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Control of Whitebrush And Associated Species

With Herbicides in Texas

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Contents

Summary

The potassium salt of 4-amino-3,5,6-trichloropicolinic acid (picloram) was more effective than phenoxy herbicides for controlling whitebrush (*Aloysia lycioides* Cham.). September and October applications of picloram were more effective than May applications. Increasing rates of picloram killed progressively more whitebrush plants while the dimethylamine salt [(4-chloro-*o*-tolyl)oxy]acetic acid (MCPA) treatments between 1 and 8 pounds per acre were often only about equally effective. Picloram was ineffective at rates up to 4 pounds per acre, however, when the soil was dry, the air temperatures were high (about 100° F.) and the whitebrush plants were naturally defoliated. Addition of MCPA to picloram rates of 0.5 pound per acre and above did not increase whitebrush control. Additions of ammonium thiocyanate, dimethyl sulfoxide (DMSO), diesel oil or metal chelates had little influence on MCPA activity on whitebrush. High rates (5 to 10 pounds per acre) of 5-bromo-3-isopropyl-6-methyluracil (isocil) and 5-bromo-3-*sec*-butyl-6-methyluracil (bromacil) controlled whitebrush but were prohibitively toxic to forage grasses for range use.

On other species, picloram applied either in May or September-October killed most tasajillo (*Opuntia leptocaulis* DC) and pricklypear (*Opuntia* sp.) cactus plants at 0.5 and 1 pound per acre, respectively. Picloram at 3 pounds per acre or more was needed to kill one-half or more of the Texas persimmon (*Diospyros texana* Scheele) plants. Picloram and the 2-ethylhexyl ester of (2,4,5-trichlorophenoxy)acetic acid (2,4,5-T) applied in May controlled honey mesquite but not when applied in the fall. Picloram was ineffective on yucca (*Yucca* sp.) and only slightly toxic to agarito (*Berberis trifoliata* Moric.) and lotebush condalia (*Condalia obtusifolia* (Hook.) Weberb.).

On herbaceous species picloram treatments released fringedleaf paspalum (*Paspalum ciliatifolium* Michx. var. *ciliatifolium*), tumble lovegrass (*Eragrostis sessilispica* Buckl.) and Texas wintergrass (*Stipa leucotricha* Trin. and Rupr.), but reduced hooded windmillgrass (*Chloris cucullata* Bisch.) and buffalograss (*Buchloe dactyloides* (Nutt.) Engelm.). Sixweeks fescue (*Festuca octoflora* Walt. var. *glauca* (Nutt.) Fern.), mat sandbur (*Cenchrus pauciflorus* Benth.) and fringed signalgrass (*Brachiaria ciliatissima* (Buckl.) Chase) were the annual grasses that increased in the picloram plots. Picloram reduced the stand of perennial forbs and the annual rosering gaillardia (*Gaillardia pulchella* Foug.) in fall but not in spring treatments.

Control of Whitebrush And Associated Species

With Herbicides in Texas[1]

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About 6 million acres of whitebrush (*Aloysia lycioides* Cham.), a member of the Verbenaceae family, occur in Texas (7). Of this area about 850 thousand acres are covered with 20 percent or more canopy. Whitebrush occurs largely in the Central Basin and Rio Grande Plain of Texas.

McCully (3) and McCully *et al.*[2] recognized that [(4-chloro-*o*-tolyl)oxy]acetic acid (MCPA) effectively controlled the top growth of whitebrush. Subsequently, a recommended method for controlling whitebrush was developed comprising 1.25 pound per acre of MCPA amine with 1 gallon diesel oil and enough water to make 8 gallons of solution per acre (1). Best results have been obtained with sprays applied either in the spring or fall when the plants are fully leafed and in full bloom. Frequently the top growth is killed, but seldom is a large percentage of plants killed. The living plants then resprout and become reestablished in 2 to 4 years.

This study was conducted primarily in the Central Basin of Texas in an attempt to develop a better chemical method for controlling whitebrush. Various rates and seasons of herbicide applications were compared.

MATERIALS AND METHODS

This study was conducted, for the most part, on upland sandy loam areas near Llano and Marble Falls. These areas had thick stands of whitebrush with scattered plants of honey mesquite (*Prosopis juliflora* var. *glandulosa* (Torr.) Cockerell), Texas persimmon (*Diospyros texana* Scheele), tasajillo cactus (*Opuntia leptocaulis* DC), pricklypear (*Opuntia* sp.), yucca (*Yucca* sp.), agarito (*Berberis trifoliata* Moric.) and lotebush condalia (*Condalia obtusifolia* (Hook.) Weberb.). One experiment was conducted at a brush nursery on a clay loam soil near Bryan.

Treatments were applied with hand sprayers on a truck-mounted, hydraulically controlled spray boom (5). Treatments, applied from July 1963 to May 1967 were replicated from two to four times. Plot size varied from 22 by 200-foot plots treated with the truck-mounted sprayer to individual plants treated with the hand sprayer. Volumes of sprays applied were equivalent to 10 g.p.a. for the truck-mounted sprayer and 20 g.p.a. for the hand sprayer.

Chemicals used included: 3-amino-*s*-triazole (amitrole); ammonium thiocyanate (NH_4SCN); 5-bromo-3-*sec*-butyl-6-methyluracil (bromacil); dimethylamine salt of 3,6-dichloro-*o*-anisic acid (dicamba); 2-ethylhexyl ester of (2,4-dichlorophenoxy)acetic acid (2,4-D); n-butyl

[1]This is a report on the current status of research on whitebrush control practices. It does not contain recommendations for the use of herbicides, nor does it imply that the uses discussed have been registered. All uses of herbicides must be registered by appropriate State and Federal agencies before they can be recommended.

Mention of a trademark name or a proprietary product does not constitute a guarantee or warranty of the product by the USDA and does not imply its approval to the exclusion of other products that may also be suitable.

[2]McCully, W. G., J. A. Tynan, and B. A. Perry. 1952. Reaction of whitebrush to growth-regulator herbicides. Tex. Agric. Expt. Sta. Prog. Rept. 1462. 3 pp.

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esters of 2,4-D and (2,4,5-trichlorophenoxy) acetic acid (2,4,5-T); butoxy ethanol ester of 4-(2,4-dichlorophenoxy)butyric acid (2,4-DB); butoxy ethanol ester of 2-(2,4-dichlorophenoxy)propionic acid (dichlorprop); dimethyl sulfoxide (DMSO); dibromo salt of 6,7-dihydrodipyrido(1,2-*a*:2′,1′*c*)pyrazinediium salt (diquat); copper, iron, manganese, sodium or zinc salts of ethylenediaminetetraacetic acid chelate (Cu, Fe, Mn, Na or Zn chelate); 5-bromo-3-isopropyl-6-methyluracil (isocil); butoxy ethanol ester of [(4-chloro-*o*-tolyl)oxy]acetic acid (MCPA ester); dimethylamine salt of MCPA; butoxy ethanol ester of 4-[(4-chloro-*o*-tolyl)oxy]butyric acid (MCPB); butoxy ethnol ester of 2-[(4-chloro-*o*-tolyl)oxy]propionic acid (mecoprop); dichloride salt of 1,1′-dimethyl-4,4′-bipyridinium salt (paraquat); 2-ethylhexyl ester of 4-amino-3,5,6-trichloropicolinic acid (picloram ester); potassium salt if picloram (picloram); mixture of triisopropanolamine salts of picloram and 2,4-D (picloram + 2,4-D); mixture of 2-ethylhexyl ester of picloram + propylene glycol butyl ether ester of 2,4,5-T (picloram + 2,4,5-T); potassium salt of 2,3,5-trichloro-4-pyridinol (pyriclor); dimethylamine salt of 2,3,6-trichlorobenzoic acid (2,3,6-TBA); 2-ethylhexyl ester of 2,4,5-T (2,4,5-T); butoxy thanol ester of 4-(2,4,5-trichlorophenoxy)butyric acid (2,4,5-TB); and propylene glycolbutyl ether esters of 2-(2,4,5-trichlorophenoxy)propionic acid (silvex).

Evaluations of percent defoliation and percent whitebrush plants killed were made once or more annually. The data presented were taken at least 1 year after treatment, except in one spray experiment where some ratings were made as soon as 5 months after treatment. At least 18 whitebrush plants were rated in each treatment. The other plant species were scattered with only one plant present in some situations for which data are presented The number of plants, however, is presented where data are particularly pertinent.

