Comments about crop coefficients for Hass Avocado on Mexican Seedling Rootstocks.

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Salinity and water effects on 'Hass' avocado yields

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Abstract

A field experiment was conducted between 1992 and 1997 in a commercial orchard of mature 'Hass' avocados on Mexican seedling rootstock (Persea americana Mill.) to determine how yield was influenced by the amount of irrigation water applied and the frequency of application. Three amounts of applied water (targeted at 90, 110 and 130% of estimated crop evapotranspiration) were applied at three frequencies (one, twice and seven times per week) with microsprinklers located beneath the tree canopy. The site was setup as a randomized complete block design with six blocks, each including one replicate of all irrigation treatments. One or two trees located at the center of the replicates were used to measure yields and tree size, and as the locations where samples of soil and soil-water were obtained for analysis from beneath the tree canopy. The average electrical conductivity and chloride concentration of the irrigation water, corrected for rain, were 0.7 $dS{\cdot}m^{-1}$ and 1.8 $mmol{\cdot}L^{-1}$, respectively. From May 1994 to Nov. 1996, salinity of the saturated-paste extracts of soil samples obtained in the 0 - 120-cm-depth

interval averaged about 2 dS·m^{-1} for all irrigation treatments. Irrigation treatments also had little influence on the maximum soil-water salinity, about 4 dS·m^{-1}, in and below the lower portion of the rootzone. Consequently, the fraction of applied water that was not used by the crop was also not influenced by irrigation treatment. Chloride concentrations in leaves were affected by applied water, but did not attain levels that are associated with leaf injury. Trees irrigated seven times per week had lower yields than trees that received less frequent irrigation. During the last two years of the experiment, when yields no longer increased with time, the yields for treatments irrigated once and twice a week increased with increasing amounts of applied water. We were able to explain the influence of both amount of applied water and soil salinity on avocado yields and leaching fraction using production function concepts. The threshold amount of nonsaline water required to obtain yields greater than zero was determined to be 620 mm/year, and the amount required to obtain maximum yield was 1200 mm/year. Yields increased with increasing amounts of applied water because of increased water availability for crop use before a soil-water salinity of about 4 dS·m^{-1} restricted water uptake. The threshold salinity above which yield decline occurred was determined to be 0.57 $dS \cdot m^{-1}$ and yield declined by 65% per unit of salinity above the threshold. Our results suggest that maximum yields of ‘Hass’ avocado on Mexican seedling rootstock are not achievable when the average annual salinity of irrigation water, including rainfall, is greater than about 0.6 $dS \cdot m^{-1}$.

CROP COEFFICIENT

Crop coefficient for mature Hass avocado on Mexican rootstocks was not discussed in the paper by Oster et al., 2007. The following comments were written in response to questions raised by the California Avocado Commission. Crop coefficient was not covered in the paper because the main message of the paper was the unusually high sensitivity of avocados to salinity. The following comments about crop coefficient are based on the data obtained at Covey Lane for the irrigation treatments irrigated once and twice a week. Because crop coefficient was not discussed in the paper, the following comments reflect the author's interpretation of the data without the benefit of peer review comments.

Based on the production function used to analyze the data, crop evapotranspiration (ETc), where crop yield wouldn't increase further with increasing amounts of available water, was 1200 mm/year provided soil salinity was 0.0 dS/m. Salinity would not affect crop evapotranspiration and, according to the concepts upon which the production function model is based (Letey et al., 1985), neither would salinity pose any limitation on crop yield. The reference evapotranspiration at Covey Lane was 1390 mm/year. The ratio, ETc/ETo would be the crop coefficient. (Kc). This ratio is 0.86. However, because of the experimental methods used this crop coefficient is based on the area covered by the tree canopy.

Crop coefficients (Allen et al., 1998) are normally based on the fraction of the total area shaded by the crop. Using equations given in Allen et al (1998), the fraction of shaded area from April 1 to September 31 averaged 0.76 for the latitude and longitude of the Cove Lane site. Consequently the crop coefficient for the total area would be 0.66 (=0.76 * 0.86)

Other climatic factors can also affect Kc. Kc values can be referenced to standard climatic conditions (Allen et al., 1998) based on wind speed (2 m/s) and minimum relative humidity (45%). For the 1995-1996 and 1996-1997 crop seasons, the average wind speed at CIMIS#62 was 1.8 m/s, the average minimum relative humidity was 42.6%, and the average relative humidity was 63.3%. For a tree height of 9-m, the correction for non standard conditions ranges from

0.00 to 0.05, which we consider to be smaller than the uncertainty involved in our estimates of Kc.

Consequently we believe the crop coefficient at Covey lane would have been 0.66 if the total area had been shaded; and based on the area actually shaded, the crop coefficient was 0.86. Considering that these are estimates, 0.66 should be rounded to 0.7 and 0.86 should be rounded to 0.9.

Final comment

If the weighted salinity of the irrigation and rain water used by the crop exceeds about 0.6 dS/m, it is likely that yields will be higher when the amount of applied water exceeds that based on our estimates of crop coefficients plus an additional 30 % of applied water for leaching. As the weighted average salinity increases, yields will decrease since it will not be possible to maintain soil salinities equal to, or lower than, the threshold salinity, no matter the amount of applied water. Further, as the amount of applied water increases to compensate for the weighted salinity of the irrigation water, problems with poor aeration will increase, and become a biological factor that can limit yields. Furthermore, as the amount of applied increases to compensate for the weighted average salinity of the irrigation water, problems with adverse environment impacts can pose physical limitations, such as seeps along hillsides. Finally, the irrigation costs will increase with increasing amounts of applied water. At some point, the increase in income due to increasing yield will be less than the incremental increase in the cost of applied water necessary to obtain the yield increase.

Ultimately, profitability coupled with biological and physical constraints will determine how much water a farmer should use to irrigate avocados, the most salt sensitive crop among the crops for which the salt tolerance coefficients are known.

References

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