Control of honey mesquite with herbicides: influence of stem number

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

Abstract

Following aerial application of herbicides, stands of honey mesquite *(Prosopis glandulosa* var. *glandulosa)* were evaluated to determine the influence of individual plant stem number on herbicide efficacy. A highly significant ($P<0.01$) relationship was found between stem number and plant mortality, with herbicide resistance increasing sharply in plants with greatest numbers of stems. This relationship was consistent among all herbicides and plant heights, which suggests that stem number may be useful in selecting the type of control method employed on specific sites.

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

Honey mesquite *(Prosopis glandulosa* var. *glandulosa)* a dominant shrub on approximately 22 million ha of Texas rangeland, has been targeted for control efforts during the last half century. Aerially applied herbicides have been used extensively to control mesquite because of the ease of application to large areas of rangeland and cost advantages over mechanical alternatives. As with mechanical methods such as chaining, herbicides often kill only the topgrowth, allowing mesquite to resprout as a multi-stemmed plant. The difficulty with controlling multi-stemmed plants in contrast to more naturally occurring few-stemmed plants has been mentioned in other studies (Fisher et al. 1959) but has not received any specific study as a potential factor of plant resistance to herbicidal control.

The objective of this study was to quantify the influence of stem number of individual honey mesquite plants in aerially applied herbicide treatments.

Materials and Methods

Honey mesquite were aerially sprayed with herbicides near Vernon, Texas, in June 1981 and July 1982. Additional sites were treated near Albany in 1981 and near Ozona in 1982. All sites had been subjected to earlier control efforts involving either aerial spraying, chaining, or both. All sites supported mesquite stands containing plants having a range of height and stem number. All sites were characterized as clay loam range sites with Vernon and Albany having Typic Paleustoll soils and Ozona having a Petrocalcic Calciustoll. Topography at all locations was flat to gently rolling.

Herbicides included clopyralid (3,6-dichloro-2-pyridinecarboxylic acid), triclopyr {[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid}, picloram (4-amino-3,5,6-trichloro-2-pyridinecarboxylic acid), and 2,4,5-T [(2,4,5-trichloro-phenoxy)acetic acid], which were applied by fixed-wing aircraft at 0.6 kg [acid equivalent (ae)] ha^{-1} in 18 L ha^{-1} of a diesel oil and water emulsion [1:6 (v:v)]. At each location, treatments were applied in a randomized complete block design (Steel and Torrie 1980). Each treatment (herbicide) was applied to 2 or 4 individual plots 4 ha in size.

Evaluations were conducted after 3 growing seasons to allow sufficient time for herbicidal action to be completed and resprouting to occur. Within each plot, 200 to 300 individual honey mesquite plants were examined for the presence or absence of live stems or leaves and grouped into one of 3 height classes: $<$ 1m = Class I; 1 to 2m = Class II; and $>$ 2m = Class III. The number of basal support stems were counted for each plant. Stems were considered independent if branching occurred within 15 cm above ground level. Trees were grouped arbitrarily into 3 stem number categories for statistical analysis: 1 to 2 stems = single stemmed; 3 to 5 stems = few-stemmed; and $>$ 6 stems = many-stemmed.

Data were processed by analysis of variance using percent plant mortality for each stem number class by height class and plot within a treatment as a data point. Percentage data were transformed (arcsin $\sqrt{x}$) prior to analysis. Interactions were evaluated for stem number class × height class, stem number class × herbicide, and height class × herbicide, stem number class × height class × herbicide, and each combination by location; however, no significant ($P<0.05$) interactions were found, including block × treatment interactions. Absence of significant interactions among partitioned sources of variation permitted each source to be examined individually and variation attributed to interactions to be incorporated into the generalized error term. Level of significance for mean separation was $P<0.05$, and significantly different means were separated by Tukey's procedure (Steel and Torrie 1980).

Results

Mesquite mortality varied with the herbicide formulation (Table 1). Over all locations, clopyralid was almost twice as effective as picloram and 3 times as effective as either triclopyr or 2,4,5-T, concurring with previous studies (Bovey and Mayeux 1980, Bovey et al. 1981, Jacoby et al. 1981, Jacoby and Meadors 1983). Plant height did not influence mesquite mortality produced by any specific herbicide or for herbicides as a group, indicating plants of all heights were equally susceptible to a given herbicide.

Mesquite susceptibility to herbicides was strongly influenced by individual tree stem number. Resistance increased proportionally with increasing stem number, averaging 55, 35, and 19% for single-, few-, and many stemmed trees across all herbicides (Table 1). Similar trends were found for each herbicide, despite the difference in efficacy.

