MEMO

To:

From: Montco Products Corporation

Date:

Re: University research shows *Surfside 37* improves irrigation efficiency and saves a significant volume of water upon initial application

Summary:

The experiment "Irrigation Efficiency as Affected by *Surfside 37* Wetting Agent" was conducted by the respected Dr. Keith Karnok at the University of Georgia in 2005. In the experiment, two initial application rates of *Surfside 37* were tested on two equal sized portions of turf and were both compared to a control plot that did not use a wetting agent. The initial application rates were 16 oz. / 1000 ft.^{2} and 32 oz. / 1000 ft.^{2} of *Surfside 37*. Both initial application rates were diluted with 2 gal. of water for every 1000 ft.^{2}. Immediately after the application of the two different rates, all plots of turf were irrigated at a rate of 312 gal. water / 1000 ft^2.

Eleven days after the application of *Surfside 37*, without any additional irrigation, water was added to each plot of turf to bring the volumetric water content of each plot up to 15%. The untreated turf required an additional 623 gal. / 1000 ft.^{2} than the turf treated with either rate of *Surfside 37*.

Eighteen days after the application of *Surfside 37*, or seven days since the turf had been irrigated, water was again added to each plot until the volumetric water content of each plot was brought up to 15%. This time, the untreated turf required an additional 312 gal. / 1000 ft.^{2} than the turf treated with either rate of *Surfside 37.*

Twenty seven days after the application of *Surfside 37* or nine days since the last irrigation, water was once again added until each plot had a volumetric water content of 15%. This time, the results varied. Both the untreated plot and the plot treated with 16 oz. *Surfside 37* / 1000 ft.^{2} required an additional 312 gal. / 1000 ft.^{2} compared to the plot treated with 32 oz. *Surfside 37* / 1000 ft.^{2}. However, the plot treated with 32 oz. *Surfside 37* / 1000 ft.^{2} did display slight discoloration compared to the other plots, but that dissipated after 10 days. There was no drop in turf quality in any of the plots.

In summary, this shows that in a dry environment without precipitation, *Surfside 37* performs best when initially applied at a rate of 16 oz. *Surfside 37* / 1000 ft.^{2} in 2 gal. water / 1000 ft.^{2} It also shows that, if applied at this rate, *Surfside 37* can save up to 935 gal. water / 1000 ft.^{2} in just the first eighteen days after the initial application.

SEE ATTACHED RESEARCH ARTICLE

IRRIGATION EFFICIENCY AS AFFECTED BY SURFSIDE 37 WETTING AGENT

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INTRODUCTION

Water repellent soils have been observed for many years in grasslands (1) forests (2) and citrus groves (3). They have become an increasing problem on golf greens since 1960, when the United States Golf Association recommended that golf green topsoil mix should contain at least 90% sand (24). Symptoms of these water repellent soils begin as small irregular shaped areas of drought-stressed turfgrass known as localized dry spots (4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,20,21,23). If left untreated these areas can increase in size and become excessively dry. Large areas of turfgrass can be severely damaged. Research has shown that the sand particles in the localized dry spots are covered with an organic coating, which renders them water repellent (4,5,6,7,8,9,10,11, 12,13,14,15,16,17,18,19,20,21,23,26). The problem is most evident during late spring, summer and early fall.

Currently, hand-watering, syringing, coring and the use of wetting agents are the best methods for controlling localized dry spots (4,5,6,7,8,9,10,11,12,13,14,15,16,20, 21,23,26) caused by water repellent soils. It is generally known that wetting agents can increase water infiltration into water-repellent soils. However, little research has been conducted on the effects of wetting agents on irrigation efficiency in golf green situations. Therefore, the objective of this research was to determine the effects of Surfside 37 wetting agent on irrigation efficiency.

