Vegetative Response Following Pinyon-Juniper Control in Arizona

J. T. O'ROURKE and P. R. OGDEN
Graduate Assistant in Range Management and Associate Professor of Range Management, The University of Arizona, Tucson.

Highlight
Mean percentage calcium carbonate levels of near 13% in the surface foot of soil and low pinyon-juniper crown cover (13% and 26%) were associated with no increase in perennial grass herbage production four to five years after pinyon-juniper control in north-central Arizona. Both percentage calcium carbonate in the surface soil and percentage pinyon-juniper crown cover are expressions of the long-time moisture regime of a site and may be good indices for predicting potential understory response which might be expected from pinyon-juniper control.

Clearing pinyon and juniper overstory is a practice frequently recommended to improve rangeland. Arnold, Jameson, and Reid (1964) found herbage production increased about three and one-half times (to near 700 lb per acre) by five to ten years after juniper control. Understory vegetative production, however, does not always improve greatly with overstory removal. Brown (1965) reported that the average production of perennial grasses increased on parts of one watershed with control of overstory. The change was not statistically significant because production was spotty and also increased on untreated watersheds. Jameson (1966) has pointed out that, since the influence of trees on blue grama (Bouteloua gracilis) is concentrated on the litter-covered areas, there is little response of blue grama to tree removal where the litter covers only a small part of the area.

A knowledge of the factors influencing understory response following pinyon-juniper control is necessary to determine what areas may profitably be treated.

The objectives of the study reported in this paper were to determine the soil, precipitation, and vegetative characteristics associated with production and basal cover changes of understory plants following pinyon juniper (Pinus edulis, Juniperus monosperma, and J. osteosperma) control in north-central Arizona.

Experimental Sites and Methods
The study area was located within the Heber Ranger District of the Sitgreaves National Forest in Coconino and Navajo Counties, Arizona. The soils of the study area are shallow and originated from limestone parent material. Four comparison sites were selected in the pinyon-juniper type along the Arizona Public Service Powerline right-of-way on which the overstory vegetation had been removed by bulldozing and hand-chopping. In the spring of 1961, a 195 ft strip along the southeast side of the right-of-way was cleared; the remaining 120 ft on the northwest side were cleared in the spring of 1962. Site names and elevations are: Boundary, 6200 ft; Ryan, 6300 ft; Second, 6500 ft; and Chevelon, 6600 ft. Understory vegetation on all sites is primarily blue grama. The Chevelon site was seeded in October of 1963 but success was so poor that any influence from the seeding was ignored in this analysis. Squirreltail (Sitaniom hystrix), woltail (Lycerus plieoides), and sand dropseed (Sporobolus cryptandrus) were the three main species contributing to the herbage production shown for other perennial grasses in Fig. 1. Following clearing, the cleared area was rested from grazing by domestic stock for two growing seasons and then returned to grazing use in 1965. All four sites were grazed by sheep during July and August of 1965 and 1966. Data were collected during the summer of 1966.

Within each year of control at each site, two clusters of five 100-step pace transects were established. and a corresponding number of transects were located in each adjacent uncontrolled area. Thus, the two years of control, each with an adjacent uncleared area, were compared as four treatments at each of the four sites. Basal cover of vegetation by species was recorded along the transects, and pinyon and juniper overstory was also determined along transects in the uncleared areas. Overstory was determined by recording the presence of cover above the pace transect points. To avoid bias resulting from pacing around obstacles, pace points were marked on a staff. When the line passed through areas where it was not practical to pace, the staff was laid along the line to determine data points. At the last pace of each transect, a 9.6 ft² herbage production plot was established. Herbage production was determined by species for all grasses by weight estimate.

The design of sampling was hierarchical, but the treatments within sites mean square was partitioned into the treatment and treatment times site components and analyzed as a factorial design. The cluster within treatment mean square with 16 degrees of freedom was utilized as the error term for testing significance of the treatment and site effects.

Soil was sampled at the 0- to 6-inch depth and the 6- to 12-inch depth and these held separate for analyses. Soil samples were collected from two locations within each cluster of transects. The four samples for each depth within each treatment at each treatment date were composited for laboratory analyses. The means of the analyses are given in Table 1. The sampling was hierarchical but the treatment within sites mean square was partitioned into its factorial components. The year within treatment mean square was utilized as the error term for testing treatment effects.

