Forage Response of a Mesquite-Buffalograss Community Following Range Rehabilitation

DONALD J. BEDUNAH AND RONALD E. SOSEBEE

Abstract

The influence of different range rehabilitation methods on honey mesquite control, herbage production, and grazing capacity were evaluated on a depleted clay loam range site in west Texas. Mesquite control by foliar application of 2,4,5-T + picloram, shredding, mechanical grubbing, mechanical grubbing and seeding to kleingrass, and mechanical grubbing and vibratilling increased herbage production and grazing capacity. Shredding increased soil cover by adding plant litter, but significantly controlled mesquite competition for only 2 years. Seeding to kleingrass resulted in a productive stand with a high estimated grazing capacity. Foliar spraying doubled grass production compared to no treatment and resulted in 76% mesquite mortality 3 years after treatment. Deferment from grazing was important in increasing herbage production during the study period; however, for maximum grazing capacity both mesquite control and proper grazing would be necessary.

In much of west Texas, overgrazing by domestic livestock and increasing density of honey mesquite *(Prosopis glandulosa* Torr. var. *glandulosa)* have resulted in depleted ranges with low forage production. Smith and Rechenthin (1964) considered mesquite the most common and widespread noxious plant in Texas. Mesquite competes with valuable range plants for water; thereby, reducing forage production and increasing the aridity of the site. Without range improvements many of these areas will continue to decrease in productivity reducing the possibility of maintaining successful and long-term ranching operations.

Jacoby et al. (1982) reported that the most dramatic forage responses following brush control have occurred on arid to semi-arid ranges where there was critical competition between brush and forage plants for water. Studies on semiarid ranges in Arizona (Cable and Tschirley 1961) and Texas (Dahl et al. 1978, Jacoby et al. 1982) have reported that grass production significantly increased following mesquite control by aerial application of herbicides. However, few replicated experiments have been conducted on the influence of different mesquite control techniques on forage production of deteriorated semiarid west Texas range sites. Therefore, the purpose of this study was to evaluate changes in vegetation following several brush control techniques on a deteriorated range site with high mesquite density.

Study Area

A mesquite-buffalograss (*Buchloe dactyloides* Nutt. Engelm.) dominated area on the Post-Montgomery Estate Ranch located 7 km north of Post, Texas, (Garza County) was chosen for the study. The area is a semiarid transition zone from the southern short grass plains of the Llano Estacado to the Red Rolling Plains of Texas. Average growing season is 216 days. High velocity winds are a critical factor in increasing evapotranspiration which averages 264.5 cm/yr (USDA 1965).

Authors are graduate research assistant and professor Department of Range and Wildlife Management Texas Tech University, Lubbock 79409. Dr. Bedunah's current address is assistant professor, Range Resource Management, School of Forestry, University of Montana, Missoula 59812.

The authors would like to thank the Post-Montgomery Estate Ranch and Mr. Tom Copeland for their support during this study.

This article is Contribution No. T-9-353 of the College of Agricultural Sciences, Texas Tech University.

Manuscript accepted February 29, 1984.

The soil series of the study area was a Sagerton clay loam which is in the fine mixed thermic family of Typic Paleustolls. The Sagerton series consists of deep, well-drained, moderately slowly permeable soils that formed in calcareous clays, and loamy sediments on nearly level to gently sloping uplands.

