



The influence of irrigation and inputs on dollar spot

Irrigation practices and chemical treatments can be used to control dollar spot in creeping bentgrass.



Creeping bentgrass (*Agrostis stolonifera*) provides an excellent playing surface for fairways, but dollar spot (*Sclerotinia homoeocarpa*) can be a chronic problem. In summer, water from irrigation is applied frequently to fairways to maintain turf health and promote vigor. The two most common approaches to irrigating fairways during summer in the mid-Atlantic region are light and frequent irrigation and deep and infrequent irrigation. Frequent irrigation (that is, five times or more per week) in summer is common primarily for aesthetic reasons. Deep and infrequent irrigation typically is recommended as a cultural disease management strategy because this practice promotes drier soil conditions, which are generally less conducive to infection by foliar pathogens (2,7,8). Studies involving the impact of irrigation and soil moisture on dollar spot severity, however, have yielded mixed results (3,5,9).

Chemical control of dollar spot

Many superintendents use a variety of chemicals on creeping bentgrass fairways. Trimmit 2SC (paclobutrazol, Syngenta) is a growth regulator that is applied to manage excess clippings, improve turfgrass color and density and suppress annual bluegrass populations. Trimmit 2SC also has fungistatic effects on *S. homoeocarpa* in creeping bentgrass (1). Wetting agents are used on fairways to improve water infiltration and to alleviate hydrophobic soil conditions. Primer Select (100% alkoxyated polyols, Aquatrols) is a non-

ionic surfactant that has been shown to suppress dollar spot (4). Chlorothalonil is perhaps the most widely used fungicide on turfgrasses. In our experiments, we used Daconil Ultrex 82.5WDG (Syngenta) for chlorothalonil. The U.S. Environmental Protection Agency placed restrictions on the use of chlorothalonil in 1999 for turfgrass use. These restrictions have created the need to elucidate approaches to improving chlorothalonil performance.

The study

The purpose of this three-year field study was to evaluate the impact of two irrigation regimes (light and frequent nighttime vs. deep and infrequent morning) and three commonly used chemicals (Daconil Ultrex, Trimmit 2SC, Primer Select) and various tank-mixes of these materials on dollar spot in fairway-height creeping bentgrass.

Site

This study was conducted at the University of Maryland Turfgrass Research Facility in College Park from 2002 to 2004. In autumn of each year, the site was renovated with Roundup (glyphosate, Monsanto) and reseeded with Crenshaw creeping bentgrass.

Irrigation regimes

Eight independently irrigated blocks, 9.8 feet × 34.4 feet (3.0 meters × 10.5 meters), were out-

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fitted with pop-up irrigation heads that delivered 5.7 gallons (21.6 liters)/minute to each block. The two irrigation regimes were:

- infrequent morning irrigation to a soil depth of 2.5 to 3 inches (6.4 to 7.6 centimeters)
- light and frequent night irrigation (on average, 0.19 inch [0.5 centimeter] water applied daily during rain-free periods).

Each irrigation treatment was applied to four randomly assigned blocks. Irrigation began at 6 a.m. for the deep and infrequent morning treatments and at 9 p.m. for the light and frequent nighttime treatments. Infrequently irrigated blocks generally received water when visible drought-stress symptoms were observed. Both irrigation regimes were adjusted based on weather patterns.

In 2002, a drought year, both frequently and infrequently irrigated blocks received approximately 0.9 to 1.5 inches (2.3 to 3.8 centimeters) of water weekly from irrigation or rainfall. Frequent rainfall in 2003 and 2004 prevented us from maintaining this regime. Precipitation during the study period totaled 18 inches (45.7 centimeters) in 2003 and 20.2 inches (51.3 centimeters) in 2004. In 2004, tarps were used to cover infrequently irrigated blocks before the onset of rain and were removed within 15 minutes after the rain had ceased. Tarps were used on 14 occasions from June 4 to Aug. 21, 2004. In 2004, the frequently irrigated blocks received an average of 2.5 inches (6.4 centimeters) of water per week, and the infrequently irrigated blocks received 0.8 inch (2.0 centimeters) of water per



week. Volumetric soil moisture was recorded two to three times per week using time-domain reflectometry; a soil-water-release curve was calculated.

