Chemical Control of Big Sagebrush in Wyoming

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COOPERATIVE studies in chemical control of big sagebrush (*Artemisia tridentata*) in west central Wyoming were started in 1949 by the Forest Service and the Bureau of Land Management. The purpose of this work was to test methods of reducing sagebrush competition to allow an increase in production of palatable native forage plants. It is believed that the results obtained will be useful in numerous areas where big sagebrush is neither an important source of browse for game nor is producing desirable forage for domestic livestock.

The experimental area, near Lander, is typical of much of the sagebrush-grassland in Wyoming between the elevations of 5,500 and 7,500 feet. The general aspect is dominated by sagebrush with an all-age stand which averages 25 to 30 plants per 100 square feet (Fig. 1A). Other shrubby species include occasional plants of small rabbitbrush (*Chrysothamnus* sp.) and spineless horsebrush (*Tetradymia canescens* var. *inermis*). There is a fair to good herbaceous understory of thickspike wheatgrass (*Agropyron dasystachyum*) and streambank wheatgrass (*A. riparium*) with lesser amounts of bluebunch wheatgrass (*A. spicatum*), Cusick bluegrass (*Poa cusickii*), Sandberg bluegrass (*P. secunda*), and needle-and-thread (*Stipa comata*). Forbs are infrequent and produce little palatable forage. They include milkvetch (*Astragalus* sp.), lupine (*Lupinus* sp.), phlox (*Phlox* sp.), and clover (*Trifolium* sp.).

[1] Maintained by the Forest Service, U. S. Department of Agriculture, in cooperation with Colorado A & M College at Fort Collins, Colorado, and with Research Center Headquarters at Laramie, Wyoming, in cooperation with the University of Wyoming.

METHODS

A total of 57 different herbicide and carrier mixtures were sprayed on big sagebrush in 1949; and 59 in 1950. The work was continued in 1951. Tractor-mounted spraying equipment was used to apply the chemicals on 1-acre ground-sprayed plots on two dates in 1949, and three dates in 1950. Airplane application was made on six 6.6-acre plots on two dates in 1949 and on eight 5-acre plots on one date in 1950. A total of 228 acres of ground-sprayed plots and 135 acres of aerial-sprayed plots have been treated with chemicals.

One year after treatment, sprayed plots were sampled by pace transect to obtain the percent kill of individual sagebrush plants. Only those plants which had no living foliage were considered when the effects of chemical treatments were evaluated.

Observations were made on the reactions of other vegetation to herbicides. Early in 1951 exclosures were constructed on several plots sprayed in 1949 to obtain herbage-production data. The experimental area outside the exclosures was grazed by cattle during each summer.

In 1949 the majority of treatments were different rates of 2,4-D and mixtures of 2,4-D and 2,4,5-T in the butyl ester form. The 1950 treatments were largely 2,4-D and 2,4,5-T isopropyl esters and some butoxy ethanol and

propylene glycol butyl ether esters. Tests were made with 2,4-D, 2,4,5-T, and mixtures of the two at rates of 0.5 to 3 pounds acid equivalent per acre in 1949, and 0.5 to 2 pounds per acre in 1950. Other chemicals tested in 1949 were pentachlorophenol and arsenic trioxide, and in 1950 tests were made with 2,4,5-T ethyl amine, maleic hydrazide, and dinitro weed killers. Carriers were water at 3- to 50-gallon-per-acre rates, diesel oil at 1- to 5-gallon rates, and a 4-to-1-gallon water-oil emulsion. Diesel oil alone as a check was tried on all dates.

Chemicals for these tests were furnished by the Sherwin-Williams Company, Du-Pont de Nemours Company, Dow Chemical Company, and others. The Big Horn Flying Service flew the aerial plots. This article is not an endorsement of commercial firms or products nor is any discrimination intended.

