Effective and Simple Solutions to Soil and Water Management

TECHNOLOGY FOCUS:

Understanding Water Repellent Soils and the Use of Irrigation Additives

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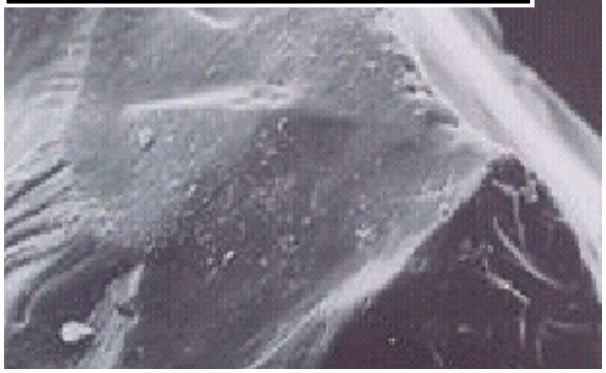
Understanding Water Repellent Soil and the Use of Irrigation Additives

- Highly productive, irrigated soils must be managed very carefully to mitigate and manage the problem of **hydrophobic soil conditions**. These problematic conditions result in soil particles that literally repel water.
- Research shows that hydrophobic soils develop from a biological process involving the natural decomposition of organic minerals such as those found in crop residue and other soil amendments, all resulting in a water repellent organic coating formation on sand and soil particles.
- These water repellent soil challenges are hastened under the circumstances of frequent wet-dry-wet cycles associated with intense irrigation. The development of this soil condition can also be accelerated by inefficient irrigation patterns, soil compaction, reduced tillage systems, and certain diseases.

Normal sand particle.

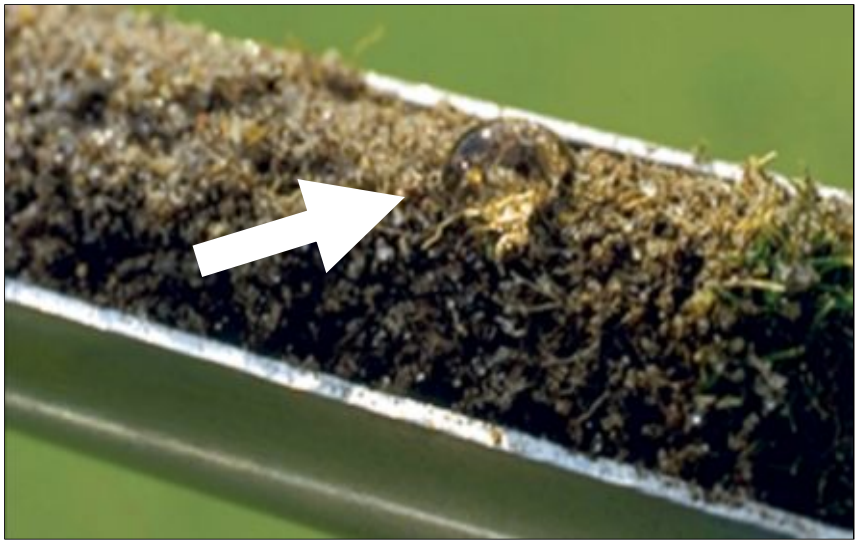


Water repellent sand particle.

How to manage the inevitable condition of soil water repellency?

- Over the past 50 years, there have been many technological advancements leading to the development of countless irrigation additives and soil treatments positioned for use in managing soil and water challenges.

- Hundreds claim to make water wetter, improve irrigation efficiency, increase the holding capacity of the soil, reduce runoff, etc…



Droplet of water placed on a water repellent soil sample.

- The use of these various products and additives provide a legitimate means of sound environmental stewardship for agricultural production. It is important to understand each technology and the difference between the available management options.

Understanding Water Repellent Soil and the Use of Irrigation Additives

- Most irrigation additive products involve some type of surfactant system. Surfactants are specialty chemicals that uniquely modify the physical and chemical characteristics of water and/or the materials where they are applied.
- Surfactant chemistry is used in nearly every aspect of our lives. Detergents, soaps, shampoos, medicines, and even food products all use some type of surfactant chemistry to improve and manage product performance.
- To be used as a legitimate irrigation additive in agricultural crop production, these products must be manufactured with ingredients that are **certified for this specific use in agricultural**.

When choosing an irrigation additive, be certain to validate with the manufacturer that the product is approved for use under...

