Control of honey mesquite with herbicides: influence of plant height

P.W. JACOBY, C.H. MEADORS, AND R.J. ANSLEY

Abstract

Stands of honey mesquite (*Prosopis glandulosa* var. *glandulosa*) were treated with aerially applied herbicides at 16 locations in western and northwestern Texas over an 8-year period to determine influence of plant height on herbicide efficacy. Plant height was not found to significantly ($P < 0.05$) influence effectiveness of a particular herbicide, but taller plants were found consistently to be more resistant. No basis was found for delaying control of honey mesquite with herbicides until plants reach a particular height.

Key Words: clopyralid, triclopyr, 2,4,5-T, picloram, plant resistance

Honey mesquite (*Prosopis glandulosa* var. *glandulosa*) has maintained essentially the same distribution and density on 22 million ha of Texas rangeland for over 4 decades despite substantial control efforts (Rechenthin et al. 1964). Although mesquite has a proven ability to reproduce in large numbers from seed, such events are mainly episodic, occurring after periods of drought and overgrazing have weakened the competitive ability of native grasses (Fisher et al. 1959, Bovey and Meyer 1981). Reestablishment of mesquite following control by aerial application of herbicides or mechanical top removal may relate more directly to the degree of plant mortality achieved with the treatment than any other factor. Honey mesquite vigorously resprouts from dormant buds at the stem base when apical dominance is broken (Fisher et al. 1946).

The herbicide 2,4,5-T [(2,4,5-trichlorophenoxy)acetic acid], which was widely used for mesquite control until its production and sale were discontinued in the early 1980's, was highly variable in producing mortality of honey mesquite (Meyer et al. 1972). Much of this variability in control has been attributed to environmental factors; however, growth type and plant height have been suggested as variables which may influence mortality (Fisher et al. 1956, Dahl et al. 1971, Meyer et al. 1972). After considerable observation, Fisher et al. (1956, 1959) concluded that regrowth must reach a height of 1.5 m or more to provide sufficient foliage to intercept and translocate enough herbicide to produce complete plant mortality of honey mesquite. These reports led subsequently to the recommendation in Texas that aerial spraying on mesquite be delayed until plants were at least 1.5 m tall and 4 to 6 years old

with dense foliage (Hoffman 1975).

We found little published data to support the concept that honey mesquite can be more effectively reduced or killed as it attains increased age or height. Therefore, our objective in this study was to determine the influence of plant height on degree of mesquite stand mortality in order to test our hypothesis that height of plants has little, if any, influence on degree of mortality following aerial application of herbicides.

Materials and Methods

Herbicides were applied to honey mesquite at 16 locations in western and northwestern Texas from 1977 to 1983. Herbicides included 2,4,5-T, triclopyr [(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid, clopyralid (3,6-dichloro-2-pyridinecarboxylic acid) and equal part [acid equivalent (ae)] combinations of each with picloram (4-amino-3,5,6-trichloro-2-pyridinecarboxylic acid). All comparisons for this study were made at the 0.6 kg ha^{-1} rate of application in a total volume of 9 or 18 L ha^{-1} of a diesel oil:water emulsion [1:6 (v:v)]. Treatments were applied by fixed-wing aircraft to two or three 2-4 ha plots in a randomized complete block design. Some herbicide treatments were omitted from specific locations and these missing values were addressed in the analyses.

Evaluations were conducted after 3 growing seasons to allow sufficient time for herbicide activity to be completed and resprouting to occur. Individual plants (200 to 300 per plot) were examined for presence of live stem or leaf tissue and assigned to one of 3 height classes: $<1 \text{ m}$ = Class I; 1 to 2 m = Class II; and $>2 \text{ m}$ = Class III.

Data were processed by analysis of variance using percent plant mortality in each height class and plot as a data point. Percentage data were transformed ($\arcsin \sqrt{x}$) prior to analysis. Level of significance for mean separation was <0.05 and significantly differing means were separated by Tukey's procedure (Steel and Torrie 1980). Herbicides were compared within and among locations, and mortalities evaluated by height class within and among locations and herbicides. Significant interactions between herbicides, height classes and locations were not found and these sources of variation were incorporated into the general error term for the analyses (Steel and Torrie 1980).

Treatment locations incorporated a broad geographical region typical of rangeland on which honey mesquite poses a major management problem to landowners (Table 1). Although treatments were applied during the recommended 40 to 90 day period following budbreak (Fisher et al. 1959), differences in growth conditions among locations and years of study provide sources of error that are difficult to isolate and partition for statistical analysis without a large number of observations.

Authors are professor, research associate, and post-doctoral research associate, Texas A&M University Agricultural Research and Extension Center, P.O. Box 1658, Vernon, Texas 76384.

