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Selective Control of Brush on Chaparral Watersheds with Soil-Applied Fenuron and Picloram

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Pelleted fenuron and picloram were applied by hand as spot treatments. Desirable browse species for big game can be retained by this method. Picloram, at half the application rate of fenuron, was less toxic than fenuron to the oaks, but more toxic to the other shrubs. Season of application, particularly as it relates to precipitation pattern, is important in the performance of soil-applied herbicides in Arizona.

The objective of watershed research in the chaparral type of Arizona is to improve water yield by reducing brush density. Since chaparral areas also produce big game, it is important to know the influence of vegetation management practices on game habitat potential. Hopefully, outputs of both water and game can be increased through manipulation of vegetation.

Until recently, the phenoxy herbicides—2,4,5-T (2,4,5-trichlorophenoxyacetic acid) and silvex(2-(2,4,5-trichlorophenoxy) propionic acid)-have provided the chief means of controlling chaparral brush (Schmutz and Whitham 1962, Lillie 1963, Pase 1967). However, because it has not been possible to eradicate the resistant sprouting species, even with repeated annual applications, other herbicides were sought. Soil applications of fenuron and picloram were effective in greenhouse tests on shrub live oak[2] (Davis 1961, 1964). Field tests also demonstrated the effectiveness of fenuron on shrub live oak (Davis and Lillie 1961, Lillie 1962) and prompted the use of soil-applied herbicides for the control of brush on chaparral watersheds.

[1]*Plant Physiologist and Plant Ecologist, respectively, located at Tempe, in cooperation with Arizona State University; central headquarters are maintained at Fort Collins, in cooperation with Colorado State University.*

[2]*Common and botanical names for plants mentioned are listed on page 4.*

This is a report of the results of hand applications of pelleted fenuron (3-phenyl-1,1-dimethylurea) and picloram (4-amino-3,5,6-trichloropicolinic acid) on two experimental watersheds for the control of mixed chaparral brush. Although both herbicides were found to have weaknesses, they offer considerable promise for modifying chaparral vegetation. The extent of stream-water contamination by the picloram treatment was reported previously (Davis et al. 1968).

Materials and Methods

Study Area

The study area is located in the Mazatzal Mountains of central Arizona, between 3,300 and 4,500 feet elevation. Slopes are steep, ranging from about 25 to 70 percent. Soils are coarse textured and shallow to moderately deep, derived from deeply weathered and fractured Precambrian granites. The aspect is northerly.

In June 1959, an intense wildfire swept over the area killing all aboveground vegetation. Shrub live oak dominated the dense prefire chaparral cover, with lesser amounts of birchleaf cercocarpus, sugar sumac, Palmer oak, yellowleaf silktassel, Emory oak, pointleaf manzanita, and desert ceanothus. All shrubs except the last two mentioned sprouted vigorously after the fire.

After the wildfire, two previously calibrated experimental watersheds (C and B) were selected for herbicide treatment of sprout regrowth, and a third (D) was retained as an untreated control. The treated areas were successfully seeded to Lehmann, weeping, and Boer lovegrasses within 1 year after the fire.

The management objective for watershed C (95.3 acres) is complete conversion from brush to grassland. Following the wildfire, an annual spray program with 2,4,5-T was initiated in May 1960 to control the sprouting shrubs. After four annual applications, shrub live oak and birchleaf cercocarpus were the dominant shrubs remaining. Attempts to eliminate these shrubs were then shifted to the use of a soil application of fenuron.

The management objective for watershed B (46.5 acres) is selective eradication of undesirable shrubs among desirable deer browse species on northeast-facing slopes. Hand applications of fenuron and picloram were used for this purpose. Watershed B had not received the previous annual herbicide treatments, and contained a normal post-fire complement of shrubs.

Herbicide Treatments

The pelleted formulations of fenuron and the potassium salt of picloram[3] used in these studies contained 25 percent active ingredient and 10 percent acid equivalent, respectively. Both herbicides were spread by hand with crews of five to seven men. The herbicides were applied as spot treatments to individual bushes or clumps of bushes; intershrub spaces were not treated. The cross-sectional diameter of a bush or clump of bushes was estimated visually. A clear acrylic tumbler calibrated in shrub diameters (4 to 12 feet), for a given herbicide and rate of application, was filled with pellets to the appropriate graduation mark. Measured amounts of pellets were scattered on the ground beneath bushes with an erect habit of growth, or throughout the crowns of bushes with dense tops extending to the ground. In the latter case the pellets sifted through the bush to the ground. The minimum amount of chemical applied to any shrub, no matter how small, was the amount for a 4-foot-diameter bush. All application rates are on either an active ingredient or acid equivalent basis.

