UNIVERSITY OF ARKANSAS, FAYETTEVILLE

Allelopathy vs. Acremonium Endophytes vs. Competition Affect on Crabgrass Suppression by 12 Perennial Ryegrasses

Dr. John W. King.

Twelve (12) perennial ryegrasses which range from moderate to high stand density and zero to 95% endophyte infection were selected and six replications of field plots were planted in late October, 1993. The cultivars and their expected percent endophyte infection are Loretta (0), Gator (0), Derby (5-10), Derby Supreme (40-45), Envy (40), Omega II (76), Manhattan II (50-90), Saturn (80), SR 4200 (80-85), Brightstar (90), Assure (95), and Yorktown III (97). The plots are maintained with good fertilizer, weed control, irrigation and 2 cm mowing practices. New seedlots were obtained for fairway overseeding trials for 1994 and 1995.

Our basic laboratory evaluation for Allelopathy is the Lemna minor L. (duckweed) bioassay. The Lemna bioassay measures allelopathic effects of extracts of plant tissues against the growth rate of duckweed fronds. Extracts from shoots are applied to duckweed cell plates at three concentrations. The amount of allelopathic inhibition (or stimulation) of duckweed varies with season of shoot tissue sample collection and extract concentration. All cultivars have affected duckweed growth. Interesting and promising results so far.

We are still working to refine a ryegrass extract-agar-crabgrass seed bioassay. Tissue extracts are added to agar in the cell plates then crabgrass seeds are placed on the agar and seedling germination and development are measured. Procedures to stabilize crabgrass germination rate in controls are still being worked on. No good data yet, but extracts can inhibit germination directly and/or cause yellowish seedlings that don't live long.

Determination of Acremonium endophyte content of stem samples from field plots showed actual infection levels different from those expected in the original seedlots and the new seedlots.

One half of each original field plot was overseeded to crabgrass in March. Bermudagrass "fairway" plots were overseeded with new seedlots of the 12 cultivars on October 25, 1994. Half of these plots were overseeded to crabgrass in late March and evaluated for crabgrass suppression. No differences in crabgrass stand could be attributed to any of the 12 culitvars.

ANNUAL REPORT FOR USGA GREEN SECTION RESEARCH GRANT PROJECT AT THE UNIVERSITY OF ARKANSAS

October 31, 1995

"Allelopathy vs. Acremonium Endophytes vs. Competition Affect on Crabgrass Suppression by 12 Perennial Ryegrasses"

Prepared by Dr. John W. King, Principal Investigator, in collaboration with Dr. Terry L. Lavy and his associate Dr. Briggs Skulman of the Soil Residue Laboratory and Dr. Charles P. West of the Forage Physiology Laboratory.

Twelve perennial ryegrasses were selected for evaluation of allelopathic crabgrass suppression with funding from $10,000 USGA grant. The 12 cultivars are Loretta, Gator, Derby, Derby Supreme, Envy, Omega II, Manhattan II, Saturn, SR 4200, Brightstar, Assure, and Yorktown III. These were selected to cover a range of density and Acremonium endophyte infection. These perennial ryegrasses were planted in October, 1995, and investigations into allelopathy began in the spring of 1994. To augment these investigations the 1994 NTEP National Perennial Ryegrass Test was planted in the fall of 1994.

REVISED OBJECTIVES: 1/31/94

1. Conduct Lemna bioassays for the allelopathic effects from leaf-stem tissue extracts from the 12 field grown cultivars in spring of 1994, then conduct Lemna tests for 6 selected cultivars in the summer of 1994 and spring and summer of 1995 and with root tissue in the spring of 1995.

2. Conduct crabgrass seedling bioassays by overseeding crabgrass into the existing field plots of the 12 PR cultivars in the spring of 1994, 1995, and 1996.

3. Evaluate crabgrass suppression in practical bermudagrass culture by overseeding the selected 6 cultivars into a common bermudagrass "fairway" area in the fall of 1994 and 1995 and overseeding with crabgrass in the following late winters.

