Effect of Salinity on Symptom Development of Rapid Blight on Perennial Rye

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Abstract

Rapid blight is a new disease of cool season turfgrasses caused by Labyrinthula terrestris. Disease often occurs on turf irrigated with high salinity water and in areas of frequent mowing. The effects of salinity of irrigation water on symptom development were studied in the laboratory using two-week-old seedlings of perennial rye "Brightstar SLT." Irrigation water was adjusted to 0.5, 0.8, 1.4, 1.8, 2.0, 2.3, 2.8, 4.0, 6.0 and 8.0 dS/m by adding artificial seawater. Plants were inoculated with a $2x10^5$ cells/ml suspension of Labyrinthula terrestris isolated from diseased turf in Arizona. Plants were infected, but not symptomatic, when irrigated with 0.5 dS/m water. At salinities from 0.8 to 8.0 dS/m, symptom development increased as salinity increased. These findings substantiate field observations that rapid blight becomes increasingly more severe as salinity of irrigation water increases.

Introduction

Rapid blight of turfgrass is caused by *Labyrinthula terrestris*, an organism that has previously only been associated with marine organisms (Bigelow, et al., 2004). *Labyrinthula terrestris* is identified by its spindle shaped cells that travel in gliding motility through net-like matrices (Bigelow, et al., 2004). Diseased turf initially appears water soaked and darkened in color on susceptible varieties of turfgrasses such as *Poa trivialis* (rough bluegrass), *Lolium perenne* (perennial rye), *Poa annua*, *Agrostis tenuis* (colonial bentgrass) and *Agrostis palustris* (creeping bentgrass) (Olsen, et al., 2004). Disease can spread rapidly in the field, especially on golf course greens, forming larger patches in which the foliage often turns a bronze color and collapses. Salt tolerant varieties of cool season turfgrasses seem to have the most tolerance to rapid blight. In Arizona, rapid blight usually occurs in golf courses irrigated with poor quality water such as effluent and /or high salinity well water. However, the range of salinities of irrigation water at disease sites varies. Therefore, laboratory studies were initiated to determine the effects of increasing salinity of irrigation water on symptom development and infection of turfgrass seedlings.

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Materials and Methods

For all experiments, "Brightstar SLT" perennial rye was seeded into autoclaved silica sand in 7-cm containers. Containers were placed on a bench in the laboratory using either natural light or 40 watt gro-lights at room temperature and irrigated with tap water. About 10 days after emergence, when a lawn of seedlings was well established, plants were irrigated to excess daily with half strength Hoagland's solution adjusted to known salinities by adding artificial seawater. Prior to inoculation, plants were cut with scissors to simulate mowing. They were inoculated by pipetting 1.0 ml of an inoculum suspension of *Labyrinthula terrestris* cells over the foliage. Symptom development was quantified using a quality rating of 1-9 with 1=dead and 9=non-symptomatic and appearing healthy. Infection by *Labyrinthula terrestris* was determined by plating plant tissue on SIA+ medium (Olsen, et al., 2003). To determine the effect of salinity on disease symptom development, irrigation water was adjusted to 2.0, 4.0, 6.0 and 8.0 dS/m in the first of two trials. Plants were also irrigated with tap water, which did not contain Hoagland's solution, in order to maintain a 0.4 dS/m salinity. Plants were either inoculated with a $2x10^5$ cells/ml suspension of *Labyrinthula terrestris* or were not inoculated. There were four replications for each treatment and the experiment was repeated once. Disease symptoms were quantified 4, 7, 9 and 13 days after inoculation. In a second study, the salinity of the irrigation water was adjusted to 0.5, 0.8, 1.4, 1.8, 2.3 and 2.8 dS/m, and symptoms were quantified at 6, 9, 12 and 21 days after inoculation. Plants were inoculated with a $1.3x10^5$ cells/ml suspension of *Labyrinthula terrestris*. There were three replications of each salinity treatment and the experiment was repeated once. Non-inoculated controls were irrigated with 2.8 dS/m water.

Results and Discussion

Studies indicate that symptom development increases as the salinity of the irrigation water applied increases. Plants inoculated with *Labyrinthula terrestris* and irrigated with 2.0, 4.0, 6.0 and 8.0 dS/m salinity water all became infected and died within 14 days. In plants irrigated with tap water (0.4 dS/m), disease symptoms did not develop and *Labyrinthula terrestris* was not isolated from the plant tissue (Table 1). At seven days after inoculation, symptoms first appeared on plants irrigated with 8.0 dS/m water. The plants had initial symptoms of wilting and darkening in color, and received a rating of five. By day nine the plants treated with 8.0 dS/m water had collapsed from infection and received ratings of 2.3. *Labyrinthula terrestris* was successfully isolated from plant tissue. At day nine symptoms began to appear on plants irrigated with 4.0 and 6.0 dS/m water, and a rating of 4.5 was given. By day 13, plants irrigated with 2.0 dS/m showed symptoms of infection. The results confirmed that plants irrigated with a higher salinity level showed symptoms earlier and collapsed faster than those irrigated at lower salinities. All plants, excluding those irrigated with tap water (0.4 dS/m), showed the same appearance of symptoms regardless of the salinity level. Each plant first appeared wilted and water-soaked and eventually collapsed. Plants irrigated with 0.4 dS/m remained healthy and retained a rating of 8.8 by day 13; *Labyrinthula terrestris* was not isolated from plant tissue. The non-inoculated control plants for each of the salinity levels showed symptoms of stress with an increase of salinity, but were not infected.

