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Controlling Shrubs in the Arid Southwest with Tebuthiuron

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Abstract

Various rates of tebuthiuron pellets were aerially applied on rangelands in the Southwest to determine effects on noxious shrubs. Creosotebush *(Larrea tridentata)* and tarbush *(Flourensia cernua)* shrubs were controlled with 0.4 and 0.3 kg active ingredient (a.i.)/ha, respectively, of tebuthiuron pellets. About 1.1 kg a.i./ha of tebuthiuron pellets controlled honey mesquite *(Prosopis glandulosa)* growing on loamy sands or sandy loams. About 0.6 and 0.5 kg a.i./ha of tebuthiuron pellets controlled whitethorn acacia *(Acacia constricta)* and desert zinnia *(Zinnia pumila)*, respectively. Higher rates of tebuthiuron are needed to control those shrubs on deep, fine textured soils than on shallow, coarse textured soils.

Woody plants have rapidly invaded new areas in the Southwest (Buffington and Herbel 1965, York and Dick-Peddie 1969). Some woody plants are responsible for reduced forage production and have other adverse effects on livestock operations (Herbel et al. 1983). Dense stands have harmful effects on the environment because of accelerated wind or water erosion in arid areas (Gould 1982). It is estimated that mesquite (*Prosopis* spp. L.) occurs on 37.7 mil ha, creosotebush (*Larrea tridentata* [DC.] Cov.) on 18.8 mil ha, and tarbush (*Flourensia cernua* DC.) occurs on 5.4 mil ha in the U.S. (Platt 1959). Various methods have been used to reduce the density and distribution of these plants (e.g., Fisher et al. 1959, Herbel and Gould 1970, Martin 1975, and Scifres 1977).

Tebuthiuron[N-(5-[1,1-dimethylethyl]-1,3,4-thiadiazol-2-yl)-N,N'-dimethylurea] is effective for chemical control of many woody plants. In Texas, it killed 80, 70, and 86%, respectively, of live oak (*Quercus virginiana* Mill.), whitebrush (*Aloysia lycioides* Cham.), and sand shinnery oak (*Q. havardii* Rydb.) at 1.1 kg active ingredient (a.i.)/ha; and 45 and 60% of Macartney rose (*Rosa bracteata* Wendl.) and blackbrush acacia (*Acacia rigidula* Benth.), respectively, at 2.2 kg a.i./ha (Meyer and Bovey 1979, 1980a, and 1980b; and Jacoby and Meadors 1982).

Meyer and Bovey (1979) reported 95, 50, and 85% of honey mesquite (*Prosopis glandulosa* Torr.) plants killed on a clay loam site in south central Texas with subsurface applications of the wettable powder of tebuthiuron at 9 kg a.i./ha applied April 1973, April and December 1974, respectively. Jacoby et al. (1982) reported creosotebush kills of 86 and 91% with applications of 0.5 and 0.7 kg a.i./ha of tebuthiuron on gravelly loams in the eastern portion of the Trans-Pecos area in Texas. Tarbush kills of 68 and 95% were obtained with the use of 0.5 and 0.8 kg a.i./ha of tebuthiuron on silty clay loams in the western part of the Edwards Plateau in Texas (Ueckert et al. 1982). Morton et al. (1978) reported that pelleted tebuthiuron treatments applied to a sandy loam soil in southern Arizona at rates of 0.56, 1.12, and 2.24 kg a.i./ha killed 77, 97, and 99% of creosotebush and 78, 100, and 100% of velvet mesquite (*P. velutina* Wooton) plants, respectively.

This study determined effects of various rates of tebuthiuron on honey mesquite, creosotebush, tarbush, and other associated woody plants.

Methods and Materials

Six range areas were treated with tebuthiuron in southern New Mexico and Arizona. A major part of the study was conducted on 2 sites on the Jornada Experimental Range, 35 km north of Las Cruces, N. Mex. Annual rainfall at the Jornada Headquarters averages 230 mm and the elevation is 1,260 m. One of the areas treated was a sandy range site dominated by mesquite. The soil is an Onite-Pintura complex (Bullock and Neher 1980). Onite is a coarse-loamy, mixed, thermic Typic Haplargid, and Pintura is a loamy, mixed, thermic Typic Torripsamment. The second treated area was a loamy range site dominated by creosotebush and tarbush. The soil is a Berino-Dona Ana association. They are both fine-loamy, mixed, thermic Typic Haplargids.

