



**ABSTRACT:** Picloram, in spray and pellet forms, was tested for its ability to kill chaparral species at several sites in southern California, in 1963. This herbicide proved to be as effective as brushkiller (2,4-D and 2,4,5-T) or slightly more so. Both herbicides killed chamise readily at low rates, but failed to kill scrub oak. Kill of other species varied between these two extremes. Excellent kill of all species after re-treatment with picloram was obtained at one test site.

## Picloram Herbicide for Killing Chaparral Species

... a preliminary rating

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One of the newer and more promising herbicides for the control of woody plants is picloram<sup>1</sup> (4-amino-3,5,6-trichloropicolinic acid). A systemic herbicide that is readily absorbed by both leaves and roots (Wiltse 1964), it injures or kills most woody species, as well as herbaceous broad-leaved plants. Established grasses are generally tolerant. Growth responses following application resemble those of the phenoxy herbicides 2,4-D and 2,4,5-T (Dow Chemical Company 1963).

After field and laboratory testing, the manufacturer reported that picloram sprayed onto foliage controlled such California shrubs as chamise (*Adenostoma fasciculatum*), manzanita (*Arctostaphylos* spp.), holly-leaf cherry (*Prunus ilicifolia*), California coffeeberry (*Rhamnus californica*), mesquite (*Prosopis juliflora*), and poison oak (*Rhus diversiloba*) (Dow Chemical Company 1963; Gantz and Laning 1963). Foliage applications have been used successfully on woody plants elsewhere in the United States (Nation and Lichy 1964; Sch-

wartzbeck and Wiltse 1964) and in Australia (Ferguson 1965). Soil applications have controlled some woody species (Dow Chemical Company 1963; Wiltse 1964). And the herbicide is claimed effective as a frill treatment (Watson and Mesler 1964).

In tests conducted at several southern California locations, starting in 1963, we found that one picloram application destroyed all woody plants which brushkiller (2,4-D and 2,4,5-T) normally kills, and sometimes it proved even more effective. The action, however, was slower than with brushkiller. In most cases, chamise was killed by picloram mixed at the rate of 1 pound per 100 gallons of solution. From 2 to 4 pounds of the herbicide was required to kill Eastwood manzanita and laurel sumac. First-year results on scrub oak were not encouraging, but at one test site, we found that a second picloram spray treatment, applied a year after the first, may eliminate scrub oak. Woody plant control in southern California often requires more than one annual application. Picloram, applied to the soil either broadcast or in a ring close to the root crowns, readily killed chamise and red shank.

### METHODS AND PROCEDURES

Picloram was applied as a foliage spray to a variety of sprouting shrubs

<sup>1</sup>A common name for this herbicide adopted by the Weed Society of America. Tordon is the Dow Chemical Company's trademark name for it. Trade names and commercial products are mentioned solely for necessary information. No endorsement by the U.S. Department of Agriculture or the University of California is implied.

on the Angeles National Forest, near Glendora; at several locations in San Diego County, and on the North Mountain Experimental Area near Banning, California. Picloram pellets were applied to sprouting shrubs on two test sites in San Diego County.

*Application methods.*--Picloram was diluted in water to concentrations ranging from 1/2 to 8 pounds active ingredient per 100 gallons of solution. The solutions were applied to sprouting shrubs as a coarse spray from small, backpack-type pressure sprayers with a hand boom. Leaves, twigs, and stems were all sprayed until solution started to drip or run off. Dry picloram pellets (Tordon 10K) were either broadcast over an area or placed in a band in measured amounts around the root crown.

*Sampling procedure.*--In most of the tests plants were tagged individually; on the tags was imprinted plant number, treatment, and date of application. In part of the San Diego County tests, all plants on small plots were sprayed but not individually tagged. Sampling was done at intervals of several months after treatment, but data were not reliable until about a year had elapsed. Plant response to treatment was recorded under the following categories:

Visible effect of herbicide

Code

No.:

- 1 No visible effect
- 2 Browning or burning of leaves or twig tips
- 3 About 1/3 of leaves dead, stem sprouting
- 4 About 1/3 of leaves dead, stems green but not sprouting
- 5 About 2/3 of leaves dead, stem sprouting
- 6 About 2/3 of leaves dead, stems green but not sprouting
- 7 All leaves and twig tips dead, stem sprouting
- 8 All leaves and twig tips dead, stems green but not sprouting
- 9 Complete top kill, crown sprouting
- 10 Plant is apparently dead.

