Wetting Agent Effects on Root-zone Moisture Distribution under Various Irrigation Regimes

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Photo by Doug Karcher

Localized dry spot affecting putting green turf that was not treated with wetting agent

Additional index words: creeping bentgrass, time domain reflectometry, sand-based, putting green

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Summary. It is not clear how various wetting agent products affect moisture distribution throughout sand-based putting green rootzones. The objective of this research was to determine how localized dry spot (LDS) incidence, and soil moisture values and uniformity were affected by the application of five commercially available wetting agents. Wetting agents were applied during the 2008 growing season and evaluated under conditions of frequent, moderate, and infrequent irrigation application. All of the wetting agents tested in this study significantly reduced LDS formation compared to the untreated control. In addition, none of the wetting agents significantly increased soil moisture values during periods of frequent or moderate irrigation. All wetting agent products significantly increased soil moisture uniformity at a 3-inch depth compared to the untreated turf. These results suggest that specific wetting agents can be used to manage LDS without adversely affecting rootzone moisture distribution.

Abbreviations: LDS, localized dry spot; TDR, time domain reflectometry

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Previous research on wetting agent efficacy (when applied to sand-based putting greens) has focused primarily on evaluating water-drop penetration times or visual LDS symptoms. This research has demonstrated that most commercially available wetting agents are effective in reducing soil hydrophobicity and decreasing LDS symptoms. However, many golf course superintendents are also concerned about how wetting agent application affects soil moisture distribution throughout the putting green rootzone. It is often stated that some wetting agents move water rapidly through the rootzone while other products retain considerable moisture near the surface; but there are little data to substantiate such claims. Furthermore, there is variation in how irrigation practices are adjusted following wetting agent application, complicating the underlying cause of undesirable wetting agent effects. Some superintendents may not alter their irrigation practices, despite adding a wetting agent to their putting green management program. This may explain some of the anecdotal evidence that suggests wetting agent application contributes to excessive surface moisture and exacerbates summer bentgrass decline.

The objective of this research was to determine how commonly used wetting agents affect rootzone moisture distribution when applied to a sand-based putting green under wet, moderate, and dry irrigation regimes.

Materials and Methods

This experiment was conducted from June through August in 2008 at the Agricultural Research and Extension Center in Fayetteville on a creeping bentgrass (*Agrostis stolonifera* cv. L-93) putting green built according to United States Golf Association specifications. The green was mowed at a 0.125-inch height six days per wk and otherwise maintained under typical golf course conditions (Table 1).

Wetting agent treatments consisted of five commercially available wetting agent products plus an untreated control (Table 2). Treatments were applied according to manufacturer's label instructions and irrigated with 0.25 inch of water following application. Treatments were applied monthly from 10 June through 10 August, except for Cascade Plus, which was applied only on 10 June and 17 June. Each treatment was applied to four replicate plots, measuring 6 by 6 ft each. Irrigation was applied judiciously (daily), moderately (every 2-3 d), and sparingly (only under severe drought stress) following the June, July, and August treatment applications, respectively, to compare the wetting agents under a range of irrigation management regimes.

Treatments were evaluated for LDS incidence and soil moisture characteristics. Localized dry spot incidence was rated weekly as a visual estimate of the percentage within each plot affected with LDS. Volumetric soil moisture was evaluated twice monthly by taking 36 measurements on a 1-by-1 ft. grid at three sampling depths (3, 5, and 8 inches) within each plot with moisture probes (TDR 300, Spectrum Technologies, Plainfield, Ill., USA). From the moisture data, average rootzone moisture and average soil moisture variance (measured by standard deviation; n=36) were calculated for each wetting agent at each sampling depth.

Results and Discussion

LDS incidence. There was relatively little LDS formation in June and most of July when irrigation was applied judiciously and moderately, respectively (Fig. 1). Wetting agent treatment effects were significant in late July when weather conditions were hot and dry, and throughout August when irrigation was applied sparingly. When irrigation was applied sparingly, all of the wetting agent treatments resulted in turf with LDS incidence significantly less than the untreated control. There were minimal differences among wetting agent products with regard to LDS incidence.

