neptune®
superior turf wetting agent

TECHNICAL INFORMATION BULLETIN

Neptune is a highly innovative, advanced non-ionic rootzone surfactant complex designed to amend soil profiles and significantly enhance water movement, water distribution, hydration and drainage in root zones influenced by water repellent soil particles. This ground breaking combination of leading edge surfactants also provides the professional turfgrass manager with an effective tool to refresh, restore and manage rootzone quality and productivity – through the uniform and stable movement, retention and distribution of water and dissolved nutrients to plant roots and to life-sustaining ecological communities that reside in this critical portion of the soil profile.

Problems with localized dry spots and turfgrass suffering under non-uniform growing conditions are more prevalent today than when USGA green method construction emerged in the early 1960's. Many superintendents are finding that rootzone growing conditions that would support quality turfgrass under USGA specifications in the past will not sustain similar quality ratings on today's turfgrass.

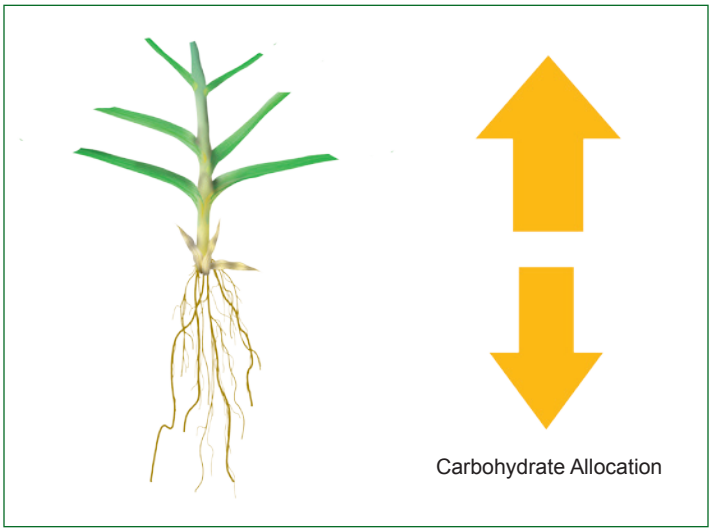
Many scientists, agronomists and professional turfgrass managers believe that increases in LDS and unhealthy turfgrass growth on USGA greens may be the result of increased hydrophobicity (water repellency) in the rootzone caused in part, by the use of new turf varieties that are prolific producers of organic matter. Decomposition of organic matter that occur during natural microbial saprophytic processes, produce non-polar organic compounds that coat soil particles and render them water repellent.

But the strongest body of research suggests that the underlying problem **may not be an increase in water repellency or water movement problems, but rather the consequence of turfgrass that has become less tolerant to water related stress due to shortened root systems and lower carbohydrate (energy) reserves caused by today's use of lower mower heights, increased play (wear) and poor water quality**.

Lowering Mowing Heights

The impact of low mowing heights on the ability of turfgrass to produce carbohydrates has been confirmed by the scientific community as having a profound negative impact on plant growth, development and stress tolerance.

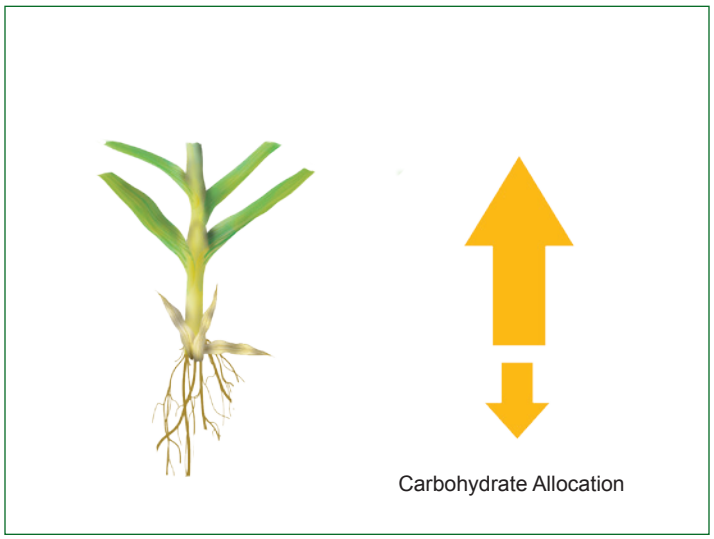
At higher mowing heights, the turf plant, is able to efficiently make use of available energy, carbon dioxide and water to produce (via photosynthesis) both structural and non-structural carbohydrates (sugars) that the plant uses as raw materials for growth, repair and metabolic maintenance. When production of photosynthates exceeds the demands of the plant, the turf plant is also able to store a portion of its carbohydrates as reserves, to use under stress conditions.