FOLIAGE SPRAY TESTS

GLENDORA RIDGE

A fire in July 1962 had removed mature brush from the Glendora Ridge. Sprouting was rapid, and by the May 9-10, 1963 spraying dates, the brush stood 1 to 2 feet tall. Picloram was applied at 1/2, 1, and 2 pounds, and the standard brushkiller<sup>2</sup> at 4 pounds per 100 gallons of spray solution.

Picloram at all rates killed chamise (*Adenostoma fasciculatum*)--something that brushkiller failed to do in this test (table 1). It was about equally effective on laurel sumac (*Rhus laurina*) and Eastwood manzanita (*Arctostaphylos glandulosa*). At the 1/2-pound rate, about one-third the manzanita and most laurel sumac leaves were killed, but the plants were not. At the higher rates most plants were killed, but some sprouted--usually from the crowns.

Scrub oak (*Quercus dumosa*) was resistant to picloram just as it has been to other herbicides. Considerable leaf kill was obtained for all treatments, but there was vigorous stem or crown sprouting from most plants.

OAK GROVE FUEL-BREAK

The Oak Grove Fuel-Break in San Diego County, originally dominated by chamise but with red shank (*Adenostoma sparsifolium*) also a problem, was hand cut and cleared over several years starting in 1958. Broadcast spraying with brush-killer satisfactorily controlled chamise regrowth, but not red shank.

On September 26, 1963, picloram at rates of 1/2, 1, and 2 pounds per 100 gallons of spray solution was hand sprayed onto sprouting red shank plants

<sup>2</sup>Two pounds 2,4-D and 2 pounds 2,4,5-T, 1 gallon diesel oil, and 98 gallons of water.

Table 1. - Spray treatments applied to sprouting brush on Glendora Ridge, May 1963, and plant response

Species	Herbicide	Rate per 100 gal. Pounds	No. of plants treated	Typical response <sup>1</sup>
Scrub oak	Picloram	1/2	30	Partial to complete leaf kill but sprouted from stem and crown
		1	30	Most leaves killed; general stem and crown sprouting
Scrub oak	2,4-D + 2,4,5-T	2	30	Same
		4	15	Half were killed; the others top killed but crown sprouted
Scrub oak	2,4-D + 2,4,5-T + Surfactants	4	30	Most plants top killed but crown sprouted.
Chamise	Picloram	1/2	5	All plants killed
		1	5	All plants killed
		2	5	All plants killed
Chamise	2,4-D + 2,4,5-T	4	15	Half of plants were killed; half top killed but crown sprouted
Eastwood manzanita	Picloram	1/2	5	One-third to half of leaves and some twigs killed. Some had stem sprouted by 9/14/64
		1	5	All plants killed
		2	5	80 percent of plants were dead; the rest crown sprouted
Laurel sumac	Picloram	1/2	5	Top killed but crown sprouted
		1	5	Three-fifths of plants dead; the rest crown sprouted
		2	5	80 percent of plants dead; the rest crown sprouted

<sup>1</sup>Observations were made October 29, 1963, May 20 and Sept. 14, 1964, and January 1965. Spray results were essentially the same at all dates.

Table 2. - Response of red shank to picloram, 2,4-D and 2,4,5-T foliage sprays<sup>1</sup>

Herbicide and rate (lbs./100 gal.)	No. of plants	Plant response
Picloram, 1/2	15	Half were killed; nearly complete leaf kill on rest followed by stem sprouting
Picloram, 1	15	80 percent killed; leaves and twigs were killed on rest; followed by some stem sprouting
Picloram, 2	15	All were killed
2,4-D, 4	44	One-third of plants dead in May 1964, 60 percent in February 1965; most others top killed but crown sprouted
2,4,5-T, 4	26	One-half of plants dead in May 1964, 90 percent in February 1965; most others top killed but crown sprouted

<sup>1</sup>Picloram plots were lost to a bulldozer before the February 1965 sampling.

that were about 12-inches tall. Suitable plants of the same size were not available for other treatments. Therefore, for comparison, 2,4-D and 2,4,5-T each at 4 pounds per 100 gallons were individually sprayed onto year-old sprouts that were 2 to 3 feet tall. Red shank was killed by picloram solution at the 1 and 2 pound rates (table 2). By February 1965, about 60 and 50 percent of the plants had been killed by

the 2,4-D and 2,4,5-T, respectively.

