Herbicidal Control of Common Broomweed

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Abstract

Common broomweed *(Amphiachyris dracunculoides)* infests Texas rangelands during the fall, winter, or spring in years with abundant soil water. Herbicidal control of common broomweed was studied in the Rolling Plains of Texas in 1977, a wet year. Dicamba and picloram plus 2,4,5-T effectively controlled broomweed at rates ranging from 0.14 to 1.1 kg a.i./ha. Tebuthiuron produced less consistent control and 2,4-D was ineffective at rates from 0.14 to 1.1 kg/ha. Broomweed production was reduced and grass production increased regardless of whether dicamba or picloram plus 2,4,5-T were applied in early December, late January, or mid-May. Grass production increased 1.5 fold following broomweed control. Compared to untreated plots, neither soil water content nor soil temperature were affected by broomweed reduction, but photosynthetic active radiation reaching more desirable forage was significantly increased by broomweed control.

Common broomweed [*Amphiachyris dracunculoides* (D.C.) Nutt.] also known as annual broomweed, is a periodic problem on rangeland. It occurs at irregular intervals usually following above-average rainfall during fall, winter, or spring. It is widespread throughout Texas, Oklahoma, Kansas, and New Mexico and purportedly causes reduced forage and animal production.

Control of common broomweed with herbicides has been investigated by several scientists. Scifres et al. (1971) reported that 2,4-D [(2,4-dichlorophenoxy) acetic acid] applied at 0.14, 0.28 or 0.55 kg a.i./ha effectively controlled common broomweed when sprayed during stem elongation around mid-May. The same rates of 2,4-D appeared less effective in early April or in mid-June. Picloram (4-amino-3,5,6 trichloropicolinic acid) + 2,4-D applied at 0.07, 0.14, or 0.28 kg/ha of each herbicide controlled common broomweed during stem elongation around mid-May. Dicamba (3,6-dichloro-*o*-anisic acid) appeared more effective than equal rates of 2,4-D when applied in early spring. Beck and Sosebee (1975) indicated that fall applications of either 2,4,5-T [(2,4,5-trichlorophenoxy) acetic acid] butyl ether ester, 2,4,5-T trimethylamine salt, or picloram plus 2,4,5-T controlled common broomweed the spring and summer following herbicide application.

Common broomweed densities were reduced (>80%) by picloram plus 2,4,5-T, triclopyr [3,5,6-trichloro-2-pyridinyl) oxy] acetic acid ester, picloram + dicamba, and picloram + trichlopyr ester applied in June at 0.55 kg/ha (Jacoby et al. 1980). Jones et al. (1977) also reported that common broomweed growing in north central Texas was significantly reduced by application of picloram applied at 0.55 kg/ha in December and March.

Increased forage production resulting from reduced competition by controlling common broomweed has been reported by Haas (1975, 1976). Grass production on two heavy clay sites sampled in October 1976 following aerial treatment in May 1975 with 2,4-D (1.1 kg/ha) was greater on treated plots than on untreated plots (1,987 and 1,479 vs 1,634 and 1,247 kg/ha, respectively).

Average production and density of broomweed growing on 3 range sites (clay loam, silty clay loam, and stoney clay) were reduced 65 and 69%, respectively, by a spring application of 2,4-D at 0.55 kg/ha (Rittenhouse et al. 1977). They also reported that broomweed production on untreated sites (590 kg/ha) was significantly greater than on treated sites (205 kg/ha). Concomitant grass production on treated sites (1249 kg/ha) was greater than on untreated sites (1025 kg/ha). Rittenhouse (personal communication) suggested that the greatest detrimental effect from common broomweed infestation may occur during the second year following production because of its physical inhibitory effect on livestock grazing.

This study was initiated in December 1976 to evaluate efficacy of common broomweed control with various herbicides. Specifically, herbicide application during late fall and winter was compared to spring application. Effect of broomweed on soil temperature, soil water content, and photosynthetic active radiation at grass level and its effect on herbage yield were also evaluated.

Experimental Procedures

The study was conducted in Hardeman County, Texas, near Chillicothe on a sandy loam range site in the Rolling Plains Resource Area (Lofton et al. 1972). Soils of the area are a Miles fine sandy loam (fine-loamy, mixed, thermic, Udic Paleustalfs) with 1 to 3% slope. The climate is classified as warm and temperate with dry winters and low humidity during the summer. Annual precipitation averages about 61 cm with rainfall peaks during April-May and September-October (Loften et al. 1972). Vegetation of the area was composed of sideoats grama [*Bouteloua curtipendula* (Michx.) Torr.], blue grama [*B. gracilis* (H.B.K.) Griffiths], threeawns (*Aristida* sp.), buffalograss [*Buchloe dactyloides* (Nutt.) Engelm.], and sand dropseed (*Sporobolus cryptandrus* (Torr.) Gray] with infestations of common broomweed and ragweed (*Ambrosia psilostachya* D.C.). Range condition at the time of herbicide application was poor to low fair.

