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STABILIZATION OF THE ROOT ENVIRONMENT IN CONJUNCTION WITH A HIGH MOISTURE LEVEL FOR MAXIMUM TOMATO PRODUCTION[1]

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Abstract. **Recent observations indicate that above normal levels of soil moisture in conjunction with root environment stability favors increased tomato production. In recent experiments, an average moisture content of 11 to 14% was maintained in the top 2 inches of the soil bed using 4 water table depths; 11 to 12 inches in a wide row culture and 14 to 16 in a close row culture. Under the experimental conditions (a dry season), both close and wide row spacings gave similar yield per plant: 27.1 and 28.7 lb., respectively. Because of the higher plant population, the close row culture yield was calculated as 3309 marketable 30 lb units/acre compared to 2289 for the wide row. Fruit size averaged 4 gm heavier with the wide row culture; fruit from the Duke cultivar was 16% larger than the Hayslip. Fertilizer rates (1200 or 1800 lb/A 18-0-25) did not affect yields among the water treatments. Modification of the moisture level as a functional advantage in the gradient-mulch system must provide a stable root environment in a combination with a plant population that favors a maximum production efficiency, regardless of rain density.**

Recent evaluations have indicated that higher levels of moisture in conjunction with a more stable root environment favors increased production (4, 5). Sporadic rainfall and the associated supplemental irrigation which cause variations in nutrient and moisture levels have been major limiting factors in crop production. With the use of a full bed mulch it has been possible to modify and minimize these variations and provide a more stable root environment. A measure of these moisture and nutrient modifications and the associated response of tomatoes are presented in this report.

Major soil variations in moisture have been associated with the design and management of the irrigation and drainage system. On the sandy soils of Florida, seepage irrigation is standard procedure and a basic component of the gradient-mulch system (3, 4, 5). However, drainage systems vary from field to field and often within fields. Field slope which might normally vary from 0 to 0.5% can be a dominant factor in any water control system. Field leveling tends to minimize high points as well as depressions and as a function of management, can vary with each grower. Water control is also dependent on the length of the rows and the distance between row and associated ditches. Thus, the management of the irrigation and drainage system would be relevant to the field topography and dimensions as well as the density of the rain (quantity x frequency/ unit of time).

The moisture content in a number of experimental plots and grower fields has been found commonly to range from 7 to 10% in the top 2 inches of the soil bed (5). In the 1980 spring crop season, variations in moisture in a grower's field were on an observational basis correlated with production (5). Yields of more than 40 lb./plant were associated with a moisture gradient of 9.9, 12.2, 16.3 (% moisture at the 0-2, 2-4, 4-8 inch depths in the soil bed). In an area that was considered comparatively dry, yields of 24 lb./plant were associated with a gradient of 7.5, 10.5, 14.9. At the other extreme, a gradient of 10.8, 12.9, 18.5 after rains remained excessively wet and the associated yield ranged from 18 to 32 lb./plant. This field had an average slope of about 0.1%, was designed as a wide row culture with 12.5 feet between rows, 1300 foot rows and a plant population of 1400/acre.

Materials and Methods

Using the above information as a guide, an experiment was designed to evaluate water control procedure used in conjunction with above normal moisture levels. A Myakka fine sand, a hyperthermic spodosol (Aeric Haplaquod) (2), was used as a base to evaluate selected variables. This field provided a relatively steep slope (0.33%) which favored a relatively rapid removal of surface water at a row length of 400 feet. The distance between rows was evaluated by providing a close row culture (7340 linear feet/acre) and a wide row culture (4840 linear feet/acre) in side by side blocks. The close row culture consisted of 7 bedded rows (4.5 ft row spacing) between ditches. The wide row cultures with a ditch between each row at a 9 foot spacing is a system that theoretically should provide better water control but less row feet/acre. There were 2 water table depths, 2 fertilizer levels, and 3 replicates in each row spacing block. The design of the system requires a comparatively deeper ditch for the close row culture and thus an associated deeper water table. Two water table levels within each block were provided by adjusting the bed height in conjunction with a variance in water table depth. This arrangement provided water tables of 14 and 16 inches in the close row culture compared to 11 and 12 in the wide row culture. This variance is essential to provide the maximum functional efficiency of either system. The depth to the water table was measured daily from the top of the soil bed to the water table using a 3-inch plastic stand pipe for each variation.

An 18-0-25 fertilizer banded primarily on the soil bed surface was used to compare levels of 1200 and 1800 lb./ acre. All plots received 500 lb. of an 0-20-0 plus 20 lb. of micro-nutrients (FN503) mixed in the soil bed. Two tomato cultivars (Duke and Hayslip) were used as test crops.

The moisture content (% of the soil dry weight) was measured at 3 increments of depth (0-2, 2-4, and 4-8 inches) in the center of the soil bed (plant row) and 8 to 10 inches from the bed center (surface banded fertilizer). A measure of the total salts and the ionic components in the saturated extract was obtained from the same increments of the soil bed. These measures were used to evaluate the stability of both nutrient and moisture gradients.

