Controlling Big Sagebrush with 2,4-D and Other Chemicals

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CHEMICALS such as 2,4-D, 2,4,5-T, and others have been widely and successfully used to control undesirable weeds and brush. Success with 2,4-D in controlling sand sagebrush (*Artemisia filifolia*) at the Southern Great Plains Field Station and other locations led workers to believe that control of big sagebrush (*Artemisia tridentata*) would be easy. The first sprayings on big sagebrush were disappointing, but as more became known about different types and rates of chemicals and carriers, chemical control began to show some promise.

To find which chemicals and carriers, and methods and dates of application, might be used for large-scale control of sagebrush this present study was undertaken near Lander, Wyoming. In size and number of plots it is one of the largest studies reported for chemical control of big sagebrush. Sprayings are being continued, but as the first-year (1949) sprayings show trends which might help other workers in the same field, these results are presented at this time. Smaller chemical spraying studies in Moffat County, Colorado, by Colorado A & M College, and in Delta County, Colorado, by the Rocky Mountain Forest and Range Experiment Station, were designed to be coordinated with this study and, although there are some exceptions, they show similar trends. During the spring and summer of 1950 more dates and treatments than were in the 1949 study were applied near Lander. Final data from these sprayings are not yet available, but 1950 defoliation shows that treatments common to both years give similar results.

[1] Maintained by the Forest Service, U. S. Department of Agriculture, in cooperation with Colorado A & M College, Fort Collins, Colorado.

Location and Description of Study Area

The chemical spraying was conducted 35 miles southeast of Lander, Wyoming, on the Sweetwater drainage. Elevation is 6,800 feet and precipitation is approximately 14 inches annually. The area slopes about 5 percent southeast. Sagebrush formed an uneven-aged stand with about 35 plants per 100 square feet—about 14 of these plants were mature and brittle, 10 were young and flexible, and 11 were seedlings not producing flowerstalks. There was an average of one-half small rabbitbrush plant (*Chrysothamnus* spp.) per 100 square feet with an occasional small plant of spineless horsebush (*Tetradymia canescens inermis*). The understory vegetation was mostly western, thickspike, and streambank wheatgrass (*Agropyron smithii*, *A. dasystachyum*, and *A. riparium*) with consider-

able prairie junegrass (*Koleria cristata*), cusick bluegrass (*Poa cusickii*), needle-and-thread (*Stipa comata*), Indian ricegrass (*Oryzopsis hymenoides*), plains reedgrass (*Calamagrostis montanensis*), and bluebunch wheatgrass (*Agropyron spicatum*). There was considerable phlox (*Phlox* spp.) and some small wild clover (*Trifolium* spp.), with an occasional plant of lupine (*Lupinus* spp.).

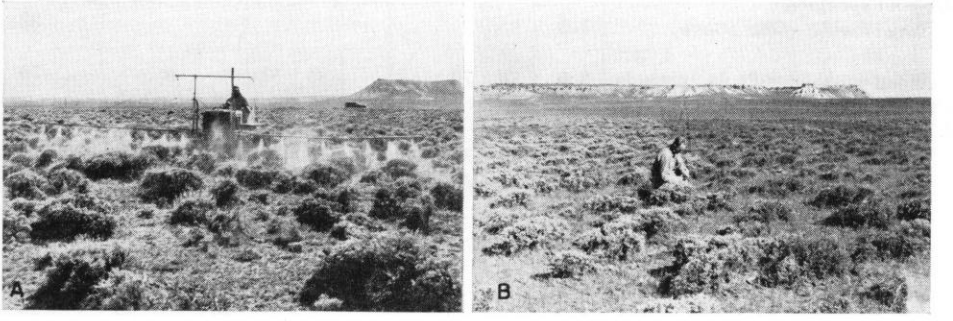

FIGURE 1. Chemical spraying of big sagebrush with tractor outfit. *A*. Caterpillar tractor attachment sprays 30-foot swath at 3 m.p.h. *B*. (left) 30-foot unsprayed border; (right) sagebrush sprayed May, 1949, with 97 percent plant kill by July, 1950.

