Citrus management under saline conditions

By Mongi Zekri, Brian Boman and Jim Syvertsen

Salinity management is of increasing concern in several citrus-producing areas of Florida due to the use of Floridan aquifer water that can contain high salt levels, leaking artesian wells that have contaminated surficial aquifer wells, and saltwater intrusion into coastal groundwater aquifers. The two main problems with the salinized water are the toxic effects of sodium and chloride ions, and the osmotic stress caused by high total dissolved solids (TDS).

An increase in the salt concentration of water in the soil solution is analogous to drought stress from soil drying since both result in reduced water uptake. Toxicity of specific ions is attributed to excess accumulation of certain ions in plant tissues and to nutritional imbalances caused by such ions. It is more difficult for roots to extract water from saline solutions than from fresh water.

Salinity is known to adversely affect all stages of plant development including root and vegetative growth. Salinity can also depress photosynthesis, flowering and fruit yield, and result in small fruit size. Citrus is generally classified as a salt-sensitive crop because physiological disturbances and growth and fruit yield reductions can occur at relatively low-salinity levels. However, with proper irrigation management, citrus trees in Florida can withstand relatively moderate salinity levels depending on the soils, scion cultivar, rootstock and general tree condition.

Salinity management should be an important component of irrigation management when the irrigation water exceeds 1200 ppm of total dissolved solids (TDS) for Florida citrus. Irrigation with high salinity water requires more frequent applications and a greater volume to leach out salts from soil than when good quality water is used. During extended droughts, salinity levels should dictate irrigation scheduling.

As soil dries, salts become concentrated in the soil solution, increasing salt stress. Therefore, salt problems are more severe under hot, dry conditions than under cool, humid conditions. Increasing irrigation frequency and

applying water in excess of plant demand may be required during hot, dry periods to minimize salinity stress.

With microirrigation systems, irrigating under the canopy to eliminate or reduce wetting of the foliage enables the use of poorer quality water that cannot be tolerated with overhead sprinklers. Direct foliar uptake of salts, and hence leaf injury, is reduced with microirrigation systems relative to overhead systems. Nevertheless, saline water cannot be used indiscriminately with microirrigation systems. Frequent irrigation intervals help to maintain a low soil water tension and reduce salt accumulation within the wetted zone. Typical symptoms of chloride tip burn on leaves are shown in the photo at left.

The primary requisite for managing soil salinity is adequate drainage because successful irrigation management to alleviate salinity problems requires leaching. Irrigation rates should be monitored to make sure that excess salts are leached below the root zone. Leaching should remove enough salts and prevent their build-up to damaging levels. However, excessive leaching can lead to loss of some essential nutrients. Heavy soils may be more problematic than sandy soils. Poorly-drained soils or soils with perched water tables are difficult to leach properly because of inadequate permeability or drainage.

Both surface and well water salinity can change throughout the year. In areas where salinity is a known problem, the water source should be tested for water quality periodically. The instructions for testing and the test results may be obtained from a county Extension office or an independent water analytical laboratory. The results of the test will determine if the water is suitable for irrigation or reveal if any special strategies will be required to alleviate some of the problems.

Effects of irrigation and fertilization on tree production and growth interact, and their management should always be considered together. There are two particularly important aspects of fertilization that should be considered when irrigating with high salinity water:

1. The addition of fertilizer salts increases the osmotic stress to which tree roots are subjected. Frequent application of low-salt-index fertilizers at low rates can be effective at minimizing effects of salinity.

2. When trees accumulate salts, their nutrient uptake is affected by the salts, and premature leaf drop may result. Therefore, additional nutrients may be needed to replace those lost through leaf drop.

When saline irrigation water is used, fertigation (injection of fertilizer through irrigation water) should be managed properly. The frequencies of fertigation and dry fertilizer application have a direct effect on salt concentrations in soil solutions. A fertilizer program using frequent applications of relatively low fertilizer levels is recommended over a program using infrequent applications of high-fertilizer (salt) concentrations. Drip irrigation systems that are managed to maximize water and fertilizer uptake efficiency may present additional salinity problems even when using high-quality water.

Selecting nutrient sources that have a relatively low-salt index (the osmotic stress effect that a nutrient material adds to a soil solution) can reduce salinity problems (See the table at right). For example, avoiding the addition of chloride from the application of muriate of potash (potassium chloride) and avoiding the addition of sodium from sodium nitrate to avoid adding potentially harmful ions to already high salt levels in irrigation water and soil are good strategies.

Calcium counteracting sodium has been known to have an ameliorating effect on the growth of plants under saline conditions. The use of enhanced potassium and nitrate fertilization is also a potent tool in reducing sodium and chloride toxicity.

RECOMMENDATION SUMMARY

In groves where salinity is a known problem (> 1200 ppm TDS), irrigate frequently to maintain high soil moisture. Evaporation removes relatively pure water from the soil, leaving salts in the soil. As a result, salts concentrate when soils dry and the potential for tree stress increases.

The volume of irrigation water should be great enough so that any accumulated salts are leached below the root zone in each irrigation.

When no single rain exceeds 1 inch, apply a soil-flushing irrigation every seven to 10 days by operating microsprinklers long enough to push water into water furrows or below 2 feet (often six to eight hours of irrigation required).

Salinity of fertilizer is likely to be important. Split fertilizer applications to five times/year or more and consider using materials with lower salt index. Well-managed fertigation is probably the best solution, with dilute weekly or biweekly applications at low rates.

Consider using supplemental foliar sprays of low-salt-index N and K materials. High salinity levels may interfere with nutrient uptake and cause premature leaf drop, which increases nutrient demand.

This article is a communication of UF, IFAS Extension/Research Team. For more information and program updates, please visit the Web site http://solutionsforyourlife.ufl.edu or contact your county Extension agent.

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Salt Index of Some Fertilizer Sources

Material and Analysis	Salt Index per unit (20 lb.) of plant nutrient
Nitrogen	
Ammonia, 82.2% N	0.572
Ammonium nitrate, 33.5% N	2.990
Ammonium sulfate, 21.2% N	3.253
Ammonium nitrate, 20.5% N	2.982
Calcium nitrate, 15.5%	4.194
Sodium nitrate, 16.5% N	6.060
Urea, 46.6% N	1.618
Phosphorus	
Normal superphosphate, 20% P_2O_5	0.390
Concentrated superphosphate, 45% P_2O_5	0.224
Concentrated superphosphate, 48% P_2O_5	0.210
Monoammonium phosphate, 12.2% N, 61.7% P_2O_5	0.405
Diammonium phosphate, 18% N, 46% P_2O_5	0.456
Potassium	
Potassium chloride, 60% K_2O	1.936
Potassium nitrate, 13.8% N, 46.6% K_2O	1.219
Potassium sulfate, 46% K_2O	0.853
Monopotassium phosphate, 52.2% P_2O_5, 34.6% K_2O	0.097
Sulfate of potash-magnesia, 21.9% K_2O, 10.8% Mg	1.971