East Lansing, Michigan

Edited by

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A.-1. ADVANCES IN BREEDING AND GENETIC STUDIES

A turfgrass breeding and genetics project has been approved by the Michigan Agricultural Experiment Station. The initial effort is toward disease resistant red fescue varieties having a creeping habit. The home owner and the sod grower need shade tolerant species. The ability to tolerate shade and drouthy soil conditions is present in Festuca rubra. Tolerance to Helminthosporium leafspot at levels similar to those attained in Merion Kentucky bluegrass have not as yet been isolated. The many sub-species of F. rubra as well as other species of Festuca are potential sources of leaf spot resistant germ plasm and will be explored.

The addition of a turfgrass pathologist to the faculty of the Department of Botany and Plant Pathology this year permits cooperative projects in which screening techniques will be developed; studies of inheritance to resistance will be initiated; and the screening and isolation of tolerant parental materials effected.

Polycross F. rubra seed was produced in 1968 in an isolation nursery containing three types of germ plasm: (1) outstanding color, texture and vigor, (2) vigorously creeping clones, and (3) potentially leaf spot tolerant parental plants. Seedlings are being established for second cycle selection in 1969-70. A single plant series will be grown under shade conditions and mowed for evaluation.

Greenhouse inoculations with Helminthosporium are being made to evaluate experimental clones and available varieties under sod conditions, and individual plants which have exhibited field resistance to leaf spot.

Introductions from the Plant Introduction Station, including related species, will be included in 1968 plantings.

Funds have been received to initiate a program for the development of improved non-creeping bentgrass varieties, particularly for tee and fairway use. Major effort here will be toward vigorous, disease resistant, heat tolerant types which will be able to resist weed invasion (Poa annua in particular) and will lack the thatch developing potential of the creeping bentgrasses. Genetic studies of the inheritance of creeping versus non-creeping growth habit in the bentgrasses as well as the fescues will be initiated.

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

Breeder's seed of Wintergreen red fescue was planted in a 15 acre seed field in Oregon in the spring of 1968. An excellent stand was obtained and Foundation seed will be produced in 1969. Seed for further testing will be available for fall seedings in 1969. Production is being sponsored by the Michigan Seed Dealer's Association.

Breeder's seed of a synthetic variety of Festuca pratense will be produced in 1969. This is a winter hardy, moderately narrow leafed variety which has demonstrated excellent quality and durability in 5 years of testing.

Stolons of two new creeping bentgrass varieties are available for testing upon request. Both have ranked high over a period of six years of testing in Michigan.

A-3. TURFGRASS EVALUATION

Evaluations of bluegrasses, red fescues, tall fescues and ryegrasses cut at 4 cm. and bentgrass cut at 0.65 cm. have been in progress for six years at East Lansing, five years at Traverse City and two years at Iron Mountain. The latter two sites are on a soil of very high sand content. Data is presented for the 1967 season of evaluation.

A-3a. BLUEGRASS VARIETY EVALUATIONS - J. B. Beard and W. E. Eaton.

East Lansing - Helminthosporium leaf spot was the only severe disease problem during 1967. Scattered leaves can be found which are infected with stripe smut but it has not yet become a problem. Merion, Pennstar, Fylking and Windsor, in that order, ranked as the outstanding Kentucky bluegrass varieties in 1967 and 1968 (Table 1). Prato, Delft, Cougar and Campus all showed a substantial decline in turfgrass quality. Brabantia, Z.W.B. and 36G22-981 have consistently been inferior. Prato, Pennstar, and Z.W.B. continue to have high density counts. Both Fylking and Windsor showed a substantial decline in density.

Table 1. 1967 BLUEGRASS VARIETY EVALUATIONS

East Lansing, MSU

(5' x 9' plots; 3 reps.
planted July 26, 1962; sandy loam soil; irrigated; 4 cm. cut)

Variety	Density Count (Shoots/sq.dm.) 8/23	Visual Turfgrass Quality Rating*** (1-best; 9-poorest)	Multiple comparison test (Based on quality)
Merion	244	2.1	a
Pennstar	257	2.4	a b
Fylking*	163	2.5	a b
Windsor*	163	2.5	a b
Newport	199	2.8	a b c
Delta	243	3.4	b c d
Park	241	3.7	c d e
Delft	228	4.1	d e f g
Prato	266	4.2	d e f g
Cougar	173	4.3	d e f g
Brabantia	198	4.3	d e f g
Campus	230	4.5	e f g h
Z.W.B.	281	5.0	f g h
Common (Kentucky source)	199	5.0	f g h
36G22-981**	72	5.2	g h
Poa Trivialis	72	5.5	h

***Average of Monthly Seasonal Ratings.
* Planted August 20, 1963.
** Planted September 2, 1964.

Traverse City - Merion continues to rank superior at Traverse City on 91% sand, followed by Pennstar and Newport (Table 2). Pennstar has shown progressive improvement in performance over the last three years. In contrast, Cougar has declined primarily because of a mild leafspot attack which occurred in 1967 for the first time since the plots were established. Newport is ranking well under irrigation but has been decidedly inferior on the unirrigated plots. Park continues to exhibit better adaptation to northern Michigan than Delta. Brabantia continues to be thinned by low temperature injury. Draylar upland bluegrass continues to rank superior to Canada bluegrass in overall turfgrass quality. Merion and Z.W.B. have the highest density counts.

Table 2. 1967 NORTHERN BLUEGRASS VARIETY EVALUATIONS
Traverse City

(5 x 7' plots; 4 reps; planted May 16, 1963;
loamy sandy soil; 91% sand; irrigated; 4 cm. cut)

Variety	Density Count 9/20/67 (Shoots per square dm.)	Visual Turfgrass Quality rating* (1-best; 9-poorest)	Multiple comparison test (Based on quality)
Merion	255	2.1	a
Pennstar	202	3.1	a b
Newport	179	3.6	a b c
Draylar Upland	186	4.2	b c d
Campus	188	4.6	b c d e
Cougar	204	4.7	b c d e
Z.W.B.	244	4.9	b c d e
Park	189	5.0	b c d e
Canada	177	5.2	b c d e f
Common (Kentucky source)	192	5.7	c d e f
Delta	170	5.7	c d e f
Brabantia	188	6.2	d e f
Rough Bluegrass	186	7.2	f

*Average of monthly seasonal ratings.

A-3b. FINE-LEAFED FESCUE EVALUATIONS - J. B. Beard and W. E. Eaton.

East Lansing - As in past years, Wintergreen, Highlight, Pennlawn, Grand Prairie, and S-59 continue to rank high in overall turfgrass quality (Table 3). However, S-59 has declined somewhat in comparison to previous years while Pennlawn and Wintergreen have improved.

