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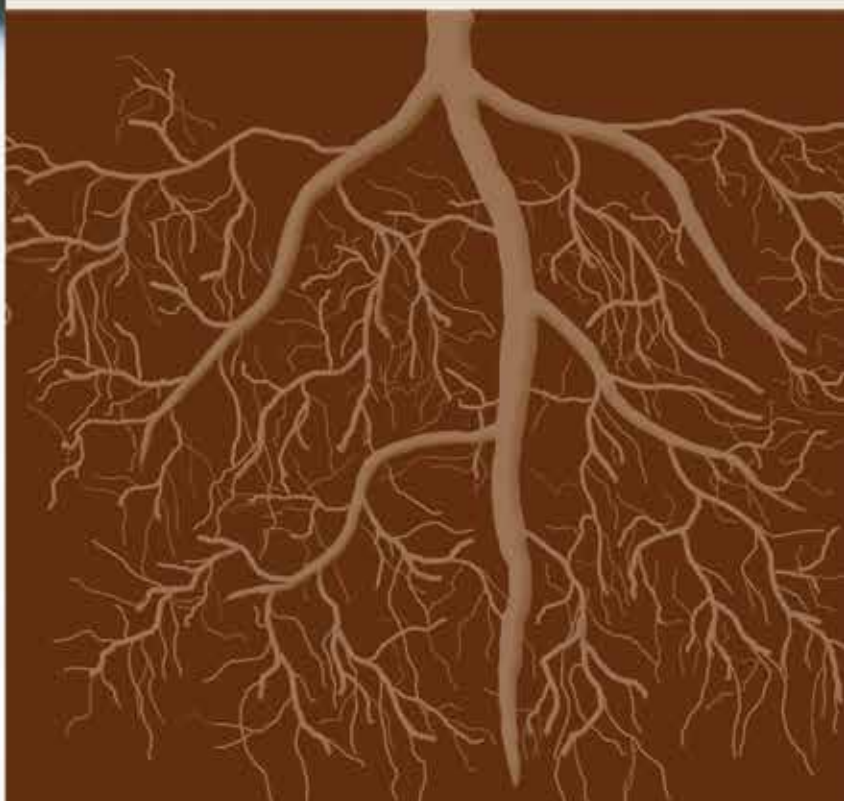
REGULATOR

HORTICULTURAL ROOT
SUBSTRATE SURFACTANT



ROOT SUBSTRATE DECLINE

Successful container production of horticultural crops is highly dependent on the ability of the substrate to contribute to root growth and root quality by: 1) providing water, 2) serving as a reservoir for nutrients, 3) permitting gas exchange to and from the roots and 4) offering root anchorage and support.

Components chosen for root substrates will vary depending on desired air-to-water ratios and other physical properties that are best for the crop that is being grown. Often overlooked is that the specific components of the root substrate make little difference to the plant. **What is important to the plant is the root environment created in the substrate**. Indeed, outside the physical root support function of the substrate, the plant responds only to the ability of its root system to acquire and supply water, oxygen, and nutrients to meet its growth and metabolic demands.

Substrate Dry-Down and Water Repellency

During production, root substrate dry-down is quite common. When the organic components (particularly peat and bark) of root substrates get dry, they can quickly develop hydrophobic (water repellent) characteristics.

Substrate Exhibiting Shrinkage

Substrate Exhibiting Preferential Flow

Water repellency is common on organic materials used to construct root substrates. Over time, organic compounds produced by the degradation of organic materials will accumulate and coat particles and aggregates in the substrate profile. As these coatings are subjected to higher temperatures and low moisture conditions, they will polymerize and form a wax-like *hydrophobic* (non-polar) layer.

Water Retention and Hydraulic Conductivity

Once root substrates become hydrophobic, they become nearly impossible to wet or re-wet, and irrigation water tends to run off or rapidly move through the larger pores in the substrate (or the sides of the pot) in preferential pathways. The result is that the substrate profile cannot retain sufficient water for the roots to accommodate the plant's water and nutrient requirements.

Channel Flow

Preferential Flow

Under water repellent conditions where the water retention characteristics and hydraulic conductivity of the root substrate are disrupted, growers may observe or experience:

- **Poor distribution of water and nutrients**
- **Poor drainage**
- **Increased production costs associated with increased hand watering**
- **Poorly developed root systems**
- **Non-uniform plants**
- **Plants with poor transplant performance**

Inefficient root system caused by channel flow of water

Inefficient root system caused by preferential flow of water

If the root system is weakened by a poor root substrate environment, the plant may be required to allocate a disproportionate amount of its photosynthetic sugar production for repair. This may result in less sugars available to support the vegetative and reproductive parts of the plant. Should the plant continue to allocate its photosynthetic sugar production to vegetative and reproductive parts, then the root system will suffer. In both cases, the plant will have difficulty reaching its genetic potential.

