THE EFFECT OF SIX HERBICIDES ON THE CONTROL OF ALFALFA AND SWEETCLOVER ON OKLAHOMA HIGHWAYS

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CHAPTER I

INTRODUCTION

Alfalfa (*Medicago sativa* L.) and sweetclover (*Melilotus officinalis* Lam.) are common in appearance on the roadsides and medians of Oklahoma highways. Here, they become weed problems for the Highway Department, and serve to justify frequent and costly mowing of the highway system.

More than 15,000 miles of state and federal highways are maintained by the Oklahoma State Highway Department. The area of rights-of-way mowed annually for the 5 year period 1960-64 averaged 244,608 acres at an average cost of $843,897.60 per year. This figure will increase every year because of the new highways that will be established.

The principle objective of this study was the evaluation of several herbicides for the control of alfalfa and sweetclover on Oklahoma highways. These legumes are undesirable plants on the highway where they frequently restrict the sight-distance for driving safety and detract from the scenic beauty of the area because of their weedy appearance resulting in frequent and expensive mowings for temporary elimination.

CHAPTER II

REVIEW OF LITERATURE

There is little work that is concerned with the control of alfalfa and sweetclover, because these legumes are widely grown for hay and pasture. On the other hand alfalfa and sweetclover are common weeds on highways. Dorschner and Buchholtz (3) found that increasing the rates of 2,4-D application reduced the stands of alfalfa. The average stand resulting from the 1.0 and 0.25 lb. a.i./A applications were approximately 28 and 68 percent of check respectively. Miller and Dunham (7) reported alfalfa varieties were slightly injured by 2,4-D at the application rates of $\frac{1}{2}$ and $\frac{1}{4}$ lb. a.i./A, and sweetclover varieties were badly injured by $\frac{1}{2}$ lb. a.i./A of 2,4-D. Klingman (5) indicated that high rates of 2,4-D of 3 to 4 lbs. a.i./A may be required to kill healthy clover. Clover weakened by overgrazing, poor soil, low soil fertility, or nematodes may be killed by a $\frac{1}{2}$ pound rate.

Ball (1) reported 2,4-D amine at 0.5 to 1 oz. in 4 gallons of water per 1000 square feet gave good control of broadleaf weeds, and all legumes will be killed or severely injured at this concentration. Herron and Phillips (4) succeeded in protecting the underseeded legumes by applying 2,4-D amine salts in the spring at the rate of $\frac{1}{4}$ lb. a.i./A. Sturkie (8) found that broadleaf winter weeds in turf areas can be controlled by spraying Dacamine 2 lbs. a.i./A or 2,4-D

1 to 2 lbs. a.i./A, or 2,4,5-T at 1 to 2 lbs. a.i./A, or dicamba 2 lbs. a.i./A in February or early March.

Behrens and Hopen (2) worked on oats undersown with alfalfa that was treated with dicamba, and the amine salt of 2,4-D in 1962 and 1963. They concluded that dicamba was much more toxic to seedling alfalfa than 2,4-D. Miller and Hogan (6) recommended dicamba at 0.5 to 1 lb. a.i./A as a post-emergence treatment for the control of clover and other broadleaf weeds; and 2,4-D amine at 1 to 2 lbs. a.i./A as a post-emergence treatment on established sods for the control of broadleaf weeds. Wise (9) indicated that clovers may be controlled with one or two applications of 2,4,4-T or 2,4,5-TP at the rate of 2 tablespoons in 1 to 5 gallons of water per 1000 square feet. The use of a combination of 2,4-D and 2,4,5-T or 2,4,5-TP will control clovers and most broadleaf weeds.

CHAPTER III

MATERIALS AND METHODS

The evaluation of herbicides for the control of alfalfa and sweetclover on the median and roadside of Oklahoma highways was started in August 1967. Two experiments were conducted; one located on the median of State Highway 51 (12 miles west of Stillwater), and the other on the roadside of State Highway 81 (5 miles south of Kingfisher).

The experiment on State Highway 51 was designed as a randomized block with four replications. The plots were 30 feet by 30 feet in size. Four herbicides and a control treatment were included in this study. The four herbicides as shown in Table I, each at two rates, were applied on August 31, 1967.