Table 3. 1967 FINE-LEAFED FESCUE VARIETY EVALUATIONS
East Lansing

(5' x 9' plots; 3 reps; planted July 11, 1962;
sandy loam soil; irrigated; 4 cm. cut)

Variety	Visual Quality Rating** (1-best; 9-poorest)	Multiple Comparison Test
Wintergreen	2.3	a
Highlight	2.4	a
Pennlawn	2.7	a b
Grand Prairie	2.8	a b c
S-59	3.0	a b c
Rainier	3.1	a b c
Duraturf	3.1	a b c
Oasis	3.2	a b c
Illahee	3.3	a b c
Syn B* (Canada)	3.3	a b c
Common Chewings	3.5	a b c
Golfrood	3.6	a b c
Olds	3.6	a b c
Syn A* (Canada)	3.8	b c
S.L. 3*	3.9	b c
Common Creeping	4.1	c
Career Sheep Fescue	5.6	d
Hard Fescue	6.8	e

* Experimental selections.
**Average of seasonal monthly ratings.

A-1c. BENTGRASS VARIETY EVALUATIONS - J. B. Beard and W. E. Eaton.

East Lansing - Fourteen bentgrass varieties (Table 4) and seven selections (Table 5) were evaluated under normal greens conditions. Except for Typhula snow mold, no significant disease activity occurred and no preventive fungicide program was followed.

Toronto and Pennlu were outstanding followed by Iagreen, Penncross, and Cohansey. Penncross continues to rank as the best seeded bentgrass. Astoria and Washington were definitely inferior. Congressional continues to decline in quality due to the invasion of off types.

Springfield, MSU-24-Ap, MSU-28-Ap and Pennpar continue to show promise. Bore, Exeter and Holfior have been inferior under greens culture.

Table 4. 1967 BENTGRASS VARIETY EVALUATIONS
East Lansing

(10' x 16' plots; 3 reps; planted Oct. 25, 1961;
loamy sand; irrigated; 6.5 mm. cut)

Variety	Visual Quality Rating* (1-best; 9-poorest)	Multiple Comparison Test
Toronto	2.1	a
Pennlu	2.2	a b
Iagreen	2.7	a b c
Penncross	2.8	b c d
Cohansey	2.8	b c d
C-1 and C-19	3.1	c d e
Old Orchard	3.4	d e f
Arlington	3.5	e f
Seaside	3.7	e f
Congressional	3.8	f
Nimisilla	3.9	f
Evansville	3.9	f
Astoria	5.2	g
Washington	5.3	g

*Average of monthly seasonal ratings.

Table 5. 1967 BENTGRASS SELECTION EVALUATIONS
East Lansing

(4' x 4' plots; 3 reps; planted August 2, 1962;
loamy sand; irrigated; 6.5 mm. cut)

Variety	Visual Quality Rating (1-best; 9-poorest)	Multiple Comparison Test (Based on Quality)
Springfield	2.0	a b
MSU-24-Ap	2.2	a b c
MSU-28-Ap	2.2	a b c
Pennpar	2.5	a b c d
Holfior	5.3	h i j k l m
Exeter	5.5	i j k l m
Bore	7.2	n o

Traverse City - Congressional, Cohansey, Penncross, and Toronto continue to rank highest in overall greens quality as was the case in 1966 (Table 6). Seaside, Astoria, Pennpar, and Holfior were inferior. Pennpar ranked highest in density.

Table 6. 1967 DENSITY AND QUALITY EVALUATIONS OF BENTGRASS VARIETIES
Traverse City

(8' x 12' plots; 3 reps; planted Aug. 18, 1964;
loamy sand, irrigated; 6.5 mm. cut)

Variety	Density Counts (Shoots/ sq.dm.) 9/20	Visual Quality Rating* (1-best; 9-poorest)	Multiple Comparison Test (Based on Quality)
Congressional	1984	2.2	a
Cohansey	2046	2.9	a
Penncross	1592	3.1	a
Toronto	2082	3.2	a
MSU-28--Ap	1721	3.4	a
Washington	1535	3.7	a
Seaside	1566	5.2	b
Astoria	1240	5.6	b
Pennpar	2356	6.0	b
Holfior	1690	6.2	b

*Average of monthly seasonal ratings.

A-3d and e. MISCELLANEOUS VARIETY EVALUATIONS - J. B. Beard and W. E. Eaton.

East Lansing - A number of turfgrass species, including ryegrasses and tall fescues, have been under test (Table 7). Norlea and MSU-21-Lp rank as the outstanding perennial ryegrass varieties. Pelo and S-23 have declined substantially in overall turfgrass quality. Among the tall fescues MSU-4-Fe continues to exhibit superiority. Kentucky 31 continues to retain a slight edge over Alta.

Table 7. 1967 MISCELLANEOUS VARIETY EVALUATIONS
East Lansing

(5' x 9' plots; 3 reps; planted July 10, 1962;
sandy loam; irrigated; 4 cm. cut)

Variety	Visual Quality Rating** (1-best; 9-poorest)	Multiple Comparison Test
	Perennial Ryegrass	
Norlea	2.6	a
MSU-21-Ap	2.6	a
Viris*	3.4	a
Sceempter*	3.8	a
S-23	4.1	a
Pelo	4.3	a

	Tall Fescue	
Backafall*	3.1	a
Syn A	3.3	a
Kentucky 31	3.3	a
Alta	3.7	a
S-170	4.0	a

* Planted September 2, 1964
**Average of monthly seasonal ratings.

B-3. SOIL TESTING - P. E. Rieke.

Soil tests after five years of treatments on Grayling Sand at Traverse City are given in Table 8. Note the increased leaching of K on irrigated plots and the high N plots. No clippings are removed from these plots.

Table 8. 1968 TRAVERSE CITY SOIL TESTS
Grayling Sand

Depth of Sample inches	Pounds per Acre P	K	Ca
Irrigated Check			
0-2	155	66	1664
4-6	70	102	1067
8-10	39	129	664
Unirrigated Check			
0-2	186	220	1152
4-6	168	135	675
8-10	54	128	812
Irrigated Nitrogen (12)			
0-2	104	44	1665
4-6	31	37	812
8-10	44	66	812
Unirrigated Nitrogen (6)			
0-2	127	88	1322
4-6	57	82	644
8-10	29	95	475

B-3. EFFECT ON SULFUR ON SOIL PH - P. E. Rieke

Surface applied surfur reduced soil pH most in the 0-2 inch depth (Table 9). Some loss of turf occurred in the plot treated with 60 pounds of sulfur.

Table 9. EFFECT OF SULFUR ON pH OF ALKALINE LOAM SOIL
Warwick Hills

Sulfur applied June, 1967.
Samples taken October, 1968.

Depth of Sample	Sulfur applied (pounds/1000 sq. ft.)		
	0	20	60
0-2	7.3	7.1	5.4
2-4	7.3	7.3	6.9
4-6	7.4	7.4	7.2
6-8	7.4	7.4	7.2

B-5a and b. TURFGRASS FERTILIZATION - P. E. Rieke.