Likewise, within each height class by herbicide, resistance increased with increasing stem number, illustrating why interactions among herbicides, height, and stem number were insignificant (Fig. 1).

Although efficacy for any particular herbicide fluctuated among the 6 tests, single-stemmed trees were consistently more susceptible than either few- or many-stemmed mesquite (Table 2). Although

Authors are professor, post-doctoral research associate, and research associate, Texas A&M University Agricultural Research and Extension Center, P.O. Box 1658, Vernon; and research technologist, Dept. Agronomy, University of Nebraska, Lincoln. At the time of the research, the junior author was research technician, Texas Agricultural Experiment Station, Vernon.

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, Vernon; Lewis Roach Spraying Service, San Angelo; and Lynn Culp Flying Service, 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-23925.

Manuscript accepted 17 May 1989.

Table 1. Mortality of honey mesquite stands summarized across all locations by herbicide, height, and stem number and across all herbicides for height and stem number.

Herbicide	Mean mortality	Height			Stem number		
		<1m	1-2m	>2m	1–2	3–5	6+
Clopyralid	64 a[1]	64[2]ns.	66	62	85 a[3]	63 b	41 c
Picloram	35 b	33	38	34	53 a	32 ab	20 b
Triclopyr	21 c	17	24	22	37 a	18 b	8 b
2,4,5-T	21 c	20	23	21	38 a	18 b	6 b
All herbicides ($\bar{x}$)	35	34 a	39 a	36 a	55 a	35 b	19 c

[1]Means within the vertical column followed by the same letter are not significantly different at the 0.05 level of probability.
[2]No significant differences were found among means for height classes within a herbicide treatment.
[3]Means within row followed by the same letter are not significantly different at the 0.05 level of probability.

Table 2. Mean mortality o honey mesquite within arbitrary groups based on number of basal support stems after 3 growing seasons following treatment with foliar applied herbicides on western Texas rangeland.

		Herbicide											
		2,4,5-T			Triclopyr			Picloram			Clopyralid		
		(Stem No. Class)											
Location	Date	1–2	3–5	6+	1–2	3–5	6+	1–2	3–5	6+	1–2	3–5	6+
		(%)											
Vernon	6/81	71a[1]	28b	10b	80a	26b	6c	—	—	—	100a	76b	61c
Vernon	7/81	53a	33b	14c	18a	25a	13a	65a	49ab	36b	90a	71b	46c
Vernon	6/82	61a	30b	11c	—	—	—	—	—	—	83a	50b	38b
Vernon	7/82	16a	11ab	3b	37a	18b	7c	41a	15b	4b	73a	58b	22c
Albany	6/81	8a	4a	0a	12a	4a	6a	—	—	—	81a	66b	40c
Ozona	7/82	21a	5b	0b	—	—	—	—	—	—	81a	59b	41c

[1]Means followed by the same letter within a row for a specific herbicide are not significantly different at the 0.5 level of significance according to Duncan's new multiple range test.

this study focused on comparisons among particular herbicides, similar trends in the stem number influence on resistance occurred for equal part mixtures of herbicides (data not shown).

Discussion

While a significant relationship between the stem number and herbicide efficacy was found, precise reasons for this effect were not identified. Other researchers have suggested the presence of independent vascular systems from the basal stem area which serve each stem could promote herbicide resistance (Sosebee et al. 1973). Multi-stemmed plants, by the nature of their growth form, may produce a greater canopy area which could impede herbicide penetration of coverage and also shade the soil more than a single-stemmed tree. Soil temperature has been related to herbicide susceptibility of honey mesquite (Dahl et al. 1971).

Numbers of stems arising from a resprouting stem base may be reflective of the physiological vigor of the plant or the amount of carbohydrate reserves. More importantly, stem numbers may influence carbohydrate source/sink relationships which are directly related to translocation of foliar applied herbicides. If stem carbohydrates are sufficient to provide for initial canopy development, a multi-stem tree might have less demand on root carbohydrates and create a weaker sink than a single-stemmed tree.

Self-pruning by trees as they advance in age suggests that competition for light, nutrients, and water might play a role in herbicide resistance. Under stress, stems might react differently when treated with a herbicide, allowing some tissue to survive.

Any one or all of these possibilities could contribute to differential survival of honey mesquite and each presents research opportunities for understanding plant resistance to herbicides.

Management Implications

From a management perspective, our findings should allow a landowner to anticipate lower degrees of control on many-stemmed growth forms of honey mesquite compared to stands supporting mainly single- to few-stemmed plants. Many-stemmed stands, being highly resistant to foliarly absorbed herbicides, could be treated with another form of brush control such as prescribed fire or rootplowing. If aerial spraying is desired, use of a highly effective herbicide such a clopyralid would offer a higher potential for control of honey mesquite. As more information is collected regarding the causative factors for herbicide resistance by woody plants such as honey mesquite, landowners will be able to better plant and conduct their brush control operations.

