

WETTING AGENT STUDY: UPDATE



This research was funded by The Environmental Institute for Golf and USGA.

GCSAA-USGA wetting agent evaluation: Update

A reanalysis of the water-droplet-penetration-test data shows no biologically significant changes from the original results.

Clark Throssell, Ph.D.

In the April 2005 edition of *Golf Course Management*, GCSAA released the results of the GCSAA-USGA Wetting Agent Evaluation. Further examination of the results after publication revealed an error in the analysis of the water-droplet-penetration-test data for the nine sites for both 2003 and 2004.

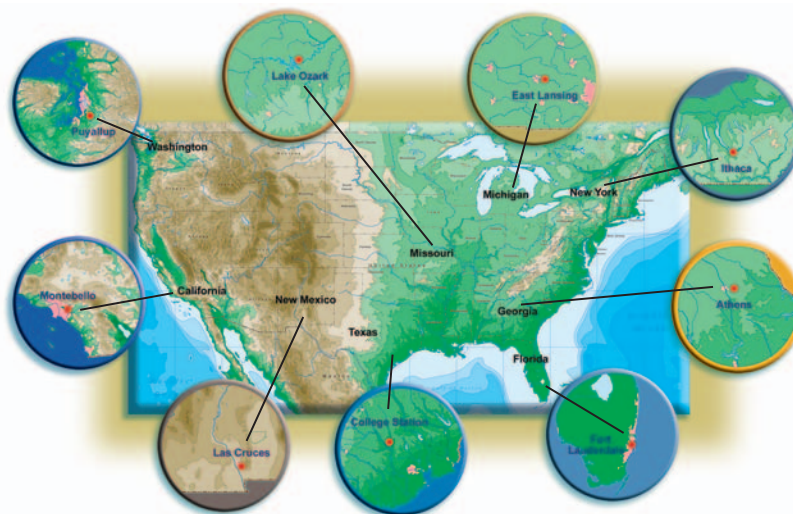
Water-droplet-penetration-test data were collected on six separate dates each year at specified intervals throughout the course of the evaluation. To determine the uniformity of the research plots, the first date of data collection occurred before any wetting agents were applied. The other five collection dates occurred after the wetting agents had been applied.

In the original analysis of the water-droplet-penetration-test data, data from all six dates were included in the analysis. This was incorrect. Only the water-droplet-penetration-test data collected from the five dates after the application of wetting agents should have been included in the analysis.

Statisticians from the National Turfgrass Evaluation Program (NTEP) have reanalyzed the water-droplet-penetration-test data using only the data collected from the five dates after wetting agents had been applied. The results of the reanalysis of the water-droplet-penetration-test data for all nine sites for both 2003 and 2004 are presented in the following pages.

The reanalysis of the water-droplet-penetration-test data revealed five major points.

- The research plots within each of the nine evaluation sites were uniform in their degree of soil hydrophobicity before wetting agents were applied. This uniformity is desirable because it means that all the



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

plots within each site were in similar condition at the start of the experiment.

- Because the plots at each evaluation site were uniform before the wetting agents were applied, the results of the two data analyses were similar. That is, the reanalysis of the water-droplet-penetration-test data using only data collected after wetting agents were applied showed only minor differences from the results of the original data analysis.
- The relative performance of the wetting agents in reducing water-droplet-penetration time at each site is nearly unchanged following the reanalysis of the data. A wetting agent that was effective in reducing water-droplet-penetration time as reported in the April issue was still effective in reducing water-droplet-penetration time when the data were reanalyzed.
- The relationship among wetting agents for

their ability to reduce water-droplet-penetration time at each site is unchanged or changed only slightly.

- The water-droplet-penetration times reported for each site have changed somewhat because the data collected before application of the wetting agents was excluded from the reanalysis. The changes in the water-droplet-penetration time have little impact on the interpretation of the results.

Although the results may have changed little following the reanalysis of the water-droplet-penetration-test data, it is only fair to all involved to ensure that the data are analyzed correctly and the correct results are published.

Clark Throssell is GCSAA's director of research.

WETTING AGENT STUDY: UPDATE

NEW MEXICO

Research cooperator: Bernd Leinauer, Ph.D., New Mexico State University, Las Cruces

Research site: New Mexico State University Golf Course, Las Cruces

WDPT, 2003-2004

Product	0.5 cm*		1.5 cm*		2.5 cm	
	2003	2004	2003	2004	2003	2004
Aqueduct	75 abcd	5 c	75 abc	20 e	61	50
Brilliance	32 e	7 c	60 bc	21 de	55	51
Cascade Plus	45 de	6 c	83 abc	27 de	75	55
Hydro-Wet	57 cde	7 c	84 abc	33 de	47	54
LescoFlo	35 e	6 c	55 c	27 de	59	58
Naiad	99 ab	51 ab	103 ab	67 a	92	79
Primer Select	68 bcde	5 c	69 bc	22 de	47	63
Respond 2	109 a	34 b	87 abc	51 bc	62	64
Surfside 37	92 abc	12 c	91 abc	37 cd	74	59
TriCure	85 abc	3 c	64 bc	25 de	59	59
Control	103 ab	52 a	118 a	59 ab	77	65

Note. Numbers in a column followed by the same letter are not significantly different from one another.

Table 1. Water-droplet-penetration time at depths of 0.5, 1.5 and 2.5 centimeters (0.2, 0.6 and 1 inch) for 2003 and 2004. Data are averaged over all sampling dates for each year.

SUMMARY

- There were no statistical differences among treatments for mean color ratings for 2003 and 2004.
- In both years, the control treatment and plots treated with Naiad and Respond 2 wetting agents showed highest water-droplet-penetration time (WDPT) at all depths. In 2003, the products Brilliance, Cascade Plus, Hydro-Wet and LescoFlo, differed significantly from the control treatment at the 0.5-centimeter (0.2-inch) depth. At the 1.5-centimeter depth, Brilliance, LescoFlo, Primer Select and TriCure showed a significant difference from the control treatment for WDPT. In 2004, Naiad did not differ significantly from the control treatment in WDPT at depths of 0.5 centimeter and 1.5 centimeters (0.2 and 0.6 inch) and had the highest reported WDPT for all treatments. Respond 2 also had no significant effect on WDPT compared to the control at the 1.5-centimeter depth. In 2003 and 2004, none of the applied surfactants differed significantly from the control treatment at the 2.5-centimeter (1-inch) depth.
- Most other products in the study appeared to alleviate water repellency to various degrees at depths of 0.5 centimeter and 1.5 centimeters (0.2 and 0.6 inch) as indicated by WDPTs lower than that of the control treatment.

