

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

PART 2. WATER RELATIONS

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Frequent furrow irrigation of fresh market tomatoes, on a sandy loam soil, caused the soil surface to seal, greatly restricting water penetration into the plant root zone. Water penetration in furrows was adequate throughout the season if the frequency of irrigation was lowered. A drip irrigation system maintains not only a desirable soil moisture distribution, but also the cultural advantage of a dry surface area for foot traffic of harvesters that improves their efficiency and reduces soil compaction.

Water penetration slows during the growing season in furrow-irrigated, fresh market tomato fields on eastern San Joaquin Valley

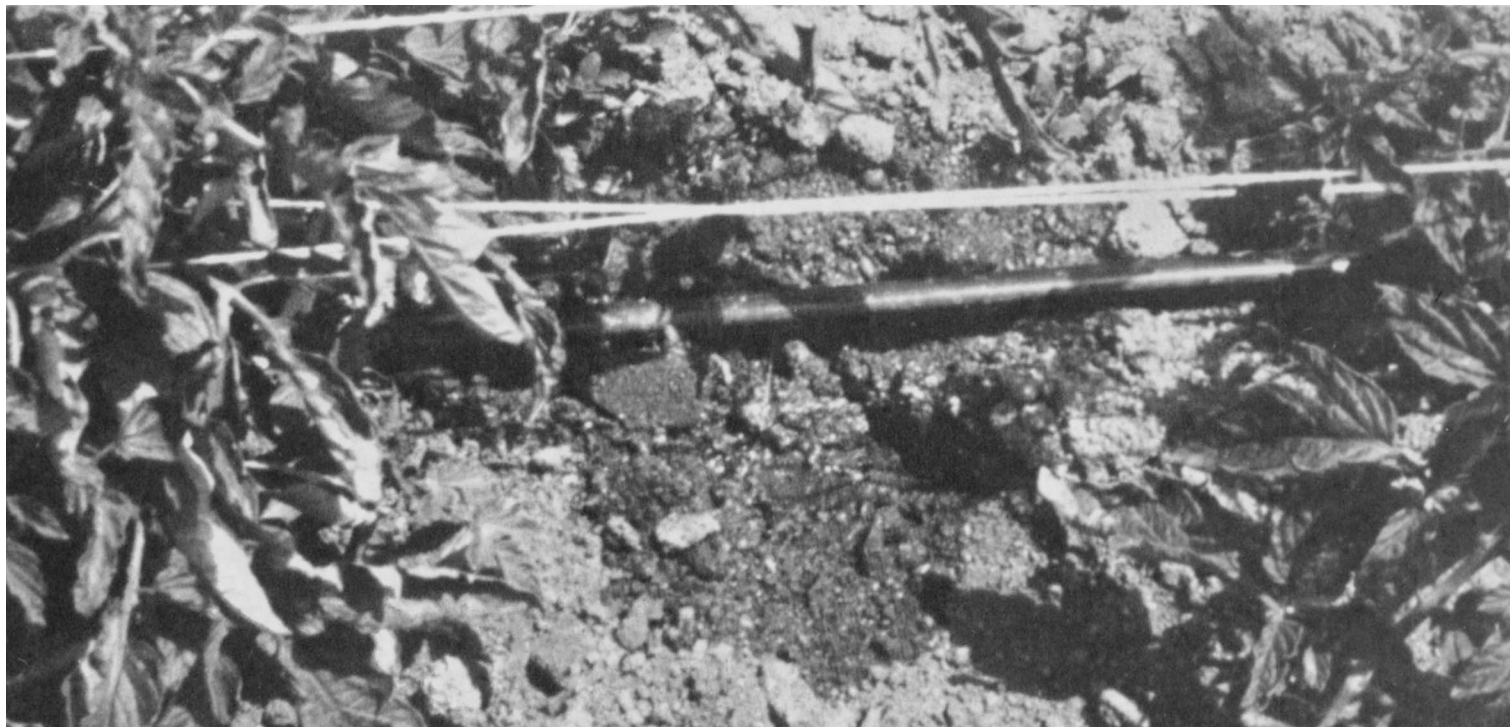
soils. Such slowing has been shown also in preliminary experiments at the Lindcove Field Station in 1973 and 1974. In 1975, an experiment was conducted at the Lindcove Field Station, on a Vista sandy loam soil, to examine the influence of furrow irrigation frequency on surface penetration capability, and to determine whether drip irrigation (trickle) could maintain adequate water penetration throughout the season.

Four irrigation treatments consisted of the furrow and drip methods, each at two intervals: infrequent (W-1) and frequent (W-2) furrow treatments, and infrequent (W-3) and frequent (W-4) drip treatments. The four treatments were replicated three times in field plots 50 feet long. Each plot comprised three rows, 5' 4" apart.

Early-season irrigations were scheduled on the basis of tensiometer readings, but poor water penetration on the most frequently irrigated furrow treatment soon rendered this impractical. The irrigation treatments are described in more detail in part 1 in this issue, along with other procedures and the resulting production trends.

Surface sealing

The frequent irrigations were initiated in late April (W-2 and W-4), the infrequent irrigations in early May (W-1 and W-3). As shown in graph 1, water penetration was becoming a problem on the frequently irrigated furrow treatment (W-2) by mid-May. The tensiometer readings at 12 inches of



Biwall drip irrigation tubing placed at the base of tomato plants. Note the wetted area around the outlet.

two adjacent plots furrow-irrigated at different frequencies illustrate the striking influence of irrigation frequency on water penetration. A final cultivation at the end of May failed to improve penetration significantly. The restriction to water penetration caused by frequent furrow irrigation is believed to be a relatively shallow surface phenomenon on this soil, related to particle dispersal, orientation, and a possible biological growth-reducing effective pore volume. Rate of water penetration may vary considerably in a short radial distance in this soil. An adjacent tensiometer-monitored replication of the frequent furrow treatment showed adequate water penetration at both 12- and 24-inch tensiometer placement depths through mid-June. Thereafter, however, no irrigation penetrated to the 12-inch depth. Graph 1 compares plots that were side by side in the study.

