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

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ABSTRACT: The evapotranspiration of the mango crop was estimated by the soil water balance method in a drip irrigated mango orchard implanted in 1998. The experiment was carried out at Federal Agricultural Technical School of Guanambi located in the Irrigated Perimeter of Ceraima, Guanambi county, Bahia State. The works 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 ETc (crop evapotranpiration), with and without covering the shaded area around plants. ETc and deep percolation varied according to distance from plant. There was a difference about 30% between ETc obtained with covered soil and bare soil for plants irrigated with 40% of reduction of water needs (ETc). The difference was about 10% in case of plants irrigated with no reduction of water needs.
KEYWORDS: evapotranpiration, water balance, mango

INTRODUÇÃO: Estimates of crop evapotranspiration (ETc) has been done based upon climatic data and a reference crop of known characteristics (Doorembos e Pruitt, 1977; Allen et al., 1998). The ETc determination is the basis for calculation of water needs and may be obtained by several methods. The soil water balance (Reichardt and Timm, 2004) is na appropriate method that consider the total inputs and outputs of water in a soil volume element during a given time interval. The soil water balance requires data of variation of soil water storage (h), precipitation (P), irrigation (I), deep percolation (DP), evapotranspiration (ET), surface run off (R) and capillary water (AC). Root depth should be known since it helps to establish the vertical limit of the control volume (Libardi, 1995). The water storage and internal drainage calculations are difficulty to obtain and the way these components are measured influences the accuracy of the method. The spatial variability of soil physical properties is a constraint for using this ETc calculation methodology. 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 plant 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’’ southland 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. A drip irrigation system with 4-L h^{-1}emitters, by number of six to ten according to treatments of 60% and 100% of ETc , respectively. The emitters were distributed on the soil surface around the trunk by a pig tail attached to lateral lines. The irrigation depth to replenish soil water deficit was estimated based upon ETc as ETo x Kc, where kc is the crop coefficient assumed as 1.0 in that phase. The ETo data collected at a climatological station of CODEVASF, Ceraima district corresponded to an average of this variable for the last tem years. 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.

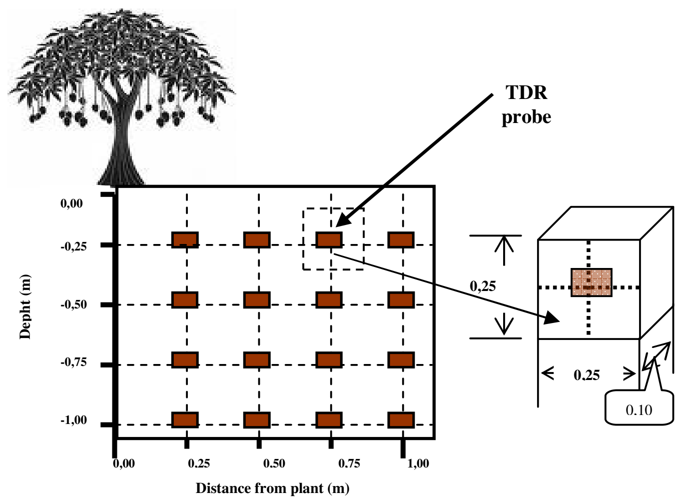

Figure 1. Distribution of TDR probes for monitoring soil water content in the mango root system.

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:

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

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.

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

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

$$DP/AC = \int_{J+1}^{J+2} q\,dt \qquad (3)$$

where:

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

sendo:

V- Representative volume of the soil where TDR probe is inserted (0.25 m x 0.25 m x 0.10 m);
A- Section of the soil where TDR probe was inserted (0,25 m x 0,25 m);
t- Time interval, considered as 1h.

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) that found 68 % to 86 % of roots distributed at depths smaller than 1.0 m within a total depth of 1.4 m and distance from plant of 3.5 m. The infiltrated water depth (LTI) at each ri distance from plant 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.

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

Upward flow was considered due to the presence of water table at depths between 1.5 and 2.0 m. 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 1(a) shows mean ETc values obtained from the soil water balance during the first fruit development phase with replenishment of 100% of ETc with and without covering of the area correspondent to a plant. Figure 1b shows the same parameter for the plants submitted to reduction of 40% of calculated water need (ETc) during the phase.

