Table 3. Analysis of variance for tomato yield.

Source of Variation	F-ratio	Significance level
Lateral distance	10.284	0.0044
Number of tubes	0.001	0.9729

plant row. It must be emphasized that these are initial results. The experiment will be repeated with additional observations to substantiate these findings.

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DRIP IRRIGATED TOMATO AS AFFECTED BY WATER QUANTITY AND N AND K APPLICATION TIMING

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Abstract. **Polyethylene-mulched tomatoes (*Lycopersicon esculentum* Mill.) were grown with drip irrigation to evaluate the effects of water quantity, and time of N+K application on fruit production. Water quantities applied were 0, 0.17, 0.34, and 0.50 times pan evaporation. The N+K applications were 100% preplant or 40% preplant with 60% applied by drip irrigation in daily or weekly applications. Rainfall was low during the season and irrigation increased the fruit yield of extra large, large, and total marketable fruit by 76, 44, and 40%, respectively. Total marketable yields increased linearly from 2,300 cartons to 2,516 cartons/acre with an increase in water applied from 0.17 to 0.50 times pan. Extra large, large, and total marketable fruit yields were higher while yields of medium-size fruit were lower with N+K applied with drip than all applied preplant. Fruit yields were similar with daily or weekly N+K applications. Leaf tissue N and K concentrations at early harvest with all preplant applied N and K were lowest with 0.17 pan water quantity and similar with 0.34 and 0.50 pan. Water quantity had less effect on leaf N and K with drip applied N and K treatments.**

Grower use of drip irrigation for tomato production in Florida has frequently been unsatisfactory due to improper use of the system. With the application of water under the mulch and a lack of precise knowledge of tomato water requirements with drip irrigation, overwatering of the crop has often resulted in leaching of N+K and lower yields. With proper use of drip irrigation for tomato, the water used was reduced substantially over that with sprinkle irrigation with the production of similar yields (6) or higher yields (2). In recent studies on coarse textured soils, tomato yields were increased with a decrease in the amount of water applied from 1.0 times pan evaporation to 0.5 pan (5). In lysimeter studies, as much as 34% of the crop water needs was supplied from the water table (7).

Soluble nutrients move with the irrigation water (1, 5) and yields were higher with nutrients applied with drip irrigation than with all nutrients applied preplant (5). Information was not found regarding the frequency of drip applied nutrients for tomato. Since water quantity influences nutrient management, a reduction in water application below 0.5 pan may result in increased fruit production. The study reported here was conducted to evaluate the effects of water quantity and timing of N and K application on tomato production.

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Materials and Methods

Tomatoes were grown during the spring of 1988 on an Arrendondo fine sand at the Horticultural Unit near Gainesville. Treatments were factorial combinations of 3 water quantities 0.17, 0.34, and 0.50 times pan evaporation applied by drip irrigation and 3 fertilizer application schedules, all preplant and part of the N and K applied with the drip irrigation in daily and weekly applications. In addition to these 9 treatments, a no irrigation control treatment was included in the study. The preplant soil pH was 6.2 and the soil tested 176 ppm for P and 56 ppm for K (Mehlich-I extraction). Beds spaced 6 feet apart were formed, plots were 30 feet long, and treatments were replicated 4 times. Fertilizer was applied at 200-50-240-40 lb./acre N-P-K-micronutrient mix. For the preplant treatments, all of the fertilizer was applied broadcast and mixed into the bed. For the split-fertilizer treatment, 40% of the N and K and all of the P and micronutrients were applied broadcast and mixed into the bed. The 60% drip-applied

N and K were applied at 12-0-14 lb./acre/week for 10 weeks in *either 1 or 7* application(s)/week. Nutrient sources were ammonium nitrate, potassium nitrate, potassium sulfate, triple superphosphate, and FN 503 (Frit Industries, Ozark, AL). Double-wall drip tubing (Chapin Twinwall, Watertown, N.Y.) with emitters spaced 9 inches apart and a delivery rate of 0.5 gal/100 ft/min was placed 3 to 4 inches from the bed center. Beds were fumigated with 240 lb./acre 67% methylbromide—33% chloropicrin mix, and 0.0015-inch thick black polyethylene mulch was applied. 'Sunny' tomatoes were transplanted 1.5 feet apart on the bed on 18 Apr. 1988. Irrigation was applied daily and the amounts were calculated based on the total plot area as a fraction of the water evaporated from a U.S. Weather Service Class A pan. A mean value was used each week from the previous week's pan evaporation. Tomatoes were pruned and staked.

Recently matured leaves were sampled for mineral analysis on 26 May, 16 June, and 7 July. Soil moisture was measured throughout the season with tensiometers placed at 6 and 12 inches below emitter tubes. Mature-green to red-ripe fruits were harvested on 5 July and 14 July and were graded into size categories of extra large, large, and medium maketable fruit (5).

