Systems approach to *Poa annua* control on putting greens

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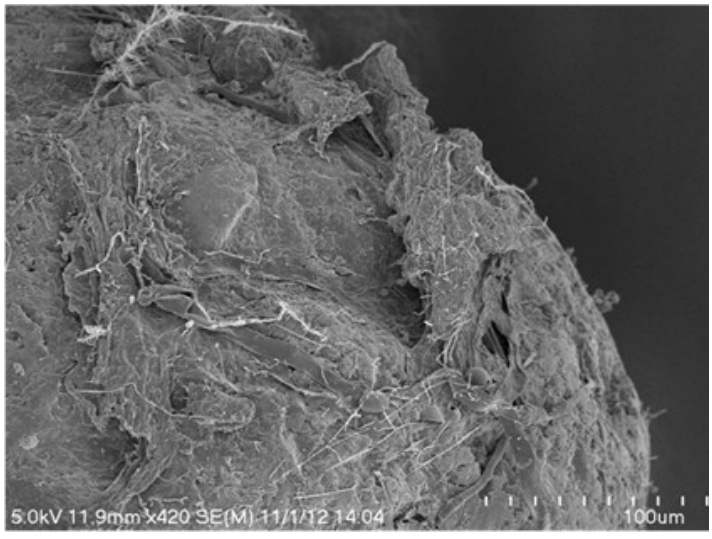
Objectives:

The overall goal of this project is to evaluate various wetting agent compounds for the purpose of removing and/or dissolving organic coatings from hydrophobic sand surface on creeping bentgrass putting greens.

Soil water repellency, responsible for localized dry spot (LDS), is a common problem for intensively managed turf, especially on sand-based growing media such as USGA greens. The cause of soil hydrophobicity is the formation of organic coatings on the surface of sand particles, which builds up over time during the decomposition of organic matter in the soil. Wetting agents contain both hydrophobic and hydrophilic groups, and are the primary management tool for superintendents for the treatment of soil water repellency. However, many questions remain unanswered. One question especially drew our interest: Can certain wetting agents remove organic coatings from water-repellent sand particles as claimed?

Early in 2014, a preliminary laboratory study was conducted to evaluate wetting agents that claimed removal of organic coatings from hydrophobic sand. Several commercialized wetting agents were also selected for testing relative to their dissolved organic carbon (DOC) level in the solutions at the labeled rates (Figure 1, next page). Our results found significant DOC differences among wetting agents tested. After determining the amount of DOC in the wetting agent solutions, 2 grams of natural hydrophobic sand (water

Electron microscopy images of hydrophobic sand (left) and a sand grain after a 24 h incubation in solution with pH=3 (right). Note the layers of organic coating on the sand grain in the left panel, and the relatively clean surface on the sand grain in the right panel.



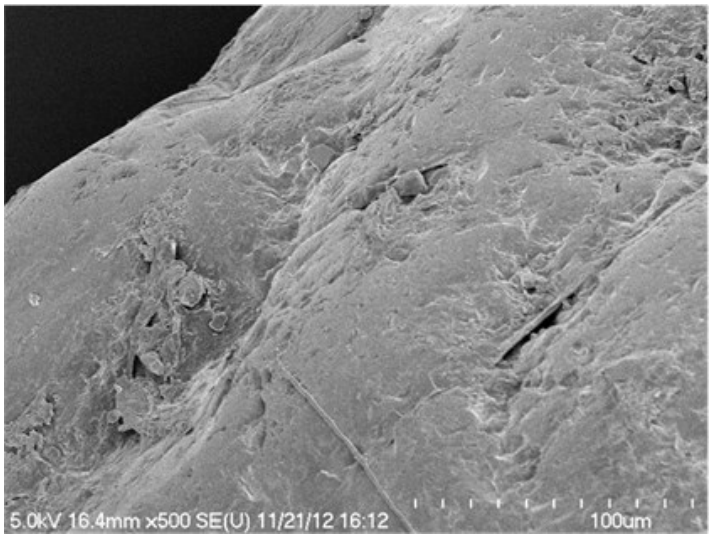


Table 1. Description of products, application rates, and concentrations.

