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EVAPOTRANSPIRATION OF MANGO CROP BY WATER SOIL BALANCE UNDER A MICROSPRINKLER IRRIGATION SYSTEM

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ABSTRACT: The evapotranspiration of the mango crop was estimated by the soil water balance method in a ten-year age microsprinkler irrigated mango orchard. The experiment was carried out at Federal Agricultural Technical School of Guanambi located in the Irrigated Perimeter of Ceraima, Guanambi county, Bahia State. The work lasted 50 days (Period of budding to initial fruit growth). Soil water content was monitored by a data acquisition system with TDR, that made readings at 15-minute intervals in many locations of a grid in a vertical plane around the plant. Data were collected for plants irrigated with amounts of water equivalents to 100 % and 60 % of CWN (calculated water need), with and without covering the shaded area around plants. ET_c and deep percolation varied according to distance from plant. The difference between average ETc calculated for covered and bare soil was larger for water application equivalent to 100% of CWN. ETc values varied with distance from plant. The difference between average ETc calculated for covered and bare soil was larger for water application equivalent to 100% of CWN. Deep percolation, total infiltrated water and storage water were larger under covered soil surface in shaded area around the plant than for bare soil under same conditions.
KEYWORDS: evapotranpiration, water balance, mango

INTRODUCTION: Most of information about mango crop irrigation remains in the choice of irrigation method and time for water application (Soares & Costa, 1995; Coelho et al., 2000). The most common and practical methods for mango crop irrigation management are based upon soil water availability, soil water potential (tensiometers) and climatic methods which use crop evapotranspiration (ETc) from reference ET (ETo) data and crop coefficients (kc) (Oliveira et al., 2002). ETc may be determined by direct methods such as lisymetry, Bowen-ratio, a combination of sap flow and evaporation method. Reichardt e Timm (2004) describe soil water balance as a important tool for ETc measurement. This method evaluates the amount of water that get in and out of a soil volume element in a time interval. ETc is determined when the parameters such as soil water storage variation (h), precipitation (P), irrigation (I), deep percolation (DP), run-off (R) ad capillary water (AC) are known. The soil physical property spatial variability become a constraint for using this methodology for ETc calculation. This variability was studied for several authors, like Greminger et al. (1985) who indicated its importance, but did not discuss about its implications in the soil water balance. The present work was carried with the objective of determining mango crop evapotranspiration by using the soil water balance method at different distances from a plant irrigated by microsprinkler system with TDR technique for monitoring soil water content.

METHODOLOGY: The work was carried out at a 10-years old cv. Tommy Atkins mango crop orchard, 8 x 4 m spacing at Irrigation District of Ceraima, Guanambi county, South west of Bahia State, Brazil, latitude of 14º13’30’’ south and longitude of 42º46’53’’wets of Greenwich. The climate is semi-arid and the area is located at 525 m height, with mean annual precipitation of 663.69 mm and mean temperature of 26ºC. The experiment was set in a sand loamy soil with high activity clay that is classified as Eutrófic Flúvic Neosol. There was no occurrence of rain in the region during the period 20/06/07 to 09/08/07 (flowering and fruit initial development) and cumulative reference evapotranspiration (ETo) was 215.61mm. Soil water supply was done by a microsprinkler irrigation system with a 56-L h^{-1}emitter per plant. Water depths correspondent to 60 % and 100 % of CWN (calculated water need) were applied at different irrigation times. CWN was based upon ETo and kc. Reference ET (ETo) data used in this growth phase were obtained at CODEVASF meteorological station, Ceraima as an average of the last 19 years. The Kc value used in the first fruit growth phase was assumed as 1.0. Irrigations were performed every day except for weekends and Mondays due to the availability of water in the canals. Soil water content was monitored at various horizontal distances (r) and depths(z) in a 0.25 m x 0.25 m grid of a vertical plane from the trunk following the direction of the larger spacing between plants with limits of r and z of 1.0 m. TDR probes were installed horizontally at several locations of the grid in order to obtain soil water content in all plane, according to Figure 1.

