Vegetative Response to Chemical Control of Broom Snakeweed on a Blue Grama Range

R. W. GESINK, H. P. ALLEY, AND G. A. LEE

Highlight: *All rates of picloram, either alone or in combination with low rates of 2,4-D, effectively controlled broom snakeweed on a blue grama range in southeastern Wyoming. Picloram also eliminated the low amounts of plains pricklypear present among the dense stands of snakeweed. Blue grama was initially injured by the 0.5 and 1 lb/acre rates of picloram, but needle-and-thread was damaged only by the 1 lb/acre rate. This initial injury to the grasses had a renovating effect upon the range, and, in combination with the elimination of undesirable plants, resulted in notable range improvement as measured 5 years after treatment. The study illustrates how herbicides may be a useful tool for selective manipulation of rangeland vegetation.*

Numerous studies concerning chemical control of undesirable plants on native rangeland have been reported over the years. Relatively little information, however, is available regarding the long-term effects of herbicides, particularly as they influence non-target components of the plant community. Laycock and Phillips (1968) have pointed out that the long-term ecological effects must be known if a herbicide is to be adequately evaluated as a method of range improvement. Because of time consuming methods, herbicide treatments are often evaluated in terms of the response of a single species (Hyder, 1971); and usually, only the short-term effects are reported.

The study presented here is an evaluation of the vegetative changes on a blue grama (*Bouteloua gracilis* [H.B.K.] Lag. ex Steud.) range in southeastern Wyoming, 5 years after the area had been subjected to treatment with herbicides. The treatments were made initially to investigate their effectiveness in the con-

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This paper is published with the approval of the Director, Wyoming Agricultural Experiment Station, as Journal Article No. 515.

The authors express their appreciation to Richard Strom, rancher, Laramie, Wyo., for providing a research area, and gratefully acknowledge the valued assistance of T. E. Bedell and R. L. Lang, Plant Science Division, Univ. of Wyoming, Laramie.

Manuscript received March 11, 1972.

trol of broom snakeweek (*Gutierrezia sarothrae* [Pursh.] Britt. & Rusby), a species which occurred in abundance on the study site. Also included in the trials were evaluations on plains prickly-pear (*Opuntia polyacantha* Haw.), a species found in relatively low amounts among the dense stands of snakeweed.

Broom snakeweed is a relatively unpalatable, competitive range week widely distributed over the western states (Forest Service, 1937). For the most part, studies on the control of this plant have been limited to the Southwest (Schmutz and Little, 1970), and only a small amount of research has been conducted in Wyoming (Alley and Lee, 1967). Stoddart and Smith (1955) state that thousands of acres of the short-grass plains have been invaded by snakeweed due to over-grazing. Recently, however, Jameson (1970) reported a study on Southwestern pinyon-juniper ranges in which changes in snakeweed over a 13-year period appeared to be the result of oscillating populations rather than of range condition.

Snakeweed is not particularly abundant in Wyoming; but it presents a range problem in certain local areas, usually those that have been subjected to heavy grazing. Herbicides used to control snakeweek have been limited largely to picloram and the chlorophenoxys (Alley and Lee, 1967; Johnsen, 1966; Schmutz and Little, 1970). Chemical control of snakeweek in Arizona has increased blue grama yields substantially (Jameson, 1966).

Plains pricklypear has received considerable attention because of the extensive acreages of rangeland it inhabits throughout the central and northern Great Plains. Thatcher et al. (1964) reported that the invasion and increased abundance of plains pricklypear has become an acute problem in many range areas of Wyoming. This abundance of pricklypear in the short-grass region has been attributed to over-grazing (Stoddart and Smith, 1955). However, 25 years of light, moderate, and heavy grazing by cattle in northeastern Colorado induced no outstanding changes in cactus population (Bement, 1968).

Bement (1968) hand-removed pricklypear from a blue grama range in northeastern Colorado and found no increase in blue grama production, but more forage was available for grazing. Alley and Lee (1969) stated that the increase in available forage from removing cactus would be in direct proportion to the density of the infestation and the ground area opened up by its removal. Although no forage production figures have been obtained from chemically treated cactus areas, Hyde et al. (1965) reported forage production was doubled where pricklypear had been controlled by mechanical beaters.

