OSU Collection

Weed Control With Phenoxy Herbicides on Native Grasslands

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Contents

PRECAUTIONS

All herbicides referred to in this report are under registration for use as given on the container in which they are sold.

They should be applied according to the manufacturer's directions and grazing restrictions followed as specified.

These herbicides should be applied so as to prevent drift from areas being treated.

Precautions should be observed when equipment in which phenoxy herbicides have been applied are used for insecticide application.

Empty containers in which herbicides are sold should have their contents destroyed by heat or steam to minimize pollution.

Weed Control with Phenoxy Herbicides on Native Grasslands

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Introduction

Several species of forbs often occur in the native grasslands of Oklahoma and adjacent states. Some of these forbs are unpalatable and are classified as weeds. Weeds are often a symptom of overgrazing, but other factors such as drought and uncontrolled burning also may cause weed problems in native grasslands. These unpalatable plants compete with palatable plants for soil moisture, plant nutrients and sunlight.

The extent of the weed problem and its relationship to grazing management is illustrated in Table 1. Overgrazed ranges averaged seven times more weeds than ungrazed range in excellent condition.

The objective of this paper is to report and summarize the results from several experiments conducted at various locations and years in

Table 1. Forage yields[1] (lb/A) from native pastures and rangelands in Central Oklahoma 1957[2].

	Grazed Range		Ungrazed Range	
County	Weeds[3]	Grass[4]	Weeds	Grass
Grady	2762	457	135	1618
Logan	2800	323	124	2110
Noble	3279	490	326	3243
Osage	2397	521	681	3132
Payne	1474	575	462	1479
AVERAGE	2542	473	346	2316

[1]Average of 20 samples from each location, using a 9.61 ft.[2] quadrat, and harvested in late summer.
[2]Annual precipitation in 1957 (48 inches) greatly exceeded the long-term average (32 inches): precipitation in 1954-1956 was very low.
[3]Heavy infestation of common broomweed and western ragweed.
[4]Grass remaining after spring and summer grazing.

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[1]Contribution of Plant Science Research Division, Agricultural Research Service, U.S. Department of Agriculture and Agronomy Department, Oklahoma Agricultural Experiment Station.
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Oklahoma. These studies involved different formulations of 2,4-dichlorophenoxyacetic acid (2,4,-D) and other herbicides, spray dates, years, volumes of spray, rates of active ingredients and methods of application.

Oklahoma's Native Grasslands

The palatable climax perennial grasses on native grasslands are big bluestem[1], little bluestem, indiangrass, switchgrass, sideoats grama, blue grama and hairy grama.

Common weedy grasses in Oklahoma are: prairie threeawn, Japanese brome, barnyardgrass and sandbur.

Some of the undesirable forbs that invade or increase on native grassland in Oklahoma are: western ragweed, lanceleaf ragweed, common ragweed, common broomweed, woolly croton, western yarrow, Louisiana wormwood, western ironweed, goldenrod, bitter sneezeweed, late eupatorium and wavyleaf bullthistle. Other weeds occasionally found in native grassland are: wild carrot, plantain, dock, hemp dogbane, milkweed, snow-on-the-mountain and cockelbur.

Native legumes that commonly occur in native grasslands are: scurfy psoralea, leadplant, yellow neptunia, partridgepea, prairieclover and catclaw sensitivebrier.

Some forbs are quite palatable to livestock and examples of these are: false boneset, longbeard hawkweed, compassplant and heath aster.

Literature Review

Weed invasion of the broad-leaf types has been noted by many investigators as an indication of the deterioration of native grasses in the tall grass prairies of the central part of the United States. Weaver and Hanson (18), in early surveys of True Prairie in eastern Nebraska, western Iowa, and parts of four adjoining states, found numerous kinds of weeds particularly in heavily grazed areas.

Harlan (6) observed that hay cut in July from native meadows in eastern Oklahoma often contained 25 to 30 percent weeds. He (7) also noted in 1957 that the severe droughts of the 1930's and 1950's suppressed the native grasses throughout the Plains States and made conditions favorable for increase of weedy grasses, weeds, and brush. Western ragweed heavily infested the native grasslands of Oklahoma in 1950 according to Elder (3).

Vengris et al. (17) reported that common ragweed contained twice as much nitrogen, 1.6 times as much phosphorus, 3.5 times as much potassium, 7.6 times as much calcium, and 3.3 times as much magnesium as

[1]Refer to Appendix Table I for scientific names of all plants.

corn. This supports the findings of Harper et al. (8) who reported that western ragweed contained 4 times as much nitrogen, twice as much phosphorus and 11 times as much calcium as big bluestem. This would indicate that more nutrients are required to produce a pound of western ragweed than a pound of grass.

