Weed Technology

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Great Plains Yucca (*Yucca glauca*) Control on Shortgrass Rangelands

Walter H. Fick[1] and Keith Harmoney[2]

[1]Professor, Department of Agronomy, Kansas State University, Manhattan, KS, USA and [2]Professor, Kansas State University, Western Kansas Agricultural Research Center, Hays, KS, USA

Research Article

Cite this article: Fick WH, Harmoney K (2019) Great plains yucca (*Yucca glauca*) control on shortgrass rangelands. Weed Technol 33:192–195. doi: 10.1017/wet.2018.85

Received: 11 May 2018
Revised: 6 August 2018
Accepted: 24 August 2018
First published online: 29 November 2018

Associate Editor:
Andrew Kniss, University of Wyoming

Nomenclature:
2,4-D; aminopyralid; chlorsulfuron; dicamba; metsulfuron; triclopyr; Great Plains yucca, *Yucca glauca* Nutt.

Key words:
Flowering stage; foliar herbicides; plant whorls; repeat treatment

Author for correspondence:
Walter H. Fick, Kansas State University, Department of Agronomy, 2004 Throckmorton Plant Sciences Center, 1712 Claflin Road, Manhattan, KS 66506. (Email: whfick@ksu.edu)

Abstract

Great Plains yucca is a native species that competes with forage plants for space and water and at high densities may warrant control. The objective of this study was to determine the efficacy of seven herbicides applied in the spring or fall for Great Plains yucca control. Six foliar herbicides applied by ground application at 187 L ha^{-1} spray volume, one herbicide applied to individual plant whorls, and a nontreated check were established in June and September of 2009 and 2011. Percent mortality was determined 12 to 16 mo after herbicide application. Most herbicides gave similar control between the 2 yr, with triclopyr in diesel applied to individual plant whorls at 10 g L^{-1} providing the greatest control at 83%. Most herbicides applied in June near the blooming stage of Great Plains yucca were more effective than September treatments. June treatments providing the greatest reduction in yucca densities were metsulfuron + dicamba + 2,4-D amine + 2,4-D low volatile ester (LVE) at 21 + 113 + 325 + 431 g ae ha^{-1}, metsulfuron + aminopyralid + triclopyr at 49 + 9 + 227 g ha^{-1}, metsulfuron + chlorsulfuron + 2,4-D LVE at 34 + 11 + 431 g ha^{-1}, and metsulfuron + aminopyralid + 2,4-D LVE at 49 + 9 + 431 g ha^{-1}. A single application of a foliar herbicide provided a maximum of 72% mortality of Great Plains yucca, suggesting that repeat application may be necessary to achieve optimum control.

Introduction

Great Plains yucca or small soapweed, is an easily recognized plant commonly found throughout the Central Great Plains (USDA-NRCS 2018). It makes up a small percentage of the plant composition on native rangelands and is found both in areas that have been protected from domestic livestock grazing for decades and in areas that have a long history of livestock grazing (Milchunas and Noy-Meir 2004). Yucca was common on the steep coarse soils adjoining river valleys throughout Kansas, as well as on rocky slopes in the east and on the western plains in association with buffalograss [*Bouteloua dactyloides* (Nutt.) Columbus] and prickly pear (*Opuntia* spp.), before the intensive agricultural development in much of Kansas (Carlton 1890). In many sites in Nebraska and Colorado, yucca is often found on steep slopes with coarse soils (Barnes et al. 1984; Kinraide 1984), where deep root structures are required to attain soil moisture.

Yucca species, including Great Plains yucca and soaptree yucca (*Yucca elata* Engelm.) are generally not widely grazed by livestock. Cattle breeds differ in their preferences for yucca species during the growing season and during the dormant season (Herbel and Nelson 1966; Winder et al. 1996). Flowering stalks and flowers are also highly selected by beef cattle in the spring (Rosiere et al. 1975). Heritability estimates in cattle show that the preference for yucca could be passed genetically to offspring (Winder et al. 1995). Winter grazing yucca with specific cattle breeds could be one form of suppression to aid other control methods. Studies conducted in Nebraska (Rittenhouse et al. 1970) and Colorado (Reppert 1960) also reported winter grazing of yucca by livestock.