Research was funded in part by: University Lands-Surface Interests, Univ. Texas System, Midland; E. Paul and Helen Buck Waggoner Foundation, Vernon; and Brush Control and Range Improvement Association, Albany. Herbicides were provided by Dow Chemical, USA, and aerial application was furnished by: Hardcastle Ag-Air, Inc., Vernon; Bruton Aerial Spraying, Inc., Garden City, H&W Flying Serv., Midland; and Lynn Culp, Breckenridge. Detailed soil classification and mapping was provided by the Soil Conservation Service, USDA.

This article is published with the approval of the Director, Texas Agricultural Experiment Station as technical article TA-23924.

Manuscript accepted 17 May 1989.

Table 1. Description of experimental locations where aerial applications of herbicides were made to control honey mesquite in western and northwestern Texas. Descriptions include ecological regions in Texas, city nearest to the experimental location, range site, soil classification, and the soil temperature at 30–40 cm depth, air temperature and relative humidity (RH) on the day of treatment, and a general rating of amount of precipitation received from January to the treatment date [normal = (N), above normal = (+), below normal = (-)].

Ecological Region	Location	Treatment Date	Range Site	Soil Classification	Temp		R.H.	Precipitation
					Soil	Air		
					° C	° C	%	
Rolling Plains	Vernon	20 June 1977	clay loam	Typic Paleustolls	30	26–28	79–69	N
	Vernon	6 July 1979	clay loam	Typic Paleustolls	27	23–33	96–62	N
	Vernon	19 June 1981	clay loam	Typic Paleustolls	26	21–26	99–76	+
	Vernon	7 July 1981	clay loam	Typic Paleustolls	27	21–29	94–66	+
	Vernon	25 June 1982	clay loam	Typic Paleustolls	26	19–21	96–86	N
	Vernon	14 July 1982	clay loam	Typic Paleustolls	26	18–27	99–75	N
Limestone	Guthrie	7 June 1983	clay loam	Typic Paleustolls	19	10–14	94–84	+
	Baird	29 June 1979	clay loam	Typic Paleustolls	27	24–27	74–71	N
	Albany	27 June 1981	clay loam	Typic Paleustolls	27	21–29	74–67	+
Prairie Edwards Plateau	Barnhart	27 June 1979	clay loam	Petrocalcic Calciustolls	27	19–22	90–75	N
	Barnhart	26 June 1980	clay loam	Petrocalcic Calciustolls	28	21–30	72–62	–
	Barnhart	15 June 1983	clay loam	Petrocalcic Calciustolls	22	26–29	66–62	–
Trans Pecos South Plains	Ozona	8 July 1982	clay loam	Petrocalcic Calciustolls	26	23–27	80–76	+
	Crane	26 May 1977	sandy	Ustalfic Haplargids	28	22–29	84–50	+
	Post	25 May 1983	deep hardland	Aridic Paleustolls	22	16–22	96–72	–
High Plains	Dumas	7 July 1983	shallow upland	Calciorthidic Paleustolls	25	20–33	72–65	–

Results

For most locations, mortality of honey mesquite within a herbicide treatment either remained constant or decreased with increasing plant height (Table 2). Exceptions were found at Albany and Ozona with the combination of 2,4,5-T and picloram, at Dumas with triclopyr, and at Ozona with the combination of clopyralid and picloram. These data, while failing to establish any clear patterns of plant susceptibility by height, illustrate why confusion may exist regarding this relationship. Considering the data for 2,4,5-T alone, there appears to be little basis for suggesting that taller plants are more susceptible than shorter ones.

A more consistent trend was apparent when data were pooled across locations for the individual herbicide treatments (Table 3). Even though mortality of honey mesquite consistently decreased with increasing plant height, rarely were the differences significant. Degree of stand mortality was more consistent for clopyralid or its

mixture with picloram than found with the other herbicides. Being more efficacious against honey mesquite than the other herbicides, clopyralid consistently produced high mortality; whereas 2,4,5-T and triclopyr, applied alone or in combination with picloram, produced practically no mortality on occasion. Picloram reduced the variation in mortality achieved by either 2,4,5-T or triclopyr alone by increasing efficacy of those herbicides. However, picloram mixed with clopyralid increased variability over clopyralid alone and was less efficacious against small to medium height plants.

Comparing herbicides across all locations and height classes reiterates the improved efficacy of clopyralid over other herbicides for controlling honey mesquite (Table 3). Relative effectiveness of these herbicides is similar to those reported in other studies (Bovey and Mayeux 1980, Bovey et al. 1981, Jacoby et al. 1981, Jacoby and Meadors 1983).

Table 2. Percentage mortality of honey mesquite at each location according to herbicide and height class. Missing values are designated by dashed lines.