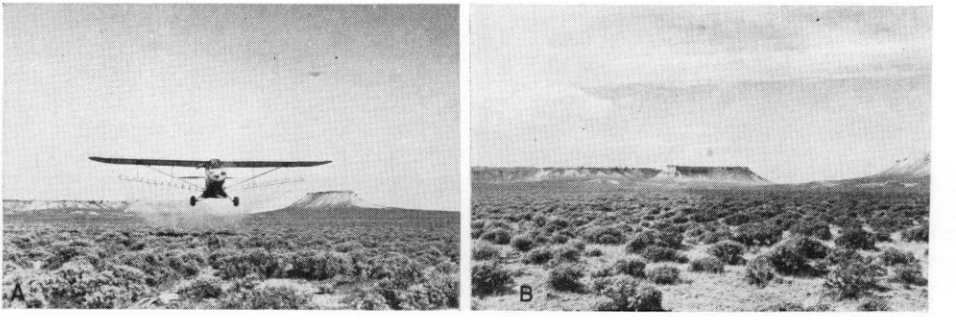

FIGURE 2. Chemical spraying of big sagebrush by airplane. *A*. Piper cub special, flies 2 to 10 feet above ground, covers 50-foot swath, at 90 m.p.h. *B*. (right) sagebrush sprayed May, 1949, with 68 percent plant kill by July, 1950.

CHEMICAL TREATMENTS

A total of 69 plots were sprayed either from the ground or from the air on one of two dates in 1949 with different types and rates of chemicals and carriers. Sixty-three 1-acre plots (60 x 726 feet) were sprayed with a 30-foot ground sprayer mounted on a Caterpillar tractor. One round trip completed a plot. There was a 30-foot strip between plots. The other six plots, 6.6 acres in size (100 x 2,640 feet), were sprayed by airplane. The plane made two trips over each plot. A 200-foot strip was left between plots. Figures 1 and 2 show the ground spray rig and the airplane in operation, and also show results of spraying. Most of the ground plots were sprayed with the butyl ester form of 2,4-D under the trade name of Weed-No-More, or a mixture of 2,4-D and 2,4,5-T under the trade name of Sherwillkill. The airplane plots were sprayed with Weed-i-cide. These and other chemicals were mixed with water at from 3 to 50 gallons

TABLE 1

Sagebrush plant mortality on July 12, 1950, after spraying on May 25 and June 15, 1949, near Lander, Wyoming

TREATMENT AND CHEMICAL	ACID PER ACRE	MAY 25						June 15					
		Water (gal.)			Diesel oil (gal.)			Water (gal.)			Diesel oil (gal.)		
		3	5	50	1	3	5	3	5	50	1	3	5
	lbs.	*percent*											
Airplane spraying													
Weed-i-cide—(6.4 pounds butyl ester acid of 2,4-D per gallon)	1.0				38	48	68					41	46
	1.4										40		
Ground spraying													
Weed-i-cide—(see above)	1.5											22	
Weed-no-more—(2.64 pounds butyl ester acid of 2,4-D per gallon)	3.0	78	79			85	81		9			70	
	2.0	68				64		42	12	43			
	1.5	63	58	97		77	70	63				42	64
	1.0		58				68		14			15	61
	0.5											9	66
Sherwillkill—(1.26 pounds butyl ester acid per gallon [0.63 pounds 2,4,5-T and 0.63 pounds 2,4-D])	1.5							30	39			24	43
	1.0							24	15	15		16	
	0.75			31				28					13
	0.50	31							27			9	13
	0.25	2	21			9	22						
	0.12	3	4			2	17						
	0.08		2			2	7						
Brushkiller 32—(2 pounds butoxy ethanol ester acid per gal. [⅔ lbs. 2,4,5-T; 1⅓ lbs. 2,4-D])	2.00											12	
Brushkiller 102—(6.4 pounds 2,4-D acid per gal. [2.1 lbs. methyl ester and 4.3 lbs. ethyl ester])	2.20											13	
Penta Weedkiller—(Approximately 1.2 lbs. pentachlorophenol per gal.)	4.0												0.5
also 2 lbs. 2,4-D per acre	4.0												6
also 1 lb. 2,4-D per acre	2.0									17			
Vintox—(4.0 pounds arsenic trioxide per gallon)	1.5								0				
	0.5								1				
Diesel oil alone	—												0
No treatment—(Check plots)		3 percent of plants dead											

per acre, and Diesel oil at from 1 to 5 gallons per acre. Table 1 shows the chemicals used, rates per acre, type and rates of carrier, and dates of spraying.

The authors are grateful to the Sherwin Williams Paint Company, the Occident Elevator, and others for supplying the chemicals for this test, but no discrimination against other products is intended and this article does not constitute an endorsement of any product mentioned. The authors also express gratitude to Melvin Christler of the Big Horn Flying service for flying the experimental areas.

Part of the plots were sprayed on May 25 and the remainder on June 15. On May 25 the sagebrush plants were growing actively with an average twig length of one-half inch. On June 15 the plants were still growing but were near maximum twig growth for the season with twigs averaging 1 inch. Some flowerstalks had started growth and were up to 5 inches in length with an average of 3 inches. The percent moisture in the soil by 6-inch depths on both spraying dates is shown in Table 2.

