Field Evaluation of a Soil Surfactant on creeping bentgrass putting green

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Summary

The objective of this study was to determine the effectiveness of two experimental wetting agents for the reduction of localized dry spot on a sand based creeping bentgrass putting green. At no time during the study period was there any statistical differences between treatments when evaluating turfgrass quality. localized dry spot, or volumetric water content of the root zone. With regard to water repellency/hydrophobicity, as measured by water droplet penetration time (WDPT), the only significant differences occurred at the thatch-air interface on the final rating date. When values were averaged over the six depths, those treatments that showed the least water repellency were OARS 190ml/100m^2 (every 4 weeks), OARS 130ml/100m^2 (every 4 weeks), PBS150 250ml (2 applications 14 days apart), and Respond 3 130 ml every 4 weeks. The test period was cool and wet and there was little development of localized dry spots.

Introduction

Water is a polar molecule, meaning that it has a large affinity for binding to itself (1). These tight cohesive forces cause surface tension and the formation of water droplets. Adhesion is water's attraction to other molecules, and in soil, is governed by whether the soil molecule is charged. If the molecule in the soil is not polar or non-polar, water will bind to itself, resulting in great difficulty to wet, also called hydrophobicity. If there are sufficient non-polar molecules in the soil, localized dry spots can form.

Hydrophobic soils are caused by water repellant coatings from several different sources such as decomposing plant materials, deposits from microbes, and plant and fungal exudates. These organic compounds can be either polar or non-polar. The polar side adheres to the soil particle exposing the non-polar side, which is hydrophobic. If this occurs on a great number of soil particles, localized dry spot can form. These are very difficult to wet, particularly if they have been allowed to dry completely.

Wetting agents or surfactants have at least one polar head and one non-polar tail. They can work in the soil to facilitate hydration and distribute water. The non-polar tail (hydrophobic) will attach to the hydrophobic soil coating leaving the polar head exposed to attract and hold water on the soil particle. This attracted water will adhere to other water molecules, which assists in the distribution of water and the reduction of localized dry spots.

The objective of this study was to determine the effectiveness of two experimental wetting agents on creeping bentgrass putting green turf on a high sand rootzone. Turfgrass quality, reduction of localized dry spot, effects on soil moisture content, and soil hydrophobicity were determined.

Methodology
The green selected for evaluation was located at the Prairie Turfgrass Research Centre in Olds, Alberta, Canada. The green was constructed to USGA specifications for putting greens and was established in 1996 to Penncross creeping bentgrass utilizing a 90%/10% mix of Torrington sand and Premier sphagnum peat moss.

Plots were established in a complete randomized block design with four replicates per treatment. Each plot measured 1m x 2 m. The trial commenced June 16, 2010 with the final set of data collected on October 6, 2010

The treatment list and data collection information is listed below. Treatments were applied with a calibrated CO_2 sprayer at a rate of 8 L/100m^2. Control plots were not treated. Plots were irrigated immediately following the application of the treatments.

Treatment List and Application Schedule.

1. OARS 190mls/100m^2 applied every 4 weeks.
2. OARS 160mls/100m^2 applied every 4 weeks.
3. OARS 130mls/100m^2 applied every 4 weeks.
4. PBS150 250mls/100m^2 2 applications 14 days apart (Day 0 and Day 14)
5. PBS150 250mls/100m^2 single application (Day 0)
6. PBS150 130mls/100m^2 applied every 4 weeks.
7. Respond 3 130mls/100m^2 applied every 4 weeks.
8. Untreated Control

Treatments were applied June 16 and 29 for the PBS150 250mls/100m^2 treatments. The remaining treatments were applied on a four week interval on June 16, July 14, August 11 and September 8.

Mowing took place three times per week at a height of 4.8mm (0.187") with a John Deere 220A walking greens mower. The green was fertilized with urea 46-0-0 on June 14, July 5, July 26, August 16 and August 30 at the equivalent rate of 0.25 kg nitrogen per 100m^2. To prevent moisture stress, plots were irrigated for 10 minutes per day as required.

Data Collected:

1) Turf Quality/phytotoxicity
   Weekly visual rating of turf quality was based on a 1-9 scale where 9 equalt best q quality and 1 equals poorest quality. Toxicity of the product to the turf (phytotoxicity) was based on a color rating where 1 is a brown turf and 9 is a dark green coloration. First assessment was made prior to initial treatment application on June 16, 2010.

2) Localized Dry Spot Formation
   Localized dry spot (LDS) is a symptom of moisture stress that typically appears as an irregularly shaped patch of turf which lacks turgor and is off colour. In this test, a 1 X 1 metre grid box was constructed with 100 individual sections that measured 10 cm X 10 cm. Individual sections that showed symptoms of LDS

were counted and a percentage of plots was then determined. Assessments were made on a weekly basis when localized dry spots were visible.