Graphic showing relative direction of carbohydrate (production) allocation in turfgrass cut at higher mowing heights. Note that while a higher amount is allocated to vegetative growth, a significant amount is also allocated to root development and storage.

However, with lowered mowing heights, the amount of available leaf-blade surface for photosynthesis is significantly reduced. The turf plant must now reallocate its production of carbohydrates and may be required to use stored carbohydrate reserves for some of its regrowth, repair and metabolic requirements. As

stored carbohydrate reserves are depleted, plant growth, vigor and competitiveness decrease.



Graphic showing relative direction of carbohydrate production allocation in turfgrass cut at lower mowing heights. Not only has the amount of carbohydrate production reduced, but the allocation ratio has shifted to favor vegetative tissues that can produce photosynthates (carbohydrates). This results in a much smaller root system that renders the turfgrass less prepared to manage life-essential functions under stress environments.

Plant root mass and rooting depths are also reduced under lowered mowing heights. Shoot density increases at the expense of root density. Shallow-rooted turf is more sensitive to water stress than deep-rooted turf and cannot use soil water reserves adequately.

Renewed Focus on Rootzone Performance

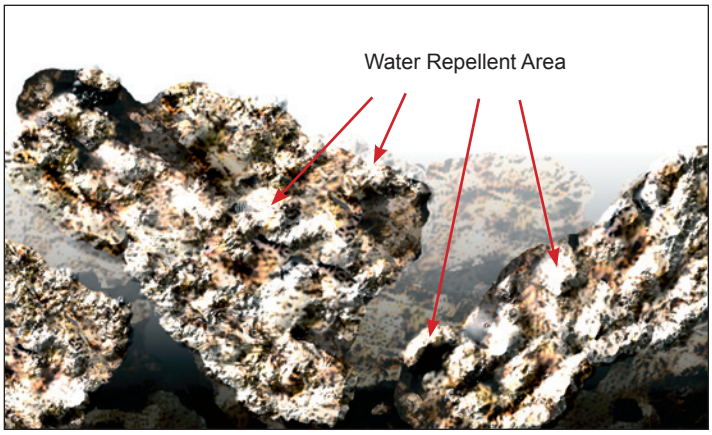
Think about it. Just the demand for firmer, faster greens – resulting in a change in mowing height -- has resulted in superintendents having to deal with turfgrass plants with less carbohydrate reserves, limited root systems and a dampened ability to tolerate stress.

Consequently, professional turfgrass managers have found it imperative to assist the plant with increased rootzone maintenance to:

- Improve water and nutrient availability
- Enhance the plant's ability to uptake applied water and nutrients (root development)
- Balance air-to-water ratios
- Reduce below-ground stress conditions

Sand, as the primary mineral fraction of the rootzone mixture, provides a coarser soil texture than native soils, maximizing water infiltration, air-filled porosity and percolation. However, greens with high sand content tend to be more water repellent than native soils.

Sand has a limited surface area and is highly susceptible to becoming coated with waxy/non-polar compounds (associated with decomposition of plant litter and through exudates produced by microorganisms present in the soil). These "coatings," when subject to wetting and drying cycles, can rapidly become water repellent (hydrophobicity) and severely disrupt the uniform movement of water through the rootzone -- leaving sections of the green without an adequate supply of water and nutrients.



Graphic representation of developing water repellent (hydrophobic) sites on sand particles.

For some superintendents, less tolerant turfgrass has revealed performance shortcomings with the surfactants they currently use. For others, dealing with less tolerant turfgrass has prompted them to search for new, innovative surfactant formulations that in addition to promoting a more consistent and effective pattern of hydration and re-hydration in the rootzone, contribute to improved plant health, enrich growing conditions and strengthen the plant's ability to withstand stress conditions.