ACKNOWLEDGMENTS

The support of Bruce Erhard, a 22-year GCSAA member and superintendent at New Mexico State University's golf course; the Rio Grande GCSA; and the Southwest Turfgrass Association is greatly appreciated. Without their generous help, this study would not have been possible.

TEXAS

Research cooperater: Joseph P. Krausz, Ph.D., Texas A&M University, College Station

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

SUMMARY

- No significant differences in overall visual quality were observed among the treatments in either 2003 or 2004.
- Hydrophobicity was worse in the upper soil levels (depths of 0.5 and 1.5 centimeters) in 2003, but was much less of a problem in 2004, perhaps because of the abundant rainfall and relatively mild temperatures in 2004.
- In 2003, when hydrophobicity was a problem, none of the wetting agent treatments significantly reduced the hydrophobicity of the soil.
- In 2004, when hydrophobicity was much less of a problem compared to 2003, several wetting agent treatments — Aqueduct, Brilliance, Hydro-Wet, LescoFlo, Primer Select and TriCure — all significantly reduced hydrophobicity compared to the untreated check. However, the level of overall hydrophobicity was so low as to be insignificant, and it is doubtful that differences among treatments were agronomically significant.
- In summary, none of the wetting agent treatments significantly improved turfgrass color or quality in either 2003 or 2004.

WDPT, 2003

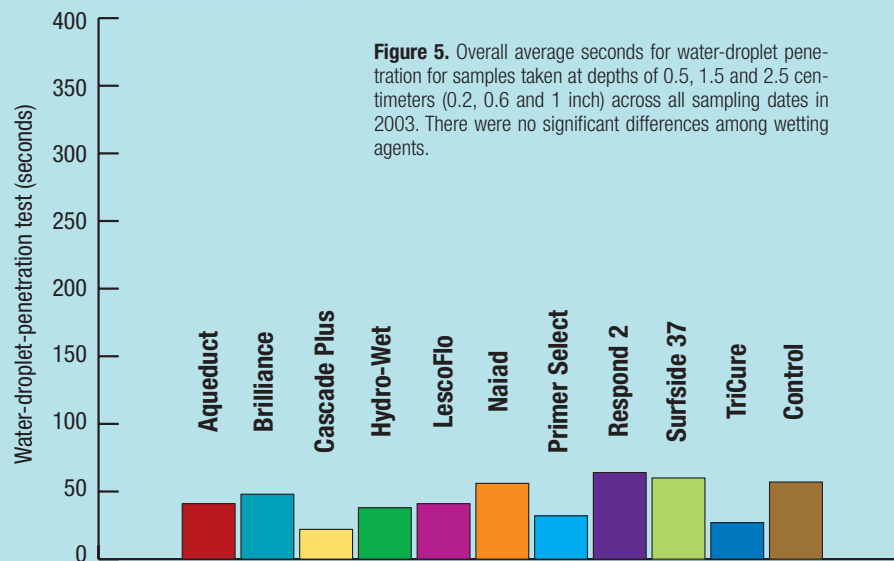


Figure 5. Overall average seconds for water-droplet penetration for samples taken at depths of 0.5, 1.5 and 2.5 centimeters (0.2, 0.6 and 1 inch) across all sampling dates in 2003. There were no significant differences among wetting agents.

WDPT, 2004

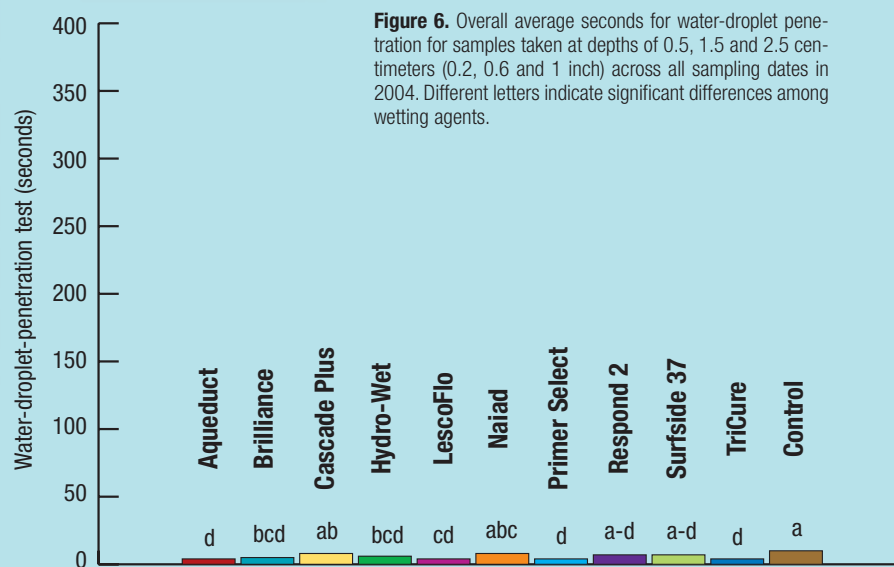


Figure 6. Overall average seconds for water-droplet penetration for samples taken at depths of 0.5, 1.5 and 2.5 centimeters (0.2, 0.6 and 1 inch) across all sampling dates in 2004. Different letters indicate significant differences among wetting agents.

