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Is It True That Certain Wetting Agents Remove Organic Coatings from Water-Repellent Sand Particles?

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Objectives: To evaluate various wetting agents for effects of removing organic coatings from hydrophobic sand surface.

Soil hydrophobicity is caused by the accumulation of organic coatings on the surface of soil particles. On sand-based putting greens, hydrophobic soil repels water, and consequently leads to localized dry spot (LDS) development. Wetting agent, amphiphilic molecules function as a “bridge” between the hydrophobic sand surface and water molecules, is the primary tool superintendents use to battle with LDS. There are a few wetting agents in the turf market, however, acclaim the property of removing organic coatings from the sand surface, and potentially solve the problem of hydrophobicity.

Results from the previous year’s laboratory experiment showed that Matador and OARS were able to reduce the hydrophobicity of sand to minimal level after one-time application following three washes. This was confirmed by removal of dissolved organic carbons in the leachate. Results from field experiment in 2015 also corroborated this effect. In 2016, we continued our field and laboratory experiments to gain a better understanding towards this group of wetting agents.

In 2016, the second year field experiment was carried out on a USGA green where LDS has been historically observed (Fig 1). Treatments, including Matador, OARS, and pHAcid, in addition to Hydro-Wet, Tournament-Ready, and Cascade Plus, were applied monthly (from May to September), to plots arranged as a RCBD with 4 replications. Hydrophobicity, measured as molarity of ethanol droplet (MED) test at 0-5 months after the initial treatment application (MAIT) showed reduced hydrophobicity following applications of all wetting agents to various extents, with the only exception of pHAcid (Table 1). No differences were found between plots treated with OARS or Matador for MED over the 5 months period. During the experiment, dollar spot (*Sclerotinia homoeocarpa* F.T. Benn.) was observed in the plot area, and plots received pHAcid, Matador and Cascade Plus showed 5-8 times greater dollar spot incidence compared to the untreated control at 5 weeks after the initial treatment (WAIT) (Table 2). The higher water content found in plots received pHAcid, Matador and Cascade Plus (Fig 2) likely contributed to the greater dollar spot incidence observed. Turf quality, measured by normalized difference vegetation index (NDVI), also showed that plots received these three wetting agents maintained greater overall turf quality compared to control and other wetting agents (Fig 3), likely attributed to the greater soil moistures they maintained.

In the laboratory, we utilized the same sand-column systems containing naturally occurred hydrophobic sand explained in previous report. The objective in 2016 laboratory experiment was to evaluate the influence of repeat wetting agents application which simulates field practices where monthly applications were typically performed. Similar to the experiment conducted in 2015, hydrophobic sand collected from the field were homogenized before packed uniformly to the same bulk density (1.66 g/cm^3). Wetting agents, at a higher volume (70 ml) than the pore volume (58ml), were applied, before three washes using water at pore volume 24h after wetting agent application. All leachates were collected for determining volume, dissolved (DOC) and particulate organic carbon (POC), and sand columns were dissembled for hydrophobicity test after oven dried to constant weight at 50 ^oC at the end of the experiment. Treatments were arranged in a CRD with 3 replications, and the entire experiment was repeated.

Compared to untreated sand, sand columns treated with water resulted in a 50% increase in hydrophobicity (Fig 4), likely due to the changes in orientation of the organic coatings during the dry-wet cycle. Application of Matador, despite the number of applications, reduced hydrophobicity to none. OARS treated sand columns, however, showed minimal hydrophobicity following one-time application, but approximately doubled the hydrophobicity following 3-time applications. It is yet to be determined the underline mechanism that explains this desperation between Matador and OARS; nevertheless, it is likely related to how the organic coatings on hydrophobic sand been removed and/or replaced. We are currently in the process of analyzing DOC and POC results for possible answers for this question. It is also worthy to note that repeat application of OARS under field conditions did not negatively impact soil hydrophobicity and hence turf quality. This is likely due to the differences in the amount of organic carbon introduced through treatment under field and laboratory conditions, and also likely related to the microbe activity under field conditions which was absent in the laboratory experiments. Analysis is undergoing for determining the possible influences of these factors.

Summary

- Under field conditions, both Matador and OARS applied monthly reduced soil hydrophobicity, compared to the untreated controls.
- Laboratory experiment revealed that the mechanism of these two wetting agents in organic coating removal/replacing could be different.
- Analysis that are still ongoing include DOC and POC for laboratory experiment, PLFA for microbial analysis from field plots, and sand particle analysis by Scanning Electron Microscope for both field and laboratory experiments.

Table 1. Treatment effect on soil hydrophobicity measured by molarity of ethanol droplet test (MED; molar) at 1 inch soil depth from 0 to 5 months (May to October, respectively) after initial treatment application (MAIT) in 2016.

