Control of Huisache with Soil Applied Herbicides*

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Highlight: Soil active herbicides were investigated for control of huisache. Tebuthiuron and bromacil were usually more effective than other herbicide sprays when applied to the soil surface or subsurface in bands spaced 4 ft apart. Karbutilate and prometone were intermediate in effect, whereas picloram, dicamba, 2,3,6-TBA, and diuron were relatively ineffective in the Houston black clay soil used in this study. Subsurface sprays were usually superior to surface treatment for all herbicides investigated. Spacing of tebuthiuron granules in bands at 6, 10, 15, or 20 ft apart showed little difference in control of huisache at 2 or 4 lb/acre. Placement of granular herbicides in bands was superior to broadcast application at 2 lb/acre, but not at 4 lb/acre.

Huisache (*Acacia farnesiana* (L.) Willd.) is a widespread woody plant in tropical and semitropical areas of North and South America (Vines 1960). In Texas, huisache infests 2 to 3 million acres of pasture and rangeland, and its rate of growth, spread, and persistence is of major concern to ranchers on infested areas (Smith and Rechenthin 1964). Mechanical methods of control, such as root plowing, grubbing, and dozing are usually effective, but expensive, and may damage the soil surface and forage stand (Powell and Box 1967; Rechenthin et al. 1964). Huisache may also rapidly recover from rootstocks and seed after mechanical treatment. Treatment of the base of the trunk with 2,4,5-T [2,4,5-trichlorophenoxy)acetic acid] at 8 lb/100 gal diesel oil or kerosene or oil alone kills individual trees. Such treatments, however, are feasible only on small areas where huisache densities are low (Hoffman 1973).

The need to develop broadcast applications of herbicide sprays or pellets for effective and economical control of huisache on large areas is apparent. Darrow (1960) defoliated huisache by aerial application of 2,4,5-T, but killed few plants. Bovey et al. (1969a) found picloram (4-amino-3,5,6-trichloropicolinic acid) to be more effective than several herbicides (including 2,4,5-T) when foliar applications were made in spring or fall. However, mixtures of picloram + 2,4,5-T (Bovey et al. 1968; Bovey et al. 1969a) or picloram + dicamba (3,6-dichloro-*o*-anisic acid) (Meyer and Bovey 1973) were also effective foliar treatments. Evening (6:00 p.m.) treatments, using picloram + 2,4,5-T, were generally more effective than foliar sprays applied at midday or morning (Bovey et al. 1972).

Bovey et al. (1969b) found that huisache was killed when at least 2 lb/acre of picloram were applied to the soil as pellets in South Texas, regardless of treatment date. However, when picloram was used on heavier clay soils in south central Texas, its effectiveness as soil sprays or pellets was considerably diminished (Bovey 1969b; Meyer et al. 1976).

Huisache is commonly found in pastures near crops sensitive to hormone-like herbicides (picloram, 2,4-D, 2,4,5-T, and dicamba). Drift of sprays onto nontarget vegetation as a result of careless application may result in crop injury. In addition to the drift hazard, herbicides for huisache control may be ineffective because of adverse weather and growth conditions or soil type.

Our objectives were to (1) investigate methods to inject herbicides into the soil in narrow bands spaced at predetermined intervals compared to surface application, and (2) study several new and established herbicides relative to their effectiveness on huisache and injury to desirable forage plants.

Materials and Methods

Herbicides investigated for huisache control included liquid sprays of picloram, 2,4,5-T, 2,4-D [(2,4-dichlorophenoxy)acetic acid], dicamba, diuron [3-(3,4-dichlorophenyl)-1,1-dimethylureal, prometone [2,4-bis(isopropylamino)-6-methoxy-*s*-triazine], 2,3,6-TBA (2,3,6-trichlorobenzoic acid), tebuthiuron } *N*-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-*N,N'*-dimethylurea}, karbutilate [*tert*-butylcarbamic acid ester with 3(*m*-hydroxyphenyl)-1,1-dimethylurea)], and bromacil (5-bromo-3-*sec*-butyl-6-methyluracil).

