Effects of nitrogen and Primo Maxx on brown ring patch development

Best management practices are still being developed for brown ring patch, a recently discovered disease of *Poa annua* greens.

Brown ring patch (also known as Waitea patch) is an emergent disease in the U.S., affecting annual and roughstalk bluegrass (*Poa annua* and *P. trivialis*) greens (2,4,7). It is caused by *Waitea circinata* var. *circinata*, which belongs to the *Rhizoctonia* group of plant pathogens. This fungus typically is active in the spring and early summer when daytime temperatures are 65 F to 85 F (18 C to 29 C) and causes yellow rings a few inches to a foot in diameter that may turn sunken, brown or necrotic over time.

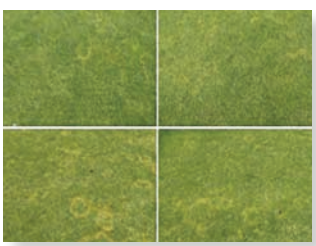
Best management practices are still being developed for this disease, and little is known about the impact of certain cultural practices. Nitrogen is known to increase the severity of *R. solani* (brown patch) (1), but its effects are not well documented for other *Rhizoctonia* diseases (3). Anecdotally, many of the locations with chronic brown ring patch have been using low-nitrogen fertility programs to increase ball-roll distance (green speed). Lack of recovery from inadequate fertility seems a plausible reason for the increased severity of the disease at these locations. The effect of plant growth regulators (for example, Primo Maxx [trinexapac-ethyl, Syngenta]) on brown ring patch is also unknown. Primo Maxx is commonly used on greens to reduce plant size in order to increase ball-roll distance (6). Some superintendents had reported that disease outbreaks could coincide with spring applications of Primo Maxx and were more severe when this material was applied, and its use slowed recovery from brown ring patch.

In the shadow of the U.S. Open

We were fortunate to perform this work at Torrey Pines Golf Course, San Diego, as preparations for the 2008 U.S. Open were taking place. The studies were conducted on three annual bluegrass greens with the cooperation of then-golf operations manager Mark Woodward, CGCS; then assistant golf operations manager Jon Maddern, CGCS; and North Course superintendent Wayne Carpenter, CGCS. Torrey Pines GC had had a history of brown ring patch, and some of the earliest fungicide work was done in 2005 with South Course superintendent Candice Combs, CGCS. As the South Course was being groomed and prepped for the tournament, we were allowed to initiate a number of replicated experiments on the North Course greens, which were shut down from play at this time so that the North Course could be used as a staging area for the tournament.

Experimental plan and layout

The overall objectives of this study were to determine the effect of nitrogen applications (using nitrate, ammonium and urea forms) alone and in combination with Primo Maxx on brown ring patch severity. A secondary objective was



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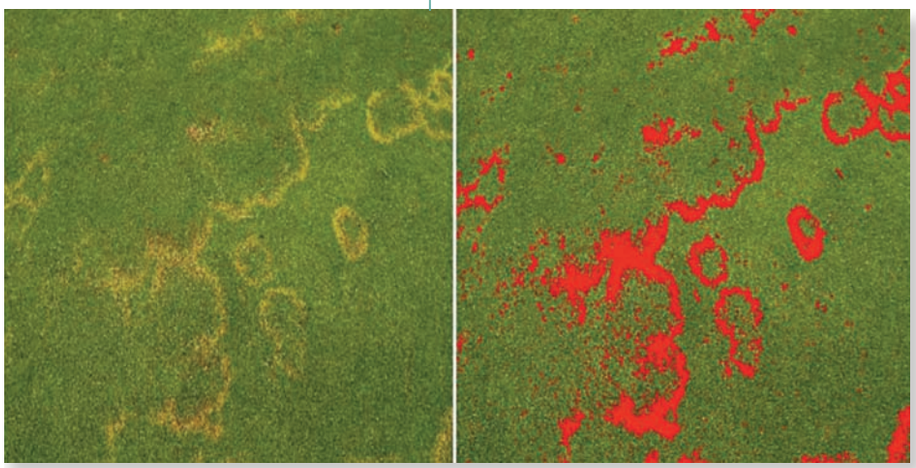


Digital analysis of disease severity using SigmaScan software and programs (5). Diseased areas appear in red. **Photos by L. Stowell**

to examine the effects of nitrogen and nitrogen plus Primo Maxx in combination with fungicide applications. Three greens on the North Course were used for these studies: No. 7, where effects of nitrogen and Primo Maxx were evaluated, and No. 2 and No. 6, where Heritage TL (azoxystrobin, Syngenta) was tested in combination with calcium nitrate and Primo Maxx.

