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GCSAA-USGA wetting agent evaluation

Superintendents can now reap the benefits of two years of comparative studies of wetting agents.

Clark Throssell, Ph.D.

GCSAA, through funding from The Environmental Institute for Golf and USGA, has completed an evaluation of selected wetting agents that began in spring 2003. For several years before the study was initiated, superintendents had expressed a strong desire for product comparison data to help them make informed product use and purchasing decisions. In response, the GCSAA research committee developed the concept of a program coordinated by GCSAA to evaluate products that are commonly used by superintendents but currently receive limited evaluation in university trials. The committee recommended, and the GCSAA Board of Directors approved, the evaluation of wetting agents for the pilot program. Wetting agents were chosen because they are widely used by superintendents across the country to manage localized dry spots, an important problem on greens, and because comparison of wetting agents in side-by-side university trials has been limited.

After the results from the evaluation have been made available, feedback will be sought from golf course superintendents, wetting agent manufacturers and the university scientists who conducted the research to help determine the value of the pilot program. Ultimately, the association will decide whether to continue the program and evaluate other products.

Advisory panel

To help GCSAA conduct the best-possible evaluation, a 10-member advisory panel was created to define experimental objectives, develop the scientific protocol, select evaluation sites, determine the method to use for including products in the evaluation and provide direction for disseminating the results. The panel comprised golf course superintendents Darren Davis; Mark Kienert, CGCS; Robert J. Maibusch, CGCS, MG; Brian Sullivan, CGCS, MG; and Mark Woodward, CGCS. Also on the panel were three university scientists who have conducted wetting agent research — John Cisar, Ph.D.; Keith Karnok, Ph.D.; and Robert Shearman, Ph.D. — and the directors of research for the USGA Green Section, Mike Kenna, Ph.D., and for GCSAA, Clark Throssell, Ph.D.

Objectives

Superintendents use wetting agents to address many different problems on the golf course, but limitations in time and funding required the scope of the evaluation to be very specific. The advisory panel decided the overall objective of the evaluation was to determine the effectiveness of selected wetting agents for managing localized dry spots on putting greens. Specific objectives were to determine:

- phytotoxicity damage to turf following wetting agent applications
- the impact of wetting agent applications on turf color and quality
- the degree of soil hydrophobicity following wetting agent applications
- dew formation following wetting agent applications
- pest damage following wetting agent applications

Localized dry spots

Although localized dry spots on putting greens can have many causes, this evaluation focused on hydrophobic or water-repellent soils. An organic coating on the soil particles, which may originate from plants, microorganisms and decomposing organic matter, causes soil to become hydrophobic (1). Soil hydrophobicity is most severe in the upper 1-2 inches (2.5-5 centimeters) of the soil profile.

Symptoms of localized dry spots are roughly circular patches of tan-colored, drought-stressed turf 12 inches (30.5 centimeters) to several feet in diameter. Turf within the localized dry spots may thin out over time, and, in severe cases, portions of the turf may die. Localized dry spots are most severe during periods of extended high temperatures and dry weather (2).

Recommended treatments for managing localized dry spots caused by hydrophobic soil include cultivation of localized dry spots to increase water penetration, hand watering to increase soil moisture content, and preventive and/or curative application of wetting agents (2).

Materials and methods

Evaluation sites

The advisory panel determined that the evaluation should be conducted at nine sites around the country that represented broad geographic regions with diverse climates and growing conditions. Interested scientists were required to submit a site profile of the putting green that would be used to conduct the evaluation. Criteria for selecting sites

The nine sites for the wetting agent evaluation were distributed across the United States.

were geographic location, a high-sand-content root zone, a history of localized dry spots on the putting green and the degree of soil hydrophobicity as determined by the water-droplet-penetration test. Locations for the wetting agent evaluation are shown on the map (above).

Wetting agents

Because of funding constraints and limited usable research plot space that met the evaluation site criteria, the advisory panel determined that 10 wetting agents and an untreated control would be evaluated. The panel selected the top 10 wetting agents that were used by superintendents, as indicated in the 2002 Plant Protectant and Fertilizer Usage Study, and were commercially available in 2003.