Tebuthiuron pellets were aerially applied on 5-ha plots at various rates on each of the sites for 4 years, 1977-80 (see Tables 1 and 2 for actual rates). Applications were made in early summer each year. At treatment, mesquite leaves were mature and beans were ripening. Creosotebush was fruiting, while tarbush was in the leaf stage. Each plot was 62 × 800 m with an untreated area 12 m wide

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Table 1. Mortality of honey mesquite 28 months after application of pelleted tebuthiuron on a sandy site on the Jornada Experimental Range.[1]

Rate[2]	Year applied	Dead plants
kg/ha		%
0.31	1980	55[b3]
0.48	1977	23[a]
0.58	1978	55[b]
1.02	1977	60[b]
1.03	1980	64[b]
1.27	1980	77[c]
1.49	1978	74[c]
1.49	1979	95[d]
1.68	1977	93[d]
2.16	1979	98[d]
2.24	1978	81[c]
2.96	1979	99[d]

[1]All trials were with pellets containing 20% active ingredient.
[2]Active ingredient.
[3]Means followed by the same letter are not significantly different ($P<.05$).

between treatments. Treatments were applied with a Piper Pawnee "C" equipped with a Transland spreader and a slotted metering plate in the herbicide hopper. The plane flew at a height of 15 m and the swath width was 12.4 m. The equipment was calibrated with pelleted formulation of tebuthiuron available that year. The flow rates of various formulations differed. Thus, the same application rates from year to year were not always achieved. Beginning and ending weights determined amounts of tebuthiuron applied to each plot. Pellet counts and vegetation responses showed that uniform applications occurred across the plot. Plots were evaluated 28 months after application by counting dead plants. Six to 19, 100-plant groups were counted on each plot, depending on plant density.

Another study site was on the Goodsite Ranch, 30 km north of Deming, N. Mex. The elevation is 1,280 m and annual average rainfall is 230 mm; however, during the 3 years of the study, rainfall was below average with only 520 mm falling from the time of treatment on June 17, 1980 until final evaluation on May 16, 1983. Soil on the site is an Upton sandy loam, mixed Typic Haplargid. Creosotebush was the dominant shrub and broom snakeweed

Table 2. Mortality of creosotebush and tarbush with broadcast aerial applications of pelleted tebuthiuron on the Jornada Experimental Range.

Year applied	Percent active ingredient	Rate[1]	Dead	
			creosotebush	tarbush
		kg/ha	% dead	
1977	20	0.20	62[b2]	76[a]
	20	0.56	95[ef]	98[b]
	20	1.28	91[d]	98[b]
1978	20	0.29	37[a]	—
	20	0.38	88[d]	—
	20	1.34	98[ef]	—
1979	20	0.57	93[de]	100[3]
	20	1.14	97[ef]	100
	20	3.28	99[f]	100
1980	10	0.28	80[c]	—
	10	0.62	76[c]	—
	10	1.14	96[ef]	—
	20	0.34	75[c]	—

[1]Active ingredient.
[2]Means followed by the same letter within a column are not significantly different ($P<.05$).
[3]Estimated only (small numbers of tarbush plants in the plots treated in 1979).

(*Xanthocephalum sarothrae* [Pursh] Shinners) was abundant. Numerous pricklypear cactus (*Opuntia* spp. Mill.) and an occasional soaptree yucca (*Yucca elata* Engelm.) were present. Tebuthiuron pellets containing 20% a.i. were applied to 8-ha plots at 0.31, 0.93, and 1.25 kg a.i./ha with a Piper Pawnee "C" aircraft. Plots were evaluated for brush kill 35 months after application.