WETTING AGENT STUDY: UPDATE

GEORGIA

Research cooperators: Keith J. Karnok, Ph.D., and Kevin Tucker, University of Georgia, Athens

Research site: University of Georgia Rhizotron and Turfgrass Facility, Athens

WDPT, 2003

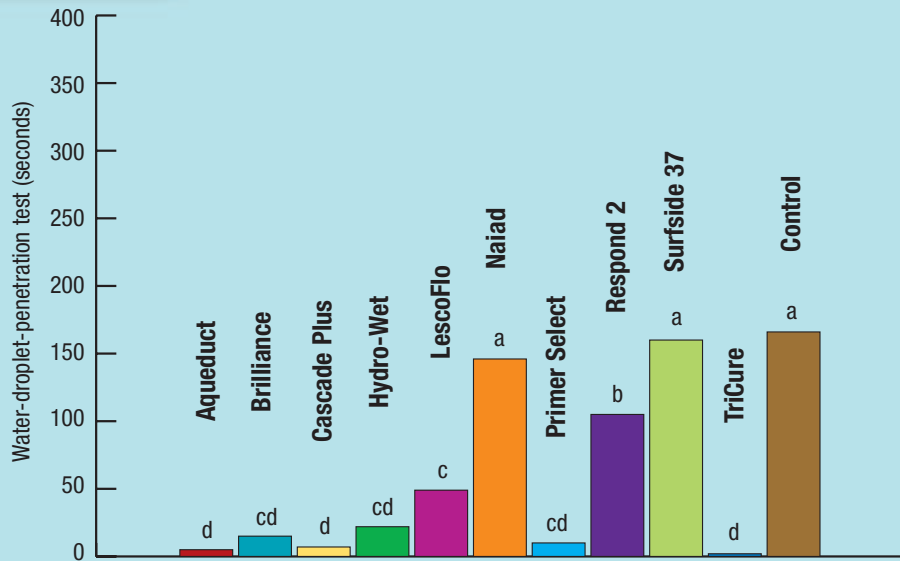


Figure 7. Water-droplet-penetration time (WDPT) in seconds averaged over depths of 0.5, 1.5 and 2.5 centimeters (0.2, 0.6 and 1 inch) and over all sampling dates for 2003. Different letters indicate significant differences among wetting agents.

WDPT, 2004

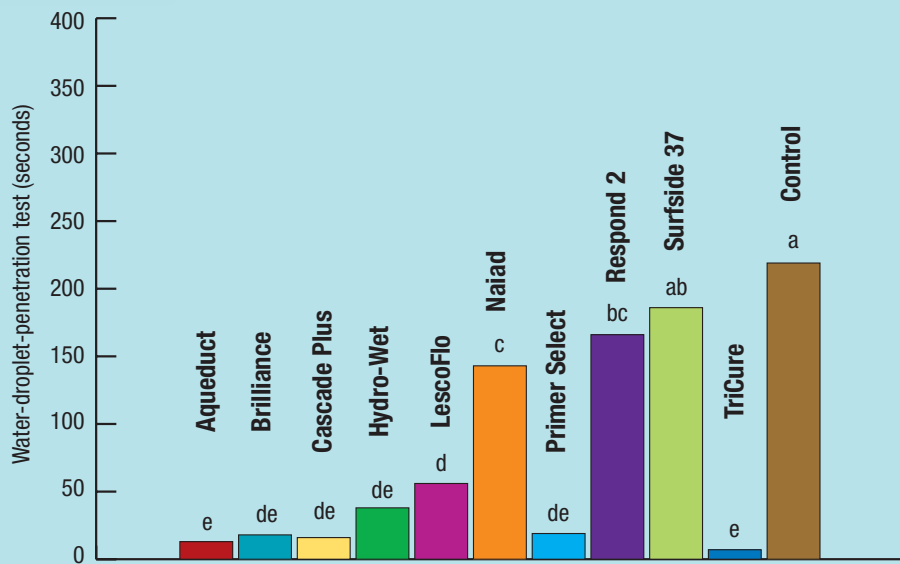


Figure 8. WDPT in seconds averaged over depths of 0.5, 1.5 and 2.5 centimeters (0.2, 0.6 and 1 inch) and over all sampling dates for 2004. Different letters indicate significant differences among wetting agents.

WETTING AGENT STUDY: UPDATE

MICHIGAN

Research cooperators: Kevin W. Frank, Ph.D., and Jeff Bryan, Michigan State University, East Lansing

Research site: Hancock Turfgrass Research Center, Michigan State University, East Lansing

SUMMARY

Mean turfgrass quality ratings from 2003 and 2004 were similar. Naiad and the untreated control were the only treatments that were significantly different in both years; they also had the lowest quality ratings.

Mean water-droplet-penetration-test results were averaged over depths of 0.5, 1.5 and 2.5 centimeters (0.2, 0.6 and 1 inch).

- **2003.** Plots treated with Naiad, Surfside 37, Respond 2 and the untreated control had the longest water-droplet-penetration times. Plots treated with Aqueduct, Brilliance, Cascade Plus, Hydro-Wet, LescoFlo, Primer Select and TriCure had the shortest times for water penetration and were statistically similar.
- **2004.** Plots treated with Naiad and the untreated control had the longest times for water penetration. Plots treated with Aqueduct, Brilliance, Hydro-Wet, LescoFlo, Primer Select and TriCure had the shortest times for water penetration and were statistically similar.

WDPT, 2003

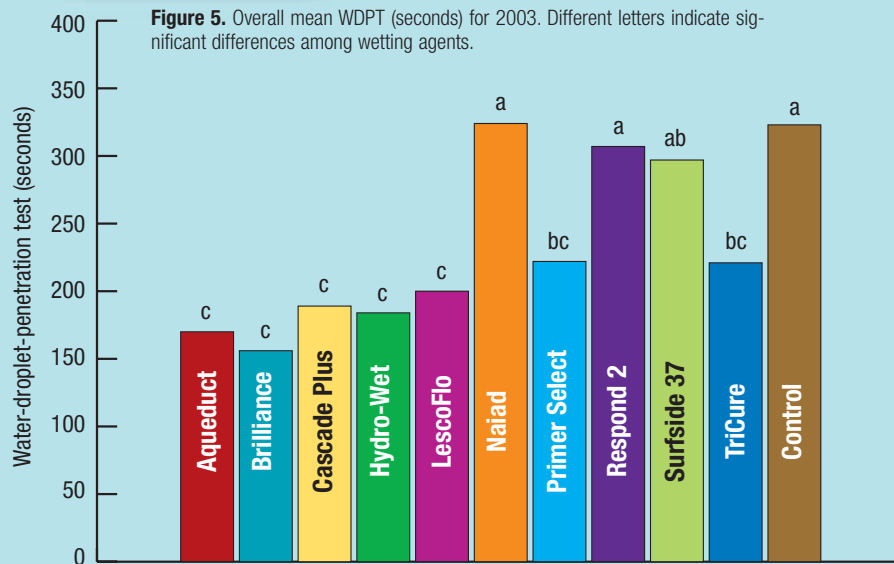


Figure 5. Overall mean WDPT (seconds) for 2003. Different letters indicate significant differences among wetting agents.

