Water Management Effects on Weeds in Vegetable Production

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Introduction: Water plays a central role for managing weeds in vegetable systems. Because moisture is needed for germinating weed seed, water is used in several cultural strategies to reduce weed seedbanks through germination before crop establishment. Irrigation method also affects weed populations in vegetables. Water can also increase weed populations when run-off from rain or irrigation carries and disperses weed seed in agricultural fields. The efficacy of herbicides and fumigants for weed control is often affected by soil moisture. Finally, water is used for non-chemical alternatives to fumigation such as soil solarization, aerobic soil disinfection, and soil steam sterilization.

Water use in cultural weed control strategies: At planting, a large proportion of weed seeds in the soil are in a non-dormant state and ready to germinate with the addition of moisture. Pre-irrigating is not only beneficial for giving the soil an optimal tilth before bed preparation, but also for germinating weed seed that could potentially compete with a young vegetable crop. Shem Tov and Fennimore (2006) reported that weed populations in lettuce were reduced by 50% by pre-irrigating and killing germinated weeds before planting. Similar to pre-irrigation, the *stale bed technique* of controlling weeds involves irrigating after bed shaping to germinate non-dormant weed seed near the soil surface. Newly emerged weeds are then killed using cultural means such as flaming or shallow tillage before planting.

After pre-irrigating and tilling soil for planting, some growers seed directly into soil moisture and avoid irrigating during germination to minimize further flushes of weeds. This technique is most often used with large seeded crops such as melons, squash and beans, which can be planted deeper than small seeded vegetables. In the past, some growers of processing tomatoes also seeded into existing soil moisture in the Sacramento Valley, but because tomato seed is small and planted shallowly, they use an implement on the planter to create a 2 to 3 inch mound of soil, known as a cap, over the seed line. Capillary action of the soil cap wicks moisture near to the surface where the seed is planted. The cap must be removed just before the seedlings emerge to prevent damage to the crop. Although the main objective of dry farming crops such as tomatoes and melons is to improve fruit flavor, another advantage is a reduction in weed numbers because the soil surface remains dry.

Irrigation method effects on weeds: Sprinkler and furrow irrigation tend to stimulate more weed germination than drip irrigation. These irrigation methods wet a greater surface area than drip. In addition, by eroding the soil and suspending shallowly buried seed, furrow irrigation can disperse weed seed within a field or transport weed seed to fields downstream that reuse the water for irrigation. Sojka et al. (2003) determined that the application of polyacrylamide polymer reduced weed seed numbers in furrow tail water by reducing soil erosion and improving water infiltration. Weeds growing along irrigation canals also disperse seed into surface water that is used to irrigate fields. Since drip systems must be filtered to prevent emitters from clogging, weed dispersal from surface water sources is less likely than with furrow and sprinkler.

Subsurface drip may offer the best advantage for reducing weed pressure. While surface placed drip tape will wet a portion of the top of a bed, subsurface drip can maintain a dry soil surface, especially if the tape is positioned at 12 or more inches below the soil surface. By transplanting vegetables into subsurface drip irrigated beds, growers can avoid wetting the soil surface with sprinklers and causing weeds to germinate (Shrestha et al 2007).

Role of water in activating herbicides and fumigants: Water is needed to solublize and transport herbicides to weed seed. Also, weed seed needs to be moist to absorb herbicides. One challenge of using drip alone for establishing a vegetable crop is to move and activate pre-emergent herbicides. Many pre-emergent herbicides used in vegetables are sprayed on the soil surface before planting and rely on overhead sprinkler water to move the herbicide into the soil and near weed seeds. Both pre-emergent herbicides oxyfluorfen and flumioxazin have been shown to be activated using surface drip in transplanted celery and cabbage providing levels of weed control comparable to sprinkler activation. (Table 1). In a study with seeded lettuce, pronamide sprayed on the bed tops did not provide significant weed control under either surface or shallowly buried drip (Fennimore et al. 2007). Injecting pronamide through the drip systems also did not control weeds.

Water also plays an important role in the transport of fumigants. Fumigants used as alternatives to methyl-bromide, such as 1,3 D cis and chloropicrin, have relatively lower vapor pressure and higher water solubility, and therefore require uniform soil moisture in beds to attain optimal weed control.

Water for non-chemical control methods Water can be used to create conditions that kill weed seed. Soil solarization takes advantage of the high heat capacity of water to sustain soil temperatures above 150 °F which is sufficient to kill many weed seed species. In locations too cool to use solarization, steam applications can also kill weed seed. Finally, saturating soil pores with water in carbon augmented soils with plastic mulch cover creates anaerobic conditions that have been shown to reduce weed densities (Daugovish et al. 2011)

References

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Table 1. Drip and sprinkler activation of herbicides in Ventura County trials, 2005-2010*.

Crop and irrigation method [1]	Weed control [2]	
	% (from untreated)	
	Oxyfluorfen[3]	Flumioxazin[4]
Cabbage, (green), transplanted into drip-only irrigated beds	96	88
Celery, transplanted into dry beds, drip-only irrigation	87	87
Celery, transplanted in drip-only pre-irrigated beds	90	79
Cabbage, sprinkler irrigation	92	80
Celery, sprinkler irrigation	75	94

* No significant crop injury or effects on yield were observed in any of the treatments.

[1] All crops were planted 1day after herbicide applications. In drip-only irrigation, a single high flow line irrigated 2 rows of crop plants. In sprinkler irrigation, overhead water was applied for the first 2-3 weeks after planting and the fields were consequently drip irrigated.

[2] Major weeds present were: nettleleaf goosefoot, mustards, burnings nettle, shepherd's-purse and annual sowthistle. The weeds were counted at three and six weeks after emergence and the total number compared to untreated check to obtain percent control.

[3] Goaltender (oxyfluorfen) was applied at 0.25 lb a. i. /acre (1 pint)

[4] Chateau (flumioxazin) 0.063 lbs a. i. /acre (2 oz/acre of product)