Soil moisture values. Rootzone depth had a significant effect on soil moisture content, with average soil moisture content of 17.9, 13.7, and 10.8 % at the 3-, 5-, and 8-inch depths, respectively. When averaged across the season, the effect of

wetting agent treatment on volumetric soil moisture was not significant. However, there was a significant wetting agent effect at the 3-inch depth on 28 August, the final evaluation date, which was after several weeks of infrequent irrigation (Fig. 2). Also, in late July, during a hot and dry period and under moderate irrigation frequency, wetting-agent treatment affected soil moisture at a 0.07 probability level (Fig 2). During periods of judicious irrigation, the wetting agent products resulted in soil moisture values similar to the untreated control. During dryer periods, Revolution and Cascade Plus resulted in higher soil moisture values than the untreated control (Fig 2).

Soil moisture variation. There was a significant wetting agent treatment x evaluation date interaction (Fig. 3) and wetting agent treatment x depth interaction (Fig. 4), with regard to soil moisture variation as measured by standard deviation. During hot and dry conditions in late July, and during infrequent irrigation applications in August, all wetting agents resulted in significantly more uniform soil moisture conditions (lower standard deviation values) compared to the control (Fig. 3). In addition, Primer Select had significantly higher moisture uniformity compared to the control during periods of judicious irrigation (Fig. 3). Wetting agent products did not differ significantly in soil moisture uniformity during infrequent irrigation application in August. At all three sampling depths, the control treatment had the least uniform soil moisture and was significantly more variable than all wetting agent treatments at the 3-inch depth (Fig. 4). Primer Select was the only wetting agent that resulted in significantly more uniform soil moisture compared to the untreated control at both the 5-inch and 8-inch depths.

Conclusions

Based on the 2008 data, all wetting agent products appear to effectively reduce LDS incidence and increase soil moisture uniformity at a 3-inch depth compared to the untreated turf. In addition, there is no evidence that these wetting agents significantly increase surface soil moisture during periods of frequent irrigation or rainfall. These results suggest that these commonly used wetting agents can be used to manage LDS without adversely affecting rootzone moisture distribution. This research is being funded by the Environmental Institute for Golf and will be repeated during the 2009 growing season.

Table 1. Maintenance of the experimental area.

Maintenance Practice	Description
Mowing	Six times per week at a 0.125 inch mowing height.
Fertility	0.5, 0.1, and 0.5 lb of N, K_2O, and P_2O_5, respectively, per 1000 ft^2 per month of active growth. Other nutrients applied according to soil test recommendations.
Irrigation	Frequent (June) – daily to prevent any drought stress symptoms. Moderate (July) – as needed to prevent moderate drought stress symptoms. Infrequent (August) – only to prevent extreme drought stress symptoms.
Growth regulation	Primo Maxx (trinexapac-ethyl) applied at 1/8 oz. per 1000 ft^2 per month of active growth.
Wetting agent application	Applied as treatment (see Table 2).
Cultivation	Hollow tine cultivation performed to affect 5% of the surface in the spring and fall.
Sand topdressing	Sand topdressing applied every 14 days throughout the growing season at an approximate rate of 4 ft^3 sand per 1000 ft^2.
Pesticides	Applied only on a curative basis.

Table 2. Wetting agent treatments.