WDPT, 2004

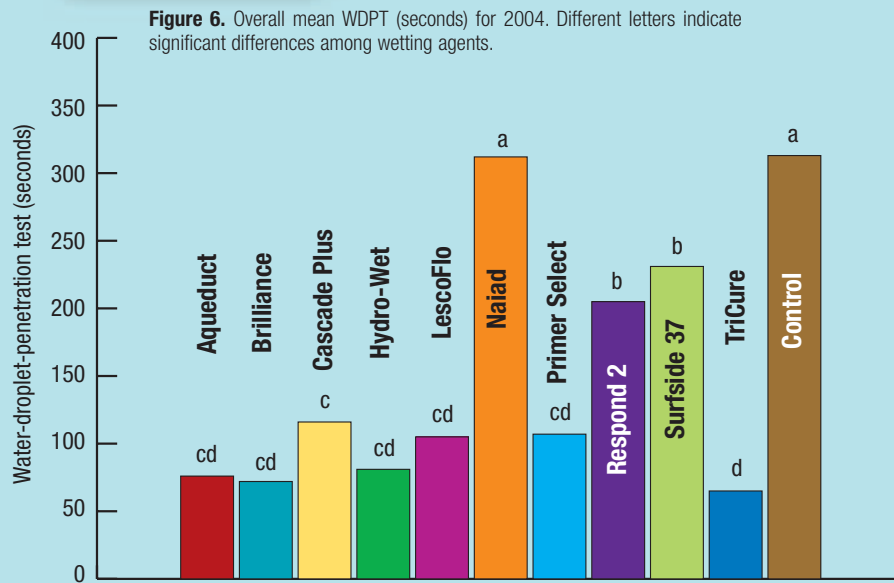


Figure 6. Overall mean WDPT (seconds) for 2004. Different letters indicate significant differences among wetting agents.

DISCUSSION

In western Washington, localized dry spot symptoms may not be as severe as in other parts of the country, where temperatures are higher. Severe LDS is rare, but superintendents often apply wetting agents to improve turf uniformity because of their possible impact on the nonuniform moisture dynamics of soil. In this evaluation, Cascade Plus, Hydro-Wet, LescoFlo and TriCure improved uniformity and therefore quality.

Naiad and Surfside 37 were mostly ineffective in improving water-droplet-penetration time (WDPT) at our site. For the other products, effects on soil hydrophobicity were limited to the upper 0.5 centimeter (0.2 inch) of the sand profile. Because WDPT was usually highest at the 2.5-centimeter (1-inch) depth (averaging 363 seconds in 2003, but often over the 600-second maximum), we increased post-application irrigation from 0.1 inch (0.25 centimeter) to 0.25 inch (0.64 centimeter) in 2004 to move the products deeper into the profile. The increased irrigation did not appear to have an impact, because WDPT below 0.5 centimeter (0.2 inch) was not significantly affected by wetting agent application in 2004.

SUMMARY

- There were no statistically significant differences in annual quality means as a result of wetting agent application in either year.
- Cascade Plus, Hydro-Wet, LescoFlo and TriCure resulted in quality ratings that were numerically higher than the control in both years. Plots treated with these products generally had a more uniform appearance.
- Wetting agents affected WDPT only at the 0.5-centimeter (0.2-inch) depth.
- In 2003, all products except Naiad significantly reduced WDPT at the 0.5-centimeter (0.2-inch) depth compared to the control. Aqueduct, Brilliance, Cascade Plus, Hydro-Wet, LescoFlo and TriCure were most effective. Primer Select, Respond 2 and Surfside 37 were intermediate in their effectiveness.
- In 2004, all products except Naiad and Surfside 37 significantly decreased WDPT at the 0.5-centimeter (0.2-inch) depth compared to the untreated control.
- No phytotoxicity data are shown, but Cascade Plus resulted in moderate phytotoxicity for two weeks following the first application in both years (May 27, 2003; May 18, 2004), and for three days following the second application in 2003 (June 6) and one week in 2004 (May 28).
- Hydro-Wet resulted in moderate phytotoxicity for 10 days following the third application in 2004 (Aug. 10).
- Brilliance resulted in moderate phytotoxicity for 10 days following the third application in 2004 (Aug. 20).

ACKNOWLEDGMENTS

I thank Geoff Rinehart and Randi Luchterhand for technical assistance.

DISCUSSION AND RESULTS

The control showed the best turfgrass quality throughout the study. Water-repellent soils have a critical moisture point. Above this point, the soil will not show signs of water repellency. Below this point, the soil will begin to repel water, and localized dry spots will become apparent. This critical moisture point varies among soils. In our case, with the irrigation regime used and greater-than-normal rainfall at times, the soil moisture content was often above the critical point, and the control showed few signs of localized dry spots.

This fact does not influence the WDPT data because the soil samples were dried below the critical moisture point before testing. To us, this is the true indicator of how well a wetting agent relieves soil water repellency. The quality data shown here most likely represent the stress the wetting agent put on the turfgrass rather than the effects of water-repellent soil. Certainly, different environments, cultural practices, soil types, and species and cultivar of turfgrass could result in different findings.

SUMMARY

- Hydro-Wet, Naiad, Respond 2 and Surfside 37 were the only wetting agents that showed no significant phytotoxicity for both 2003 and 2004.
- Aqueduct, Brilliance, Primer Select and TriCure showed significant phytotoxicity compared to the control in both years. In most cases, the wetting agents with the greatest potential for causing phytotoxicity did so during the periods of greatest turfgrass summer stress.
- LescoFlo, Naiad, Respond 2 and Surfside 37 did not reduce turfgrass quality compared to the control for 2003 and 2004.
- Phytotoxicity was most severe during the peak summer stress months.
- Aqueduct, Cascade Plus, Hydro-Wet, Primer Select and TriCure all reduced turf quality compared to the control in both years.
- The greatest soil water repellency occurred in the top 2.5 centimeters (1 inch) of the soil profile.
- Soil water repellency was most severe toward the end of summer in both years.
- Surfside 37, Naiad and Respond 2 were the least effective in reducing soil water repellency.
- Aqueduct, Brilliance, Cascade Plus, Hydro-Wet, LescoFlo, Primer Select and TriCure significantly reduced soil water repellency in both years.
- In terms of reducing soil water repellency, the relative ranking of wetting agents remained essentially the same regardless of soil depth or degree of water repellency.

