14 Years of Rabbitbrush Control in Central Oregon

JOSEPH M. MOHAN

Highlight: *Fourteen years (1956 to 1970) of chemical control for rubber and green rabbitbrush using the ester forms of 2,4-D produced consistent control, ranging from 85 to 98% on rubber rabbitbrush. The amount of new twig growth, soil moisture, rate and methods of application, total seasonal twig growth, and subsequent drought conditions proved critical for effective kills. Selective kills were achieved by manipulation of these factors. Site potential and response to changes that result from chemical control must be recognized. "Drainage Effect" is a complex of thermal drafts, topography, and soil differences that can adversely influence the percentage of rabbitbrush control achieved.*

The Crooked River National Grassland lies about 130 miles southeast of Portland, Ore., near the town of Madras (Fig.1). Elevation ranges from 2241 ft at Madras to 5108 on Gray Butte. Average annual precipitation for the last 24 years is 8.8 inches, varying from 4 to 12 inches. Frost-free periods usually do not exceed 100 days. Soils are sandy to sandy loam in texture and susceptible to wind erosion. Land form is a gentle north slope broken by numerous lava rimrocks and a few precipitous canyons.

Vegetational types are generally associations of western juniper (*Juniperus occidentalis* Nutt.), big sagebrush (*Artemisia tridentata* Nutt.), bluebunch wheatgrass (*Agropyron spicatum* (Pursh.) Scribn. and Smith.), with Idaho fescue (*Festuca idahoensis* Elmer.) on the steeper north slopes.

At one time over 700 homesteads and ranches were located within this area; however, land being farmed was abandoned due to drought in the 1930's. About 65,000 acres of abandoned cropland reverted to a dense stand of rubber rabbitbrush (*Chrysothamnus nauseosus* (Pall.) Britt.) with some green rabbitbrush (*C. viscidiflorus* (Hook.) Nutt.) and big sagebrush. On these lands rubber rabbitbrush usually grows in excess of 40 inches high and is so dense as to make observation of ground cover difficult.

Chemical control of rabbitbrush on the Crooked River National grassland was first recorded in 1951. This area was then known as the Central Oregon Land Utilization Project under the administration of Soil Conservation Service. A June application of butyl ester of (2,4-dichlorophenoxy) acidic acid (2,4-D) appeared to achieve good control of rubber rabbitbrush, but little lasting control was noted. A 1954 application of butyl ester of 2,4-D at 1.8 pounds of acid equivalent per acre gave 86% control of rubber rabbitbrush.

This administrative study reviews the brush control by spraying on the Grassland from 1956 through 1970. Some spray was applied with ground rigs and fixed wing planes, but most was applied by helicopter. Diesel oil has been the carrier with few exceptions.

Review of Literature

For good results from spraying, new twig growth on rabbitbrush must exceed 3 inches, according to Hyder et al. (1958). Paulson and Miller (1968) found Parry rabbitbrush (Chrysothamnus parryi (Gray.) Greene.) was killed 65% in a 3-inch twig growth, and 82% at 3 to 6-inch twig growth. In drought years, rabbitbrush will not produce enough new twig growth to reach susceptible stage of development (Hyder et al., 1957).

The most effective single date for spraying rabbitbrush, according to Robertson and Cords (1957), was the middle of the active growing period, when the carbohydrate reserves in the twigs were relatively high and were being rapidly depleted. Regrowth is often a problem in spraying rabbitbrush (Kissinger and Vaughn, 1952b; Hyder, 1966; McIlvain and Savage, 1946).

Hyder et al. (1958) recommend spraying rabbitbrush when Sandberg bluegrass (*Poa secunda* Presl.) reaches a flowering stage in which it has matured yet retains some green color. Laycock and Phillips (1968) found evidence of possible harmful effects of improperly timed spray on rabbitbrush, since 2,4-D applied at an unsuitable time may allow rabbitbrush to increase by removing broadleaved competition. Hyder et al. (1957) controlled big sagebrush and green rabbitbrush simultaneously with proper timing. McKell (1956) found that the green rabbitbrush flowering stage is approximately a week or two earlier than rubber rabbitbrush, which, in turn, is about 2 weeks earlier than big sagebrush.