The potassium salt of picloram, the propylene glycol butyl ether esters of 2,4-D and 2,4,5-T, the dimethylamine salt of dicamba and 2,3,6-TBA and prometone were liquid formulations; diuron, tebuthiuron, karbutilate, and bromacil were wettable powders. Tebuthiuron was also applied as 10% active ingredient in ⅛-inch extruded pellets.

Herbicides were initially applied with a chisel injector that sprayed a stream of herbicide, diluted in water, into the slice made by the chisel (Bovey et al. 1976). The chisel was constructed of 1-inch steel, 30 inches long, 8 inches wide at the top, and 6 inches at the bottom. The leading edge was sharpened to slide through soil and roots of woody plants. The spray nozzle, attached at the backside of the chisel, allowed herbicide placement 6 to 8 inches into the soil. Original spray pressure was 275 lb/inch^2 at spray volumes of 40 gal/acre.

Subsurface application equipment was redesigned since shallo-rooted woody plants tended to be uprooted and drag on the chisel (Bovey et al. 1976). A coulter, 32 inches in diameter, was placed in front of the chisel to eliminate dragging of brush on the chisel. We also found high spraying pressures unnecessary and now use 50 lb/inch^2 with no stoppage of spray from the nozzles. Spray volume with redesigned equipment was 28 gal/acre because higher volumes of carrier are required to properly suspend and spray the wettable powder herbicides at rates up to 8 lb/acre. Spray volume can be changed by merely changing nozzle tip size. Number 5 stainless steel Spraying Systems Co. Conejet Tips[1] were used. Soil surface or subsurface herbicide sprays were applied in bands at 4-ft intervals with the same equipment. Pellets of tebuthiuron were applied to the soil in rows at intervals of 6, 10, 15, and 20 ft with a pellet applicator (Flynt et al. 1976). Broadcast applications of pellets for comparison to pellets

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applied in bands were made by hand. Picloram, 2,4,5-T, 2,4-D, dicamba, diuron, and bromacil were applied alone or in mixtures as foliar sprays. Spray volume was 20 gal/acre. The remaining herbicides were applied in bands as surface or subsurface sprays only, since they are generally more effective as soil treatments and may cause considerable forage injury when applied as broadcast sprays.

The majority of the experiments were conducted in dense stands of huisache 3 to 12 ft tall growing on a Houston black clay soil near Washington, Texas. Experiments for data in Table 1, however, were obtained at Bryan, Texas, on an Erving clay loam. All herbicides were applied to duplicate 60 by 60 ft plots at various rates up to 8 lb/acre at various times during the year as indicated in the Tables that follow.

Control ratings consisted of evaluating 10 plants at random in each plot 2 or 3 years after treatment for percent canopy reduction. Plants showing no living foliage or sprouts were considered dead.

Results and Discussion

As indicated in previous studies (Bovey et al. 1969b; Meyer et al. 1976), soil applications of picloram are effective for huisache control except on heavy clay soils. Data in Table 1

Table 1. Control of huisache with subsurface and foliar sprays of picloram and 2,4,5-T, 2 years after treatment, on August 11, 1971 at Bryan, Texas[1].

Herbicide	Soil placement	Rate (lb/acre)	Canopy reduction (%)	Dead plants (%)
Picloram	Subsurface	2	24 ab	1 e
Picloram	Subsurface + foliar	1+1	68 c	28 d
Picloram + 2,4,5-T	Subsurface + foliar	1+1	20 a	2 e
Picloram[2]	Foliar	2	96 d	82 b
Picloram	Foliar	2	92 d	86 ab
2,4,5-T	Foliar	2	39 b	4 e
Picloram	Subsurface	4	70 c	44 c
Picloram	Foliar	4	100 d	100 a
Picloram	Subsurface + foliar	2+2	98 d	92 ab
Control	—	—	0 a	0 e

[1] Numbers within a column followed by the same letter do not differ significantly at the 5% level using Duncan's multiple range test. Treatments were evaluated July 17, 1973.

