EVALUATION OF WATER MOVEMENT IN RAISED BEDS AS AFFECTED BY BED LOCATION, PLANT LOCATION, PREVIOUS CROP AND BED HISTORY USING DYE INJECTION

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Introduction

Effectiveness of drip-applied chemicals, such as emulsified Telone products and metam sodium, in plasticulture is dependent on adequate distribution of the chemical in the entire bed. Emulsified chemicals move mainly with drip irrigation water, and improper wetting of a bed would therefore limit the efficacy of the chemical emulsion. Several methods have been used to determine water movement in soil, but one of the most simple and cheap methods is the use of dye. Previous studies using a blue water-soluble dye have shown that the sandy soils in the southeastern USA are difficult to wet completely. Injection times of up to 8 hours were required to ensure uniform wetting of a 30 in. bed, and even then beds could not be completely wetted up to the shoulder.

In this test we evaluated water movement in newly established vegetable beds as well as in vegetable beds that were previously cropped. In the subtropical climate of the southeastern US, polyethylene beds are commonly used for two to four vegetable crops before they are destroyed (double- or multiple cropping). Soil pesticides on these double-cropped beds can only be applied through the drip system. Dye was injected in 4 different tests (1) following a first crop of eggplant, (2) following a first crop of squash, (3) following a second crop of squash and jalapeno and (4) following a second crop of squash as compared to a newly build bed.

Materials and Methods

All tests were done at the Blackshank Farm, CPES, Tifton, GA on a Fuquay loamy sand (88% sand, 9% silt, 3% clay) between August and November 2004. Water movement was evaluated in double-cropped beds (1) following a first crop of eggplant (and three different winter crops), (2) following a first crop of squash, (3) following a second crop of squash and jalapeno (first crop tomato) and (4) following a second crop of squash and uncropped new bed.

All raised beds were 30 in. wide and 8 in high. Drip tape was buried about 1 in. deep. Beds were installed using a commercial tractor-drawn bed-former together with the black polyethylene film mulch and drip tape just before injecting dye. The drip tape used was Aquatraxx (12-in. spacing between emitters and a flow rate of 0.45 gal/hr at @ 10 psi). Distribution of drip irrigation water was evaluated using a blue marking dye (Signal®). The dye was injected into all plots concurrent with the drip irrigation (1 pint of dye/100 gal of water delivered to the plots). The beds were injected with the dye and pushed with water for 6 hours (150 gal/100 ft bed length).

Width, depth and area of soil covered by the drip water was evaluated the following day by digging trenches across the beds or by digging out the lateral half of a section of the bed along the drip tubing. 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. Measurements were made across the bed at points on the emitters and equidistant between emitters. Width of the blue dye pattern (at the soil surface, at 6 in., and at 12 in. deep), depth of the pattern from the top of the bed and area covered by the blue dye were recorded for each surface. The width of the dye pattern was measured with a ruler, and the dye-covered area with a 24 in. by 24 in. grid etched in plexiglass by counting all grid squares in which half or more of the square was blue.

Data are means of three or four replications of measurements per bed. Means followed by the same letter are not significantly different (P = 0.05) according to Duncan's multiple range test.

Summary

Winter crops had little effect on water movement following a first crop of eggplant, nor had removal or incorporation of the winter crop biomass (Table 1). Water movement was better when measured inside old eggplant plots as compared to inside alleys (non-cropped areas), probably due to high soil compaction in the alleys as these areas were used to walk between plots (Table 1). However, this was noted in TEST 2 following squash, possibly because squash has a shorter growing season and alleys were therefore less compacted (Table 2). Also location of previous squash plants did not significantly affect water movement in this test (Table 2). Location of previous plants did show some effect in TESTS 3 (jalapeno) and especially TEST 4 (squash), with better water movement when measured on plants as compared to between plants (Tables 3, 4).

No significant difference in water movement between old and new beds was measured, but waterfronts in old beds were generally much more irregular than in new beds (Table 4).

Greatest differences in water movement were noted for emitter location, with consistently wider waterfronts being noted on emitters as compared to between emitters (Table 5). When averaged over emitters, wider waterfronts were observed following a second crop of jalapeno as compared to squash (Table 6). This was possibly related to the fact that by the time of dye injection, most of the squash plants had died, while jalapeno was still growing. Average values also showed poorer water movement at 12 " deep in alleys as compared to cropped bed areas (Table 6).

Acknowledgments

The authors wish to thank Chris Williamson, Tonya Jo Cravens, Unessee Hargett and Don Hickey for technical support.

Table 1. Width of dye pattern and total dye coverage area of cutaway face of plastic covered beds, following a first crop of

eggplant, as affected by bed location and winter crops, August, 2004, Blackshank farm, Tifton, GA (TEST 1).

FACTOR	Width of dye pattern (inches) at different soil depth						Dye coverage (square inches)	
	On Emitter			Between Emitter			On Emitter	Between Emitter
	0 in.	6 in.	12 in.	0 in.	6 in.	12 in.		
BED LOCATION								
Plot (crop)	12.3	17.8	23.6	15.4	19.0 a	20.0 a	244 a	279 a
Alley (no crop)	13.3	15.0	25.0	19.0	8.7 b	8.0 b	157 b	28 b
WINTER CROP								
Rye	10.5	18.5	21.5	17.0	22.5	15.5	236	288
Turnip	12.5	16.0	32.0	8.0	14.0	22.5	-	-
Rutabaga	14.0	19.0	20.5	15.5	14.5	16.5	260	288
BIOMASS WINTER CROP								
Incorporated	10.0	16.0	22.3	14.7	19.3	20.0	264	316
Removed	14.7	19.7	27.0	12.3	14.7	16.3	234	260

Data are means of 3-6 replications of measurements per bed. Means followed by the same letter are not significantly different (P = 0.05) according to Duncan's multiple range test. No letters indicate treatments are not significantly different.

