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# Soil structure, crop quality tied to water quality

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*By Brent Rouppet*

Irrigation water quality is becoming progressively more important since many growers are irrigating either with snow-melt runoff from the Sierra Nevada, Cascade or other mountains, or poor quality subsurface water.

Therefore, one the most important current issues with growing crops in the West is the issue of water quality and how it relates to soil structure, crop quality, and crop production.



For irrigation water to be effective it needs to penetrate into the soil supplying enough water to sustain the crops until the next irrigation. Yet, most irrigation water used in California and the West is harmful to good soil structure, and eventually to plant growth and crop quality. Because infiltration problems develop slowly they are often overlooked. In many cases it takes just a few seasons for plants to begin to die or for the soils to become increasingly less productive.

The most important factor for water penetration is too many or too little salts in the water and/or soil. While all water used for irrigation contains some dissolved salts, the suitability of water for irrigation depends on the kinds and amounts of salts present. The salts of concern for irrigation and water penetration are primarily compounds of positively charged anions (calcium, magnesium, potassium and sodium), and negatively charged anions (bicarbonate, carbonate, chloride and sulfate). Many don't realize that as irrigation water moves down into the soil profile, it does one of two things. It is either depositing salts in the soil, or it is stripping or removing essential elements or constituents from the root zone.

Salinity (electrical conductivity of water and sodium content or sodicity of irrigation water, especially influence whether soil particles remain together or separate (flocculate and deflocculate). The higher the sodium content and lower the total salt content of irrigation water, the more likely soil particles will become separated and disorganized. This is caused by a chemical imbalance between calcium and sodium plus magnesium, both villains to good soil structure. Since both salinity and the amount of sodium and magnesium in irrigation water influences aggregate stability, all must be considered when determining the likelihood that water quality can reduce water infiltration.

Snow-melt runoff from the Sierra Nevada, Cascade and other mountains contains very little salts.

**Lack of calcium**

Danyal Kasapligil, agronomist with Dellavalle Laboratory, Fresno says: "A lack of calcium in the majority of soils due to snow-melt irrigation water, or poor quality subsurface water, is leading to serious problems in California. What we are seeing in the field is, not only are there more and more water penetration problems, but crop quality is also rapidly declining because of a lack of calcium in our irrigation water."

It has been field proven: for irrigation water to penetrate deeply into the soil, the electrical conductivity of the water needs to be greater than approximately 0.60 dS/m (decisiemens per meter). Irrigation water with less than 0.60 dS/m conductivity will contribute to loss of soil structure and reduce water penetration. The electrical conductivity of snow-melt

runoff from the Sierra Nevada Mountains typically measures 0.02 dS/m or less. This water is too pure. It lacks calcium, essential for good soil structure; and any calcium existing in the soil profile leached below the root zone over time or used by the crops, and is typically not being replaced in required quantities.

Also, for optimum soil structure there should be approximately 16 times more calcium than sodium, and 8 times more calcium than magnesium in the soil.

Another major problem with irrigation water that contributes to poor soil structure is the presence of bicarbonate salts. The problem with bicarbonate present in irrigation water is it will combine with any calcium in the water or soil to form lime when the water evaporates. Bicarbonate is the most toxic anion that exists in relation to plant health. Irrigation water that has excessive levels of bicarbonates should be treated with an acid to eliminate the potential for lime precipitation.

**Ways to help**

There are several ways to help improve water infiltration problems including:

-- Physically breaking surface crusts and compacted soils with use of chisels, and rippers.

-- Applying organic matter such as composts and manures to improve the stability of soil aggregates.

-- Using wetting agents and related products to help with soil hydrophobicity.

However, since the problem of water quality and penetration is for the most part one of chemistry and not physics or mechanics, a chemical solution to the problem using soil amendments containing calcium is usually required. With its addition, calcium's availability is increased in the soil while sodium and magnesium are decreased. The result is increased total salt concentration of the soil water and decreased exchangeable sodium concentration. Poor water penetration is directly caused by a chemical imbalance in the soil and irrigation water.

Balancing both the soil and irrigation water using additional calcium can correct nearly all water penetration problems

Chemically, calcium counterbalances sodium and/or magnesium, thus increasing both macro- and micro-pore formation in the soil. The result is a reduction in:

-- Soil aggregate degradation.

-- Surface crusting.

-- Deflocculation or cementing problems.

When calcium is applied to the soil and/or irrigation water, the detrimental sodium and magnesium are removed from the soil system. The chemical reaction and positive effect is immediate and dramatic, but not permanent. Therefore, a routine calcium application maintenance program is generally required.

Water now penetrates deeper into the soil profile due to a more flocculated or organized soil condition.

-- Less water is wasted due to runoff or "ponding" on the soil surface, thus reducing both wet and dry areas and erosion.

-- Less irrigation water is required to achieve the same results.

-- There is an improvement in water use efficiency. Twenty-five to 100 percent more water is available in calcium treated soils versus untreated

soils.

-- There is increased oxygenation in the root zone.

-- Calcium is an essential plant nutrient, generally found in deficient quantities in most soils.

Calcium is often required by crops in amounts comparable to nitrogen and potassium. Bitter pit in apples, blossom-end rot in tomatoes, peppers and watermelons; blackheart of celery, club-root in cole crops, are all calcium deficiency related. Calcium deficiency also reduces fruit quality and seed formation and quality in all crops.

**More problems**

John Witzske, owner of Water Right Technologies, Modesto, says, "I have been working with a lot of growers in the coastal valleys, especially berry and grape growers, where they are experiencing more water penetration and crop quality problems than ever before. The problem is directly related to a lack of calcium, plus high bicarbonate and sodium in the irrigation water and soil, along with high soil magnesium in many areas. With the use of organic soil amendments along with a balanced calcium and acid program, we are correcting many of the associated water penetration and crop quality problems in those areas."

We have witnessed fields and crops that have not only benefited from precise and accurate water and soil treatment for water penetration problems, but often the crops themselves have been saved from failure. Treatment of irrigation water and soils to improve water penetration should be considered a vital component and necessary "first step" to all successful soil and water management programs in the agriculture.

(Brent Rouppet is a soils consultant. He is a former faculty member at Cal Poly, San Luis Obispo and New Mexico State University. He is also former Senior Soil Scientist for Soil Solutions International and Soil Solutions Australia. His Ph.D. is in soil chemistry/soil-plant relations from Colorado State University. E--mail soildoctor@fertile-soil.com)



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