B-1358
May 1981

Response of Camphorweed and Associated Vegetation to Herbicides and Prescribed Burning

The Texas Agricultural Experiment Station
Neville P. Clarke, Director, College Station, Texas
The Texas A&M University System

Contents

Summary

Camphorweed, an annual broadleaved plant, occurs primarily on sandy sites in Texas, most commonly within 50 kilometers of the coast. During the past ten years, however, camphorweed has spread 175 kilometers inland. The recent spread of camphorweed and its persistence on rangeland are presently of concern to South Texas livestock producers, but effective control methods have not previously been developed.

Research was conducted in Jim Hogg County in the southern portion of the South Texas Plains from May 1977 through August 1979. Camphorweed was effectively controlled by a single application of 2,4-D ester or amine formulations at 0.6 or 1.1 kilograms per hectare (kg/ha) applied as a broadcast spray from late winter to early summer. Broadcast applications of 0.6 or 1.1 kg/ha of dicamba+2,4-D (1:3), 2,4,5-T+picloram (1:1), or 0.14 kg/ha of picloram alone were also effective for camphorweed control. The herbicide sprays reduced the population densities of desirable broadleaves for the growing season of treatment only. Pelleted picloram or tebuthiuron at 0.6 or 1.2 kg (active ingredient)/ha were equally as effective as herbicide sprays applied at the same rates. A cool-season burn applied with a light, fine fuel load; moderate wind speed; and low relative humidity significantly reduced the density of live camphorweed, slightly decreased herbaceous standing crop, and increased utilization of herbaceous standing crop during the first growing season. A camphorweed management program might include initial use of herbicides to reduce the camphorweed infestation, followed by periodic burning to suppress reinvasion of this troublesome weed.

Response of Camphorweed and Associated Vegetation to Herbicides and Prescribed Burning

J. L. MUTZ, C. J. SCIFRES, AND C. W. HANSELKA*

Introduction

Camphorweed (*Heterotheca subaxillaris* [Lam.] Britt & Rusby) is an annual, aromatic, herbaceous member of the Compositae. It typically develops slender, procumbent to erect stems and occurs in coastal areas from New Jersey to Tamaulipas, Mexico (Correll and Johnston, 1970). Camphorweed occurs primarily on sandy sites in Texas and is most common within 50 kilometers (km) of the coast. However, land owners and rangeland resource managers have observed that camphorweed has increased its range westward during the past 10 years, and well-developed stands now occur on sandy range sites 175 km inland. As its range extended westward, camphorweed was first observed in turnrows of cultivated fields, but it is now a dominant invader of many sandy range sites ranging from poor to good condition. Once dense stands of camphorweed are established on a range site, production of desirable vegetation diminishes. The recent spread of camphorweed and its persistence on rangeland are presently of concern to South Texas livestock producers.

Camphorweed produces yellow flowers from late summer through early fall. No research has been conducted in Texas on germination behavior of camphorweed seeds (achenes). However, camphorweed achenes germinated in the spring and the fall in North Carolina (Awang and Monaco, 1978) while germination occurred only in the fall in Kentucky (Baskin and Baskin, 1976). Achenes of camphorweed exhibit germination dimorphism (Awang and Monaco, 1978). Freshly-matured disk achenes will germinate in light or darkness over a wide range of temperatures immediately upon dispersal. Ray achenes are dormant at dispersal and must afterripen before they are capable of germination. High temperatures promote afterripening while low temperatures prolong dormancy. Since seed dispersal occurs in the fall, germination of ray achenes is delayed for at least a year after maturation of the parent plant (Baskin and Baskin, 1976). This mechanism ensures perpetuation of infestations through periods when environmental conditions are not favorable for seed germination and seedling establishment.

Camphorweed seedlings emerge in the spring and early fall on South Texas rangelands. Seedlings which emerge in the fall overwinter as rosettes until spring when active growth is resumed following rainfall. Based on research with other range weeds such as common broomweed (*Xanthocephalum dracunculoides*), foliar-applied herbicides are generally most effective when applied during the seedling, rosette, or stem elongation stages of growth, if environmental conditions are not limiting to herbicide absorption and translocation (Scifres, Hahn and Brock, 1971).