Klingman (11) reported that ragweed had a high water requirement and that for every pound of weeds produced there is one pound less grass production. This is also in agreement with Peters (15) et al. finding that timothy yields increased about 1 pound for each 1 pound of weeds controlled by herbicides.

Weedy species have been known to increase in fertilized rangeland (Huffine and Elder, 9) and cool season weeds became a problem in an eastern Oklahoma range fertilization study (Elder and Murphy, 4). Elwell (5), in samples collected in several pastures in central Oklahoma in the fall of 1957, found common broomweed producing about seven times more vegetation than the native grasses.

Seed harvested from a weedy native pasture in 1957 by Elwell (5) was adequate to maintain a plant population of about 7 plants/ft^2 for each of 39 years if the broomweed seed remained viable for the period. This illustrates the prolific seed production potential of this annual weed.

Several weed investigators including Bovey, Klingman, Lambert, Langston, Peters, Trew and Zahnley (1, 10, 12, 13, 15, 16 and 19) have reported effective control of several weeds in grassland with 2,4-D.

Elder (3) reported good western ragweed control in Oklahoma with one lb/A of 2,4-D, but McCarty and Scifres (14) found that higher rates were necessary for control in Nebraska.

Research Methods, Locations and General Soil Conditions

Sites selected for weed control research were on native grasslands which had been grazed by livestock for about 40 to 50 years. The test areas near Stillwater, Muskogee and Duncan, Oklahoma were on loamy prairie range sites which were generally free of surface stones. Research plots at Wagoner and Bartlesville, Oklahoma were also on loamy prairie site with some surface stones.

Factors which were evaluated were different herbicides, formulations, rates, dates of application, spray volume, carriers, time of day, kind of equipment and an additive.

Treatment methods, herbicides used and other specifics are given with each of the following experiments conducted.

Formulations of 2,4-D, 2,4,5-T, and Silvex with an Additive (NH_4SCN)

Methods

Ground spray applications were made in mid-July 1959, using a broadjet nozzle with 30 gal/A of a water carrier near Stillwater. Plots were 20 x 100 ft. in two replications. The ester formulations of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), and 2-(2,4,5-trichlorophenoxy) proprionic acid (silvex) were all propylene glycol butyl esters and the 2,4-D low volatile ester was butoxy ethanol ester.

Precipitation for May, June, July, and August was 3.60, 4.43, 1.43, and 3.11 inches, respectively.

Weed stems were counted from 10 samples of 2- X 2-ft quadrats in each plot 3 months after treatment. Results were expressed as percentage control over an unsprayed check.

Results

The additive, ammonium thiocyanate, has been used for brush control to increase absorption or translocation of the herbicide to the root zone thus producing greater root kill.

The addition of ammonium thiocyanate to 2,4-D did not increase weed control, and the response with the addition of ammonium thiocyanate to 2,4,5,-T and silvex was variable (Table 2). In general, 2,4,-D was just as effective as 2,4,5-T and silvex.

Table 2. Weed control with different herbicides and an additive applied to the foliage in mid-July. Central Oklahoma.

Herbicide, Formulation, and Additive[1]	Rate lb/A	Percent Control[2] Western Ragweed	Common Broomweed	All Weeds	Heath Aster[3]
2,4-D amine	1.0	81 a	77 bc	65 ab	96 ab
2,4-D lithium salt	1.0	71 a	92 ab	69 ab	99 a
2,4-D ester[4]	1.0	79 a	86 ab	74 a	85 bc
2,4-D ester + NH_4SCN	1.0 + 0.5	69 a	77 bc	52 b	95 ab
2,4,5-T ester	1.0	81 a	67 c	54 b	94 ab
2,4,5-T ester + NH_4SCN	1.0 + 0.5	69 a	99 a	77 a	99 a
Silvex ester	1.0	32 b	88 ab	31 c	99 a
Silvex + NH_4SCN	1.0 + 0.5	80 a	67 c	72 a	85 bc

[1]The additive NH_4SCN is ammonium thiocyanate.

[2]Averages within a weed species followed by the same letter are not significantly different (Duncan's multiple range test, .05 level).

[3]Heath aster is a forb of moderate forage value and not a weed.

[4]The 2,4,-D ester was butoxy ethanol (low volatile). The 2,4,5-T and silvex esters were propylene glycol butyl ether.

