1966 TURFGRASS RESEARCH SUMMARY

MICHIGAN STATE UNIVERSITY

Prepared by
James B. Beard

Department of Crop Science

and

Paul E. Rieke

Department of Soil Science

A. TURFGRASS EVALUATION, DEVELOPMENT, AND BREEDING

Bluegrass, red fescue, tall fescue, ryegrass (4 cm. cut) and bentgrass (0.65 cm. cut) evaluations have been in progress 4.5 years at East Lansing, and 3.5 years at Traverse City on 91% sand. Specific data will be presented for the 1965 year plus general observations for 1966.

A-1a. BLUEGRASS VARIETY EVALUATIONS - James B. Beard.

East Lansing - A severe leafspot attack occurred in mid May, 1965. The comparative degree of thinning of 17 Kentucky bluegrass varieties is shown in Table 1. During 1965 Merion ranked first in overall turf quality. Also, ranking high were Cougar, 16-F, Newport and K5(47).

Table 1. 1965 BLUEGRASS VARIETY EVALUATIONS
East Lansing

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

Variety	Density count 10/7/65 (Shoots per square dm.)	Leafspot thinning (1-least; 9-most)	Quality rating** (1-best; 9-poorest)	Multiple comparison test (Based on quality)
Merion	287	1.8	1.4	a
Cougar	206	3.2	1.7	a
16-F*	205	2.5	1.8	a
Newport	245	3.0	2.0	a b
K5(47)*	301	3.5	2.1	a b
Campus	184	3.0	2.4	b c
Delta	251	4.5	2.7	b c
Delft	191	4.2	2.7	b c
Park	239	4.7	2.7	b c
Prato [2]	363	5.5	3.0	c d
Windsor [2]	225	2.5	3.1	c d
Z.W.B.	264	6.2	3.2	c d
J-0217* [2]	240	2.2	3.3	c d
Common Kentucky	191	5.8	3.8	d e
36622-981* [2]	318	2.0	3.9	d e
Brabantia	279	7.3	4.5	e f
Nu Dwarf [1]	157	6.7	4.7	f
Common Poa trivialis	225	-	5.4	f

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

Initially, Cougar ranked quite low due to severe leafspot susceptibility. However, it has shown progressive improvement through 1966. K5(47) has declined in turf performance in 1965 and 1966 but still ranks well. Prato showed a sharp decrease in quality and leafspot tolerance in 1965 and 1966. Windsor performed much more satisfactorily at 6 pounds of nitrogen per 1,000 sq. ft. than at 4. Brabantia, Nu Dwarf, ZWB, Common, and Prato were quite susceptible to leafspot. Park, Delta and Delft continue to show leafspot susceptibility, but are able to recover from the thinning quite rapidly under southern Michigan conditions. Prato, 36622-981, and K5(47) were superior in density while Common, Delft, Campus and Nu Dwarf were quite low.

Traverse City - No leafspot has been observed at Traverse City during the initial 3.5 years. Ten Kentucky bluegrass varieties are compared in Table 2.

Table 2. 1965 NORTHERN BLUEGRASS VARIETY EVALUATIONS
Traverse City

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

	Density count 9/15/65 (Shoots per square dm.)	Percent low temperature kill 4/20/65	Quality rating* (1-best 9-poorest)	Multiple comparison test (Based on quality)
Cougar	164	5	2.5	a
Merion	138	4	2.9	a
Park	119	6	3.1	a
ZWB	161	8	3.3	a
Common	138	4	3.3	a
Newport	132	3	3.4	a b
Delta	140	8	3.5	a b
K5(47)	144	11	3.6	a b
Campus	105	14	3.9	b
Brabantia	212	46	5.3	b c
Upland Bluegrass	112	23	5.5	c
Canada Bluegrass	101	24	5.9	c
Poa trivialis	51	0	8.7	d

* Average of monthly seasonal ratings

Cougar, Merion, Park, ZWB, and Common ranked as the top five varieties in 1965. Brabantia was definitely inferior at this northern location due primarily to a lack of low temperature tolerance. No significant degree of low temperature kill was noted on the other nine Kentucky bluegrass varieties. Ranking highest in density were Brabantia, Cougar and ZWB. Park, ZWB and Common are ranking much higher in comparison to the East Lansing data. Poa trivialis was severely thinned by heat and desiccation during a two day period in mid-July, between irrigations.

A-1b. FINE-LEAFED FESCUE EVALUATIONS - James B. Beard.

East Lansing - Eighteen fine-leafed fescues are compared in Table 3. A severe, early leafspot attack occurred in mid-June, 1965. The top ranking red fescue varieties were S-59, Highlight, Grand Prairie, MSU-47-Fr and Oase. Illahee, common chewings, common creeping, and SL-3 continue to be inferior. Golfrood, which ranked high in previous years, had a very drastic decrease in turf quality. Of the commercially available varieties, Pennlawn and Rainier ranked highest.

