Vigorous weed growth in frequently wetted areas is a serious drawback of drip and low-volume sprinkler systems.

Weed control under drip and low-volume sprinkler irrigation

Bill B. Fischer □ David A. Goldhamer □ Thomas Babb □ Roger Kjelgren

Drip and other types of low-volume microsprinklers and misters are being used in some orchards and vineyards as an alternative to conventional irrigation methods. Water and energy costs, as well as the development of agricultural areas where the topography and soil type limit furrow or basin irrigation, have stimulated the use of low-volume frequent applications of water. Low-volume emitters also have the potential to improve uniformity of water application.

A serious drawback, however, is that vigorous weed growth occurs in the wet areas. Weed control is often shorter lived in frequently wetted soil than under gravity or conventional impact sprinkler irrigation methods. The poor performance of preemergence herbicides is related to the water management strategies associated with drip and low-volume systems — strategies fundamentally different from those used in surface gravity irrigation.

Under conventional methods, such as furrow, flood, basin, and impact sprinklers, water applications are at intervals of less than 10 days to 20 days or more during the season, depending on crop, climate, and soil conditions. Water is applied much more frequently under drip and low-volume irrigation, however — usually daily with drip and two to three times a week with low-volume sprinklers. Degradation of preemergence herbicides appears to be related to high soil water levels and length of time these levels remain in the soil. High-frequency irrigation can thus cause these chemicals to perform poorly.

In frequently wetted soil, summer annual grasses and broadleaf weeds, especially barnyardgrass (*Ecinochloa crus-galli*), crabgrass (*Digitaria sanguinalis*), pigweed (*Amaranthus albus*), purslane (*Portulaca oleracea*), and cudweed (*Gnaphalium purpureum*), grow vigorously and are difficult to control. It has been reported that weeds, such as sprangletop (*Leptochloa* sp.) and purple ammannia (*Ammannia coccinea*), that commonly occur in rice fields have become prevalent in many orchards.

Soil-persistent herbicides applied preemergence, such as napropamide (Devrinol) and oryzalin (Surflan) do not provide adequate long-lasting control. Therefore, the application of contact or systemic herbicides, such as paraquat, dinoseb, and glyphosate (Roundup), may be necessary. Some orchardists have found it necessary to treat the area around drip emitters four to eight times a year to control weeds — an expense that possibly could be eliminated or minimized.

Field experiment

We investigated weed growth and control under different irrigation methods in a vineyard and a deciduous orchard at the University of California Kearney Agricultural Center in Fresno County, California.

The vineyard study used 15 rows of mature Thompson Seedless vines divided into three, five-row plots. One plot had low-volume sprinklers suspended from raised laterals; the sprinklers were 2 feet above the ground midway between the vines. Both 360- and 40-degree spray patterns directing the water along the vine rows were evaluated. In another plot, two drip emitters per vine, spaced 2½ feet from either side of the trunk, were installed.

Automatic controllers permitting different durations of water application were installed in both the drip and sprinkler plots. Volumetric discharge rates were 1 and 5 gallons per hour through the emitters and sprinklers, respectively. The vines were irrigated daily in the drip and twice a week in the low-volume plots. A third plot was basin-flood irrigated on the average of once every 20 days. A strip of raised soil (berm) approximately 3 feet wide under the vines confined the water to a 7-foot-wide basin between the vine rows.

The herbicides were applied in mid-February with a commercial-type sprayer to a 4½-foot-wide area centered on the vine row. The native vegetation between the rows was mowed periodically during the season. Eight herbicide regimes plus a nontreated control were tested under each irrigation method (table 1).

In the deciduous tree study, we evaluated drip and low-volume sprinkler irrigation on young bareroot Flavorcrest peach, Nubiana plum and Nonpareil and Mission almonds planted in early 1982. Two almond varieties were used because they differ significantly in their susceptibility to some herbicides.

