Mixed-Brush Reestablishment Following Herbicide Treatment in the Davis Mountains, West Texas

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ABSTRACT

Regeneration of *Mimosa biuncifera* (catclaw mimosa), *Acacia greggii* (catclaw acacia), and associated vegetation was assessed following application of the herbicide tebuthiuron (1.7 kg a.i. ha^{-1}) in the Davis Mountains, Texas. Density and foliar cover of shrubs, foliar cover of herbaceous vegetation, and presence of catclaw seed banks were assessed on herbicide-treated and untreated control sites. Tebuthiuron did not completely kill catclaw shrubs, nor did it prevent shrub regeneration within six years of treatment. Regrowth occurred from basal crowns, aerial stem sprouts, and seedlings of both species. *Aloysia gratissima* and *A. wrightii* (whitebrush) were effectively eliminated by herbicide treatment and showed no indication of regeneration on treated sites. Within the herbicide treatment, *Aristida* sp. (perennial threeawn) and *Bouteloua curtipendula* (sideoats grama) had higher foliar cover, perhaps in response to shrub reductions. Catclaw seeds were not detected in the seed bank, although seedlings did emerge on treated sites, suggesting a transient seed pool. Although tebuthiuron treatment impacted vegetation composition and abundance, significant potential remains for mixed-brush communities to dominated these sites.

KEYWORDS: *Acacia greggii*, catclaw, *Mimosa biuncifera*, seed bank, tebuthiuron, Trans-Pecos

Catclaws [*Mimosa biuncifera* Benth (catclaw mimosa) and *Acacia greggii* Gray (catclaw acacia)] and associated shrubs are distributed in mountains and valleys throughout the Trans-Pecos Natural Region of far-west Texas. These mixed-brush vegetation assemblages typically form dense thickets which have likely encroached upon grasslands during the past century, as well as increased in abundance throughout their range (Powell, 1988). Because of their density and spinescent nature, these shrubs have become a serious deterrent to physical movement by

Accepted 2 Jul 1996. This research was funded in part by the Houston Livestock Show & Rodeo, Inc., and Sul Ross State University Research Enhancement. The authors gratefully acknowledge the McCoy Land and Cattle Company for permission to conduct research on the Seven Springs Ranch. Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the authors and does not imply its approval to the exclusion of other products or vendors. *Corresponding author.

livestock and wildlife (McGinty et al., 1992). Furthermore, based on studies in similar ecosystems, it is perceived that these shrubs compete substantially with herbaceous forage species for limited resources (*e.g.* water), thus reducing forage production potential (Morton et al., 1990).

Catclaw shrubs can be effectively top-killed when treated with 1.7 kg a.i. ha^{-1} of tebuthiuron (Spike 20P), aerially applied in a dry pelleted form (Nelson and Vick, 1988; McGinty et al., 1992). However, initial treatment costs are high, in excess of \$108.68 ha^{-1}, making long-term shrub suppression critical to the cost-effectiveness of the treatment. Based on an assumed cost of \$108.68 ha^{-1} and a 4% discount rate, the treatment would have to last in excess of 50 years to recoup initial treatment costs (McGinty et al., 1992). However, preliminary results from herbicide applications made annually from 1988 to 1992 in the Davis Mountains of West Texas on this shrub complex indicate that within four years of initial treatment, shrubs begin to reestablish on treated sites (McGinty et al., 1992).

From this preliminary work it appears that a pivotal question in the treatment and control of these species is: what mechanisms of reproductive biology allow catclaw shrubs to rapidly recolonize a site? The objectives of this study were to quantitatively assess mechanisms of plant establishment for *A. greggii* and *M. biuncifera* following tebuthiuron application in the Davis Mountains, Texas. We hypothesized that new plant recruitment must arise from either viable seeds or resprouts from existing vegetative structures. Seeds may be present as a persistent seed bank, or come from off-site seed recruitment. In either situation, seeds would be present in the seed bank. The specific objectives of this study were to: 1) assess the number of catclaw and associated shrubs developing on these sites, 2) determine what proportion of shrubs arise from seed and vegetative structures, 3) determine the presence and relative abundance of catclaw shrub seed banks, 4) relate the presence of a seed bank and new stem sprouts to the reestablishment potential of catclaw shrubs, and 5) assess response of herbaceous foliar cover to herbicide treatment.