Literature Cited

Bovey, R.W., and H.S. Mayeux. 1980. Effectiveness and distribution of 2,4,5-T, triclopyr, picloram and 3,6-dicloropicolinic acid in honey mesquite *(Prosopis glandulosa* var. *juliflora).* Weed Sci. 28:666-670.

Bovey, R.W., R.E. Meyer, and J.R. Baur. 1981. Potential herbicides for brush control. J. Range Manage. 34:144-148.

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.

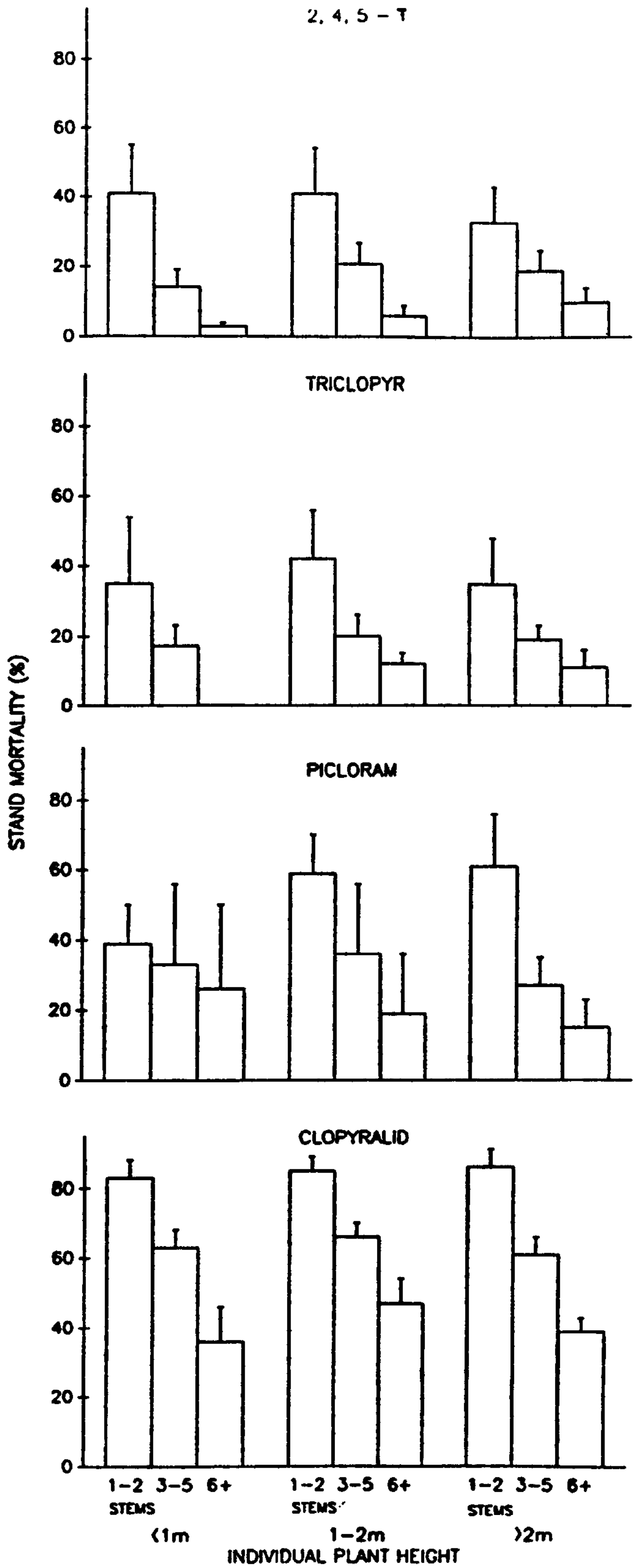

Fig. 1. Mortality of honey mesquite stands following aerial application with 2,4,5-T, triclopyr picloram or clopyralid at 0.6 kg/ha^{-1} in western Texas as influenced by number of stems per plant within 3 height classes. Vertical lines on bars represent the s.e. of $\bar{x}$.

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 Agric. Exp. Sta. Bull. 935.

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 glandulosa* var. *juliflora)* with 3,6-dichloro- picolinic acid. Weed Sci. 29:376-378.

Sosebee, R.E., B.E. Dahl, and J.P. Goen. 1973. Factors affecting mesquite control with Tordon 225 mixture. J. Range Manage. 26:369-371.

Steel, R.G.D. and J.H. Torrie. 1980. Principles and procedures of statistics-a biometrical approach. McGraw-Hill Book Co., New York. .