

# Susceptibility of Selected Woody Plants to Pelleted Picloram

LYNN M. KITCHEN, C.J. SCIFRES, AND J.L. MUTZ

## Abstract

Picloram pellets, aerially applied at 1.1 kg/ha in the spring to South Texas mixed-brush, effectively controlled spiny hackberry and pricklypear, and 2.2 kg/ha temporarily controlled blackbrush acacia. However, agarito, desert yaupon, lotebush, Texas persimmon, and whitebrush were only slightly susceptible to soil applications of picloram, and honey mesquite and creeping mesquite were tolerant. Range site exerted a significant influence only with initial defoliation of twisted acacia. Although canopy reduction of twisted acacia after one growing season was higher on Shallow than on Rolling Blackland or Claypan Prairie range sites, it was apparently only moderately susceptible to pelleted picloram. Shredding prior to pellet applications did not improve the level of brush control compared to applying the picloram to undisturbed brush stands. There was no consistent difference in brush control within an application rate between 5% or 10% active ingredient formulations of picloram pellets.

Chemical brush control on rangeland, especially in Texas, is accomplished largely with sprays of hormone-type herbicides. However, aerial application of sprays containing 2,4,5-T [(2,4,5-trichlorophenoxy) acetic acid], picloram (4-amino-3,5,6-trichloropicolinic acid), dicamba (3,5-dichloro-*o*-anisic acid), and similar herbicides is often limited because of the potential for physical spray drift and/or movement of vapors to herbicide-susceptible agronomic crops, ornamentals, or vegetables. Also, extensive acreages of brushland in Texas are not treated each year because foliar herbicide applications must be carefully timed to coincide with the phenological stage of maximum susceptibility of the brush. This stringent requirement usually reduces the spray season for species such as honey mesquite (*Prosopis glandulosa* var. *glandulosa*) to fewer than 60 days annually (Scifres 1973). Moreover, many of the woody species in mixed stands such as the *Prosopis-Acacia* complex of the South Texas Plains, may not be highly susceptible to the sprays at the time honey mesquite is most susceptible.

Because of the limitations of sprays, recent research has emphasized development of dry herbicide formulations, particularly pellets, for brush management. Potential of physical drift is greatly reduced, and the hazards of volatility are essentially eliminated, when pellet formulations are used.

In contrast to timing requirements for maximum activity

of herbicide sprays, pellets can apparently be applied during a relatively long period each year (Bovey et al. 1972; Meyer et al. 1976; Meyer et al. 1978). The apparent requisites for activity of soil-applied herbicides are rainfall adequate for dissolution and movement of phytotoxic amounts of chemical into the soil, active plant growth to ensure root absorption, and sufficient residual activity for adequate exposure time of the target species to phytotoxic levels of the herbicide (Scifres 1972b). Thus, pelleted herbicides might be applied during any time of the year, except during summer drought, with expectations of effective results, depending on rainfall and species susceptibility (Bovey et al. 1972; Meadors et al. 1978).

Picloram is taken up by the foliage and/or the roots of many species and is relatively persistent in most soils, especially those containing low percentages of organic matter and clay (Bovey and Scifres 1971). Picloram is formulated as pellets containing either 5% or 10% active ingredient. Individual-plant applications of 10% picloram pellets effectively control Texas persimmon (*Diospyros texana*) (Scifres 1975b), lotebush (*Ziziphus obtusifolia*) (Scifres and Kothmann 1976), redberry juniper (*Juniperus pinchotii*) (Scifres 1972a), and Macartney rose (*Rosa bracteata*) (Meyer et al. 1976; Scifres 1975a). Broadcast applications of 10% picloram pellets at 2.2 to 4.5 kg/ha also effectively control redberry juniper (Robison and Cross 1970). Broadcast picloram sprays at conventional application rates do not effectively control Texas persimmon or lotebush (Bovey et al. 1970).