TRT #	Treatments	Concentrations (product volume/ water volume)	Highest label rates
1	pH Acid	15.64 ml/L	2 oz in 1 gallon of water
2	OARS	27.37 ml/L	7 oz in 2 gallons of water
3	Matador	46.92 ml/L	6 oz in 1 gallon of water
4	Water	0	0

droplet penetration test yielded more than 2,500 s) collected from a 7 years old putting green was incubated in each solution for 24 hours. The same amount of artificial hydrophobic sand made by coating with octadecylamine, was also included in this study for a comparison. DOC concentrations in the incubated wetting agent solutions were analyzed, and results indicated a significant difference for wetting agents in reacting with artificial or natural hydrophobic sand (Figure 2). Analysis of DOC also found certain wetting agents, such as pH Acid, showed significant amount of DOC gaining after incubating natural hydrophobic sand (Figure 2). The inability of pH Acid for removing of organic carbon from the artificial sand likely indicates different chemistry compared to natural hydrophobic sand, which further confirms the necessary of utilizing natural hydrophobic sand for such studies.

The next laboratory study we conducted was utilizing the infiltration system demonstrated in Figure 3 below in order to simulate the field conditions where wetting agent solutions are infiltrated into the rootzone soil. The soil columns were built using PVC tubes with 5-cm internal diameter and 0.4 cm thickness, with the bottoms covered with a layer of fine fabric cloth to hold the sand but permit liquid penetration. In order to ensure the uniformity of the natural hydrophobic sand we used in this study, sand from the LDS area on a 7 years old green was collected and air dried. The sand was then screened with a

Figure 1. Dissolved organic carbon concentration (mg/L) in various wetting agent solutions at label rates (n=3).

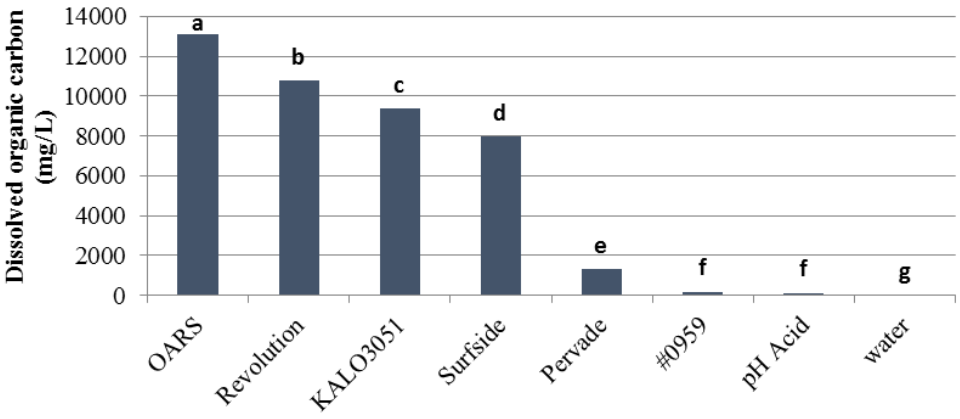


Figure 2. Dissolved organic carbon changes after incubating 2 grams of natural or artificial made hydrophobic sand (n=3) in representative wetting agents.

