Spraying 2,4-D by Airplane on Sand Sagebrush and Other Plants of the Southern Great Plains

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EXTENSIVE tests were made in May 1947 and 1948 of the airplane application of 2,4-D (2,4-dichlorophenoxyacetic acid) on sagebrush infested rangeland near the U. S. Southern Great Plains Field Station, Woodward, Oklahoma. These studies followed successful trials of hand spraying 2,4-D on rod-square plots of sand sagebrush (*Artemisia filifolia* Torr.) in May, 1946.

The testing of chemicals was started after extensive studies by the Station since 1937 had shown conclusively that eradication of sand sagebrush by mowing is an extremely effective range improvement practice. Studies of vegetation and grazing tests during the past 10 years have shown that removal of sand sagebrush by mowing in two successive years during June increased grass density 90 percent, carrying capacity 45 percent, gain per head 14 percent, and gain per acre 78 percent, as published in semi-annual progress reports of the Station and elsewhere (*2*).

Although mowing was highly effective, it was too slow and costly to be widely used on large tracts of low-priced rangeland. The new chemical 2,4-D sprayed by airplane promised to overcome both of these important objections.

The results reported herein are based on investigations conducted by the Division of Forage Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, and the Bureau of Animal Industry, Agricultural Research Administration, U. S. Department of Agriculture, in cooperation with the Oklahoma Agricultural Experiment Station. In this study, the authors are indebted to J. R. Harlan, Bureau of Plant Industry, who actively participated in all phases of the tests in 1947; to A. L. Brown, formerly of the same agency, who was in charge of the spraying work in 1948; to J. E. Webster and V. G. Heller, Oklahoma Agricultural Experiment Station for conducting root reserve studies of the shrubs; and to W. H. Black, Bureau of Animal Industry, for cooperation in the grazing studies.

Description of Experiments

Location, Soils, Vegetation, Precipitation

The tests were made on over 1000 acres of sandy rangeland near Higgins in the Panhandle of Texas and on the Southern Plains Experimental Range near Fort Supply, Okla. These areas are representative of nearly 5,000,000 acres of land infested with sand sagebrush, skunkbush (*Rhus trilobata* Nutt.), sand plum (*Prunus angustifolia* Marsh.) and shinnery oak (*Quercus havardi* Rydb.) in Colorado, Kansas, New Mexico, Texas, and Oklahoma. The sandy soils are located in belts ranging from 3 to 15 miles in width along major streams of the region. The soil texture on the test areas varies from fine sandy loam to dune phase of sand.

The vegetation consists of an upper story of shrubs averaging about three feet in height but ranging from one to six feet. The plants of sand sagebrush are uniformly spaced and the foliage cover usually occupies about one-third of the ground area. Skunkbush and sand plum usually occur as scattered plants through-

out the sandy areas. Shinnery oak is confined to the Miles series of loamy fine sand where it often makes up more than 75 percent of the foliage density. Dominant grasses in the understory are blue grama (*Bouteloua gracilis* (H.B.K.) Lag.) and sand dropseed (*Sporobolus cryptandrus* (Torr.) A. Gray). Despite heavy grazing in the past, many of the tall native grasses are present in small quantities. Sufficient grasses occur between and within the shrubs to provide a good basis for rapid natural recovery when the shrubs are killed. Reseeding is rarely necessary.

Average annual precipitation at Woodward is 23.06 inches with 70 percent, or 16.20 inches, falling as rain during the 6 months April through September. April, May, and June are the 3 wettest months of the year, and the 1947 precipitation during these months was nearly twice normal. Growing conditions for all shrubs were extremely favorable. Annual precipitation over the region to which these tests are applicable is generally less than 23 inches and drops to 14 inches in eastern Colorado.