Herbicides, Formulations, Dates and Rates

Methods

Ground spray applications were made with a John Bean sprayer equipped with a broadjet nozzle on two dates, June 17 and July 18, near Stillwater in 1958. Plot size was 40 x 1320 ft. in two replications. The spray carrier was at 20 gal/A.

Precipitation for May through August was 1.0, 6.6, 6.2, and 5.0 inches respectively.

Weeds were counted in 10 quadrats (9.61 ft^2 each) 4 months after the application. Results were expressed as percent reduction over an unsprayed control.

Results

The amine and the butyl ester of 2,4-D were quite effective at the 0.75 lb/A rate (Table 3). In general, the 2,4,5-T, silvex and 2-(2,4-dichlorophenoxy) proprionic acid (dichlorprop) were less effective in weed control than 2,4-D.

Herbicides, Formulations and Rates

Methods

A compressed air hand sprayer applying 40 gal/A in a water carrier was used. Plot size was 10 X 30 ft. in 3 replications. The spray application

Table 3. Herbicides, formulations, dates and rates of application for western ragweed and common broomweed control. Stillwater, 1958.

Herbicide and Formulation	Percent Control[1]				
	Western Ragweed 6/17	Western Ragweed 7/18	Common Broomweed 6/17	Common Broomweed 7/18	Average Weeds and Dates
		0.75 lb/A Rate			
2,4-D					
Isopropyl ester	74 b	81 bc	67 b	67 b	73
Butyl ester	95 a	78 cd	92 a	67 b	84
Dimethyl amine	97 a	94 a	88 a	79 ab	90
2,4,5-T amine	--	84 bc	--	17 d	51
Silvex ester[2]	--	55 e	--	83 ab	69
		1.00 lb/A Rate			
2,4-D					
Isopropyl ester	97 a	85 b	92 a	92 a	92
Butyl ester	97 a	100 a	92 a	67 b	89
Silvex ester[2]	--	72 d	--	38 c	55
Dichlorprop amine	--	85 b	--	13 d	49

[1]Averages within a weed species followed by the same letter are not significantly different (Duncan's multiple range test, .05 level).

[2]The silvex formulation was propylene glycol butyl ether ester (low volatile).

was made in early May 1959 near Stillwater.

Total precipitation for that year was a record 62 inches with monthly amounts for April through August of 2.2, 5.3, 3.8 17.7 and 3.5 inches, respectively.

Weeds were counted four months after the spraying and expressed as percent control over the unsprayed plots (Table 7).

Results

Effective control of all weeds was obtained from all treatments at the 1.5 lb/A rate (Table 4).

Herbicides, Formulations and Dates

Methods

Aerial applications on two dates, April 17 and May 23, 1963, were applied near Wagoner. Each of the herbicides was applied at 0.8 lb/A in 3 gal/A of diesel oil in water emulsion carrier. Plot size was 160 X 660 ft in two replications.

Table 4. Herbicides, formulations and rates applied in early May 1959 for weed control. Stillwater.

		Percent Control[1] over Untreated			
Herbicide	Rate lb/A	Western Ragweed	Common Broomweed	Western Yarrow	Misc. Weeds[2]
2,4-D butyl ester	0.75	90 a	99 a	64 a	17 c
	1.00	82 a	31 b	76 a	69 ab
	1.50	92 a	91 a	84 a	76 ab
Average		88	72	75	54
2,4-D dimethylamine	0.75	99 a	78 a	81 a	79 ab
	1.00	98 a	66 a	84 a	81 ab
	1.50	94 a	97 a	76 a	59 b
Average		97	80	81	73
2,4,5-T Butoxy ethanol ester	0.75	86 a	85 a	88 a	78 ab
	1.00	99 a	75 a	88 a	81 ab
	1.50	91 a	91 a	84 a	81 ab
Average		92	84	87	80
2,4,5-T dimethylamine	0.75	81 a	97 a	24 b	79 ab
	1.00	72 a	94 a	96 a	83 a
	1.50	80 a	91 a	76 a	79 ab
Average		78	94	65	80
Silvex propylene glycol butyl ether ester	0.75	94 a	85 a	99 a	59 b
	1.00	96 a	99 a	69 a	55 b
	1.50	97 a	99 a	99 a	79 ab
Average		96	95	89	64

[1]Averages within a weed species followed by the same letter are not significantly different (Duncan's multiple range test, .05 level).

[2]Miscellaneous weeds were plantain, Carolina geranium and dock species with traces of western ironweed and wavyleaf bullthistle.

Precipitation for April and May was 4.44 and 1.08 inches, respectively.