All products were applied according to label directions and at the highest label rate for control/management of localized dry spots. A complete list of the wettings agents, rates and timing of applications is given in Table 1.

During the two years of the evaluation, the wetting agents were identified by code. Scientists did not know the identity of the products until all data had been collected.

Duration of the evaluation

The wetting agent evaluation was conducted over a four-month period in 2003 and 2004 when stress from localized dry spots was at its peak. Each scientist determined when the peak stress period occurred from the presence of localized dry spots at the site.

Data collected

At each site, data were collected for phytotoxicity, turf color and quality and degree of soil hydrophobicity.

Phytotoxicity. Ratings were taken one, three and seven days after each application of a wetting agent. All plots were rated each time phytotoxicity ratings were taken. The rating scale is 1-9, where 1 = brown or discolored turf, 7 = acceptable damage and 9 = green turf, no damage.

Turf color. Ratings were taken every two weeks beginning seven days after the initial application of the first wetting agent treatment. The rating scale is 1-9, where 1 = brown, 5 = medium green and 9 = dark green.

Turf quality. Ratings were taken every two weeks beginning seven days after initial application of the first wetting agent treatment. The rating scale is 1-9, where 1 = poor quality, 5 = acceptable quality and 9 = excellent quality.

Degree of soil hydrophobicity. The water-droplet-penetration test was used to determine soil hydrophobicity. Soil cores 1.9 centimeters (0.75 inch) in diameter were taken to a depth of 6 centimeters (2.4 inches). Droplets of distilled, deionized water were placed on soil cores at 0.5, 1.5, 2.5, 3.5, 4.5 and 5.5 centimeters (0.2, 0.6, 0.9, 1.4, 1.8 and 2.2 inches) below the soil surface. The time it took for the water droplet to penetrate into the soil core was determined. The maximum time for water-droplet penetration was 600 seconds. Any water droplet remaining after 600 seconds was recorded as 600 seconds. Three to five soil cores were taken per plot. Water-droplet-penetration times (WDPT) from all

WETTING AGENTS AND RATES

Product/rate (ounces)*	Timing	Spray volume (gallons/1,000 sq. ft.)†	Watering in
Aqueduct			
8	first application	1	irrigate before next mowing
8	1 week after first application	1	irrigate before next mowing
8	once every four weeks after second application	1	irrigate before next mowing
Brilliance			
8	first application	2	immediately after application
8	10 days after first application	2	immediately after application
8	12 weeks after second application	2	immediately after application
Cascade Plus			
8	first application	2	immediately after application
8	10 days after first application	2	immediately after application
Hydro-Wet			
8	first application	10	immediately after application
8	two weeks after first application	10	immediately after application
2	every two weeks after second application	5	immediately after application
LescoFlo			
8	first application	10	immediately water in
8	two weeks after first application	10	immediately water in
Naiad			
8	first application	10	immediately after application
8	two weeks after first application	10	immediately after application
6	once every four weeks after second application	10	immediately after application
Primer Select			
6	first application	2	irrigate before next mowing
6	every four weeks following first application	2	irrigate before next mowing
Respond 2			
10	first application	8	immediately after application
10	8 weeks after first application	8	immediately after application
Surfside 37			
32	first application	10	immediately after application
4	every two weeks after first application	10	immediately after application
TriCure			
6	first application	2	immediately water in
6	every four weeks following first application	2	immediately water in

*2, 4, 6, 8, 10 and 32 ounces = 59.1 milliliters, 0.12 liter, 0.17 liter, 0.24 liter, 0.30 liter and 0.94 liter, respectively.
†1, 2, 5, 8, and 10 gallons/1,000 square feet = 40.7, 81.5, 203.7, 326 and 407.5 liters/1,000 square meters, respectively.

Table 1. Wetting agents, rates of application in fluid ounces, timing of application, spray volume and post-application watering instructions used in the GCSAA/USGA wetting agent evaluation. The first application of all wetting agents was made on the same date and before the appearance of any symptoms of localized dry spots.