[2] Plants pushed over by steel blade 2 ft above soil during spraying.

support earlier conclusions. For example, 2 lb/acre of picloram applied subsurface produced only 24% canopy reduction and 1% dead plants, whereas comparable rates of foliar sprays killed over 80% of the huisache plants. Combined applications of 2 lb/acre (1 lb/acre foliar and 1 lb/acre subsurface) increased kill (28%) over that applied subsurface only, but were not as effective as foliar sprays at the same total rate. Foliar sprays of 2,4,5-T at 2 lb/acre were not effective. Picloram at higher rates (4 lb/acre) applied subsurface killed 44% of the huisache, but in clay loam soil it was not as effective as foliar sprays at 2 or 4 lb/acre.

Other herbicides available in 1971 showing promise for huisache control by foliar or soil application are given in Table 2. Bromacil applied subsurface at 8 lb/acre killed all huisache. At 4 lb/acre, bromacil killed only 20% of the plants. Other herbicides, rates and methods of application were essentially ineffective. Bromacil was equally effective when treatments were repeated in 1973 (Table 3).

Spring application of picloram as a soil treatment was ineffective, although high rates (8 lb/acre) killed 55% of the huisache. Other herbicides showing high activity (50% kill or more) at 8 lb/acre by subsurface application were prometone,

Table 2. Control of huisache with subsurface or foliar sprays of dicamba, diuron, diuron +2,4-D, bromacil, and bromacil +2,4-D, 2 years after treatment on September 15, 1971 at Washington, Texas[1].

Herbicide	Herbicide placement[2]	Rate (lb/acre)	Canopy reduction (%)	Dead plants (%)
Dicamba	Subsurface	2	21 ab	0 c
Dicamba	Subsurface	4	17 ab	0 c
Dicamba	Foliar	2	55 d	5 c
Dicamba	Subsurface + foliar	1+1	53 d	0 c
Diuron	Subsurface	2	31 bc	0 c
Diuron	Subsurface	4	52 d	5 c
Diuron	Subsurface	8	80 e	25 b
Diuron	Subsurface + foliar	2+2	48 cd	0 c
Diuron + 2,4-D	Subsurface	1+1	10 a	0 c
Diuron + 2,4-D	Foliar	1+1	48 cd	5 c
Bromacil	Subsurface	4	72 e	20 b
Bromacil	Subsurface	8	100 f	100 a
Bromacil + 2,4-D	Subsurface	2+2	54 d	5 c
Bromacil + 2,4-D	Foliar	2+2	46 cd	5 c
Control	—	—	32 bc	0 c

[1] Numbers within a column followed by the same letter do not differ significantly at the 5% level using Duncan's multiple range test. Treatments were evaluated September 18, 1973.

[2] Herbicides applied subsurface were placed in bands 4 ft apart.

Table 3. Control of huisache with surface or subsurface sprays of picloram, prometone, 2,3,6-TBA, tebuthiuron, karbutilate, diuron, and bromacil, 3 years after treatment on May 21, 1973 at Washington, Texas[1].