METHODS

Study Area

The study was located on an Igneous Hill and Mountain range site within a desert grassland vegetation zone (Turner, 1977; Jaco, 1980) on the McCoy Land and Cattle Co. Seven Springs Ranch, about 12 km south of Toyahvale, Jeff Davis and Reeves Counties, Texas. The area occurs in a transition zone between the Davis Mountain range and the Pecos Plain in the northeastern Chihuahuan Desert (Powell, 1988). Study sites were on predominantly SE slopes at elevations between 1,370 to 1,575 m. Area winters are typically cool and dry, while summers are hot. Precipitation totals 30 to 36 cm annually and occurs mainly from July through August. Soils are primarily a Brewster stony loam series, Lithic Haplustoll (Turner, 1977), which occur in rough topography where slopes often exceed 7%.

Climax vegetation consists of short- and midgrasses, with some perennial forbs and woody shrubs (Turner, 1977; Jaco, 1980). Extant herbaceous species included *Aristida* sp. (perennial threeawn), *Bouteloua eriopoda* (black grama), *Bouteloua gracilis* (blue grama), *Bothriochloa barbinodis,* and *Schizachyrium* sp. (bluestem grasses). The shrub component included *Acacia greggii* (catclaw acacia), *Aloysia* sp. (whitebrush), *Mimosa biuncifera* (catclaw mimosa), and *Opuntia* sp. (cacti). Catclaw shrubs were the dominant shrubs found in draws and on hillside slopes. Nomenclature follows Hatch et al. (1990).

Commercial applications of Spike 20P pelleted herbicide were made during August of 1988, 1989 and 1991 at 1.7 kg a.i. ha^{-1}. Four study sites were selected, each represented by an herbicide-treated and untreated control site, yielding four replicates. Study sites were grazed following treatment.

Vegetation Assessment

Three categories were inventoried for each shrub species: 1) seedlings -- small plants with no attachment to mature crowns or root systems, 2) basal sprouting plants -- top killed individuals exhibiting sprouting from basal regions, and 3) aerial sprouting stems -- shoots arising from stems of mature plants that had been top-killed. An entire plant was considered an individual, irrespective of the number of stems emerging from the crown. Foliar cover and density of shrubs were assessed using 20 stratified random 20.0 m^2 circular quadrats per replicate ($n=80$ per treatment). Herbaceous vegetation was evaluated with a modified canopy coverage method (Daubenmire, 1959), using 20 stratified random quadrats (25 x 50 cm) sampled in each treatment replication ($n=80$ per treatment). Samples were collected between July and October 1993.

The shrub seed bank was assessed by collecting 30 stratified random soil samples (1.9 x 5 cm) from each treatment replicate using an Oakfield soil sampler between July and October 1993 ($n=120$ per treatment). Soil samples were sieved through U.S. standard 10 to 18 sieves (2 to 1 mm) to isolate shrub seeds, which were then removed and compared with voucher specimens for identification.

Significant differences ($P \leq 0.05$) among treatments were tested using a completely random one-way analysis of variance with SPSS/PC+ V4.0 (SPSS Inc. 1990). Density data were subjected to a square root transformation $[(x + 0.5)^{1/2}]$ prior to analysis, whereas cover data were subjected to an arcsine transformation [arcsine $(x)^{1/2}$] prior to analysis. Means and standard errors are presented as untransformed values.

RESULTS AND DISCUSSION

Woody Vegetation

By the third through sixth years following treatment, total live plants of *Mimosa biuncifera* were significantly fewer in the herbicide treatment (Table 1). McGinty et al. (1992) noted almost complete control of *Mimosa* for the first two years following initial herbicide treatment in the same area. *Mimosa* density was also significantly lower on treated sites for seedlings and aerial sprouts (Table 1), indicating the herbicide effectively reduced stem density. However, the presence of seedlings and residual mature plants indicated a strong replacement potential for shrubs, and that long-term efficacy of the herbicide may be limited. This is further supported by high foliar cover of *Mimosa* basal sprouts and seedlings on treated sites relative to controls, which characterized the fairly rapid replacement of *Mimosa* tissues following herbicide treatment.

