Outline for Managing Irrigation of Florida Citrus with High Salinity Water[1]

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Salinity Management

Salinity management is sometimes an important component of irrigation management. High levels of salts in irrigation water can compromise water relations in citrus trees, resulting in water stress even when soils have a relatively high water content. Irrigation with high salinity water requires more frequent applications and a greater volume than when good quality water is used. In addition, proper management will require flushing of salts with excess irrigation water. During extended droughts, salinity levels should dictate irrigation scheduling.

This document has been prepared as an easily implemented guide for Florida citrus growers using high salinity water. It is recommended that growers implement irrigation management practices to manage salinity when irrigation water salinity exceeds 1200 ppm of total dissolved solids (TDS). This threshold is somewhat arbitrary since research in Florida has shown that the detrimental effects of salinity increase in direct proportion to the irrigation salinity level (Fig. 1 and Fig. 2).

Typically, more salinity results in lower yields and growth. However, when water is below 1200 ppm, detrimental effects are likely to be minimal. More detailed information on effects of salinity on citrus management can be found in an IFAS Circular titled "Managing Salinity in Florida Citrus" located at: http://edis.ifas.ufl.edu/ae171.

Irrigation and fertilization interact in their effects on tree production and growth, and management of one should always consider the other. 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 (see IFAS Circular 1411 at: http://edis.ifas.ufl.edu/ae171 for more details).

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.

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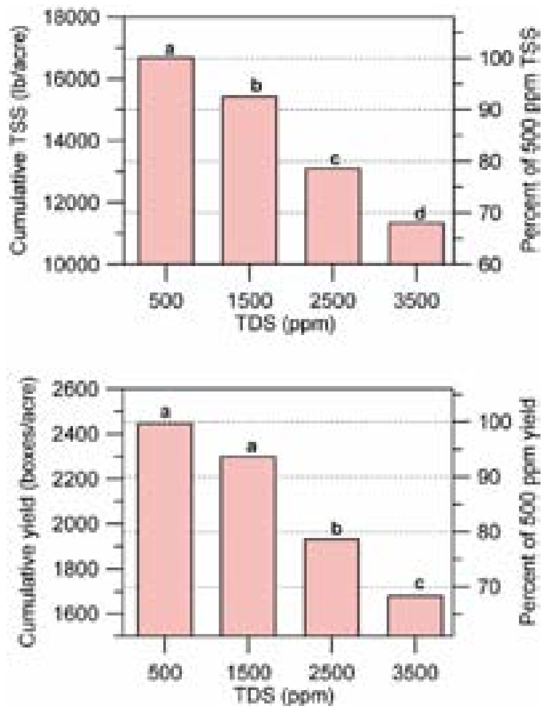

Figure 1. Five-season (1996/97 through 2000/01) cumulative yields and soluble solids by irrigation salinity level for 'Valencia' orange on rough lemon rootstock planted in 1986 (Boman, 2001). The right axis expresses parameters as a percentage of that measured for irrigation with 500 ppm TDS water. Means followed by the same letter are not significantly different according to Duncan's Multiple Range Test (P=0.05).

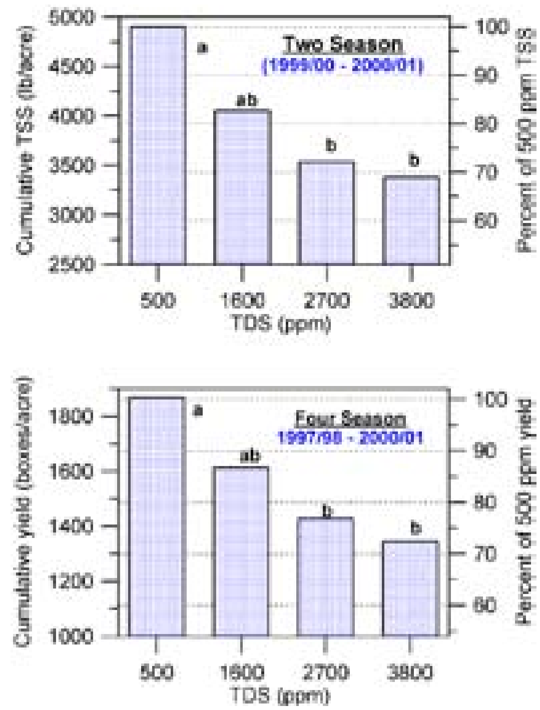

Figure 2. Four-season (1997/98 through 2000/01) cumulative yields and two-season (1999/00-2000/01) soluble solids by irrigation salinity level for 'Ray Ruby' grapefruit on Swingle citrumelo rootstock planted in 1990 (Boman, 2001). The right axis expresses parameters as a percentage of that measured for irrigation with 500 ppm TDS water. Means followed by the same letter are not significantly different according to Duncan's Multiple Range Test (P=0.05).

Evapotranspiration

The change of water from a liquid to a gaseous state is called evaporation. Evaporation rate is affected by solar radiation, air temperature, vapor pressure, wind, and atmospheric pressure. Evaporation occurs from raindrops, free water surfaces (i.e. lakes and ditches), and from water that has settled onto vegetation or soil. During evaporation, moisture is moved into the atmosphere as water vapor.

The transfer of water from plants to the atmosphere as vapor through leaf openings is called transpiration. The amount of transpiration depends on the plant species and the amount of light exposure, temperature, humidity, wind, and time of year. Transpiration increases movement of water to the atmosphere. Aeas that have healthy plants that shade the ground will have increased transpiration and reduced soil evaporation compared to areas with bare soil.

