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Herbage Production Following Brush Control with Herbicides in Texas[1]

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Highlight

The herbicides, 4-amino-3,5,6-trichloropicolinic acid (picloram), 5-bromo-3-*sec*-butyl-6-methyluracil (bromacil), (2,4,5-trichlorophenoxy)acetic acid (2,4,5-T), 3,6-dichloro-*o*-anisic acid (dicamba) applied alone and in certain combinations caused significant increases in grass production for several months to several years at three locations in Texas, depending upon the degree of brush control obtained. Native grasses usually tolerated picloram, 2-chloro-4-(ethylamino)-6-(isopropylamino)-*s*-triazine (atrazine), 2-chloro-4,6-bis(ethylamino)-*s*-triazine (simazine) and (2,4-dichlorophenoxy)acetic acid (2,4-D) as granules and sprays at rates up to 2 lb./acre without reduction in yield on pasturelands at three locations in Texas.

The influence of herbicides on forage production is of major concern on pasture and rangelands, especially after applications of high rates for brush control. Barrons (1969) reviewed the ecological benefits of herbicide usage on range and pasturelands and indicated that many areas in the world are covered with unpalatable or poisonous plants that could be controlled to create improved grasslands. Therefore, increasing herbage production while controlling brush and many unpalatable or poisonous plants would increase the value of the treated area. Research is needed to show these herbage increases following herbicide sprays.

The comprehensive studies of Klingman and McCarty (1958) on pastures at Lincoln, Nebraska, established that weed control increased the consumption of vegetation by livestock 252% of the check on grazed plots and up to 318% when grazing was deferred to June 15 and rotationally grazed thereafter. Forage consumption was increased on an average of 20% by mowing and 47% by spraying with (2,4-dichlorophenoxy) acetic acid (2,4-D).

Experiments in the Missouri Ozarks by Ehrenreich and Buttery (1960) indicated herbage production was increased 40 to 60 times on plots where hardwood tree competition was reduced by herbicides or a combination of girdling overstory trees and spring burning. Reseeding following control of hardwoods with tall fescue (*Festuca arundinacea* Schreb.) was recommended for improving herbage quality. Bentley (1967) reported that conversion of chaparral to grass in California was least expensive with 2,4-D and 2,4,5-T, although some species were resistant and required several applications. However, the most difficult phase of the conversion process was establishment of perennial grasses.

In Texas, although reseeding may be desirable in some areas, desirable native species do produce an excellent grass cover after brush

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control with herbicides. In northwest Texas, Fisher et al. (1959) showed over a 10-year period, annual acre-gains of 18 percent with yearling steers on pastures treated with 2,4,5-T, compared to pastures infested with honey mesquite (*Prosopis juliflora* (Swartz) DC. var. *glandulosa* (Torr.) Cockerell). Pastures were moderately stocked at 6.5 acres/head for 156 days (May 1 to October 3). This increase was valued at $1.00/acre/year at that time.

Robison and Fisher (1968) showed increases of 5 times more forage per acre on sprayed than on unsprayed areas infested with sand shinnery oak (*Quercus havardii* Rydb.). Arnold and Santelmann (1966) studied the effect of picloram on native grasses in the field and greenhouse in Oklahoma. Picloram applied at ¾, 1½ and 3 lb./acre prevented seedling growth of blue grama (*Bouteloua gracilis* (Willd. ex H.B.K.) Lag. ex Griffiths), sideoats grama, big bluestem (*Andropogan gerardi* Vitman) and switchgrass (*Panicum virgatum* L.). When applied at the two to four-leaf stage at 1½ lb./acre, picloram significantly reduced density of all species. However, when picloram was applied to established native range at 1, 2 and 4 lb./acre, production of desirable forage grasses was not reduced, but forb production was reduced.

Studies in Central Texas by Meyer et al. (1969) showed that fall and spring applications of picloram increased the production of perennial native grasses and reduced perennial and annual forb production by the next summer. However, total production of vegetation was similar to the untreated areas, regardless of treatment.

Hoffman (1966) increased the grazing potential for cattle from 67 animal units to 178 on 1000 acres after spraying Macartney rose infested pastures with 2,4-D in southeast Texas. The unsprayed area produced an average of 2,482 pounds of forage per acre; whereas the sprayed area produced 5,346 pounds.

Koshi (1957) studied the response of herbage production in East Texas by partial and complete removal of an oak overstory. Data indicated that a five-fold increase in grass production was maintained for a 3-year period by complete overstory removal.

