# RATES AND DATES OF 2,4-D APPLICATION FOR RANGE WEED CONTROL IN CENTRAL AND EASTERN OKLAHOMA

By

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

# CHAPTER I

## INTRODUCTION

Approximately half of the total land area of the United States is used for pastures and grazing purposes, and weeds are a problem on nearly all these forage lands (24). The rangelands have declined in productivity during the past century, as a result of poor management and lack of scientific knowledge (24). One of the real challenges in agriculture today is to bring these rangelands back to high productivity.

Trends toward dominance by weeds can be halted or changed by judicious use of chemical control methods, introduction of new forage-plant species, and control of the kinds and numbers of grazing animals and their seasons of use. Because of factors such as climate and soil depletion or erosion, some ranges do not respond readily to improvement measures. Nevertheless, many rangelands in Oklahoma can be made more productive by existing techniques of which almost all will include some form of chemical weed control.

One of the problems with using a phenoxy herbicide such as 2,4-D (2,4-dichlorophenoxy acetic acid), has been susceptible crops such as soybeans and cotton. If good results could be obtained from early application before susceptible crops are planted, this would reduce the difficulties in many areas.

The purpose of this study was to evaluate rates and dates of 2,4-D application for range weed control. If earlier dates and lighter application rates could be used, this will greatly enhance the opportunity of obtaining satisfactory weed control without harming susceptible crops.

## CHAPTER II

## LITERATURE REVIEW

The effectiveness of herbicides as a weed control measure has been substantiated by research and widespread use in field crops. Chemical weed control on native ranges has also been used as a means of range improvement. Reduction of weed populations releases the grasses from competition for water, nutrients, light, and other factors of the environment.

Audus (1), Fletcher (8), Sheets and Danielsen (25), and Thiegs (29) in exhaustive reviews show that herbicides exert a marked effect on the ecology of soil microorganisms. Processes such as soil respiration, ammonification and nitrification may serve as indices of the persistence or decomposition of these chemicals.

In Nebraska, Klingman and McCarty (19) reported that one pound of 2,4-D ester per acre, applied for three years, decreased perennial broadleaf weeds 70 per cent and increased forage production 47 per cent. Other studies including those by Cornelius and Graham (4) and Mitich (23) have reported an increase in grass with a reduction of broadleaf plants by spraying with herbicides. Hurd (12) found in Wyoming, total forb cover, as well as herbage production, showed a greater reduction with the two and four pound rates of 2,4-D than with the one pound rate.

Smika et al. (26), reported highly significant increases in native grass yields by spraying high infestations of fringed sage (Artemisia frigida) with 2.5 pounds of 2,4-D per acre.

Major advantages of herbicides are: high selectivity, quick kill, low cost, use on steep and rocky areas, and protection of the soil from erosion. Herbicides, however, do damage the desirable plants when used at certain times and concentrations. Since many plants are susceptible to injury only at certain growth stages, injury to desirable species may be reduced by controlling herbicidal concentrations and by proper timing.

Klingman (20) pointed out that susceptibility coincides with periods of active growth. For example, small grains may be very susceptible to 2,4-D in the germinating and seeding stages, tolerant in the fully tillered stage, and again susceptible in the jointing and heading stage. Though most plants become more tolerant with age, others remain susceptible. However, Klingman (14) reported no lasting herbicidal damage to seedlings of warm or cool season grasses.

On grazed ranges, the ground cover and air-dry herbage production of forbs are often two to three times that of the combined grasses and sedges, Hurd and Kissinger (13).

Sperry (28) found that broadcast applications with formulations of 2,4-D applied at the rate of one pound per acre have obtained the best control of rayless goldenrod, (Iscoma wrightii). Good kills of perennial broomweed, (Gutierrezia sarothrae) resulted from 2,4-D applied by both ground and air equipment at the rate of one pound per acre in the spring, under optimum growing conditions (27). In California, Cornelius and Graham (6) obtained an 85 per cent kill of

big sagebrush (Artemisia tridentata) and a large increase in native perennial grasses through applications of one pound of 2,4-D butyl ester per acre in late June. Studies in Wyoming by Hull et al. (11) indicate that at least 75 per cent of a big sagebrush stand can be killed by applications of two pounds of 2,4-D isopropyl ester per acre, thus allowing native grass production to double or triple. Blaisdell and Mueggler (2) found that various esters of 2,4-D when applied in sufficient quantity at the proper season can effectively thin a stand of big sagebrush and allow a substantial increase in native grasses.

Klingman (18) stated that herbicides are more efficient for the control of most broad-leaved weeds and brush than mowing or hand clearing. Effective control is not dependent upon very critical timing, as is mowing; nevertheless, for many perennial plants, there is a definite relationship between optimum time for mowing and optimum time for spraying (16, 17). Klingman and McCarty (15, 16, 17) found that the total production of dry matter in pasture treatments, where most of the broad-leaved weeds were controlled, averaged 92 per cent more than that of the weedy check.

Corns and Schraa (6) found that repeated treatments with rates of 2,4-D of from one to four pounds per acre applied to intact plants of silverberry (Elaeagnus commutata) in June and to the limited re-growth in August were no more effective than single early summer treatments.

McIlvain et al. (22) conducted extensive control experiments on sand sagebrush, (Artemisia filifolia) in Oklahoma, showing that one proper application of 2,4-D at one to two pounds per acre could kill

three-fourths of the sagebrush on infested lands.

In a study conducted in Canada, Hay and Quellettee (10) found that the best results from the standpoint of both yield of grass and reduction of weeds in pastures were obtained when fertilizer treatments were supplemented by 2,4-D applications.

Hauser et al. (9) found in a study in North Carolina that ester or amine salt formulations of 2,4-D at rates sufficiently high to control most annual broad-leaved weeds and many perennial weeds could be used safely in ladino clover-orchard grass pasture if applied during tolerant stages of growth. There was no marked difference in yield of total forage due to formulation or rate of 2,4-D applied in April, June, or August.

Elder (7) reported that some pastures in Oklahoma produced 1000 pounds per acre dry weight of western ragweed (Ambrosia psilostachya) and that it was considered the most harmful pasture weed on most of the 18 million acres of grassland in the state. He further stated that mowing to control ragweed was not effective but that 2,4-D at one-half to three-fourths pound per acre would eradicate it.

Control studies by Bovey et al. (3) on western ragweed in Nebraska showed that as little as one-half pound of 2,4-D per acre gave effective control for at least three years when applied in late May.

# CHAPTER III

## METHODS AND MATERIALS

In April, 1969, a study was initiated at two locations to study the effects of rates and dates of 2,4-D application for range weed control. One site was located northwest of Stillwater, Oklahoma[1], and the other at the Eastern Oklahoma Pasture Station near Muskogee[2]. The same experimental design, treatments, methods and techniques were used at each location.

### Treatments

A factorial design with five application dates and four rates of 2,4-D plus an unsprayed check in four replications was used.

The analysis of variance was calculated first with the untreated check, then the check was dropped out to have a balanced factorial to detect interaction effects.

The four rates of 2,4-D were: 1/4, 1/2, 1, and 2 pounds of active ingredient per acre plus the unsprayed check. The five treatments were applied, beginning in early April, at approximately two

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[1] In the Southeast quarter ($SE^4$), of the ($SE^4$), of section thirty-two (32), township twenty (20), north (N), range two (2), east (E) of the Indian Meridian.

