CULTURAL MANAGEMENT FOR NECROTIC RING SPOT OF KENTUCKY BLUEGRASS

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Management of necrotic ring spot (*Leptosphaeria korrae*) of Kentucky bluegrass (*Poa pratensis*) using bio-organic and slow-release fertilizers was investigated in field experiments at three locations in southern Michigan.

Necrotic ring spot (NRS) is one of the most common diseases of Kentucky bluegrass in Michigan (Otto, 1986) and can be an extremely devastating disease if left unchecked. This disease is most active in spring and fall although symptoms may become expressed anytime of year. Symptoms of NRS appear as depressed frog-eye type patches ranging in size from 3" to 3' in diameter. In cool weather red to yellow blades of grass appear in the patch. During hot dry weather the affected blades wilt and turn straw colored. Current disease management for NRS include application of fungicides such as Rubigan, Banner, and Chipco. Although synthetic chemicals are available, their effectiveness may depend on local conditions. Disease management through cultural or integrated practices may provide long term control and reduce use of potentially harmful chemicals.

Because of the relative ease in manipulation of cultural factors such as irrigation techniques, aeration, and fertility programs, the turfgrass community offers potential for biological disease management. Changes in the microflora of the turf system, brought about by use of bio-organic and slow-release fertilizers with proper irrigation, may be more rapid than in other systems. Bowen, 1980, suggests changes in soil microflora and build up of pathogen antagonists may be quickest under crops and conditions leading to high root concentrations. In recent studies we have shown that at least part of the effectiveness of bio-organic amendments in reducing disease may be due to their stimulating effect on soil and thatch microorganisms (Melvin, 1990). Reduced disease severity after application of bio-organic and slow-release fertilizers may also be the result of supplimental nutrition to the plant for formation of new tissues.

Field trials designed to test fertilizers and irrigation treatments on NRS were performed at Country Place Condominiums, Novi, Yankee Springs Country Club, Yankee Springs, and the Hancock Turfgrass Research Center, Michigan State University, East Lansing, Mi. Disease pressure was heavy and uniform at all test sites prior to treatment application.

The Novi site consisted of Kentucky bluegrass muck sod which was irrigated for 15 minutes 4 nights per week and mowed to 2.5" weekly. The Yankee Springs site was seeded in August 1985 with equal parts Baron, Bensun and Merit Kentucky bluegrass, and Pennlawn fine fescue. The turf was maintained at 1.125" and irrigated on a as needed basis. Test plots at both sites measured 6 x 9' and were arranged in a randomized complete block design with three replications. The Hancock Turfcenter site consisted of 7 year old Kentucky bluegrass (cultivars Baron, Bristol and Victa) muck sod mowed to 2.5" twice weekly. This study was designed to determine the effects of bio-organic and slow-release fertilizers, in combination with irrigation treatments, on NRS and thatch. Experimental design was a randomized complete block design 2 factor factorial with bio-organic amendments and slow-fertilizers applied in combination with three irrigation treatments (2.5mm/da, 80% OPE, and rain only). Fertilizers were applied to 6 x 6' plots in each of nine 36 x 36' irrigation blocks. Three irrigation blocks received 2.5mm/da supplemental irrigation applied at noon. Three blocks received a twice weekly 80% OPE (open pan evaporation) irrigation treatment (80% of the water lost from an open evaporation pan was applied on mondays and thursdays, ex: 1" lost = .8" applied). The remaining three blocks received no supplemental irrigation (rain only).

Slow-release fertilizers were provided by Par EX (IBDU, 18-3-24) and Nor-Am Chemical Corporation (Nitroform, 38-0-0). Bio-organic fertilizers were provided by KLM Bio Systems Inc. (Biogroundskeeper-granular, 7-5-5), Ringer Corporation (Lawn Restore, 9-4-4), Sustane Corporation (Sustane, 5-2-4), and The Andersons, Lawn Fertilizer Division (Regenerate, 9-3-6). Aqua-Gro (wetting agent) was provided by Aquatrols Corporation of America.