In July 1968, vegetation was sampled in 10 by 30-foot plots sprayed in spring or fall 1967 with 1 and 2 pounds per acre of the potassium salt of picloram either as a spray or as a 2-percent formulation of picloram granules. Dry weight per acre and percent frequency of occurrence were estimated for individual grasses and forbs in 14 4.8 square foot areas per treatment. Little rain fell in the 2-month period following the spring application, but good rainfall occurred soon after the fall treatment.

Environmental temperature and rainfall data were taken from U.S. Weather Bureau records for College Station for the nursery experiment and at Llano for the Llano and Marble Falls sites.

RESULTS

Effectiveness of 11 Herbicides on Whitebrush

On September 22, 1966, nine phenoxy herbicides, picloram and pyriclor were sprayed at a 1 pound per acre rate on whitebrush at the field nursery at Bryan. Four replications of seven plants were used for each treatment. The plants were about 6 feet tall and 2 years old. They were sprayed with hand sprayers from a tractor at 6 to 9 p.m. This experiment was highly significant for two reasons: (a) It summarizes the relative effectiveness of the various chemicals, and (b) it represents the "ideal" time of herbicide application on whitebrush.

Some chemicals were more toxic to whitebrush than others (Table 1). Picloram killed all the plants. MCPA amine killed 95 percent; MCPB and 2,4-D killed 70 percent; mecoprop killed 55 percent; and 2,4-DB killed 45 percent of the plants. The other herbicides killed 5 percent or less of the plants.

Of our field experiments in the last 6 years, this is the only one in which almost all of the whitebrush plants were killed by MCPA. Picloram was also more toxic at 1 pound per acre than in many other experiments.

Possible important phenological and environmental factors responsible for excellent control include: 1) The plants were uniformly in full leaf (including the large leaves) and full flower; 2) the leaf surfaces were dry at spraying; 3) the sky was clear the day before and after spraying; 4) maximum and minimum air temperatures the day of spraying were 83 and 52° F., respectively; and 5) there was good soil moisture — in fact, the tractor could hardly be maneuvered down the muddy rows during the spraying operation. College Station weather records indicated 5.3 inches of rain in August and 6.5 inches of rain from September 4 to 18, 1966. No recorded rain fell from September 19 to 29.

Picloram and MCPA Sprays

Table 2 shows the percent of whitebrush plants killed by 1 and 2 pound-per-acre rates of picloram and MCPA applied to individual plants with a hand sprayer at Marble Falls. Six replications of three plants each were sprayed 33 times in 1966 and 1967 for each of the four treatments. Foliation at spraying, maximum and minimum

TABLE 1. EFFECTIVENESS OF HERBICIDES APPLIED AT 1 POUND PER ACRE ON WHITEBRUSH GROWN IN A NURSERY; SPRAYED SEPTEMBER 22, 1966 AND RATED AUGUST 29, 1968

Chemical	Percent dead plants	Percent defoliation
MCPA	95	99
Mecoprop	55	87
MCPB	70	94
2,4-D	70	94
Dichlorprop	0	25
2,4-DB	45	84
2,4,5-T	0	48
Silvex	0	43
2,4,5-TB	5	26
Picloram	100	100
Pyriclor	0	10
Untreated	0	10

TABLE 2. PERCENTAGE DEAD WHITEBRUSH PLANTS RESULTING FROM TREATMENTS WITH PICLORAM AND MCPA APPLIED 33 TIMES BETWEEN MARCH 26, 1966, AND FEBRUARY 27, 1968, AND CONDITIONS AT TIME OF SPRAYING[1]

Date sprayed	Chemical				Foliation at spraying	Temperature maximum/ minimum	Rainfall			
	Picloram		MCPA				Before spraying		After spraying	
	1 pound per acre	2 pounds per acre	1 pound per acre	2 pounds per acre			2 weeks	1 week	2 weeks	1 week
	Percent dead plants				Percent	F	Inch			
Mar 26, 1966	94	83	0	11	20	66/44	0	0	0.29	0
Apr 5	100	100	5	17	30	66/41	.20	.09	0	.40
Apr 25	72	100	5	0	50	71/61	0	1.37	2.90	.11
Apr 30	100	100	22	33	50	82/70	.40	4.42	.44	.04
May 14	89	89	22	5	70	79/60	.42	.06	0	.40
Jun 2	28	100	11	11	30	90/66	.07	.65	0	0
Jun 15	39	39	0	0	10	94/67	0	0	.57	0
Jul 6	11	45	0	0	30	93/74	0	0	.04	0
Jul 28	39	94	11	5	50	100/74	0	0	.09	.38
Aug 30	100	94	28	56	50	95/72	.15	1.03	.27	3.49
Sep 14	70	100	5	5	80	92/71	.27	3.49	2.43	0
Sep 27	33	83	17	45	65	93/69	2.43	0	0	0
Oct 13	100	100	22	11	40	93/69	0	0	0	0
Oct 27	89	100	0	5	15	84/40	0	0	0	0
Nov 23	72	100	0	0	13	83/60	0	0	0	0
Dec 12	39	89	0	0	11	47/18	0	.11	0	0
Jan 23, 1967	72	94	0	0	15	70/36	.24	0	.06	.27
Feb 9	72	100	0	0	0	55/25	0	.27	0	.25
Mar 1	50	89	0	0	5	72/29	.25	0	.05	0
Mar 20	73	100	20	20	8	73/59	.05	0	.66	0
Apr 11	50	72	0	0	10	90/62	0	.28	1.49	.59
May 3	55	100	17	11	75	71/57	.59	.86	.02	.14
May 18	44	61	22	17	75	87/54	.02	.14	4.67	0
Jun 15	50	100	5	5	30	95/69	0	0	0	0
Jul 7	72	100	0	6	25	102/74	0	.36	0	.36
Aug 2	55	82	5	11	10	102/75	.36	0	0	1.02
Aug 25	82	100	55	55	20	92/68	.99	.32	0	.31
Sep 11	27	66	0	37	30	93/58	.31	0	1.52	2.09
Oct 11	100	100	50	55	50	81/52	0	1.02	.15	0
Nov 2	100	100	66	37	50	80/40	0	1.13	2.54	0
Dec 18	88	100	0	5	10	70/32	.37	.49	0	.23
Jan 24, 1968	77	100	0	0	0	68/32	0	4.98	.08	.04
Feb 27	82	100	0	0	0	74/42	1.19	.02	.02	.10
Average	67	90	12	14						

[1]Applications made prior to May 3, 1967, were rated in September 1967; subsequent treatments were rated in July 1968.

temperatures the day of spraying and rainfall 1 and 2 weeks before and after spraying are also listed. The results are summarized by month in Figure 1. Applications made March 26, 1966, to April 11, 1967 were rated September 1967. Subsequent applications were rated July 28, 1968. In all cases picloram was more effective than MCPA. In these 2 years 2 pounds per acre picloram was effective at all times; generally, the 1 pound per acre picloram was slightly less effective, particularly in the drier months of June through August. MCPA was more effective in the fall than in May and June. MCPA was least effective in the winter when the whitebrush plants were not foliated.

Picloram was applied at rates of 0.5 to 6 pounds per acre, and MCPA was applied at rates of 1 to 8 pounds per acre. Table 3 summarizes the results of May and September-October treatments of picloram and MCPA applied to whitebrush with the truck-mounted sprayer. All treatments were rated at least 1 year after application.

In all cases equivalent rates of picloram were superior to the same rates of MCPA applied at the same time. Fall picloram treatments were more effective than those applied in May; a 2 pound per acre rate applied in May was less effective than 1 pound per acre applied in the fall. Increasing the rate of picloram generally resulted in

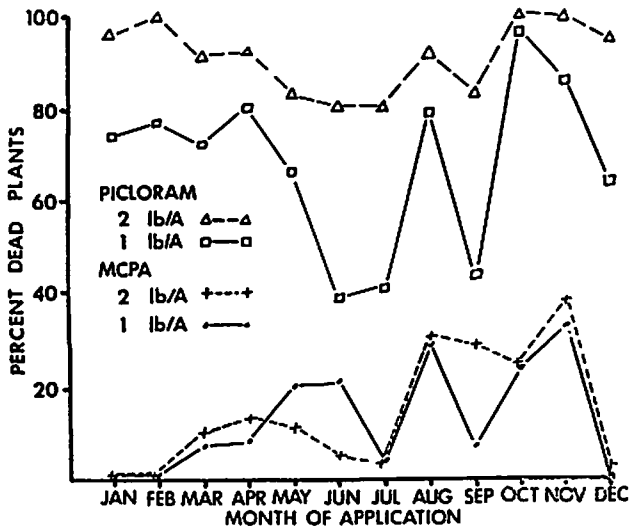


Figure 1. Percent whitebrush killed by 1 and 2-pounds per acre rates of picloram and MCPA applied 33 times during 1966 and 1967, summarized by month of spraying.