[2] In the Southeast quarter ($SE^4$), of the ($NE^4$), of the ($NE^4$) of section thirty-two (32), township fourteen (14), north (N), range seventeen (17), east (E) of the Indian Meridian.

week intervals (Table I). The treatment intervals varied due to climatic conditions. Soil moisture was excellent during all treatments. All treatments were applied with a wind reading below 10 miles per hour. The minimum and maximum temperatures for both locations from March 1 through June 30, 1969, are listed in Appendix Tables XI and XII.

Most weed species were in the rosette stage at both study areas on the first application date. All were less than one inch in height. By the second application date all plants were actively growing. Many of the early maturing species such as daisy fleabane (Erigeron strigosus Muhl)[3], and blackeyedsusan (Rudbeckia hirta L.) were in the third leaf stage. On the third spray date all plants were in the early elongation stage. Western yarrow (Achillea lanulosa Nutt.) and bighop clover (Trifolium procumbens L.) were starting to bloom. By the fourth date all dominant cool season weedy species were blooming. Some of these species were daisy fleabane, western yarrow, blackeyed-susan, bighop clover, and wavyleaf thistle (Cirsium undulatum Nutt. Spreng.). By the fifth application date the dominant cool season species had matured and were producing seed.

The plots were 14 feet by 40 feet. A low volatile ester of 2,4-D was applied from a ground sprayer with 30 gallons per acre volume applied at 30 pounds per square inch and 3 miles per hour.

## Forage and Forb Production

Total plant production was determined by clipping a 3 by 10 foot area in each plot. The samples were clipped approximately 1

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[3]Nomenclature of plants in this study follows Waterfall (30).

TABLE I

DATES OF 2,4-D APPLICATION FOR RANGE WEED CONTROL PLUS ENVIRONMENTAL DATA FOR STILLWATER AND MUSKOGEE, 1969

| LOCATION[1] | DATE | | TEMPERATURE (F) SOIL | TEMPERATURE (F) AIR | PER CENT RELATIVE HUMIDITY | TIME |
|---|---|---|---|---|---|---|
| S | 1st | April 2 | 63° | 62° | 92 | 7:00 p.m. |
| M | 1st | April 3 | 68° | 70° | 72 | 5:15 p.m. |
| S | 2nd | April 21 | 74° | 66° | 80 | 5:15 p.m. |
| M | 2nd | April 22 | 81° | 82° | 30 | 2:55 p.m. |
| S | 3rd | May 5 | 76° | 68° | 76 | 5:15 p.m. |
| M | 3rd | May 6 | 88° | 83° | 76 | 1:30 p.m. |
| S | 4th | May 26 | 79° | 80° | 79 | 9:30 a.m. |
| M | 4th | May 23 | 78° | 75° | 96 | 5:30 p.m. |
| S | 5th | June 16 | 72° | 74° | 65 | 8:45 a.m. |
| M | 5th | June 9 | 77° | 71° | 72 | 3:00 p.m. |

[1]S indicates Stillwater; M denotes Muskogee.

[2]Time when field application commenced. Total application took approximately two hours.

inch above ground level. Two harvests were made at each site, one in June and the other in August. Each harvest was taken from a different site within the plot. Grasses and forbs were divided by hand separation. Only green, growing plants were harvested. Field samples were oven dried, weighed, and yields converted to total dry weight per acre.

The first harvest was to obtain data on cool season forbs, most of which were nearing maturity at the first harvest date. Some of the plant species which were noted in the first harvest were daisy fleabane, blackeyedsusan, and western yarrow.

The second harvest provided information on warm season forbs, primarily western ragweed (Ambrosia psilostachya DC, var. coronopifolia T. & G), and included at Muskogee, lanceleaf ragweed (Ambrosia bidentata Michx.). None of the cool forbs were included in this harvest because all were matured and dried if not partially disintegrated.

Common and scientific names of all plants observed in the study are listed in Appendix Table XIII.

## Species Composition

Forb counts were taken with a 6-inch by 20-foot belt transect. The transect was read at ground level, with all plant species under the transect being recorded. The belt transect readings were taken in June and August.

Species composition of the study area was determined by the point frame method, described by Levy and Madden (21), using a total of 400 points at each location to characterize the flora of the site

(Appendix Tables XIV and XV). These samples were taken in unsprayed control plots in late August.

## Stillwater Site

The Stillwater study was conducted on a poor condition, loamy prairie range site. The soil of this area is Zaneis loam with 1-3% slope. The climate of the area is relatively temperate, but with hot, often dry summers, mild autumns, mild to cold winter, and cool springs. Average annual precipitation is 32 inches. Rainfall for the study area was 10 per cent below normal for 1969 (Appendix Table XVI).

## Muskogee Site

The study at Muskogee was conducted on a poor condition, loamy prairie range site. The soil at this site is Taloka silt loam with 1-3% slope. The climate of the area is of warm, humid continental type. Average annual precipitation is 42 inches. Rainfall for the study area was 11 per cent below normal for 1969 (Appendix Table XVII).

# CHAPTER IV

## RESULTS AND DISCUSSION

Soil moisture conditions were excellent through June 15, 1969, but severe midsummer drought developed as the season progressed. This undoubtedly affected the production at the second harvest.

### Forb Production, 1st Harvest, Stillwater

The Stillwater first harvest was June 12, 1969, which was before the fifth date of application. Therefore, data from only the first four application dates are presented.

All four dates of application produced significant reductions in forb production from that of the unsprayed check plots (Figure 1). The greatest reduction in forbs was obtained at the second date which was not significantly different from that of the first date, but the second date of application was significantly superior to the third date in forb control. At this time, the unsprayed plots had already produced 467 pounds per acre of primarily cool season forbs. The fifth spray date was too late to have any effect on these annual forbs because many were already producing seed.

Although the total forb production was significantly reduced by all rates of 2,4-D there was no difference between application rates (Table II).

