Responses of Native and Introduced Grasses Following Aerial Spraying of Velvet Mesquite In Southern Arizona

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Velvet mesquite *(Prosopis juliflora* var. *velutina* (Woot.) Sarg.)[3] covers large acreages in the Southwest, has greatly thickened during the past 60 to 75 years, and has been responsible for sizable losses in perennial grass forage. These facts are well known and well documented (Parker and Martin, 1952; Glendening, 1952). The need for information on methods of control and on the benefits to be expected are obvious.

Velvet mesquite can be controlled best by mechanical or chemical methods. Aerial application of herbicides is the most feasible control method where velvet mesquite exceeds 200 trees per acre (Reynolds and Tschirley, 1957). But before aerial spraying is widely adopted as a control measure, there should be some assurance that increased grass production will pay for the cost of control. To help answer this question, data from an area on the Santa Rita Experimental Range about 30 miles southeast of Tucson, Arizona, showing the response of native and introduced perennial grasses following aerial spraying of velvet mesquite are presented here.

The Study Area

The study area covers 150 acres at an elevation of 4000 feet. The 32-year average annual precipitation is about 16 inches; 10 inches falls in the summer (June through September).

During the study period (1954-59) annual precipitation averaged 8 percent above the long-time mean. Summer rainfall was 26 percent above average, and winter precipitation was 21 percent below. Within the 6-year study period both summer and winter precipitation varied widely from year to year, as shown in the following tabulation:

Precipitation

Year	Summer (June-Sept.)	Winter (Oct.-May)	Annual (June-May)
	— —	inches	— —
1954-55	14.40	3.42	17.82
1955-56	17.62	4.05	21.67
1956-57	6.42	4.73	11.15
1957-58	9.31	8.55	17.86
1958-59	13.44	3.28	16.72
1959-	11.36	....	....
1954-59 Average	12.09	4.81	17.04
Long-time Average	9.55	6.09	15.64

The annual and seasonal precipitation for the study period included amounts that approached the highest and lowest values for the entire 32-year period of record.

Before treatment, overstory vegetation on the study area consisted of about 225 velvet mesquite and a few catclaw acacia *(Acacia greggii* A. Gray) per acre, with an understory of lower growing shrubs, primarily false mesquite *(Calliandra eriophylla* Benth.) and velvet pod mimosa *(Mimosa dysocarpa*

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[2] *In cooperation with the University of Arizona.*

[3] *Plant nomenclature follows Kearney and Peebles (1951).*

Benth.). The area supported only a sparse scattering of perennial grass plants. These were found most often under the mesquite trees or in depressions and drainageways. Principal species present were Arizona cottontop (*Trichachne californica* (Benth.) Chase), plains bristlegrass (*Setaria macrostachya* H. B. K.), side-oats grama (*Bouteloua curtipendula* (Michx.) Torr.), Rothrock grama (*B. rothrockii* Vasey), perennial three-awn (*Aristida* spp.), and cane bluestem (*Andropogon barbinodis* Lag.). The perennial grasses were so sparse that seeding was thought necessary to insure a rapid increase in grass production following mesquite control (Figure 1).

Materials and Methods

The spraying treatment consisted of applying ¾ pound acid equivalent of esters of 2,4,5-trichlorophenoxyacetic acid[4] (2,4,5-T) in a 1:4 diesel oil-water emulsion at a total volume of 5 gallons per acre. This was applied by a Piper cub flying 33-foot swaths in May 1954 on 90 acres of the study area. On the same day the entire 150-acre study area was aerially seeded with Lehmann lovegrass (*Eragrostis lehmanniana* Nees) at the rate of 1 pound per acre without seedbed preparation. In June 1955, 80 acres of the 90 that were sprayed in 1954 were resprayed, 40 acres with ½ pound and 40 acres with ¾ pound of 2,4,5-T[5] per acre in diesel oil-water emulsions at total volumes of 5 gallons per acre. The 1955 application was made with a Stearman biplane flying 42-foot swaths.