3) Volumetric Water Content (VMC)
Percent volumetric water content was determined in each plot using a Hydrosense water content moisture sensor (Campbell Scientific Edmonton, Alberta). Five sampling points were randomly selected along an X which ran from corner to corner and the grid box was placed at two locations in each plot. In addition, 10 sampling locations were randomly selected within the plots for a total of twenty measurements. The same points were assessed bi-weekly.

4) Water repellency/hydrophobicity as measured by water droplet penetration time was sampled for prior to initial treatment application and every eight weeks thereafter. Five soil cores were collected from each plot with a 2 cm soil probe to a depth of 15 cm. Cores were placed horizontally in trays and air dried for two weeks at room temperature. Dried cores were evaluated for hydrophobicity using the water droplet penetration time (WDPT) test (Lety, 1969). A 35 µl droplet of distilled water was dispensed via a pipette. Droplets were placed at 1 cm intervals along the core starting at the thatch-air interface and ending at 6 cm. The thatch-air interface is considered to be that point where there is a distinct difference between the soil and the thatch. Using a stopwatch, the length of time (in seconds) was determined for the water droplet to completely penetrate the soil core. Droplets that did not penetrate the core for 10 minutes (600 seconds) were recorded as >600seconds.

Results:

Particle Size Distribution of the Sand Green

An analysis of the particle size distribution showed that the rootzone mixture met the specifications for construction of a USGA specification putting green (table 1).

Table 1 – Particle size distribution of rootzone mixture for sand based green.

Sieve size	Percentage within range	USGA specs (%)
>2.0 mm	7%	
1.0-2.0 mm	1%	<10%
0.5-1.0 mm	12%	
0.25-0.5 mm	66%	>60%
0.15-0.25 mm	11%	<20%
<0.15 mm	2%	<5%

Weather Data

The summer of 2010 had no extended warm or dry periods. Temperatures were below normal and precipitation was above normal when compared with averages for Olds from 1914-2002.

Turf Quality

There were no significant differences in turf quality on any of the rating dates as a result of the various treatment applications (data not shown).

Phytotoxicity
At no time was there any phytotoxic reaction to the application of the products (data not shown).

Localized Dry Spot Formation
At no time was there any evidence of localized dry spot (data not shown).

Volumetric Water Content
Volumetric water content of the soils was not affected by application of the various treatments (table 3). Values were very consistent between rating periods and ranged from a low value of 18% to a high value of 25%.

Table 3 - Volumetric water content for various treatments.

Treatments	Week 0	Week 2	Week 4	Week 6
	%			
OARS 190 mls/100m^2 every 4 weeks	20a	20a	23a	22a
OARS 160 mls/100m^2 every 4 weeks	19a	20a	23a	23a
OARS 130 mls/100m^2 every 4 weeks	20a	21a	24a	23a
PBS150 250mls/100m^2 2 applications 14 days apart	18a	19a	22a	21a
PBS150 250mls/100m^2 single application	20a	21a	24a	23a
PBS150 130 mls/100m^2 every 4 weeks	20a	21a	23a	22a
Respond 3 130 mls/100m^2 every 4 weeks	19a	21a	23a	22a
Control (water Only)	19a	20a	22a	21a
$LSD_{0.05}$	n/s	n/s	n/s	n/s

Treatments	Week 8	Week 10	Week 12
	%		
OARS 190 mls/100m^2 every 4 weeks	21a	19a	24a
OARS 160 mls/100m^2 every 4 weeks	22a	20a	25a
OARS 130 mls/100m^2 every 4 weeks	22a	20a	25a
PBS150 250mls/100m^2 2 applications 14 days apart	21a	19a	23a
PBS150 250mls/100m^2 single application	22a	20a	25a
PBS150 130 mls/100m^2 every 4 weeks	23a	19a	24a
Respond 3 130 mls/100m^2 every 4 weeks	22a	19a	24a

Control (water Only)	21a	19a	23a
$LSD_{0.05}$	n/s	n/s	n/s

* Values that have the same letter as a suffix are not significant from each other

Water Droplet Penetration Time Test

There were no significant differences between treatments at any depth prior to the initiation of the study (table 4). The thatch-air interface had the highest water repellency as measured by water droplet penetration times. Hydrophobicity was not detected at the 5 cm depth.

Table 4 – Water repellency/hydrophobicity as measured by water droplet penetration time, June 16.

Treatments	Thatch-Air Interface	2nd cm	3rd cm	4th cm	5th cm	6th cm
	seconds					
OARS 190 mls/100m^2 every 4 weeks	48a	34a	9a	3a	1a	1a
OARS 160 mls/100m^2 every 4 weeks	61a	38a	6a	2a	1a	1a
OARS 130 mls/100m^2 every 4 weeks	44a	43a	12a	5a	1a	1a
PBS150 250mls/100m^2 2 applications 14 days apart	42a	43a	8a	3a	1a	1a
PBS150 250mls/100m^2 single application	68a	40a	13a	3a	1a	1a
PBS150 130 mls/100m^2 every 4 weeks	77a	52a	14a	4a	1a	1a
Respond 3 130 mls/100m^2 every 4 weeks	52a	44a	11a	3a	1a	1a
Control (water Only)	54a	35a	11a	4a	1a	1a
$LSD_{0.05}$	n/s	n/s	n/s	n/s	n/s	n/s

* Values that have the same letter as a suffix are not significantly different from each other.