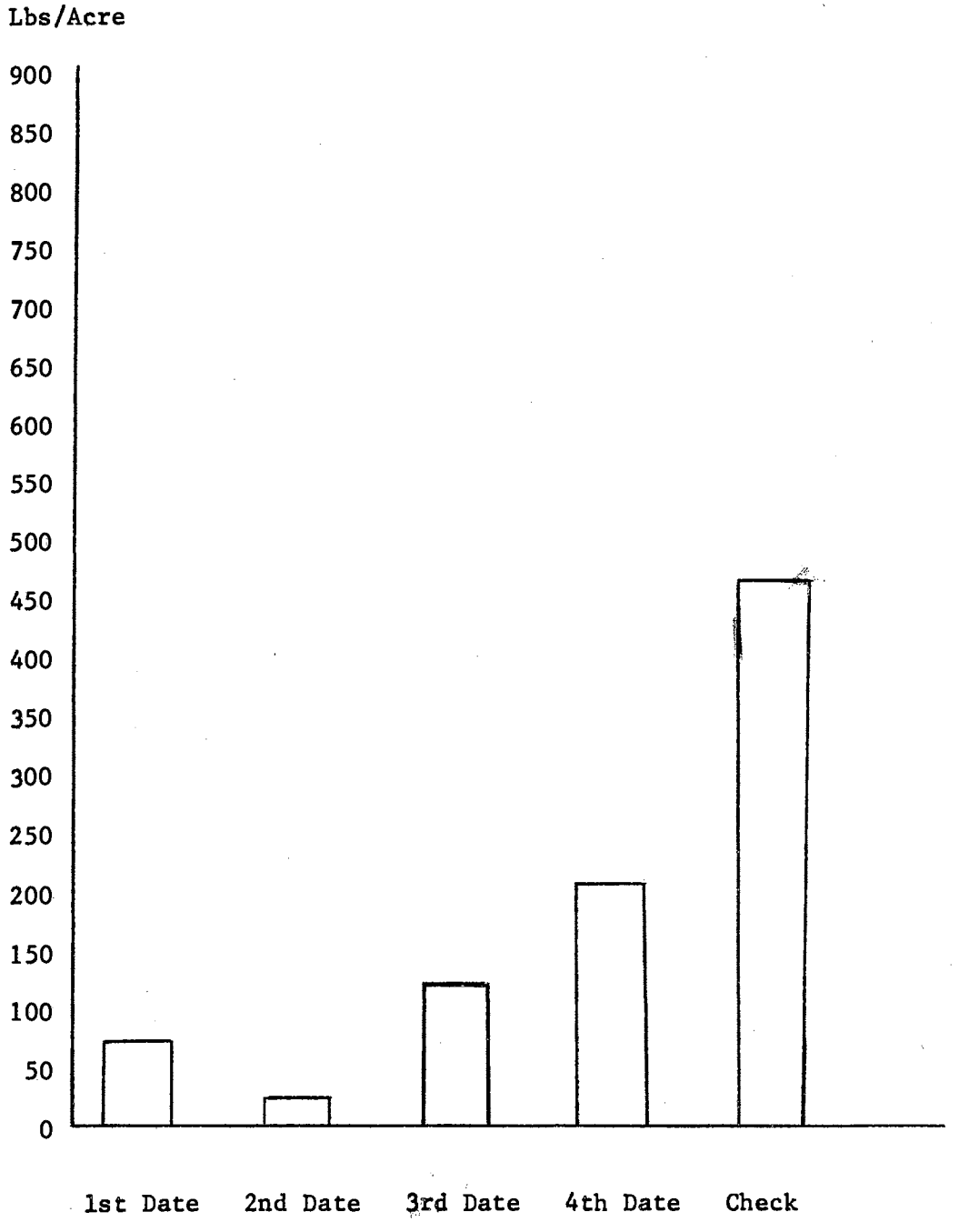


Figure 1. Weed Production at Stillwater, June 12, 1969, as Influenced by Dates of 2,4-D Application. (LSD = 65 pounds per acre).

TABLE II

WEED PRODUCTION[1] IN POUNDS PER ACRE AS INFLUENCED BY RATES AND DATES OF 2,4-D, STILLWATER, FIRST HARVEST[2]

| Dates | RATES IN LBS/A 1/4 | 1/2 | 1 | 2 | Date Means |
|---|---|---|---|---|---|
| 1st | 107 | 105 | 5 | 49 | 68bc |
| 2nd | 53 | 29 | 14 | 18 | 29c |
| 3rd | 200 | 109 | 156 | 44 | 129b |
| 4th | 286 | 200 | 177 | 195 | 216a |
| Rate Means | 161a | 113a | 87a | 77a | |

Unsprayed Check--467[3]

[1]Means within a column or within a row followed by the same letter are not significantly different. (P=.05)

[2]Fifth date is not included because it had not been applied by the time of this clipping.

[3]Production was significantly greater than that of any sprayed plots.

## Forb Production, 2nd Harvest, Stillwater

The second harvest at Stillwater was August 7, 1969. This harvest included all five application dates. However, only green actively growing plants, primarily ragweeds, were harvested. All early maturing annual forbs were gone by the second harvest.

All application dates produced significant reductions in forb production from that of the untreated check plots (Figure 2). The greatest forb reduction occurred on the second date which was not significantly different from that of the third or fourth date but was significantly superior to either the first or fifth date of application. The untreated check produced 544 pounds of broadleaf forbs per acre.

All rates of application produced significant reductions in forb yields from that of the unsprayed check plots, but the 1/2, 1, and 2 pound rates produced the greatest forb reduction (Table III).

## Forb Production, 1st Harvest, Muskogee

The first harvest was June 18, 1969, at Muskogee, which was only nine days after the fifth date of application. Therefore, only data from the first four application dates are presented.

These four application dates produced significant reductions in forb yield as compared to the untreated check plots (Figure 3). The greatest reduction in forbs was obtained on the second date which was not significantly different from that of the third date, but the second date of application was significantly superior to both the first and fourth dates in forb control. The unsprayed plots at this

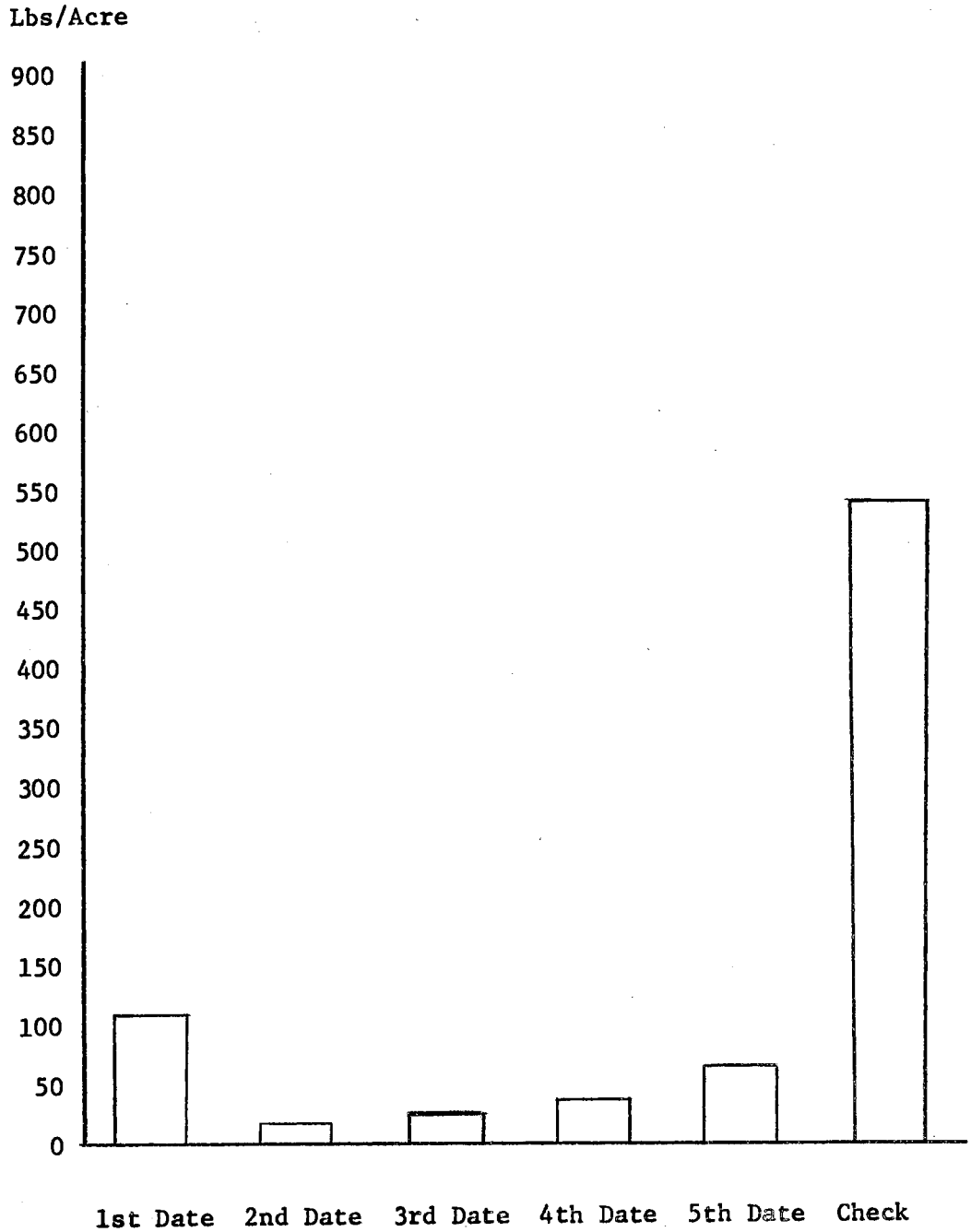


Figure 2. Weed Production at Stillwater, August 7, 1969, as Influenced by Dates of 2,4-D Application. (LSD = 22 pounds per acre).

