

below the zone of chemical placement (see photo). A severe below-ground tip burning was evident on the treated plants, but this was quite localized. Less than 3 inches below this chemical band, root appearance was relatively normal. The more fleshy nature and lighter color of the treated roots probably reflects the depletion of food reserves following a full season without top growth. This can be related to the marked reduction in root population found on the profile of the trench in the treated plot.

These initial vineyard studies of the two soil residual chemicals, dichlobenil and chlorthiamid, indicate a possibility of effective control of field morning glory in a planting of vines. The subsurface banding technique of application of the chemicals may be entirely necessary to obtain uniform high control, however. Although the more soluble chlorthiamid was more effective than dichlobenil applied on the soil surface, the morning glory control afforded by this treatment was insufficient to suggest its use without follow-up treatments. The effectiveness of the subsurface, banded treatments was evident; however, it appears that this band must remain undisturbed for at least one season.

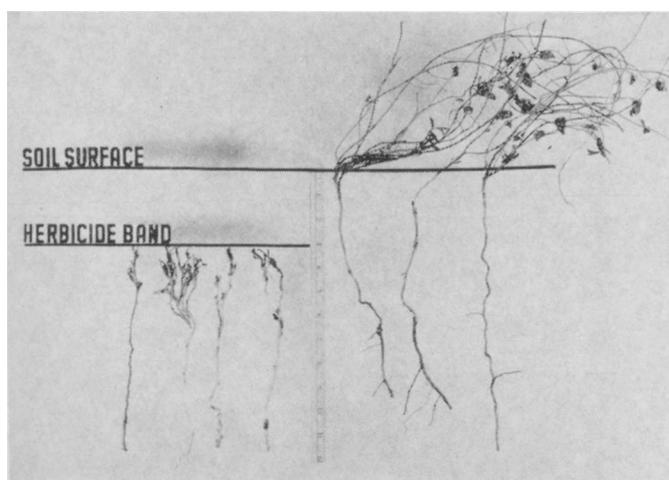
### Irrigation

The usefulness of these herbicides for weed control and their safety in young vineyards is no doubt related to the method of application of irrigation water to the vines and to the soil type at the site. Irrigation applied by sprinkler or flooding over the treated soil could both reduce the effectiveness of the herbicide on the weeds and increase its danger to the vines.

Under the conditions of these trials, both chemicals appear to be safe for use on young grapevines. Additional tests, however, will be conducted on plants less than three years of age, and their reaction to higher dosage rates will be examined. These studies and others on various means of mechanical incorporation of the chemicals into the soil are now under way in the experimental vineyards at U. C., Davis.

Dichlobenil has federal registration for use on grapes but is not currently recommended by the University of California. Chlorthiamid is an experimental material.

*Lloyd A. Lider is Associate Professor of Viticulture, Department of Viticulture and Enology; and Oliver A. Leonard is Botanist, Department of Botany, University of California, Davis.*



A. H. LANGE  
H. AGAMALIAN  
R. BRENDLER  
M. SNYDER

Weed competition in cole crops can be severe.

Of the many herbicides tested recently in California cole crops, FW-925 (TOK-E-25)—applied pre-emergence without incorporation—had the largest and most consistent margin of safety for direct-seeded cole crops. Such herbicides as DCPA, Glenbar, and bensulide also gave adequate control of certain weed species, along with an excellent margin of safety. Herbicides with less safety but with a wider weed control spectrum included trifluralin and CIPC. CDEC was effective on some important weed species, but had a somewhat narrower margin of safety. Combinations of herbicides—including trifluralin and FW-925 are being tested this year in uniform trials on cole crops throughout California. This is a progress report of research with new herbicides and is not to be considered a recommendation of the University of California. Many of the materials used in these tests are not registered for use in cole crops.