Commercial formulations of ethyl, butyl, and isopropyl esters of 2,4-D were tested in comparison with commercially prepared sodium salts of 2,4-D and with a mixture of the pure acid of 2,4-D in a water solution of sodium carbonate (to be hereafter referred to as a homemade salt). The homemade salt was formulated to provide a product the cost of which would not be prohibitive for use on low-value rangelands. It is made by thoroughly dissolving 0.5 pound of sodium carbonate in 4 gallons of water, adding 1 pound of pure 2,4-D and then emulsifying with 1 gallon of diesel oil. This is sufficient for 1 acre. No amines were included in the 1947 tests, but were used along with the other chemicals in 1946 and 1948. The water used in the tests came from a local well near the landing strip and did not contain an excess of minerals. The diesel oil was No. 2 grade and was supplied direct to the mixing tank from a tank truck.

Equipment

All flying tests were made by an airplane provided cooperatively by an agricultural flying service company, the Franklin Flying Service, Davis, Calif. The airplane, a converted Stearman, was specifically equipped for spraying. The boom extended the full 30 feet length of the wings and was equipped with nozzles at 12-inch intervals. Each nozzle had a spring-loaded shut-off valve. The 100-gallon supply tank was mounted in the front cockpit, and the liquid was forced out of the nozzles at about 25 pounds pressure by a wind-driven centrifugal pump. A by-pass valve on the pump gave return-flow agitation to the liquid in the tank. By changing the size and number of nozzles and the pressure within the boom, the volume of liquid applied to each acre could be controlled. The pilot, a World War II veteran, was well qualified by several years spraying experience.

In determining the best time or date-of-spraying, ground equipment was used. But this machine lacked efficiency. A small tractor was equipped with a belt-driven gear pump which supplied the liquid from a barrel to a well-braced, 10-foot boom at 30 pounds pressure. The barrel supply tank did not contain a mechanical agitator, which would have facilitated mixing powder forms of 2,4-D and emulsifying water and diesel oil. At the slow speed which was necessary in traveling over the rough rangeland, the lowest useable volume per acre was 12 gallons. However, this was reduced to 5 gallons with much superior equipment used in 1948.

The tank used for mixing all materials which were sprayed by airplane was a

commercial livestock spraying machine with a gasoline-driven pump and mechanical agitator. The capacity of the tank was 150 gallons and since no batches over 100 gallons were used a very thorough job of mixing was accomplished. The pump on the spraying machine was used to transfer the mixed material into the supply tank of the plane.

Methods

The plots for the date-of-spraying tests, which were made at two-week intervals, were 20 feet by 719 feet, or one-third of an acre. Duplicate plots were sprayed on each date. Plots sprayed by airplane in testing different brands and formulations of 2,4-D were one mile long and 33 feet wide. The width of these plots was entirely too small, however, because cross winds carried an unknown quantity of material away, but not onto adjacent plots since they were widely separated. The plots sprayed by airplane for rate and volume tests were from one-fourth to one-half mile long and up to one-eighth mile wide.

All plane flights were made cross-wind so that a compensating over-lap of spray resulted in the calibrated quantity of material being applied to the downwind side of the wider plots. Three flagmen were used to mark the plane course over each plot; one at each end of a flight and one in the middle. Each flagman waved a yard-square white flag to enable the pilot to spot his flight line. Measured stakes were used to keep the flagmen in proper alignment. Distribution of the oily spray was checked by the use of white cards. When water was used as a carrier, microscope slides darkened with smoke were used to catch the spray.

Early effects of the treatments were observed daily for three days after sprayings. Thereafter estimates of percentage defoliation and discoloration were made at monthly intervals. Final results of percentage kill were determined by four observers over a year later. Each observer counted the number of dead and living sagebrush plants in alternate belt transects approximately 6 feet wide and extending either the entire length of the plots or until each observer had counted approximately 100 plants. On the wider plots each observer read two such transects extending a half mile in length. The data collected from the wider plots were subjected to an analysis of variance. There was no significant difference between the readings obtained by any one man on two transects within each plot, nor between men on the same plot. A variation of 5.1 percent was necessary for a statistically significant difference at the 5 percent level between plots.

Several of the plots were situated half on native range mowed in June of 1946 and half on non-mowed native range to determine the effects of mowing before spraying. All plots were grazed in the spring until treated; thereafter, grazing was deferred to enable the grass to make maximum growth and to compete with the weakened brush.