Neptune Rootzone Surfactant

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The development of Neptune Rootzone Surfactant is driven by advances in surfactant and formulation technology coupled with an understanding that the health and growth potential of turfgrass is intimately tied to, and influenced by, rootzone performance.

The rootzone defines the area from which turfgrass can draw moisture as well as serves as a rich reservoir of life-essential physical, chemical and biological processes for the turf plant. The rootzone is also the target for applied fertilizers, pesticides and other plant health products that need to be directed to the plant via the root system. Therefore, it is essential that water movement into and through the rootzone is uniform and that distribution of air and water remain consistent.

Surfactant Complex

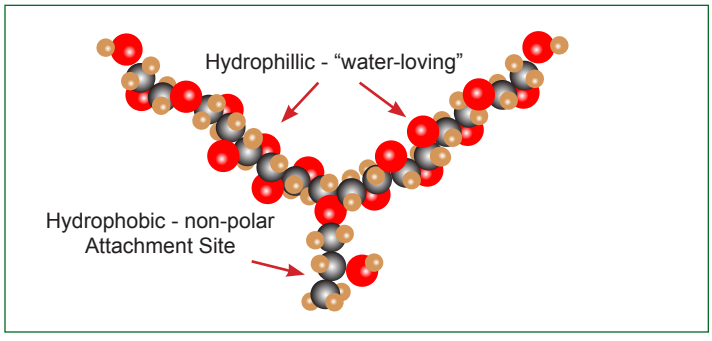
The surfactant chemistries used in the Neptune formulation blend have been selected to address the demand by turfgrass managers for a surfactant solution that will:

- Promote a more uniform movement of water (uniform wetting front) into and through the rootzone
- Provide consistent hydration and re-hydration to ensure turf is supplied with adequate water and nutrients
- Establish optimum air-to-water ratios
- Increase turf resilience and stress tolerance

The Neptune surfactant complex contains unique surfactants that are designed to work in sand-based profiles, in root zones containing highly variable (heterogeneous) soil types and organic matter (such as native soils / push-up greens) and in highly amended soils.

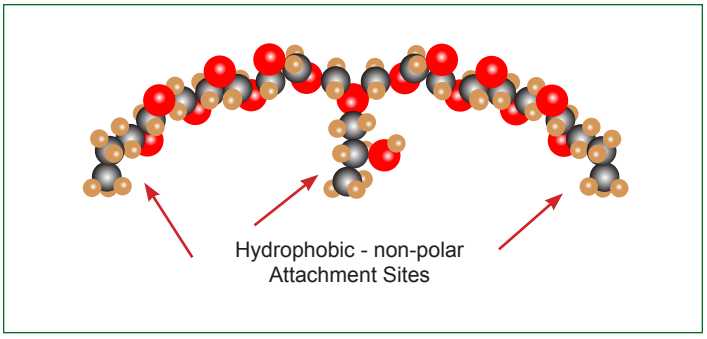
What sets Neptune apart from its competitors is that while both of its surfactant constituents, possess different performance characteristics, they have been constructed to work in harmony together to form a very uniform and consistent pattern of hydration and re-hydration – even with highly water repellent rootzone profiles.

One of the surfactant blend components is a complex tri-block copolymer containing non-polar terminating groups. These unique terminating groups provide additional non-polar "anchors" that the surfactant uses to adhere to the water repellent surface of the soil particle.



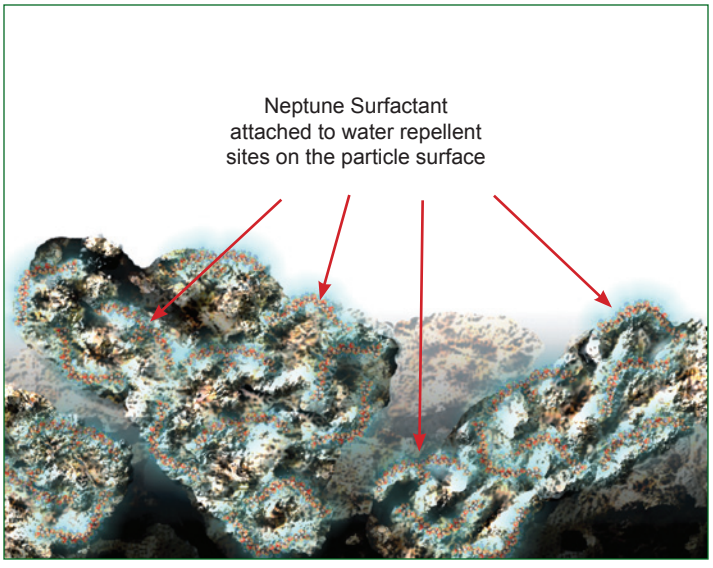
Graphic representation of typical tri-block co-polymer. Surfactant normally attaches to hydrophobic (water repellent) surface at its non-polar functional group site(s).