ACCORDING TO recent estimates, two-thirds of the total cole crop production in western United States is produced in California, involving nearly 61,000 acres. Cole crops include broccoli, cabbage, cauliflower, brussels sprouts, turnips, rutabagas, radishes, chinese cabbage, mustard greens, kohlrabi, and collards. Largest acreage in California is in broccoli, cauliflower, cabbage, and brussels sprouts. According to a 1965

survey of weed control problems in vegetable crops, about 5% of the approximately 36,000 acres surveyed had been treated with such herbicides as CDEC (Vegadex), CIPC, or DCPA (Dacthal).

In this same survey, the principal weeds found in cole crops included burning nettle, shepherdspurse, pigweed, lambs-quarter, groundsel, annual ryegrass, nightshade, cheeseweed and mustard. Chickweed, annual bluegrass, and purslane are also important weeds in coastal vegetable areas. In Monterey County, as much as 30 to 35% of the acreage is now treated with herbicides. On most of this acreage the herbicides are applied to cole crops that have been direct-seeded. Ninety-five per cent of the broccoli, cabbage, and cauliflower is currently direct-seeded in Monterey County; the other 5% is transplanted. It has also been estimated that hand weeding costs approximately \$30 to \$55 an acre for cole crops.

### Chemical control

Most of the herbicides found safe on crucifer crops were also weak on some winter annuals such as those found in the family *Cruciferae*. Counts listed by species in table 1 show results of both good and poor control by a given herbicide on some weed species. Shepherdspurse was not controlled by benefin (Balan) or trifluralin (Treflan); whereas purslane, henbit and speedwell were controlled.

CDEC (Vegadex) applied at 6 to 8

TABLE 1. AVERAGE NUMBER OF WEEDS PER PLOT AND AVERAGE PERCENT WEED CONTROL IN CABBAGE

Herbicide	Rate	Shepherds- purse	Purslane	Hairy nightshade	Henbit	Burning nettle	Speed- well	Cheese- weed	Control
	lbs/A	Average number of weeds per plot							Average percent
Ramrod	4	42	26	13	2	3	0	1	89
"	8	2	8	6	1	3	0	1	97
CDEC	6	43	13	30	0	3	0	3	88
Trifluralin	1	93	4	13	5	8	0	0	85
"	2	26	0	4	0	0	0	3	95
Benefin	1	92	4	31	6	4	0	5	83
"	2	64	3	30	0	8	0	5	86
Bensulide	4	43	14	44	40	14	3	9	78
Glenbar	4	55	25	45	9	11	1	8	81
"	8	49	22	34	8	11	0	1	85
Check	..	86	83	82	70	38	13	19	0

# WEED CONTROL IN COLE CROPS

TABLE 2. AVERAGE WEED CONTROL AND PHYTOTOXICITY RATINGS IN CABBAGE AFTER HERBICIDE APPLICATION AT ONE LOCATION IN SACRAMENTO COUNTY

Incorporated herbicides	Amount	Weed control (6 months)	Phytotoxicity rating*		
			(1 month)	(3 months)	(6 months)
	lb/A	%			
CDEC	4	15	1.5	1.0	1.5
CDEC	8	52	0.8	0.8	0.5
DCPA	8	78	2.0	1.0	0
DCPA	15	92	1.8	1.0	1.5
Trifluralin	1	75	2.5	1.3	2.0
Trifluralin	4	80	2.5	2.8	2.0
Desmetryne	1	82	3.3	2.0	2.0
Desmetryne	4	75	8.2	6.5	6.5
Check	0	0	1.0	1.7	0

\* 0 = no effect 10 = all killed

lbs per acre gave nearly 80% control when all 12 trials were averaged (graph 1). However, in some of the trials, CDEC showed very poor control while in others, it gave excellent weed control. CDEC was weak on groundsel, shepherdspurse and sow thistle but showed good control on nettle, pigweed and chickweed.

**DCPA (Dacthal)** used at rates from 4 to 8 lbs per acre gave a wide range of weed control, varying from none to 96% in some trials. DCPA was particularly effective on grassy weeds in late spring and summer. Resistance to DCPA was shown by many of the winter weeds such as shepherdspurse, other crucifer weeds, cheeseweed, groundsel and sow thistle. DCPA was quite effective on purslane, lambsquarter and pigweed, and high rates gave good broadleaf weed control.