Chemical treatments

Six chemical treatments were evaluated:

- Daconil Ultrex 82.5WDG at 3.2 ounces of product/1,000 square feet (0.98 gram/square meter)
- Trimmit 2SC at 0.18 fluid ounce product/1,000 square feet (0.06 milliliter/square meter)
- Primer Select at 2.0 fluid ounces of product/1,000 square feet (0.64 milliliter/square meter)

Dollar spot can be a chronic problem on creeping bentgrass fairways in the mid-Atlantic region of the U.S. Crenshaw creeping bentgrass was selected for this study because it is known to be highly susceptible to dollar spot. Photos by S. McDonald

2002 treatments and infection centers

Treatment [†]	Rate/1,000 square feet (metric rate)	No. of infection centers/plot			
		Aug. 22		Aug. 26	
		Frequent	Infrequent	Frequent	Infrequent
Daconil Ultrex	3.2 ounces (0.98 gram/square meter)	0.0 b	2.0 b	0.5 b	0.0 b
Trimmit 2SC	0.18 fluid ounce (0.06 milliliter/square meter)	1.0 b	1.0 b	3.5 b	5.5 b
Primer Select	2.0 fluid ounces (0.64 milliliters/square meter)	3.3 b	46.8 a	5.8 b	62.0 a
Daconil Ultrex + Trimmit 2SC	3.2 ounces + 0.18 fluid ounce	0.0 b	0.0 b	0.8 b	0.3 b
Daconil Ultrex + Primer Select	3.2 ounces + 2.0 fluid ounces	0.0 b	0.0 b	0.0 b	0.8 b
Daconil Ultrex + Trimmit 2SC+ Primer Select	3.2 ounces + 0.18 fluid ounce + 2.0 fluid ounces	0.0 b	0.4 b	1.0 b	0.0 b
Untreated	---	18.5 a	56.8 a	29.8 a	87.3 a
Irrigation					
Frequent		3.3 b		5.9 b	
Infrequent		15.5 a		22.3 a	

[†]Treatments were applied on a 14-day interval beginning June 17 and ending Aug. 26, 2002.

[‡]Means in a column followed by the same letter are not significantly different.

Table 1. Number of *Sclerotinia homoeocarpa* infection centers in Crenshaw creeping bentgrass fairway turf as influenced by irrigation, Daconil Ultrex, Trimmit 2SC and Primer Select in 2002.



The study site at the University of Maryland Turfgrass Research Facility in College Park consisted of eight independently irrigated blocks.

- Daconil Ultrex 82.5WDG + Trimmit 2SC
- Daconil Ultrex 82.5WDG + Primer Select
- Daconil Ultrex 82.5WDG + Trimmit 2SC + Primer Select

Rates for tank-mix treatments were the same as for each chemical applied alone (for 2002 treatments, see Table 1). The rate of Daconil Ultrex 82.5WDG was reduced to 1.8 ounces product/1,000 square feet (0.55 gram/square meter) in 2004 (for 2004 treatments, see Table 2).

Disease ratings

Plots were rated 52 times for disease over the three seasons. Dollar spot was assessed by count-

ing the number of dollar spot infection centers per plot until they had coalesced. Thereafter, plots were rated visually on a linear 0% to 100% scale. Subjectively, an acceptable threshold was judged to be eight to 10 infection centers per plot, or 0.5% plot area blighted.

For each plot, we calculated an area-under-disease-progress curve, which provides a single value that expresses disease level (that is, the higher the number, the greater the disease level) over a defined period. Area-under-disease-progress curve values were calculated separately for early-season (that is, infection centers) data collection periods and late-season (that is, % plot area blighted) data collection periods (6).

Summary of findings

2002 irrigation results

Soil moisture averaged 15% in the infrequently irrigated plots on July 10, 2002, and dollar spot developed in those plots on July 19 (Figure 1). Dollar spot pressure increased in late August and early September 2002, when 87 infection centers were observed in the infrequently irrigated untreated plots, and 30 in the frequently irrigated untreated plots (data not shown). Soil moisture levels during this period ranged from 22% to 24% in the plots with infrequent irrigation and 29% to 32% in the plots with frequent irrigation. As soil moisture decreased, dollar spot severity increased (Table 1).

