Control of threadleaf rubber rabbitbrush with herbicides

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Abstract

Foliar sprays of 2,4-D [(2,4-dichlorophenoxy)acetic acid]), picloram (4-amino-3,5,6-trichloro-2-pyridinecarboxylic acid), dicamba (3,6-dichloro-2-methoxy benzoic acid), or clopyralid (3,6-dichloro-2-pyridinecarboxylic acid) were applied in 30 or 150 L of total spray solution ha^{-1} to threadleaf rubber rabbitbrush [*Chrysothamnus nauseosus* ssp. *consimilis* (Greene) Hall & Clem] in Garfield County, Utah. Additional herbicide treatments were applied in 150 L ha^{-1} in Sevier County, Utah. Herbicides were less effective when applied in 30 L ha^{-1} than when applied in 150 L of total spray solution ha^{-1}. Mortality was 74 to 87% following applications of 4.4 kg a.e. (acid equivalent) 2,4-D ha^{-1}. Dicamba applied at 3.3 kg ha^{-1} resulted in 70 to 87% mortality, and picloram applied at 0.8 kg ha^{-1} resulted in 56 to 79% mortality. The greatest mortalities (84 to 97%) occurred on areas treated with 2.2 kg clopyralid ha^{-1}. Mortality of threadleaf rubber rabbitbrush increased an average of 28, 17, 33, and 27% following applications of 2,4-D, dicamba, picloram, and clopyralid respectively, by using 150 L spray volume. Greatest increases were at the lowest herbicide rates. Applying herbicides in greater amounts of carrier (water) significantly increased both mortality and canopy reduction of threadleaf rubber rabbitbrush for at least 39 months.

Key Words: clopyralid, dicamba, picloram, 2,4-D, spray volume

At least 8 species of rabbitbrush (*Chrysothamnus* spp.) occur in the Great Basin area of the western United States. They are most abundant on open plains, valleys, foothills, and mountains to 3,300 m (Hitchcock et al. 1969). Rabbitbrush frequently increases following removal of big sagebrush (*Artemisia tridentata* Nutt.) with fire, heavy grazing, or herbicides. Most herbicide applications for rabbitbrush contol have been directed at rubber rabbitbrush [*Chrysothamnus nauseosus* (Pallas) Britt.] or green rabbitbrush [*Chrysothamnus viscidiflorus* (Hook.) Nutt.].

Rubber rabbitbrush is most susceptible to conventional herbicides when new leader growth reaches 6 to 9 cm (Hyder et al. 1958, Mohan 1973, Cluff et al. 1983) and is less susceptible in dry years. Mohan (1973) suggested spraying rubber rabbitbrush with 2.2 kg 2,4-D [(2,4-dichlorophenoxy) acetic acid] ester ha^{-1} only when new leader growth exceeded 10 cm and enough water is present in the upper 10 cm of soil for rapid growth of rubber rabbitbrush.

Cluff et al. (1983) evaluated the efficacy of picloram (4-amino-3,5,6-trichloro-2-pyridinecarboxylic acid), dicamba (3,6-dichloro-2-methoxybenzoic acid), silvex [2-(2,4,5-trichloro-phenoxy)propionic acid], 2,4,5-T [(2,4,5-trichlorophenoxy) acetic acid], and triclopyr {[(3,5,6-trichloro-2-pyridinyl)oxy]acetic acid} on threadleaf rubber rabbitbrush [*Chrysothamnus nauseosus* ssp. *consimilis* (Pallas) Britt.] in central Nevada. They reported threadleaf rubber rabbitbrush mortalities averaged 87% on areas sprayed with 2.2 kg 2,4-D ha^{-1}. Mortality following applications of triclopyr (3.4 kg ha^{-1}), silvex (3.4 kg ha^{-1}), or dicamba (3.4 kg ha^{-1}) were similar to 2,4-D.

Despite data indicating adequate control of rubber rabbitbrush with available herbicides, many resource managers report poor results. Newer herbicides and/or different application techniques may increase efficacy of rubber rabbitbrush control efforts. Objectives of this study were to (1) compare threadleaf rubber rabbitbrush control achieved with clopyralid (3,6-dichloro-2-pyridinecarboxylic acid) versus control achieved with previously recommended herbicides and (2) to evaluate the influence of spray volume on herbicide efficacy.

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Materials and Methods

Study Sites

Experiments were established near Antimony (Garfield County) and Salina (Sevier County), Utah. The Garfield County site was dominated by mountain big sagebrush [*Artemisia tridentata* ssp. *vaseyana* (Rydb.) Beetle] and threadleaf rubber rabbitbrush at 2,290 m elevation with a mean annual precipitation of 36 cm. About 50% of the precipitation falls during the 90-day growing season. Soil at this site was a Codley silt loam (fine, silty, carbonatic, frigid Ustic Torriorthent).

