FISILADE 2000 (PP005): A NEW POSTEMERGENCE HERBICIDE FOR THE CONTROL OF GRASS WEEDS

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Abstract. FUSILADE 2000 (PPoo5) is the commercial name for fluazifop-P-butyl. The chemical name is butyl (R)-2-[4-[[5-(trifluoromethyl)-2-pyridinyl]oxy]phenoxyl]propanoate. FUSILADE 2000 1E contains 1 pound (+) isomer (fluazifop-P-butyl) per gallon.

FUSILADE 2000 effectively controls a broad spectrum of both perennial and annual grasses in broadleaf crops. Current EPA labels include cotton, soybeans, noncrop, nonfood, and ornamentals.

FUSILADE 2000 rapidly enters the plant via the leaves. It moves in both the xylem and phloem. The first visible symptom of activity is cessation of growth in 24 to 48 hours. Meristematic tissue becomes necrotic and young leaves show chlorosis. Actively growing young grasses show symptoms much quicker than older grasses or those under stress from such factors as drought or very high temperatures. Either a non-ionic surfactant or crop oil concentrate should be added to the spray solution at 1/4% v/v or 1% v/v, respectively. Extensive testing in the western U.S. has shown fusilade 2000 to be 1 1/2 to 2 times as active as the original FUSILADE 4E. New labels anticipated for 1986 include carrots, peanuts, onions and garlic.

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THE BRITTLEBUSH PROBLEM AND POTENTIAL CONTROL MEASURES IN BUFFELGRASS PASTURES IN SONORA, MEXICO

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Abstract. More than 300,000 hectares (ha) of rangelands have been seeded to buffelgrass (*Cenchurus ciliarus* Link.) in Sonora, Mexico. There are an additional three million ha which could be seeded. Buffelgrass pastures produce more than eight times as much forage as native pastures. Stocking rates on native pastures are from 30 to 40 ha/Animal Unit Year (AUY); whereas, on buffelgrass pastures stocking rates are from 3 to 4 ha/AUY. Brittlebush (*Encelia farinosa* Gray) has invaded buffelgrass seedings as well as native pastures. Brittlebush densities as high as 30,000 mature plants/ha occur in seeded pastures and seedling densities often exceed 48,000 plants/ha. Biomass of mature brittlebush plants on these areas average 20 tons Dry Matter (DM)/ha. Brittlebush seed production can

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vary from several grams to over 60 kg Pure Live Seed (PLS)/ha/year. Several studies were conducted to determine the effectiveness of mechanical and chemical brush control methods on plant mortality. Mowing killed few plants and temporarily reduced growth. Hand removal resulted in 100% mortality, but seedlings rapidly reinvaded and densities were equal to pretreatment levels after three months. Soil applied pelleted tebuthiuron at 0.5 and 1.0 kg active ingredient (ai)/ha killed 73 and 98% of the plants respectively, during the first year; while soil applied pelleted picloram at 0.5 and 1.0 kg acid equivalent (ae)/ha killed 93 and 99% of the plants, respectively. A single, hot summer burn killed 32% of the mature plants and 60% of the seedlings. Burning in two consecutive years killed 70% of the mature plants and 90% of the seedlings. High intensity livestock grazing reduced brittlebush growth, but caused no significant changes in brittlebush density after three years.

Introduction

There is no doubt that shrub species, primarily the ones not preferred by grazing animals, are increasing on rangelands (2, 3, 6). Mechanical brush control practices such as cabling, mowing, railing and disk plowing generally provide temporary control (7,9). Foliar herbicides such as 2,4-D [(2,4-dichlorophenoxy)acetic acid]; 2,4,5-T[(2,4,5-Trichlorophenoxy)acetic acid]; picloram (4-amino-3,5,6-Trichloropicolinic acid); and dicamba (3,6-dichloro-o-anisic acid) have controlled only a limited number of shrubby species (5, 8). Soil applied herbicides such as tebuthiuron (N-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-N,N^1-dimethylurea) and picloram control many woody species that are resistant to foliar applied herbicides (12, 13), while fire effectively controls some non-sprouting brush species (4,16).

The increase of brittlebush in the Sonoran Desert has been documented. Densities of the species have almost doubled in 30 years near Tucson, Arizona (14). In Sonora, Mexico, brittlebush densities increased on mechanically disturbed areas seeded to buffelgrass, abandoned farmlands, and on overgrazed rangelands. At least 50% of the 300,000 ha of buffelgrass pastures established in the State of Sonora have been invaded by brittlebush (Figure 1); and more than 60% of the 3 million ha suitable for buffelgrass seeding have varying amounts of brittlebush.

