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Control of Yaupon and Associated Species[1]

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Abstract. Early spring spray applications of the potassium salt of 4-amino-3,5,6-trichloropicolinic acid (picloram) and certain formulations of 1:1 mixtures of picloram plus (2,4,5-trichlorophenoxy)acetic acid (2,4,5-T) controlled yaupon (*Ilex vomitoria* Ait.). Ester formulations of picloram or picloram plus 2,4,5-T were ineffective. Combinations of surfactant and oil: water carriers usually did not improve herbicide performance over water carriers. Granular picloram was superior to sprays when applied as soil treatments at equal rates and controlled yaupon at most dates of application. Post oak (*Quercus stellata* Wangenh.) and blackjack oak (*Quercus marilandica* Muenchh.) were controlled more effectively by picloram or picloram plus 2,4,5-T sprays on the foliage than by granular picloram as a soil treatment. Picloram granules usually killed winged elm (*Ulmus alata* Michx.) regardless of date of application.

INTRODUCTION

YAUPON is an evergreen shrub that occurs throughout the southeastern United States. It affords some browse for deer and cattle but is considered a weed on approximately 1.1 million hectares of pasture and rangeland in the piney woods and post oak savannahs of Texas (11).

The dominant oak overstory can be controlled with 2,4,5-T but yaupon increases following oak removal. Lehman and Davis (10) controlled yaupon with repeated sprays of 2,4,5-T but they found picloram more effective than 2,4,5-T. Early spring treatments (April) were most effective.

We studied various herbicides, mixtures, and formulations for control of yaupon and associated species of post oak, blackjack oak, and winged elm.

MATERIALS AND METHODS

Picloram, 2,4,5-T, (2,4-dichlorophenoxy)acetic acid (2,4-D), 3,6-dichloro-*o*-anisic acid (dicamba), disodium methanearsonate (DSMA), and certain combinations of these herbicides were applied in water or diesel oil at 93.5 L/ha to 6.1 by 30.5 m plots in duplicate or triplicate with a tractor or truck-mounted sprayer. Granular picloram was broadcast by hand every month during 2 years to different duplicate plots 12.2 m square containing mixed stands of yaupon, oaks, and winged elm. Active ingredients of the small borate pellets was 2% picloram. Specific herbicide formulations and dates and rates of application will be given later.

The experimental area, located at Carlos, Texas, was an Axtell fine sandy loam soil of 1 to 3% slope. The woody vegetation had been disturbed by mechanical control methods several years before our studies. Yaupon regrowth ranged from 1 to 3 m in height with at least 10 plants per plot. Oak and winged elm regrowth was 1 to 4 m in height and was usually less dense than yaupon.

Brush control evaluations were made by estimating percentage canopy reduction of all brush species in treated and untreated areas.

RESULTS AND DISCUSSION

Three years after application the potassium salt of picloram was more effective at 2.24 and 4.5 kg/ha in reduc-

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ing the canopy growth of yaupon than equal rates of the ester of picloram or 2,4-D and 2,4,5-T (Table 1). However, at 1.12 kg/ha no differences occurred. These results agree with those of Lehman and Davis (10).

The ester of picloram is more sensitive to photolytic and thermal degradation than the potassium salt (5). Reduced activity of the ester as compared to the salt (1, 5) may be due to herbicide loss from soil and plant surfaces after application.

Table 1. Percentage canopy reduction of yaupon, winged elm, and post and blackjack oaks 1 and 3 years after herbicidal sprays on June 6, 1967, at Carlos, Texas.

