EVALUATION OF INSECTICIDES AGAINST *TABANUS ABACTOR* PHILIP BY EXPOSURE TO TREATED ANIMALS AND BY TOPICAL APPLICATION

By

STEVEN MACK PRESLEY

Bachelor of Science

Agricultural Science Texas Tech University

Lubbock, Texas

1982

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
May, 1985

EVALUATION OF INSECTICIDES AGAINST TABANUS
ABACTOR PHILIP BY EXPOSURE TO TREATED
ANIMALS AND BY TOPICAL APPLICATION

Thesis Approved:

Russell Wright
Thesis Adviser

J. Alexander Hair

Richard G. Price

Ronald W. McNew

Norman N. Durham
Dean of the Graduate College

ACKNOWLEDGMENTS

I wish to express my sincere gratitude to Dr. Russell E. Wright for his guidance, supervision, and support throughout this study as my major adviser, and his assistance in preparation of this manuscript. I also wish to thank the members of my committee, Drs. Jakie A. Hair, Ronald W. McNew, and Richard G. Price, for their time, advisement, and assistance during the course of this work.

Appreciation is extended to Lisa Coburn and the other members of the support staff which assisted with the maintenance and mechanics of this project.

A special note of thanks is also extended to the faculty and graduate students of the Department of Entomology for their friendship, interest, and encouragement.

A most sincere debt of gratitude goes to my parents-in-law, Laurence and Delfina, for their understanding, and encouragement, and to my parents Don and Jerri, who have supported and loved me throughout my quests, for without their inspiration this would not have been accomplished.

Finally, to the three most special people in my life, my wife, Terri, and my two sons, Anthony and Asa, I offer my deepest and most sincere appreciation for their constant love, understanding and patience. They alone have given me the will and desire to obtain this goal through the happiness and fulfillment gained from being a part of a loving and caring family.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

The horse flies (Tabanidae) are considered to be major pests of cattle and horses in Oklahoma. Hollander and Wright (1980b), Schomberg (1952), Schomberg and Howell (1955), and Wright et al. (1984) have reported that the major tabanid pests of cattle in eastern Oklahoma are *Tabanus abactor* Philip, *T. equalis* Hine, *T. mularis* Stone, *T. subsimilis* Bellardi, *T. sulcifrons* Macquart, and *Hybomitra lasiophthalma* Macquart. Irritation by these pests has been observed to cause typically content, docile cattle to become agitated and restless attempting to avoid or dislodge the flies.

The actual blood loss attributed to horse flies is dependent on the species size and the population pressure in the area. Estimated daily blood loss per animal during peak population periods have ranged from 100-300 cc (Cameron 1926; Philip 1931; Webb and Wells 1924). Blood loss of 200 cc per day was reported by Hollander and Wright (1980a) during June and July in northcentral Oklahoma. Tabanids are also known to be mechanical vectors of *Anaplasma marginale*, with at least six species capable of vectoring the disease in Oklahoma (Howell et al. 1941).

Several studies have shown production losses could be directly or indirectly attributed to horse fly attack (Decker 1955; Schomberg and Howell 1955; Schomberg 1952; U.S.D.A. 1965;). Bruce and Decker (1951) reported significant differences in the amount of butterfat produced by Guernsey cows when fly-stressed and fly-free herds were compared. Roberts and Pund (1974) and Perich (unpublished data) found average daily gain differences of 0.09-0.10 kg between fly-stressed and fly-free cattle.

Most attempts to control horse flies have been unsatisfactory. Wilson (1968a) attempted to control populations of Tabanus lineola (F.) and T. fuscicostatus Hine attacking cattle on pastures in Louisiana with sticky traps, and although large numbers of tabanids were trapped, adequate protection from fly attack was not achieved. Spencer (1972) reported that attractant traps around recreational areas did not significantly reduce tabanid populations. Insecticide sprays and granular formulations have been used along woodlot perimeters and salt marshes but were not effective in reducing populations for significant time periods (Hansens 1956; Hansens 1981; Howell et al. 1949). Insecticide dispersed via dust bags or treadle switch sprayers were used as self-treatment devices and provided some temporary relief for cattle (Berry and Hoffman 1963). Bruce and Decker (1951), Decker (1955) and Grannet and Hansens (1956) reported that short term tabanid control with insecticides resulted in increased butterfat production in dairy cows. Harris and Oehler (1976) evaluated eight insecticides applied to horses in field tests against several tabanid species and found that only the synthetic pyrethroid compounds were effective in killing these pests.