Young and mature brittlebush plants are shrubs with dense hemispheric canopies, reaching 80 cm in diameter and frequently over 1 m in height. Leaves are gray-green and densely hairy; 2 to 5 cm long and 1.5 to 2.5 cm wide. Disc flowers of some plants are yellow or purple. Brittlebush is very abundant on dry rocky slopes up to 950 m in elevation. In the United States it is distributed in southern California, southern Nevada, southwestern Utah and southern and western Arizona. In Mexico it is distributed in Baja, California, Sonora and Sinaloa (Figure 1) (1, 10, 11).

Literature pertaining to brittlebush control does not exist. The objectives of this study were: 1) To determine the infestation potential and the amount of competition between buffelgrass and brittlebush, 2) to evaluate the effectiveness of herbicides and mechanical treatments, fire and grazing practices on brittlebush control, and 3) to develop effective and economical practices to reduce brittlebush densities in buffelgrass pasture.

Materials and Methods

A series of experiments were conducted to evaluate the response of buffelgrass to several brush control methods at two sites in Sonora, Mexico. Rancho Maria de Lourdes is located 28 km north of Hermosillo along the Hermosillo-Nogales Highway. Elevation is 260 m and precipitation averages 309 mm annually, with 70% falling in the summer and 30% during the winter. Mean monthly temperature is 24.2^{o} C. Soils are deep loams and pH is 6.7. Two nine-year-old buffelgrass pastures were selected; one in good condition and moderate brittlebush infestation and the other in poor condition and highly infested with brittlebush. Other brushy species at the site were: palo verde (Cercidium spp), ironwood (Olneya tesota A. Gray), mesquite (Prosopis julifora (Swartz) D.C.), kidneywood (Eysenhardtia orthocarpa S. Wats) and torchwood (Bursera spp).

Treatments were: 1) hand removal of brittlebush, 2) hand removal and fertilizer (80 kg/ha of nitrogen as urea (+) 40 kg/ha of phosphorus as triple superphosphate), 3) burning, broadcast application of 20% pellets of tebuthiuron at 4) 0.5 and 5) 1.0 kg ai/ha, and broadcast application of 10% pellets of picloram at 6) 0.5 and 7) 1.0 kg ae/ha. Treatments were applied in both pastures on May 1985, replicated three times and arranged in randomized complete block design.

Brittlebush density was estimated before and after treatment application in three randomly selected 30 m^2 quadrats per plot. Forage production was estimated at the end of the summer growing season by clipping ten 1 m^2 quadrats randomly placed in each plot. Forage was dried at 40^{o} C for 72 h. Brittlebush biomass was estimated by removing and weighing all plants present within 15 by 30 m plot. To determine the effect of each treatment on reproductive capacity, buffelgrass seed production was estimated by harvesting seed randomly on twenty 1 m^2 quadrats in each plot.

The second site is at Centro de Investigaciones Pecuarias del Estado de Sonora (CIPES): located 72 km north of Hermosillo along the Hermosillo-Nogales Highway. Elevation is 450 m and annual precipitation is 328 mm; 70% falls in summer and 30% in winter. Mean monthly temperature is 21.9^{o} C. Soils are deep, sandy loams and pH is 6.8.

Your studies were placed on four 7-year-old buffelgrass pastures with dense stands of buffelgrass and highly infested with brittlebush.

Study one. Mowing was applied before the summer growing season of 1983 in half of a 40 ha pasture. The remaining half was left as an untreated quadrats each. Brush mortality was calculated from densities on treated and untreated plots. Forage production (standing biomass) was estimated at the end of the growing season of 1984 and 1985 by clipping 80 randomly placed 1 m^2 quadrats.

Study two. In the summer of 1982, two-thirds of a 70 ha pasture was burned and in summer of 1983 half of the area previously burned in 1982 was reburned to determine the effect of a single burn and of two burns. Brittlebush density was estimated from the number of plants in 40 randomly placed 45 m^2 quadrats in plots burned once, twice and on the untreated check.

Study three. Grazing studies were started in 1983. Treatments applied were light, moderate and intensive continuous grazing with stocking rates of 4, 3, and 2 ha/AUY, respectively. Brittlebush density was estimated from 30 randomly placed 45 m^2 quadrats on each of the grazed pastures and on an ungrazed excluded area.

