THIRD
ANNUAL PROGRESS REPORT

concerning

DEVELOPING BROWN PATCH AND PYTHIUM DISEASE RESISTANCE IN BENTGRASS AND ZOYSIAGRASS

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USGA TURFGRASS PATHOLOGY RESEARCH

THIRD ANNUAL PROGRESS REPORT 1989

I N D E X

Executive Summary

Third Annual Progress Report 1 November, 1989

Developing *Rhizoctonia* Brown Patch and *Pythium* Disease Resistance in Bentgrass and Zoysiagrass

Principal Investigator: Dr. Phillip F. Colbaugh

Research Period of this report: 1 May 1989 to 1 Nov. 1989

New techniques developed for volume handling and inoculating of turfgrass field samples were successfully used for mass screening of bentgrass germplasm lines for *Pythium* spp. resistance. Core samples from the field or greenhouse were placed in plastic McDonald's sundae cups and were covered with plastic lids containing aeration holes. The sundae cups were placed in covered clear plastic boxes after grass samples were inoculated with pathogenic fungi and maintained in a moisture saturated environment for a 7-day period.

This technique allows the fungi to grow in water saturated air and provides conditions under which predictable results can be expected with regard to the pathogenic development of the fungi. Large scale disease screening efforts with the cups was accomplished with two walk-in environmental chambers maintained with continuous incandescent lighting and temperatures of 26C. The technique is now being used routinely to screen as many as 530 turfgrass genotypes

with reliable Pythium blight results in five to seven days.

Considerable progress has been made in the identification of bentgrass genotypic lines with resistance to Pythium foliar blighting. Large numbers of bentgrass genotypes have been challenged with highly virulent Pythium spp. strains, and some of the genotypes which withstood the initial inoculations were re-challenged with Pythium spp. to reinforce their resistance status. Of 1203 field collected bentgrass lines inoculated during the reporting period, 5.9% expressed Pythium blight resistance, while 11% showed disease tolerance and 83% were moderately or highly susceptible to the disease. The commercial bentgrass variety, Penncross, was consistently highly susceptible with an overall mean disease severity rating of 96.3%. Previous studies have shown that bentgrass germplasm lines obtained from the field were more resistant to Pythium blight than the same plants grown on a greenhouse bench for extended periods prior to inoculation. At this time, all inoculations are carried out on field-grown turfgrass samples in order to maximize the identification of disease resistance.

Third Annual Progress Report 1 November, 1989

Developing Rhizoctonia Brown Patch and Pythium Disease Resistance in Bentgrass and Zoysiagrass

I. Introduction:

On 17 February, 1987, the Texas Agricultural Experiment Station and the Texas A&M University Research Foundation accepted research funds as per contract agreement (FPN 5654000) with the United States Golf Association to conduct investigations to develop Rhizoctonia brown patch and Pythium disease resistance in bentgrass and zoysiagrass. This is a cooperative project with the turfgrass breeding and development efforts for both grasses, under the direction of Dr. Milton C. Engelke also at the Texas A&M University Research and Extension Center at Dallas, Texas. This third annual research research report is for the period 1 May 1989 to 1 November 1989, and represents the past six months of active research on the cooperative disease assessment project.

II. Project Personnel:

Mrs. Ann Heidel who was assisting on this project for the past year on field, greenhouse and laboratory research has terminated her employment to relocate with her family to Houston, TX. Thomas J. McAfee has been employed to handle the extensive field sampling and greenhouse testing required during the summer and fall. McAfee will also assume duties in the maintenance and collection of fungal culture isolates for the program.

In order to increase our time consuming field research

efforts on this project during the summer, we also hired an additional part-time employee, Jonathan Dunham, who is a high school student in the nearby Richardson School District. Jon assisted (15 hrs/wk) in the collection of plant materials from the field plots and maintenance of our greenhouse plants.

III. *Pythium* DISEASES - ONGOING RESEARCH

1. Isolate Collection and Storage:

The USGA isolate collection of *Pythium* spp. has been assembled for long-term preservation through encapsulation of the cultures and storage at a temperature known to insure their survival. Initially, many routine transfers of *Pythium* spp. cultures on agar slants became contaminated by saprophytic bacteria. This destroyed some of the cultures and necessitated repeated transfers to keep the cultures viable. Storage of the cultures in distilled water has recently overcome the contamination problem. The unique collection of turfgrass *Pythium* spp. strains now requires 6-month examinations for culture viability and contamination. New isolates are being added to the Collection as they become available through cooperation with golf course superintendents. As in the past, each culture of the Collection was plated on water agar in a petri dish and transfers were made in triplicate to distilled water in vials. Subcultures were also made on water agar slants in large test tubes as a back-up to insure prolonged survival of the fungi in storage.

2. **Procedures for Mass Disease Screening:**

Previous studies assisted in the development of mass disease screening techniques we now use for assessments of large numbers of plant samples. It was determined early in the disease evaluation research that plant samples from field plots were more resistant to Pythium blight than similar samples maintained for extended periods on the greenhouse bench. Bentgrass plugs are now taken routinely from the field and inoculated the following day to insure the maximum expression of disease resistance on experimental lines. The use of two large walk-in inoculation chambers are employed for incubating the plant samples at uniform 27 C temperatures over the seven day period necessary to determine Pythium disease reactions.

Results with inoculations in McDonald's cups were consistently better than other containers used for the turf plugs. Subsequent investigations indicated the plastic sundae cups with attached snap on lids containing aeration holes gave better results than other methods and containers used (Fig. 1a). In all cases, the samples kept in the walk-in growth chambers (Fig. 1b) revealed quicker infection and disease, and the results were overall more reliable than other inoculation methods considered for mass disease screening studies. Five days following the inoculation of the bentgrasses severe foliar disease is observed on the Pythium susceptible variety Penncross.

The Walk-in growth chambers are two small (7 x 10 ft) windowless rooms with incandescent lighting and individual heat pumps to maintain 26 C temperatures required for infection. Banks of

A.

B.

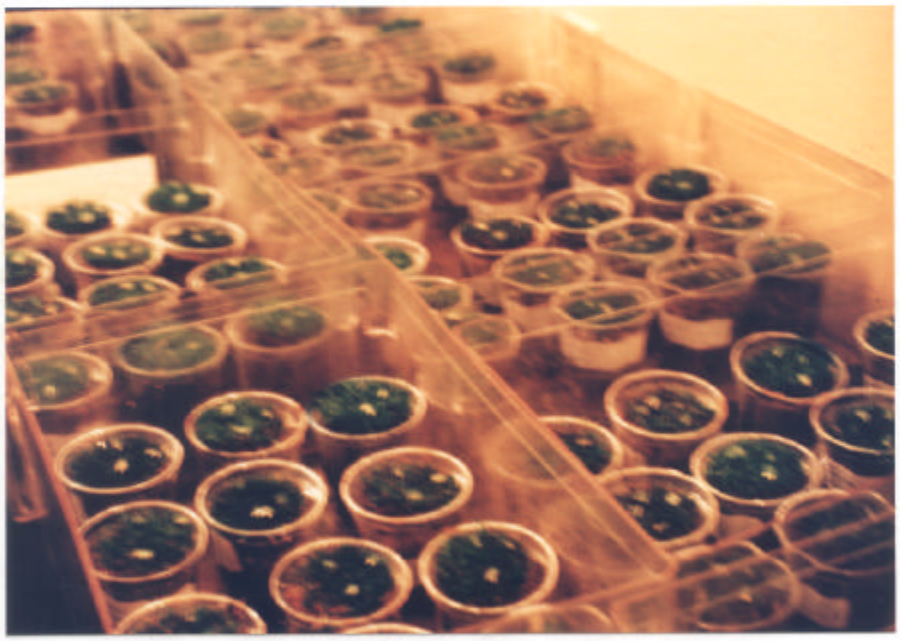

Fig. 1. Plastic crispers containing replicate McDonald's sundae cups with aeration holes in lids (A.) and inoculated turfgrass samples prior to capping with lids (B.).

incandescent lights have been installed to hang ca. 1.0 m over the benches for continuous lighting during the inoculation period which lasts for 5 to 7 days. During the later part of the summer, the heat pump units in the walk-in chambers were replaced because of occasional break down of the older units. Trial runs with the new equipment have shown their capability to maintain constant temperatures in the range for disease reactions for extended periods of time.

A method for the evaluation of foliar blighting by Pythium spp. was developed to improve the rating system which was used over the past two years. The reason this method was developed was because foliar blighting frequently occurs in the center of the inoculated leaf canopy but often does not extend to the periphery of the plug. This failure to blight the edges of the plug caused many ratings not to be 100% even though the center was completely blighted in response to the inoculation with the four pathogenic Pythium spp. isolates. In discussions of the problem with Dr. J. A. Reinert, he suggested the use of a simple center rating system aided by a standardized circular form.

