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Herbicide Control of Broom Snakeweed (Gutierrezia sarothrae)

Clinton A. Stonecipher
USDA-ARS, clint.stonecipher@usda.gov

Corey Ransom
Utah State University, corey.ransom@usu.edu

Eric Thacker
Utah State University, eric.thacker@usu.edu

Kevin D. Welch
USDA-ARS, kevin.welch@ars.usda.gov

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Herbicide Control of Broom Snakeweed (Gutierrezia sarothrae)

Abstract

Broom snakeweed (*Gutierrezia sarothrae* [Pursh] Britton & Rusby) is a native invasive species that is widely distributed across western North America. It is very competitive with other vegetation and can reduce or displace desirable grasses and forbs. Removal of snakeweed from rangelands can result in increased forage production of desirable plant species. The evaluation of new herbicides to determine their efficacy in controlling broom snakeweed assists in providing land managers with alternatives to control broom snakeweed. The objective of this study was to evaluate herbicides applied in the spring to determine efficacy of control of broom snakeweed. 2,4-D + triclopyr had the greatest reduction in snakeweed density at 97 ± 14.6 % ($P < 0.0001$). Aminopyralid and 2,4-D were also effective at reducing snakeweed density at 73 ± 14.6 % control. Our results demonstrate that 2,4-D + triclopyr, a new herbicide, can be used in controlling broom snakeweed in the spring.

Keywords

Invasive weed, broom snakeweed, poisonous plant, weed management, 2, 4-D, aminopyralid, 2, 4-D + triclopyr

Cover Page Footnote

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Introduction

Broom snakeweed [*Gutierrezia sarothrae* (Pursh) Britton & Rusby] is a short-lived perennial, suffrutescent subshrub that is widely distributed across western North America. It is adapted to a wide range of soils and occupies plant communities from desert grassland, short-grass prairie, salt-desert shrub, sagebrush steppe, pinyon/juniper, and mountain brush (Ralphs and McDaniel, 2011). Snakeweed is not palatable to livestock (Pieper, 1989) but may be consumed when other forage is lacking and may cause abortions and other physiological problems in livestock (Dollahite and Anthony, 1957).

Broom snakeweed is a prolific seed producer and can increase in density following disturbances such as overgrazing, fire, or drought (Ralphs and McDaniel, 2011). Pulse establishment of broom snakeweed populations allows massive stands to establish (Ralphs and McDaniel, 2011). Snakeweed is very competitive with other vegetation and can reduce or displace desirable grasses and forbs, resulting in significant reduction in forage production (Ueckert, 1979; McDaniel *et al.*, 1982).

Removal of snakeweed from rangelands can result in increased forage production of desirable plant species. Also, a healthy perennial plant community can aid in suppressing the reestablishment of snakeweed (Thacker *et al*., 2008). Snakeweed can be effectively controlled by herbicides and the timing of herbicide application can depend on the type of herbicide used or location. For example, picloram and metsulfuron have shown good control when applied in the fall in New Mexico (McDaniel, 1989; McDaniel and Duncan, 1987) and when applied in the spring on shortgrass rangelands in Wyoming (Whitson and Freeburn, 1989). Aminopyralid, metsulfuron, and picloram + 2,4-D have been shown to be effective in the fall (Keyes *et al*., 2011) and picloram was effective when applied in the spring or fall in big sagebrush (*Artemisia tridentata* subsp. *tridentata* Nutt.) sites.

The mode of action of herbicides refers to the biochemical and biophysical interactions with the plant that the herbicide disrupts to interfere with plant growth and development. Growth regulator herbicides mimic natural plant growth hormones and disrupt several growth processes in susceptible plants. Amino acid inhibitor herbicides inhibit the activity of the acetolacetate synthase enzyme, which is involved in the synthesis of the branch chain amino acids. Both growth regulator (e.g., picloram and aminopyralid) and amino acid inhibitor (e.g., metsulfuron) herbicides have been effective in controlling snakeweed.