Fig. 1. *View of gentle north slope found on much of Crooked River National Grassland with Gray Butte in center background.*

At the time of the research, the author was range conservationist, U.S. Forest Service, Prineville, Oregon. He was formerly district ranger, Crooked River National Grassland, Prineville, and is retired at present.

The author thanks Mr. E. William Anderson, State Range Specialist, Soil Conservation Service, for his valuable assistance in editing this paper; and Mr. Myron B. Rollins, District Soil Scientist, Bureau of Land Management, Prineville, Oregon, and Mr. George L. Green, Soil Survey Party Leader, Soil Conservation Service, The Dalles, Oregon for their assistance in classifying the soils of this study.

Manuscript received April 28, 1972.

Butyl ester 2,4-D with water as a carrier gave most satisfactory kills for some (Tingey and Robinson, 1952; Hyder et al., 1952). Hull et al. (1952) found highest average kills with diesel as a carrier. A 3 pound per acre acid equivalent of 2,4-D gave good rabbitbrush control (Hyder et al., 1958; Hyder, 1966).

Rabbitbrush and bunchgrass appear to be in direct competition with each other (McKell and Chilcote, 1957) because of the nature of their root systems. Old rabbitbrush plants (in the 25-year old class) appear to be almost independent of weather conditions or competition from bunchgrass or smaller plants because they have both a deep and spreading root system (McKell, 1956).

Frischknecht (1963) at Benmore, Utah, compared root systems of rubber rabbitbrush and big sagebrush. Lateral roots of big sagebrush became more highly developed than lateral roots of rubber rabbitbrush in surface soils, the zone where grass roots are more numerous. Frischknecht questioned whether control of rabbitbrush in crested wheatgrass stands is justified on the area he studied. Plant communities give a better indication of the nature of environment than individual factors (Oosting, 1958).

Methods of Study

Table I summarizes the 14 herbicide applications on rubber rabbitbrush, green rabbitbrush, and big sagebrush for the years of 1956 to 1970 evaluated in this study.

Each year during spraying, new twig growth measurements of the species being controlled plus that of the associated species and stage of development were recorded daily. Black-and-white photographs and colored slides of these measurements were taken. Distance down to damp soil adequate for maximum plant growth was measured and recorded daily.

Results of the years 1956–1966 were recorded in September 1968; results for the years 1967–1970 were recorded in October 1971.

For each year's spray treatment 100 measurements were made along a pace transect. Paced intervals were six paces or approximately 36 feet. The rabbitbrush or sagebrush plant nearest to the left foot was recorded. Kill was determined by plant kill, not top kill. Partial top kill was also recorded but is not included in Table 1.

Results Observed

Site Recognition

Recognition of sites for rabbitbrush control involves some knowledge of indicator species, soil texture, soil depth, available content of the soil, and site potential. Areas incapable of supporting big bunchgrass, such as bluebunch wheatgrass, should be excluded from the spray project area. Indicator species and soils are an integral unit. Indicator species can be considered an expression of site, while soil texture is one of the determining factors of that site. Big sagebrush with an understory of native perennial bunchgrass is indicative of an excellent spray opportunity, but sagebrush or rabbitbrush alone is not as good an indicator of spray potential.

Round-headed buckwheat (*Eriogonum sphaerocephalum* (Dougl.) ex Benth.) or stiff sagebrush (*Artemisia rigida* (Nutt.) Gray.), are fair to good big game forage. They grow in soils too shallow to support bunchgrass and should not be sprayed. On the grassland, stiff sagebrush occurs in 9 inches or less of soil above bedrock; wild buckwheat occurs in the 9- to 11-inch soil depth.