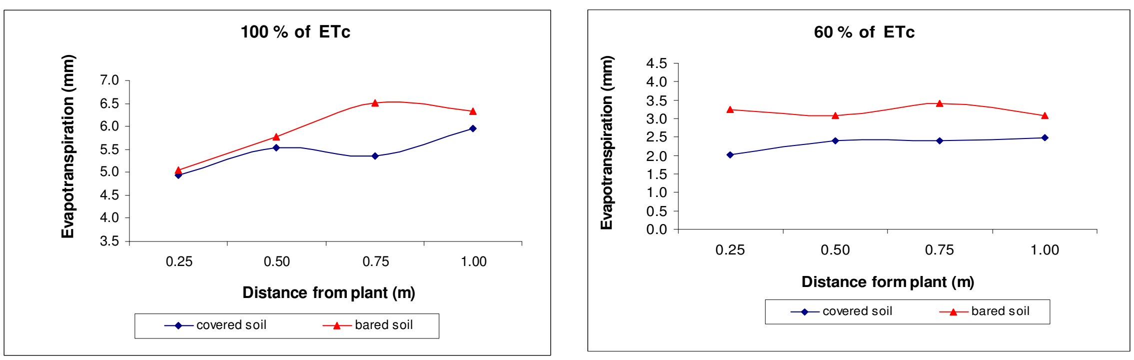

Figure 1. Crop evapotranspiration by water balance method for mango plants with replenishment of 100 % of ETc (a) and 60 % of ETc (b), with and without covering of shaded area.

Results showed larger evapotranspiration by plants with no reduction of calculated water needs and with bare soil that was due to larger soil evaporation in this situation. ETc was larger at distances of 0.50 m and 0.75 m from plant, matching with the location of drippers and possibly with the zones of larger root concentration. Figures 2 (a) and (b) show average values of deep percolation for three consecutive days with daily irrigation for plants with no reduction of water needs and with 40% reduction, respectively, considering covered and bare soil at the area shaded by canopy. Values of DP were larger for larger amounts of applied water and for covered soil. In case of bare soil, DP was smaller closer to the trunk and a little larger at locations farther from the trunk. There was a difference about 30% between ETc obtained with covered soil and bare soil for plants irrigated with 40% of reduction of water needs (ETc). The difference was about 10% in case of plants irrigated with no reduction of water needs.

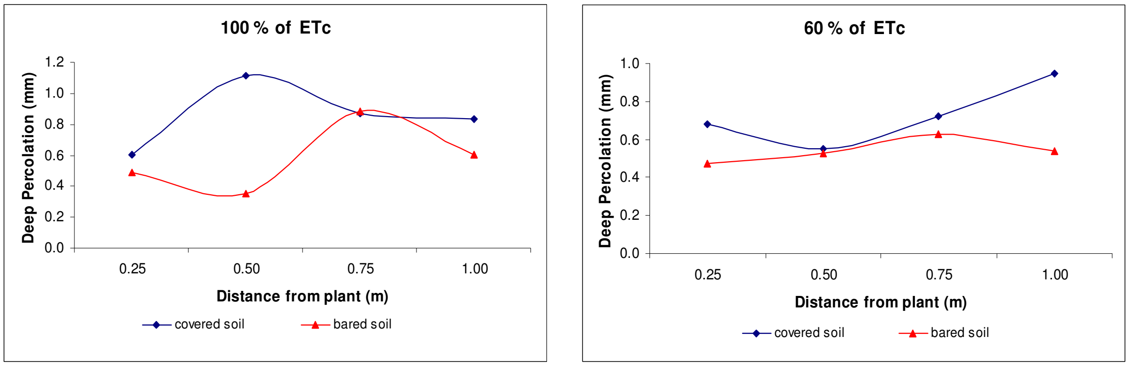

Figure 2. Deep percolation under mango plants irrigated with replenishment of 100 % of ETc (a) and 60 % of ETc (b), with and without covering of shaded area.

CONCLUSIONS: ETc and DP varied according to distance from plant. There was a difference about 30% between ETc obtained with coated soil and bare soil for plants irrigated with 40% of reduction of water needs (ETc). The difference was about 10% in case of plants irrigated with no reduction of water needs.

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