Results from Past and On-going Research on Citrus ET & Kc

Advances in Citrus Water Use Workshop
Strathmore, CA – March 26, 2019

D. Zaccaria, R. Snyder, G. Marino, G. Douhan, B. Sanden
University of California, Davis - Agricultural Water Management Lab
Correspondence: dzaccaria@ucdavis.edu
Most of these studies were conducted in Orange orchards grown with infrequent irrigation (surface or sprinkler irrigation) and using the soil-water budget to estimate ETc and Kc.

All these studies highlighted the uncertainty of the field water balance approach as factor limiting the precision of the ETc estimates.

They also indicated the need for more precise measurements of Citrus ET in commercial field production conditions and ET interactions with climatic variables and cultural practices.
Working with drip irrigated clementines in a precise weighing lysimeter in Valencia, Spain, Castel found that the annual $K_c$ was linearly related to ground cover and reported the following relationship:

$$K_c = 0.006 \text{ ground cover} + 0.272 \quad (R^2 = 0.96)$$

He also emphasized that the $K_c$ will depend on the frequency of wetting of the orchard floor; he found that without rain, surface evaporation for young drip irrigated trees varied between 8 to 30 percent of total $ET_c$ while after a rain, it reached 30 to 50 percent of total (Castel, 1997).
72 combinations of treatments including 3 irrigation levels (80%, 100%, and 120% ETc), 3 N fertilizer levels, gibberellic acids (±), and fungicide-nematocide (±) were included in the economic analysis. Irrigation appeared to have the largest effect on yield. The highest production level occurred at 120% of evapotranspiration demand of the trees. This result was surprising, since we felt that overirrigation would lead to root health problems by encouraging Phytophthora populations. To date this has not occurred, and the trees receiving 120% of evapotranspiration yielded 12% more fruit than the trees receiving 100% of evapotranspiration. Those trees receiving only 80% of evapotranspiration demand yielded only 3% less than those receiving 100% of evapotranspiration. While these figures may encourage growers who face water shortages, we should add that the trees receiving 80% of evapotranspiration are losing leaves and declining, and the fruit are smaller and of poorer quality. Nevertheless, citrus appears able to weather short periods of water stress with relative ease. Irrigation effects were uniform across the other variables.
Research on micro-sprinkler irrigated mature citrus (70% GC) in Tulare County (2001-2004)

by R. Snyder and N. O’Connell

- ET and Kc of orchards with four different canopy coverages (2004)

*Kc ~ 1.00 was observed for a mature Navel orange orchard (~ 70%) that also had 2.5 times the average yield observed in Tulare County in the same year (2003)*
East-West Rows Near Lindsay (photo @ ~ 8:00 am)

Light hits the ground only near sunrise & sunset
Clearly, this research indicates that citrus growers could potentially increase water productivity (crop x drop or $$/unit water) using crop coefficient higher than Kc = 0.65.
Measurement of light interception by navel orange orchard canopies: the case study of Lindsay, California.

\( K_c = 0.85 \) for \( GC = \sim 65-70\% \) => near Catania, Italy
THE UC RESEARCH PROJECT ON CITRUS ET MEASUREMENTS

Instrumented 3 Navel orange and 3 Page mandarin orchard blocks.

Measuring actual ET and Kc with N-S vs. E-W row orientations, + 3 water applications corresponding to Kc = 0.60, Kc = 0.70, Kc = 1.0

The 2 Control blocks are irrigated based on Kc = 0.70, whereas the 2 irrigation treatments with N-S are irrigated based on Kc = 0.6, and Kc = 1.0

We measure the actual ET and Kc with EC-SR equipment, light interception by the tree canopy with the Mule Light Bar, while monitoring soil moisture with Watermarks, and tree water status with SWP, dendrometers and IR Thermometers.
NAVEL ORANGES
105 year-old

BLOCK 4
9.5 Ac: N-S
Kc = 0.70

BLOCK 7
12 Ac: E-W
Kc = 0.70

BLK 5
Kc = 0.6

BLK 5
Kc = 1.0
PAGE MANDARINS
16 year-old

BLK 3: 5 Ac
E-W
Kc = 0.70

BLK 2-N: 5 Ac
N-S
Kc = 0.60

BLK 2-S: 5 Ac
N-S
Kc = 1.0

BLK 4: 10 Ac
N-S
Kc = 0.70
THANK YOU!