Table 3. 1965 FINE-LEAFED FESCUE VARIETY EVALUATIONS
East Lansing

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

Variety	Density count 10/9/65 (Shoots per squate dm.)	Leafspot thinning 6/15/65 (1-least; 9-most)	Quality rating** (1-best; 9-poorest)	Multiple comparison test (Based on quality)
S-59*	546	2.0	1.6	a
Highlight	445	1.5	1.8	a
Grand Prairie	349	2.2	2.0	a
MSU-47-Fr*	498	2.7	2.0	a
Oase	484	3.5	2.1	a b
Syn B*	313	1.7	2.3	a b
Duraturf	299	3.0	2.5	a b c
Pennlawn	296	3.8	2.6	a b c
Rainier	329	4.2	2.7	a b c
Olds	268	3.2	2.9	b c d
Syn A*	321	2.8	3.1	b c d
Illahee	245	5.8	3.7	c d e
Common Chewings	271	5.0	3.8	d e
Common Creeping	285	5.8	4.0	d e
SL-3*	233	5.7	4.5	e f
Golfrood	428	3.5	5.1	f g
Career Sheeps Fescue	299	5.8	5.3	f g
Hard Fescue	217	8.6	7.5	h

* Experimental selections.
** Average of Monthly Seasonal Ratings.

S-59, MS-47-Fr, Oase, Highlight and Golfrood had a high density. Hard fescue was unsatisfactory under irrigated management and heavier soil conditions.

Traverse City - Thirteen fine-leafed fescues compared on a soil containing 91% sand (Table 4). No leafspot has been observed during the initial 3.5 years at this northern location. Pennlawn has ranked highest of the commercially available varieties in overall quality due primarily to superior tolerance to drought and low temperature kill.

Table 4. 1965 NORTHERN FINE-LEAFED FESCUE VARIETY EVALUATIONS
Traverse City

(5x7' plots; 4 reps.; planted May 18, 1963; loamy sand (91% sand); irrigated; 4 cm. cut)

Variety	Density count 9/15/65 (Shoots per square dm.)	Percent low temperature kill 4/20/65	Quality rating** (1-best; 9-poorest)	Multiple comparison test (Based on quality)
Highlight	212	2	3.9	a
Pennlawn	209	10	4.3	a
Duraturf	157	21	4.4	a b
Syn A*	136	34	4.6	a b
Illahee	146	18	4.8	a b
Common Chewings	167	14	4.9	a b c
Common Creeping	140	40	4.9	a b c
Rainier	138	51	5.2	b c
Syn B*	164	53	5.3	b c
MSU-47-Fr*	161	49	5.4	b c d
Olds	132	66	5.6	b c d
Hard fescue	127	6	6.0	c d e
Career Sheeps fescue	189	11	6.8	e f

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

Highlight ranked highest in quality and low temperature tolerance under irrigated conditions but was unacceptable when not irrigated. On a sandy soil with no leafspot, Illahee ranks higher than Rainier while the opposite was observed at East Lansing. MSU-47-Fr did not perform well in 1965 due to severe low temperature kill. Highlight and Pennlawn had the highest density.

During the 1964-65 winter soil temperatures were low enough for significant low temperature kill data to be taken on the turfgrass varieties at Traverse City. Olds, Syn B, Rainier, MSU-47-Fr, and common creeping had extensive low temperature kill. Showing the best low temperature tolerance were Highlight, hard fescue, Pennlawn, Career sheeps fescue and common chewings red fescue.

This data on red fescue low temperature kill substantiates earlier studies conducted in freezing chambers. It is evident that the red fescues have a surprising lack of low temperature tolerance when compared with the creeping bentgrasses and Kentucky bluegrasses. In red fescue selection and breeding programs for northern locations, low temperature hardiness is a characteristic which must be improved.

A-1c. BENTGRASS VARIETY EVALUATIONS - James B. Beard.

East Lansing - Fourteen bentgrass varieties (Table 5) and seven selections (Table 6) maintained under putting green conditions. Except for gray snow mold, no diseases were observed and no preventative fungicide program followed.

Table 5. 1965 BENTGRASS VARIETY EVALUATIONS
East Lansing

(10x16' plots; 3 reps.; planted Oct. 25, 1961; loamy sand; irrigated; 6.5 mm.cut)

Variety	Density count 10/15/65 (Shoots per square dm.)	Depth of thatch (cm.)	Quality rating* (1-best; 9-poorest)	Multiple comparison test (Based on quality)
Toronto	1808	4.9	1.6	a
Pennlu	1483	4.7	1.9	a
Iowa K-13	1475	6.1	2.0	a
Cohansey	1137	4.6	2.1	a b
Congressional	1798	4.2	2.1	a b
Penncross	1364	5.1	2.2	a b
C-1 + C-19	1563	5.5	2.4	a b
Old Orchard	1258	3.7	2.5	a b
Seaside	1250	3.2	2.7	a b c
Arlington	1367	4.2	2.7	a b c
Evansville	1811	6.8	3.5	c d
Nimisilla	1124	3.1	4.1	d e
Astoria	881	3.8	4.8	e
Washington	1036	4.7	5.3	e

* Average of monthly seasonal ratings.