The study area was on a clay loam range site. Climax vegetation of this site is primarily a short grass community with a few mid-grasses intermingled (USDA 1965). Climax decreasers include blue grama (*Bouteloua gracilis* (H.B.K.) Griffiths), side-oats grama (*B. curtipendula* (Michx.) Torr.), vine-mesquite (*Panicum obtusum* (H.B.K.)), and western wheatgrass (*Agropyron smithii* Rydb.). Important increasers of the climax vegetation include buffalograss, silver bluestem (*Bothriochloa saccharoides* (SW) Rydb.), tobosagrass (*Hiliaria mutica* (Buckl.) Nash), white tridens (*Tridens muticus* (Torr.) Nash), and Texas wintergrass (*Stipa leucotricha* Trin. & Rupr.). Common invaders included perennial three-awns (*Aristida* L. sp.), sand dropseed (*Sporobolus cryptandrus* (Torr.) Gray), hairy tridens (*Erioneuron pilosum* (Buckl.) Nash), Texas grama (*Bouteloua rigidiseta* (Steud.) Hitchc.), tumble grass (*Schedonnardus paniculatus* (Nutt.) Trel.), prickley pear (*Opuntia polyacantha* Haw.), cholla (*Opuntia imbricata* (Haw.) Engelm.), mesquite, and lotebush (*Ziziphus obtusifolia* (T. & G.) Gray) (USDA 1965).

At the initiation of the study, the site was in low fair range condition and was in a downward trend. Mesquite and buffalograss were the major overstory and understory dominants, respectively. Mesquite averaged 939 trees/ha. The area historically had been grazed by cattle year long.

Methods

The study area was fenced in August, 1977, and protected from grazing by large herbivores for the duration of the study. Three rows of six 0.4-ha plots were located in a completely randomized design with 3 replications/treatment. The treatments. or types of vegetation manipulation, were: (1) shredding mesquite, (2) foliar spraying mesquite, (3) mechanically grubbing mesquite, (4) mechanically grubbing between mesquite trees, (5) vibratilling, (6) seeding to kleingrass (*Panicum coloratum* Walt.), and (7) a check or no treatment.

All treatments had been applied by June 1, 1978, except for the vibratilling and seeding, which were not completed until May, 1979, because of problems in employing a contractor.

Treatments

Shredding

Mesquite was top removed on May 18, 1978, using a rotary shredder and farm-type tractor. Shredding was accomplished at a relatively slow travel rate and no attempt was made to reshred large debris. No other treatment was applied either simultaneously or subsequently to shredding.

Foliar Spray

Mesquite foliage was sprayed with a 1:1 mixture of 2,4,5-Trichlorophenoxy-acetic acid (2,4,5-T) + 4-amino-3,5,6-picolinic acid (picloram) at 0.6 kg a.i./ha. The herbicide was applied on May 31, 1978, using a John Bean sprayer equipped with a hand sprayer. Individual mesquite trees were sprayed until the foliage was completely wet. Spraying was delayed until soil temperatures surpassed the minimum threshold soil temperature of 24° C (Dahl et al. 1971). Soil temperatures were measured with standard laboratory thermometers and averaged 25.5° C at a 45-cm depth.

Grubbing Trees

Mesquite was removed mechanically by grubbing on May 30 and 31, 1978, using a rear-mounted grubber on a farm-type tractor. The trees were removed below the basal crown, leaving a pit where the tree was removed.

Grubbing between Trees

Grubbing between trees was used as a treatment to evaluate if the herbage response was a result of the method of removal (grubbing and possibly impounding water) or from the removal of mesquite competition. Grubbing between trees was done on June 1, 1978, using the same equipment and procedures as used for grubbing the trees (including size of pit). An attempt was also made to simulate the number of pits per plot created by the grubbing tree treatment.

Vibratill

Mesquite was removed mechanically by grubbing and raking. A vibratiller (large chisel with an oscillating unit, driven by a power takeoff that causes the tynes to fracture subsurface soil simultaneously with ripping) with the tynes set for a 76-cm row spacing and a 60-cm depth was pulled across the prevailing slope. The vibratill disturbed the soil surface and fractured the claypan, but left much of the vegetation intact.

Seeded

Mesquite was removed mechanically by grubbing. The plots were then plowed with a vibratiller, disked, and kleingrass was drilled-seeded at 1.4 kg/ha (PLS) on May 10, 1979. Kleingrass-seeded plots were never fertilized nor irrigated.

