The upland stony loam and upland loam sites have soils that are considerably different, particularly with respect to the coarse fragments; but the subsoils on both have a high clay content. Moisture-holding capacities on both sites are sufficient to store all the winter precipitation; however, juniper roots must penetrate deeper on the upland stony site to obtain the same amount of moisture because coarse fragments take up about half the soil volume. Growth of juniper extends over a longer period of time on these two sites than on the hardpan site, and this probably accounts for the open, less compact crowns.

The variations in foliage-production crown-diameter relations make it necessary to develop separate prediction estimates or yield tables for each site. However, once the yield tables are developed, they should be usable from year to year within the range site. Estimates of foliage yield computed from crown diameter should be considered as average annual yield rather than applying to a specific year. If yearly foliage yields or fluctuations in annual yields are to be considered, detailed studies or estimates of current growth will need to be made.

Summary

Reliable estimates of foliage and fruit yields of juniper can be made easily and quickly from measurements of crown diameter. The best correlations and regressions were obtained using logarithmic equations. Prediction equations were greatly improved by placing trees in crown classes (sparse, medium, and dense). With samples of 20 trees within each crown class, estimates of mean foliage and fruit can be predicted within 10% of the mean with 95% confidence on many sites.

Yield tables developed from preliminary sampling can be used by field personnel to record foliage and fruit yield for trees with various crown diameters as illustrated in Table 3.

LITERATURE CITED


Chemical Control of an Old Stand of Chaparral to Increase Range Productivity

CHESTER A. PERRY, CYRUS M. McKELL, JOE E. GOODIN, AND THOMAS M. LITTLE

Farm Advisor, Agricultural Extension Service, Los Angeles County; Associate Professor of Agronomy, Assistant Agronomist, University of California, Riverside; and Extension Biometrician, University of California, Agricultural Extension Service, Riverside.

Highlight

Spraying an old stand of chaparral with herbicides was shown to increase range-carrying capacity 37% by the end of the third year. Control of Ceanothus spp., Salvia leucophylla and Adenostoma fasciculatum was estimated at between 89 and 100% for the various species.

Forage production on sprayed areas, consisting mostly of annual grasses and forbs, was nearly double that of nonsprayed areas.

The usual sequence of steps in converting chaparral to grassland in California has been (a) preparation of brush for burning by clearance of fire breaks, and sometimes mashing the brush with a bulldozer, (b) control burning, (c) reseeding with adapted forage grasses, and (d) application of herbicides to control brush regrowth (Love and Jones, 1952). In areas where burning has not been permitted, mechanical clearing has been employed—although at a high cost—to rid the slopes of brush and allow reseeding and spraying.

The possibility of by-passing the step of clearing the brush, either by fire or mechanical means, and applying herbicides directly to the standing brush has not been advocated up to this time. The reasons often given are that old stands of chaparral are hard to kill with chemicals (Leonard and Harvey, 1956; Leonard and Carlson, 1953) and that costs would exceed returns. At the 6,000-acre Temascal Ranch in Los Angeles County, chemical treatment of standing brush was the most likely choice to follow because controlled burning of brush was considered.

1 Paper No. 1760, University of California Citrus Research Center and Agricultural Experiment Station, Riverside.

2 The cooperation of Richard Hathaway, Hathaway Ranch Company, Santa Fe Springs, California, and Elwood Berg, Toxo Spray-Dust Inc., Santa Fe Springs, California is gratefully acknowledged.
too hazardous and many of the slopes were too steep for mechanical clearing.

Unpredictable annual rainfall of 7 to 20 inches at the Temascal discouraged any attempts to increase forage yields by range fertilization, and drill-seeding new range grass and legume species. However, much improvement was made through the years by broadcast-seeding native soft chess (Bromus mollis), bur clover (Medicago hispida), and filaree (Erodium botrys) on mechanically-cleared brush areas of ridge tops and flat areas.

The cow-calf stocking rate for the Temascal Ranch reached a peak in the late 1950's and early 1960's. Fifteen hundred animal unit months was considered the working capacity of the ranch. During the past several years, many range-improvement practices such as water development, ranch roads, and drift fences were adopted to make more efficient use of the grazing land and thus offset the steady increase in labor costs, as well as the rapid rise in land taxes. As peak cow and calf numbers were reached with a seasonal supplemental feeding program, the owners realized that if they were to increase production they would have to do something positive about the brush-covered areas. Almost half of the ranch was potential grazing land but was covered with a dense growth of chaparral.