Table 1. Mean density per ha (± 1 *SE*) for three categories of woody plant species found in herbicide (tebuthiuron) treated and control sites on the Seven Springs Ranch (n=80).

Species	Basal Sprouts		Seedlings		Aerial Sprouts		Total (All Categories)	
	Herb	Control	Herb	Control	Herb	Control	Herb	Control
MIBI†	758.0 (200.0)	358.0 (110.0)	75.0 (37.0)*	0.0 (0.0)	425.0 (117.0)*	8733.0 (632.0)	1258.0 (275.0)*	9092.0 (596.0)
ACGR	208.0 (147.0)	0.0 (0.0)	33.0 (26.0)	0.0 (0.0)	47.0 (30.0)*	425.0 (187.0)	283.0 (155.0)	425.0 (171.0)
ALOY	0.0 (0.0)*	825.0 (290.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)*	1225.0 (224.0)	0.0 (0.0)*	2055.0 (446.0)
ACCO	42.0 (30.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	108.0 (100.0)	42.0 (30.0)	108.0 (100.0)
AGAV	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	42.0 (18.0)*	0.0 (0.0)	42.0 (18.0)*	0.0 (0.0)
COER	150.0 (79.0)	33.0 (33.0)	0.0 (0.0)	0.0 (0.0)	242.0 (127.0)	0.0 (0.0)	392.0 (156.0)*	33.0 (33.0)
OPUN	75.0 (37.0)	17.0 (12.0)	0.0 (0.0)	0.0 (0.0)	108.0 (43.0)	133.0 (37.0)	183.0 (54.0)	150.0 (38.0)
PRGL	1050.0 (481.0)	892.0 (403.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	175.0 (107.0)	1050.0 (481.0)	1066.0 (417.0)

† MIBI=*Mimosa biuncifera;* ACGR=*Acacia greggii;* ALOY=*Aloysia* sp.; ACCO=*Acacia constricta*; AGAV=*Agave* sp.; COER=*Condalia ericoides*; OPUN=*Opuntia* sp.; PRGL=*Prosopis glandulosa.*
*Significant difference within row for a given sprout location ($P \leq 0.05$) .

Mature plant density and foliar cover of *Acacia greggii* was significantly lower on herbicide-treated than control sites (Tables 1 and 2). Mean density and foliar cover of basal sprouts and seedlings, however, did not appear to be affected by herbicide treatment. The total number of *A. greggii* plants was also not affected by the herbicide, which suggests that the *Acacia* was more tolerant of the herbicide than *Mimosa*, results supported by McGinty et al. (1992). Basal sprouts, aerial sprouts, and total number of live plants of *Aloysia* sp. were, however, significantly less on treated than control sites (Table 1). Tebuthiuron appears an effective means to control *Aloysia*. Similar reductions have been noted in Texas using pelleted tebuthiuron (Scifres et al., 1979; Meyer and Bovey, 1980).

Prosopis glandulosa was not significantly affected by the tebuthiuron treatment (Table 1), comparable to results obtained by Scifres et al. (1979). *P. glandulosa* has been shown to have significant control by soil applied tebuthiuron on clay-loam soils in south central Texas (Meyer and Bovey, 1979) and southern New Mexico (Herbel et al., 1983), but success has been limited in deep, fine-textured soils in Arizona (Herbel et al., 1983). Herbel et al. (1983) noted good results for *P. glandulosa* were obtained in the southwestern United States on loamy-sand to sandy-loam soils with 1.0 to 1.2 kg a.i. ha^{-1}, but that fine-textured soils required higher application rates to achieve plant mortality. Basal sprouts and new seedling growth of woody plants were often found only where the base of a top-killed plant remained. The amount of organic matter and clay content in the soil affects the absorption of tebuthiuron (Coffman et al., 1993; Duncan and Scifres, 1983). Tebuthiuron is not an herbicide recommended for use on *Prosopis glandulosa* (Welch, 1991).