TABLE III

WEED PRODUCTION[1] IN POUNDS PER ACRE AS INFLUENCED BY RATES AND DATES OF 2,4-D, STILLWATER, SECOND HARVEST

| Dates | RATES IN LBS/A | | | | Date Means |
|---|---|---|---|---|---|
| | 1/4 | 1/2 | 1 | 2 | |
| 1st | 225 | 77 | 93 | 42 | 110a |
| 2nd | 52 | 1 | 0 | 5 | 13c |
| 3rd | 46 | 32 | 7 | 5 | 23c |
| 4th | 135 | 25 | 0 | 2 | 42c |
| 5th | 162 | 60 | 10 | 56 | 71b |
| Rate Means | 126a | 39b | 23b | 23b | |

Unsprayed Check--544[2]

[1]Means within a column or within a row followed by the same letter are not significantly different. (P=.05)

[2]Production was significantly greater than that of any sprayed plots.

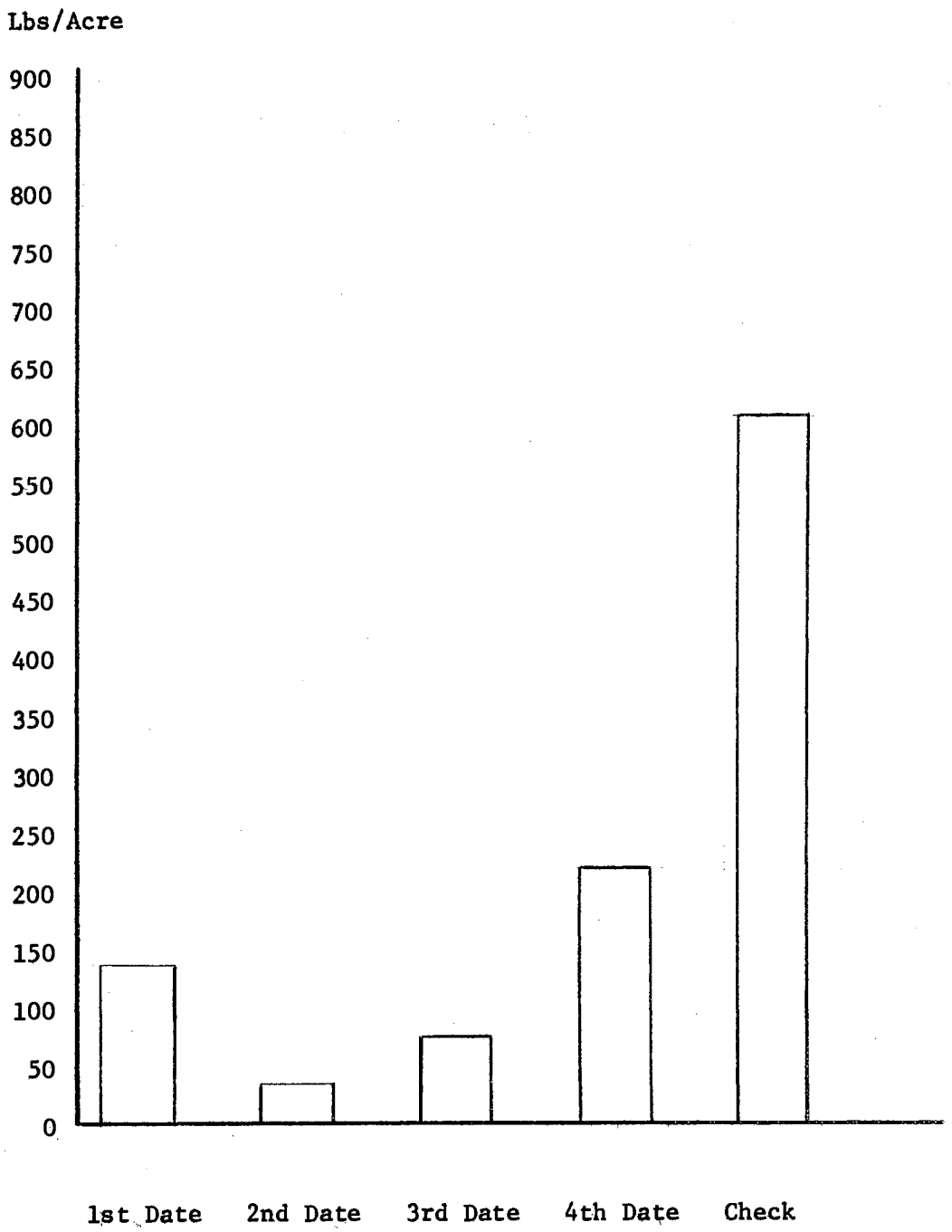


Figure 3. Weed Production at Muskogee, June 18, 1969, as Influenced by Dates of 2,4-D Application. (LSD = 108 pounds per acre).

time had already produced 605 pounds per acre of mainly cool season forbs.

Forb production was significantly reduced by all application rates and the 2 pound rate was superior to the 1/4 and 1/2 pound rate (Table IV).

### Forb Production, 2nd Harvest, Muskogee

The second Muskogee harvest was on August 19, 1969, which included all five application dates.

Total forb production in the untreated check plots was 845 pounds per acre which was the highest of all harvests at either location.

All application dates produced significant decreases in forb production from that of the untreated checks (Figure 4). The least effective date was the first, but no differences existed between the last four dates of application.

Every rate of application produced significant forb reduction when compared to the unsprayed check plots. However, the 1/2, 1, and 2 pound application rates were significantly superior to the 1/4 pound rate (Table V).

### Grass Production

There was no significant difference between the treated plots and the untreated plots at either location in grass production (Appendix Table XXII). Perhaps one reason for lack of improvement in grass production could be attributed to the fact that the grass yield was dominated by early maturing cool season grasses plus the midsummer droughty conditions which affected the last harvest.

TABLE IV

WEED PRODUCTION[1] IN POUNDS PER ACRE AS INFLUENCED BY RATES AND DATES OF 2,4-D, MUSKOGEE, FIRST HARVEST[2]

| Dates | RATES IN LBS/A 1/4 | 1/2 | 1 | 2 | Date Means |
|---|---|---|---|---|---|
| 1st | 178 | 206 | 135 | 60 | 145ab |
| 2nd | 94 | 29 | 13 | 24 | 39b |
| 3rd | 45 | 97 | 69 | 55 | 68b |
| 4th | 399 | 360 | 95 | 48 | 225a |
| Rate Means | 180a | 174a | 77ab | 48b | |

Unsprayed Check--605[3]

[1]Means within a column or within a row followed by the same letter are not significantly different. (P=.05)

[2]Fifth date was not included because application was just previous to the clipping.