MATERIALS AND METHODS

The field experiment was initiated June 6, 2005 on the University of Georgia Experimental Golf Green that was built in 1996 to USGA specifications with a topsoil mix consisting of 85% sand and 15% peat (24). The green consists of 325.2 square meters (3500 ft.^{2}) of 'Penncross' creeping bentgrass (*Agrostis stoloniferous* var. *palustris*). The green was mowed at 0.64 cm (0.25 inch) and irrigated as needed with 0.95 cm (0.375 inch) of water when sufficient rainfall did not occur. Regular maintenance practices (fertilizer and pesticide applications) were performed as needed. Daily temperature and rainfall were recorded for the duration of the experiment.

Treatments were applied to 0.61 X 0.61 meter (2 X 2 ft.) plots with a CO_2 backpack sprayer. Immediately after application, treatments were irrigated into the soil with 1.3 cm (0.5 inch) of water. The following treatments were applied:

1. Surfside 37: 50.9 l/ha (16 oz./1000 ft.^{2}) in 814.9 liters of water/ha (2.0 gallons/1000 ft.^{2}) applied on 6/6/05.
2. Surfside 37: 101.8 l/ha (32 oz./1000 ft.^{2}) in 814.9 liters of water/ha (2.0 gallons/1000 ft.^{2}) applied on 6/6/05.
3. Control.

Visual turfgrass color (1 to 9, 1 = brown, dead turf and 9 = dark green, healthy turf) and quality (1 to 9, 1 = very poor quality and 9 = excellent quality) ratings were taken on 6/6/05 (before treatment application), 6/7/05, 6/9/05, 6/17/05, 6/24/05 and 7/3/05.

Soil water repellency was determined by the molarity of ethanol droplet test (MED) on 6/6/05 (before treatment application), 6/17/05, 6/24/05 and 7/3/05 (25). Soil samples were taken with a 0.64 cm (0.25 inch) soil probe to a depth of 5 cm (2.0 in.).

Five soil samples were taken from each plot and combined into one bulk sample per plot. Samples were dried for 24 hours in an oven at 35 C (95 F). After drying, samples were removed from the oven and allowed to equilibrate to room temperature [21.1 - 23.9 C (70 - 75 F)] and humidity (60 - 65%). Samples were sieved through a 2 mm (#10 United States Standard Series) mesh screen and the MED test was performed on the sieved, dried soil.

The soil was placed in a 5 cm (2.0 in.) diameter X 1 cm (0.39 in.) deep dish to provide a uniform surface and depth. A series of 40 uL aqueous ethanol droplets at 0.4 M intervals were placed on the soil surface. The molarity of the droplet that completely infiltrated within 5 seconds was recorded as the soil MED value (0 = non-water repellent, 4 = extremely water repellent)

To determine irrigation efficiency, plots were protected from rainfall and irrigation with a fiberglass cover and allowed to dry out. When soil volumetric water content (VWC) reached approximately 5%, water was applied in 1.3 cm (0.5 inch) increments and VWC was determined after each irrigation application. When VWC reached approximately 15%, irrigation was terminated. Irrigation efficiency was determined by calculating the amount of water needed to raise VWC to approximately 15%. After irrigation, plots were allowed to dry out again and the process was repeated. Irrigation efficiency was determined on 6/17/05, 6/24/05 and 7/3/05.

VWC was determined by time-domain reflectometry (TDR) (22). A single pair of stainless steel rods was inserted into the soil at a parallel distance of 1.9 cm (0.75 inch). The rods were 5.1 cm (2.0 inches) in length and had a diameter of 0.32 cm (0.13 inch). Soil electromagnetic capacitance was determined by pulsing a wave down the soil probes with a Trime-FM (Mesa Systems Co., Framingham, MA). The Trime-FM monitored the reflectance pattern and converted the readings into VWC (% volume/volume). The VWC readings were recorded from the LCD data screen on the Trime-FM. Four VWC readings were taken per plot. Experimental design was a randomized complete block with four replications per treatment. Data were subjected to analysis of variance (ANOVA) procedures with treatment means separated by Duncan's Multiple Range Test at the 0.05 level of probability.