The relative effectiveness of aerial applications of picloram pellets for control of a broad spectrum of woody plants in mixed stands has not been thoroughly studied. Also, recent research indicated that broadcast applications of the pellets were more effective for Macartney rose control when applied immediately after burning of Coastal Prairie than for control of undisturbed stands (Gordon 1976). It was postulated that the picloram was more readily absorbed by roots after the mature topgrowth was removed than by undisturbed Macartney rose plants.

The objectives of this research were to evaluate (1) the susceptibility of various woody species to aerial applications of pelleted picloram, and (2) the influence of shredding prior to applications of picloram pellets on control of the woody plants.

## Study Site Descriptions

Two experiments were conducted in South Texas mixed-brush communities near Campbellton about 80 km south of San Antonio. Major brush species included honey mesquite, whitebrush, creeping mesquite (*Prosopis reptans*), blackbrush acacia (*Acacia rigidula*) twisted acacia (*Acacia tortuosa*), catclaw acacia (*Acacia*

Authors are former Research Assistant, Professor, and Assistant Research Scientist, Department of Range Science, Texas A&M University, College Station, 77843. Kitchen is now a Graduate Research Assistant, Agronomy Department, University of Kentucky, Lexington, 40506. The authors gratefully acknowledge Julia Scifres for typing and preparing this manuscript. Appreciation is extended to Drs. L.F. Bouse and R.W. Bovey for allowing use of their research aircraft for application of the herbicide. Also, David Embry, Rob Gordon, Jerry McAtee and Carl Mohr helped with plot installation and evaluation. This research was partially supported financially by the 74 Ranch, Campbellton, Texas and the P.H. Welder Ranches, Victoria, Texas. Published with approval of the Director, Texas Agricultural Experiment Station as TA-14863.

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**Table 1. Textural classes, organic matter content (%), and pH of soil from various depths (cm) from the Rolling Blackland, Claypan Prairie, and Shallow range sites near Campbellton, Texas.**

Depth	pH	Organic matter	Textural components (%)		
			Sand	Silt	Clay
Rolling Blackland					
0-3	6.9	4.1	31	20	49
3-8	7.3	2.9	26	27	47
8-15	7.4	2.5	28	22	50
15-30	7.4	2.3	28	25	47
30-46	7.5	2.1	22	23	56
Claypan Prairie					
0-3	5.4	3.2	46	20	34
3-8	5.5	2.6	43	23	34
8-15	5.7	2.1	34	26	39
15-30	6.0	2.2	25	21	53
30-46	6.5	2.1	25	20	55
Shallow					
0-3	7.4	3.2	48	16	37
3-8	7.4	2.4	30	25	45
8-15	7.4	2.2	27	25	48
15-30	7.4	1.8	22	22	56
30-46	7.6	1.5	22	19	58

greggii), spiny hackberry (*Celtis spinosus*), Texas persimmon, Carolina wolfberry (*Lycium carolinianum*), Berlandier wolfberry (*L. berlandieri*) pricklypear (*Opuntia* sp.), lotebush, agarito (*Berberis trifoliolata*), desert yaupon (*Schaefferia cuneifolia*), and knifefleaf condalia (*Condalia spathulata*). Canopy cover of the brush stands ranged from 21 to 90%, depending on range site, at initiation of the research.

The study area near Campbellton was stratified into range sites designated by the Soil Conservation Service, as the Shallow Range Site, Claypan Prairie Range Site, and Rolling Blackland Range Site. Soils range from neutral to slightly basic clays and clay loams on the Rolling Blackland and Shallow Sites to acid sandy clay loams and loams on the Claypan Prairie Range Site (Table 1). The Claypan Prairie Range Site is typified by Laparita soils on nearly level to gently sloping uplands usually in proximity to small drainages. A claypan is prominent at 15 to 30 cm deep. The Rolling Blacklands Range Site is characterized by Monteola soils, and gently undulates with occasional slopes to 8%. Fashing soils typify the Shallow Range Site which generally occurs on gently sloping to convex surfaces with gradients of 1 to 5%.