[3]Production was significantly greater than that of any sprayed plots.

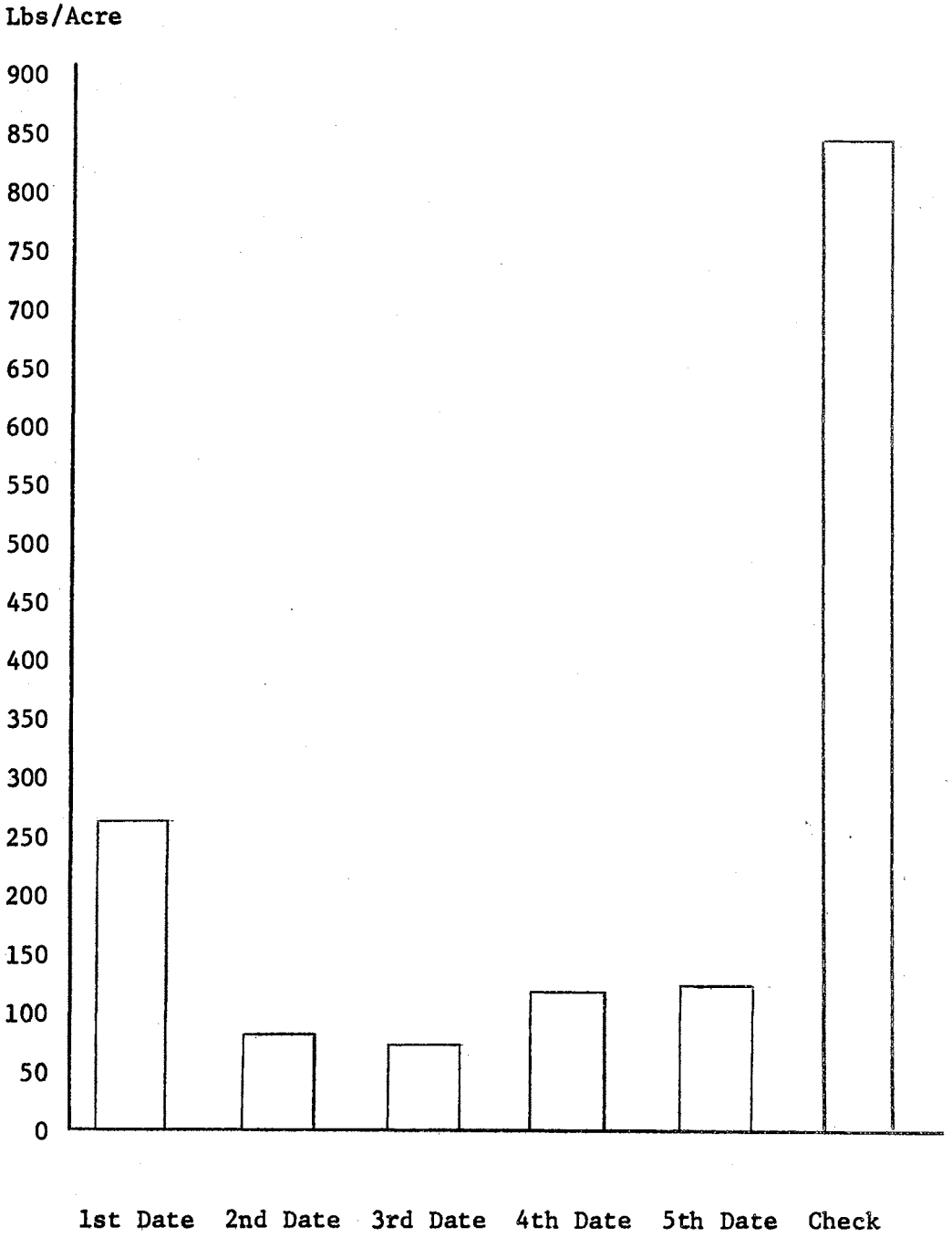


Figure 4. Weed Production at Muskogee, August 19, 1969, as Influenced by Dates of 2,4-D Application. (LSD = 88 pounds per acre).

TABLE V

WEED PRODUCTION IN POUNDS PER ACRE AS INFLUENCED BY RATES AND DATES OF 2,4-D, MUSKOGEE, SECOND HARVEST[1]

| Dates | RATES IN LBS/A | | | | Date Means |
|---|---|---|---|---|---|
| | 1/4 | 1/2 | 1 | 2 | |
| 1st | 316 | 364 | 213 | 169 | 264a |
| 2nd | 255 | 30 | 10 | 11 | 77b |
| 3rd | 221 | 52 | 9 | 0 | 71b |
| 4th | 265 | 99 | 106 | 9 | 119b |
| 5th | 341 | 82 | 56 | 11 | 122b |
| Rate Means | 280a | 126b | 77b | 39b | |

Unsprayed Check--845[2]

[1]Means within a column or within a row followed by the same letter are not significantly different. (P=.05)

[2]Production was significantly greater than that of any sprayed plots.

## Forb Numbers

Plant counts were made before each harvest at both locations. The majority of the weeds in the June harvest were western yarrow and blackeyedsusan. The August harvests were primarily ragweeds. Only the data for the major weedy plants were presented because of the high variation in these data.

Blackeyedsusan is a common invader on the native ranges of earlier successional stages. It produces mature seeds by early June and the plant counts at Stillwater, indicated that one and two pound rates on the first two dates gave some control (Table VI). As the season progressed, it was apparent that even at the higher rates the plant was much more difficult to control.

The plant count study at Muskogee gave quite similar results on blackeyedsusan (Table VII). The higher rates at the second and third dates gave satisfactory results but the fourth date, May 23, was too late for any reasonable suppression of this species.

Another weed dominant in this study was western ragweed, a native, warm-season perennial forb. Western ragweed at Stillwater was controlled quite satisfactorily with higher rates at the first four dates (Table VIII). Even the 1/4 pound rate, gave good results at the third and fourth dates.

The results on western ragweed at Muskogee were unsatisfactory at the lower rates (Table IX). Apparently 1 to 2 pounds of 2,4-D per acre will be required to achieve some control over this species.

Lanceleaf ragweed, which is a dominant weedy forb in eastern Oklahoma was not found at Stillwater. The plant counts on this

TABLE VI

AVERAGE NUMBER OF BLACKEYEDSUSAN PLANTS PER TRANSECT FOR EACH RATE AND DATE OF 2,4-D AT STILLWATER, JUNE 4, 1969

| | RATES IN LBS/A | | | |
|---|---|---|---|---|
| Dates | 1/4 | 1/2 | 1 | 2 |
| 1st | 10 | 11 | 3 | 0 |
| 2nd | 25 | 14 | 7 | 2 |
| 3rd | 22 | 13 | 10 | 6 |
| 4th | 15 | 21 | 25 | 28 |
| 5th | * | * | * | * |
| Check | 15 | | | |

*Plant count readings were made before the last application; therefore, no information was available for the fifth date.