RESULTS AND DISCUSSION

Turfgrass Color And Quality

No differences in turfgrass color or quality were observed among the treatments and control before treatment application (Tables 1 and 2). On 6/6/05 experimental plots had an average turfgrass color and quality rating of 8.2 and 8.5 respectively (Tables 1 and 2). Turfgrass color ratings of the Surfside 37 (101.8 l/ha) treatment were lower than the color ratings of the control, but not different than the color ratings of the Surfside 37 (50.9 l/ha) treatment on 6/7/05 and 6/9/05 (Tables 1 and 2). However, no differences in turfgrass quality were observed among the treatments and control on these dates.

No differences in turfgrass color or quality were observed among the treatments and control on 6/17/05 and 6/24/05 (Tables 1 and 2). Turfgrass color and quality of the control plots was lower than the color and quality of the Surfside 37 (50.9 l/ha) and Surfside 37 (101.8 l/ha) treated plots on 7/3/05 (Tables 1 and 2). Therefore, under the conditions of this study the data indicate that Surfside 37 (101.8 l/ha) can cause a reduction in turfgrass color during the first few days after application. However, the discoloration was not severe and dissipated within 10 days. The Surfside treatments did not cause a reduction in turfgrass quality. As the experiment progressed, turfgrass color and quality of the control plots decreased, while the Surfside 37 treated plots maintained good color and quality. On the final observation date turfgrass color and quality ratings of the control were lower than the Surfside 37 treated plots (Tables 1 and 2).

Soil Water Repellency

Moderately high soil water repellency (MED 2.4 to 2.5) was observed for all plots before initial treatment application on 6/6/05 (Table 3). Compared to the control, a reduction in soil water repellency was observed on the Surfside 37 (50.9 l/ha) and Surfside 37 (101.8 l/ha) treated plots on 6/17/05 and 6/24/05 (Table 3). No difference in soil water repellency was observed between the Surfside 37 (50.9 l/ha) and Surfside 37 (101.8 l/ha) treated plots on 6/17/05 and 6/24/05 (Table 3). Soil water repellency of the Surfside 37 (101.8 l/ha) treated plots was lower than the soil water repellency of the control plots and the Surfside 37 (50.9 l/ha) treated plots on 7/3/05. Therefore, under the conditions of this study, the data indicate that Surfside 37 (101.8 l/ha) reduced soil water repellency for at least 27 days. Surfside 37 (50.9 l/ha) reduced soil water repellency for at least 18 days, but less than 27 days.

Irrigation Efficiency

Initial Irrigation

No differences in VWC were observed among the treatments and the control before the initial irrigation on 6/17/05 (Table 4). Experimental plots had an average VWC of 5.0%. After 1.3 cm (0.5 inch) of water had been applied, the VWC of both Surfside 37 treatments was significantly higher than the VWC of the untreated control plots (Table 4). VWC of the Surfside 37 (50.9 l/ha) treated plots was 16.5% after 1.3 cm (0.5 inch) of water had been applied. VWC of the Surfside 37 (101.8 l/ha) treated plots was 16.0% after 1.3 cm (0.5 inch) of water had been applied. Therefore, irrigation of the treated plots was terminated. After 2.5 cm (1.0 inch) of water had been applied to the control plots, the VWC was significantly less than the VWC of the Surfside 37 (50.9 l/ha) and Surfside 37 (101.8 l/ha) treated plots after 1.3 cm (0.5 inch) had been applied. VWC of the control plots was not different than the treated plots after 3.8 cm (1.5 inch) of water had been applied (Table 4). Therefore, the data indicate that an additional 2.5 cm (1 inch) of water had to be applied to the control plots before the VWC was comparable to the VWC of the Surfside 37 (50.9 l/ha) and Surfside 37 (101.8 l/ha) treated plots.