NORTH MOUNTAIN EXPERIMENTAL AREA

Brush sprouts on a previously cleared fuel-break in the Experimental Area were removed by hand cutting in March 1963. Ten sprouting shrubs of several species were hand sprayed with picloram at each of 3 or 4 rates, and with brushkiller at one rate on July 8, 1964 (table 3).

Table 3.--Herbicide spray treatments applied to 10 sprouting brush plants on the North Mountain Experimental Area, 1964-1965

Brush species	Herbicide	Rate per 100 gal.	Plant response to herbicide	
			September 15, 1964	May 25, 1965
		<i>Pounds</i>		
Scrub oak	Picloram	1	One-third leaf kill	All plants stem sprouting
		2	One-third kill	Two-thirds leaf kill with stem sprouting
		4	Two-thirds leaf kill	One-third dead, one-third stem sprouting stems green on rest
	Brush-killer <sup>1</sup>	4	Nearly complete leaf kill stems green	Two-thirds dead, complete leaf kill but stems green on rest
		4	Complete leaf kill stems green	Complete top kill but general crown sprouting
Eastwood manzanita	Picloram	1	Leaves were burned	Partial leaf kill general stem sprouting
		2	One-third leaf kill	One-fifth dead rest two-thirds leaf kill with some stem sprouting
	Brush-killer	4	Complete leaf kill	All plants dead
		4	Complete leaf kill	All plants dead
Chamise	Picloram	1	One-third to two-thirds leaf kill	One-third dead rest stem or crown sprouting
		2	Three fourths dead	Nine-tenths dead rest crown sprouting
		4	One-third dead two-thirds leaf kill on rest	All dead
	Brush-killer	4	Complete leaf kill	All dead
Toyon	Picloram	2	One-third leaf kill	One-fifth dead rest stem sprouting
		4	Two-thirds leaf kill	One-fifth dead, rest stem sprouting
Woolly blue-curlys <sup>2</sup>	Picloram	1	One-third to two-thirds leaf kill	One-fifth dead rest stem sprouting
		2	One-third to two-thirds leaf kill	One-half dead, rest stem sprouting
		4	One-third leaf kill	One-third dead, one-third stem sprouting
California <sup>3</sup> buckwheat	Picloram	1	Slight yellowing	One-third dead, one-third stem sprouting, one-third no effect
		2	Moderate yellowing	Two-thirds dead, one-third stem sprouting
		4	Moderate yellowing	Two-thirds dead, rest have green stems

<sup>1</sup>Two pounds each of 2,4-D and 2,4,5-T, 1 gallon of diesel oil and 98 gallons of water.

<sup>2</sup>*Trichostema lanatum*.

<sup>3</sup>*Eriogonum fasciculatum*.

We have noted that picloram works somewhat slower than does brushkiller, and that appeared to be the case in this test. Most chamise plants, for example, appeared to have been killed by brushkiller, whereas the process was only partially completed by picloram.

Picloram at rates we had used elsewhere had less effect on scrub oak than did brushkiller at the recommended rates. At North Mountain, the highest picloram rate used previously was doubled. This 8-pound rate gave some promise of scrub oak control. And it appeared to be as effective as the brushkiller.

*Retreatment.*--All plants that survived the first spray treatment were resprayed in June 1965 with the same herbicide and rate as a year earlier. Picloram at rates of 2 pounds or more was quite effective--even on scrub oak. The 2-pound rate killed 60 percent of scrub oak plants and 100 percent of chamise, toyon, Eastwood manzanita, woolly blue-curly (*Trichostema lanatum*), and California buckwheat (*Eriogonum fasciculatum*). The 4-pound rate killed all species, including scrub oak. At the 1-pound rate, 10 to 30 percent of treated plants of all species, except woolly blue-curly, survived.