Results from commercial applications of conventional herbicides such as 2,4-D ([2,4-dichlorophenoxy] acetic acid) for control of camphorweed have resulted in erratic control.[1] Since camphorweed has only recently been recognized as a management problem on Texas rangeland, effective control methods have not been developed. However, application of 4.5 kilograms per hectare (kg/ha) of asulam (methyl sulfanilylcarbamate) in July controlled camphorweed in North Carolina (Skroach, 1975). Awang and Monaco (1978) reported that camphorweed can be controlled with a number of herbicides commonly used in agronomic crops.

*Respectively, assistant range scientist and professor, The Texas Agricultural Experiment Station (Texas A&M University Agricultural Research and Extension Center at Corpus Christi and the Department of Range Science); and area range specialist, Texas Agricultural Extension Service, Corpus Christi.

KEYWORDS: Camphorweed/range weed control/herbicides/prescribed burning/applied ecology/range management.

[1]Garlyn Hoffman, Texas Agricultural Extension Service, 1976, personal communication.

Applications of these herbicides in the winter when the camphorweed plants were in the rosette stage were not as effective as applications in the spring after the camphorweed had developed stems. Translocated herbicides were more effective than contact herbicides when treating camphorweed in later stages of development. None of the herbicides that are effective for controlling camphorweed in agronomic crops are registered by the Environmental Protection Agency for range weed control in Texas. Destruction of the aerial parts of camphorweed plants developed beyond the rosette stage is not necessarily effective for control since the plants may resprout from any live tissues remaining near the ground.

The objectives of this research were to evaluate (1) various herbicides, herbicide combinations, and formulations for camphorweed control; (2) the potential of cool-season burns for suppressing camphorweed; and (3) the response of associated herbaceous vegetation to camphorweed control.

Materials and Methods

Study Area

Research was conducted on a Nueces-Sarita soil association in Jim Hogg County approximately 30 km south of Hebbronville, Texas, in the southern portion of the South Texas Plains. Typically, the Nueces-Sarita association consists of Nueces series, 45 percent; Sarita series, 33 percent; and Delmita and Falfurrias series and active sand dunes, 22 percent. Formed from wind-deposited materials, these soils are deep, nearly level to gently sloping, and gently undulating. They are moderately well drained and have a low water-holding capacity.

Average annual precipitation varies from about 40 to 90 centimeters (cm) with rainfall peaks occurring from May to June and in September (Waldrip, 1957). Summers are typically dry with high temperatures and high evaporation rates. Most of the South Texas Plains is used for range livestock production but a considerable amount of row-crop production occurs in the immediate study area.

Potential vegetation for the study site includes seacoast bluestem (*Schizachyrium scoparium* var. *littoralis*), several bristlegrasses (*Setaria* spp.), *Paspalum* spp., *Chloris* spp., and *Trichloris* spp., longspike silver bluestem (*Bothriochloa saccharoides* var. *longipaniculata*), big sandbur (*Cenchrus myosuroides*), and tanglehead (*Heteropogon contortus*). Continuous yearlong grazing has resulted in a botanical composition consisting mostly of species of relatively low quality for grazing such as threeawns (*Aristida* spp.), Pan American balsamscale (*Elyonurus tripsacoides*), and low-growing panicums (*Dichanthelium* spp.). Many herbaceous broadleaved species, several of which are important diets of wildlife and domestic livestock, are also found on the sandy sites. Large tree-type honey mesquites (*Prosopis glandulosa* Torr. var. *glandulosa*), 5 to 7 meters (m) tall, are scattered throughout this plant community. These honey mesquite mottes provide shade and cover for domestic livestock and game animals.