Herbicide	Herbicide placement[2]	Rate (lb/acre)	Canopy reduction (%)	Dead plants (%)
Picloram	Subsurface	2	42 a-d	0 f
Picloram	Subsurface	3	65 c-j	25 d-f
Picloram	Surface	3	48 a-f	5 f
Picloram	Subsurface	4	51 a-g	0 f
Picloram	Surface	4	45 a-e	10 f
Picloram	Subsurface	8	91 i-k	55 b-d
Prometone	Subsurface	2	36 a-c	0 f
Prometone	Subsurface	4	80 f-k	55 b-d
Prometone	Surface	4	56 a-h	25 d-f
Prometone	Subsurface	8	93 jk	80 ab
2,3,6-TBA	Subsurface	2	39 a-d	0 f
2,3,6-TBA	Subsurface	4	31 ab	0 f
2,3,6-TBA	Surface	4	36 a-c	10 f
2,3,6-TBA	Subsurface	8	43 a-e	5 f
Tebuthiuron	Subsurface	2	66 c-j	25 d-f
Tebuthiuron	Subsurface	4	83 g-k	70 ab
Tebuthiuron	Surface	4	58 b-i	25 d-f
Tebuthiuron	Subsurface	8	100 k	100 a
Karbutilate	Subsurface	2	47 a-f	30 c-f
Karbutilate	Subsurface	4	49 a-f	10 f
Karbutilate	Surface	4	37 a-c	5 f
Karbutilate	Subsurface	8	81 f-k	55 b-d
Diuron	Subsurface	2	44 a-e	0 f
Diuron	Subsurface	4	71 d-k	15 ef
Diuron	Surface	4	49 a-k	0 f
Diuron	Subsurface	8	83 fg	50 b-e
Bromacil	Subsurface	2	76 e-k	30 c-f
Bromacil	Subsurface	4	88 k	65 a-c
Bromacil	Surface	4	72 d-k	20 d-f
Bromacil	Subsurface	8	97 jk	95 a
Control	—	—	22 a	0 f

[1] Numbers within a column followed by the same letter do not differ significantly at the 5% level using Duncan's multiple range test. Treatments were evaluated October 22, 1976.

[2] All herbicides were applied in bands 4 ft apart.

Table 4. Control of huisache with surface or subsurface sprays of picloram, prometone, 2,3,6-TBA, tebuthiuron, karbutilate, diuron, and bromacil, 3 years after treatment on September 19, 1973 at Washington, Texas[1].

Herbicide	Herbicide placement[2]	Rate (lb/acre)	Canopy reduction (%)	Dead plants (%)
Picloram	Subsurface	4	24 ab	0 e
Picloram	Surface	4	51 b-d	5 d-e
Prometone	Subsurface	4	57 cd	15 c-e
2,3,6-TBA	Subsurface	4	34 a-c	0 e
Tebuthiuron	Subsurface	2	80 d-f	55 a-d
Tebuthiuron	Subsurface	4	74 d-f	30 b-e
Tebuthiuron	Surface	4	80 d-f	45 b-e
Tebuthiuron	Subsurface	8	99 f	95 a
Karbutilate	Subsurface	2	34 a-c	0 e
Karbutilate	Subsurface	4	89 ef	60 a-c
Karbutilate	Surface	4	64 c-e	40 b-e
Karbutilate	Subsurface	8	93 ef	50 a-e
Diuron	Subsurface	4	58 cd	10 c-e
Bromacil	Subsurface	4	96 ef	70 ab
Control	—	—	8 a	0 e

[1] Numbers within a column followed by the same letter do not differ significantly at the 5% level using Duncan's multiple range test. Treatments were evaluated October 22, 1976.
[2] All herbicides were applied in bands 4 ft apart.

karbutilate, and diuron. At 4 lb/acre, prometone, tebuthiuron, and bromacil killed more huisache than other herbicides at 4 lb/acre. Subsurface placement of all herbicides was superior to surface application. Improved huisache control with subsurface relative to surface treatment may be due to placement of the herbicide closer to the root zone of the huisache and/or protection of the herbicide from the elements. Grass and forb injury was greatly reduced by band application, although some herbicides eliminated all vegetation within the 10 to 12-inch wide treated strip. For each herbicide, grass and forb injury in the treated band, by each specific herbicide, was similar from surface or subsurface treatment. Most bare strips revegetated with herbaceous plants within 1 year, regardless of herbicide or rate.