Cost of each ¾-pound spray treatment was $3.25 per acre ($1.25 for flying, $1.80 for herbicide, and $0.20 for diesel oil). The ½-pound spray treatment cost $2.65. The cost of seeding was $3.00 per acre ($1.00 for flying and $2.00 for seed). Thus, the total costs for the two spray treatments and the seeding were $9.50 and $8.90 per acre, respectively, for the ¾ + ¾ and ¾ + ½-pound 2,4,5-T applications.

The study area was protected from grazing by domestic livestock for the 1954 and 1955 growing seasons to encourage the establishment of lovegrass and native grass seedlings.

Data taken to evaluate the effectiveness of the treatments included: (1) defoliation and mortality of velvet mesquite trees on the sprayed area, and (2) herbage production of lovegrass and of native perennial grasses on the sprayed and unsprayed areas.

Defoliation was estimated to the nearest 10 percent for each of 100 marked trees in each treatment. Defoliation as used in this paper is the difference between the amount of foliage present at the time of observation and that present before treatment. Foliage at the time of observation may include leaves on the original crown as well as those on crown and basal sprouts.

Herbage production of perennial grasses was obtained from five 9.6-square-foot plots on each of ten ¼-mile paced transects on the sprayed area and an equal number on the unsprayed area. Herbage weights were estimated by species on all 5 plots on each paced transect. Herbage on one of the 5 plots on each transect was then clipped and weighed to establish a regression for adjusting the estimates.

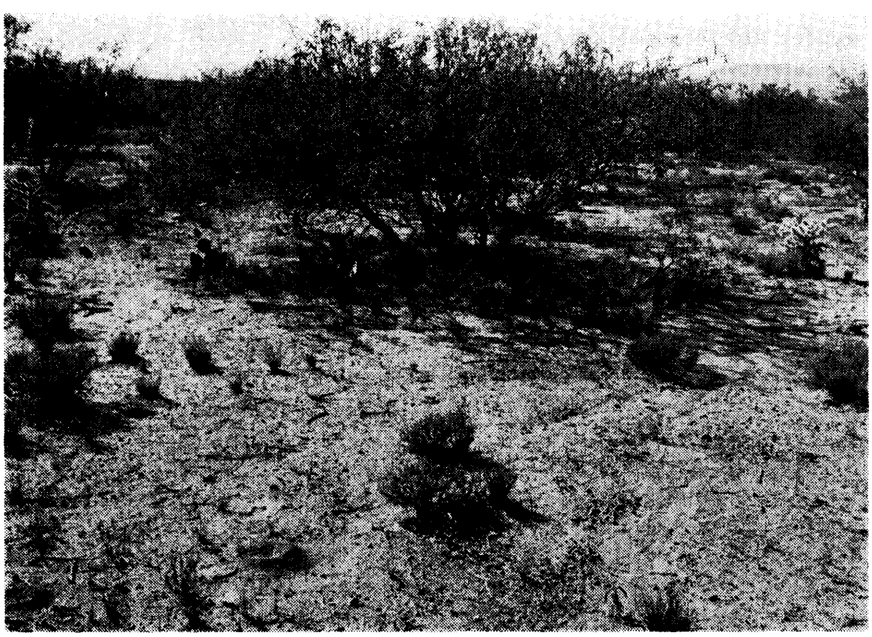

FIGURE 1. Unimproved range adjacent to study area showing dominance of mesquite and sparse grass cover.

Results and Discussion

The first spray treatment defoliated nearly all mesquite trees. However, because 95 to 100 percent of the sprayed trees sprouted the following spring, the second spray treatment was necessary.

In the fall of 1957, three growing seasons after the second spraying, mesquite mortality on the area sprayed once was only 2 percent. Mortalities on the areas resprayed with ½ and ¾ pound per acre of 2,4,5-T were 30 and 54 percent, respectively. By the fall of 1959, the mortality was 2, 36, and 58 percent, respectively on these areas.