TABLE VII

AVERAGE NUMBER OF BLACKEYEDSUSAN PLANTS PER TRANSECT FOR EACH RATE AND DATE OF 2,4-D AT MUSKOGEE, JUNE 9, 1969

| | RATES IN LBS/A | | | |
|---|---|---|---|---|
| Dates | 1/4 | 1/2 | 1 | 2 |
| 1st | 7 | 3 | 5 | 3 |
| 2nd | 4 | 3 | 3 | 4 |
| 3rd | 2 | 4 | 1 | 2 |
| 4th | 7 | 7 | 5 | 9 |
| 5th | * | * | * | * |
| Check 7 | | | | |

*Plant count readings were made before the last application; therefore, no information was available for the fifth date.

TABLE VIII

AVERAGE NUMBER OF WESTERN RAGWEED PLANTS PER TRANSECT FOR EACH RATE AND DATE OF 2,4-D AT STILLWATER AUGUST 1, 1969

| | RATES IN LBS/A | | | |
|---|---|---|---|---|
| Dates | 1/4 | 1/2 | 1 | 2 |
| 1st | 35 | 9 | 12 | 2 |
| 2nd | 28 | 4 | 2 | 0 |
| 3rd | 19 | 9 | 1 | 0 |
| 4th | 20 | 9 | 12 | 7 |
| 5th | 36 | 26 | 20 | 20 |

Check 48

TABLE IX

AVERAGE NUMBER OF WESTERN RAGWEED PLANTS PER TRANSECT FOR EACH RATE AND DATE OF 2,4-D AT MUSKOGEE, AUGUST 7, 1969

| | RATES IN LBS/A | | | |
|---|---|---|---|---|
| Dates | 1/4 | 1/2 | 1 | 2 |
| 1st | 20 | 10 | 5 | 2 |
| 2nd | 20 | 5 | 1 | 0 |
| 3rd | 18 | 1 | 0 | 14 |
| 4th | 25 | 3 | 1 | 1 |
| 5th | 15 | 2 | 0 | 0 |

Check 14

species at Muskogee revealed some degree of control on all treated plots (Table X). The best suppression on this species came from earlier dates and higher rates of 2,4-D.

TABLE X

AVERAGE NUMBER OF LANCELEAF RAGWEED PLANTS PER TRANSECT FOR EACH RATE AND DATE OF 2,4-D AT MUSKOGEE, AUGUST 7, 1969

| | RATES IN LBS/A | | | |
|---|---|---|---|---|
| Dates | 1/4 | 1/2 | 1 | 2 |
| 1st | 12 | 8 | 5 | 6 |
| 2nd | 15 | 9 | 5 | 0 |
| 3rd | 16 | 10 | 1 | 1 |
| 4th | 20 | 14 | 1 | 2 |
| 5th | 35 | 4 | 1 | 1 |
| Check 50 | | | | |

# CHAPTER V

## SUMMARY AND CONCLUSIONS

In April of 1969, a detailed study on the effects of 2,4-D for range weed control at two locations was initiated. Primarily the plants studied were forb species such as daisy fleabane, western yarrow, wavyleaf thistle, blackeyedsusan, western ragweed, and lanceleaf ragweed. A wide range of rates and dates of 2,4-D for range weed control gave good results.

Generally, the early April treatment was too early for the lighter application rates (1/4 and 1/2 pound), but good control was obtained at Stillwater from these on the late April and early May applications. At Muskogee the 1/2-1 pound rates gave good control in late April and early May. As the growing season advanced, a higher rate was needed to obtain satisfactory results.

By early June the unsprayed plots had produced 467 pounds per acre of weedy forbs at Stillwater, and 544 pounds per acre at Muskogee. Early dates were more effective for cool season forbs but less effective for warm season forbs.

The data and the statistical analyses from both studies, indicate satisfactory control of weedy species in this first year; however, grass yield was only improved slightly. The grass composition was composed mainly of cool season grasses which were gone after the first harvest. The limited increase in grass yield probably was the

result of a summer drought which affected the late harvest yields.

From these data, it can be concluded that it is possible to achieve good weed control on native range, by spraying ahead of the planting of susceptible crops such as cotton and soybeans.

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# APPENDIX

TABLE XI

DAILY MINIMUM AND MAXIMUM TEMPERATURE[1] FROM MARCH 1, 1969, THROUGH JUNE 30, 1969, AT STILLWATER (DEGREES FAHRENHEIT)

| Day | March | | April | | May | | June | |
|---|---|---|---|---|---|---|---|---|
| | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. |
| 1 | 26 | 49 | 43 | 54 | 57 | 79 | 58 | 91 |
| 2 | 33 | 50 | 53 | 77 (1st)[2] | 57 | 80 | 54 | 73 |
| 3 | 31 | 44 | 54 | 72 | 59 | 81 | 54 | 75 |
| 4 | 22 | 47 | 56 | 82 | 61 | 79 | 55 | 77 |
| 5 | 25 | 50 | 42 | 84 | 62 | 74 (3rd) | 54 | 76 |
| 6 | 34 | 40 | 39 | 56 | 59 | 77 | 58 | 88 |
| 7 | 29 | 42 | 44 | 65 | 58 | 80 | 64 | 92 |
| 8 | 23 | 49 | 59 | 80 | 57 | 74 | 64 | 90 |
| 9 | 16 | 30 | 57 | 87 | 47 | 60 | 60 | 88 |
| 10 | 18 | 37 | 48 | 75 | 51 | 75 | 60 | 69 |
| 11 | 21 | 34 | 39 | 71 | 43 | 68 | 64 | 84 |
| 12 | 18 | 39 | 48 | 74 | 54 | 78 | 61 | 90 |
| 13 | 21 | 41 | 53 | 71 | 56 | 81 | 60 | 77 |
| 14 | 26 | 51 | 42 | 62 | 63 | 82 | 62 | 80 |
| 15 | 31 | 36 | 53 | 72 | 56 | 81 | 52 | 69 |
| 16 | 27 | 42 | 57 | 82 | 58 | 80 | 55 | 73 (5th) |
| 17 | 29 | 57 | 54 | 80 | 55 | 78 | 59 | 79 |
| 18 | 32 | 68 | 48 | 69 | 53 | 57 | 60 | 78 |
| 19 | 35 | 76 | 40 | 58 | 51 | 68 | 60 | 84 |
| 20 | 36 | 85 | 39 | 65 | 55 | 83 | 67 | 91 |
| 21 | 27 | 64 | 41 | 71 (2nd) | 65 | 85 | 70 | 85 |
| 22 | 39 | 70 | 55 | 78 | 59 | 87 | 75 | 95 |
| 23 | 48 | 72 | 51 | 79 | 54 | 65 | 67 | 97 |
| 24 | 37 | 51 | 42 | 67 | 54 | 73 | 67 | 90 |
| 25 | 32 | 45 | 51 | 72 | 61 | 82 | 67 | 91 |
| 26 | 26 | 50 | 60 | 73 | 61 | 84 (4th) | 77 | 91 |
| 27 | 31 | 55 | 48 | 69 | 64 | 87 | 74 | 93 |
| 28 | 42 | 64 | 40 | 64 | 66 | 87 | 75 | 94 |
| 29 | 30 | 68 | 35 | 58 | 66 | 89 | 76 | 95 |
| 30 | 31 | 47 | 40 | 72 | 66 | 91 | 75 | 95 |
| 31 | 29 | 50 | -- | -- | 69 | 90 | -- | -- |

[1] Official Weather Bureau Station was approximately 2 miles south of the plots.

[2] Refers to dates of herbicide applications.