In addition to commercial treatments, four experimental organic fertilizers (provided by Ringer Corporation) were investigated as possible carriers for two bacteria, which were selected as potential biological control organisms because of their ability to inhibit pathogen growth on agar. The organic carriers: compost plus (10-2-6), H-50 (10-2-6), and a molasses-based organic fertilizer (12-2-6) were used as culture broth (48g/L) for the bacteria which were added from stock cultures grown on potato dextrose agar. The bacteria were applied as a composite, and with enough of the corresponding organic fertilizer to provide 1.0#N/M. Bacteria were also applied alone as washed cells, and to an experimental liquid organic fertilizer labeled "30-06" (9-1-2). Bacteria were added to 30-06 twelve hours before application and at application. Bacteria for the 30-06 and the "washed cells" treatments, were provided by centrifugation of trypticase soy culture broths (TSB), after 48hr incubation on shake culture, to concentrate the cells. Concentrated cells were then added to water and applied as a drench, or added to

30-06 at the appropriate time. The supernatant was recovered upon concentration of cells and stored (10°C) until application.

All granular treatments were preweighed and applied by hand, liquid amendments were applied as drenches with two gallons water. All nitrogen carrying treatments were applied at 1#N/M, Aqua-Gro was applied at the recommended label rate. NPK treatments were applied in the same ratio as Lawn Restore (9-4-4). Treatments were applied monthly beginning in May and ending in October (6 applications).

Disease severity was recorded with respect to size and total number of active ring spots, and the percentage of area diseased, as estimated by visual observation. *Leptosphaeria korrae* was isolated from roots of plants which exhibited signs of NRS. Selected treatments in the Hancock trial were also evaluated for their effect on thatch thickness. On 26 October three 43mm diameter plugs were taken from test plots for thatch measurements. Treatment means were compared using analysis of variance and either Duncan's Multiple Range test or the Least Significant Difference test.

Thatch Study Results.

Factorial analysis indicate differences in thatch thickness between irrigation treatments to be highly significant (F=11.17), as are differences between fertilizer treatments (F=3.22) (table 1). When combined with daily irrigation, all treatments, except the molasses-based organic fertilizer, produced less thatch than when combined with other irrigation treatments. The average thickness in thatch among treatments combined with daily irrigation (19.5mm) was less than when treatments were combined with 80% OPE irrigation (21.8mm), or without supplemental irrigation (rain only) (21.7mm). Analysis of treatment means within an irrigation regime reveal Nitroform, IBDU, and Lawn Restore, when combined with daily or 80% OPE irrigation treatment, had significantly less thatch than the untreated control, which received only the corresponding irrigation treatment (no fertilizer). Without supplemental irrigation, no treatment was found to have a significant effect on thatch.

Disease Study Results.

Hancock Turfcenter. Factorial analysis indicate no significant differences in disease severity between irrigation treatments (F=2.63) but a highly significant difference between fertilizer treatments (F=20.18) (table 2). Analysis of treatment means within an irrigation regime reveal significant differences in disease incidence between fertilizer treatments. When combined with daily irrigation, plots treated with Nitroform, Lawn Restore, IBDU, Sustane, molasses-based fertilizer, molasses-based fertilizer plus bacteria, and

Biogroundskeeper-fertilizer effectively managed NRS. When combined with 80% OPE irrigation, areas treated with IBDU, the molasses-based fertilizer, molasses-based fertilizer plus bacteria, 9-4-4, Lawn Restore, or Nitroform had acceptable levels of disease management and were significantly different than untreated plots. Without supplemental irrigation, Lawn Restore, Biogroundskeeper-fertilizer, Sustane, IBDU, Nitroform, molasses-based fertilizer, molasses-based fertilizer plus bacteria, and 9-4-4 treatments provided excellent control.

Yankee Springs. The commercial bio-organic fertilizers Lawn Restore, Sustane, and Biogroundskeeper-fertilizer, and the slow-release fertilizer IBDU provided excellent disease management (table 3). Significant disease suppression was also obtained with H-50 plus bacteria, and bacteria in TSB with urea.