Table 2. Width of dye pattern and total dye coverage area of cutaway face of plastic covered beds, following a first crop of

squash, as affected by bed and plant location, November 2004, Blackshank farm, Tifton, GA (TEST 2).

FACTOR	Width of dye pattern (inches) at different soil depth						Dye coverage (square inches)	
	On Emitter			Between Emitter			On Emitter	Between Emitter
	0 in.	6 in.	12 in.	0 in.	6 in.	12 in.		
BED LOCATION								
Plot (crop)	13.3	17.3	22.1	11.2	16.2	21.8	207	176
Alley (no crop)	13.5	17.5	22.3	13.3	14.8	18.5	193	162
PLANT LOCATION								
On	13.3	16.8	23.0	10.5	14.5	21.0	203	171
Between	13.3	18.0	21.0	11.7	17.3	22.3	212	181

Data are means of 3-6 replications of measurements per bed. Means followed by the same letter are not significantly different (P = 0.05) according to Duncan's multiple range test. No letters indicate treatments are not significantly different.

Table 3. Width of dye pattern and total dye coverage area of cutaway face of plastic covered beds, following a second crop of squash and jalapeno (tomato 1st crop), November 2004, Blackshank farm, Tifton, GA (TEST 3).

FACTOR	Width of dye pattern (inches) at different soil depth						Dye coverage (square inches)	
	On Emitter			Between Emitter			On Emitter	Between Emitter
	0 in.	6 in.	12 in.	0 in.	6 in.	12 in.		
PREVIOUS CROP								
Squash	11.5	18.5	21.8	8.0	13.3	16.8	215	163
Jalapeno	11.5	19.5	24.5	10.7	17.0	20.3	220	178
PLANT LOCATION (Jalapeno)								
On	10.0	21.0	26.0	11.8	17.0	21.0	248	178
Between	13.0	18.0	23.0	9.5	17.0	19.5	191	178

Data are means of 3-6 replications of measurements per bed. Means followed by the same letter are not significantly different (P = 0.05) according to Duncan's multiple range test. No letters indicate treatments are not significantly different.

Table 4. Width of dye pattern and total dye coverage area of cutaway face of plastic covered beds, following a first crop of squash as compared to an uncropped new bed, November 2004, Blackshank farm, Tifton, GA (TEST 4).

FACTOR	Width of dye pattern (inches) at different soil depth						Dye coverage (square inches)	
	On Emitter			Between Emitter			On Emitter	Between Emitter
	0 in.	6 in.	12 in.	0 in.	6 in.	12 in.		
BED HISTORY								
New	10.5	14.2	16.3	8.5	12.7	14.2	166	155
Old	11.5	14.0	17.7	10.0	10.8	15.5	173	151
PLANT LOCATION								
On	12.5	16.0	22.0	11.3 a	11.8	14.0	193 a	150
Between	11.0	13.0	15.5	7.5 b	9.0	18.5	161 b	148
BED LOCATION								
Plot (crop)	11.5	14.0	17.7	10.0	27.5	15.5	172	150
Alley (no crop)	15.7	15.7	16.7	11.3	14.0	14.7	175	155

Data are means of 3-6 replications of measurements per bed. Means followed by the same letter are not significantly different (P = 0.05) according to Duncan's multiple range test. No letters indicate treatments are not significantly different.

Table 5. Average width of dye pattern and total dye coverage area of cutaway face of plastic covered beds on as compared to between drip emitters for different tests, August-December 2005, Blackshank farm, Tifton, GA.

TEST	LOCATION	Width of dye pattern (inches) at different soil depth			Dye coverage (square inches)
		0 in.	6 in.	12 in.	
1	On emitter	16.8	16.9	24.0	209
	Between emitter	12.7	15.1	15.2	178
2	On emitter	13.3	17.3	22.1	202 a
	Between emitter	11.2	16.2	21.8	170 b
3	On emitter	11.9 a	18.6 a	22.8 a	210 a
	Between emitter	9.8 b	15.5 b	19.0 b	172 b
4	On emitter	11.0 a	14.4 a	17.0 a	170 a
	Between emitter	9.3 b	12.2 b	14.8 b	153 b

Data are means of 6-24 replications of measurements per bed. Means followed by the same letter are not significantly different (P = 0.05) according to Duncan's multiple range test. No letters indicate treatments are not significantly different. Measurements were taken in cropped bed areas only (no alleys).

Table 6. Average width of dye pattern and total dye coverage area of cutaway face of plastic covered beds in cropped plots as compared to uncropped alleys for different tests, August-December 2005 (average on and between emitters), Blackshank farm, Tifton, GA.

TEST	VARIABLE	LOCATION/ CROP/ PLANT	Width of dye pattern (inches) at different soil depth			Dye coverage (square inches)
			0 in.	6 in.	12 in.	
1,2,4	Bed location	Plot (crop)	11.6	14.6	19.3 a	178
		Alley (no crop)	13.5	14.8	15.7 b	165
2,3,4	Plant location	On plant	11.8	15.5	20.2	182
		Between plant	11.3	15.5	19.8	179
3	Previous crop	Squash	9.8 b	15.9 b	19.3 b	189
		Jalapeno	11.5 a	17.7 a	21.8 a	189
4	Bed history	Old	10.8	13.2	16.6	162
		New	9.5	13.4	15.3	160

Data are means of 6-24 replications of measurements per bed. Means followed by the same letter are not significantly different (P = 0.05) according to Duncan's multiple range test. No letters indicate treatments are not significantly different.