Treatment		Description	Manufacturer
1.	Control	Untreated control	
2.	Cascade Plus	2 app's @ 8oz/ 1000 ft^2 (7 days apart)	Precision Labs, Inc. (Waukegan, IL)
3.	Magnus	4 oz/ 1000 ft^2 monthly	Precision Labs, Inc. (Waukegan, IL)
4.	TriCure AD	6 oz / 1000 ft^2 monthly	Mitchell Products (Millville, NJ)
5.	Revolution	6 oz / 1000 ft^2 monthly	Aquatrols, Inc (Paulsboro, NJ)
6.	Primer Select	4 oz / 1000 ft^2 monthly	Aquatrols, Inc (Paulsboro, NJ)

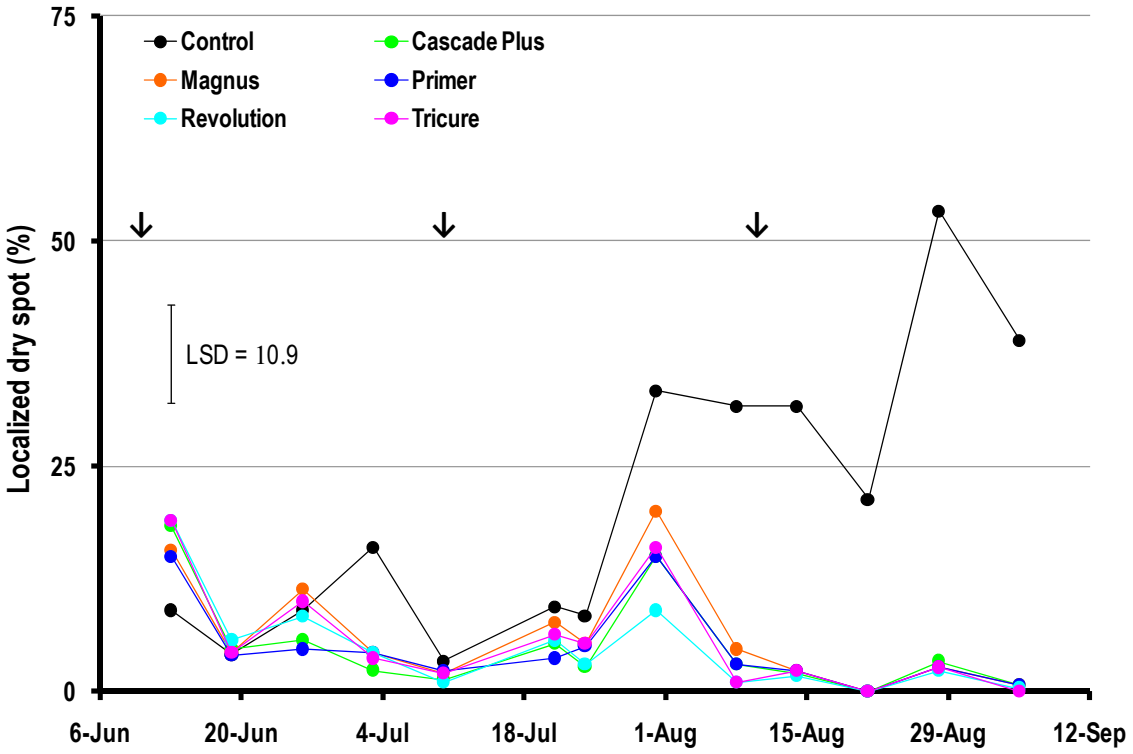

Fig. 1. Localized dry spot incidence as affected by wetting agent treatment. Arrows indicate treatment dates for all products, except for Cascade Plus which was applied only on 15 May and 22 May. Error bar represents Fisher's least significant difference value (α = 0.05) for comparing wetting agent treatments within dates.