Location and Date		Herbicides																	
		2,4,5-T			2,4,5-T + picloram			Triclopyr			Triclopyr + picloram			Clopyralid			Clopyralid + picloram		
		I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
(%)																			
Vernon	20 June 1977	7	6	1	20	16	6	8	2	5	61	37	37	79	73	73	—	—	—
Vernon	6 July 1979	36	5	27	48	26	16	7	3	2	26	16	9	90	54	41	82	62	53
Vernon	19 June 1981	40	30	23	59	37	21	44	33	21	—	—	—	76	75	60	63	60	56
Vernon	7 July 1981	15	22	25	—	—	—	23	33	33	77	71	67	57	60	38	63	80	64
Vernon	25 June 1982	37	30	26	58	52	45	—	—	—	—	—	—	63	60	49	74	61	40
Vernon	14 July 1972	4	10	7	34	37	34	36	32	26	51	63	55	48	52	48	66	65	44
Guthrie	7 June 1983	10	9	10	24	15	1	24	21	23	20	12	7	—	—	—	38	44	17
Baird	29 June 1979	—	—	—	53	50	43	30	10	22	58	65	57	99	99	70	85	73	64
Albany	27 June 1981	3	1	5	17	27	41	2	8	8	—	—	—	89	71	71	41	50	50
Barnhart	27 June 199	16	4	10	49	45	28	24	19	10	38	22	14	52	77	44	74	70	48
Barnhart	26 June 1980	8	8	8	18	32	8	42	70	36	29	24	7	99	83	37	50	40	45
Barnhart	15 June 1983	59	68	62	36	35	24	35	38	23	27	33	20	86	91	83	82	82	83
Ozona	8 July 1982	10	14	14	49	61	62	—	—	—	—	—	—	62	74	64	73	75	85
Crane	5 May 1977	10	7	4	38	31	24	15	11	7	—	—	—	84	76	61	—	—	—
Post	25 May 1983	19	16	7	20	30	13	30	25	7	29	20	6	—	—	—	58	62	28
Dumas	7July 1983	76	60	54	89	85	90	31	16	87	93	91	85	—	—	—	87	96	91

Table 3. Mean mortality of honey mesquite summarized for all locations by herbicides or equal part mixtures applied at 0.6 kg ha⁻¹ and evaluated 3 post-treatment.

Herbicide	Height Class			Pooled Height
	I	II	III	$\bar{x}$
	%			(%)
2,4,5-T	25.5 a ¹	24.4 a	21.5 a	23.1 z ²
2,4,5-T + Picloram	40.4 a	38.3 a	29.9 b	36.2 y
Triclopyr	25.7 a	23.1 a	21.5 a	23.4 z
Triclopyr + Picloram	44.7 a	40.6 a	31.9 b	31.9 y
Clopyralid	76.4 a	74.0 a	58.6 b	69.7 x
Clopyralid + Picloram	67.9 a	66.8 a	56.7 b	63.8 x
Pooled Herbicide ($\bar{x}$)	44.8 a	42.5 a	35.3 b	

¹Means within a row followed by the same letter (a,b) are not significantly different at the 0.05 level of probability.

²Means within a column followed by the same letter (x,y,z) are not significantly different at the 0.05 level of probability.

Pooling mortality data by height class across all locations indicates a stronger difference than shown in previous comparisons (Table 3). Height of honey mesquite plants in this grouping indicates plants become more resistant to herbicides with increasing height, but efficacy was not significantly reduced until plant height exceeded 2 m.

Lack of significant interactions indicates that differences in mortality among herbicides, height classes, or locations were not strongly influenced by one another but rather, each variable responded independently. Therefore, the influence of height would be equally applicable to all herbicides and locations.

Discussion

These data, which are based on observed responses of more than 40 thousand individual honey mesquite plants to aerially applied herbicides, presents a sound basis for rejecting the concept that herbicidal treatments should be delayed until plants reach a particular height. In contrast, these data indicate that honey mesquite may become increasingly resistant to herbicidal control measures as they become taller.

Our data fail to explain why taller plants may be less susceptible to herbicides than shorter plants, leaving the reasons open to speculation. Intuitively, several possibilities can be enumerated. Shorter plants, after absorbing herbicide, have less distance to translocate the material to the basal bud zone. These shorter stems may not absorb or metabolize as much herbicide during translocation as would taller stems. Younger stem tissue, prior to the development of thick bark, may actively absorb herbicide spray and contribute to total herbicide uptake. Taller plants may also develop sufficient foliage to provide a shielding effect on a portion of the canopy, especially on the lower or leeward side of the tree during treatment. Taller plants may be deeper rooted, responding more slowly to soil warming, a factor linked to herbicide susceptibility.