[4] *Formulations used were: Butoxyethanol, ethoxyethoxy, isopropyl, and butoxyethoxypropanol esters of 2,4,5-T.*

[5] *Formulations used were: Propyleneglycolbutylether and butoxyethanol esters of 2,4,5-T.*

Table 1. Yield of native perennial grasses and Lehmann lovegrass on sprayed and unsprayed range

Year	Herbage Production					
	Sprayed			Unsprayed		
	Lehmann lovegrass	Native perennials	Total	Lehmann lovegrass	Native perennials	Total
	(pounds per acre, air dry)					
1954	0	312	312	0	118	118
1955	110	804	914	18	172	190
1956	339	508	847	24	231	255
1957	229	700	929	72	231	303
1958	336	751	1087	124	651	775
1959	424	409	833	186	362	548

In contrast to the large difference in mortality between the two areas sprayed twice, the difference in defoliation was small. When expressed as percentages of the original foliage, defoliation in 1957 was 88 percent for the ¾ + ½-pound treatment and 95 percent for the ¾ + ¾-pound treatment. Defoliation in the fall of 1959 was 86 percent for the ¾ + ½-pound treatment, 95 percent for the ¾ + ¾-pound treatment, and 17 percent for the single spraying with ¾ pound of 2,4,5-T.

The single aerial spray killed very few trees and resulted in only temporary defoliation. Both two-spray treatments killed an appreciable number of trees and resulted in relatively permanent defoliation. The ¾ + ¾-pound treatment killed 60 trees per acre more than the ¾ + ½-pound treatment, but the amount of live mesquite canopy was approximately the same on the two areas in 1959. Thus, competition for moisture between mesquite and perennial grasses was also about the same on the two areas, and no difference in perennial grass production was apparent. Therefore, on the basis of increased forage production, the added expense of the additional ¼ pound of 2,4,5-T per acre was not justified. Justification for the expense of an additional ¼ pound of 2,4,5-T on the second treatment would have to be based on the type of third treatment that might be applied when the effectiveness of the first two treatments disappears. If the third treatment were an aerial spray, the cost of the treatment would be the same regardless of the density of the stand. However, if individual trees were treated the third time, the more trees present the higher the cost and the greater the justification for obtaining a higher total plant kill in the first two treatments. The slow rate at which the canopy recovered after being sprayed indicates that competition between mesquite and perennial grasses will not become severe for several more years.

Native perennial grasses responded quickly after the initial defoliation of the mesquite (Table 1). During the 1954 growing season native perennial grasses produced almost three times as much herbage per acre on the sprayed area as on the unsprayed area. This first-year increase in perennial grass herbage resulted mainly from increased growth of plants that were present at the time of treatment. During subsequent years, the establishment of many new plants increased production further (Figure 2). Unusually high summer rainfall in 1954 and 1955 contributed to the quick response of the native perennial grasses following mesquite control. During the six growing seasons following the first spraying, the sprayed area produced almost twice as much native perennial grass herbage as the unsprayed area.

An average of one Lehmann lovegrass seedling per 5 square feet was established on the sprayed area during the first growing season after seeding and spraying. Herbage production of lovegrass on the sprayed area increased from essentially nothing in 1954 to 424 pounds per acre in 1959, compared with 186 pounds per acre in 1959 on the unsprayed seeded area. During the six growing seasons following seeding, the sprayed area

FIGURE 2. Excellent perennial grass herbage production on area sprayed twice with ¾ pound per acre of 2,4,5-T and seeded to 1 pound per acre of Lehmann lovegrass; photographed February 1958, four growing seasons after the first spraying.