4. Conduct crabgrass seedling bioassays by overseeding crabgrass into petri dishes containing the surface 1 cm of soil from a 5 cm diameter plug. Do this in the spring of 1994 with the

12 cultivars and then with the selected 6 cultivars in the summer of 1994 and the spring and summer of 1995 and 1996.

5. Determine Acremonium endophyte content of field grown plant stems of the 12 cultivars in the spring of 1994 and from these plots in the spring of 1995 and 1995. Determine Acremonium endophyte content of plants grown from the seed lots of the 12 cultivars used for overseeding the original plots and "fairway" overseeded plots. (Recent discussions with Dr. West indicate the need for this more extensive endophyte monitoring.)

6. Determine Acremonium endophyte contribution to allelopathy in the cultivar showing the strongest allelopathic effects associated with endophyte in previous bioassays. Do this by growing plants from E- and E+ seed in pots in the greenhouse in 1995-96 and conducting Lemna and petri dish bioassays.

7. Report research results at ASA convention in the fall of 1995 and 1996.

8. Submit research article(s) for publication in the fall of 1996.

CULTURE OF FIELD PLOTS

As explained in more detail in the spring progress report, the PR Allelopathy plots were protected from contamination from rain washed tall fescue seed by applying pre-emergence herbicide in early November. No evidence of TF contamination was found.

All field plots were fertilized with 1 lb N/1000 (M) sq.ft. from ammonium nitrate on 11/29/94 and 2/25/95. On April 28 0.5 lb N/M from 24-8-16 (with %0% slow release N) was applied. One pound N/M from ammonium nitrate was applied on 9/14/95 (except to PR/Overseeding) and 10/28/95 to all plots.

Crabgrass was overseeded at 1.1 lb/M into the east half of the PR Allelo and PR/Overseeding and a western strip of the NTEP PR plots on 3/30 and 4/1/95. Balan 2.5G (benefin) at 2.5 lb ai/A was applied to the non-crabgrass portion of these plots on 4/8 & 6/6/95. Trimec was applied in mid March to control broadleaf weeds. MSMA was applied at 2 lb ai/A to the crabgrass portions on 7/26, 8/4 and 8/11/95 to control crabgrass.

The PR Allelo, PR/Overseeding and the crabgrass strips in the NTEP PR were mowed at 3/4th inch height from late winter to mid

summer after crabgrass data were collected. The low mowing was discontinued in mid August because the stand densities declined greatly from heat stress, brown patch disease and/or MSMA injury. Stand density had been outstanding in the spring. Low mowing resumed on the PR Allelo and PR/Overseeding areas in mid September.

All areas were kept well watered from mid June onward.

The seed lots, which had taken a few weeks to assemble last year, were stored in another project's deep freezer (my freezer at home is full of other seed) from early spring onward. When I retrieved the seed bags in late September, I noted that workman building shelves had pulled the plug on the freezer. I made what turned out to be a bad mistake; I pushed ahead with overseeding of PR Allelo and PR/Overseeding from 9/25 to 10/3/95. None of the seed came up! At best, I may be able to overseed again by late November with Re-May cloth covers.

LABORATORY METHODS - copied here from 10/30/94 report.

The Lemna bioassay involves collecting tissue samples from the field plots. These are stored in a freezer. Samples are weighed (10 g), chopped, ground with water, coarsely filtered, centrifuged, filtered 3 times and full strength or diluted extracts are placed in 24 celled plates (6 reps per cultivar or concentration) with duckweed fronds and nutrient media. These plates are kept in a growth chamber for a week. Then the number of fronds are counted and inhibition (or stimulation) is calculated. A corollary process keeps multiplying the duckweeds so plenty of uniform 3-frond duckweeds are available for transfer to cell plates. The final filtration and transfer of fronds especially are done aseptically. Fungal contamination in the cell plates is a problem sometimes.

A ryegrass extract-agar-crabgrass seed bioassay has been developed but no data has been collected yet. The extracts are prepared as outlined above, then added to liquid agar in the cell plates. Then scarified and surface sterilized crabgrass seeds are placed on the solidified agar. Germinated crabgrass plants are counted and root and shoot lengths are rated. Fungal contamination is a serious problem, but we believe present procedures will allow a 7 to 10 day germination/growth period before fungi overrun the cells.