The bottom of a plastic McDonald's sundae cup was cut off to expose a 4.0 cm dia. circular area and this was placed over the center of the inoculated turf samples after their removal from the inoculation chambers. Disease ratings of foliar blight were assessed only in the center area of the cup using the bottom of the cut cup as a standard circular area for evaluation. Use of this method allowed us to eliminate the peripheral area of the foliar canopy which was often consistently not infected and

presumed to be due to aeration or humidity effects on the pathogen near the container wall.

3. **Pathogenicity of Pythium on Bentgrass**

a) **Aerial Photographs of diseased green:**

Occasionally a natural outbreak of disease can be used to determine the disease reaction of germplasm lines in the field. Such was the case with an outbreak of Pythium blight on the experimental green at TAMU-Dallas. After laboratory diagnosis of the disease, aerial photographs were taken of the bentgrass green on 10 June to document the distribution of disease symptoms on different areas of the green. Although the disease had been noted one week earlier, no disease protective fungicide was used to prevent its spread during the Pythium epiphytotic.

Symptoms of Pythium damage can be seen as patches of dead grass on the green (fig. 2). In the figure, areas planted to Penncross (P) bentgrass are blocked off to identify areas primarily affected by the disease. The variety Penncross was severely damaged by Pythium blight; however, areas within the plantings of experimental lines of bentgrass were relatively free of disease symptoms. Diseased areas noted within the germplasm breeding block areas often surrounded the experimental lines without the experimental grasses succumbing to the disease. This pattern of disease development illustrates the tolerance of many experimental germplasm lines to a typical outbreak of Pythium blight under natural environmental conditions. Field notes of the disease reaction observed on this data were not recorded because of the possibility of differing

Fig. 2. Symptoms of Pythium blight on Elite Selection Nursery Green #1 on 15 July, 1989.

exposure of the germplasm lines to the Pythium fungus. One advantage of the mass disease screening methods in use, is the uniform exposure of the germplasm lines to pathogenic disease organisms for a specified time in a conducive environment for infection.

b: **Reinoculation of Surviving Bentgrasses:**

Inoculated bentgrasses originating from field plots were removed from the inoculation chamber after seven days and placed on a greenhouse bench for further observation. The recovery growth of the grasses paralleled the degree of foliar blighting initially observed following inoculation. There appeared to be little crown recovery on grasses with dead foliage during the subsequent 20 days in the greenhouse. Only those varieties showing some resistance in the inoculation chamber demonstrated any regrowth potential following inoculation. The absence of regrowth of the crown originating leaf tissue on blighted grasses indicates the pathogenic progress of the disease reached and destroyed the crown rather rapidly, even though the inoculation and infection was on the leaf blades. These observations agree with typical outbreaks of Pythium blight which usually kills the entire plant, thus destroying any potential for recovery after the disease has been arrested.

Several of the bentgrass genotypes from previous studies were maintained in the greenhouse for a minimum of three weeks before they were again inoculated to determine their resistance to Pythium blight. Some of the surviving plants were again re-challenged with the same Pythium strains; they were treated in all respects as if

they were challenged for the first time.

Re-inoculation of these bentgrass genotypes showing resistance after the first inoculation demonstrated some interesting results. Test genotypes which were immediately reinoculated with Pythium spp. succumbed to foliar blight although slowly. These results again suggest the extended incubation of the grasses in a low light intensity has some deleterious effects on the observed resistance to Pythium foliar blight. Survivors of the second round re-inoculation study are shown in Table 1.

Previous studies have shown that bentgrass germplasm lines taken directly from the field are more tolerant of Pythium blight than the same grasses taken from extended culture on a greenhouse bench. In one study, 45% of the population of field collected bentgrass germplasm lines expressed some resistance to Pythium blight while only 8% of the same population of plants demonstrated blight resistance when grown on a greenhouse bench before inoculation with Pythium spp. The standard variety Penncross was among the most disease susceptibile of the bent population studied regardless of the method of sampling.

Successes in current areas of research stress the desirability of following certain avenues further, for example, comparisons of greenhouse maintained and immediately dug field samples of turfgrasses. There are indications that turfgrasses loose their hardihood when they are maintained for extended periods in the greenhouse, whereas field samples challenged with fungi shortly after the samples have been dug up, still retain some protective qualities where fungal infections are concerned.

Table 1. Surviving population of experimental bentgrass lines subjected to two inoculations with Pythium spp. following their initial collection from the field and post inoculation growth on a a greenhouse bench for three or more weeks.

Entry	Field Plot #	Entry	Field Plot #
1	404	21	418
2	312	22	1809
3	902	23	1511
4	501	24	1209
5	115	25	1416
6	1007	26	1303
7	804	27	309
8	1812	28	205
9	1004	29	813
10	1107	30	701
11	509	31	106
12	1214	32	1317
13	110	33	1407
14	709	34	1405
15	210	35	305
16	606	36	1310
17	315	37	1210
18	1410	38	1807
19	1803	39	1309
20	905	40	1607

a/ All bentgrass experimental lines were inoculated and incubated in one of two walk-in temperature chambers during a seven day period.

b/Percent blight was determined by visual assessments of the foliar canopy of each turfgrass sample where estimates of the percentage area infected were made following the disease cycle.

c.) **Inoculation Studies - bentgrass green:**

Mass inoculation procedures used for the previous studies were used to determine Pythium resistance among bentgrass germplasm lines obtained from advanced germplasm selections in the TAMU-Dallas experimental green nursery plots. Cores of each of the germplasm lines giving two and occasionally four replications of each variety were dug on 30 June from respective field plots and were transferred to the walk-in inoculation chambers where they were challenged with the virulent strains of Pythium spp. Ten cores of the standard variety Penncross was used in the study for comparisons of disease susceptibility among germplasm lines. The infected bentgrasses were removed from the inoculation chamber after 7 days and placed on a greenhouse bench for observation. The foliar blighting by Pythium spp. on these grasses is shown in Table 2. Once again, there appeared to be little crown recovery on the grasses during the subsequent 20 days in the greenhouse excepting those varieties showing some resistance in the inoculation chamber.

Evaluations of blighting in this study indicated the standard comparison variety Penncross consistently ranked in the lower one-third or the most disease susceptible group (Table 2). Examination of disease reaction by use of the fisheye center blight method appeared to be more critical for assessing disease than the older method of using the percentage of disease on the entire foliar canopy. There were 17 experimental germplasm lines of 80 experimental lines tested that demonstrated complete resistance to foliar blighting using both of disease assessment and among all

Table 2. Pythium foliar blighting in percent area infected of field plot plugs taken from Bentgrass Green and GPIN plots and inoculated in a walk-in treatment chamber for a seven day period.

WEEK 26		JUN 28 89		JUN 30 89
	PLOT NUMBER	PERCENT BLIGHT	*/RR	FISHEYE METHOD
1	4-2	0		0
2	5-14	* 0	RR	0
3	10-08	0		0
4	2-31	0		0
5	11-6	0		0
6	6-26	* 0		20
7	5-36	* 0		0
8	5-36	* 0		0
9	14-36	0		0
10	3-46	* 0		0
11	2-55	* 0		0
12	3-24	* 0		0
13	1001	0		95
14	3-46	* 0		0
15	14-11	0		0
16	2104	0		50
17	12-13	0		10
18	15-11	* 0		0
19	1004	* 0		20
20	13-17	* 0		70
21	8-16	* 0		5
22	8-20	* 0		0
23	5-14	* 0	RR	0
24	8-20	* 0		0
25	5-38	0		0
26	5-14	* 0	RR	0
27	2506	* 0	RR	0
28	1506	* 0		0
29	1709	* 0	RR	5
30	1004	* 0		5
31	1005	* 0		0
32	1208	0		30
33	1511	* 0		0
34	5-52	0		0
35	1306	* 0		0
36	1001	80		10
37	1209	35		80
38	1306	* 0		5
39	1404	55		100
40	2-55	* 5		60

* = Consistent Pythium resistance among replications
RR = Pythium resistance also shown in previous studies

Table 2 cont:

WEEK 26		JUN 28 89			JUN 30 89
	PLOT NUMBER	PERCENT BLIGHT			FISHEYE METHOD
41	6-26	*	0		0
42	6-1		5		20
43	4-30		20		50
44	4-30		20		70
45	5-14	*	0	RR	0
46	12-16		10		10
47	2404	*	5	RR	5
48	803		10		80
49	1709	*	5	RR	15
50	2506	*	0	RR	0
51	8-16	*	5		25
52	1208		85		100
53	5-45		85		100
54	14-11		65		100
55	5-48		55		90
56	1209		55		100
57	14-36		50		90
58	1404		65		90
59	4-53		75		75
60	1204		50		100
61	1005		60		70
62	14-53		85		100
63	2205		85		100
64	2404	*	5	RR	5
65	1506	*	5		15
66	14-57		65		15
67	13-17	*	10		90
68	3-24	*	10		50
69	3-11		65		100
70	805		70		100
71	2305		40		75
72	805		65		100
73	2104		65		90
74	3-09		90		90
75	12-16		55		80
76	5-52		90		100
77	4-42		80		100
78	1111		90		80
79	5-38		80		100
80	2305		60		90
81	1801		85		90
82	2-34		90		100
83	2205		90		100
84	14-57		90		90
85	4-1		95		90
86	4-41		80		100
87	4-1		98		90
88	1111		95		90
89	5-48		93		90