Several species showed no response to herbicide treatment, but their representation in the community was so small that sample size was insufficient for definitive interpretations. *Opuntia* sp., *Acacia constricta* (whitethorn acacia), and *Condalia ericoides* (javelinabush) density and foliar cover estimates were not significantly different between treatments (Tables 1 and 2), although Herbel et al. (1983) noted good control of *A. constricta* with tebuthiuron on coarse-textured soils. Tebuthiuron appears to have little impact on *Opuntia* sp. when applied at labeled rates (Scifres et al., 1979; Herbel et al., 1985). *Agave* sp. were not present in any control sites, however, total plant density and mean foliar cover were significantly greater on the herbicide-treated sites (Tables 1 and 2). This may have been related to minor site differences that were not readily apparent, but it was perhaps in response to a reduction in the abundance of competing species.

Herbaceous Vegetation

Five grass taxa and one forb dominated the understory on all of the sites (Table 3). Three species showed significant differences between treatments; *Aristida* sp., *Bouteloua curtipendula*, and *Hilaria mutica* (tobosa grass). Mean foliar cover of *Aristida* sp. and *B. curtipendula* were significantly greater on the treated than control sites (Table 3). Once shrub dominance was reduced, these two grasses appeared to respond favorably to release from competition. *H. mutica*, however, exhibited lower foliar cover in the herbicide treatment (Table 3). Tebuthiuron may have directly affected individual plants, as occurred with *Sporobolus flexosa* (mesa dropseed) in southern New Mexico (Herbel et al., 1985). Negative effects on grass production have been noted in south Texas where application rates over 2.24 kg a.i. ha^{-1} of tebuthiuron were applied (Scifres and Mutz, 1978). However, minor

Table 2. Mean foliar percent cover (±1 *SE*) for three categories of woody plant species found in herbicide (tebuthiuron) treated and control sites on the Seven Springs Ranch (n=80).

Species	Basal Sprouts		Seedlings		Aerial sprouts		Total (All Categories)	
	Herb	Control	Herb	Control	Herb	Control	Herb	Control
MIBI†	3.1 (0.94)*	1.1 (0.27)	0.1 (0.04)*	0.0 (0.00)	2.1 (0.54)*	48.8 (3.31)	5.2 (1.15)*	50.0 (3.21)
ACGR	0.5 (0.25)	0.0 (0.00)	0.1 (0.04)	0.0 (0.00)	0.2 (0.14)*	1.8 (0.80)	0.7 (0.35)	1.8 (0.80)
ALOY	0.0 (0.00)*	2.0 (0.55)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)*	8.4 (1.48)	0.0 (0.00)*	10.4 (1.84)
OPUN	0.1 (0.05)	0.0 (0.02)	0.0 (0.00)	0.0 (0.00)	0.2 (0.08)	0.3 (0.09)	0.3 (0.09)	0.3 (0.09)
ACCO	0.1 (0.07)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.2 (0.16)	0.8 (0.67)	0.3 (0.19)	0.8 (0.67)
PRGL	1.0 (0.43)	1.9 (0.85)	0.0 (0.00)	0.0 (0.00)	0.1 (0.08)	0.4 (0.25)	1.1 (0.44)	2.3 (0.88)
COER	0.0 (0.02)	0.1 (0.07)	0.0 (0.00)	0.0 (0.00)	0.4 (0.19)*	0.0 (0.00)	0.4 (0.19)	0.1 (0.07)
AGAV	0.1 (0.04)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.4 (0.13)*	0.0 (0.00)	0.4 (0.13)*	0.0 (0.00)

†MIBI=*Mimosa biuncifera*; ACGR=*Acacia greggii;* ALOY=*Aloysia* sp.; OPUN=*Opuntia* sp.; ACCO=*Acacia constricta*; PRGL=*Prosopis glandulosa*; COER=*Condalia ericoides*; AGAV=*Agave* sp.
*Significant difference within row for a given sprout location ($P \leq 0.05$).

variation in range site characteristics between treatment and control sites may have been the dominant influence. Herbicide treatment had no apparent effect on foliar cover for *B. gracilis*, *Heteropogon contortus* (tanglehead), and *Solanum* sp. (nightshade) (Table 3).