Three more sites were in Cochise County, Ariz. Two were in the San Pedro Valley on the Little Boquillas Ranch. One site near Fairbanks was dominated by creosotebush and whitethorn acacia (*Acacia constricta* Gray). Tarbush, mariola (*Parthenium incanum* H.B.K.), and desert zinnia (*Zinnia acerosa* [DC.] Gray) were also present at lower densities. Soils at this site are shallow, well-drained, nearly to moderately steep, medium textured over a lime-cemented hardpan of the Kimbrough-Cave Association (Richmond 1971). Kimbrough is a loamy, mixed, thermic shallow Petrocalcic Calciustoll. Cave is a loamy, mixed, thermic shallow Typic Paleorthid.

The second site, near Hereford, was dominated by whitethorn acacia with desert zinnia, broom snakeweed, honey mesquite, and burroweed (*Haplopappus tenuisectus* [Greene] Blake) present. Soils at this site are deep, well-drained, nearly level to hilly, fine-textured, of the White-House-Tubac-Forrest Association. White House and Forrest are fine, mixed, thermic Ustollic Haplargids, and Tubac is a fine, mixed, thermic Typic Paleargid. The elevations are 1,220 and 1,300 m at the Fairbanks and Hereford sites, respectively.

The third site on the Cook Ranch is about 10 km east of Douglas-Bisbee International Airport at an elevation of about 1,375 m. Creosotebush, whitethorn acacia, and honey mesquite were the most abundant woody plants on the site, with tarbush, mariola, desert zinnia, broom snakeweed, skunkbush (*Rhus trilobata* Nutt.), and ocotillo (*Fouquieria splendens* Engelm.) less abundant. Soils at the Cook Ranch study area are shallow, well-drained sandy loams on the upper slopes and ridges belonging to the Kimbrough-Cave Association and the Comoro-Anthony-Grabe Association in the bottomland portions. Comoro and Grabe are coarse-loamy, mixed, thermic Cumulic Haplustolls, and Anthony is a coarse-loamy, mixed (calcareous), thermic Typic Torrifluvent. All 3 sites are in the Southeastern Arizona Basin and Range Resoure area and the Chihuahuan semidesert grassland environmental zone.

Tebuthiuron pellets containing 20% a.i. were applied on June 19, 1978, at Fairbanks and Hereford with a Thrush Commander equipped with a Transland spreader and slotted metering plate in the hopper. Treatments at Douglas were applied with a Piper Pawnee "C" on July 21, 1978. Rates of application at Fairbanks were 0.24, 0.64, and 1.25 kg a.i./ha. At Hereford they were 0.55, 1.10, and 1.65 kg a.i./ha; and at Douglas they were 0.28, 1.12, and 2.22 kg a.i./ha. Plots at the Hereford and Douglas sites were 8.0 ha and those at Fairbanks were 4.7 ha. Plots were evaluated 39 months after application by determining dead plants within each plot. Percentages of dead plants were subjected to analyses of variance, and means evaluated using Duncan's multiple range test ($P<0.05$) on all tests. We used variability within plots for our statistical comparisons because limited amounts of herbicide prevented replications.

Results and Discussion

On the Jornada sandy site, except the 0.48 kg a.i./ha rate, all treatments killed 55% or more of the honey mesquite (Table 1). Areas treated in 1977 and 1978 were dominated by mesquite sand dunes with occasional broom snakeweed. We observed that rates of 1.49 kg/ha or higher of tebuthiuron inhibited the growth and development of mesa dropseed (*Sporobolus flexuosus* [Thurb.] Rydb.) that normally increases when mesquite is controlled on sandy range sites (Herbel et al. 1983). Plots treated in 1979 and 1980 had a scattered stand of mesquite, some on dunes, but intermingled with mesa dropseed. Observations indicated that estab-

lished mesa dropseed in the 1979 and 1980 plots was not affected by tebuthiuron, but higher rates killed the seedlings. Sandy soils dominated the area but one end of the 1980 plots occurred on a owland site with heavier soils where only 3% of the mesquite was killed. Counts obtained from this area were not included in the data shown in Table 1. Lowland areas or sites with heavier soils apparently need more tebuthiuron than was used to obtain satisfactory kills.