Mesquite Mortality

Mesquite mortality (%) was measured by counting living trees in each plot before treatment and 3-years post-treatment. Mesquite trees showing any resprouting 3 years post-treatment were considered to be living. Mesquite mortality was considered to be important in assessing the potential longevity of the treatment.

Standing Crop and Soil Cover

Herbage data (standing crop) were collected after each growing season (approximately October 1). Herbage was determined by clipping 21 randomly located 0.45m² quadrats/treatment at 1-cm stubble height. Herbage was separated by grass species, broomweed species (*Xanthocephalum dracunculoides* (D.C.) Shinners and *X. sarothrae* (Pursh) Shinners), or by grouping all other forbs. Woody, herbaceous, and standing litter were also collected for each quadrat after removing the current year's growth. The herbage was oven dried at 50° C for at least 7 days and then weighed. Weights were converted to kilograms of oven-dried material per hectare.

Herbage was classified by 3 groups. The first group was total grass production, which was a sum of standing crop (kg/ha) of threeawns (*Aristida longiseta* Steud. and *A. purpurea* Nutt.), buffalograss, sand dropseed, blue grama, hairy tridens, windmill grasses (*Chloris cucullata* Bisch. and *C. verticillata* Nutt.), sand muhly (*Muhlenbergia arenicola* Buckl.), feather fingergrass (*Chloris virgata* Swartz), silver bluestem, Arizona cottontop (*Digitaria californica* (Benth.) Henr.), vine-mesquite, plains bristlegrass (*Setaria macrostachya* H.B.K.), tobosagrass, and kleingrass. Total forb production or the sum production of broomweeds and other forbs constituted the second group. The third group was the sum of standing crop (total production) of grasses and forbs.

Ground cover was estimated ocularly for each quadrat by species (foliar cover) and for litter before clipping. Total ground cover was determined as the sum of litter and the canopy cover of living herbaceous vegetation.

Climatological Data

A climatological station for measurement of precipitation, air temperature, relative humidity, and evaporation was located on the study site. Precipitation was measured with a tipping bucket rain gauge equipped with an event recorder capable of detecting changes in precipitation events every 5 min. Air temperature and relative humidity were measured and recorded with a *Skyline* hygrothermograph. Evaporation was measured from a standard Weather Bureau Class A free surface pan.

Grazing Capacity

Grazing capacity was estimated from herbage production data, similarly to methods used by McDaniel et al. (1982). Grazing capacity was determined from the proper use factor (PUF) and production according to the following equation:

$$\frac{\text{PUF} \times \text{Species dry weight/ha}}{4967 \text{ kg}} = \text{ha/AUY}$$

Desirable plants, decreasers and the more palatable increasers, were assigned a 50% PUF (Table 1). Intermediate plants, increasers, and palatable invaders, were given a PUF between 30 and 40%.

Table 1. Palatability rating and proper use factor (PUF) of plants used for determinging grazing capacity.

Palatability rating	Plant species or grouping	Proper use factor (%)
High	*Bouteloua gracilis*	50
	Bothriochloa saccharoides	50
	Digitaria californica	50
	Panicum coloratum	50
	Panicum obtusum	50
	Setaria macrostachya	50
	Perennial forbs	45
Moderate	*Buchloe dactyloides*	40
	Chloris sp.	30
	Leptoloma cognatum	30
	Sporobolus cryptandrus	30
Low	*Aristida* sp.	20
	Hilaria mutica	20
	Muhlenbergia arenicola	20
	Panicum hallii	20
	Erioneuron pilosum	20
	Xanthocephalum sp.	0
	Annual forbs	0
	Annual grasses	0

Invader plants were assigned a PUF of 20 to 30%. Annual and perennial broomweed and annual grasses were not included in grazing capacity determinations. Intake for an animal unit (AU) was considered to be 13.6 kg/day (Bell 1973).