Weeds were counted at the time of treatment and in September following the treatments from 9 samples (2- X 2- ft quadrat) from each plot.

Results

Effective control over the total of all weeds was obtained by all treatments (Table 5). There was no difference in control of all weeds from April or May treatments.

Formulations and Dates of Applying 2,4-D

Methods

Ground spray applications with 0.75 lb/A of 2,4-D was applied with a John Bean[2] power sprayer in June, 1962. Sprayer used was equipped with a broadjet nozzle and application was 20 gal/acre with a water carrier. The dates and formulation tested at Stillwater are listed in Table 2. Plots for each treatment were 40 X 2178 feet.

Clipped plots for western ragweed production were 20 samples of a 2 X 2 ft. quadrat in each plot taken in September after the treatments.

Precipitation for each of the months, April through August 1962, was 1.6, 2.0, 6.2, 5.0 and 1.4 inches, respectively.

Results

The low volatile ester gave consistently effective weed control on all dates (Table 6). The other formulations were less effective when applied in April than when applied in May or June.

Formulations, Rates and Dates of 2,4-D

Methods

Aerial applications of 2,4-D were applied near Duncan in March, April and May 1962. Plots were 160 X 1320 ft. in two replications and 3 gal/A with a water carrier.

Precipitation was above average with May, June, and July receiving 5.0, 12.4 and 2.7 inches, respectively.

Weeds were counted in ten 2- X 2- ft. samples from each treated and untreated plot in September following the applications.

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[2]Mention of trademark name or a proprietary product does not constitute a guarantee or warranty of the product by the U.S. Department of Agriculture or Oklahoma State University and does not imply its approval to the exclusion of other products that may also be suitable.

Table 5. Herbicides, formulations, and dates with aerial application (0.8 lb/A). Wagoner, 1963.

	Percent Control[1]							
	Western & Lanceleaf Ragweed		Goldenrod and Common Broomweed		Misc. Weeds[2]		All Weeds	
Herbicide	April 17	May 23	Apr. 17	May 23	Apr. 17	May 23	Apr. 17	May 23
2,4-D								
Low Volatile Ester[3]	100 a	100 a	81 ab	43 b	92 ab	94 a	91 a	84 a
Diamine	100 a	100 a	76 ab	90 a	85 ab	87 ab	86 a	90 a
2,4,5-T								
Low Volatile Ester[3]	100 a	100 a	88 ab	100 a	93 a	85 ab	93 a	90 a
Diamine	89 b	----	95 a	----	79 b	----	84 a	----
2,4-D + 2,4,5-T								
Low Volatile Ester[3]	93 b	100 a	71 b	95 a	91 ab	97 a	87 a	97 a
Diamine	89 b	93 b	86 ab	98 a	51 c	74 b	64 a	82 a

[1]Averages within a weed species followed by the same letter are not significantly different (Duncan's multiple range test, .05 level).
[2]Western ironweed, dotted gayfeather, wavyleaf bullthistle, western yarrow and hemp dogbane.
[3]Low volatile ester was butoxy ethanol.

Table 6. Western ragweed production[1] and percent control with formulations of 2,4-D applied at 0.75 lb/A on four dates in native grass. Stillwater, 1962.

Application Date Production % Control	Esters[2] Low Volatile	 High Volatile	Amines Dimethyl	 Alkanol
April 18				
Lb/A	60	280	520	530
% Control	93	69	42	40
May 2				
Lb/A	30	40	130	100
% Control	98	96	85	89
May 15				
Lb/A	50	40	60	50
% Control	94	96	93	94
June 19				
Lb/A	30	80	130	50
% Control	98	91	85	94
Average of Dates				
Lb/A	43	110	210	183
% Control	93	88	76	79

[1]The untreated check produced 890 lb/A of western ragweed.
[2]The low volatile ester was butoxy ethanol and the high volatile ester was butyl.

Results

The low volatile ester was more consistent in producing good results especially at the 0.75 rate (Table 7). At higher rates differences were small and insignificant. Control of weeds by the mid-April application was generally more consistent than the mid-March or May treatments

Table 7. Rates, formulations, and dates of 2,4-D aerial applications. Duncan, 1962.