Table 2 cont:

WEEK 26		JUN 28 89	JUN 30 89
	PLOT NUMBER	PERCENT BLIGHT	FISHEYE METHOD
90	14-53	95	100
91	11-33	99	100
92	4-42	90	90
93	3-09	100	100
94	11-33	100	100
95	12-5	95	100
96	13-32	98	100
97	2-34	100	100
98	12-13	100	95
99	4-53	100	95
100	4-41	90	100
101	13-32	93	100
102	3-09	95	100
103	3-09	100	100
104	4-41	98	100
105	8-58	100	100
106	4-42	100	100
107	4-42	98	100
108	4-2	80	90
109	4-27	70	100
110	11-6	80	95
111	5-20	65	100
112	5-20	65	95
113	1710	45	100
114	4-30	60	100
115	3-11	60	100
116	PENNCROSS	55	97
117	2111	60	100
118	1810	65	100
119	1710	55	100
120	3-6	85	100
121	4-30	30	95
122	PENNCROSS	85	100
123	4-27	85	100
124	2304	100	100
125	1703	95	95
126	4-41	90	95
127	2405	90	95
128	2508	95	100
129	PENNCROSS	98	100
130	10-08	100	100
131	PENNCROSS	98	100
132	PENNCROSS	98	95
133	8-58	99	100
134	10-2	100	100
135	2508	100	100
136	5-45	98	100
137	12-29	98	100
138	PENNCROSS	99	98
139	PENNCROSS	99	99

Table 2 cont:

WEEK 26	PLOT NUMBER	JUN 28 89 PERCENT BLIGHT	JUN 30 89 FISHEYE METHOD
140	2-31	100	100
141	12-5	100	100
142	3-6	100	100
143	4-1	100	100
144	4-1	100	100
145	PENNCROSS	99	100
146	PENNCROSS	98	100
147	2405	99	100
148	1810	99	99
149	12-04	100	100
150	2111	99	99
151	1801	100	100
152	1204	100	100
153	803	100	100
154	1703	100	100
155	2304	100	100
156	12-04	100	100
157	6-1	30	20
158	12-29	15	50
159	10-2	90	100
160	PENNCROSS	85	90

a/ All bentgrass experimental lines were inoculated and incubated in one of two walk-in temperature chambers during a seven day period.

b/Percent blight was determined by visual assessments of the foliar canopy of each turfgrass sample where estimates of the percentage area infected were made following the disease cycle.

replications used (Table 2). It is interesting to note that of the 17 superior disease resistant germplasm selections, there were four that were shown to be resistant in previous disease screen studies (Table 2).

d.) **Inoculation Study Cores from NHTS/HTS:**

Methods as previously described were used for inoculation of bentgrass germplasm lines obtained from bentgrass field nurseries planted with bentgrasses from high temperature tolerant (HTS) and not high temperature tolerant (NHTS) experimental lines. A total of 508 cores were obtained on 14 July from the nurseries and subjected to mass inoculation procedures previously described for the walk-in inoculation chamber. The standard variety Penncross was well represented in the study in order to determine possible effects of location within the inoculation chamber on the disease reaction observed. Of the 508 samples under study 79 (16%) were var. Penncross which was placed in groups of 10 in single inoculation trays or scattered randomly as single replicates among experimental lines in different trays.

Results of disease assessments after the 7-day inoculation period indicated the variety Penncross had a 90-100% disease rating in almost all of the replicates studied. Placement of Penncross in differing incubation trays or location within single trays did not vary the susceptible disease reaction observed (Table 3). Seventy-one experimental bentgrass germplasm lines gave a disease reaction of 30% or less foliar blighting. This group included 66 (17%) of the 378 heat-treatment selections (HTS) studied and 5 (9.8%) of the 51 not heat treatment (NHTS) select-

Table 3. Pythium Foliar blighting in percent area infected of field plot plugs taken from NHTS and HTS-Bentgrass Nursery Plots and inoculated in a walk-in treatment chamber for seven days.

WEEK 26 (NHTS-HTS) JUL 14 89

	NUMBER	SAMPLE \a	TRAY	PERCENT BLIGHT \b
1	PENN	PENNCROSS	1	100
2	PENN	PENNCROSS	1	99
3	PENN	PENNCROSS	1	99
4	PENN	PENNCROSS	1	99
5	PENN	PENNCROSS	1	100
6	PENN	PENNCROSS	1	100
7	PENN	PENNCROSS	1	94
8	PENN	PENNCROSS	1	93
9	PENN	PENNCROSS	1	100
10	PENN	PENNCROSS	1	99
11	PENN	PENNCROSS	2	100
12	PENN	PENNCROSS	2	99
13	PENN	PENNCROSS	2	100
14	PENN	PENNCROSS	2	98
15	PENN	PENNCROSS	2	96
16	PENN	PENNCROSS	2	99
17	PENN	PENNCROSS	2	96
18	PENN	PENNCROSS	2	98
19	PENN	PENNCROSS	2	99
20	PENN	PENNCROSS	2	92
21	PENN	PENNCROSS	3	99
22	PENN	PENNCROSS	3	92
23	PENN	PENNCROSS	3	98
24	PENN	PENNCROSS	3	99
25	PENN	PENNCROSS	3	90
26	PENN	PENNCROSS	3	100
27	PENN	PENNCROSS	3	100
28	PENN	PENNCROSS	3	100
29	PENN	PENNCROSS	3	100
30	PENN	PENNCROSS	3	99
31	PENN	PENNCROSS	4	98
32	PENN	PENNCROSS	4	100
33	PENN	PENNCROSS	4	98
34	PENN	PENNCROSS	4	100
35	PENN	PENNCROSS	4	100
36	PENN	PENNCROSS	4	92
37	PENN	PENNCROSS	4	100
38	PENN	PENNCROSS	4	100
39	PENN	PENNCROSS	4	99

Table 3 cont:

WEEK 26 JUL 14 89

	NUMBER	SAMPLE	TRAY	PERCENT BLIGHT
40	PENN	PENNCROSS	4	85
41	15-17	NHTS	5	100
42	15-15	HTS	5	100
43	15-18	HTS	5	98
44	15-21	HTS	5	80
45	16-17	NHTS	5	5
46	15-19	HTS	5	80
47	15-20	HTS	5	40
48	14-21	HTS	5	70
49	15-16	HTS	5	100
50	14-16	HTS	5	95
51	15-17	HTS	5	100
52	PENN	PENNCROSS	5	100
53	14-18	HTS	6	90
54	14-17	NHTS	6	95
55	14-15	HTS	6	75
56	13-17	HTS	6	95
57	PENN	PENNCROSS	6	98
58	14-20	HTS	6	40
59	14-19	HTS	6	80
60	13-20	HTS	6	100
61	14-17	HTS	6	100
62	13-18	HTS	6	80
63	13-21	HTS	6	99
64	13-16	HTS	6	70
65	PENN	PENNCROSS	7	100
66	13-17	NHTS	7	90
67	12-20	HTS	7	100
68	12-19	HTS	7	85
69	12-21	HTS	7	95
70	12-15	HTS	7	50
71	12-17	HTS	7	100
72	13-15	HTS	7	90
73	12-16	HTS	7	100
74	12-17	NHTS	7	100
75	13-19	HTS	7	95
76	12-18	HTS	7	98
77	10-21	HTS	8	90
78	PENN	PENNCROSS	8	98
79	9-18	HTS	8	50
80	9-17	HTS	8	100
81	9-19	HTS	8	5
82	9-16	HTS	8	100
83	10-15	HTS	8	90
84	9-20	HTS	8	98
85	10-18	HTS	8	95
86	10-20	HTS	8	100
87	10-16	HTS	8	100
88	9-21	HTS	8	95
89	8-17	NHTS	9	75

Table 3 cont:

WEEK 26 JUL 14 89

	NUMBER	SAMPLE	TRAY	PERCENT BLIGHT
90	7-15	HTS	9	100
91	8-15	HTS	9	100
92	8-20	HTS	9	100
93	8-18	HTS	9	60
94	8-19	HTS	9	100
95	8-16	HTS	9	90
96	8-21	HTS	9	100
97	8-17	HTS	9	100
98	9-15	HTS	9	100
99	9-17	NHTS	9	75
100	PENN	PENNCROSS	9	95
101	16-19	HTS	10	98
102	17-17	NHTS	10	90
103	16-15	HTS	10	100
104	16-16	HTS	10	100
105	17-16	HTS	10	100
106	17-18	HTS	10	85
107	16-20	HTS	10	70
108	16-17	HTS	10	30
109	16-21	HTS	10	100
110	16-18	HTS	10	5
111	17-20	HTS	10	100
112	PENN	PENNCROSS	10	100
113	11-19	HTS	11	100
114	11-18	HTS	11	100
115	11-16	HTS	11	80
116	10-17	NHTS	11	90
117	11-17	NHTS	11	100
118	PENN	PENNCROSS	11	50
119	11-17	HTS	11	0
120	11-15	HTS	11	5
121	11-21	HTS	11	100
122	11-20	HTS	11	40
123	10-19	HTS	11	65
124	10-17	HTS	11	100
125	PENN	PENNCROSS	12	95
126	17-18	HTS	12	7
127	16-9	HTS	12	5
128	17-12	HTS	12	100
129	16-11	HTS	12	100
130	17-11	NHTS	12	5
131	17-11	HTS	12	95
132	17-10	HTS	12	90
133	17-13	HTS	12	98
134	18-10	HTS	12	95
135	17-14	HTS	12	40
136	17-9	HTS	12	100
137	PENN	PENNCROSS	13	20
138	9-14	HTS	13	50
139	9-12	HTS	13	100

Table 3 cont:

WEEK 26 JUL 14 89

	NUMBER	SAMPLE	TRAY	PERCENT BLIGHT
140	8-8	HTS	13	20
141	8-9	HTS	13	100
142	8-13	HTS	13	0
143	9-11	NHTS	13	100
144	9-11	HTS	13	100
145	9-10	HTS	13	10
146	8-11	NHTS	13	85
147	8-12	HTS	13	100
148	8-14	HTS	13	100
149	10-8	HTS	14	100
150	10-9	HTS	14	80
151	9-8	HTS	14	100
152	10-11	NHTS	14	95
153	9-9	HTS	14	100
154	10-12	HTS	14	100
155	10-10	HTS	14	0
156	11-10	HTS	14	98
157	PENN	PENNCROSS	14	95
158	10-14	HTS	14	10
159	10-13	HTS	14	10
160	10-11	HTS	14	0
161	13-9	HTS	15	99
162	13-13	HTS	15	100
163	13-12	HTS	15	100
164	12-13	HTS	15	100
165	12-8	HTS	15	100
166	PENN	PENNCROSS	15	95
167	13-14	HTS	15	100
168	13-11	HTS	15	100
169	13-11	NHTS	15	100
170	13-10	HTS	15	95
171	12-10	HTS	15	0
172	12-14	HTS	15	0
173	14-13	HTS	16	50
174	14-12	HTS	16	90
175	14-10	HTS	16	90
176	PENN	PENNCROSS	16	100
177	15-12	HTS	16	100
178	13-8	HTS	16	90
179	14-14	HTS	16	80
180	14-11	HTS	16	95
181	14-11	NHTS	16	100
182	15-11	NHTS	16	100
183	14-9	HTS	16	100
184	14-8	HTS	16	10
185	15-13	HTS	17	30
186	15-14	HTS	17	30
187	PENN	PENNCROSS	17	95
188	16-12	HTS	17	100
189	16-8	HTS	17	15

Table 3 cont:

WEEK 26 JUL 14 89

	NUMBER	SAMPLE	TRAY	PERCENT BLIGHT
190	16-13	HTS	17	100
191	15-10	HTS	17	100
192	15-9	HTS	17	0
193	15-11	HTS	17	95
194	15-8	HTS	17	95
195	16-14	HTS	17	10
196	16-11	NHTS	17	70
197	5-12	HTS	18	100
198	5-11	HTS	18	100
199	5-11	NHTS	18	10
200	PENN	PENNCROSS	18	60
201	5-14	HTS	18	100
202	5-10	HTS	18	90
203	6-11	HTS	18	100
204	6-11	NHTS	18	100
205	6-9	HTS	18	95
206	6-12	HTS	18	95
207	5-13	HTS	18	100
208	6-13	HTS	18	50
209	PENN	PENNCROSS	19	100
210	3-9	HTS	19	10
211	3-12	HTS	19	80
212	3-11	NHTS	19	70
213	3-8	HTS	19	100
214	3-14	HTS	19	90
215	2-9	HTS	19	0
216	2-11	HTS	19	100
217	3-11	HTS	19	95
218	2-10	HTS	19	100
219	2-13	HTS	19	90
220	2-11	NHTS	19	5
221	6-16	HTS	20	90
222	7-17	NHTS	20	50
223	7-21	HTS	20	90
224	7-19	HTS	20	100
225	7-18	HTS	20	100
226	7-20	HTS	20	100
227	6-20	HTS	20	98
228	6-21	HTS	20	98
229	6-17	NHTS	20	100
230	7-17	HTS	20	100
231	7-16	HTS	20	100
232	PENN	PENNCROSS	20	98
233	17-1	NHTS	21	90
234	17-1	HTS	21	90
235	7-16	HTS	21	98
236	17-4	HTS	21	100
237	17-2	HTS	21	10
238	17-3	HTS	21	100
239	16-7	HTS	21	100

Table 3 cont:

WEEK 26 JUL 14 89

	NUMBER	SAMPLE	TRAY	PERCENT BLIGHT
240	PENN	PENNCROSS	21	98
241	16-6	HTS	21	98
242	16-5	HTS	21	100
243	16-2	HTS	21	100
244	17-5	HTS	21	100
245	6-1	NHTS	22	100
246	7-1	HTS	22	100
247	7-3	HTS	22	100
248	7-6	HTS	22	100
249	PENN	PENNCROSS	22	98
250	7-7	HTS	22	90
251	7-4	HTS	22	100
252	6-1	HTS	22	100
253	7-1	NHTS	22	98
254	7-2	HTS	22	12
255	8-1	NHTS	22	100
256	7-5	HTS	22	100
257	PENN	PENNCROSS	23	100
258	9-5	HTS	23	15
259	9-4	HTS	23	100
260	8-5	HTS	23	80
261	8-4	HTS	23	100
262	8-2	HTS	23	100
263	8-7	HTS	23	100
264	9-7	HTS	23	0
265	9-6	HTS	23	60
266	8-6	HTS	23	10
267	8-3	HTS	23	20
268	8-1	HTS	23	90
269	16-1	HTS	24	90
270	15-3	HTS	24	100
271	16-4	HTS	24	80
272	15-6	HTS	24	100
273	15-1	HTS	24	90
274	16-3	HTS	24	90
275	15-7	HTS	24	0
276	15-5	HTS	24	100
277	16-1	NHTS	24	100
278	PENN	PENNCROSS	24	100
279	15-1	NHTS	24	100
280	15-2	HTS	24	70
281	6-17	HTS	25	100
282	6-15	HTS	25	70
283	6-18	HTS	25	50
284	5-19	HTS	25	5
285	5-20	HTS	25	100
286	5-18	HTS	25	70
287	5-21	HTS	25	100
288	6-19	HTS	25	100
289	5-16	HTS	25	90

Table 3 cont:

WEEK 26 JUL 14 89

	NUMBER	SAMPLE	TRAY	PERCENT BLIGHT
290	15-17	NHTS	25	100
291	PENN	PENNCROSS	25	98
292	5-15	HTS	25	50
293	9-1	HTS	26	100
294	10-4	HTS	26	100
295	10-5	HTS	26	5
296	10-3	HTS	26	100
297	10-1	HTS	26	100
298	PENN	PENNCROSS	26	98
299	10-6	HTS	26	70
300	9-3	HTS	26	20
301	9-2	HTS	26	5
302	9-1	NHTS	26	0
303	10-2	HTS	26	10
304	10-7	HTS	26	0
305	3-2	HTS	27	98
306	3-6	HTS	27	100
307	2-5	HTS	27	100
308	2-3	HTS	27	20
309	2-6	HTS	27	100
310	PENN	PENNCROSS	27	90
311	3-4	HTS	27	0
312	3-1	HTS	27	100
313	2-4	HTS	27	100
314	3-3	HTS	27	90
315	3-5	HTS	27	90
316	3-7	HTS	27	90
317	11-2	HTS	28	100
318	11-4	HTS	28	50
319	PENN	PENNCROSS	28	100
320	11-6	HTS	28	90
321	12-7	HTS	28	10
322	12-4	HTS	28	100
323	11-7	HTS	28	100
324	10-1	HTS	28	98
325	11-1	HTS	28	25
326	11-5	HTS	28	0
327	11-3	HTS	28	50
328	12-5	HTS	28	100
329	3-17	NHTS	29	100
330	3-20	HTS	29	100
331	4-17	NHTS	29	98
332	4-18	HTS	29	100
333	4-19	HTS	29	90
334	4-16	HTS	29	100
335	4-17	HTS	29	100
336	4-15	HTS	29	20
337	4-21	HTS	29	5
338	4-20	HTS	29	70
339	PENN	PENNCROSS	29	100

Table 3 cont:

WEEK 26 JUL 14 89

	NUMBER	SAMPLE	TRAY	PERCENT BLIGHT
340	5-17	HTS	29	100
341	5-5	HTS	30	5
342	4-7	HTS	30	80
343	4-6	HTS	30	0
344	5-6	HTS	30	90
345	4-2	HTS	30	5
346	5-7	HTS	30	90
347	PENN	PENNCROSS	30	98
348	4-1	NHTS	30	0
349	4-4	HTS	30	5
350	4-1	HTS	30	98
351	4-5	HTS	30	98
352	3-1	NHTS	30	100
353	1-1	HTS	31	30
354	1-4	HTS	31	100
355	1-7	HTS	31	100
356	2-2	HTS	31	80
357	1-1	NHTS	31	85
358	PENN	PENNCROSS	31	95
359	2-1	HTS	31	100
360	1-6	HTS	31	95
361	1-2	HTS	31	100
362	1-3	HTS	31	100
363	2-1	NHTS	31	100
364	1-5	HTS	31	98
365	12-2	HTS	32	90
366	PENN	PENNCROSS	32	100
367	13-5	HTS	32	70
368	13-1	HTS	32	100
369	13-1	NHTS	32	90
370	13-6	HTS	32	100
371	12-1	HTS	32	100
372	12-6	HTS	32	90
373	12-3	HTS	32	90
374	13-4	HTS	32	90
375	12-1	NHTS	32	100
376	13-7	HTS	32	20
377	14-1	HTS	33	95
378	13-2	HTS	33	100
379	14-2	HTS	33	100
380	14-3	HTS	33	100
381	15-4	HTS	33	100
382	14-7	HTS	33	100
383	14-4	HTS	33	100
384	13-3	HTS	33	100
385	PENN	PENNCROSS	33	100
386	14-1	NHTS	33	100
387	14-5	HTS	33	5
388	14-6	HTS	33	90
389	19-17	NHTS	34	40

Table 3 cont:

WEEK 26 JUL 14 89

	NUMBER	SAMPLE	TRAY	PERCENT BLIGHT
390	18-18	HTS	34	90
391	18-15	HTS	34	100
392	18-19	HTS	34	100
393	18-21	HTS	34	100
394	17-19	HTS	34	90
395	18-17	NHTS	34	100
396	PENN	PENNCROSS	34	95
397	18-20	HTS	34	100
398	17-17	HTS	34	100
399	17-15	HTS	34	100
400	18-16	HTS	34	100
401	PENN	PENNCROSS	35	85
402	17-7	HTS	35	90
403	19-1	NHTS	35	100
404	18-1	NHTS	35	100
405	18-6	HTS	35	100
406	18-7	NHTS	35	100
407	18-1	HTS	35	100
408	18-2	HTS	35	100
409	20-1	NHTS	35	100
410	18-3	HTS	35	100
411	18-5	HTS	35	95
412	18-4	HTS	35	10
413	5-1	NHTS	36	100
414	5-2	HTS	36	20
415	5-4	HTS	36	100
416	5-3	HTS	36	100
417	6-7	HTS	36	80
418	6-5	HTS	36	70
419	6-6	HTS	36	100
420	5-1	HTS	36	100
421	PENN	PENNCROSS	36	85
422	6-3	HTS	36	100
423	6-2	HTS	36	10
424	6-4	HTS	36	30
425	1-11	NHTS	37	100
426	1-11	HTS	37	100
427	2-14	HTS	37	100
428	2-12	HTS	37	100
429	PENN	PENNCROSS	37	100
430	2-8	HTS	37	100
431	1-9	HTS	37	5
432	1-10	HTS	37	90
433	1-14	HTS	37	95
434	1-13	HTS	37	100
435	1-8	HTS	37	70
436	1-12	HTS	37	60
437	2-17	NHTS	38	90
438	2-15	HTS	38	30
439	1-21	HTS	38	100

Table 3 cont:

WEEK 26 JUL 14 89

	NUMBER	SAMPLE	TRAY	PERCENT BLIGHT
440	1-17	NHTS	38	100
441	1-15	HTS	38	45
442	1-20	HTS	38	85
443	1-17	HTS	38	100
444	2-19	HTS	38	100
445	PENN	PENNCROSS	38	100
446	1-16	HTS	38	100
447	1-19	HTS	38	100
448	1-18	HTS	38	95
449	PENN	PENNCROSS	39	100
450	4-9	HTS	39	90
451	4-11	NHTS	39	90
452	4-13	HTS	39	80
453	4-12	HTS	39	100
454	4-14	HTS	39	100
455	4-11	HTS	39	100
456	3-10	HTS	39	95
457	3-13	HTS	39	90
458	5-9	HTS	39	85
459	4-8	HTS	39	80
460	4-10	HTS	39	80
461	12-12	HTS	40	90
462	12-11	NHTS	40	100
463	11-14	HTS	40	10
464	11-13	HTS	40	15
465	11-9	HTS	40	100
466	11-11	NHTS	40	95
467	11-8	HTS	40	100
468	12-9	HTS	40	100
469	12-11	HTS	40	5
470	PENN	PENNCROSS	40	100
471	11-11	HTS	40	100
472	11-12	HTS	40	100
473	18-11	HTS	41	98
474	18-8	HTS	41	98
475	18-14	HTS	41	90
476	19-11	NHTS	41	100
477	18-9	HTS	41	90
478	PENN	PENNCROSS	41	100
479	18-13	HTS	41	80
480	18-11	NHTS	41	90
481	18-12	HTS	41	100
482	20-11	NHTS	41	100
483	0	HTS	41	0
484	0	HTS	41	0
485	3-21	HTS	42	100
486	3-15	HTS	42	100
487	PENN	PENNCROSS	42	90
488	2-16	HTS	42	100
489	2-17	HTS	42	0

Table 3 cont:

WEEK 26 JUL 14 89

	NUMBER	SAMPLE	TRAY	PERCENT BLIGHT
490	3-18	HTS	42	100
491	3-17	HTS	42	100
492	3-16	HTS	42	100
493	3-19	HTS	42	100
494	2-21	HTS	42	100
495	2-20	HTS	42	100
496	2-18	HTS	42	100
497	10-8	HTS	43	10
498	7-9	HTS	43	0
499	6-14	HTS	43	15
500	7-12	HTS	43	90
501	7-11	NHTS	43	100
502	7-10	HTS	43	20
503	PENN	PENNCROSS	43	100
504	8-11	HTS	43	100
505	7-14	HTS	43	100
506	7-8	HTS	43	100
507	7-13	HTS	43	80
508	7-11	HTS	43	100

a/ All bentgrass experimental lines were inoculated and incubated in one of two walk-in temperature chambers during a seven day period.

b/Percent blight was determined by visual assessments of the foliar canopy of each turfgrass sample where estimates of the percentage area infected were made following the disease cycle.

ions studied.

e.) **Inoculation Study Cores from HTS:**

Further research on the germplasm line selections from the non heat treated selections (NHTS) and the heat treatment selections (HTS) of respective field nurseries was conducted on 20 July. The standard commercial bentgrass variety Penncross was again used in each of the inoculation trays for the comparison of disease reaction among experimental germplasm lines. Methods of handling and inoculation of cores of grasses collected from the field nurseries are the same as those described for mass inoculation techniques.

Results of the study after 7-days inoculation with four virulent strains of Pythium spp. are shown in Table 4. The commercial variety Penncross consistently ranked among the poorest group in disease reaction. Only two Penncross cores of 70 tested ranked less than 90% blighting either after placement in groups of 10 or singly in trays. Erratic disease for these two was attributed to possible failures in inoculating with all four strains of Pythium spp.

Of experimental germplasm lines studied, 18 (33%) of 53 selections from the HTS nursery and 66 (16%) of 412 selections from the NHTS nursery block were observed to be resistant to Pythium foliar blighting.

5. Inoculation Check on Consistency

A demonstration experiment was set-up to check the consistency of results obtained in mass screening for disease

Table 4. Pythium Foliar blighting in percent area infected of field plot plugs taken from NHTS and HTS-Bentgrass Nursery Plots and inoculated in a walk-in treatment chamber for seven days.