A third experiment was conducted near Cotulla, about 100 km south of San Antonio. The site near Cotulla is Rolling Hardland dominated by blackbrush acacia. Soil is predominately LaSalle Clay with frequent rock outcrops.

## Methods

Experiments at Campbellton were designed as randomized complete blocks arranged as split blocks. Shredding was compared to no shredding as main plot effects, and picloram pellet treatments were applied to 1.5-ha subplots. The treatments were triplicated in an experiment installed on May 17, 1976. Treatments were duplicated in another experiment installed on May 25, 1977, immediately adjacent to the 1976 experiment. Main plots were shredded on January 30, 1976, or on May 1, 1977. The 5 and 10% formulations of picloram pellets (approximately 1.6 and 2.4 mm diam, respectively) were applied at 0, 1.1, or 2.2 kg/ha (active ingredient) with fixed wing aircraft, except in the 1977 experiment where 1.1 and 1.6 kg/ha of the 10% formulation were applied. Picloram pellets were applied in 13.7 m-wide swaths with a spreader attachment used for aerial application of fertilizer and seeds. Experiments (years) were statistically analyzed separately.

In 1976, each subplot was stratified into range sites for vegetation sampling. Composition of the woody plant communities were

determined prior to treatment using the point-center-quarter method (Cottam and Curtis 1956) at 25, equally spaced points on a 270-m line down the center of each plot. The lines were resampled at 13 months after treatment to determine changes in canopy cover and percentage of woody plants killed following treatment. At 13, 26, and 42 months after treatment, visual estimates of canopy cover reduction by species were recorded along the lines. The experiment installed in 1977 was evaluated 13 and approximately 30 months after treatment by estimating canopy cover reductions of woody plants by species along a line down the center of each subplot.

A weather station was installed in the center of the study area to monitor rainfall. Soils were sampled for characterization by range site from each main plot at 0 to 3, 3 to 8, 8 to 15, 15 to 30, and 30 to 45 cm deep. The samples were divided into two subsamples and textural components were determined by the hydrometer method, pH of a 1:2 slurry, and organic matter by acid digestion and titration.

On May 24, 1977, the 5% formulation of picloram pellets was aerially applied at 1 and 2.4 kg/ha and the 10% formulation was applied at 1 and 2 kg/ha to the site near Cotulla. The pellets were applied in 12-m-wide swaths to 3-ha plots with each treatment duplicated in a randomized complete block design. Approximately 14 and 27 months after herbicide application, live canopy cover reduction of woody plants was estimated along a line down the center of each plot.

## Results and Discussion

### Shredding/Picloram Pellet Combinations

Average woody plant canopy cover (62%) of undisturbed brush stands near Campbellton did not change appreciably during this study. The canopy cover was reduced to 11% on plots at 18 months after shredding only (Table 2). Pellet applications to undisturbed areas reduced the overall canopy cover to 19 to 25%. Applications of picloram pellets to shredded plots did not significantly reduce the woody plant canopy cover after 13 months compared to that on plots shredded only or that on plots receiving the herbicide only. Also, analysis of variance did not indicate a significant shredding-by-herbicide interaction, regardless of evaluation time. Therefore, shredding and picloram pellet applications were additive rather than herbicide activity being increased on shredded areas compared to treatment to undisturbed brush. Since the same results were obtained from the experiment conducted in 1977, data from shredded and undisturbed plots were averaged for evaluation of susceptibility of individual brush species.

