

Solarization And Steam Heat For Soil Disinfestation In Flower And Strawberry

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Abstract

The objective of this research is to develop an economically feasible combined solarization and steam heat, soil disinfestation system for field-grown flowers and strawberry. Soil solarization performance in cool coastal areas of California is often inconsistent due to fog and cool summer temperatures that do not allow soil to reach high temperatures required to reliably kill soil pests. Coastal California is also the principal strawberry fruit and cut flower production region, and solarization has displaced virtually no methyl bromide (MB) use in these crops. Soil disinfestation with steam has a long and proven track record for control of soil pests including weeds and pathogens in greenhouse and nursery settings. However, use of steam at the field level has been limited due to difficulty in treating large areas with existing steam applicators and high energy costs for steam disinfestation. A steam blanket prefabricated to fit the bed widths and plot lengths was used for the injection of steam into finished planting beds with a mobile steam generator. Each plot required about 1-1.5 hours to apply steam and raise soil temperatures to 70°C at a depth of 6 inches. We do expect large increases in efficiencies by treating larger areas. Results to date indicate that weed control with steam plus solarization was comparable to MB.

Full Season Drip Irrigation in Lettuce – Impact on Weed Control

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INTRODUCTION

The acreage of lettuce under drip irrigation in the Salinas Valley has noticeably increased during the past 10 years; in 2005, 31% of the vegetable acreage was drip irrigated compared with 3% of the acreage in 1993 (Thomasberg et al. 2007). Despite the increased acreage under drip, overhead sprinklers are used on most of the vegetable acreage from planting until thinning. After thinning and side-dressing of fertilizer, drip tape is usually installed on top of the beds and used to irrigate the crop until harvest.

Growers have justified the costs of using surface-placed drip after sprinklers by such advantages as reducing water use, minimizing foliar diseases, and increasing fertilizer-use efficiency. Growers in the Salinas Valley have experimented with irrigating lettuce with drip tape from planting to harvest. Full season use of drip maximizes the benefits of drip irrigation and eliminates some of the disadvantages of sprinklers. For full season use, the tape is buried a few inches below ground so that the crop can be planted and thinned without damaging the tape. Besides eliminating the costs of using overhead sprinklers, using only drip can improve access to the field by keeping the furrows dry, prevent the formation of soil crusts which reduces emergence, and permits growers to irrigate with a high uniformity during windy conditions.

Obtaining uniform germination with shallowly buried drip tape can be a significant limitation to using full-season drip: particularly, obtaining uniform wetting of the bed tops. Where as overhead sprinklers apply water directly to the seed line, water from the buried drip tape must move both upward and horizontally to the seed. In some cases, growers have needed to irrigate for as much as 24 hours during a single set to obtain a satisfactory level of moisture in the seedline, and on some soil types, such as well-aggregated clays, the drip system was unable to move moisture to the seedline if the soil was initially too dry.

Weed control can be another challenge to germinating lettuce with drip tape. Where overhead sprinklers are used they effectively activate the commonly applied preemergent herbicides, Kerb and Prefar. Sprinkler applied water is considered necessary to obtain full efficacy from these herbicides, because the overhead application of water moves the herbicide from the soil surface to the depth where germinating weed seed are located. Questions arise about the efficacy of activating surface applications of Kerb and Prefar with drip irrigation due to differences in the movement of the germination water from the drip tape. Water from the drip tape is moving laterally as well as downward and the question is, can water from the drip system effectively activate the preemergent herbicides and provide good weed control.

METHODS

We conducted two field trials: *Trial No. 1*: In 2006 we compared sprinkler and drip germinated lettuce. The trial was conducted at the USDA Spence research farm on a sandy loam soil. Three application methods of Kerb: 1) bedtop spray, 2) injection into the drip tape, and 3) no Kerb. Three irrigation methods were tested: 1) one line of drip tape in the bed middle on the bed surface, 2) one line of drip tape in the bed middle buried at 2 inch depth; and 3) sprinkler irrigation. Kerb was applied at 1.2 lbs a.i./A. Each treatment was replicated four times and each plot was one bed wide by 135 feet long. The sprinkler plots were separated from the from the drip plot to prevent contamination between plots. *Trial No. 2*: 2007 trial was conducted with a cooperating grower on a site with Salinas Clay Loam Soil. The drip tape buried drip at 2-3" depth. The herbicides were sprayed 14 hours after the initiation of the germination water and the water was run for 4 hours following the application. All materials were applied with a CO₂ backpack sprayer at 30 psi applying 72 gallons of water per acre. Each plot was one 40 inch bed wide by 30 feet long.

RESULTS

Trial No. 1: The primary weed species at the trial site were shepherd's-purse and common groundsel. Plots treated by Kerb Chemigation had less common groundsel than plots treated with Kerb on the bed top. Drip germinated treatments had significantly fewer weeds than sprinkler irrigated treatments (Table 1). Kerb had no effect on the lettuce stand whether applied by spray or chemigation. Lettuce stand in the drip irrigated treatments were higher than in the sprinkler irrigation treatments. Kerb application method did not affect lettuce yield, but lettuce yields in drip irrigated plots were higher than in sprinkler irrigated plots (data not shown).

Trial No. 2: On August 3 the weeds were small and there were fewer purslane plants in the Prefar treatments than in the Kerb treatments (Table 2); however, by August 31 there were no difference in the number of purslane plants per plot between the Kerb and Prefar treatments indicating mortality of purslane seedlings in the Kerb treatment. Prefar provided better control of burning nettle on the August 3 evaluation date; on August 31 the high rates of both Prefar and Kerb provided better control of this weed than the lower rates. Prefar provided better weed control of total weeds than Kerb on the August 3 evaluation date but there were no significant differences among the herbicide treatments on the August 31 evaluation date with both herbicides providing greatly improved weed control than the untreated.