Needleandthread (*Stipa comata* Trin. and Rupr.) and Thurber needlegrass (*Stipa thurberiana* Piper.) indicate a severe site with extreme soil drainage in the top few inches. Chemical control on these sites often appears to be spotty or variable. This is due to the rapid loss of soil moisture in the top 4 inches. Top soil droughtiness often inhibits seedling establishment on this site after spray application.

Each locality and site will have its own combination of indicator plants. Consistently successful rabbitbrush control cannot be expected without the ability to interpret correctly such indicators.

Drainage Effect

Drainage effect is the term applied when the effectiveness of spraying is reduced by thermal updrafts and downdrafts, deeper, more sandy soils, and rolling terrain (Fig. 2). Micro-climate is influenced by such features as topography, soil texture, and soil moisture. The pattern and kind of thermal air currents associated with these factors apparently contribute to this phenomenon that reduces effectiveness of spray.

Decrease in rabbitbrush control of from 20 to 50% has been noted in wide, shallow drainages with very sandy soils. Steep or *V*-shaped drainages do not seem to experience this reduced control. Wide, shallow drainages are subject to crosswinds and turbulence as well as the

Table 1. Treatments made and results obtained from 14 tests of 2,4-D applications to rubber and green rabbitbrush and big sagebrush.

Year	Method of application	2,4-D formulation & carrier	Lbs/acre acid equiv.	Date of application	Date[1] results judged	Kill (%)		
						Rubber rabbitbrush	Green rabbitbrush	Big sagebrush
1956	Ground-boom	Butyl ester + water	2 & 4	6/9, 6/21	9/68	98	91	72
1957	Fixed wing airplane	" " "	2	6/19	9/68	95	0	0
1958	Fixed wing airplane	" " "	2	6/6–6/7	9/68	14	0	0
1959	No spraying–insufficient twig growth due to drought.							
1960	Helicopter	Butyl ester + diesel	2	6/5–6/7	9/68	85	85	85
1961	Helicopter	" " "	2	6/16–6/18	9/68	85	29	10
1962	Helicopter	" " "	2	6/14–6/22	9/68	96	–	100
1963	Helicopter	(Low volatile) Iso-Octyl + diesel	2	6/10–6/15	9/68	94	75	75
1964	Helicopter	" " "	2	6/3–6/13	9/68	96	75	94
1965	Helicopter	" " "	2	6/2–6/7	9/68	83	29	80
1966	Helicopter	" " "	2	5/26–5/29	9/68	100	–	94
1967	Helicopter	" " "	2	6/10–6/12	10/71	85	42	73
1968	Helicopter	" " "	2	6/8–6/16	10/71	72	55	–
1969	Helicopter	" " "	2	5/27–6/11	10/71	78	41	79
1970	Helicopter	" " "	2	6/10	10/71	98	71	100

[1] Spray results based on evaluations (1956–1966) in 1968, and (1967–1970) in 1971.

Fig. 2. *North Willow "U"-shaped drainage in the center background with typical upland in the foreground.*

thermal updrafts and downdrafts which are also channeled in the steeper *V*-shaped drainages.

Two such occurrences, one in the East Cyrus pasture and the other in the North Willow Creek pasture of the grassland, have been studied in some detail. Both drainages are wide, shallow, and *U*-shaped, and both have somewhat sandy soils. The East Cyrus drainage is 1220 ft wide and 35 ft deep, while the North Willow Creek is 1840 ft wide and 15 ft deep. Table 3 summarizes these differences in effective chemical control.

Soils in the East Cyrus drainage were classified as Degner gravelly loam in the drainage bottom and as Degner clay loam on the adjacent upland. Control on green rabbitbrush dropped from 75% on the upland area to 25% in the drainage. Rubber rabbitbrush control ranged from 53% on the upland to 31% in the drainage. Big sagebrush control varied from 97% in the upland to 50% in the drainage.

