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Influence of Management Practices on Rhizoctonia Large Patch Disease in Zoysiagrass

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Abstract. **Mowing heights from 1.2 to 5.1 cm, five N sources with two application rates (74 and 148 kg N/ha per year), and seven preemergence herbicides were evaluated in field studies in Manhattan and Wichita, Kan., for their effect on large patch disease, caused by *Rhizoctonia solani* Kuhn AG 2-2, in zoysiagrass *(Zoysia* spp.). Turf mowed at 1.2 and 2.5 cm was more severely blighted than turf mowed at 4.5 or 5.1 cm. At all mowing heights, turf recovered by August or September. Disease severity was not influenced by N source, N rate, or preemergence herbicides.**

Rhizoctonia solani Kuhn AG 2-2 causes large patch disease in zoysiagrass throughout the North American transition zone (Green et al., 1993). Patch symptoms are most common in spring and fall as the turfgrass enters and breaks winter dormancy. It also may occur in mid-summer during unusually cool, wet weather. *Rhizoctonia solani* causes a sheath blight of zoysiagrass shoots, resulting in progressive turf thinning in distinct, circular patches. During weather favorable for the disease, patches may expand rapidly and coalesce to blight large turf areas. Zoysiagrass slowly refills blighted areas during the summer.

We are unaware of any studies researching the effect of various management practices on the development and severity of rhizoctonia large patch. Turfgrass managers have associated severe large patch outbreaks with spring preemergence-herbicide applications or excessive N fertilization. Patch symptoms also appear to be more severe at low mowing heights. Mowing heights, N fertilization, and preemergence herbicide application influence severity of other turfgrass diseases caused by *R. solani.* For example, rhizoctonia brown patch in tall fescue *(Festuca arundinacea* Schreb.) was more severe when the turf was mowed at 2.5 cm than at 6.4 cm (Watkins et al., 1990). High N applications have been associated with increased turf susceptibility to rhizoctonia brown patch in cool-season turfgrasses (Bloom and Couch, 1960; Cook et al., 1964; Demoeden, 1991; Smiley et al., 1992), and natural N source applications decrease brown patch severity on creeping bentgrass *(Agrostis palustris* Huds.) (Nelson, 1991; Nelson and Craft, 1992). The preemergence herbicide N-butyl-N-ethyl- α,α,α, -trifluoro-2,6-dinitro-p-toluidine (benefin) at 3.4 $kg\cdot ha^{-1}$ increased brown patch severity in greenhouse-grown bermudagrass *[Cynodon dactylon* (L.) Pers.] (Karr et al., 1979).

Our objective was to determine whether mowing height, N source, N application rate, and preemergence herbicides influenced the development and seventy of large patch disease in zoysiagrass.

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Materials and Methods

The effects of mowing height, N source, and N application rate on large patch development were examined in field plots in Manhattan and Wichita, Kan., in 1991 and 1992. In Manhattan, plots were established on 'Meyer' zoysiagrass grown on a Chase silt loam soil [fine, montmorillonitic, mesic, Aquic, Arquidolls]. Plots were arranged in a split-plot design with mowing heights serving as the main plots and N source and application rate as the subplots. Mowing heights were 1.3, 2.5, and 5.1 cm, and plots were arranged in 1.5 x 15.0-m strips. Turfgrass was mowed twice weekly with a reel mower. Mowing height and N treatments were replicated in four randomized complete blocks.

Mowing strips were divided into ten 1.5 × 1.5-m subplots and treated with either urea (46N-0P-0K), urea formaldehyde (38N-0P-OK; Nitroform, Nor-Am Chemical Co., Wilmington, Del.), poultry litter (5N–2P-4K, Sustane Corp., Cannon Falls, Mont.), sewage sludge (5N–2P-0K; Milorganite Division-MMSD, Milwaukee, Wis.), or bovine waste (5N-0P-0K; Bova Mura, PBI/Gordon Corp., Kansas City, Me.). Each fertilizer was applied in June and August to provide 74 or 148 kg N/ha per year.

A similar mowing height and N source study was established in Wichita, Kan., in July 1991 on a plot containing 12 cultivars of Z. *japonica* and Z. *japonica* × *Z. tenuifolia* Wind. ex Trin. that had intermixed. The soil was a Canadian fine sandy loam [coarse-loamy, mixed, thermic, Udic Haplastollos). Mowing heights were 1.3,2.5, and 4.5 cm, and mowing height main plots were arranged in 0.9 × 4.5-m strips and were replicated in three randomized complete blocks. The N sources were applied to ten 0.9 × 0.45-m subplots in Aug. 1991 to provide 37 or 74 kg N/ha per year and in June and Aug. 1992 to provide 74 or 148 kg N/ha per year.