40 CFR 180.910 (materials exempt and approved for use on growing crops and raw ag commodities)

or

40 CFR 180.920 (materials exempt and approved for use on growing crops only)

Understanding Water Repellent Soil and the Use of Irrigation Additives

- Different kinds of irrigation additives and soil wetters are approved for use as legitimate management tools for hydrophobic soil conditions and improved irrigation efficiency. However, it is important to understand the different types of chemistry and the expected performance of each surfactant.

- Generally all soil wetting and penetrating products on the market today can be organized into three primary groups of surfactant chemistry: Anionic Surfactants, Nonionic Surfactants, and block polymer Nonionic Surfactants.

The Irrigation Additive Market...

Three general types of soil commercial soil wetting chemistry:

- Anionic Surfactants
- Nonionic Surfactants
- Block Polymer Surfactants

General Overview of Surfactants Used as Irrigation Additives...

	Anionic Surfactants	Nonionic Surfactants	Block Polymer Surfactants
Primary Mode of Action	Water	Water	Water & Soil
Reduces Surface Tension	Excellent	Excellent	Good
Compatibility in Mixing	Poor	Good	Good
Crop & Plant Safety	Problematic	Good	Good
Hard Water Antagonism	Yes	None	None
Residual Performance	Limited	Limited	Excellent
Primary Use in Ag/Turf	Foam Marker	Spray Adjuvant	Soil Wetter

Understanding Water Repellent Soil and the Use of Irrigation Additives

The earliest wetting agents utilized for improvement of irrigation efficiency in agricultural and turf production were based on the conventional general purpose anionic surfactants.

Performance Strengths of Anionic Surfactants…

- Primary mode of action…treats the water by effectively reducing surface tension.
- Anionic electrostatic charge aids in temporary adsorption onto the soil particles, acting as an agglomeration aid for fine clay particles.

Performance Limitations of Anionic Surfactants…

- Degrade quickly in the soil solution and are antagonized by hard water minerals and deliver very limited residual control.
- Can be phytotoxic to sensitive plants under certain circumstance.
- Limited tank mix compatibility, preventing co-application with soil amendments and fertilizers.

Anionic Surfactants...

Typical Ingredient Statements:

Ammonium Lauryl Ether Sulfates

Sodium Lignosulfonates

Sodium Alkyl Sulfosuccinates

EXCELLENT FOR USE AS FOAM MARKERS AND SHAMPOOS

Understanding Water Repellent Soil and the Use of Irrigation Additives

Nonionic surfactants represent the most widely used type of surfactant chemistry in agricultural production. This chemistry is widely used in many spray adjuvant systems to aid in pesticidal spray performance.

Performance Strengths of Nonionic Surfactants…

- Primary mode of action…effectively reduce the surface tension of water improving infiltration.
- Wide range of compatibility and plant safety. The nonionic properties render the chemistry mostly non-reactive with most other materials.
- Readily available and generally less expensive.

Performance Limitations of Nonionic Surfactants…

- Very small, low molecular weight molecules that tend to deliver poor adsorption and retention properties in soil.
- Easily leached through the treatment zone and only provide a short term benefit.

Nonionic Surfactants… (Foliar Applied)

Typical Ingredient Statements:

Nonyl Phenol Ethoxylates

Alcohol Ethoxylates

Modified organosilicones and blends

EXCELLENT FOR USE AS SPRAY ADJUVANTS WITH PESTICIDES

Understanding Water Repellent Soil and the Use of Irrigation Additives

Because block polymer surfactants **treat the soil in addition to the water**, this class of chemistry represents a quantum improvement in the approach for wetting hydrophobic soils and the management of intensely irrigated agricultural and turf production systems.

Performance Strengths of Block Polymer Surfactants…

- Primary mode of action treats the soil by adsorbing strongly onto soil particles and improves wetting characteristics of treated water.
- Residual control with good rewetting performance and long lasting effect.
- Good compatibility with crop safety and can be used effectively in a wide range of application conditions.

Performance Limitations of Block Polymer Surfactants…

- Not as readily available because they are manufactured with more costly raw materials.
- Do not reduce the surface tension of water as dramatically as anionic and nonionic surfactants.