Table 3. Mean foliar cover (%) (± 1 *SE*) for herbaceous plants found in herbicide treated and control sites on the Seven Springs Ranch (n=80).

Species	Herbicide	Control	F Prob.
Aristida sp.	4.3 (0.22)	0.5 (0.50)	0.005*
Bouteloua curtipendula	19.0 (3.18)	8.0 (1.79)	0.003*
Hilaria mutica	0.6 (0.40)	5.0 (2.03)	0.033*
Bouteloua gracilis	3.7 (0.91)	3.2 (0.84)	0.672
Heteropogon contortus	4.7 (1.12)	2.5 (1.03)	0.154
Solanum sp.	0.5 (0.26)	1.2 (0.53)	0.235
Total	32.8 (7.09)	20.4 (6.72)	

*Significant difference within row ($P \leq 0.05$)

Seed Bank

From 240 soil samples, no seeds of *M. biuncifera* or *A. greggii* were found. Five *Acacia constricta* seeds were encountered, and all were present in untreated control areas. Granivory by rodents has been noted as an important mechanism in reducing seed banks in desert environments (Soholt, 1973; Kemp, 1989). Javelinas (*Dicotyles tajaccu*) reportedly utilize catclaw and mesquite (*Prosopis* sp.) seeds as a food source (Sowles, 1980). During the study several groups of javelinas were observed rooting around the base of *Mimosa* plants, and mule deer (*Odocoileus hemionus*) were observed eating seed pods and leaves of *M. biuncifera* and *A. greggii* near a study site. Kemp (1989) contends that shrubs in hot deserts rely on the annual production of relatively small seed crops for reproduction rather than the accumulation of large persistent seed banks. Small annual seed crops permit greater opportunity to respond to favorable environmental conditions for seed germination, and avoid reliance on a persistent seed bank which is subject to predation by rodents and ants which seek relatively large shrub seeds as a food source. Our failure to detect appreciable shrub seed density indicates an absence of persistent seeds and suggests dependence on other reproductive strategies (e.g. a transient seed bank and vegetative sprouting).

Synthesis and Conclusions

Initial response of *Mimosa biuncifera* and *Aloysia* sp. to tebuthiuron application in these communities was very favorable (McGinty et al., 1992), with 91-100%

control (initial density was 1,436-2,152 ha^{-1}) in the first year following treatment. *Acacia greggii* showed control levels of 42-60% (initial density was 0-1,507 ha^{-1}) during this period. For nearby areas treated in the same manner, however, plant densities after herbicide application were 1,250 ha^{-1} for *M. biuncifera*, and 300 ha^{-1} for *A. greggii* by 1993. *Aloysia* sp. still showed no regeneration, whereas *Prosopis glandulosa* was not affected.

In the 2 to 6 years following herbicide treatment a substantial number of mixed-brush plants reestablished. Although no seeds of *M. biuncifera* or *A. greggii* were found in soil samples, seedling plants were encountered, demonstrating the probable existence of at least a transient seed pool. This is indicative of the potential role seeds play in recolonizing herbicide treated areas. The primary source of regeneration, though, was by resprouting from crowns and aerial stems. It appears the herbicide initially impacted catclaw shrubs, but after a brief quiescent period, they initiated new growth from existing tissue (Tables 1 and 2). Marked differences were noted in herbaceous vegetative cover, with significantly greater cover for several species on treated sites, notably *B. curtipendula*.