Study four. Foliar sprays were applied in the summer of 1985. Foliar herbicides applied were: dimethylamine salt of 2,4-D, isooctyl ester of 2,4-D, potassium salt of picloram, dimethylamine salt of dicamba, dimethyl amine salt of 2,4-D (+) potassium salt of picloram, triethylamine salt of 2,4,5-T (+) triethylamine salt of picloram and potassium salt of picloram (+) dimethylamine salt of dicamba each at rates of 0.5 and 1.0 kg ae/ha. Each treatment was triplicated in a 15 by 30 m plot and arranged in a randomized complete block design. Brittlebush density was estimated before and after treatment application in three randomly selected 30 m^2 quadrats per plot.

Data collected were subjected to analyses of variance and when significant ($P \leq 0.05$) differences were detected, means were separated by Duncan's Multiple Range Test (15). In the mowing, burning and grazing studies we used variability within plots for our statistical comparisons because a limited number of pastures prevented replication.

Results

Precipitation in both summer and winter of 1982 was near the ten-year average, above average during summer and winter of 1983 and 1984 and below average in summer and winter of 1985 at the two study sites.

Rancho Maria de Lourdes. Brittlebush density and biomass were significantly different among pastures (Table 1). Density of young and mature brittlebush plants was almost four times greater and biomass almost three times greater in the poor condition pasture compared with the good condition pasture. Plants on the good condition pasture were 0.190 kg heavier than plants on the poor condition pasture.

Table 1. Brittlebush density and biomass at two 9-year-old buffelgrass pastures at Rancho Maria de Lourdes, Hermosillo, Sonora, Mexico in 1985.

Pasture Condition	Plants		Density	Biomass
			(Plants/ha)	(kg DM/ha)
Good	Mature		6,790	7,747
	Young		7,440	997
		Total	14,330	8,744
Poor	Mature		27,800	21,628
	Young		29,300	2,432
		Total	57,100	24,060

The highest brittlebush mortality was obtained with soil applied herbicides (Table 2). Apparently range condition and brush density do not influence herbicide effectiveness. Hand removal of brittlebush initially killed all plants in both pastures. However, brittlebush seedlings rapidly

Table 2. Brittlebush mortality (%) five months after the application of several brush control methods on two buffelgrass pastures with different range conditions at Rancho Maria de Lourdes, Hermosillo, Sonora, Mexico in 1985.

Treatments	Pasture Condition Good	Pasture Condition Poor
	---(% Mortality)---	
Hand removal	60 bc[a]	43 c
Hand removal (+)		
Fertilizer[b]	52 c	35 c
Burning[c]	71 b	44 c
Tebuthiuron (ai/ha)		
0.5 kg	73 b	78 b
1.0 kg	98 a	90 a
Picloram (ae/ha)		
0.5 kg	93 a	86 ab
1.0 kg	99 a	96 a

[a]Means within columns followed by the same letter are not significantly different ($P \geq 0.05$) according to Duncan's Multiple Range Test.
[b]80 kg/ha of nitrogen as urea (+) 40 kg/ha of phosphorus as triple superphosphate.
[c]Burned before the summer rains.

reinvaded and densities were almost equal to pretreatment levels after three months. Tardy and reduced summer rainfall had a considerable effect on brittlebush seedling densities. Seedling mortality at five months was 60 and 43% in the good and poor condition pastures, respectively. Fertilizer application did not affect seedling density, but plants appeared greener and more succulent.

Forage production increased from 10 to 70% after treatment and was significantly greater than in the untreated checks at the good condition site (Table 3). Forage production was greatest after fire, followed by the hand removal (+) fertilizer and the high application rates of both herbicides.

Table 3. Forage production of buffelgrass (kg DM/ha) five months after application of several brush control methods at Rancho Maria de Lourdes, Hermosillo, Sonora, Mexico in 1985.

Treatments	Good Condition Site		Poor Condition Site	
	Forage Production	Increase	Forage Production	Increase
	(kg/ha)	(%)	(kg/ha)	(%)
Hand removal	1531 c[a]	14	365 b	44
Hand removal (+)				
Fertilizer[b]	1952 b	49	421 a	65
Burning[c]	2286 a	70	363 b	43
Tebuthiuron (ai/ha)				
0.5 kg	1508 c	12	361 b	47
1.0 kg	1773 bc	31	278 c	10
Picloram (ae/ha)				
0.5 kg	1463 c	10	382 b	51
1.0 kg	1851 bc	38	416 a	64
Check	1345 d	--	253 c	--

[a]Means within columns followed by the same letter are not significantly different ($P \geq 0.05$) according to Duncan's Multiple Range Test.
[b]80 kg/ha of nitrogen as urea (+) 40 kg/ha of phosphorus as triple superphosphate.
[c]Burned before the summer rains.