		Percent Control[1]					
		Dimethyl Amine			Low Volatile Ester[2]		
2,4-D lb/A	Date Applied	Western Ragweed	Misc. Weeds	Av.	Western Ragweed	Misc. Weeds	Av.
0.75	March 14	8 c	93 a	51	97 a	95 a	96
	April 13	97 a	87 ab	92	98 a	98 a	98
	May 23	71 b	78 b	75	97 a	91 a	94
	Average	59	86	73	97	95	96
1.50	March 14	82 ab	95 a	89	96 a	76 b	86
	April 13	91 a	96 a	94	99 a	94 a	97
	May 23	90 a	93 a	92	99 a	82 ab	91
	Average	88	95	92	98	84	91
3.0	March 14	80 ab	90 a	85	88 ab	98 a	93
	April 13	96 a	96 a	96	72 b	86 a	79
	Average	88	94	91	80	92	86

[1]Percent control in comparison to untreated plots. Averages within a weed species followed by the same letter are not significantly different (Duncan's multiple range test, .05 level).
[2]The low volatile formulation was propylene glycol butyl ether ester.

although the low volatile ester gave good results with 0.75 lb/A 2,4-D on March 14.

A second study (Table 8) on an adjacent pasture produced more weed control from esters than from the amine at low rates. Heavy stocking rates with cattle were continued on this pasture and three years later the weeds were as abundant as before spraying.

Rates of 2,4-D as One and Two Treatments

Methods

Aerial applications of low volatile (propylene glycol butyl ether) ester of 2,4-D in an oil in water carrier were applied near Duncan in 1960 and 1961. Spraying was done on May 17 both years on plots 160 X 1320 ft. in 2 replications.

Precipitation was near normal for both seasons.

Weeds were counted in ten 2- X 2- ft samples in each plot 4 months after each spray application. Forage yields were obtained by clipping 5 quadrats (9.61 ft^2 from each plot the first year when no grazing occurred in the pasture. Grazing began the second year and forage yield samples were clipped from large cage exclosures (20 samples, 11.5 X 24 inches, from each plot.

Table 8. Formulations and rates of 2,4-D aerial applications in mid-May. Duncan, 1962.

		Percent of Weed Control[2]		
Formulation[1]	2,4-D lb/A	Western Ragweed	Common Broomweed	Total of All Weeds[3]
Dimethyl Amine	0.5	54 c	95 a	88 b
	0.75	77 b	97 a	88 b
	1.00	79 b	95 a	93 b
	Average	70	96	91
High Volatile Ester	0.5	94 a	99 a	98 a
	0.75	98 a	99 a	98 a
	1.00	97 a	99 a	98 a
	Average	96	99	98
Low Volatile Ester	0.5	98 a	99 a	96 ab
	0.75	99 a	99 a	98 a
	1.00	99 a	99 a	97 a
	Average	99	99	97

[1]Esters were butyl for high volatile and propylene glycol butyl ether for low volatile.
[2]Averages within a weed species followed by the same letter are not significantly different (Duncan's multiple range test, .05 level).
[3]All weeds include western ragweed and common broomweed plus western yarrow, wavyleaf bullthistle, wooly croton, western ironweed and some annual species.

Results

The single 0.5 lb of 2,4-D/A treatment was statistically less effective than higher rates on western ragweed control (Table 9). However, even this rate gave acceptable control one year after application. Excellent weed control was obtained from all other treatments.

Yields of grasses were increased (Table 10) by the first treatment with 2,4-D (at 0.5, 0.75 and 1 lb/A) by 1.2, 1.8 and 2 times, respectively. Grass yields following the two treatments of 2,4-D (at 0.5 and 0.75 lb/A per treatment) were 1.7 and 1.8 times, respectively.

Table 9. Rates of 2,4-D[1] as one and two aerial treatments. Duncan, 1960 and 1961.

Lb/A of 2,4-D		Pecent Control[2] over Untreated		
1960	1961	Western Ragweed	Common Broomweed	Total of All Weeds[3]
0.50	--	88 b	94 a	96 ab
0.50	0.50	98 a	97 a	97 ab
0.75	--	97 a	93 a	94 b
0.75	0.75	97 a	93 a	95 ab
1.00	--	96 a	91 a	86 b
1.00	1.00	98 a	100 a	99 a

[1]Oil in water carrier, 3 gal/A volume, of low volatile ester (propylene glycol butyl ether).
[2]Averages within a weed species followed by the same letter are not significantly different (Duncan's multiple range test, .05 level). Evaluations were made in August 1961.
[3]Include miscellaneous weeds as traces of western yarrow, wavyleaf bullthistle, wooly croton, and wild carrot.

Table 10. Forage production from rates of 2,4-D[1] and two annual aerial treatments. Duncan, 1960 and 1961.