Table 2 shows the creosotebush and tarbush kill using tebuthiuron on the Jornada. Tebuthiuron killed over 60% of the target species, except for the application of 0.29 kg/ha in 1978. Observations showed a large increase in the basal cover of the residual stands of bush muhly (*Muhlenbergia porteri* Scribn.), tobosa (*Hilaria mutica* [Buckl.] Benth.), and mesa dropseed on the areas treated with tebuthiuron, compared to adjacent untreated areas.

On the Goodsite Ranch, the 0.31 kg/ha rate of tebuthiuron did not control creosotebush, but the 0.93 and 1.25 kg/ha rates both gave effective control (Table 3). The 0.31 kg/ha rate of tebuthiuron killed 35% of the broom snakeweed plants and the 2 higher rates killed all of them. The minimum rate for effective control of broom snakeweed at this site was not determined because of the large difference between the 2 lowest rates (0.31 and 0.93 kg/ha); however, it is probably near the 0.6 kg a.i./ha rate found to give effective control on the Southern High Plains (Sosebee et al. 1979). Observations indicated increased size and vigor of bush muhly and plains bristlegrass (*Setaria macrostachya* H.B.K.) on plots treated at the 2 high rates. Both desert holly (*Perezia nana* Gray) and Russian thistle (*Salsola kali* L.) plants were abundant on the plot treated with tebuthiuron at 0.93 kg/ha, and they were present but not abundant on plots treated at the 0.31 and 1.25 kg/ha rates. The lower rate did not effectively control woody plants which were competing with these plants for moisture, and the higher rate was phytotoxic to these species.

Excellent control of all species was obtained with all rates of tebuthiuron at the Fairbanks site (Table 4). One possible reason for the high mortality at Fairbanks was the shallowness and coarse texture of the soils. The 0.55 kg/ha rate killed 64% of whitethorn acacia plants at Hereford, compared to 91 and 93% at the 0.27 and 0.64 kg/ha rates at Fairbanks (Table 4). The 0.55 kg/ha rate killed 88% of zinnia plants; whereas, all rates killed all desert zinnia at Fairbanks. Increased stands of bush muhly, spike dropseed (*Sporobolus contractus* A. Hitchc.), and threeawns (*Aristida* spp. L.) were observed on all the treated plots at the Fairbanks site. Broom snakeweed control was not as high at Hereford as at the Goodsite Ranch, with the 0.55 and 1.10 kg/ha rates killing 69 and 65% of the broom snakeweed plants, respectively, at Hereford. However, the 0.93 and 1.25 kg/ha rates killed all broom snakeweed plants at Goodsite. At Hereford, tebuthiuron treatments were less effective in killing burroweed and honey mesquite than broom snakeweed. Observations indicated an increase in the cover of bush muhly and plains bristlegrass with all treatments at the Hereford site.

At Douglas (Table 5) the 0.28 kg/ha rate was not as effective in controlling creosotebush as the 0.27 kg/ha rate at Fairbanks, or the 0.20 and 0.28 kg/ha rates at the Jornada. Also, the 0.28 kg/ha rate was less effective in controlling whitethorn acacia at Douglas than at Fairbanks, but was comparable to the results at Hereford. Higher rates, 1.12 and 2.22 kg/ha, gave nearly complete kills of whitethorn acacia at Douglas. Observations indicated an increased stand of bush muhly and gramas (*Bouteloua* spp. Lag.) on all plots at Douglas.

Tebuthiuron was not as effective in killing honey mesquite at comparable rates at the Douglas site as at the Jornada or Hereford sites. This occurred because most honey mesquite plants are growing on the bottomland portions of the Douglas plots which have deeper, finer-textured soils.

Tarbush was susceptible to tebuthiuron and good control was obtained at all rates at all sites. Desert zinnia was not effectively controlled by the 0.28 kg/ha rate of tebuthiuron, but higher rates gave excellent control. Skunkbush and ocotillo plants were highly susceptible to tebuthiuron at all rates.

