

THE EVOLUTION OF SOIL WETTING

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Wetting agents, also known as, soil surfactants or wetters, are getting increased exposure. With efficient water use and conservation being goals for both environmental stewardship and sustainability, the effect of wetting agents on water delivery to soils and overall water needs is being considered beyond Dry Patch management. A look at the evolution of these turf management tools may lend some perspective and the opportunity to understand some good, “bad”, and practical news about these widely used, yet still vaguely understood, materials.



In A Nut Shell

Invented in the mid-1950's soil wetting agents/soil surfactants have gone from a single, purpose formulated product and some detergents to well over 50 products developed specifically for turf management.

There are significant differences in the chemical structures and performance of many of today's soil surfactants; and there are a variety of effective products to choose from which will be more or less effective in different situations.

The good news is that there are more legitimate soil wetting agents/soil surfactants on the market than ever before. The “bad” news is that no single test can tell you which product is “the best” for you. Turf managers are best served by reviewing their particular needs and the objective information on available products, followed by evaluation and choice of what best suits their situation.

The Originals

To better understand the variety of products available – a review of their “evolution” may be useful. AquaGro (Aquatrols), the original patented soil wetting agent, was a blend of nonionic surfactants including an alkylphenol ethoxylate (APE) and a fatty acid polyglycol. Between the mid-1950's and early-1970's few other effective and safe products were available.

In the 1960's Dr John Letey, at UCLA-Riverside, tested two products on very hydrophobic soils. These materials were Aqua-Gro (a mid molecular weight surfactant blend) and Soil Penetrant (a low molecular weight surfactant). The two products performed very differently. Aqua-Gro wet more slowly and was highly adsorbed on the soil particles. Soil Penetrant wet faster and deeper and was not readily adsorbed on the soil particles. Differences in plant safety were also recorded with Soil Penetrant being more phytotoxic than Aqua-Gro on the plant material tested.

Other research in the 1960's was conducted by Drs J. Boodley and R. Shelldrake, at Cornell University, looking at surfactants for better

wetting of peat-based horticultural substrates. They found that, even within the non-ionic group of surfactants which were by then considered to be safest for use with plants, there were differences in wetting efficacy and plant safety.

The first controlled research specifically for use in turf management was conducted in the early 1970s by Drs J. Beard and P. Rieke, at Michigan State University. They evaluated the effect of several products on water repellency and dry patch on golf courses. Of the 10 or so products tested, only AquaGro and HydroWet were effective in combating dry patch. Both products contained an APE as an ingredient.

While APEs were not the only surfactant ingredient used in soil wetting agents, they and a particular one - nonylphenol ethoxylate (NPE) - were the most widely used ingredients in the effective products available through the end of the 1980s.

At sufficiently high rates, NPEs are effective for wetting water repellent materials. Because these compounds adsorb tightly onto soils, they also provide some residual effectiveness. NPE effectiveness, and how long they last, depends greatly on the rate of active ingredient applied per area and the soil environmental conditions. Unfortunately, rates giving acceptable results were also quite phytotoxic if not sufficiently diluted or aggressively water in immediately following application. At today's conventional water spray volumes – NPE based materials are likely to burn most turf. To address this, some products have been packaged in diluted formulations, recommended at very low rates, or require application of large quantities of water with or directly after application. While this is effective for lowering toxicity – it also reduces efficacy.

Early Innovations

In addition to APE based materials available to turf managers, other surfactant ingredients were also packaged for use on turf in the late 1970's and 1980's. One example is the anionic surfactant sodium lauryl sulfate found in shampoos. Other mixtures of APEs, anionics and nonionics also appeared. The amounts of active ingredient and water in different products varied dramatically. Many of these wetting agents, at fairly low rates, will increase water penetration into soils to some extent. However, by their chemical nature, most do not adsorb onto soil and therefore have little to no residual effect.

Other innovations in the early formulations included – injectable (granular formulations), “Pellets” for hose end application, and “Natural Products” such as the Yucca and seaweed extract materials. While the “natural products” are indeed less phytotoxic to turf, they show limited efficacy at improving wetting. An NPE is often added to the formulation to enhance performance. Most of these innovations continue today in certain product formulations.

A Step Beyond in the 90s

In addition to phytotoxicity concerns, in the early 1990s APEs also became suspect from an environmental safety standpoint. The concerns were potential for long-term accumulation in waterways and endocrine disrupting behaviour from some breakdown products. While adsorption and degradation in soils would likely mitigate these problems, some companies chose to look for more environmentally benign alternatives that were safer to turf and still effective as soil wetting agents. This combination of performance parameters was found in “block copolymer” surfactants.