Toronto, Pennlu and Iowa K-13 rank highest in turf quality in 1965 followed by Cohansey, Congressional and Penncross, in that order. Washington, Astoria and Nimisilla were unacceptable.

Thatch measurement taken after four years showed Evansville, and Iowa K-13 with objectionable levels of thatch accumulation. Penncross and Toronto are vigorous varieties which have a greater thatching tendency if not managed properly.

Table 6. 1965 BENTGRASS SELECTION EVALUATION
East Lansing

(4x4' plots; 3 reps.; planted Aug. 2, 1962; loamy sand; irrigated; 6.5 cm. cut)

Variety	Density count 10/17/65 (Shoots per square dm.)	Quality rating*** (1-best; 9-poorest)	Multiple comparison test (Based on quality)
MSU-24-Ap	889	1.6	a
MSU-28-Ap	977	1.7	a
Pennpar*	775	1.9	a
Springfield*	1307	2.2	a
Holfiar	1106	3.4	b
Exeter*	821	6.1	c
Bore**	450	6.2	c

* Planted July 2, 1963 *** Average of monthly seasonal ratings.

Bentgrass selections showing promise are MSU-24-Ap, MSU-28-Ap, and Pennpar. The density of Pennpar has been low. Exeter and Bore have been unsatisfactory, with considerable difficulty experienced in establishment.

Traverse City - Seven newly established bentgrass varieties showed significant differentials in susceptibility to gray snow mold (Typhula itoana) (Table 7). No snow mold fungicide has been previously applied to the area.

Table 7. GRAY SNOW MOLD SUSCEPTIBILITY OF BENTGRASS VARIETIES
Traverse City

(8x12' plots; 3 reps.; planted Aug. 18, 1964; loamy sand, irrigated; 6.5 mm. cut)

Variety	Percent killed	Multiple comparison test
Astoria	17	a
Congressional	18	a
Penncross	38	b
Washington	53	b c
Toronto	60	c
Seaside	73	d
Cohansey	75	d

Astoria and Congressional showed the least snow mold injury, having only 17 and 18 percent injury. Intermediate in snow mold susceptibility were Penncross, Washington and Toronto, with Seaside and Cohansey showing the greatest susceptibility. None of the varieties had total resistance to snow mold.

Through 1966 Toronto, Congressional and Penncross have ranked high in terms of overall seasonal quality. Astoria, Seaside, Washington, and Holfiar have not shown adequate density and uniformity.

A-1d. RYEGRASS AND TALL FESCUE VARIETY EVALUATIONS - James B. Beard

East Lansing - Six ryegrasses, six tall fescues and four other grasses are under evaluation (Table 8). Norlea continues as the outstanding ryegrass in terms of turf quality. Viris and Norlea have the best low temperature hardiness. Common perennial is definitely inferior to the five ryegrass selections tested.

Table 8. 1965 MISCELLANEOUS VARIETY EVALUATION
East Lansing

(5x9' plots; 3 reps.; planted July 10, 1962; sandy loam; irrigated; 4 cm. cut)

Variety	Density count 10/12/65 (Shoots per square dm.)	Percent winter-kill 4/20/65	Quality rating** (1-best; 9-poorest)	Multiple comparison test (Based on quality)
		Perennial Ryegrass		
Norlea	147	8	2.2	a
S-23	197	45	2.8	a b
Sceempter*	153	16	2.9	a b
Pelo	209	32	3.0	a b
Viris*	184	3	3.1	b
Common	200	53	4.4	c
		Tall Fescue		
MSU-4-Fe	164	18	1.7	a
Syn A	122	13	2.4	a
Kentucky 31	102	17	2.7	a b
Alta	101	10	3.5	b c d
Backafall*	107	8	4.1	c d e
S-170	144	18	4.5	d e
		Others		
Evergreen Timothy*	231	0	2.6	a
Redtop	236	50	3.0	a
Upland Bluegrass	233	10	3.2	a b
Canada Bluegrass	305	3	4.0	b

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

Kentucky 31 continues to rank higher than Alta through 1965. The MSU-4-Fe and Syn A selections rank highest in quality.

Evergreen timothy has shown good turf quality, density and winter hardiness through the first two years. The quality declines during high temperature periods. It shows promise for the cool, wet soils of northern Michigan, particularly under close cutting. Draylar upland bluegrass ranks better than Canada bluegrass.

Traverse City - Tall fescue evaluations at Traverse City show MSU-4-Fe to rank highest, with Kentucky 31 ranking better than Alta (Table 9).