Compound	0 MAIT	1 MAIT	2 MAIT	3 MAIT	4 MAIT	5 MAIT
	------------------------------MED (molar) --------------------------------					
Control	2.63 a2†	3.33 a1	3.18 a1	3.08 a1	3.03 a1	3.05 a1
pHAcid	2.53 ab2	3.13 a1	2.95 ab1	2.85 a1	3.00 a1	3.03 a1
Hydro-Wet	2.43 ab12	2.50 b12	2.63 cd1	2.30 bc2	2.23 b23	1.95 c3
Tournament Ready	2.40 ab1	2.53 b1	2.55 cd1	2.40 b1	2.45 b1	2.35 b1
OARS	2.28 b2	2.63 b1	2.68 bc1	2.25 bc2	2.25 b2	2.13 bc2
Matador	2.45 ab12	2.65 b1	2.53 cd1	2.05 c3	2.45 b12	2.18 bc23
Cascade Plus	2.50 ab12	2.60 b1	2.35 d123	2.23 bc23	2.43 b123	2.13 bc3

†Means followed by the same letters in each column were not significantly different based on Fisher’s protected LSD at $P<0.05$; Means followed by the same numbers in each row were not significantly different based on Fisher’s protected LSD at $P<0.05$.

Table 2. Treatment effect on percent disease cover (%) evaluated at 1, 5, 9, 13, and 17 weeks after the initial treatment application (WAIT) in 2016.

Compound	1 WAIT	5 WAIT	9 WAIT	13 WAIT	17 WAIT
	------------------------------------% disease ------------------------------------				
Control	1.0 a23	0.8 b23	0.0 a3	4.0 a1	0.8 ab23
pHAcid	1.0 a5	4.5 a23	0.8 a5	8.0 a1	1.0 ab5
Hydro-Wet	0.3 a23	1.3 b23	0.0 a3	4.0 a1	0.0 b3
Tournament Ready	0.8 a34	0.8 b34	0.0 a4	5.8 a1	1.0 ab34
OARS	1.3 a34	6.5 a1	0.8 a34	6.8 a1	2.0 ab234
Matador	0.5 a34	1.5 b34	0.8 a34	7.0 a1	2.8 a23
Cascade Plus	1.3 a34	5.0 a12	0.3 a4	7.3 a1	0.8 ab4

†Means followed by the same letters in each column were not significantly different based on Fisher’s protected LSD at $P<0.05$; Means followed by the same numbers in each row were not significantly different based on Fisher’s protected LSD at $P<0.05$.

Fig 1. Field plots overall view. Picture were taken at 7 weeks after the initial treatment application (WAIT) on July 11, 2016.

Fig 2. Volumetric water content (VWC; %) influenced by wetting agents applied. Data were collected every other week from 1 to 19 weeks after the initial treatment application (WAIT). There were no wetting agent by evaluation timing interaction; hence, wetting agent main effect was presented. Bars labeled with the same letters were not significantly different based on Fisher's Protected LSD (*P*<0.05).