From these data in the arid Southwest, we obtained satisfactory control of woody species under the following conditions and rates of tebuthiuron pellets:

1. Honey mesquite growing on loamy sands to sandy loams, about 1.0–1.2 kg a.i./ha;
2. Creosotebush growing on sandy loams to loams, about 0.4 kg a.i./ha.
3. Tarbush growing on loams, about 0.3 kg a.i./ha.
4. Broom snakeweed growing on sandy loams to loams about 0.6 kg a.i./ha. (to insure adequate distribution, pellets with 10% a.i. may be superior to pellets with 20% a.i.).
5. Whitethorn acacia growing on sandy loams to loams, about 0.6 kg a.i./ha.
6. Mariola growing on sandy loams, about 0.3 kg a.i./ha; on

Table 3. Mortality of creosotebush and associated species with broadcast aerial application of pelleted tebuthiuron on the Goodsite Ranch, Deming, New Mexico.

Plant species	Rate of application[1]		
	0.31 kg/ha	0.93 kg/ha	1.25 kg/ha
	% dead		
Creosotebush	2[a2]	82[b]	97[c]
Broom snakeweed	35[a]	100[b]	100[b]
Cactus	0	0	0

[1]Active ingredient.
[2]Means followed by the same letter within a row are not significantly different ($P<.05$).

Table 4. Mortality of shrubs with broadcast aerial applications of pelleted tebuthiuron on the Little Boquillas Ranch, Cochise County, Arizona.[1]

Plant speciea	Fairbanks site			Hereford site		
	Application rate (kg/ha)[2]					
	0.27	0.64	1.25	0.55	1.10	1.65
	% dead					
Creosotebush	78[a3]	81[a]	100[a]	—	—	—
Whitethorn acacia	91[b]	93[b]	100[b]	64[a]	98[b]	98[b]
Tarbush	87[a]	90[a]	100[a]	—	—	—
Mariola	100[a]	100[a]	100[a]	—	—	100[a]
Desert zinnia	100[a]	100[a]	100[a]	88[a]	100[a]	100[a]
Broom snakeweed	—	—	—	69[a]	65[a]	95[b]
Burroweed	—	—	—	54[a]	62[a]	90[b]
Honey mesquite	—	—	—	38[a]	71[b]	69[b]

[1]Applied June 19, 1978, evaluated September 1981.
[2]Active ingredient.
[3]Means followed by the same letter within a row are not significantly different ($P<.05$).

Table 5. Mortality of shrubs with broadcast aerial applications of pelleted tebuthiuron on the Cook Ranch, Douglas, Arizona.[1]

Plant species	Rate of tebuthiuron (kg/ha)[2]		
	0.28	1.12	2.22
	% dead		
Creosotebush	42[a3]	100[b]	100[b]
Whitethorn acacia	54[a]	96[b]	98[b]
Honey mesquite	25[a]	36[a]	65[b]
Tarbush	78[a]	100[b]	100[b]
Mariola	9[a]	100[b]	100[b]
Desert zinnia	32[a]	100[b]	100[b]
Broom snakeweed	18[a]	86[b]	100[b]
Skunkbush	50[a]	100[b]	100[b]
Ocotillo	60[a]	100[b]	100[b]

[1]Applied July 21, 1978; evaluated September 15, 1981.
[2]Active ingredient.
[3]Means followed by the same letter within a row are not significantly different ($P<.05$).

loams, about 1.0 kg a.i./ha.

7. Desert zinnia growing on sandy loams to loams, about 0.5 kg a.i./ha.
8. Skunkbush growing on loams, about 0.6 kg a.i./ha.
9. Ocotillo growing on loams, about 0.3 kg a.i./ha.
10. Burroweed growing on sandy loams, about 1.0 kg a.i./ha.

Tebuthiuron proved to be highly effective for control of creosotebush, whitethorn acacia, tarbush, broom snakeweed, and honey mesquite at several locations in the arid Southwest. Tebuthiuron had little effect on cactus. Soil type strongly influenced the degree of control obtained. Higher rates of tebuthiuron were needed to control woody plants on deep, fine textured soils than on shallow, coarse textured soils. Observations indicated a substantial increase of herbaceous plants on some plots. Future trials should measure this response.

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