A summary of 1967 and 1968 quality ratings for a series of nitrogen carrier treatments on Merion is given in Table 10. Treatments, applied on the 15th of the specified month, were initiated in 1967. Ammonium nitrate was superior to the organic carriers and multiple applications gave higher quality turf. May and winter split applications of ammonium nitrate are promising at this point. The 12 pound ureaform application gave the highest quality turf in 1968. Spring applications reduced dandelion counts.

Table 10. AVERAGE QUALITY RATINGS FOR THE MERION FERTILITY STUDY ON FINE SANDY LOAM AT EAST LANSING. AVERAGE OF THREE REPLICATIONS FOR SEVEN DATES. NITROGEN APPLIED AT SIX POUNDS PER 1000 SQ. FT.

Treatment	Visual Turfgrass Quality Rating (1-best; 9-poorest)		Dandelions/ 1000 sq. ft.
	1967	1968	1968
33-0-0; April	2.63	3.17	37
33-0-0; May	2.70	3.24	29
33-0-0; April, Aug.	3.10	3.10	105
33-0-0; April, May, Aug.	2.73	2.74	94
33-0-0; April, Aug., Sept.	3.17	2.95	134
33-0-0; Aug.	4.33	3.67	171
33-0-0; May, Nov.	4.07	2.90	106
33-0-0; May, Feb.	4.03	3.07	123
6-3-0; April	3.47	3.67	77
6-3-0; April, May, Aug.	4.17	3.33	200
UF; April	4.97	3.86	180
UF; April, May, Aug.	5.57	4.29	200
UF; April, May, Aug. (12)	4.13	2.38	123
CHECK	6.83	7.95	875
LSD (0.05)	0.29	0.33	--

B-5b. EFFECT OF NITROGEN RATES ON SEEDED AND SODDED MERION - P. E. Rieke.

At lower rates of nitrogen, sodded Merion gives more competition against weeds than seeded Merion (Table 11). Sodded Merion requires about 2 pounds less nitrogen to give a significant response after 2 years of applications.

Table 11. SUMMARY OF 1968 VISUAL TURFGRASS QUALITY RATINGS FOR THE MERION NITROGEN FERTILITY STUDY.
East Lansing.

Averages for 3 replications on 7 dates (1-best; 9-poorest)

Pounds nitrogen per 1000 sq. ft.	Seeded		Sodded	
	Quality rating	Dandelions /1000 sq.ft.	Quality rating	Dandelions /1000 sq.ft.
0	6.98	762	5.74	447
2	4.93	476	4.10	219
4	3.52	86	3.02	114
6	2.40	29	2.07	48
8	2.00	19	1.62	57
10	1.36	10	1.43	10
12	1.19	10	1.38	19
14	1.19	0	1.33	10
LSD (.05)	0.48	--	0.43	--

B-5b. EFFECT OF NITROGEN RATES ON THREE KENTUCKY BLUEGRASSES AND TWO RED FESCUES - P. E. Rieke.

A comparison of quality ratings for three Kentucky bluegrass varieties grown at 4 levels of nitrogen at East Lansing is given in Table 12. Delta was severely attacked by leaf spot giving poor quality turf most of the season. Common Kentucky was less affected. Windsor was more aggressive against weeds at lower nitrogen levels in 1968 than the other two bluegrasses. Merion receiving similar nitrogen treatments was even more competitive against weeds.

Table 12. SUMMARY OF 1968 QUALITY RATINGS FOR NITROGEN RATES ON THREE KENTUCKY BLUEGRASSES.
East Lansing

Averages for 3 replications on 7 dates (1-best; 9-poorest)

Pounds Nitrogen per 1000 sq.ft.	Common		Delta		Windsor	
	Quality rating	Dandelions/ 1000 sq.ft.	Quality rating	Dandelions/ 1000 sq.ft.	Quality rating	Dandelions/ 1000 sq.ft.
2	5.28	1087	4.71	1180	5.33	876
4	4.05	847	3.86	552	3.90	505
6	3.24	324	3.98	200	2.55	314
8	3.05	200	4.14	162	1.81	162
LSD (.05)	0.63	--	N.S.	--	0.59	--

In 1968 Pennlawn red fescue appeared to tolerate higher nitrogen rates than Wintergreen. A significant increase in turf quality occurred between 2 and 3 pounds of nitrogen per 1,000 square feet per year for Wintergreen and between 4 and 6 pounds for Pennlawn. Somewhat higher dandelion counts were found in the Pennlawn plots than in the Wintergreen.

B-5b. NITROGEN RATE, TIMING AND CARRIER STUDIES ON KENTUCKY BLUEGRASS AND RED FESCUE GROWN ON 91% SAND - P. E. Rieke and J. B. Beard.

Average quality ratings of three turfgrass species after four years of nitrogen treatments at Traverse City are shown in Table 13. Generally the higher nitrogen rates and split applications give the highest quality turf. An exception is Ureaform which gives consistently lower quality turf. The average quality is not affected by time of application. Coated urea in two applications looks especially promising.

Table 13. 1965-68 AVERAGE VISUAL TURFGRASS QUALITY RATINGS FOR MERION AND COMMON KENTUCKY BLUEGRASS AND PENNLAWN RED FESCUE UNDER IRRIGATED CONDITIONS ON GRAYLING SAND AT TRAVERSE CITY.

Carrier	Number of Applications*	Visual Turfgrass Quality Rating (1-best; 9-poorest)
Urea	1	3.04
	2	2.64
	3	2.85
	6	2.57
Milorganite	1	3.09
	2	2.65
	3	2.52
Ureaform	1	3.28
	2	3.26
	3	3.31
Coated Urea	1	3.26
	2	2.56
Check	-	5.58
1/2X*	6	3.35
X	6	2.57
1 1/2X	6	2.08

*Nitrogen application rate is 8 pounds per 1000 sq. ft. for Merion; 4 pounds for Common and 3 pounds for Pennlawn.

The comparative degree of crabgrass infestation into Pennlawn red fescue as influenced by nitrogen rates and carriers is shown in Table 14.

Table 14. CRABGRASS DENSITY RATINGS AT TRAVERSE CITY FOR PENNLAWN RED FESCUE (10-NONE; 20-SEVERE). AVERAGE OF TWO REPLICATIONS.

Nitrogen Treatment	1967	1968
Check	14.5	15.0
1/2X	13.5	15.0
X	12.0	13.0
1 1/2X	11.5	12.5
Urea	13.2	12.8
Milorganite	16.7	18.5
UF	16.8	17.8
LSD (0.05)	0.6	1.1

B-7. PESTICIDE SOIL STUDIES - J. Timmerman and P. E. Rieke.

A study was made of the effects of selected pesticides on turfgrass growth, interactions with turfgrass fertilizers, and nitrogen transformations in soil. In general, the two organophosphate insecticides B25141 and Diazinon and the fungicide Tersan-OM increased top growth, percent nitrogen in the leaf tissue, and nitrogen uptake during certain periods of growth in both the greenhouse and field experiments. Turfgrass color was also improved by these pesticides in the field. Acti-dione thiram depressed growth in the greenhouse. All other pesticides had no effect. These effects were more noticeable in the first month after application, and were magnified when 10 times the recommended rate of the pesticides were used.