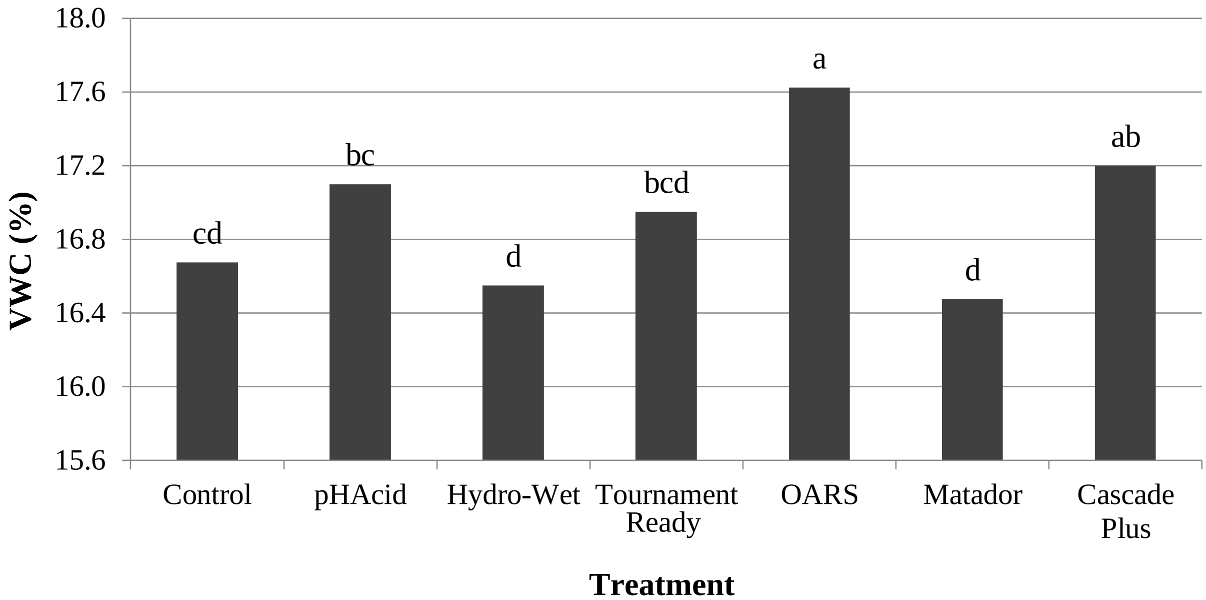

Fig 3. Normalized difference vegetation index (NDVI) influenced by wetting agents applied. Data were collected every other week from 1 to 19 weeks after the initial treatment application (WAIT). There were no wetting agent by evaluation timing interaction; hence, wetting agent main effect was presented. Bars labeled with the same letters were not significantly different based on Fisher's Protected LSD (*P*<0.05).

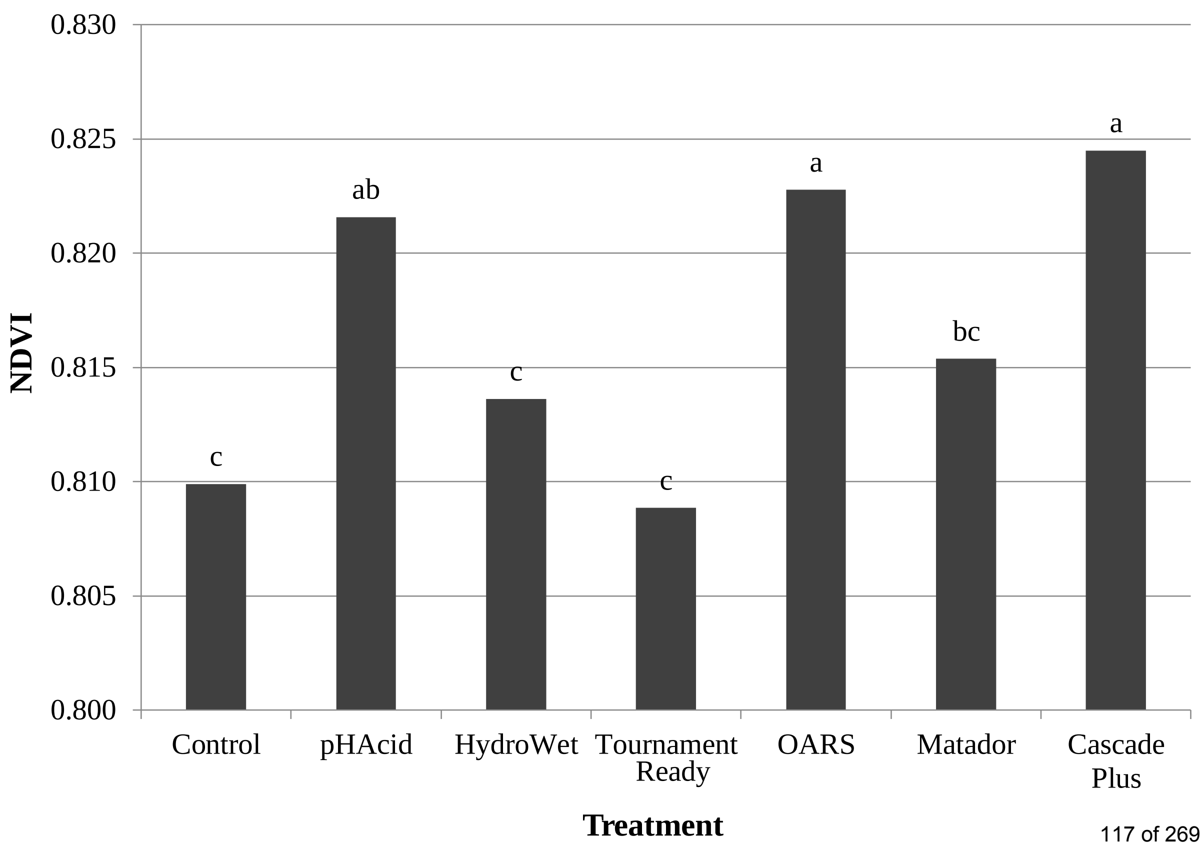

Fig 4. Soil hydrophobicity influenced by wetting agents that were applied to sand columns in the laboratory. Hydrophobicity was determined by using molarity of ethanol droplet (MED; molar) test after 1 or 3 times wetting agent applications (1 or 3 app, respectively), compared to sand columns received no or water only treatment. Bars labeled with the same letters were not significantly different based on Fisher's Protected LSD (*P*<0.05).