Block Polymer Surfactants...
(Soil Applied)

Typical Ingredient Statements:

Alkoxylated polyols

Co-polymers of polyethylene and polypropylene glycols

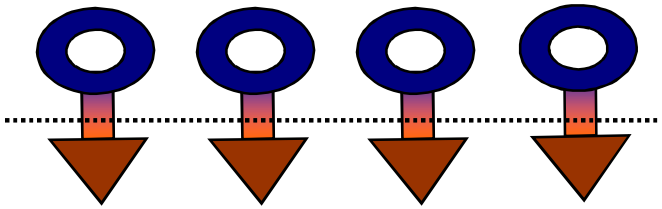
Nonionic polyol

EXCELLENT BASE SURFACTANT
FOR USE AS SOIL WETTING AGENTS

Understanding Water Repellent Soil and the Use of Irrigation Additives

Block Polymer Surfactant Chain…

Hydrophilic
– water loving heads



Hydrophobic
– water repelling tail

- The chemical structure of block polymer surfactants is represented in a chain of many surfactant molecules. “Poly” means “many” and thus the term block polymer surfactant.
- This organized block polymer chain provides chemistry residual and longer lasting effect than either anionic or nonionic surfactants.
- The chemistry works so well as a soil wetter because each molecule is composed of a hydrophilic (water loving) head and a hydrophobic (water repelling) tail.
- When applied and incorporated into the soil solution, the hydrophobic tail of the wetting agent is attracted to the hydrophobic coating on the soil particles.
- While the tail of these molecules adhere to the water repellent organic coating, the hydrophilic head remains a readily accessible site for water to attach, driving water into the soil profile rather than forcing water to run off the surface of the soil particle.

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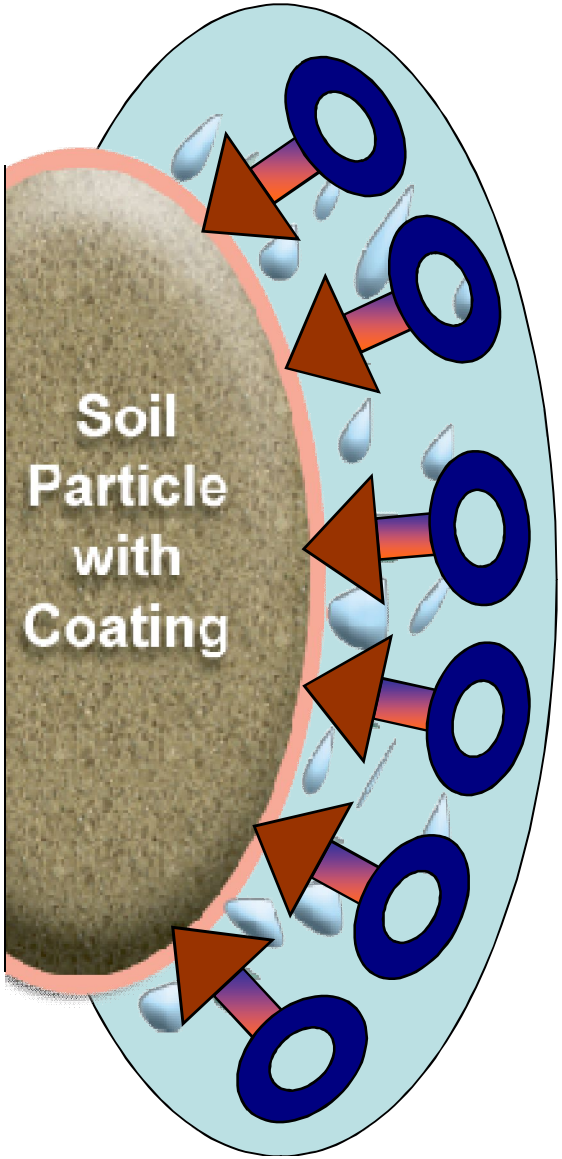
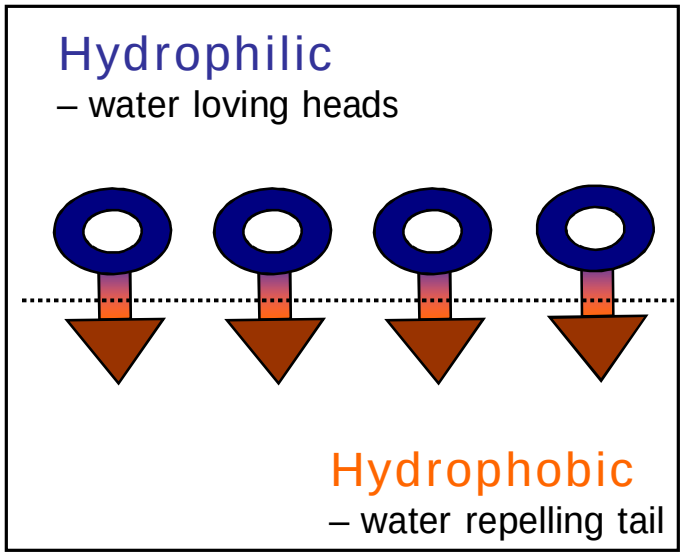