For each irrigation method, 27 plots, each containing four trees, one of each variety, spaced 17 feet apart were established in a randomized block design. Herbicide applications were limited to a 3½-foot strip on each side of the tree rows. Therefore, the herbicide-treated area in each plot was 7 by 68 feet. Eight herbicide regimes, plus a nontreated control, were replicated three times (table 2). The herbicides were applied with an experimental sprayer in early March 1982, and the treatments were repeated in succeeding years in mid-January.

We rated weed control in the vineyard and orchard four or five times each year and, after each evaluation, sprayed weeds in all plots with glyphosate or sulphosate (Touchdown). Hence, on each evaluation date, only newly emerged weeds were rated. This system allowed assessment of the effectiveness of the herbicides on numerous weed species and their persistence under the different methods of water application.

The net amount of applied water available for crop use was the same under each irrigation method in both the vineyard and orchard plots. In planning the irrigation schedule, we estimated crop water use from long-term historical daily evapotranspiration estimates and published crop coefficient values for grapes and deciduous trees. Adjustment for immature tree canopy size was based on the shaded area of the orchard floor mea-

TABLE 1. Performance of herbicides under different irrigation methods in a vineyard

Herbicides*	Rates†	Weed control in wetted area‡		
		Basin flood	Drip emitters	Mist emitter
	lb ai/A	%	%	%
Diuron (Karmex) + simazine (Princep)	1.5 + 1.5	98	35	55
Oryzalin (Surflan) + simazine	4 + 1	100	25	50
Napropamide (Devrinol) + simazine	4 + 1	85	25	40
Oryzalin + simazine + oxyfluorfen (Goal)	2 + 1 + 2	100	35	60
Napropamide + simazine + oxyfluorfen	2 + 1 + 2	98	50	65
Napropamide + simazine	4 + 2	90	35	40
Oryzalin + simazine	4 + 2	85	35	50
Oxyfluorfen + simazine	2 + 1	80	0	30

NOTE: No symptoms of phytotoxicity were observed.
* Glyphosate (Roundup) or sulphosate (Touchdown) added to all treatments at 2 pounds active ingredient per acre as a tank mix to control emerged weeds.
† Rates: lb ai/A = pounds active herbicide applied per treated acre.
‡ Herbicides applied March 5, 1982, and February 18, 1983. Evaluated November 19, 1984.

TABLE 2. Performance of herbicides under drip and low-volume sprinklers in a deciduous orchard

1983

Herbicide*	Rates	Weed control in wetted area			
		4/6/83		10/12/83	
		Drip	Sprinkler	Drip	Sprinkler
	lb/ai/A	%	%	%	%
Napropamide + simazine	4 + 1	96	98	22	88
Oryzalin + simazine	4 + 1	100	100	42	85
Napropamide + oxyfluorfen	4 + 2	97	94	65	93
Oryzalin	4	97	97	37	84
Napropamide + simazine + oxyfluorfen	2 + 1 + 2	100	96	65	93
Oryzalin + simazine + oxyfluorfen	2 + 1 + 2	99	90	58	93
Oxyfluorfen	3	98	95	15	96
Untreated	—	39	28	22	28

1984

Herbicide*	Rates	Weed control in wetted areas					
		5/19/84		8/22/84		10/20/84	
		Drip	Spklr	Drip	Spklr	Drip	Spklr
	lb ai/A	%	%	%	%	%	%
Napropamide + simazine	4 + 1	57	93	85	90	66	81
Oryzalin + simazine	4 + 1	97	100	78	99	73	86
Napropamide + oxyfluorfen	4 + 2	93	97	87	97	78	90
Oryzalin + oxyfluorfen	4 + 2	96	93	80	99	76	93
Napropamide + simazine + oxyfluorfen	2 + 1 + 2	97	99	90	99	85	93
Oryzalin + simazine + oxyfluorfen	2 + 1 + 2	100	98	78	99	90	96
Oxyfluorfen	2	90	98	88	98	75	83
Oxyfluorfen + simazine	2 + 1	99	99	87	99	76	90
Untreated	—	0	30	87	83	26	35

NOTE: No evidence of phytotoxicity was seen through 1984 on any trees.
* Glyphosate or sulphosate added to all treatments as a tank mix at 3 ponds active ingredient per acre to control emerged weeds.

sured at midday during the summer. Application efficiencies were estimated at 70 percent for the drip and low-volume sprinkler irrigated trees in 1983 and 90 percent in 1984. For the vineyard, application efficiency estimates were 75 percent for the basin-flood and 90 percent for the drip and low-volume sprinkler irrigated vines.

