with minimal variation from fluctuations of the water table. The ultimate design must include a stable root environment in combination with a plant population that favors a maximum production efficiency, regardless of rain density.

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WATERMELON RESPONSE TO DRIP AND SPRINKLER IRRIGATION[1]

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Abstract. **'Sugarlee' watermelons** [Citrullus lanatus **(Thunb.) Matsum. & Nakai] were grown in 1981 at Gainesville on Myakka fine sand and at Leesburg on Apopka fine sand to evaluate 4 irrigation treatments (drip fertigation, overhead sprinkler irrigation, overhead sprinkler fertigation, and no irrigation) and 2 plant spacing treatments (2.5 or 5 ft apart in rows 10 ft apart). The benefit of irrigation when compared with no irrigation was greater on the deep sands at Leesburg than on the flatwoods Myakka soil. At Leesburg early yield was enhanced with drip fertigation compared with overhead or no irrigation; irrigation significantly increased total yield over the unirrigated plants but there were no significant differences among the 3 irrigation methods. Irrigation treatments had no effect on yield at Gainesville. Total yield was higher with the higher plant population at both locations. About 40% less water was used with the drip system than with overhead irrigation. Weed growth was much greater with overhead than with drip irrigation.**

Watermelons are grown on sandy soils throughout most of Florida. Almost all growers in South and Central Florida apply supplemental water. North and West Florida have heavier soils and more frequent rainfall during the growing season than does South Florida. The amount of irrigated watermelon acreage may be as low as 20 or 30% in North and West Florida. Except for the seepage-irrigated fields of South Florida, irrigation systems are generally of the portable, overhead sprinkler type. Watermelon plants are widely spaced, often 40 to 50 ft^2 allowed per plant, and, when irrigation is necessary early in the season, efficiency of water use is very poor. Because of limitations in irrigation capacity, growers generally irrigate only every 7 to 10 days. On most of Florida's sandy soils, plants probably are under a water stress within 4 or 5 days after irrigation.

Drip systems may increase irrigation efficiency and watermelon yield by providing a uniform and consistent supply of moisture in the root zone. The main benefits of drip irrigation are conservation of water and reduced energy use in pumping (1, 3, 8, 9). Most reports indicate that drip systems use 30 to 60% less water than overhead sprinkler irrigation. However, drip irrigation has also contributed to yield increases in pepper (1), tomato (5), and watermelon (10). Application of at least some of the fertilizer through the drip system, fertigation, resulted in increased yields of several vegetables (4, 6, 7). Watermelon yields were increased when spacing between hills was reduced from 8 ft to 2 ft (2).

Experiments were conducted to evaluate the response of watermelons to irrigation method and plant population on 2 different soil types.

Materials and Methods

'Sugarlee' watermelons were grown on Apopka fine sand near Leesburg and on Myakka fine sand near Gainesville in the spring of 1981. Seeds were planted February 24 at Leesburg and March 12 at Gainesville. Treatments were the 4 irrigation methods (drip fertigation, overhead sprinkler irrigation, overhead sprinkler fertigation, and no irrigation) and 2 in-row spacings (2.5 or 5.0 ft apart in rows 10 ft apart). Treatments were arranged in a split-plot design with irrigation treatments as main plots and plant spacings as subplots. Subplots were single 50-ft rows and treatments were replicated 4 times. Separator rows, 10-ft wide, were situated between irrigation treatments to minimize the affect of treatment on adjacent plots. Fertilizer was applied at 150-200-200 lb/acre (N-P_2O_5-K_2O) for all treatments. All the P (superphosphate) and 30 lb/acre fritted micronutrients (FTE 503) were applied preplant in a 3-ft-wide band and incorporated prior to bedding. Sources of N and K were NH_4NO_3 and KCl, respectively. With overhead irrigation and no irrigation, 2/3 of the N and K_2O were applied preplant and 1/3 at layby. With drip and overhead fertigation, 1/3 of the N and K_2O was applied preplant and 2/3 was injected into the irrigation water.

Double tube drip hose ("Bi-wall" manufactured by RIS Irrigation Systems) was used for the drip treatments. Water was supplied daily and fertilizer was injected continuously when the irrigation was in operation. At Gainesville the drip system was shut off for 1 or 2 days following rainfalls

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that exceeded 0.25 inch. Based on the assumption that the drip hose would apply moisture to a 2-ft-wide strip of soil (20% of the field area), water application increased in increments, from 0.21 inches/week early in the season, to 0.70 inches/week late in the season at 9 psi (Table 1). Microsprinklers (manufactured by RIS Irrigation Systems) with a 0.055-inch-diameter orifice were used to supply overhead irrigation. These sprinklers covered a diameter of 15 ft and were spaced 10 ft apart in the row. The gross rate of application was approximately 0.16 inch/hr at 15 psi. The overhead sprinklers were operated at night when wind was at a minimum. Water was applied in 3 consecutive nights each week to supply 1 inch of irrigation water per week. If rainfall occurred, the duration of the overhead run was reduced accordingly. However, to facilitate weekly injection of fertilizer, about 0.3 inch of water was applied even when rainfall exceeded 1 inch/week. The amount of fertilizer injected in the drip and overhead fertigation systems was varied during the season depending on estimated plant requirements (Table 1).

