Drip and Furrow Irrigation of Fresh Market on a Slowly Permeable Soil:

PART 1. PRODUCTION

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Growers of fresh market tomatoes frequently attribute an increase in small fruit during the growing season to poor water relations. In studies on a Vista sandy loam soil, greater numbers of small fruit were produced by drought-stressed plants. A high frequency of furrow irrigation caused the soil surface to "seal" greatly restricting water penetration and lowering the production of large tomatoes. Production was best when water was added through a drip hose placed at the base of plants in the row or by less frequent furrow irrigation.

Growers of tomatoes for the fresh market often report that there are more small tomatoes as the season progresses. The general feeling is that productivity is related to the ability to move adequate irrigation water into the soil. Preliminary studies at the Lindcove Field Station in 1973 and 1974 indicate that yield and size of fresh market tomatoes are indeed influenced when soil penetration by furrow-applied water is reduced. A soil surface that is constantly moist from frequent water addition while daily picking is going on leads to soil compaction by harvest laborers walking over the moist soil. Reduced water penetration may lead to increased frequency of irrigation, further compounding the problem.

In 1975 an irrigation trial was established at the Lindcove Field Station on a Vista sandy loam soil with the fresh market tomato variety 6718. Tomato transplants were set 2 feet apart in the row, 25 plants per row. Each plot was 3 rows spaced 5.33 feet apart. Each treatment was replicated three times. Before the plants were set, two bands of fertilizer were placed 14 inches apart at a depth of 5 inches. The transplants were then set midway between the fertilizer bands. The fertilizer was ammonium sulfate at 80 pounds of nitrogen per acre. Transplants were set on February 20 and covered with plant protectors (hot caps) for frost protection.

On two occasions, May 23 and July 2, 20 pounds of nitrogen (ammonium sulfate) were dissolved and applied through the drip hose or applied in the furrow bottom near the row, followed by irrigation.