The petri dish bioassay method was to cut a 5 cm diameter plug from each ryegrass field plots, cut grass off at crowns, cut to a one (1) cm surface soil thickness, place in a petri dish, overseed

with 50 crabgrass seeds, water as needed, and keep covered on the greenhouse bench.

Acremonium endophyte infection is determined by a sero-immunoassay that Dr. Charles P. West and his associate Melody Marlatt have developed in their Forage Physiology Laboratory. Fundamentally, the technique involves using an antibody developed by rabbits fed Acremonium infected tall fescue. The antibody has been proven to react against the Acremonium species in both tall fescue and perennial ryegrasses. Basically, a grass stem is cut off near the crown and the juice from a lower 1-2 mm section is squeezed onto a paper appropriately treated with the antibody solution. A red stain develops if that stem is infected with Acremonium. Thus this is a qualitative test -- Acremonium is or is not present. We collect 20+ stems randomly from each plot, test 20 stems for Acremonium, and calculate the percent infection. This method is much faster than microtome slicing/staining and examination under a microscope.

RESULTS AND DISCUSSION

Laboratory Bioassays

The Lemna bioassay of shoot samples collected in late summer of 1994 of the 12 cultivars was conducted during November (Table 1; included in April progress report). Loretta, Gator, Manhattan II (E), Saturn, SR 4200, Brightstar, Assure and Yorktown II inhibited duckweed at all three concentrations of extract. Derby, Derby Supreme and Omega II did not inhibit duckweed at any concentration. Envy inhibited at the two higher concentrations, but not at the lower concentration. This is in contrast to results from the spring 94 samples (Table 1 of 10/31/94 report) where most cultivars stimulated duckweed and Derby Supreme, Envy, Loretta, and Brightstar inhibited duckweed at the full strength concentration. Table 2 shows part (my technicians were spending a disproportionate proportion of their time on the tall fescue allelopathy samples) of the results from the spring 95 shoot samples. Loretta and Gator had no effect compared to control, but Derby, Derby Supreme, Envy and Omega II give results that differ with extract concentration. This may suggest that allelopathy in perennial ryegrass may be sensitive to seasonal changes as is tall fescue. More study is needed to clarify these inconsistencies.

Considerable laboratory work was done with the extract-agar-crabgrass seed bioassay. This bioassay was run on the fall 94 shoot samples of Envy, Omega II and Manhattan II in late October of

94, on Derby, Derby Supreme and Gator in late April 95 and on Yorktown III, Assure and Brightstar in early May of 95. Over these three runs the percent crabgrass germination in the controls dropped from about 100 to 40 to 16%. (From mid May though mid July I had to pull lab workers partially into the field to count densities, etc.) So far even though more methods work was done in mid summer; we are not satisfied with the crabgrass germination. One very interesting observation was that many of the crabgrass seedlings were yellowish to whitish in color when treated with extract, but were green in the controls. The proportion of the percentage of yellowish seedlings during the three runs increased from about 20 to 60 to 100%; the opposite of the trend in crabgrass seed germination. The tissue samples of Loretta, Saturn and SR 4200 were used up in attempts to get good data during August. Although some differences appear to exist among cultivars, we are not yet confident in this method or data.

Discussions with Dr. Briggs Skulman who adapted the Lemna bioassay here for testing allelopathy in rice, tall fescue, and now perennial ryegrass cultivars and thus is very experienced with this bioassay assures me that unexpected and sometimes murky and inconsistent results are not uncommon in allelopathy research.

Acremonium Infection Monitoring

Acremonium endophytes infection level has been determined for the original 12 cultivars (Table 3--same as included in April progress report--data for reps 2,3 & 4 included in 10/31/94 report). Table 4 shows results of rechecking values circled in Table 3 and Manhattan II and the Acremonium infection in the 1994 new seedlots. Rechecking showed some variability in infection levels, especially for Manhattan II. Considerable variations occurs among reps. Differences between expected and measured infection occurs within each seedlot and between seedlots. The change between seedlots of SR 4200 is the most striking. Acremonium monitoring is important.