[3] *The picloram used in this study was donated by The Dow Chemical Company, Midland, Mich.*

Watershed C was treated with fenuron pellets in late summer, August 10-15, 1964, at an intended rate of 16 pounds per acre on the ground actually treated. The overall application rate on the watershed was 3.6 pounds per acre. Enough rain fell to dissolve the pellets and move the fenuron into the soil during late summer and early fall (4.6 inches from August 15 through October 17).

Northeast-facing slopes of watershed B were treated with fenuron and picloram in midwinter (January 25-February 1, 1965). Fenuron was applied on 16.4 acres at an intended rate of 16 pounds per acre on the ground actually treated. The overall application rate on the treated slopes was 18.3 pounds per acre. Thus, the intended rate was considerably exceeded. A 2.1-acre slope of a side drainage was treated with picloram at an intended rate of 8 pounds per acre on the ground actually treated. The overall application rate on the 2.1-acre slope was calculated to be 9.3 pounds per acre. Again, the application rate on the ground actually treated was higher than intended. Treatments are difficult to apply accurately with ground crews in dense brush.

Ample late-winter rainfall disintegrated the pellets and moved the herbicides into the soil prior to the start of spring growth and the dry spring and summer period. Picloram was tested at half the rate of fenuron on the basis of chemical activity and cost.

Evaluation of Treatments

The treatments were evaluated by observing the responses of tagged bushes over a 3-year period. Fifty bushes each of shrub live oak and birchleaf cercocarpus were tagged on watershed C; they were located in five areas across the watershed. Five major shrub species were evaluated on watershed B: shrub live oak, birchleaf cercocarpus, sugar sumac, yellowleaf silktassel, and Palmer oak. Fifty bushes each of the first two species and 30 each of the other species were tagged in both the picloram- and fenuron-treated areas. The tagged bushes were located in several representative areas across the watershed.

Shrub responses to the herbicides were evaluated during the fall or early winter months for 3 growing seasons following treatment. The grading system included a visual estimate of percent leaf injury, and a tally of living and dead bushes. Two or three years are necessary before mortality of sprouting species can be judged. The leaf injury rating is a measure of defoliation as well as leaf necrosis.

Records from rain gages at the base of each watershed showed the following amounts of precipitation during 3 years following treatments:

	Watershed C	Watershed B
First year	28.6	38.2
Second year	33.2	17.4
Third year	22.4	[1]13.8
Cumulative	[2]90.0	[3]69.4

[1]44 weeks [2]3 years 17 weeks [3]2 years 44 weeks

Results

The effect of the fenuron treatment on watershed C was less than anticipated. After 3 growing seasons, the mortality of shrub live oak was 48 percent, while that of birchleaf cercocarpus was only 26 percent (table 1). The action of fenuron was essentially complete after the second growing season. Leaf injury at the end of the first growing season was 77 percent for shrub live oak and 61 percent for birchleaf cercocarpus. Regrowth leaves developed less severe injury symptoms; by the end of 3 growing seasons the injury ratings had decreased to 62 percent for shrub live oak and 35 percent for birchleaf cercocarpus.

The fenuron treatment on watershed B was more effective than that on watershed C (table 1). Shrub mortality and leaf injury percentages after 3 growing seasons were highest for shrub live oak, intermediate for sugar sumac, birchleaf cercocarpus, and Palmer oak, and lowest for yellowleaf silktassel. It required 2 to 3 years to produce its maximum effect.

Effectiveness of picloram, at half the rate of fenuron, varied widely among the five shrubs (table 1). Its action was rapid and severe on birchleaf cercocarpus, sugar sumac, and yellowleaf silktassel. By the end of the first growing season its effect on these shrubs was nearly complete. Action of picloram on the oaks was slow and less severe; 2 to 3 growing seasons were required for maximum shrub response.

Discussion

Fenuron was less effective in controlling shrub live oak and birchleaf cercocarpus on watershed C than on watershed B because of several interrelated factors: season of application, amount and seasonal pattern of precipitation, and loss of fenuron from the shrub root zone of the soil by leaching and microbial decomposition. Watershed C was treated in August. It received 14.8 inches of rain prior to the treatment of watershed B in February. Also, during the remainder of the test period, watershed C received 5.8 inches more rain than watershed B. Since the shrubs were inactive during the late fall and winter months, it is likely that they largely escaped the effects of fenuron during this period of loss in the soil through leaching and decomposition. This suggests the advisability of mid- to late-winter applications in Arizona. The application should be timed to avoid the bulk of the winter rains, but to receive enough rain to disintegrate the pellets and move the herbicide into the soil before the late spring and summer dry period.