Herbicides applied to .004 ha plots (6.4 × 6.4 m) included dicamba (dimethylamine salt), picloram (triisopropanolamine salt) plus 2,4,5-T (triethylamine salt), tebuthiuron (N-[5(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-*N,N'*-dimethylurea; 80% a.i. wettable powder) and 2,4-D (propylene glycol butyl ether esters formulation). All herbicides were applied at 0.14, 0.28, 0.55, and 1.1 kg a.i./ha; 2,4-D was also applied at 2.2 kg a.i./ha. No additives or surfactants were used; all liquid herbicides were applied in aqueous solution and tebuthiuron was applied as an aqueous suspension. The chemicals were applied with a CO_2 compression hand sprayer at a constant pressure of 170 KPa. Herbicide treatments were applied to plots arranged in a randomized complete block design with 3 blocks. Treatments were applied December 8, 1976, January 27 and May 12, 1977 (preceding umbel formation). The area was fenced to exclude livestock grazing for the duration of the study.

Results of herbicide applications were obtained in August 1977 by measuring herbage production on all treatments. Herbage yields were measured by clipping all vegetation at 1-cm stubble height in 5, 0.1-m² rectangle quadrats per plot. Herbage was separated by species and dried in a forced air oven for at least 1 week at 46° C to obtain the oven-dried weights. Degree of broomweed control was based on reduction in yield.

Environmental parameters measured at the time of herbicide application included soil water content (obtained gravimetrically

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This manuscript is contribution no. T-9-299 of the College of Agricultural Sciences, Texas Tech University, Lubbock.
Manuscript received July 21, 1982.

from 3 soil cores per plot at 15-cm increments from 0 to 60 cm depths), relative humidity, and soil temperature (obtained at 15, 30, 45, and 60-cm depths). Soil temperature was measured by driving a 1-cm steel shaft into the ground at prescribed depths and then inserting a glass mercury-filled thermometer into the hole. The thermometer was allowed to come into equilibrium with the soil temperature (15 minutes or longer) before being read. Relative humidity was measured with a sling psychrometer. Photosynthetic active radiation (PAR) was measured with a Lambda Quantum Sensor. PAR measurements were made above the broomweed canopy in full sunlight and within the broomweed canopy at the height of the grasses. Soil water content, soil temperature, and PAR were measured biweekly throughout the 1977 growing season.

Herbage yields, soil water content, soil temperature and PAR were analyzed by using standard analysis of variance procedures. Where appropriate, treatment means were separated by Duncan's new multiple range test.

Results and Discussion

Environmental conditions were conducive for common broomweed germination during the fall of 1976 and spring of 1977. Early fall, winter, and spring precipitation exceeded the long-term average for our study area (Fig. 1). Consequently, the water content (%) in the soil profile was sufficient for germination and emergence of common broomweed at the time of herbicide application in the late fall, mid-winter, and late spring. Soil temperatures apparently were warm enough to insure a physiological response of the annual forbs that were growing at the time of herbicide application.

All of the herbicides tests, except 2,4-D and tebuthiuron at 0.14 kg/ha, reduced common broomweed production when compared to the check treatments (Table 1). Dicamba and picloram plus 2,4,5-T effectively controlled broomweed when applied at all rates (0.14 to 1.1 kg/ha) but control from tebuthiuron was erratic. There were no differences in broomweed production among tebuthiuron treatments applied at rates of 0.14 to 1.1 kg/ha; however, rates of 0.28 and 1.1 kg/ha produced significantly less broomweed than the check.

Time of herbicide application (late fall to late spring) was irrelevant, if environmental conditions allow germination, seedling establishment, and growth (Table 2). Application of effective herbicides significantly reduced broomweed production and significantly increased grass production regardless of the application