The combination of water evaporating and transpiration is called evapotranspiration (ET). The amount of irrigation required depends on the ET rate, soil characteristics, root zone depth, and the efficiency at which the water is applied.

Citrus trees require water for transpiration throughout the year. Water requirements vary with climate, ground cover, cultivation practices between rows, weed control, tree size and age, scion, and rootstock. Water requirements of grapefruit are higher than orange or mandarin varieties.

Young trees only require about 1 gal/day during the first 2 years and about 4, 7, 12, and 17 gallons per day from the third to the sixth year, respectively. Large, vigorous, healthy trees require more water than weak, non-productive trees. Daily water requirements vary considerably during the year (Table 1) depending primarily on temperature, humidity, and wind velocity. Irrigation strategy should be adjusted for non-typical weather conditions, when bloom is very early or late, or when temperatures are unseasonably cool or warm for several days.

General Calendar for Managing Irrigation Based on Irrigation Water Salinity

February Through Mid-June

The period of greatest concern is from pre-bloom through early fruit development - typically February through mid-June.

A. IF SALINITY IS LESS THAN 1200 PPM:

- Irrigate normally (supplementing rainfall with irrigation to reach recommended level)

1. Except in very coarse sands (which may require water daily), irrigations can be applied in 2-3 irrigations per week (e.g. In April, trees may require 34 gal/tree/day. To meet this irrigation requirement, 3 applications of 80 gal/tree would suffice).

2. The volume of irrigation water should not be so great that water is clearly being flushed from beds in coastal groves or pushed below three feet in Ridge soils.

3. If drought extends 4+ weeks with no single rain exceeding 1 inch, apply a soil-flushing irrigation by operating microsprinklers long enough to push water into water furrows or below 3 feet if there is no hardpan (often 8-10 hours).

- Salinity should be low enough to not influence the selection of fertilizer materials. Use the cheapest materials that meet tree nutrient needs, avoiding application just prior to expected heavy rains.

B. IF SALINITY IS GREATER THAN 1200 PPM:

- 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.

1. The volume of irrigation water should be great enough so that water is clearly being flushed from beds (or below 3 feet if there is no hardpan) in each irrigation.

2. When no single rain exceeds 1 inch, apply a soil-flushing irrigation every 7-10 days by operating microsprinklers long enough to push water into water furrows or below 3 feet if there is no hardpan (often 8-10 hours).

- Salinity of fertilizer is likely to be important. Split applications to 5 times/year or more and consider using materials with lower salt index. Fertigation is probably the best solution, with weekly or bi-weekly 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.

Mid-June - November.

Trees will handle greater water stress, but they use more water than in cooler months. Irrigations should commence before 50-60% of the soil moisture is depleted.

A. IF SALINITY IS LESS THAN 1200 PPM:

• Irrigate normally (supplementing rainfall with irrigation to reach recommended level)

1. Monitor water table and soil moisture to determine if irrigation is necessary. Once June drop period is passed, the trees will tolerate slightly more soil moisture depletion before adverse effects are noticed. Therefore, the interval between irrigations can usually be increased by 1 day or more compared to spring intervals of 1-2 days.

2. Irrigation can be applied in 3 irrigations per week, if necessary.

3. The volume of irrigation water should NOT be so great that water is clearly being flushed from beds or below 3 feet if there is no hardpan.

- Salinity should be low enough to NOT influence the selection of fertilizer materials. Use the cheapest materials that meet tree nutrient needs, avoiding application just prior to expected heavy rains.

B. IF SALINITY IS GREATER THAN 1200 PPM:

• Monitor water table and soil moisture to determine if irrigation is necessary. Once irrigations are required, irrigate at least every other day to minimize concentration of salts in soil solution.

1.The volume of irrigation water should be great enough so that water is clearly being flushed from beds (or below 3 feet if no hardpan) after each irrigation.

2. When no single rain exceeds 1 inch, apply a soil-flushing irrigation every 7-10 days by operating microsprinklers

long enough to push water into water furrows or below 3 feet if there is no hardpan (often 8-10 hours).

- Selection of fertilizer materials should consider effects of salinity. Split applications to 5 or more times per year and consider using materials with lower salt index. Fertigation is probably the best solution.

- 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.

November - January

Trees will handle greater water stress, and use less water. For all water salinities encountered in Florida citrus production areas, irrigating normally (supplementing rainfall with irrigation to reach recommended level) should be adequate.

1. 15-25 gallons per day per tree for mature trees

2. Irrigation every 5-8 days should be sufficient.

References

Boman, B. J. 2001. Effects of saline irrigation water on Florida citrus. Pub. No. SH2001-SP12. St. Johns River Water Management District, Palatka, Fla. 79 pp.

Table 1. Typical reference evapotranspiration (ETo) rates, crop coefficients (Kc), and evapotranspiration (ET) for healthy, mature, well-watered citrus calculated from long-term data (West Palm Beach).

Month	Kc	ETo	ET	116 trees/ac	145 trees/ac	181 trees/ac
		gal/tree/day	gal/tree/day	gal/tree/day		
Jan	0.90	0.10	0.09	21	17	14
Feb	0.90	0.13	0.12	27	22	18
Mar	0.90	0.16	0.14	34	27	22
Apr	0.90	0.19	0.17	40	32	26
May	0.95	0.19	0.18	42	34	27
Jun	1.00	0.18	0.18	42	34	27
Jul	1.00	0.18	0.18	42	34	27
Aug	1.00	0.18	0.18	42	34	27
Sep	1.00	0.16	0.16	37	30	24
Oct	1.00	0.14	0.14	33	26	21
Nov	1.00	0.12	0.12	28	22	18
Dec	1.00	0.10	0.10	23	19	15