We studied the effects of several herbicides on the production of grasses and forbs at four locations in Texas following weed and brush control, using low, moderate, and high rates of herbicides.

Material and Methods

Field Sites

Field plots were established near Victoria, Carlos, Llano, and Marble Falls, Texas. This provided an appreciable range in climate, edaphic conditions, and botanical composition of vegetation.

A dense stand of shrub-type live oak (*Quercus virginiana* Mill.) 3 to 12 feet tall was studied at Victoria, on the Gulf Coast Prairie. Herbaceous vegetation included little bluestem (*Andropogon scoparius* Michx.), brownseed paspalum (*Paspalum plicatulum* Michx.), Indiangrass (*Sorghastrum nutans* (L.) Nash), threeawn (*Aristida* spp.), lovegrass (*Eragrostis* spp.), knotroot bristlegrass (*Setaria grisebachii* Fourn.), bitter sneezeweed (*Helenium amarum* (Rafin.) H. Rock), and Lindheimer croton (*Croton lindheimeri* (Engelm. & Gray) Wood). The average Katy gravelly sandy loam profile consisted of a light brownish-gray, gravelly, sandy loam surface layer about 20 inches thick having a pH of 5.5 and a gravel content of 10 to 30 percent. The subsoil was gray, sandy clay with yellowish brown and red mottles and centered around small iron concretions. It had a moderate to coarse blocky structure and a pH of 5.0 to 6.0. The amount of sand increased with depth, and a few calcium carbonate concretions occurred at depths of 54 to 60 inches in many places.

Llano and Marble Falls, Texas, are located in the Central Basin. Whitebrush (*Aloysia lycioides* Cham.) 4 to 7 feet tall predominated with scattered plants of honey mesquite, Texas persimmon (*Diospyros texana* Scheele), pricklypear (*Opuntia* spp.) and tasajillo (*Opuntia leptocaulis* DC.). Major grasses in the area were sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.), curlymesquite (*Hilaria belangeri* (Steud.) Nash), vine mesquite (*Panicum obtusum* H.B.K.), and buffalograss (*Buchloe dactyloides* (Nutt.) Engelm.).

The granite soils near Marble Falls and Llano contained from 30 to 50% gravel. The surface soil was deep with 18 to 24 inches of a light brown gravelly, loamy sand. The subsoil was a red or yellow and gray clay. The surface soil absorbed water well, but the heavy subsoil took it slowly.

The predominant brush species at the Carlos site were yaupon (*Ilex vomitoria* Ait.), post oak (*Quercus stellata* Wangenh.), and blackjack oak (*Quercus marilandica* Muenchh.). The yaupon and oaks were 3 to 8 feet and 4 to 15 feet tall, respectively. Predominant herbaceous species were little bluestem, bristlegrass, Indiangrass, brownseed paspalum, Lindheimer croton, and bitter sneezeweed. The soil at the Carlos site was an Axtell fine sandy loam, shallow variant. The A horizon was a gray fine sandy loam to a depth of 5 to 10 inches. The dark, heavy clay of the B horizon caused a perched water table in rainy season, but the C horizon gave excessive subdrainage. Consequently, the soil had characteristics of both a wet and dry soil.

Brush Control

We applied herbicides as sprays to plots in a randomized block design with two or three replications per treatment at Victoria, Llano and Carlos, Texas. Plots were either 20- or 22-ft wide and 100- or 200-ft long. We applied herbicides with a truck or tractor sprayer in 10 gallons spray per acre, except bromacil which was applied in 20 gallons per acre.

Table 1. Rainfall data (inches) for years and locations where vegetation was sampled following brush control in Texas.[1]