WDPT SCALE

Time (seconds)	Degree of repellency
0 – 5	none
5 – 60	slight
60 – 600	moderate to high
600 – 3,600	severe
above 3,600	extreme

Table 2. Scale for interpreting water-droplet-penetration test data.

cores from each plot were averaged by depth, and that average was used to characterize that plot. Soil cores were collected for the water-droplet-penetration test within five days before the first wetting agent application and at two, four, eight, 12 and 16 weeks after the first wetting agent application.

The scale for interpreting water-droplet-penetration test data is shown in Table 2.

Additional data on dew and pest damage were collected at some sites. Data for these variables are available at www.eifg.org.

Experimental design

Minimum plot size was 3 by 3 feet (0.9 by 0.9 meter), and scientists were encouraged to use larger plots if sufficient uniform research area was available. Each treatment was replicated four times. The same plots used for the evaluation in 2003 were used in 2004, with the same treatments applied to the same plots in both years. Treatments were arranged in a randomized complete block design.

Data analysis

Guangling Gao, Ph.D., and Kevin Morris of the National Turfgrass Evaluation Program analyzed data from all sites. Analysis of variance and mean separation were performed to determine the impact of the wetting agents. All data were analyzed by NTEP to ensure uniformity. Data for each site were analyzed and reported separately. The data were not analyzed and summarized over all locations.

Research site management

The advisory panel required creeping bentgrass greens in the evaluation to be mowed at a maximum height of 0.140 inch (3.6 millimeters) at least six days per week. For bermudagrass greens, the maximum mowing height was 0.156 inch (4 millimeters) and the minimum mowing frequency was six days per week. Cultivation that penetrated the soil surface was not allowed during the four-month evaluation period. Grooming and light verticutting were allowed, provided the blades did not penetrate the soil surface. Topdressing with 100% sand was allowed during the evaluation period.

Watering practices followed during the evaluation are broken down by week.

- *Weeks 1 through 8.* Plots were watered at 70% potential evapotranspiration (ET) for bermudagrass greens and 80% potential ET for creeping bentgrass greens. These crop coefficients were guidelines, and adjustments were permitted to meet the specific conditions at each site. Greens were not watered daily. To the greatest extent possible, water was applied deeply and infrequently. During weeks 1-8, greens were subjected to only slight stress from localized dry spots on plots in the middle ranking of turf quality.
- *Weeks 9 through 12.* Plots were irrigated so that plots in the middle ranking of turf quality received moderate stress from localized dry spots. Plots were provided enough water to keep them alive. Some but not all plots should have shown visible, moderate stress from localized dry spots.
- *Weeks 13 through 16.* Plots were watered as described above for weeks 1-8.

Beyond the specific requirements for mowing height, mowing frequency, cultivation, topdressing and watering outlined above, the putting greens in the evaluation were maintained as high-quality putting turf using management practices appropriate for the local area. Turf plots were maintained to prevent substantial loss of turf in the control plots.

Interpretation of the results

The results from each evaluation site are summarized over the next 37 pages. A tremendous volume of data was collected at each site, and space limitations in *GCM* permit publication of only the key findings from each site and a limited amount of data to support those findings. The wetting agents are presented in the same order in each graph to help reduce confusion.

Readers are encouraged to find the evaluation site that is most similar to their golf course in terms of location, growing conditions and grass species and review the results from that site for help in making decisions regarding the performance of the wetting agents. We do not think it is appropriate to draw conclusions from a northern evaluation site for use on a golf course in the South and vice versa.

The complete set of summarized data for all sites and the entire scientific protocol used to conduct the evaluation are available at www.eifg.org.

Acknowledgments

I would like to acknowledge the nine cooperators who conducted the study and devoted many hours and untold energy to making it a success: John Cisar, Ph.D.; Barb Corwin, Ph.D.; Kevin Frank, Ph.D.; Keith Karnok, Ph.D.; Joe Krausz, Ph.D.; Bernd Leinauer, Ph.D.; Eric Miltner, Ph.D.; Sowmya Mitra, Ph.D.; and Frank Rossi, Ph.D. In addition, I would like to thank Jeff Nus, Ph.D., former director of research for GCSAA and current manager of Green Section research for USGA, who played a critical role in the development of the product evaluation concept that was implemented in the project.