TABLE 2

Average percent moisture in soil samples to a 2-foot depth

DEPTH OF SAMPLE (inches)	PERCENT MOISTURE	
	May 25	June 15
0- 6	15	14
6-12	18	16
12-18	19	18
18-24	9	20

RESULTS

Before plots were sprayed, three 50-square-foot permanent samples were staked in each plot. On these samples the amount of sagebrush was counted by four age classes: (1) seedlings; (2) young; (3) mature; and (4) dead. Other shrub species were also recorded. In July 1950, over 13 months after spraying, the plants were recounted and classified as to percent kill of each plant and an additional 200 plants on each plot were classified. The percent of plants completely killed of these 200 plants and the plants in the three 50-square-foot samples per plot are shown in Table 1.

Date of spraying or stage of plant development was one of the most important factors for the success of spraying. May 25, when the twigs were 0.5 inch long and had approximately one-half of their seasonal growth, was generally better than June 15 when twig growth was near completion and flowerstalks had commenced to elongate. Averaging all treatments where there is direct comparison between early and late gives 66 percent kill for early spraying and 47 percent for late. From Table 2 it will be seen that soil moisture was slightly better on the second date than on the first.

Chemicals.—The type and amount of chemical which killed two-thirds or more of the brush plants varied with carrier and season. Based on the few comparisons, the butyl ester form of 2,4-D usually gave better results than mixtures of 2,4-D and 2,4,5-T or the contact sprays. In other studies the mixtures have often been better than 2,4-D. In general the higher the rate of chemical the better the kill. On the early date there were only two comparisons with 1, 1.5, and 3 pounds of 2,4-D. Here 1 pound averaged 63-percent kill; 1.5 pounds averaged 64 percent; and 3 pounds averaged 80 percent. There were four comparisons between 1.5 and 3 pounds, with 1.5 pounds averaging 70-percent kill and 3 pounds averaging 81 percent.

Carriers varied in effectiveness with the amount used and the date of application. In general, oil was better than water at the same rate. Using all rates

of carrier (except 50 gallons) and all rates of 2,4-D on May 25, oil averaged 74-percent kill of plants and water averaged 66 percent. The best kill of 97 percent was from 50 gallons of water and 1.5 pounds of 2,4-D applied as a ground spray on May 25 (Fig. 1B). This gave a 99 percent kill of the foliage. As only 25-gallon nozzles were available, it was necessary to go over this plot twice. The better results may have been from more complete wetting of the foliage. Other than this one plot the amount of water used had no consistent effect upon brush kill. Except on May 25 with 2,4-D, 5 gallons of oil was generally better than 3 or 1, but 5 gallons of oil alone as a check gave no kill. There is a tendency for oil as a carrier to be effective over a longer period than water.

With the airplane spray, the best kill was 68 percent of the plants and 93 percent of the foliage, using 1 pound of 2,4-D and 5 gallons of Diesel oil per acre on May 25 (Fig. 2B).

Sagebrush plants reacted much the same regardless of age class. There was a tendency for smaller plants to be either completely dead or completely alive, but the percentages of plants killed were similar for both young and old.

Other vegetation on the sprayed plots was little damaged by spraying. An exception was phlox which was almost completely killed. Approximately 20 percent of the rabbitbrush plants were killed, but in most cases the tops were just killed back for 1 year. A few of the tops of spineless horsebrush were killed back, but most plants were not affected. The lupine wilted in 1949 but grew again in 1950.

Discussion

In this article the authors do not attempt to weigh the merits of sagebrush or the different methods of sagebrush control. This is merely a report of first-year results on a large spraying study for chemical control of big sagebrush, presented to help others who are interested in this same problem.

One of the difficulties of large-scale experimental spraying is keeping the nozzles clean and keeping the pressure adjusted and the speed uniform on all types of terrain. When spraying with a ground rig at 3 miles per hour, the nozzle openings for 3 gallons or less per acre are so small that they clog easily and these low rates are not practical under field conditions. Diesel oil clogs less than water. With the greater speed of the airplane, the nozzle openings are larger and there is little clogging even at 1 gallon or less per acre. When nozzles clog and have to be cleaned or the pressure or speed changes, this upsets the rate per acre and often makes direct comparison difficult between chemicals, carriers, and dates. For example, the amount of chemical actually used as shown in Table 1 is not always what was planned. Through a mistake in mixing on May 25, too little Sherwillkill was used and there is little comparison here. As different companies supplied chemicals for ground and airplane spraying there is poor direct comparison between the two methods of spraying.

