Water requirements of drip irrigated tomatoes in Central California

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Abstract. Accurate estimation of crop water requirements (CWR) is essential to optimize water use efficiency and develop efficient irrigation scheduling practices. This is particularly important in Central California where continuous droughts have accentuated the need to conserve water and improve on-farm water management. The most accurate method to determine CWR is with precision weighing lysimeters, which measure actual crop evapotranspiration (ET_a). Thus, the objectives of this study were to determine ET_a data, develop new crop coefficients (K_c), and evaluate the relationship between K_c and crop ground cover for processing tomatoes grown under subsurface drip irrigation. The study was conducted on a clay loam soil. Average ET_a , K_c , and ground cover data will be presented. Relationship between K_c and ground cover will also be evaluated.

Keywords. Crop coefficient, water requirement, irrigation scheduling, lysimeter.

Major changes in crop production systems have occurred over the past decade throughout California. In the Central Valley, many agricultural producers have transitioned from low-value crops grown under flood irrigation to higher value crops, such as vegetables and fruits, produced with low-volume irrigation, i.e., drip. A typical example is the conversion of flood-irrigated cotton to processing tomatoes grown with drip irrigated systems. Other growers have also opted for production of row crops under drip irrigation. These changes, partly due to farmers' desire to increase their revenues as well as constrained agricultural water supplies to satisfy urban and environmental water demands, has been accentuated in the last few years following multiple droughts and consequent reductions in surface water allocations. In some areas of the Central Valley, growers received 20% or less of their normal allocations the last few years. Under such reduction in surface water availability throughout the region and with the adoption of new cropping and irrigation practices, it is important to develop management practices that conserve water and optimize water use efficiency (WUE).

A direct factor affecting WUE is irrigation efficiency (IE). Although IE has improved with the implementation of drip irrigated systems, most agricultural producers continue to schedule irrigations based on visual observations of soil moisture conditions and plant health, as well as general knowledge of historical needs. Such practices often lead to over application of irrigation water, particularly in vegetable cropping systems. Few growers utilize estimations of crop water requirements (CWR) for scheduling irrigations, although such method has been found to increase yields and reduce total applied water (Parker et al., 1996). This is mostly attributed to the difficulty in determining daily CWR values for site specific conditions and to the paucity of data available, especially for drip irrigated systems.

Crop water requirement, also defined as crop evapotranspiration (ET_c), is commonly calculated by multiplying weather-based estimates of reference evapotranspiration (ET_o) with a crop coefficient (K_c): $ET_c = K_c * ET_o$. The ET_o represents the evaporative demand of the atmosphere and daily values can be easily obtained through the California Irrigation Management Information System (CIMIS). The K_c represents the effects of crop, management, and environmental conditions on ET_c (i.e., crop type, growth development stage, soil water content, texture, fertility, salinity, pests, diseases, as well as irrigation management - method/frequency). Published K_c data are available for major agricultural crops (Allen et al., 1998; 2007). However, these published data were developed a few decades ago for specific growing conditions and irrigation practices (i.e., flood) which are not always representative of cropping systems observed today. This is particularly true for crops grown under low-volume irrigation (i.e., drip).

To date, research on such production systems has been limited to very few vegetable crops (Ayars, 2008; Bryla et al., 2010). Therefore, there is a need to expand the development of CWR and K_c data to additional drip irrigated cropping systems important for California agriculture. The most accurate method to determine CWR is with precision weighing lysimeters, which measure actual crop evapotranspiration (ET_a). Thus, the objectives of this study were to determine ET_a data, develop new crop coefficients (K_c), and evaluate the relationship between K_c and crop ground cover for processing tomatoes grown under subsurface drip irrigation.

The study was conducted in the Central Valley of California on a claim loam soil. The site included two large weighing lysimeter facilities, each containing a 15-tonne soil tank (2 m x 2m x 2.25 m) positioned on a scale system capable of measuring small weight changes of less than 0.01 kg. The lysimeters were located in the center of two adjacent 1.7-ha (4.2 acre) fields. One lysimeter was planted with grass to measure the reference ET (ET_o). The second lysimeter, referred to as crop lysimeter, was planted with processing tomatoes grown under drip irrigation. The tomato crop was transplanted both in the crop lysimeter and in the surrounding field on 60-inch beds. The tomatoes were planted 12 inches apart along the beds and were irrigated with a sub-surface drip irrigation system installed at 12 inches. The cultural practices and fertilizer applications followed the regular site schedule.

The lysimeter was replenished each time a predetermined crop ET depth had been withdrawn from the soil tank. The surrounding field was irrigated based on the ET data obtained from the crop lysimeter. Irrigation was applied daily. The parameters measured during the growing season included: daily ET_c, K_c, and weekly ground cover which was obtained from a Tetracam infra-red camera. These data are currently being compiled and analyzed and will be presented. Relationship between K_c and ground cover will also be discussed.

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