Greens were an approximate 80/20 mix of annual bluegrass and creeping bentgrass, which were mowed three times a week at a height of 0.150 inch (3.8 millimeters). All regular fertility applications were stopped by mid-March. The average maximum daytime temperatures during the study ranged from 64 F to 69 F (18 C to 21 C) and average soil temperatures (at a 6-inch depth) ranged from 61 F to 69 F (16 C to 21 C).

Effects of nitrogen and Primo Maxx

In this experiment, we determined the effect on brown ring patch development of three nitrogen sources — urea (46-0-0), calcium nitrate (15-0-0) and ammonium sulfate (21-0-0) — alone and in combination with Primo Maxx. Reagent-grade water-soluble nitrogen was applied on April 8 and April 22 (trial 1) and on May 3 and May 17 (trial 2) at the rate of 0.5 pound nitrogen/1,000 square feet (2.4 grams/square meter) or 1 pound nitrogen/1,000 square feet total (4.8 grams/square meter). Primo Maxx was applied at a rate of 0.125 fluid ounce/1,000 square feet (0.016 ounce a.i./1,000 square feet [0.04 milliliters/square meter]) alone and in combination with the nitrogen sources. Check plots were treated with water only. All applications were made using a CO_2-powered sprayer and 2 gallons/1,000 square feet (81.5 milliliters/square meter) water volume. Each treatment had five 6-foot × 6-foot replicated plots in a randomized split-plot design.

Disease severity was rated weekly by photographic analysis using SigmaScan software (5). Briefly, high-resolution images of each plot were taken weekly using a Nikon D70 digital camera and tripod set at fixed height and angle. Images were cropped and processed to analyze fixed, equal areas, and software was set to distinguish between yellow-brown symptomatic and non-symptomatic turf.

Turf color was measured weekly using a FieldScout CM-1000 chlorophyll meter, making six measurements per plot. Statistical analyses were done for both disease severity and color data.

Effect of nitrogen and Primo Maxx on color

	Chlorophyll meter rating*							
	Trial 1				Trial 2			
Treatment + rate/1,000 square feet	Apr 4	Apr 11	Apr 18	Apr 25	May 2	May 9	May 16	May 23
Water	294	284 c	265 e	248 e	212	219 d	199 c	231 d
1 pound calcium nitrate	286	326 a	289 d	267 d	210	222 d	209 bc	245 d
1 pound ammonium sulfate	294	312 b	308 c	285 c	213	231 c	211 bc	259 c
1 pound urea	287	326 a	331 b	303 b	211	240 c	212 bc	277 bc
0.125 fluid ounces Primo Maxx	294	284 c	344 b	329 ab	209	246 bc	223 ab	292 ab
0.125 fluid ounces Primo Maxx + 1 pound calcium nitrate	292	307 b	377 a	335 ab	207	254 bc	230 a	304 a
0.125 fluid ounces Primo Maxx + 1 pound ammonium sulfate	292	304 b	375 a	345 a	209	265 ab	226 ab	301 a
0.125 fluid ounces Primo Maxx + 1 pound urea	287	323 a	368 a	348 a	214	269 a	232 a	299 a

*The mean of five replicated plots using six FieldScout CM-1000 readings per plot; in a column, means followed by the same letters are not significantly different from each other. There were no significant differences among treatments on April 4 and May 2.

Table 1. Effect of nitrogen and Primo Maxx on turfgrass color.

Effects of nitrogen, Primo Maxx and Heritage TL

The low rate of Heritage TL (1 fluid ounce/1,000 square feet [0.32 milliliter/square meter]) was applied alone or in combination with 0.5 pound/1,000 square feet calcium nitrate and/or 0.125 fluid ounce/1,000 square feet Primo Maxx. All applications were made as described above to four 6-foot × 6-foot replicated plots per treatment in a randomized split-plot design. Previous studies had shown that the low labeled rate of Heritage TL provided only moderate control of the disease and it was hoped that the combination of the fungicide with nitrogen or nitrogen and Primo Maxx would help increase the effectiveness of the fungicide. Disease severity, using a 0 to 10 scale (where 0 is no disease and 10 is 100% of plot affected by disease), was rated once a week for five weeks from April 25 to May 23 and analyzed as described above.