### Range Site Relationships

There were no differences among range sites in reaction of

**Table 2. Canopy cover of woody plants on shredded and unshredded South Texas Plains mixed-brush communities 13 months following aerial application of two rates and formulations of pelleted picloram near Campbellton in May 1976.**

Picloram treatment		Foliar cover (%) by shredding treatment <sup>1</sup>	
Active ingredient (%)	Rate (kg/ha)	Shredded <sup>2</sup>	Undisturbed
0	0	11 a	62 b
5	1.1	6 a	25 a
10	1.1	6 a	20 a
5	2.2	7 a	19 a
10	2.2	7 a	22 a

<sup>1</sup>Means within the picloram/shredding interaction set or within an average response row or column followed by the same letter are not significantly different at the .05 level according to Duncan's multiple range test.

<sup>2</sup>Plots shredded in January 1976.

**Table 3. Average canopy reduction and percentage twisted acacia completely defoliated on the Rolling Blackland, Claypan Prairie and the Shallow Site 13 months following aerial application of two rates and formulations of pelleted picloram near Campbellton in May 1976.<sup>1</sup>**

Picloram treatment		Rolling Blackland and Claypan Prairie		Shallow	
Active ingredient (%)	Rate (kg/ha)	Avg canopy reduction (%)	Complete defoliation (%)	Avg canopy reduction (%)	Complete defoliation (%)
—	0	0 a	0 r	9 a	0 r
5	1.1	19 ab	4 r	65 d	30 s
10	1.1	36 bc	4 r	68 d	36 s
5	2.2	42 c	4 r	73 d	47 s
10	2.2	21 b	5 r	72 d	52 s

<sup>1</sup>Canopy reduction or complete defoliation means followed by the same letter are not significantly different at the .05 level according to Duncan's multiple range test.

the woody species to the pelleted picloram except with twisted acacia (Table 3). Percentage canopy reduction of twisted acacia following application of picloram pellets in 1976 was lower on Rolling Blackland and Claypan Prairie Sites than on Shallow Sites. Twisted acacia plants completely defoliated on Shallow Sites ranged from 30 to 52% of the population with no significant difference among picloram treatments. Few plants on Rolling Blackland or Claypan Prairie Range Sites were completely defoliated. This differential response was difficult to explain since organic matter and clay contents were similar among the sites (Table 1). However, because of this interaction, the response of twisted acacia was not reported across range sites. Response of other species was averaged over range sites for discussion of relative susceptibilities. The Shallow Sites composed about 75% of the 1976 experimental area and essentially all of the 1977 experimental area.

Response of twisted acacia in 1977 was similar to that reported from the experiment in 1976. Canopy reduction of twisted acacia was 55% and 76% at 13 months after applications of 1.1 kg/ha of the 5% and 10% formulation, respectively, of picloram pellets to Shallow Sites in 1977 (data not shown). In the same study, 1.6 kg/ha of the 10% formulation reduced the twisted acacia canopies by 80%, and 2 kg/ha of the 5% formulation reduced the canopies of 82%. Twisted acacia plants completely defoliated ranged from 15 to 25% of the population where the lower rate was applied, and from 30 to 40% where the higher rate was applied in 1977, regardless of picloram pellet formulation. Canopy reduction averaged less than 15% by 30 months after application of the higher rates of the picloram pellets but the twisted acacia treated with the lower rates had completely recovered.

#### Relative Susceptibility of Woody Plants

The study area near Campbellton was extremely dry at the time the study was initiated. No significant rainfall had occurred during the 60 days prior to herbicide application in 1976. However, almost 16 cm of rainfall were received the 30 days following application of picloram pellets. This amount of rainfall was considered adequate for movement of the herbicide into the soil and for root uptake of the chemical. Almost 120 cm of rainfall were received during the 12-month period following pellet applications. Over 15 cm of rainfall were received during the 30-day period following application of the pellets in 1977 and 100 cm were received by 13 months after application. Therefore, rainfall condi-

tions at the Campbellton study site were considered conducive to activity of soil-applied herbicides. In contrast, 13 cm of rainfall were received the month following application of the pellets near Cotulla but total rainfall was only 39 cm for the year following installation of the experiment.