TABLE I

HERBICIDES AND RATES USED IN THE EXPERIMENT ON STATE HIGHWAY 51 FOR THE CONTROL OF ALFALFA AND SWEETCLOVER

Herbicides	Chemical Name	Rate lbs. a.i./A
Dicamba (Banvel-D)	2-methoxy-3,6-dichlorobenzoic acid	1.5 and 0.75
Fenac*	2,3,6-trichlorophenylacetic acid	15.0 and 7.5
MSMA	Monosodium acid methanearsonate	3.0 and 1.5
Monex	MSMA & Diuron [3(3,4-dichlorophenyl) -1,1-Dimethylurea]	4.0 and 2.0

*0.5% surfactant added.

A bicycle sprayer was used to apply the herbicides at a rate of 40 gallons per acre with a pressure of 38 pounds per square inch (psi); at a speed of 2 miles per hour (mph). Teejet nozzles were used to apply the herbicides in this experiment. All herbicides were applied when the wind velocity was below 10 miles per hour to assure as uniform an application as possible. The temperature at the time of spraying was about 75° F.

The check plots did not receive any herbicide treatment as they were used as reference for determining the amount of alfalfa and sweetclover control obtained from each herbicide and rate.

On September 10, 1967, the experiment on the roadside of State Highway 81 was initiated in a randomized block design with four replications. The plots were 10 feet wide and 45 feet long.

Four herbicides as shown in Table II, each at two rates were applied.

TABLE II

HERBICIDES AND RATES USED IN THE EXPERIMENT ON STATE HIGHWAY 81 FOR THE CONTROL OF ALFALFA AND SWEETCLOVER

Herbicide	Chemical Name	Rate lbs. a.i./A
Dicamba (Banvel-D)	2-methoxy-3,6-dichlorobenzoic acid	1.5 and 0.75
2,4-D (Dacamine 4 D)	2,4-dichlorophenoxyacetic acid	1.5 and 1.0
Fenac*	2,3,6-trichlorophenylacetic acid	15.0 and 7.5
2,4,5-T (Dacamine 4 T)	2,4,5-trichlorophenoxyacetic acid	1.5 and 1.0

*0.5% surfactant added.

The herbicides were applied with a pick-up truck with an attached boom sprayer. The herbicides were applied in 40 gallons of solution per acre, at a pressure of 38 psi, and a speed of 2 mph. The wind velocity was between 10 to 12 miles per hour, and the temperature was 70° F at the time the herbicides were applied.

This experiment is located on a rather steep slope alongside the road, which made the application of a uniform rate and complete plant coverage difficult. The spray angle varied with the terrain, and the speed of vehicle movement differed with the slope.

Both experiments were evaluated on April 12, 1968. Data were collected by taking 10 (1 square yard) random samples and counting the number of alfalfa and sweetclover plants in 90 square feet of each treatment area.

CHAPTER IV

RESULTS AND DISCUSSION

The herbicides were evaluated on April 12, 1968, for the control of alfalfa and sweetclover in both experiments. Data from the experiment on State Highway 51 were statistically analyzed as shwon in Table III and indicated a significant difference in treatments. Fenac at the rates of 15 lbs. and 7.5 lbs. a.i. per acre and dicamba (Banvel-D) at 1.5 lbs. and 0.75 lb. a.i. per acre, both were significantly more effective in the control of alfalfa and sweetclover than other treatments that were included. MSMA at the rates of 3 lbs. and 1.5 lbs. a.i. per acre, and Monex at 4 lbs. and 2 lbs. a.i. per acre were not effective in the control of these legumes as shown in Table IV. The actual plant counts for all treatments are shown in Appendix Table I. A previous observation of herbicide activity was made one month after application. Evaluation of herbicide activity readings made one month after treatment showed that dicamba (Banvel-D) provided faster effect on alfalfa and sweetclover when compared with Fenac at both rates used. MSMA and Monex at the low and high rates showed very little toxicity to both legumes. An evaluation, October 31, 1967, of herbicide activity two months after application showed both dicamba (Banvel-D) and Fenac at either rate were equally effective in the control of alfalfa and sweetclover. Neither MSMA nor Monex at either rate was effective in the control of alfalfa or