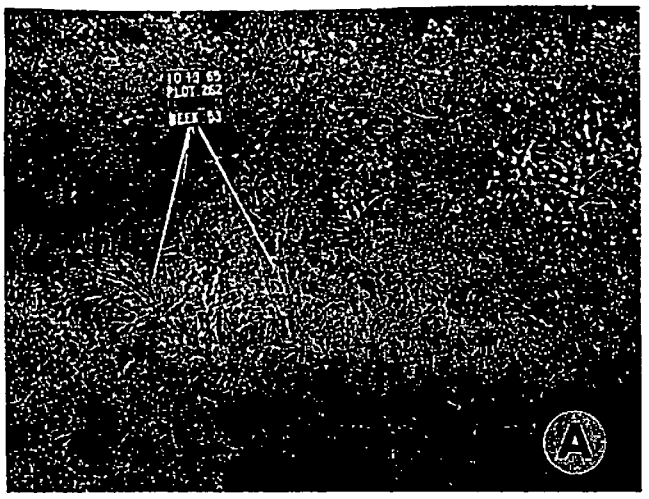
progressively more whitebrush plants being killed. A 2 pound per acre rate usually killed all the whitebrush plants in the fall.

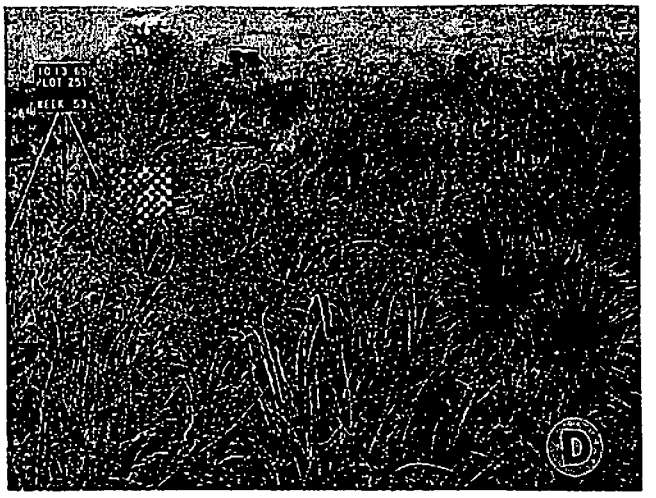
MCPA was less effective than picloram. The percentages of plants killed with MCPA varied markedly; however, rates up to 8 pounds per acre often were not appreciably more toxic to whitebrush than the 1 pound per acre rate. The May 1966 treatments at Marble Falls were less effective than most others, possibly because the herbicide may have been washed from the foliage during a 0.5-inch rain falling within 2 hours after spraying.

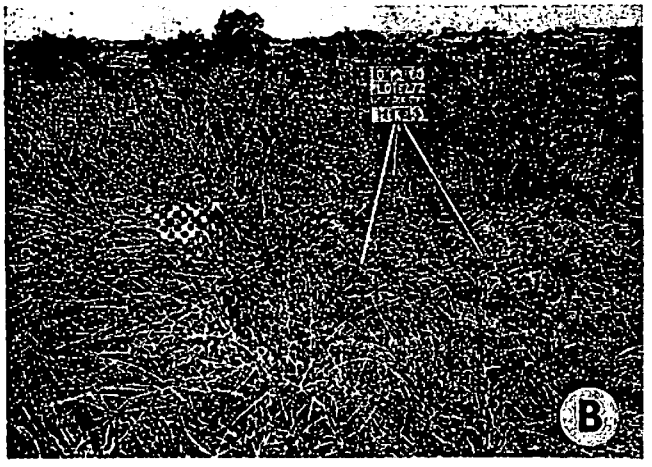
Representative plots 22 by 200 feet treated with picloram or MCPA in October 1964 and with picloram in May 1965 are shown a year after treatment in Figures 2 and 3, respectively. In the 1964 fall treatments (Figure 2), all of the treated whitebrush plants were defoliated, except a few along the road which had been missed by the spray, and a good stand of grass was present. Texas persimmon was not injured appreciably by the 2 pound per acre rate of picloram (Figure 2C), and yucca was not injured by the 4 pound per acre rate (Figure 2D). The 1 pound per acre rate of MCPA killed most of the whitebrush stems but killed only 13 percent of the plants.

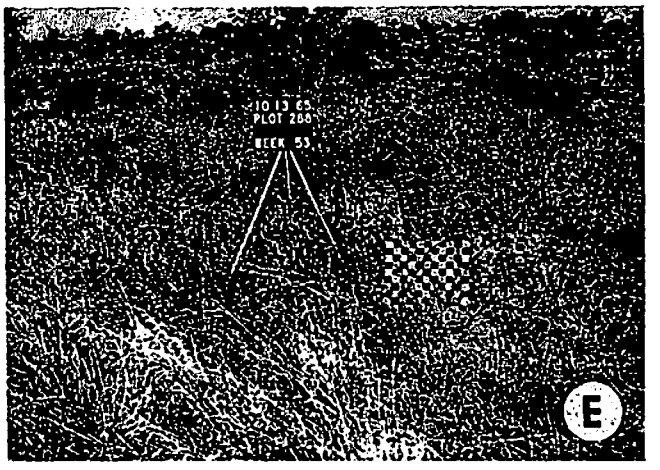
TABLE 3. PERCENT DEFOLIATION AND PERCENT WHITEBRUSH PLANTS KILLED BY PICLORAM AND MCPA APPLIED BY TRUCK SPRAYER, MAY AND SEPTEMBER-OCTOBER, LLANO AND MARBLE FALLS

Year applied Location	Rate, pounds per acre								
	0.5	0.75	1	1.5	2	3	4	6	8
	Percent dead plants/percent defoliation								
					PICLORAM				
					May treatments				
1964 Llano			10/87		45/83		75/98		
1965 Llano	20/85		80/93		85/99	95 99	95/99	100/100	
1966 Llano						100 100		100/100	
1966 Marble Falls	0/36		10/43		80/98	95 99			
1967 Marble Falls	5/76		50/95		70/97				
					September-October treatments				
1963 Llano		37/80		47/75		87 98			
1964 Llano			92/99		100/100	100 100	100/100		
1965 Llano	45/94		90/99	100/100	100/100	100 100	100/100		
1966 Marble Falls	48/93	63/96	90/99	100/100	100/100	100/100			
					MCPA				
					May treatments				
1964 Llano			0/47				20/67		30/86
1965 Llano			25/86		45/90				
1966 Marble Falls			0/32		0/35				
					September-October treatments				
1963 Llano			0/38				0/44		0/40
1964 Llano			13/84		25/83		10/79		
1965 Llano			15/82				0/92		
1966 Marble Falls			0/78						









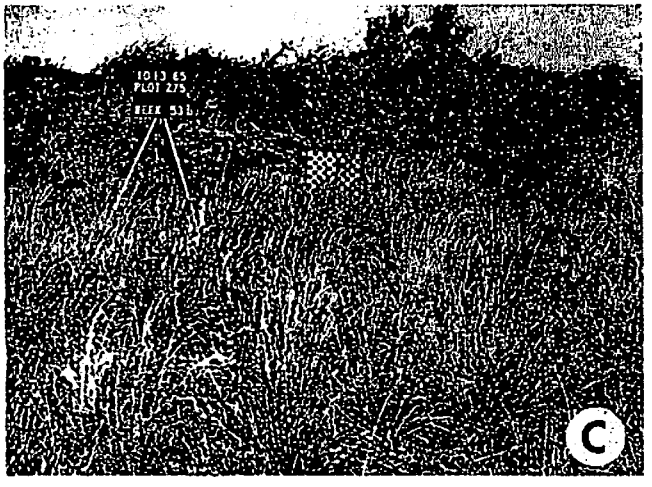


Figure 2. Llano, Texas — whitebrush sprayed October 7, 1964, and photographed October 13, 1965. A. Untreated. B. 1 pound per acre picloram. C. 2 pounds per acre picloram. D. 4 pounds per acre picloram. E. 1 pound per acre MCPA; untreated brush in background.