Herbicide Treatments

Herbicide sprays were applied with a tractor-mounted boom sprayer on May 3, 1977; February 23, 1978; and June 13, 1979 to duplicate 0.2-ha plots. All experiments were designed as randomized complete blocks. Herbicide treatments included the butoxyethanol ester of 2,4-D at 0.6 and 1.1 kg/ha, dimethylamine salt of 2,4-D at 0.6 and 1.1 kg/ha, 2,4,5-T ([2,4,5-trichlorophenoxy] acetic acid) plus picloram (4-amino-3,5,6-trichloropicolinic acid) (1:1) at 0.3 and 0.6 kg/ha of total herbicide; dicamba (3,6-dichloro-*o*-anisic-acid) plus 2,4-D (1:3) at 0.6 and 1.1 kg/ha of total herbicide; and picloram as the potassium salt at 0.14 kg/ha. Liquid herbicides were applied in 187 liters per hectare (l/ha) of water. Picloram pellets (5 or 10 percent active ingredient) and tebuthiuron (*N*-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-y1]-*N,N'*-dimethylurea) pellets (20 percent active ingredient) were applied at 0.6 or 1.1 kg/ha (active ingredient) in the experiment begun on May 3, 1977. The herbicide pellets were applied with a tractor-mounted broadcast spreader normally used for applying seed or dry fertilizers. At least ten soil samples were randomly collected to a depth of 15 cm for gravimetric determination of soil-water content on each date of herbicide application.

The number of camphorweeds and other broadleaf herbaceous plants was counted prior to treatment and at selected times post-treatment within 10 permanently located, 0.25-m^2 areas equidistantly spaced along a diagonal line across each plot. Plots treated on May 3, 1977 were evaluated on May 1, 1977 (pretreatment counts); August 4, 1977; December 14, 1977; June 12, 1978; and August 2, 1979. Plots sprayed on February 23, 1978 were evaluated on February 23, 1978 (pretreatment counts); December 12, 1978; and June 12, 1978. Plots sprayed on June 13, 1978 were evaluated pretreatment on June 23, 1978 and on September 11, 1978. Percentage reduction in live camphorweed plants was based on pretreatment counts. All data were statistically analyzed using analysis of variance (Ostle, 1963). Mean difference was compared with Duncan's multiple range test at the 0.05 level.

Prescribed Burning

On February 23, 1978, a 12-ha sandy site supporting an average of 2,270 camphorweed plants/ha was burned with a headfire. Prior to burning, ten permanent belt transects, about 36 m long by 2.7 m wide, were established within the area to be burned and ten similar transects were established in an adjacent untreated area. Camphorweed densities on each area were estimated by counting the number of plants within the belt transects. Immediately prior to burning, standing fine fuel (standing crop plus mulch) in ten, 0.25-m^2 sampling areas, equidistantly spaced along the permanent lines, were harvested to ground level and the mulch collected. Because of freezing weather prior to sampling, all standing fine fuel was dead. All fuel samples were sealed in metal cans, air-dried for 48 hours at 65° C, and weighed. Oven-dry water content of soil was determined on ten samples recovered from 0 to 8, 8 to 15, and 15 to 30 cm deep from the burned plot. Environmental conditions monitored were relative humidity determined with a sling psychrometer; air temperature at 2 m; soil temperature at 2 cm; and wind velocity and direction at a height of 2 m with a hand-held anemometer.

Asbestos cards supporting temperature-sensitive pellets (ranging in sensitivity from 37° to 650° C in 37° C increments) were used at 10 randomly located monitoring stations to estimate maximum temperature during the burn at 3 cm above ground level.

A backfire was ignited on the leeward side and allowed to burn approximately 15 to 20 m into the area before the headfire was ignited (Scifres, 1980). Flame front speed (meters per minute) was determined by placing marked metal stakes 22 m apart at two stations. The time required for the flame front to travel between the stakes at each station was recorded and averaged. Flame height (m) was estimated visually.

Ten portable grazing exclosures were established after burning on the burned area and adjacent unburned area to facilitate evaluation of range forage production and utilization. The exclosures were constructed from 10-gauge welded concrete reinforcement wire with 15 by 15-cm openings. Each exclosure was approximately 3 m tall and 3.5 m in diameter.