Laboratory analyses on soil samples were made for texture, moisture holding capacity at ½ atm and 15 atm tension, soil reaction, calcium carbonate, total soluble salts, potassium, nitrate-nitrogen, total nitrogen, and phosphate.
The phosphates and nitrates were extracted for 15 minutes in water through which CO$_2$ was bubbled. Phosphate was determined using molybdic acid and stannous chloride reagents. Nitrate was determined by the phenoldisulfonic acid method. Potassium was determined in a CO$_2$ extract with a Beckman-D4 flame photometer, and total nitrogen percentage was determined by Kjeldahl analyses.

Precipitation from June to November of 1966 was collected in three Tru-Chek rain gauges at each of the four sites.

**Results and Discussion**

Perennial grass basal cover averaged 21.4% at the Boundary site and 14.4% at the Ryan site, and control of pinyon-juniper overstory vegetation did not increase perennial grass cover at these sites. Pinyon-juniper control did increase perennial grass cover at the Second and Chevelon sites. The treatment times site interaction was significant. Perennial grass cover averaged 7.8% on uncleared areas at the Chevelon site and 24.0% where pinyon-juniper had been removed. At the Second site, the uncleared area had a perennial grass cover of 15.9% and perennial grass cover on the cleared areas was 23.4%. These cover responses are reflected in the herbage production data shown in Fig. 1. Perennial grass production along the cleared right-of-way was very nearly the same as for adjacent pinyon-juniper areas at the Boundary site. Clearing pinyon-juniper decreased perennial grass production at the Ryan site but resulted in over twice the production at the Second site and nearly four times the production of adjacent noncleared areas at the Chevelon site. Perennial grass production, as measured by 9.6-ft$^2$ plots, was extremely variable on all sites. The coefficient of variation among plots was 90%.

Annual grass basal cover averaged 1% to 2% on the uncontrolled areas of all sites and was little different from this after control for the Boundary and Ryan sites but averaged 15% to 14% on the Second and Chevelon sites after control. Basal area of forbs ranged from 0.0% to 0.3% on uncontrolled areas but ranged from 1.2% to 5.6% after control. The increase of forbs with pinyon-juniper overstory removal was evident at all sites. Basal cover of shrubs and half shrubs averaged 2.1%, 1.7%, 0.5%, and 0.3% for the Boundary, Ryan, Second, and Chevelon sites, respectively. Statistical significance was not shown for the slightly higher cover of shrubs on the cleared right-of-way. Snakeweed (*Gutierrezia* sp.) was the primary half shrub which showed an increase with control.

Pinyon-juniper control could be recommended for increased herbage production on the Second and Chevelon sites but not for the Boundary and Ryan sites. When a comparison of the site characteristics (Table 1) is made with the response, a number of factors are shown to be associated with the response obtained. Perhaps the most obvious factor associated with poor understory herbage increase is the high calcium carbonate percentage of the soils at the Boundary and Ryan sites. Since phosphorus availability and soil reaction are closely associated with calcium carbonate content in the soil, these characteristics were also correlated with response. The calcium carbonate percentage of the surface foot of soil was about 13% for the poor sites and averaged near 5% for the two better sites.
Effects of Grazing on a Hardland Site in the Southern High Plains

JIMMY W. BROWN AND JOSEPH L. SCHUSTER
Research Associate and Professor of Range Management, Department of Range and Wildlife Management, Texas Tech University, Lubbock, Texas

Highlight

The vegetation and soil characteristics of an ungrazed butte are compared with those of a similar site on an adjacent High Plains area. Woody plant cover was greater and more diverse on the butte while herbaceous vegetation was more productive and of higher quality. Species composition and production was representative of shallow hardlands of the Southern High Plains region. Soil characteristic differences reflected the detrimental influence of continued herbage removal and trampling by livestock on the grazed area.

An ungrazed isolated butte was studied to learn the effects of grazing on the vegetation and soils of a hardland site on the Southern High Plains. Such relict areas commonly serve as the basis for determining range site potential. The comparison of the relict area with an adjacent area which had received unrestricted grazing by cattle since the late 1800's also let us determine the effects of grazing on the soils and vegetation.

The butte (Flat Top Mountain) is located approximately 20 miles northwest of Snyder, Texas, and 8 miles southeast of Justiceburg on U.S. Highway 84. Flat Top Mountain (Fig. 1), adjacent to the escarpment (Cap Rock) of the Llano Estacado, straddles the line between Garza and Scurry Counties. The grazed area is located in Scurry County and is the nearest point to the isolated butte, which lies approximately 2 miles to the east of the Cap Rock. Elevations of the Cap Rock and the butte are 2,885 ft and 2,865 ft respectively.

The Llano Estacado, or Staked Plains, is the...