Results

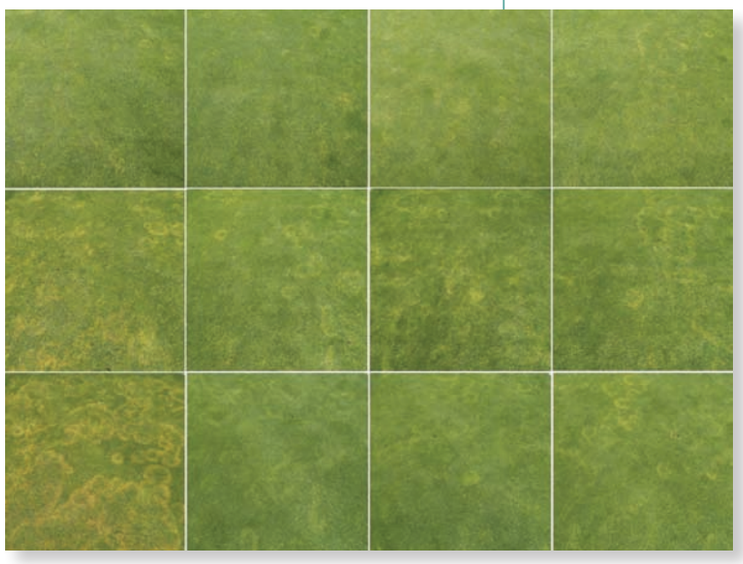
Effects of nitrogen and Primo Maxx

Turf color was taken as an indication that turf showed a physiological response to fertility treatments and as an indirect measurement of turf quality. Results varied between experiments, but trends were generally consistent over the evaluation period. Compared to the treatments with only water, all nitrogen treatments had a positive effect on turf color in both experiments. In most cases, there were not significant differences between nitrogen sources, but overall, urea appeared to give a stronger color response (Table 1). Soil analysis for nitrogen was inconclusive for two samplings taken during the first trial, suggesting that nitrogen was being immediately absorbed by the turf. Plots treated with Primo Maxx had higher chlorophyll readings (darker color) than those treated with nitrogen alone, and plots treated with Primo Maxx and nitrogen had the highest turf color readings.

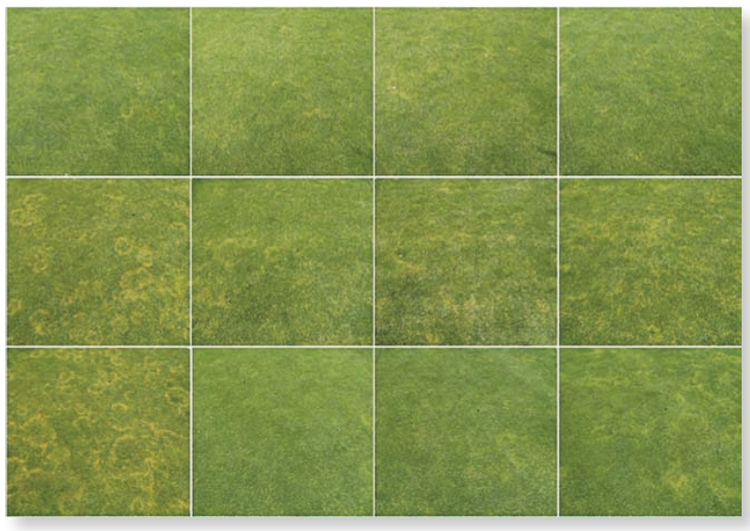
Generally, plots that received nitrogen, regardless of source or whether it was applied alone or in combination with Primo Maxx, had significantly less brown ring patch than plots treated with only water or Primo Maxx (Table 2). Results are shown only for Trial 1, but results from Trial 2 were similar. Plots treated with Primo Maxx had slightly more disease than plots treated only with water on two of four rating dates in Trial 1.

Effects of nitrogen, Primo Maxx and Heritage TL

In both trials, Heritage TL applied at 1 fluid ounce/1,000 square feet with 0.5 pound nitrogen/1,000 square feet calcium nitrate, or with 0.5



Effects of nitrogen applied at 1 pound/1,000 square feet on brown ring patch severity. Treatments are arranged by column (**left to right**): water only, calcium nitrate, ammonium nitrate and urea. Photos within a row were taken on the same date (**top to bottom**): April 8, April 22 and May 6.