Results and Discussion

Soil water tensions from planting (18 Apr. was Julian Day 109) to the end of the season as influenced by water quantity at soil depths of 6, and 12 inches are shown in Fig. 1. Rainfall for the first 6 weeks of the season (Table 1) averaged less than 0.25 inch/week. Thus, the soil water tensions shown in Fig. 1 reflected mostly stored water and that applied by irrigation. The largest differences in soil water tension due to treatment were obtained at the 6-inch depth and the least difference at the 12-inch soil depth. At the 6-inch soil depth, soil water tensions in the root zone were less than 10 centibars (cb) with the 0.17 to 0.50 pan water quantities for the first month after transplanting. On a sandy soil 10 to 15 cb or below is considered to be an adequate level of soil water. With the no irrigation treatment, soil tensions were about 10 cb at the time of transplanting and were about 30 cb 1 month later. By the end of the second month (170 Julian Day), soil water tensions remained well below 10 cb with 0.34 and 0.50 pan water quantities but were over 20 cb with 0.17 pan and over 60 cb with no irrigation. By the time of the harvests (187 and 196 Julian Days) soil water tensions generally were the highest recorded during the season. At the 12-inch depth, soil tensiometer readings were lower during the early part of the season and higher during the latter part of the season than readings at the 6-inch soil depth.

Marketable fruit of extra-large, large, and total yields were increased significantly by irrigation (Table 2). Irrigation increased marketable yields about 40% over the yield obtained with the non-irrigated treatment. Although the yields of extra large and large fruit tended to increase with an increase in water quantity applied from 0.17 to 0.50 pan, only the total marketable yield was increased significantly by water quantity. Total yields increased linearly from 2,300 to 2,516 25-lb. cartons/acre with an increase in applied water quantity. In past work, tomato yields decreased with an increase in water quantity from 0.5 to 1.0 pan (5).

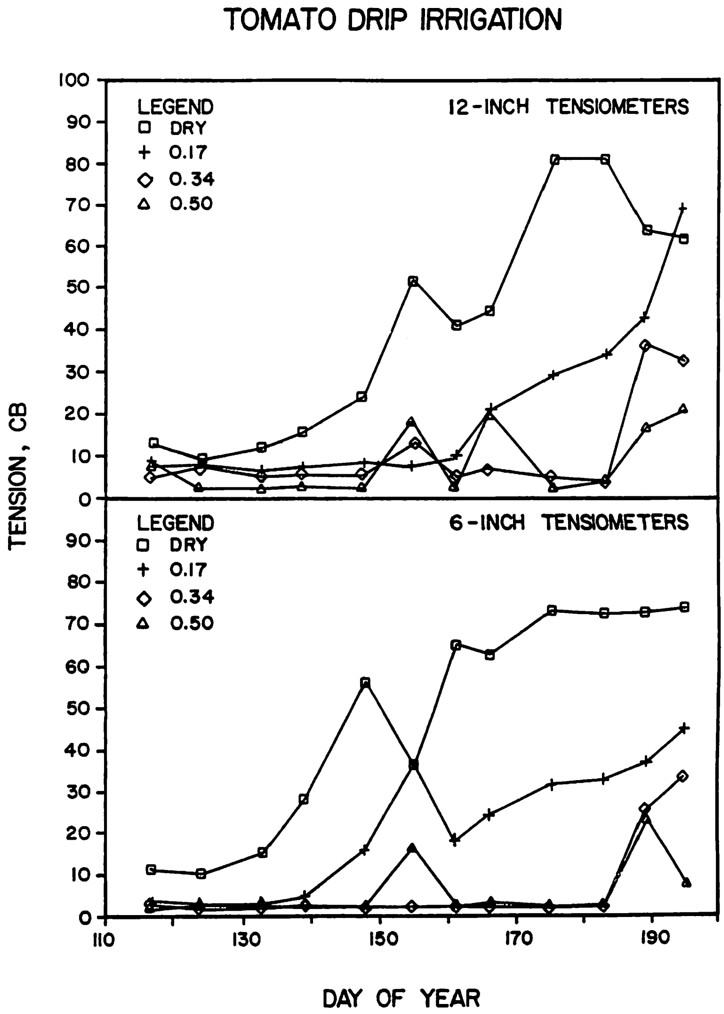

Fig. 1. Soil water tensions (cb) at 6- and 12-inch depths under the emitter tubes from transplanting (109 Julian Days) to harvest (187 and 196 Julian Days).

Marketable fruit of extra-large, large, medium and total fruit yields were significantly greater with 60% of the N and K applied by drip irrigation than all applied preplant (Table 3). This agrees with results from past studies with tomato (5). The number of N+K applications per week, 1 or 7, had no effecct on fruit yield (Table 3). This finding was similar to results obtained on strawberries where these frequencies of application of drip applied N and K had no effect on fruit yield (3). It is apparent that with drip irrigation, it is critical that part of the N+K be applied by drip irrigation. With only a part of the N and K applied at planting, nutrient leaching would be expected to be reduced, thus the efficiency of applied N+K should

Table 1. Rainfall and drip irrigation amounts applied with 0.17, 0.34, and 0.50 pan per 2 week period during the 1988 tomato season.

