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Implications of soil water repellency on crop water productivity

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Water scarcity in a changing climate challenges sustaining and increasing crop productivity to feed a growing global population. Aquifer depletion, drought, and rising pumping costs dictate that continued production of many crops will be limited without the development of novel strategies to optimize efficient rootzone delivery of water. Heterogeneous wetting and flow results in deprivation of a consistent water supply to plants, decreased rootzone storage of water, and non-uniform soil distribution of crop production and crop protection chemicals. Over the past decade, soil water repellency has been identified in diverse soils and cropping systems ranging from field and row crops to highly managed, perennial tree fruits and vines irrigated with potable or treated wastewater.

Recently, the deleterious impacts of SWR on irrigation efficiency and crop productivity have been documented in arable soils with compromised wetting (contact angle <90°). Management strategies to mitigate soils with compromised wetting, also referred to as subcritical soil water repellency (SCWR), may increase soil available water and distribution. This report reviews the effects of low level surfactant treatment (10-12.5 L ha-1 season-1) on hydraulic properties in soils with SCWR and different textural classes, and the resulting effects on crop water productivity, nitrogen efficiency, and plant stress tolerance under deficit irrigation.

Application of low volumes of surfactant (an alkyl polyglycoside - block copolymer co-formulation) resulted in increased soil volumetric water content at the 0-10 cm and 10-25 cm depths ($p = 0.05$) on each measurement date throughout the growing season in soils of different textural classes with SCWR. Under deficit irrigation, crop yield and quality in the surfactant treatment were significantly greater $p = 0.05$) per unit volume of applied water versus the control across soil types. Where measured, leaf nitrogen content was consistently greater ($p = 0.05$) in the surfactant treatment. In fruit bearing horticultural crops, increased quality in the surfactant treatment was associated with decreased heat and light stress damage. Alleviation of low level water repellency resulted in improved crop water productivity and increased abiotic stress tolerance in surfactant treated soils.