Forage production increased from 43 to 65% after treatment at the poor condition site and was significantly greater than the untreated checks following all treatments except the high rate of tebuthiuron. Forage production was greatest following hand removal (+) fertilizer and the high rate of picloram.

The greater forage production on the hand removed (+) fertilizer indicates that buffelgrass responds to range fertilization, and forage production increases can be expected in good condition pastures.

Buffelgrass forage production in the untreated checks in the good condition pasture was more than five times greater than the checks in the poor condition pasture (Table 3), while brittlebush biomass in the poor condition pasture was almost three times greater than in the good condition pasture (Table 1). These differences were due to management, because both pastures were seeded on the same date and in contiguous pastures.

Buffelgrass seed production was greatest after hand removal with or without fertilizer, burning and the low rate of picloram applied in the good condition pasture (Table 4). Seed production was greatest in hand removed (+) fertilized plots in the poor condition pasture.

Table 4. Buffelgrass seed production as affected by several brush control methods of Rancho Maria de Lourdes, Sonora, Mexico in 1985. Data was collected five months after treatment application.

Treatments	Good Condition Site Seed Production	Poor Condition Site Seed Production
	(kg/ha)	(kg/ha)
Hand removal	20.9 a[a]	9.4 b
Hand removal (+)		
Fertilizer[b]	21.2 a	12.5 a
Burning[c]	20.1 a	9.5 b
Tebuthiuron (ai/ha)		
0.5 kg	18.3 b	9.1 b
1.0 kg	10.9 d	5.4 d
Picloram (ae/ha)		
0.5 kg	19.1 ab	8.9 bc
1.0 kg	14.4 c	8.8 bc
Check	13.9 c	7.6 c

[a]Means within columns followed by the same letter are not significantly different ($P \geq 0.05$) according to Duncan's Multiple Range Test.
[b]80 kg/ha of nitrogen as urea (+) 40 kg/ha of phosphorus as triple superphosphate.
[c]Burned before the summer rains.

CIPES. Mowing did not reduce brittlebush densities. Mowed plants grew back to pretreatment sizes within three years and mowing had no effect on forage production.

A single, hot summer burn in 1982 killed 32% of mature plants and 60% of seedlings. Remaining plants sprouted vigorously during the next year. Burning in two consecutive years killed 70% of mature plants and 90% of seedlings. Remaining plants were injured and have not recovered.

Cattle were observed grazing leaves and tips of stems of brittlebush plants; however, grazing intensity did not appear to affect brittlebush densities. Brittle bush size was less under heavy grazing than under moderate and light. It was not possible to determine if plant damage was due to grazing or trampling since botanical composition of diets in grazing animals were not determined. foliar applied herbicides had no effect on brittlebush populations.