Two techniques have been used to measure the actual toxicity of insecticides on dipteran pests of livestock; 1) exposure of specimens to treated surfaces and 2) topical application of insecticides to the specimens. Both of these techniques have been used to evaluate the toxicity of insecticides against face flies Musca autumnalis DeGeer (Hall and Foehse 1980; Knapp and Herald 1983; Treece 1961; Turner and Wang 1964), house flies M. domestica L. (Hall and Foehse 1980; Treece 1961; Schouest et al. 1983; Weaver and Begley 1982), stable flies Stomoxys calcitrans (L.) and horn flies Haematobia irritans (L.)(Schmidt and Kunz 1980), and the screwworm Cochliomyia homnivorax Coquerel (Rawlins et al. 1983).

However in only a few instances have these techniques been used to evaluate the toxicity of insecticides against Tabanidae. Wilson (1968b) tested the residual effectiveness of eight insecticides against the striped horse fly T. lineola (F.) exposed to treated glass jars for 20 minutes and found greater than 71% mortality was caused by coumaphos and 100% mortality caused by crotoxyphos at 0.5% and 0.3% respectively. Bay et al. (1976) exposed field collected horse flies to cattle and horses treated with 0.025% and 0.25% permethrin dust and 0.05% and 0.1% permethrin spray, and found greater than 70% mortality caused by both spray concentrations on horses and cattle for two weeks, and greater than 50% mortality caused by the 0.25% dust for three weeks on both horses and cattle. Harris (1976) evaluated topical applications of 23 insecticides including coumaphos and pyrethrins against three tabanid species and reported that only high dosage rates of these two insecticides (1-10 mg/fly) caused over 50% mortality.

The penetration of a chemical through the integument of an insect to a site of action is indicative of the physiological response induced. Wigglesworth (1942) reported the selective toxicity of insecticides will vary for the same compound depending on the nature of the solvent. Schouest et al. (1983) used kerosene as a synergist to acetone, among other compounds, for topical application of insecticides to house flies. They found that the use of a synergist with acetone improved the penetration of the insecticide through the cuticle.

CHAPTER II

EFFECTIVENESS OF INSECTICIDES AGAINST *TABANUS ABACTOR* PHILIP EXPOSED TO TREATED ANIMALS

Introduction

In many agricultural regions of North America, horse flies (Tabanidae) are common and important pests of cattle and horses. These flies inflict a painful bite that causes the animal to expend energy in an attempt to avoid or dislodge them. Blood loss associated with feeding has been estimated at from 100-300 cm^3 per animal daily during peak population activity periods (Cameron 1926; Hollander and Wright 1980a; Philip 1931; Webb and Wells 1924). Potential production losses have also been associated with horse flies. Bruce and Decker (1951) reported significant decreases in butterfat produced by fly-stressed dairy cows. Perich (unpublished data) found an average daily gain difference of 0.09 kg between horse fly-stressed and horse fly-free Hereford heifers during 1982 and 1983 in northcentral Oklahoma.

Horse flies have also been incriminated as vectors of animal disease. Krinsky (1976) reviewed the role of these pests as vectors of several organisms causing various mammalian diseases.

Many control procedures have been used in attempts to reduce horse fly populations, but none have been satisfactory. The use of trapping procedures to reduce adult populations have been studied. Wilson (1968a) used sticky traps baited with dry ice in an attempt to control Tabanus lineola (F.) and T. fuscicostatus Hine attacking cattle on pastures in Louisiana. Although large numbers were trapped, populations were not reduced enough to provide protection from attack. Insecticide sprays have been used along woodland perimeters and pastures, but did not significantly reduce horse fly populations (Hansens 1956; Hansens 1981; Howell et al. 1949). Direct application of insecticides to animals has given from two days to one week control of horse flies (Berry and Hoffman 1963; Decker 1955; Granett and Hansens 1956). Roberts and Pund (1974) found that short term control of Tabanids improved the ease of handling the cattle. Harris and Oehler (1981) reported that a permethrin spray gave 75% control of horseflies for about two weeks on treated horses.

Tabanus abactor comprises about 50% of the total tabanid population attacking cattle in northcentral Oklahoma. It is abundant from mid June to mid August, and actively feeds from mid morning to dark (Hollander and Wright 1980 a.,b.; Wright et al. 1984). The pest status, medium size, abundance, and ease of collection made it the logical species on which to evaluate the effectiveness of several insecticides and application techniques for possible control of tabanid populations.

