Saline irrigation water: impacts on citrus production

By Mongi Zekri, Barrett Gruber and Brian Boman

WHAT CONDITIONS LEAD TO IRRIGATION WATER BECOMING SALINIZED?

Irrigation of Florida citrus can be challenging due to the variety of ways that salts can be introduced into the agricultural water supply. For example, the use of Floridan aquifer water containing high salt levels, leaking artesian wells that have contaminated surficial aquifer wells, saltwater intrusion into groundwater aquifers, and the salt index of fertilizers are all factors that should be taken into consideration when developing a citrus irrigation management plan.

In general, all irrigation water has at least some dissolved salt. The degree to which irrigation water is salinized can be measured through monitoring the total dissolved solids (TDS). Typically, irrigation water intended for citrus production is usually considered "adequate" if the TDS, measured in parts per million (ppm), is less than 1,000 ppm to 1,200 ppm. In irrigation water with TDS values greater than 1,000 ppm, the potential for developing toxic conditions for plant growth arises from high levels of sodium and chloride ions. High concentrations of these ions, even when the total volume of irrigation water applied is adequate for tree growth and fruit production, can make it more difficult for a tree to take up water from the soil due to increased osmotic stress of the plant's root cells.

WHY IS MONITORING IRRIGATION WATER SALINITY IMPORTANT?

If irrigation water salinity is not managed (for example, if the TDS value chronically exceeds 1,200 ppm), there is an increased risk of toxicity to the citrus tree. Highly salinized water negatively affects all biological stages of citrus, including root, leaf and fruit development (Figure 1). Citrus is considered to be a salt-sensitive crop because important plant physiological processes (including leaf photosynthesis and flower induction) are negatively impacted with even moderately salinized irrigation water.

Figure 1. Symptoms of salt damage (yellowing and desiccation) to citrus foliage.

HOW CAN IRRIGATION WATER SALINITY BE MANAGED?

Throughout the growing season, water content within the soil fluctuates. During the rainy months of summer, water content is higher, and in the drier months of winter, it is lower. Salt ions become concentrated within the soil when

water contents are relatively low. This is due to the inability of salts to be leached below the citrus tree's root zone. Thus, periodic leaching may be required to help flush salts from the root zone. This flushing is accomplished by frequent irrigation cycles during the dry months of the year.

If groves are located in a region where it is known that TDS values regularly exceed 1,200 ppm, or in areas where soil is poorly drained or where there is a perched water table, there is an increased risk of salinity-associated plant toxicity. In these situations, frequent irrigation cycles are also used to help flush excess salts beyond the citrus tree's root zone. However, salt concentrations also fluctuate throughout the year, and it is important to regularly monitor the TDS value of irrigation water. A county Extension agent can assist in developing a salinity monitoring program, including providing instructions on how to take water samples and interpreting the results. Regular maintenance of any water furrows, ditches and canals will also reduce the risk of developing salinity-associated toxicity by ensuring that the soil in the grove is drained properly.

The salt index (Table 1) and fertilizer source materials should be taken into consideration when developing a citrus irrigation management plan. As values of the salt index increase, the osmotic stress (the stress placed on citrus roots' ability to absorb water from the soil) also increases. Thus, selecting fertilizers with low salt indexes, particularly in situations where TDS values exceed 1,200 ppm, should be part of the management program. Specifically, replacing sodium nitrate and potassium chloride N and K sources with lower salt index N and K materials should result in lowered salinity-associated stress and reduce exposure to toxic Na and Cl in the soil solution. Frequent irrigation cycles aimed at leaching salts below the root zone (mentioned above) can also flush essential plant nutrients away from roots. Therefore, using split-applications of dry, water-soluble fertilizers several times during the year, or low-volume, low-concentration with high-frequency liquid fertigation cycles, may be preferred to fewer fertilizer applications at higher rates.

Citrus scion cultivar and rootstock also have known interactions with salinized irrigation water. Generally, grapefruit cultivars are more sensitive to high salt levels than orange cultivars, although both grapefruit and orange cannot tolerate salinized irrigation water for long periods of time. Through both anecdotal and formal research observations, it has been noted that some rootstocks are more forgiving of saline irrigation water than others. The following rootstock varieties are generally viewed as being relatively less-to-more sensitive to salinity: Cleopatra mandarin, sour orange, sweet orange, Swingle citrumelo, Carrizo citrange and rough lemon.

SUMMARY

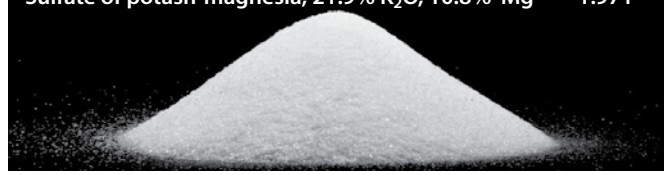
The salinity of irrigation water can have far-reaching effects on citrus production. Chronically high levels of salt (when TDS values exceed 1,200 ppm) can severely damage citrus tree growth and fruit production. Under these conditions, it is important to regularly provide a flushing irrigation that will be successful in leaching potentially toxic salt ions past the root zone. Even when water sources typically have TDS values below 1,200 ppm, periods of little rainfall can lead to high concentrations of salt ions in the soil. Thus, a leaching irrigation is often also required in times of little or no rainfall. The following are basic guidelines that might form the basis for successful citrus irrigation management.

• Regular flushing irrigations to achieve root zone leaching (duration of at least six hours every seven to 10 days) when TDS values regularly exceed 1,200 ppm or during periods of little or no rainfall

• Maintenance of any water furrows, ditches or canals to ensure that the grove space is drained properly

Table 1. 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% N	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



• Avoid using fertilizers whose components have high salt indexes. If using dry fertilizer, rely upon split applications as frequently as possible. If fertigating, rely on low-volume, low-concentration applications with frequent cycles.

• Rootstock selection can have significant implications regarding salinity management. Swingle, Carrizo and rough lemon are relatively more sensitive to salt, although all citrus is susceptible to salinity-associated toxicity.

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Hall of Fame nominations sought

Nominations are being sought for potential inductees to the Florida Citrus Hall of Fame, with induction ceremonies scheduled for March 7, 2014 at Florida Southern College in Lakeland. The luncheon is co-sponsored by Florida Citrus Mutual and the Florida Department of Citrus.

The deadline for nominations is November 1, and all nominations should include a summary of the nominee's accomplishments, letters of support from industry members and a photo. Nomination forms are available at www.FloridaCitrusHallofFame.com or from Brenda Eubanks Burnette at (561) 351-4314.

Completed applications should be e-mailed to BBurne1003@aol.com, or hard copies should be sent to Florida Citrus Hall of Fame, 411 E. Orange St., Lakeland, FL 33801. For more information, contact either Burnette or John Jackson (jackson71344@yahoo.com).