Field Plot Data

The visual quality and density rating data taken from the PR Allelo field plots is presented in Table 5. Significant differences among cultivars occurred for April and May turfscores and quality, especially density, declined severely during August. This resulted from a combination of low mowing, heat stress (not drought stress), brown patch disease and MSMA injury. The May density rating showed

differences and was an attempt to get some data on density's effect on crabgrass germination. Significant differences occurred in the overall scores. Similar data (and results) were collected from the PR/Overseeding plots.

Significant differences in ryegrass density counts among cultivars occurred (Table 6). However, no differences due to PR cultivars were found for percent crabgrass cover visual estimates or counts of crabgrass plants. Despite the fact that PR percent cover was 100% for all plots in reps 2-6 during the spring, enough crabgrass germinated to result in 50-60% crabgrass cover by mid July. Similar data was collected from the PR/Overseeding plots where crabgrass was overseeded into bermuda "fairway" overseeded to PR cultivars. Although the statistical analysis has not returned from the Stat Lab yet, a few simple calculations suggest that it is unlikely that cultivars affected crabgrass germination significantly. Great variability exists in the data. The number of crabgrass plants are roughly one third of those reported in Table 6. The percent cover visual estimates in the half of the plots overseeded to crabgrass were mostly 60-70% bermuda, 10-15% ryegrass and 10-20% crabgrass by July 22nd. So no differences in crabgrass stand due to any allelopathic or density-competitive effects were found among these 12 PR cultivars.

The estimated percent crabgrass cover in the low mowed strip where crabgrass was overseeded in the NTEP PR test ranged from about 5 to 35% among the 99 cultivars. Although statistical analysis is not finished yet, it appears likely that differences among cultivars exist.

GENERAL DISCUSSION

We are well into this research into allelopathy vs. competition vs. endophyte affects on crabgrass suppression by these 12 perennial ryegrass cultivars. All objectives, except the petri dish bioassay, have been met or exceeded by the fact of still testing 12 cultivars. Also, a graduate student is working on this project now along with good lab tech people.

The loss of the seedlots obtained in 1994 seriously impairs this fall's reseeding and overseeding tests and delays Acremonium E+ and E- testing. New seedlots will require another round of Acremonium infection level testing.

Allelopathy has been shown to exist in the Lemna bioassays and the agar-crabgrass seedling bioassays. The lack of consistent

levels of allelopathy among the 12 cultivars over seasons is a problem.

We all knew going into these studies that none of these 12 cultivars would not give adequate field levels of crabgrass control compared to preeemerence herbicides. The lack of statistical differences in crabgrass stand due to any of these 12 selected cultivars is disappointing. Further refinement of our bioassays, especially the agar-crabgrass seedling bioassay, will provide an economical means of screening perennial ryegrass accessions and cultivars for allelopathy. Eventually perennial ryegrasses having high levels of allelopathy against crabgrass will be developed.

FINANCIAL ACCOUNTING

As of October 30, 1995, expenses posted to the USGA grant account were $10,729.17 for payroll, $174.82 for materials and supplies, $441.98 for travel and $284.22 for other direct costs for a total of $11,630.19. Since no transfers of funds to cover material costs for laboratory bioassays and Acremonium determinations have been made yet, we are over budget. Mostly because we are still testing all 12 cultivars.

FINAL COMMENTS

Most of 12 perennial ryegrass cultivars have shown allelopathic inhibition of duckweed in one season or another. The agar-crabgrass seedling bioassay will become our most direct method of measuring allelopathy. These are exciting and promising results. We are a long, long way from being able to recommend specific ryegrass cultivars to control crabgrass. Nevertheless, we have a well-rounded research approach and team for accessing crabgrass suppression by (up to 99) perennial ryegrass cultivars. Eventually, proper selection of ryegrass cultivars may become a more important part of IPM programs for turfgrass culture. We appreciate greatly the support of the USGA Green Section Research grant in pursuing these research goals.

Table 1.