Results and Discussion

At the end of a four-day test period, extending from May 26 to May 29, 1947, it was obvious that an airplane could rapidly apply 2,4-D to moderately rough and rolling range land. Some dunes had slopes up to 25 percent and the difference in elevation of the land within a mile-long plot was often 200 feet. Whenever possible the spray plane flew at an altitude of 6 to 10 feet. It was noted in several instances when checking final mortality in 1948, that the sagebrush in the bottoms of deep pockets was killed more completely than the sage near the tops of the dunes. Possible eddying of spray or more

favorable moisture conditions for growth might have accounted for this difference. at less than one pound per acre. Plants severely affected were distorted, drying or

TABLE 1

Summary of different brands and formulations of 2,4-D applied by airplane on May 26–29, 1947, showing the percentage of sand sagebrush plants severely affected by the treatment and the final percentage kill

TYPE OF 2,4-D		MATERIAL USED PER ACRE			PERCENTAGE OF PLANTS SEVERELY AFFECTED IN 1947 ON			PERCENTAGE OF PLANTS DEAD ON 6/10/48
Chemical compound	Percent pure acid	2,4-D acid equiv.	Solvent		6/25	7/25	8/25	
			Quantity	Type				
	pct.	*lbs.*	*gals.*		*pct.*	*pct.*	*pct.*	*pct.*
Isop. ester	37.0	1.2	3.5	DO-ester	15	65	80	70
Ethyl ester	9.6	1.0	2.9	DO-ester	50	95	99	81
Isop. ester	38.6	.9	3.4	DO-ester	40	65	95	72
Isop. ester	38.6	1.0	3.7	W-ester	40	65	90	63
Sodium salt	100.0	1.1	5.6	Water	1	20	75	25
Sodium salt	75.9	1.1	3.1	Water	5	20	80	45
Sodium salt	70.0	1.1	3.3	W-DO (2-1)	5	20	75	46
Sodium salt	83.6	.9	2.6	W-DO (2-1)	5	40	75	50

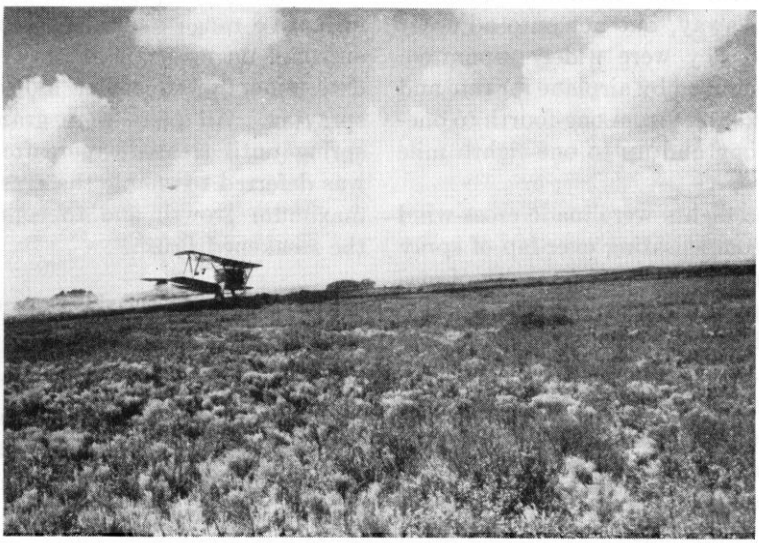

FIGURE 1. STEARMAN PLANE SPRAYING 2,4-D ON SAND SAGEBRUSH

Tests of Brands and Formulations

Due to drifting of spray, the applications on the long narrow plots were not as heavy as indicated in table 1. At the reduced rates of application, the esters killed more sand sagebrush than the salts, which indicates that esters may be used dried, purple-colored, and either partially or completely defoliated within 1 to 3 months after treatment. DO-ester in the table indicates diesel oil and ester material combined; W-ester indicates water and ester material combined.

