SIXTH ANNUAL PROGRESS REPORT

DEVELOPING BROWN PATCH AND PYTHIUM DISEASE RESISTANCE IN BENTGRASS AND ZOYSIAGRASS

submitted by

Dr. Phillip F. Colbaugh
Associate Professor of Plant Pathology

and

Susan P. Metz
Plant Pathology Research Associate

Texas Agricultural Experiment Station - Dallas, Texas
Texas A&M University System

Jointly Sponsored Research By: United States Golf Assoication and the Texas Agricultural Experiment Station.

1 November 1992

USGA TURFGRASS PATHOLOGY RESEARCH

SIXTH ANNUAL PROGRESS REPORT 1992

I N D E X

EXECUTIVE SUMMARY

SIXTH ANNUAL PROGRESS REPORT
November 1992

Dr. Phillip F. Colbaugh

and

Susan P. Metz

USGA research on bentgrass and zoysiagrass resistance to Pythium and Rhizoctonia blight is completing the sixth and final year of study. This report includes unreported research from May to November 1992 and summaries of research from previous reports. Progress during the period between May and November 1992 has centered on assessments of Pythium blight resistance in bentgrass polycross populations; assessments of the Dallas bentgrass germplasm introduction nursery (GPIN) for resistance to Pythium root rot, and the evaluation of the National Turfgrass Evaluation Program (NTEP) bentgrasses and zoysiagrasses for resistance to Rhizoctonia blight.

Current bentgrass research has included the testing of synthetic polycross populations for resistance to Pythium blight. Disease resistant bentgrass progeny lines were identified after inoculating germplasm lines from reciprocal crosses of resistant and susceptible bentgrass parental lines. In two inoculation studies, genetic populations from the B, C, K, and L crossing blocks were more blight resistant than other populations studied. A disease heritability analysis was also conducted which utilized intercrossed 'resistant' and 'susceptible' parental lines and reciprocal cross progeny plants obtained from a Pythium blight resistant N population. The susceptibility of progeny from crosses involving at least one of the 'resistant' parental lines gave an overall mean of 6.9% blight while crosses without a resistant parent gave a 14.3% blight rating. The inheritance of foliar disease resistance appears to be a predictable and stable characteristic based on investigations using crosses of disease resistant bentgrass parental lines. This knowledge will be useful in determining the segregation of disease resistance in future disease screening research.

A root inoculation procedure was used to screen GPIN bentgrass germplasm lines for resistance to Pythium root rot. This method was used to screen over 1550 plants. At present, we are maintaining 123 germplasm lines of bentgrass that appear to have some resistance to Pythium root rot disease. The surviving population represents about 12% of the total plants screened.

Standard inoculation techniques were used to determine the susceptibility of the National Turfgrass Evaluation (NTEP) collection of bentgrass and zoysiagrass to Rhizoctonia and Pythium blight diseases. In repeated Rhizoctonia foliar inoculations, the NTEP bentgrass entry Syn3-88 demonstrated the lowest mean percent blight of the 20 entries tested. The superior germplasm lines Syn3-88, Providence, Penncross and UM8401 were statistically better than National, Forbes and Syn4-88. The NTEP zoysiagrass experimental line Dalz 9006 and commercial cultivar Meyer also

demonstrated a low susceptibility to Rhizoctonia foliar blight following inoculation. Inoculation studies with Pythium blight on NTEP bentgrasses demonstrated Pennlinks, Penncross, National, MSCB-6, SYN3-88 and Cobra to be among the most resistant genotypes. Similar inoculation studies with Pythium blight on 40 zoysiagrasses demonstrated the germplasm lines TAES3357, TAES3365, TAES3356, TAES3364, TAES3358, DALZ8508 and DALZ8517 to be the most resistant of experimental zoysiagrasses tested. The relationship of Rhizoctonia blight susceptibility and leaf blade texture class was investigated. In contrast to other types of grasses, the fine textured zoysiagrass leaf types were less susceptible to foliar blight. Other reports of field data and inoculation results with dollarspot on bentgrasses and zoysiagrass are also included in this report.

I. Introduction:

The Texas Agricultural Experiment Station accepted funds per contract agreement (FPN 5654000) with the United States Golf Association on February 17, 1987. This year completes the sixth year of the cooperative investigation. This project has been a cooperative research effort with the Breeding and Genetic Improvement Program for bentgrasses and zoysiagrasses under the direction of Dr. M. C. Engelke at TAES-Dallas.

II. Project Personnel:

My research associate, Ms Sue Metz, has been assigned full time responsibility on the disease assessment project for the past year. Field and laboratory technical assistance is being supplied by USGA funding to support a local high school graduate, Michael Cotton.

III. Pythium Disease Research:

a. Pythium Culture Collection:

The USGA Pythium spp. isolate collection was assembled earlier this year. Additions were made to this collection during the Spring with Pythium spp. isolates obtained from golf course green samples. A Pythium ultimum isolate was also added to the USGA collection this summer with an isolate sent from Dr. C. Howell USDA-Plant Pathology, College Station. All cultures in the Pythium spp. Collection were placed in long-term storage for future research efforts.

b. Pythium Inoculation Studies:

Inoculation studies using Pythium spp. as the disease causing agent were carried out several times throughout the year. The studies concentrated on determining resistance in bentgrass germplasm lines produced from TAES parental lines and genetic polycrosses obtained from Tangent, Oregon.