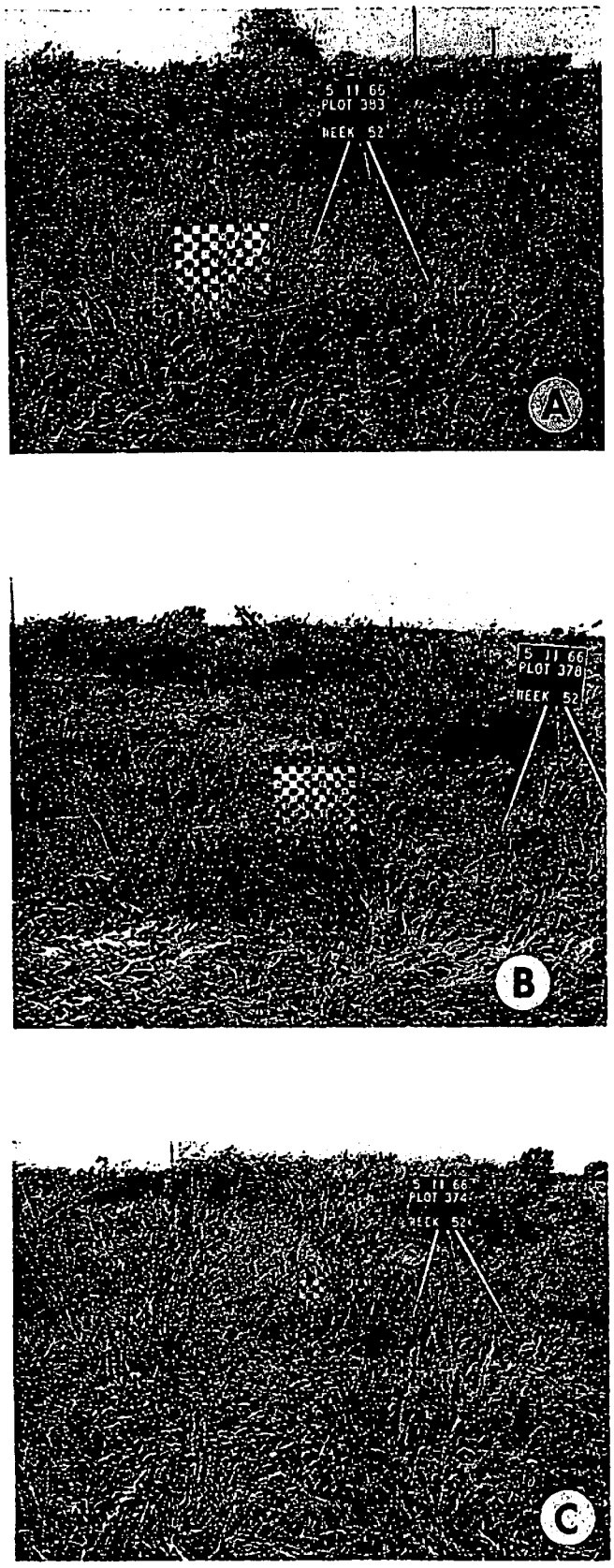


Figure 3. Llano, Texas — whitebrush sprayed May 11, 1965, and photographed May 11, 1966. A. one-half pound per acre picloram center foreground; untreated in left background. B. 1 pound per acre picloram. C. 2 pounds per acre picloram; untreated in background.

The May 1965 treatments (Figure 3) all killed the stems of the whitebrush, but the 0.5, 1, and 2 pounds per acre rates of picloram killed 20, 80 and 85 percent of the plants, respectively. The others had begun re-sprouting from the base of the stem.

Picloram and MCPA Mixtures

Table 4 shows the effects of picloram and MCPA alone and in mixtures on whitebrush at Llano and Marble Falls. The August 1964 treatments were applied by hand sprayer to plots 25 by 65 feet. Treatments at the other dates were applied by the truck-mounted sprayer. Two replications were used.

Significantly, none of the August 5, 1964, treatments killed any whitebrush even at rates up to 4 pounds per acre. At the time of spraying, the whitebrush plants were naturally defoliated, and little other living vegetation was present. The soil was extremely dry, and maximum daily air temperature was about 100° F. Apparently little of either herbicide was intercepted by the whitebrush, and both herbicides were lost before they could be leached into the root zone for root uptake.

The other picloram and MCPA mixtures were applied either in May or in September and October when the whitebrush plants were in full leaf and flower. At these times both herbicides were more active than in August 1964. However, there was no advantage in adding MCPA to picloram rates of 0.5 pound per acre or more. It was hoped that some of the more persistent picloram could be replaced by the addition of a less persistent phenoxy herbicide, but this does not seem feasible with MCPA on whitebrush.

Influence of Adjuvants

Table 5 shows the effectiveness of adding various adjuvants, including ammonium thiocyanate, DMSO, diesel oil and metal chelates to MCPA and in some cases, picloram and 2,4,5-T. The sprays were applied with the truck-mounted sprayer. The percent dead plants and percent defoliation ratings are listed both for the herbicide: adjuvant mixture and for the herbicide treatment alone. The results indicate no beneficial response from adding the adjuvant to the herbicides for whitebrush control.

Herbicides Other Than Picloram and MCPA

The phytotoxicity of nine herbicides other than MCPA and picloram was presented in Table 1. Those excellent results would be expected again on only rare occasions. This section presents results that commonly occurred in the Texas Central Basin area.

TABLE 4. PERCENT WHITEBRUSH PLANTS KILLED AND PERCENT DEFOLIATION BY PICLORAM AND MCPA APPLIED ALONE AND IN MIXTURES AT LLANO AND MARBLE FALLS[1]

MCPA rate, pounds per acre	Picloram rate, pounds per acre					
	0	0.5	1	2	3	4
	Percent dead plants/percent defoliation					
			August 5, 1964			
0	0/46			0/52		0/66
1			0/35			
2	0/46			C/44		
4	0/44					
			October 7, 1964			
0	0/30		92/99	10C/100	100/100	100/100
0.5		5C/85	90/94			
1	13/84	65/87	80/84	95/99	100/100	
2	25/83	35/84	80/88	90/99		
3			85/99			
4	10/79					
			May 11, 1965			
0			0/30	80/93		
1			25/86	70/92		
2			45/90			
			October 12, 1965			
0			0/30	90/99		
1			15/82	95/99		
			September 27, 1966			
0			0/4	90/99		
1			0/78	85/98		

[1]Ratings were made April 28-29, 1968.

TABLE 5. PERCENTAGE DEAD WHITEBRUSH PLANTS/DEFOLIATION RESULTING FROM ADJUVANT ADDITIONS TO MCPA AND PICLORAM[1]

Herbicide	Rate, pounds per acre	Percent dead plants/ percent defoliation		Date applied
		Mixture	Herbicide alone	
MCPA + ammonium thiocyanate	1 + 0.2	17/85	13/84	Oct 7, 1964
MCPA + ammonium thiocyanate	1 + 0.5	20/86	25/86	May 11, 1965
MCPA + DMSO	1 + 1% V[2]	20/82	13/84	Oct 7, 1964
	2 + 1% V[2]	25/83	25/83	Oct 7, 1964
MCPA + Diesel oil	1 + 1 gal	25/83	13/84	Oct 7, 1964
	1 + 1 gal	25/83	25/86	May 11, 1965
	1 + 1 gal	0/78	15/82	Oct 12, 1965
MCPA + ammonium thiocyanate	1 + 2	0/73	0/78	Sep 27, 1966
MCPA + zinc chelate	1 + 2	0/75	0/78	Sep 27, 1966
MCPA + zinc chelate + iron chelate	1 + 1 + 1	0/49	0/78	Sep 27, 1966
MCPA + iron chelate	1 + 1	0/75	0/78	Sep 27, 1966
MCPA + manganese chelate	1 + 1	0/72	0/78	Sep 27, 1966
MCPA + copper chelate	1 + 1	0/52	0/78	Sep 27, 1966
MCPA + sodium chelate	1 + 2	0/74	0/78	Sep 27, 1966
MCPA ester + diesel oil	1 + 1 gal	5/85		Oct. 12, 1965
Picloram + ammonium thiocyanate	1 + 0.5	85/99	80/93	May 11, 1965
Picloram + diesel oil	2 + 1 gal	90/99	85/99	May 11, 1965
	2 + 1 gal	100/100	100/100	Oct 12, 1965
2,4,5-T + ammonium thiocyanate	0.5 + 0.5	0/85	0/85	May 11, 1965

[1]Rated April 28-29, 1968.
[2]V = Volume.