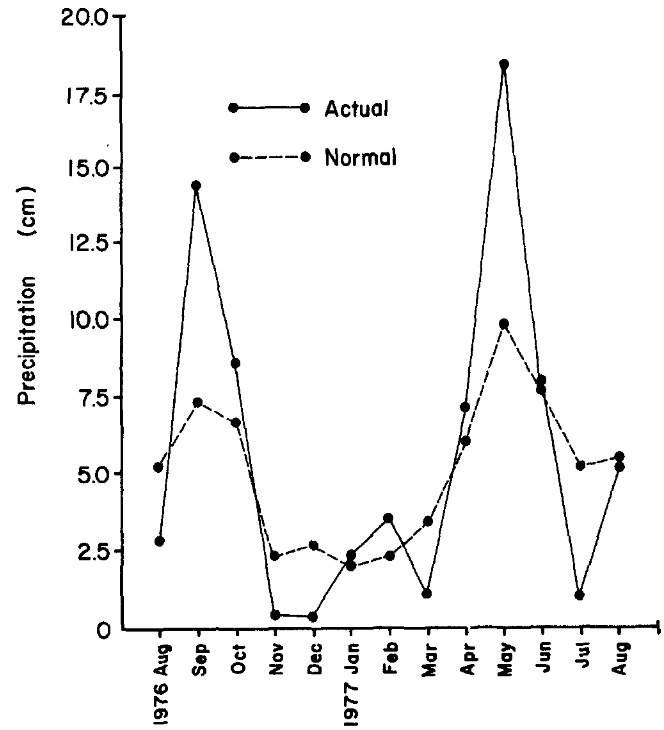

Fig. 1. *Average normal monthly precipitation for Quanah, Hardeman County, Texas (Mitchell 1977) and actual monthlu precipitation on the study site August, 1976, through August, 1977.*

date. We agree with Heitschmidt (1979), however, that if environmental conditions are not conducive for common broomweed infestations during the fall, winter or spring, the spray date would become important. As noted by Scifres et al. (1971) and Gordon (1982), the most appropriate time for spraying common broomweed would be mid-April to mid-May (prior to umbel formation) because natural attrition is high during dry winters and spring.

Production of desirable forbs (exclusive of ragweed) was reduced by all herbicides used to control broomweed except tebuthiuron (0.14 and 0.28 kg/ha) and dicamba (0.14 kg/ha) (Table 1). Forb production was reduced regardless of herbicide application

Table 1. Production (kg/ha) of grasses, forbs (excluding broomweed and ragweed, broomweed, and ragweed following herbicide application in the winter and spring of 1977. Since herbicide application date did not significantly affect ($P \leq 0.05$) herbage production, the data were pooled. Herbage yields were obtained August, 1977.

Herbicide	Herbicide application rate (kg/ha)	Grass	Forbs	Broomweed	Ragweed	Total
Check	0	1064 gh[1]	492 a	719 ab	1011 abc	3286 a
Dicamba	.14	1529 defg	465 ab	90 d	741 bcde	2825 ab
	.28	1511 defg	232 de	12 d	515 cdef	2270 b
	.55	1859 bcde	185 e	4 d	250 def	2298 b
	1.1	1875 bcde	188 e	45 d	27 ef	2135 b
2,4-D	.14	1318 fgh	268 cde	770 a	892 abcd	3248 a
	.28	1020 gh	273 bcde	716 ab	1246 ab	3255 a
	.55	1042 gh	279 bcde	594 ab	1061 abc	2976 ab
	1.1	1454 efgh	219 fe	648 ab	443 cdef	2764 ab
	2.2	2056 bc	157 e	483 abc	201 def	2897 ab
Picloram + 2,4,5-T	.14	1654 cdef	207 de	66 d	295 def	2222 b
	.28	2455 a	106 e	23 d	110 ef	2694 ab
	.55	2357 ab	165 e	2 d	0 f	2524 ab
	1.1	2312 ab	141 e	0 d	3 f	2456 ab
Tebuthiuron	.14	946 h	449 abc	417 bc	1452 a	3264 a
	.28	1278 fgh	394 abcd	267 cd	1280 ab	3218 a
	.55	1628 cdef	299 bcde	422 bc	647 bcdef	2996 ab
	1.1	2002 bcd	109 e	178 cd	660 bcdef	2949 ab

[1]Means within a column followed by similar lower case letters are not significantly different ($P \leq 0.05$).

Table 2. Influence of herbicide application date on production (kg/ha) of herbaceous plants on a sandy loam range site in north central Texas.

Treatment date	Grasses	Forbs	Broomweed	Ragweed
12-7-76	1495 a[1]	245 a	354 a	729 a
1-27-77	1602 a	285 a	312 a	729 a
5-12-77	1676 a	243 a	248 a	399 b

[1]Means within each column followed by similar lower case letters are not significantly different ($P \geq 0.05$).

date.

Because of the wet spring in 1977, ragweed became a major component of the plant community. However, the ragweed infestations were effectively controlled with picloram plus 2,4,5-T (0.14 to 1.1 kg/ha), 2,4-D (2.2 kg/ha), and dicamba (0.55 and 1.1 kg/ha). Since ragweed is a perennial and did not begin growth until in the spring, it was controlled only by late spring application of herbicide.