Novi. Disease expression at this site was diffuse and unevenly distributed due to water saturated areas. Areas treated with Sustane, Lawn Restore, Regenerate, 9-4-4 and Sustane combined with IBDU, had significantly less disease than the untreated control and provided an acceptable level of disease management (table 4). The experimental bacteria when applied with urea, or with the molasses-based fertilizer, or with 30-06 (12 hr prior to application) also performed well.

Conclusion.

Data obtained from these same Hancock test plots in previous years (Melvin, 1990) revealed less disease development in plots receiving daily irrigation. Contradiction of results may be due to increased rainfall without extended drought during the past season causing the release of nutrients from unused organic matter present in non-irrigated plots, which was not released in previous years when conditions were drier. In addition, mineralization of native nitrogen in irrigated check plots, (no supplemental N since 1987) and consequential loss of nitrogen due to leaching, quite possibly created significant nutrient deficiencies which reduced host resistance thus favoring disease development. Similar conclusions have been drawn regarding severity of take-all in wheat (Huber, 1968).

Several bio-organic and slow-release fertilizers, when applied regularly with adequate irrigation, demonstrated effective thatch, and necrotic ring spot management. The experimental bacteria also demonstrated disease management potential and, like other treatments, disease severity was reduced with nitrogen application. Monthly applications of controlled release nitrogen (1#N/M) appears to play an important role in disease recovery.

1) Bowen, G. D. 1980. Misconceptions, concepts, and approaches in rhizosphere biology. In D. Ellwood, et al (eds), Contemporary microbial ecology, Academic Press, pp. 283-304.

2) Huber, D.M.; Painter, C.G.; McKay, H.C.; Peterson, D.L. 1968. Effect of nitrogen fertilization on take-all of winter wheat. *Phytopathology* 58:1470-1472

3) Melvin, B.M. 1990. Effect of fertilizer and irrigation treatments on necrotic ring spot of Kentucky bluegrass. 60th Ann. Mich. Turf. Proc. pp. 90-108.

4) Otto, M. E. Studies in the isolation, pathogenicity, epidemiology and control of *Leptosphaeria Korrae* causing necrotic ring spot of *Poa pratensis* L. in Michigan. **1987** M.S. Thesis. Michigan State University.

Table 1. Effect of bio-organic and slow-release fertilizers combined with irrigation treatments on thatch of Kentucky bluegrass. Thatch thickness (mm), 10/26/90.

TREATMENT MEANS

TREATMENT	IRRIGATION REGIME 0.1"/DA	80% OPE, 2/WK	RAIN ONLY
1. NITROFORM	17.3 A*	20.8 A	20.1 A
2. IBDU	17.3 A	20.9 A	20.6 A
3. LAWN RESTORE	18.5 AB	20.5 A	22.6 A
4. 9-4-4	19.6 AB	21.7 AB	21.9 A
5. BIOGROUNDSKEEPER-FERT.	19.8 AB	22.0 AB	22.1 A
6. SUSTANE	20.2 AB	22.1 AB	21.2 A
7. MOLASSES	21.6 B	22.1 AB	22.2 A
8. CONTROL	21.5 B	24.2 B	22.9 A
ave	19.5	21.8	21.7

* Treatment means followed by the same letter are not significantly different, P=0.05, Least Significant Difference test. Treatments were applied monthly from May through October (6 applications). Nitrogen carrying amendments were applied at 1#N/M.

ANALYSIS OF VARIANCE SUMMARY.

SOURCE OF VARIATION	DF	MEAN SQUARE	F VALUE
IRRIGATION	2	41.394	11.17**
FERTILIZER TREATMENTS	7	11.930	3.22**
I x F	14	1.681	0.45NS
ERROR	46	3.707	

*,** F significant at P=0.05 and 0.01, respectively.
NS = not significant.

Table 2. Effect of Bio-organic and slow-release fertilizers combined with irrigation treatments on necrotic ring spot of Kentucky bluegrass. Percent area diseased, 11/10/90.

TREATMENT MEANS.