IMPROVING ROOT SUBSTRATE ENVIRONMENT

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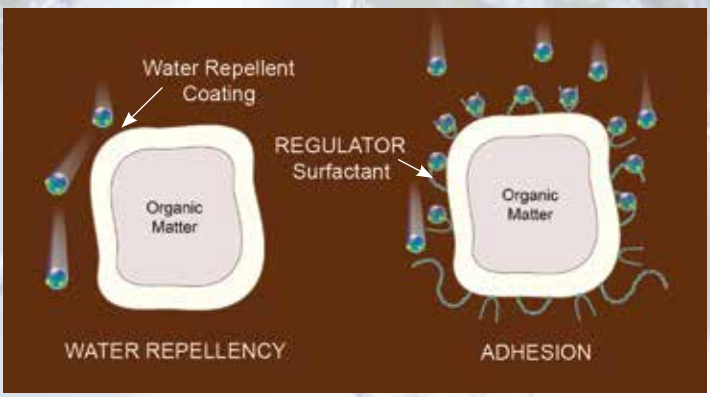
HORTICULTURAL ROOT SUBSTRATE SURFACTANT

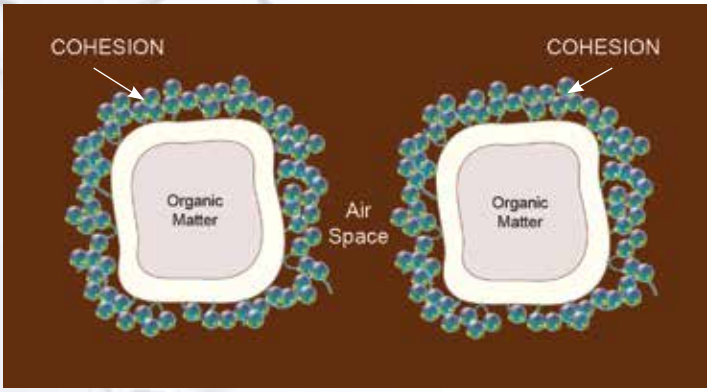
REGULATOR is a technologically superior blend of advanced surfactants that restores and improves the infiltration, hydration, water retention and capillary characteristics of hydrophobic (water repellent) horticultural root substrates.

Used according to label directions, REGULATOR will act on water repellent organic components of root substrates to address areas of:

Water Repellency. When the REGULATOR surfactant blend is applied to the substrate, it attaches to water repellent (non-polar) areas on organic particles and creates sites where water can attach to the surface (adhesion). Adhesion is strongly associated with hydration or "wetting" of an organic surface.



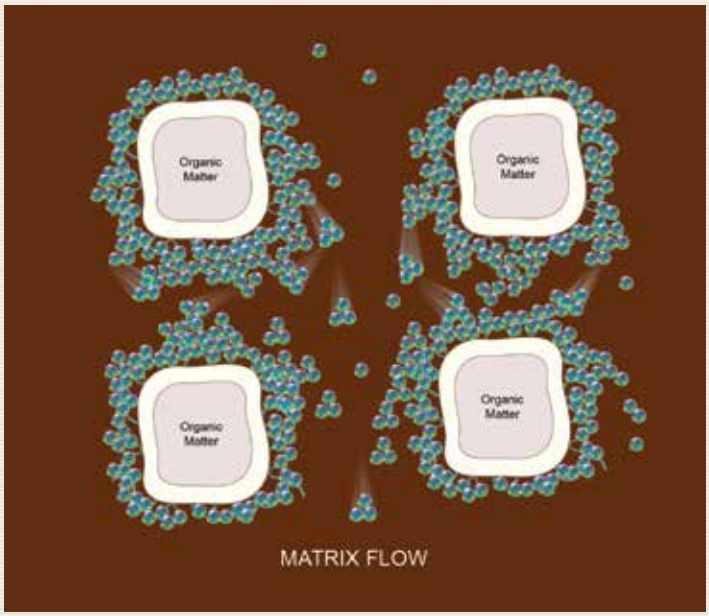
Once adhesion of water molecules is restored on the water repellent organic surface by REGULATOR surfactant molecules, additional water molecules will build on the surface via cohesion. This water-to-water attraction in conjunction with adhesion creates and retains available water needed by the roots to meet the transpirational and metabolic demands of the plant.



The surfactant chemistries in REGULATOR Root Substrate Surfactant were carefully selected for their ability to attach to non-polar surfaces and to establish optimum hydration (wetting) patterns.

Capillary Action. REGULATOR also plays a very important role in the uniform movement of water through a water repellent substrate matrix. As excess water builds on the surfactant amended organic substrate particle surface, it is pulled downward by gravity and is moved laterally by adhesion and cohesion to continue its vertical and horizontal movement through the substrate matrix (*"matrix flow"*).

This directional influence by water's attraction to the REGULATOR surfactant amended surface encourages uniform water movement and improved air-to-water ratios throughout the substrate – a hydraulic tension called "capillary action."