Block Polymer Surfactant Soil Performance…



1. Hydrophobic tail is attracted to the hydrophobic, water repellent soil particle.

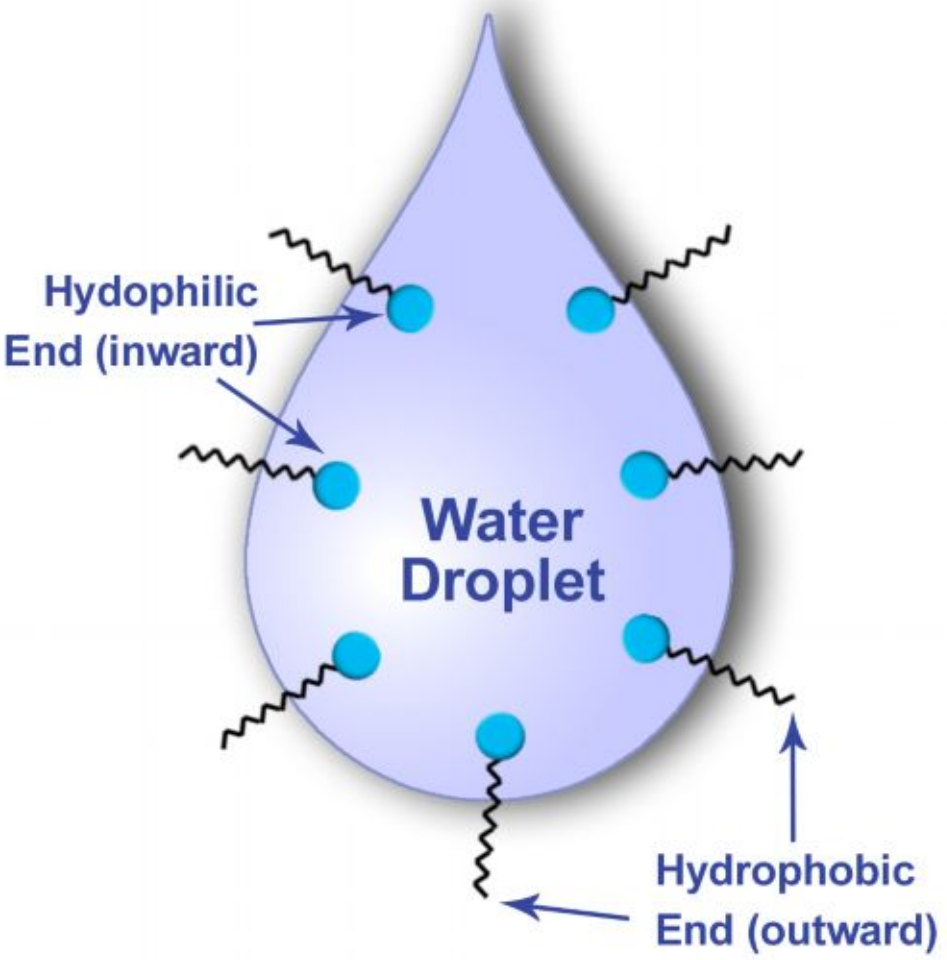
2. Surfactant molecule attaches to the soil particle, large molecular structure is strongly attracted.

3. The hydrophilic head attracts and retains moisture, improving soil wetting and moisture retention.

Surfactant in Water

When surfactants are applied to soil with water as the carrier (such as irrigation), the water grabbing ends of the surfactant molecules are strongly attracted to other molecules while the water repellent ends are forced outward.