Table 1. Weekly water and fertilizer applications and rainfall during the growing season at Leesburg and Gainesville.

Week[z]	Drip irrigation (inches/wk)	Fertilizer[y] (% of total/wk)	Rainfall (inches/wk)	
			Leesburg	Gainesville
1	0.21	4	0.00	0.60
2	0.21	4	1.45	1.00
3	0.28	4	1.02	1.50
4	0.28	4	1.29	0.05
5	0.42	6	0.00	0.00
6	0.42	6	0.00	0.00
7	0.42	8	0.02	0.05
8	0.49	8	0.00	0.15
9	0.49	12	0.01	0.05
10	0.56	12	0.00	0.00
11	0.56	12	1.29	0.30
12	0.70	10	0.77	0.40
13	0.70	10	2.33	0.73

[z]At Leesburg week 1 began March 8 and week 13 ended June 6. At Gainesville week 1 began March 12 and week 13 ended June 11.
[y]The % of total injected N and K supplied during a given week in drip and overhead fertigation.

Tissue N concentrations were determined on leaf samples taken from the youngest fully expanded leaves on May 14 and June 11 at Leesburg and May 14, June 10, and July 2 at Gainesville. Mature fruit were harvested May 27 and June 4 and 18 at Leesburg and June 9 and 18 and July 2 at Gainesville.

Results and Discussion

Rainfall at Leesburg and Gainesville was adequate for plant growth early and late in the season but only a trace of rain fell during a 6-week period at mid-season (Table 1). Moisture was less critical at Gainesville than at Leesburg because of the greater water-holding capacity and higher water table. The total amount of water applied to the drip-irrigated plots was much less than that applied to the overhead plots. An estimated 100 ft² per plot were wet with the drip system and 728 ft² with overhead sprinklers. Actual water use per plot at Leesburg was 3,459 gal with overhead and 2,230 gal with drip, about 36% less water with drip than with overhead. This translates into a savings of 56,785 gal/acre or a saving of just over 2 acre-inches of water. Overhead irrigation was not used after May 20 when rainfall was adequate but the drip system was not stopped until June 6. Rate of water application with drip was highest the last 3 weeks (Table 1) and if drip irrigation had been reduced or shut off at the same times as the overhead, actual water use might have been as low as 1,588 gal per plot, a savings, on an acre basis, of another 2 acre-inches of irrigation water.

At Gainesville estimated water usage with the overhead system was 2,760 gal per plot and with drip about 1,436 gal per plot, a 44% savings in water. This amounts to a savings of almost 4 acre-inches of irrigation water.

Early and total yields at Leesburg were significantly affected by method of irrigation (Table 2). Because of the very low mid-season rainfall, early yield was very low in non-irrigated plots. Later rainfall stimulated some plant growth. Early yield was highest with drip irrigation probably because this system supplies water to the root zone. Total yields were not significantly different among the irrigation treatments; there was no apparent benefit from applying the fertilizer in the irrigation water by overhead fertigation. At Gainesville, irrigation treatment had no effect on total yield.

Table 2. Main effects of irrigation method and plant spacing on early and total watermelon yields at Leesburg and Gainesville.

Treatment	Yield (cwt/acre)			
	Gainesville		Leesburg	
	Early	Total	Early	Total
Irrigation				
None	5.6 c	131.7 b	21.4	293.4
Overhead —[z]	45.7 b	316.9 a	13.1	309.8
Overhead +	56.1 b	296.7 a	31.5	285.8
Drip	111.3 a	275.1 a	32.5	311.9
F[y]	**	**	N.S.	N.S.
Plant spacing (ft)				
2.5 x 10	56.6	286.8	25.1	330.9
5.0 x 10	57.1	223.4	24.2	269.4
F	N.S.	**	N.S.	**

[z]Overhead irrigation without fertilizer injection (—) and overhead fertigation (+).
[y]F values were significant at the 1% (**) level and means were separated by orthogonal comparisons or F values were not significant (N.S.). Interactions were not significant.