Soil mineral nitrogen (ammonium + nitrate) in pots receiving Milorganite as the nitrogen source was significantly higher than the no pesticide treatment when treated with B25141 and Cadminate at the recommended rate, and B25141, Diazinon, Dieldrin, and acti-dione thiram at 10 times the recommended rate in the greenhouse. This was not observed in the field.

In a laboratory incubation study, Tersan-OM applied at rates of possible accumulations over a period of time increased ammonification and nitrification in soil receiving Milorganiate as the nitrogen source. Diazinon, B25141, Dieldrin, and Calo Clor at these rates resulted in inhibition of ammonification. All pesticides caused significant changes from the control soil in patterns of ammonification and nitrate accumulation from Milorganite.

C-1. SEEDLING GROWTH - K. T. Payne.

Seed of three Kentucky bluegrass and two red fescue varieties was exposed to a 100 gausse electro-magnetic field for 2-3 seconds. Initial germination was more rapid in Pennlawn and Wintergreen red fescue and Fylking bluegrass. This was not noted in Merion or Common Kentucky bluegrasses. Major differences in

total germination or root length were not noted between treated and untreated seed lots of the five varieties when germinated under a constant temperature of 20° or an alternating regime of 16° and 30°.

C-1 and 2. ANNUAL BLUEGRASS GROWTH AND DEVELOPMENT STUDIES - J. B. Beard.

Annual bluegrass clones were collected from throughout North America. Great variations in growth and development were evident. Two distinct strains of annual bluegrass were found with a graduation of types found in between the extremes. One extreme is the classical erect growing, annual, bunch type which is a prolific seed producer while the other is a prostrate, vigorously stoloniferous, perennial type which produces very few seedheads.

C-3. TURFGRASS MIXTURE ECOLOGY STUDY ON A SANDY SOIL - J. B. Beard.

The eighteen mixtures included in the study ranked well through 1963 and 1964. No significant low temperature injury occurred in the winter of 1963-64 due to the extensive snow cover. During the winter of 1964-65, severe kill of ryegrasses was observed. In mixtures containing ryegrass, 90 to 95% loss of turf was noted. As a result, mixtures containing ryegrass have performed poorly throughout 1965, 1966, and 1967 (Table 15).

Table 15. PERFORMANCE OF FIVE SELECTED TURFGRASS MIXTURES
Traverse City

(5' x 7' plots; 4 reps.; planted May 16, 1963; loamy sand; 91% sand; irrigated; 4 cm. cut)

Percent Composition (on a seed number basis)			Visual Turfgrass Quality Rating* (1-best; 9-poorest)				
Kentucky Bluegrass	Red Fescue	Perennial Ryegrass	1964	1965	1966	1967	Multiple Comparison Test
75	25	0	3.1	3.8	4.5	2.8	a b
25	75	0	3.2	3.9	4.7	2.8	a b
50	50	0	3.4	4.2	5.0	3.1	a b c
60	20	20	3.6	7.7	5.8	4.9	d e f g h
33	33	33	3.3	8.0	6.6	6.1	g h

*Average of monthly ratings.

D-2a. EFFECTS OF NITROGEN NUTRITION AND TEMPERATURE ON THE GROWTH, CARBOHYDRATE CONTENT, AND NITROGEN METABOLISM OF COOL-SEASON GRASSES - H. B. Stoin and J. B. Beard.

The effects of ammonium vs. nitrate nitrogen and level of nitrogen on the growth and chemical composition of several cool-season grasses were studied at day/night temperatures of 21/16 C and 32/26 C in controlled environment chambers.

An interaction between nitrogen nutrition and temperature on the growth of the cool-season grasses occurred. In a nutrient solution

experiment the growth of Italian ryegrass (Lolium multiflorum Lam.) was always reduced by the high temperature, and the reduction was greater at high levels of nitrogen and with ammonium-N. At the low temperature an increase in level of nitrate-N increased growth while an increase in level of ammonium-N decreased growth. In a soil experiment in which nitrification of added ammonium-N was not prevented, additions of either ammonium or nitrate-N caused an increase in growth of the tops of perennial ryegrass (Lolium perenne L.) and tall fescue (Festuca arundinacea Schreb.) at the low temperature but not at the high temperature. In a second soil experiment in which nitrification of added ammonium-N was prevented, ammonium-N was superior to nitrate-N for top growth of Italian ryegrass. An increase in growth for the high level of ammonium-N but not for the high level of nitrate-N occurred at the low temperature. No response to source or level of nitrogen occurred at the high temperature.

Changes in soluble carbohydrate content did not appear to be the causal factor of growth reduction at high temperatures nor for the interactions which occurred. In no cases were the soluble carbohydrates exhausted, nor did they appear to be present in concentrations limiting to growth.

In the nutrient solution experiment protein nitrogen content appeared to be slightly increased by ammonium-N compared to nitrate-N and slightly decreased by high temperature. The soluble amino nitrogen content was generally higher with ammonium-N than nitrate-N and increased at the high temperature with ammonium-N but not with nitrate-N.

In the first soil experiment when no nitrogen was added, protein nitrogen content at the low temperature was generally lower than at the high temperature. When nitrogen was added, no differences due to temperature occurred at the first harvest. Between harvests protein nitrogen content decreased where growth continued but remained the same in the roots at the high temperature where no growth was occurring. The soluble amino nitrogen content was generally higher with nitrogen additions and at the high temperature. The level of available nitrogen appeared to exert a greater effect than did temperature. Between harvests the soluble amino nitrogen content decreased at both temperatures. In the second soil experiment where free ammonium, nitrate, glutamine, and asparagine nitrogen were determined, these fractions all were quite low and increased with an increase in ammonium nitrogen level but not with an increase in temperature.

The effects of nitrogen nutrition and temperature on nitrogen metabolism appeared more likely to involve a blockage or slow down of protein synthesis rather than an increase in protein breakdown. An accumulation of some toxic nitrogen compound at high nitrogen levels could also be involved.

D-3b. WINTER DESICCATION CONTROL - J. B. Beard and J. Lapp.

Twenty-two types of winter protection covers are under evaluation for effectiveness in desiccation and low temperature kill prevention. Controlled climate chambers and actual field tests are being conducted. Several promising new covers have been found which control water loss and also have good insulating properties. Wilt-proof and topdressing were not effective in the 1967 tests.

D-3c. THE INFLUENCE OF WATER TEMPERATURE ON THE SUBMERSION TOLERANCE OF CREEPING BENTGRASS, KENTUCKY BLUEGRASS, ANNUAL BLUEGRASS AND RED FESCUE - D. P. Martin and J. B. Beard.