The term "forage utilization" will be used here to mean grass forage loss—the combination of losses such as weathering, trampling, and consumption by wild animals and insects as well as forage consumed by livestock. The exclosures were placed at the mid-point of each belt transect. On August 10, 1978, herbaceous vegetation in 0.25-m^2 sampling areas was harvested to a 2.5-cm stubble height within each exclosure and from a randomly-selected grazed area approximately 2 m from the exclosure. The herbage in each sampling area was divided into grasses and broadleaves, air dried, and weighed. Differences in herbaceous standing crop between caged and grazed samples were used to estimate forage utilization for that period. After harvesting, the exclosures were moved to a randomly determined point along the permanent line and secured until the second harvest on August 2, 1979.

Results and Discussion

Responses to Herbicides

Environmental conditions during herbicide application. On May 3, 1977, near optimum environmental conditions prevailed for control of annual broadleaf plants with foliar-applied, translocated herbicides. Air temperature was 25° to 27°C, relative humidity was no less than 60 percent, and wind speed was 0 to 12 km/hr during the application of sprays. Soil-water content in the surface 15 cm averaged 9 percent, near field capacity (10 percent) for the sandy soil of the study area. Camphorweed plants ranged from 2.5 to 15 cm tall, but approximately 75 percent of the population was less than 7 cm tall.

Environmental conditions for control of camphorweed with foliar sprays were not considered favorable on February 23, 1978. Soil-water content averaged 4 percent on an oven-dry basis—near wilting point for the soil of the study area. Air temperatures were 16° to 22°C, and relative humidity was less than 50 percent. Wind speed was less than 8 km/hr during herbicide application. The camphorweed plants were 2.5 to 7 cm tall, and showed signs of foliar necrosis, apparently the result of freezing weather and dry conditions prior to treatment.

The study site received less than normal rainfall throughout the winter and spring of 1979. However, by late May 1979, precipitation provided enough moisture for the camphorweed to germinate and initiate growth. When the experiment was installed on June 13, 1979, soil-water content was about 5 percent, air temperature was 33°C, and relative humidity was 85 percent or higher during herbicide application. The camphorweeds were 10 to 15 cm tall and actively growing. These conditions were considered near optimum for herbicide control of the camphorweed based on results with other herbaceous weeds (Scifres, Hahn, and Brock, 1971).

Camphorweed control. Since there were no significant differences in the response of camphorweed to herbicides between the May 3, 1977 and June 13, 1979 application dates, data were pooled within evaluation times where possible. All herbicide sprays resulted in excellent camphorweed control for 13 months (Table 1). Treated areas were virtually free of camphorweed for two growing seasons. Thus, 0.6 to 1.1 kg/ha of herbicides normally used for herbaceous weed control, 2,4-D (ester or amine formulation) or dicamba plus 2,4-D (3:1), applied in the spring or early summer, will effectively control camphorweed if growing conditions are favorable for herbicidal activity. If associated species such as honey mesquite are also to be controlled, application of 2,4,5-T + picloram (1:1) at 0.6 or 1.1 kg/ha may be justified.

Desirable broadleaf plants, especially legumes such as Texas snoutbean (*Rhyncosia americana*), least snoutbean (*Rhyncosia minima*), and coast indigo (*Indigo miniata* var. *miniata*) were eliminated from the botanical composition for 6 to 7 months following application of the herbicide sprays. However, the desirable plants generally had increased in density by 13 months following application of several of the herbicides, compared to untreated plots (Table 2). The greatest increase in desirable plant density occurred on plots treated with the lower rate of 2,4-D ester, picloram, and either rate of 2,4,5-T plus picloram or dicamba plus 2,4-D. Although there was a general trend for camphorweed densities to be lower on treated than on untreated plots at 27 months (third growing season) following application of the herbicide sprays, reinfestation was extensive except on plots receiving the high application rate of 2,4,5-T plus picloram (Table 1).