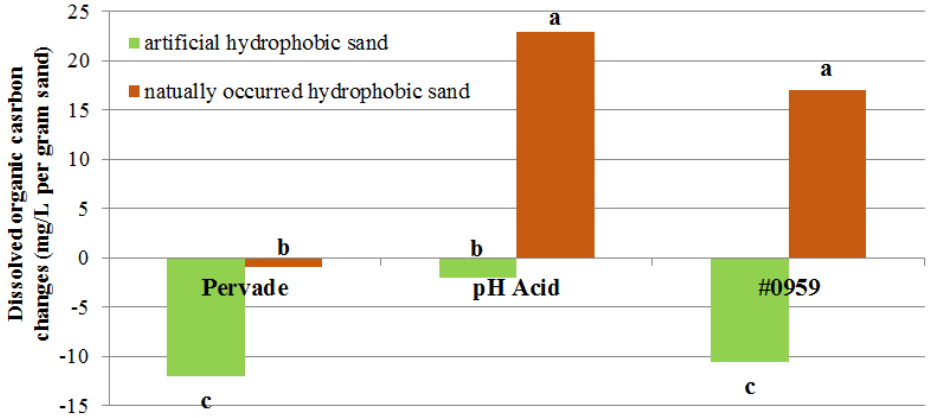
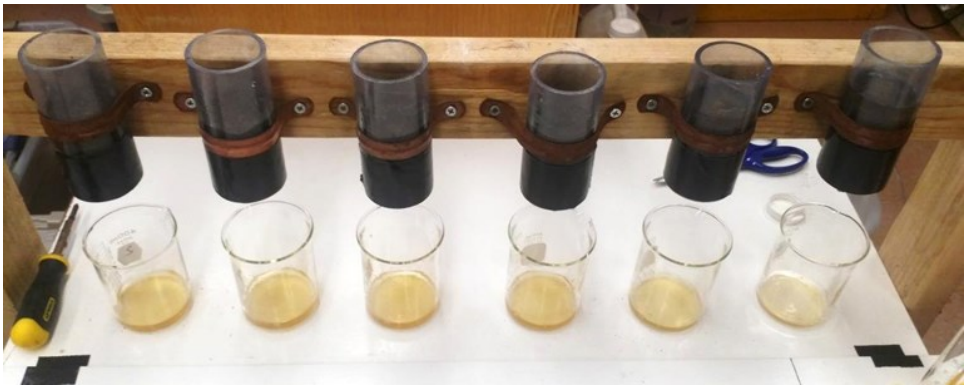


Figure 3. Infiltration and leachate collection system.



series of sieves with opening sizes of 2, 1, 0.5, 0.25, and 0.1 mm to remove plant residues before a thorough mixture for future use.

A total of 254 g of the processed natural hydrophobic sand was packed uniformly for 7.62 cm depth in the sand column described above, which resulted in a bulk density of 1.64 g/cm3. The hydrophobicity was determined as moderately to strongly hydrophobic (120 to 300 seconds) by water droplet penetration test (WDPT). Particle density of the sand was measured as 2.6 g/cm3, and the pore volume (saturation water content) was determined as 57ml (36.9% porosity). To saturate the soil profile, 70ml of each treatment (Table 1) was carefully applied to the top of the soil column. The columns were then drained under gravity, and the leachates were collected for volume and DOC determination. After 24 hours, treated columns were applied with water three times repeatedly, in order to wash the residue solution through the soil profile. The amount of water applied is consistent with the pore volume at 57 ml for each wash, and each wash was separated by 30 minutes to allow the solutions to leach out of the soil columns. Leachate of each wash cycle was collected for DOC analysis and volume measurement. This experiment was replicated 3 times for each wetting agent and the experiment was repeated once.

Currently, other wetting agent treatments are still under analysis, with only results from pH Acid treatment available for this report. Results showed that the DOC concentration in the leachate decreased following the repeated wash (Figure 4). The DOC concentration yielded in the first wash was approximately 2.5 times higher than the DOC in the second wash. Although the DOC centration further decreased, the third wash still yielded a DOC at 200 mg/L DOC in the leachate. Subsequently, the three washes into the pH Acid treated sand columns showed approximately 400% organic carbon gaining (Figure 5). This is equivalent to more than 80 mg of DOC that was removed.

However, it is unclear whether the DOC removed from pH Acid treated sand is totally attributed to the interaction with wetting agent molecules. A water-only treatment is currently in process to answer this question.