As new products become available, they need to be tested to determine their efficacy in controlling broom snakeweed to provide land managers with alternatives. The objective of this study was to test herbicides applied in the spring to determine efficacy of control of broom snakeweed.

Materials and Methods

Study Site: Plots were established in northern Utah, 8 km southeast of Wellsville, Utah (41°34.071'N; 111°54.0405'W) on a west facing slope with an elevation of 1662 m. The soil is a fine, montmorillonitic, frigid, Pachic Palexerolls (Mountain stony loam). The ecological site is classified as mountain big sagebrush [*Artemisia tridentata* Nutt. ssp. vaseyana (Rydb.) Beetle] and has the potential to produce 1962 kg ha^{-1} of total air-dried herbage (USDA, NRCS 2018). Vegetation at the site consists of slender wheatgrass [*Elymus trachycaulus* (Link) Gould ex Shinners], basin wildrye [*Leymus cinereus* (Scribn. & Merr.) Á. Löve], sheep fescue (*Festuca ovina* L.), Sandberg bluegrass (*Poa secunda* J. Presl), bulbous bluegrass (*Poa bulbosa* L.) bluebunch wheatgrass [*Pseudoroegneria spicata* (Pursh) Á. Löve], mountain big sagebrush, tailcup lupine (*Lupinus caudatus* Kellogg) common yarrow (*Achillea millefolium* L.), death camas [*Zigadenus paniculatus* (Nutt.) S. Watson] and broom snakeweed.

Experimental Design: The study was laid out in a randomized complete block design consisting of four blocks. Each block consisted of 13 plots (3 x 9 m) with six herbicide treatments applied at an early and six herbicide treatments at a late application timing in the spring, and one untreated control plot. Herbicides and application rates are listed in Table 1. Early application occurred on April 13, 2017 and late application occurred on May 11, 2017. Herbicides were combined with a 0.25% v/v nonionic surfactant (Activator 90, 90% active, Loveland Products, Loveland, CO). Herbicides were applied using a CO_2-pressurized backpack sprayer at a rate of 168 L/ha.

Measurements: Total number of snakeweed plants were counted within a 1-m belt transect down the center of each plot prior to herbicide application, one year and two years following treatment. Snakeweed plant counts were converted to the number of plants/$meter^2$. Percent change in plant densities was calculated by the difference in snakeweed plants prior to herbicide application and one year and two years following herbicide treatment.

Data Analyses: Snakeweed density and percent change in death camas density were assessed as a randomized block design using a generalized linear mixed model (PROC GLIMMIX) method in a mixed model analysis of variance with repeated measures in SAS v. 9.4 (SAS Institute, Cary, NC). Plots were the experimental units and the four blocks were the replicates. Herbicide treatment, application timing, location, and year were the fixed effects factors and block and repeated measures were incorporated as random effects factors. Snakeweed density was square root transformed to meet assumptions of normality and homogeneity of variance. Treatment means were reported as original, non-transformed data with standard errors. Treatment means were separated using the LSMEANS method and main effects were adjusted for Type I error inflation using the Tukey method.

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Table 1. List of herbicides and application rates used to treat broom snakeweed (*Gutierrezia sarothrae*).