1. Inoculation Method:

Inoculation procedures with Pythium spp. were standardized for repeatability of disease inoculation results from experiment to experiment. Bentgrass germplasm samples were randomized using a complete block experimental design and placed in 35 cm. X 60 cm. clear plastic tubs. In all studies evaluating bentgrass germplasm for resistance to Pythium blight, a 0.5 cm. diam. disc of P. aphanidermatum (#24) was placed on the center of the bentgrass plug. The inoculated bentgrass plugs were thoroughly misted with sterile water before and after each inoculation. The trays were covered with 4 ml clear plastic and placed in a lighted walk-in growth chamber maintained at 28C. Disease severity ratings on the inoculated bentgrass plugs were evaluated after five days by means of a visual rating scale based on 0-100% infection. The only variation on this technique involved trimming of the bentgrass plugs in some studies due to the length of time the plugs had been grown in the greenhouse prior to inoculation. In all cases where trimming occurred, shears were surface sterilized with a 10% solution of common household bleach. The length of time a bentgrass sample was grown in the greenhouse prior to inoculation was however, thought to ultimately influence the disease severity rating.

2. Results and Discussion:

a. Bentgrass Polycross Inoculations

The lack of availability of germplasm lines and the limited space in the walk-in chamber for inoculation of members of the genetic crossing block referred to in Engelke, et al (1990 USGA 6th rpt. p. 8) necessitated inoculations of the populations in stages. The first study of the synthetic polycross population included the populations A, C, E, and I. These results were reported in the May 1992 semi-annual report. Bentgrass germplasm lines from the populations which survived the first inoculation were maintained in the greenhouse for 11 days and re-challenged with P.aphanidermatum (#24). Plugs were trimmed to a standard height of 2.5 cm. for the second inoculation to increase the ease of determining percent foliar infection. Results indicated a greater percentage of infection in all populations being re-challenged after an 11 day time period (Table 1). In the first study, populations A and I appeared to show slightly greater resistance to Pythium foliar blight than others tested. Results of the second inoculation were analyzed using Statistical Analysis Systems (SAS). Means were grouped into four ranges of infection. Range 1= 0-25% infection, 2 = 26-50% infection, 3 = 51-75% infection and range 4 = 76-100% infection. The C population had the greatest number of polycross germplasm lines (2.7%) in the 0-25% range.

The standard bentgrass cultivar Penncross was highly susceptible to Pythium blight in both studies. Higher levels of resistance was shown in the populations from the polycross after the first inoculation. It was interesting to note that after the second round inoculation 2.7% of the C population remained in the 0-25% infection range (Table 1) which exceeded the other populations in the study. The devastating effects of the second round inoculation probably reflects a higher susceptibility to disease because of the long exposure of the test plants to low light conditions in the inoculation chamber. One explanation for different levels of infection to Pythium foliar blighting may be attributed to different levels of horizontal resistance in the germplasm collection.

Horizontal resistance does not protect the bentgrass Pythium germplasm from becoming infected but does slow down the spread of the foliar blight. Horizontal resistance is affected by varying environmental conditions. Bentgrass germplasm showing little infection from the first study can become more susceptible in the second study due to the prior weakening of physiological processes that provide plants with horizontal resistance defense mechanisms. Maintaining the test plants under low light conditions for several days would lower the level of resistance normally demonstrated under high light intensity. With horizontal resistance tolerance to disease can result from specific heritable genes although the genetics of this type of resistance is not fully understood.

The remaining polycross populations were inoculated August 27, 1992 using the standard inoculation method. Results of the second polycross study showed very little foliar blighting in the crosses while the commercial cultivar Penncross was 100% susceptible (Table 2). The polycross populations from groups L, B and K were statistically more resistant than populations D and J. All five of the experimental populations were more resistant to Pythium foliar blight than the standard variety Penncross.

Table 1. Comparison of bentgrass polycross population susceptibility to Pythium foliar blighting following two separate inoculations 11 days apart.

		Polycross Population Disease Means[1]				
	Range	A[2]	I	E	C	Penncross
1st Inoculation	0-25	87	83	70	73	0
	26-50	7	7	6	6	0
	51-75	2	7	6	4	0
	76-100	5	1	17	17	100
2nd Inoculation	0-25	1.8	0	.62	2.7	0
	26-50	.9	2.7	2.4	1.7	0
	51-75	.9	2.7	1.8	.55	0
	76-100	96.3	94.4	95.1	95	99

1/ Foliar disease rating determined five days after inoculation with Pythium aphanidermatum #24. Means calculated by SAS GLM. Pr F =.001 and Pr > F =.06 for first and second study respectively.
2/ Population sizes; Populations A, I, E, and C with seven, five, nine and 10 parental cross populations respectively. Inoculations performed on 18 sub-samples of each crossing population.

Table 2. Disease reaction of synthetic bentgrass germplasm lines to foliar blighting caused by inoculation with Pythium aphanidermatum

Polycross Population % Disease Means[1]					
D[2]	J	L	B	K	Penncross
25.5 b	21.6 b	8.0 c	8.9 c	10.0 c	100 a

1. Separation of means by Duncan's Multiple Range Test(P=.05).
2/ Population sizes; Populations D, J, L, B, and K with three, one, six, seven and one parental cross populations respectively. Inoculations were performed on 18 sub-samples of each crossing population.

b. Intercrossing Pythium Resistant and Susceptible Parental lines.