Reduction of live camphorweed plants exceeded 90 percent within 3 months after application of pelleted herbicides on May 3, 1977 except where the 10 percent picloram pellets were applied at 0.6 kg/ha active ingredient. The 10 percent picloram pellets applied at 0.6 kg/ha controlled 75 percent of the camphorweeds within 90 days after application (Table 1). Camphorweed density was reduced by 95 and 98 percent at 90 days after application of the 5 percent picloram pellets at 0.6 and 1.1 kg/ha, respectively. The lower initial control from the 10 percent picloram compared to the 5 percent formulation at 0.6 kg/ha was attributed to more even distribution of the 5 percent formulation. At 13 months following application, there was no significant difference in control of camphorweed between the two formulations of picloram pellets, regardless of application rate. Tebuthiuron at 0.6 and 1.2 kg/ha controlled 90 and 97 percent of the camphorweed, respectively, after 12 months.

Although there was a considerable amount of variation in density of desirable plants among plots receiving the pelleted herbicide treatments, the general trend indicated no change in density compared to that of the untreated plots, with the exception of reduced density of forbs on plots treated with tebuthiuron at 1.1 kg/ha (Table 2). Herbicidal damage to all herbaceous plants was apparent for at least 13 months on plots treated with 1.1 kg/ha of tebuthiuron. The desirable forb population was decreased to 4.5 plants/m^2, compared to 15.4 plants/m^2 on untreated areas. The pelleted herbicides were no more effective than the herbicide sprays for controlling camphorweed into the third growing season after application (Table 1).

Table 1. Average reduction (%) in density of live camphorweed plants after application of various herbicides, rates, and formulations with ground equipment on May 3, 1977 and June 13, 1979 near Hebbronville, Texas

Treatment		Months after application[a]			
Herbicide(s)	Rate (kg/ha)	3	7	13	27[b]
None	0	0 a	0 a	0 a	0 a
Sprays					
2,4-D (ester)	0.6	97 c	100 c	99 c	20 bc
2,4-D (ester)	1.1	98 c	99 c	100 c	40 cd
2,4-D (amine)	0.6	100 c	99 c	89 b	0 a
2,4-D (amine)	1.1	100 c	100 c	96 c	20 bc
2,4,5-T + picloram (1:1)	0.3	99 c	99 c	99 c	15 ab
2,4,5-T + picloram (1:1)	0.6	100 c	100 c	99 c	60 d
Dicamba + 2,4-D (1:3)	0.6	99 c	100 c	99 c	30 c
Dicamba + 2,4-D (1:3)	1.1	99 c	100 c	99 c	30 c
Picloram	0.14	90 c	95 c	96 c	5 a
Pellets					
Picloram (5%)	0.6	95 c	97 c	98 c	30 c
Picloram (5%)	1.2	98 c	98 c	98 c	10 ab
Picloram (10%)	0.6	75 b	87 b	98 c	20 bc
Picloram (10%)	1.2	99 c	99 c	99 c	20 bc
Tebuthiuron (20%)	0.6	90 c	97 c	98 c	15 ab
Tebuthiuron (20%)	1.2	97 c	95 c	99 c	0 a

[a]Means within a column followed by the same letter are not significantly different at the 5 percent level according to Duncan's multiple range test.
[b]Data based on May 3, 1977 applications only.

Table 2. Density (plants/m^2) of desirable broadleaved plants at 13 months followinng application of various herbicides, formulations and rates on May 3, 1977 near Hebbronville, Texas

Treatment		
Herbicide(s)	Rate (kg/ha)	Plant density[a]
None	--	15.4 c
Sprays		
2,4-D (ester)	0.6	31.3 f
2,4-D (ester)	1.1	18.7 cd
2,4-D (amine)	0.6	17.2 cd
2,4-D (amine)	1.1	15.9 cd
2,4,5-T + picloram (1:1)	0.3	31.3 f
2,4,5-T + picloram (1:1)	0.6	25.6 e
Dicamba + 2,4-D (1:3)	0.6	33.1 f
Dicamba + 2,4-D (1:3)	1.1	31.8 f
Picloram	0.14	29.9 ef
Pellets		
Picloram (5%)	0.6	11.3 b
Picloram (5%)	1.2	11.4 b
Picloram (10%)	0.6	11.5 b
Picloram (10%)	1.2	22.1 de
Tebuthiuron (20%)	0.6	13.2 bc
Tebuthiuron (20%)	1.2	4.5 a

[a]Means followed by the same letter are not significantly different at the 5 percent level according to Duncan's multiple range test.