The number and weight of marketable fruit from 4 weekly harvests ending on June 5, 1981 were used to obtain the yield data (lb./plant, lb./fruit, and 30 lb. units/acre) were correlated with the respective variables. Plots were 20 feet long with 10 plants/plot. Both cultivars (determinates) were staked and tied, but were not pruned.

Results and Discussion

Because of minimal rain, irrigation was constant from February until June. Water tables did not fluctuate more

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than 1 inch above or below that indicated (Table 1) and moisture gradients indicated on April 1 were typical until the end of the growing season. Note that the percent moisture in the soil profile for the 12 inch water table (wide row culture) was about equivalent to the 14 inch water table in the close row culture. The highest level of moisture was associated with the 11 inch water table; the lowest level was associated with the 16 inch water table. It is significant that all 4 water tables provided moisture levels above 11% in the top 2 inches of the soil bed and the associated yields were equivalent. With irrigation + rain (June 3) the water table and moisture gradients fluctuated accordingly. This gradient variation in June did not affect yields as the final harvest occurred on June 5th. On June 4, 12 hours after the irrigation water had been cut off (0.27 inches of rain on June 2, 0.38 on June 3, and 1.14 on June 4) the water table in the wide row culture had dropped 10 inches compared to only 4 inches in the close row. This indicates that management required to provide stability would vary with the row spacing system.

A measure of the moisture (Table 1) and nutrient gradients (Table 3) as well as equivalent per plant yields (Table 2) supports the existence of equivalent root environments. However, on a per acre basis, the close row culture with 3670 plants/acre averaged 3309 marketable 30-lb. compared to 2289 units from 2420 plants for the wide row culture. Depth to the water table or level of fertilizer did not affect yields. Fruit size was slightly larger with the wide row compared to the close row; the Duke cultivar averaged a larger size fruit compared to the Hayslip.

The average production of fresh market tomatoes in Florida is about 800 units (1) and some of the better growers obtain yields of 1600 (5). Being able to produce 30 to 40 lb. of tomatoes/plant provides a potential for maximum production efficiency. Producing up to 3500 marketable units/acre from a field culture has not been previously recorded. What is most significant is that the unit cost of production for an 800 unit yield may range around $3.00 compared to $0.80 for a 3000 unit yield. In this particular season (minimal rain), the highest level of production was associated with an above normal level of moisture, a stable root environment and the higher plant population using the Duke cultivar. Stability of the root environment means that both nutrient and moisture gradients vary by design

Table 1. Effect of row spacing, fertilizer levels and water table depth on distribution of moisture (%) in the soil profile (April 1, 1981).

Culture	Water table depth (inches)	Fert. 18-0-25 rate lbs/A	Depth in soil profile (inches) 0-2	2-4	4-8	0-8
Wide	12	1200	14.4	18.3	25.2 a[z]	20.8
		1800	13.0	17.2	25.0 a	20.1
	11	1200	13.1	15.9	21.4 ab	17.9
		1800	11.5	16.6	20.9 b	18.0
Close	14	1200	12.0	14.7	22.0 b	17.7
		1800	11.6	14.1	21.1 b	17.0
	16	1200	11.8	14.1	17.8 c	15.4
		1800	10.9	13.4	17.7 c	14.9

[z]Values followed by the same letter within culture are not significantly different at the 5% level by Duncan's multiple range test.

Table 2. Effect of row spacing, fertilizer levels and water table depth on the yield of two tomato cultivars.

Culture	Water table depth (inches)	Fert. 18-0-25 rate lbs/A	Yield[z] Lbs/plant Duke	Lbs/plant Hayslip	Lbs/fruit[y] Duke	Lbs/fruit[y] Hayslip	30 lb units/A Duke	30 lb units/A Hayslip
Wide	11	1200	31.7	28.2	.434	.361	2550	2280
		1800	29.8	28.1	.407	.372	2410	2070
	12	1200	30.5	24.9	.416	.360	2420	2010
		1800	30.2	26.4	.418	.347	2440	2130
Close	14	1200	28.1	26.1	.416	.360	3430	3190
		1800	29.2	24.9	.410	.348	3570	3040
	16	1200	27.1	25.4	.409	.343	3310	3100
		1800	28.5	27.4	.400	.348	3480	3350

[z]Treatment differences were not significant.
[y]Duke (mean size 0.413) was significantly larger than Hayslip (0.335); LSD 5% 0.010, 1% 0.034.

Table 3. Effect of row spacing, fertilizer levels and water table depth on distribution of soluble salts (ppm) in the soil profile (April 1, 1981).[z]

Culture	Water table depth (inches)	Fert. 18-0-25 rate lbs/A	Depth in soil profile (inches) Fert. 0-2	Fert. 2-4	Fert. 4-8	Row 0-2	Row 2-4	Row 4-8
Wide	11	1200	17360	3360	1540	8260	3520	1512
		1800	50400	16240	5040	3920	2240	1680
	12	1200	81760	16800	2060	8260	2270	1176
		1800	183680	19600	3150	5040	1568	1736
Close	14	1200	19320	9660	2660	6860	4130	2240
		1800	35840	15400	3780	6160	4060	1736
	16	1200	21560	8400	2352	3990	5040	2492
		1800	60480	16520	3220	9100	4620	1988

[z]Treatment differences were not significant.

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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