Salinity

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This is the final article on soil testing. The specific topics discussed in the five previous articles are summarized below and can be reviewed at UCCE county websites. Tehama County website is located at http://www.cetehama.ucdavis.edu. Select UCCE Tehama, orchard crops, Fruit and Nut newsletter then scroll down to each article:

1. General overview of soil testing and the types of information provided from them (May 2009).
2. Interpreting soil pH and Saturation Percentage measurements (April 2010).
3. Primary plant nutrients: Nitrogen (N), Phosphorus (P), and Potassium (K) (July 2010).
4. Secondary plant nutrients: Calcium (Ca), Magnesium (Mg), and Sulfur (S) (November 2010).
5. Plant micronutrients: boron (B), chloride (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni), and zinc (Zn) (April 2011).

The focus of this article is soil testing to diagnose salinity conditions. Soil testing can help diagnose three different types of field conditions that adversely affect orchard performance: 1) osmotic effects caused by excessive root zone salinity; 2) specific ion toxicities resulting from the accumulation of too much boron, chloride, or sodium and 3) soil chemistry properties that can affect soil structure and reduce water infiltration.

Osmotic Effects

Electrical conductivity measured in the saturation soil extract (EC_e) increases as soil salinity increases and is a measure of the osmotic influences on crop growth and yield. Under non-saline soil conditions, the concentration of solutes in plant root cells is higher than in the soil-water surrounding the roots. This gradient allows water to move freely from the soil into the plant root. When soil salinity increases in the soil-water surrounding the root and exceeds a critical threshold, the gradient between the solute concentration in the root cells and the soil-water around the root lessens, causing reduced water availability to plants. In response to increased soil salinity, agricultural crops such as almond internally produce more sugars and organic acids to increase the solute concentrations inside root cells and attempt to re-establish the gradient for water to again move freely into root cells. However, this internal plant process that adjusts for soil salinity competes for energy that would otherwise be used in photosynthesis, thereby, suppressing crop growth and yield. Symptoms of soil salinity are subtle, typically characterized by smaller less vigorous trees with lower productivity.

Table 1 provides guidelines to identify excess salinity in the root zone of almond orchards and the effect on almond yield potential. Salinity is usually expressed as deciseimens per meter (dS/m). Almonds with average rootzone salinity less than 1.5 dS/m would not be expected to affect almond production potential when the leaching fraction is 15 percent or more. Generally, osmotic effects from salinity in soils or irrigation water are uncommon in the Sacramento Valley and more likely to be observed in the San Joaquin Valley.

Table 1. Guidelines to identify excess salinity in orchard soils and water supplies, and their effect on yield potential for mature almond trees.

	Percent of full almond yield potential		
Salinity Measurement in (dS/m)	100 %	99 to 40 %	< 40 %
Average root zone	< 1.5	1.5 – 4.8	> 4.8

Specific Ion Toxicity

Specific elements such as boron (B), chloride (Cl), and sodium (Na) may accumulate in soil. If these specific elements become overly concentrated in the rootzone, crop injury is expressed first as scorching in older leaves and sometimes stems and shoots die back as concentrations in plant tissues increase. Thresholds for ion toxicity are specific for different crops and specific elements. For almond, thresholds of 5.0 meq Cl/l, 0.5 mg B/l, and an average sodium adsorption ratio (SAR) greater than 5.0 represent rootzone conditions where the onset of specific toxicities may be expected. SAR is a value that describes the balance between sodium versus calcium and magnesium in the soil-water. Using the SAR to diagnose sodium toxicity is preferred to examining only the Na levels in soil because it considers the exchange reactions that are affected by the sodium, calcium, and magnesium balance. The risk of specific ion toxicity is more likely as levels in the rootzone increase above these thresholds. Severe limitations for planting almonds are expected when Cl, B, and SAR levels exceed 15.0 meq Cl/l, 3.0 mg B/l, and 15.0, respectively.

Slow Water Infiltration

Low salinity and high SAR levels contribute to unstable soil structure. Soil aggregates swell and disperse into individual particles when irrigated. After the applied water recedes, the particles settle: finer textured clay and silt particles fill the pore spaces between larger sand particles to form a slowly permeable surface crust. The salinity of the soil-water (ECe) and the sodicity (SAR) of the soil-water must be considered together to assess the extent that salinity is contributing to a water infiltration problem. As a general rule, if the SAR of the soil-water is 10 times greater than the EC the probability of slow water infiltration developing is high. If the SAR is 5 to 10 times higher than the EC there is a possibility that salinity is contributing to an infiltration problem but other factors may be more significant. When the SAR is less than 5 times higher than the EC, it is unlikely that salinity is contributing to slow water infiltration.

Some scientific evidence suggests that magnesium can contribute to soil dispersion when it is predominant in a soil. The above guidelines do not address soils where sodium is low but magnesium (Mg) is relatively high in comparison to calcium (Ca). As a general rule, when Mg levels in a soil-water extract exceed a 1:1 ratio to calcium, soils may develop infiltration problems.