Although spraying conditions were not considered optimum during the February 23, 1978 application, excellent camphorweed control occurred for at least 6 months following application of the 2,4-D ester or amine at 0.6 or 1.1 kg/ha and of dicamba plus 2,4-D at 0.6 kg/ha (Table 3). Because of cold weather, desirable broadleaf plants were not present during the herbicide application and, consequently, were not affected by the treatments. Within 6 months following treatment, broadleaf plant densities ranged from about 12 to 19 plants/m^2, regardless of herbicide(s) or rate applied (Table 3).

Prescribed Burning

Burning conditions. The total fine fuel was 2,340 kg/ha of which 1,204 kg/ha was standing material. The standing dead fine fuel contained about 12 percent water while the mulch contained nearly 10 percent at the time of burning. Soil-water content was about 4 percent. The burned area supported approximately 2,270 camphorweed plants/ha prior to treatment while the adjacent unburned area supported about 1,030 plants/ha. Air temperature was 19°C, and relative humidity was 25 percent during the burn. Wind speeds ranged from 12 to 24 km/hr, causing the flame front to move at approximately 31 m/minute and to attain heights of 4.5 to 6 m. Maximum fire temperature at ground level was 205°C, with a temperature of 150 occurring at most recording stations.

Table 3. Reduction (%) in number of live camphorweed plants and density (plants/m^2) at 6 months following application of 2,4-D and dicamba+2,4-D with ground equipment on February 23, 1978 to a sandy site near Hebbronville, Texas

Treatment		Camphorweed	
Herbicide	Rate (kg/ha)	reduction (%)[a]	Forb density[a]
None	--	0	13.6
2,4-D ester	0.6	99	18.9
2,4-D ester	1.1	100	14.7
2,4-D amine	0.6	100	12.2
2,4-D amine	1.1	100	16.0
Dicamba+2,4-D	0.6	100	14.9

[a]No significant difference among means (P≤.05).

Responses to burning. At 6 months after installation of the fire (August 10, 1978), the burned area was virtually free of camphorweed. The adjacent, unburned area supported approximately 495 plants/ha. Natural mortality of camphorweed was high during the summer, but this is common among annual plants and probably accounts for the apparent "residual control" noted the third growing season after application of some herbicides.

After burning, the study area did not receive significant rainfall until the latter part of May. Consequently, forage response was minimal during that period, and herbage production and utilization were not measurable. On August 10, 1978, standing crop produced since date of burn (February 23, 1978) was 2,359 kg/ha on the burned area and 2,572 kg/ha on the adjacent unburned area. Grass accounted for 2,080 kg/ha of the standing crop, and broadleaf plants produced 278 kg/ha on the burned area (Table 4). Grass standing crop on the unburned areas was 2,079 kg/ha.

At 6 months following burning, utilization of the standing crop on the burned area was greater than on the unburned area (Table 4). More than 90 percent of the total herbaceous standing crop was utilized on the burned area while 74 percent was utilized on the unburned area. On the burned area, about 95 percent of the grass standing crop was utilized, while only 52 percent of the broadleaves was utilized. On the unburned site, about 60 percent of the broadleaves was utilized, and 96 percent of the grass standing crop.

On August 2, 1979, 18 months following burning, the total standing crop in the exclosures protected from grazing was 2,576 kg/ha, while on the unburned area the standing crop was 2,632 kg/ha. Forage utilization 18 months after burning was relatively low, reflecting a reduction in stocking rate on the study area, and was only slightly higher on the burned site than on the unburned site (Table 4). Although camphorweed was evident in the burned plot at 18 months following treatment, the density was estimated at 40 percent less than on the unburned plot.

Conclusions

These data indicate that camphorweed can be effectively controlled with applications of 2,4-D ester or amine at 0.6 or 1.1 kg/ha from late winter to early summer. Unless other difficult-to-control herbaceous weeds are present in the stand, the higher rates of 2,4-D or inclusion of herbicides such as dicamba or picloram would probably not be warranted. However, where control of woody species such as honey mesquite is also desired, dicamba or mixtures of 2,4,5-T and picloram may be the most effective of the herbicides evaluated in this study.

