

Effects of Mesquite Control and Mulching Treatments on Herbage Production on Semiarid Shrub-Grasslands

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Abstract.—Effects of complete removal of mesquite overstory, complete removal of mesquite overstory with control of post-treatment sprouts, and retention of the mesquite overstory as a control on herbage production are described. Mulching treatments included applications of a chip mulch, a commercial compost, lopped-and-scattered mesquite branchwood, and an untreated control. Preliminary results of this study provide an insight on the changes in herbage production as a result of mesquite overstory control and the addition of mulches.

Introduction

Encroachment of woody species on rangelands in the southwestern United States has been observed since the early 1900s. Increases in woody species such as mesquite (*Prosopis* spp.) have been a long-time concern to rangeland managers and livestock producers because the encroachment has often reduced herbage production and, therefore, livestock production. This phenomenon has been documented in studies that have observed, conversely, that total grass density increased and soil erosion decreased on sites where mesquite was controlled (Heitschmidt and Dowhower 1991, Martin and Morton 1993). The encroachment of mesquite and other woody species onto rangelands has been attributed to over-grazing, reduced fire frequency, and climate change.

The intent of this study is to determine the changes in herbage production, if any occur, in response to mesquite overstory control, the addition of mulches, and combinations thereof. Such information could be then incorporated into management practices to enhance the productivity and stewardship of semi-desert grass-shrub rangelands in the future. Preliminary results of the study are presented in this paper.

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Study Description

Study Area

The study area was the Santa Rita Experimental Range, approximately 50 km south of Tucson, Arizona. The experimental range, established in 1903, encompasses nearly 21,500 ha that are representative of the semi-desert grass-shrub rangelands in southern Arizona, New Mexico and Texas. The range is located on a broad sloping bajada cut by shallow washes draining northwest into the Santa Cruz River basin. Soils are composed of Pleistocene alluvium that are formed from sloping fans extending from the Santa Rita Mountains to the Santa Cruz River Valley (Martin and Reynolds 1973). The climate is typically arid: precipitation is sparse, relative humidity is low, and high winds occurring during the spring can be desiccating. Precipitation, about 250 mm at 900 m elevation, increasing to 500 mm at 1,370 m, is mostly rainfall, with 60% occurring between July and September. There are two growing seasons for herbaceous plants: one occurs in early spring when the temperatures become favorable, while the other is late summer or early fall when the rains begin and end the summer dry season.

Woody vegetation on the Santa Rita Experimental Range is dominated by stands of velvet mesquite (*Prosopis velutina*). An increase in shrubs such as velvet mesquite, cholla and prickly pear cactus (*Opuntia* spp.), and burroweed (*Haplopappus tenuisectus*) has been observed on the range since the early 1900s. The dominant grass species is Lehmann lovegrass (*Eragrostis lehmanniana*), an introduced species that was first planted at the Santa Rita Experimental Range in 1937. Black grama (*Bouteloua eriopoda*) and Arizona cottontop (*Digitaria californica*) are also found intermixed.

Study Design and Treatments

The study design consisted of 60, 5 x 5 m, plots, with a 1 m buffer between them, excluded from large herbivores. The plots were blocked for subsequent statistical analysis based on information from a pretreatment overstory inventory; the treatments were then randomly assigned to the plots.

The treatments, applied in July 1995, consisted of three overstory treatments and four mulching treatments within each of the overstory treatments. Each combination of overstory and mulching treatments was replicated 5 times. The three overstory treatments were complete removal of mesquite overstory, complete removal of mesquite overstory with control of post-treatment sprouts in July 1997, and an untreated control. The mulching treatments included applications of a chip mulch, a commercial compost, lopped-and-scattered mesquite branchwood, and a control. The chip mulch, derived from chipping the cut mesquite branchwood, was distributed on the plots to a depth of 15 to 25 mm on the plots. The commercial compost was fir-based with 0.5% nitrogen, 0.1% iron, and 0.2% sulfur; approximately 0.25 m³ of compost was applied to the plots. The lopped-and-scattered mesquite branchwood was spread in a manner to completely cover the plot.

Data Collection and Analysis

A pretreatment estimate of herbage production was made in June 1995 to provide a point-of-reference for post-treatment estimates. Post-treatment herbage production was estimated biannually (spring and fall) during May and October, respectively, from 1996 to 1998. Herbage production was estimated by the weight-estimate method (Pechanec and Pickford 1937) on 9.6 square-foot sample plots. Collected samples were then allowed to dry. Once completely dried, the herbage samples were separated by plant species, weighed, and extrapolated to pounds per acre.