WETTING AGENT STUDY: UPDATE

MISSOURI

Research cooperator: Barbara S. Corwin, Ph.D., University of Missouri, Columbia

Research site: The Club at Porto Cima, Lake Ozark, Mo.

SUMMARY

- In 2003, the average color rating for plots treated with Cascade Plus was significantly lower than the average color rating for the control as well as all other wetting agent treatments. The average color rating for plots treated with LescoFlo was significantly better than the average color rating for plots treated with Brilliance, Cascade Plus and HydroWet, but did not differ significantly from the control.
- There were no significant differences in color rating among treatments in 2004.
- The root zone of the putting green at this study site had a slight degree of water repellency during the course of this study.
- Although statistically significant differences were observed among treatments in both 2003 and 2004, there was only an 11-second difference in water droplet penetration between the longest mean time and the shortest mean time in both years. It is doubtful the differences in mean water-droplet-penetration times were agronomically meaningful.
- The products that were most effective in reducing soil hydrophobicity also reduced turfgrass color.

ACKNOWLEDGMENTS

I would like to thank Paul Naudet, superintendent, and Mike Renfro, turf equipment technician, at The Club at Porto Cima; 2003 summer interns Shea Nelson and Ben Stover from Iowa State University; and 2004 summer intern Kyle Briscoe from the University of Missouri.

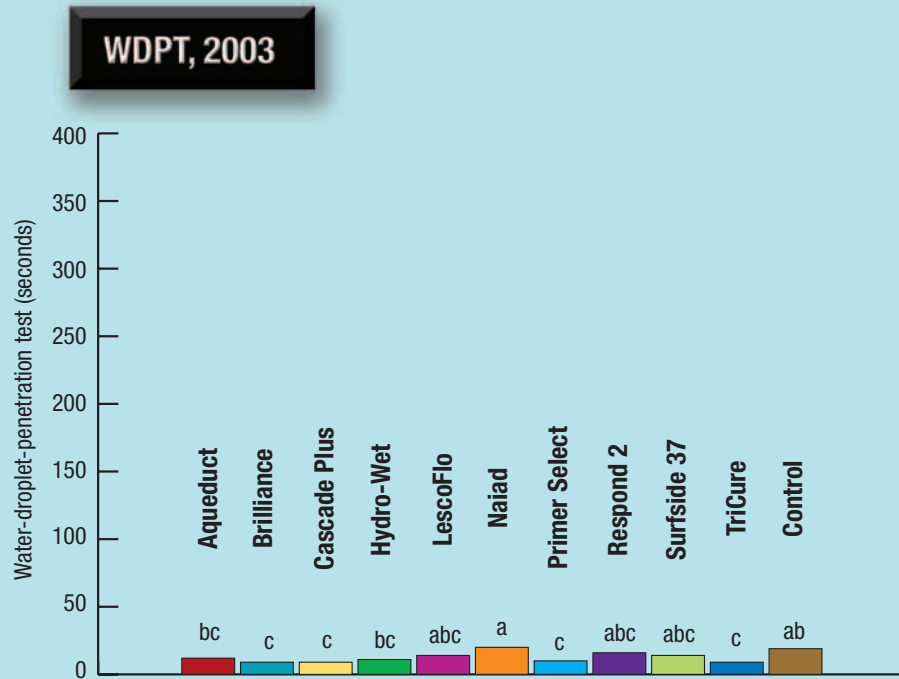


Figure 5. WDPT (seconds) averaged over 0.5, 1.5 and 2.5 centimeters (0.2, 0.6 and 1 inch) and over all sampling dates for 2003. Different letters indicate significant differences among wetting agents.

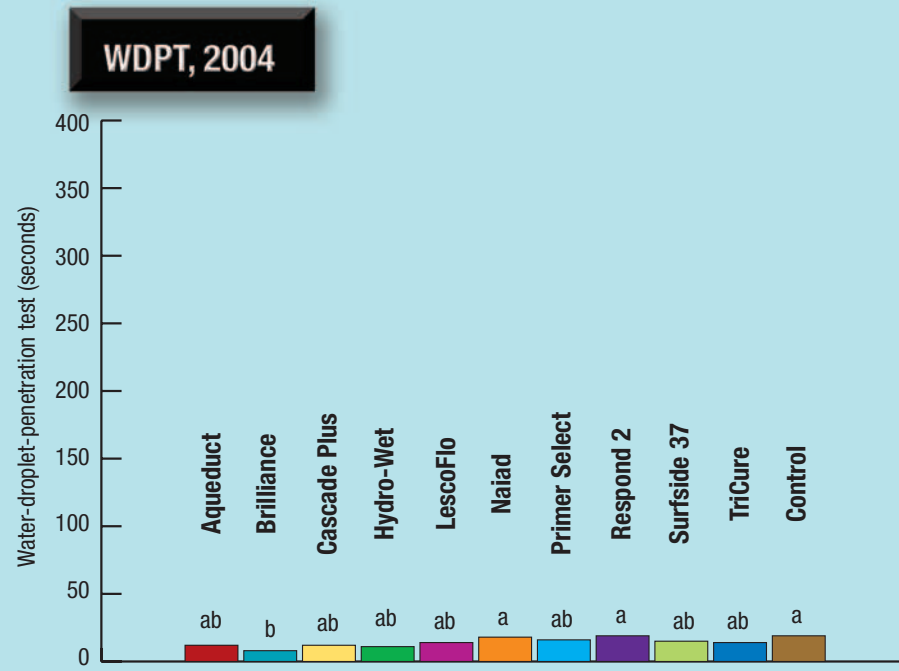


Figure 6. WDPT (seconds) averaged over 0.5, 1.5 and 2.5 centimeters (0.2, 0.6 and 1 inch) and over all sampling dates for 2004. Different letters indicate significant differences among wetting agents.