Effects of nitrogen and Primo Maxx on brown ring patch severity. Plots were treated with water, 1 pound nitrogen/1,000 square feet and/or 0.125 fluid ounce/1,000 square feet Primo Maxx. Treatments are arranged by column **(left to right)**: Primo Maxx, calcium nitrate + Primo Maxx, ammonium nitrate + Primo Maxx and urea + Primo Maxx. Photos within a row were taken on the same date (**top to bottom**): April 8, April 22 and May 6.

Nitrogen and Primo Maxx vs. brown ring patch

Treatment + rate/1,000 square feet	Disease severity rating*						
	Apr 8	Apr 15	Apr 22	Apr 29	May 6	May 13	May 20
Water	1.21	7.82	18.38 b	29.97 b	31.11 a	10.34 a	13.60 a
1 pound calcium nitrate	1.66	4.94	2.25 c	1.14 c	0.89 b	0.50 b	0.83 b
1 pound ammonium sulfate	1.53	5.47	2.80 c	0.59 c	0.11 b	0.26 b	0.52 b
1 pound urea	1.26	3.58	3.67 c	1.85 c	1.34 b	0.76 b	1.07 b
0.125 fluid ounce Primo Maxx	0.85	9.01	25.17 a	36.40 a	33.14 a	9.69 a	15.48 a
0.125 fluid ounce Primo Maxx + 1 pound calcium nitrate	1.11	5.49	5.53 c	1.32 c	0.71 b	0.55 b	1.37 b
0.125 fluid ounce Primo Maxx + 1 pound ammonium sulfate	1.19	6.48	6.33 c	3.76 c	0.86 b	0.40 b	0.50 b
0.125 fluid ounce Primo Maxx + 1 pound urea	1.12	4.94	8.13 c	1.61 c	0.47 b	0.40 b	0.47 b

*The mean of five replicated plots using SigmaScan to determine the percentage of pixels affected by disease; means followed by the same letters are not significantly different from each other. There were no significant differences among treatments on April 8 and April 15.

Table 2. Effects of nitrogen and Primo Maxx on brown ring patch severity.

pound nitrogen/1,000 square feet calcium nitrate and 0.125 fluid ounce Primo Maxx, resulted in less disease than the check or Heritage TL applied alone (Figure 1). Previous studies had suggested that low-rate curative applications of Heritage TL would not be 100% effective, so the inability of the application to provide complete control was not unexpected. Disease pressure decreased by May 23, but overall, Heritage TL applied with nitrogen or nitrogen plus Primo Maxx resulted in less disease for the four-week evaluation period.

Conclusions

Although brown ring patch is caused by a *Rhizoctonia*-like fungus, it appears to develop differently than other *Rhizoctonia* diseases, such as brown patch (*R. solani*). In these studies, there appears to be a clear connection between the reduction of brown ring patch severity and the application of nitrogen.

Disease severity could be significantly reduced by nitrogen and, in these studies, no differences in disease severity ratings were detected among applications of 1 pound nitrogen/1,000 square feet using ammonium sulfate, calcium nitrate or urea. Primo Maxx used alone appeared to slightly increase disease severity in some cases, but this effect was not observed in plots treated with nitrogen and Primo Maxx.

The reduction in disease severity appeared to be a plant growth response to the nitrogen applications, as measured by the difference in color between the treated and unfertilized check plots. Among nitrogen sources, urea and ammonium sulfate appeared to give a better color response than calcium nitrate on some evaluation dates, but this difference was not as evident when nitrogen was applied in combination with Primo Maxx. Turf color was higher in plots treated with nitrogen and Primo Maxx compared to plots treated with nitrogen alone.

Although Primo Maxx may be associated with a slight increase in disease severity, the benefits of its application likely outweigh any negative effects. In these experiments, applications of Primo Maxx with nitrogen resulted in the best turf color and in disease suppression equivalent to nitrogen used alone.

The application of nitrogen as a sole means of brown ring patch control may be limited in practicality, as the application of high nitrogen rates may result in excess foliar growth and a possible reduction in ball-roll distance. The application of 1.0 pound nitrogen/1,000 square feet may be excessive, but we also showed that even 0.5 pound calcium nitrate/1,000 square feet (applied with or without Primo Maxx) greatly increased the effect of Heritage TL applied at the low label rate. The combined results of the studies presented here do show that increased nitrogen fertility reduces the severity of brown ring patch and suggests that this disease be included with diseases such as anthracnose and dollar spot, which are associated with low nitrogen fertility.