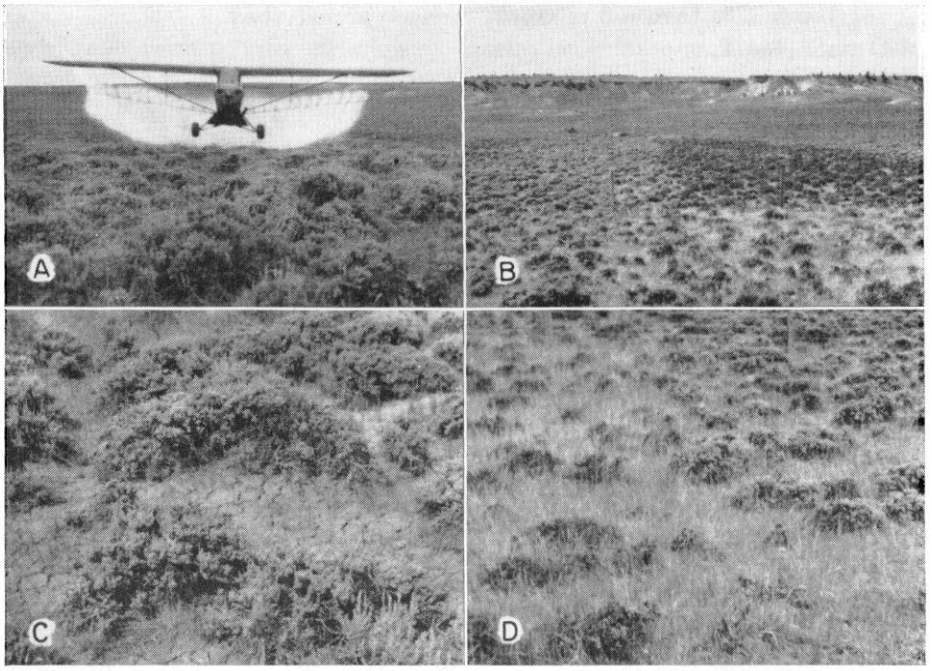

FIGURE 1. A. Airplane spraying a 50-foot swath of big sagebrush (FS 465823).

B. The plot on the right was sprayed with 3 pounds of 2,4-D per acre in 1949. In 1950, 78 percent of the sagebrush plants were dead and in 1951 air-dry grass production was 562 pounds per acre.

C. Close-up of untreated area. Note suppressed grass and high proportion of bare soil.

D. 97 percent of the sagebrush plants on the left were killed by spraying in 1949. In 1951 this area produced 645 pounds of air-dry grass compared to 222 pounds for the unsprayed area on the right.

RESULTS

This paper summarizes the principal findings of the first two years' study. The 1949 work was reported earlier in more detail by Hull and Vaughn (1951). The treatments made in 1950 and their results were reported by Kissinger *et al* (1952).

1949

Date of treatment—The rate of kill was closely correlated with the growth stage of big sagebrush at time of treatment. May 25 treatments, when twigs were 0.5 inch long and had approximately

one-half of their seasonal growth, averaged 50 percent higher kill than June 15 treatments when twig growth was near completion.

Chemicals—The 2,4-D butyl ester gave higher sagebrush kills than did mixtures of 2,4-D and 2,4,5-T, or other chemicals. As little as 1.5 pounds acid equivalent of 2,4-D on May 25 killed an average of 73 percent of the plants.

again an important factor affecting sagebrush kill. Highest kills were from treatments made during the period June 5 to 10 (Table 1). 2,4,5-T appeared to be effective earlier in the season and for a longer period than 2,4-D.

Sagebrush twig growth has been a poor index of the best time to spray in this area owing to yearly variations in date and rate of development. The growth

TABLE 1

Sagebrush plants dead on July 25, 1951, from treatments made on three dates in 1950

CHEMICAL	DATE OF SPRAYING	POUNDS ACID PER ACRE	GALLONS CARRIER PER ACRE						
			Water				Oil		Emulsion
			3	5	10	25	3	5	4 water–1 oil
			Percent kill						
2,4-D ester weedkiller (3.34 lbs. isopropyl ester per gallon)	May 15	½	2	4	3	—	5	26	—
		1	13	6	29	31	37	26	7
		2	37	25	19	—	48	49	—
	June 5–10	½	12	45	25	16	65	26	15
		1	17	35	41	12	69	37	29
		2	40	58	41	32	60	74	43
	June 25	½	10	16	8	—	8	20	—
		1	42	34	42	12	55	27	17
		2	50	39	45	—	66	56	—
2,4,5-T ester brushkiller (2.66 lbs. isopropyl and 0.67 lb. amyl ester per gallon)	May 15	1	59	43	50	—	71	62	—
	June 5–10	½	27	49	59	—	68	52	—
		1	53	65	52	66	88	81	—
		2	51	90	71	—	94	85	—
	June 25	1	3	51	49	—	62	76	—

Carriers—Generally, higher sagebrush kills were obtained using diesel oil as the carrier than the same volumes of water, although water at all rates gave good results on May 25.

Vegetation—Sagebrush plants reacted much the same to treatment regardless of age. Other vegetation was little affected except phlox which was almost completely killed. Small rabbitbrush, horsebrush, and lupine were damaged but grew again in 1950.

1950

Date of treatment—Stage of plant development at time of treatment was

stage of associated vegetation appears to be a more reliable indicator. Highest sagebrush kills were obtained in 1949 and 1950 from treatments made just prior to and during the early bloom stage of the native bluegrasses.

Chemicals—Considering all treatments, the isopropyl and amyl esters of 2,4,5-T gave consistently highest kills for a given amount of chemical. One pound acid equivalent of 2,4,5-T usually gave somewhat higher kills than 2 pounds acid equivalent per acre of 2,4-D. Table 2 illustrates the comparative performance of commercial ester formulations of 2,4-D and 2,4,5-T where the factors

of spraying date and type and rate of carrier were constant. Both 2,4,5-T and mixtures of 2,4,5-T and 2,4-D gave higher kills than did 2,4-D alone. Isopropyl ester formulations were more effective than propylene glycol butyl ether or butoxy ethanol esters.

