



Soil Surfactants: Retainers and Penetrants in Turfgrass Management

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Understanding Soil Surfactants in Turf Management

Soil surfactants, commonly referred to as wetting agents, have become indispensable tools in the management of turfgrass, especially in sports turf such as football pitches and golf courses. These chemical agents are essential for addressing localised dry spots (LDS), improving moisture uniformity, enhancing infiltration, and increasing rootzone moisture retention. Despite their widespread use, there remains considerable confusion surrounding the terminology and performance of these products, particularly those labelled as "retainers" or "penetrants" [1].

This paper reviews recent field-based and laboratory research to explore the actual functional differences between these two marketed classes of wetting agents. Additionally, it examines the structure-function relationships at the molecular level, with an emphasis on the implications for irrigation efficiency and water conservation

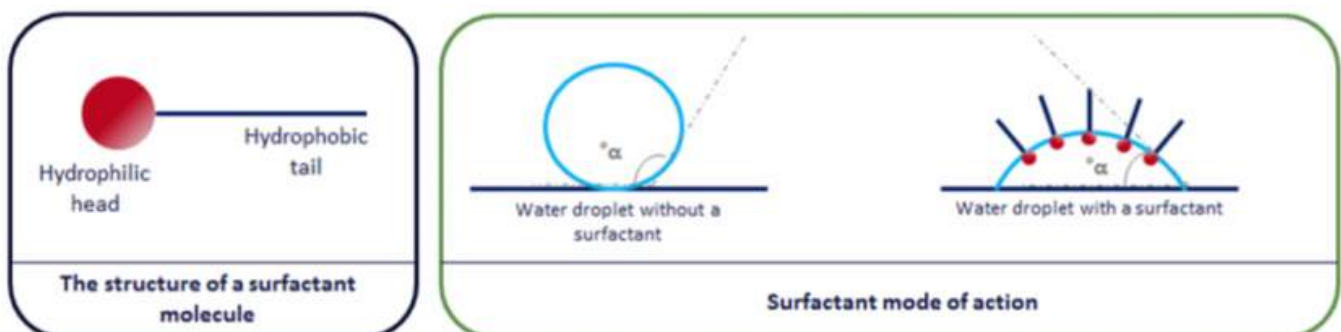


Background & Terminology



Wetting agents are surfactants with hydrophilic and hydrophobic components that reduce surface tension and influence water movement in soils. Terms like "penetrants" and "retainers" are marketing labels rather than regulated definitions. Penetrants are thought to enhance water infiltration, while retainers aim to slow percolation and retain moisture in the rootzone. However, field studies suggest these labels lack consistent, measurable differences in soil moisture performance.

Unlike pesticides, wetting agents face less regulatory scrutiny, resulting in limited publicly available data on their composition and effectiveness. Labels like "penetrant" and "retainer" are not standardized across manufacturers, making their performance expectations speculative. This raises a key question: do these agents actually perform as marketed under real-world conditions?



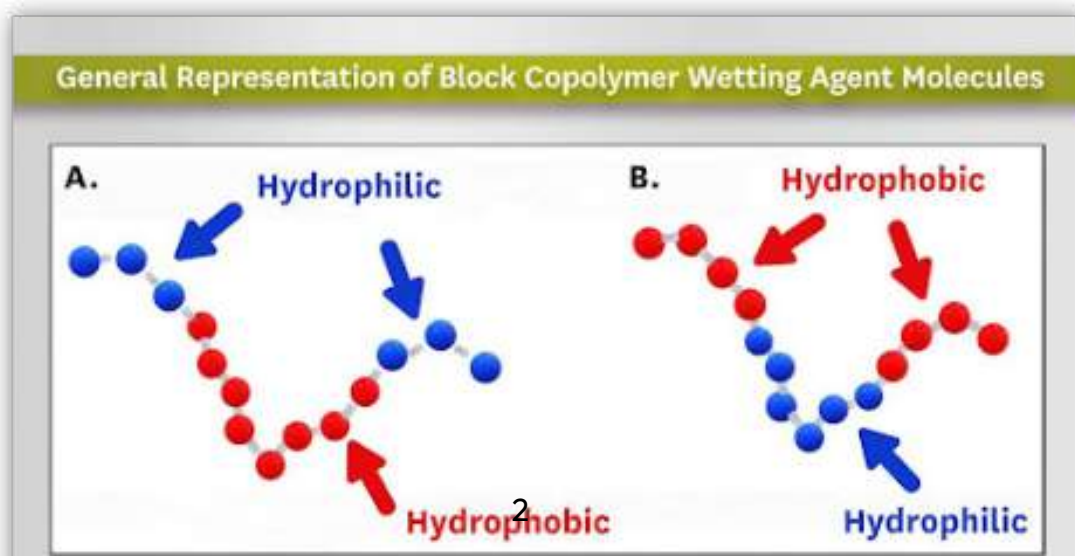
Conceptual Basis for Penetrant and Retainer Terminology

The functional identity of penetrant and retainer surfactants is linked to their structural arrangement. Most soil surfactants used in turfgrass management are block copolymers with hydrophilic and hydrophobic segments, allowing interaction with both water and soil.