Soils in the North willow drainage were found to be Metolius sandy loam in the drainage bottom and Agency loam on the upland area. Control on the upland area averaged 75% for green rabbitbrush, 96% for rubber rabbitbrush, and 94% for big sagebrush; in the drainage bottom control was only 38% for green rabbitbrush, 50% for rubber rabbitbrush, and 83% for big sagebrush.

Twig Growth and Soil Moisture

Development of at least 4 inches of new twig growth is basic for effective chemical control of rabbitbrush. Table 2 summarizes the twig growth predictions for the years of treatment. In drought years rabbitbrush growth will not reach this minimum. Because 1959 was such a year on the Grassland, we did not spray.

Adequate soil moisture for maximum plant growth should be at or within 4 inches of the soil's surface for best rabbitbrush control. This means very damp soil that is slightly below the saturation point. Data demonstrating the validity of this criterion are available in the Grassland files, showing both good results (over 90%) when moisture was favorable and poor results (under 75%) when soil moisture fell below the 4-inch level. On the Grassland, green rabbitbrush control was less than 50% when spray application occurred when soil moisture was below 4 inches. Maximum control of rubber rabbitbrush was achieved with soil moisture in the 4-inch zone; over 85% control of this species has also been obtained when the soil moisture level was down to the 7-inch zone.

Two pounds acid equivalent of butyl ester 2,4-D per acre was applied to the North Grizzly pasture in 1957. Soil moisture was down to 5 inches; new twig growth was 5 inches long on big sagebrush and 6 inches on both green and rubber rabbitbrush. Ninety-five percent control of rubber rabbitbrush was obtained, with no control of either green rabbitbrush or big sagebrush. Soil moisture was below the required depth, so no green rabbitbrush was killed. Big sagebrush was too far advanced in development for effective control.

The east side of Round Butte was sprayed in 1969 with 3 lb/acre acid equivalent of iso-octyl 2,4-D. Big sagebrush had 3 inches of new growth, green rabbitbrush 3 inches, and rubber rabbitbrush 2 inches. Soil was damp 2 inches below the soil surface. Temperature ranged from 49 to 57°F. Control was as follows: Green rabbitbrush, 95%; rubber rabbitbrush, 41%; and big sagebrush, 58%; Unsatisfactory control of rubber rabbitbrush was due to insufficient new twig development. Excellent control of green rabbitbrush was attributed to sufficient twig development, soil moisture within the 4-inch level, and application of 3 lb/acre acid equivalent. Big sagebrush control was too late to achieve best results, as this species usually reaches the stage of maximum susceptibility 2 to 3 weeks earlier than green rabbitbrush.

Table 2. Twig growth prediction summary at six dates during the years 1956–1970.

Species	Inches of new twig growth by dates					
	5/13	5/22	6/6	6/15	6/27	7/25
Rubber rabbitbrush						
Range	0–2.5	0–2.5	2.0–5.0	2.75–6.0	3.5–9.0	3.5–12.0[1]
Average	.66	.75	3.4	4.1	5.1	8.1
Green rabbitbrush						
Range	0–2.5	0– .25	2.0–6.0	3.25–8.0	2.25–9.0	3.5–12.0[1]
Average	.60	.76	3.9	5.4	5.7	8.1
Big sagebrush						
Range	0–2.75	1.2–4.7	4.0–7.0	3.0–8.0	2.5–9.0	4.5–12.0[1]
Average	1.31	1.42	5.1	5.25	5.3	8.9

[1] Total seasonal growth had ceased.

Formulations and Carriers

Spray applications on the Grassland prior to 1963 contained butyl ester of 2,4-D with both diesel oil and water as carriers. Since 1963 iso-octyl ester of 2,4-D and diesel oil have been used in a total formulation of 3 gallons per acre. Use of diesel oil as a carrier cuts down weight, which is always a cost factor in aerial operations. In addition, diesel oil helps the mixture to penetrate the leaf surface.