Responses of desirable species to picloram in rangeland ecosystems have not been extensively studied (Scifres and Halifax, 1972). In pricklypear control studies in western Nebraska, picloram eliminated about 50% of the native grass with May and July applications of 2 and 4 lb/acre (Wicks et al., 1969). Hyde et al. (1965) reported similar results in northeastern Wyoming. Picloram at less than 1 lb./acre injured smooth bromegrass (*Bromus inermis* Leyss.), especially with fall applications (McCarty and Scifres, 1968). Gesink et al. (1972) showed that smooth brome was greatly injured with picloram treatments of 1 and 1.5 lb/acre, western wheatgrass (*Agropyron smithii* Rydb.) was only slightly injured, and Kentucky bluegrass (*Poa pratensis* L.) was not injured by these rates. In Oklahoma picloram applied to established warm-season native grass species did not reduce forage production or desirable plant frequency; however, certain perennial grasses were injured when treated during the two- and four-leaf stages. At the six-leaf stage, only blue grama and side-oats grama (*Bouteloua curtipendula* [Michx.] Torr.) stands were reduced at the high treatment level of 4 lb/acre (Arnold and Santelmann, 1966).

Materials and Methods

This study was established in 1966 on a blue grama range near Laramie, Wyo. The area had been heavily grazed by sheep and in 1966 supported dense, uniform stands of snakeweed. Pricklypear was also present on the site, but in considerably less abundance than snakeweed. Blue grama comprised most of the perennial grass cover but was present in relatively small amounts because of the competition from snakeweed and pricklypear. Other perennial grasses that occurred as scattered plants were needle-and-thread (*Stipa comata* Trin. and Rupr.), western wheatgrass, and Indian ricegrass (*Oryzopsis hymenoides* [R. and S.] Ricker).

Herbicide treatments were made on a site with less than 1% slope and nearly uniform vegetation and soils. The soils of this area are deep, well-drained, loamy sands.

The herbicides were applied on June 26, 1966, as individual trials on unreplicated, 1/5 acre (43 x 200 ft) plots (Fig. 1). A truck-mounted sprayer was used to apply the herbicides in water at a spray volume of 25 gal/acre.

Herbicides[1] and rates applied were as follows:

Herbicide	*Rate*
1. Untreated check	
2. Silvex	2.00 lb./acre
3. Silvex	4.00 lb./acre
4. Picloram	0.50 lb./acre
5. Picloram	1.00 lb./acre
6. Picloram	0.25 lb./acre
+ 2,4-D	+1.00 lb./acre
7. Picloram	0.50 lb./acre
+ 2,4-D	+2.00 lb./acre

Visual evaluations concerning the vegetative response to the treatments were recorded each year. Percent control of undesirable plants was determined by averaging separate ocular estimates made by three individuals. In 1971, an intensive vegetation survey of the study area was made by utilizing the line intercept method (Canfield, 1941) to sample each 1/5 acre plot with ten randomly located 30 ft transects. Herbage was clipped by species from 15 circular (2.5 ft dia.) plots randomly located in each of the 1/5 acre herbicide treatments. Samples were oven-dried at 80 C for 24 hr and weighed. Cover and production estimates were tested by analysis of variance and Duncan's multiple range test at the 5% level of significance.

Results and Discussion

Snakeweed Response

All treatments that included picloram effectively controlled snakeweed (Table 1). These four treatments provided 95 to 100% control for 3 years after application date. After 5 years this level of control was still apparent for both picloram at 0.5 lb./acre (Fig. 1), and one combination of picloram + 2,4-D (0.5 + 2 lb./acre). Snakeweed control with picloram at 1 lb./acre and the other combination of picloram + 2,4-D (p.25 + 1 lb./acre) declined after 5 years with values of 85 and 80%, respectively, for each treatment.

Silvex treatments did not control snakeweed (Fig. 1). Recent field observations suggest that this occurred because treatments were applied too late into the growing season after the plants had developed beyond more susceptible growth stages.