Fire alone does not control soapweed yucca, as fire resulted in mortality of less than 15% and increased yucca rosette densities in the plant community (Masters et al. 1988; Parmenter 2008). This increase in vegetative reproduction is also the main methodology for yucca to maintain and increase populations among years of highly variable flowering and seed set (Kingsolver 1986) due to environmental conditions. However, burning did reduce plant size for up to 2 yr and wildlife browsing on new growth of surviving yucca increased immediately to almost half of the yucca population during the year after burning (Masters et al. 1988; Parmenter 2008).

Suppression through grazing or fire may aid control of dense yucca populations with herbicides. Integrating burning or mechanically shredding yucca before herbicide treatment resulted in better control (Masters et al. 1988). For stands of yucca greater than

800 plants ha^{-1}, such control measures are needed to increase yield and soil water storage available for surrounding desirable vegetation (Sosebee et al. 1982). Many foliar herbicides have been effective for yucca control but are no longer available due to environmental and health concerns (Bovey 1964). Oliver (1984) applied herbicides monthly and concluded that foliar-applied herbicides should be applied during or immediately following flowering. Soil-applied herbicides, including tebuthiuron and hexazinone, were more effective than foliar-applied herbicides in west Texas (Oliver 1984). Newer herbicides are available, although few studies have examined yucca control with newer herbicide combinations. This study was initiated to evaluate Great Plains yucca control using herbicide combinations applied in spring and fall to compare broadcast applications with an individual plant treatment.

Materials and Methods

The research site was located in southern Trego County, KS (38.735 N, 99.728 W, on a limy upland ecological site consisting of an Armo loam soil (fine-loamy, mixed, mesic Entic Haplustolls). The dominant graminoid vegetation on the site consisted of blue grama [*Bouteloua gracilis* (Willd. ex Kunth) Lag. ex Griffiths], sideoats grama [*Bouteloua curtipendula* (Michx.) Torr.], buffalograss, western wheatgrass [*Pascopyrum smithii* (Rydb.) Á. Löve], and field brome (*Bromus arvensis* L.). Common forbs at the site were western ragweed (*Ambrosia psilostachya* DC), upright prairie coneflower [*Ratibida columnifera* (Nutt.) Wooton & Standl.], fringed sagebrush (*Artemisia frigida* Willd.), broom snakeweed [*Gutierrezia sarothrae* (Pursh) Britton & Rusby], and Russian-thistle (*Salsola tragus* L). The site also had a high density of Great Plains yucca, averaging 8,167 plants ha^{-1} across all plots Treatments consisted of four replications, with each plot being 4.1 by 7.6 m. In 2009 herbicides were applied June 24 and September 28, while in 2011 treatments were applied June 18 and September 21. The early-summer application was made to yucca plants that were in the early stages of bolting to early flower development across the site. Fall applications were made during the time period just before the average first frost date for the research site. Seven herbicide treatments and a nontreated control were compared for efficacy on yucca (Table 1). All foliar broadcast treatments included a methylated seed oil at 0.25% or 1.00%, depending on product label, on a v/v basis, and the final spray volume was equivalent to 187 L ha^{-1} at 172 kPa using TeeJet® 8004 flat-fan nozzles (Spraying Systems, Wheaton, IL). Foliar broadcast treatments were applied with a handheld boom attached to a CO_2-pressurized container. The only individual plant treatment was applied using a pressurized handheld sprayer with a cone nozzle tip and was applied to just wet the whorl of each plant. All live yucca plants within each plot were counted before treatment. At 15 or 16 mo after treatment for the spring-applied herbicides and 12 or 13 mo after treatment for the fall-applied herbicides, all live yucca plants were once again counted within each plot. Mortality is based on the percent change between pre- and posttreatment yucca densities. Yucca plants with any visible sign of green foliage were considered live plants.