We are planning additional studies examining the effects of fertility (such as iron) that should contribute to our understanding of how to best manage brown ring patch. For the time being,

Effects on brown ring patch

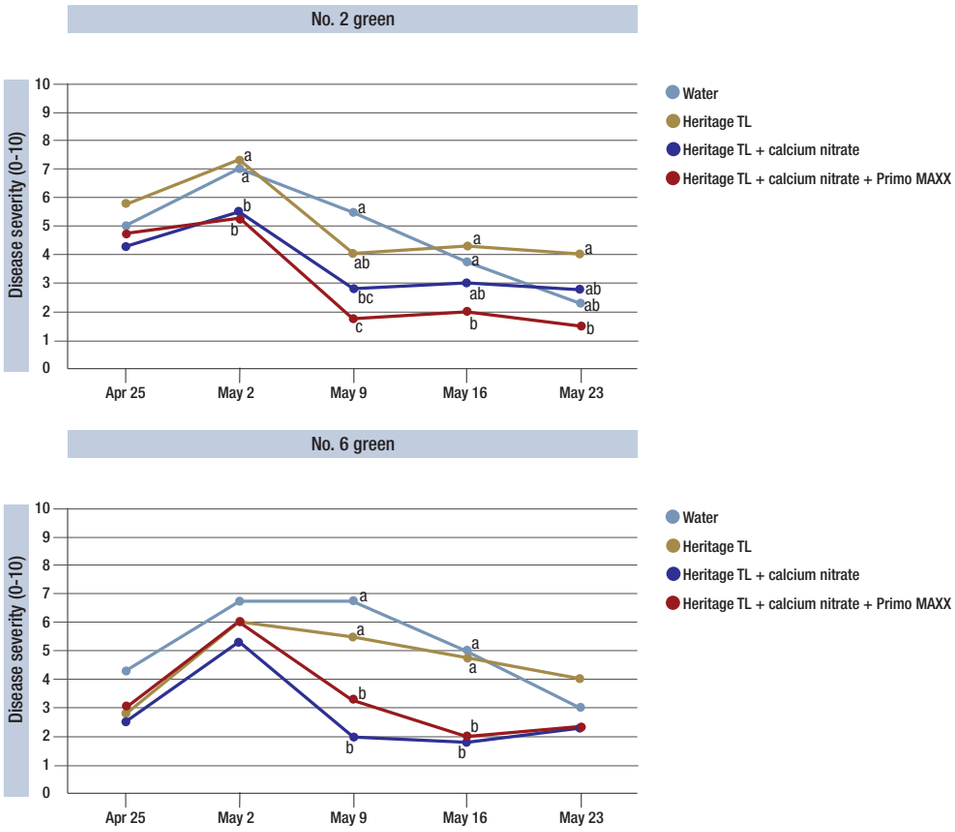


Figure 1. Effects on brown ring patch of the low label rate of Heritage TL (1 fluid ounce/1,000 square feet) applied with calcium nitrate (0.5 pound/1,000 square feet) or the same rate of calcium nitrate + Primo Maxx (0.125 fluid ounce/1,000 square feet) on the No. 2 and No. 6 greens. Plots were rated on a 1 to 10 scale for disease severity; each data point reflects the mean of four replicated plots. There were no significant differences among treatments on April 25 on both greens and on May 2 and May 23 on the No. 6 green. Different letters on the same date indicate significant differences between values.

increased nitrogen fertility appears to be a key factor in reducing the impact of this disease.

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The research says

→ In these studies, increased nitrogen fertility reduced the severity of brown ring patch.

→ No differences in disease severity ratings were detected among treatments using the 1-pound rate of ammonium sulfate, calcium nitrate or urea.

→ Primo Maxx used alone appeared to slightly increase disease severity in some cases; this effect was not observed in plots treated with nitrogen and Primo Maxx.

→ Applications of Primo Maxx with nitrogen resulted in the best turf color and in disease suppression equivalent to nitrogen used alone.

→ Even the 0.5-pound rate of calcium nitrate (with or without Primo Maxx) greatly increased the effect of a fungicide applied at the low label rate.