Lb/A of 2,4-D		Production in Lb/A		
1960	1961	Forbs[2]	Grasses[3]	Total
Yield in first year of treatment				
None	--	624	1995	2619
0.50	--	301	2387	2688
0.75	--	6	3684	3691
1.00	--	5	4019	4024
Yield in second year of treatment				
None	--	493	3339	3832
0.50	0.50	20	5011	5031
0.75	0.75	45	5516	5561

[1]Oil in water carrier, 3 gal/A volume of low vol ester (propylene glycol butyl ether).
[2]Includes a small quantity of heath aster and native legumes.
[3]Primarily little bluestem, big bluestem, indiangrass, switchgrass, blue grama, hairy grama and sideoats grama plus a small quantity of prairie threeawn.

Rates and Dates of 2,4-D

Methods

Ground applications of low volatile ester (propylene glycol butyl ether) of 2,4-D in a water carrier were applied near Stillwater and Muskogee in 1969. Plots were 14 X 40 ft and spray volume was 30 gal/A.

Five application dates and four rates of 2,4-D plus an unsprayed check in four replications were evaluated at each location.

Soil moisture was good at the dates of spraying but summer precipitation was below average. The April, May and June rainfall for Stillwater in 1969 was 1.93, 3.60 and 4.38, respectively. Rainfall for the same months of 1969 at Muskogee was 3.94, 4.90 and 1.25 inches, respectively.

Weed production was obtained by mowing a 3 X 10 ft area in each plot on two harvest dates. The first harvest date contained mostly cool season weeds such as daisy fleabane, blackeyed susan and western yarrow. The second harvest contained primarily western ragweed and included lanceleaf ragweed at Muskogee.

Table 11. Weed control with rates and dates of 2,4-D low volatile ester ground applications. Stillwater and Muskogee, 1969.

2,4-D lb/	Harv.[1] Date	Percent Control[2] at indicated Dates of 2,4-D Application					
		Stillwater dates					
		4/2	4/21	5/5	5/26	6/16	Av.
0.25	1	77	89	57	39	--	66
	2	59	90	92	75	70	77
0.50	1	78	94	77	57	--	76
	2	86	100	94	95	89	93
1.00	1	99	97	67	62	--	81
	2	83	100	99	100	98	96
2.00	1	90	96	91	58	--	84
	2	92	99	99	100	90	96
		Muskogee dates					
		4/3	4/22	5/6	5/23	6/9	Av.
0.25	1	71	84	93	34	--	70
	2	63	70	74	69	60	67
0.50	1	66	95	84	40	--	71
	2	57	96	94	88	90	85
1.00	1	78	98	89	84	--	87
	2	75	99	99	87	93	91
2.00	1	90	96	91	92	--	92
	2	80	99	100	99	99	95

[1]Weed harvest dates at Stillwater were June 12 (1st) and August 7 (2nd). Muskogee harvest dates were June 18 (1st) and August 19 (2nd).

[2]Percent control is reduction in weeds from the unsprayed check which produced 467 and 544 lb/A at Stillwater and 605 and 845 lb/A at Muskogee for the 1st and 2nd harvest respectively.

Clippings were made on untreated and treated plots for each replication. These weed clippings were oven-dried to constant weight and the weights compared to the untreated samples as percentage control.

Results

Many treatments (rates and dates) produced at least 90 percent control, which would be satisfactory (Table 11). In general, best results were obtained in late April and early May with 0.5 lb/A or more of 2,4-D.

Carriers and Volumes with 2,4-D

Methods

Aerial applications of different carriers in two different volumes with 0.75 lb/A of 2,4-D low volatile ester were applied on May 17, 1960 near Duncan.

Precipitation for May, June and July 1960 was 5.1, 2.1, and 8.0 inches, respectively.

Weeds were counted in ten 2- X 2- ft. samples at the time of treatment and in September following the applications.

Results

The 1.5 gal/A of diesel oil in water carrier was equally effective as the 3.0 gal/A and was a very effective treatment (Table 12).

Table 12. Carriers and volumes with 0.75 lb/A of 2,4,D low volatile ester aerial applications. Duncan, 1960.

	Percent Control[1]			
Volume and Spray Carrier	Western Ragweed	Common Boomweed	Yarrow	All Weeds[2]
1.5 gal/A				
Diesel Oil	60 b	78 a	62 b	78 a
Water	66 b	80 a	75 ab	88 a
Diesel oil in water	99 a	98 a	99 a	97 a
Average	75	85	79	88
3.0 gal/A				
Diesel Oil	89 ab	85 a	88 ab	83 a
Water	99 a	99 a	75 ab	96 a
Diesel oil in water	89 ab	95 a	99 a	94 a
Average	92	93	87	91

[1]Percent control in comparison to the untreated plots. Averages within a weed species followed by the same letter are not significantly different (Duncan's multiple range test, .05 level).
[2]Western ragweed, common broomweed, western yarrow, wavyleaf bullthistle, wooly croton and western ironweed.