Mature sods of Toronto creeping bentgrass (Agrostis palustris Huds.). Merion Kentucky bluegrass (Poa pratensis L.) annual bluegrass (P. annua L.) and Pennlawn red fescue (Festuca ruba L.) were submerged in constant temperature water tanks at water temperatures of 10, 20 and 30° C. Three replications of each species were removed at designated intervals, drained and placed in a greenhouse at 20°C. for evaluation of survival. Differentials in tolerance to extended periods of submersion were evident with Toronto creeping bentgrass being superior, Merion Kentucky bluegrass and annual bluegrass ranking intermediate, and Pennlawn red fescue being quite intolerant. The duration of submersion tolerance was inversely proportional to the water temperature. Symptoms of injury at 30°C. were visible on the intolerant species at the time of removal from the water tank and after 3 to 4 days on the tolerant grasses. There was a rapid loss of chlorophyll followed by general plant deterioration. Death occurred initially at the leaf tips of older leaves followed by a brownish discoloration of the leaf sheath.

D-3d. SHADE ADAPTATION - J. B. Beard.

Sixteen Kentucky bluegrass and red fescue varieties were sodded into a densely shaded area in August of 1968. Fylking and Pennstar were the only Kentucky bluegrass varieties showing promise in terms of initial fall sod establishment. All the red fescues had poor establishment characteristics which was attributed to the Helminthosporium leafspot activity present in August. Observations will continue through the 1969 growing season.

E-1. MOWING INVESTIGATIONS - J. B. Beard.

Reel and rotary mowers are being compared under four heights of cut: 1.3, 2.6, 3.9 and 5.2 cm. The study was initiated in the fall of 1962. Visual differences have been observed for five years with the rotary mowed plots having a browned appearance for 3 to 4 days after mowing, particularly during active growth periods and in late fall. Significant differences have not been found in density between the two types of mowers. Density was increased as the mowing height was lowered. This is a study conducted jointly with Ohio State University.

F-1b. ANNUAL BLUEGRASS RESPONSE TO PRE-EMERGENCE HERBICIDES - A. J. Turgeon and W. F. Meggitt.

Ten herbicides were applied to greenhouse flats containing 7-week old Newport Kentucky Bluegrass and Seaside Bentgrass planted separately in one-third sections of the flats. The middle-third were seeded to Poa annua just prior to herbicide application.

Table 16. EFFECTS OF PRE-EMERGENCE HERBICIDES ON POA ANNUA AND INJURY TO NEWPORT BLUEGRASS AND SEASIDE BENTGRASS. (one month after treatment)

Treatment	Rate in (lbs./acre)	Percent control of Poa annua	Percent kill of: Bluegrass	Bentgrass
TOK	12	100	100	100
Benefin	3	100	15	60
Bensulide	15	65	0	0
Ca arsenate	260	0	0	0
Dichlobenil	4	100	0*	0*
Bromacil	1	100	100	100
CDAA	6	100	100	100
DCPA	10	100	0	0
CIPC	18	100	100	100
Endothall	2	20	20	30

*No apparent thinning of the turf, although growth was completely stopped. Thinning was noticed 6 weeks after treatment and observation of the roots showed extensive die-back.

Bromacil, CDAA, CIPC, and TOK completely killed the turf (Table 16). DCPA showed best results with complete control of Poa annua and no injurious effects to the turf. Benefin gave moderate to severe injury to the turf while Bensulide did not give satisfactory control of the Poa annua. Calcium arsenate was ineffective under the conditions of this study.

F-1b. THE USE OF GROWTH RETARDENTS TO CONTROL POA ANNUA - A. J. Turgeon and W. F. Meggitt.

Several growth retardants were applied to plots of bentgrass and bluegrass turf infested with Poa, on March 21. This study was designed to determine whether growth retardents will reduce the competitive aggressiveness of Poa annua when applied under conditions of differential dormancy. (Poa is physiologically active while turfgrasses are still dormany from overwintering).

F-1c. CONTROLLING CREEPING BENTGRASS IN KENTUCKY BLUEGRASS TURF - A. J. Turgeon and W. F. Meggitt.

Greenhouse studies now underway and subsequent field trials will be used to determine the effects of silvex, benefin, and several experimental compounds on bentgrass infestations in Kentucky bluegrass turf.

F-2a. FUSARIUM BLIGHT STUDIES - R. P. Scheffer.

Twenty-one turf samples which showed typical blight symptoms were brought into the greenhouse during the fall of 1967 and spring of 1968. Fungi were isolated from the dying plants, cultured, and inoculated onto healthy greenhouse grown grass to test for pathogenicity.

This test showed that 16 of the sources yielded mildly pathogenic Fusarium isolates while 11 sources gave highly pathogenic Fusarium isolates (Table 17). An isolate typical of the most pathogenic forms was submitted to Dr. W. C. Snyder, an expert in Fusarium taxonomy at the University of California. He confirmed the fungus as F. tricinctum.

Table 17. LIST OF FIELD SAMPLES AND RELATIVE PATHOGENICITY OF FUSARIUM ISOLATES.

Sample Number	Date Collected	Michigan Sources	Typical Ring Symptoms	Mildly Pathogenic Isolates	Moderately Pathogenic Isolates	Highly Pathogenic Isolates
1	9/19/67	Belleville	X	X	X	X
2	9/19/67	Belleville	X	X	X	X
3	9/19/67	New Boston		X	X	
4	9/19/67	Ann Arbor		X		
5	9/21/67	Lansing	X	X	X	X
6	10/2/67	East Lansing		X		
7	10/5/67	Warren	X	X	X	
8	10/9/67	Flint		X		
9	10/9/67	Grosse Pointe				
10	10/11/67	East Lansing	X	X	X	X
11	10/18/67	East Lansing		X		
12	11/13/67	East Lansing	X	X	X	X
13.1	3/7/68	Gregory	X	X	X	X
13.2	3/7/68	Gregory		X	X	X
13.3	3/7/68	Gregory	X	X	X	X
14	3/26/68	Mason	X			
15	3/29/68	Salem		X	X	X
16	4/3/68	St. Clair Co.				
17	4/3/68	Grand Rapids				
18	4/9/68	East Lansing		X	X	X
19	4/23/68	Gregory	X	X	X	X
20	4/25/68	Port Huron				
21	5/2/68	Holt				X

F-2a. SNOW MOLD-NUTRITION STUDIES - J. B. Beard, J. Vargas, P. E. Rieke.

The effect of nitrogen rates, carriers, and time of application on Typhula smow mold activity is being investigated. One year's data indicates that the Typhula snow mold incidence was significantly increased by higher nitrogen rates, greater nitrogen availability and a mid-September nitrogen fertilization.

F-2b. TYPHULA SNOW MOLD CONTROL - J. B. Beard.

Boyne Highlands, Michigan, was selected as the experimental site for the Snowmold Fungicide study, since a uniform attack of Typhula snowmold

was assured on the Penncross bentgrass. The experimental area was snow covered from late November until mid-March and the soil temperatures dropped from 34°F. on November 4, to a low of 20° F. in late January 19, 1968, and remained near that temperature until early in March when a warming trend occurred.