The effects of herbicides other than MCPA and the potassium salt of picloram applied with the truck-mounted sprayer at Llano and Marble Falls are summarized in Table 6. As was shown in Table 1, 2,4-D was more toxic to whitebrush than 2,4,5-T; however, neither herbicide was very effective for killing the plant. A spray of 2,4-D at 1 pound per acre killed 51 percent of the whitebrush top growth. Dicamba applied in July or September was ineffective on whitebrush. Diquat and paraquat desiccated the whitebrush leaves rapidly within a day or two after treatment but killed only the new, green stem tips. The 2,3,6-TBA herbicide had little activity on whitebrush when applied in July 1963.

Bromacil and isocil (Figure 4) particularly at the 10 pound per acre rate, were highly toxic to whitebrush. They hold promise where soil sterilant activity is needed and where cacti are absent. They have little promise for range use because of their high toxicity to grasses and forbs.

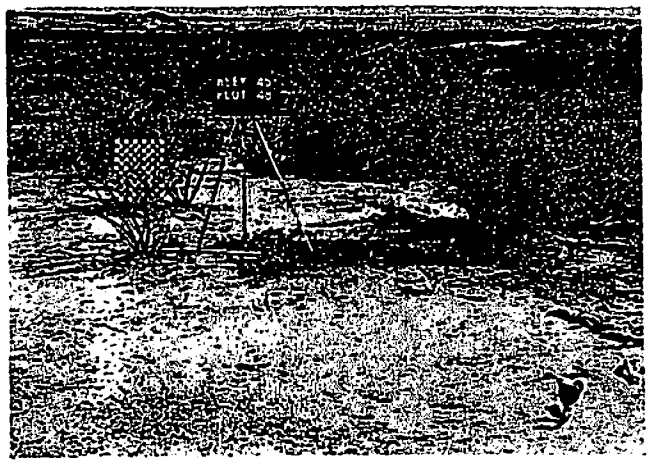


Figure 4. Llano, Texas — whitebrush area treated with 10 pounds per acre of isocil July 30, 1963, and photographed June 8, 1964.

Herbicide Mixtures Other Than Picloram Plus MCPA

Results of truck spraying of herbicide mixtures other than picloram:MCPA mixtures on whitebrush are summarized in Table 7. Ratings for the first chemical applied alone at the same rate as in the mixture are also included. The mixtures of 2,4-D + 2,4,5-T killed a low percentage of whitebrush plants except at the rate of 24 + 24 pounds per acre in May 1966. Probably this was due to the 2,4-D. In the one comparison, 2,4-D alone at 2 pounds per acre killed more whitebrush than the same amount plus 2 pounds per acre of 2,4,5-T.

TABLE 6. PERCENT DEAD WHITEBRUSH PLANTS AND PERCENT DEFOLIATION RESULTING FROM HERBICIDES OTHER THAN MCPA AND PICLORAM AT LLANO AND MARBLE FALLS

Chemical	Rate, pounds per acre	Percent dead plants/ percent defoliation	Date applied
2,4-D	8	0/49	Sep 30, 1963
	1	0/51	May 11, 1964
	4	0/42	May 11, 1964
	8	0/47	May 11, 1964
	2	30/83	Oct 7, 1964
2,4,5-T	4	0/12	Jul 30, 1963
	8	0/10	Jul 30, 1963
	12	0/27	Jul 30, 1963
	8	0/20	Sep 30, 1963
	1	10/58	May 11, 1964
	4	0/44	May 11, 1964
	8	0/54	May 11, 1964
2,4,5-T + diesel oil	0.5 + 1 gal	0/85	May 11, 1965
Dicamba	4	0/0	Jul 30, 1963
	8	0/7	Jul 30, 1963
	12	0/43	Jul 30, 1963
	8	7/67	Sep 30, 1963
Diquat	8	3/19	Sep 30, 1963
Paraquat	4	0/37	May 11, 1964
	3	0/27	May 20, 1966 (Llano)
	6	0/29	May 20, 1966
Bromacil	2.5	0/15	Jul 30, 1963
	5	14/45	Jul 30, 1963
	10	77/96	Jul 30, 1963
	5	5/41	May 11, 1964
Isocil	2.5	0/15	Jul 30, 1963
	5	47/87	Jul 30, 1963
	10	100/100	Jul 30, 1963
2,3,6-TBA	4	0/0	Jul 30, 1963
	8	4/18	Jul 30, 1963
	12	4/49	Jul 30, 1963

Mixtures of picloram + 2,4,5-T were not consistently more effective than the same amount of picloram alone on whitebrush in the four comparisons of the potassium salt formulation. In the other comparisons, the picloram ester + 2,4,5-T ester mixtures were markedly less active than the picloram salt alone.

Picloram + 2,4,5-T + silvex mixtures were variable. The low rate may have been more toxic to whitebrush than the 0.5 pound per acre rate of picloram alone. The reverse was true, however, at the high rate. This mixture has promise where whitebrush, honey mesquite and yucca occur in the same area. The 2,4,5-T and silvex would be expected to enhance the control of the latter two species respectively.

Dicamba may have enhanced picloram activity slightly, but amitrol had no effect. Adding 2,4,5-T affected MCPA activity little. Adding dicamba to MCPA was of no benefit.

Addition of paraquat caused various whitebrush responses to MCPA, 2,4,5-T and picloram. Paraquat reduced MCPA activity, probably by injuring the leaves before maximum MCPA uptake and translocation could

be accomplished. The paraquat effect on 2,4,5-T was not clear because of the low 2,4,5-T activity. Paraquat had little effect on picloram activity probably because picloram at 2 pounds per acre is highly active through the soil and, consequently, toxic even though the foliar activity might have been limited.

The addition of 2,4-D to picloram increased activity over picloram alone in the one direct comparison on May 1967. In May 1964, the addition of 3.2 pounds per acre of 2,4-D increased the activity over that of picloram alone (the 0.8 pound per acre rate in the mixture is compared with 1.0 pound per acre). In October 1964, the mixture

TABLE 7. PERCENT DEAD WHITEBRUSH PLANTS AND PERCENT DEFOLIATION RESULTING FROM HERBICIDE MIXTURES OTHER THAN MCPA + PICLORAM, LLANO AND MARBLE FALLS