Picloram and fenuron exhibited different toxicity patterns toward chaparral shrubs. Picloram, at half the application rate of fenuron, was more effective than fenuron on birchleaf cercocarpus, sugar sumac, and yellowleaf silktassel, but less effective on the oaks (shrub live oak and Palmer oak). Fenuron was slower acting on all of the shrub species except Palmer oak.

Table 1.--Percent control of five shrub species, 3 growing seasons after spot treatments with pelleted fenuron and picloram at two seasons--late summer (August 10-15, 1964) and midwinter (January 25 - February 1, 1965)

Species	Treated with pelleted fenuron (16 pounds per acre) during--				Treated with picloram (8 pounds per acre) during midwinter (watershed B)	
	Late summer (watershed C)		Midwinter (watershed B)			
	Dead bushes	Leaf injury	Dead bushes	Leaf injury	Dead bushes	Leaf injury
	Percent					
Shrub live oak	48	62	82	94	56	66
Palmer oak	--	--	40	67	23	47
Birchleaf cercocarpus	26	35	54	71	94	99
Sugar sumac	--	--	57	83	100	100
Yellowleaf silktassel	--	--	20	43	100	100

The descending order of shrub susceptibility was:

Picloram	Fenuron
Sugar sumac	Shrub live oak
Yellowleaf silktassel	Sugar sumac
Birchleaf cercocarpus	Birchleaf cercocarpus
Shrub live oak	Palmer oak
Palmer oak	Yellowleaf silktassel

Although the spot-treatment application of picloram was probably heavier than necessary to control the picloram-sensitive species, it was marginal for the resistant oaks. The fenuron application was too low for all of the shrubs. Spot-treatment application rates of fenuron should be higher than 16 pounds per acre during years of high rainfall.

Hand applications of pelleted herbicides are more practical than aerial applications for treating open stands of brush; grass on intershrub spaces is spared and less chemical is required. As the density of brush increases, however, aerial applications become more practical. In relatively dense brush, aerial applications may be expected to be more effective than hand-applied spot treatments because of the added percentage of the root systems which will come in contact with the herbicide in the intershrub spaces. To control undesirable shrubs among desirable browse species with soil applications of fenuron or picloram, selective hand applications are necessary.

Because picloram is more toxic than fenuron to some shrubs and vice versa, and because the necessary rates of either herbicide to control all of the shrub species is excessive, a duo-herbicide treatment is an interesting possibility when hand applications are feasible. Picloram and fenuron could be applied singly to the shrubs most sensitive to each herbicide to achieve broad-spectrum brush control. Each herbicide could be used at the lowest rate commensurate with adequate control.

Two natural products of chaparral watersheds are water and big game. One way to approach a maximized balanced output of these products is to eliminate all but the desirable browse species. This necessitates a selective hand application, such as that described for watershed B. In addition to application problems, however, the end result may be less than desired from the standpoint of browse potential; the natural stand of browse shrubs may be undesirable in kind, or density, or both. Another approach might involve an aerial herbicide application for nonselective eradication of brush, followed, after appropriate periods of time, by grass and browse establishment programs. This approach would allow the establishment of specific browse shrubs in desired densities for a maximized balanced output of water and game.

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*Address requests for copies to originating office.

COMMON AND BOTANICAL NAMES OF PLANTS MENTIONED

Shrubs

Ceanothus, desert
Ceanothus greggii A. Gray
Cercocarpus, birchleaf
Cercocarpus betuloides Nutt.
Manzanita, pointleaf
Arctostaphylos pungens H.B.K.
Oak, Emory
Quercus emoryi Torr.
Oak, Palmer
Q. chrysolepis var. *palmeri* (Engelm.) Sarg.
Oak, shrub live
Q. turbinella Greene
Silktassel, yellowleaf
Garrya flavescens S. Wats.
Sumac, sugar
Rhus ovata S. Wats.

Grasses

Lovegrass, Boer
Eragrostis chloromelas Steud.
Lovegrass, Lehmann
E. lehmanniana Nees
Lovegrass, weeping
E. curvula (Schrad.) Nees

CAUTION: If you use herbicides, apply them only when needed and handle them with care. Follow the directions and heed all precautions on the container label. If herbicides are not handled or applied properly, or if unused portions are disposed of improperly, they may be injurious to humans, domestic animals, desirable plants, honeybees and other pollinating insects, fish or wildlife, and may contaminate water supplies.

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