Location and year	March	April	May	June	July	Aug.	Sept.	Oct.	Total for year (Jan. 1–Dec. 30)
Victoria, 1963	0.25	0.84	1.58	4.89	1.48	3.02	1.23	1.25	22.05
Departure from normal	–2.07	–1.78	–2.54	1.89	–2.13	–0.11	–3.00	–2.23	–14.15
Victoria, 1964	2.10	0.50	3.09	3.77	1.81	6.84	7.64	0.34	33.22
Departure from normal	–0.22	–2.12	–1.03	0.73	–1.80	3.71	3.41	–3.14	–2.88
Victoria, 1967	0.49	1.72	2.38	T	1.26	3.03	14.52	4.92	33.90
Departure from normal	–1.83	–0.90	–1.74	–3.04	–2.35	–0.10			–2.30
Llano, 1967	1.13	2.40	6.61	T	0.72	1.31	4.40	0.96	25.52
Departure from normal	–0.32	–0.55	2.62	–2.58	–1.30	–0.41	3.03	0.65	–3.07
Carlos, 1967 (College Station)	1.78	3.78	6.78	0.25	4.58	1.35	4.69	3.68	32.49
Carlos, 1968 (College Station)	1.94	6.28	6.90	12.63	6.10	0.18	4.38	2.48	61.04
Victoria, 1970	4.44	2.38	5.81	2.87	3.51	1.44	7.41	2.63	39.78
Departure from normal	2.12	–0.24	4.11	–0.17	–0.10	–1.69	3.18	–0.85	3.58
Marble Falls, 1970 (Burnet)	3.67	2.28	6.09	6.78	0.58	0.04	4.44	2.09	25.22
Carlos, 1970 (College Station)	3.97	4.26	3.51	0.84	0.65	0.20	4.12	4.30	33.85

[1] From "Climatological Data" U. S. Dep. of Commerce, National Climatic Center, Federal Bldg., Asheville, N.C. 28801.

Herbicides studied included the dimethylamine salt of 3,6-dichloro-*o*-anisic acid (dicamba), 2-ethylhexyl ester formulations of 2,4-D and 2,4,5-T, the potassium salt of 4-amino-3,5,6-trichloropicolinic acid (picloram), 1,1'-dimethyl-4,4'-bipyridinium salts (paraquat), 5-bromo-3-*sec*-butyl-6-methyluracil (bromacil), and 5-bromo-3-isopropyl-6-methyluracil (isocil). Additional formulations applied at Marble Falls, Texas, included the propylene glycol butyl ether esters of 2,4-D and 2,4,5-T, the isooctyl ester of picloram, the triethylamine salts of 2,4,5-T plus picloram (1:1), the triisopropanolamine salt of 2,4-D plus picloram (1:2) and the dimethylamine salt of [(4-chloro-*o*-tolyl)oxy] acetic acid (MCPA).

Percentage of brush controlled was estimated at the time of forage harvest. Grasses and broadleaf plants were separated and oven-dried after harvesting two, 2.8 by 10-ft areas in each plot at the ground level. One experiment at Carlos involved broadcast applications of 2 percent picloram granules at 2 and 4 lb./acre to different plots (40 by 40 ft) each month for two years. One square meter of forage of the standing crop was harvested from the middle of each plot in October 1970.

Pasture Weed Control

We applied granules and sprays of 2-chloro-4-(ethylamino)-6-(isopropylamino)-*s*-triazine (atrazine), 2-chloro-4,6-bis(ethylamine)-*s*-triazine (simazine) and the potassium salt of picloram to triplicate, 10 by 30 ft plots. All herbicides were applied at ½, 1 and 2 lb./acre and were compared with equal rates of 2,4-D sprays for weed control in native pastures. Sprays were applied at 20 gallons/acre with a hand sprayer. Granules were broadcast by hand. Plots were usually clipped for forage yields at the end of each growing season in which the treatments were made, similar to that described in the previous section.

Results and Discussion

Forage Production Following Brush Control

Preliminary studies (data not shown) established in the fall (1963) and spring (1964) indicate a rapid release of native grasses where high rates of herbicides were used for control of live oak at Victoria, Texas. For example, 2,4,5-T sprayed in April 1964 at 8 and 12 lb./acre reduced the live oak canopy 55 and 68%, respectively, 6 months after treatment and resulted in production of over 1600 lb./acre of oven-dry grass, compared to 100 lb./acre of grasses in the control. Other treatments which produced increased grass production (1200 to 1600 lb./acre) about one year after treatment included summer applications of bromacil at 5 lb./acre, 2,4,5-T plus dicamba at 4 + 4 lb./acre, and fall treatments of picloram at 4 and 8 lb./acre, picloram plus 2,4-D at 0.8 + 3.2 and 1.6 + 6.4 lb./acre. Bromacil at 10 lb./acre, and paraquat plus bromacil at 4 + 5 lb./acre applied in October, resulted in excellent live oak control, but retarded growth of grasses. Less than 500 lb./acre oven-dry grass occurred on these plots. Bromacil applied at 10 lb./acre in August apparently killed all vegetation. Below normal rainfall during 1963 and 1964 (Table 1) apparently prolonged the persistence of bromacil, and treated areas were void of vegetation at least one year. Grass production in all areas was less than normal because of limited rainfall.