Schmutz and Little (1970) also found picloram to be a very effective treatment for snakeweed in Arizona. Picloram was two to four times more toxic to snake-

[1]Chemical names of herbicides used were: 2-(2,4,5-trichlorophenoxy) propionic acid (Silvex), 4-amino-3,5,6-trichloropicolinic acid (Picloram), 2,4-dichlorophenoxy) acedic acid (2,4-D).

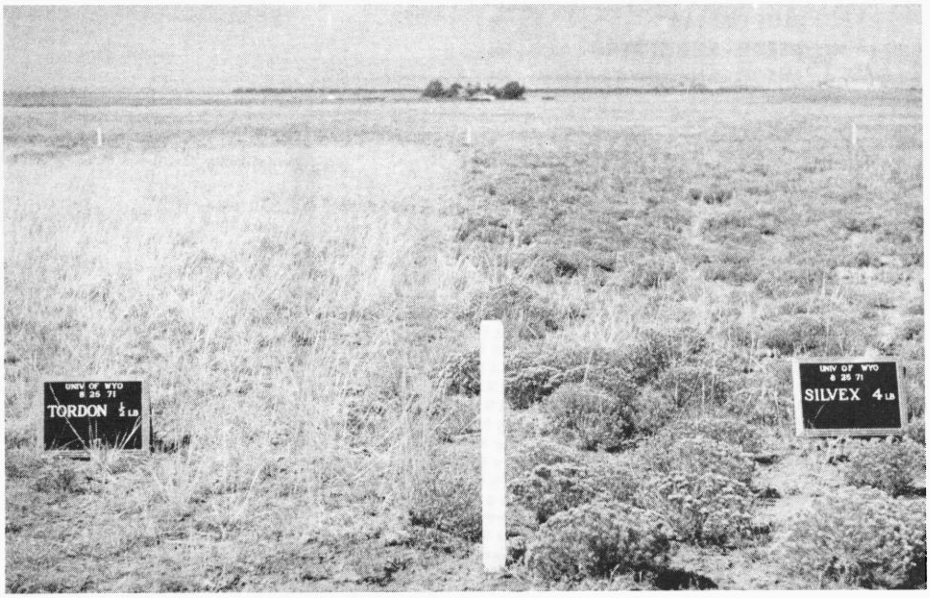

Fig. 1. *View of picloram (*Tordon*) treatment at 0.5 lb/acre and silvex treatment at 4 lb/acre as they appeared in August of 1971, 5 years after treatment. The silvex plot is similar to the untreated check.*

weed than 2,4-D or 2,4,5-T, and the period of susceptibility was longer. They suggested the longer period of susceptibility may result from greater picloram translocation under moisture stress, as reported by Merkle and Davis (1967).

Pricklypear Response

All rates of picloram and picloram + 2,4-D completely controlled pricklypear for the entire 5 year period, a response consistent with previously reported studies. The silvex treatments, however, were much less effective. At 4 lb./acre, silvex gave 80% control the first year after treatment, but this dropped to 50% when control was evaluated after 5 years. The 2 lb./acre rate was even less effective, with only 20–25% control for the entire study period. The effectiveness of silvex in the control of pricklypear has been demonstrated (Alley and Lee, 1969; Thatcher et al., 1964; Wicks et al., 1969), but no explanation can be provided for the unusual results obtained in this study.

Perennial Grass Response

Certain perennial grasses were injured during the first and second years after the herbicides were applied. Blue grama cover was greatly reduced on the areas treated with picloram at 0.5 and 1 lb./acre, and one combination of picloram + 2,4-D (0.5 + 2 lb./acre). Picloram at 1 lb./acre not only injured blue grama but also greatly reduced the abundance of needle-and-thread, a species not adversely affected by the lower rates. Neither silvex treatments nor the other combination of picloram + 2,4-D (0.25 + 1 lb./acre) injured any perennial grass species.