The less frequent furrow treatment (W-1), irrigated at weekly intervals throughout the season, showed good water penetration during the entire irrigation season. No tendency was observed toward the high degree of surface sealing resulting from the high frequency treatment.

Water intake rates for the two furrow irrigation frequencies were determined at two dates in late season (see Table). The volume of water shown represents the difference in volume between inflow measurements and outflow at the end of the 50-foot rows (total for two furrows, one on each side of individual rows). Tabular values are averages of the three replications and four measurements at 90-minute intervals on July 16. Three measurements were made at two-hour intervals on July 23. The average intake water volume for W-1, 4.14 cubic feet per hour, is equivalent to a water penetration rate of 0.19 inch per hour, considering the entire soil surface. This compares with 0.05 inch per hour for the frequently irrigated plot, about one-fourth as fast.

Drip and furrow methods compared

Drip irrigation was through biwall tubing (Chapin) immediately adjacent to plants in the row. After June 1, the high frequency plot (W-4) was irrigated for 12 hours three times weekly (Monday, Wednesday, Friday), the same as for the high frequency furrow treatment. Ear-

lier irrigations had been less frequent because water demand was lower. The low frequency, W-3 plot was irrigated for 12 hours on Wednesday of each week, the same as for W-1. The high frequency drip treatment delivered slightly more water than the expected demand (see part 1).

Tensiometers at a 12-inch depth in the row for the W-4 treatment had an average reading of 10 centibars after June 1. The corresponding value for a 24-inch depth was 20 centibars. Tensiometers at 12 inches for the W-3 treatment consistently approached 80 centibars the day before irrigation and occasionally exceeded the air entry value. The water volume added with this treatment consistently rewet the 12-inch in-row depth but was not always sufficient to reach the 24-inch depth. As expected, this treatment allowed an appreciable water deficit and reduced yield correspondingly (part 1). The high frequency treatment (W-4) may have allowed a small water loss by drainage below the root zone, but achieved high production.

To evaluate both vertical and lateral water distribution, soil samples were taken from the center replication on July 17, the day after

each treatment was irrigated, at 6-inch intervals to a depth of 5 feet. Samples were collected directly in the row, at half the distance from the row to midway between rows, and midway between rows, respectively referred to in graph 2 as row, 1/2, and center.

The measured water contents were converted to matric potential from laboratory-measured water-release curves. Most of the water that plants can use from this soil is held at a value not lower than -1 bar. Little or no water is available for plants at values lower than -15 bars.

Graph 2 shows that the infrequently irrigated furrow treatment had good vertical and lateral water distribution following irrigation. The surface 6 inches is very dry midway between rows, but below two feet the water is evenly distributed horizontally. Except in an approximate 6-inch radial zone around the furrow, the entire cross-sectional profile of the frequently irrigated treatment is quite dry. Because this small zone was kept wet, production was reasonably good (part 1). The most droughty treatment was the infrequent drip. While the soil volume immediately near the row was rewetted to a depth below 12 inches, this volume of water was not adequate to avoid excessive stress. Probably the most favorable water

distribution is with the frequently irrigated drip treatment. A large amount of available water was maintained in soil near the row to a depth of two feet. Below two feet the soil water was held at -1/3 bar and decreased to slightly lower values at greater depth. This distribution of soil water should adequately meet plant demands with minimal deep percolation losses.

The water relations evident from this study show reduced water penetrability from surface sealing by high frequency furrow irrigation materially influencing the water volume available for plant use. This, in turn, was reflected in total yield and production trends. A lower frequency (irrigation at weekly intervals) on this sandy loam soil gave a much improved water condition by maintaining an adequate penetra-

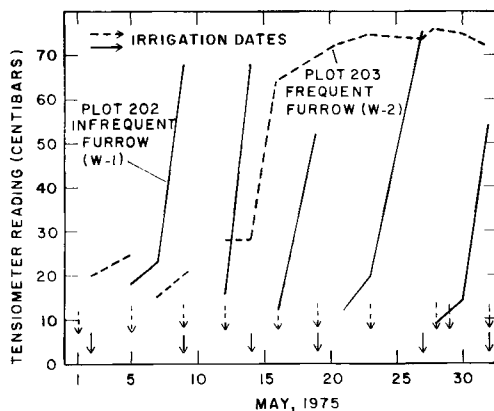
tion rate through the season. A desirable soil moisture distribution was provided by drip irrigation if sufficient water was added to meet plant demands throughout the season. A cultural advantage of the drip system is that the soil surface area for foot traffic is kept dry, resulting in less soil compaction and greater harvest efficiency. The economics of this system will be examined in greater detail.

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Table. Water intake rates at two dates for infrequently and frequently furrow-irrigated tomato plots at the Lindcove Field Station in 1975.

	Water intake/50' of row	
	7/16/75	7/23/75
	(cubic feet per hour)	
Infrequent	4.39 b	3.90 b
Frequent	1.55 a	0.91 a

Graph 1. Tensiometer readings at 12 inches for the infrequent (W-1) and frequent (W-2) furrow irrigation treatments during May on a Vista sandy loam at the Lindcove Field Station.



Graph 2. Soil wetting profiles on tomatoes the day after water addition for two irrigation methods, each at two frequencies.