Previous studies identified the N polycross populations to be particularly resistant to Pythium blight. The N population and parental clones were previously inoculated on the heat bench with disappointing results due to low disease pressure under fluctuating temperature and moisture conditions on the heat bench. New samples of the N population germplasm lines were inoculated in the walk-in growth chamber on 17 September, 1992. The standard inoculation method was used to study the reciprocal crossing block using disease resistant N population parental lines and susceptible parental lines (Table 3) as well as hybrid progeny plants resulting from intercrossing.

The parental lines and progeny from intercrosses were well represented in inoculation studies with the N population as shown in Table 3. The study contained 18 samples of each cross, 18 samples of the reciprocal cross, three replications of each parental line and 21 replications of the standard variety Penncross. The total replications for each inoculated parental line ranged from a minimum of 12-24 test plants. On the basis of the inoculation results (Table 3), the parental lines 3285, 2859

Table 3. Progeny performance of parental crosses of 'susceptible' and N 'resistant' bentgrass germplasm lines following inoculation with *Pythium aphanidermatum* #24.

Parental[a] Cross	9/17/92[b] Mean %Blight	
Parental lines		
3276 (MS)	22.0	b
3285 (R)	7.0	cde
2784 (MS)[c]	13.9	bcde
2922 (MS)	19.3	bc
2859 (R)	5.0	cde
2916 (R)	1.6	de
2784 X 2922	15.4	bcde
3276 X 2784	11.0	bcde
2922 X 2784	13.6	bcde
3285 X 2859	10.8	bcde
2859 X 3285	7.1	bcde
3276 X 3285	5.9	cde
3285 X 3276	6.0	cde
2922 X 3285	4.2	cde
3285 X 2916	4.1	cde
2916 X 3285	5.0	cde
2784 X 2916	10.3	bcde
2916 X 2784	9.7	bcde
Penncross	87.7	a

a/ Reciprocal crosses of N population susceptible and Pythium blight resistant parental lines.
b/ Mean percent infection on 9-17-92 five days following inoculation with *P. aphanidermatum*. Statistical separation of means using Duncan's Multiple Range Test (Pr>F=.16).
c/ Susceptibility rating of parental lines based on disease reaction R=resistant, MS=moderately susceptible.

and 2916 demonstrated resistance to *Pythium* blight. The parental lines 3276, 2784 and 2922 were somewhat less resistant to the fungus and were given an intermediate susceptibility rating. All of the parental lines were statistically less susceptible to *Pythium* blight than the standard variety Penncross. The susceptibility of progeny from crosses involving at least one of the above resistant parental lines gave an overall mean disease rating of 6.9% while progeny from crosses without a resistant parent gave a 14.3% disease rating compared to the standard variety Penncross which had a mean disease rating of 88%.

One of the problems with the disease analysis of the genetic crossing block is understanding the numerical codes assigned to the parental lines. We have not dealt with the parent line code numbers 2859, 2916, 2922, 3276, 2784, and 3285 before so it is difficult at this point to know their origins. Our parent line disease assessments indicated some resistance in all of the lines used in the crossing block when compared to the standard variety Penncross. It is possible that the characterization of parental lines from the field is not always the same as on greenhouse grown plants we used in these experiments. It is interesting to note a lower mean disease rating for crosses involving the parental lines identified as resistant in our inoculation study. Differing exposures of the genetic populations in Tables 1 and 2 to greenhouse growth conditions, differences in the quality of the genetic material at the time of inoculation, and the limited sampling (6-12% of total) of the seedling populations of the genetic block for our inoculations are some limitations of the experiment. More opportunities with the genetic collection will be discussed when the genetics and pathology group make their review of this new information.

C. Investigations on *Pythium* Root Rot Resistance

Soil cores 2.0 cm in diameter were obtained from the Germplasm Introduction Nursery (GPIN) and evaluated for root rot resistance. This was a continuation of the root rot screening program which was started in 1991.

Materials and Methods:

Methods and materials used for the initial screening study are mentioned in the Fifth Annual Progress and the Sixth Semi-Annual Progress Report for the USGA. A greenhouse sand bench measuring 22.5 ft^2 was steam sterilized at 180 F for 30 min and allowed to cool. The bench was inoculated with 5,000 cc/yd^3 of *Pythium aphanidermatum* inoculum grown on a sterilized mixture of millet and wheat seed. Bentgrass germplasm surviving the initial screening were then planted randomly into the bench. The bench was saturated with water each day for 1 month to aid in *Pythium* colonization of roots. Soil samples taken at random throughout the bench confirmed the spread of the *Pythium* inoculum. The bentgrass germplasm lines were maintained on the bench throughout the summer. Cultural practices involved weekly trimming and watering only as needed. A 20-20-20 water soluble fertilizer was applied on three occasions at 250 ppm N.

Results and Discussion

To date 146 different bentgrass germplasm lines have survived both root rot screening efforts. Seven of these bentgrass plugs have two replications surviving in the bench. This gives a stronger indication of some root rot resistance to the strain of Pythium aphanidermatum presently challenging the bentgrass roots. The plugs will be maintained in the bench and challenged with different Pythium spp., such as P. graminicola which is known to be a damaging root rot pathogen.