**Trifluralin** gave a high average weed control of over 80% at the 1-lb-per-acre rate, and nearly 92% at 2 lbs (graph 1). Trifluralin showed a wide spectrum of weed control, but was weak on many of the broadleaf winter annuals including shepherdspurse, mustard, burning nettle, groundsel and henbit. It was effective on summer grasses and such broadleaf annuals as lambsquarter, pigweed, purslane and puncture vine. It was very ineffective

on nightshade and some of the other solanaceous weeds.

**Bensulide (Prefar)** showed fair weed control over the range of 4 to 8 lbs (graph 1), but these rates were not sufficient in some tests. Bensulide was an excellent grass killer, but was not very effective on many of the broadleaf annuals such as shepherdspurse, nightshade, groundsel, sow thistle, burning nettle and a number of the legume weed species. Certain broadleaves such as pigweed, purslane and lambsquarter, were controlled, however.

**Glenbar** averaged somewhat better weed control at 8 lbs per acre than its analog, DCPA. However, data from fewer tests were available.

**FW-925 (TOK-E-25)**, a surface-applied pre-emergence herbicide, gave excellent weed control at rates from 2 to 8 lbs (graph 1). It was somewhat selective and the average shown may be misleading because of the small number of trials being compared. Most broadleaf weeds were controlled either pre- or early post-emergence. Species resistant to FW-925 were chickweed, groundsel and shepherdspurse (at the three- or four-leaf stage). FW-925 gave excellent control of

purslane and many grasses and broadleaf weeds. Although FW-925 appears to be promising for weed control in cole crops on the basis of results thus far, critical experiments have not been made with this herbicide—including variations in amounts of sprinkler irrigation water applied before and after emergence. Since a concentrated layer of FW-925 herbicide on the surface acts to girdle the stems of weeds and susceptible crops, moisture could be important in the activation of this herbicide. The stage of germination when maximum activity occurs must also be checked out under controlled sprinkler irrigation studies before recommendations can be made. Under furrow irrigation (with no rainfall), this herbicide has performed with a more than adequate margin of safety in cole crops.

**CP-31393 (Ramrod)** used at 4 to 8 lbs per acre has given some good weed control (graph 1), but is somewhat ineffective for a number of the winter annual weeds.

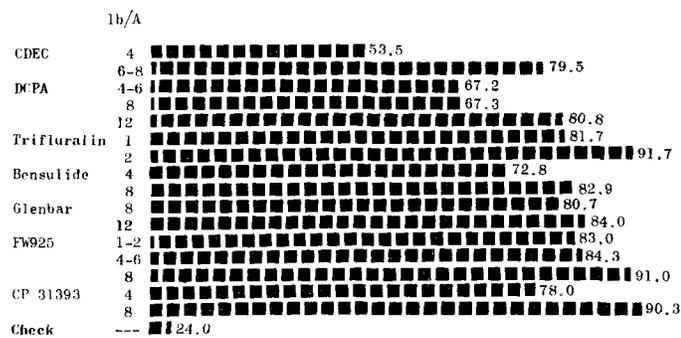
A summary of stand counts and phytotoxicity ratings in broccoli showed that DCPA, Glenbar, bensulide, and FW-925 have a wide margin of safety (graph 2). Herbicides such as CDEC, Trifluralin,

Spectacular selective weed control with a low rate of TOK-E-25.



A combination (left) of trifluralin (Treflan) and TOK-E-25 gave a broader spectrum of weed control than trifluralin alone (right)—Monterey County photograph.





Graph 1 (left). Average percentage weed control in cole crops from counts and chemical control ratings for 12 field trials, each replicated 4 to 6 times. Graph 2 (below). Number of broccoli trials showing weed control and safety ratings for herbicides used.