A comparison of the grass cover estimates obtained from the 1971 survey showed the silvex treatments were essentially similar to the untreated check (Fig. 1 and 2). The highest cover of blue grama (14.3%), occurred with the lowest rate of the combination of picloram + 2,4-D (0.25 + 1 lb./acre). Blue grama cover estimates from the other three picloram treatments were significantly lower, ranging from 6.8% to 8.9%; but these values were still significantly high when compared to the silvex treatments and the untreated check.

All areas treated with picloram alone or in combination with 2,4-D had a higher cover of needle-and-thread than either the untreated or silvex-treated area. The highest cover for this grass, 4.6 and 4.3%, occurred on areas that received picloram at 0.5 lb/acre and the combination of picloram + 2,4-D (0.5 + 2 lb./acre), respectively.

The miscellaneous grasses occurring on the study plots were Indian ricegrass, western wheatgrass, Junegrass (*Koeleria cristata* [L.] Pers.), Sandburg bluegrass (*Poa secunda* Presl.), and sand dropseed (*Sporobolus cryptandrus* [Torr.] Gray). Cover values for these species did not differ significantly among treatments. All miscellaneous grasses, with one exception, were found to occur on all treated plots. Sand dropseed was found only on areas that received picloram at 0.5 lb./acre and the combination of picloram + 2,4-D (0.5 + 2 lb./acre).

By 1971, perennial grass production had increased substantially with all treatments which included picloram (Fig. 3). Needle-and-thread produced 500 and 444 lb./acre, respectively, on the areas treated with picloram at 0.5 lb./acre and the combination of picloram + 2,4-D (0.5 + 2 lb./acre). Production of needle-and-thread was significantly lower on areas treated with picloram at 1 lb./acre and the combination of picloram + 2,4-D (0.25 + 1 lb./acre), but was greater than on either the untreated or silvex treated areas.

Blue grama production on all picloram-treated plots was significantly

Table 1. Control (%) of snakeweed and pricklypear as recorded for 5 years following treatments.

Treatment[1] and Species	Percent control				
	1967	1968	1969	1970	1971
Silvex 2.0 lb/A					
Snakeweed	00	00	00	00	00
Pricklypear	25	25	25	20	20
Silvex 4.0 lb/A					
Snakeweed	00	00	00	00	00
Pricklypear	80	65	65	60	50
Picloram 0.5 lb/A					
Snakeweed	100	100	100	95	95
Pricklypear	90	100	100	100	100
Picloram 1.0 lb/A					
Snakeweed	100	100	100	90	85
Pricklypear	95	100	100	100	100
Picloram 0.25 lb/A +2,4-D 1.0 lb/A					
Snakeweed	98	100	95	85	80
Pricklypear	95	99	100	100	100
Picloram 0.5 lb/A + 2,4-D 2.0 lb/A					
Snakeweed	100	100	99	95	95
Pricklypear	95	100	100	100	100

[1]Treatments were applied June 26, 1966.

greater than on silvex treated plots or the untreated check (Fig. 3). The treatment on which the highest cover of blue grama occurred, picloram + 2,4-D (0.25 + 1 lb./acre), resulted in the lowest production for this species of all picloram treatments. The blue grama stand on this plot was not initially reduced by the herbicide treatment; 5 years after application the blue grama plants still exhibited their characteristic low growth habit. In contrast, blue grama plants were more sparse on areas treated with the higher rates of picloram, either alone or in combination with 2,4-D; plants were vigorous and robust with a great deal of foliage and many seed heads. These higher rates of picloram appeared to have a renovation effect on the blue grama stands. The results are similar to those obtained from range pitting investigations in this region, where blue grama stands were thinned. In years subsequent to treatment, the thinned stands outproduced the original (Rauzi and Lang, 1956).