2004 irrigation results

In 2004, a significant irrigation effect, how-

2004 dollar spot vs. treatments

Treatment ¹	Rate/1,000 square feet	% plot area blighted ²				% plot area blighted AUDPC ³	
		Aug. 30		Sept. 17		Frequent	Infrequent
		Irrigation treatment					
		Frequent	Infrequent	Frequent	Infrequent	Disease × time	
Daconil Ultrex	1.8 ounces	1.0 b	1.5 b	9.8 abc	13.0 c	390 b	627 bc
Trimmit 2SC	0.18 fluid ounce	2.9 b	2.6 b	9.5 bc	15.8 c	869 b	882 b
Primer Select	2.0 fluid ounces	11.7 a	27.5 a	16.5 ab	46.3 b	1,784 a	4,326 a
Daconil Ultrex + Trimmit 2SC	1.8 ounces + 0.18 fluid ounce	0.5 b	0.3 b	6.5 c	4.1 d	295 b	209 c
Daconil Ultrex + Primer Select	1.8 ounces + 2.0 fluid ounces	0.9 b	1.5 b	12.8 abc	13.0 c	480 b	640 bc
Daconil Ultrex + Trimmit 2SC + Primer Select	1.8 ounces + 0.18 fluid ounce + 2.0 fluid ounces	0.5 b	1.5 b	7.0 c	12.8 d	279 b	213 c
Untreated	—	11.4 a	29.3 a	18.5 a	63.3 a	1,898 a	4,924 a
Irrigation							
Frequent		4.1 b		11.5 b		857 b	
Infrequent		9.2 a		24.0 a		1,685 a	

¹Treatments were applied on a 14-day interval beginning June 1 and ending Aug. 16, 2004.

²Means in the same column followed by the same letter are not significantly different.

³AUDPC, the area-under-disease-progress curve, provides a single value that expresses disease level (the higher the number, the greater the disease level) over a defined period. These values were calculated for the period of Aug. 17-Sept. 27, 2004.

Table 2. Percent of plot area blighted by *Sclerotinia homoeocarpa* in Crenshaw creeping bentgrass as influenced by irrigation, Daconil Ultrex, Trimmit 2SC and Primer Select in 2004.



ever, was not observed until Aug. 24, when soil moisture averaged 23% in infrequently irrigated plots (Figure 2). On Aug. 24 and Aug. 30, dollar spot severity was negatively correlated with soil moisture (Table 2). On Sept. 9 and Sept. 17, 2004, disease severity was negatively and strongly correlated with soil moisture. Dollar spot pressure in 2004 peaked in the infrequently irrigated untreated control (63.3% plot area blighted) plots on Sept. 17, at which time soil moisture averaged 23%. On the same day in the frequently irrigated plots, soil moisture averaged 36% and only 18.5% plot area blighted was observed in control plots. Hence, when moisture levels for this soil approached its wilting point in a range of 20% to 23% in late summer, dollar spot became more severe in the creeping bentgrass. Low soil moisture levels in a similar range (16%-23%) occurring earlier in the season, however, were not associated with increases in dollar spot severity in any year. It is possible that when soil moisture levels were low earlier in the season, *S. homoeocarpa* inoculum levels or some other unknown factors were not sufficient to incite severe blighting.

Trimmit 2SC

The data for the area-under-disease-progress curve showed that Trimmit 2SC alone reduced dollar spot levels in all years. On six occasions over the three years when the dollar spot threshold of eight to 10 infection centers per 337 square feet (31.5 square meters) had been exceeded in untreated plots, Trimmit 2SC alone provided acceptable dollar spot control (Tables 1, 2; most data not shown).

Trimmit 2SC alone provided better dollar spot control in the frequently irrigated plots on 9 of 13 rating dates, when compared to the infrequently irrigated plots in 2002 and 2004. Over all years, Trimmit 2SC alone reduced dollar spot blighting by 40% to 60% on 11 rating dates and by greater than 60% on 20 rating dates. It should be noted that the Trimmit 2SC rate we evaluated (0.18 ounce product/1,000 square feet [0.06 milliliter/square meter]) was a low label rate. These results support earlier work (1), corroborating that Trimmit 2SC applied alone provides a significant level of dollar spot suppression.