Weed control *	+	1	8	2	7	9		3	4	3	2	4	3	4	5	3	4	1	1	5					
	-	1			2			4	3	1	1	2	2		3	1	2	1	2						
Safety *	+	1	2	8	1	7	4		6	7	4	3	3		7	4	2	2	3	1	3				
	-			2		2	4	1									2	3		1	2				
Rate (lb/A)		1	2	4	6	8		1	2	4	4	6	8	12	4	8	12	4	8	6	8	4	6	3	
Herbicide		FW925	Trifluralin	DCPA	Glenbar	Bensulide	CDEC	IPC	CIPC																

\*Number of trials: satisfactory (+); unsatisfactory (-).

and CIPC showed somewhat narrower margins of safety. When broccoli yield data from seven locations were summarized, average yields were affected very little by even higher rates of a number of herbicides. The safest of these herbicides were bensulide, Glenbar and DCPA. Trifluralin plots at 2 lbs per acre showed somewhat lower average broccoli yields than at the 1-lb rate, whereas many of the other herbicides showed increased yields at the higher rates, indicating responses from the extra weed control.

In one furrow-irrigated trial near Santa Maria, careful records were kept of the number of heads and weights at each of seven harvests. These data clearly indicate a reduction of yield and a possible delay in harvest from the higher (2 lb) rate of trifluralin. In this same test, FW-925 showed no toxicity in applications up to 4 lbs per acre, and no indication of delay. CDEC showed a reduction in number of heads and weight when used at 8 lbs per acre.

**Broccoli summary**

A summary of all broccoli trials on a plus or minus basis (for weed control and safety) showed trifluralin at 1 lb was somewhat weak in controlling winter weeds but was safe for use on the crop

in seven out of nine trials. Although the 2-lb rate gave better weed control, it also gave excess phytotoxicity four out of eight trials. FW-925 showed excellent weed control and safety in most trials. Bensulide, like DCPA and Glenbar, showed excellent safety up to 8 lbs per acre and satisfactory weed control in most trials at that rate of application. IPC and CIPC showed some injury at herbicidal rates.

**Cabbage summary**

In one early fall trial in Sacramento County, DCPA (Dacthal) gave good weed control at 8 to 16 lbs per acre with no indications of injury. Trifluralin was intermediate in weed control with some indications of phytotoxicity at the higher rate. CDEC gave poor weed control at rates of 4 to 8 lbs. Desmetryne, a triazine used in European cole crops, gave intermediate weed control but excessive toxicity at the 4-lb-per-acre rate. In another trial, in Ventura County, FW-925 applications gave outstanding weed control and resulted in the highest cabbage yields. Fairly good yields were also obtained from applications of 4 to 8 lbs of CDEC per acre; however, trifluralin at 1 and 2 lbs, and CDEC at 8 lbs, were among the poorer yielding treatments. A summary of all the cabbage trials indicated somewhat better weed control from

applications of 1 to 4 lbs of trifluralin and 5 to 8 lbs of DCPA.

**Brussels sprouts**

These herbicides were generally safe except for trifluralin at 2 to 4 lbs on brussels sprouts; however, the data from only two trials on brussels sprouts were available. The results indicated no injury with CDEC (Vegadex) and DCPA. More tests in more areas will be necessary for a complete evaluation of herbicides on brussels sprouts.

In one test in Los Angeles County, comparing sprinkler and furrow (incorporated) irrigation, trifluralin showed considerable promise for weed control in mustard greens.

*A. H. Lange is Weed Control Specialist, Agricultural Extension Service, University of California, Riverside. H. Agamalian is Farm Advisor, Monterey County; R. Brendler is Farm Advisor, Ventura County; and Marvin Snyder is Farm Advisor, Santa Barbara County. Many farmers cooperated by contributing land, produce, and time to make this study possible. Farm Advisors Theodore Torngren, Sacramento County; Richard Puffer, Los Angeles County; Norman Welch, Santa Cruz County; and Vincent Rabatzky, Extension Vegetable Crops Specialist, UC, Davis, also cooperated.*

Weedy, untreated field of cabbage in Ventura County.



Herbicide-treated field of cabbage in Ventura County.