Literature cited

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2. McCarty, L.B. 2001. Best golf course management practices. Prentice Hall, Upper Saddle River, N.J.

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FLORIDA

Research cooperators: John L. Cisar, Ph.D. (jlci@ufl.edu), professor of environmental horticulture; D.M. Park, graduate student; and K.E. Williams, senior biologist, University of Florida Fort Lauderdale Research and Education Center

Research site: Otto Schmeisser Florida GCSA Research Green, University of Florida Fort Lauderdale Research and Education Center

Photo by K.E. Williams

Overview of the experimental area on March 19, 2004.

PUTTING GREEN CHARACTERISTICS

Construction method: USGA recommendations

Soil texture: 97.0% sand, 1.9% silt, 1.0% clay

Root-zone organic matter: 3.04%

Thickness of thatch/mat: 0.625 inch (15.9 millimeters)

Yearly average hydrophobicity of control plots: 2003, 71 seconds; 2004, 104 seconds

Mowing height: 0.156 inch (4 millimeters)

Mowing frequency: 6 days/week

Cultivar: Tifdwarf bermudagrass

Study dates: April 22 – Aug. 12, 2003; Feb. 16 – June 7, 2004

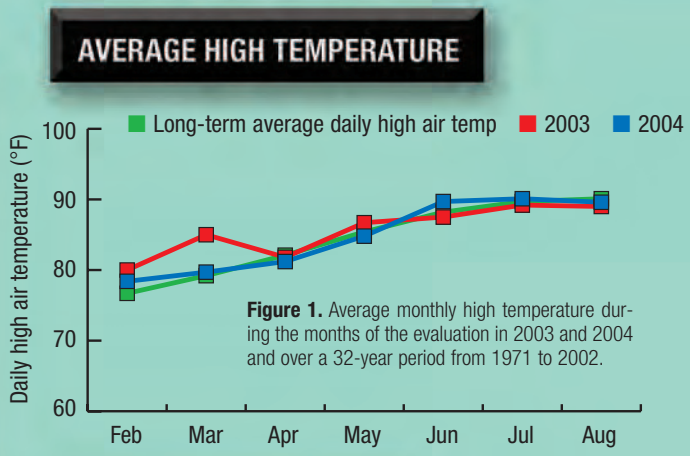

Figure 1. Average monthly high temperature during the months of the evaluation in 2003 and 2004 and over a 32-year period from 1971 to 2002.

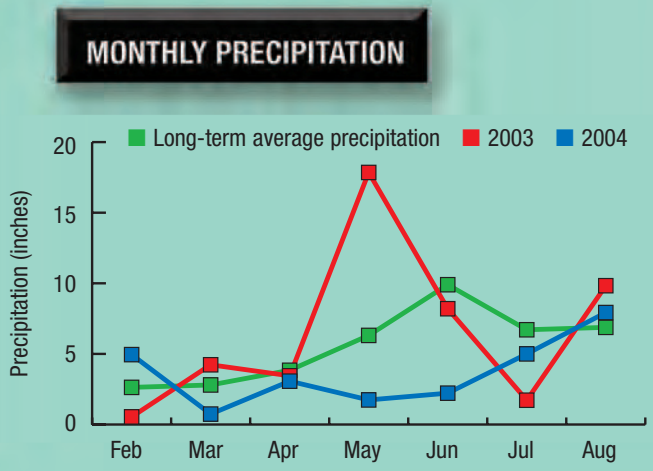

Figure 2. Total monthly precipitation during the months of the evaluation in 2003 and 2004 and the normal monthly precipitation total over a 32-year period from 1971 to 2002.