Perennial Ryegrass Shoot Phytotoxicity to Lemna minor (at 10g/30ml initial extraction) November 1994

Code	Cultivar	Extract Concentration	Final # Fronds	Control # Fronds	% of Control	SD
1	Loretta	Full (10g/30ml)	4.2	42.5	9.8	Y
1	Loretta	1/2	23.3	42.5	54.9	Y
1	Loretta	1/4	21.8	42.5	51.4	Y
2	Gator	Full (10g/30ml)	2.8	42.5	6.7	Y
2	Gator	1/2	19.7	42.5	46.3	Y
2	Gator	1/4	26.7	42.5	62.8	Y
3	Derby	Full (10g/30ml)	38.5	27.5	140.0	N
3	Derby	1/2	36.8	27.5	133.9	N
3	Derby	1/4	21.7	27.5	78.8	N
4	Derby Supreme	Full (10g/30ml)	22.7	27.5	82.5	N
4	Derby Supreme	1/2	20	27.5	72.7	N
4	Derby Supreme	1/4	18.2	27.5	66.1	N
5	Envy	Full (10g/30ml)	9.7	41.2	23.5	Y
5	Envy	1/2	18	41.2	43.7	Y
5	Envy	1/4	24.3	41.2	59.1	N
6	Omega II	Full (10g/30ml)	22.3	24.5	91.2	N
6	Omega II	1/2	32.5	24.5	132.7	N
6	Omega II	1/4	28	24.5	114.3	N
7	Manhattan II	Full (10g/30ml)	1.3	68	2.0	Y
7	Manhattan II	1/2	26.3	68	38.7	Y
7	Manhattan II	1/4	32.7	68	48.0	Y
8	Saturn	Full (10g/30ml)	-0.3	68	-0.5	Y
8	Saturn	1/2	31.3	68	46.1	Y
8	Saturn	1/4	30.7	68	45.1	Y
9	SR4200	Full (10g/30ml)	-0.3	47.8	14.6	Y
9	SR4200	1/2	17.7	47.8	28.9	Y
9	SR4200	1/4	23.7	47.8	36.2	Y
10	Bright Star	Full (10g/30ml)	-2	47.8	-4.2	Y
10	Bright Star	1/2	16.7	47.8	34.8	Y
10	Bright Star	1/4	10.2	47.8	21.3	Y
11	Assure	Full (10g/30ml)	-0.7	53.5	-1.3	Y
11	Assure	1/2	15.2	53.5	28.4	Y
11	Assure	1/4	26.2	53.5	48.9	Y
12	Yorktown III	Full (10g/30ml)	4.2	53.5	7.8	Y
12	Yorktown III	1/2	18.5	53.5	34.6	Y
12	Yorktown III	1/4	23	53.5	43.0	Y

SD = significant difference at one standard deviation
Y = significant phytotoxic effect compared to the control
N = No significant phytotoxic effect compared to the control
S = Significant phytostimulation effect when compared to the control

Table 2. Perennial Ryegrass Shoot Phytotoxicity to Lemna minor (at 10g/30ml initial extraction) spring 1995						
Code	Cultivar	Extract Concentration	Final # Fronds	Control # Fronds	% of Control	SD
1	Loretta	Full (10g/30ml)	28	21.8	127.3	N
1	Loretta	1/2	20.5	21.8	93.2	N
1	Loretta	1/4	20.3	21.8	92.4	N
2	Gator	Full (10g/30ml)	22.3	21.8	101.5	N
2	Gator	1/2	21.5	21.8	97.7	N
2	Gator	1/4	24.7	21.8	112.1	N
3	Derby	Full (10g/30ml)	0.7	25.8	2.6	Y
3	Derby	1/2	19.7	25.8	76.1	N
3	Derby	1/4	23.7	25.8	91.6	N
4	Derby Supreme	Full (10g/30ml)	2	25.8	7.7	Y
4	Derby Supreme	1/2	20.7	25.8	80.0	N
4	Derby Supreme	1/4	23.3	25.8	90.3	N
5	Envy	Full (10g/30ml)	15.7	18	95.0	N
5	Envy	1/2	22.8	18	138.4	S
5	Envy	1/4	21.5	18	130.3	N
6	Omega II	Full (10g/30ml)	11	18	66.7	Y
6	Omega II	1/2	20.2	18	122.2	N
6	Omega II	1/4	21.5	18	130.3	S

SD = significant difference at one standard deviation
Y = significant phytotoxic effect compared to the control
N = No significant phytotoxic effect compared to the control
S = Significant phytostimulation effect when compared to the control

TABLE 3.