Eight fungicides in eighteen different treatments of three replications were applied in a randomized block design, on November 20, 1967. Variables included high and low rates of application plus fall, and fall/spring applications.

Results of the fungicide study are presented in Table 18. The percentage kill by Typhula snow mold is based on the average of three individual ratings taken in the spring of 1968, after the snow melted and fungal growth ceased.

PMAS gave excellent control in the field trial with Panogen also giving very good control at the 3 oz. rate. Other fungicides giving adequate control were Cadmium, Calo-Gran, Tersan-OM, and Calo-Clor. Dyrene and Dacanil were unsatisfactory for Typhula snowmold control being no better, statistically, than the check which received no fungicide.

Table 18. SNOW MOLD CONTROL ON PENNCROSS CREEING BENTGRASS.
Boyne Highlands, Michigan

Treatment	Rate (oz./1000 Sq.Ft.)	Time of Application	Percent Snowmold Ave. of 3 Ratings	Multiple Comparison Test
PMAS	2 of 10%	Fall/Spring	3	a
Cadmium	3	Fall	4	a
PMAS	2 of 10%	Fall	4	a
Panogen	3 + 3	Fall/Spring	4	a
Panogen	3	Fall	7	a
Calo-gran	8#	Fall/Spring	8	a
Tersan-om	8 + 3	Fall/Spring	8	a
Calo-clor	4	Fall	8	a
Calo-clor	4 + 4	Fall/Spring	9	a
Calo-gran	8#	Fall	9	a
Cadmium	5	Fall	14	a b
Cadmium	3 + 3	Fall/Spring	15	a b
Dacanil	8	Fall	26	a b c
Dyrene	6 + 4	Fall/Spring	34	b c d
Dacanil	6 + 2	Fall/Spring	41	c d
Dacanil	6	Fall	42	c d
Check	-	-	44	c d
Dacanil	8 + 3	Fall/Spring	48	d

F-4. NEMATODES EFFECTS IN SOD PRODUCTION - R. Itam and J. A. Knierim.

Fourteen genera of plant nematodes were observed for occurrence and vertical distribution in Merion grass grown on organic soil. The effect of sod heating on 6 of these was studied at 3 ranges of temperature namely: 60-104°F for 37 hours; 60-114° F for 50 hours; 68-117°F for 36 hours. Comparisons of extraction techniques and nematode occurrence in organic and mineral sod were also studied.

Merion Kentucky bluegrass sod grown on mineral soil contained larger numbers of genera and individual tylenchid nematodes than in sod raised on organic soil. Heat acculuation in Merion sod stacks to 115°F or higher signified the maturation within the stacks of conditions lethal to most of the associated tylenchid nematodes, including Aphelenchoides sp., Aphelenchus sp., Ditylenchus sp,, and Tylenchus sp. Populations of Pratylenchus and pre-adult paratylenchus survived Merion sod heating beyond 115°F.

These findings indicate that practically all tylenchid nematodes shipped in organic Merion sod would survive the heat development in the sod stacks during the first day of shipment. As the stack period exceeded 24 hours and the temperature rose above 104°F, the effect of "sod-heating" would become increasingly harmful to both the nematodes and the grass. A more precise knowledge of nematode species involved and heat development within sod stacks is needed before the necessity of control measures can be assessed.

G-1. ROADSIDE ESTABLISHMENT - D. P. Martin, J. Kaufman and J. B. Beard.

Most of the research work done on roadside establishment involved investigations conducted on sand slopes. Studies of specific interest are those of seedbed preparation and seed mixtures comparisons.

On the sandy soil at the Marshall plots, the incorporation of a two-inch layer of topsoil was very beneficial. Various other methods of preparation showed little effect with the exception that better seedbed preparation resulted in improved establishment.

The presence of cereal grains in the seed mixture, resulted in a definite increase in perennial grass establishment on a sandy site. The deciding factors involved were the amount of cereal grain present in the mixture and the sandy soil site. A new study initiated in the fall of 1968, including various rates of cereal grain in the seed mixture, was established on a level sandy site. A second phase of this study will involve the using of various rates of a spring cereal grain in a spring seeding.

A new plot area was established at the MSU campus on September 12, 1968. The five areas of investigation are: (1) seedbed preparation, (2) seeding rates, (3) fertilizer placement, (4) seeding methods, and (5) date of seeding. Observations and ratings will be made during the 1969 growing season.

On June 5, 1968, a project was initiated on established roadside turf through the application of chemical growth retardants. Evaluations throughout the summer indicated that there was some seed head inhibition, and very little vegetative growth retardation of the perennial grasses. In 1969 a more exhaustive study will be conducted, including a few new chemicals and variations in rates of application.

In addition to the projects already mentioned, ratings will be continued throughout the growing season at Marshall, at the campus plots, and at the proposed growth retardant plots. Dates of seeding will be continued at the campus site throughout the entire 1969 season.

G-2. ROOTING OF KENTUCKY BLUEGRASS SOD GROWN ON MINERAL AND ORGANIC SOIL - J. B. Beard and W. E. Eaton.

The vertical sod lifting technique is being utilized to evaluate the rooting of mineral and organic grown sod over a duration of two years. A set of sod treatments are lifted at 15 day intervals throughout the growing season. Through the first one-fourth of the experimental period there have been no significant differences between the two treatments.

G-2. ESTABLISHMENT - SODDING - P. E. Rieke and R. Carrow.

In a sod rooting study concerning nitrogen and phosphorus seedbed fertilization, maximum root production occurred when one pound of nitrogen and two pounds of P_2O_5 were applied. Application rates above and below these caused decreased root counts.

G-3. A TECHNIQUE TO MEASURE SOD STRENGTH FOR USE IN SOD PRODUCTION STUDIES - P. E. Rieke, J. B. Beard and C. M. Hansen.

In studying the effects of management practices on sod production an objective means for measuring sod strength has been needed. The extent of root and rhizome growth determines whether sod is ready to be harvested. A device was constructed to obtain an estimate of the contribution of roots and rhizomes to sod strength by determining the weight required to tear a piece of sod 40 cm. wide. One-half of the sod piece is clamped on a stationary playform; the other portion on a portable platform which is attached by a cable to a metal container. Silica sand is added to the container at a constant rate to provide a uniform increase in stress. Sod strength is recorded as the weight required to tear the sod piece at the interface between the platforms. The sod must be cut at a uniform depth for consistent results. Good correlation was found between sod strength measurements and root and rhizome weights as influenced by nitrogen treatments. In evaluation of selected species and varieties for sod production, consistent differences in sod strength were observed ranging from 15 to 40 kg. This technique provides a useful research tool for evaluating management factors in sod production.

G-3. GRASS MIXTURES FOR SOD PRODUCTION - J. B. Beard.

A sod strength measuring apparatus was used to evaluate the comparative sod strengths of ten different Pennlawn red fescue - Merion Kentucky bluegrass mixtures. Based on one year's data, as little as 30% Merion was sufficient to provide adequate sod strength of young sods (Table 19). More mature stands decline substantially in sod strength. This study is now being repeated.