There were no significant differences between treatments on the second rating date.

Table 5 - Water repellency/hydrophobicity as measured by water droplet penetration time, August 11.

Treatments	Thatch-Air Interface	2nd cm	3rd cm	4th cm	5th cm	6th cm
	seconds					
OARS 190 mls/100m^2 every 4 weeks	66a	46a	14a	5a	1a	1a
OARS 160 mls/100m^2 every 4 weeks	83a	55a	28a	13a	4a	1a
OARS 130 mls/100m^2 every 4 weeks	83a	66a	19a	6a	1a	1a
PBS150 250mls/100m^2 2 applications 14 days apart	66a	74a	26a	12a	2a	1a

PBS150 250mls/100m^2 single application	65a	44a	12a	5a	1a	1a
PBS150 130 mls/100m^2 every 4 weeks	67a	46a	19a	5a	1a	1a
Respond 3 130 mls/100m^2 every 4 weeks	33a	73a	15a	6a	1a	1a
Control (water Only)	75a	70a	20a	10a	1a	1a
$LSD_{0.05}$	n/s	n/s	n/s	n/s	n/s	n/s

* Values that have the same letter as a suffix are not significantly different from each other.

On the final rating date, the only significant differences occurred at the thatch-air interface (table 5). The highest WDPT was for the water control only. Those treatments that showed the least water repellency were OARS 190ml/100m^2 (every 4 weeks), OARS 160ml/100m^2 (every 4 weeks), OARS 130ml/100m^2 (every 4 weeks), PBS150 130ml every 4 weeks and Respond 3 130 ml every 4 weeks.

Table 5 - Water repellency/hydrophobicity as measured by water droplet penetration time, October 6.

Treatments	Thatch-Air Interface	2nd cm	3rd cm	4th cm	5th cm	6th cm
	seconds					
OARS 190 mls/100m^2 every 4 weeks	20c	61a	14a	3a	1a	1a
OARS 160 mls/100m^2 every 4 weeks	18c	107a	22a	5a	3a	1a
OARS 130 mls/100m^2 every 4 weeks	26bc	84a	16a	2a	1a	1a
PBS150 250mls/100m^2 2 applications 14 days apart	62b	49a	18a	5a	1a	1a
PBS150 250mls/100m^2 single application	62b	88a	24a	3a	1a	1a
PBS150 130 mls/100m^2 every 4 weeks	25bc	116a	34a	9a	3a	1a
Respond 3 130 mls/100m^2 every 4 weeks	11c	59a	20a	4a	1a	1a
Control (water Only)	130a	72a	21a	4a	1a	1a
$LSD_{0.05}$	37	n/s	n/s	n/s	n/s	n/s

* Values that have the same letter as a suffix are not significantly different from each other.

When values were averaged over the six depths, differences occurred on the final rating date (table 6). Those treatments that showed the least water repellency were OARS 190ml/100m^2 (every 4 weeks), OARS 130ml/100m^2 (every 4 weeks), PBS150 250ml (2 applications 14 days apart), and Respond 3 130 ml every 4 weeks.

Table 6 - Water droplet penetration time, average of six depths.

Treatments	June 16th Week 0	August 11th Week 8	October 6th Week 16
	seconds		

OARS 190 mls/100m^2 every 4 weeks	16a	22a	17ab
OARS 160 mls/100m^2 every 4 weeks	18a	31a	26bcde
OARS 130 mls/100m^2 every 4 weeks	18a	29a	22abc
PBS150 250mls/100m^2 2 applications 14 days apart	16a	30a	23abcd
PBS150 250mls/100m^2 single application	21a	22a	30bcde
PBS150 130 mls/100m^2 every 4 weeks	25a	23a	31bcde
Respond 3 130 mls/100m^2 every 4 weeks	19a	22a	16a
Control (water Only)	18a	30a	38e
$LSD_{0.05}$	n/s	n/s	13

* Values that have the same letter as a suffix are not significantly different from each other.

Discussion

Soil hydrophobicity, by nature, is highly variable. As a result, in this test statistical differences between treatments were few. In addition, localized dry spots will be more prevalent in conditions of warm weather with minimal precipitation. The test period was cool and wet and there was little development of localized dry spots. A longer period of evaluation under warmer and drier conditions would likely provide a better evaluation of the products in this trial.

References

Miller, Lee. 2005. Wetting Agents – The Old, The New, What They Are and What They Do. Pages 19-21. www.magcs.org