Treatment	Trade name	Active ingredient	Application rate —g ai/ae ha^{-1}—	Manufacturer
2,4-D Amine	2,4-D Amine	Dimethylamine salt of 2,4-Dichloro-phenoxyacetic acid	2130	Agristar, Allbaugh LLC, Ankeny, IA
2,4-D + triclopyr	Crossbow®	2,4-dichlorophenoxyacetic acid, butoxyethyl ester + 3,5,6-trichloro-2-pyridinyloxyacetic acid, butoxyethyl ester	1120 + 560	Dow AgroSciences LLC, Indianapolis, IN
Quinclorac	Facet® L	Dimethylamine salt of quinclorac: 3,7-dichloro-8-quinolinecarboxylic acid	420	BASF Corporation, Research Triangle Park, NC
Aminopyralid	Milestone®	Triisopropanolammonium salt of 2-pyridine carboxylic acid, 4-amino-3,6-dichloro-	123	Dow AgroSciences LLC, Indianapolis, IN
Imazapic	Plateau®	Ammonium salt of imazapic (±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-5-methyl-3-pyridinecarboxylic acid	175	BASF Corporation, Research Triangle Park, NC
Chlorsulfuron	Telar®	2-chloro-N-[(4-methoxy-6-methyl-1,3,5-triazin-2-yl)aminocarbonyl]benzenesulfonamide	52.5	E. I. duPont de Nemours and Company, Wilmington, DE

Results and Discussion

Herbicide treatments were applied at two different times in the spring in an effort to control snakeweed. There was no difference ($P < 0.05$) in snakeweed control between plants treated in April or May, thus, data is combined for the two application times.

Snakeweed density was similar between all plots prior to herbicide application ($P > 0.05$; Figure 1). The herbicides, 2,4-D + triclopyr, aminopyralid, and 2,4-D amine were successful in reducing snakeweed density between pretreatment evaluations and post herbicide evaluations the year following herbicide application ($P < 0.0001$). The change in snakeweed at two years following herbicide application was similar to the first year following herbicide application (Figure 1). The greatest reduction in snakeweed density occurred with 2,4-D + triclopyr and snakeweed density was reduced from 3.7 ± 0.99 plants/m^2 before herbicide application to 0.1 ± 0.99 plants/m^2 the two years following herbicide application, respectively. Aminopyralid and 2,4-D amine were also effective at reducing snakeweed density ($P < 0.0001$; Figure 1). Snakeweed density decreased from 4.4 ± 0.99 plants/m^2 to 1.2 ± 0.99 plants/m^2 at two years following 2,4-D amine application and from 4.2 ± 0.99 plants/m^2 to 1.1 ± 0.99 plants/m^2 both years following aminopyralid application, respectively. There was no change in snakeweed density in the imazapic treated plots. The reduction in snakeweed density in the quinclorac and chlorsulfuron treated plots were not significantly different from pre-herbicide densities (Figure 1).

Percent change in snakeweed density was the greatest in the 2,4-D + triclopyr treated plots ($P < 0.0001$; Figure 2) at 97 ± 14.6 %. Aminopyralid and 2,4-D amine both had 73 ± 14.6 % change in snakeweed density (Figure 2). Keyes *et al*. (2013) showed 42% control of snakeweed with aminopyralid in the spring but had 93% control in the fall. There was natural reduction of snakeweed in the control plots at 20 ± 14.6 % however, there was no reduction of snakeweed in the imazapic plots (0 ± 14.6). The percent change of snakeweed density for quinclorac and chlorsulfuron were low and not significantly different from the control plots. Keyes *et al*. (2013) were also unsuccessful at controlling snakeweed with chlorsulfuron in the spring as well as in the fall.

Growth regulator (e.g., picloram and aminopyralid) herbicides have been shown to be effective in controlling snakeweed (Keyes *et al*., 2013; McDaniel, 1989b; McDaniel and Duncan, 1987; Whitson and Freeburn, 1989). In the current study, aminopyralid was effective in controlling snakeweed along with the growth regulator herbicides, 2,4-D amine and 2,4-D + triclopyr. However, the growth regulator herbicide, quinclorac was not effective in controlling snakeweed. Amino acid inhibitor (e.g., metsulfuron) herbicides have also been effective in controlling snakeweed, however, in this study the two amino acid inhibitor herbicides evaluated, imazapic and chlorsulfuron, were not effective in controlling snakeweed.