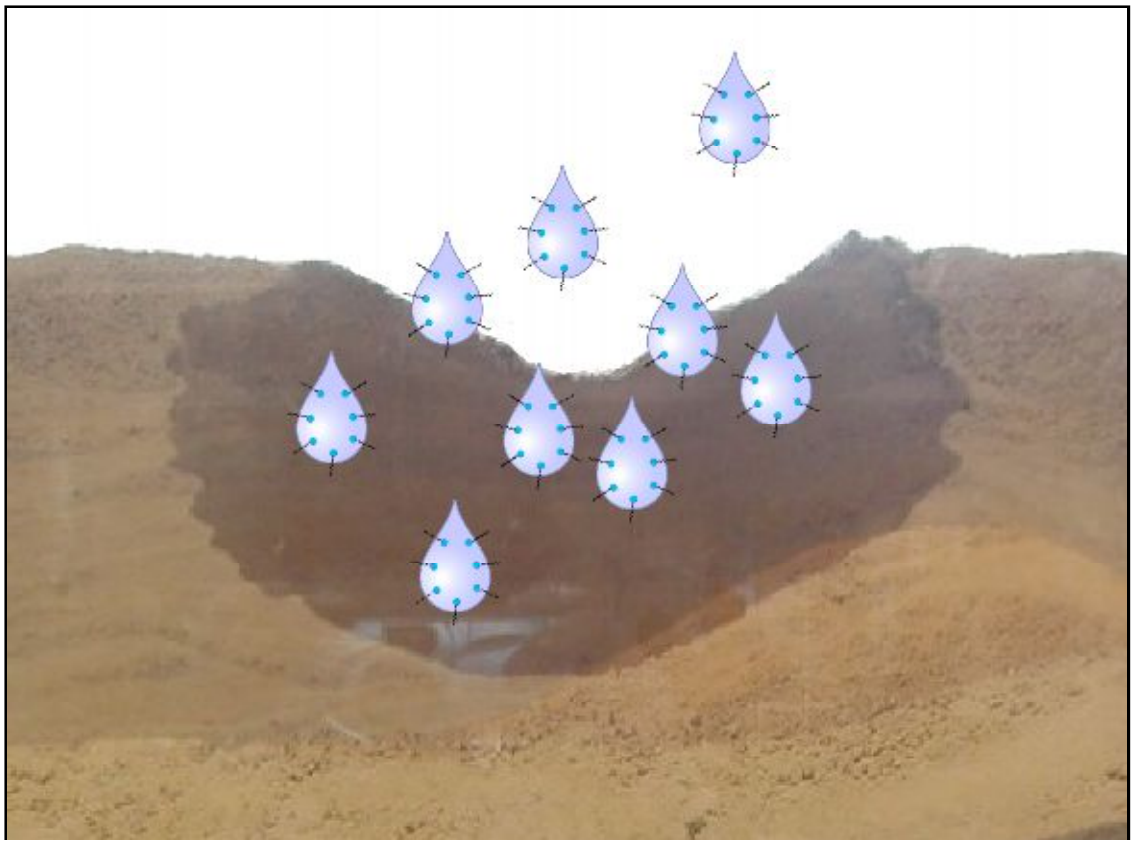
Surface tension is reduced as water molecules “push” outward toward the hydrophil of surfactant



Surfactants in a Soil Profile

•Surfactants in a Soil Profile

When a surfactant is applied to the soil profile, water repellent (hydrophobic), region of the surfactant attaches to the water repellent site on the soil particle. This serves as an attachment site for water molecules allowing the soil to hydrate.



Adsorption is the Key

- Different surfactants have varying degrees of ability to adsorb onto soils
- Adsorption has an effect upon lateral and vertical movement as well as residual capability
- Surfactant component should have moderate affinity to organic matter for residual
- Ideally, the surfactant should stage adsorption to modulate water movement
- Balance rewetting with flash wetting

Aqua-Drive

Designed to DRIVE Water into Hydrophobic Soils.

Aqua-Drive is an irrigation additive designed to improve soil wetting and penetration characteristics of treated irrigation water.

"Making water wetter" by reducing the surface tension of the irrigation water is one dimension of performance, but **Aqua-Drive** does much more than that. As the name suggests, **Aqua-Drive** literally helps "drive" irrigation water into hard-to-wet and hydrophobic soils.