Treatment with tebuthiuron at 1.7 kg ha^{-1} on mixed-brush in the Davis Mountains of West Texas effected notable compositional shifts in vegetation following initial treatment. The effects appear to be relatively short-lived, though, with respect to plant density and foliar cover of key species of the shrub community complex. With the cost-effectiveness of herbicide treatment in this instance dependent on a treatment life in excess of 50 years, it appears that a tebuthiuron treatment regimen for catclaw and associated shrubs will not recover costs.

REFERENCES

Coffman, C.B., J.R. Frank, and W.E. Potts. 1993. Crop responses to hexazinone, imazapyr, tebuthiuron, and triclopyr. Weed Tech. 7:140-145.

Daubenmire, R. 1959. A canopy-coverage method of vegetational analysis. Northwest Sci. 33:43-64.

Duncan, K.W., and C.J. Scifres. 1983. Influence of clay and organic matter of rangeland soils on tebuthiuron effectiveness. J. Range Manage. 36:295-297.

Hatch, S.L., K.N. Gandhi, and L.E. Brown. 1990. Checklist of the vascular plants of Texas. Texas Agric. Exp. Sta. MP-1655, College Station.

Herbel, C.H., W.L. Gould, W.F. Leifeste, and R.P. Gibbens. 1983. Herbicide treatment and vegetation response to treatment of mesquites in southern New Mexico. J. Range. Manage. 36:149-151.

Herbel, H.H., H.L. Morton, and R.P. Gibbens. 1985. Controlling shrubs in the arid southwest with tebuthiuron. J. Range Manage. 38:391-394.

Jaco, H.B. 1980. Soil survey of Reeves County, Texas. USDA Soil Cons. Serv., Washington, DC.

Kemp, P.R. 1989. Seed banks and vegetation process in deserts, p. 257-281 In M.A. Leck et al. (eds.). Ecology of soil seed banks. Academic Press, San Diego.

Meyer, R.E., and R.W. Bovey. 1979. Control of honey mesquite (*Prosopis juliflora* var. *glandulosa*) and associated species with soil applied herbicides. Weed Sci. 28:204-212.

Meyer, R.E., and R.W. Bovey. 1980. Control of whitebrush (*Aloysia lycioides*)

and associated species with soil-applied herbicides. Weed Sci. 28:204-212.
McGinty, A., L. Boswell, and W. Seipp. 1992. Treatment life following control of mixed brush in the Davis Mountain area, p.40-44. In A. McGinty (ed.). 1992 Farwest-District VI range result demonstration. Texas Agric. Ext. Serv. College Station.
Morton, H.L., F.A. Ibarra-F, M.H. Martin-R, and J.R. Cox. 1990. Creosote-bush control and forage production in the Chihuahuan and Sonoran Deserts. J. Range Manage. 43:43-48.
Nelson, J.T., and C. Vick. 1988. Chemical control of mesquite, creosotebush, and catclaw mimosa with tebuthiuron and subsequent grass production. Texas J. Agric. Nat. Resour. 2:30-31.
Powell, M.A. 1988. Trees and shrubs of Trans-Pecos Texas. Big Bend Nat. History Assoc., Inc.
Scifes, C.J., and J.L. Mutz. 1978. Herbaceous vegetation changes following applications of tebuthiuron for brush control. J. Range Manage. 31:375-378.
Scifres, C.J., J.L. Mutz, and W.T. Hamilton. 1979. Control of mixed brush with tebuthiuron. J. Range Manage. 32:155-158.
Soholt, L.F. 1973. Consumption of primary productivity by a population of kangaroo rats (*Dypodomys merriami*) in the Mojave Desert. Ecol. Monogr. 43:357-367.
Sowles, L.K. 1980. Collared peccary. In J. L. Schmidt and D. L. Gilbert (eds.). Big game of North America. Stackpole Books, Harrisburg, PA.
SPSS Inc. 1990. SPSS/PC 4.0 Base manual. Chicago.
Turner, A.J. 1977. Soil survey of Jeff Davis County, Texas. USDA Soil Cons. Serv., Washington, DC.
Welch, T.G. 1991. Chemical weed and brush control: suggestions for rangeland. Texas Agric. Ext. Serv. B-1466, College Station.