This unique construction is designed to change the "footprint" of the surfactant on the soil particle in order to promote a more consistent level of hydration and rehydration. In addition to directing a more favorable pattern of hydration for the tri-block copolymer surfactant, the polymer construction of this tri-block copolymer also reduces the rate of microbial degradation which makes the surfactant's last longer.



Graphic representation of Neptune tri-block co-polymer. Additional non-polar terminal groups provide additional sites for attachment and change the surfactant's "shape" as it sits on the particle surface.

In addition to its innovative tri-block copolymer, Neptune is formulated in combination with a high molecular weight, complex surfactant proven to promote uniform vertical and lateral movement of water and solutes into and through the soil profile.

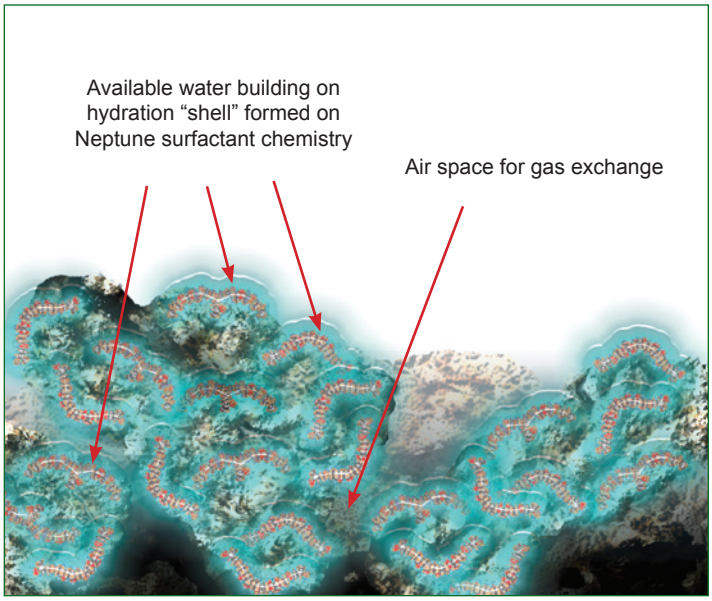


Graphic representation showing Neptune chemistries attaching to hydrophobic sites on water repellent soil particles

When Neptune's surfactant blend is introduced into the soil profile, its chemistries attach to non-polar areas on water repellent soil particles where they attract water and encourage

the formation of a uniform hydration "shell" on the soil particle surface.

As additional water is added to the rootzone profile, water builds on the initial hydration "shell" to provide a uniform source of available water to turfgrass roots. Excess water (not needed by the plant) is pulled off the hydrated soil particles by gravity.



Superintendents will also find that with use of Neptune, root zones will hydrate and drain more uniformly – facilitating gas exchange and enabling beneficial rootzone biological activities to commence rapidly following precipitation/irrigation events.

APPLICATION RATES:

Greens & Tees, Fairways, Bunker Faces, Collars, Sports Turf and Parks/ Recreations Areas

Sand-Based Soil Profiles

Apply Neptune at 6 oz. per 1000 ft^2 in 2 gallons of water (180 ml. per 100 sq. meters in 8 liters of water). For best results, apply monthly throughout the growing season. No watering-in is required when used at recommended rates.

When incorporated within a comprehensive root zone management program, use of Neptune's unique surfactant chemistries will result in:

- **Increased water use efficiency**
- **Uniform movement and availability of water, fertilizers and other water soluble materials into and throughout the rootzone**
- **Root zones with vastly improved air-to-water ratios**
- **Reduced moisture stress to turfgrass**
- **Prevention and treatment applications for localized dry spot and water repellent soils**
- **Improved drainage**
- **Improved turf resilience and stress tolerance**
- **Dew Suppression**

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