Spray Volume for Aerial Application

Methods

Aerial applications of 0.75 lb/A of 2,4-D as butyl ester with a water carrier were applied on June 1, 1962 near Duncan. Plot size was 160 X 1320 ft. in two replications.

Precipitation for May, June and July was 5.0, 12.4 and 2.7 inches, respectively.

Weeds were counted in 10 samples (2- X 2- ft quadrats) in each plot 4 months after treatment and expressed as percent control over an unsprayed treatment.

Results

All volumes from 1 to 4 gal/A produced excellent weed control with no significant difference among treatments (Table 13).

Time of Day: Effect of Spray Results

Methods

Ground spray applications with a broadjet nozzle on a John Bean power sprayer were applied on July 16, 1958. Time of the spraying is given in Table 8. Spray applied was 20 gal/A with a water carrier on 2 replications. Plot size was 40 X 1320 ft. A rate of 0.75 lb/A of butyl ester of 2,4-D was applied. Relative humidity varied from a low of 55 percent in daytime to a high of 85 percent at night and wind velocity varied from 0-7 miles/hr at the time of application.

Precipitation was 9.69 inches for the month prior to the treatments and 4.42 inches for the month after treatment.

A stem count of weeds was taken from 10 samples (9.61 ft^2 quadrats) from each plot 3 months after spraying.

Table 13. Volume of spray for weed control with aerial applications of 0.75 lb/A of 2,4-D. Duncan, 1962.

	Percent Control			
Volume Gal/A	Western Ragweed	Common Broomweed	Misc. Weeds[1]	All Weeds
1	94	98	94	94
2	96	100	97	97
3	99	100	98	98
4	85	98	100	97

[1]Western yarrow, wavyleaf bullthistle, wooly croton and western ironweed.

Results

The time of day or night had no appreciable effect upon control of western ragweed and common broomweed (Table 14).

Table 14. Time of day for applying 0.75 lb/A butyl ester of 2,4-D. Stillwater, 1958.

Time of Application	Percent Control over Untreated Areas: Western Ragweed	Common Broomweed	Both Weeds
Midnight	91	95	92
4 a.m.	95	95	95
8 a.m.	98	91	95
10 a.m.	86	91	88
2:30 p.m.	95	59	83
8 p.m.	95	91	94

Spray Equipment for Aerial Application

Methods

The Micronair and standard boom were compared for aerial applications using different rates and spray volumes of butyl ester of 2,4-D on April 26, 1966. Location of this study was near Bartlesville.

A monowinged airplane with four micronair units mounted on the rear edge of the wing applied the spray in a 40 ft. swath. The standard boom had 17 Teejet nozzles and was mounted on the same kind of airplane flying a 40-ft. swath. Spray patterns were checked with dye-cards (2). Plots were 160 X 1320 ft.

Precipitation was below average with April through August receiving 1.7, 3.5, 2.7, 3.4 and 2.9 inches, respectively.

Weeds were counted along a 500 ft. linear transect in each plot.

Results

The most consistent treatment with the Micronair unit was at 2.5 gal/A volume and these results were equal to the results from the aerial boom sprayer (Table 15). The coarse (large spray drops) aerial spray gave very poor control of miscellaneous weeds. Weed control was only fair on ragweeds, common broomweed and miscellaneous weeds with 0.37 lb/A of 2,4-D at 0.5 gal/A spray applied by Micronair unit.

Table 15. Spray equipment for aerial application. Bartlesville, 1966.

Vol. Gal/A	Droplet Size	2,4-D Lb/A	Percent Control over Untreated			
			Ragweeds[1]	Broom-weed	Misc. Weeds[2]	All Weeds
Micronair Sprayer						
0.5	Medium	0.37	72	50	52	58
1.0	Medium	0.75	84	86	72	81
2.5	Medium	0.75	98	100	83	94
2.5	Course	0.75	100	100	20	73
2.5	Fine	0.75	100	100	92	97
Boom Sprayer						
2.5	Fine	0.75	84	100	83	89

[1]Includes western and lanceleaf ragweed.
[2]Miscellaneous weeds were croton, gumweed, wavyleaf thistle, dogbane and yarrow.

Discussion and Summary

Herbicides

The herbicide 2,4-D was just as effective and more consistent in producing good weed control than 2,4,5-T, silvex and dichlorprop (Tables 2, 3, 4, and 5).