Figure 4. Dissolved organic carbon (DOC) concentration in leachates from three washes. Means (n=6) labeled by different letters above the bars are significantly different by Fisher's protected LSD (P=0.05).

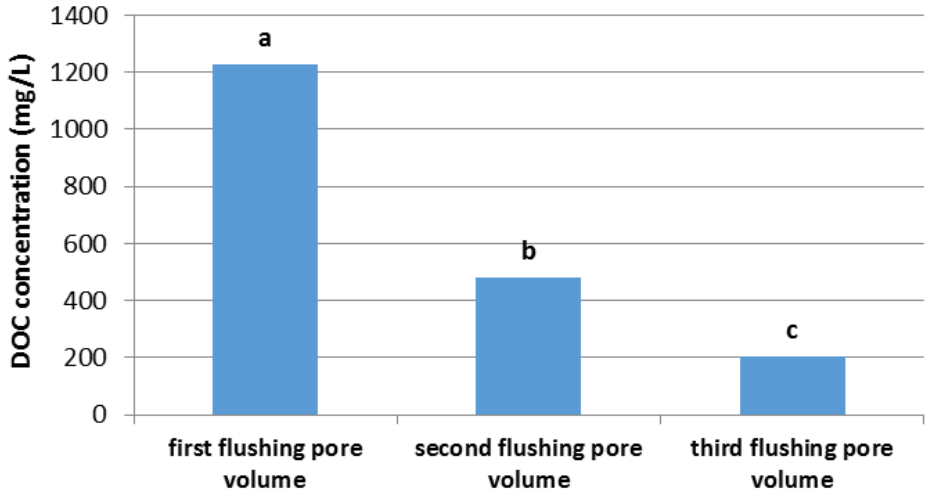
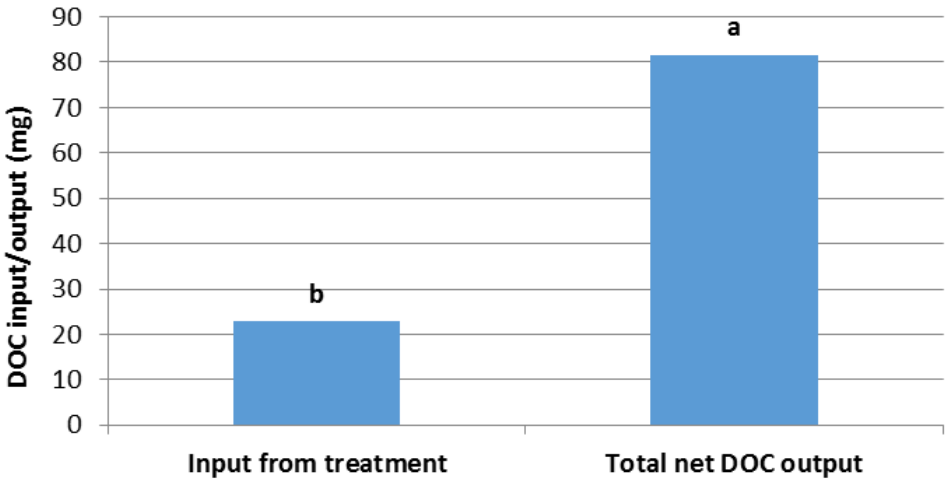


Figure 5. Amount of dissolved organic carbon (DOC) input from pH Acid solution, and the total DOC output yield in three washes after pH Acid treatment. Means (n=6) labeled by different letters above the bars are significantly different by Fisher's protected LSD (P=0.05).



Summary

- Different wetting agents contain different levels of organic carbon.
- Artificially made hydrophobic sand is not an ideal experimental material for such a study likely due to different chemical compositions compared to the natural hydrophobic sand.
- Application of wetting agent, such as pH Acid, showed promise of removing DOC from the natural hydrophobic sand.
- Experiments with other wetting agent treatments are still ongoing, and the results will be updated when they become available.

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