Herbicide[a]	Application rate	Yaupon[b]		Post and blackjack oaks[b]		Winged elm[b]
		1 year	3 years	1 year	3 years	1 year
	(kg/ha)	(%)	(%)	(%)	(%)	(%)
Picloram + 2,4-D	0.37 + 0.75	15 ef	13 de	25 efg	13 cd	10
	0.75 + 1.50	25 def	20 d	58 bcde	80 a	13
	1.50 + 3.00	80 ab	30 cd	83 abc	70 ab	38
Picloram + 2,4,5-T	0.56 + 0.56	40 bcdef	25 cd	25 efg	30 cd	10
	1.12 + 1.12	50 abcde	23 d	90 ab	88 a	15
	2.24 + 2.24	63 abcde	78 ab	100 a	100 a	100
Picloram (K salt)	1.12	33 cdef	30 cd	40 defg	45 bc	35
	2.24	58 abcde	68 b	75 abcd	70 ab	15
	4.50	95 a	88 a	88 ab	90 a	100
2,4,5-T	1.12	30 cdef	20 d	35 defg	35 cd	20
	2.24	60 abcde	18 d	20 efg	15 cd	5
	4.50	75 abc	40 c	75 abcd	93 a	13
2,4-D	1.12	20 def	20 d	33 efg	10 cd	3
	2.24	13 ef	18 d	18 efg	18 cd	0
	4.50	65 abcd	25 cd	53 bcdef	30 cd	3
Picloram (ester)	1.12	15 ef	15 de	13 fg	13 cd	8
	2.24	30 cdef	15 de	18 efg	23 cd	20
	4.50	33 cdef	20 d	45 cdef	35 cd	15
None		0 f	0 e	0 g	0 d	0

[a]Formulations included the potassium salt of picloram, the 2-ethylhexyl ester of 2,4-D and 2,4,5-T, a 1:1 and 1:2 mixture of the triisopropanolamine salts of picloram plus 2,4,5-T and picloram plus 2,4-D, respectively, and the isooctyl ester of picloram.

[b]Numbers in columns followed by the same letter do not differ significantly at the 5% level using Duncan's multiple range test.

Combinations of picloram with 2,4-D were usually not as effective as picloram alone at equal rates on yaupon and oaks 1 and 3 years after treatment (Table 1). However, picloram plus 2,4,5-T at 1.12 plus 1.12 kg/ha controlled oaks as effectively as 4.5 kg/ha of 2,4,5-T or picloram. The picloram plus 2,4,5-T mixture was not as effective in controlling yaupon as the potassium salt of picloram at equal rates. Winged elm was controlled only by the highest rate of picloram (4.5 kg/ha) and picloram plus 2,4,5-T (2.24 plus 2.24 kg/ha) sprays.

In 1968, mixtures of picloram plus 2,4,5-T were applied to yaupon with various surfactants and carriers (Table 2). No differences occurred in yaupon control among treatments. Control of yaupon tended to increase as herbicide rate was increased, although 1.7 plus 1.7 kg/ha of picloram plus 2,4,5-T were not significantly different from rates of 0.56 plus 0.56 kg/ha. Three years after treatment some mixtures of picloram plus 2,4,5-T containing surfactant Renex 30 and AL 411A in oil[3] effectively controlled oaks. Winged elm was killed by several treatments including picloram and picloram plus 2,4,5-T.

Lehman and Davis (10) showed that April applications of picloram or 2,4,5-T were usually most effective in controlling yaupon. Treatments made at other times during the year were less effective. The potassium salt of picloram

[3]Mention of trademark name or a proprietary product does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture or Texas A&M University and does not imply its approval to the exclusion of other products that may also be suitable.

Table 2. Percentage canopy reduction of yaupon, winged elm, and post and blackjack oaks 1 and 3 years after herbicidal sprays on July 19, 1968, at Carlos, Texas.

Herbicide[a]	Additive[b]	Application rate	Yaupon[c]		Post and blackjack oaks[c]		Winged elm[c]	
			1 year	3 years	1 year	3 years	1 year	3 years
		(kg/ha)	(%)	(%)	(%)	(%)	(%)	(%)
Picloram + 2,4,5-T	0.5% X-77	0.56 + 0.56	75 ab	33 a	45 b	23 de	50	43
		1.12 + 1.12	90 a	58 a	90 ab	68 abc	90	
		1.70 + 1.70	97 a	63 a	99 a	70 ab		100
2,4,5-T	None	2.24	75 ab	45 a	50 ab	30 cde	20	10
	1:4 Diesel oil:water	2.24	65 ab	38 a	60 ab	50 bcd	55	20
Picloram (K salt)	0.5% X-77	2.24	93 a	70 a	95 ab	73 ab	95	100
Picloram + 2,4,5-T	0.5% Renex 30	1.12 + 1.12	97 a	33 a	100 a	95 a	95	90
	0.5% Renex 30 in Diesel oil:water	1.12 + 1.12	88 a	68 a	93 ab	93 a	90	95
Picloram + 2,4,5-T (ester)	0.5% Oil:water emulsifier	1.12 + 1.12	68 ab	30 a	70 ab	50 bcd	70	50
Picloram (K salt) + 2,4,5-T ester	0.5% Renex 30 in Diesel oil:water	0.56 + 0.56	85 a	45 a	68 ab	50 bcd	60	50
Picloram + 2,4,5-T	0.5% Renex 30 in Diesel oil:water	1.12 + 1.12	95 a	55 a	93 ab	58 abcd	90	100
	0.5% AL 411A	1.12 + 1.12	50 b	40 a	70 ab	58 abc	75	100
	0.5% AL 411A in Diesel oil:water	1.12 + 1.12	78 ab	33 a	85 ab	65 abc	85	80
	0.5% AL 411A in mentor 28 oil:water	1.12 + 1.12	80 ab	40 a	95 ab	90 a	40	25
None	None		5 c	10 c	10 c	5 e	5	8