Chemicals	Rate, pounds per acre	Percent dead plants/ percent defoliation	Date applied
2,4-D + 2,4,5-T	2 + 2	0/19	Jul 30, 1963
2,4-D + 2,4,5-T	4 + 4	0/28	Jul 30, 1963
2,4-D + 2,4,5-T	6 + 6	0/25	Jul 30, 1963
2,4-D + 2,4,5-T	2 + 2	5/81	Oct 7, 1964
2,4-D	2	30/83	Oct 7, 1964
2,4-D + 2,4,5-T	4 + 4	10/86	May 11, 1965
2,4-D + 2,4,5-T	4 + 4	0/43	Aug 5, 1964
2,4-D + 2,4,5-T	6 + 6	5/52	May 20, 1966 (Llano)
2,4-D + 2,4,5-T	12 + 12	25/71	May 20, 1966
2,4-D + 2,4,5-T	24 + 24	65/90	May 20, 1966
Picloram + 2,4,5-T	2 + 0.5	95/99	May 11, 1965
Picloram	2	85/99	May 11, 1965
Picloram + 2,4,5-T	1.5E[1] + 6	30/83	May 20, 1966 (Llano)
Picloram + 2,4,5-T	3E[1] + 12	35/84	May 20, 1966
Picloram	3	100/100	May 20, 1966
Picloram + 2,4,5-T	6E[1] + 24	45/83	May 20, 1966
Picloram	6	100/100	May 20, 1966
Picloram + 2,4,5-T	0.5 + 0.5	20/92	May 3, 1967
Picloram	0.5	5/76	May 3, 1967
Picloram + 2,4,5-T	0.75 + 0.75	25/92	May 3, 1967
Picloram	0.75	50/95	May 3, 1967
Picloram + 2,4,5-T	1 + 1	40/94	May 3, 1967
Picloram	1	70/97	May 3, 1967
Picloram + 2,4,5-T + silvex	0.5 + 0.25 + 0.25	25/92	May 3, 1967
Picloram	0.5	5/76	May 3, 1967
Picloram + 2,4,5-T + silvex	1 + 0.5 + 0.5	55/94	May 3, 1967
Picloram	1	70/97	May 3, 1967
Picloram + dicamba	1 + 1	90/99	May 11, 1965
Picloram	1	80/93	May 11, 1965
Picloram + amitrole	1 + 2	80/94	May 11, 1965
MCPA + 2,4,5-T	1 + 0.5	20/83	Oct 7, 1964
MCPA	1	13/84	Oct 7, 1964
MCPA + 2,4,5-T + diesel oil	1 + 0.5 + 1 gal	15/85	May 11, 1965
MCPA	1	25/86	May 11, 1965
MCPA + dicamba	1 + 1	20/82	May 11, 1965
MCPA + paraquat	4 + 4	0/35	May 11, 1964
MCPA	4	20/67	May 11, 1964
2,4,5-T + paraquat	4 + 4	0/43	May 11, 1964
2,4,5-T	4	0/44	May 11, 1964
Picloram + paraquat	2 + 4	40/90	May 11, 1964
Picloram	2	45/83	May 11, 1964
Diquat + bromacil	4 + 5	37/53	Sep 30, 1963
Picloram + 2,4-D	0.14 + 0.8	0/37	Sep 30, 1963
Picloram + 2,4-D	0.29 + 1.6	10/56	Sep 30, 1963
Picloram + 2,4-D	0.58 + 3.2	33/62	Sep 30, 1963
Picloram + 2,4-D	0.8 + 3.2	25/91	May 11, 1964
Picloram	1[2]	10/87	May 11, 1964
Picloram + 2,4-D	0.5 + 2.0	70/87	Oct 7, 1964
Picloram	1[2]	92/99	Oct 7, 1964
Picloram + 2,4-D	0.5 + 1	30/92	May 3, 1967
Picloram	0.5	5/76	May 3, 1967

[1]Some comparable rates of individual chemicals were added for comparison. E = isooctyl ester of picloram; unmarked picloram = potassium salt formulation.

[2]1 pound per acre picloram — the closest comparable treatment at this date.

was less effective than 1 pound per acre of picloram; unfortunately, no 0.5 pound per acre picloram application was included in the treatment. A mixture of 0.5 + 0.5 pound per acre of picloram and MCPA at this date (Table 4) killed 50 percent of the plants; consequently, it does not seem reasonable to believe there was very much enhancement of activity by 2,4-D in the 2,4-D + picloram mixture.

Herbicides on Plants Other Than Whitebrush

A number of other woody plants occurred on the whitebrush areas in the Central Basin. Often only a few plants were sprayed in any one treatment. Generally, however, a fairly good response could be determined from the summary of results over several years. Results are summarized for honey mesquite, tasajillo cactus, pricklypear cactus and Texas persimmon. Observations and results from a small experiment on the response of herbaceous grasses and forbs to herbicides are also included.

May treatments of picloram at 1 pound per acre or more and of 2,4,5-T applied with the truck sprayer were highly effective on honey mesquite (Table 8). These results, compared with those from other research (2), are higher than expected. Generally, however, there may have been better hericide coverage on these small isolated plants than on dense stands of mesquite. None of the fall treatments of any herbicide were effective on mesquite other than to kill the stem tips.

The cactus species were highly sensitive to picloram (Table 8). Picloram at 0.5 pound per acre killed most tasajillo while rates of 0.75 pound per acre and above consistently killed all the tasajillo in May or September-October. Picloram at rates of 1 pound per acre and above killed pricklypear. Several months elapsed before the plants died.

The following number of Texas persimmon plants killed/number rated occurred in plots of picloram applied in May and September-October: 0.5 pound per acre — 0/22; 1 pound per acre — 1/52; 2 pounds per acre — 1/29; 3 pounds per acre — 17/33 and 4 pounds per acre — 4/6. Thus, a 3 pound per acre rate or higher was required to kill a substantial number of Texas persimmon plants. None of the three phenoxy herbicides at rates up to 8 pounds per acre killed any Texas persimmon plants in these broadcast treatments.

Picloram was ineffective on yucca and only slightly toxic to agarito and lotebush condalia. The scattered live oak (*Quercus virginiana* Mill.) were injured but not killed by picloram at rates up to 2 pounds per acre; this is an advantage where oaks are desired for shade and as a source of acorns for wildlife food.

Table 9 shows the response of herbicide mixtures other than picloram + MCPA on honey mesquite, tasajillo, pricklypear and Texas persimmon applied with the truck sprayer. All treatments containing either picloram or 2,4,5-T were toxic to honey mesquite in the May treatments. None of the herbicides were very toxic to honey mesquite in the fall. All treatments containing picloram were toxic to tasajillo; only the 24 + 24 pound per acre rate of 2,4-D + 2,4,5-T was highly toxic to tasajillo. Here the 2,4,5-T was probably the principal toxic agent. All treatments containing 1 pound per acre or more of picloram killed

TABLE 8. INFLUENCE OF PICLORAM; 2,4,5-T; 2,4-D; AND MCPA ON HONEY MESQUITE, TASAJILLO, PRICKLYPEAR AND TEXAS PERSIMMON[1]

Chemical	Rate, pounds per acre	Species: Honey mesquite, May, Percent defoliation	Species: Honey mesquite, Sep-Oct, Percent defoliation	Species: Tasajillo, Percent stem injury	Species: Pricklypear, Percent stem injury	Species: Texas persimmon, Percent defoliation
Picloram	0.5	32	10	97	55	17
	0.75		7	100	35	10
	1	95	8	100	100	21
	1.5		10	100		14
	2	100	25	100	100	15
	3	100	10	100	100	65
	4	100	10	100		74
	6			100	100	100
2,4,5-T	0.5	97		0	0	10
	1			5		10
	4	100		30		20
	8		10	0	0	35
2,4-D	1			10	0	0
	2	30	10		2	10
	4			5		20
	8		10	5		8
MCPA	1	10	11	4	5	8
	4		10	3	0	10
	8			0	0	10

[1]An average of May and September-October applications, 1963-67.

TABLE 9. CONTROL OF HONEY MESQUITE, TASAJILLO, PRICKLYPEAR AND TEXAS PERSIMMON BY HERBICIDE MIXTURES, MAY AND SEPTEMBER-OCTOBER TREATMENTS

Chemical	Rate, pounds per acre[1]	Species				
		Honey mesquite		Tasajillo	Pricklypear	Texas persimmon
		May	September-October			
		Percent defoliation		Percent stem injury	Percent stem injury	Percent defoliation
Picloram + 2,4,5-T	0.5 + 0.5	82		100	0	10
	0.75 + .75	100		100	30	10
	1 + 1	100				10
	1.5E + 6			100	100	35
	2 + 0.5	99		100	100	
	3E + 12	70		100	100	80
	6E + 24			100	100	85
Picloram + MCPA	0.5 + 0.5		33	100		45
	0.5 + 1		10	83		20
	0.5 + 2		12	92		10
	1 + 0.5		10	100		38
	1 + 1		25	100	100	20
	1 + 2		10	100		10
	1 + 3			100		27
	2 + 1		20	100		8
	2 + 2		20	100		15
Picloram + MCPA	1 + 3		15	100		27
2,4,5-T + 2,4,-D	2 + 2		10	3		10
	6 + 6	80		15	10	30
	12 + 12	98		55		40
	24 + 24	77		100		10
MCPA + 2,4,5-T	1 + 0.5	94	10	3	5	16
Picloram + 2,4-D	0.5 + 2		35	100		10
MCPA + dicamba	1 + 1	10		8		10

[1]E = isooctyl ester of picloram; unmarked picloram = the potassium salt formulation.

the pricklypear. No Texas persimmon plants were killed by these mixtures; only three plants occurred in the highest two rates of picloram + 2,4,5-T esters applied May 20, 1966, at Llano.

The response of herbaceous plants to herbicides was not followed in great detail. One picloram experiment was sampled; observations were made on the other plots. Picloram was applied March 20, 1967, and September 10, 1967, by hand sprayer to areas 10 by 30 feet. Picloram was applied as a spray at 2 pounds per acre in March and as both granules and sprays at 1 and 2 pounds per acre in the fall. The vegetation analysis was made in July 1968. Untreated areas were included for both the 1 and 2 pound per acre treatments.