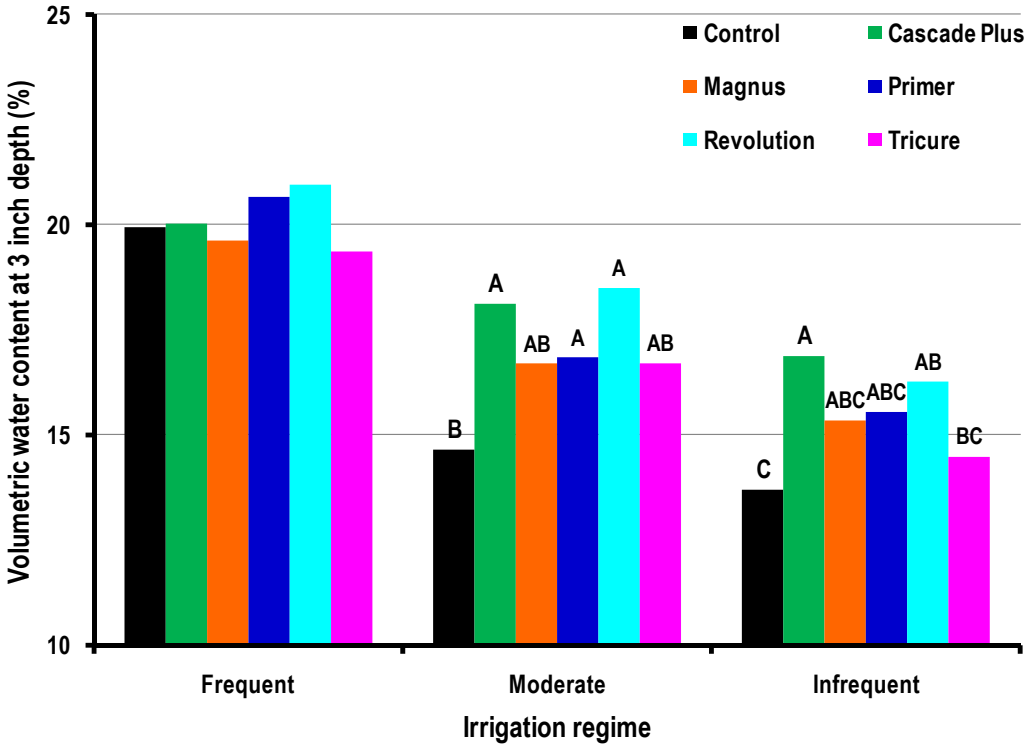

Fig. 2. Effect of wetting agent treatment on soil moisture content at the 3-inch depth, during June, July, and August, when irrigation was applied frequently, moderately, and infrequently, respectively. Within irrigation regimes, bars sharing a letter are not significantly different (α = 0.07).