Statistical Analysis

The Statistical Analysis System (SAS) package programs were used (Helwig and Council 1979). Analysis of variance was used to test for differences in treatment means at the 0.05 level of probability. If the analysis of variance tests showed a significant treatment effect, means were separated using Duncan's new multiple range test (Steel and Torrie 1960).

Results and Discussion

Mesquite Control

At the initiation of the study, mesquite canopy cover and density averaged 22% and 939 trees/ha, respectively. All mesquite control techniques had the immediate effect of eliminating live mesquite canopy cover.

Foliar application with 2,4,5-T + picloram resulted in 78% root kill 3 years post-treatment. However, the reduction in mesquite canopy cover and transpiration surface was estimated to be 98%.

Mechanically grubbing mesquite resulted in top removal of all mesquite trees and 90% root-kill. Mesquite grubbing followed by

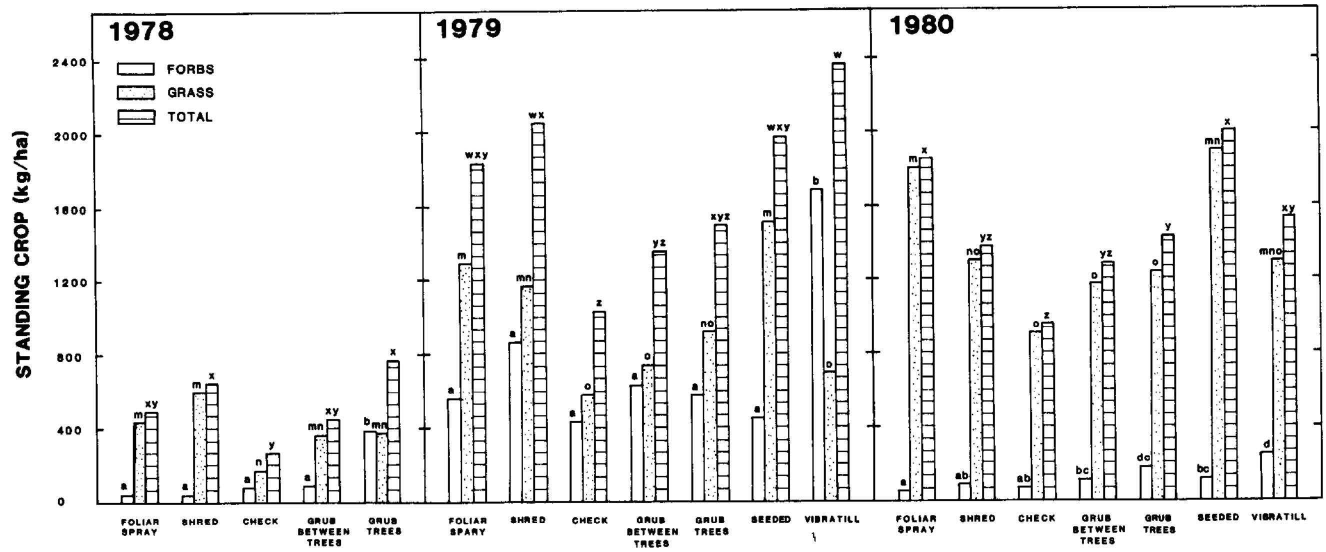

Fig. 1. *Influence of range rehabilitation treatments on total forb, total grass and total production (sum of the standing crop of total forbs and total grass) for 1978, 1979 and 1980. Means within the same year with a similar superscript are not significantly different (P<0.05).*

vibratilling, or vibratilling and seeding kleingrass, resulted in 96% and 94% root kill 3 years post-treatment, respectively.

Shredding severely suppressed mesquite for the 1978 growing season. Mesquite regrowth was not evident until the middle of the second growing season. By the end of the second growing season mesquite regrowth was of low stature with few stems reaching 80 cm high. In 1980, there was rapid stem elongation with many plants attaining heights of 1.2 m. Mesquite regrowth appeared more robust in 1980 than in 1979. However, some mesquite control compared to the check was still evident in 1980 with mesquite canopy cover of 6%.

