Herbicides for control of

ANNUAL WEEDS IN CALIFORNIA APPLES AND PEARS

A. H. LANGE · C. L. ELMORE · G. W. MOREHEAD
E. K. STILWELL · S. M. MCRITCHIE · D. W. CHANEY · J. J. SMITH
L. C. HENDRICKS · K. O. ROBERTS

PRE-EMERGENCE HERBICIDES such as simazine and diuron (Karmex) are widely used for annual weed control in commercial apple and pear producing areas outside California. A 1964–65 survey of California orchards showed that very few acres of apples and only about 1000 acres of pears were sprayed for annual-weed control during that winter. Both simazine and diuron have been registered for use in apples and pears by the state of California and USDA. New developments in orchard culture, including hedge-row planting of pears, together with the scarcity of hand labor, have resulted in a recent upsurge of interest on the part of California orchardists.

Weed-free strip down the tree row in photo below was photographed several months following herbicide applications at a Santa Clara County pear orchard, in cooperative trials by the University of California Agricultural Extension Service.

The work reported here summarizes five years' results of a general study in California deciduous fruit tree nurseries and orchards on the effectiveness of several herbicides for the control of annual weeds in apples and pears. The response of specific weeds, and the tolerance of several ages of apple and pear trees for diuron and simazine were determined in the major production areas of California. The effect of soil-applied herbicidal treatments on foliar conditions, stand, and growth is also reported. Herbicides were applied in nine nursery and 20 pear orchard trials and in three nursery and four apple orchard trials, over a period of five years (1960–65).

Nursery trial

In several commercial nurseries, plantings of liners and young grafted stock of apples and pears were treated: two trials were conducted in Sutter and three in Merced counties. Weed control and tree response were recorded periodically through the growing season. Stand percentage and tree damage were recorded in trials as noted in the tables.

A series of herbicidal rates were applied from November to March in the 20 orchards. The standard trial consisted of three rates of diuron and three of simazine. On the lighter soils with young trees the rates of 1, 2, and 4 lbs (active ingredient) were used; on heavy soils and older trees, 2, 4, and 8 lbs were tested. Where standing weeds were present, 1 to 2 lbs per acre of amitrole were added, depending on species and size of weeds present.

These trials were set up over a wide range of environmental conditions on soils varying in organic matter from 0.6 to 11%; clay content ranged from 7 to 30%; sand content was 14 to 87%; and silt content was 12 to 56%. Each orchard trial contained single tree plots treated in a strip 5 to 10 ft wide down the tree row from center to center of the inner space. Width of the treated strip varied with the age of the orchard.

Weed control ratings of 7 and above, on a scale of 0–10, were considered commercially acceptable. Phytotoxicity was also rated on a 0–10 scale; however, any toxicity symptoms were considered detrimental.

Weed control

Weed control summaries over a period of 12 months showed that rates of 2 and 4 lbs of diuron and simazine generally gave commercially acceptable weed control. Degree of control varied with locations. Weed control from 4 lbs of diuron

Untreated row of young pear trees, photo above, taken in Sacramento County, showing weed growth in contrast to good weed control through preemergence herbicide applications around two trees below.

TABLE 1. THE EFFECT OF DIURON AND SIMAZINE ON THE FOLIAR CONDITION OF ALL AGE PEAR TREES FROM NINE NURSERY AND 20 ORCHARD TRIALS (AVERAGES, 1960–65)*

Herbicide	lb/A	Nursery trees (1 & 2 yr. old liners)		Orchard trees (All ages)	
		Ave.	Range	Ave.	Range
Diuron	1	0	.03–.05	0	0
"	2	0.6	0–1.2	0	0–0.6
"	4	0.1	0.2–0.8	0.1	0–0.7
"	8	3.5	0.5–6.5	0.1	0–0.3
Simazine	1	0.3	0–1.8	0	0
"	2	0	0	0.1	0–1.0
"	4	0.8	0–4.0	0.1	0–0.7
"	8	1.5	0.7–2.0	0.4	0–2.3
Check	0	0	0	0	0

* Phytotoxicity ratings from 0–10: 0 = no effect, 3 = recognizable toxicity symptoms, 5 = chlorosis pattern and burn, 10 = all leaves dead.

TABLE 2 PHYTOTOXICITY FROM DORMANT SEASON SOIL APPLICATIONS OF SIMAZINE AND DIURON AT 18 LOCATIONS IN PEAR AND APPLE ORCHARDS IN THE MAJOR FRUIT PRODUCING AREAS OF CALIFORNIA