[a]Formulations included a 1:1 mixture of triethylamine salts of picloram plus 2,4,5-T; the isooctyl ester of picloram plus the propylene glycol isobutyl ether esters of 2,4,5-T; the propylene glycol butyl ether esters of 2,4,5-T, and the potassium salt of picloram.

[b]Surfactant X-77 is a mixture of alkylarylpolyethylene glycol, free fatty acids, and isopropanol; Renex 30 is polyoxyethylene tridecyl ether; AL 411A is polyoxyethylene sorbitol esters; and Mentor 28 is a nontoxic oil. All herbicides were applied in water or 1:4 oil:water emulsion carriers at 93.5 L/ha.

[c]Numbers in columns followed by the same letter do not differ significantly at the 5% level using Duncan's multiple range test.

reduced yaupon canopy by 93%. The ester of picloram and the esters and triethylamine salts of picloram plus 2,4,5-T were ineffective on yaupon, regardless of date of application. The potassium salt of picloram combined with the ester of 2,4,5-T or dicamba produced some yaupon control but was less effective than the potassium salt of picloram alone. Aerial spraying with the low-volatile esters of 2,4,5-T 2 years consecutively is recommended for post and blackjack oaks in May or June (7). Haas and Watson (9) found picloram and picloram plus 2,4,5-T slightly superior to 2,4,5-T for post oak control from a single application of a total of 2.24 kg/ha. Our results with ground application equipment are similar to those of Haas and Watson who used aerial applications (Tables 1 and 2). The most effective herbicidal sprays for control of both oak species in 1969 were the potassium salt of picloram alone and in combination with the ester of 2,4,5-T applied in April and the triethylamine salts of picloram plus 2,4,5-T applied in June (Table 3). No comparison was made with 2,4,5-T alone.

Table 3. Percentage canopy reduction of yaupon, winged elm, and post and blackjack oaks 2 years after several herbicidal sprays at 2.24 kg/ha on April 27, June 18, August 21, and October 14, 1969, at Carlos, Texas[a].

Herbicide[b]	Month applied	Yaupon	Post and blackjack oaks	Winged elm
		(%)	(%)	(%)
Picloram (ester)	April	10	37	100
	June	20	15	100
	August	17	18	10
	October	40	8	100
Picloram (K salt)	April	93	85	100
	June	52	35	55
	August	27	15	100
	October	43	28	10
Picloram + 2,4,5-T (amine salts)	April	15	67	100
	June	47	80	100
Picloram + 2,4,5-T (amine salts)	August	32	23	5
Picloram + 2,4,5-T (amine salts)	October	40	28	100
Picloram (K salt) + 2,4,5-T (ester)	April	68	88	
Picloram (K salt) + 2,4,5-T (ester)	June	35	73	100
Picloram (K salt) + 2,4,5-T (ester)	August	43	33	
Picloram (K salt) + 2,4,5-T (ester)	October	42	20	
Picloram + 2,4,5-T (esters)	April	18	60	100
Picloram + 2,4,5-T (esters)	June	35	33	30
Picloram + 2,4,5-T (esters)	August	17	20	10
Picloram + 2,4,5-T (esters)	October	25	7	5
Picloram (K salt) + dicamba	April	63	15	100
Picloram (K salt) + dicamba	June	40	13	45
Picloram (K salt) + dicamba	August	40	13	20
Picloram (K salt) + dicamba	October	45	8	92
None		0	0	0

[a]Yaupon and oaks: LSD between dates = 8; between treatments = 11; between two treatments at same date = 22; and between dates at same level = 22.
[b]Herbicides included the potassium salt and the isooctyl ester of picloram; the triethylamine salt of picloram plus 2,4,5-T; the isooctyl ester of picloram plus the propylene glycol isobutyl butyl ether ester of 2,4,5-T; the propylene glycol butyl ether ester of 2,4,5-T, and the dimethylamine salt of dicamba. Herbicide mixtures were at 1:1 ratios (active ingredient).