Chemicals. Although the higher rates of chemical give higher brush kills, the increased kill is often relatively expensive. It may be that spraying with another light rate in 2, 3, or 5 years will give better results for the same cost. Because of the good control on one plot with 0.5 pound of 2,4-D in 5 gallons of oil, more emphasis might be given lighter dosages of different chemicals and carriers on different dates to see if chemical costs can be reduced.

Sagebrush plants apparently do not translocate spray material radially. Portions of the plants which were missed in spraying remained alive and vigorous despite the fact that other portions of the plant were completely dead. Colorado A & M College sprayed sagebrush plants with 2,4-D in Poudre Canyon in 1946. Portions of plants which were not killed at that time are still alive and growing vigorously today. Whether the portions which are still alive and vigorous in this present study will spread and form large plants or whether they will weaken and die is not known. As the fate of these partially dead plants is not known, the discussion is based on the percent of plants which are completely dead. The percent of plants dead and the percent of foliage killed were charted to show the relationship between the two (Fig. 3).

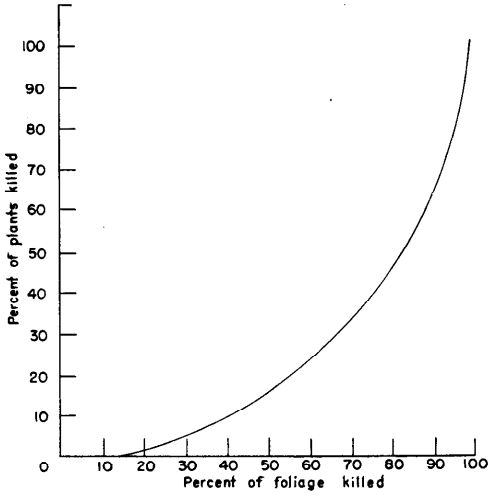

FIGURE 3. Big sagebrush plants killed in relation to foilage killed on 69 plots near Lander, Wyoming.

Methods of spraying depend on topography and many other factors. Ground and airplane spraying should give much the same results for similar treatments. If this proves to be true, then cost of application by ground as compared to air will be the deciding factor in determining the spraying methods. At this location and with the equipment used, large-scale air spraying would have cost about $1.75 per acre and ground spraying $3.00 per acre.

There was a good but much suppressed understory of grass on the sprayed area. Observations showed increased volume of grass where there was a good brush kill, but as the area was open to grazing the increase was not measured. This will be done during the second growing season. A partial answer may be found on an area just north of the experimental area where the brush was graded off in late fall of 1948. During 1950, native sod grasses on the graded portion yielded 569 pounds per acre as compared to 89 pounds on the untreated native range.

SUMMARY

An area of big sagebrush near Lander, Wyoming, was sprayed on May 25 and June 15, 1949 with different types and rates of chemicals and carriers and by both ground-spray rig and by airplane. This report gives results from the first-year's spraying with the hope that this information will assist other workers in this field.

Date of spraying or stage of plant development was important with best results when the twigs were about one-half inch long or half grown. Chemical treatments varied greatly but in general 2,4-D in the butyl ester form gave better results than did mixtures of 2,4-D and 2,4,5-T or contact sprays. The higher the rate of chemical, the better the kill, with as little as 1.5 pounds of acid per acre giving good results. Diesel oil was

generally more effective than water as a carrier and appeared to be effective over a longer period than water. In most cases the higher the rate of oil, the better the results.

The age or size of the sagebrush plants seemed to have little effect upon the percent kill. As airplane and ground spraying appear equal in effectiveness, cost will be a major factor in determining which method should be employed on large areas. Although the increase in vigor and size of the grass in the understory was noticeable on the sprayed area, it was not measured because the entire area was grazed in 1950. With the exception of phlox, which was badly damaged, the other shrubs and broadleafed vegetation were little affected by spraying.

SIXTY-YEAR-OLD SAGEBRUSH

How long do individual plants of big sagebrush live on the range in Montana? During a study of competition between grass and big sagebrush W. E. Booth of Montana State College counted the annual growth rings in about 300 individual plants. The plants were taken from three separate areas in the Madison, Gallatin, and Trail Creek drainages and ring counts were from stem cross sections one inch above the ground. Of the total number of plants observed, 31.5 percent were in the 31–35 year age class. Numbers of plants by 5-year age classes, diminished both ways from this modal class. Less than one percent of the plants were under five years old. The oldest ones, again less than one percent of the total, were in the 56–60 year age class. Even though the history of the selected areas is incomplete it is known that they had recently been only lightly used by livestock and big game. These data indicate that under certain conditions, at least, big sagebrush will live to a ripe old age in Montana.—*From* Proceedings Montana Academy of Science, Vol. 7 and 8, pp. 23–25.