CALIFORNIA

Research cooperators: Sowmya (Shoumo) Mitra, Ph.D., California State Polytechnic University, Pomona

Research site: Montebello (Calif.) Golf Course

SUMMARY

- No phytotoxicity was observed in 2003, but significant injury was observed in 2004. The difference in response could be due to the change in weather conditions between the two years.
- In 2004, Cascade Plus caused the greatest phytotoxicity at one and three days after treatment.
- The most hydrophobic regions were at depths of 1.5 and 2.5 centimeters (0.6 and 1.0 inch) for both years.
- All the wetting agent treatments reduced dew formation on the turf compared to the control.
- In both years, Aqueduct, Hydro-Wet, LescoFlo, Primer Select, Surfside 37 and TriCure significantly reduced dew formation seven days after application compared to the other products in the study.
- Overall, based on the average water-droplet-penetration test in 2003, Aqueduct, Brilliance, Cascade Plus, LescoFlo, Primer Select and TriCure significantly reduced hydrophobicity compared to the control and Respond 2. There was no difference among the Respond 2, Naiad, Hydro-Wet and Surfside 37 treatments.
- In 2004, according to the overall average water-droplet-penetration test, Aqueduct reduced hydrophobicity significantly compared to the control, Brilliance, Hydro-Wet, LescoFlo, Naiad, Primer Select, Respond 2, Surfside 37 and TriCure. The Aqueduct and Cascade Plus treatments were not significantly different. There were no significant differences among the Brilliance, Cascade Plus, Hydro-Wet, LescoFlo, Primer Select and TriCure treatments.

ACKNOWLEDGMENTS

I greatly appreciate the help and support I received from Fernando Garcia, six-year GCSAA member and superintendent at Montebello Golf Course; Juan Perez (Senior Project 2003); Kevin White (Senior Project 2004); Kent Kurtz, Ph.D.; Russell Plumb; Bianca Good; Himani Swami; Paitawee Suphandrita; and Magdy Fam.

WDPT, 2003

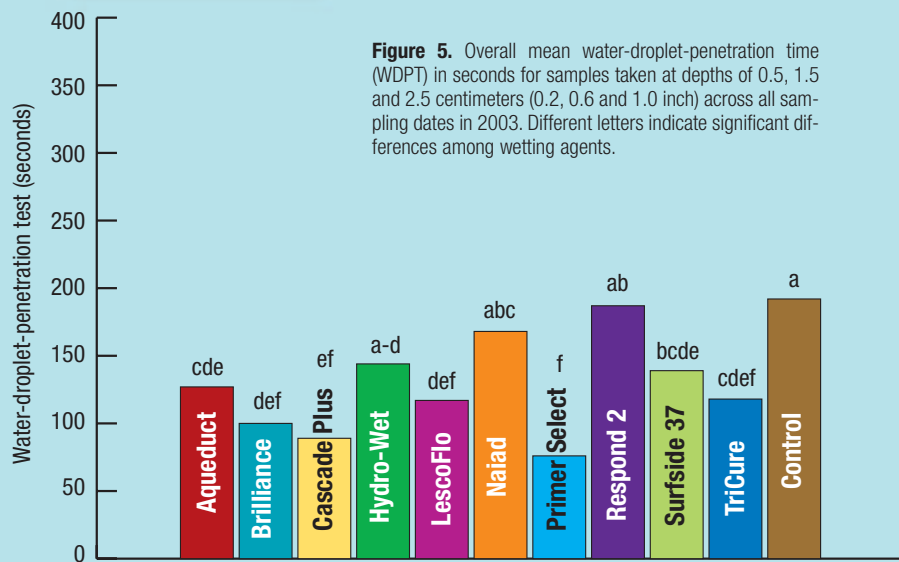


Figure 5. Overall mean water-droplet-penetration time (WDPT) in seconds for samples taken at depths of 0.5, 1.5 and 2.5 centimeters (0.2, 0.6 and 1.0 inch) across all sampling dates in 2003. Different letters indicate significant differences among wetting agents.

WDPT, 2004

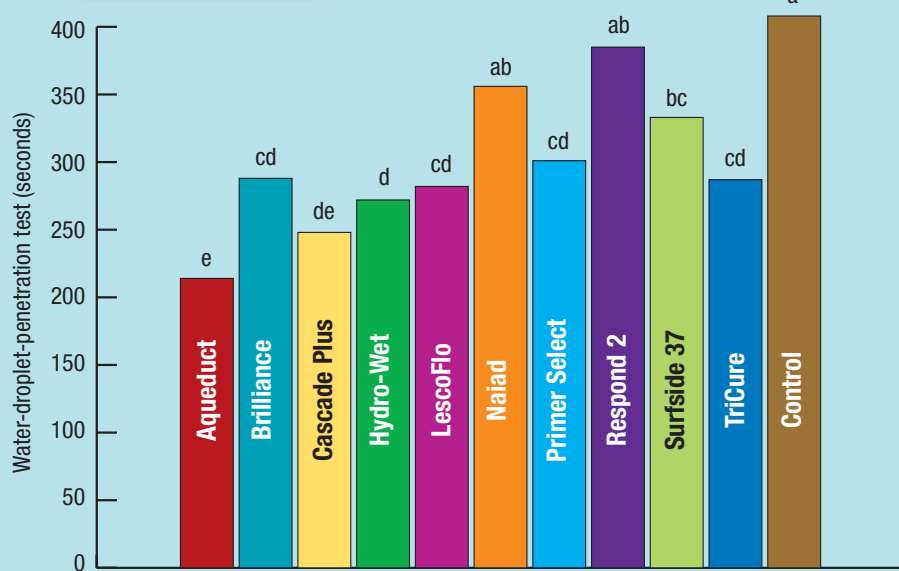


Figure 6. Overall mean WDPT for samples taken at depths of 0.5, 1.5 and 2.5 centimeters (0.2, 0.6 and 1.0 inch) across all sampling dates in 2004. Different letters indicate significant differences among wetting agents.