Applications of picloram pellets (5 or 10 percent active ingredient) or tebuthiuron pellets (20 percent active ingredient) in the spring were equally effective for camphorweed control as equivalent rates of the herbicide sprays evaluated. However, the pellet formulations offer an alternative to sprays where spray drift poses a potential hazard to adjacent herbicide-susceptible crops. All herbicide treatments reduced the density of desirable forbs, primarily legumes, for at least one growing season after spring application, but broadleaf plants other than camphorweed were not affected by winter application of herbicide sprays.

A cool-season prescribed burn conducted with a relatively low standing fine fuel load and moderate wind speeds but with a low relative humidity effectively reduced the camphorweed population for one growing season. Based on these results, range livestock producers desiring to develop management systems for rangeland supporting heavy infestations of camphorweed might consider selecting an appropriate herbicide as an initial treatment to be applied in winter or spring. Following the herbicide application, periodic cool-season burns may effectively suppress invading camphorweeds.

Table 4. Total standing crop (kg/ha) and percentage utilized from February 23, 1978 to August 10, 1978 and from August 10, 1978 to August 2, 1979, and numbers of live camphorweeds per hectare on August 10, 1978 and August 2, 1979, on burned and unburned sites near Hebbronville, Texas

		Total standing crop		
Treatment	Grazing period	Produced (kg/ha)	Utilized (%)	Camphorweed plants/ha[a]
Burned	February 23, 1978 to August 10, 1978	2359	92	0
	August 10, 1978 to August 2, 1979	2576	33	6768
Unburned	February 23, 1978 to August 10, 1978	2572	74	495
	August 10, 1978 to August 2, 1979	2632	21	11,444

[a]Camphorweed densities recorded on last day of grazing period.

Literature Cited

Awang, M. B. and T. J. Monaco. 1978. Germination, growth, development, and control of camphorweed (*Heterotheca subaxillaris*). Weed Sci. 26: 51-57.

Baskin, W., and C. C. Baskin. 1976. Germination dimorphism in *Heterotheca subaxillaris* var. *subaxillaris*. Bull. Torrey Bot. Club. 103:201-206.

Correll, D. S. and M. C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Found. Renner, Texas. 1881 pp.

Ostle, B. 1963. Statistics in research. Iowa State Univ. Press. Ames, Iowa. 585 pp.

Scifres, C. J. 1980. Brush Management. Principles a[illegible] practices for Texas and the Southwest. Texas A[illegible] Univ. Press. 360 pp.

Scifres, C. J., R. R. Hahn, and J. H. Brock. 1971. Phenology and control of common broomweed on Texas rangelands. J. Range Manage. 24:370-373.

Skroach, W. A. 1975. Weeds in horticultural apples. South. Weed Sci. Soc. Res. Rep. 28:157.

Waldrip, W. J. 1957. Farming and ranching risk as influenced by rainfall. III. TAES Bull. MP-241. 20 pp.

Acknowledgments

Land and partial financial support for this research furnished by the Eshleman-Vogt Ranch near Hebbronville, Texas, is greatly appreciated. The authors are grateful to T. C. Longnecker for his help in initiating the research project, Julia Scifres for typing and preparing the manuscript, and W. C. Mohr and Eldon Yeager for their efforts in plot establishment, maintenance, and evaluation. Also, the interest of Harold, Harris, and Charles Kaffie in this project is greatly appreciated.

Metric — English Equivalents

Metric unit	English equivalent
Centimeter (cm)	0.4 inch
Gram (g)	0.035 ounce (weight)
Hectare (ha)	2.47 acres
Kilogram per hectare (kg/ha)	0.89 pound per acre
Kilometer (km)	0.62 statute mile
Liter (l)	0.26 gallon
Meter (m)	3.28 feet
Degrees centigrade (°c) × 1.8 + 32	Degrees farenheit

The Texas Agricultural Experiment Station, Neville P. Clarke, Director, College Station, Texas
2M — 5-81