Data Analysis

The experimental design was a modified split plot with year as the whole plot. The subplots were a two-factor factorial arrangement of treatments (2 dates by 8 herbicides) in a randomized complete block with four replications. Percent mortality data were transformed using an arcsine square-root transformation (Steel and Torrie 1960) and subjected to ANOVA using MSTAT v. 3.00 (Michigan State University, East Lansing, MI). Means presented in the text and tables are from untransformed data. Fisher's protected LSD was used for mean separation at $P \leq 0.05$.

Results and Discussion

Data are presented primarily based on the presence of an interaction between date and treatment. The year by date interaction was nonsignificant, as was the three-way interaction of year by date by treatment ($P > 0.31$). A significant year by treatment

Table 1. Seven herbicide treatments and a nontreated control applied to evaluate efficacy on yucca.

Herbicide	Trade name	Rate	Manufacturer	Adjuvant
		g ai or ae ha^{-1}		% MSO
Metsulfuron	Escort® XP	21	E.I. du Pont de Nemours and Company	0.25
Metsulfuron + dicamba + 2,4-D amine	Escort® XP + Weedmaster®	21 + 113 + 325	E.I. du Pont de Nemours and Company; BASF Corporation	0.25
Metsulfuron + dicamba + 2,4-D amine + 2,4-D LVE	Escort® XP + Weedmaster® + Low Vol 4	21 + 113 + 325 + 431	E.I. du Pont de Nemours and Company; BASF Corporation; Dow AgroSciences LLC	1.00
Metsulfuron + aminopyralid + triclopyr	Chaparral™ + Remedy® Ultra	49 + 9 + 227	Dow AgroSciences LLC	1.00
Metsulfuron + aminopyralid + 2,4-D LVE	Chaparral™ + Low Vol 4	49 + 9 + 431	Dow AgroSciences LLC	1.00
Metsulfuron + chlorsulfuron + 2,4-D LVE	Cimarron® Plus + Low Vol 4	34 + 11 + 431	E.I. du Pont de Nemours and Company; Dow AgroSciences LLC	1.00
Triclopyr ester in diesel	Remedy® Ultra	10[a]	Dow AgroSciences LLC	None
Nontreated control				

[a] g L^{-1}.

https://doi.org/10.1017/wet.2018.85 Published online by Cambridge University Press

interaction ($P < 0.01$) was caused by metsulfuron at 21 g ai ha^{-1} providing greater control of Great Plains yucca in 2009 (38%) than 2011 (10%) but is considered irrelevant, because both levels of control are considered commercially unacceptable. All other treatments gave similar Great Plains yucca control between the 2 yr. Average yucca mortality was 44% and 34% in 2009 and 2011, respectively (unpublished data). This difference is probably related to differences in growing season precipitation (Table 2). In 2009, April through September precipitation was 113% of average, whereas in 2011, April through September precipitation was only 65% of average. Foliar-applied herbicides are generally more effective when plants are actively growing and not under moisture stress. All of the foliar treatments contained metsulfuron, and dry conditions may reduce the activity of this herbicide (Anonymous 2015).

Table 2. Monthly precipitation in Trego County, KS, during 2009 and 2011.