In this test the homemade salt, which

is listed in the table as containing 100.0 percent pure acid, killed only 25 percent of the sagebrush compared to 45 percent for the commercial salts with which it was compared. However, on the wider plots where there was less drifting of spray the homemade salt killed 78 percent as compared to 86 percent for the best ester treatment.

As shown in Table 1, the esters affected the sagebrush more quickly than did the salts. The test was not adequate to measure accurately any differences between the various esters. However, other tests indicated that the isopropyl ester may be more effective than the butyl ester. The use of diesel oil instead of water as a carrier for the isopropyl ester increased the kill by 9 percent. The addition of diesel oil to the salt solution used in this test did not increase the percentage kill materially. However, the addition of one gallon of diesel oil per acre increased the effectiveness of the salt solution in several other tests made in 1947 with ground equipment.

Ninety-five percent of the leaves of shinnery oak were distorted, discolored, and defoliated by the ester solution used at one pound per acre, and only about 10 percent of the leaves were similarly affected by the salt solutions. However, the shinnery oak in all plots was root-sprouting vigorously within three months after being treated and only a few stems were actually killed. The many, thick, horizontal roots of this plant do not seem to be greatly affected by 2,4-D in any form. Another test of the chemicals 2,4-D and 2,4-5-T (2,4,5 trichlorophenoxyacetic acid), both in the form of isopropyl ester, was made on shinnery oak in May, 1948. Although conclusions cannot be made until a year later, 2,4-5-T appears to injure shinnery more severely than 2,4-D.

Many native range legumes were found growing in all treated plots one year after treatment. The native legumes do not appear to be as susceptible to 2,4-D as do the common legume crops. Legumes which were either not affected or not completely killed included the vetches and loco weeds (*Astragalus sp.*) and (*Oxytropis sp.*), partridge pea (*Chamaecrista fasciculata* (Michx.) Greene), bundle flower (*Desmanthus illinoensis* (Michx.) MacM.), western indigo (*Indigofera leptosepala* Nutt.), silky prairie clover (*Petalostemon villosus* Nutt.), scurfpea (*Psoralea sp.*), sensitive briar (*Leptoglottis Nuttallii* D.C.), and perhaps most important in this region, sand pea (*Tephrosia virginiana* (L.) Pers.).

Most annual range weeds were completely killed by nearly all treatments. Some of the common plants which were easily destroyed were tall mint (*Monarda pectinata* Nutt.), common ragweed (*Ambrosia artemisaefolia* A. Gray), horsetail (*Erigeron canadensis* L.), prairie thistle (*Cirsium undulatum* (Nutt.) Spreng.), showy gaillardia (*Gaillardia pulchella* Foug.), woolywhite (*Hymenopappus sulphureus* Rydb.), the pigweeds (*Amaranthus sp.*), lanceleaved lambsquarter (*Chenopodium lancelolatum* Muhl.), Texas croton (*Croton texensis* (Klotzsch Muell. Arg.), stick leaf (*Mentzelia stricta* (Osterhout) Stevens), cocklebur (*Xanthium sp.*), and smooth sumac (*Rhus glabra* L.), a shrub.

Plants which have not been entirely killed by one application of one pound per acre applied at the proper time for killing sagebrush include bush morning glory (*Ipomoea leptophylla* Torr.), annual eriogonum (*Eriogonum annuum* Nutt.), queens root (*Stillingia sylvatica* L.), wild grape (*Vitis vulpina* L.), common hackberry (*Celtis occidentalis* L.), cotton wood (*Populus sp.*), sand plum (*Prunus angustifolia* Marsh.), ash (*Fraxinus sp.*), small soapweed (*Yucca glauca* Nutt.), and prickly pear cactus (*Opuntia sp.*).

Date of Spraying

Of more importance than the brand or formulation of 2,4-D used to kill sand sagebrush is the proper time of application and the stage of growth of the plant (*3*). Semi-monthly sprayings made in duplicate from May 29, 1947, until September 26, 1947, indicated that applications made when the plants were growing rapidly in May produced the highest percentage kill (fig. 2). Sufficient soil moisture and other favorable conditions for rapid growth are essential and commonly occur in May. Extensive date-of-spraying tests being conducted during 1948 by the Woodward Station should yield more conclusive information. There is some indication that sagebrush can be controlled in April as well as in May.