The estimated dry weights of individual species are arranged in order of decreasing weight found in the untreated plots of the 1 pound per acre treatment (Table 10). The plants are listed in five groups: perennial grasses, annual grasses, perennial forbs, annual forbs and other plants (rushes and sedges). Because the results are highly variable, only trends seem to be significant.

The total weight of the perennial grasses was greater in all herbicide treated plots than in the untreated plots. The greatest increase occurred in the plots sprayed in the fall, and the smallest increase occurred in the plots sprayed in the spring. The spring 2 pound per acre treatment had slightly more perennial grass than the corresponding untreated area, probably because of competition from the forbs. The following perennial grasses increased in the treated areas: fringeleaf paspalum (*Paspalum ciliatifolium* Michx. var. *ciliatifolium*), tumble lovegrass (*Eragrostis sessilispica* Buckl.) and Texas wintergrass (*Stipa leucotricha* Trin. and Rupr.) except in the 2 pound per acre spring treatment. Hooded windmillgrass (*Chloris cucullata* Bisch.) and buffalograss (*Buchloe dactyloides* (Nutt.) Engelm.) decreased. The others were too variable to judge.

Observations in other treatments indicate that the hooded windmillgrass and buffalograss decreased in the picloram treatments. The Arizona cottontop (*Trichachne californica* (Benth.) Chase) stand was too uneven to afford a valid judgment. Arizona cottontop generally increases markedly on sites where it is present at time of treatment of picloram applied at rates at least up to 4 pounds per acre. Vine mesquite (*Panicum obtusum* H.B.K.) also spreads rapidly in picloram treated areas where it is present at time of treatment. Established sideoats grama also tolerates picloram up to 4 pounds per acre.

Most of the perennial grass increase occurs as enlargement of the established plants during the first year. Changes in seedling establishment of these important perennial species were not studied.

TABLE 10. WEIGHT OF HERBACEOUS VEGETATION (ESTIMATED POUNDS PER ACRE DRY WEIGHT), LLANO, JULY 1968, AS INFLUENCED BY 1967 SPRING AND FALL APPLICATIONS OF PICLORAM

Species		Fall 1967					Spring 1967
Common name	Scientific name	Untreated	Granule 1 pound per acre	Spray 1 pound per acre	Granule, 2 pounds per acre	Spray, 2 pounds per acre	Spray, 2 pounds
		Perennial Grasses					
Hooded windmill-grass	*Chloris cucullata* Bisch.	222	122	146	119	48	89
Purple threeawn	*Aristida purpurea* Nutt.	123	59	264	121	221	104
Fringeleaf paspalum	*Paspalum ciliatifolium* Michx. var. *ciliatifolium*	118	168	166	198	128	342
Buffalograss	*Buchloe dactyloides* (Nutt.) Engelm.	115	67	36	74	56	0
Arizona cottontop	*Trichachne californica* (Benth.) Chase	55	36	93	2	18	5
Tumble lovegrass	*Eragrostis sessilispica* Buckl.	49	180	201	143	160	104
Vine-mesquite	*Panicum obtusum* H.B.K.	13	16	0	66	104	0
Texas wintergrass	*Stipa leucotricha* Trin. and Rupr.	8	140	87	90	16	0
Texas grama	*Bouteloua rigidiseta* (Steud.) Hitchc.	4	11	4	0	10	0
Sideoats grama	*Boutelous curtipendula* (Michx.) Torr.	0	0	0	5	0	120
	Total perennial grasses	707	799	997	817	861	764
		Annual Grasses					
Rescuegrass	*Bromus willdenowii* (Kunth.)	40	30	23	40	22	37
Sixweeks fescue	*Festuca octoflora* Walt. var. *glauca* (Nutt.) Fern.	37	96	77	79	90	50
Mat sandbur	*Cenchrus pauciflorus* Benth.	33	76	267	128	277	84
Fringed signalgrass	*Brachiaria ciliatissima* (Buckl.) Chase	10	130	49	150	193	30
Miscellaneous annual grasses		12	0	0	0	13	3
	Total annual grasses	132	332	416	397	595	204
	Total grasses	839	1131	1413	1214	1456	968
		Perennial Forbs					
Upright prairie-coneflower	*Ratibia columnaris* (Sims) D. Don	285	0	0	22	0	26
Field ragweed	*Ambrosia confertiflora* D.C.	162	1	1	1	0	38
Greenthread	*Thelesperma* sp.	18	0	0	0	0	0
Slender vervain	*Verbena halei* Small	12	10	1	5	3	28
Carolina horsenettle	*Solanum carolinese* L.	10	0	0	2	0	0
	Total perennial forbs	487	11	2	30	3	92
		Annual Forbs					
Rosering gaillardia	*Gaillardia pulchella* Foug.	175	33	0	54	0	228
Texas croton	*Croton texensis* (Klotzch) Muell. Arg.	26	63	67	31	53	32
Wooly plantain	*Plantago purshii* var. *purshii* (Roem and Schult.)	15	0	1	3	4	26
Yellow woodsorrel	*Oxalis dillenii* var. *dillenii* Jacq.	10	10	5	17	4	14
Prairie pepperweed	*Lepidium densiflorum* Schrad.	1	12	12	20	2	27
Miscellaneous annual forbes		16	3	4	8	0	77
	Total annual forbs	243	121	89	134	63	404
	Grand total forbs	730	132	91	164	66	496
		Other Plants					
Rushes	*Juncus* sp.	0	1	3	15	27	37
Sedges	(Cyperaceae)	3	5	8	10	32	3
	Total rushes and sedges	3	6	11	25	59	40
	Grand total vegetation	1572	1269	1515	1403	1581	1504

Annual grasses (Table 10) increased in all picloram treatments. Sixweeks fescue (*Festuca octoflora* Walt. var. *glauca* (Nutt.) Fern.), mat sandbur (*Cenchrus pauciflorus* Benth.), and fringed signalgrass (*Brachiaria ciliatissima* (Buckl.) Chase) increased markedly in the fall treatments. The rescuegrass (*Bromus willdenowii* Kunth.) response was not clear. At time of analysis the rescuegrass was hard to find, whereas in May it had been prolific on the general area. These results show that annual grasses rapidly reinvade picloram treated areas.

Observations on other plots at the same experimental sites indicate that annual grasses begin reinfesting the area within a month during periods of good rainfall even where the 4 pound per acre rate of picloram has been applied. Perhaps the plants are tolerant to the herbicide, but more likely they germinate in herbicide-free soil after the herbicide has been leached deeper into the soil profile.

The total weight of grasses, including both the perennials and annuals, increased in all treated plots, with the biggest increases occurring in the fall sprayed plots (Table 10).

Five perennial forbs were found on the area (Table 10). All decreased on the picloram treated plots except slender verbena (*Verbena halei* Small) in the spring treatment. Most of the untreated area was heavily infested with upright prairie-coneflower (*Ratibia columnaris* (Sims) D. Don) and field ragweed (*Ambrosia confertiflora* D.C.); these were conspicuously reduced in the treated plots. The control of these two species was less marked in the spring treatments than in fall treatments.

The total weight of annual forbs also was reduced markedly in the fall treatments, particularly on the sprayed areas compared with the untreated areas (Table 10). Annual forbs were abundant, however, in the spring treated plots. The reduction in the fall occurred largely as a result of the control of rosering gaillardia (*Gaillardia pulchella* Foug.). Texas croton (*Croton texensis* (Klotzch) Muell. Arg.) and prairie pepperweed (*Lepidium densiflorum* Schrad.) seemed to increase slightly in the treated plots. The rosering gaillardia was probably controlled early by the fall treatment when the plant was small. The Texas croton probably germinated early in the summer when the herbicide residue was much less.

The weights of the rush (*Juncus* sp.) and sedge (*Cyperaceae*) species may have increased slightly in the treated plots, but the infestations were not sufficient to support definite conclusions.

The total estimated dry weight of all species (Table 10) varied from 1,581 to 1,269 pounds per acre. Surprisingly, this total weight of vegetation is somewhat constant suggesting that some other factor such as lack of moisture was limiting growth. The increase in grass production in the treated areas was concurrent with the decrease in forb production.

Table 11 presents the percent occurrence (frequency) of the same herbaceous species in the 14 4.8 square foot quadrats. In general, the trends of frequency data and weight data were similar.