Picloram[4] applied in early spring was effective for control of winged elm. Elwell (8) also found aerial sprays of picloram plus 2,4,5-T and 2,4,5-T plus NH_4SCN or 3-amino,1,2,4-triazole (amitrole) effective on winged elm. Our studies indicate winged elm may also be controlled in the fall (Table 3). The ester of picloram and the triethylamine salts of picloram plus 2,4,5-T were especially effective. However, the potassium salt of picloram applied in April was most effective in controlling yaupon, oaks, and winged elm simultaneously. Applications of herbicidal sprays in the fall were not effective on the oaks and yaupon.

Addition of high rates of surfactant and dimethyl sulfoxide (DMSO) did not reduce canopy of yaupon or oaks significantly (Table 4). Various formulations of picloram plus 2,4,5-T were not significantly different for brush control. Dicamba plus 2,4,5-T gave poor brush control.

Table 4. Percentage canopy reduction of yaupon, winged elm, and post and blackjack oaks 1 year after aerial herbicidal sprays at 2.24 kg/ha on May 3, 1970, at Carlos, Texas.

Herbicide[a]	Yaupon[b]	Post and blackjack oaks[b]	Winged elm[b]
	(%)	(%)	(%)
Picloram (salt)	82 a	57 ab	100
Picloram (salt) + 5% X-77 + 10% DMSO	73 a	70 a	100
Picloram (salt) + 2,4,5-T (ester)	50 b	57 ab	100
Picloram + 2,4,5-T (salts)	60 ab	75 a	100
Picloram (salt) + dicamba (salt)	60 ab	37 ab	90
Dicamba + 2,4,5-T (ester)	23 c	27 ab	20
None	0 d	0 b	0

[a]Formulations similar to Table 3.
[b]Numbers in columns followed by the same letter do not differ significantly at the 5% level using Duncan's multiple range test.

Addition of DMSA to 2,4-D acid or 2,4,5-T acid did not increase the effectiveness on yaupon, compared to an ester of 2,4-D or 2,4,5-T, and usually decreased its effect on oaks (Table 5). Poor control of winged elm resulted from all treatments. It is usually disadvantageous to combine hormone-like and contact herbicides for control of these brush species (2, 4).

Table 5. Percentage canopy reduction of yaupon, winged elm, and post and blackjack oaks 1 and 2 years after treatment with 2,4-D or 2,4,5-T plus DSMA sprays on May 20, 1969, at Carlos, Texas[a].

Herbicide	Application rate	Yaupon		Post and blackjack oaks		Winged elm	
		1 year	2 years	1 year	2 years	1 year	2 years
	(kg/ha)	(%)	(%)	(%)	(%)	(%)	(%)
2,4-D (ester)	4.50	55 abc	28 ab	60 a	50 a	20	20
2,4,5-T (ester)	4.50	70 a	58 a	60 a	50 a	40	20
2,4-D (acid) + DSMA	2.24 + 5.60	70 a	23 ab	25 bc	10 de	25	10
	4.50 + 11.20	45 bc	23 ab	25 bc	18 cd	25	15
2,4,5-T (acid) + DSMA	2.24 + 5.60	35 c	48 a	20 bc	30 bc	25	10
	4.50 + 11.20	63 ab	43 a	35 ab	40 ab	25	10
None		0 d	0 b	0 c	0 e	0	0

[a]Numbers in columns followed by the same letter do not differ significantly at the 5% level using Duncan's multiple range test.

Granular picloram, applied to separate plots every month for 2 years, was superior to sprays at comparable rates for yaupon control (2.24 kg/ha) (compare data in Tables 3 and 6). Excellent control of yaupon resulted regardless of the month the granular picloram was applied (except in August). In central Texas, July and August are hot and dry, limiting herbicide penetration into the root zone and allowing extensive exposure to sunlight (3). Granular picloram was effective even though rainfall was limited during the winter and spring months of 1970 and 1971 (Table 7). Control evaluations made 2 years after the 1969 treatments are not shown since they were similar to those made after 1 year.