WEEK 29 INSECTORY 4 & 5 (NHTS-HTS) JULY 20 89

	NUMBER	SAMPLE \a	TRAY	PERCENT BLIGHT \b
1	3-10	HTS	1	5
2	2-14	NHTS	1	100
3	2-13	NHTS	1	90
4	3-9	NHTS	1	0
5	3-11	NHTS	1	10
6	3-10	NHTS	1	70
7	3-12	NHTS	1	60
8	2-11	NHTS	1	100
9	2-10	NHTS	1	40
10	PENN	PENNCROSS	1	100
11	3-8	NHTS	1	40
12	2-10	HTS	1	30
13	10-20	NHTS	2	100
14	10-18	NHTS	2	100
15	16-3	NHTS	2	100
16	9-17	NHTS	2	90
17	9-21	NHTS	2	100
18	PENN	PENNCROSS	2	100
19	9-16	NHTS	2	100
20	10-19	NHTS	2	20
21	10-15	NHTS	2	100
22	10-17	NHTS	2	100
23	9-18	NHTS	2	100
24	9-20	NHTS	2	100
25	17-18	NHTS	3	100
26	PENN	PENNCROSS	3	100
27	16-15	NHTS	3	100
28	16-19	NHTS	3	100
29	9-19	NHTS	3	90
30	16-17	NHTS	3	20
31	16-20	NHTS	3	100
32	16-15	HTS	3	100
33	17-15	HTS	3	100
34	16-21	NHTS	3	10
35	17-15	NHTS	3	100
36	17-17	NHTS	3	100
37	16-18	NHTS	3	100
38	15-4	NHTS	4	80
39	15-7	NHTS	4	100
40	16-5	NHTS	4	100
41	16-6	HTS	4	90
42	PENN	PENNCROSS	4	100
43	15-6	NHTS	4	100
44	15-1	NHTS	4	100
45	15-5	NHTS	4	75
46	15-3	NHTS	4	100
47	16-1	NHTS	4	30
48	15-2	NHTS	4	100

Table 4. continued:

DISEASE OBSERVATIONS (NHTS-HTS)
WEEK 29 INSECTORY 4 & 5 JULY 20 89

	NUMBER	SAMPLE	TRAY	PERCENT BLIGHT
49	16-4	NHTS	4	100
50	13-2	NHTS	5	100
51	14-5	NHTS	5	100
52	14-3	NHTS	5	100
53	14-1	NHTS	5	70
54	15-6	HTS	5	0
55	14-6	NHTS	5	40
56	14-2	NHTS	5	100
57	13-7	NHTS	5	100
58	14-6	HTS	5	80
59	14-7	NHTS	5	0
60	14-4	NHTS	5	100
61	PENN	PENNCROSS	5	90
62	3-15	HTS	6	5
63	3-18	NHTS	6	100
64	3-21	NHTS	6	10
65	3-19	NHTS	6	100
66	3-16	NHTS	6	100
67	PENN	PENNCROSS	6	100
68	3-17	NHTS	6	100
69	3-15	NHTS	6	10
70	2-21	NHTS	6	5
71	2-20	NHTS	6	0
72	2-15	NHTS	6	80
73	2-18	NHTS	6	100
74	5-20	NHTS	7	60
75	6-20	NHTS	7	100
76	PENN	PENNCROSS	7	100
77	5-16	NHTS	7	100
78	5-21	NHTS	7	80
79	5-18	NHTS	7	100
80	6-21	NHTS	7	100
81	5-15	HTS	7	100
82	5-19	NHTS	7	100
83	6-17	NHTS	7	100
84	6-15	HTS	7	0
85	6-19	NHTS	7	100
86	18-21	NHTS	8	100
87	18-15	HTS	8	100
88	18-19	NHTS	8	90
89	PENN	PENNCROSS	8	100
90	18-15	NHTS	8	100
91	18-17	NHTS	8	100
92	18-16	NHTS	8	100
93	17-19	NHTS	8	100
94	17-20	NHTS	8	90
95	17-21	NHTS	8	10
96	18-18	NHTS	8	100
97	18-20	NHTS	8	80
98	11-21	NHTS	9	80
99	11-18	NHTS	9	100
100	10-15	HTS	9	90
101	10-21	NHTS	9	100

Table 4. continued:

DISEASE OBSERVATIONS (NHTS-HTS)
WEEK 29 INSECTORY 4 & 5 JULY 20 89

	NUMBER	SAMPLE	TRAY	PERCENT BLIGHT
102	10-16	NHTS	9	40
103	11-16	NHTS	9	100
104	11-20	NHTS	9	100
105	11-19	NHTS	9	100
106	PENN	PENNCROSS	9	100
107	11-15	HTS	9	100
108	11-17	NHTS	9	100
109	11-15	NHTS	9	5
110	17-7	NHTS	10	100
111	17-4	NHTS	10	100
112	16-2	NHTS	10	90
113	17-3	NHTS	10	100
114	17-6	HTS	10	15
115	16-7	NHTS	10	5
116	17-1	NHTS	10	0
117	PENN	PENNCROSS	10	100
118	17-2	NHTS	10	0
119	17-5	NHTS	10	100
120	17-6	NHTS	10	100
121	16-6	NHTS	10	100
122	7-6	HTS	11	80
123	6-5	NHTS	11	90
124	6-3	NHTS	11	10
125	7-3	NHTS	11	20
126	8-7	NHTS	11	90
127	7-1	NHTS	11	80
128	7-6	NHTS	11	5
129	7-4	NHTS	11	15
130	PENN	PENNCROSS	11	100
131	7-2	NHTS	11	100
132	7-7	NHTS	11	5
133	7-5	NHTS	11	100
134	8-2	NHTS	12	100
135	8-5	NHTS	12	100
136	9-2	NHTS	12	10
137	9-4	NHTS	12	100
138	PENN	PENNCROSS	12	90
139	9-5	NHTS	12	75
140	8-4	NHTS	12	100
141	8-6	HTS	12	100
142	8-6	NHTS	12	100
143	8-1	NHTS	12	100
144	8-3	NHTS	12	100
145	9-1	NHTS	12	90
146	PENN	PENNCROSS	13	100
147	2-5	NHTS	13	0
148	1-7	NHTS	13	100
149	1-6	HTS	13	40
150	1-5	NHTS	13	100
151	1-4	NHTS	13	90
152	1-2	NHTS	13	100
153	2-7	NHTS	13	30
154	2-6	NHTS	13	100

Table 4. continued:

DISEASE OBSERVATIONS (NHTS-HTS)

WEEK 29 INSECTORY 4 & 5 JULY 20 89

	NUMBER	SAMPLE	TRAY	PERCENT BLIGHT
155	1-3	NHTS	13	100
156	1-6	NHTS	13	10
157	1-1	NHTS	13	100
158	9-7	NHTS	14	100
159	PENN	PENNCROSS	14	100
160	10-3	NHTS	14	100
161	10-6	NHTS	14	80
162	10-4	NHTS	14	30
163	10-6	HTS	14	100
164	10-1	NHTS	14	100
165	9-6	HTS	14	100
166	9-6	NHTS	14	80
167	9-3	NHTS	14	15
168	10-2	NHTS	14	100
169	10-7	NHTS	14	100
170	2-4	NHTS	15	20
171	3-6	HTS	15	100
172	3-4	NHTS	15	0
173	2-3	NHTS	15	80
174	3-7	NHTS	15	100
175	3-5	NHTS	15	100
176	PENN	PENNCROSS	15	100
177	2-6	HTS	15	0
178	2-2	NHTS	15	100
179	2-1	NHTS	15	100
180	3-1	NHTS	15	0
181	3-6	NHTS	15	100
182	20-7	NHTS	16	80
183	19-5	NHTS	16	5
184	20-6	NHTS	16	70
185	20-3	NHTS	16	60
186	20-5	NHTS	16	100
187	20-1	NHTS	16	100
188	19-4	NHTS	16	80
189	19-7	NHTS	16	60
190	19-2	NHTS	16	100
191	PENN	PENNCROSS	16	100
192	20-4	NHTS	16	0
193	20-2	NHTS	16	100
194	3-3	NHTS	17	100
195	3-2	NHTS	17	12
196	4-6	HTS	17	80
197	4-6	NHTS	17	100
198	4-3	NHTS	17	100
199	4-2	NHTS	17	100
200	4-7	NHTS	17	90
201	4-4	NHTS	17	100
202	5-6	NHTS	17	100
203	5-6	HTS	17	100
204	PENN	PENNCROSS	17	100
205	4-5	NHTS	17	12
206	6-4	NHTS	18	15
207	6-6	NHTS	18	100

Table 4. continued:

DISEASE OBSERVATIONS (NHTS-HTS)