In Sept.-1991, subplot centers and the center of the edges between main treatments in each subplot were inoculated with ≈ 4 g of *R. solani* AG 2-2 (isolate Kan. 118) oat *(Avena sativa* L.) inoculum at both locations. The inoculum preparation we used has been outlined by Tisserat et al. (1989). Three 2.5-cm deep soil cores with 2.5-cm diameters were removed within a 12-cm-diameter circle at each inoculation site. Inoculum was then evenly distributed in the bottom of the three holes, and the soil cores were replaced. During Sept. and Oct. 1991, Mar. and June 1992, and Sept. and Oct. 1992, ≈ 13 mm of water per week was applied by irrigation to maintain moist soil conditions and encourage large patch development.

Patch diameters in each subplot center were measured at biweekly intervals from Oct. 1991 through June 1992, except during turf dormancy. Patch diameters could not be accurately measured after June 1992 because patches in plot centers coalesced with patches expanding from subplot edges. Therefore, we determined the percent area of each subplot damaged by patch symptoms by measuring the affected areas. Turf damage was rated on a 0-9 scale (0 = no patches; 1 =1% to 11% of the subplot area with patch symptoms; 2 = 12% to 22%; 3 = 23% to 33%; 4 = 34% to 44%; 5 = 45% to 55%;6 = 56% to 66%; 7=67% to 77%; 8 = 77% to 88%; and 9 = > 88%).

Disease severity in each plot was also determined because *R. solani* did not cause all shoots within patches to blight. The percentage of infected shoots in patches could not be determined directly because of the rapid decomposition of diseased tissue. Therefore, we calculated a shoot density reduction (SDR) in zoysiagrass caused by the disease as follows: SDR(%) = [(average number of shoots in 2.5 cm^2 of healthy turf in subplots – surviving number of shoots in 2.5 cm^2 at the diseased patch center)/average number of shoots in 2.5 cm^2 of healthy turf in subplots] × 100. Data for turf damage and SDR were collected biweekly from Oct. 1991 to Oct. 1992, except during turf dormancy.

Patch diameter, turf damage, and SDR for each sampling date were plotted, and areas under the disease progression curves (AUDPC) for Fall and Spring 1991 and 1992 were calculated by the method described by Burpee (1992). The AUDPC values were used, to compare disease development and severity among treatments. Large patch was considered to be active (i.e., progressing) during sampling intervals when sheath blighting was observed on individual shoots within patches. There was a 2- to 3-week delay between the sheath blighting cessation and a turf damage rating reduction. We performed an analysis of variance on AUDPC values using SAS software (SAS Institute, Cary, N.C.); means were separated by Scheffe's S method (Milliken and Johnson, 1984),

Preemergence herbicides [dimethyl tetrachloroterephthalate (DCPA); 2-*tert*-butyl-4-(2,4-dichloro-5-isopropoxy phenyl)-Δ^2–1, 3, 4-oxadiazolin-5-one] (adiazon); O, O-diisopropyl phosphorodithioate-S-ester with N-(2-mercaptoethyl)benzenesulfonamide (bensulide); N-(1-ethylpropyl)-3,4 dimethyl-2,6 dinitrobenzenamine (pendimethalin); 2-chloro-4,6-bis(ethylamino)-s-triazine (simazine); 1-(2-methylcyclohexyl)-3-phenylurea (siduron); and benefin] were examined for their influence on large patch disease in 'Meyer' zoysiagrass during 1991 and 1992 in Manhattan. Application rates were as follows ($kg\cdot ha^{-1}$): DCPA, 5.9 and 11.8; oxadiazon, 1.7 and 3.4; bensulide, 5.6 and 11 .2; pendimethalin, 0.8 and 1.6; simazine, 1.1 and 2.2; siduron, 10.1 and 20.2; and benefin, 1.1 and 2.2. Treatments were applied as a split application in April and June at one-half of the aforementioned rates. Liquid herbicides were applied with a CO_2 backpack sprayer (R & D Sprayers, Opelousas, La.) equipped with a two-nozzle, hand-held boom with T-jet flat fan nozzles (Spraying Systems Co, St. Louis). Dry herbicides were applied using a shaker bottle. Plots were 1.9 × 3.7 m. Treatments were arranged in a randomized complete-block design with three replications. Initial treatments were applied in 1988, and the treatments continued yearly through 1992. Turf was mowed at 1.9 cm throughout the-experiment. Plots were irrigated with ≈ 13 mm of water per week from Apr. to June 1992 and from Sept. to Oct. 1992 to maintain moist soil conditions and encourage large patch development.

