RESPONSE OF YUCCA TO FIRE, HERBICIDE, AND MECHANICAL TREATMENTS

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ABSTRACT

Response of individual yucca(Yucca glauca) plants to fire, herbicide, and mechanical treatments, applied singularly and in combination, was evaluated during two consecutive growing seasons. Plant tops were removed by burning plants with a propane burner or shredding to a 6 inch stubble height. Tebuthiuron [N-(5(1,1-dimethylethyl) -1,3,4-thiadiazol-2-yl)-N,N'-dimethylurea] was applied at rates of 1 and 2 lb a.i./ac and a 1:1 mixture of picloram (4-amino-3,5,6-trichloropicolinic acid) and 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) was applied to yucca foliage at 2 lb/ac. Greatest plant mortality occurred when herbicides were applied alone, 67%, or when tebuthiuron at 2 lb/ac was applied following burning or shredding, 73 and 93%, respectively. In contrast, burning and shredding alone caused yucca mortalities of only 13 and 33%, respectively. Burned yucca, regardless of herbicide treatment, produced an average of 1.3 new shoots/plant compared to 0.3 shoots produced by unburned plants. Across all treatments, yucca weight declined 85% during the study period.

INTRODUCTION

Yucca (**Yucca glauca**) or small soapwood is a xerophytic shrub ranging in distribution from Arizona, east to Texas and north to North Dakota (Vines, 1960). In Texas this species reaches greatest abundance in the western half of the state and occupies over 3.5 million acres in the Rolling and High Plains (Robison, 1968). On severly degraded rangeland in the panhandle of Texas, densities of yucca often exceed 2000 plants/ac (Sosebee and Churchill, 1982). Depletion of soil water and reduction in forage production resulting from such high densities necessitate control measures be instituted to maintain or improve livestock carrying capacity.

Yucca is susceptible to basal sprays of 2,4,5-T (2,4,5-trichlorophenoxyacetic acid), silvex [2-(2,4,5-trichlorophenoxy) propanoic acid], and karbutilate [m-(3,3-dimethylureido)phenyl-**tert**-butylcarbamate] and is intermediately susceptible to foliar sprays of 2,4,5-T and silvex (Bovey, 1977). Robison (1968) found consistent control of **Y. glauca** with 2,4,5-T and silvex. Moreover, forage production on treated areas was 1830 lb/ac compared to 846 lb/ac on untreated areas. However, these effective herbicides are no longer available for use. Generally, currently available herbicides provide inadequate control of yucca. Jacoby et al. (1983) found the frequency of yucca was unchanged following the application of 1 lb a.i./ac of tebuthiuron [N-(5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl)-N,N'-dimethylurea]. As a group, **Yucca** sp., are tolerant to fire and maintain their position in plant communities after a burn (Wright and Bailey, 1982). However, following a wildfire in the desert southwest, Humphrey (1949) reported a 25% reduction in yucca. In this instance, fire-induced mortality was enhanced by drought conditions at time of the wildfire.

Effectiveness of mechanical treatments depends on whether whole plant or top removal treatments are used (Scifres, 1980). Disc plowing resulted in a 21% reduction in yucca density (Herndon, 1982). Lower than expected mortality resulted from low soil moisture which hindered ability of plow to sever and exhume rhizomes. Since yucca propagates vegetatively, top removal will not provide long-term control. Top removal, sufficient to remove apical dominance, will likely increase yucca density by stimulating shoot growth from rhizomes.

Top removal combined with herbicide treatment improves control of a number of undesirable brush species in South Texas beyond that of treatments applied alone (Scifres et al.,1983). Similarly, top removal followed by herbicide application may enhance yucca control. The objective of this study was to determine the efficacy of fire, herbicides, and shredding alone and in combination for yucca control.

MATERIALS AND METHODS

The study site was located in Terry County, 3 mi north of Brownfield, Texas. Soil on the site is classified as an Amarillo loamy fine sand (Aridic Paleustalf). Slope ranges from 0 to 3%. Prior to 1976, the site was cultivated. In 1976 weeping lovegrass(**Eragrostis curvula**) and alfalfa (**Medicago sativa**) were planted on the site. Yucca and catclaw mimosa (**Mimosa biuncifera**) were the most abundant shrubs on the site.

The study was initiated in April 1983 to evaluate the response of yucca to 12 combinations of herbicide, fire, and shredding treatments. Each treatment combination was imposed on 15 plants. The fire treatment was conducted on April 15, 1983 using an individual propane plant-burner (Britton and Wright, 1979). To ensure uniformity of the burn treatment, propane pressures of 5.5 psi for 1 min followed by 1 psi for 15 sec were used. Fire temperatures at the soil surface simulated by these pressures were similar to that generated by combustion of a fine fuel load of 5400 lb/ac (Wright et al., 1976). At this time, additional plants were clipped to a 6 inch stubble height to simulate shredding.