IV. Rhizoctonia Disease Research

a. Rhizoctonia Isolate Collection:

The pathogenicity assessment of 25 Rhizoctonia solani isolates resembling AG2-2 was determined in past studies during 1991. This collection was reassembled in the spring of 1992 with isolate #R64 being chosen as the most virulent pathogen. Transfers of isolate #64 were made weekly to new potato-Dextrose agar (PDA) to insure a virulent pathogen for foliar inoculation studies.

b. Rhizoctonia Inoculation Studies:

Inoculation studies involving Rhizoctonia solani have centered on the National Turfgrass Evaluation Programs(NTEP) collection of bentgrass and zoysiagrass. Progress was made in determining the disease resistance among field grown bentgrass varieties. Two inoculation studies were completed using the NTEP bentgrass entries. Significant differences in reaction to Rhizoctonia blight were observed among members of the NTEP bentgrass collection. The inoculation of NTEP zoysiagrasses has also demonstrated statistical differences in disease reaction among the experimental and commercial cultivars.

1. Bentgrass Inoculations:

The NTEP bentgrass experimental greens at TAMU Dallas are being maintained at a height of 10 cm (1/4 inch). The plots were fertilized at a rate of 0.5 lb. every two weeks using a 21-4-11 elite fertilizer. This rate will be reduced to 0.25 lb. every two weeks during the summer months. Each of the 60 plots measure 5 x 10 ft dimensions and represent 20 bentgrass entries replicated three times. Soil cores were taken from the greens March 4, 1992 and April 10, 1992 to be used in two separate inoculations. Three samples were taken from each plot representing a varietal entry, giving a total of 180 samples for each separate inoculation. The location of samples as designated from the field plot plan was recorded to detect plot variations that might affect the study. The core samples were completely randomized using block randomization with nine replications of each bentgrass entry. The cores 7.0 cm in diameter were placed in plastic McDonald's sundae cups and maintained in the greenhouse at 25 C until inoculation. The inoculations took place on 16 March and 22 April, one week after collections of the field turf samples.

Agar discs 0.5 cm in diameter were taken at random from a 8.5 cm dia petri dish containing Rhizoctonia spp. and placed in the center of each turfgrass plug. The Rhizoctonia strain (#64) used in this study had a pathogenicity rating of 2.5 on a scale of 0-4 as determined in previous studies. The NTEP plugs were misted with a 1:10 dilution of V-8 juice and sterile water to help provide nutrients to initiate pathogen activity. Plastic caps were placed over the plugs in order to ensure humidity favorable for pathogen growth. The inoculated cups were placed in plastic trays, covered with 4 ml plastic and placed in a growth chamber which was maintained at 28 C for optimum disease development.

Procedures for the second inoculation were as mentioned above except the 0.5 cm agar discs containing the Rhizoctonia spp. was taken from the outer growing edge of a culture growing on agar. This was changed to help eliminate variables in the inoculation procedure that might have contributed to inconsistent results.

Plants in both inoculations were evaluated for percent disease severity eight days after inoculations were made. A visual disease severity rating was employed based on percent foliar disease development from 0-100%. Analysis of variance was performed using SAS GLM procedure to evaluate the statistical significance of treatment means. A standard arcsin inverse transformation was performed because of the distribution of the data. Means were separated using the Waller-Duncan K-ratio test. It should be noted that the F test value computed using SAS GLM Analysis of Variance for the first inoculation $P > F = .072$ level of significance and in the second inoculation $P > F = .013$.

Results and Discussion:

The comparative susceptibility of NTEP bentgrass entries to Rhizoctonia solani is shown in Table 4. The results of the first inoculation at the 90% confidence level showed significant differences of Rhizoctonia spp. susceptibility between the NTEP entries. The variety National with a mean percent infection of 70.7% showed a significant increase in susceptibility to Rhizoctonia spp. brown patch when compared to the bentgrass varieties 88-CBL, Syn3-88 and Providence. The second inoculation at the 95% confidence level showed a significant susceptibility of the varieties Forbes and Putter compared to the resistant varieties Penncross and Cobra (Table 4).

When comparing the results of both Rhizoctonia inoculations by ranking, seven entries were in the top ten or ten most susceptible group, in both inoculations the rankings were; 1. National, 2. Forbes, 3. Syn4 88, 4. Normarc 101, 5. SR 1020, 6. 88 CBE, and 7. WVP 89 D 15. These seven entries were consistently in the top ten susceptible group based on our inoculations. There were also seven NTEP entries that consistently appeared in the top ten most resistant; 1. Syn3 88, 2. Penncross, 3. MSCB 8, 4. MSCB 6. UM 8401, and 7. BR 1518. These seven entries were consistent in appearing in the top ten resistant varieties based on our inoculations. These are not statistical differences but based only on numerical rankings of mean percent susceptibility ranking.

2. Zoysiagrass Inoculations:

Growth chamber inoculations were used to determine the susceptibility of six commercial and 18 experimental Zoysiagrass cultivars to Rhizoctonia solani.

Materials and Methods

Six commercial varieties and 18 experimental cultivars of zoysiagrass were vegetatively propagated into plugs measuring 16 25 cm^2, based upon parent stock material available. Vegetative plugs were planted into 39 cm^2 plastic pots, using Metro-Gro Mix as the media. The Zoysiagrass plugs were maintained at a height of 2.5 cm. and a complete water soluble fertilizer (Peter's Special) was applied once per week. After establishment in the greenhouse for one month, each of the Zoysiagrass spp. cultivars were placed in 33 cm X 58.4 cm plastic trays using a randomized complete block design with six replications.