Table 5. Control of huisache with surface or subsurface sprays of picloram, prometone, 2,3,6-TBA, tebuthiuron, karbutilate, bromacil, and diuron, 2 years after treatment on May 16, 1974 at Washington, Texas [1,2]

Herbicide	Herbicide placement[2]	Rate (lb/acre)	Canopy reduction (%)	Dead plants (%)
Picloram	Subsurface	8	87 c-e	80 a-c
Prometone	Subsurface	4	80 b-e	50 a-f
Prometone[3]	Surface	4	92 de	80 a-c
Prometone	Subsurface	8	83 c-e	65 a-d
2,3,6-TBA	Subsurface	8	42 ab	0 f
Tebuthiuron	Subsurface	2	71 a-e	45 b-f
Tebuthiuron	Subsurface	4	95 de	84 a-c
Tebuthiuron	Surface	4	93 de	90 ab
Tebuthiuron	Subsurface	8	100 e	100 a
Karbutilate	Subsurface	2	47 a-c	6 f
Karbutilate	Subsurface	4	84 c-e	60 a-e
Karbutilate	Surface	4	73 b-e	35 c-f
Karbutilate	Subsurface	8	96 de	80 a-c
Bromacil[4]	Subsurface	2	54 a-d	10 ef
Bromacil[4]	Subsurface	4	90 de	65 a-d
Bromacil[4]	Surface	4	89 de	60 a-e
Bromacil[4]	Subsurface	8	100 e	100 a
Diuron[4]	Subsurface	8	55 a-d	25 d-f
Control	—	—	31 a	0 f

[1] Numbers within a column followed by the same letter do not differ significantly at the 5% level using Duncan's multiple range test. Treatments were evaluated October 22, 1976.
[2] All herbicides were applied in bands 4 ft apart.
[3] One replication only.
[4] Applied July 22, 1974.

Table 6. Control of huisache with pelleted tebuthiuron (10% active ingredient) applied broadcast or in bands 6, 10, 15, and 20 ft apart on November 12, 1973, and December 5, 1974, at Washington, Texas[1].

Spacing (ft)	Rate (lb/acre)	1973		1974	
		Canopy reduction (%)	Dead plants (%)	Canopy reduction (%)	Dead plants (%)
Broadcast	2	60 b	30 ab	51 ab	5 f
6	2	95 c	70 cd	69 bc	25 ef
10	2	87 c	75 cd	66 bc	35 d-f
15	2	77 bc	50 bc	83 cd	35 d-f
20	2	87 c	75 cd	75 cd	40 c-f
10	3	—	—	93 d	45 b-e
Broadcast	4	89 c	75 cd	92 d	80 ab
6	4	95 c	80 cd	98 d	85 a
10	4	97 c	90 d	97 d	70 a-d
15	4	84 c	65 b-d	96 d	75 a-c
20	4	88 c	80 cd	93 d	80 a-d
Control	—	20 a	0 a	41 a	10 ef

[1] Numbers within a column followed by the same letter do not differ significantly at the 5% level using Duncan's multiple range test. Treatments were evaluated October 22, 1976.

Treatments in the fall of 1973 and spring of 1974 indicated that subsurface application of tebuthiuron at 2 lb/acre killed more huisache than other herbicides at comparable rates (Tables 4 and 5). At the 4 lb/acre rate, karbutilate and bromacil were as effective as tebuthiuron. When applied in May 1974, prometone was equally effective as tebuthiuron, karbutilate, and bromacil. In general, differences in fall and spring treatments of most herbicides were slight. Although some exceptions were observed, subsurface placement of the herbicide was more effective than application on the soil surface.

Tebuthiuron pellets applied in the winter months of 1973 and 1974 killed more huisache at 2 lb/acre when placed in continuous bands compared to broadcast applications (Table 6). Little difference occurred in total kill of the brush, regardless of band spacing (6, 10, 15, or 20 ft apart). However, when 4 lb/acre of tebuthiuron was applied broadcast, broadcast and banded treatments were equally effective. The data indicate that band applications of tebuthiuron pellets at 2 lb/acre may have potential for huisache control, minimizing herbicide rate required and forage injury.

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