The first block copolymer based product brought to market was HydroFlo followed soon by a differently structured block copolymer, Primer 604. Many other block copolymer based products followed. This ushered in an age of products that were effective against water repellency and could be applied in lower amounts of water with no need for immediate watering in to avoid turf injury. Most of the products introduced in the 1990s were block copolymers of one sort or another – whether injectable products, treatment or monthly program products, or “season long” products. The particular block copolymer chemistries vary, as do the suggested application rates, both contributing to differences in performance between products. This is similar to products in the pesticide field – where, although the broad class is the same, the performance of particular formulations varies.

Also making an appearance in the 1990’s were the organosilicone, “super spreading” surfactants. This chemistry is excellent at very low rates for extremely fast spreading and penetration of solutions – however applied at higher rates it can be extremely phytotoxic if not abundantly watered in. In addition the organosilicone chemistries are hydrolytically unstable and rapidly degrade as pH drops below 7. For these reasons – this chemistry has not been widely used to manage soil water repellency. However, it remains an excellent spray adjuvant material.

Many factors contributed to the increase in products during this period. Increased use of wetting agents by turf managers resulted in companies recognizing a business opportunity for effective products. More research substantiating efficacy of some soil surfactants increased use as well. Distributor organisations with their own brands wanted their own wetting agent too. And with the original patent on AquaGro expired, and no new patents applied for in turf, it was a wide open market. In this sense the wetting agent market was like a generic/post patent market.

As mentioned, there are many block copolymer surfactant products on the market today – however their performance varies because all block copolymers are not the same. There are straight blocks and reverse blocks with varying molecular weights and chain lengths. Depending on the formulation, they have different effects on how water disperses or is held. In addition, the “blocks” are also rate dependent, i.e. different rates will give different levels of effect. As has been seen by Dr Letey and colleagues in the 1960’s, Drs Beard & Rieke in the 1970’s, Dr Karnok in the 1980’s, and Dr J. Cisar, at the University of Florida, and others since the 1990’s, even within the same general class of surfactants there are variations in performance based upon formulation, use rate and environmental conditions.

Recent Innovations

Since 2000, there have been additional developments in soil wetting agent/surfactant technology, resulting in yet new performance options for turf managers. These developments have come from continued research by a few companies looking for improvements to existing block copolymer formulations and/or new and novel formulations with performance advantages to separate them from the pack.

Some developments have been simple but useful application changes, or program modifications. Others have involved formulation modification or the inclusion of additional. Still others have been novel enough to be eligible for patents – so there really is something new about them.

In the case of Dispatch, the patented technology involves combining certain block copolymer materials with another surfactant class – alkyl polyglucosides (APGs) – to create a synergistic effect which dramatically increases infiltration efficiency at very low application rates. In the case of OARS, a patented combination of an organic solvent and a surfactant complex is designed to remove accumulations of water repellent humic substances from soil surfaces. And in the case of Revolution, the new invention is constructing the block copolymer molecule with methyl caps which affects how the material orients itself on soil particles and influences water movement through the soil.

These newest formulations and the associated products take soil surfactants to a new level. While they have some familiar soil wetting agent performance characteristics, their novel formulations promise results that go beyond what has been achieved with previous products. From removing or overcoming the causes of problems in the case of OARS and Dispatch to allowing the rootzone to function hydrologically as intended in the case of Revolution, the new patented products offer a new level of control in managing the turf system. Time and use will show how real and important these new performance promises are. At this point, the information suggests that they are at least worth a try.

The Bottom Line – What to make of it all

There has been a tremendous amount of research and development on soil surfactants for turf management since their introduction in the 1950s. This article has attempted to shed some light on their evolution through the decades. All soil wetting agents/surfactants have some things in common – some impact on how water moves across or through soil. However that’s where the similarity stops. Different ingredients, different levels of active ingredients, and different application rates and frequencies make real differences in how these products perform in the real world.

So, the good news is that there are numerous soil surfactant products that are effective to some degree or another. The “bad” news is that there is no single clearly superior product for everyone. The practical news is that turf managers and advisors can evaluate needs and options on a case by case basis to determine which chemistries are likely to work best for them in accomplishing their goals.

To this end, turf managers can take a pragmatic approach.

First, assess the soil wettability and solute distribution needs at the particular location;

- **Then, consider which companies and products have a history and performance profiles with supporting data, user experience and technical backing that suggest they can address the needs.**
- **Finally, try those products on site to determine which one or several are the best fit – agronomically, economically and customer support wise.**

As with other product segments, the choices and capabilities of soil surfactants have evolved over time. What’s best for you depends on the needs you have, the results you want and the resources you choose to employ.

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