Spiny hackberry was the most susceptible woody species to picloram pellets. At 60 days after herbicide application, the spiny hackberry canopy was reduced by 85% where the picloram pellets were applied, regardless of rate and averaged across formulations (data not shown). The 2.2 kg/ha rate of either pellet formulation completely eliminated spiny hackberry canopies 13 months after 1976 applications, and reduced the canopies by 96 and 98% following applications in 1977 (Table 4). At 26 months after applications of the pellets in 1976, spiny hackberry canopy reductions exceeded 90% (Table 5), and more than 85% of the spiny hackberry plants were apparently dead (data not shown), regardless of herbicide rate or formulation. After 14 months and with less than half the rainfall (58 cm) occurring on the Campbellton site, canopy cover of spiny hackberry was eliminated by the picloram pellets near Cotulla (data not shown). All picloram pellet treatments had completely controlled the spiny hackberry at 42 months after application in 1976, and canopy reduction ranged from 93 to 100% at 30 months after installation of the experiment near Campbellton in 1977. At 27 months after application of the picloram pellets near Cotulla, canopy reduction of spiny hackberry exceeded 90%, regardless of herbicide rate or formulation. Control of spiny hackberry with picloram pellets at all locations was similar to that reported after application of picloram sprays at 1.1 or 2.2 kg/ha in the fall (Bovey et al. 1970) or in the spring (Meadors et al. 1978).

Blackbrush acacia is susceptible to sprays containing picloram alone or picloram + 2,4,5-T applied in the spring or in the fall (Bovey et al. 1970). At 60 days after applying 1.1 kg/ha of the picloram pellets near Campbellton in 1976, blackbrush acacia canopies were reduced by slightly more than 50% (data not shown). Percentage canopy reduction after application of 2.2 kg/ha was variable, but the higher rate of the 5% formulation reduced the canopy cover of blackbrush acacia by 96% after 60 days. The 2.2 kg/ha rate of picloram pellets reduced the blackbrush canopies by 65 to 79% after 13 months with little difference between years of application (Table 4). The control levels were similar to those reported by Bovey, Baur and Morton (1970) following application of picloram sprays at 1.1 to 2.2 kg/ha in the fall. The 1.1 kg/ha rate of picloram pellets tended to be less effective, regardless of formulation, than 2.2 kg/ha both years of application (Table 4). Meadors et al. (1978) reported that sprays of 2,4,5-T + picloram at 1.1 kg/ha were more effective than the same rate of picloram pellets for blackbrush acacia control.

Recovery of blackbrush acacia was apparent after 26 months where 1.1 kg/ha of the picloram pellets were applied near Campbellton but canopy reduction exceeded 60% where 2.2 kg/ha were applied (Table 5). After 26 months 5 to 12% of the blackbrush acacia plants were completely defoliated by 1.1 kg/ha of the picloram pellets whereas 42% of the blackbrush acacia plants were completely defoliated by 2.2 kg/ha (data not shown). After 27 months near Cotulla, canopy reduction averaged 22% where the lower rates of picloram pellets were applied but varied from 40% to 80% where 2 and 2.4 kg/ha of herbicide were applied, respec-

**Table 4. Canopy reduction of eight woody species 13 months after aerial application of picloram pellets to South Texas mixed brush in May 1976 and May 1977 near Campbellton.**