Table 4. Rhizoctonia blight susceptibility ratings for R. solani inoculated bentgrass varieties in the NTEP collection.

Bentgrass[1] Variety	Mean[2] 3/16/92	Mean 4/17/92
1. National	70.67 a	48.2 abc
2. Cobra	55.3 ab	9.2 d
3. Putter	55.1 ab	18.3 bcd
4. Syn4 88	52.0 ab	56.3 ab
5. SR 1020	51.3 ab	31.6 abcd
6. Pennlink	46.1 ab	17.4 bcd
7. Normarc 101	44.4 ab	48.3 abc
8. Forbes	42.8 ab	64.3 a
9. WVP 89 D 15	40.2 ab	31.1 bcd
10. 88 CBE	40.2 ab	37.2 abcd
11. Syn1 88	37.4 ab	21.1 bcd
12. Carmen	39.4 ab	31.8 abcd
13. MSCB 6	39.4 ab	17.4 bcd
14. MSCB 8	33.3 ab	19.6 bcd
15. Penncross	31.1 ab	13.3 cd
16. BR 1518	27.2 ab	26.0 bcd
17. UM 8401	26.1 ab	24.7 bcd
18. 88 CBL	18.3 b	42.8 abcd
19. Syn3 88	16.9 b	18.3 bcd
20. Providence	8.6 b	35.6 abcd

[1] Ranking of the NTEP entries based on percent susceptibility eight days after inoculation.
[2] Separation of means using Waller-Duncan K-ratio Test (P=.01) Means followed by the same letters are not significantly different.

Rhizoctonia solani isolate (# 64), which was determined by previous studies to be highly pathogenic, was transferred to a 100 X 15 mm. petri dish containing Potato Dextrose Agar (PDA) and left to colonize the dish for three days. For this experiment, 15 0.5 cm plugs containing Rhizoctonia solani were transferred to 15 separate PDA petri dishes and left to colonize for three days. Ten 0.5 cm discs containing Rhizoctonia solani were taken from the growing edge of each plate, with one 0.5 cm disc transferred to each zoysiagrass cultivar replicate.

The Zoysiagrass plugs were misted with a 2% dilution of V-8 juice and sterile pond water to help provide nutrients for initial pathogen growth. Each of the six plastic trays containing the Zoysiagrass cultivars were covered with plastic film and placed in a lighted walk-in growth chamber maintained at 28 C for optimum disease pressure.

The cultivars were evaluated for disease susceptibility seven days after inoculation. A visual rating system was employed based on percent foliar disease development from 0-100 percent foliar canopy infection. Data was subjected to analysis of variance to test the correlation between zoysiagrass cultivar and percent disease infection. Correlations between the zoysiagrass leaf textural classes and percent disease infection were also determined. Observations were made concerning each cultivars recovery ability after heavy disease exposure. Zoysiagrass cultivars were placed into three categories based upon shoot density and leaf discoloration (Table 5).

Results and Discussion

Evaluations of blight activity after seven days of heavy disease pressure determined the variety Meyer to be the least susceptible of the commercial germplasm lines to Rhizoctonia blight. This finding agrees with Texas field observations by Green (1986). The cultivars DALZ 8502, DALZ 8507, and DALZ 9006, all exhibited low susceptibility among the experimental zoysiagrasses studied. The zoysiagrass germplasm line CD 2013 showed a significant increase in Rhizoctonia blight compared with all other Zoysiagrass spp. studied.

The relationship of Rhizoctonia blight susceptibility and leaf blade texture class was also studied. The zoysiagrasses were separated by leaf blade textural classes including fine, medium fine, medium, and coarse in order to compare disease susceptibility within textural types (Table 5). In general the fine textured zoysiagrasses showed less susceptibility in foliar blighting from Rhizoctonia solani. Among fine textured grasses, Dalz 9006 showed the lowest percentage of disease activity, although not significantly lower than Dalz 8507, also a fine textured zoysiagrass. The commercial cultivar Emerald had the highest rate of disease of zoysiagrasses classified as fine. There was no significant differences in disease susceptibility among the remaining three textural classes, medium fine, medium, and coarse (Table 5). The experimental zoysiagrass cultivar CD 2013, a medium textured zoysiagrass was significantly more prone to foliar blighting from Rhizoctonia solani than all other zoysiagrass cultivars tested, exclusive of textural classification. The zoysiagrass plugs are presently being grown in the green house and plans are being made to repeat the inoculation study.

Table 5. Ranking of commercial and experimental Zoysiagrass cultivars by textural classification and foliar blighting by *Rhizoctonia solani*.