Analyses of variance were made to determine if statistically significant differences occurred in post-treatment herbage production among the overstory treatments, mulching treatments, and years following treatment; production of early (spring) growers and late (fall) growers were analyzed separately. Tukey-Kramer HSD was used to determine which treatments had a significantly different effects on herbage production. All statistical analyses were evaluated at a 0.05 level of significance.

Results and Discussion

Pretreatment herbage production (including a mixture of early and late growers) was approximately 930 kg/ha. Average post-treatment production of early growers on the control plots was 525 kg/ha, and average post-treatment production of late growers was 2,600 kg/ha.

Overstory treatments had no effect on either early or late herbage production over the initial 4-year post-treatment study period. There were no differences in the production of early growers among the mulching treatments. However, there was a difference in the production of late growers; this difference was between the lopped-and-scattered mesquite branchwood and the control. Herbage production was lower on plots with the lopped-and-scatter mulching treatment than on the control plots, suggesting that the former treatment might have suppressed the growth of late growers.

A difference was found in early and late herbage production in the post-treatment years of the study. The greatest difference the production of early growers was found between 1995 and 1996, this being a reduction in herbage production from pre-treatment in 1995 to post-treatment in 1996. Production of early growers began to increase with each year after 1996, but not to the level of production in 1995. The largest difference in production of late growers occurred between 1995 and 1997. Late herbage production declined with each year until 1998, at which time there was an increase in production, but again not enough to bring the level of production up to the pre-treatment level.

Effects of the treatments on changes in soil properties will be evaluated in the future. It is possible that a linkage between herbage production and soil properties can be identified to help in explaining the initial results of the study reported here.

Conclusions

As encroachment of mesquite shrubs continues to be a concern on many southwestern rangelands, understanding the processes of semi-arid shrub-grassland ecosystems has become an important focus of research. This study seeks to determine the effects of mesquite overstory control and the modification of soil properties by adding mulches on herbage production. It is hoped that further insights of the effects of the treatments on herbage production can be obtained with the planned analyses of changes in soil properties following the treatments.

Future evaluations of precipitation regimes might also prove useful; the study period included a prolonged drought period (with departures in average annual precipitation of 30% or more), which might have masked the treatment effects. Cable (1975, 1976) found that 65-to-90% of the year-to-year variability in herbage production on semi-arid shrub-grasslands can be attributed to the amount of precipitation. The effects of the treatments, therefore, may become more apparent as the study continues. In similar studies where mesquite was controlled and herbage production was monitored, it took 3 years and longer before changes in perennial grass densities became evident (Martin 1975, Martin and Morton 1993).

One explanation for the observed reduction in herbage production after the treatments could be the alteration of microclimates as a result of the elimination of the mesquite overstory. A mesquite overstory can function to improve soil conditions under their canopies by a redistribution of nutrient ions from areas beyond their canopies to areas beneath their canopies (Tiedemann and Klemmedson 1973); removal of this overstory, therefore, could have the opposite effect.

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Literature Cited

- Cable, D. R. 1975. Influence of precipitation on perennial grass production in the semidesert Southwest. *Ecology* 56:981-986.
- Cable, D. R. 1976. Twenty years of changes in grass production following mesquite control and reseeding. *Journal of Range Management* 29:286-289.
- Heitschmidt, R. K., and S. L. Dowhower. 1991. Herbage response following control of honey mesquite within tree lysimeters. *Journal of Range Management* 44:144-149.
- Martin, S. C. 1975. Ecology and management of southwestern semidesert grass-shrub ranges: The status of our knowledge. USDA Forest Service, Research Paper RM-156, 38 pp.
- Martin, S. C., and H. L. Morton. 1993. Mesquite control increases grass density and reduces soil loss in southern Arizona. *Journal of Range Management* 46:170-175.
- Martin, S. C., and H. G. Reynolds. 1973. The Santa Rita Experimental Range: Your facility for research on semi-desert ecosystems. *Arizona Academy of Science* 8:56-67.
- Pechanec, J. F., and G. D. Pickford. 1937. A weight estimate method for determination of range or pasture production. *Journal of the American Society of Agronomy* 29:894-904.
- Tiedemann, A. R., and J. O. Klemmedson. 1973. Effects of mesquite on physical and chemical properties of the soil. *Journal of Range Management* 26:27-29.