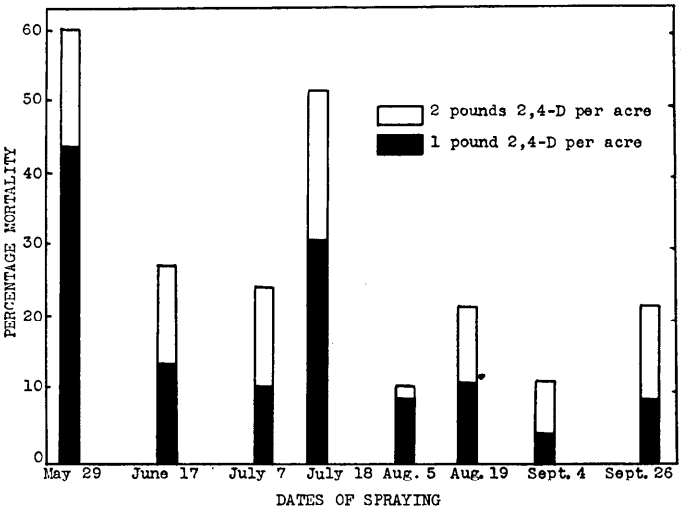

FIGURE 2.

Average percentage mortality of sand sagebrush from duplicate plots sprayed with one and two pounds per acre of the homemade salt of 2,4-D, without diesel oil, on the dates indicated in 1947. Results were obtained in August, 1948.

Tests of Rates of 2,4-D and Volumes of Carriers

The quantity of 2,4-D used per acre to kill sand sagebrush is extremely important. One pound of 2,4-D, acid equivalent, per acre is sufficient material when properly applied and in some instances appears to be more effective than higher rates (table 2). In general, the esters can be used in smaller quantities than the salts (*4*). Whereas one pound of the sodium salt is the minimum effective dosage, three-fourths pounds of the ester, properly applied, appears to give comparable results. Some investigators have obtained satisfactory results with as little as one-half pound of the ester. However, further experimentation is necessary before it can be definitely stated that one-half pound of the ester is sufficient material to give consistent kills. Extensive tests conducted with airplanes and ground-spray equipment in 1948, when finally evaluated in 1949, should provide more conclusive information on many phases of the spray work.

The kill of sagebrush resulting from one-half, one, or two pounds of 2,4-D applied in one gallon of diesel oil has been less in every instance than when 3

gallons of diesel oil were used. Five gallons of total fluid per acre, including one gallon of diesel oil, is suggested for the application of the sodium salt solutions, and at least 3 gallons when esters are used. Dense or tall brush requires more fluid per acre than thin or low-growing stands.

Test of Flight Spacings

Flight spacings of 30, 45, 60, and 100 feet were tested. There was no essential difference in the coverage and resultant kill obtained between 30- and 45-foot flight spacings when the flights were made crosswind in a wind velocity ranging from 10 to 20 miles per hour. Strips of live sagebrush plants were clearly apparent on all plots sprayed at 60- or 100-foot intervals regardless of wind velocity or gallons of spray per acre (table 3). The material applied to the 100-foot plots consisted of pure 2,4-D acid dissolved in methyl alcohol antifreeze. This material appears to give good results but was not tested at other flight spacings; hence conclusions as to its effectiveness cannot be made. It was noted that even a small quantity of water in the mixture causes crystallization.

Comparison of Results on Mowed and Nonmowed Land

Regrowth on sand sagebrush is usually dense, succulent, and fast growing. The tests made in 1946 and in 1947 showed conclusively that second-growth plants are more susceptible than nonmowed plants to treatment with 2,4-D. The percentage kill resulting from one pound per acre of homemade salt was 78 percent on nonmowed range and 99 percent on second-year growth.