WETTING AGENT STUDY: UPDATE

FLORIDA

Research cooperators: J.L. Cisar, Ph.D. (jlc@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

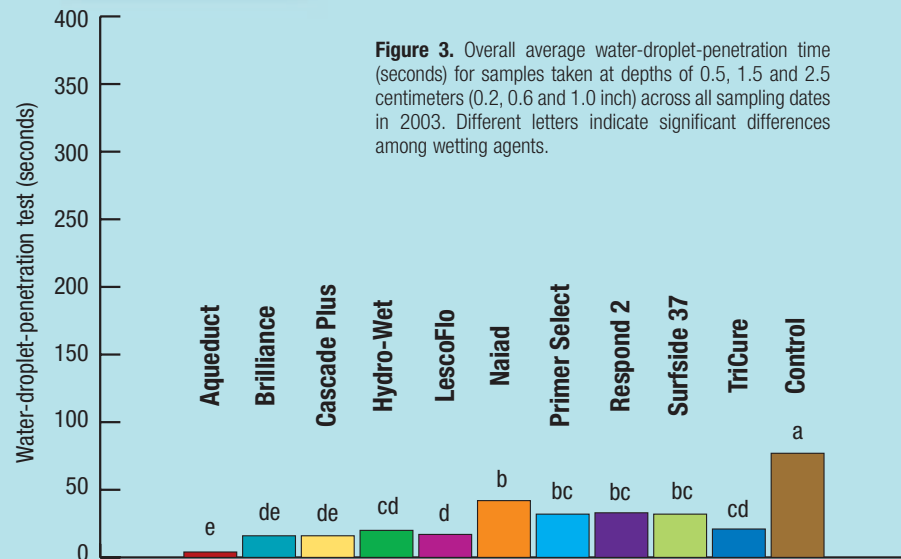


Figure 3. Overall average water-droplet-penetration time (seconds) for samples taken at depths of 0.5, 1.5 and 2.5 centimeters (0.2, 0.6 and 1.0 inch) across all sampling dates in 2003. Different letters indicate significant differences among wetting agents.

WDPT, 2004

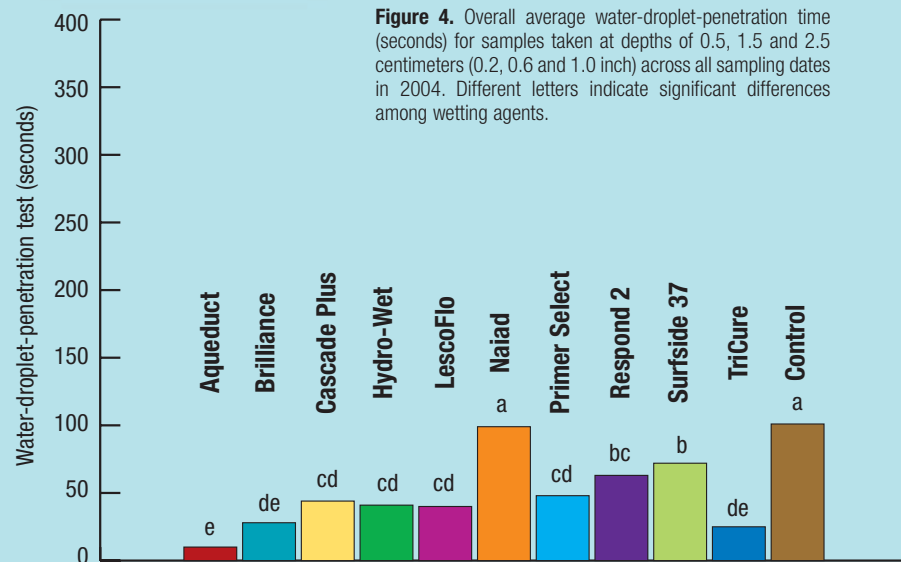


Figure 4. Overall average water-droplet-penetration time (seconds) for samples taken at depths of 0.5, 1.5 and 2.5 centimeters (0.2, 0.6 and 1.0 inch) across all sampling dates in 2004. Different letters indicate significant differences among wetting agents.

WETTING AGENT STUDY: UPDATE

WASHINGTON

Research cooperators: Eric Miltner, Ph.D. (miltner@wsu.edu), assistant turfgrass research agronomist, Washington State University, Puyallup

Research site: Washington State University Puyallup Research and Extension Center, Farm 5, Puyallup

WDPT, 2003

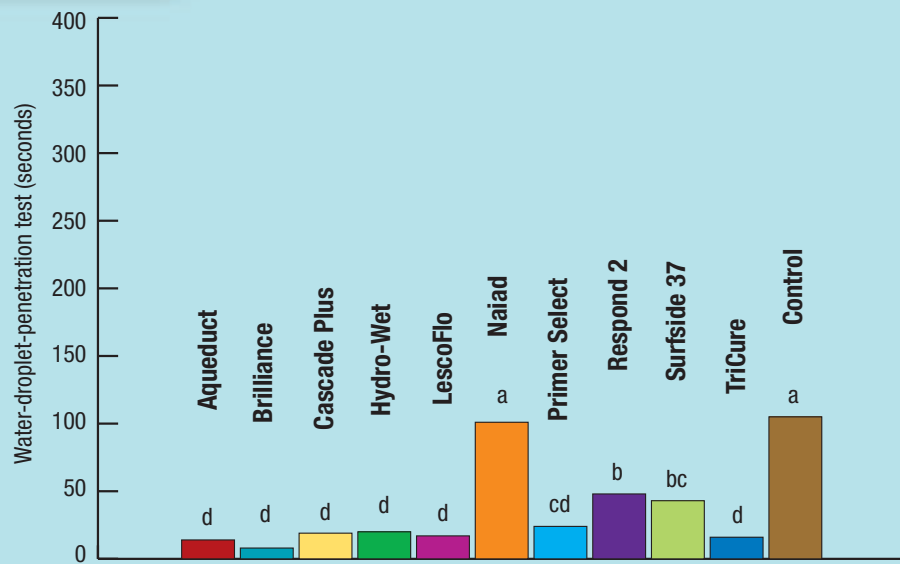


Figure 5. Overall average water-droplet-penetration times (WDPT) in seconds for samples taken at a depth of 0.5 centimeter (0.2 inch) across all sampling dates in 2003. Means with the same letter are not significantly different.