An evaluation of the movement of Kerb in the soil was conducted to better understand the movement of Kerb in a situation where it is activated by water coming from drip tape as opposed to sprinklers which is the common method currently used in the Salinas Valley. The evaluation showed that about 75% of the 2.0 lb a.i. application of Kerb remained in the top 2.0 inches of soil (Table 2); 62.5% of the material was in the top 0.5 inch of soil which is the zone of active weed seed germination. These results help us to better understand the movement of Kerb in soils

under this irrigation scheme and will need to be built upon in the future to better understand the movement of Kerb and how best to optimize its use in lettuce production.

CONCLUSIONS

The irrigation system used for germinating lettuce impacted weed pressure; drip germinated lettuce had less initial weed pressure than sprinkler germinated lettuce. The movement of water from drip tape differs from the pattern of movement from sprinkler irrigation; however, Kerb and Prefar were successfully activated and provided good weed control in the two trials conducted in these studies.

LITERATURE CITED

Thomasberg, K., J. Barreras, C. James and T. Campa. 2007. 2005 Groundwater summary report. Monterey County Water Resources Agency.

http://www.mcwra.co.monterey.ca.us/Agency_data/GEMS_Reports/2005%20Summary%20Report.pdf

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Table 1. Effect of Kerb application method (spray, chemigation or untreated) and irrigation method (surface tape, buried tape or sprinkler) on weed densities, lettuce stand and visual injury.

Kerb application	Irrigation	Weed densities (no. / species / 10ft ²)			Lettuce stand	Visual Injury
		Shepherd's Purse	Common groundsel	Total Weeds	No./ 10ft ¹	Rating ² (0-10)
Spray	Surface	1.9 b	12.0 c	21.4 c	60.3 a	0.0
Spray	Buried	4.1 b	13.1 c	24.0 c	60.5 a	0.0
Spray	Sprinkler	86.4 b	52.1 a	145.3 b	42.6 b	0.0
Chemigation	Surface	8.3 b	10.8 c	26.9 c	56.6 a	0.0
Chemigation	Buried	5.8 b	10.1 c	24.4 c	52.1 ab	0.0
Untreated	Surface	16.6 b	11.3c	41.1c	59.1 a	0.0
Untreated	Buried	16.5 b	14.1 c	46.1 bc	51.9 ab	0.0
Untreated	Sprinkler	243.4 a	38.4 b	297.6 a	42.3 b	0.0
LSD (P=0.05)		90.6	10.6	102.6	10.1	---
Treatment Prob (F)		0.0002	0.0001	0.0001	0.0029	---
<i>Main effects of Kerb application</i>						0.0
Spray		30.8 b	25.8	328.9	54.5	0.0
Chemigation		7.0 b	10.4	300.1	54.4	0.0
Untreated		92.2 a	21.3	347.7	51.1	0.0
Anova						---
Kerb application		0.0177	0.2589	0.6925	0.3343	---
<i>Main effects of Irrigation method</i>						
	Surface	8.9 b	11.3b	286.5 b	58.7 a	0.0
	Buried	8.8 b	12.5 b	290.7 b	54.8 a	0.0
	Sprinkler	164.9 a	45.3 a	449.1 a	42.4 b	0.0
Anova						---
Irrigation method		<.0001	<.0001	<.0001	<.0001	---

¹ Number of seedlings in 10 feet of a single plant line

² Rating scale: 0 = no injury; ≤2 = commercially acceptable; 10 = dead plants

Table 2. Number of weeds per 45 ft² on two dates

Material	Material/A	a.i./A	Purslane		Shepherd's Purse		Burning Nettle		Total Weeds	
			8/3	8/31	8/3	8/31	8/3	8/31	8/3	8/31
Kerb 50W	2.0 lbs	1.0	12.0	2.5	2.3	1.0	6.3	1.3	23.7	7.3
Kerb 50W	4.0 lbs	2.0	11.0	2.3	1.0	0.8	6.5	0.3	22.2	6.5
Prefar 4E	3.0 quarts	3.0	1.5	5.8	1.8	0.5	2.5	0.8	9.0	8.5
Prefar 4E	6.0 quarts	6.0	0.3	3.8	1.5	0.3	1.0	0.0	6.0	4.5
Kerb 50W	4.0 lbs	2.0	0.3	1.8	1.8	0.0	1.0	0.3	7.3	3.5
Prefar 4E	6.0 quarts	6.0								
Untreated	---	---	25.5	43.5	1.0	0.3	7.3	1.5	37.8	45.8
LSD (0.05)			7.7	13.4	n.s.	n.s.	3.7	0.9	8.6	13.2

Table 3. Analyses of Kerb in soil on August 1.

Soil Depth	2.0 lbs a.i./A Kerb Treatment ppm Kerb	Percent of 2.0 lbs a.i./A Kerb application at each soil depth ²	Untreated ¹ Treatment ppm Kerb
0.0 – 0.5 inch	7.53 a	62.5	0.0
0.5 – 1.0 inch	0.70 b	5.5	0.0
1.0 – 1.5 inch	0.48 b	4.0	0.8
1.5 – 2.0 inch	0.30 b	2.5	0.0
LSD (0.05)	2.71	---	---

1 – One replication sampled; 2 – a total of 74.5% of the 2.0 lb a.i./A application was recovered in the top 2.0 inches of soil.