Efforts were concentrated on the chemical treatment of three brush types: purple sage (Salvia leucophylla (Fig. 1); chamise (Adenostoma fasciculatum) (Fig. 2); and California lilac (Ceanothus spp.) (Fig. 3). When the decision was made to spray mature brush (in lieu of waiting for a wild fire to burn over the range, which last occurred in 1929), the owners decided to invest between $250 and $300 in chemical brush control per cow unit (an estimate of 25 to 30 acres/cow unit at an average cost of $10/acre). Under suitable conditions in previous years, one treatment of 3 lb/acre of 2,4-D acid gave practically 100% kill of purple sage. Resident grasses were abundant during the year after treatment. Excellent control of chamise was expected, based on previous treatments, but the results from spraying Ceanothus were less positive and quite variable.

Materials and Methods

In May, 1962, spraying operations were begun using either 2,4-D or brush killer (combined 2,4-D and 2,4,5-T), depending upon the dominant species to be sprayed at a particular site. Variable weather conditions extended spray operations through May and into June. Late spring rains caused an extended period of vegetative growth, but anthesis had occurred in all species at all sites prior to completion of the spraying. Due to the rugged terrain, application was made by helicopter without the aid of flagmen. Flight lines followed the contour of slopes wherever possible, and a uniform altitude was maintained for each particular area insofar as possible. Follow-up treatment was made in the spring of 1963 on small areas missed in the original flight pattern (Fig. 4).

Sites predominantly covered by purple sage were sprayed with 3 lb/acre 2,4 D low volatile ester, one gal diesel oil, and water to a total volume of 10 gal. Sites on which the dominant species was either Ceanothus or Adenostoma were sprayed with 5.0 lb/acre of brush killer (2.5 lb 2,4-D and 2.5 lb 2,4,5 T). Again
the carrier was one gal. of diesel oil plus water to a total volume of 10 gal.

About 1000 acres of sage-covered and 2000 acres of chamise-covered rangeland at lower elevations were sprayed. Ceanothus spp. were scattered on north and northeast slopes in solid stands and in mixed brush stands at high elevations on the deeper, more fertile soils. California buckwheat (Eriogonum fasciculatum) and black sage (Salvia mellifera) added appreciably to total vegetation cover, but were found primarily on slopes too steep for treatment.

Increased animal unit months carrying capacity was recorded for each season after the original treatment.

During the third season following the original treatment (spring, 1962), a vegetation analysis was performed at the peak of spring growth. Factors analyzed included percentage of brush kill effected by the herbicides, degree of brush knockdown following death, density of the remaining brush. Sampling of brush included 7 pairs of transects (on sprayed and similar nonsprayed areas) for each of the 3 brush types. Information concerning brush density, dead brush, and degree of knockdown was recorded at 5 locations along a 100-ft transect. All data were subjected to a factorial analysis of variance.

Forage production on a green weight basis was estimated on a total of 840 one-square-foot plots in sprayed and nonsprayed areas of the 3 brush types. At each brush-observation point along the transects through the chaparral, 4 estimates of forage yield/ft² were recorded. The estimate of total yield was subdivided into percentage of perennial grass, annual grass, and other forage species.

Prior to sampling, a period of training for forage estimation was undertaken. Three teams of 2 workers each trained themselves to estimate the green weight forage yield within a square foot frame by estimating, cutting and weighing. A goal was set and obtained for estimating a 10% accuracy. During the 2-day sampling period, additional references to actual cut weights were made to maintain proficiency.

Results and Discussion

Brush Control. — Three relatively dry years followed the 1962 treatment; rainfall averaged between 7 and 12 inches per season. As the brush lost its foliage and the canopy opened, grasses and forbs began to invade the site.

About the same kill was effected for all 3 types of vegetation. Spraying significantly reduced the live brush on all sites, and caused an over all kill of 96% as compared with 14% from natural causes in paired controls. The least effective herbicidal treatment was on Ceanothus (89%), whereas almost 100% control was achieved on sage and chamise sites.