Table 19. COMPARATIVE SOD STRENGTHS OF CERTAIN SELECTED KENTUCKY BLUEGRASS--RED FESCUE MIXTURES.

Mixture (Percent composition) (on a seed number basis)		Sod strength (pounds to tear sod)	
Merion	Pennlawn	5 months*	17 months**
100		93	99
30	70	91	76
20	80	90	71
10	90	66	69
	100	59	38

* Planted June 2, 1967
**Planted May 25, 1966

G-3. EFFECT OF NITROGEN FERTILIZATION ON SOD PRODUCTION - P. E. Rieke.

Rhizomes were removed from plugs obtained from the 0, 30, and 60 pound-treated plots in May, 1968. Maximum numbers of rhizomes, length of rhizomes and weight of rhizomes resulted from the 30 pound treatment. Lowest values in each case occurred in plugs from the 60 pound treatment (Table 20). The sod strength determinations give a good indication of the degree of root and rhizome development.

Table 20. EFFECT OF NITROGEN ON SOD STRENGTH OF MERION AND ON ROOT AND RHIZOME WEIGHTS (HOUGHTON MUCK).*

Pounds Nitrogen per acre per mo.	Sod Strength (pounds) 10/67	9/68	Roots and** rhizomes (gm)	Rhizomes*** (gm)
0	31.9	114.1	1.38	0.23
15	57.8	134.0	1.67	0.37
30	64.7	114.8	1.20	0.25
45	59.3	113.0	1.05	0.16
60	65.7	88.1	0.87	0.12
LSD (.05)	16.3	34.9		

* Seeded 5/12/67
** In 144 sq. in., 7/68
***In 13.6 sq. in., 9/68.

G-3. SOD PRODUCTION RESEARCH - J. B. Beard, P. E. Rieke and K. T. Payne.

Two acres of experiments on various phases of sod production were established at the M.S.U. Muck Experimental Farm in August of 1968. Studies underway include:

(a) Evaluating rate of sod formation of 36 Kentucky bluegrasses.
(b) Shade mixture studies.
(c) Bluegrass blend evaluations.
(d) Nitrogen rates and time of application.
(e) Dates of seeding.
(f) Mowing height and frequency.
(g) Subsidence rate under sod production.
(h) Wind erosion control.

Most of the experiments will be evaluated using the Michigan sod strength technique.

G-4. MECHANISM OF SOD HEATING IN SHIPMENT - J. W. King and J. B. Beard.

A technique has been developed for duplicating the sod heating process under experimental conditions using 2 x 2 x 3 foot insulated boxes. The amount of pressure applied to a sod stack was found to be an important factor in duplicating the heating process. The technique also involves the recording of temperatures at various locations in the sod stack as well as the periodic collection of gas samples. Sod kill is observed at between 102 and 104°F and occurs within 24 to 48 hours. Cultural factors which are being studied in relation to the rate of heating include nitrogen nutritional level, moisture content, cutting height, and clipping removal. Height of cut has been one of the major factors based on one year's data.

H-1. TURFGRASS EXTENSION REPORT _ D. P. Martin and J. B. Beard.

A three-quarter time graduate assistant position was established in the Department of Crop Science at Michigan State University in January of 1968, to assist in turfgrass extension responsibilities. The primary responsibility is to advise professional turfmen, teach extension classes, and coordinate the writing and publication of several lawn bulletins. Currently plans are to publish five bulletins including (1) Lawn Establighment, (2) Lawn Maintenance, (3) Weed Identification and Control, (4) Lawn Diseases and Insects, and (5) Sod Production, The first two will be available in the spring of 1969.

The biennial Northern Michigan Turfgrass Field Day was held September 4, 1968, at Traverse City, Michigan. There were 240 professional turfmen from the northern part of the state in attendance. Activities included viewing of the experimental plots, equipment demonstrations, and a series of research reports.

The 39th Annual Michigan Turfgrass Conference held on March 12-13, 1969, was attended by over 475 professional turfmen. Visiting university professors appearing on the program were Dr. Reed Funk, Rutgers University, and Dr. Ray Keen, Kansas State University. In addition to the M.S.U. turfgrass research reports, topics emphasized included (a) labor costs and management, and (b) turfgrass varieties, improvement and community ecology. The 40th Annual Michigan Turfgrass Conference is scheduled for January 27-28, 1970, at the Kellogg Center on the M.S.U. campus.

The Annual Michigan Turfgrass Field Day has been scheduled for East Lansing on Thursday, September 4, 1969. The experimental area was completely reestablished last fall so many new experiments will be available for viewing. We are

also planning a new venture, a Sod Producers Field Day at the M.S.U. Muck Experimental Farm northeast of East Lansing. This is scheduled for Wednesday, September 10, 1969. Sod growers will have an opportunity to observe rate 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 will also be discussed.

H-2a. TWO YEAR TURFGRASS MANAGEMENT TECHNICAL TRAINING PROGRAM - J. W. King.

The two-year Turfgrass Management Technical Training Program was initiated at Michigan State University in the fall of 1966. The M.S.U. program is the fourth comparable program to be offered by land-grant universities. The demand for graduates and student trainees exceeds the supply.

The program begins in the fall with two terms of classroom technical training. From late March to mid-September the students are employed in the student placement training program at a golf course, sod farm, or other turfgrass facility. The students return to campus for two more terms of course work. The academic training includes basic chemistry, botany, mathematics, and English courses. Technical courses in turfgrass management, soil fertility, irrigation and drainage, ornamental horticulture, landscaping, insects, pests, plant diseases, landscape equipment, and small engines comprise the major part of the program. Courses in accounting, small business management, and personnel practices are required . Further training in business and humanities can be obtained by electing courses in salesmanship, financial credit and practices, business law, and psychology. The course fee for each term on campus is $184 for Michigan residents ($420 for non-Michigan residents). Room and board is $315 per term.

Growth of the program has been rapid. Six were graduated in March, 1968. Sixteen were graduated in March, 1969. Twenty-eight students are on placement training this season. Forth or more new students are expected next fall. A wide and varied program for informing prospective students of the program is in progress. Nevertheless, a majority of the students learned of the program and were encouraged to enroll by their golf course superintendent employers. More than 90% of the students plan to become golf course superintendents, but interest in sod farming and lawn care businesses is increasing. The average age of 1st year students was 19.2 years. About one-third were from out of Michigan. Graduates are well qualified to assume the responsibilities of assistant golf course superintendents; some have positions as superintendents of small golf courses. The average starting salary of graduates is $7,500. For further information contact Mr. John King, Department of Crop Science, Michigan State University, East Lansing, Michigan 48823.

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

A four year undergraduate cirriculum leading to a BS degree in turfgrass management was initiated 3 years ago at Michigan State University. Eighteen students are now enrolled in this program. Three were graduated in 1968.