Brushkiller at the 4-pound rate killed all chamise and Eastwood manzanita, but only 10 percent of scrub oak. Most of these plants showed stem sprouting a year after retreatment.

#### WESTFORK FUEL-BREAK

Picloram was applied to vigorous sprouts of three brush species on the Westfork Fuel-Break on Palomar Mountain in July 1964. Observations about one year later showed that picloram and brushkiller were about equally effective in killing sprouting shrubs, or in retarding their growth (table 4). At all

rates both herbicides killed nearly all chamise plants. At the 4 and 8 pound rates picloram was somewhat more lethal to sprouting manzanita than was brushkiller at its heavy rates. Picloram killed virtually all treated manzanita plants; brushkiller destroyed topgrowth, but there was crown sprouting on 25 percent of the plants.

Neither picloram nor brushkiller destroyed any scrub oak plants. The typical action at all rates for both herbicides was that leaf kill increased as herbicide rate was increased. Except for twig tips at higher rates, stems appeared green and healthy. Stem sprouting was common, although somewhat less so on the picloram-treated plants than on the brushkiller-treated plants.

#### SANTA YSABEL

Picloram in concentrations of 1, 2, and 3 pounds in 100 gallons of water was sprayed onto nearly pure chamise sprouts on the Santa Ysabel test site, San Diego County, on May 14, 1963. All plants on 10- by 10-foot plots replicated three times were treated. The test area was at 3,000 feet elevation; mean annual rainfall was about 17 inches.

Five weeks after treatment, chamise sprayed with picloram was brown and appeared to be dying. The effect was about the same through all concentrations and replications. At this stage picloram-inflicted injury resembled that from isooctyl ester of 2,4-D (2,4-dichlorophenoxyacetic acid) applied to similar plots at the same time. The 2,4-D, however, produced a more rapid top kill than did picloram at this stage.

Table 4.--Results from spraying herbicides on chaparral plants on Palomar Mountain, San Diego County, 1964

Species and herbicide	Rate <sup>1</sup> Lbs./100 gals.	Response 1 year after treatment
Scrub oak:		
Picloram	1	Two-thirds to complete leaf kill; stem sprouting
	2	Two-thirds to complete leaf kill; most stems sprouting
	4	Complete leaf and small twig kill; stems green
	8	Complete leaf and small twig kill; stems green
2,4-D + 2,4,5-T	2	Complete leaf and small twig kill; stem sprouting
	4	Complete leaf and small twig kill; stem sprouting
	8	Complete leaf and small twig kill; stem sprouting
	16	Complete leaf and small twig kill; stem sprouting, but some complete top kill
Chamise:		
Picloram	1	95 percent killed
	2	95 percent killed
	4	All killed
	8	All killed
2,4-D + 2,4,5-T	2	90 percent killed; complete leaf kill on rest
	4	All killed
	8	95 percent killed; complete top kill on rest but crown sprouted
	16	All killed
Eastwood manzanita:		
Picloram	1	One-third killed; light to severe leaf damage on rest with considerable stem sprouting
	2	One-third killed; light to severe leaf damage on rest with considerable stem sprouting
	4	All killed
	8	90 percent killed; severe leaf and twig damage on rest
2,4-D + 2,4,5-T	2	45 percent killed; severe leaf and twig damage but 25 percent stem sprouting
	4	45 percent killed; severe leaf and twig damage but 25 percent stem sprouting
	8	70 percent killed; stem or crown sprouting on rest
	16	70 percent killed; stem or crown sprouting on rest

<sup>1</sup>Each rate of both herbicides was applied to 15 scrub oak plants and 25 chamise and manzanita plants.

By October 15, 1963, when the next observations were made, top kill was essentially complete on all picloram-sprayed plots and more complete than on 2,4-D treated plots. There was no resprouting in any picloram treated chamise plots during the next 16 months; however, in comparable 2,4-D sprayed plots, a few plants have resprouted.

#### SOIL-APPLIED HERBICIDE TEST

Picloram may be applied as a pellet-herbicide containing 10 percent active ingredient. Small quantities of this herbicide were available in 1963 and were tested in San Diego County.