Aeration. Once the physical characteristics of water repellent organic particles in root substrate particles have been corrected with REGULATOR, the grower is now in a position to manage air-to-water ratios through deployment of appropriate irrigation practices.

APPLICATION INFORMATION

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HORTICULTURAL ROOT SUBSTRATE SURFACTANT

REGULATOR Root Substrate Surfactant is a blend of non-ionic surfactant chemistries designed to effectively manage water repellent conditions in the root substrate profile. By improving the penetration, wetting, uniformity of water movement and air-to-water ratios in the horticultural substrate, a more favorable environment for root development, increased root mass, and improved root function is established.

Growers will find that plants respond to the improved root substrate environment of organic components (such as peat and bark) treated with **REGULATOR**:

- **Increased irrigation efficiency**. Growers have improved control of their substrate's air-to-water ratios. Growers can now irrigate their horticultural crops for growth, uniformity and vigor rather than for preventing substrate water repellency
- **Improved carbohydrate allocation**. Plants don't have to divert photosynthetic sugar production need for growth and maintenance to repair unhealthy root systems. Photosynthetic sugar production can now be allocated to support growth and maintenance of plant and reproductive parts
- **Better crop performance**. Improved growth, vigor and uniformity
- **Enhanced utilization of applied amendments**. Crops respond well (and predictably) to uniform and thorough distribution of fertilizers, pesticides and other amendments
- **Reduced costs**. Less time is required to address crops exhibiting problems associated with poor air-to-water ratios.

USE DIRECTIONS

SUBSTRATE PREPARATION – NURSERY CONTAINERS, POTS, FLATS
Apply REGULATOR at 2 to 4 ounces in 2 gallons of water per cubic yard of substrate (75 to 150 ml in 10 L of water per cubic meter). Add surfactant to water and agitate or stir. Spray as uniformly as possible while media is blending. Mix thoroughly.

Difficult to wet mixes: Apply REGULATOR at 5 to 7 ounces in 2 gallons of water per cubic yard of substrate (200 to 300 ml in 10 L of water per cubic meter). Add surfactant to water and agitate or stir. Spray as uniformly as possible while media is blending. Mix thoroughly.

SUBSTRATE PREPARATION – PLUG OR PROPAGATION
Apply REGULATOR at 2 to 4 ounces in 2 gallons of water per cubic yard of substrate (75 to 150 ml in 10 L of water per cubic meter). Add surfactant to water and agitate or stir. Spray as uniformly as possible while media is blending. Mix thoroughly.

PLANTS IN PRODUCTION – NURSERY CONTAINERS, POTS, FLATS
Drench: Drench with 600 ppm solution of REGULATOR (8 ounces per 100 gallons / 300 ml per 500 liters of water). Additional drench applications can be applied every 4 to 6 weeks following initial drench.

Injection: REGULATOR can be applied by injection through an irrigation system by mixing in a fertilizer stock tank. If using an untreated mix, drench with 600 ppm solution, then reapply at 10 ppm in each irrigation or 100 ppm weekly.

If using a mix containing a media surfactant, apply REGULATOR at 10 ppm in each irrigation or 100 ppm weekly.

When mixing with fertilizer, add REGULATOR to the stock tank BEFORE dissolving the fertilizer. Stir the mixture well.

PLANTS IN PRODUCTION – PLUG OR PROPAGATION
Drench before germination or after first leaf stage with a 300 ppm solution of REGULATOR (4 ounces per 100 gallons / 150 ml per 500 liters of water).

PRE-SHIPMENT APPLICATION
Apply a 600 ppm drench of REGULATOR (8 ounces per 100 gallons / 300 ml per 500 liters of water) within 2 weeks of shipment.

INJECTION TABLE

Ounces of REGULATOR per Gallon Stock Solution (ml / L)				
Injector Ratio	PPM REGULATOR			
	10	100	300	600
1:300	0.40 (3.13)	3.8 (29.7)	11.5 (89.8)	23.0 (179.7)
1:200	0.30 (2.34)	2.6 (20.3)	7.7 (60.1)	15.5 (121.1)
1:150	0.20 (1.56)	1.9 (14.8)	5.7 (44.9)	11.5 (89.8)
1:128	0.15 (1.17)	1.6 (12.5)	5.0 (39.1)	10.0 (78.1)
1:100	0.10 (0.78)	1.3 (10.1)	3.8 (29.7)	7.6 (59.4)
1:64	0.08 (0.62)	0.8 (6.2)	2.4 (18.7)	4.8 (37.5)
1:50	0.06 (0.47)	0.6 (4.7)	1.9 (14.8)	3.8 (29.7)
1:30	0.04 (0.31)	0.4 (3.1)	1.2 (9.4)	2.4 (18.7)
1:16	0.02 (0.16)	0.2 (1.6)	0.6 (4.7)	1.2 (9.4)

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