Vegetation was harvested in October 1970 from plots treated in 1963 to 1965 which had the best live oak control (Table 2). Grasses and forbs arising, apparently from seed, were on plots where originally vegetation was killed by treatment with bromacil and isocil in August

Table 2. Yields (lb./acre, oven-dry) of vegetation in October 1970 after treatment of live oak infested ranges near Victoria, Texas, at various times with various herbicides and herbicide rates (lb./acre).[1,2]

Date of treatment	Treatment: Herbicide	Rate	Yield: Grasses	Forbs	Live oak regrowth	*Rubus* spp.	Total
August 1963	Bromacil	10	1850abc	340abc	0a	55ab	2245ab
	Isocil	10	2400ab	270abc	5a	25b	2700a
October 1963	Bromacil	10	1480abc	320abc	0a	150a	1950ab
	Paraquat + Bromacil	4+5	1350bc	480ab	0a	75ab	1905ab
October 1964	Picloram	8	1680abc	380abc	0a	95ab	2155ab
	Bromacil	10	1570abc	480ab	20a	130a	2200ab
June 1965	Picloram	8	2400ab	400abc	100b	50ab	2950a
	Bromacil	8	1400bc	630a	20a	90ab	2140ab
None-original stand			0d	0c	0a	0b	0c
Cleared and mowed[3]	-	-	2530a	130bc	190c	60ab	2910a
Mowed—April 1970	-	-	20d	20bc	1020d	10b	1070bc

[1] Original live oak—5 to 6 ft tall with stem diameters ½ to 2 inches.
[2] Plots grazed lightly since 1967 until April 1970.
[3] Dozed July 1963; mowed July 1964, 1965, 1966 and April 1970.

1963. Grass production was lower where bromacil and paraquat plus bromacil were applied in October and bromacil applied in June, than the plots maintained by frequent mowing. However, grass yields were higher on all treated plots as compared to production from the original live oak stand or live oak mowed in April 1970. Forb production increased on treated areas. *Rubus* spp. appeared to encroach most on areas treated with bromacil. All herbicide plots were mowed and cleared of debris in April 1970 to enable mechanical harvesting of the vegetation. The mowing treatment, early light grazing until April 1970, and below normal rainfall (Table 1) during the growing season probably reduced the grass production potential.

Studies established in April 1969 through March 1970 indicated that substantial increases in grass production are possible following brush control with pelleted picloram (Table 3). Areas treated in May, June, September, October and February produced significantly more grass than the untreated areas. The winter treatments, such as those in February, are of special interest since they resulted in excellent brush control and grass production. Mid-winter treatments of granular herbicides would also minimize any hazard to crops from drift, volatilization or runoff water since sensitive crops are not grown during winter in this area. August treatments, applied when hot and dry, resulted in poorer brush control and lower grass yields at 2 lb./acre, than treatments applied during other months.

Grass release as a result of controlling yaupon and associated woody species near Carlos, Texas,

Table 3. Oven-dry yields (lb./acre) of vegetation in October 1970 and control[1] (%) of yaupon after treatment of yaupon infested ranges near Carlos, Texas, with picloram granules (lb./acre) at various dates.[2]

Picloram granules (lb./acre)	Date of application	Yaupon control	Grass yield	Date of application	Yaupon control	Grass yield
2	April 1969	90ab	1857abc	April 1970	95ab	2857a
4		97a	2284abc		98a	2149a
2	May 1969	75cd	1513abc	May 1970	100a	1114b
4		99a	2840ab		100a	917bc
2	June 1969	95ab	2700ab	June 1970	78c	843bc
4		93ab	1422abc		100a	199c
2	August 1969	65d	1341bc	July 1970	68d	695bc
4		95ab	2073abc		90ab	423bc
2	September 1969	95ab	3055ab	August 1970	40f	122c
4		100a	2719ab		50e	692bc
2	October 1969	95ab	2491abc	September 1970	30g	125c
4		95ab	2788ab		50e	133c
2	February 1970	99a	2669ab	October 1970	0h	178c
4		98a	3190a		0h	263c
Control		0e	844c		0h	406bc

[1] Estimates of canopy reduction of yaupon (*Ilex vomitoria* Ait.) at time of forage harvest.
[2] Values within a column followed by the same letter are not significantly different at the 5% level.