FLORIDA

Research cooperators: J.L. Cisar, Ph.D. (jlci@ufl.edu), professor of environmental horticulture; D.M. Park, graduate student; and K.E. Williams, senior biologist, University of Florida Fort Lauderdale Research and Education Center

Research site: Otto Schmeisser Florida GCSA Research Green, University of Florida Fort Lauderdale Research and Education Center

SUMMARY

South Florida has a subtropical climate, with a wet season from May through October followed by a dry season from November through April. Wet-season weather is characterized by high temperatures with intense rainfall occurring frequently in the afternoons. Dry-season weather is characterized by high evapotranspiration (ET) conditions (high temperatures and windy) with infrequent yet intense rainfall. The rapid wetting and drying cycles and high ET create an optimal environment for the development of soil water repellency. For both 2003 and 2004, significant differences were found among wetting agents and between wetting agents and the non-treated (control) turfgrass.

WDPT, 2003

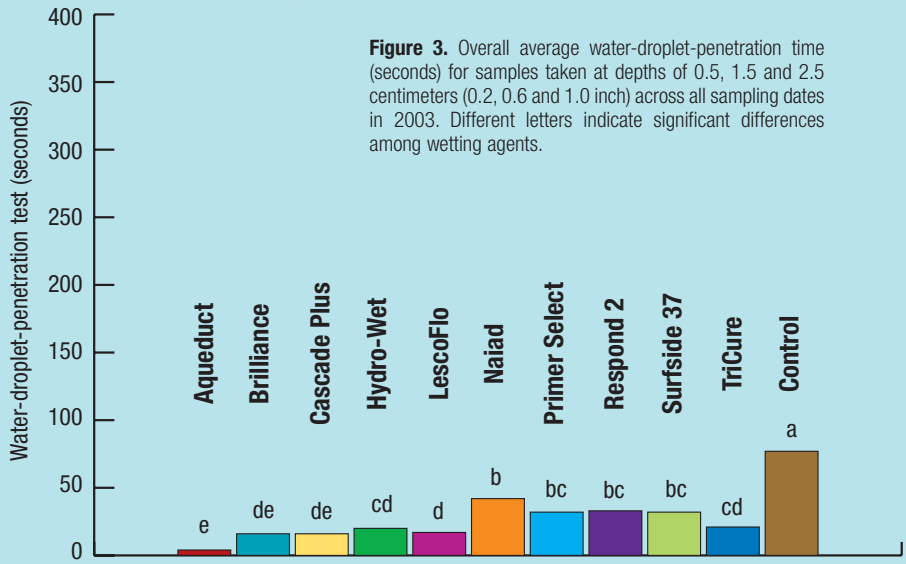

Figure 3. Overall average water-droplet-penetration time (seconds) for samples taken at depths of 0.5, 1.5 and 2.5 centimeters (0.2, 0.6 and 1.0 inch) across all sampling dates in 2003. Different letters indicate significant differences among wetting agents.