On April 20, 1983, when yucca was at the pre-bloom phenological stage, pelleted tebuthiuron (20% a.i.) was applied to a 1-yd^2 area around burned, shredded, and intact plants at rates of 1 and 2 lb/ac. On June 3, 1983, when intact yucca were at the bloom growth stage, a 1:1 mixture of picloram (4-amino-3,5,6-trichloropicolinic acid) and 2,4,5-T was applied to foliage of burned, shredded, and intact yucca at 2 lb/ac in a water:oil emulsion carrier using a hand operated sprayer.

Before treatment, plant height, canopy diameter, and number of new shoots were recorded. A new shoot was defined as aerial plant growth arising from within 1-yd^2 around treated plants. Similar measurements and plant mortality determinations were made September 29, 1983 and October 9, 1984. A plant was considered dead if leaves originating from the parent plant were chlorotic on more than 50% of their leaf

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surfaces and shoots from basal buds were not evident.

Topgrowth of plants clipped during the shredding treatment, April 15, 1983, and at the last sampling period, October 9, 1984, was collected, oven dried and weighed. At the final sampling date five plants from each treatment combination were harvested. Plant weights were used to develop predictive equations with plant volume as the independent variable and weight as the dependent variable. The formula for a cylinder was used with canopy diameter, average length of two perpendicular directions, as the cylinder diameter and plant height as height of the cylinder. Weight estimates obtained at study initiation and termination were compared to determine changes in above-ground plant weight during the experiment.

The experiment was designed in a completely random manner with individual plants as replications. Plant mortality by treatment was compared using Chi-square analysis ($P < 0.05$). All possible combinations of pairs of treatments were compared. Number of new shoots per plant were compared using Duncan's multiple range test ($P < 0.05$) (Steele and Torrie, 1980). Pre- and post-treatment plant weights were predicted using regression analysis and compared using Student's t-test ($P < 0.05$).

RESULTS AND DISCUSSION

Precipitation was 1.3 and 3.4 inches below the long-term average of 18 inches in 1983 and 1984, respectively. Although total precipitation during 1983 was greater than 1984, 1.7 inches more rainfall occurred from May to August 1984 than during that period in 1983. Rainfall, 0.7 inches, sufficient to move tebuthiuron into the soil profile occurred the day after application.

Greatest plant mortality resulted from combined top removal, either by burning or shredding, followed by application of tebuthiuron at 2 lb/ac (Table 1). Mortality of burned and shredded plants treated with 2 lb/ac of tebuthiuron was 73 and 93%, respectively. In contrast, mortality of burned and shredded plants treated with tebuthiuron at 1 lb/ac was only 13%. Mortality of burned and shredded plants was lower than plants treated only with herbicides. Burned and shredded plant mortality averaged 21% as compared to 67% for plants treated only with herbicides.

High mortality of untreated plants and those treated with tebuthiuron at 1 lb/ac may be linked to high infestation of these plants with fungal pathogens. Based on visual observations made at the final plant evaluation date, more plant pathogens were found on leaves of unburned and unshredded plants when compared to burned and shredded plants. The three most prominent pathogens on leaf surfaces were fungi from the genera **Hysterographium**, **Kellermania**, and **Torula**. These pathogens are phytophagous and may produce toxins which inhibit plant growth. Removal of older leaves and replacement with new shoots may account for differential pathogen infestation among plants which had topgrowth removed and those which did not. Older leaves are often more susceptible to pathogen penetration and infestation than younger leaves (Royle, 1976).

An unusually wet fall in 1983 may have contributed to the apparent increase in fungal pathogen infestation. Of the total precipitation received during 1983, 48% occurred during a 5-day period in October. Resultant cool, moist environmental conditions may have enhanced fungal growth and subsequent pathogen infestation of yucca. Cool, moist enviromental conditions induced by excessive precipitation were cited as increasing levels of snowmold fungus (**Typhula** sp.) infestation on mountain big sagebrush (**Artemisia tridentata** var. **vaseyana**) (Sturges, 1986).

An antagonistic relationship may have existed between tebuthiuron and the herbicide mixture, picloram +2,4,5-T. Mortality of burned plants treated with a combination of tebuthiuron and picloram + 2,4,5-T was 33% as compared to a 73% mortality of burned plants treated with 2 lb/ac of tebuthiuron. Possibly the hormone-like activity of picloram + 2,4,5-T altered plant metabolism to the extent that phytotoxicity of tebuthiuron was reduced.

Table 1. Mortality and number of new yucca shoots on a site near Brownfield, Texas 18 months after fire, herbicide, and shredding treatments.