TABLE III

ANALYSIS OF VARIANCE FOR HERBICIDE TREATMENTS IN THE CONTROL OF ALFALFA AND SWEETCLOVER BASED ON ACTUAL PLANT COUNT APRIL 12, 1968, IN THE EXPERIMENT ON SH-51

Sources	d.f.	M.S.	F
Total	35	35,168.48	
Blocks	3	27,054.77	
Treatments	8	123,929.65	18.789**
Error	24	6,595.64	

**Significant at the 1% level of probability.

TABLE IV

HERBICIDE EFFECT ON THE CONTROL OF ALFALFA AND SWEETCLOVER ON STATE HIGHWAY 51

Herbicide	Rate lbs. a.i./A	Avg. No. Live plants/90 sq.ft.	Multiple Range Test*
Fenac	15.0	13	A
Dicamba (Banvel-D)	1.5	19	A
Fenac	7.5	33	A
Dicamba (Banvel-D)	0.75	44	A
MSMA	1.5	305	B
Monex	2.0	309	B
Monex	4.0	366	B
MSMA	3.0	438	B
Check	---	348	B

*Treatments with the same letter are not significantly different at the 5% probability level by Duncan's New Multiple Range Test.

sweetclover as is shown in Appendix Table II.

The second experiment was located on State Highway 81, five miles south of Kingfisher. The treatments were evaluated on April 12, 1968. A significant difference in treatments was indicated in the control of alfalfa and sweetclover as shown in Table V. Fenac at the rates of 15 lbs. and 7.5 lbs. a.i. per acre, dicamba (Banvel-D) at 1.5 lbs. and 0.75 lb. a.i. per acre, 2,4-D (Dacamine 4 D), and 2,4,5-T (Dacamine 4 T) each at 1.5 lbs. and 1.0 lb. a.i. per acre all provided equally significant control of alfalfa and sweetclover as shown in Table VI. The actual plant counts for all treatments are shown in Appendix Table III. The rather high number of alfalfa and sweetclover plants in each treatment might be the result of improper herbicide application as described in Chapter III. The evaluation of chemical activity one month and two months after treatment showed rather large numbers of both alfalfa and sweetclover plants throughout the entire treatment area (Appendix Table IV).

TABLE V

ANALYSIS OF VARIANCE FOR HERBICIDE TREATMENTS IN THE CONTROL OF ALFALFA AND SWEETCLOVER BASED ON ACTUAL PLANT COUNT APRIL 12, 1968, IN THE EXPERIMENT ON SH-81

Sources	d.f.	M.S.	F
Total	35	1,528.54	
Blocks	3	4,449.59	
Treatments	8	2,313.25	2.565*
Error	24	901.84	

*Significant at the 5% level of probability.

TABLE VI

HERBICIDE EFFECT ON THE CONTROL OF ALFALFA AND SWEETCLOVER ON STATE HIGHWAY 81

Herbicide	Rate lbs. a.i./A	Avg. No. Live plants/90 sq.ft.	Multiple Range Test*
Fenac	15.0	20	A
2,4-D (Dacamine 4 D)	1.5	36	A
2,4-D (Dacamine 4 D)	1.0	37	A
Fenac	7.5	43	A
Dicamba (Banvel-D)	0.75	58	A
Dicamba (Banvel-D)	1.5	64	A
2,4,5-T (Dacamine 4 T)	1.5	66	A
2,4,5-T (Dacamine 4 T)	1.0	68	A
Check	---	102	B

*Treatments with the same letter are not significantly different at the 5% probability level by Duncan's New Multiple Range Test.

CHAPTER V

SUMMARY AND CONCLUSIONS

Two experiments were conducted to evaluate the use of six herbicides for the selective control of alfalfa and sweetclover on Oklahoma highways. The data indicated the herbicides Fenac, dicamba (Banvel-D), 2,4-D, and 2,4,5-T are equally effective in the control of alfalfa and sweetclover on Oklahoma highways.

There were no apparent indications of herbicide phytotoxicity to the desirable grasses in these treatment areas from the materials tested.

A relative comparison of the costs of each herbicide for alfalfa and sweetclover control is shown in Table VII. The least expensive herbicide used in these experiments was 2,4-D, while Fenac appeared to be the most expensive.

However, Fenac is both a pre-emergence and post-emergence herbicide. If this chemical can prevent the germination and establishment of these legumes for a long period, it might suggest that Fenac at the rate of 7.5 a.i./A may be the most economical chemical because of time and labor saved in the control of alfalfa and sweetclover on Oklahoma highways.