Grass production following common broomweed and ragweed control was significantly increased (Table 1) in the picloram (0.14 to 1.1 kg a.e./ha), tebuthiuron (0.55 kg a.i./ha), dicamba (0.55 and 1.1 kg a.e./ha), and 2,4-D (2.2 kg a.e./ha) treatments. Grasses responding to broomweed control primarily included sideoats grama, buffalograss, blue grama, threeawns, Arizona cottontop [*Digitaria californica* (Benth.) Henr.], tumble windmillgrass (*Chloris verticillata* Nutt.), sand dropseed, Texas wintergrass (*Stipa leucotricha* Trin. and Rupr.), gummy lovegrass (*Eragrostis curtipedicellata* Buckl.), and fall witchgrass [*Leptaloma cognatum* (Schult. Chase]. Time of herbicide application made no difference in grass production. Average grass production was increased approximately 1.5-fold following broomweed control and up to 2.3-fold when both broomweed and ragweed were controlled.

There were no significant differences in water content and temperature in the upper 60 cm of soil relative to treatment throughout the growing season in 1977. Shading by the taller weedy species did not alter the soil temperature sufficiently to adversely affect production of desirable forage species.

Incident PAR was significantly attenuated by the taller noxious weeds, broomweed, and ragweed. Quantity of light reaching the grasses was consistently higher in all herbicide treatments that controlled both broomweed and ragweed. Treatments that controlled the broomweed and ragweed had 80 to 100% of PAR reaching the understory grasses during the growing season. Whereas, grasses in the check plots received only 50 to 72% of PAR (Fig. 2). Amount of light reaching the grass in the picloram plus

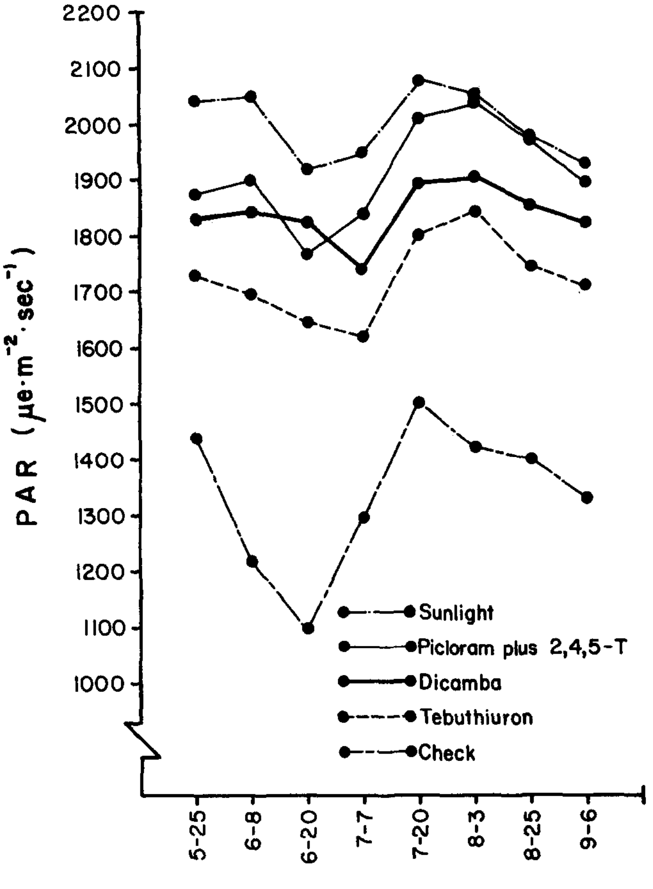

Fig. 2. *Effect of broomweed control on PAR ($e \bullet m^{-2} \bullet sec^{-1}$) impinging upon understory grasses. There were not significant differences ($P \leq 0.05$) among herbicide treatments that controlled common broomweed and full sunlight. PAR reaching the grass level was significantly ($P \leq 0.05$) attenuated by the broomweed in the check treatments.*