TABLE 2

Summary of various rates of 2,4-D and carriers as applied by airplane on May 26–29, 1947, showing the effects upon sand sagebrush

TYPES OF 2,4-D		MATERIAL USED PER ACRE			PERCENTAGE OF PLANTS SEVERELY AFFECTED IN 1947 ON			PERCENTAGE OF PLANTS DEAD ON 6/10/48
Chemical compound	Percent pure acid	2,4-D acid equiv.	Solvent		6/25	7/25	8/25	
			Quantity	Type				
Plots two plane flights wide								
	pct.	*lbs.*	*gals.*		*pct.*	*pct.*	*pct.*	*pct.*
Isop. ester	38.6	.5	1.0	DO-ester	30	75	90	59
Isop. ester	38.6	2.4	1.3	DO-ester	50	90	95	67
Isop. ester	38.6	1.0	3.0	DO-ester	66	90	99	86
Isop. ester	38.6	2.2	3.0	DO-ester	66	95	99	64
Plots eight plane flights wide								
Butyl ester	32.0	.5	1.0	DO-ester	10	20	10	25
Butyl ester	32.0	1.0	1.0	DO-ester	66	90	99	36
Butyl ester	32.0	2.0	1.0	DO-ester	80	75	95	23

Characteristics of Regrowth of Sprayed Sagebrush

Some regrowth in the form of adventitious shoots has appeared on from one-third to one-half of all sand sagebrush plants treated in every plot during the three-year experimental period, 1946–

47–48. These sprouts generally appear in the fall when conditions are favorable for plant growth and may reappear the following spring. Most of these sprouts die within a few weeks. Sagebrush plants sprayed with one-half, three-fourths, one, and one-and-one-fourth pounds of butyl ester per acre on April 19, 1948, became completely defoliated within four weeks and then produced abnormal adventitious shoots on June 29, 1948. These shoots were probably produced as the result of over 6 inches of precipitation falling between June 21 and 29, 1948. The sprouts died and disappeared during July. A study was made of the character of regrowth found in 1948 on the sagebrush plants sprayed in 1947 (table 4). From a total of 6778 sagebrush plants randomly observed on two plots, nearly 20 percent produced shoots from underground parts. Only 5 percent had regrowth on the stems of the old plants. The foliage cover on over 75 percent of the plants showing regrowth was less than one-fifth the area occupied by the original plants before they were sprayed.

TABLE 3

Summary of various flight spacings used when applying 2,4-D by airplane on May 26, 1947, showing the resultant coverage as measured by percentage kill of sand sagebrush

FLIGHT SPACING	TYPE OF 2,4-D USED	MATERIAL USED PER ACRE			PERCENTAGE OF PLANTS SEVERELY AFFECTED IN 1947 ON			PERCENTAGE OF PLANTS DEAD ON 6/10/48
		2,4-D acid equiv.	Quantity	Type	6/25	7/25	8/25	
ft.		*lbs.*	*gals.*		*pct.*	*pct.*	*pct.*	*pct.*
30	Sodium salt	1.0	5.0	W-DO (4-1)	75	98	99	78
45	Sodium salt	.7	3.7	W-DO (4-1)	70	90	99	73
60	Sodium salt	1.0	5.0	Water	65	75	85	26
100	Alc. solution	1.0	3.0	W-DO (8-1)	50	65	70	—
100	Alc. solution	1.0	2.0	Diesel	30	65	70	—
100	Alc. solution	1.0	1.0	Diesel	30	65	65	—

TABLE 4.

Summary of the character of regrowth made by June 10, 1948, on 6778 sagebrush plants which were sprayed by airplane with sodium salt of 2,4-D on May 26–29, 1947. Percentage regrowth is expressed as a percentage of original foliage cover.