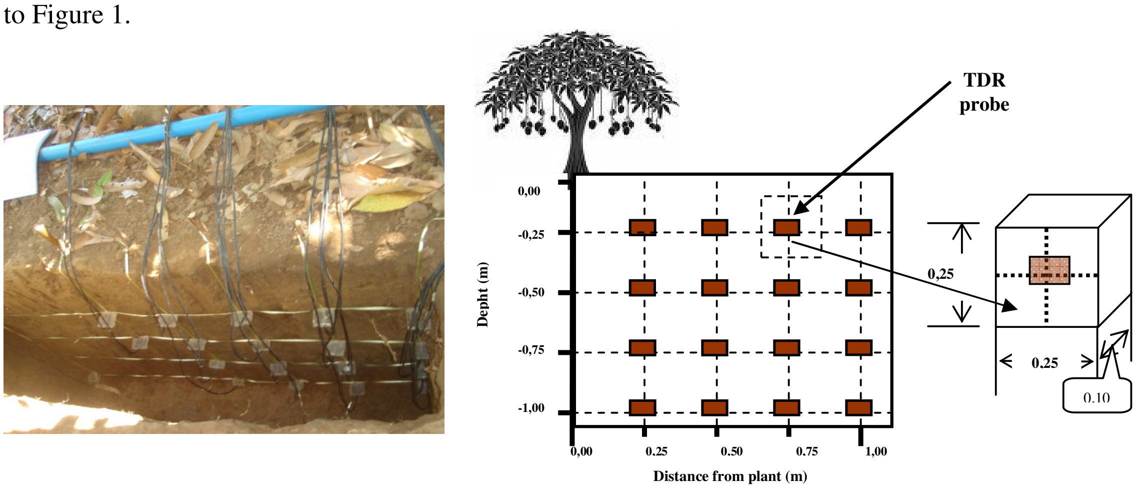

Figure 1. Distribution of TDR probes for monitoring soil water content in the mango root system.

Soil water content readings were made in the planes considering the soil surface covered with a plastic sheet and uncovered during the first fruit growth phase in order to evaluate the contribution of evaporation in the crop evapotranspiration process. Soil water content data were collected every 15 minutes by an acquisition data system with a TDR equipment and one datalogger Soil water storage was determined by trapezium method (Libardi, 1995) at different horizontal distances (ri), i.e., at 0.25 m, 0.50m, 0.75 m e 1.0 m from the mango trunk according to the equation1:

$$h_L = \int_0^L \theta(Z)dz = \left[0,5\times\theta(Z_i) + \sum_{i=1}^{n-1} \theta(Z_i) + 0,5\times\theta(Z_n)\right]\times\Delta z \quad (1)$$

In which:

Θ - soil water content, m^3m^{-3},

Δz – thickness of soil layer, m.

Soil water storage (mm) was obtained by equation 2 (Libardi, 1995) for each day.

$$\Delta h = h_t - h_{t-1} \quad (2)$$

Deep percolation (DP) and/or upward capillary flow (AC) for all distances (ri) below effective root depth was calculated by equation 3:

$$DP/AC = \int_{J+1}^{J+2} qdt \quad (3)$$

where:

$$q = \frac{\theta - \theta'}{t} \cdot \frac{v}{A} \qquad (4)$$

sendo:

V- o volume da seção onde a sonda esta inserida no solo (0,25m x 0,25m x 0,10m),

A- a área da seção onde a sonda esta inserida no solo (0,25m x 0,25m),e,

t- intervalo de tempo (2h).

The effective root depth was considered as 1.0 m based upon works of Choudhury e Soares (1992), Coelho et al. (2001) e Oliveira et al. (2001). The infiltrated water depth (LTI) at each ri distance from plant (Figure 2) was determined according to equation 5, where $\theta_{J+1}(z)$ is the soil water content after irrigation and $\theta_j(z)$ is the water content before irrigation .

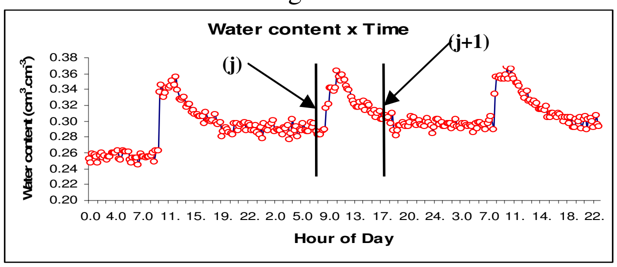

Figure 2. Soil water content as function of time among irrigation events

$$LTI = \int_0^L \theta_{J+1}(Z) - \theta_J(Z)dz \qquad (5)$$

Upward flow was considered due to the elevation of water table in the soil prpofile after irrigation. Surface run off was disregarded, therefore soil water balance was calculated based upon equation 6:

$$P + I \pm {DP}/{AC} \pm \Delta h \pm R - ETc = 0 \qquad (6)$$

RESULTS AND DISCUSSION: Figure 3a shows average values of ETc determined by the soil water balance method for mango plants during the first fruit growth phase, considering 100% of CWN, with and without soil covering the shaded area around the plant. Figure 3b ilustrates the same parameters for plants under water depth of 60% of CWN. Results showed that there was larger ETc by irrigated plants with 100 % of CWN and with the shaded area without covering. This evidences the contribution of soil water evaporation to evapotranspiration process. The difference between average ETc