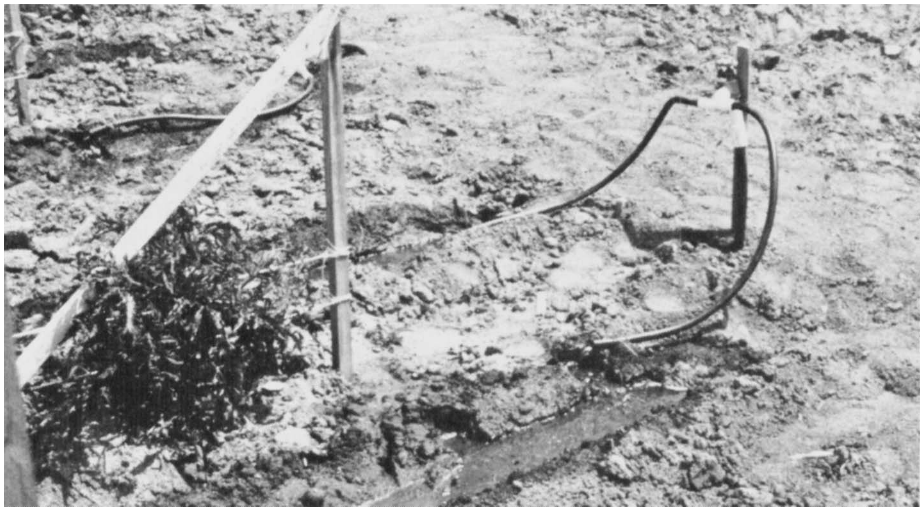
Irrigation treatments

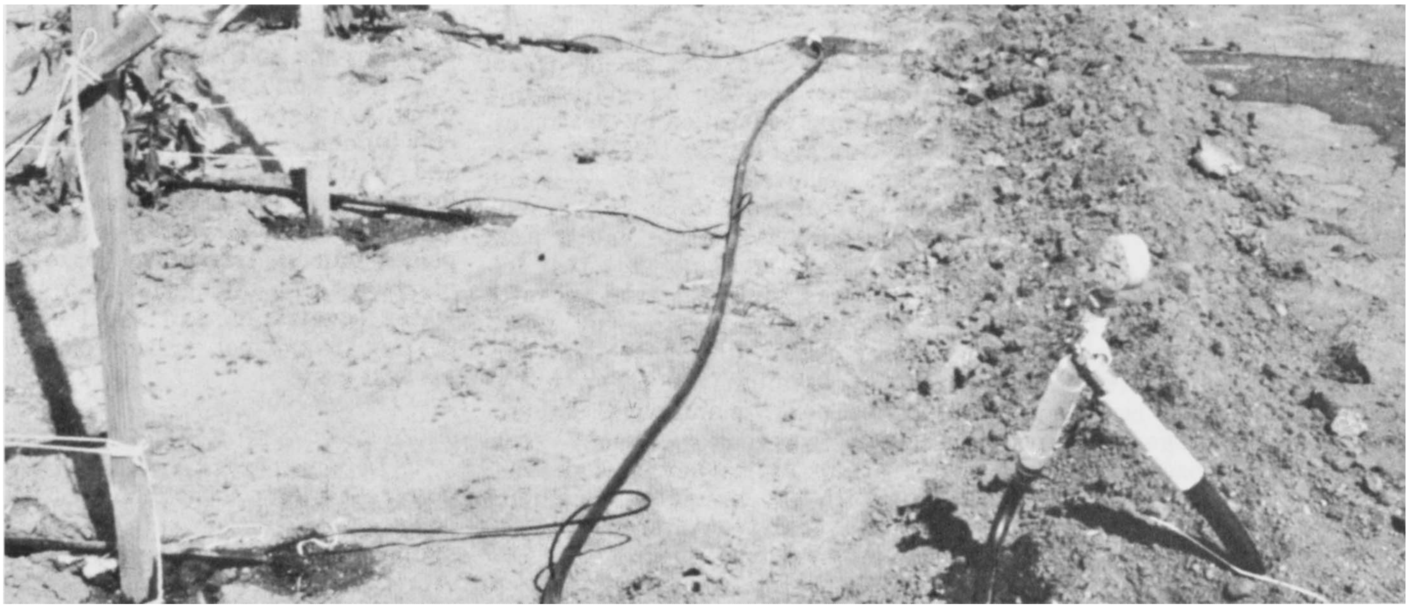
Two methods of irrigation were used: furrow and drip, each at two frequencies.

Symbol	Irrigation method	Irrigation frequency
W-1	furrow	infrequent
W-2	furrow	frequent
W-3	drip	infrequent
W-4	drip	frequent

The furrow system consisted of a conventional furrow placement 1 foot on each side of the row. A return-flow system was used. For the drip method, 8-mil biwall tubing was used (Chapin) with outlets 12 inches apart on the outside wall and 72 inches apart on the inside wall. Outflow rate at various pressures was measured at the experimental site. From this calibration it was determined that a pressure of 10 psi at the sub main would provide the flow rate desired. A pressure gauge and regulator (along with in-line filters) were installed for each 3-row plot.

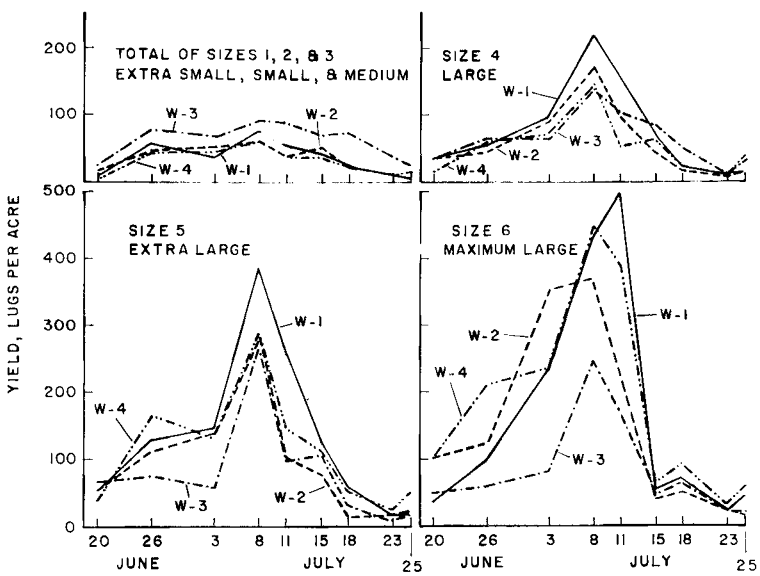
Soil water status was monitored throughout the season with tensiometers placed within the tomato row at 12- and 24-inch depths in all treatments of two replications. In early season (before June 1) the infrequently and frequently furrow-irrigated treatments, respectively designated W-1 and W-2, were irrigated when the 12-inch tensiometer reached values of 70 and 30 centibars. Scheduled the same way during this time were the infrequent (W-3) and frequent (W-4) drip irrigation treatments. Irrigations were started for W-2 and W-4 on April 30, but W-1 and W-3 were delayed until May 2. Before that time, spring rains kept the soil adequately wet on all treatments. During May, the dry treatments (W-1 and W-3) were irrigated at weekly intervals for 6 to 7 hours, whereas the wet treatments (W-2





Furrow and drip irrigation systems of the study.

Graph. Production trends of four size groupings of fresh market tomatoes from furrow and drip irrigation each at two frenquencies.



and W-4) were irrigated at 3-day intervals for 6 to 7 hours.