TWO MODES OF ACTION:

1. Improved Water Surfactancy

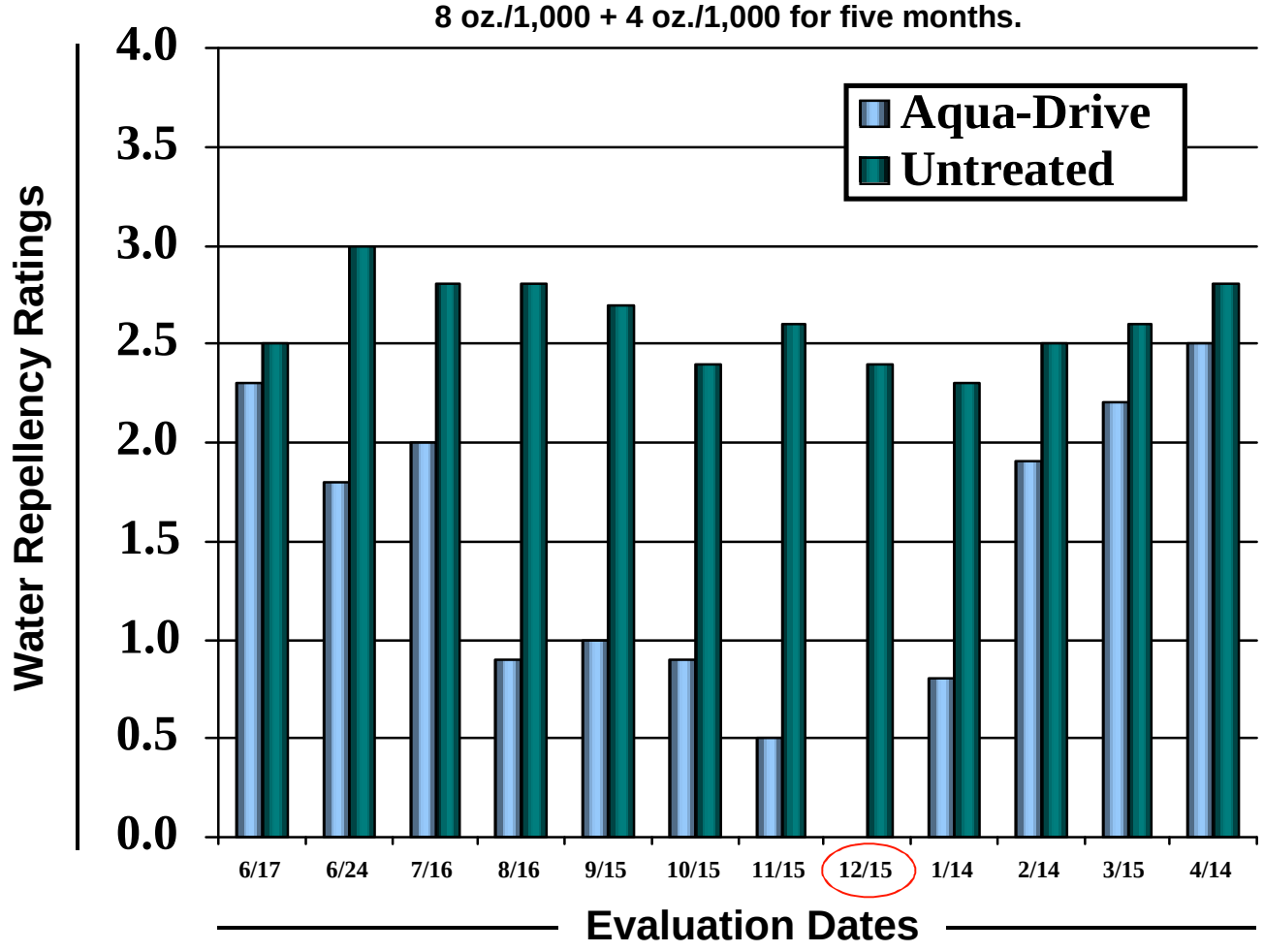
Reduces surface tension and improves wetting properties of irrigation water.

2. Enhanced Soil Penetration & Re-Wetting Characteristics.

Surfactant molecules attach to hydrophobic soil colloids "driving" water and hydration into hard to wet soil profiles.

University of Georgia Study

Soil **WATER REPELLENCY** as affected by Aqua-Drive.



Scale of 0.0 to 4.0 (0.0 = non-water repellent and 4.0 = extremely water repellent).