Table 9. 1965 TALL FESCUE AND RYEGRASS VARIETY EVALUATIONS
Traverse City

(5x7' plots; 4 reps.; planted May 16, 1963; loamy sand (91% sand); irrigated; 4 cm. cut)

Variety	Density count 9/16/65 (Shoots per square dm.)	Percent winter-kill 4/20/65	Quality rating* (1-best; 9-poorest)	Multiple comparison test (Based on quality)
		Tall Fescue		
MSU-4-Fe	64	61.3	4.8	a
Kentucky 31	71	58.8	5.5	a b
Alta	50	58.8	6.4	b
		Perennial Ryegrass		
MSU-21-Lp	104	67.5	7.1	a
Common	79	92.3	8.3	b

* Average of monthly seasonal ratings.

MSU-21-Lp ranks higher than common perennial ryegrass. However, all ryegrasses were unacceptable at this northern location.

A-4a. TURFGRASS DROUGHT TOLERANCE STUDIES - James B. Beard.

Eight Kentucky bluegrass and eight red fescue varieties were planted May 16, 1963, on 91% sand at Traverse City. The plots were irrigated throughout the 1963 and 1964 growing season to insure uniform establishment. During the 1965 season irrigation was withheld. The only water received by the plots was normal rainfall.

Table 10. COMPARATIVE DROUGHT TOLERANCE AND RECOVERY OF EIGHT BLUEGRASS VARIETIES
Traverse City

(5x7' plots; 2 reps.; planted May 16, 1963; loamy sand; 4 cm. cut)

Variety	Drought tolerance 8/19/65*	Drought recovery 9/16/65*
Cougar	4.0	4.0
K 5 (47)	6.3	5.0
Park	7.0	6.0
Merion	7.5	6.3
Delta	7.5	6.5
Common	7.5	6.5
Brabantia	7.5	6.5
Newport	8.0	7.0

* 1-best; 9-poorest.

The comparative drought tolerance of eight Kentucky bluegrass varieties is shown in Table 10. All varieties were severely thinned by mid-August. Cougar, a selection from Washington State, proved to be superior in drought tolerance and recovery. K 5 (47) also ranked well in terms of drought recovery, followed by Park and Merion. Although recognized as a high management grass, Merion did exhibit a fair ability to recover from drought.

All eight red fescue varieties showed a similar degree of browning during peak drought stress (Table 11). However, certain varieties had a much better ability to recover from drought. Outstanding in drought recovery was Pennlawn followed in order by Illahee and Rainier. The other five red fescue varieties were inferior.

Table 11. COMPARATIVE DROUGHT TOLERANCE AND RECOVERY OF EIGHT RED FESCUE VARIETIES
Traverse City

(5x7' plots; 2 reps.; planted May 16, 1963; loamy sand; 4 cm. cut)

Variety	Drought tolerance 8/19/65*	Drought recovery 9/14/65*
Pennlawn	7.0	4.3
Illahee	6.8	5.0
Rainier	6.8	5.3
Common creeping	7.8	6.3
MSU-47-Fr	6.8	6.3
Olds	7.3	6.5
Common chewing's	7.8	6.8
Highlight	8.8	7.3

* 1-best; 9-poorest.

A-4b. TURFGRASS MIXTURE ECOLOGY STUDY ON SANDY SOIL - James B. Beard.

Out of eighteen mixtures most 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 performed poorly throughout 1965 and 1966 (Table 12).

Table 12. PERFORMANCE OF FIVE SELECTED MIXTURES ON SANDY SOIL
Traverse City

(5x7' plots; 4 reps.; planted May 16, 1963; loamy sand (91% sand); irrigated; 4 cm. cut)

	Percent composition on a seed number basis			Turf quality rating (1-best; 9-poorest)		
	Common Kentucky bluegrass	Pennlawn red fescue	Perennial ryegrass	1964*	1965*	Multiple comparison test
1	75	25	-	3.1	3.8	a
2	25	75	-	3.2	3.9	a
3	50	50	-	3.4	4.2	a
4	60	20	20	3.6	7.7	b
5	33	33	33	3.3	8.0	b

* Average of monthly ratings.

The detrimental effects of ryegrass in bluegrass-red fescue mixtures is much more striking in northern Michigan on sandy soils than at East Lansing. The dryer soil conditions favor ryegrass establishment which in turf suppresses the permanent establishment of bluegrass and red fescue seedlings. Under these conditions the resultant composition of the turf is 80 to 95% ryegrass which may subsequently winterkill.

Mixtures containing redtop, roughstalk bluegrass or tall fescue were definitely inferior in turf quality and density.

B-3. EFFECTS OF N AND K NUTRITION ON LOW TEMPERATURE SURVIVAL - James B. Beard and Paul E. Rieke.