Previous research has shown picloram or metsulfuron as effective in controlling snakeweed when applied in the fall in New Mexico (McDaniel, 1989b; McDaniel and Duncan, 1987) and when applied in the spring in Wyoming (Whitson and Freeburn, 1989). More recent research has shown that aminopyralid or metsulfuron or picloram + 2,4-D applied in the fall were all effective at controlling snakeweed (Keyes *et al*., 2013). This same research has also shown that picloram, applied on big sagebrush sites in Utah, was effective at eliminating snakeweed following either spring or fall applications. The results from our research has revealed 2,4-D + triclopyr as another herbicide to be added to the list as effective in controlling broom snakeweed following spring application. Further research will need to be conducted to determine its efficacy following fall application. Aminopyralid and 2,4-D amine displayed moderate control of snakeweed when applied in the spring. Further research is needed to determine control efficacy of 2,4-D in the fall. Our results demonstrate that 2,4-D + triclopyr, a new herbicide, that can be used in controlling broom snakeweed in the spring.

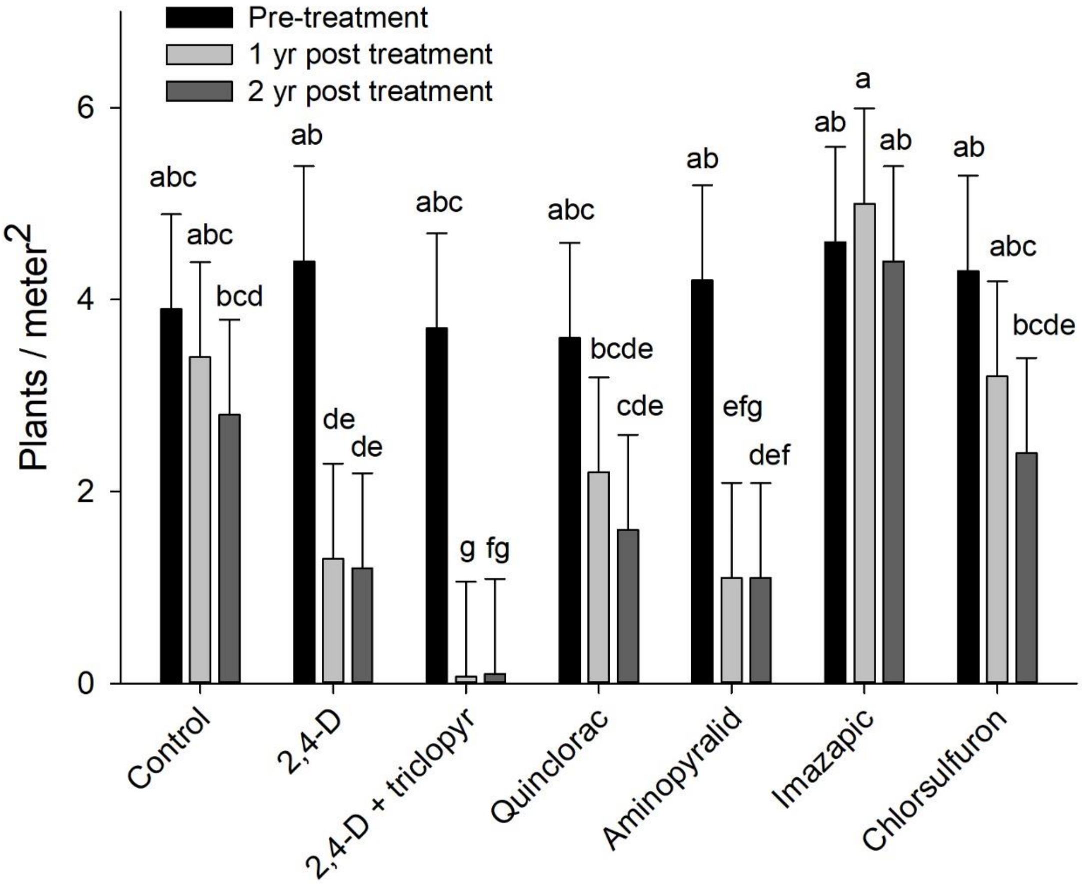

Figure 1. Broom snakeweed (*Gutierrezia sarothrae*) density (plants/m^2) prior to herbicide treatment (Pre-treatment), one year following herbicide treatment (1 yr post treatment) and two years following herbicide treatment (2 yr post treatment). Error bars represent standard errors. Bars with the same letter are not significantly different at P < 0.05.