Period	Rainfall (inches)	Pan ET (inches) 0.17	0.34	0.50
17/4-30/4	0.80	0.47	0.93	1.40
1/5-14/5	0.37	0.58	1.17	1.75
15/5-28/5	0.31	0.55	1.10	1.65
29/5-11/6	1.90	0.58	1.17	1.75
12/6-25/6	0.90	0.58	1.17	1.75
26/6- 9/7	0.40	0.58	1.17	1.75
(Total)	(4.68)	(3.34)	(6.71)	(10.05)

Table 2. Main effects of water quantity on marketable tomato yield. 1988.

Water quantity (pan)	Marketable yield (25 lb. cartons/acre)			
	Extra large[z]	Large	Med.	Total
0	328	793	603	1724
0.17	531	1104	665	2300
0.34	593	1126	688	2407
0.05	612	1189	715	2516
Signif.[y]				
0 vs water	**	**	NS	**
Quantity	NS	NS	NS	L*

[z]Mean fruit size for fruit categories were 7.3 oz extra large, 5.3 oz large and 4.1 oz medium.
[y]F values for comparisons were significant at the 1% (**) level or not significant (NS), and significant water quantity effects were linear (L).

be higher and this resulted in higher yields than with all preplant applied N + K.

Water quantity applied influenced leaf N concentrations (Table 4) at the time of fruit set (26 May). The N concentrations were higher with irrigation (6.52%) than with no irrigation (6.00%) and were higher with 0.34 pan water quantity than with 0.17 and 0.50 pan. However, water quantity applied had no effect on leaf K concentrations (Table 4).

Leaf N and K concentrations were affected by the time of N and K applications (Table 5). Early in the season (26 May), both N and K leaf concentrations were higher with split than all preplant N and K application, but later in the season, N + K concentrations were higher with preplant fertilization. Fruit yields were higher with the split fertilization and the lower tissue concentration may reflect increased utilization of N + K by fruit. Although the number of N and K applications per week did not influence fruit yield, leaf N concentration at the 6 June sampling and leaf K concentrations at the 6 June and 7 July samplings were higher with continuous N + K application (7 times/week) than with 1 time/week. However, N and K concentrations with both times of applications were considered adequate for maximum growth (5).

As indicated by data in Fig. 1, tomatoes growing without irrigation became progressively drier as the season progressed. This resulted in significantly less extra large, large and total marketable fruit than with the irrigated treatments. With the 3 applied water quantities, soil water was adequate early in the season but the soil became drier later in the season with the 0.17 pan water quantity. This indicates that water use exceeded the amount applied. Soil

Table 3. Main effects of N and K application time on marketable tomato yield. 1988.

N and K time applied	Marketable yield (25 lb. cartons/acre)			
	Ex. lg.	Large	Med.	Total
Preplant	461	1070	745	2276
Split	638	1174	661	2473
Signif.[z]	**	**	*	**
Split (no./wk)				
1	634	1186	673	2493
7	642	1162	649	2453
Signif.[z]	NS	NS	NS	NS

[z]F values for comparisons were significant at the 5% (*) or 1% (**) levels or not significant (NS).

Table 4. Main effects of water quantity on tomato leaf N and K concentrations. 1988.

Water quantity (pan)	Nutrient concn (%)					
	Nitrogen			Potassium		
	26/5	16/6	7/7	26/5	16/6	7/7
0.0	6.00	4.75	3.62	2.53	2.31	1.40
0.17	6.45	4.62	3.71	2.55	2.11	1.50
0.34	6.67	4.46	3.63	2.59	2.13	1.44
0.50	6.44	4.48	3.48	2.60	2.06	1.42
Signif.[z]						
0 vs. water	*	NS	NS	NS	NS	NS
Water quantity	Q*	NS	L*	NS	NS	NS

[z]F values for comparisons were significant at the 5% (*) level or not significant (NS), and water quantity effects were linear (L) or quadratic (Q).

Table 5. Main effects of time of N and K application on tomato leaf N and K concentration. 1988.

N and K time applied	Nutrient concn (%)					
	Nitrogen			Potassium		
	26/5	16/6	7/7	26/5	16/6	7/7
Preplant	6.29	4.77	3.65	2.48	2.29	1.60
Split	6.64	4.39	3.59	2.63	2.00	1.38
Signif.[z]	**	**	NS	*	**	**
Split (no./wk)						
1	6.59	4.17	3.43	2.64	1.83	1.26
7	6.68	4.61	3.74	2.62	2.18	1.49
Signif.[z]	NS	**	NS	NS	**	**

[z]F values for comparisons were significant at the 5% (*) or 1% (**) levels or not significant (NS).

water tensions were lower and similar with 0.34 and 0.50 pan irrigation quantities. Although total yields increased linearly with a linear increase in water applied, yield increase with each water increment was only about 4.5% and no difference in individual fruit size categories' yields were found due to water quantity. This research and past studies indicate that tomato irrigation requirements of tomato grown on a sandy soil is 0.50 pan or greater but less than 1.0 pan.

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