Materials and Methods

The study was done at the Cross Timbers Experimental Range located 11 km southwest of Stillwater in Payne County, Oklahoma. The range area consisted of upland forest of Quercus marilandica (Black-jack oak),

Q. stellata (Post oak), and tall grass prairie of Panicum oligosanthes (Rossette panicgrass), Andropogon scoparius (Little bluestem), and Sorghastrum nutans (Indian grass) (Ewing et al. 1984). Tabanus abactor was collected from twelve cattle of mixed dairy breeds which were assigned to four treatment groups of three animals each, according to their size, age, and coloration.

Ten insecticide formulations were evaluated during 1983 and 1984, three insecticide treatments were compared against a control group during each of four test periods. The insecticides, dosage rates, and application methods used are shown in Table I. The animals were washed and allowed to dry for 24 hours prior to any treatment. All insecticides were applied at the rates recommended by the manufacturer for horn fly control. To avoid any cross-treatment contamination, the different groups of cattle were held in separate pastures and subsequent tests were not started until the previous treatments were ineffective.

Tabanids were collected from each animal of a specific treatment group at one day following application of the insecticide to the animals, and at seven day intervals thereafter. During each exposure period the three animals treated with the same insecticide were tethered at one of three collection sites located along the woodlots edge. Horse flies were collected from each treatment group, including a control group, on seperate consecutive days each week. Fifty blood engorged flies were collected from each animal of a treatment group, total 150 flies, during each exposure period, using the technique of Hollander and Wright (1980a). The preferred landing sites of the flies were the legs and underline area of the cattle, therefore it was necessary to relocate them to the back and flanks where the hair was long enough to attach the clip-cups. Tabanids were allowed to blood-feed for four or five minutes, depending on their degree of engorgement, and were removed and placed into an ice cooled chest to immobilize them during transport to the laboratory.

In the laboratory the immobilized flies were sorted into 15 groups of ten flies each, according to the animal from which they were collected, and each group of flies was placed into a paper bioassay cage (1.9 l paper carton), and supplied with 10% sugar-water in saturated cotton balls placed on the nylon mesh lids of the cages. Cotton balls were resoaked and the bottom of the cages were moistened every 12 hours to insure nutrition and to maintain a high humidity environment.

Mortality observations were made one hour after the flies were placed into the bioassay cages, and at 12 hour intervals thereafter (ie. 1, 12, 24, 36, 48 hours). The data were recorded as the number of dead flies (no activity when breathed on), the number of morbid flies (unable to walk or move freely, but still alive), and the number of flies exhibiting no adverse effects.

Results

The actual (uncorrected) percentage mortality for each treatment, including controls, during each exposure period was analyzed via an analysis of variance procedure. Analysis of the variation in effectiveness over time among the treatments (ie. one day, one week, two weeks, three weeks, four weeks), showed significant differences relative to time post-treatment of the animals (statistics ranging from; F = 211.78-326.04, R^2 = 0.995-0.997, and $Pr > F$ = <0.05).

TABLE I

INSECTICIDES AND INSECTICIDE APPLICATION TECHNIQUES EVALUATED FOR CONTROL OF *T. ABACTOR*, PAYNE COUNTY, OK. 1983-1984

Test	Group	Treatment and Formulation	Rate[1]	Evaluation Period
	1	Fenvalerate, 8.0% P.V.C.[2] ear tag	2/Hd.	6/26-7/11
1	2	Permethrin, 5.7% spray (water)[3]	0.05%	6/28-7/13
1983	3	Coumaphos, 11.6% spray (water)[3]	0.06%	6/29-7/14
	4	untreated	--	6/30-7/15
	5	Permethrin, 10.0% P.V.C.[2] ear tag	2/Hd.	7/17-8/8
2	6	Permethrin, 1.0% pour-on	150-200ml/Hd.	7/19-8/9
1983	7	Dioxathion, 10.5%/Dichlorvos, 0.5% spray (water)[3]	0.11%	7/20-8/4
	8	Untreated	--	7/21-8/10
	9	Chlorpyrifos, 5.0%/Cypermethrin, 7.0% P.V.C.[2]	2/Hd.	6/19-7/16
3	10	Flucythrinate, 7.5% P.V.C.[2] ear tag	2/Hd.	6/20-7/2
1984	11	Chlorfenvinfos, 16.0% P.V.C.[2] ear tag	2/Hd.	6/21-7/3
	12	Untreated	--	6/22-7/17
4	13	Crotoxyphos, 16.0%/Fenvalerate, 4.0% P.V.C.[2] ear tag	2/Hd.	7/19-7/31
1984	14	Permethrin, 1.0% pour-on	150-200ml/Hd.	7/17-8/10
	15	Untreated	--	7/17-8/11

1 = No. tags/animal; % A.I./100gal. water; Amount of solution/animal.
2 = P.V.C. (polyvinyl chloride).
3 = Carrier used for spray application.