Nitrogen rates of 0, 4, 12 and 16 pounds per 1,000 sq. ft. per year and potassium rates of 0, 2, 4, 6 and 8 pounds were applied in all combinations to Toronto creeping bentgrass and common Kentucky bluegrass. After two years under these fertility treatments, the plots were sampled and the grass plugs subjected to low temperatures ranging from -1 to -23°C. No kill of Toronto bentgrass occurred down to -23°C. with any of the fertility treatments.

Common Kentucky bluegrass showed distinct responses. The data indicates that the balance between nitrogen and potassium is most critical in low temperature survival and not just a low nitrogen and high potassium level. Maximum survival at any one nitrogen level occurred at potassium levels one-half to one-third that of nitrogen. Excessive kill occurred at nitrogen feeding levels above 8 pounds. The potassium response to low temperature survival is especially interesting since it occurred at extremely high soil potassium test levels (348 to 683 pounds per acre).

B-1. NITROGEN CARRIER, RATE AND FREQUENCY OF APPLICATION STUDY ON A SANDY SOIL. Paul E. Rieke and James B. Beard.

Pennlawn red fescue, Merion Kentucky bluegrass, and common Kentucky bluegrass plots were established May 16, 1963, on a soil containing 91% sand at Traverse City. Initial fertility treatments were applied May 14, 1964. A basic rate of nitrogen application (referred to as the "X" rate in subsequent data) was selected for each variety and irrigation regime as given in Table 13.

Table 13. BASIC ANNUAL NITROGEN FERTILIZER APPLICATION ("X") IN POUNDS N PER 1000 SQUARE FEET PER YEAR FOR THREE GRASSES AND TWO IRRIGATION REGIMES

	Irrigated	Unirrigated
Pennlawn Red fescue	3	1.5
Common Kentucky bluegrass	4	2
Merion Kentucky bluegrass	8	4

Soluble nitrogen was applied as urea in six monthly applications at annual rates of 0, 1/2X, X, and 1½X as shown in Table 14. Under irrigated conditions on this sandy soil the X and 1½X treatments resulted in similar turf except for common Kentucky bluegrass which showed an increase in quality under the higher nitrogen treatment. Without irrigation the basic "X" rate of application resulted in generally higher quality turf.

Table 14. AVERAGE OF 1965-66 MONTHLY QUALITY RATINGS FOR SOLUBLE NITROGEN TREATMENTS APPLIED AS UREA IN SIX EQUAL APPLICATIONS (1-BEST; 9-POOREST).

	Pennlawn Red fescue		Common Kentucky bluegrass		Merion Kentucky bluegrass	
N rate*	Irr.**	Unirr.**	Irr.	Unirr.	Irr.	Unirr.
0	4.3	6.1	4.4	6.3	4.1	6.3
1/2X	2.3	5.1	2.6	5.3	2.3	5.3
X	1.6	4.5	2.4	4.9	1.3	4.9
1 1/2X	1.5	4.3	1.8	5.3	1.3	5.3

*For basic nitrogen rates, see Table 13.
**Irr.=irrigated; unirr.-unirrigated.

Table 15. AVERAGE OF 1965-66 MONTHLY QUALITY RATINGS AS AFFECTED BY CARRIER AND FREQUENCY OF APPLICATION (1-BEST; 9-POOREST). NITROGEN WAS APPLIED AT THE RATES OUTLINED IN TABLE 13.

		Pennlawn red fescue		Common bluegrass		Merion bluegrass	
Carrier	No. of appl.	Irr.	Unirr.	Irr.	Unirr.	Irr.	Unirr.
Urea	1*	2.8	5.3	3.0	5.7	1.8	4.3
	2	2.6	5.7	2.7	5.3	2.0	5.1
	3	2.2	5.3	2.5	5.0	1.6	4.8
	6	1.6	4.5	2.4	4.9	1.3	4.3
Milorganite	1	1.9	5.1	2.9	5.3	1.8	5.2
	2	2.0	5.1	2.5	4.8	1.7	4.8
	3	1.8	4.8	2.4	5.3	1.4	4.8
Ureaform	1	2.6	5.9	2.7	5.7	1.8	5.3
	2	2.7	6.1	3.0	5.8	2.1	5.8
	3	2.3	5.6	3.0	5.3	1.8	5.3
Coated Urea	1	2.5	5.7	2.6	5.3	1.8	5.2
	2	2.6	5.7	2.6	5.5	2.2	5.0
N-Serve	1	1.8	5.4	2.3	5.3	1.6	5.0
	2	3.0	4.8	2.3	5.0	2.4	5.3
Combination**	4	1.9	5.6	2.1	5.3	1.6	4.8

*For one application, all the nitrogen was applied in April. For multiple applications, the fertilizer was divided into equal portions for each application.
**The combination treatment provided 12% of the nitrogen as urea in April, 56% as ureaform in May, 6% as urea in July and 25% as Milorganite in August.