DISCUSSION

Picloram is a promising chemical for controlling whitebrush. The percentage of plants killed seems to be determined by the environment, stage of plant growth and rate of chemical used. Generally, the best time to apply picloram is either in April-May or September-October when the plants are in full leaf and full flower. Good soil moisture at spraying time is beneficial. Herbicide penetration into the leaves seems to require at least 1 day; a rain during this period, particularly within 2 hours, reduces the overall effectiveness probably by washing the chemical off the foliage. Subsequently, good rains are beneficial for leaching picloram into the root zone. Picloram activity was particularly reduced when the whitebrush plants were naturally defoliated during hot, dry periods; subsequent rains failed to leach toxic quantities of picloram into the root zone, even when rates as high as 4 pounds per acre were applied. A large part of the picloram was probably broken down by the light (4). Sprays of picloram applied in the winter were more effective than those applied in warm, dry periods in the summer. This indicates the plants were killed by root uptake even though the plants were naturally defoliated. Meyer and Riley (6) also found that picloram granules effectively controlled whitebrush, particularly when applied during the cooler months of the year. Granules, however, were less effective than sprays.

The rate of picloram chosen for application depends on the degree of control desired, the cost of the chemical and the desired effect on other species. The lowest, average and highest percentages of whitebrush plants killed — lowest)average(highest — for the various truck sprays of picloram in the May and September-October treatments are: 0.5 pound per acre — 0)24(48; 0.75 pound per acre — 37)50(63; 1 pound per acre — 10)63(92; 1.5 pound per acre — 47)73(100; 2 pounds per acre — 45)85(100; 3 pounds per acre — 87)98(100; 4 pounds per acre — 75)92(100; 6 pounds per acre — 100). The repeated sprays by hand boom at Marble Falls killed an average of 67 and 90 percent of the whitebrush plants at 1 and 2 pound per acre rates, respectively. The 1 pound per acre picloram treatment usually killed 80 percent or more of the whitebrush plants when applied other than during a hot, dry summer period and seemed to be the most efficient overall treatment. Higher rates of picloram insured killing a high percentage of whitebrush plants except in hot, dry periods but generally caused unnecessary injury to grass.

MCPA was the most effective of the chlorinated phenoxy herbicides tried; however, it seldom killed more than 25 percent of the whitebrush plants even at rates as high as 8 pounds per acre at Llano and Marble Falls. In only one instance in the field nursery, when the whitebrush plants were in full leaf and flower with good soil moisture and reasonably cool temperatures, did 1 pound per acre of MCPA kill almost all the plants. MCPA, in other studies at the nursery not reported in this paper, killed a low percentage of whitebrush plants; therefore, neither soil type nor location seemed to be critically important. No MCPA treatment killed more than 45 percent of the whitebrush plants either at Llano or at Marble Falls. However, when fully foliated, most whitebrush stems were killed by MCPA; some grass increase was observed also.

Mixing picloram with phenoxy herbicides or other adjuvants did not increase whitebrush control. The advantage of mixtures, except for honey mesquite[3], seems to be in broadening the spectrum of activity on other species in a mixed brush stand.

[3]Robison, E. D. 1967. Response of mesquite to 2,4,5-T, picloram and 2,4,5-T/picloram combinations (Abstract). Proc. Southern Weed Conference. p. 199.

TABLE 11. FREQUENCY OF OCCURRENCE OF HERBACEOUS VEGETATION IN 4.8 SQUARE FOOT QUADRATS AS INFLUENCED BY 1967 SPRING AND FALL APPLICATIONS OF PICLORAM, LLANO, JULY 1968

Species		Fall					Spring
Common name	Scientific name	Untreated	Granule, 1 pound per acre	Spray 1 pound per acre	Granule, 2 pounds per acre	Spray, 2 pounds per acre	Spray, 2 pounds per acre
		Perennial Grasses					
Hooded windmillgrass	*Chloris cucullata* Bisch.	90	81	90	67	38	86
Purple threeawn	*Aristida purpurea* Nutt.	80	30	85	85	95	80
Fringeleaf paspalum	*Paspalum ciliatifolium* Michx. var. *ciliatifolium*	55	67	76	76	76	100
Buffalograss	*Buchloe dactyloides* (Nutt.) Engelm.	42	43	38	33	29	0
Arizona cottontop	*Trichachne californica* (Benth.) Chase	31	19	19	5	5	5
Tumble lovegrass	*Eragrostis sessilispica* Buckl.	19	43	62	43	43	29
Vine-mesquite	*Panicum obtusum* H.B.K.	12	10	0	14	33	0
Texas wintergrass	*Stipa leucotricha* Trin. and Rupr.	7	24	29	33	14	0
Texas grama	*Bouteloua rigidiseta* (Steud.) Hitchc.	5	5	5	0	19	0
Sideoats grama	*Boutelous curtipendula* (Michx.) Torr.	0	0	0	5	0	14
		Annual Grasses					
Sixweeks fescue	*Festuca octoflora* Walt. var. *glauca* (Nutt.) Fern.	74	100	90	86	71	100
Rescuegrass	*Bromus willendowii* (Kunth.)	55	52	33	52	24	48
Mat sandbur	*Cenchrus pauciflorus* Benth.	43	62	86	62	95	57
Fringed signalgrass	*Brachiaria ciliatissima* (Buckl.) Chase	7	52	24	52	33	19
		Perennial Forbs					
Field ragweed	*Ambrosia confertiflora* D.C.	88	10	10	0	5	14
Upright prairieconeflower	*Ratibia columnaris* (Sims) D. Don	60	67	67	43	71	100
Slender vervain	*Verbena halei* Small	31	33	10	14	5	72
Carolina horsenettle	*Solanum carolinese* L.	17	0	0	5	0	0
		Annual forbs					
Rosering gaillardia	*Gaillardia pulchella* Foug.	67	5	0	5	0	100
Texas croton	*Croton texensis* (Klotzch) Muell. Arg.	60	67	67	43	71	100
Yellow woodsorrel	*Oxalis dillenii* var. *dillenii* Jacq.	55	48	29	57	29	72
Woolly plantain	*Plantago purshii* var. *purshii* (Roem and Schult.)	24	0	5	5	5	52
Prairie pepperweed	*Lepidium densiflorum* Schrad.	5	24	10	38	5	62
		Other plants					
Rushes	*Juncus* sp.	0	5	10	29	19	33
Sedges	(Cyperaceae)	10	14	29	19	57	14

Honey mesquite plants were killed by applications of 2,4,5-T and picloram in May but not in the fall. Therefore, only spring treatments can be applied to control both whitebrush and mesquite with one spray. The recommended 0.5 pound per acre 2,4,5-T spring treatment (2) gave the expected good control of mesquite stems and killed 20 to 30 percent of the plants. The 1 and 2 pound per acre picloram treatments also were effective only in May. The 0.25 + 0.25 pound per acre 2,4,5-T + picloram mixture as reported by Robison[3] may be the most efficient treatment for honey mesquite; however, more picloram will be needed to control other brush species.

Picloram effectively controlled both tasajillo and pricklypear cactus when applied either in May or September and October at rates of 0.5 and 1 pound per acre, respectively. Phenoxy herbicides were less toxic to cactus than picloram; 2,4,5-T was most effective, followed by 2,4-D and MCPA, respectively.

Broadcast picloram sprays were not promising for controlling yucca, agarito, lotebush condalia or Texas persimmon. May treatments of picloram at rates of 3 to 6 pounds per acre killed some or most Texas persimmon but also unduly injured the grass. Picloram as an individual plant treatment on Texas persimmon, however, may be useful.

Picloram does affect grass forage production and will probably require a longer deferment period than the phenoxys for range improvement. Perennial grasses such as Arizona cottontop, fringeleaf paspalum, sideoats grama, Texas wintergrass and tumble lovegrass readily come back, while hooded windmillgrass and buffalograss are injured. Annual grasses such as fringed signalgrass, mat sandbur and sixweeks fescue rapidly invade the area presumably after the picloram has been leached below the root zone.

Picloram controlled most forbs. The fall applications containing 0.5 pound per acre or more of picloram in 1964 killed the germinating winter weeds, allowing the established grasses to utilize the winter and spring moisture for growth; 2,4-D and MCPA did not have sufficient residual activity to control these weeds.

Picloram has not been registered for use on grazing lands, September 1969.

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