If green rabbitbrush exceeds 50% of the crown cover, results on the Grassland indicate the need for application of 3 lb/acre of an ester form of 2,4-D. This same concentration can cause extensive resprouting in rubber rabbitbrush, which requires the 2 lb/acre acid equivalent of an ester form of 2,4-D.

Controls

Spray applied with spotty distribution or in incorrect amounts can cause failure

Table 3. Drainage effect on chemical control in drainage areas as contrasted to adjacent upland area.

Area	Species	Control (%)	
		Upland	Drainage
East Cyrus	Big sagebrush	97	50
	Green rabbitbrush	75	25
	Rubber rabbitbrush	53	31
North Willow	Big sagebrush	94	83
	Green rabbitbrush	75	38
	Rubber rabbitbrush	96	50

in brush control efforts. Drift is affected by droplet size, gravity, and turbulent air. Droplets of 1,100 microns and larger fall by gravity. Air resistance is minimal (Boving, 1965). Contracts for aerial spray work usually specify size of orifice tips, allowable discharge rate, and spray boom operating pressure. If these contractual requirements are met, field conditions produce 2 added causes for variable droplet size and distribution, namely: air turbulence (wind) and thermal disturbance (temperature). *Drift* is defined as that deviation from the intended spray pattern due to wind or air turbulence and detectable on oil sensitive cards.

Control of drift is measured by placing oil sensitive cards in the area to be protected and watching these cards during the spray operation. Control of drift is achieved by quick radio action if spray droplets begin to appear on these cards, and by timing spray application to take advantage of upslope or downslope winds which carry the spray away from the desired protection area.

Volatization of spray is defined as that vaporization of fine droplets which occurs at 70°F. and above. Volatization droplets are often too fine to be detectable by the oil sensitive cards. Shutting down spray operation at 70°F is the best prevention. Volatized material can drift for great distances, as attention to temperature is important.

Forage Production

In 1960, 1100 acres of the Rush Pasture were sprayed primarily for rubber rabbitbrush. In 1961 the remaining 700 acres were sprayed. On the same site in 1961, crested wheatgrass covered by the 1960 spray operation remained green for 3 weeks longer than that on the adjacent unsprayed area. Total height-growth of crested wheatgrass averaged 3 to 4 inches more in the sprayed area. Available forage in this pasture rose from 400 AUM in the fall prior to spraying to about 1000 AUM at the same season of use after control. Under central Oregon conditions, rabbitbrush control more than doubled forage production.

Conclusions

Consistent chemical control of both green and rubber rabbitbrush is possible if certain standards are met. Based on results observed over the years 1956-1970, the following requirements for maximum effectiveness are: 1) at least 4 inches of new twig growth on both green and rubber rabbitbrush; 2) two pounds of acid equivalent per acre of 2,4-D ester for rubber rabbitbrush and 3 pounds acid equivalent per acre if green rabbitbrush predominates; 3) adequate soil moisture for good plant growth within 4 inches of soil surface at the time of spray application; 4) wind velocity below 7 miles per hour and temperature of below 70°F; and 5) helicopter or plane remaining at or below 20 ft in altitude when spraying. Dry, hot weather shortly after spraying application contributes significantly to effectiveness of brush control.

Literature Cited

Boving, P.A. 1969. Notes on factors affecting drift. Unpublished paper presented at Lehman Hot Springs Herbicide Management Symposium, p. 2.

Cook, C. Wayne, 1963. Herbicide control of sagebrush on seeded foothill ranges in Utah. J. Range Manage. 16:190-195.

Frischknecht, Neil C. 1963. Contrasting effects on big sagebrush and rubber rabbitbrush on production of crested wheatgrass. J. Range Manage. 16:70-74.