In Sept. 1991, herbicide-treated plots were divided into four 0.9 × 3.7-m sections. Centers of two plot sections were inoculated with 4 g of oat inoculum infested with *R. solani* AG 2-2 as described previously. The two remaining plot sections were inoculated in Mar. 1991. Patches were rated and data analyzed by methods described previously.

Results and Discussion

Large patch symptoms developed at inoculation sites in Wichita in Oct. 1991 and continued through turf dormancy on 31 Oct. 1991 (Fig. 1). In 1991, symptoms did not occur in Manhattan. Disease ratings after turf dormancy could not be accurately determined and were discontinued. Nevertheless, discrepancies in ratings between late Fall 1991 and Spring 1992 indicated that some disease development occurred following turf dormancy. Large patch developed at inoculation sites at both locations in Apr. 1992 and continued through mid-June. The zoysiagrass slowly recovered during July and Aug. 1992, but patch symptoms redeveloped at both locations in Sept. 1992 and were evident until turf dormancy in early November.

No interaction occurred among AUDPC values for mowing height and N treatments, except in Fall 1992 in Manhattan. There were no clear trends to the interaction effects; therefore, AUDPC values for mowing height (Table 1) and N effects were analyzed separately. Mowing height influenced large patch development at both locations. In Manhattan, patch diameter, turf damage, and SDR decreased as mowing height increased (Table 1). In Wichita, turfgrass mowed at 4.5 cm exhibited a lower SDR ($P \leq 0.06$) than turf mowed at either 2.5 or 1.3 cm. Although patch diameters and turf damage ratings were generally smaller at the higher mowing heights in Wichita, AUDPC values were not significantly different. Burpee and Martin (1992) suggested that higher mowing heights on warm-season grasses mask rather than suppress some patch symptoms caused by *R. solani. This* does not appear to be the case in our studies because SDR values, which were an indirect measure of the amount of sheath blighting, were higher at the low mowing heights.

SDR ratings began to decrease in late May in Wichita and by mid-June in Manhattan, and they continued to decline at both locations through the summer (Fig. 1). Sheath blighting caused by *R. solani* was not detected during this interval. At all mowing heights, turfgrass recovered completely or nearly completely (SDR ratings < l0%)by early to mid-August in Manhattan and by late September in Wichita. At the highest mowing height, turfgrass had lower SDR ratings for each sampling period. Zoysiagrass recovered duringJuly and August primarily by new shoot formation on existing, healthy stolons within diseased areas and not by stolon regrowth from. outside diseased patches.

Nitrogen application rates did not affect large patch development or turfgrass recovery in Manhattan or Wichita. High-N application rates increase brown patch in cool-season turfgrasses (Bloom and Couch, 1960; Smiley et al., 1992; Watkins et al., 1990), but the influence of high N on *R. solani* damage to warm-season grasses is not clear. Beard (1982) reported that St. Augustinegrass*[Stenotaphrum secundatum* (Walt.) Kuntze] deficient in N was more susceptible to *R. solani.* The 74-and