TYPE OF REGROWTH	REGROWTH BY PERCENTAGE CLASSES						
	0–10	11–20	21–30	31–40	41–50	Over 50	Total
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Root sprouts only-old stems dead...	12.9	4.0	1.6	.4	.4	.4	19.7
Live regrowth on old stems.....	.8	1.0	.6	.4	.3	1.6	4.7

Effects of Rainfall on Sprayed Areas

Rain falling within a few hours after ester solutions and within 12 hours after salt solutions have been applied may reduce or nullify effects of the treatments. Poor kills have been obtained on sagebrush sprayed with the sodium salt of 2,4-D about 10:00 a.m. when a heavy rain occurred after dark the same day. Good results were obtained with the same material applied the day before the rain. There has been no opportunity to make similar observations on ester solutions experimentally applied at this station; however, other investigators report little reduction in effect when rains follow shortly after ester solutions have been applied (*1*).

Precaution

Care should be taken that spray is not accidentally applied or does not drift onto such susceptible plants as cotton, alfalfa, sweetclover, garden crops, ornamental shrubs and trees, or other crops known to be injured by 2,4-D.

SUMMARY

Brush eradication studies conducted by the U. S. Southern Great Plains Field Station at Woodward, Okla., since 1937 have proved conclusively that removal by mowing of sand sagebrush from sandy native rangeland of the Southern Plains is an extremely effective range improvement practice. However, removal of the brush by mechanical means is slow and costly. The use of 2,4-D for the control of sand sagebrush and other noxious plants promised to overcome these objections; hence, a test was started to find a practical means of rapidly applying a relatively low-cost but effective chemical on large acreages thereby killing the brush and increasing the returns from the land.

Tests of 2,4-D in the form of esters and sodium salts were made by both air and ground equipment in May of 1947, and date-of-spraying tests were made semi-monthly throughout the summer. The experiments were conducted on more than 1000 acres of sandy native rangeland in the Texas Panhandle and in northwestern Oklahoma. The study areas were representative of nearly 5,000,000 acres of similarly infested rangeland in the Southern Great Plains. Although sand sagebrush is the dominant shrub on these lands, other shrubs which are detrimental to the range include skunkbush, sand plum, and shinnery oak. Precipitation in the region ranges from about 14 inches in eastern Colorado to about 25 inches in southwestern Oklahoma.

Of the brands and formulations of 2,4-D tested, the esters produced effect most rapidly. However, at one pound per acre, which was determined to be sufficient, both the salts and esters produced nearly identical final kills. Although the esters were not tested adequately at rates lower than one pound, indications were that quantities less than one pound might be found to be satisfactory. Extensive tests made in 1948 should yield more conclusive information. A homemade preparation, consisting of 1 pound of pure 2,4-D acid, 0.5 pound of sodium carbonate, 4 gallons of water, and 1 gallon of diesel oil, has proved to be a cheap and effective solution when properly applied. The addition of one gallon of diesel oil per acre increases the effectiveness of both ester and salt solutions.

Shinnery oak was not severely affected by any formulation of 2,4-D. Other hard-to-kill plants were listed, as were those plants easily killed by 2,4-D.

Semi-monthly sprayings made during 1947 indicated that sand sagebrush was most susceptible to 2,4-D in the early spring when it was growing rapidly. The month of May is considered the best time to spray sand sagebrush in the Southern Great Plains.

Three gallons of total fluid per acre were much more effective than one gallon as a carrier for the ester solutions. The suggested minimum quantity of material for the application of 2,4-D is 3 gallons per acre when using esters and 5 gallons per acre when using sodium salt.

Flight spacings of 30 and 45 feet proved superior to wider spacings. The width of the boom on the plane was 30 feet; therefore, a spacing not more than one and one-half times the width of the boom should be considered maximum.

Regrowth occurs on nearly all treated sagebrush plants regardless of formula

used. However, many of the sprouts die and disappear. About 20 percent of the plants sprayed with sodium salt of 2,4-D at one pound per acre in 1947 produced root sprouts by June of 1948. Many of these sprouts were still dying at that time.

Rain falling within a few hours after ester solutions and within 12 hours after salt solutions have been applied may reduce or nullify effects of the treatments.

Adequate precautions must be taken to insure against accidental application or drift of 2,4-D onto susceptible crops.

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