Graduate study is offered at the MS and Ph.D. level in all phases of turfgrass science. Turfgrass students enrolled for graduate study during 1968 were as follows: (Table 21)

Name	Appointment	BS Degree (from)
Carrow, R.	1/2 - Soils	Michigan State University
Coleman, R.	1/2 - Soils	Texas A & M University
Kaufmann, J.	3/4 - Roadsides	Goshen College
King, J.	3/4 - Teaching	Purdue University
Martin, D.	3/4 - Extension	Goshen College
Rahling, B.	3/4 - Extension	Oklahoma State University
Shearman, B.	1/2 - Physiology	Oregon State University
Stoin, H.	1/2 - Physiology	Ohio State University
Turgeon, A.	3/4 - Weeds	Rutgers University
Vallieu, K.	1/2 - Physiology	Michigan State University

MSU TURFGRASS STUDIES IN PROGRESS OR PLANNED FOR 1969

A-1. TURFGRASS BREEDING PROGRAM - K. T. Payne.

The red fescue breeding program has been expanded. Primary goals are the development of shade tolerant, leaf spot and drought resistant varieties with a more vigorous creeping habit. At present the sod industry is in need of such a variety. Several lines of Festuca elatior have been isolated that have excellent winterhardiness and turfgrass quality. Additional evaluation of these will be made and seed increase will be initiated for the most promising. A breeding program for the improvement of bentgrass is being established. While strains having potential use on greens will not be ignored, the main emphasis will be toward bentgrasses needed for other areas such as fairways or tees and high quality lawns.

A and B. UPPER PENINSULA TURFGRASS INVESTIGATIONS - D. R. Christensen, D. J. Reid, P. E. Rieke, and J. B. Beard.

Bluegrass, red fescue, ryegrass and tall fescue variety, mixture, and cultural studies; plus nitrogen rate, carrier and frequency of application investigations being conducted at Iron Mountain, Michigan. Soil on the site is a loamy sand. All studies are being maintained under irrigated and non-irrigated conditions.

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

Laboratory measurements of infiltration, moisture tension curves and compaction are continuing on soil cores removed from 24 soil mix plots maintained under field conditions for eight years.

B-4b. PLANT NUTRIENT REMOVAL STUDY - J. B. Beard and P. E. Rieke.

The total leaf production of Toronto creeping bentgrass, common Kentucky bluegrass, and Pennlawn red fescue has been collected and is being analyzed for both major and minor essential element content. The leaf tissue collected over a three year period is now being analyzed.

B-4b. MANAGEMENT REQUIREMENTS OF THE MSU RED FESCUE POLYCROSS - P. E. Rieke.

A study of the cutting height and nutritional requirements of Wintergreen red fescue is being conducted.

B-4c. NITROGEN-POTASSIUM FERTILITY STUDIES - J. B. Beard and P. E. Rieke.

Nitrogen rates of 0, 4, 8, 12 and 16 pounds per 1000 square feet per year and potassium rates of 0, 2, 4, 6 and 8 pounds are being applied in all combinations to Toronto creeping bentgrass and Kentucky bluegrass. Objectives of this study are to evaluate the effects of these treatments on low temperature survival, wear tolerance, and turfgrass quality.

C-3. THE ECOLOGY OF ANNUAL BLUEGRASS GROWTH AND DEVELOPMENT - J. B. Beard.

The optimum, minimum and maximum levels of various environmental and soil factors on the growth and developments of annual bluegrass are being studied. Also, of concern is the hereditary variability in terms of growth habit and life cycle.

D-2a. METABOLIC MECHANISMS OF HIGH TEMPERATURE GROWTH STOPPAGE - J. Kaufman and J. B. Beard.

Potential blockages in nitrogen metabolism are being investigated in relation to the high temperature growth stoppage of cool season turfgrasses. The temperature activity curves of certain key enzymes are being studied as is the effect of physiological preconditioning.

D-2b. MANAGEMENT FACTORS IN WINTERKILL - J. B. Beard, P. E. Rieke and W. E. Eaton.

The influence of various types of nitrogen carriers, nitrogen rates, time of nitrogen application and potassium level on low temperature kill of turfgrasses. The effects of cutting height and thatch are also being studied.

E-3. THATCH FORMATION STUDIES - J. B. Beard.

A continuing long term study of culture factors involved in thatch formation of Merion Kentucky bluegrass. A management system is desired which will minimize thatch build-up and the associated disease problems. Factors under evaluation include height of cut (2.5 vs 5 cm.); clipping return vs. removal;

mechanical thatch removal vs. none; and seven nitrogen fertilization rates compared in all possible combinations. The study was initiated in 1962 with data collection continuing.

F-1a. EFFECTS OF HERBICIDE COMBINATIONS ON BROADLEAVED WEEDS - A. J. Turgeon and W. F. Meggitt.

Several herbicide combinations including 2,4-D, silvex, MCPP, and dicamba will be applied to a number of broad-leaved weeds common to Michigan. Attention will also be given to pre-establishment control of broad-leaved weeds, particularly in sod fields.

F-1b. EFFECT OF PRE-EMERGENCE HERBICIDES ON DESIRABLE TURFGRASS SPECIES - W. F. Meggitt and J. B. Beard.

Ten pre-emergence herbicides were applied to two year old sods of Merion Kentucky bluegrass, common Kentucky bluegrass and Pennlawn creeping red fescue in May, 1964. In 1965 a second treatment was applied to those treated in 1964 and additional plots were established to provide single treatments in 1965. The objective of this study is to evaluate the effects of these herbicides on desirable turf grasses. These studies include treatments made in a single year as well as repeated applications in subsequent years. Of concern is the immediate effects of these materials, and the ultimate effect on density of desirable species.

F-2a. RESISTANCE OF HELMINTHOSPORIUM KEAF SOIT - J. Vargas and K. T. Payne.

An attempt will be made to determine the inoculum concentration and environmental condition necessary to separate resistant lines of red fescue from susceptible lines to Helminthosporium leaf spot in the greenhouse.

F-2a. CAUSES OF FUSARIUM BLIGHT - J. Vargas.

The development of Fusarium blight in relation to environmental conditions preceding disease development and condition of turf in which it occurs. Attempts will be made to reproduce the typical symptoms in the field by inoculating them with virulent strains of Fusarium tricinctum.

F-2b. THE CONTROL OF FUSARIUM BLIGHT - J. Vargas and A. Andersen.

Chemical studies will be run in an attempt to find a fungicide which will control Fusarium blight.

F-2b. NUTRITIONAL EFFECTS ON THE DEVELOPMENT OF FUSARIUM BLIGHT - J. Vargas and P. Rieke.

The effect of nitrogen on Fusarium blight development at high and low pH and in relation to phosphorus and potassium levels will be investigated.

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4. Stoin, H. B. 1968. Effects of nitrogen nutrition and temperature on the growth, carbohydrate content, and nitrogen metabolism of cool season grasses. Ph.D. Thesis, Michigan State University. pp. 1-61.

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1. Anonymous. 1969. Lawn Weed Control. Extension Bulletin E-653.

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