Textural Class[1]	Commercial Cultivar[2]	Experimental Cultivar	Percent infection[3]	
Fine	Emerald		36.2	ghi
		Dalz 8502	26.7	hij
		Dalz 8507	20.0	ijk
		Dalz 9006	15.8	jk
Medium Fine		Dalz 8501	55.8	cdef
		Dalz 8508	32.5	hij
		Dalz 8701	73.0	bc
		GT 2004	57.5	cde
Medium	Meyer		10.8	k
		Dalz 8516	30.0	hij
		CD 2013	100.0	a
		TC 2033	29.2	hij
Coarse	Belair		67.5	bcd
	El Toro		37.5	fghi
	Korean		77.8	b
	Sunburst		70.0	bcd
		Dalz 8512	76.7	b
		Dalz 8514	35.0	hi
	CD 259-13		53.3	efgh
		GT 2047	64.7	bcd
		TGS-B10	34.7	hi
		TGS-W10	38.3	efgh
		JZ1A89-1	60.8	cd
		TC5018	42.5	efgh

[1] Textural leaf classifications based on leaf blade width and height.
[2] Commercial and experimental zoysiagrass cultivars in the National Turfgrass Evaluation Program.
[3] Mean foliar blighting percentages from a growth chamber inoculation with *Rhizoctonia solani* under heavy disease pressure. Means followed by the same letter are not significantly different.

APPENDIX

The following publications have been prepared for submission to:

Biological and Cultural Tests for Control of Plant Diseases. American Phytopathological Society Press. 1992.

P. F. Colbaugh & M. C. Engelke
APS B&C Tests - 1992

PYTHIUM BLIGHT ON NTEP BENTGRASSES. 1991. Twenty bentgrass genotypes including 9 commercial and 11 experimental lines were examined in inoculation studies for resistance to Pythium foliar blight. Nine replicate soil cores per variety entry were removed four times during the year from a bentgrass green with three completely randomized blocks and transferred to 8 cm dia plastic cups. One replicate soil core of each variety was placed in a covered plastic crisper and inoculated with an agar block containing Pythium aphanidermatum (P-24) known to be highly pathogenic on bentgrass. After inoculaltion, the grass samples were incubated in a lighted walk in chamber maintained at 28 C and were misted daily with sterile water to favor foliar blighting over a five day period.

The mean per cent susceptibility of the varieties to Pythium blight is shown for all four of the inoculation studies. The susceptibility of the bentgrass collection appeared to vary during the year. The highest percentage of infection was during the Summer and Fall II inoculations which gave an overall mean percent blight rating of 68 and 71 % respectively. The lowest blight ratings occurred during the Spring and Fall I inoculation study each with a 26 % overall blight rating. Pennlinks, Penncross, National and MSCB-6, Syn3-88 and Cobra were numerically the most resistant genotypes. Providence and BR1518 were among the most susceptible of the genotypes tested and were significantly more susceptible than the standard variety Penncross.

Bentgrass Variety	Mean % Susceptibility Ratings *				
	Spring	Summer	Fall I	Fall II **	Mean ***
Carmen	20.0	61.0	24.6	80.0	46.4 abcd
SR1020	11.1	87.0	28.6	68.3	48.8 abcd
Normarc 101	31.7	86.0	32.2	61.1	52.8 abc
Cobra	4.4	74.0	30.5	62.8	42.9 bcd
MSCB-6	22.8	75.0	16.6	68.7	40.7 cd
SYN1-88	28.9	68.0	18.5	75.6	47.6 abcd
SYN4-88	1.1	74.0	18.9	94.8	47.1 abcd
National	18.3	65.0	5.6	40.0	34.8 cd
SYN3-88	22.2	73.0	18.9	50.0	41.1 bcd
Providence	45.6	72.0	87.9	95.3	63.6 a
Penncross	18.7	61.0	8.9	58.3	35.8 cd
88CBL	14.4	65.0	30.0	89.0	48.0 abcd
Pennlinks	7.8	61.0	1.1	58.9	32.3 d
Forbes 8912	32.8	67.0	21.1	77.6	49.6 abcd
Putter	55.0	35.0	26.1	78.8	48.8 abcd
WVPB89D15	38.9	69.0	21.9	67.0	46.8 abcd
MSCB8	38.3	60.0	25.0	79.2	50.6 abcd
BR1518	71.1	51.0	41.7	80.6	61.1 ab
88CBE	25.0	82.0	35.0	65.6	51.1 abcd
UM8401	21.1	84.0	25.6	63.7	48.5 abcd

* Per cent blight ratings are means of nine replicate test inoculations for each variety and date.
** Inoculations were made on 4 April, 17 July, 20 October and 17 November
*** Means followed by a common letter are not significantly different (DMRT P=0.05)

PYTHIUM BLIGHT OF INOCULATED ZOYSIAGRASSES. 1988. Thirty-six experimental and four commercial zoysiagrasses were examined for resistance to Pythium spp. foliar blight. Four soil core samples of each of the 40 zoysiagrasses were transferred into individual plastic cups (8 cm dia) and maintained on a greenhouse bench one month prior to inoculation with Pythium aphanidermuatum. Genotypes TAES3356 and TAES3368 were hybrid zoysias selected for drought resistance and low fertility requirements while Meyer, Emerald, El Toro, Belair and FC13521 were commercially available varieties. After one month in the greenhouse, the grasses were placed randomly in plastic vegetable crispers and each inoculated with two agar discs containing two turfgrass isolates of P. aphanidermatum known to cause severe foliar blighting. Each of the cups containing the inoculated test grasses were covered with snap-on clear plastic lids with four aeration holes and maintained in a walk-in growth chamber where daily misting, temperature (27 C) and light conditions 24 hr (200 fc) favored Pythium blight infection over a seven day period.