Penetrants typically have hydrophilic groups (ethylene oxide, EO) flanking a central hydrophobic block (propylene oxide, PO), forming a straight block copolymer or Pluronic structure. This design reduces surface tension and enhances water infiltration by disrupting hydrogen bonding between water molecules.

Retainers, often called Pluronic R surfactants, feature reverse block copolymer structures where the hydrophilic EO block is central and flanked by hydrophobic PO groups. The hydrophobic terminals anchor to non-polar soil particles, promoting moisture retention by extending hydrophilic segments into pore spaces.

While these structural distinctions provide a useful framework, many commercial formulations are blends or have intermediate traits, performing dynamically based on soil conditions, moisture levels, and timing. This highlights the need for practitioners to assess surfactants through site-specific performance data rather than relying solely on marketing labels.



RESEARCH REVIEW

Field Performance on Bermudagrass under Deficit Irrigation

A pivotal two-year field study conducted by Xiang et al. (2021) at the University of California, Riverside, assessed ten commercially available soil surfactants applied to 'Tifway II' hybrid bermudagrass under deficit irrigation levels of 45%, 55%, and 65% reference evapotranspiration (ET_o). The surfactants tested included products marketed both as penetrants and retainers, applied alone or in tank mixes.

Key findings demonstrated that all surfactant treatments improved soil volumetric water content (VWC) and moisture uniformity compared to untreated controls. Treated plots showed up to a 16% increase in VWC, with visual turf quality and percent green cover (PGC) maintained above acceptable thresholds throughout the study period. Interestingly, only minimal differences were observed between individual surfactant treatments, and no consistent trend emerged to distinguish penetrants from retainers in terms of performance outcomes.

These findings underscore that while surfactants can enhance drought resilience, the distinction between product classes may be less relevant than site-specific performance and application strategy [1].



RESEARCH REVIEW

University of Arkansas Trials: Evaluating Function Beyond Labels

O'Brien (2024) at the University of Arkansas conducted trials on eight branded wetting agents applied to sand-based putting greens of creeping bentgrass and ultradwarf bermudagrass over two seasons. The study found no significant differences in volumetric water content (VWC) among the products, regardless of label ("penetrant" or "retainer") or soil depth measured. Both types improved VWC uniformity compared to untreated turfgrass but showed no consistent separation in performance.

In another trial on 'Flagstick' creeping bentgrass, monthly applications of the same surfactants were monitored at depths of 0.5, 1.5, 3.0, and 4.8 inches. Results reinforced previous findings, with penetrants and retainers often showing overlapping performance. In some cases, penetrants retained more moisture than retainers from the same manufacturer. Season-long VWC differences averaged less than 2.5%, with penetrants occasionally outperforming retainers in moisture retention.

These findings highlight that marketing labels do not reliably predict surfactant performance, emphasizing the need for independent, replicated field trials.



Active Ingredients and Structure- Function Insights



The chemical basis of surfactant action was further explored in O'Brien's structural-function analysis of block copolymer compounds. Four poloxamer surfactants (EO-PO block copolymers) with identical hydrophobe backbones but differing hydrophilic chain lengths (and thus hydrophilic-lipophilic balance, HLB) were tested.

The results confirmed that HLB strongly influenced performance. Compounds with lower HLB values (more hydrophobic) performed more like commercial penetrants, encouraging infiltration and rapid water movement. In contrast, high-HLB compounds (more hydrophilic) tended to hold moisture near the surface but were also more prone to developing localised dry spot (LDS) under stress.

Interestingly, the performance of these pure compounds often mirrored that of complex commercial formulations, suggesting that a surfactant's core structure has a greater impact on its function than branding alone. These findings support the need to consider HLB and EO/PO ratios when selecting or formulating wetting agents for specific soil and climatic conditions [2].

Conclusion

Wetting agent performance varies widely based on climate, irrigation, soil type, and organic matter, highlighting the need for site-specific management rather than relying on chemical properties alone.

Studies show that “penetrant” and “retainer” labels often fail to reflect real-world performance on sand-based rootzones. Products within the same category can perform inconsistently, and manufacturer differences further challenge these labels. Neither type reliably impacts volumetric water content (VWC) compared to untreated plots, and surface firmness remains unaffected by product classification.

Effective wetting agent strategies require monitoring VWC, evapotranspiration, and understanding how seasonal patterns and organic matter influence performance. Moving beyond marketing labels and focusing on measurable results leads to more consistent, optimal outcomes in sports turf management.



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