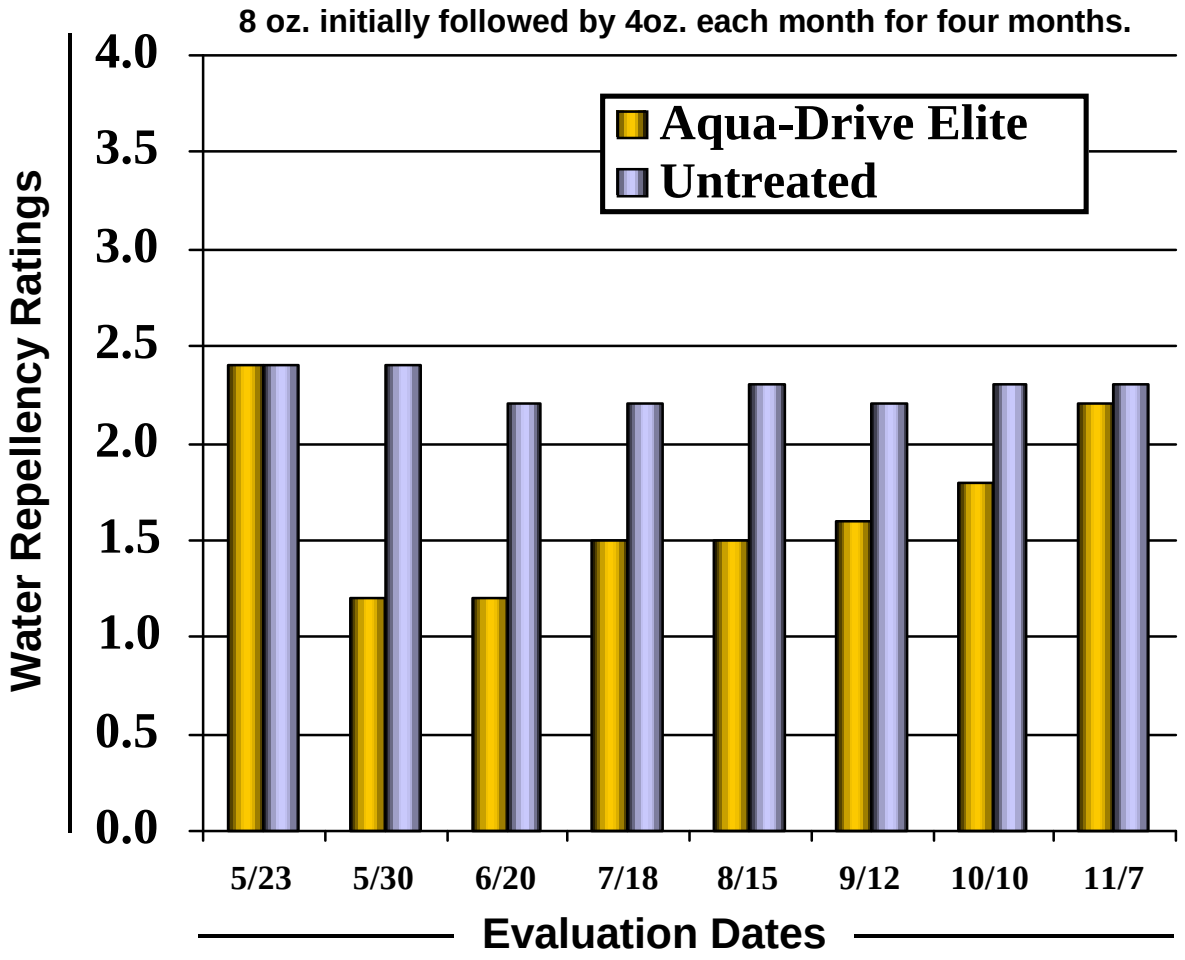
University of Georgia Study

Objective
Determine the effects of Aqua-Drive Elite on soil water repellency.

Results
Aqua-Drive Elite significantly reduced soil water repellency.

University of Georgia Study

Soil WATER REPELLENCY as affected by Aqua-Drive Elite.



Scale of 0.0 to 4.0 (0.0 = non-water repellent and 4.0 = extremely water repellent).

University of Arkansas Study

Objective

Research conducted to determine the effects of “Aqua-Drive Elite” wetting agent on the microbial activity of a sandy type soil media compared to two leading commercial wetting agents and a control.

Result

Aqua-Drive Elite has no negative effects on the microbial activity of the soil. When compared to control plots, microbial activity was increased, on average, when Aqua-Drive Elite was applied. Aqua-Drive Elite provided slightly enhanced soil respiration data (microbial activity) compared to control and competitive wetting agents.