During the first year of treatments (1964) the 1½X treatments resulted in consistently higher quality turf than the X rates. This may have resulted from the absence of organic matter in the root zone since the topsoil was removed from the site previous to establishment. The increased nitrogen response likely reflected a gradual build-up in organic matter and microorganism populations in the soil during this time.

The effects of nitrogen carrier and number of applications on turf quality are given in Table 15. Although some variability is present it is apparent that multiple applications of all carriers, including ureaform, result in higher quality than single applications. This is especially true for urea (a soluble source) applied at 6 times per year compared to fewer times of application.

The variable turf quality on plots treated with N-Serve reflect its tendency to burn the grass. When no burn effects are present, the turf quality on these plots ranks equal to other treatments. The combination treatment (see footnote, Table 15) has given good results, especially under irrigated conditions.

Irrigation and nitrogen treatments have had marked effects on soil tests on this sandy soil. (Table 16). These plots receive phosphorus and potassium each spring. Under the irrigated treatment potassium is apparently being leached while calcium and magnesium levels increased.

Table 16. EFFECT OF IRRIGATION AND FERTILITY LEVEL ON SOIL TESTS
Traverse City, October, 1966

Treatment	pH	Soil tests in pounds per acre P	K	Ca	Mg
Unirrigated Merion	6.4	130	256	1629	59
Irrigated Merion	7.2	88	87	2392	171
Irrigated Red Fescue	7.3	115	100	2351	168

B-2. EFFECT OF FERTILIZER PLACEMENT ON GRASS GERMINATION - Paul E. Rieke.

Nitrogen (ammonium nitrate), phosphorus (0-20-0), and potassium (potassium chloride) were added to the soil at the rates and placements shown. "Surface" applied fertilizer was placed on the soil surface with the seed and scratched into the soil to no more than one-quarter inch. The "mixed" treatments were worked into the soil to a 2-inch depth followed by seeding. Merion bluegrass was seeded at one pound per 1000 square feet. The data shown are an average of 3 replications. (Table 17).

Table 17. EFFECT OF FERTILIZER PLACEMENT ON GERMINATION OF MERION BLUEGRASS IN THE GREENHOUSE (CONOVER LOAM)

# Nutrient per 1,000 sq. ft.	Fertilizer Placement	Number of Viable Shoots				
		Nitrogen		Phosphorus	Potassium	
		10 days	30 days	20 days	10 days	30 days
Check	-	96	153	146	88	140
1	Surface	94	139	120	90	139
2	Surface	90	134	30	97	143
1	Mixed	118	159	185	105	145
2	Mixed	115	159	143	89	129
4	Mixed	99	148	114	96	138
6	Mixed	107	148	113	96	128
8	Mixed	69	122	42	71	112
20	Mixed	29	57	10	60	84

The effect of phosphorus placed on the surface was particularly effective in reducing germination. Phosphorus treatments were repeated on Conover loam and Houghton muck as outlined in Table 18.

Table 18. EFFECT OF PHOSPHORUS PLACEMENT ON GERMINATION OF MERION BLUEGRASS IN THE GREENHOUSE

Treatment Pounds/1000 square feet	Fertilizer Placement	Number of Viable Shoots					
		Houghton muck			Conover loam		
		10 days	15 days	30 days	10 days	15 days	30 days
Check		104	177	238	60	149	223
1	Surface	47	119	135	54	118	126
2	Surface	8	58	50	17	65	38
1	Mixed	68	150	187	86	149	193
2	Mixed	51	138	145	82	142	165
4	Mixed	13	70	53	67	125	100
6	Mixed	2	31	13	17	55	40
8	Mixed	1	37	13	31	56	32

Nitrogen and potassium treatments were repeated and effects were not apparent at moderate application rates. Pennlawn Red Fescue was less affected by the presence of phosphorus than Merion bluegrass.

A field plot was established in the fall of 1965 comparing fertilizer placements and rates on germination of Merion bluegrass. Percent cover was estimated in July, 1966. When phosphorus was applied on the surface at 2 1/2 or 5 pounds of P per 1,000 square feet, a 10-20% reduction in percent cover resulted. Nitrogen and potash did not affect germination and establishment under these conditions.

C-2b. SNOW MOLD FUNGICIDE - FERTILITY INTERACTION STUDY - James B. Beard

Studies were conducted during the winters of 1963-64 and 1964-65 at Traverse City. The interrelationships of six fungicides and six fertility treatments in the control of Typhula snow mold on creeping bentgrass and annual bluegrass were investigated. Calo-Clor, Calo-Gran, and the Calo-Clor-Milorganite dry blend gave control superior to Tersan-OM and Dyrene. Dyrene gave unsatisfactory control. No effect of fertility on snow mold incidence was found, due possibly to the severity of snow mold which overshadowed nutritional effects. Time of fungicide application studies emphasize the importance of a fall treatment. Where the fall application was missed a 45 percent reduction in snow mold control occurred.