Table 2. Comparative per acre costs and returns from sprayed and unsprayed mesquite infested range land[1]

Year	Total herbage production		Cumulative costs		Cumulative gross returns		Cumulative net returns	
	Sprayed	Unsprayed	Sprayed	Unsprayed	Sprayed	Unsprayed	Sprayed	Unsprayed
	(lbs./Acre)		(Dollars)					
1954	312	118	6.50	3.12	1.56	.59	—4.94	—2.53
1955	914	190	9.51	3.24	6.19	1.56	—3.32	—1.68
1956	847	255	9.89	3.37	10.68	2.90	0.79	— .47
1957	929	303	10.28	3.50	15.75	4.54	5.47	1.04
1958	1087	775	10.69	3.64	21.82	8.60	11.13	4.96
1959	833	548	11.11	3.78	26.86	11.68	15.75	7.90

[1] Costs and returns computed at 4 percent interest compounded annually.

produced more than three times as much lovegrass herbage as the unsprayed area.

The relatively high yield of native perennial grass on the sprayed area during the first summer after spraying and in subsequent years indicates that the seeding of Lehmann lovegrass probably was not necessary. Native perennial grass herbage production probably would have increased even more on the sprayed area if the lovegrass had not been seeded.

Lehmann lovegrass is generally considered to be less palatable to cattle than are most of the native perennial grasses. Cable and Bohning (1959) report that cattle graze Lehmann lovegrass very lightly during the summer and early fall but take it willingly in the late winter and spring. At this time of year, the lower part of the stems of lovegrass is green and relatively succulent, while most native grasses are dry.

A complete economic analysis of mesquite control would include items such as cost of treatment, additional cattle, other interest charges, death loss, freight, auction fees, labor for handling cattle, fence maintenance, stock water development, land taxes, and interest on the valuation of land and improvements. Net return in this study was based on treatment cost and an estimated interest of 4 percent. There was no basis for estimating other costs. No costs were assessed for deferment of the pastures during the growing seasons of 1954 and 1955. Deferment was deemed necessary on the pasture to permit the grasses to recover in vigor on the untreated as well as on the treated area.

Since animal weight-gain data were not available, the value of the increased perennial grass herbage resulting from mesquite control and seeding was estimated by the use of these assumptions: (1) fifty percent of the total herbage produced is usable forage, (2) a cow consumes 20 pounds of air-dry forage a day, (3) a cow-day of grazing produces 1 pound of salable beef, and (4) the net selling price of range beef is 20 cents a pound.

If we assume four percent interest on the capital invested in the range improvement project, the net return from the combined mesquite treatment and seeding operation exceeded costs after the third growing season (Table 2). Return from the unsprayed area calculated at the same rate of interest showed a net profit after the fourth growing season. At the end of the fourth growing season, when both areas returned a profit, spraying showed an advantage of \$4.43 an acre. By the end of the sixth growing season this had increased to \$7.85 an acre.

The herbage production data obtained during this study indicate that: (1) the presence of mesquite reduces perennial grass production, and (2) mesquite competition must be eliminated or reduced drastically for seeding to be successful. These findings confirm the results of previous studies on the Santa Rita Experimental Range.

Summary

Herbage production of native perennial grasses and Lehmann lovegrass was compared on sprayed and unsprayed portions of a velvet mesquite-infested pasture.

In 1959, five growing seasons after the final spray treatment, mesquite mortality was 58 percent on the area sprayed with ¾ pound of 2,4,5-T in each of the two successive years. On the area sprayed with ¾ pound followed by ½ pound of 2,4,5-T, mortality was 36 percent; and on the area sprayed once, 2 percent. Defoliation in 1959 was 95, 86, and 17 percent, respectively, on the three treatment areas.

Herbage production of native perennial grasses averaged almost twice as much on the sprayed as on the unsprayed area for the six growing seasons after the first spraying. Herbage production of lovegrass averaged more than three times as much on the sprayed as on the unsprayed area during the same time. No difference in perennial grass herbage production between the two areas sprayed twice was apparent.

Increased production of perennial grass on the areas sprayed twice more than paid the cost of spraying and seeding in the first three growing seasons after the first spraying. The slow rate of

mesquite recovery indicates that the effects of the treatment will last several more years.

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