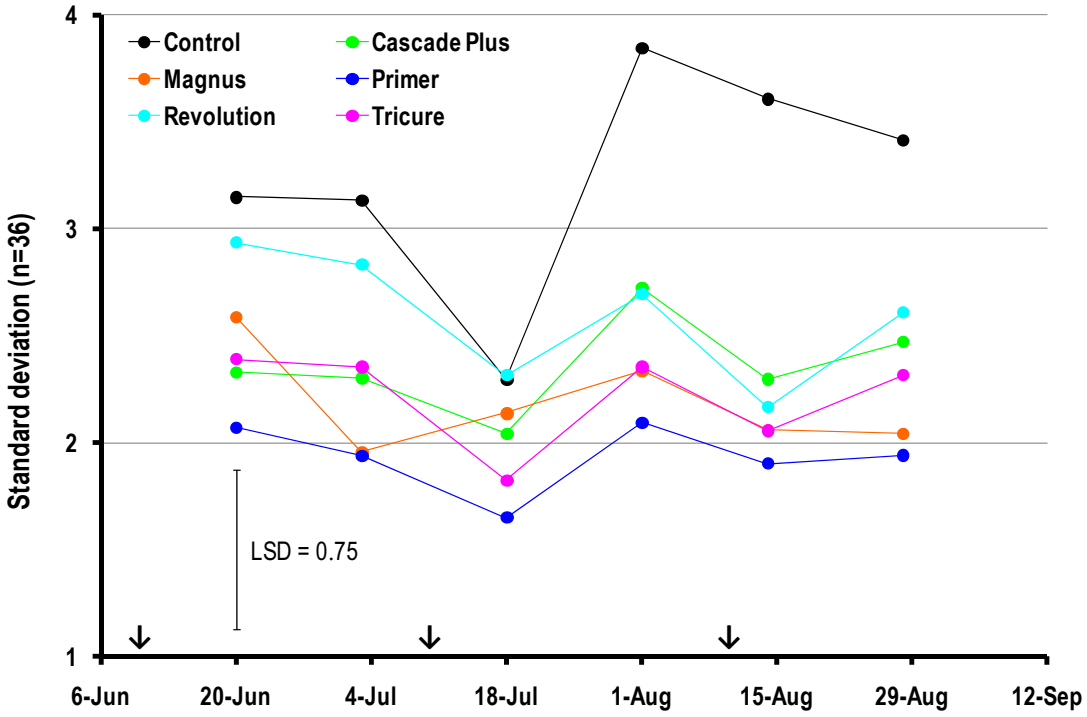

Fig. 3. Soil moisture variation as affected by wetting agent treatment and date. High standard deviation values correspond to less uniform soil moisture conditions. Arrows along the x axis indicate treatment dates for all products, except for Cascade Plus which was applied only on 15 May and 22 May. Error bar represents Fisher's least significant difference value for comparing wetting agent treatments within dates.

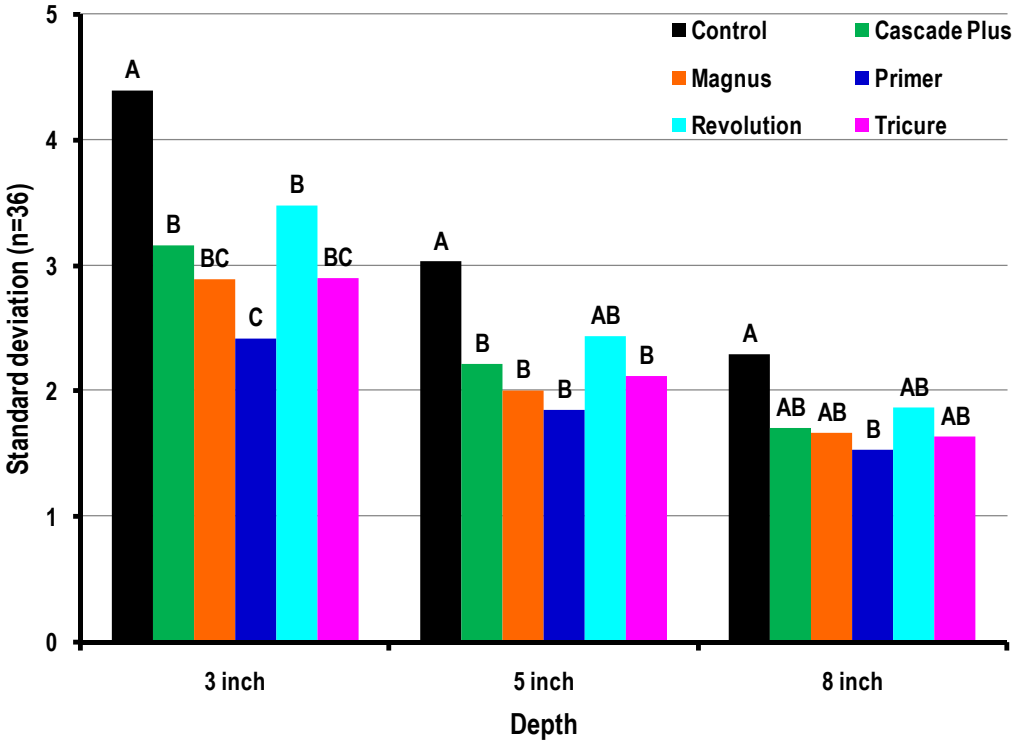

Fig. 4. Soil moisture variation as affected by wetting agent treatment and sampling depth. High standard deviation values correspond to less uniform soil moisture conditions. Within depths, bars not sharing a letter are significantly different according to Fisher's least significant difference value test (α = 0.05).