Weed control

Weed control in both the vineyard and deciduous orchard reflected the susceptibility of the weeds to the applied herbicides and their persistence under the different irrigation methods. In both studies, all herbicide treatments were very effective through mid-May regardless of the irrigation method. In the orchard, however, later evaluation indicated that all herbicide treatments under the low-volume sprinklers provided better weed control than they did under drip. As the season progressed, the differences in effectiveness became greater, as illustrated by the October evaluation in 1983 (table 2).

In the vineyard study, the most effective and longest residual weed control occurred under basin-flood irrigation, where no water was applied over the herbicide-treated area. Unlike the orchard, the vineyard showed no appreciable difference in weed control between the drip and low-volume sprinklers throughout the season. We attribute this result to disruption of the sprinkler's spray pattern by low-hanging canes of the vines. Deposition of the water directly beneath the point of spray interception caused a wetted surface area similar to that associated with drip emitters. Soil wetness beneath the vines was prolonged by the vine canopies, which limited surface evaporation and promoted high humidity. It should be noted that mechanical cane cutting (removal of the canes within approximately 2 feet of the soil surface) is practiced in the production of certain grape varieties. This cutting allows an uninterrupted spray pattern and could presumably improve herbicide performance with low-volume sprinklers.

In the orchard, the most effective weed control under low-volume sprinklers throughout the 1983 season was in areas treated with oxyfluorfen (Goal). Oxyfluorfen under drip irrigation, however, showed poor seasonal performance. Generally, more effective weed control with drip irrigation was obtained where oxyfluorfen was applied in combination with other herbicides. Under low-volume sprinklers, the same herbicide combinations resulted in substantially better weed control.

In both studies, we observed shifts in weed populations in 1984. Species that are tolerant of or marginally susceptible to certain herbicides or combinations of herbicides became dominant. For example, in the oxyfluorfen-treated plots, cudweed, horseweed (*Conyza canadensis*), and flax-leaved fleabane (*Conyza bonariensis*) predominated. As a result, in both the drip and low-volume sprinkler plots, superior weed control was obtained in areas treated with combinations of three herbicides: (1) oryzalin, simazine (Princep), and oxyfluorfen or (2) napropamide, simazine, and oxyfluorfen (table 2).

Conclusions

These studies demonstrated that preemergence herbicides give more effective and longer residual weed control with low-volume sprinklers than with drip emitters. This effect is presumably due to the more rapid microbiological and chemical (hydrolysis) degradation of herbicides in the continually wetted soil associated with high-frequency drip irrigation.

It thus appears that low-volume sprinklers, while having most of the advantages of drip emitters, also offer the potential of better preemergence herbicide performance because of less frequent and concentrated water applications. However, since the management of unwanted vegetation continues to be troublesome and expensive in orchards and vineyards under localized irrigation, research is planned to evaluate the effectiveness and selectivity of certain herbicides introduced in the irrigation system through drip emitters and low-volume sprinklers.

Bill B. Fischer is Farm Advisor, Fresno County, and David A. Goldhamer is Soil and Water Specialist, Kearney Agricultural Center, Parlier, both with University of California Cooperative Extension. Thomas Babb, formerly Research Associate, Fresno County, is now Agronomist, Amstar Corp. and Roger Kjelgren, formerly Research Associate, Kearney Agricultural Center, is now a graduate student, University of Washington, Seattle.