EFFECT OF IRRIGATION TIMES ON WETTING PATTERNS IN FLORIDA VEGETABLE SOILS

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The impending loss of methyl bromide for soil fumigation has led to the evaluation of numerous new and old products for control of soilborne diseases, nematodes and weeds. In Florida, 1, 3-dichloropropene + chloropicrin provided soilborne pest control and crop yields equivalent to those of methyl bromide + chloropicrin when applied in a conventional shank injection. Efficacy of emulsified 1, 3-dichloropropene and chloropicrin products applied through drip irrigation systems was excellent in the western United States. However, in the sandy soils of Florida, drip application of these and other materials was ineffective for control of soilborne pests. The lack of performance in Florida soils with a high percentage of sand (>95%), coupled with excellent performance in heavier western soils, suggested that drip application may not provide adequate distribution of soil fumigants in sandy soils. The objective of the studies reported here was to evaluate the distribution of drip irrigation water in sandy soils when applied through one or two drip tubes at various irrigation times.

Trials were conducted at the Gulf Coast Research and Education Center of the University of Florida in Bradenton, FL. Soil type was EauGallie fine sand. Beds (80 cm wide, 20 cm tall) were formed and covered with clear plastic mulch in accordance with normal grower practices. Drip tubing used was T-Tape® with an emitter spacing of 30.5 cm and delivering 1.7 l/min/30.5 m at 0.55 bars. Distribution of drip irrigation water was evaluated using a blue marking dye (Signal®). The effect of irrigation time on drip water distribution was evaluated in four trials. Irrigation times in the initial trial (October, 2000) were 0.5, 1, 2, 3, and 4 hr. One and two drip tubes per bed were evaluated. The second trial was conducted in December, 2000 with a single drip tube and irrigation times of 2, 4, 6, 8, 10 and 12 hr. A third trial was conducted in January, 2001 using a single drip tube and irrigation times of 4, 6, and 8 hrs. In April, 2001, a fourth trial was conducted using two drip tubes per bed and irrigation times of 4, 6, 7, 8, and 10 hr.

Width, depth and area of soil covered by the drip water were evaluated by digging cross sections across the beds. After digging rough trenches, the bed face was prepared for measurement by shaving off thin layers of soil until a flat surface was exposed at the desired location in the bed. For trials with single drip tubes, measurements were made across the bed at points on the emitters and equidistant between emitters. Trials with two drip tubes were evaluated by digging a trench across the bed and preparing a flat surface similar to the process for single tubes. Observations in the October trial were made at three random locations in the bed. Observations in the April trial were made at a point on one of the emitters, then the bed face was shaved back in 5.1 cm increments for a total of four faces at each location in the bed. Measurements were taken at two locations in each replicate.

To measure the distribution of drip water, a 6.4 mm plexiglass sheet, scored at 2.54 cm intervals in both directions, was held against the bed face to be measured.

Maximum width of the blue dye pattern, depth of the pattern from the top of the bed and area covered by the blue dye were recorded for each surface. Area was estimated by counting all grid squares in which half or more of the square was blue. The October trial was not replicated. The other trials were set up in a randomized complete block design with four replicates. Plot size was 7.6 m of bed.

Examples of width, depth and area wetted by drip irrigation water in these trials are given in Tables 1-2. In single tube trials, drip patterns on the emitter were wider than deep and increased in a linear manner as irrigation time increased (Table 1). Drip patterns between emitters were also somewhat wider than deep, but were not as consistent as patterns on emitters. As with patterns on the emitters, increases in width, depth and area were generally linear when measured between emitters. Despite irrigation times of up to 12 hrs, increases over time in width, depth and area of wetting on or between emitters remained linear, suggesting that distribution of drip water would continue to increase at irrigation times longer than 12 hrs.

Width, depth and area wetted by drip irrigation water applied through two drip tubes in April are given in Table 2. The width of the wetting pattern was the distance from the outer edge of the pattern from one drip tube to the outer edge of the patter from the other drip tube and did not take into account gaps in distribution between the two patterns. Width of the drip irrigation patterns approached the maximum bed width after about 7 hrs irrigation time. Depth of drip water also approached the maximum depth of beds at about 7 hrs. Despite similar width and depth of wetting at 8 and 10 hrs, the area wetted after 10 hrs was significantly greater than that after 8 hrs. This suggests that the additional drip water was filling in gaps between or within patterns although the overall width and depth were not increasing.

The percent of total bed volume wetted at various irrigation times is given in Fig. 1. Combined data from all trials suggests that bed volume wetted increases in a relatively linear manner in response to increased irrigation times. The percent of bed volume wetted with two drip tubes was about double that with a single tube as we would expect. Maximum wetted volume was about 45% after 12 hrs with a single tube and 85% after 10 hrs with two tubes. The fact that no irrigation time resulted in more than about 45% wetting of the total bed volume suggests that single drip tubes will not provide thorough coverage of the soil volume needed for adequate soil fumigation. Irrigation times of greater than 12 hrs should improve distribution of drip water, but may be impractical for injecting soil fumigants, which should be monitored during injection. As a result, two drip tubes appear to be necessary to obtain the degree of coverage needed to apply soil fumigants.

