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Water use efficiency of a banana plantation in a screenhouse

J Tanny, U Dicken, A Grava, and S Cohen

Institute of Soil, Water and Environmental Sciences, Agricultural Research Organization, The Volcani Center, P. O. B. 6, Bet-Dagan 50250, Israel

Shading banana and other orchard crops with screens is becoming increasingly popular in arid and semi-arid regions due to the resulting decreased water use and increased fruit quality. This study focused on measurements of water vapor and CO2 fluxes in a large commercial flat-roof banana screenhouse in northern Israel whose dimensions were 300 m long, 200 m wide and 6 m high. Measurements were conducted using an eddy covariance system deployed on a pole near the center of the screenhouse, allowing a minimum fetch of 100 m in all wind directions. The system measured the three air velocity components, air sonic temperature, air humidity and CO2 concentration. Measurements were conducted during 21 days between July 7th (DOY 189) and August 17th 2007 (DOY 230). During this period the banana plants grew from 2.8 to 4.6 m height and leaf area index increased from 0.5 to 1.8. Additional measurements of net radiation and soil heat flux enabled the analysis of energy balance closure.

Energy balance closure analysis gave the regression line Y = 0.85X - 0.5 (R2 = 0.84) where Y represents the consumed energy (latent plus sensible heat fluxes) and X represents the available energy (net radiation minus soil heat flux). This result (slope close to unity) validates the measured evapotranspiration (latent heat flux). Farmer's irrigation increased during the measurement period due to both plant growth and climate variation. Daily evapotranspiration of the plantation increased from 1.7 to 3.2 mm of water during the measurement period. Daily water consumption was on average 70% of the applied irrigation, suggesting that the plantation was over-irrigated. The water use efficiency (WUE) was defined as the total daily mass of CO2 consumed by the plantation per unit mass of water used. Results show that WUE generally increased during the measurement period, implying that larger banana plants were more efficient in using the available water than smaller plants.