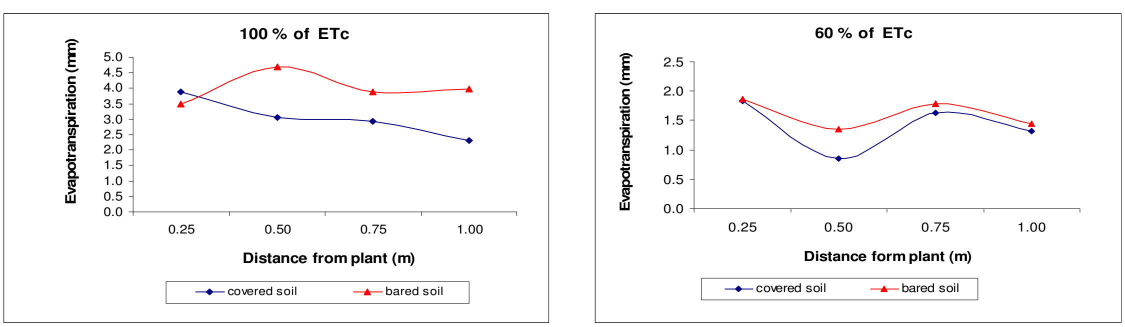

Figure 3. Crop evapotranspiration by water balance method for mango plants with replenishment of 100 % of ETc (a) and 60 % of ETc (b), with and without covering of shaded area.

calculated for covered and bare soil was 23.98% for an application of 100% of CWN. This difference stayed at 12.34% for an application of 60% of CWN. The calculated ETc values from soil water balance ranged from 57 to 75% and from 40 e 46 % of the used ETc for calculated irrigation depth based upon replenish of 100% CWN and 60 % CWN, respectively, for plants with and without covering on the shaded area around plant. Figures 4a and 4b show average values of deep percolation obtained through the soil water balance for three day period or three irrigation cycles considering plants irrigated with 100% of CWN and 60% of CWN, respectively, with and without covering the shaded area under the plant. Deep percolation under covered soil surface was larger than under bare soil. Also, total infiltrated water and storage water were larger for covered soil surface under shaded area around the plant than for bare soil under same conditions.

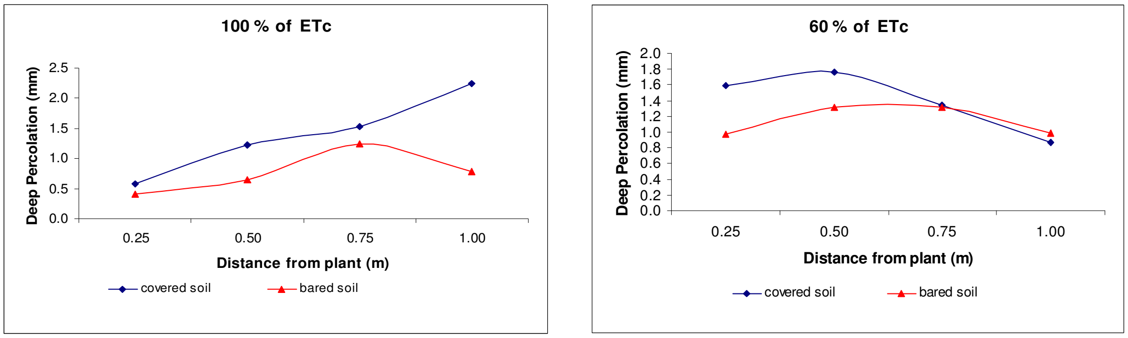

Figure 4. Deep percolation under mango plants irrigated with replenishment of 100 % of ETc (a) and 60 % of ETc (b), with and without covering shaded area around the plant.

CONCLUSION: ETc values varied with distance from plant. The difference between average ETc calculated for covered and bare soil was larger for water application equivalent to 100% of CWN. Deep percolation, total infiltrated water and storage water were larger under covered soil surface in shaded area around the plant than for bare soil under same conditions.

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