Primer Select

On seven of 52 rating dates over three years, Primer Select reduced dollar spot by as much as 30% to 50% when using the individual rating date data (most data not shown). When examining all area-under-disease-progress curve data, however, treatment with Primer Select alone reduced dol-

lar spot levels only twice, when compared to the untreated control. Applying a combination of Daconil Ultrex 82.5WDG + Trimmit 2SC was beneficial on a majority of the rating dates, but

Soil moisture, 2002

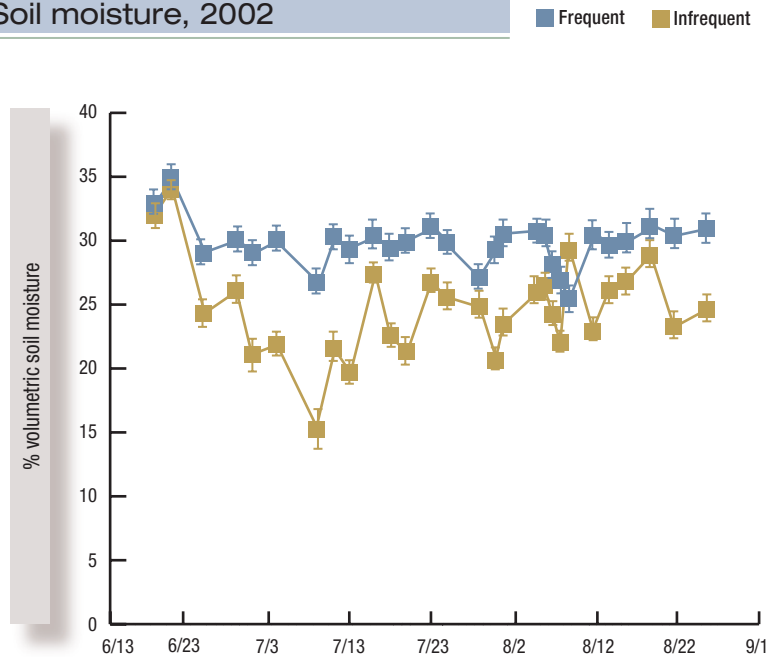


Figure 1. On Aug. 22 and 26, 2002, dollar spot severity was negatively correlated with soil moisture. Vertical bars represent ±1 standard error of the mean.

Soil moisture, 2004

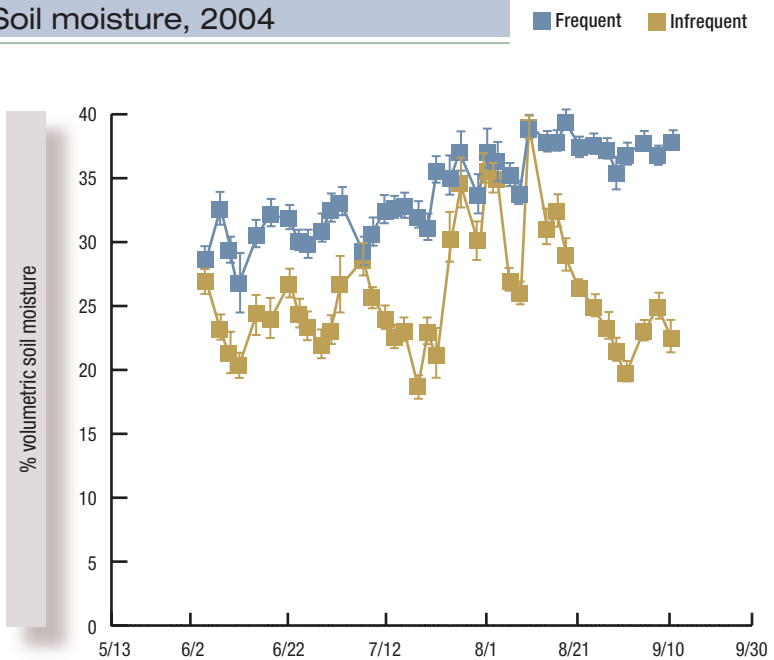


Figure 2. On Aug. 24 and 29 and Sept. 9 and 17, 2004, dollar spot severity was negatively correlated with soil moisture. Vertical bars represent ±1 standard error of the mean.