TREATMENT	IRRIGATION REGIME 0.1"/DA	80% OPE, 2/WK	RAIN ONLY
1. MOLASSES WITH BACTERIA	0.0 A*	2.7 A	0.0 A
2. NITROFORM	0.0 A	3.7 A	2.0 AB
3. MOLASSES	0.0 A	5.7 A	0.7 A
4. LAWN RESTORE	1.7 A	3.7 A	0.0 A
5. IBDU	2.0 A	2.0 A	1.0 AB
6. 9-4-4	3.3 A	3.0 A	0.0 A
7. SUSTANE	4.0 A	8.7 AB	2.7 AB
8. BACTERIA SUPERNATANT	4.7 A	7.7 AB	5.3 AB
9. BIOGROUNDSKEEPER-FERT.	5.0 A	9.3 AB	0.0 A
10. WASHED BACTERIA CELLS	28.3 B	10.0 AB	10.0 B
11. CONTROL	36.7 B	16.7 B	30.0 C
ave	7.8	6.6	4.7

* Treatment means followed by the same letter are not significantly different, P=0.05, Least Significant Difference test. Treatments were applied monthly from May through October (6 applications). Nitrogen carrying amendments were applied at 1#N/M.

ANALYSIS OF VARIANCE SUMMARY.

SOURCE OF VARIATION	DF	MEAN SQUARE	F VALUE
IRRIGATION	2	80.525	2.63NS
FERTILIZER TREATMENTS	10	818.428	20.18**
I x F	20	73.659	2.40**
ERROR	64	30.647	

*,** F significant at P=0.05 and 0.01, respectively.
NS = not significant.

Table 3. Effect of bio-organic fertilizers on necrotic ring spot of Kentucky bluegrass, Yankee Springs, MI. Disease rating, 11/2/90.

TREATMENT	RATE/M	# RINGS	RING SIZE 0-3	3-6	6-9	% AREA DISEASED
1. BACTERIA IN TSB + UREA	1.0#N	0	0	0	0	0.0 A*
2. SUSTANE + IBDU, 1:1	1.0#N	1	0	1	0	0.3 A
3. H-50 WITH BACTERIA	1.0#N	1	0	1	0	1.7 A
4. SUSTANE	1.0#N	2	0	0	2	2.7 A
5. BIOGROUNDSKEEPER-FERTILIZER	1.0#N	3	0	0	3	4.0 A
6. IBDU	1.0#N	7	0	0	7	8.3 AB
7. 30-06	1.0#N	9	0	6	3	10.0 ABC
8. LAWN RESTORE	1.0#N	4	0	0	4	11.7 ABC
9. BACTERIA SUPERNATANT + UREA	1.0#N	8	2	4	2	11.7 ABC
10. COMPOST PLUS WITH BACTERIA	1.0#N	10	0	2	8	11.7 ABC
12. N + K (9-0-4)	1.0#N, 0.44#K	9	2	3	4	11.7 ABC
13. 30-06[2] + BACTERIA	1.0#N	9	0	5	4	13.3 ABC
14. N + P (9-3-0)	1.0#N, 0.44#P	7	0	1	6	15.3 ABCD
15. NPK (9-4-4)	1.0#N, 0.44#P, 0.44#K	7	1	1	5	16.0 ABCD
16. WASHED BACTERIA CELLS		7	0	5	2	16.0 ABCD
17. COMPOST PLUS	1.0#N	11	1	1	9	16.3 ABCD
18. TSB		10	1	3	6	16.7 ABCD
19. H-50	1.0#N	9	0	3	6	17.3 ABCD
20. WASHED BACTERIA CELLS + UREA	1.0#N	17	0	8	9	20.0 ABCD
21. MOLASSES WITH BACTERIA	1.0#N	13	5	1	7	20.7 ABCD
22. P + K (0-4-4)	0.44#P, 0.44#K	13	3	6	4	21.7 ABCD
23. BACTERIA IN TSB		14	1	5	8	22.7 ABCD
24. UREA	1.0#N	20	2	8	10	31.0 BCD
25. BACTERIA SUPERNATANT		19	0	6	13	31.7 BCD
26. MOLASSES[3]	1.0#N	20	4	6	10	32.3 CD
28. PHOSPHORUS	0.44#P	19	5	5	9	33.3 CD
27. 30-06[1] + BACTERIA	1.0#N	23	0	8	15	33.3 CD
29. POTASSIUM	0.44#K	15	4	7	4	38.3 D
30. CONTROL		41	11	12	18	66.7 E

* Treatment means followed by the same letter are not significantly different, P=0.05, Duncans Multiple Range test. Treatments were applied monthly from May through October (6 applications). Nitrogen carrying amendments were applied at 1#N/M.