Month	2009	2011	30-yr average
	————————mm————————		
January	2	10	14
February	3	18	18
March	< 1	25	42
April	104	30	50
May	66	35	80
June	61	55	74
July	88	72	89
August	71	59	68
September	73	14	48
October	78	48	37
November	20	13	23
December	29	40	18
Total	594	419	561

A significant date by treatment interaction occurred ($P < 0.01$), with most herbicides applied in June being more effective than September treatments (Table 3). Superior foliar-applied treatments in June included metsulfuron + dicamba + 2,4-D amine + 2,4-D low volatile ester (LVE) (72% mortality), metsulfuron + aminopyralid + triclopyr (58% mortality), metsulfuron + aminopyralid + 2,4-D LVE (64% mortality), and metsulfuron + chlorsulfuron + 2,4-D LVE (66% mortality). Metsulfuron applied alone in June across both years also gave better yucca control than the September application, but provided only 36% mortality. None of the September foliar-applied broadcast herbicides provided more than 34% control averaged across the 2 yr. Triclopyr in diesel applied to individual yucca plants was equally effective (77% to 89% mortality) in June and September. Even in the untreated control, some yucca plants did not survive from one year to the next. Less than 10% of the yucca population in untreated control plots suffered mortality during the study (Table 3).

Aerial application of silvex [2-(2,4,5-trichlorophenoxy)-proprionic acid] at 2.2 kg ha^{-1} using diesel fuel as a carrier provided 80% control of yucca (Bovey 1964). This author noted that substantial yucca resprouting had occurred 2 yr after herbicide application and that repeat treatment would be necessary for best control. Oliver (1984) concluded that foliar-applied herbicides need to be applied during or immediately following flowering. In his study, yucca was treated monthly on two ecological sites, with yucca control less on sandy soils. The highest control achieved with silvex was 82%. In the current study, a foliar application in June 2009 or 2011, near the flowering stage of Great Plains yucca, with metsulfuron + dicamba + 2,4-D amine + 2,4-D LVE at 21 + 113 +325 + 431 g ha^{-1} provided similar control (72%).

At the time the current study was initiated, no foliar treatments were recommended for yucca control (Thompson et al. 2009), as 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) and silvex were no longer available. Recommendations included soil application of hexazinone and growing point treatment with triclopyr or triclopyr plus fluroxypyr. These individual plant treatments would be reasonable to use on scattered stands of yucca, but dense stands or yucca growing on steep topography would justify use of

Table 3. Great Plains yucca response to herbicides applied in June and September of 2009 and 2011 in Trego County, KS.

Herbicide[a]	Rate	June	September
	g ai or ae ha^{-1}	————% mortality[b]————	
Metsulfuron	21	36 c	12 c *
Metsulfuron + dicamba + 2,4-D amine	21 + 113 + 325	26 c	16 c
Metsulfuron + dicamba + 2,4-D amine + 2,4-D LVE	21 + 113 + 325 + 431	72 ab	34 b *
Metsulfuron + aminopyralid + triclopyr	49 + 9 + 227	58 ab	14 c *
Metsulfuron + aminopyralid + 2,4-D LVE	49 + 9 + 431	64 ab	10 c *
Metsulfuron + chlorsulfuron + 2,4-D LVE	34 + 11 + 431	66 ab	34 b *
Triclopyr in diesel	10[c]	77 a	89 a
Untreated	—	10 d	8 c

[a]All herbicides were foliar-applied at 187 L ha^{-1}, except triclopyr in diesel, which was applied to wet the whorl of individual yucca plants.
[b]Means in a column followed by the same lowercase letter are not different according to Fisher's protected LSD ($P \geq 0.05$). An asterisk (*) indicates a significant difference ($P \leq 0.05$) between June and September applications of a herbicide.
[c]g L^{-1}.

https://doi.org/10.1017/wet.2018.85 Published online by Cambridge University Press

foliar-applied herbicides. Repeat treatment with foliar herbicides is necessary to optimize control of Great Plains yucca, with timing near the flowering stage to achieve the greatest control.

Acknowledgments. The authors thank David Hilker for allowing us to conduct this research on his property in Trego County, KS. This research received no specific grant from any funding agency or the commercial or not-for-profit sectors. No conflicts of interest have been declared. This is contribution no. 18-384-J from the Kansas Agricultural Experiment Station.

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