TABLE XII

DAILY MINIMUM AND MAXIMUM TEMPERATURE[1] FROM MARCH 1, 1969, THROUGH JUNE 30, 1969, AT MUSKOGEE (DEGREES FAHRENHEIT)

| Day | March | | April | | May | | June | |
|---|---|---|---|---|---|---|---|---|
| | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. |
| 1 | 32 | 50 | 44 | 76 | 52 | 79 | 58 | 84 |
| 2 | 32 | 49 | 58 | 76 | 50 | 82 | 51 | 74 |
| 3 | 36 | 49 | 58 | 82 (1st)[2] | 52 | 81 | 49 | 74 |
| 4 | 26 | 52 | 62 | 80 | 57 | 76 | 53 | 78 |
| 5 | 33 | 51 | 46 | 68 | 62 | 77 | 55 | 84 |
| 6 | 33 | 44 | 47 | 64 | 55 | 83 (3rd) | 59 | 88 |
| 7 | 25 | 55 | 48 | 79 | 60 | 78 | 63 | 86 |
| 8 | 25 | 45 | 59 | 76 | 53 | 72 | 62 | 87 |
| 9 | 17 | 39 | 65 | 80 | 44 | 76 | 62 | 80 (5th) |
| 10 | 19 | 37 | 48 | 72 | 53 | 72 | 59 | 62 |
| 11 | 20 | 39 | 44 | 76 | 41 | 77 | 67 | 89 |
| 12 | 28 | 46 | 53 | 75 | 54 | 78 | 70 | 85 |
| 13 | 26 | 51 | 51 | 66 | 60 | 81 | 63 | 88 |
| 14 | 33 | 45 | 50 | 71 | 57 | 83 | 63 | 81 |
| 15 | 37 | 51 | 51 | 82 | 58 | 78 | 52 | 74 |
| 16 | 36 | 62 | 55 | 85 | 63 | 81 | 52 | 78 |
| 17 | 32 | 69 | 55 | 76 | 60 | 73 | 57 | 80 |
| 18 | 36 | 76 | 51 | 63 | 55 | 69 | 64 | 83 |
| 19 | 43 | 84 | 41 | 67 | 59 | 80 | 59 | 89 |
| 20 | 41 | 71 | 42 | 75 | 60 | 87 | 70 | 88 |
| 21 | 30 | 70 | 50 | 81 | 62 | 87 | 68 | 93 |
| 22 | 42 | 72 | 55 | 80 (2nd) | 62 | 83 | 77 | 93 |
| 23 | 47 | 64 | 51 | 71 | 54 | 76 (4th) | 67 | 86 |
| 24 | 40 | 49 | 45 | 72 | 60 | 82 | 63 | 89 |
| 25 | 31 | 52 | 48 | 77 | 60 | 84 | 78 | 89 |
| 26 | 29 | 54 | 63 | 73 | 61 | 87 | 77 | 91 |
| 27 | 37 | 62 | 52 | 73 | 64 | 87 | 78 | 91 |
| 28 | 44 | 75 | 42 | 65 | 62 | 88 | 74 | 94 |
| 29 | 35 | 53 | 39 | 70 | 62 | 89 | 75 | 94 |
| 30 | 32 | 56 | 49 | 76 | 65 | 86 | 72 | 95 |
| 31 | 45 | 54 | -- | -- | 68 | 86 | -- | -- |

[1]Official Weather Bureau Station was approximately 15 miles northeast of the plots.

[2]Refers to dates of herbicide applications.

TABLE XIII

PLANT SPECIES FOUND AT STILLWATER AND MUSKOGEE
BY SCIENTIFIC AND COMMON NAMES

| Scientific Name | Common Name |
|---|---|
| Achillea lanulosa | western yarrow |
| Andropogon gerardi | big bluestem |
| Andropogon scoparius | little bluestem |
| Andropogon virginicus | broomsedge bluestem |
| Ambrosia psilostachya | western ragweed |
| Ambrosia bidentata | lanceleaf ragweed |
| Aristida oligantha | prairie threeawn |
| Asclepias latifolia | broadleaf milkweed |
| Aster ericoides | heath aster |
| Bouteloua curtipendula | sideoats grama |
| Bouteloua gracilis | blue grama |
| Bouteloua hirsuta | hairy grama |
| Bromus japonicus | japanese brome |
| Buchloe dactyloides | buffalograss |
| Carex spp. | sedge |
| Chloris verticillata | windmillgrass |
| Cirsium undulatum | wavyleaf thistle |
| Croton capitatus | wooly croton |
| Cynodon dactylon | bermudagrass |
| Erigeron strigosus | daisy fleabane |
| Gutierrezia dracunculoides | annual broomweed |
| Juncus spp. | rush |
| Leptoloma cognatum | fall witchgrass |
| Mentha arvensis | field mint |
| Panicum scribnerianum | scribner panicum |
| Panicum virgatum | switchgrass |
| Plantago purshii | wooly plantain |
| Psoralea tenuiflora | scurfpea |
| Rudbeckia hirta | blackeyedsusan |
| Rudbeckia grandiflora | plantainleaf coneflower |
| Setaria lutescens | yellow bristlegrass |
| Solidago missouriensis | missouri goldenrod |
| Sorghastrum nutans | indiangrass |
| Tridens flavus | purpletop |
| Trifolium procumbens | bighop clover |
| Vernonia baldwini | baldwin ironweed |

TABLE XIV

SPECIES COMPOSITION OF THE STILLWATER STUDY AREA ON AUGUST 29, 1969, DETERMINED WITH A POINT FRAME

| PLANT SPECIES | TOTAL EACH SPECIES | PER CENT OF EACH SPECIES |
|---|---|---|
| Japanese Brome | 81 | 42.6% |
| Blue Grama | 28 | 14.7 |
| Hairy Grama | 23 | 12.1 |
| Little Bluestem | 19 | 10.0 |
| Windmillgrass | 13 | 6.8 |
| Big Bluestem | 4 | 2.1 |
| Buffalograss | 4 | 2.1 |
| Fall Witchgrass | 3 | 1.6 |
| Sideoats Grama | 3 | 1.6 |
| Western Ragweed | 3 | 1.6 |
| Heath Aster | 2 | 1.1 |
| Annual Broomweed | 1 | 0.5 |
| Bristlegrass | 1 | 0.5 |
| Broomsedge | 1 | 0.5 |
| Carex | 1 | 0.5 |
| Prairie Threeawn | 1 | 0.5 |
| Rudbeckia | 1 | 0.5 |
| Western Yarrow | 1 | 0.5 |

TABLE XV

SPECIES COMPOSITION OF THE MUSKOGEE STUDY AREA ON SEPTEMBER 8, 1969, DETERMINED WITH A POINT FRAME

| PLANT SPECIES | TOTAL EACH SPECIES | PER CENT OF EACH SPECIES |
|---|---|---|
| Bermudagrass | 67 | 33.2% |
| Japanese Brome | 59 | 29.2 |
| Lanceleaf Ragweed | 26 | 12.9 |
| Bighop Clover | 11 | 5.5 |
| Carex | 10 | 5.0 |
| Panicum | 9 | 4.5 |
| Little Bluestem | 4 | 1.9 |
| Western Ragweed | 4 | 1.9 |
| Indiangrass | 3 | 1.5 |
| Heath Aster | 1 | 0.5 |
| Big Bluestem | 1 | 0.5 |
| Heath Aster | 1 | 0.5 |
| Mint | 1 | 0.5 |
| Prairie Threeawn | 1 | 0.5 |
| Switchgrass | 1 | 0.5 |
| Purpletop | 1 | 0.5 |

TABLE XVI

MONTHLY PRECIPITATION IN INCHES AT STILLWATER[1]
FOR THE YEAR 1969

| MONTH | AMOUNT (INCHES) |
|---|---|
| January | 0.75 |
| February | 2.27 |
| March | 2.60 |
| April | 1.93 |
| May | 3.60 |
| June | 4.38 |
| July | 1.43 |
| August | 3.11 |
| September | 3.77 |
| October | 3.63 |
| November | 0.08 |
| December | 1.24 |
| Total | 28.79 |
| 30-Year Average | 32.18 |

[1]Plots were 2 miles north of the weather station.