In a subsequent study, plants were irrigated with water adjusted to salinities of 0.5, 0.8, 1.4, 1.8, 2.3, and 2.8 dS/m (Table 2). At nine days, infection was confirmed in plants irrigated with 1.4, 1.8, 2.3 and 2.8 dS/m. Similar to the previous study, symptoms of rapid blight occurred more quickly as the salinity of the irrigation water increased. The quality of plants irrigated with 1.8, 2.3 and 2.8 dS/m was significantly different from those irrigated with 0.5, 0.8 and 1.4 dS/m water. After 21 days, all plants were infected (*Labyrinthula terrestris* was isolated from plant tissue), but plants irrigated with 0.5 dS/m water were not symptomatic. Plants irrigated with 0.5 dS/m water, maintained a rating of 9 throughout the duration of the 21 day study. The non-inoculated control plants, irrigated with 2.8 dS/m water had a quality rating of nine throughout the 21 day experiment and were not infected.

Conclusions

Labyrinthula terrestris was commonly associated with marine organisms; however, *Labyrinthula terrestris* has been identified as the causal organism of rapid blight in turfgrasses. Rapid blight has been problematic on golf courses in Arizona that irrigate with reclaimed and effluent water and/or high salinity well water. Disease in Arizona golf courses has been associated with a range of salinities. Based on laboratory findings symptoms of rapid blight will occur in turf irrigated with water having a salinity of 0.8 dS/m and higher. Furthermore, *Labyrinthula terrestris* can be isolated from plants irrigated with 0.5 dS/m water; however, disease symptoms are absent. Laboratory studies have confirmed that disease severity (symptom development) increases as the salinity of irrigation water increases.

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References

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Table 1. Effect of salinity of irrigation water at 2.0, 4.0, 6.0 and 8.0 dS/m on symptom development.

	Days after Inoculation							
	4		**7**		**9**		**13**	
Salinity dS/m	Quality[1]	Infection[2]	Quality	Infection	Quality	Infection	Quality	Infection
Tap (0.4)	**9.0 a**	-	**9.0 a**	-	**9.0 a**	-	**8.8 a**	-
2.0	**9.0 a**	-	**9.0 a**	-	**7.0 b**	-	**2.0 b**	+
4.0	**9.0 a**	-	**7.8 b**	-	**4.5 c**	+	**2.0 b**	+
6.0	**9.0 a**	-	**7.5 b**	-	**4.5 c**	+	**1.0 c**	+
8.0	**9.0 a**	-	**5.0 c**	+	**2.3 d**	+	**1.0 c**	+

[1]Turf quality is a rating of 1-9 of disease symptoms, with 1=dead and 9=healthy. Values are the average of four replications. Values in a column followed by the same letter are not significantly different, determined by the Tukey-Kramer HSD comparison of means test.
[2]Infection indicates that *Labyrinthula* was isolated from plant tissue at the time of rating.

Table 2. Effect of salinity of irrigation water at 0.5, 0.8, 1.4, 1.8, 2.3 and 2.8 dS/m on symptom development

	Days after Inoculation							
	6		**9**		**12**		**21**	
Salinity dS/m	Quality[1]	Infection[2]	Quality	Infection	Quality	Infection	Quality	Infection
0.5	**9.0 a**	-	**9.0 a**	-	**9.0 a**	-	**9.0 a**	+
0.8	**9.0 a**	-	**8.3 a**	-	**7.0 a**	+	**7.0 b**	+
1.4	**9.0 a**	-	**7.7 a**	+	**4.3 b**	+	**3.3 c**	+
1.8	**7.7 a**	+	**5.0 b**	+	**3.0 b**	+	**3.7 c**	+
2.3	**8.0 a**	-	**3.0 c**	+	**1.7 c**	+	**1.0 d**	+
2.8	**8.0 a**	+	**1.7 d**	+	**1.0 c**	+	**1.0 d**	+

[1]Turf quality is a rating of 1-9 of disease symptoms, with 1=dead and 9=healthy. Values are the average of three replications. Values in a column followed by the same letter are not significantly different, determined by the Tukey-Kramer HSD comparison of means test.
[2]Infection indicates that *Labyrinthula* was isolated from plant tissue at the time of rating.