After May, water penetration became so slow for the frequently irrigated furrow treatment (W-2) that scheduling by tensiometer reading was impractical. In early June, when increased foliage and radiation increased the water demand, a new schedule was established for all treatments which continued for the duration of the experiment. The infrequent treatments (W-1 and W-3) were still irrigated weekly (Wednesday), but for 12 hours. Frequently irrigated treatments were irrigated on Monday, Wednesday, and Friday of each week for 12 hours. Total water available for the two furrow treatments depended more on water intake rate than on frequency and

Table 1. Size designation of fresh market tomatoes.

Trial Designation	USDA designation	Los Angeles lug size	Diameter size range (inches)
Size 1	Extra-small	7x8	1 28/32 - 2 4/32
Size 2	Small	7x7	2 4/32 - 2 9/32
Size 3	Medium	6x7	2 9/32 - 2 17/32
Size 4	Large	6x6	2 17/32 - 2 28/32
Size 5	Extra-large	5x6, 5x5	2 28/32 - 3 15/32
Size 6	Maximum-large	4x5	3 15/32 - over

duration of water application (see part 2 for a full discussion). The frequent drip irrigation sequence was established to provide about 20 percent more water (0.39 inch per day) than the expected demand, whereas the infrequent drip treatment (W-3) was expected to induce considerable drought stress during fruit development.

Harvesting

Harvest dates were June 20 and 26, and July 3, 8, 11, 15, 18, 23, and 25, with the peak harvest at about July 8. On each harvest date all tomatoes with more red color than the "breaker" stage were picked and divided into sizes (see table 1).

Production trends

It developed that the total yield of extra-small, small, and medium-sized fruits was a relatively small part of total yield, contributing less than 100 lugs per acre at the peak picking dates. The extra-small, small, and medium sizes are normally packed in 3-layer lugs. As shown in the graph, the yield of extra-small, small, and medium sizes was highest for treatment W-3 (infrequent drip). The low volume of water available from this treatment caused the greatest plant stress throughout the season. Next highest for those tomato sizes were the frequent (W-2) and infrequent (W-1) furrow treatments. The frequent drip treatment (W-4) provided an optimum soil water condition (see part 2 in this issue) and produced the least amount of small tomatoes (graph and table 2).

The large, extra-large, and maximum-large sizes are all packed in two-layer flats and contributed most of the total production. For size 4 (large) the yield at the peak pick date was highest for the W-1 treatment, followed by the W-2 and W-4 treatments. The low water available from the W-3 treatment resulted in the lowest peak pick yield. Total yield of size 4 (large) tomatoes showed no statistically significant separation by treatment, but was highest for the W-1 treatment followed by W-3, W-2 and W-4 in that order (table 2).

Size 5 (extra-large) had a peak pick yield and total yield that followed the same pattern, but with a statistical separation by treatment. Again, the infrequent furrow treatment (W-1) gave the highest peak yield, though total production was not significantly better than for either W-4 or W-2 (table 2). The low water availability of the W-3 treatment gave the lowest yield of the size.

Peak pick yield of size 6 (maximum-large) was also achieved with the W-1 treatment. Peak production of 496 flats per acre (on July 11) was about twice that observed for W-3 (on July 8). Peak yields from W-2 and W-4 were intermediate between those from W-1 and W-3. However, high production over a longer period characterized the optimum moisture conditions of the W-4 treatment, producing a substantially higher total season yield (table 2).

Severe water penetration problems developed during the growing season on the wet-furrow treatment plots. Soil surface sealing prevented the frequent furrow irrigation from reflecting the amount of water applied to the soil surface. Water availability was governed more by penetration rate than by irrigation frequency for the furrow method (see part 2). Productivity directly reflected the soil water conditions. The trial confirmed the observations that water penetration markedly influences total yield, fruit size, and peak harvest yield of fresh market tomatoes. Application of irrigation water through a drip hose placed immediately at the base of plants in the row could improve water penetration and avoid compaction from foot traffic of the harvest crew.

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Table 2. Total-season fresh market tomato yield as influenced by frequency and method of irrigation at the Lindcove Field Station in 1975.

Tomato size	Furrow, infrequent (W-1)	Drip, infrequent (W-3)	Furrow, frequent (W-2)	Drip, frequent (W-4)
	Lugs per acre*			
1	96.75 a**	199.05 a	92.75 a	68.09 a
2	75.69 a	114.54 a	61.89 a	60.82 a
3	156.96 a	241.28 a	176.85 a	149.61 a
4	688.36 a	590.18 a	529.68 a	485.79 a
5	1184.73 b	673.60 a	822.21 ab	1010.26 ab
6	1499.79 b	758.69 a	1294.00 b	1633.16 b
Total	3702.28b	2577.34 a	2977.38 ab	3407.73 ab

* Sizes 1, 2, and 3 are 3-layer lugs, while 4, 5, and 6 are 2-layer flats.
** Numbers not followed by the same letter within a size class or for the total of all sizes, differ at a 5% probability level according to Duncan's multiple-range test.