TABLE XVII

MONTHLY PRECIPITATION IN INCHES AT THE EASTERN OKLAHOMA PASTURE STATION[1] FOR THE YEAR 1969

| MONTH | AMOUNT (INCHES) |
|---|---|
| January | 3.75 |
| February | 3.03 |
| Marcn | 4.03 |
| April | 3.94 |
| May | 4.90 |
| June | 1.25 |
| July | 2.05 |
| August | 2.36 |
| September | 0.85 |
| October | 8.08 |
| November | 0.54 |
| December | 2.57 |
| Total | 37.35 |
| 30-Year Average | 42.27 |

[1]Plots were 1 mile north of the weather station.

TABLE XVIII

ANALYSIS OF VARIANCE OF WEED PRODUCTION IN GRAMS PER PLOT FOR STILLWATER, FIRST HARVEST[1]

Without The Unsprayed Checks

| Source | df | MS | F | |
|---|---|---|---|---|
| Total | 63 | ---- | ---- | -- |
| Replications | 3 | 1,398.55 | 1.728 | ns |
| Dates | 3 | 10,192.89 | 12.600 | ** |
| Rates | 3 | 2,192.22 | 2.709 | ns |
| Dates x Rates | 9 | 483.12 | 0.597 | ns |
| Error | 45 | 808.94 | ---- | -- |

With The Unsprayed Checks

| Source | df | MS | F | |
|---|---|---|---|---|
| Total | 67 | ---- | ---- | -- |
| Replications | 3 | 1,368.76 | 1.6467 | ns |
| Treatments | 16 | 5,475.71 | 6.5872 | ** |
| Error | 48 | 831.26 | ---- | -- |

[1]Includes data from only the first four application dates.

TABLE XIX

ANALYSIS OF VARIANCE OF WEED PRODUCTION IN GRAMS PER PLOT FOR STILLWATER, SECOND HARVEST

Without The Unsprayed Checks

| Source | df | MS | F | |
|---|---|---|---|---|
| Total | 79 | ----- | ----- | -- |
| Replications | 3 | 246 | 0.64 | ns |
| Dates | 4 | 2,359 | 6.10 | ** |
| Rates | 3 | 4,592 | 11.86 | ** |
| Dates x Rates | 12 | 363 | 0.94 | ns |
| Error | 57 | 387 | ----- | -- |

With The Unsprayed Checks

| Source | df | MS | F | |
|---|---|---|---|---|
| Total | 83 | ----- | ----- | -- |
| Replications | 3 | 370 | 0.36 | ns |
| Treatments | 20 | 5,818 | 5.65 | ** |
| Error | 60 | 1,019 | ----- | -- |

TABLE XX

ANALYSIS OF VARIANCE OF WEED PRODUCTION IN GRAMS PER PLOT FOR MUSKOGEE, FIRST HARVEST[1]

Without The Unsprayed Checks

| Source | df | MS | F | |
|---|---|---|---|---|
| Total | 63 | ---- | ---- | -- |
| Replications | 3 | 2,993 | 1.35 | -- |
| Dates | 3 | 10,837 | 4.88 | ** |
| Rates | 3 | 6,915 | 3.12 | * |
| Dates x Rates | 9 | 2,593 | 1.17 | ns |
| Error | 45 | 2,220 | ---- | -- |

With The Unsprayed Checks

| Source | df | MS | F | |
|---|---|---|---|---|
| Total | 67 | ---- | ---- | -- |
| Replications | 3 | 2,100 | 0.48 | ns |
| Treatments | 16 | 10,154 | 2.31 | * |
| Error | 48 | 4,400 | ---- | -- |

[1]Includes data from only the first four application dates.

TABLE XXI

ANALYSIS OF VARIANCE OF WEED PRODUCTION IN GRAMS PER PLOT FOR MUSKOGEE, SECOND HARVEST

Without The Unsprayed Checks

| Source | df | MS | F | |
|---|---|---|---|---|
| Total | 79 | ---- | ---- | -- |
| Replications | 3 | 944 | 0.64 | ns |
| Dates | 4 | 9,612 | 6.53 | ** |
| Rates | 3 | 21,320 | 14.47 | ** |
| Dates x Rates | 12 | 1,080 | 0.73 | ns |
| Error | 57 | ---- | ---- | -- |

With The Unsprayed Checks

| Source | df | MS | F | |
|---|---|---|---|---|
| Total | 83 | ---- | ---- | -- |
| Replications | 3 | 3,042 | 1.23 | ns |
| Treatments | 20 | 15,126 | 6.11 | ** |
| Error | 60 | 2,475 | ---- | -- |

TABLE XXII

GRASS PRODUCTION[1] IN POUNDS PER ACRE FROM 2,4-D TREATED PLOTS FROM TWO HARVESTS AND TWO LOCATIONS

| Date | Rate (Lb/A) | STILLWATER 1st Harvest | STILLWATER 2nd Harvest | MUSKOGEE 1st Harvest | MUSKOGEE 2nd Harvest |
|---|---|---|---|---|---|
| Unsprayed | Check | 1153 | 814 | 1744 | 2171 |
| 1st | 1/4 | 1645 | 1031 | 1208 | 1971 |
| 1st | 1/2 | 1230 | 1288 | 1452 | 2085 |
| 1st | 1 | 1906 | 1519 | 1695 | 1904 |
| 1st | 2 | 2045 | 1634 | 1445 | 2095 |
| 2nd | 1/4 | 1272 | 940 | 1567 | 2158 |
| 2nd | 1/2 | 689 | 1465 | 1338 | 2198 |
| 2nd | 1 | 1468 | 1216 | 1364 | 2182 |
| 2nd | 2 | 1018 | 1288 | 1481 | 2442 |
| 3rd | 1/4 | 1198 | 885 | 1766 | 2099 |
| 3rd | 1/2 | 1156 | 1171 | 1580 | 2221 |
| 3rd | 1 | 950 | 795 | 1965 | 2674 |
| 3rd | 2 | 879 | 927 | 2032 | 2001 |
| 4th | 1/4 | 1140 | 1214 | 1607 | 2488 |
| 4th | 1/2 | 1182 | 1085 | 2265 | 2469 |
| 4th | 1 | 1716 | 1043 | 1605 | 1797 |
| 4th | 2 | 1085 | 1155 | 1814 | 2432 |
| 5th | 1/4 | 1214 | 697 | 2018 | 2356 |
| 5th | 1/2 | 1005 | 971 | 1638 | 2411 |
| 5th | 1 | 1269 | 914 | 1197 | 1461 |
| 5th | 2 | 1481 | 1476 | 1836 | 2291 |
| Mean | - | 1272 | 1121 | 1649 | 2186 |

[1]Means within a harvest were not significantly different.

VITA

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