Therefore, all brush control techniques were effective in reducing mesquite canopy cover 3 years post-treatment. However, mesquite regrowth was a problem for the shredding treatment after only 2 years.

Herbage Production

Mesquite removal by all treatments resulted in increased herbage production and vegetative ground cover for the 3-year period. We believe the increased herbage production was largely a function of reduced competition between mesquite and herbaceous plants.

One growing season after brush removal total herbage production increased for the shred- and grub-tree treatments compared to the check (Fig. 1). Mechanical grubbing impounded water and decreased runoff (Bedunah 1982). However, much of the increased water of the grub-between-tree treatment was apparently used by mesquite, which resulted in no change in herbage production when compared to the check.

Grass production for the shred treatment was higher than for the check (Fig. 1). On both the foliar spraying and shredding treatments there was a reduction in mesquite; however, foliar spraying caused a minor amount of grass mortality. Mesquite removal by shredding could increase grass production in a number of ways. Shredding would return nutrients to the soil and the litter would protect the soil surface from raindrop impact and reduce soil water evaporation.

Thus, any type of mesquite removal or soil disturbance caused at least a trend of increased herbage production compared to the check on this depleted site. However, this range site in excellent condition should have produced more than three times the measured (USDA 1965). The treatments causing the most favorable herbage response decreased mesquite competition and improved site conditions for infiltration (Bedunah 1982).

During the second season of the experiment the check produced less total herbage than the foliar spray, shredding, seeded or vibratill treatments. Forb production was greatest for the vibratill treatment averaging 1,695 kg/ha, which accounted for 71% of the total herbage (Fig. 1). Much of the increase in forb production was annual broomweed, which averaged 1,147 kg/ha or 67% of the total forb production. All other treatments, except seeded, had annual broomweed comprising greater than 75% of the total forb production.

In 1979 the check, foliar spray, shred and grub treatments had similar forb and annual broomweed production. The seeded treatment had no annual broomweed production because of the plowing and disking in early May. Since annual broomweed averaged 1,147 kg/ha for the vibratill treatment, the amount of actual forage was less than 1,241 kg/ha. Also actual forage production for all other treatments, except the seeded, averaged 24% less because of annual broomweed. Thus, in 1979 when environmental conditions were more favorable for plant growth, much of the increased growth was in an unusable herbaceous plant, annual broomweed.

In 1980, herbage production was greater for the foliar spray, seeded, grub tree, and vibratill treatments compared to the check (Fig. 1). Mesquite regrowth was evident on the shredded areas in 1980; thus, herbage production for the shred treatment was beginning to respond similarly to the check. Scifres and Hoffman (1974) reported that shredding mesquite could result in prolific sprouting which would require retreating in 4 to 7 years. Our data support their conclusion. However, in areas where cropland makes aerial application of herbicides unfeasible, shredding could be used to reduce the stature of mesquite trees, increase soil protection by addition of the shredded mesquite and allow for foliar application of herbicides from ground equipment where herbicide drift could be reduced.

During 1980, the vibratill treatment had noticeably taller buffalograss that stayed green longer than that on other areas. Klett (1969) found an increase in soil moisture on vibratilled areas and Langley and Fisher (1939) reported that buffalograss remained green longer following contour listing. The grasses revegated the disturbed areas and responded favorably to the moderately severe vibratill treatment 1-year post-treatment. Grass production for the foliar spray and seeded treatments was higher than the shred, check, or grub treatments in 1980. Therefore, we believe the small amount of mesquite regrowth on foliar spray plots had little influence on grass growth during the study.