Increasing the plant population from about 870/acre (5.0 x 10 ft) to 1740/acre (2.5 x 10 ft) significantly increased yields at both locations (Table 2). The increased yields with the higher plant population at Leesburg and Gainesville were 28% and 22%, respectively. Interactions between treatments were not significant.

No differences in leaf tissue N concentrations were apparent at Leesburg (Table 3). At Gainesville tissue N concentrations were lower on the second and third sampling dates than on the first. On the third date of sampling, tissue N was significantly higher in the unirrigated and drip-irrigated plots than those with overhead sprinklers. This may have been due to excessive leaching following excessive rainfall and irrigation application. Foliar N deficiency symptoms were not apparent.

In this trial, overhead irrigation with the micro-sprinklers was not altogether comparable with standard commercial overhead irrigation. To minimize the effect of wind on water placement, all overhead irrigation was done at night. Physical limitations of irrigation equipment and water supply required the 1-inch application to be achieved by applying 1/3 inch/night for 3 consecutive nights. Thus, during each weekly period the overhead plots went only 4 days without water and the water stress was less in the experimental situation than would be expected in a more practical case where an inch of water is applied once every week.

Table 3. Main effects of irrigation method and plant spacing on N concentration in watermelon leaves at Leesburg and Gainesville.

Treatment	Leaf N (%)[z] Leesburg A	Leesburg B	Gainesville A	Gainesville B	Gainesville C
Irrigation					
None	4.1	3.7	4.7	4.1	4.1 a
Overhead –[y]	3.9	4.0	4.5	4.0	3.7 b
Overhead +	4.0	4.1	4.6	4.2	3.6 b
Drip	4.0	4.0	4.5	4.2	4.0 a
F[x]	N.S.	N.S.	N.S.	N.S.	**
Plant spacing (ft)					
2.5 x 10	4.0	3.9	4.6	4.0	3.8
5.0 x 10	4.0	3.9	4.5	4.2	3.8
F	N.S.	N.S.	N.S.	*	N.S.

[z]Leaves were sampled at Leesburg on May 14 (A) and June 11 (B), and at Gainesville on May 14 (A), June 10 (B), and July 2 (C).
[y]Overhead irrigation without fertilizer injection (–) and with fertilizer injection (+).
[x]F values were significant at the 5% (*) and 1% (**) level and means were separated by orthogonal comparisons or F values were not significant (N.S.).

An additional benefit of drip irrigation, besides the savings in water used, was the restricted growth of weeds. Continuous wetting of the soil surface of the overhead-irrigated plots allowed weed seed germination and provided adequate moisture for prolific weed growth over the entire plot area. Weed growth with drip irrigation was limited to a narrow band down the row middle.

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QUANTITY AND RATE OF WATER APPLICATION FOR DRIP IRRIGATED TOMATOES[1]

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Abstract. **The effects of emitter location, quantity and rate of water application with drip irrigation were evaluated on tomato** (Lycopersicon esculentum) **plant growth and fruit production. Greenhouse studies were conducted in ground beds of Chipley fine sandy soil during 2 seasons. The rate of water application/emitter, from 0.5 to 2.0 gal/hr had no effect on plant growth and fruit yield. However, fruit yields were significantly influenced by the quantity of water applied in both seasons. During the 1977-78 season, the number of marketable fruit was 16% greater with a water application quantity of 1.0 compared to 2.0 times pan evaporation. However, fruit size was larger with the higher water quantity and total marketable fruit yield increased only 6% over that obtained with the 1 pan treatment. In the second season, marketable fruit yield was 30% greater with 1.0 pan than 0.5 pan with 2 drip lines/bed. With 1 drip line/bed, yields were similar with both water quantities. Leaf tissue nutrient data indicated that N and K concentration were not different with the 1.0 and 2.0 pan irrigation quantities. Leaf N was higher and P lower with 0.5 than 1.0 pan water quantity in the second season.**

Overhead and subsurface irrigation systems currently are the most extensively used systems for tomato production in Florida. Generally about 15 to 20 or 45 to 60 inches/acre of water are used per season with the 2 systems, respectively (2, 5). In recent studies, tomato production was similar to or higher with one-half as much water from drip as with overhead irrigation (2, 6, 7). Nutrients are easily leached from the plant root zone with drip irrigation (1) and soluble fertilizers must be applied with the irrigation water to obtain highest yields (6). The quantity, rate of water application, and placement of emitters has been shown to influence soil water distribution, nutrient uptake (1, 3, 4) and tomato root growth (3). Precise control of these factors is necessary to prevent excessive nutrient leaching and to produce maximum yields.

These studies were conducted to evaluate the effects of water quantity, rate of application and drip emitter location on tomato leaf tissue composition and fruit yield.

Experimental Procedures

Experiments were conducted in a fiberglass greenhouse

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