Location	Crop	Approx. age	Soil characteristics				Type irrig.	Phytotoxicity	
			O.M.	Sand	Silt	Clay		Simazine	Diuron
		(years)							
Placer	Apple	1	11.0	66.4	26.8	6.8	Sprinkler	–	–
Sac.-3	Pear	2	7.5	18.8	55.6	25.6	"	–	–
S. Cruz	Apple	1	7.3	72.8	16.8	10.4	Furrow	–	–
Sac.-2	Pear	2 & 5	6.6	20.1	53.0	26.9	None	–	–
Son.	"	4	6.4	32.4	42.0	25.6	Sprinkler	–	–
Lake-2	"	Mature & 2	6.2	33.2	56.0	10.8	"	–	–
S. Clara	"	6	6.0	20.8	54.8	24.4	"	–	–
Napa	"	2	5.8	41.6	36.8	21.6	"	–	–
Stan.	"	1 & 2	5.5	13.6	48.8	37.6	Furrow	–	–
C.C.-2	"	2	5.3	26.0	52.0	22.0	Sprinkler	–	–
S. Joaquin	"	3	5.3	24.0	64.0	12.0	"	–	–
Lake-1	"	Mature & 2	4.8	47.2	38.0	14.8	"	–	–
Sac.-1	"	1	4.4	54.8	37.8	7.4	Flood	–	–
Sac.-4	"	1	4.4	54.8	37.8	7.4	"	+	–
C.C.-1	"	3	4.1	19.2	56.2	24.6	Furrow	–	–
Butte	"	4	4.2	50.8	39.6	9.6	Sprinkler	–	–
S. Berdo.	Apple	4	3.5	74.0	18.0	8.0	"	–	–
L.A.	Pear	3	0.6	81.0	12.0	7.0	"	+	+

+ = an unacceptable degree of symptoms on the foliage (a rating of 3 or more).
– = no visible symptoms, or symptoms considered to be inconsequential.

was commercially acceptable for about 6 to 7 months.

Although most of the herbicide applications were made in the early spring, fall vs. spring applications suggested slightly longer summer weed control from spring applications.

Although variations existed from test to test, particularly with spring applications, there appeared to be about one month more weed control from spring applications at 2 lbs per acre of simazine and diuron than from fall applications. There was more variation in weed control from spring applications. This was probably due to less rainfall or other moisture on some of the spring treatments. Late fall applications received more natural rainfall than did the spring applications, which accounted for better herbicide activation (through moisture leaching the herbicide into the surface inch of soil which contains a large number of the germinating seeds).

The main weeds accounting for less effective weed control with simazine in the summer included barnyardgrass and cheeseweed, whereas the main weeds not controlled with diuron were groundsel, cheeseweed and wild oats. Neither herbicide controlled bindweed, johnsongrass, bermudagrass, curly dock, perennial smartweed nor other perennial weeds.

Pears

Results of 1964 nursery pear trials indicated that diuron and simazine were generally safer than most other herbicides tested. Diphenamid and prometryne appeared to be equally safe but gave inadequate weed control. In these trials, using rates of 1 to 4 lbs, simazine appeared to be somewhat more toxic than diuron (at equivalent rates), although both were much safer than the uracil herbicides when tested at two locations. At location 2, liners were one year older than location 1 liners which may explain the difference. However, the pattern was generally similar at both locations and also at another trial with Winter Nelis liners. Although leaf symptoms were observed with applications of both simazine and diuron, the rates of 2 and 4 lbs per acre were generally safe in these tests.

The 1965 nursery trials again substantiated the safety of diuron as compared with simazine for pears. Although trifluralin, diphenamid, and DCPA (Dacthal) were not incorporated into the soil, they did give some weed control. In these trials, there was insufficient weed growth in the check plots to make an accurate evaluation of weed control. There were no indications of phytotoxicity at high rates.

The results of the Sutter County nursery test were substantiated in the Merced County test conducted in a salty, somewhat lighter soil (organic matter 3.2%). Diuron and simazine showed considerable more toxicity under poor growing conditions. A summary of all nine nursery trials and 20 orchard pear trials indicated little toxicity even on young trees, from either simazine or diuron. Diuron was consistently more toxic than simazine on young trees, but the reverse was true on older orchard trees. In the older trees with deeper root systems, soil may have had more buffering action than in the young, shallow-rooted nursery trees. In the young nursery trees, diuron was more toxic than simazine (at equivalent rates), particu-

larly under adverse growing conditions at Merced, although there was considerable variation at rates up to 4 lbs on young liners. In most instances, rates up to 4 lbs of simazine and diuron gave very little in the way of toxicity symptoms in orchard experiments. From these results it would appear that simazine may be safer on very young trees, while diuron may be safer on established trees in the more mature orchards—although both compounds appear to have an adequate margin of safety on bearing pear trees.

Apples

Results of 1964 herbicide tests in nurseries indicated diuron and simazine to be about equal in degree of toxicity to young apple liners. Young apple trees grafted to Gravenstein (consequently 1 year older) showed fewer injury symptoms than one-year-old apple liners. The grafted apples were grown in soil with an organic matter content of 3.2%, and the liners on a soil with 2.1%, which may also have influenced the results.

A comparison of diuron and simazine applications in apples indicated, as with pears, slightly more injury from diuron on young nursery trees than from simazine at equivalent rates. However, young apple trees treated in orchards showed no injury from either diuron or simazine up to and including 8 lbs per acre. The indications are that once trees are established in the orchard very little injury results from the use of 2 to 4 lbs of diuron or simazine for annual weed control.