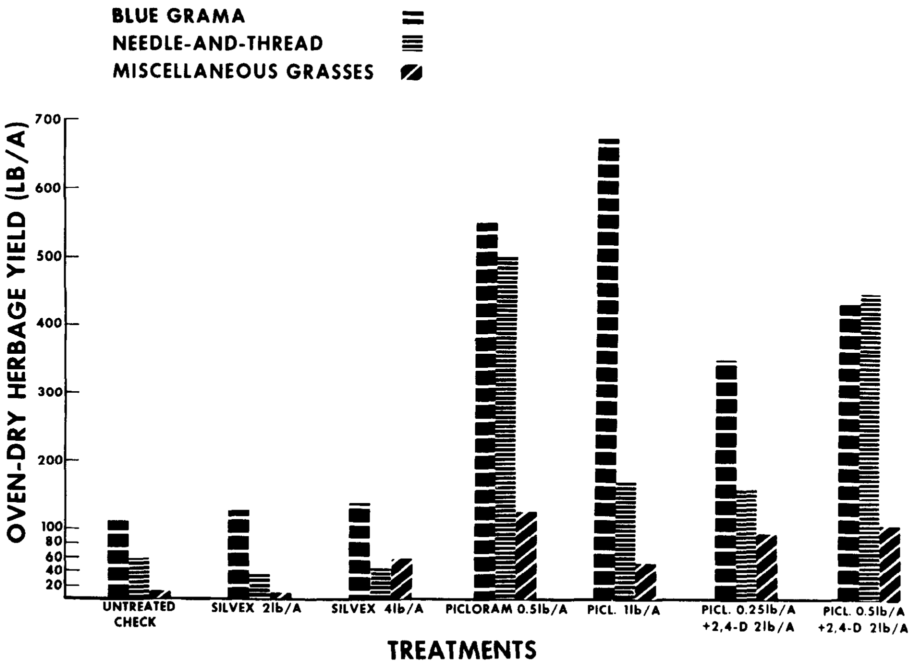

Fig. 3. *Herbage yields (lb/acre) oven-dried, 5 years after treatment.*

Plant Community Response

Essentially no vegetative changes occurred as measured 5 years after treatment with silvex. Some pricklypear was eliminated; however, this did not appear to affect perennial grass and forb production and cover, primarily because pricklypear was not originally a particularly abundant species.

One combination of picloram + 2,4-D (0.25 + 1 lb./acre) completely removed pricklypear and gave high level control of snakeweed. This treatment did not injure perennial grasses present; therefore, upon the elimination of cactus and snakeweed, there were large increases in blue grama. Needle-and-thread did not increase greatly with this treatment, probably because of competition provided by the rather dense stands of blue grama that developed on the treated area.

Picloram at 1 lb./acre eliminated both snakeweed and pricklypear and for 2 years after treatment caused injury to both blue grama and needle-and-thread. Blue grama recovered after the second year and with the removal of snakeweed and pricklypear competition, greatly increased in abundance. This high rate of picloram appeared to have a renovation effect upon the blue grama, resulting in vigorous growth as evidenced by exceptionally high herbage production for this species. Needle-and-thread grass recovered after the second year but did not significantly increase under this treatment.

Picloram at 0.5 lb./acre and the other combination of picloram + 2,4-D (0.5 + 2 lb./acre) affected the plant community similarly. These two treatments eliminated snakeweed and pricklypear and injured blue grama but did not damage needle-and-thread. With a reduction of blue grama during the first 2 years and with the elimination of snakeweed and pricklypear, an excellent opportunity was provided for an increase in needle-and-thread, a species that precedes blue grama in natural succession in this region. By 1971, blue grama had greatly increased, but needle-and-thread was still abundant on these areas. These two treatments caused a shift towards earlier stages of succession. This deduction was made on the basis of the large amounts of needle-and-thread and the presence of sand dropseed which occurred as a result of these two treatments. That needle-and-thread and sand dropseed characterize early successional stages is borne out by Lang (1945) in a study of the revegetation of abandoned farm land on the short-grass plains of southeastern