TABLE VII

RELATIVE COSTS PER ACRE OF THE EFFECTIVE HERBICIDES EVALUATED IN THIS INVESTIGATION

Herbicide	Lbs. a.i./A	Costs of Herbicide/A
Dicamba (Banvel-D)	1.5	$ 9.38
Dicamba (Banvel-D)	0.75	4.69
2,4-D (Dacamine 4 D)	1.5	2.34
2,4-D (Dacamine 4 D)	1.0	1.56
2,4,5-T (Dacamine 4 T)	1.5	4.44
2,4,5-T (Dacamine 4 T)	1.0	2.96
Fenac	15.0	83.00
Fenac	7.5	41.50

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APPENDIXES

APPENDIX TABLE I

NUMBER OF INDIVIDUAL ALFALFA AND SWEETCLOVER PLANTS IN 90 SQUARE FEET OF TREATED AREA ON APRIL 12, 1968, ON STATE HIGHWAY 51

T R	Check	Dicamba (Banvel-D)		Fenac		MSMA		Monex	
		0.75 lbs. ai/A	1.5 lbs. ai/A	2.5 lbs. ai/A	15 lbs. ai/A	1.5 lbs. ai/A	3 lbs. ai/A	2 lbs. ai/A	4 lbs. ai/A
1	359	52	30	81	17	274	492	352	272
2	277	75	21	30	19	303	332	223	292
3	269	46	25	21	16	242	275	265	283
4	485	0	0	0	0	399	651	394	616

APPENDIX TABLE II

NUMBER OF INDIVIDUAL ALFALFA AND SWEETCLOVER PLANTS IN 90 SQUARE FEET OF TREATED AREA ON SEPTEMBER 30, 1967, AND OCTOBER 31, 1967, ON STATE HIGHWAY 51

Herbicide	Lbs. a.i. per Acre	Avg.No.Live Plants/ 90 sq. ft. September 30, 1967	Avg.No.Live Plants/ 90 sq. ft. October 31,1967
Dicamba (Banvel-D)	1.5	6	1
Dicamba (Banvel-D)	0.75	11	7
Fenac	15.0	12	2
Fenac	7.5	16	5
MSMA	3.0	256	126
MSMA	1.5	224	99
Monex	4.0	226	139
Monex	2.0	181	105
Check	---	282	132

APPENDIX TABLE III

NUMBER OF INDIVIDUAL ALFALFA AND SWEETCLOVER PLANTS IN 90 SQUARE FEET OF TREATED AREA ON APRIL 12, 1968, ON STATE HIGHWAY 81

T / R	Check	Dicamba (Banvel-D)		2,4-D (Dacamine 4 D)		2,4,5-T (Dacamine 4 T)		Fenac	
		0.75 lbs. ai/A	1.5 lbs. ai/A	1 lbs. ai/A	1.5 lbs. ai/A	1 lbs. ai/A	1.5 lbs. ai/A	7.5 lbs. ai/A	15 lbs. ai/A
1	191	98	127	46	38	25	95	66	18
2	84	43	64	60	68	93	57	50	31
3	70	53	61	29	37	121	81	16	28
4	64	37	4	14	1	31	29	41	3

APPENDIX TABLE IV

NUMBER OF INDIVIDUAL ALFALFA AND SWEETCLOVER PLANTS IN 90 SQUARE FEET OF TREATED AREA ON OCTOBER 11, 1967, AND NOVEMBER 9, 1967, ON STATE HIGHWAY 81

Herbicide	Lbs. a.i. per Acre	Avg.No.Live Plants/ 90 sq. ft. October 11, 1967	Avg.No,Live Plants/ 90 sq. ft. November 9, 1967
Dicamba (Banvel-D)	0.75	23	19
Dicamba (Banvel-D)	1.5	17	16
2,4-D (Dacamine 4 D)	1.0	20	21
2,4-D (Dacamine 4 D)	1.5	18	15
2,4,5-T (Dacamine 4 T)	1.0	26	23
2,4,5-T (Dacamine 4 T)	1.5	16	17
Fenac	7.5	14	12
Fenac	15.0	11	8
Check	---	81	92

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