OAK GROVE FUEL-BREAK

Picloram pellets were applied to the soil surface in a band close to the base of individual red shank plants on the Oak Grove Fuel-Break, on Sept. 26, 1963. Five rates were used: 1/4, 1/2, 1, 2, and 4 ounces of the commercial product (10 percent a.e.) per plant. Ten plants, each with year-old sprouts about 3 to 4 feet high, were treated with each rate. As part of another test, fenuron was applied to comparable plants at four rates ranging from about 0.2 to 1.8 ounces per plant.

By late December all plants treated with picloram at the higher rates were in obvious distress, with from 1/3 to 2/3 of the leaves dead or dying. At the lighter rates there was slight burning or browning of leaves on some plants to about one-third leaf kill. Response to fenuron at this time was about the same as for picloram. There had been 1.10 inches of rainfall in October, 1.42 in November, and 2.42 during December.

Damage to plants treated with picloram continued to develop (table 5), so that by the May sampling date about 65

percent were dead at the lower rates and 90 percent at the higher rates. No sprouting occurred. Plants treated with fenuron at medium to high rates suffered considerable leaf kill, but many plants sprouted from stems. Plants sprayed with brush-killer were top killed, but numerous plants sprouted from crowns or stems.

SANTA YSABEL PLOTS

Picloram pellets were broadcast on May 14, 1963 on the Santa Ysabel plots, over the soil surface of 10- by 10-foot replicated plots. Rates were 50, 100, and 150 pounds (5, 10, and 15 pounds of actual picloram) per acre. Chamise dominated on the plots.

With only a trace of rainfall following treatment, no injury to vegetation had resulted by 5 weeks after treatment. Observations were made soon after 2-1/2 inches of rainfall in mid-October, when top kill of chamise was virtually complete where foliage had been sprayed during spring. But plants on pellet-treated plots still showed no evidence of injury. Later, as more rain fell, chamise began dying, and by spring all chamise was dead.

Table 5.--Condition of sprouting red shank plants treated with picloram pellets, Oak Grove Fuel-Break, 1963

Rate (oz./plant)	No. of plants	Average condition rating in...				Remarks
		Nov. 1963	Jan. 1964	May 1964	Oct. 1964	
1/4	10	2	6	8	10	80 percent of plants were dead by Oct. 1964, and all plants by May 1966. Kill was a little slower than at heavier rates.
1/2	10	2	8	8	10	Two-thirds of plants dead May 1964, and 80 percent in Oct. 1964. Another had died by May 1966.
1	10	4	8	10	10	All plants dead by May 1964.
2	10	4	8	9	10	90 percent of plants dead by May 1964; the rest badly damaged. Same situation May 1966.
4	5	6	8	9	10	One plant contained green stems but was not sprouting May 1964, but was dead May 1966.

On plots treated with picloram pellets no sprouting was evident 16 months after treatment; however, in comparable plots receiving 2,4-D, some sprouting occurred.

#### LAKESIDE PLOTS

Additional plots were established at the Lakeside plots, in San Diego County, in January 1964. These replicated plots, 30- by 30-feet in size, also were treated with picloram at 50, 100, and 150 pounds per acre. Vegetation was mixed chaparral, chiefly chamise, California buckwheat (*Eriogonum fasciculatum*), Cleveland sage (*Salvia clevelandii*), Mission manzanita (*Xylococcus bicolor*), California sagebrush (*Artemisia californica*), and laurel sumac.

Favorable moisture conditions existed through much of the winter-spring period following treatment. By June the picloram had killed all or nearly all topgrowth of the woody species at all rates, but some *Stipa* and *Erodium* had survived the 50-pound rate. In October 1964 none of the sprayed plants showed any evidence of life. But, on plots treated with 2,4-D, some plants of chamise and California buckwheat did resprout.

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Remarks	Date
50 percent of plants were dead by Oct. 1964 and all plants by May 1965. Kill was a little slower than at heavier rates.	10
Two-thirds of plants dead May 1964 and 80 percent in Oct. 1964. Another had died by May 1965.	10
All plants dead by May 1964.	10
90 percent of plants dead by May 1964. The rest badly damaged. Some situation May 1965.	10
One plant contained green stems but was not sprouting May 1964 but was dead May 1965.	10

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