Regardless of the causative factors, implications of this study fail to support the decision for a landowner to delay treatment of honey mesquite with aerially applied herbicides because of plant height. Delaying treatment provides mesquite additional time to grow and become more resistant, to compete with forage plants and reduce production of rangeland, and to interfere with livestock handling.

This study also indicates that risk avoidance can be accomplished by selection of a herbicide which is capable of producing high efficacy with consistency. Current recommendations for

retreating mesquite every 5 to 7 years are based on the low efficacy achieved with 2,4,5-T (Whitson and Scifres 1981, Van Tassel and Conner 1986). While this recommendation is still valid for triclopyr, more effective products such as clopyralid create new possibilities through higher degree of stand mortality. It has been noted that forage response associated with mesquite control may be lost 1 to 3 years after treatment unless a high degree of stand mortality is achieved (Dahl et al. 1978, Torell and McDaniel 1986). Achieving high levels of plant mortality would appear to be more advantageous than merely removing top growth, considering current prices for herbicides.

Summary

Height of individual honey mesquite plants was evaluated as influence on the effectiveness of aerially applied herbicides. Plant height was not found to influence the efficacy of any particular herbicide, although taller plants generally showed greater resistance. There does not appear to be any rationale for delaying herbicidal treatment until honey mesquite plants reach a specific height.

Literature Cited

- Bovey, R.W., and H.S. Mayeux. 1980. Effectiveness and distribution of 2,4,5-T, triclopyr, picloram, and 3,6-dichloropicolinic acid in honey mesquite (*Prosopis glandulosa* var. *juliflora*). Weed Sci. 28:666-670.
- Bovey, R.W., and R.E. Meyer. 1981. The response of honey mesquite to herbicides. Texas Agr. Exp. Sta. Bull. 1363.
- Bovey, R.W., R.E. Meyer, and J.R. Bauer. 1981. Potential herbicides for brush control. J. Range Manage. 34:144-148.
- Dahl, B.E., R.E. Sosebee, J.P. Goen, and C.S. Brumley. 1978. Will mesquite control with 2,4,5-T enhance grass production? J. Range Manage. 31:129-131.
- Dahl, B.E., R.B. Wadley, M.R. George, and J.L. Talbot. 1971. Influence of site on mesquite mortality from 2,4,5-T. J. Range Manage. 24:210-215.
- Fisher, C.E., J.L. Fultz, and H. Hopp. 1946. Factors affecting action of oils and water soluble chemicals in mesquite eradication. Ecol. Monogr. 16:10-126.
- Fisher, C.E., C.H. Meadors, and R. Behrens. 1956. Some factors that influence the effectiveness of 2,4,5-trichlorophenoxyacetic acid in killing mesquite. Weeds 4:139-147.
- Fisher, C.E., C.H. Meadors, R. Behrens, E.D. Robison, P.T. Marion, and H.L. Morton. 1959. Control of mesquite on grazing lands. Texas Agr. Exp. Sta. Bull. 935.
- Hoffman, G.O. 1975. Control and management of mesquite on rangeland. Texas Agr. Ext. Serv. Misc. Pub. 386.
- Jacoby, P.W., and C.H. Meadors. 1983. Triclopyr for control of honey mesquite (*Prosopis juliflora* var. *glandulosa*). Weed Sci. 31:681-685.
- Jacoby, P.W., C.H. Meadors, and M.A. Foster. 1981. Control of honey mesquite (*Prosopis juliflora* var. *glandulosa*) with 3,6-dichloro-picolinic acid. Weed Sci. 29:376-378.
- Meyer, R.E., R.W. Bovey, W.T. McKelvy, and T.E. Riley. 1972. Influence of plant growth stage and environmental factors on the response of honey mesquite to herbicides. USDA, Agr. Res. Serv., and Texas Agr. Exp. Sta. Bull. 1127.
- Rechenthin, C.A., H.M. Bell, R.J. Pederson, and D.B. Polk. 1964. Grassland restoration. II. Brush Control. USDA, SCS, Temple, Texas.
- Steel, R.G.D., and J.H. Torrie. 1980. Principles and procedures of statistics—a biometrical approach. McGraw-Hill Book Co., New York.
- Torell, L.A., and K.C. McDaniel. 1986. Optimal timing of investments to control honey mesquite. J. Range Manage. 39:378-382.
- Van Tassel, L.W., and J.R. Conner. 1986. An economic analysis of brush control practices and grazing systems in the Rolling Plains of Texas. Texas Agr. Exp. Sta. Misc. Pub. 1619.
- Whitson, R.E., and C.J. Scifres. 1981. Economic comparison of honey mesquite control methods with special reference to the Texas Rolling Plains. J. Range Manage. 34:415-420.