IMMUNOASSAY DATA

Dr. John King's ryegrass field study

Date of report: 12-19-94

CULTIVAR	PERCENT INFECTION							
	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	MEAN	EXPECTED
Assure	15	0	0	0	0	0	3	94-96
Brightstar	100	95	95	95	85	90	93	90
Derby	15	20	10.5	0	15	20	14	5-10
Derby Supreme	35	30	20	50	25	45	34	40-45
Envy	15	25	100	90	20	50	50	40
Gator	10	35	25	0	35	0	18	0
Loretta	5	5	10	15	0	5	7	0
Manhattan II	25	0	25	0	10	15	13	50-98
Omega II	20	0	55	5	5	30	19	76
Saturn	20	0	15	60	10	10	19	80
SR4200	95	90	100	100	80	100	94	80-85
Yorktown III	95	67	80	90	75	50	76	97

Table 4.

Tissue Print Immunoblot Assay Data
U.S.G.A. Perennial ryegrass overseeded with bermuda allelopathy field study.
Date of report: 8-31-95

		1994 Rechecks	
Trt. No.	Cultivar	Rep 3	Rep 4
5	Envy	55	100
6	Omega II	25	
7	Manhattan II	45	55
8	Saturn		65

		1995					
Trt No.	Cultivar	Rep 1	Rep 2	Rep 3	Rep 4	Mean	Expected
1	Loretta	30	5	0	30	16	0
2	Gator	15	10	0	5	8	0
3	Derby	45	25	0	10	20	5-10
4	Derby Supreme	25	0	5	0	8	40-45
5	Envy	45	5	5	0	14	40
6	Omega II	0	0	65	0	16	76
7	Manhattan II	35	5	15	5	15	50-98
8	Saturn	30	20	5	60	29	80
9	SR4200	0	5	0	0	1	80-85
10	Brightstar	65	100	90	85	85	90
11	Assure	5	40	30	15	23	94-96
12	Yorktown III	55	45	15	65	45	97

TABLE 5. QUALITY AND DENSITY RATINGS OF PERENNIAL RYEGRASS ORIGINAL PLOTS									
								DENSITY	OVERALL
		TURF QUALITY RATING						RATING	SCORE[1]
CODE	VARIETY	2/20	3/11	4/20	5/15	7/21	8/22	5/15	
1	LORETTA	6.4	6.4	6.4d	5.8 cd	5.6	3.2	5.8 cd	62.8 cd
2	GATOR	6.8	7.2	6.4 cd	6.0 bcd	6.4	2.4	6.0 bcd	65.2 bcd
3	DERBY	6.8	7.2	6.0 d	5.6 d	5.0	2.8	5.6 d	61.4 d
4	DERBY SUPREME	5.8	6.2	6.4 cd	6.0 bcd	4.8	3.6	5.8 cd	61.2 d
5	ENVY	7.0	7.2	7.6 b	6.4 bc	6.0	3.4	6.6 b	70.2 ab
6	OMEGA II	6.4	6.6	6.6 cd	5.8 cd	6.6	4.0	6.0 bcd	66.8 a-d
7	MANHATTAN II	6.4	6.6	7.0 bc	6.6 b	5.8	3.4	6.2 bcd	66.4 a-d
8	SATURN	7.2	8.2	6.6 cd	6.2 bcd	6.6	3.6	6.2 bcd	70.8 ab
9	SR 4200	6.4	6.2	7.6 b	6.2 bcd	5.6	3.4	6.4 bc	66.2 bcd
10	BRIGHTSTAR	6.6	6.8	8.6 a	7.6 a	6.0	3.0	7.4 a	73.0 a
11	ASSURE	6.4	7.2	7.0 bc	6.4 bc	5.8	3.4	6.0 bcd	66.8 a-d
12	YORKTOWN II	6.8	7.6	7.0 bc	6.4 bc	6.4	3.6	6.0 bcd	69.4 abc
	C.V.	15	19	9	9	21	27	10	8
	PR>F	0.73	0.44	0.0001	0.0003	0.42	0.36	0.0028	0.017
	LSD	----	----	0.77	0.72	----	----	0.75	6.7

[1]Overall score is the percentage of the highest possible score. Actual score (sum of 7 ratings) divided by 9 (rating scale is 1 to 9) x 7.