FIG. 1. Untreated brushy area at Carlos, Texas, produced 844 lb./acre oven-dry forage (upper). Area treated with picloram granules at 4 lb./acre in February 1970 produced 3190 lb./acre oven-dry forage by October 1970 (lower). Photos taken October 1970.

is shown in Fig. 1. A treatment of 2 and 4 lb./acre of picloram applied in April 1970 caused native grass production of 2857 and 2149 lb./acre oven-dry forage, respectively (Table 3). The control plots for 1970 produced 406 lb./acre of forage. Slight damage to grasses at these rates was sometimes observed following treatment during the growing season, as indicated for the September and October 1970 treatments, when harvested in October 1970. Injury or reduction in the stand and growth was temporary since most of the grasses recovered rapidly if there was sufficient rainfall (about 15 inches) to dissipate the herbicide (Bovey and Scifres, 1971). Grass production increased with time elapsed after treatments from April to August 1970 when harvested in October 1970. Many plots had produced more grass than the control.

These studies indicate that in sub-humid areas, where high rates of herbicides are needed to control brush, substantial increases in grass production may occur shortly after treatment.

Long-term effects of herbicides used at high rates at Carlos, Texas, in 1964 and 1965, that initially killed all brush, are presented in Table 4. Close mowing of the plots in early April to clean off debris, grazing in May, and low rainfall in mid-summer reduced grass production in all plots. However, treated plots usually produced about twice as much forage as in the untreated plots. Herbicide rates reported in Table 4 exceed rates normally used in brush control by 4 to 8 times.

Herbicides sprayed at three dates at Marble Falls, Texas, indicate significant increases in grass production following effective whitebrush control (Table 5). Effective herbicides for control of whitebrush included picloram or mixtures of 2,4,5-T, 2,4-D, or dicamba with picloram. The grass stand has been maintained since 1966. Forb production, however, was essentially eliminated in plots receiving picloram at 1, 3, and 2 to 3 lb./acre for May 1969, May 1966 and September 1966, respectively. Rainfall prior to harvest in October 1970 is given in Table 1.

Picloram was not usually detected in soils to a depth of 2- to 3-ft at Carlos, Victoria, and Llano at rates up to 8, 8, and 4 lb./acre, respectively, 1 year after treatment, using bioassay and gas chromatographic detection procedures (Bovey and Scifres, 1971). Apparently disappearance and dilution of the herbicides in the soil by rainfall was rapid enough to allow grass recovery.

Table 4. Vegetation production (lb./acre, oven-dry) in October 1970 after treatment of yaupon infested ranges near Carlos, Texas, at various dates with picloram or picloram plus paraquat mixtures.[1]

Treatment	Rate (lb./acre)	Date of application	Yields[2]	
			Grasses	Forbs
Picloram	8	May 1964	908a	99ab
Picloram + paraquat	4+4	May 1964	982a	94ab
Picloram	8	June 1964	757a	39b
Picloram + paraquat	4+4	June 1964	962a	65ab
Picloram	4	June 1964	749ab	128ab
Picloram	8	October 1964	1061a	74ab
Picloram	8	May 1965	751a	71ab
Picloram + paraquat	4+4	May 1965	924a	103ab
Picloram + paraquat	4+2	May 1965	736ab	172a
Control			406c	0b

[1] All brush killed including yaupon (*Ilex vomitoria* Ait.), winged elm (*Ulmus alata* Michx.), post oak (*Quercus stellata* Wangenh.) and blackjack oak (*Quercus marilandica* Muenchh.).

[2] Values within a column followed by the same letter are not significantly different at the 5% level. Close mowing of all plots in April and grazing in May of 1970 reduced the amount of vegetation present at harvest time.

Forage Production Following Weed Control

Plots were established in 1967 to study the relative tolerance of grasses when treated with promising herbicides for control of herbaceous weeds in pastures. Data for herbicides applied at ½ and 1 lb./acre are not shown since there were usually no significant differences among treated and untreated plots (Table 6). Forb populations were low as indicated in the untreated control plots at all locations in 1967 and 1968. Low rainfall after treatment, especially at Llano and Victoria, tended to mask weed control effects due to poor growing conditions. Grass production was lowest at Llano and highest at Carlos.