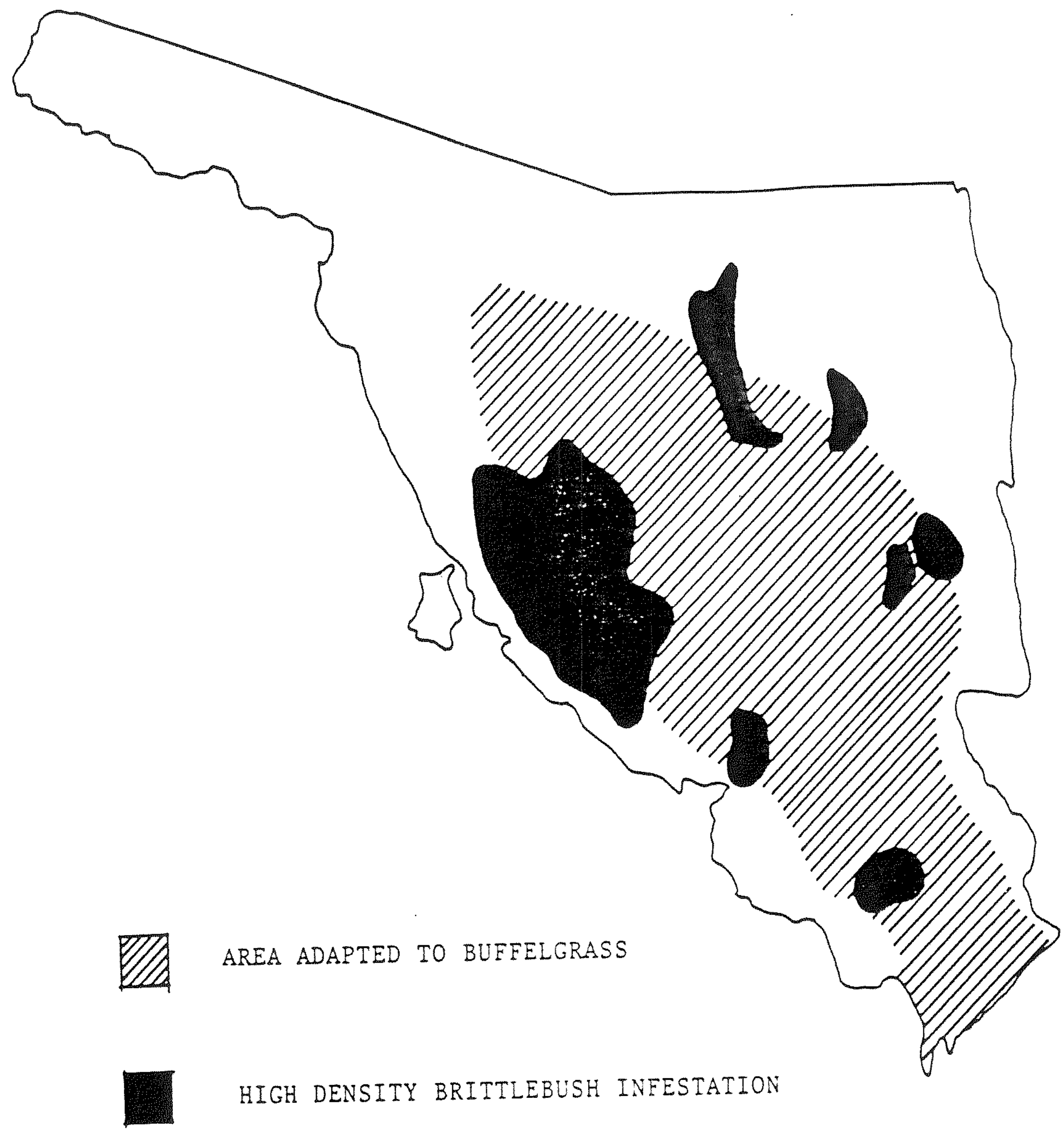

FIGURE 1.- THE AREA SEEDED OR WHERE BUFFELGRASS COULD POTENTIALY BE SEEDED TO IMPROVE RANGELAND PRODUCTION, AND AREAS WHERE BRITTLEBUSH IS THE DOMINANT SPECIES IN SONORA, MEXICO.

Figure 1. The area seeded or where buffelgrass could potentially be seeded to improve rangeland production and areas where brittlebush is the dominant species in Sonora, Mexico.

Conclusions

Preliminary data suggest that brittlebush reduces forage production and is a strong competitor with buffelgrass. The soil applied herbicides tebuthiuron and picloram, and prescribed burning seem to adequately control brittlebush. Brittlebush reinfestation appears to be related to range management practices. Large number of small brittlebush plants were found after hand removal. Rainfall, drought and other environmental factors will determine the longevity of brittlebush control measures.

Acknowledgements

The authors wish to thank Lic. Luis Encinas Johnson and Mr. Jose Luis Garcia for all the facilities given at Maria de Lourdes Ranch, the members of the Patronato de CIPES and Gobierno del Estado de Sonora for financial support, and to Lilly Research Laboratories, Dow Chemical Company and Veliscol Chemical Corporation for providing the herbicides. Thanks to all the technicians and field workers for establishing plots and helping in the collection of data.

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BRUSH CONTROL AND FORAGE PRODUCTION ON SOUTHEASTERN ARIZONA RANGELANDS

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Abstract. We aerially applied tebuthiuron [N-(5-[1,1-dimethylethyl]-1,3,4-thiadiazol-2-yl)-N, N'-dimethylurea] at rates ranging from 0.27 to 1.65 kg ai/ha to reduce competition of creosotebush (*Larrea tridentata* [DC] Coville), whitethorn acacia (*Acacia constricta* Benth.), desert zinnia (*Zinnia pumila* Gray), tarbush (*Florensia cernua* DC) and associated half-shrubs at three sites. Plant mortality was greatest on shallow, coarse-textured soils and least on deep, fine-textured soils. Creosotebush mortalities ranged from 32 to 100%, whitethorn acacia from 31 to 100%, tarbush from 87 to 100% and desert zinnia from 88 to 100%. Shrub mortalities increased as herbicide rate increased. Perennial grass forage production across all herbicide rates increased from 50 to 478 kg/ha between one and three years at two sites; and varied from 376 to 914 kg/ha between two and seven years at the third site. Forage production increased as

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