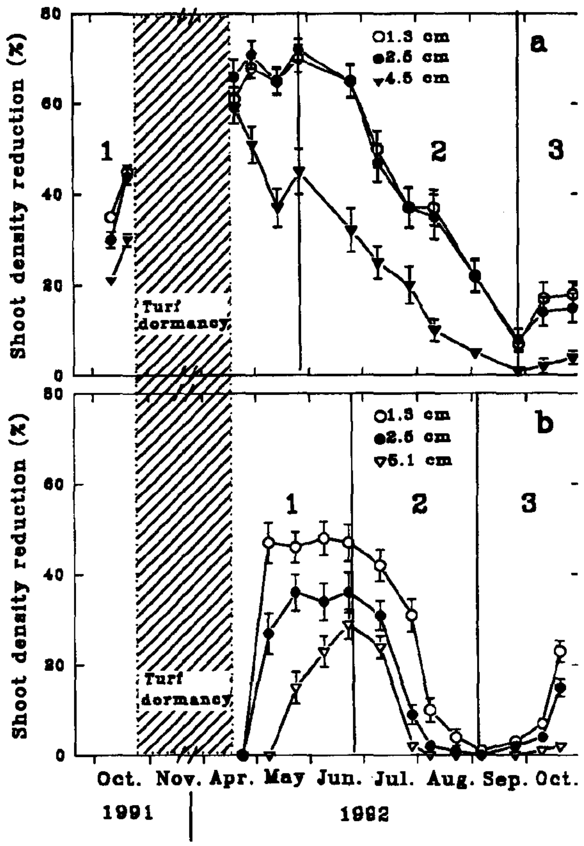

Fig. 1. Seasonal mowing height effect on zoysiagrass shoot density reduction caused by *Rhizoctonia solani* in (a) Wichita and (b) Manhattan, Kan. Shoot density reduction values were an indirect measure of sheath blighting amount within individual patches. Bars represent the standard error. Intervals 1 and 3 represent periods when large patch disease was active and from which AUDPC values for shoot density reduction in Table 1 were calculated using days as the basis of the horizontal axis. Interval 2 represents the period when sheath blighting could not be detected in patches and when zoysiagrass was recovering from large patch.

Table 1. Influence of mowing height on large patch development in zoysiagrass.

Mowing ht (cm)	AUDPC[z] Patch diam[w] Manhattan	Patch diam[w] Wichita	Turf damage[x] Manhattan	Turf damage[x] Wichita	SDR[y] (1000s) Manhattan	SDR[y] (1000s) Wichita[v]
Fall 1991 and Spring 1992						
1.3	1250 a[u]	5790 a	158 a	1070 a	2.60 a	12.6 a
2.5	1120 a	6150 a	107 b	1170 a	1.79 b	12.8 a
4.5	---	5440 a	---	798 a	---	9.69 b
5.1	647 b	---	38 c	---	0.77 c	---
Fall 1992[t]						
1.3	---	---	46 a	39 a	0.265 a	0.441 a
2.5	---	---	38 b	42 a	0.155 b	0.396 a
4.5	---	---	---	32 a	---	0.094 a
5.1	---	---	28 c	---	0.022 c	---

[z]AUDPC = area under the disease progression curve, using days as the horizontal axis. ZAUDPC values for Fall 1991 and Spring 1992 were combined for analysis.

[y]SDR = shoot density reduction; total percent area under mean SDR curve = [average number of shoots in 2.5 cm^2 of healthy turf– number of surviving shoots in 2.5 cm^2 at disease patch centers)/average number of shoots in 2.5 cm^2 of healthy turf] × 100.

[x]Total area under mean turf damage rating curve (0 = no damage, 9 = > 88% plot damaged).

[w]Total area under mean patch diameter curve.

[v]Mean separation within columns by Scheffe's S method ($P \leq 0.06$).

[u]Mean separation within columns by Scheffe's S method ($P \leq 0.05$).

[t]Area under the disease progression curve during tire second season of disease.

148-kg N/ha per year application rates used in our study were not excessively high for zoysiagrass in the transition zone. Furthermore, N was applied in summer during periods of zoysiagrass recovery. The effect of higher N application rates or of N applied during large patch development (spring and fall) should be examined.

Nitrogen carrier did not influence large patch development or turf recovery at either location (data not presented). In these studies, natural and synthetic N sources were applied at equivalent rates; this was done to avoid confounding N application rates with other possible antagonistic effects (i.e., biological antagonism) of the natural N source on large patch development. Previous researchers that have documented a decrease in turf disease seventy used frequent applications and high rates of compost material (Nelson and Craft, 1991, 1992). It is not clear whether disease reduction in the aforementioned studies was a result of the high N rates applied or some other biological effect.

Kansas turfgrass managers occasionally observed an increase in large patch severity on zoysiagrass following preemergence herbicide applications in the spring. Some herbicides are known to influence disease development (Altman and Campbell, 1977). Nevertheless, none of the seven preemergence herbicides evaluated in our study influenced disease development. Spring preemergence-herbicide applications may simply coincide with favorable environmental conditions necessary for patch development.

Mowing height was the only cultural practice evaluated that influenced large patch development and progression and zoysiagrass recovery. Hence, raising mowing heights during infection periods and turf recovery would be advisable to reduce large patch seventy.

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