Spraying significantly reduced brush cover on all sites. Initially, sage-covered sites were more open than either chamise or Ceanothus sites, and spraying reduced the cover in all cases by about 10%.

At the time of sampling, nonsprayed areas were characterized by a high proportion of standing brush. A small number of Ceanothus and chamise plants were dead and broken from natural causes, but sage plants were all essentially intact and healthy. In contrast, plants on sprayed plots had died and were beginning to break up and to be pushed...
Table 1. Estimated average forage yield (in lb/acre green weight) and species composition in relation to brush type. Temascal Ranch, Los Angeles County, 1965.

<table>
<thead>
<tr>
<th>Forage Type</th>
<th>Sprayed Ceanothus</th>
<th>Non-sprayed Ceanothus</th>
<th>Sprayed Chamise</th>
<th>Non-sprayed Chamise</th>
<th>Average forage yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual grass</td>
<td>2351</td>
<td>815</td>
<td>3747</td>
<td>2982</td>
<td>3156</td>
</tr>
<tr>
<td>Perennial grass</td>
<td>1784</td>
<td>1118</td>
<td>719</td>
<td>1858</td>
<td>1858</td>
</tr>
</tbody>
</table>

1 Figures shown are the average of 140 square-foot plots.

Forage Production.—The total green forage yield was nearly doubled by herbicide application (Table 1). On nonsprayed areas the yield was estimated at 1,858 lb/acre while on sprayed areas it was 3,156 lb/acre. The Ceanothus type was the most productive, chamise intermediate, and sage the least productive.

Forage composition deserves some consideration inasmuch as the ranch was not seeded after the spray treatment. Overall production of grass increased nearly 100% as a result of herbicide application (Table 1). Again, the Ceanothus type produced the most grass, followed by the sage and chamise type range. Some chamise plots were void of grass cover. Most of the increase can be attributed to the annual grasses soft chess and red brome (Bromus rubens) since no overall increase in perennial grass productivity was observed. With respect to type, however, there was an increase in perennial grass on the sage and chamise areas and an apparent decrease on the Ceanothus areas. This decrease in perennial grass may have resulted from the better accessibility of the area to grazing use after chemical treatment and the resultant increase in annual grasses. Although the non-sprayed Ceanothus range produced considerable forage, the heavy dense brush acted as a barrier to grazing and it was not generally available to cattle.

The abundance of other forage species was not significantly different on the treated areas than on nontreated areas. This result is rather striking since it might be expected that the 2,4-D and 2,4,5-T would decrease the concentration of broad-leaf species. A trend in the direction of more broad-leaf species on the treated areas may develop in the future.

Increased Carrying Capacity.—An appreciable increase in forage production occurred during the first season after treatment. Livestock numbers amounted to 2,430 animal unit months (AUM) in the year of treatment with 630 AUM accounted for by supplemental feed. The following year, 2,466 AUM were inventoried with supplemental feed contributing to only 247 AUM. Cattle grazed in areas that had been closed to them by brush in years past. During the third year, 1964, grazing intensity increased and the ranch inventoried 2,815 AUM of grazing. Supplemental feed supported 335 AUM. The increase in carrying capacity from 1,800 to 2,480 AUM represents a 37.7% increase in productivity over the 1962 inventory.

Costs and Returns.—With an increased rate of production established, a cost recovery period for chemical brush control can be estimated. Five dollars is considered a fair value for an AUM of grazing in Los Angeles County. At this rate, the 680 AUM increase has a value of $3,400/year. Assuming that the production of the improved range continues to increase, the 680 AUM would represent an average figure for several years and the total treatment cost of $30,000 (3,000 acres at $10 per acre) would be returned in about 9 years.

Still to be determined is the length of time that it takes for dead brush species to break down and decompose, how long after spraying maximum benefits occur, and how long the treatment continues to be effective. Not all brush species are killed by one chemical application. Whether the brush species that are more resistant to the chemicals will grow back and actually replace those that were killed remains unanswered. We expect that once the brush species are killed out, the growth of forage-type herbaceous cover will be great enough to prevent the establishment of brush seedling.

LITERATURE CITED