1 Bacteria washed cells added 12 hr. prior to application.

2 Bacteria washed cells added to 30-06 at application.

3 Due to unavailability of molasses-based fertilizer an organic fertilizer (10-3-4) without molasses, but similar to the molasses-based product, was substituted in August and September applications.

Table 4. Effect of bio-organic fertilizers on necrotic ring spot of Kentucky bluegrass, Novi, MI. Disease rating, 11/2/90.

TREATMENT	RATE/M	# RINGS	RING SIZE 0-3	3-6	6-9	% AREA DISEASED
1. SUSTANE + IBDU, 1:1	1.0#N	1	1	0	0	1.3 A*
2. SUSTANE	1.0#N	3	3	0	0	3.3 A
3. LAWN RESTORE	1.0#N	2	2	0	0	3.3 A
4. MOLASSES WITH BACTERIA	1.0#N	2	1	1	0	3.3 A
5. NPK (10-3-4)	1.0#N, 0.44#P, 0.44#K	3	2	1	0	4.7 AB
6. H-50	1.0#N	4	3	1	0	5.0 AB
7. BACTERIA IN TSB + UREA	1.0#N	3	1	0	2	5.0 AB
8. 30-06[1] + BACTERIA	1.0#N	2	2	2	0	5.0 AB
9. REGENERATE	1.0#N	5	5	0	0	6.0 AB
10. SUSTANE + AQUA-GRO	1.0#N, 8oz	4	2	2	0	6.7 ABC
11. BIOGROUNDSKEEPER-FERTILIZER	1.0#N	6	4	2	0	7.0 ABC
12. H-50 WITH BACTERIA	1.0#N	5	2	3	0	8.3 ABC
13. WASHED BACTERIA CELLS + UREA	1.0#N	6	3	3	0	8.3 ABC
14. POTASSIUM	0.44#K	6	4	2	0	8.3 ABC
15. IBDU (MAY-AUG-OCT)	1.5#N	5	4	1	0	9.0 ABC
16. 30-06	1.0#N	7	5	2	0	10.0 ABC
17. N + P (9-4-0)	1.0#N, 0.44#P	6	2	4	0	10.0 ABC
18. COMPOST PLUS WITH BACTERIA	1.0#N	8	5	3	0	10.3 ABC
19. BACTERIA SUPERNATANT + UREA	1.0#N	4	1	1	2	11.7 ABC
20. P + K (0-4-4)	0.44#P, 0.44#K	7	4	2	1	11.7 ABC
21. IBDU	1.0#N	8	3	5	0	12.7 ABC
22. BACTERIA SUPERNATANT		7	4	3	0	13.3 ABC
23. AQUA-GRO	8oz	10	6	3	1	13.3 ABC
24. N + K_2 (9-0-4)	1.0#N, 0.44#K	8	2	5	1	13.3 ABC
25. 30-06[2] + BACTERIA	1.0#N	6	2	3	1	13.3 ABC
26. COMPOST PLUS	1.0#N	5	1	2	2	13.3 ABC
27. BACTERIA IN TSB		6	3	3	0	14.0 ABC
28. PHOSPHORUS	0.44#P	9	4	2	3	14.3 ABC
29. MOLASSES-BASED FERTILIZER	1.0#N	9	3	4	2	15.0 ABC
30. WASHED BACTERIA CELLS		14	8	3	3	16.7 ABC
31. UREA	1.0#N	10	3	3	4	20.0 BC
32. CONTROL		13	7	6	0	21.7 C
33. TSB		22	6	9	7	38.3 D

* Treatment means followed by the same letter are not significantly different, P=0.05, Least Significant Difference test. Treatments were applied monthly from May through October (6 applications). Nitrogen carrying amendments were applied at 1#N/M.

[1] Bacteria washed cells added 12 hr. prior to application.

[2] Bacteria washed cells added to 30-06 at application.