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Tomato Irrigation Scheduling for Optimum Production

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Tomato Irrigation Scheduling for Optimum Production

Abstract

The most common irrigation scheduling practice by Iowa vegetable growers is the imperfect soil moisture 'feel' method. Even during a growing season with normal rainfall, supplemental irrigation is necessary to avoid moisture stress, particularly during the blossom and fruit bulking period, which can result in lack of fruit set, reduced fruit size, sunburn fruit, and a lack of uniform ripening. The main questions are: when to turn on the irrigation system, and how long to run the pump.

Keywords

Horticulture

Disciplines

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Tomato Irrigation Scheduling for Optimum Production

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Introduction

The most common irrigation scheduling practice by Iowa vegetable growers is the imperfect soil moisture 'feel' method. Even during a growing season with normal rainfall, supplemental irrigation is necessary to avoid moisture stress, particularly during the blossom and fruit bulking period, which can result in lack of fruit set, reduced fruit size, sunburn fruit, and a lack of uniform ripening. The main questions are: when to turn on the irrigation system, and how long to run the pump.

Two major irrigation scheduling techniques are soil-based or climatic-based. The soil-based technique involves indirectly measuring the soil moisture quantity in the crop rootzone by use of soil tensiometers. The tensiometer can be used to determine 20 to 25% depletion of the available water capacity and then calculate the amount required to bring the soil moisture back to field capacity. The climatic-based system measures several climatic parameters (light radiation, temperature, wind speed, relative humidity, etc.) to evaluate the moisture loss from the soil and plant. This loss is called evapotranspiration or ET and is available on a daily basis from many weather stations throughout Iowa and posted on the internet. The ET is multiplied by a crop coefficient, typically the percent crop canopy development, to determine crop water loss. Thus, a grower could time the irrigation events by using internet-based ET data coupled with the growth phase of the tomato crop.

The objective of this work was to compare the ET-based climate approach to tensiometers soil water measurements for yield, fruit quality, and water use efficiency for a fresh market tomato crop.

Materials and Methods

Five-week-old tomato transplants, cv. Mountain Fresh, raised in 72-cell plastic trays, were transplanted to field plots on May 17, 2007. The culture system included 4-ft wide SRM-olive wavelength selective mulch with a single-line-source drip irrigation system (16 mm tubing, 12-in. emitter spacing, 0.53 gal/h per emitter: Toro Micro-Irrigation Co., El Cajon, CA.) that produced a wetted radius of 16 in. Planting arrangement was a three-row plot with a single row on 6-ft centers, with plants spaced 18 inches in-row. The center row of 10 plants was used for data collection. The necessary P and K, according to soil test report, and 60 lb N/acre were broadcast and rotovated in prior to laying the plastic mulch. Pest management practices were common to the area. Plants were pruned once to the first cluster, staked, and tied following the Florida stake and weave system.

Tensiometers (Irrometer Co., Riverside, CA.) were placed at two depths, 8 and 16 in., in-between plants and approximately 8-in. from the drip line. Readings were taken daily at approximately 8 a.m. and averaged from two replications. When readings of the 8-in. tensiometers reached 30–35 cb (the 25% depletion level) irrigation was applied to bring the active rootzone (2-ft) soil moisture back to field capacity. The ET treatment was based on the daily formula of: (ET-rainfall) multiplied by percent crop canopy coverage. Percent crop canopy was the observed vegetative coverage of the plastic-soil surface, and the value was never below 40% even as young transplants. Only rainfall amounts > 0.01-in. were recorded. Daily ET value was obtained from the Lewis web-based weather station (<http://mesonet.agron.iastate.edu/agclimate/index.php>). Irrigation was initiated when accumulated ET value was > 1.25 in. The two

irrigation treatments were replicated four times in a randomized complete block design.

Fruit harvest began on July 26 when 10% of the fruit were at the breaker-stage. All fruit showing color were harvested once per week until September 4, a total of six weeks. Yield data included overall fruit size and weight of marketable and cull fruit. The marketable category was graded into four sizes: extra large ($> 2\frac{3}{4}$ in. diameter), large ($2\frac{3}{4}$ to $2\frac{1}{2}$ in.), medium ($2\frac{1}{2}$ to $2\frac{1}{4}$ in., and small ($< 2\frac{1}{4}$ in.). Culls were fruit $< 1\frac{1}{2}$ in. and those with rots, radial and concentric cracks, or with ripening disorders over more than 5% of the fruit surface.

Results and Discussion

The growing conditions were warm with below rainfall until August. From May 28 to July 31 the area received only 4.75 in. From August 1 to

the last harvest (September 4) 8.2 in. of rain fell. Table 1 indicates that high marketable yields were obtained from either irrigation scheduling method. The amount of cullage was very low, $< 10\%$. The tensiometer method resulted in applying 34% more water at a cost of \$372/acre, compared with the daily ET method. In addition, the tensiometers, depending on length, cost about \$70 each. With less water used to produce the same yield, the ET method water use efficiency was 31.7% higher than the tensiometers method. The data show that the 8-in. tensiometer trigger point for an irrigation event can be set higher than 30–35 cbar. More water was applied than necessary with the tensiometers method as shown by the wetter soil tension readings near the bottom of the rootzone (16-in. depth), compared with the ET method (Figure 1).

Table 1. Comparison of irrigation scheduling methods on tomato yield, water use, and cost of irrigation water.¹

Treatment	Marketable yield cwt/acre	Total yield cwt/acre	Cull %	Water applied inches	gallons	WUE ²	Water cost ³
Tensiometer	669	738	9.1	11.1	300,862	6027	\$ 1,474
Daily ET	659	725	9.2	8.3	224,946	7940	1,102
Significance, 5%	ns	ns	ns				

¹Units expressed on a per acre basis.

²WUE = water use efficiency expressed as lb marketable fruit per in. of applied water.

³Water cost = rural water at \$4.90 per 1,000 gallons.

NS = no statistical difference.

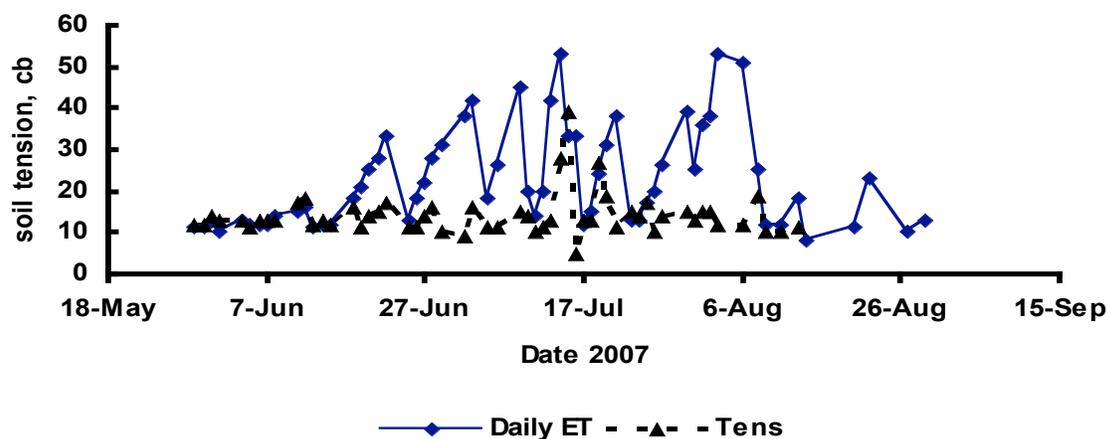


Fig. 1. Effect of irrigation method on soil water tension at the 16-in. soil depth.