Grazing Capacity

The estimated grazing capacity was significantly increased by all range rehabilitation practices where mesquite was controlled (Table 2). Seeding to kleingrass resulted in the greatest estimated grazing capacity for 1979. However, in 1980, grazing capacities for the foliar spray and vibratill treatments were similar to the seeded treatment. Mean estimated grazing capacity across treatments established in 1978 showed an increase in grazing capacity for each year. In 1978 mean grazing capacity was estimated at 28 ha/AUY compared to 13 ha/AUY in 1979 and 10 ha/AUY in 1980.

Table 2. Influence of range rehabilitation treatments on grazing capacity (ha/AU/yr) during 1978, 1979 and 1980[1].

Rehabilitation treatment	Year 1978	1979	1980
Foliar spray	27.2b (x)[2]	10.9bc(y)	7.6bc(z)
Shred	20.3b (x)	10.3cd(y)	10.2ab(y)
Check	53.9a (x)	20.8a (y)	15.0a (z)
Grub between trees	30.0ab(x)	15.2ab(y)	11.9ab(z)
Grub trees	19.4b (x)	13.4c (xy)	9.0bc(y)
Kleingrass	——[3]	5.7d (x)	5.4c (x)
Vibratill	——	12.0bc(x)	8.3bc(y)

[1]It was assumed that 9934 kg of total forage (dry weight) are required to support an animal unit (AU) per year.
[2]Means followed by a similar letter within each column or in parenthesis within each row are not significantly different at the 0.05 level of probability.
[3]No data were available in 1978 for the vibratill or kleingrass treatments.

Grazing capacity is a function of the amount and kind of forage available. Most of the increase in grazing capacity was a result of an increase in grass production each year (Fig. 2). Grazing capacity

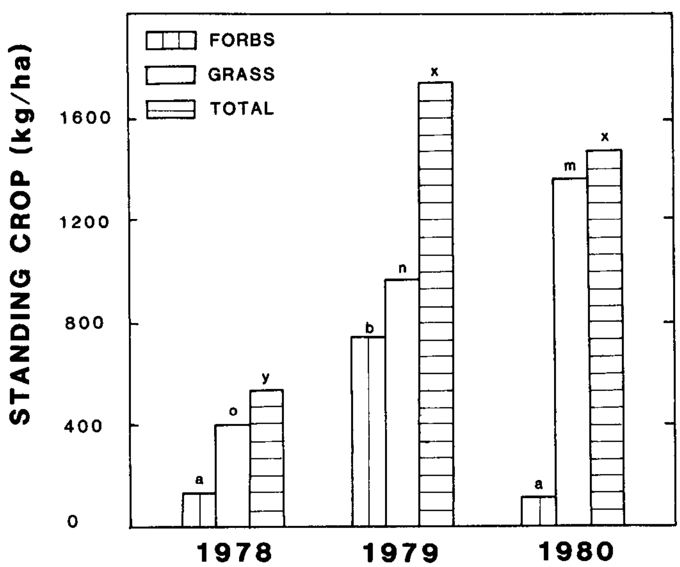

Fig. 2. *Mean total forb, total grass, and total production (sum of the standing crop of total forbs and total grass) for the foliar spray, shred, check, and grub treatments combined for 1978, 1979 and 1980. Means with a similar superscript are not significantly different (P<0.05).*

was more related to total grass production than total herbage production because of the high production of annual broomweed during 1979. Buffalograss and sand dropseed were the most important species, averaging 38% and 19%, respectively, of the total herbage production for nonseeded treatments. Brock et al. (1978) and McDaniel et al. (1982) reported greater production of decreasers within the mesquite canopy zone. For this site, decreaser species comprised less than 2% of the total herbage production. Few decreasers were present even under mesquite trees. There was no significant species composition change for nonseeded areas during the study, except for an increase in annual broomweed in 1979. The high production of annual broomweed in 1979, compared to 1978 and 1980, was probably caused by the higher amount of precipitation during June, July, and August (Fig. 3).