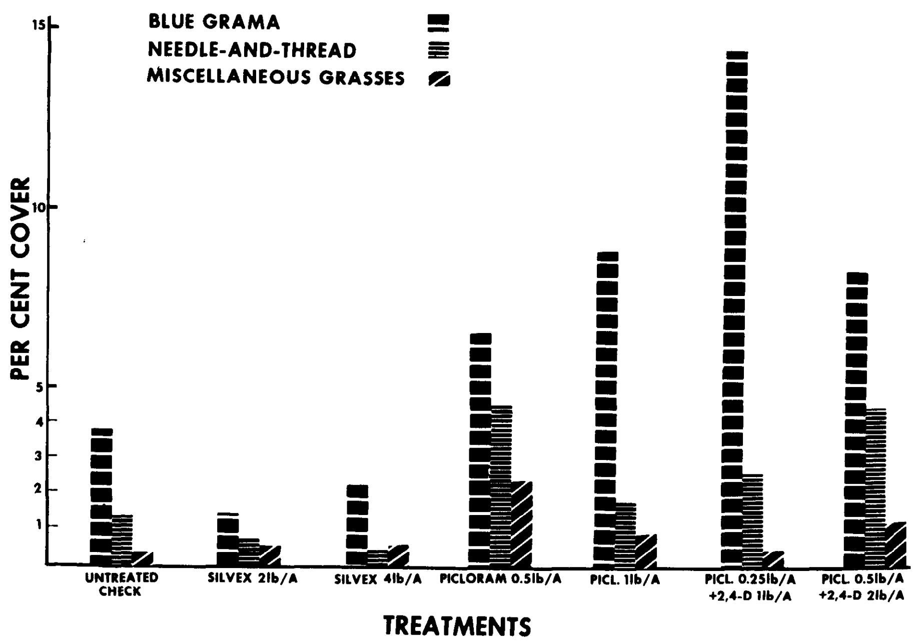

Fig. 2. *Basal cover of grasses 5 years after treatment.*

Wyoming.

This study shows how a portion of a snakeweek infested, blue grama range was improved greatly by manipulation of the vegetation with the use of various picloram treatments. Although picloram has been used in the past primarily as a means to eliminate undesirable plants, it may also have potential as a tool for the selective manipulation of rangeland vegetation.

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Effects of Cultural and Management Practices on Seed Production of 'Plains' Bluestem

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Highlight: *Seed production of 'Plains' bluestem (*Bothriochloa ischaemum *[L.] Keng.) is difficult to assess because of its indeterminate flowering habit and its vegetative canopy which, when excessive, interferes with seed harvests. The variety will produce two seed crops annually. The first matures in July and the second, if managed properly, in October. The effects of three management treatments on the amount of forage associated with each seed crop were highly significant in 2 out of 3 years. The study suggests that a delay of about 21 days in removing the residual forage remaining after the summer seed harvest will favorably influence fall seed yields. Where nitrogen was applied, the decline in vegetation associated with the seed crop was directly related to the previous year's forage cropping practice. Burning residual litter in early March, fertilizing with a 60-45-0 (N, P, K) pound rate of N and P was best for the production of a summer seed crop. The removal of residual forage by mowing and baling about July 29, cultivation, fertilization, and irrigations as needed, favorably influenced fall seed yields. The combined yield of the two crops in 1969 was in excess of 200 lb/acre pure seed.*

Bothriochloa ischaemum var. *ischaemum* belongs to the tribe *Andropogoneae* and is composed of warm season, perennial, bunchgrasses locally termed "Old World bluestems." Numerous accessions of these grasses were acquired by the Oklahoma Agricultural Experiment Station and investigated by Harlan and Associates (1958, 1961) in basic biosystematic studies of the genus. Attributes of Old World bluestems include aggressiveness, persistence, and good forage yield potential. Generally, they reproduce by facultative apomixis, have an indeterminate flowering habit, and bear chaffy seeds which are difficult to harvest, process, and plant.

'Plains' bluestem (*B. ischaemum* var. *ischaemum*) is a recent varietal release developed from the Old World bluestem collection. The forage production of the variety is at its maximum and of greatest value to livestock in Oklahoma during the summer, i.e., July, August, and September. The cultivar spreads aggressively by volunteer seedlings and will produce seed

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The paper is a contribution of Plant Science Res. Div., Agr. Res. Serv., U. S. Dep. Agr., and Oklahoma Agricultural Experiment Station at Stillwater.

Manuscript received February 16, 1972.