Addendum report on "Allelopathy vs. Acremonium endophyes vs. Competition Affect on Crabgrass Suppression by 12 Perennial Ryegrasses"

by John W. King,
University of Arkansas
11/8/95

The USGA Perennial Ryegrass Overseeding into Common Bermudagrass 'Fairway' Test was initiated in the summer of 1994 by preparing an area with weed control, fertilizing and mowing at 3/4 inch height. The 12 perennial ryegrasses were overseeded at 60 g/1.5 x 1.5m plot after vertical grooving on October 25th. Crabgrass was overseeded into the east half of each plot after spiking on March 30, 1995 and benefin pre-emergence was applied to the west half of each plot.

Visual estimates of percent winter broadleaf weeds were taken in February, March, April and May. The mean broadleaf weed cover increased to only 2.4% with a range of 0 to 5% in April and decreased to nearly zero in May. The differences were not statistically significant. Adjacent non-overseeded bermuda plots had 23% broadleaf weeds in May. Overseeding, of course, reduced winter weeds.

Visual estimates of percent ryegrass cover were made in February (82), March (86), April (98), May (97), June (59) and in July in the east (16) and west (23) halves of the plots (mean percentage in parentheses). The differences among cultivars were significant only in March. Loretta and Manhattan II were highest with 91% and Brightstar was lowest with 76% cover and statistical overlap was abundant. By May it was possible to distinguish bermuda by making estimates in the morning when the dew was on the turf. The mean percentage of bermuda cover was 3% in May, 41% in June, and in July 63% in the east half and 76% in the west half.

Crabgrass seedlings were not discernable in May or early June. (Border plots had been treated with pre-emergence herbicide.) The east half of the plots where crabgrass had been overseeded had a mean of 21% crabgrass with a range of 5 to 40% in mid July. The west half of the plots where pre-emergence herbicide had been applied did not have crabgrass. Differences due to ryegrass cultivars in crabgrass by percent cover estimates and stem counts per 4" diameter plug were not statistically significant (Table 7). Thus any differences in allelochemical content of the 12 perennial ryegrass cultivars selected for this investigation were not great enough to produce practical field result differences in crabgrass suppression.

The NTEP 1994 Perennial Ryegrass Test was under-taken as an adjunct to our PR allelopathy studies. It was planted in the fall of 1994, fertilized well in the fall and late winter and mowed at a 3 ½ inch height. On April 1, 1995 a 21" strip on the western edge of the plots was spiked, overseeded with crabgrass and kept mowed at a 3/4" height. The visual

estimate of percent crabgrass cover in the 99 PR cultivars data was taken on July 24th (Table 8). Although statistical overlap was abundant, APM and TopHat plots had only 8% crabgrass while Linn had 45%. Whether these differences are due to allelopathy and/or density cannot be determined by this test, but clearly Linn was the least dense and APM and TopHat were among the more dense cultivars. This test will be repeated next season on the east side of the plots. Also, tissues samples of APM, TopHat, DSV NA 9402 and Linn will be evaluated for allelopathy by the Lemna and crabgrass seed agar bioassays.