WDPT, 2004

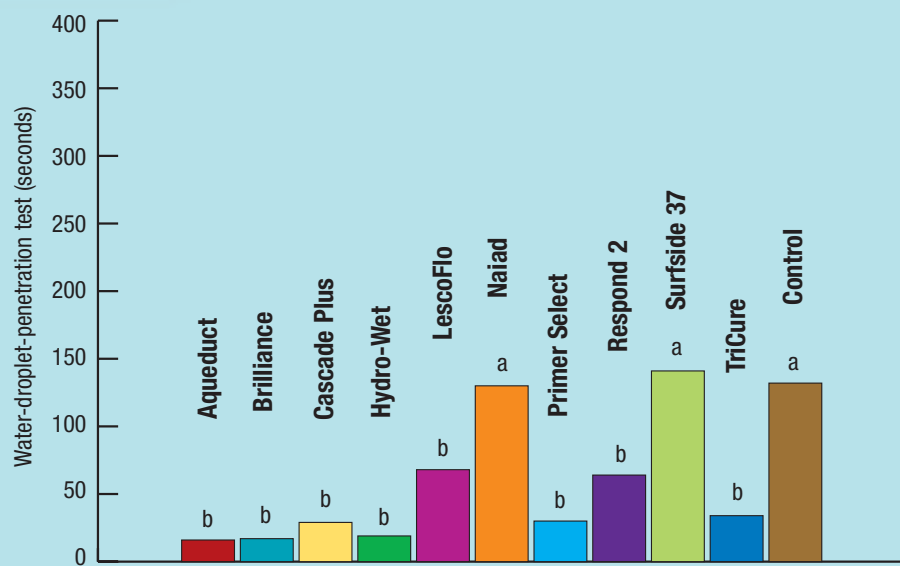


Figure 6. Overall average WDPT (seconds) for samples taken at a depth of 0.5 centimeter (0.2 inch) across all sampling dates in 2004. Means with the same letter are not significantly different.

NEW YORK

Research cooperator: Frank S. Rossi, Ph.D., Cornell University, Ithaca, N.Y.

Research site: Cornell Turfgrass and Landscape Research Laboratory, Ithaca, N.Y.

SUMMARY

- In general, the 2003 and 2004 growing seasons were among the wettest in the last 100 years in central New York state. Both years experienced above-average rainfall; rainfall in 2004 was 12 inches (30.5 centimeters) above normal for the months of the study.
- There were no significant differences in mean turf-quality ratings averaged over the two years among the treatments (Figure 3). Phytotoxicity data (not shown) do not reveal any obvious injury associated with the treatments.
- There were significant statistical differences among the wetting agents in both years of the study (Figures 4, 5). However, as the data indicate, this site did not exhibit the severe water repellency we have observed in years of normal rainfall. Therefore, we do not believe there were biologically meaningful differences among the treatments.
- The conclusion from the two-year study at our location suggests that a sand green historically prone to localized dry spot may benefit from wetting agent use, and some wetting agents do appear to be better than others. However, when rainfall is above average, greens do not require supplemental wetting agent treatments for water repellency.

WDPT, 2003

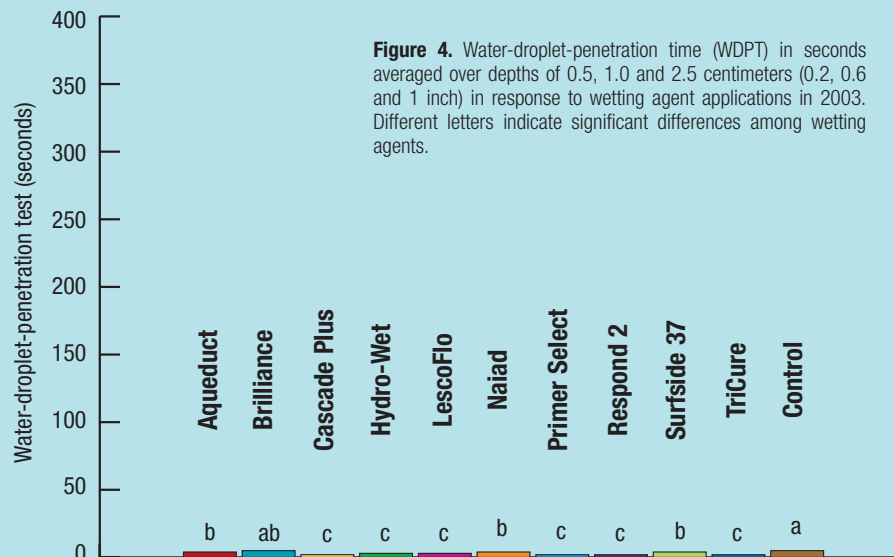


Figure 4. Water-droplet-penetration time (WDPT) in seconds averaged over depths of 0.5, 1.0 and 2.5 centimeters (0.2, 0.6 and 1 inch) in response to wetting agent applications in 2003. Different letters indicate significant differences among wetting agents.

WDPT, 2004

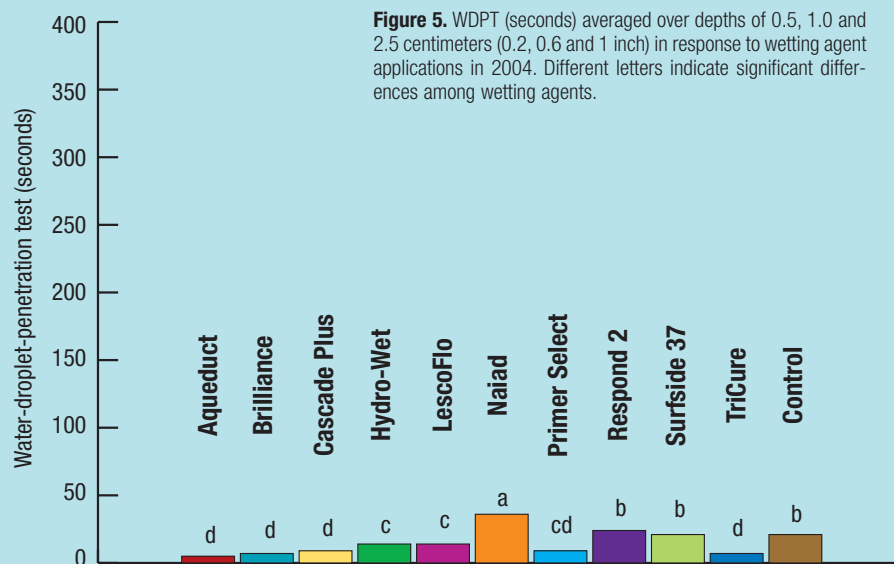


Figure 5. WDPT (seconds) averaged over depths of 0.5, 1.0 and 2.5 centimeters (0.2, 0.6 and 1 inch) in response to wetting agent applications in 2004. Different letters indicate significant differences among wetting agents.