Gould, W. L., F.E. Phipps, and W. R. Furtick. 1962. The effects of flight evaluation and herbicide carrier on control of range brush. Res. Progress Rep. Western Weed Control Conf. p. 23-24.

Hyder, Donald N. 1953. Controlling big sagebrush with growth regulators. J. Range Manage. 6:109-116.

Hyder, Donald N. 1955. Sagebrush (*Artemisia tridentata*) spraying in Oregon. Res. Progress Rep. Western Weed Control Conf. p. 46-48.

Hyder, Donald N., Forrest A. Sneva, D. O. Chilcote, and W. R. Furtick. 1957. Chemical control of rabbitbrush. Res. Progress Rep. Western Weed Control Conf. p. 46-47.

Hyder, D. N., F. S. Sneva, D. O. Chilcote, W. R. Furtick. 1958. Chemical control of rabbitbrush with emphasis upon simultaneous control of big sagebrush. Weeds 6:289-297. 289-297.

Hyder, D. N. 1966. Rabbitbrush (*Chrysothamnus viscidiflorus* Nutt., *C. Nauseosus* Britt.) *In*: Chemical control of range weeds. Chemical plant control subcommittee and range seeding equipment committee. U.S. Dep. Agr. and U.S. Dep. Interior. p.36.

Hyder, D. N., and F. S. Sneva. 1960. Spraying for big sagebrush in stands of bitterbrush. Res. Progress Rep. Western Weed Control Conf. p. 19-21.

Hyder, D. N., and F. A. Sneva. 1962. Selective control of big sagebrush associated with bitterbrush. J. Range Manage. 15:211-215.

Hull, A. C., Jr., N.A. Kissinger, Jr., and W. T. Vaughn. 1952. Chemical control of big sagebrush in Wyoming. J. Range Manage. 5:398-402.

Kissinger, N. A. Jr., A. C. Hull Jr., and W. T. Vaughn. 1952a. Chemical control of big sagebrush in Wyoming. Rocky Mountain Forest and Range Exp. Sta. Paper No. 9 (processed).

Kissinger, N. A. Jr., and W. T. Vaughn. 1952b. Reaction of small rabbitbrush to 2,4-D and 2,4,5-T in central Wyoming. Res. Progress Rep. Western Weed Control Conf. p. 25-26.

Laycock, William A., and Thomas A. Phillips. 1968. Long-term effects of 2,4-D on lanceleaf rabbitbrush and associated species. J. Range Manage. 21:90-93.

McIlvain, E. H., and D. A. Savage. 1946. Spraying 2,4-D by airplane on sand sagebrush and other plants of the southern Great Plains. J. Range Manage. 2:43-52.

McKell, Cyrus, M. 1956. Some characteristics contributing to the establishment or rabbitbrush (*Chrysothamnus sp*). Unpub. PhD Thesis, Oregon State College, Corvallis, 140 p.

McKell, Cyrus M., and William W. Chilcote. 1957. Response to rabbitbrush following removal of competing vegetation. J. Range Manage. 10:228-230.

Mueggler, Walter F., and James P. Blaisdell. 1958. Effects on associated species of burning, roto-beating, spraying, and railing sagebrush. J. Range Manage. 11:61-66.

Oosting, Henry J. 1948. The study of plant communities. W. H. Freeman and Company, San Francisco, Calif. p. 389.

Paulsen, Harold A., Jr., and John C. Miller. 1968. Control of parry rabbitbrush on mountain grasslands of western Colorado. J. Range Manage. 21:175-177.

Robertson, Joseph H., and H. P. Cords. 1957. Survival of rabbitbrush (*Chrysothamnus* sp.), following chemical, burning, and mechanical treatments. J. Range Manage. 10:83-89.

Tingey, D. C., and Max Robinson. 1952. Chemical control of rabbitbrush (*Chrysothamnus nauseosus* var *consimilis*). Res. Progress Rep. Western Weed Control Conf. p. 61.