Second Irrigation

No differences in VWC were observed among the treatments and the control before the second irrigation on 6/24/05 (Table 5). Experimental plots had an average VWC of 4.9%. After 1.3 cm (0.5 inch) of water had been applied, the VWC of both

Surfside 37 treatments was significantly higher than the VWC of the untreated control plots (Table 5). VWC of the Surfside 37 (50.9 l/ha) treated plots was 15.6% after 1.3 cm (0.5 inch) of water had been applied. VWC of the Surfside 37 (101.8 l/ha) treated plots was 16.5% after 1.3 cm (0.5 inch) of water had been applied. Therefore, irrigation of the treated plots was terminated. VWC of the control plots was not different than the treated plots after 2.5 cm (1.0 inch) of water had been applied (Table 5). Therefore, the data indicate that an additional 1.3 cm (0.5 inch) of water had to be applied to the control plots before the VWC was comparable to the VWC of the Surfside 37 (50.9 l/ha) and Surfside 37 (101.8 l/ha) treated plots.

Third Irrigation

No differences in VWC were observed among the treatments and the control before the initial irrigation on 7/3/05 (Table 6). Experimental plots had an average VWC of 5.1%. After 1.3 cm (0.5 inch) of water had been applied, the VWC of the Surfside 37 (101.8 l/ha) treated plots was significantly higher than the VWC of the Surfside 37 (50.9 l/ha) treated plots and the untreated control plots (Table 6). No difference in VWC was observed between the Surfside 37 (50.9 l/ha) treated plots and the untreated control plots (Table 6). VWC of the Surfside 37 (101.8 l/ha) was 16.3% after 1.3 cm (0.5 inch) of water had been applied. Therefore, irrigation of the Surfside 37 (101.8 l/ha) treated plots was terminated.

VWC of the Surfside 37 (50.9 l/ha) treated plots and the control plots was not different than the Surfside 37 (101.8 l/ha) treated plots after 2.5 cm (1.0 inch) of water had been applied (Table 6). The data indicate that an additional 1.3 cm (0.5 inch) of water had to be applied to the Surfside 37 (50.9 l/ha) treated plots and the control plots before the VWC was comparable to the VWC of the Surfside 37 (101.8 l/ha) treated plots. Therefore, the results of the third irrigation indicate that the effectiveness of one application of Surfside 37 (50.9 l/ha) on irrigation efficiency is at least 18 days, but less than 27 days. Whereas, the effectiveness of one application of Surfside 37 (101.8 l/ha) is at least 27 days.

SUMMARY

Under the conditions of this study, the data indicate that Surfside 37 applied at a rate of 101.8 l/ha (32 oz./1000 $ft.^2$) can decrease turfgrass color. However, the discoloration was not severe and dissipated within 10 days. Neither Surfside treatment caused a reduction in turfgrass quality. Turfgrass color and quality ratings of the Surfside 37 treatments was greater than the color and quality ratings of the control 27 days after application.

The data also indicate that Surfside 37 can decrease soil water repellency and increase irrigation efficiency. Results of this study demonstrate that untreated turfgrass requires 2 to 3 times as much irrigation water to reach a comparable VWC of Surfside 37 treated turfgrass. The data also indicate that one application of Surfside 37 (50.9 l/ha) can decrease soil water repellency and increase irrigation efficiency for at least 18 days, but less than 27 days. In contrast, one application of Surfside 37 (101.8 l/ha) can decrease soil water repellency and increase irrigation efficiency for at least 27 days.

However, it must be kept in mind that in golf course situations the soil may not be allowed to dry to the extent it was in this experiment. Previous research has shown the ability of water to infiltrate water repellent soil decreases as VWC of the soil decreases. Since turfgrass may rapidly wilt if the soil was allowed to dry to a VWC of 4 to 5%, golf greens may or may not be allowed to dry to that extent. Therefore, in most golf course situations, Surfside 37 treated turfgrass would most likely require less irrigation, however the amount of water needed to raise VWC of non-treated soil to a level comparable to the VWC of Surfside 37 treated soil may not be as pronounced as demonstrated in this experiment.