Formulations

The many formulations evaluted included amines (dimethyl, alkanol, and diamine), low volatile esters (butoxy ethanol and propylene glycol butyl ether) and high volatile esters (butyl and isopropyl). The low volatile esters were dependable in producing consistent weed control (Table 2, 3, 4, 5, 6, 7, and 8). The amine formulation usually gave adequate control, especially if the rate of treatment was slightly higher (Tables 7 and 8), but the amine was less effective than low volatile ester at an early spray date (Table 7).

Rates

In some studies the lowest rates of application tested were 0.75 lb/A of low volatile ester of 2,4-D (Tables 3, 4, and 7) and 0.5 lb/A (Tables 8 and 9). These gave good results but the 0.5 lb/A rate was less effective than 0.75 lb/A in Table 10. Rates of 0.25 lb/A of low volatile ester were capable of producing good weed control at Stillwater, but higher rates were needed at Muskogee (Table 11).

Dates

An early date of application would be beneficial if spraying could be done before susceptible crops are seeded. Good results were obtained in late April and early May (Tables 5, 6, 7 and 11). Spraying in early April (Table 11) and mid-March (Table 7) produced effective control when higher rates of low volatile ester of 2,4-D were used. When spraying was delayed until June, a higher rate of application was necessary (Table 11).

Volume

There was no difference in weed control using aerial application of 1.5 to 3.0 gallons/A volume (Table 12) or from 1 to 4 gallons/A volume (Table 13).

Carriers

In an airplane study of carriers at Duncan, Oklahoma, diesel oil-in-water, water and diesel oil were about equal in results (Table 12).

Time of day

The time of the day when spraying was done had no effect upon weed control (Table 14).

Spray equipment

Aerial applications using a boom sprayer and the Micronair unit produced similar results at the same rate and volume of 2,4-D (Table 15).

Additive

Ammonium thiocyanate at 0.5 lb. plus 1 lb/A of 2,4-D did not increase weed control, but the same additive with 2,4,5-T and silvex did give some weed control on some species (Table 2).

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Appendix Table I. Common and scientific names of plants.

Common Name	Scientific Name
	Grasses
Barnyardgrass	*Echinochloa crusgalli*
Big bluestem	*Andropogon gerardii*
Blue grama	*Bouteloua gracilis*
Hairy grama	*B. hirsuta*
Indiangrass	*Sorghastrum nutans*
Japanese brome	*Bromus japonicus*
Little bluestem	*Andropogon scoparius*
Prairie threeawn	*Aristida oligantha*
Sandbur	*Cenchrus spp.*
Sideoats grama	*Bouteloua curtipendula*
Switchgrass	*Panicum virgatum*
Timothy	*Phleum pratense*
	Forbs
Bitter sneezeweed	*Helenium tenuifolium*
Blackeyed susan	*Rudbeckia hirta*
Carolina geranium	*Geranium carolinianum*
Catclaw sensitivebrier	*Schrankia nuttallii*
Cocklebur	*Xanthium spp.*
Common broomweed	*Gutierrezia dracunculoides*
Common ragweed	*Ambrosia artemisiifolia*
Compassplant	*Silphium laciniatum*
Daisy fleabane	*Erigeron strigosus*
Dock	*Rumex spp.*
Dotted gayfeather	*Liatris punctata*
False boneset	*Kuhnia eupatoriodes*
Gumweed	*Gwindelia squarrosa*
Heath aster	*Aster ericoides*
Hemp dogbane	*Apocynum cannabinum*
Lanceleaf ragweed	*Ambrosia bidentata*
Late eupatorium	*Eupatorium serotinum*
Longbeard hawkweed	*Hieracium longipilum*
Louisiana wormwood	*Artemisia ludoviciana*
Milkweed	*Asclepias spp.*
Partridgepea	*Cassia fasciculata*
Plantain	*Plantago spp.*
Prairieclover	*Petalostemum spp.*
Scurfy psoralea	*Psoralea tenuiflora*
Snow-on-the-mountain	*Euphorbia marginata*
Sticky goldenrod	*Solidago gymnospermoides*
Wavyleaf bullthistle	*Cirsium undulatum*
Western ragweed	*Vernonia baldwinii*
Western ragweed	*Ambrosia psilostachya*
Western yarrow	*Achillea lanulosa*
Wild carrot	*Daucus carota*
Woolly croton	*Croton capitatus*
Yellow neptunia	*Neptunia lutea*
	Shrub
Leadplant	*Amorpha canescens*