The Sevier County site was dominated by threadleaf rubber rabbitbrush growing on silty loams (fine, silty, mixed, frigid Xerollic Haplargid). This site is at 1,919 m elevation with a mean annual precipitation of 37 cm. About 80% of the annual precipitation falls between November and April. The mean frost-free period is about 100 days.

Herbicide Applications

Herbicide treatments at both sites were applied to 3 replications of 3- by 30-m plots in randomized complete block designs. Herbicides were applied in water with a CO_2-powered backpack sprayer in 30 or 150 L total spray solution ha^{-1} at the Garfield County site and at 150 L ha^{-1} at the Seiver County site. Application rates for each herbicide were based on previous research; however, because clopyralid had not been reported previously, a wider range of rates (0.6 to 2.2 kg ha^{-1}) was used. A commercial surfactant (a mixture of alkyl-polyoxyethylene glycols, free fatty acids, and isopropanol) was included at 0.5% (v/v).

Treatments at the Garfield County site were applied on 20 July 1983 and 16 June 1984. Treatments were the propylene glycol butyl ether ester of 2,4-D at 2.2 and 4.4 kg a.e. ha^{-1}; the dimethylamine salt of dicamba at 3.3 and 4.4 kg a.e. ha^{-1}; the potassium salt of picloram at 0.6 and 0.8 kg a.e. ha^{-1} and; the monoethanolamine salt of clopyralid at 0.6, 1.1, and 2.2 kg a.e. ha^{-1}. New leader growth of threadleaf rubber rabbitbrush was 5 to 12 cm during both the 1983 and 1984 applications. Air temperature was 19 to 23° C and relative humidity was 39 to 47% during the 1983 applications. Temperature and relative humidity were 18 to 24° C and 48 to 54% respectively, during the 1984 applications. Soil-water content was not measured, but the associated herbaceous vegetation was actively growing during both the 1983 and 1984 applications.

Treatments were applied at the Sevier County site on 14 June 1984. Dicamba (3.3 kg ha^{-1}), clopyralid (1.1 and 2.2 kg ha^{-1}), and 2,4-D (3.3 and 4.4 kg ha^{-1}) were applied in 150 L of total spray solution ha^{-1}. Ambient temperature was 17 to 25° C, relative humidity was 28 to 40%, and threadleaf rubber rabbitbrush leader growth was 4 to 8 cm when herbicides were applied. Associated herbaceous vegetation was still green when herbicides were applied, but grass leaves were beginning to fold from water-stress.

Evaluations

Treatments were evaluated in Oct. 1985 and Oct. 1986. The 1986 evaluations followed third and fourth post-treatment growing seasons of the 1984 and 1983 applications, respectively. No significant

differences were found between Oct. 1985 and Oct. 1986 evaluations of plots treated in 1983. Consequently, Oct. 1986 evaluations were used as the final evaluation on experiments initiated in 1983 and 1984.

Percentage canopy reduction (CR) of each woody plant rooted within a 25-m long by 2-m wide belt transect in each plot was visually estimated. Totally defoliated plants were examined for presence of basal or stem sprouts. The proportion of completely defoliated plants with no sprouts to the total number of plants was used as an estimate of mortality.

Statistical Analysis

Data were subjected to arc $\sin\sqrt{x}$ transformation prior to analysis of variance. The herbicide treatment by spray volume interaction was significant at the Garfield County site for both mortality and CR. Neither the application date by spray volume nor the application date by herbicide treatment interaction was significant at the Garfield County site. Analysis of variance was pooled over application dates for the Garfield County site and presented by treatment for each site. Least significant difference (L.S.D.) at the 5% level was used to separate statistically different treatment means.

Results and Discussion

Threadleaf rubber rabbitbrush mortality for the 150 L ha^{-1} treatments was similar to those reported by Cluff et al. (1983) for dicamba. Mortality following 4.4 kg 2,4-D ha^{-1} averaged 87% for both sites when the higher spray volume was used and 74% with the lower spray volume. Shrub mortality exceeded 90% at the Garfield County site on areas sprayed with 4.4 kg dicamba ha^{-1} or 1.1 to 2.2 kg clopyralid ha^{-1} at 150 L ha^{-1} spray volume (Table 1). No treatment produced over 88% mortality at the Sevier County site (Table 2).

Threadleaf rubber rabbitbrush mortality increased an average of 28, 17, 33, and 27% following 2,4-D, dicamba, picloram, and clopyralid applications respectively, by using the higher total spray volumes. Those increases were always greatest at the lowest herbicide rates. Applying herbicides in greater amounts of carrier (water) significantly increased both mortality and canopy reduction of threadleaf rubber rabbitbrush for at least 39 months. These data suggest that improved efficacy is possible with higher spray volumes. Improved efficacy with higher carrier volumes is probably due to improved coverage of herbicide on both the shrub canopies and leaf surfaces; possibly resulting in increased absorption.