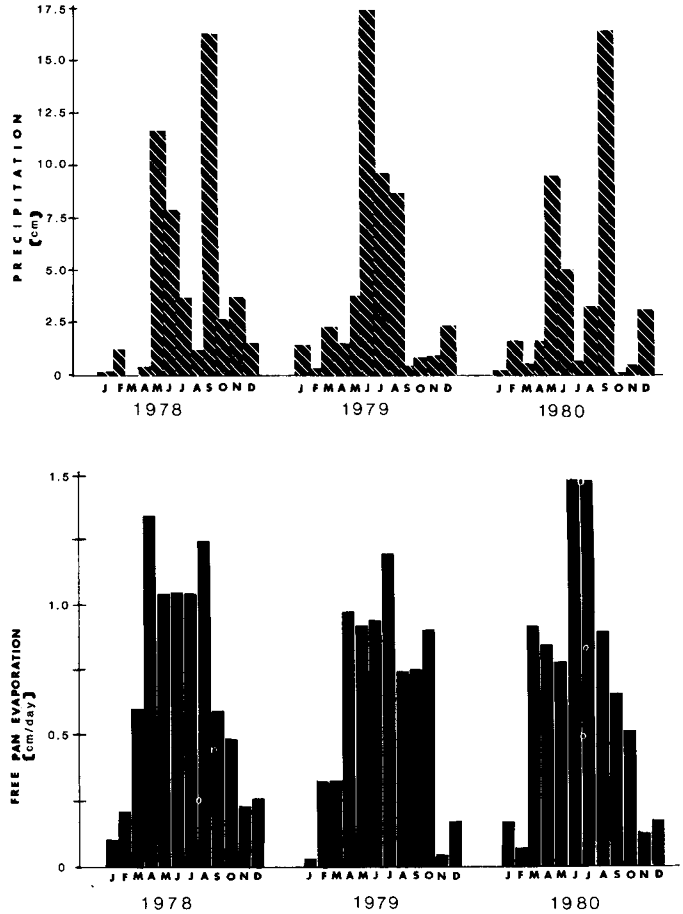

Fig. 3. *Precipitation and freepan evaporation for 1978, 1979 and 1980.*

Much of the increase in grass production for this site was a result of mesquite control but grass showed an increase even for the check treatment. McDaniel et al. (1982) stated that a dormant season grazing regime following honey mesquite control should be carried out for one or more years, depending upon the range condition of treated pastures and the management goals. Therefore, we believe that some of the increased grass production was from an increase in vigor of the perennial plants associated with the rest from grazing and an increase in plant cover for protection of the soil surface. The range trend was up, but 3 years was not long enough to detect a change in range condition.

Summary and Conclusions

Mesquite removal by all range rehabilitation methods resulted in increased herbage production and grazing capacity. Each method influenced site conditions in a particular manner. The best range rehabilitation method for range sites in west Texas will depend on initial site conditions, management concerns and expected economic returns.

For very depleted sites, with few valuable forage plants, seeding improved grasses would result in a rapid increase in grazing capacity. Mechanical grubbing alone or followed by vibratilling, decreased surface runoff and would result in long term control of mesquite.

Shredding mesquite resulted in only a short term (2 years) control and increase in herbage production. Shredding influenced site conditions by increasing plant litter, returning nutrients to the soil, and increasing grass production the year of the treatment. Shredding mesquite, in combination with another treatment, may offer a valuable range rehabilitation alternative for sites with poor herbaceous plant cover, but still having some valuable forage plants. Foliar spraying with 2,4,5-T + picloram was the most feasible control method for this site. The foliar spray resulted in satisfactory mesquite control, provided high grazing capacity and cost would be much lower than mechanical rehabilitation methods.

For deteriorated range sites a deferment from grazing would be important to improve the vigor of the forage plants. Nevertheless, for maintenance of maximum grazing capacity both mesquite control and proper grazing would be necessary.

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