Control of the large post oak and blackjack oak trees was usually poor from granular picloram treatments with

[4]LEHMAN, S. K. and F. S. DAVIS. 1967. Control of winged elm (*Ulmus alata* Michx.). Abstr., Weed Sci. Soc. Amer. p. 23.

Table 6. Percentage canopy reduction of yaupon, winged elm, and post and blackjack oaks 1 year after application of granular picloram every month for 2 years at Carlos, Texas*.

Month of treatment	Application rate	Year of treatment					
		1969–70			1970–71		
		Yaupon	Post and blackjack oaks	Winged elm	Yaupon	Post and blackjack oaks	Winged elm
	(kg/ha)	(%)	(%)	(%)	(%)	(%)	(%)
April	2.24	90 ab	15 ij	100	85 abc	20 bc	100
April	4.50	95 ab	20 hij		93 a	30 bc	
May	2.24	75 cd	25 ghij	100	90 ab	25 bc	
May	4.50	99 a	53 cdefg	100	100 a	23 bc	100
June	2.24	95 ab	38 fghi	100	80 abcd	15 bc	100
June	4.50	93 ab	48 efghi	100	95 a	48 abc	100
July	2.24	85 bc	50 defgh	95	68 cd	25 bc	
July	4.50	100 a	55 bcdefg	100	88 abc	30 abc	
August	2.24	65 d	25 ghij	100	43 e	13 bc	
August	4.50	95 ab	80 abcde		60 de	25 bc	
September	2.24	95 ab	55 bcdefg		70 bcd	20 bc	
September	4.50	100 a	40 fghi		80 abcd	38 abc	50
October	2.24	95 ab	55 bcdefg	100	89 abc	38 abc	
October	4.50	95 ab	68 abcdef	100	95 a	43 abc	
November	2.24	98 ab	25 ghij	100	85 abc	28 abc	100
November	4.50	97 ab	90 a	100	93 a	25 bc	100
December	2.24	85 bc	20 hij		98 a	23 bc	
December	4.50	98 a	88 ab		100 a	28 abc	
January	2.24	99 a	83 abcd	98	92 a	15 bc	100
January	4.50	100 a	68 abcdef	100	98 a	25 bc	100
February	2.24	100 a	25 ghij	100	95 a	40 abc	95
February	4.50	98 ab	35 fghi	100	100 a	50 abc	100
March	2.24	97 ab	25 ghij	100	95 a	55 ab	100
March	4.50	100 a	85 abc	100	98 a	75 a	100
None		0 e	0 j	0	0 f	0 c	0

*Evaluations of December 1970, and January, February, and March 1971 treatments made after 6 months.

Table 7. Rainfall (cm) at the Carlos, Texas, experimental site from April 1969 through March 1971.

Date of treatment	1969–70	1970–71
	(cm)	(cm)
April	22.3	10.8
May	4.5	8.9
June	8.0	2.1
July	1.9	1.7
August	9.6	0.5
September	17.1	20.0
October	8.1	10.9
November	6.1	2.2
December	12.6	2.5
January	4.8	0.6
February	11.4	5.0
March	10.1	2.1

some exceptions (Table 6). Sufficient rainfall to leach the herbicide to the root zone of the trees may be required for best results. Effective control of oaks was obtained from November and December 1969 applications. Apparently some control of post and blackjack oaks was obtained with granular formulations of 3-phenyl-1,1-dimethylurea (fenuron) (7).

Winged elm was usually killed in all treated plots regardless of rate or date of application (Table 6).

Practical treatment of mixed brush consisting of yaupon, post oak, blackjack oak, and winged elm could include spray applications of 2,4,5-T or mechanical methods to remove the oak overstory followed by granular applications of the potassium salt of picloram to control yaupon and winged elm in the understory. Native grass production has increased two-to-six fold as a result of brush removal in this area from sprays or granular picloram treatments (6). Picloram usually was not detected in treated soils 1 year after application at rates up to 4.5 kg/ha (3). Fall, winter, or early spring treatments of brush with picloram pellets in areas where susceptible crops are grown during summer months would minimize hazard from herbicide drift or runoff.

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