Rubber rabbitbrush leaf surfaces are densely tomentose which minimizes contact of spray droplets with the leaf surface. For example, turkey mullein [*Eremocarpus setigerus* (Hook.) Benth.] plants were sprayed with 20 to 780 L ha^{-1} total spray volume and the leaves examined with the cathodoluminescence detection mode of a scanning electron microscope (Hess et al. 1974). The amount of herbicide reaching the cuticle surface increased with increasing spray volumes (Hess et al. 1974). Similar results may be expected on rubber rabbitbrush when low spray-volumes are used.

Threadleaf rubber rabbitbrush mortality and CR were lower at the Sevier County site than the Garfield County site for all herbicides tested in 150 L ha^{-1} total spray volume (Tables 1 and 2). Differing responses to herbicides may have been related to the winter precipitation regime of the Sevier County site compared to the Garfield County site, which receives more summer precipitation. By the time leader growth was sufficent for spraying at the Sevier County site, soil water contents appeared to have been low; resulting in less effective threadleaf rubber rabbitbrush control.

Picloram applied at 0.6 kg ha^{-1} killed 32 to 52% of the threadleaf rubber rabbitbrush (Tables 1 and 2) but appeared to provide inconsistent control of big sagebrush (data not shown). These observations and the data of Tueller and Evans (1969) and Whisenant (1987) suggest that low rates (0.3 to 0.6 kg ha^{-1}) of picloram may be used to control rubber rabbitbrush without eliminating big sagebrush.

The Siever County site also contained fourwing saltbush [*Atriplex canescens* (Pursh) Nutt.] in at least 1 replication of each treatment. All herbicides except clopyralid killed fourwing saltbush. Fourwing saltbush was also resistant to clopyralid in a west Texas study (Jacoby et al. 1981). Clopyralid has been shown to be highly selective between certain plant families in other studies (Bovey and Meyer 1981, O'Sullivan and Kossatz 1982, Whisenant 1987). Clopyralid also effectively controls big sagebrush without causing significant damage to such important shrub species as antelope bitterbrush [*Purshia tridentata* (Pursh.) DC.] or Saskatoon serviceberry (*Amelanchier alnifolia* Nutt.) (Whisenant 1987). This potential for increasing the selectivity of rangeland herbicide applications should be examined in other communities.

These data suggest that threadleaf rubber rabbitbrush can be effectively controlled (≥87% mortality) with sprays of clopyralid at 2.2 kg ha^{-1}, dicamba at 4.4 kg ha^{-1}, or 2,4-D ester at 4.4 kg ha^{-1} applied in spray volumes of 150 L ha^{-1}. Spray volumes of 30 L ha^{-1} will decrease the efficacy of those herbicides. In a winter-precipitation regime, soil-water may be largely depleted before new leader growth reaches the recommended 10 cm length. Threadleaf rubber rabbitbrush mortality may be reduced under those conditions.

Table 1. Canopy reduction (%) and mortality (%) of threadleaf rubber rabbitbrush following herbicide applications in Garfield County, Utah.

Treatment			
Herbicide	Rate (kg ae ha^{-1})	Canopy reduction (%)	Mortality (%)
		--30 L ha^{-1} total spray volume--	
None	——	3	0
2,4-D	2.2	52	40
2,4-D	4.4	80	74
Dicamba	3.3	84	70
Dicamba	4.4	89	81
Picloram	0.6	39	32
Picloram	0.8	72	56
Clopyralid	0.6	41	26
Clopyralid	1.1	86	81
Clopyralid	2.2	91	84
		--150 L ha^{-1} total spray volume--	
None	——	5	1
2,4-D	2.2	70	57
2,4-D	4.4	93	87
Dicamba	3.3	90	87
Dicamba	4.4	97	95
Picloram	0.6	61	52
Picloram	0.8	88	79
Clopyralid	0.6	66	57
Clopyralid	1.1	96	95
Clopyralid	2.2	99	97
L.S.D. (0.05)		6	7

Table 2. Percentage canopy reduction and mortality of threadleaf rubber rabbitbrush following herbicide applications in Sevier County, Utah.

Treatment			
Herbicide	Rate (kg ae ha^{-1})	Canopy reduction (%)	Mortality (%)
None	——	4	0
2,4-D	3.3	90	85
2,4-D	4.4	91	87
Dicamba	3.3	84	77
Picloram	0.6	50	37
Picloram	0.8	78	69
Clopyralid	1.1	81	70
Clopyralid	2.2	93	88
	L.S.D. (0.05)	12	15

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