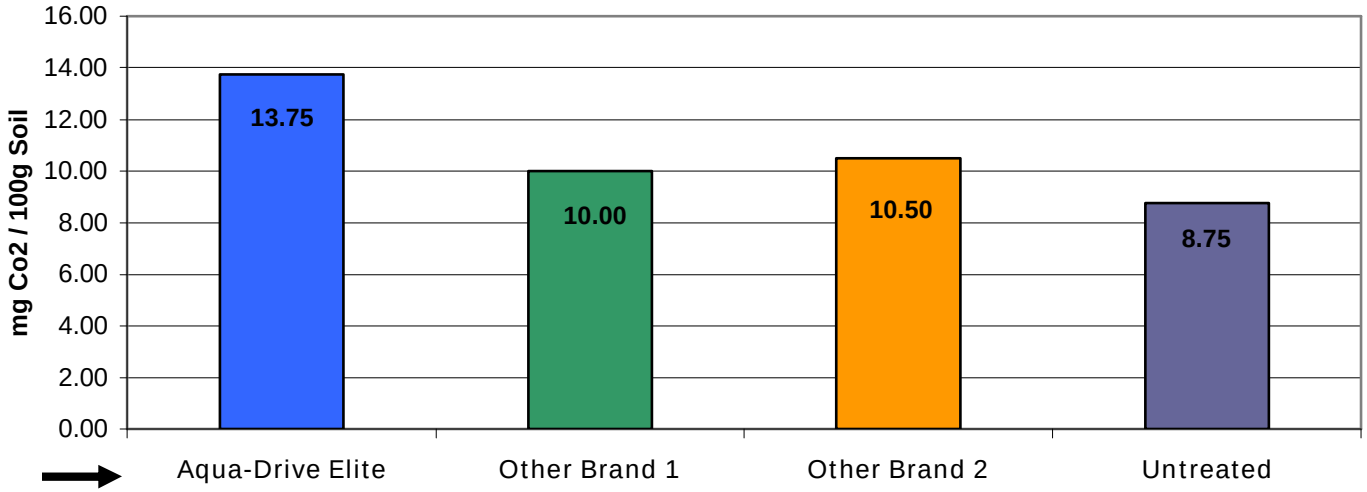
Aqua-Drive Elite

Proven Performance...Microbial Activity

Douglas Karcher, Ph. D.
Department of Horticulture
University of Arkansas
February 2002

Aqua-Drive Elite increased soil respiration by 57% over untreated soil!

Soil Respiration as Affected by Wetting Agent Applications*



*Samples collected 14 days following final wetting treatment.
Values represent cumulative respiration following 9 days of incubation.

Aqua-Drive Aqua-Drive Elite

The Importance of Post Harvest Irrigation with Aqua-Drive Products!

For perennial crops such as grapes, tree fruits and nut crops, post harvest irrigation has a direct effect on next years crop set. During the harvest period, crops are stressed to the maximum limits. Through this extended period of time without irrigation water and nutrient uptake, crops are depleted of substantial energy reserves. The growth cycle is a continual process and a lack of adequate moisture inhibits the plants ability to re-build the nutritional reserves required to set next years crop.

Post harvest irrigation efficiency is negatively impacted by the excessive dry down during harvest, which creates a hydrophobic soil condition. Managing the natural physical characteristics (adhesion and cohesion) of water under these hard-to-wet environmental conditions is critical to maximize the returns of post harvest watering cycles.

DIAMOND K

Aqua-Drive Aqua-Drive Elite

Pre-Emergent Herbicide Use Consideration for *Aqua-Drive Products...*

Every year, pre-emergent herbicides are applied to many acres of orchards and vineyards. Getting the water to uniformly incorporate and distribute the herbicide is difficult. Water will follow a path of least resistance and that will affect the results.

If the water doesn't uniformly and effectively incorporate the herbicide then two problems can occur. Weeds can emerge when they shouldn't and the herbicide won't last as long as it should.

Adding Aqua-Drive to the tank-mix will improve the uniformity and distribution of the herbicide. These improvements will insure that the herbicide gets to where it is supposed to be.

Aqua-Drive insures better targeting of the herbicide. And the weed control is at the level intended and for the length of time intended.

DIAMOND K

Aqua-Drive
Aqua-Drive Elite

…are specifically formulated to effectively assist in the management and conservation of water in agricultural production systems

…may be used with center pivot irrigation systems, drip irrigation systems, and ground applicators

…formulated with proven block polymer chemistry

…are backed by over 30 years of water management experience

…are competitive with all products on the market today