D-1a. MOWER INVESTIGATIONS - James 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 four years with the rotary mowed plots having a browned appearance for 3 to 4 days after mowing, particularly during active growth periods in late fall. Significant differences have not been found in density. This is a joint study with Ohio State University.

D-1b. CUTTING HEIGHT EFFECTS ON LOW TEMPERATURE SURVIVAL - James B. Beard.

Common Kentucky bluegrass, maintained at cutting heights of 1.3, 2.6, 3.9 and 5.2 cm. for 3 years, was subjected to low temperatures ranging from -1 to -23°C. No significant difference in kill was observed at the 5.2 and 3.9 cm. cutting heights. A very sharp increase in kill occurred at cutting heights below 3.9 cm. The increase in kill was the greatest between 3.9 and 2.6 cm. with a further small increase between 2.6 and 1.3 cm. On Kentucky bluegrass, a cutting height of 3.9 cm. or higher may reduce the chance of low temperature kill.

D-5a. CAUSAL FACTORS IN HIGH TEMPERATURE GROWTH STOPPAGE OF GRASSES - Harlan R. Stoin and James B. Beard.

The changes in the content and composition of the soluble nitrogen fraction of Kentucky bluegrass were studied in controlled environment chambers. Temperature variables were 21 and 35°C with a 16 hour day and a common 16°C night temperature. After 6 days, high temperature resulted in a 23% increase in total soluble nitrogen, an increase in the proportion of amides to free amino acids, and increased ammonia. Aspartic and Glutamic acids decreased at 35°C while asparagine showed an eleven-fold increase. Glycine, alanine, valune, isoleucine, and lysine increased at 35°C. Glutamine, leucine, and proline were highly variable. Cystine, methioning, phenylalanine, tyrosine, histidine, arginine, tryptophan, and hydroxproline were not found in measurable quantities.

D-5b. EFFECT OF WIND AND SYRINGING ON THE TURF MICROENVIRONMENT - Thomas Duff and James B. Beard.

Microenvironment studies show an air movement of 4 mph lowered the turf mat temperature a maximum of 7°C, in comparison to an adjacent site where movement was restricted. Five cm. soil temperatures were 5.5°C cooler due to a 4 mph wind. The relative humidity at 7.5 cm. above ground was unchanged.

A mid-day syringing with 64 mm. of water lowered the turf mat and 5 cm. soil temperature 1 to 2°C. This cooling effect lasted less than 2 hours. Although the degree of temperature reduction was small, the maximum temperature reached on unsyringed plots was much higher; thus giving significant cooling. See literature citation on page 19.

D-5c. CHARACTERIZATION OF DROUGHT VS. HEAT EFFECTS - James E. Fischer, James B. Beard, Robert Olien and Earl Erickson.

A wind tunnel technique has been developed to distinguish heat stress from moisture stress; thus permitting the characterizing of factors causing drought or summer dormancy in turfgrass. Creeping bentgrass, Kentucky bluegrass, red fescue and annual bluegrass are being studied. Detailed studies with annual bluegrass show high temperature kill at 40°C in a near saturated atmosphere. This is a surprisingly low killing temperature.

D-5d. WINTERKILL INVESTIGATIONS - James B. Beard.

Studies of the winterkill causes are continuing as well as management practices to reduce injury. Data on the relative low temperature hardiness of nineteen turfgrasses has been published. See literature citation on page 19. Recent studies where grass plants were sealed in glass jars for 160 days at 4°C showed no injury of Toronto creeping bentgrass while annual bluegrass was killed after 90 days.

E-1. MIXTURES STUDIES FOR MICHIGAN ROADSIDES - James B. Beard.

Roadside turfgrass mixture studies show the six top ranking mixtures to contain predominantly Kentucky bluegrass, creeping red fescue and perennial ryegrass. The data indicate a minimum of 20% (by seed number) of each of the three species is required. On the alkaline soil, ryegrass was superior to redtop. Such species as smooth bromegrass, orchardgrass, bentgrass, alfalfa, white clover, vetch and roughstalk bluegrass made no significant contribution to the mixtures. Mixtures containing tall fescue ranked above average but below the bluegrass-red fescue-ryegrass combinations. The use of cereal rye lowered density, soil stabilization and overall turf quality.

E-4a. MULCH EVALUATION STUDIES - James B. Beard.

Three studies on mulches for roadside establishment are complete and published. See publication citations on page 19.

OTHER TURFGRASS RESEARCH CURRENTLY IN PROGRESS

A-4. RED FESCUE BREEDING AND SELECTION - Kenyon T. Payne.

Special emphasis is being placed on the development of improved red fescue varieties for sod production, sandy soils, and shaded environments. Key characteristics desired are vigorous rhizome production and leafspot resistance.