Picloram treatment		Canopy reduction (%) <sup>1</sup>							
Active ingredient (%)	Rate (kg/ha)	Agarito	Blackbrush acacia	Desert yaupon	Honey mesquite	Lotebush	Prickly-pear	Spiny hackberry	White-brush
1976 Application									
—	0	2 a	6 ab	3 a	0 a	4 a	14 a-d	9 ab	13 a-d
5	1.1	11 d	61 hi	5 ab	0 a	13 a-d	41 efg	98 kl	35 efg
5	2.2	30 d-f	74 ij	44 fgh	0 a	29 cde	84 jkl	100 l	87 jkl
10	1.1	10 abc	51 gh	10 abc	0 a	13 a-d	54 gh	98 kl	77 ij
10	2.2	24 b-e	79 ijk	34 efg	1 a	30 def	74 ij	100 l	88 jkl
1977 Application									
—	0	0 a	0 a	0 a	0 a	0 a	—	0 a	0 a
5	1.1	4 a	44 cd	3 a	0 a	13 ab	—	78 fg	35 bc
5	2.2	10 ab	65 ef	14 ab	3 a	36 bcd	—	98 h	44 cd
10	1.1	9 a	38 bcd	2 a	0 a	14 ab	—	78 fg	40 cd
10	1.6	8 a	73 ef	15 ab	0 a	30 bc	—	96 gh	56 de

<sup>1</sup>Means within an experiment followed by the same letter are not significantly different at the .05 level according to Duncan's multiple range test.

tively. However, the blackbrush acacia had completely recovered, regardless of picloram treatment, at 42 months after application in 1976. Only scattered plants had not recovered completely from the picloram treatments at 30 months after application in 1977.

The lower rate of the picloram pellets reduced the blackbrush acacia canopies by 14 to 25% after 14 months near Cotulla (data not shown). At 2 kg/ha, the 10% formulation reduced the canopies of blackbrush acacia by 45% and killed 10% of the plants. The 5% formulation, applied at 2.4 kg/ha reduced the canopies by 90% and completely defoliated 65% of the blackbrush acacia plants in the experiment near Cotulla.

Initial response of pricklypear was erratic, especially to the lower rates of picloram pellets the year of application near Campbellton. Also insect damage complicated isolation of initial herbicide effects. However, the response of pricklypear was fairly uniform at 1 year after treatment. Green cladophyll area of pricklypear was reduced by 74 to 84% by 13 months after applying 2.2 kg/ha of the picloram pellets in 1976 (Table 4). Pricklypear control improved 2 years after application of the low rate of the pellets compared to the earlier evaluations. Green cladophyll area reduction of pricklypear exceeded 70% where 1.1 kg/ha of the pellets were applied and was greater than 95% where the higher rate was applied. About 70% of the pricklypear plants were killed by 1.1 kg/ha of the picloram pellets and 85% were killed by the high application rate, regardless of formulation (data not shown). At 42 months after application of the picloram pellets, pricklypear was completely controlled, regardless of application rate of formulation. Pricklypear occurrence was not adequate for evaluation

following applications of treatments near Campbellton in 1977 or in the experiment near Cotulla.

Within 60 days after application of the picloram pellets at 1.1 kg/ha near Campbellton, whitebrush canopies were reduced by 42%, and by about 60% where 2.2 kg/ha were applied (data not shown). Whitebrush response varied somewhat between experiments near Campbellton based on evaluations 13 months after application. Picloram pellets applied at 2.2 kg/ha in 1976 reduced the whitebrush canopies by more than 85%. At 13 months after application of the high rates of the pellets in 1977, canopy reduction was 44 to 56%. The low rate did not reduce the whitebrush canopies by more than 40% except where the 10% formulation was applied in 1977. Whitebrush control was reduced at 26 months after application compared to earlier evaluations (Table 5). At 1.1 kg/ha, no whitebrush defoliation occurred where the 10% formulation was applied, and canopy reduction was only 29% where the 5% formulation was used. Average canopy reduction varied from 53 to 61% where 2.2 kg/ha of the picloram pellets were applied with 11% of the plants completely defoliated. By 30 months and 42 months after application of the picloram pellets in 1977 and 1976, respectively, the whitebrush had completely recovered, regardless of rate or formulation.