Results of inoculations after seven days demonstrated good Pythium blight resistance among the germplasm lines and commercial varieties studied. The disease hardiness of the zoysiagrasses was indicated by the large number of genotypes (18) with less than 10% foliar blighting while only four of the germplasm lines were damaged more than 50%. The commercial varieties Meyer and Emerald were numerically more resistant to Pythium blight than El Toro, Belair and FC 13521 which also ranked among the more resistant cultivars in the study. The germplam lines TAES3357, TAES3365, TAES3356, TAES3364, TAES3358, DALZ8508, and DALZ8517 ranked among the most resistant of experimental zoysiagrasses used in the study.

Zoysiagrass Cultivar	Percent Foliar Blight 1	2	3	4	Mean %	
TAES3357	0.5	2	1	2	1.4	a
TAES3365	1	2	0.5	4	1.9	ab
TAES3356	1	1	1	5	2.0	ab
TAES3364	6	5	1	4	4.0	abc
TAES3358	5	3	7	2	4.2	abc
DALZ8508	2	4	0.5	12	4.6	abc
DALZ8517	6	5	6	1	4.8	abc
TAES3367	1	2	10	7	5.0	abc
MEYER	6	4	5	2	6.3	abcd
TAES3372	10	4	6	5	6.3	abcd
EMERALD	10	6	6	4	6.5	abcd
DALZ8514	10	3	8	5	6.5	abcd
DALZ8511	10	6	8	5	7.3	abcd
TAES3363	20	2	4	3	7.3	abcd
TAES3366	1	1	7	20	7.3	abcd
DALZ8523	10	10	10	3	8.3	abcd
DALZ8512	10	10	12	7	9.7	abcd
DALZ8701	20	10	10	05	11.3	abcd
EL TORO	12	10	10	05	11.3	abcd
DALZ8516	40	4	2	2	12.0	abcd
DALZ8513	25	15	4	4	12.0	abcd
DALZ8506	26	10	10	4	12.5	abcd
BELAIR	40	18	3	01	15.5	abcd
TAES3359	20	8	10	10	16.3	abcd
TAES3360	12	33	10	10	16.3	abcd
DALZ8515	28	28	8	2	16.5	abcd
DALZ8507	28	20	10	12	17.5	abcde
FC 13521	45	35	2	3	21.2	abcde
DALZ8502	33	28	26	20	26.7	bcde
TAES3361	75	28	5	5	28.3	bcde
DALZ8504	60	32	13	15	30.0	def
DALZ8505	18	12	10	80	30.0	def
DALZ8503	48	42	10	22	30.5	def
DALZ8501	72	42	7	2	30.7	def
TAES3362	65	20	20	20	31.3	def
DALZ8510	75	40	35	12	40.5	ef
DALZ8522	85	75	40	9	52.3	fg
TAES3368	95	90	80	08	68.3	gh
DALZ8524	75	75	85	60	73.8	hi
TAES3477	95	95	93	92	93.8	i

* Data represents a mean of four replications

** Means followed by a common letter are not significantly different (DMRT, P=0.05)

P. F. Colbaugh, S. P. Metz & M. C. Engelke
APS B&C Tests - 1992

RHIZOCTONIA BLIGHT ON NTEP BENTGRASSES. 1992. Twenty bentgrass genotypes including 9 commercial varieties were examined in inoculation studies for resistance to Rhizoctonia foliar blight. Nine replicate soil cores were removed two times during the Spring from a bentgrass green with three completely randomized variety planting blocks and the cores were transferred to 8 cm dia plastic cups. One replicate soil core of each variety was placed in a covered plastic crisper and inoculated with an agar block containing Rhizoctonia solani (R-64), known to be pathogenic on bentgrass. After inoculation, the grass samples were incubated in a lighted (24 hr. 200 fc) walk-in chamber at 28 C and were misted daily with sterile water to maintain excess moisture in the foliar canopy for eight days.

The mean per cent susceptibility of varieties to Rhizoctonia blight is shown for both inoculation dates. The overall mean per cent infection for Spring I and Spring II was very similar with 37 and 34% blight respectively. Varieties with consistently good resistance to Rhizoctonia blight were SYN3-88, Providence, Penncross, UM8401, BR1518, and MSCB8 with less than 27% blight and were significantly more resistant than the commercial varieties Forbes and National.

Bentgrass Variety	Inoculation Trial % Blight * Spring I	Spring II **	Mean ***	
SYN3-88	16.9	18.3	17.6	a
Providence	8.7	35.6	22.1	ab
Penncross	31.1	13.3	22.2	ab
UM8401	26.1	24.7	25.4	ab
BR1518	27.2	26.0	26.6	abc
MSCB-8	33.3	19.6	26.5	abc
MSCB-6	39.4	17.4	28.4	abcd
88CBL	18.3	42.8	30.6	abcd
SYN1-88	37.4	21.1	31.3	abcd
Pennlinks	46.1	48.3	31.8	abcde
Cobra	55.3	9.1	32.2	abcde
Carmen	39.4	31.8	34.6	abcde
Putter	55.1	18.3	36.7	abcde
WVP 89D-15	40.2	37.2	36.9	abcde
88CBE	40.2	37.2	39.0	abcde
SR1020	51.3	31.6	42.1	abcde
Normarc 101	44.4	48.3	46.4	bcde
SYN4-88	52.0	56.3	54.2	cde
Forbes 89-12	42.7	64.3	54.9	de
National	70.7	48.2	59.4	e