WEEK 29 INSECTORY 4 & 5 JULY 20 89

	NUMBER	SAMPLE	TRAY	PERCENT BLIGHT
208	PENN	PENNCROSS	18	100
209	5-5	NHTS	18	100
210	5-2	NHTS	18	100
211	5-7	NHTS	18	100
212	6-2	NHTS	18	90
213	6-1	NHTS	18	100
214	5-4	NHTS	18	100
215	6-7	NHTS	18	12
216	6-6	HTS	18	90
217	5-3	NHTS	18	90
218	11-2	NHTS	19	100
219	12-2	NHTS	19	90
220	12-1	NHTS	19	100
221	12-6	NHTS	19	100
222	11-7	NHTS	19	85
223	11-6	NHTS	19	90
224	PENN	PENNCROSS	19	100
225	11-3	NHTS	19	100
226	11-4	NHTS	19	70
227	11-5	NHTS	19	100
228	10-5	NHTS	19	100
229	11-6	HTS	19	100
230	PENN	PENNCROSS	20	100
231	PENN	PENNCROSS	20	100
232	PENN	PENNCROSS	20	100
233	PENN	PENNCROSS	20	100
234	PENN	PENNCROSS	20	100
235	PENN	PENNCROSS	20	100
236	PENN	PENNCROSS	20	95
237	PENN	PENNCROSS	20	100
238	PENN	PENNCROSS	20	100
239	PENN	PENNCROSS	20	100
240	18-1	NHTS	21	100
241	18-3	NHTS	21	90
242	18-6	HTS	21	0
243	19-1	NHTS	21	100
244	19-6	NHTS	21	40
245	18-7	NHTS	21	100
246	18-5	NHTS	21	100
247	19-3	NHTS	21	100
248	18-6	NHTS	21	70
249	18-4	NHTS	21	100
250	18-2	NHTS	21	80
251	PENN	PENNCROSS	21	100
252	6-15	NHTS	22	0
253	7-19	NHTS	22	0
254	7-16	NHTS	22	100
255	7-21	NHTS	22	100
256	7-18	NHTS	22	100
257	7-15	HTS	22	0
258	7-17	NHTS	22	100
259	PENN	PENNCROSS	22	95
260	6-16	NHTS	22	100

Table 4. continued:

DISEASE OBSERVATIONS (NHTS-HTS)
WEEK 29 INSECTORY 4 & 5 JULY 20 89

	NUMBER	SAMPLE	TRAY	PERCENT BLIGHT
261	7-20	NHTS	22	100
262	6-18	NHTS	22	10
263	7-15	NHTS	22	100
264	PENN	PENNCROSS	23	50
265	13-3	NHTS	23	100
266	13-6	HTS	23	12
267	12-7	NHTS	23	30
268	12-4	NHTS	23	100
269	12-3	NHTS	23	100
270	13-1	NHTS	23	90
271	13-4	NHTS	23	100
272	13-6	NHTS	23	100
273	13-5	NHTS	23	100
274	12-6	NHTS	23	100
275	12-5	NHTS	23	100
		INSECTORY FIVE		
276	15-16	NHTS	1	100
277	15-19	NHTS	1	100
278	15-17	NHTS	1	100
279	15-18	NHTS	1	40
280	15-15	HTS	1	95
281	15-21	NHTS	1	100
282	15-21	NHTS	1	100
283	14-20	NHTS	1	30
284	14-15	HTS	1	95
285	15-15	NHTS	1	100
286	16-16	NHTS	1	100
287	PENN	PENNCROSS	1	100
288	13-17	NHTS	2	15
289	12-21	NHTS	2	70
290	12-16	NHTS	2	100
291	12-20	NHTS	2	90
292	PENN	PENNCROSS	2	100
293	12-19	NHTS	2	100
294	12-15	NHTS	2	100
295	13-19	NHTS	2	100
296	13-20	NHTS	2	100
297	12-15	HTS	2	80
298	12-17	NHTS	2	100
299	12-18	NHTS	2	100
300	10-10	NHTS	3	100
301	9-12	NHTS	3	100
302	10-13	NHTS	3	80
303	PENN	PENNCROSS	3	100
304	10-10	HTS	3	100
305	10-12	NHTS	3	90
306	9-9	NHTS	3	100
307	9-13	NHTS	3	100
308	9-10	NHTS	3	90
309	9-14	NHTS	3	100
310	9-11	NHTS	3	100
311	10-8	NHTS	3	100
312	PENN	PENNCROSS	4	100

Table 4. continued:

DISEASE OBSERVATIONS (NHTS-HTS)

WEEK 29 INSECTORY 4 & 5 JULY 20 89

	NUMBER	SAMPLE	TRAY	PERCENT BLIGHT
313	PENN	PENNCROSS	4	100
314	PENN	PENNCROSS	4	100
315	PENN	PENNCROSS	4	100
316	PENN	PENNCROSS	4	100
317	PENN	PENNCROSS	4	100
318	PENN	PENNCROSS	4	100
319	PENN	PENNCROSS	4	100
320	PENN	PENNCROSS	4	NO INOC
321	14-10	NHTS	5	100
322	14-13	NHTS	5	100
323	PENN	PENNCROSS	5	85
324	14-12	NHTS	5	100
325	13-14	NHTS	5	12
326	14-9	NHTS	5	100
327	14-8	NHTS	5	90
328	14-10	HTS	5	5
329	13-12	NHTS	5	100
330	13-10	HTS	5	100
331	13-9	NHTS	5	100
332	13-13	NHTS	5	100
333	3-14	NHTS	6	100
334	4-10	HTS	6	20
335	5-10	NHTS	6	100
336	4-13	NHTS	6	100
337	4-8	NHTS	6	100
338	PENN	PENNCROSS	6	100
339	4-14	NHTS	6	5
340	4-10	NHTS	6	30
341	3-13	NHTS	6	40
342	4-9	NHTS	6	100
343	4-12	NHTS	6	40
344	4-11	NHTS	6	90
345	6-9	NHTS	7	100
346	5-12	NHTS	7	90
347	PENN	PENNCROSS	7	100
348	5-11	NHTS	7	5
349	5-9	NHTS	7	100
350	5-14	NHTS	7	100
351	5-13	NHTS	7	100
352	6-10	HTS	7	100
353	5-10	HTS	7	90
354	6-11	NHTS	7	100
355	5-8	NHTS	7	90
356	6-10	NHTS	7	100
357	15-9	NHTS	8	90
358	15-13	NHTS	8	95
359	15-14	NHTS	8	100
360	14-14	NHTS	8	100
361	15-12	NHTS	8	100
362	16-10	NHTS	8	100
363	PENN	PENNCROSS	8	NO INNOC(10)
364	14-11	NHTS	8	90
365	15-8	NHTS	8	100

Table 4. continued:

DISEASE OBSERVATIONS (NHTS-HTS)
WEEK 29 INSECTORY 4 & 5 JULY 20 89

	NUMBER	SAMPLE	TRAY	PERCENT BLIGHT
366	15-10	NHTS	8	30
367	15-11	NHTS	8	100
368	15-10	HTS	8	60
369	16-11	NHTS	8	90
370	19-11	NHTS	9	5
371	PENN	PENNCROSS	9	100
372	19-10	NHTS	9	100
373	20-11	NHTS	9	100
374	20-13	NHTS	9	100
375	20-9	NHTS	9	30
376	19-9	NHTS	9	100
377	19-12	NHTS	9	100
378	19-13	NHTS	9	80
379	19-8	NHTS	9	100
380	20-8	NHTS	9	100
381	20-10	NHTS	9	100
382	PENN	PENNCROSS	10	100
383	PENN	PENNCROSS	10	85
384	PENN	PENNCROSS	10	100
385	PENN	PENNCROSS	10	100
386	PENN	PENNCROSS	10	100
387	PENN	PENNCROSS	10	90
388	PENN	PENNCROSS	10	100
389	PENN	PENNCROSS	10	100
390	PENN	PENNCROSS	10	100
391	13-8	NHTS	11	100
392	12-11	NHTS	11	15
393	12-10	NHTS	11	100
394	12-9	NHTS	11	100
395	12-8	NHTS	11	100
396	12-10	HTS	11	15
397	12-14	NHTS	11	100
398	13-10	NHTS	11	100
399	13-11	NHTS	11	100
400	12-12	NHTS	11	80
401	12-13	NHTS	11	100
402	PENN	PENNCROSS	11	80
403	20-21	NHTS	12	100
404	20-18	NHTS	12	100
405	19-20	NHTS	12	100
406	19-16	NHTS	12	100
407	PENN	PENNCROSS	12	100
408	19-21	NHTS	12	100
409	19-15	NHTS	12	90
410	20-20	NHTS	12	80
411	20-15	NHTS	12	100
412	19-19	NHTS	12	95
413	19-17	NHTS	12	20
414	19-18	NHTS	12	100
415	2-17	NHTS	13	60
416	1-15	HTS	13	5
417	1-21	NHTS	13	20
418	PENN	PENNCROSS	13	100

Table 4. continued:

DISEASE OBSERVATIONS (NHTS-HTS)