No significant differences occurred in grass production between herbicide-treated and untreated areas 6 months after application at

Table 5. Vegetation production (lb./acre, oven-dry) in October 1970 and whitebrush control (%) after treatment of rangeland near Marble Falls, Texas, with various herbicides in May and September 1966 and May 1969.[1]

Date of application	Treatment	Rate (lb./acre)	Whitebrush control[2]		Oven-dry yield[2]	
			Defoliation	Dead	Grasses	Forbs
May 1969	MCPA	1	70d	0d	1133cd	301bd
	Picloram	1	95ab	55ab	2435a	0d
	Picloram	0.5	90ab	30bcd	2322a	8d
	Picloram + 2,4,5-T (amine salts)	0.5+0.5	92ab	40bcd	1940ab	8d
	Picloram + 2,4,5-T (ester)	0.5+0.5	92ab	35bcd	2240a	8d
	2,4,5-T	1	29e	0d	939d	450b
	Picloram + 2,4-D	0.33+0.67	86bc	15cd	2403a	12d
	2,4-D	1	79cd	15cd	1696abcd	31d
	Picloram + dicamba	0.5+0.5	94ab	45bc	1802abc	12d
	Dicamba	1	13f	0d	1396bcd	70d
	Picloram[3]	1	94ab	55ab	2303a	0d
	Control	–	10f	0d	851d	821a
May 1966	Picloram	2	98a	85a	1934ab	98cd
	Picloram	3	98a	85a	2140ab	4d
September 1966	Picloram	1	93ab	60ab	1371bcd	203cd
	Picloram	2	99a	95a	2209a	0d
	Picloram	3	99a	90a	2153ab	4d
	MCPA	2	18f	0d	951d	493b
	Control	–	10f	0d	976d	325bc

[1] Brush is predominately whitebrush (*Aloysia lycioides* Cham.) with scattered plants of tasajillo (*Opuntia leptocaulis* DC.) and Texas persimmon (*Diospyros texana* Scheele).

[2] Values followed by the same letter do not differ at the .05 level of significance.

[3] Isooctyl ester.

Table 6. Oven-dry production (lb./acre) of herbaceous vegetation following weed control in pastures at three locations in Texas.[1]

Herbicide	Llano[2]		Victoria[2]		Carlos[2]	
	Grass	Forbs	Grass	Forbs	Grass	Forbs
Atrazine spray	1339a	2	2311	3	3814	7
Atrazine granules	620ab	6	2083	79	4456	19
Simazine spray	1193ab	3	1864	30	4454	1
Simazine granules	1243ab	172	2129	115	4082	62
Picloram spray	1058ab	10	1818	17	3888	0
Picloram granules	397b	0	2519	5	4321	0
2,4-D spray	519ab	38	1693	96	4481	6
Control	1086ab	228	1649	165	3267	325

[1]Treated with 2 lb./acre of all herbicides, March 16, 17 and 20, 1967; harvested September 13, October 4 and September 18, 1967, for Carlos, Victoria and Llano, Texas, respectively.
[2]Values within column one followed by the same letter are not significantly different at the 5% level; values in all other columns are not significantly different.

Llano, Texas. However, picloram granules at 2 lb./acre tended to reduce grass and forb production. Highest grass yields at Victoria were produced in plots receiving picloram granules at 2 lb./acre. Trends were apparent among treatments, but no significant increases occurred in grass and forb production due to weed control. At Carlos, Texas, no differences occurred among treatments but grass production tended to increase as application rate was increased. Picloram sprays and granules at 2 lb./acre eliminated all forbs.

Additional studies at Carlos were established in October 1967 and April 6, 1968 (Table 7). Plots treated in March 1967, October 1967, and April 1968 were harvested in November 1968. Significant differences in grass yields among treatments usually did not occur. Atrazine granules and picloram sprays and granules at 2 lb./acre killed all forbs in the April 1968 treatments, but had little effect in plots treated in March 1967 and October 1968. Abundant rainfall during 1968 (Table 1) apparently dissipated the herbicides rapidly.

Table 7. Oven-dry production (lb./acre) of herbaceous vegetation following herbicide applications at three dates on pastures at Carlos, Texas.[1]

Herbicide	Spring 1968[2]		Fall 1968[2]		Spring 1967[2]	
	Grass	Forbs	Grass	Forbs	Grass	Forbs
Atrazine spray	3328	54	3665	345	3758	163
Atrazine granules	4107	0	3578	145	2596	109
Simazine spray	3287	18	3746	182	4030	36
Simazine granules	2997	36	3972	127	2805	18
Picloram spray	3165	0	3723	454	4426	381
Picloram granules	2942	0	3195	435	3142	254
2,4-D spray	3322	0	3107	454	2796	363
Control	3078	170	2977	299	3009	423

[1]Treated with 2 lb./acre of all herbicides, March 16, 1967; October 1967 and April 6, 1968 and harvested November 5, 6 and July 1968.
[2]Values in all columns are not significantly different at the 5% level.

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