* Per cent blight ratings are means of nine replicate test inoculations for each variety and date.
** Inoculations for Spring I and Spring II were on 16 March and 28 April.
*** Means followed by a common letter are not significantly different (DMRT P = 0.05)

P. F. Colbaugh and M. C. Engelke
APS B&C Tests - 1992

SCLEROTINIA DOLLAR SPOT ON BENTGRASSES. 1992. The incidence and severity of Sclerotinia dollarspot on 20 entries from the bentgrass National Turfgrass Evaluation Program was determined during the month of August on a nursery green at TAMU-Dallas, TX. The number of dollar spot disease centers were determined by direct counts on each of three replicate 4.5 m^2 field plots planted in a randomized block design. Dollar spot symptoms were determined on the two year old experimental bentgrass green maintained at 0.4 cm cutting height.

SR1020 and SYN3-88 were significantly more susceptible to dollarspot than the other bentgrass entries. SYN1-88 and Carmen had numerically a high incidence of disease symptoms but were not significantly different from the other entries. Less than 20 disease centers were recorded on the following cultivars 88 CBE, WVPB89D15, SYN4-88, 88-CBL, Providence, Pennlinks and Putter. With the exception of the most susceptible varieties SR1020 and SYN1-88 the mean # of disease centers for all other members of the NTEP collection was not statistically different than the standard variety Penncross.

Bentgrass Variety	# Disease Centers/Plot				
	1	2	3	Mean #	
Forbes 89-12	9.5	12.5	41.5	21.2	c
Normarc 101	11.0	10.0	71.0	31.7	c
UM 8401	23.0	14.5	52.5	30.0	c
Pennlinks	10.0	16.0	27.5	17.8	c
Penncross	20.0	9.5	61.0	30.2	c
Providence	7.5	13.0	32.0	17.5	c
SR 1020	57.5	49.0	223.5	110.0	a
MSCB-6	35.0	7.0	50.0	30.7	c
Carmen	64.3	27.0	67.5	52.9	bc
BR1518	32.5	14.0	22.5	23.0	c
WVPB 89D15	13.5	13.5	17.0	13.0	c
National	15.0	24.0	21.0	20.0	c
88 CBE	8.5	13.5	17.0	13.0	c
88 CBL	4.0	13.0	27.0	14.7	c
Cobra	16.5	7.0	77.5	33.7	c
SYN1-88	30.0	24.0	111.5	55.2	bc
SYN3-88	53.0	26.0	168.0	82.3	ab
Putter	23.5	14.0	16.5	18.0	c
MSCB 8	25.0	13.5	37.0	25.2	c
SYN4-88	13.0	8.5	19.0	13.5	c

* Number of infection center determined on replicate 50 ft^2 field plots and are expressed as a mean of three replications

** Numbers followed by the same letter are not significantly different (DMRT P=0.05)

P. F. Colbaugh and M. C. Engelke
APS B&CTests - 1992

SCLEROTINIA DOLLAR SPOT INCIDENCE ON ZOYSIAGRASS. 1987-88. The incidence and severity of naturally occuring symptoms of Sclerotinia dollar spot was determined on field planting blocks of experimental and commercial varieties of zoysiagrass. Field observations of disease symptoms were made on zoysiagrass cultural study blocks at TAMU-Dallas during the months of October and November for two consecutive years. Observations of disease incidence were made on three replicate cultural study blocks with randomized plantings of commercial and experimental zoysiagrasses. Disease ratings were based on per cent disease severity on replicate plants in the field plots.

Among the genotypes included in the study,, the incidence of dollar spot symptoms was greatest on the variety Emerald and TAES3477 during both years. Dollar spot symptoms were also noted on the experimental variety DALZ8502 both years and during one of the two years of observation on DALZ8508 and DALZ8501. During the second year, two hybrid zoysiagrasses, TAES3372 and TAES3477, were added to the study. Although TAES3372 showed no incidence of disease, hybrid TAES3477 showed severe disease symptoms. The zoysiagrass selection TAES3477 was observed only one time during 1988 and had severe disease symptoms.

Descriptions of leaf texture classifications and leaf density ratings for each of the turfgrasses are shown. Commercial and experimental varieties with fine leaf texture and a high density of leaves were generally more susceptible than turfgrasses with coarse leaf texture and low leaf density in the foliar canopy. The experimental variety DALZ8516 was an exception to these observations. Even though the expervar had a fine leaf texture and a high leaf density in the foliar canopy, no dollar spot disease was observed during the two year study.

Variety or Expervar	Leaf Texture Class	Leaf Density Rating	Mean % Infection on Plot Oct. 1987	Nov. 1988	
Belair	Coarse	3.2	0	0	b
El Toro	Coarse	4.2	0	0	b
Meyer	Medium	3.0	0	0	b
TAES3372	Medium	2.3	-	0	b
Emerald	Fine	3.3	28.0	19.3	ab
DALZ8516	Fine	6.3	0	0	b
DALZ8501	Fine	3.5	0	5.3	b
DALZ8502	Fine	6.2	4.0	4.0	b
DALZ8508	Fine	3.5	3.5	0	b
TAES3477	Fine	5.0	-	30.0	a

* Rating based on estimated per cent diseased leaf canopy during October 1987 and November 1988.

** Means followed by a commn letter are not significantly different (DMRT P = 0.05)