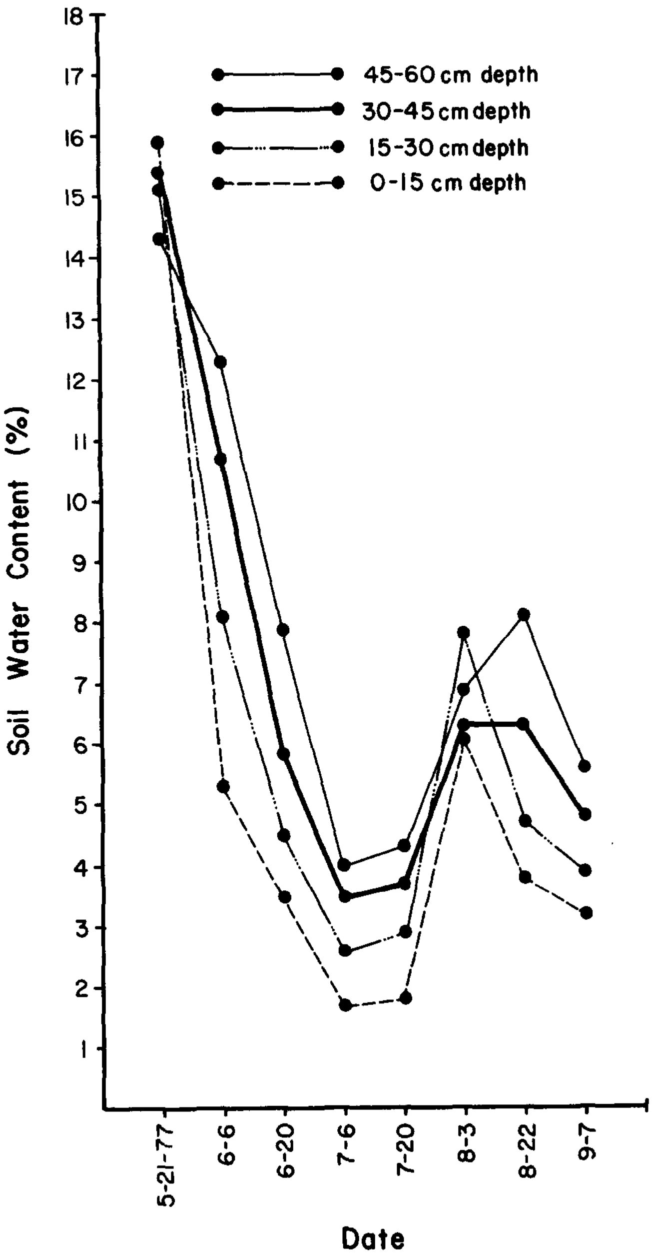

Fig. 3. *Trend of soil water content (%) at 4 depths throughout the growing season in 1977. There were no significant differences ($P \leq 0.05$) among bromweed-infested and broomweed-free areas, therefore, the data were pooled.*

2,4,5-T treatments approached full sunlight by August, correlated with a high degree of control of broomweed and ragweed. Although PAR reaching the understory vegetation (grasses) increased with control of broomweed and ragweed, control of both species was not necessary to increase PAR reaching the grasses (Table 1, dicamba applied at 0.28 kg/ha). The decrease in PAR available to the grasses between late May and late June can be attributed to the density of annual broomweeds. As soil water became limiting (Fig. 3), the density of broomweed decreased, allowing more PAR to reach the grass by early July. After the plants formed the umbel or "broom", the quantity of PAR available to the grasses again declined. These data suggest that lack of PAR may be the major environmental factor limiting grass production in dense stands of tall weeds. Fisher et al. (1959) reported similar results indicating that average production of buffalograss growing under heavy to dense shade was reduced by at least 50%.

Management Implications

Since annual broomweed is a periodic problem on Texas rangelands, the cost of controlling (or not controlling) this noxious plant must be weighed against the multiple year effect of its occurrence. These effects include reduced calf crop, reduced weaning weights, reduced accessibility to available forage, and increased incidence of "pink eye" in cattle (Kothmann and Rittenhouse 1980).

Direct benefits the year of control include increased grass production, which is translated into increased carrying capacity. Although one probably cannot increase stocking rate following broomweed control, reduction of stocking rate would not be necessary with broomweed control. Assuming 13,244 kg of herbage per year (18 kg/day) is required to carry an animal unit in the Rolling Plains of Texas, the carrying capacity on broomweed infested ranges averaged 12 ha/AUY (animal unit year). Control of common broomweed and the increase of grass production (1.5-fold) would increase the carrying capacity to 8 ha/AUY. Control of both common broomweed and ragweed (accompanied by a 2.3-fold increase in grass production would increase the carrying capacity to 5 ha/AUY.

If common broomweed is not controlled during the years in which infestations reduce grass production, one conceivably would have to reduce the stocking rate by a third to avoid damaging the range resource. Reductions up to 50% would also become necessary if both broomweed and ragweed infestations become a problem. Control of annual weeds that occur as a result of climatic conditions usually will not improve range condition, but will allow greater forage production.

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