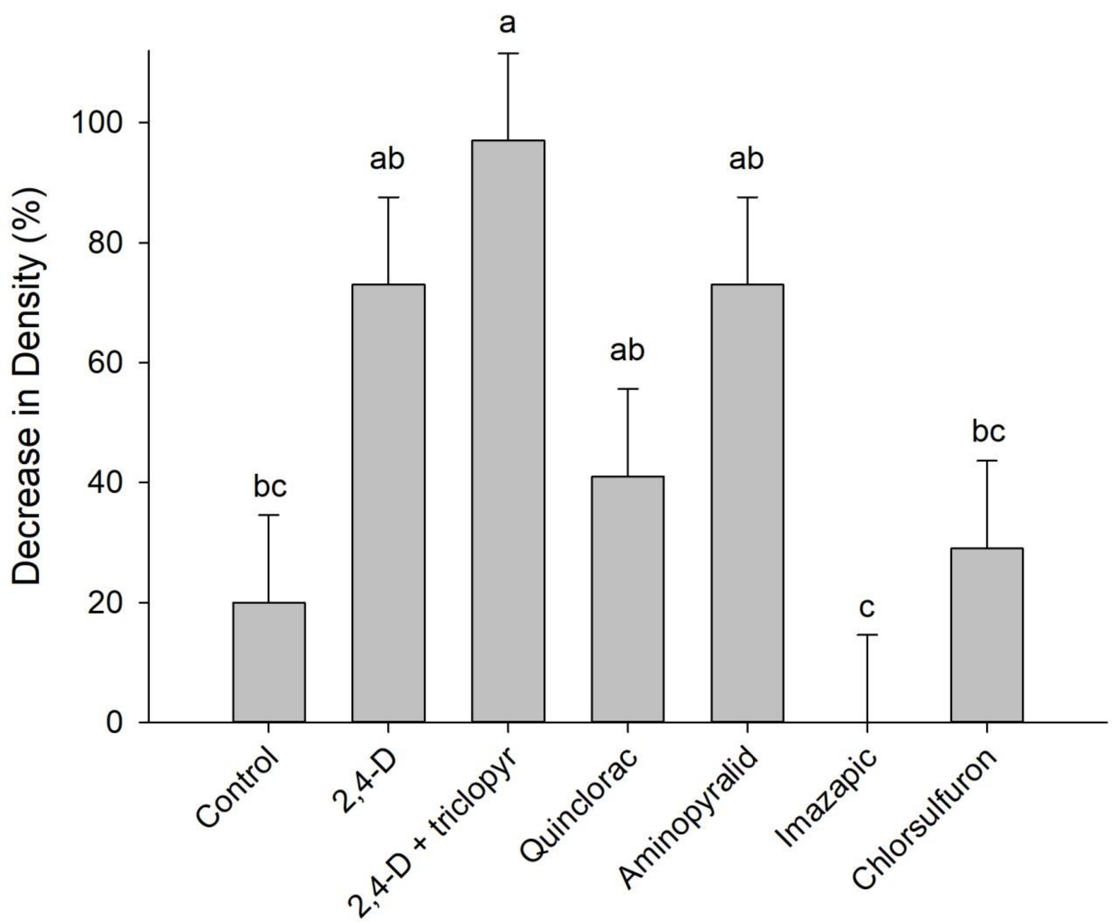

Figure 2. Percent change in broom snakeweed (*Gutierrezia sarothrae*) density the two years, following herbicide application, combined. Error bars represent standard errors. Bars with the same letter are not significantly different at P < 0.05.

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