Summary

Results of the 1965 screening trial in commercial nurseries suggested greater safety to young pear liners from simazine than from diuron at equivalent rates, although the extent of symptoms appeared to be somewhat comparable. Other herbicides in these tests appeared to be no safer than simazine or diuron and many consistently gave poorer weed control. Both simazine and diuron can be expected to give commercial weed control for approximately six months at rates of 2 to 4 lbs per acre. Higher rates of diuron were used without encountering toxicity symptoms except in young liners where even a 4-lb application was not safe. From the results reported here, young trees growing in unfavorable soil conditions could be expected to be susceptible to injury from both diuron and simazine. Fall applications, combined with a contact herbicide, gave slightly longer weed control than spring applications. When diuron and simazine were compared on a pound-for-pound basis in established orchards, simazine gave somewhat better weed control. Low rates were less effective on soils containing high organic matter than on soils containing low organic matter. Both simazine and diuron appeared to have sufficient safety at herbicidal rates recommended for use in established apple and pear orchards.

The University of California weed control recommendation is for applications of diuron at 3.2 lbs per acre in a single fall application or 1.6 lbs per acre in split fall and spring applications for apples and pears. Simazine is recommended at 2 to 4 lbs per acre in a single strip application after harvest for annual weed control in established trees one year or older. These herbicides should not be used in shallow or sandy soils that are low in organic matter, such as are found in the desert valleys.

TABLE 3. THE EFFECT OF DIURON AND SIMAZINE ON THE FOLIAR CONDITION OF ALL AGE APPLE TREES FROM THREE NURSERY AND THREE ORCHARD TRIALS (AVERAGES, 1963–65)

Herbicide	lb/A	Nursery trees (1 & 2 yr. old liners)		Orchard trees* (1–3 yrs. old)	
		Ave.	Range	Ave.	Range
Diuron	1	0.4	0–0.8	–	–
"	2	2.8	2.8	0	0
"	4	2.3	0.3–3.7	0	0
"	8	4.2	4.2	0	0
Simazine	1	0.8	0–1.8	–	–
"	2	0.4	0–0.8	0	0
"	4	2.3	0–3.8	0	0
"	8	2.7	1.3–4.2	0	0
Check	0	0	0	0	0

* Young established orchard trees.

Arthur H. Lange is Extension Weed Control Specialist, Agricultural Extension Service, University of California, Riverside; Clyde L. Elmore is Extension Service Weed Technologist, Davis; Gordon W. Morehead is Farm Advisor, Sacramento County; Edwin K. Stilwell is Farm Advisor, Contra Costa County; Scott M. McRitchie is Farm Advisor, Butte County; David H. Chaney is Farm Advisor, Sutter County; John J. Smith is Farm Advisor, Placer County; Lonnie C. Hendricks is Farm Advisor, Merced County; and Kim O. Roberts is Farm Advisor, Sonoma County.

Cooperation in conducting these tests was obtained from D. E. Bayer, L. L. Buschmann, D. I. Grover, H. M. Kempen, F. M. Charles, W. S. Seyman, D. E. Ramos, E. C. Koch, N. W. Ross, G. R. Post and many other farm advisors who contributed information and support to this program—as well as many California farmers. Jim Quick conducted the organic-matter and physical analyses of the soils.

Control of

POWDERY MILDEW can reduce yield and quality of cantaloupes in the arid inland valleys of California. The plants are defoliated, particularly around the crown of the plant. Thus the fruits become sunburned, ripen prematurely, and are lacking in soluble solids, and in general have poor edibility. The ratio of culls to marketable fruit increases tremendously. Powdery mildew is caused by the fungus, *Erysiphe cichoracearum.*

La Jolla trials

Cooperative trials were established with the USDA Horticultural Field Station, La Jolla, to determine the effectiveness of some of the newer fungicides for the control of powdery mildew of cantaloupe. Karathane has been the standard treatment used. The cantaloupe variety, Golden Gate, was used in the experimental trials since it is very susceptible to powdery mildew. Seed was planted in the greenhouse in peat pots on July 11, 1966, and transplanted to the field on August 8. Six plants were used per plot and all treatments were replicated five times. The materials and rates per 100 gallons of fungicidal mixture are as follows: Morestan (6-methyl 1-2, 3-quinoxalinedithiol cyclic carbonate) 1 lb 25% WP; Morocide (2-*sec*-butyl-4, 6-dinitrophenyl-3-methyl-2-butenoate) 1 lb 50% WP; Karathane (dinitro(1-methylheptyl) phenyl crotonate) 1 lb 25% WP; ammonium polysulfide 65%, 2 pints; and the check treatment. Four ounces of Triton B-1956 spreader-sticker were used with the Karathane spray per 100 gallons. All materials were applied at the rate of 250 gallons per acre at a pressure of 250 psi. Spray applications were made every seven days, on August 24, 31, and September 7.

Plots were rated on a scale of 0 to 5