The research says

→ This field study assessed the influence of two irrigation regimes (light and frequent nighttime vs. deep and infrequent morning irrigation) and six chemical treatments (Daconil Ultrex, Trimmit 2SC, Primer Select, chlorothalonil + Trimmit 2SC, Daconil Ultrex 82.5WDG + Primer Select, and Daconil Ultrex 82.5WDG + Trimmit 2SC + Primer Select) on dollar spot severity on creeping bentgrass fairways over a three-year period.

→ Applying a low label rate of Trimmit 2SC alone reduced dollar spot levels in all years.

→ Applying a combination of Daconil Ultrex 82.5WDG + Trimmit 2SC was beneficial on some rating dates over the three years, but applying a tank-mix of Daconil Ultrex 82.5WDG + Primer Select was not.

→ Dollar spot was more severe in late summer in creeping bentgrass that received deep and infrequent vs. light and frequent irrigation in 2002 and 2004, and disease severity was negatively correlated with volumetric soil moisture.

→ Soil moisture levels above 25% were associated with an improved ability of each of the three products, Daconil Ultrex, Trimmit 2SC and Primer Select, to suppress dollar spot.



When dollar spot fungi are active, the fungal mycelia, which may resemble a spider web, can be seen on the turf.

applying a tank-mix of Daconil Ultrex 82.5WDG + Primer Select was not.

Conclusions

Dollar spot was shown to be more severe in creeping bentgrass that was irrigated infrequently in late summer 2002 and 2004. There were few significant differences among treatments in 2003 because rainfall was frequent (no data shown or discussed).

The wilting point of turf plants for this soil was 22% under laboratory conditions without traffic, low, frequent mowing and other stresses typically experienced by fairway turf. The additional stress of real-world conditions may cause turf on the golf course to wilt at different levels of volumetric soil moisture, depending on soil characteristics and management practices. After soil moisture levels consistently fell below 23% in late summer 2002 and 2004, dollar spot became more severe in the infrequently irrigated blocks.

Data from this study have shown that maintaining moisture levels above 25% (that is, above the wilting point) for this soil in late summer when severe disease outbreaks occurred can reduce dollar spot severity and improve the ability of Daconil Ultrex, Trimmit 2SC and Primer Select to suppress the disease in fairway-height creeping bentgrass. In addition, because the rate and application intervals for Daconil Ultrex are restricted, these data will help superintendents use chlorothalonil to manage dollar spot more efficiently. Because environmental conditions vary widely among regions, these find-

ings and conclusions may apply only to creeping bentgrass grown in a transition zone climate in the mid-Atlantic region.

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Literature cited

1. Burpee, L.L., D.E. Green and S.L. Stephens. 1996. Interactive effects of plant growth regulators and fungicides on epidemics of dollar spot in creeping bentgrass. *Plant Disease* 80(11):1245-1250.
2. Couch, H.B. 1995. Diseases of turfgrasses. Krieger Publishing, Malabar, Fla.
3. Couch, H.B., and J.R. Bloom. 1960. Influence of environment on disease of turfgrass. II, Effect of nutrient, pH, and soil moisture on *Sclerotinia* dollar spot. *Phytopathology* 50:761-763.
4. Dernoeden, P.H., J.E. Kaminski and J.M. Krouse. 2002. Dollar spot control with fungicides, nitrogen sources and a wetting agent, 2001. *Fungicide and Nematicide Tests* 57: T06. www.plantmanagementnetwork.org/pub/trial/fntests/ (verified May 31, 2007).
5. Jiang, H., J. Fry and N. Tisserat. 1998. Assessing irrigation management for its effects on disease and weed levels in perennial ryegrass. *Crop Science* 38(2):440-445.
6. McDonald, S.J., P.H. Dernoeden and C.A. Bigelow. 2006. Dollar spot and gray leaf spot severity as influenced by irrigation, chlorothalonil, paclobutrazol, and a wetting agent. *Crop Science* 46(6):2675-2684.
7. Smiley, R.W., P.H. Dernoeden and B.B. Clarke. 2005. Compendium of turfgrass diseases. 3rd ed. American Phytopathological Society, St. Paul, Minn.
8. Vargas, J.M. 2004. Management of turfgrass diseases. 3rd ed. CRC Press, Boca Raton, Fla.
9. Watkins, J.E., R.C. Shearman, R.E. Gaussoin et al. 2001. An integrated approach to dollar spot management on a bentgrass fairway. *International Turfgrass Society Research Journal* 9:729-735.

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