WDPT, 2004

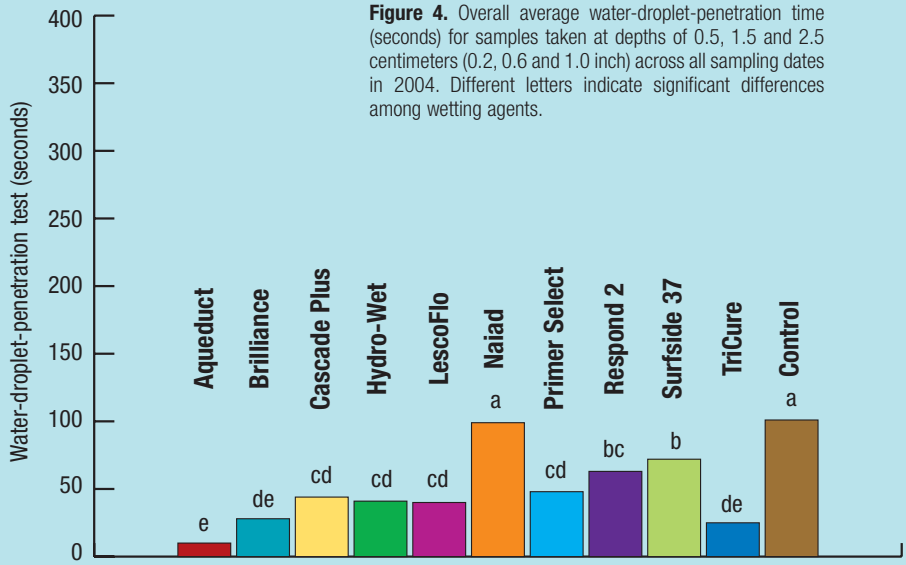

Figure 4. Overall average water-droplet-penetration time (seconds) for samples taken at depths of 0.5, 1.5 and 2.5 centimeters (0.2, 0.6 and 1.0 inch) across all sampling dates in 2004. Different letters indicate significant differences among wetting agents.

TEXAS

Research cooperator: Joseph P. Krausz, Ph.D. (krausz@ag.tamu.edu), professor and Extension specialist, plant pathology and microbiology, Texas A&M University, College Station

Research site: Texas A&M University Turfgrass Field Laboratory, College Station

Photo courtesy of J.P. Krausz

The wetting agent evaluation site in Texas was at the Texas A&M University Turfgrass Field Laboratory in College Station.

PUTTING GREEN CHARACTERISTICS

Construction method: USGA recommendations

Soil texture: 97.8% sand, 1.0% silt, 0.6% clay

Root-zone organic matter: 1.35%

Depth of thatch/mat: 0.25 inch (6.4 millimeters)

Yearly average hydrophobicity of control plots: 2003, 58 seconds; 2004, 11 seconds

Mowing height: 0.156 inch (4 millimeters)

Mowing frequency: 6 days/week

Cultivar: FloraDwarf bermudagrass

Study dates: May 20 – Sept. 2, 2003; May 4 – Aug. 31, 2004

AVERAGE HIGH TEMPERATURE

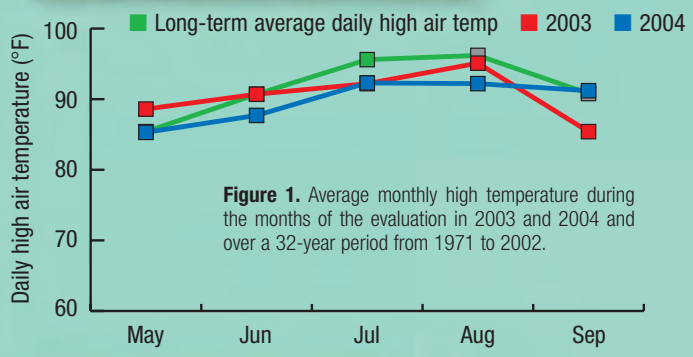

Figure 1. Average monthly high temperature during the months of the evaluation in 2003 and 2004 and over a 32-year period from 1971 to 2002.

MONTHLY PRECIPITATION

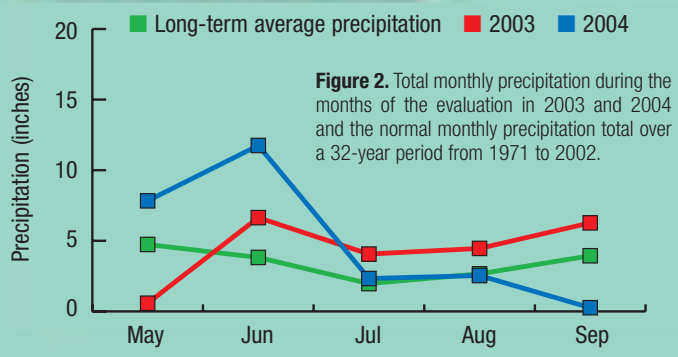

Figure 2. Total monthly precipitation during the months of the evaluation in 2003 and 2004 and the normal monthly precipitation total over a 32-year period from 1971 to 2002.

TURF COLOR, 2003

Figure 3. Mean ratings for turf color in 2003 (on a scale of 1-9, where 1 = brown and 9 = dark green). There were no significant differences among wetting agents.

TURF COLOR, 2004

Figure 4. Mean ratings for turf color in 2004 (on a scale of 1-9, where 1 = brown and 9 = dark green). There were no significant differences among wetting agents.