TABLE 6. PERENNIAL RYEGRASS AND CRABGRASS DENSITY COUNTS AND PERCENT COVER IN PR ALLELOPATHY FIELD PLOTS - 95

		PR	CRABGRASS	PERCENT	PERCENT	
		DENSITY	DENSITY	CRABGRASS	PR COVER[3]	
		COUNTS[1]	COUNTS[1]	COVER[2]	WEST	EAST
CODE	VARIETY	5/11+	7/18+	7/21	8/22	8/22
1	LORETTA	231 bcd	151	54	49	26
2	GATOR	249 a-d	149	58	28	22
3	DERBY	210 cd	177	64	41	16
4	DERBY SUPREME	208 d	173	62	58	30
5	ENVY	259 ab	155	60	53	33
6	OMEGA II	274 ab	170	50	70	31
7	MANHATTAN II	253 abc	174	48	54	25
8	SATURN	244 bcd	136	62	56	31
9	SR 4200	262 ab	165	54	54	30
10	BRIGHTSTAR	292 a	157	66	44	21
11	ASSURE	260 ab	151	68	48	31
12	YORKTOWN III	250 a-d	135	56	54	36
	C.V.	14	20	26	36	56
	Pr>F	0.0191	0.40	0.59	0.16	0.75
	LSD	44	----	----	----	----

[1]Number of shoots per 4" diameter cup cutter.
[2]The percent crabgrass cover is a visual estimate.
[3]The percent PR cover "west" refers to the half of plot given pre-emergence crabgrass herbicide. The "east" half was overseeded to crabgrass and suffered MSMA injury in addition to other stresses.

TABLE 7. CRABGRASS INVASION INTO BERMUDAGRASS "FAIRWAY" OVERSEEDED TO PERENNIAL RYEGRASSES IN OCTOBER, 1994, AND CRABGRASS ON MARCH 30, 1995.

CODE	CULTIVAR	% COVER 7/22	CRABGRASS SHOOTS PER 4" DIA.PLUG ON 7/18+
1	LORETTA	25.0	51
2	GATOR	23.8	75
3	DERBY	18.8	86
4	DERBY SUPREME	18.8	112
5	ENVY	23.8	77
6	OMEGA II	21.5	50
7	MANHATTAN II E	15.0	49
8	SATURN	25.0	88
9	SR 4200	18.8	67
10	BRIGHTSTAR	18.8	83
11	ASSURE	18.8	52
12	YORKTOWN III	23.8	80
	C.V.	45	50
	Pr > F	0.92	0.50

TABLE 8. PERCENT CRABGRASS COVER IN 99 NTEP PERENNIAL RYEGRASSES ON JULY 24,1995, WITHIN LOW MOWN STRIPS OVERSEEDED WITH CRABGRASS ON APRIL 1ST.

% COVER	CULTIVARS
8 a	APM, TopHat
15 ab	Laredo, MVF-4-1, MED 5071, J-1706
17 abc	Accent, Omi
18 a-d	PST-2M3, WVPB 92-4, Dancer, Riviera II, PST-2R3, Essence, RPBD, Prizm
20 a-e	Calypso II, MB 44, BAR USA 94-II, PSI-E-1, APR 131, WVPB-93-KFK, CAS-LP-23, Achiever, MB 47, Williamsburg, Cutter
22 b-f	SR 4200, PST-2CB, PC-93-1, ISI-R2, Koos-93-3, Express, SR 4010, PST-28M
23 b-g	Elf, BAR Er 5813, LRF-94-C7, ZPS-3DR-94, Precision, LRF-94-CB, APR 106, MB 45, MB 43, ISI-MHB, TopHat
25 b-h	LRF-94-MPRH, Figaro, Quickstart, PST-2DLM, PST-GH-94, Brightstar, Assure, DSV NA 9401, Pick 928, PST-2FF
27 b-i	MB 42, APR 124, J-1703, Koos 93-6, Pick PR-84-91, MB 41, Pegasus, PST-2DGR
28 c-i	Nobility, MB 46, Saturn, Imagine, WX3-91, Manhattan III, PST-2ET, SR 4400, ZPS-2NV
30 d-i	APR 066, DLP 1305, LESCO-TWF, Divine, PST-2FE, WVPB-PR-C-2, Night Hawk, TMI-EXFL94, ZPS-PR1, Navajo, Esquire
32 e-i	LFR-94-B6
33 f-j	Pennfine, WX3-93, Edge
35 g-j	Advantage, MB-1-5, Morning Star, Stallion Select, Nine-O-One, Vivid, PS-D-9
37 hij	ZPS-2ST, Pick Lp 102-92
41 ij	DSV NA 9402
45 j	Linn
C.V. 11	
Pr>F 0.0001	
LSD 13	