B-3. NITROGEN-POTASSIUM FERTILITY STUDIES - James B. Beard and Paul 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 common Kentucky bluegrass. Objectives of this study are to evaluate the effects of these treatments on low temperature survival, wear tolerance, and turf quality.

B-4a. PLANT NUTRIENT REMOVAL STUDY - James B. Beard and Paul E. Rieke.

The total leaf production of Toronto creeping bentgrass, common Kentucky bluegrass, and Pennlawn red fescue has been collected and analyzed for both major and minor essential element content. The study has been underway two full growing seasons. The data is in the final stages of processing.

B-4b. EFFECT OF SELECTED PESTICIDES ON AVAILABILITY OF NITROGEN FROM NITROGENOUS FERTILIZERS - James Timmerman and Paul E. Rieke.

Effects are being studied under both greenhouse and field conditions.

C-2a. EFFECT OF PRE-EMERGENCE HERBICIDES ON DESIRABLE TURFGRASS SPECIES - William F. Meggitt and James 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 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.

D-3a. THATCH FORMATION STUDIES - James B. Beard.

A continuing study of management factors involved in thatch formation.

D-4. MANAGEMENT REQUIREMENTS OF THE MSU RED FESCUE POLYCROSS - Paul E. Rieke.

A study of the cutting height and nutritional requirements of an improved red fescue polycross.

D-5. CAUSAL FACTORS IN HIGH TEMPERATURES GROWTH STOPPAGE OF GRASSES - Thomas Duff, Harlan Stoin and James B. Beard.

Two phases of this study are now underway: a. Investigation of photosynthetic and respiration rates of creeping bentgrass at supra-optimal temperatures and the relationship of these rates to plant carbohydrate levels. b. Effect of high temperatures on nitrogen metabolic pathways. Specifically included are the keto-acids and amino acids such as glutamic acid, aspartic acid, and arginine.

D-6. FLOODING-TEMPERATURE INTERACTION STUDIES - James B. Beard and David Martin.

Effect of extended flooding at 10, 20 and 30°C on four turfgrasses: Merion Kentucky bluegrass, Toronto creeping bentgrass, Pennlawn red fescue, and annual bluegrass. The mechanism of kill is being investigated.

D-7. SOIL MIXTURES FOR GREENS - Paul E. Rieke.

Continuation of study on plots now established. The importance of the size range of sand is being investigated in the laboratory.

D-8. SOD PRODUCTION STUDIES ON ORGANIC AND MINERAL SOILS - James B. Beard, Paul E. Rieke and John King.

N, P, and K. requirements and cutting height effects in relation to development of sod. Frequency and rate of nitrogen application, and the height of cut-nitrogen interaction are under continued investigation. Other investigations include grass mixtures for sod, seed quality, and a comparison of soil removal under sod production versus cropping effects on subsidence. Currently underway are studies on the mechanism and prevention of sod heating in shipment.

D-9. UPPER PENINSULA TURFGRASS INVESTIGATIONS - Donald J. Reid, Donald L. Thurlow, Paul E. Rieke and James B. Beard.

Bluegrass, red fescue, ryegrass and tall fescue variety, mixture, and management studies; plus nitrogen rate, carrier and frequency of application studies 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.

E-4b. HIGHWAY TURF ESTABLISHMENT STUDIES - James E. Fischer, James B. Beard and Paul E. Rieke.

A second three-year study of mulch, turf mixture, and fertilization practices initiated in July of 1966.

RECENT PUBLICATIONS

Technical:

1. Beard, J.B. Direct low temperature injury of nineteen turfgrasses. Quarterly Bulletin of Mich. Agr. Exp. Sta. 48(3):377-383. 1966.

2. Beard, J.B. A comparison of mulches for erosion control and grass establishment on light soil. Quarterly Bulletin of Mich. Agr. Exp. Sta. 48(3):369-376. 1966.

3. Beard, J.B. and Daniel, W.H. Relationship of creeping bentgrass (Agrostis palustris Huds.) Root growth to environmental factors in the field. Agronomy Journal 58:337-339. 1966.

4. Duff, D.T. and Beard, J.B. Effects of air movement and syringing on the microclimate of bentgrass turf. Agronomy Journal 58:495-497. 1966.

General:

1. Beard, J.B. Winter injury. The Golf Superintendent 34(1):24-30. 1966.

2. Beard, J.B. and Rieke, P.E. Michigan Turfgrass Report 3(1):1-15. 1966.

3. Rieke, P.E. Selecting a turf fertilization program. Mimeo pp. 1-6. 1966.

4. Beard, J.B. and Rieke, P.E. Sod production in Michigan. Mimeo pp. 1-7. 1966.

5. Lucas, R.E., Rieke, P.E. and Farnham, R.S. Peats for soil improvement and soil mixes. Michigan Extension Bulletin No. 516. 1966.