Treatment[1]	Total mortality[2] %	New shoots[3] (No./plant)
Untreated	40 ab	0.1 a
F	13 a	1.5 de
F + T (1)	13 a	1.8 e
F + T (2)	73 c	0.8 abcd
F + T (2) + P (2)	33 a	1.2 cde
F + P (2)	20 a	1.1 bcde
S	33 a	0.6 abc
S + T (1)	13 a	0.3 ab
S + T (2)	93 c	0 a
T (1)	67 bc	0.2 a
T (2)	67 bc	0.5 abc
P (2)	67 bc	0.2 a

[1]Treatment abbreviations follow: F = fire, T = tebuthiuron, P = picloram + 2,4,5-T, and S = shred. Numbers in parenthesis indicate rate of herbicide applied expressed as active ingredient, i.e. (1) = 1 lb/ac and (2) = 2 lb/ac.

[2]Means followed by the same letter are not significantly different at the 0.05 level of probability according to Chi-square analysis.

[3]Mean number of new shoots followed by the same letter are not significantly different at the 0.05 level of probability according to Duncan's Multiple Range Test.

Table 2. Yucca weight estimates and reduction in plant weight from beginning to end of experiment conducted near Brownfield, Texas from April 1983 to October 1984[1]

Treatment[2]	Plant weight[3] (g/plant)		Weight reduction %)
	April 1983 (Pre-treatment)	Oct. 1984 (Post-treatment)	
	Mean	Mean	
Untreated	366 a	106 b	71
F	285 a	44 b	85
F + T (1)	407 a	73 b	82
F + T (2)	394 a	32 b	92
F + T (2)+ P (2)	364 a	43 b	88
T + P (2)	269 a	45 b	83
S	348 a	64 b	82
S + T (1)	325 a	101 b	69
S + T (2)	269 a	3 b	99
T (1)	348 a	14 b	96
T (2)	394 a	17 b	96
P (2)	289 a	79 b	73

[1]Means within a treatment are significantly different at the 0.05 level of probability according to Student's t-test.

[2]Treatment abbreviations follow: F = fire, T = tebuthiuron, P = picloram + 2,4,5-T, and S = shred. Numbers in parenthesis indicate rate of herbicide applied expressed as active ingredient, i.e. (1) = 1 lb/ac and (2) = 2 lb/ac.

[3]Predictive equations developed from plant weights are:

Pre-treatment: $Y = 0.00074x + 31.195$, $R^2 = 0.80$

Post-treatment: $Y = 0.00054x + 3.552$, $R^2 = 0.78$

Lower mortality of burned and picloram + 2,4,5-T treated plants compared to plants treated only with picloram + 2,4,5-T may result from difference in plant maturity at time of herbicide application. At this time only 13% of burned plants were at the early bloom growth stage as compared to 40% of the unburned plants. Scifres (1980) indicated yucca was most susceptible to foliar application of 2,4,5-T or silvex at this growth stage.

Burned plants and burned plants treated with 1 lb/ac of tebuthiuron produced more new shoots by the end of the experiment than untreated, shredded, and herbicide-treated plants (Table 1). Change in status of apical dominance may account for difference in shoot numbers between burned and shredded plants. Apparently, top removal by shredding did not remove apical dominance. In contrast, fire-induced mainstem damage removed apical dominance, stimulating shoot production from buds on rhizomes. On average, burned plants, regardless of herbicide treatment, produced 1.3 new shoots/plant while only 0.3 shoots were produced by unburned plants. In comparsion to other burned plants, low number of shoots produced by burned plants treated with tebuthiuron at 2 lb/ac resulted from high mortality caused by the herbicide.

Within treatment, yucca weight declined significantly during the experiment (Table 2). Across all treatments, plant weight declined an average of 85%. Weight reduction associated with untreated plants reflect the high mortality which may be partially attributable to high levels of fungal pathogen infestation. Based on low mortality of burned and shredded plants, except those treated with 2 lb/ac of tebuthiuron, decline in plant weights resulted from plant top removal at the beginning of the experiment.

CONCLUSION

Burning or shredding combined with application of 2 lb/ac of tebuthiuron caused the greatest yucca mortality. Lowest mortality and greatest number of resprouts were produced after burning or burning coupled with application of 1 lb/ac of tebuthiuron. Based on mortality and number of resprouts fire rejuventated individual yucca plants. Removal of older shoots by fire facilitated production of new shoots from rhizomes.

Impact of fungal pathogens on plant mortality can only be speculated and not conclusively demonstrated by this study. However, high mortality of untreated or plants treated with tebuthiuron at 1 lb/ac when compared to burned or shredded plants suggest another factor, possibly fungal pathogens, may have contributed to the observed mortality. Additional information on relative phytotoxicity of the various pathogens is needed. Once the most virulent species are identified, their populations might be augmented to a level sufficient to enhance yucca control.

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