The low rate of picloram pellets was not highly effective for control of agarito, desert yaupon or lotebush, regardless of year of treatment, herbicide formulation, or time of evaluation. The high rates reduced the canopies of agarito by 24 to 30% at 13 months following 1976 treatments near Campbellton but were ineffective following applications of the pellets in 1977 (Table 4). The agarito canopies had recovered about 26 months (Table 5) and no agarito plants were killed

**Table 5. Canopy reduction of eight woody species at 26 months after aerial application of picloram pellets to South Texas mixed brush in May 1976 near Campbellton.**

Picloram treatment		Canopy reduction (%) <sup>1</sup>							
Active ingredient (%)	Rate (kg/ha)	Agarito	Blackbrush acacia	Desert yaupon	Honey mesquite	Lotebush	Pricklypear	Spiny hackberry	Whitebrush
—	0	0 a	1 a	3 ab	0 a	0 a	0 a	0 a	5 ab
5	1.1	2 a	22 bcd	6 ab	0 a	3 ab	75 hi	93 jk	29 cde
5	2.2	13 abc	73 hi	41 def	1 a	7 ab	98 k	91 ijk	61 gh
10	1.1	13 ab	17 abc	19 abc	0 a	4 ab	73 hi	94 jk	0 a
10	2.2	13 abc	62 ghi	47 ef	0 a	32 cde	96 jh	91 ijk	53 fg

<sup>1</sup>Means followed by the same letter are not significantly different .05 level according to Duncan's multiple range test.

(data not shown).

Initial response of desert yaupon was similar to that of agarito. After 13 months, the 1.1 kg/ha did not significantly reduce desert yaupon canopies in either experiment near Campbellton, and the high rate was only partially effective following 1976 applications (Table 4). However, canopy reduction in the 1976 experiment at 26 months after application of 2.2 kg/ha was similar to results after 13 months (Table 5). Desert yaupon canopies were completely restored at 30 and 42 months after application of the picloram pellets in 1977 and 1976, respectively.

The canopies of lotebush were essentially unaffected at 60 days after picloram applications. Lotebush response after 13 months was similar between experiments near Campbellton, and the higher picloram rate reduced the canopies by 29 to 36% (Table 4). After 26 months, 2.2 kg/ha of the 10% formulation had significantly reduced the lotebush canopies, but by only 32% (Table 5). Lotebush canopies were completely restored at 30 and 42 months after application of the picloram pellets in 1977 and 1976, respectively.

Based on results of these studies, spiny hackberry and pricklypear are apparently highly susceptible to picloram pellets. However, pricklypear responds more slowly than spiny hackberry. Blackbrush acacia, susceptible to sprays containing picloram (Meadors et al. 1978), is not highly susceptible to picloram pellets on sites most favorable for control. Agarito, desert yaupon, lotebush, and whitebrush were not effectively controlled by picloram pellets. As in experiments by Bovey et al. (1969), honey mesquite was tolerant of picloram pellets in this study, regardless of formulation or time of evaluation (Tables 4, 5). There was no difference in the response of creeping mesquite and honey mesquite to the picloram pellets.

These data do not indicate any advantage, relative to brush control, of the 5% formulation of picloram pellets compared to 10% formulation. The 10% formulation would be advantageous logistically in that less formulated herbicide must be transported, handled, and applied to achieve the desired application rate of active ingredient.

The overall woody plant responses the growing season following pellet applications in the spring were not adequate to release the herbaceous understory (Kitchen 1977). Lack of positive forage response until the second growing season after spring applications of tebuthiuron [*N*-(5-[1,1-dimethylethyl]-1,3,4-thiadiazol-2-yl)-*N*,*N'*-dimethylurea] pellets to mixed-brush stands was also reported (Scifres and

Mutz 1978). In contrast, sprays applied in the spring may result in significant forage release, depending on rainfall, the season of application to mixed brush (Scifres et al. 1976). Compared to defoliation levels normally occurring within 30 days after the application of aerial sprays, the slow response of even the most susceptible brush to pellets must be considered a disadvantage.

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