TABLE 2

*Percent of sagebrush plants killed by different commercial ester formulations of 2,4-D and 2,4,5-T**

CHEMICAL	POUNDS ACID EQUIVALENT PER ACRE		
	½	1	2
	Percent kill		
2,4-D			
Isopropyl ester	26	37	74
Propylene glycol butyl ether ester	—	20	41
Butoxy ethanol ester	—	4	6
2,4,5-T			
Isopropyl and amyl ester	52	81	85
Propylene glycol butyl ether ester	—	47	77
2,4-D and 2,4,5-T mixtures			
Propylene glycol butyl ether ester (1:1)†	—	64	89
Butoxy ethanol ester (2:1)	—	16	18

* In 5 gallons of diesel oil per acre during the period June 5 to 10, 1950.

† Ratio of 2,4-D to 2,4,5-T in the mixtures.

The ethyl amine of 2,4,5-T was less effective during the optimum period than the esters of 2,4-D. Maleic hydrazide and the dinitro weed killers had little herbicidal effect on big sagebrush in these studies.

Cost—The studies provide a comparison of chemical costs but have not been carried long enough to show the degree of kill which will provide the maximum return on the spraying investment. For example, 2 pounds acid equivalent per acre of 2,4-D isopropyl ester was required to kill 74 percent of the plants. At current jobber prices this would mean about $3.00 per acre for chemical. A slightly higher kill, 81 to 88 percent, (Table 1) was obtained in these studies using 1 pound of 2,4,5-T isopropyl ester. Here again cost of chemical would be approximately $3.00 per acre. The 2,4-D and 2,4,5-T mixture at $2.50 per pound may prove to be the least costly for any desired sagebrush kill. One pound of low-volatile ester of this mixture gave a 64-percent kill. Since isopropyl esters of 2,4-D and 2,4,5-T gave higher kills than the corresponding low-volatile esters, a mixture of 2,4-D and 2,4,5-T in the isopropyl ester form may also be superior.

TABLE 3

Average air-dry herbage production of perennial grasses in 1951 on sagebrush plots sprayed in 1949

SPECIES	AVERAGE SAGEBRUSH KILLS				
	Untreated	58%	66%	78%	97%
	Pounds per acre				
Total grass	222	490	553	559	645
Thickspike and streambank wheatgrasses	189	318	420	449	493
Bunchgrasses (all)	33	172	133	110	152

Costs of application will depend on volume, size of project, and availability of equipment. In this area, aerial application costs varied from $3.00 to $5.00 per acre and tractor application from $2.00 to $3.00 per acre. Tractor application is slow and would be limited to small projects.

Carriers—Highest average sagebrush kills were obtained on all dates using diesel oil as a carrier. Although a 90-percent kill was obtained with 2 pounds of 2,4,5-T in 5 gallons of water per acre on June 5 to 10 (Table 1) the majority of the higher kills were obtained with oil.

In no instance did results with 3 gallons of water per acre compare favorably with 3 gallons of oil.

The higher kills obtained with 3 gallons of oil as compared with 5 gallons of oil per acre are not explainable on the basis of available data. Neither are the unusually high kills for the 0.5- and 1-pound rates of 2,4-D in 3-gallon treatments on June 5 to 10.

Methods of spraying—During both years, airplane and ground spraying appeared equal in effectiveness. Cost will therefore be a major factor in determining which method to use on any area.

Other vegetation—Many rabbitbrush plants were killed back to the root crown, but in the following year grew new shoots and showed no evidence of permanent damage. The data indicate that small rabbitbrush is somewhat more susceptible to 2,4-D than to 2,4,5-T. Rabbitbrush also appeared to reach the stage of maximum susceptibility later in the season than did big sagebrush. Horsebrush was not injured by any of the treatments. Phlox was damaged and often completely killed by both 2,4-D and 2,4,5-T in openings where it was not protected by the sagebrush foliage.

Grass production—Grass production may be increased two to three times in 2 years by chemical control of big sagebrush where there is a fair grass understory present before treatment (Table 3). These increases are to some degree proportional to the percent of sagebrush plants killed (Fig. 1B to 1D).

Thickspike and streambank wheatgrasses were the most abundant grasses in the study area. These species rapidly formed an open sod in the bare spaces following sagebrush kill. Bluegrasses, bluebunch wheatgrass, and needle-and-thread were the principal bunchgrasses. The increased grass production was due to the spread and increase in vigor of the original plants rather than to establishment of new plants from seed.

Cattle seemed to prefer the sprayed plots and at midseason in 1951 grass utilization on the 1949 sprayed areas was nearly twice as heavy as on adjacent unsprayed areas. We believe this concentration resulted from the increased supply of available forage.

Summary

Studies near Lander, Wyoming, reveal that 75 percent and higher kills of big sagebrush can be obtained with as little as 1 pound per acre of 2,4,5-T ester or 2 pounds per acre of 2,4-D ester. These herbicides were most effective in this area when applied in 3 to 5 gallons of diesel oil carrier about the time the native bluegrasses started blooming. Treatments which gave good control of big sagebrush did not result in severe damage to other shrubby species or herbaceous vegetation.

Airplane and ground-spraying equipment gave similar results for comparable treatments.

Native grass production was increased approximately two to three times by killing 60 to 97 percent of the sagebrush.

LITERATURE CITED

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