WEEK 29 INSECTORY 4 & 5 JULY 20 89

	NUMBER	SAMPLE	TRAY	PERCENT BLIGHT
419	1-15	NHTS	13	100
420	1-19	NHTS	13	100
421	1-20	NHTS	13	100
422	2-15	HTS	13	100
423	2-19	NHTS	13	100
424	2-16	NHTS	13	100
425	1-18	NHTS	13	100
426	1-17	NHTS	13	100
427	5-15	NHTS	14	100
428	4-16	NHTS	14	25
429	PENN	PENNCROSS	14	100
430	5-17	NHTS	14	100
431	4-21	NHTS	14	100
432	4-18	NHTS	14	100
433	4-17	NHTS	14	100
434	4-15	NHTS	14	15
435	4-19	NHTS	14	100
436	4-20	NHTS	14	90
437	3-20	NHTS	14	100
438	4-15	HTS	14	12
439	PENN	PENNCROSS	15	100
440	9-15	NHTS	15	100
441	8-16	NHTS	15	100
442	9-15	HTS	15	80
443	8-19	NHTS	15	5
444	8-20	NHTS	15	100
445	8-17	NHTS	15	100
446	8-15	NHTS	15	90
447	8-15	HTS	15	0
448	8-21	NHTS	15	100
449	8-18	NHTS	15	20
450	PENN	PENNCROSS	15	100
451	1-8	NHTS	16	90
452	1-10	HTS	16	10
453	1-12	NHTS	16	20
454	2-9	NHTS	16	30
455	1-13	NHTS	16	100
456	1-10	NHTS	16	100
457	PENN	PENNCROSS	16	100
458	1-11	NHTS	16	25
459	1-14	NHTS	16	70
460	1-9	NHTS	16	85
461	2-12	NHTS	16	100
462	2-8	NHTS	16	15
463	17-12	NHTS	17	100
464	17-11	NHTS	17	100
465	16-9	NHTS	17	100
466	16-12	NHTS	17	100
467	16-10	HTS	17	80
468	PENN	PENNCROSS	17	100
469	16-14	NHTS	17	100
470	17-10	HTS	17	100
471	17-9	NHTS	17	100

Table 4. continued:

DISEASE OBSERVATIONS (NHTS-HTS)

WEEK 29 INSECTORY 4 & 5 JULY 20 89

	NUMBER	SAMPLE	TRAY	PERCENT BLIGHT
472	17-10	NHTS	17	100
473	16-13	NHTS	17	100
474	16-18	NHTS	17	90
475	17-13	NHTS	17	100
476	7-13	NHTS	18	20
477	8-10	NHTS	18	25
478	8-12	NHTS	18	100
479	8-13	NHTS	18	100
480	8-11	NHTS	18	90
481	8-9	NHTS	18	100
482	8-8	NHTS	18	100
483	PENN	PENNCROSS	18	100
484	8-10	HTS	18	5
485	9-10	HTS	18	5
486	8-14	NHTS	18	100
487	9-8	NHTS	18	100
488	14-15	NHTS	19	100
489	14-18	NHTS	19	100
490	13-15	NHTS	19	100
491	PENN	PENNCROSS	19	100
492	13-16	NHTS	19	100
493	13-21	NHTS	19	100
494	14-17	NHTS	19	100
495	14-16	NHTS	19	100
496	14-21	NHTS	19	100
497	14-19	NHTS	19	100
498	13-15	HTS	19	100
499	13-18	NHTS	19	15
500	6-13	NHTS	20	5
501	7-11	NHTS	20	100
502	7-12	NHTS	20	90
503	7-14	NHTS	20	100
504	7-8	NHTS	20	100
505	7-9	NHTS	20	100
506	7-10	NHTS	20	100
507	6-12	NHTS	20	100
508	PENN	PENNCROSS	20	70
509	6-8	NHTS	20	100
510	7-10	HTS	20	60
511	7-14	NHTS	20	100
512	19-14	NHTS	21	100
513	18-12	NHTS	21	100
514	18-13	NHTS	21	100
515	17-8	NHTS	21	40
516	17-14	NHTS	21	100
517	18-10	HTS	21	100
518	18-10	NHTS	21	100
519	18-9	NHTS	21	100
520	18-14	NHTS	21	100
521	18-8	NHTS	21	100
522	18-11	NHTS	21	30
523	PENN	PENNCROSS	21	100
524	11-12	NHTS	22	40

Table 4. continued:

DISEASE OBSERVATIONS (NHTS-HTS)
WEEK 29 INSECTORY 4 & 5 JULY 20 89

	NUMBER	SAMPLE	TRAY	PERCENT BLIGHT
525	11-8	NHTS	22	100
526	10-9	NHTS	22	20
527	10-11	NHTS	22	100
528	11-10	HTS	22	10
529	11-11	NHTS	22	100
530	10-14	NHTS	22	100
531	PENN	PENNCROSS	22	100
532	11-9	NHTS	22	100
533	11-14	NHTS	22	100
534	11-10	NHTS	22	100
535	11-13	NHTS	22	80

a/ All bentgrass experimental lines were inoculated and incubated in one of two walk-in temperature chambers during a seven day period.

b/Percent blight was determined by visual assessments of the foliar canopy of each turfgrass sample where estimates of the percentage area infected were made following the disease cycle.

resistance among bentgrass germplasm lines. Analysis of records dating back during the last two years indicated that several varieties were consistently superior to others used in the pathology Pythium testing program. Germplasm lines identified in two or more assays with Pythium resistance were: #2506, 1709, 2404, 5-14, 6-26, 5-36, 3-46, 8-20, 1306, 15-11, 1004, 1506, 1005, 2-55, 3-24, 1317, and 8-16. Three of the experimental varieties with Pythium disease resistance were compared with the commercial variety Penncross using four isolates of Pythium spp. and the inoculation conditions previously described for mass disease screening procedures.

The results of this study are shown in Fig. 3. The commercial variety Penncross was easily killed after only five days of incubation after inoculation while the experimental lines 2506 5-14 and 1709 were resistant to **Pythium** foliar blighting.

IV. Rhizoctonia Diseases Ongoing Research

1. **USGA Turfgrass Rhizoctonia Isolate Collection:**

Turfgrass Rhizoctonia isolates are now being maintained in long term storage in small prescription vials (3 drams) on PDA at a temperature of 20 C. The collection is the larger of the two being maintained for the research program. Some of the Rhizoctonia spp. isolates appear to develop a leathery crust on the surface of the culture which is very difficult to obtain subcultures for use in inoculation studies. For this reason, transfers from the isolate collection will be made at 6-month intervals to insure survival of isolates in the Rhizoctonia

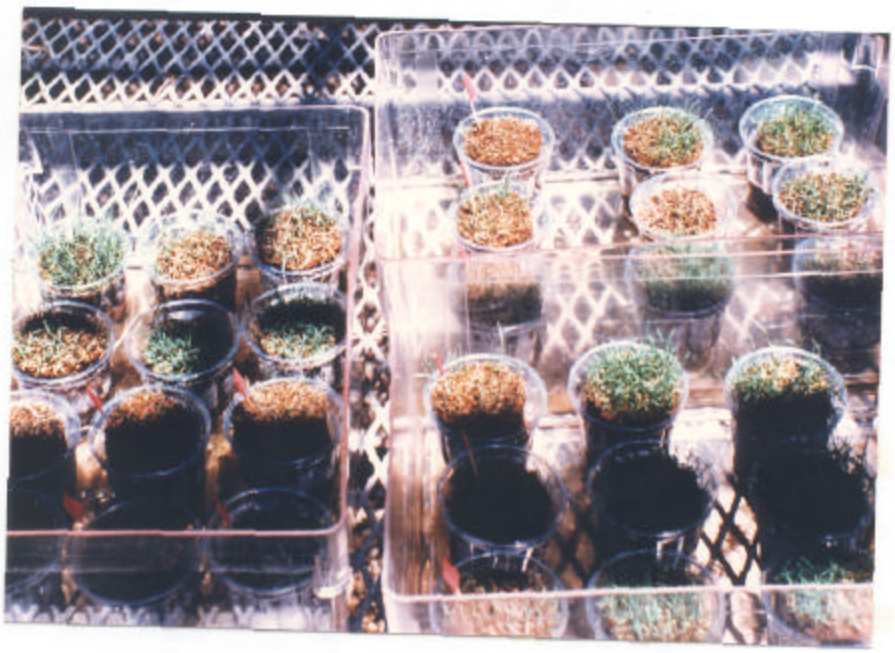

Fig. 3. Pythium induced foliar blighting on disease susceptible var. Penncross (note red flag markers) compared to disease tolerant experimental bentgrass lines 2506, 1709 and 5-14.

culture collection. Inoculation studies with these isolates were temporarily put on hold because of the exciting results with the Pythium spp. studies.

V. Areas of Future Research Investigations:

Future research efforts will focus on the identification of **Rhizoctonia** blight resistance among members of the bentgrass collection at TAMU-Dallas. Particular attention will be given to possible linked characters for disease resistance for both Pythium and Rhizoctonia incited diseases using the mass disease screening technology we have recently employed. Further efforts are planned to examine more of the collection of zoysiagrass at TAMU-Dallas, however, we have had some difficulty in the collection of suitable zoysiagrass specimens for inoculation. This problem stems from the fact that much of the erect growth is lost when field cores are removed for our work. Perhaps this problem can be overcome with samples from field plots with a reduced height of cut.

Additional culture collections of pathogen isolates are maintained in my laboratory; however, I would appreciate as much help as possible in obtaining virulent strains of the Helminthosporium and Sclerotinia dollarspot pathogens. Any input in this area would aid my efforts and reduce time for collecting fungal isolates that can be used in disease screening studies by other investigators.