Irrigation times with one and two tubes were combined and converted to liters per 30.5 m of bed. Percent of the total bed volume wetted at various rates of water delivery are presented in Fig. 2. There was a highly significant (R^2 = 90.32, $P < 0.00001$) correlation between liters of water applied and percent of bed volume wetted, regardless of the number of tubes. These data suggest that volume of soil wetted is directly proportionate to the amount of water applied, at least for soils used in these studies.

Table 1 Effect of irrigation time on distribution of drip water through a single drip tube, Bradenton, FL, December, 2000*.

Irrigation Time (hrs)	On Emitters			Between Emitters		
	Width (cm)	Depth (cm)	Area (cm^2)	Width (cm)	Depth (cm)	Area (cm^2)
2	26.9 f	19.6 e	428 e	8.1 d	8.4 d	61 e
4	32.5 e	24.4 d	666 d	17.5 c	18.8 c	301 d
6	36.8 d	28.7 c	888 c	29.2 b	25.1 b	648 c
8	41.4 c	31.8 b	1128 b	32.0 b	28.2 ab	758 c
10	46.5 b	33.5 b	1266 b	40.1 a	30.5 ab	1008 b
12	51.6 a	38.4 a	1523 a	44.7 a	33.8 a	1285 a

*Data are means of two locations in each of four replicates. Means followed by the same letter in the same column are not significantly different according to Tukey's Studentized Range Test (P = 0.10).

Table 2 Effect of irrigation time on distribution of drip water applied through two drip tubes, Bradenton, FL, April, 2001.

Irrigation Time (hrs)	Width (cm)	Depth (cm)	Area (cm^2)
4	63.2 a	44.7 b	1613 c
6	66.0 a	48.3 ab	1919 c
7	76.2 a	51.6 a	3144 b
8	74.9 a	51.8 a	3048 b
10	75.4 a	52.6 a	3694 a

*Data are means of eight locations in each of four replicates, two locations were on one emitter and two each at 5.1, 10.2 and 15.3 cm off the emitter. Means followed by the same letter in the same column are not significantly different according to Tukey's Studentized Range Test (P = 0.10).

Figure 1. Percent of total bed volume wetted by drip irrigation water with one or two drip tubes in four trials at Bradenton, FL.

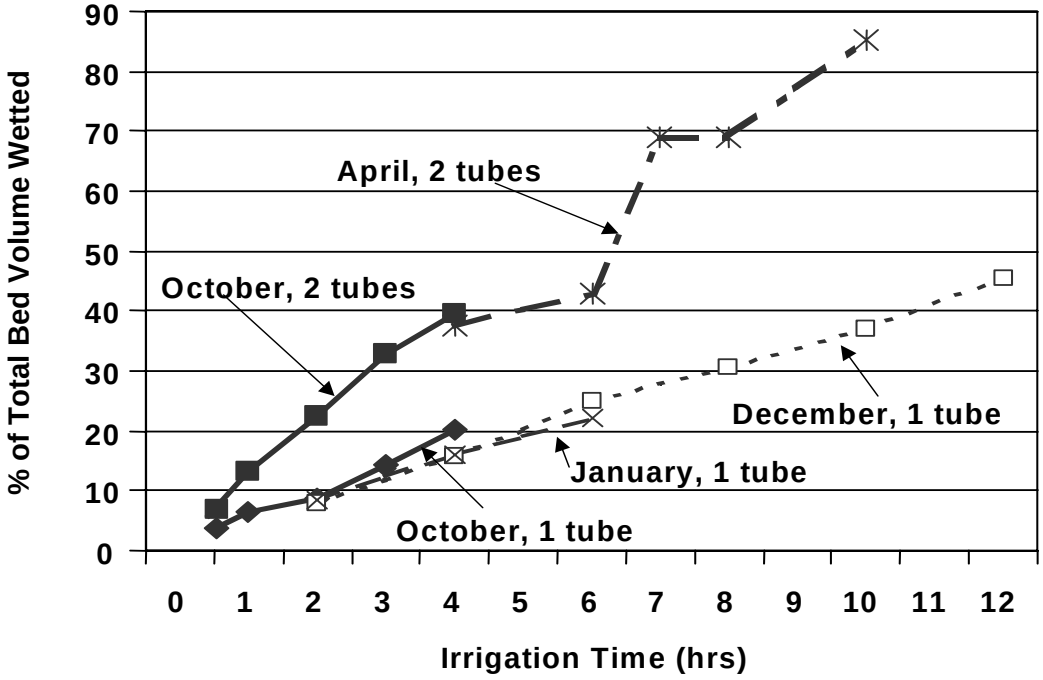

Figure 2. Relationship of percent total bed volume wetted to total water volume delivered in 30.5 m of bed, regardless of number of drip tubes used.