The effectiveness of each treatment within a test, relative to the exposure period are presented separately for each test. This illustrates the number of days a formulation was effective and the rapidity of effectiveness to the flies following exposure. The effectiveness of the insecticides was most evident within the first 12h post-exposure (Figures 1-4). Any subsequent mortality appeared to be associated with similar mortality in the control group. For this reason the mortality values in Table II are derived from the 12h post-exposure observations for the animals treated with the same insecticide formulation within a given test period. A t-test was used to compare the mean percentage mortality among the treatments within a specific exposure period (Table II).

Test 1, 1983 (Figure 1, Table II).

The permethrin spray killed 73 and 43% of the specimens at 12h post-exposure one day and one week after treatment respectively, but gave no significant mortality at two weeks post-treatment. Twelve hours following exposure of the flies, the fenvalerate ear tags caused only about 15% mortality at one day and one week post-treatment. The coumaphos spray gave no significant fly reduction during any exposure period.

Test 2, 1983 (Figure 2, Table II).

The permethrin pour-on formulation was the most effective material tested, causing 83, 76 and 80% mortality to exposed horse flies, 12h

TABLE II

PERCENTAGE MORTALITY OF *T. ABACTOR* COLLECTED FROM ANIMALS TREATED WITH TEN INSECTICIDE FORMULATIONS, PAYNE COUNTY, OK.[1]

		$\bar{X}$% mortality @ 12h post-exposure of flies[2]				
Test	Treatment	1 day[3]	1 wk[3]	2 wk[3]	3 wk[4]	4 wk[5]
	Fenvalerate ear tags	16.7^{B}	12.0^{B}	7.3^{A}	--	--
1	Permethrin spray	73.3^{A}	43.3^{A}	4.0^{A}	--	--
1983	Coumaphos spray	6.7^{BC}	2.7^{B}	1.3^{A}	--	--
	Control	1.3^{C}	0.7^{B}	1.3^{A}	--	--
	Permethrin ear tags	19.3^{B}	30.0^{B}	79.3^{A}	54.7^{A}	--
2	Permethrin pour-on	83.3^{A}	76.0^{A}	80.0^{A}	46.0^{A}	--
1983	Dioxathion/Dichlorvos spray	23.3^{B}	22.0^{B}	24.7^{B}	--	--
	Control	3.3^{C}	23.0^{B}	26.7^{B}	20.7^{B}	--
	Chlorpyrifos/Cypermethrin ear tags	19.3^{A}	31.3^{A}	28.0^{A}	36.0^{A}	26.0^{A}
3	Flucythrinate ear tags	18.0^{A}	19.3^{B}	8.0^{B}	--	--
1984	Chlorfenvinfos ear tags	0.7^{B}	2.0^{C}	0.0^{B}	--	--
	Control	2.7^{B}	5.3^{BC}	4.0^{B}	3.3^{B}	0.7^{B}
	Crotoxyphos/Fenvalerate ear tags	30.7^{B}	28.7^{B}	22.0^{B}	--	--
4	Permethrin pour-on	94.0^{A}	89.3^{A}	56.7^{A}	3.7^{A}	--
1984	Control	0.7^{C}	4.7^{C}	2.0^{C}	10.7^{A}	--

1 = Percentage mortality values derived from observations at 12h post-exposure of flies to treated animals (total 150 flies/observation).

2 = Values followed by the same letter within tests and exposure periods are not significantly different [Alpha = 0.05; T-test (L.S.D.) for mean comparison].

3 = D.F. = 30, T = 2.0423

4 = D.F. = 14, T = 2.1448

5 = D.F. = 4, T = 2.7763

Figure 1. Effectiveness of fenvalerate ear tags, permethrin spray, and coumaphos spray, against *T. abactor* collected one day, one week, and two weeks post-treatment for Test 1, 1983., Payne Co., OK.

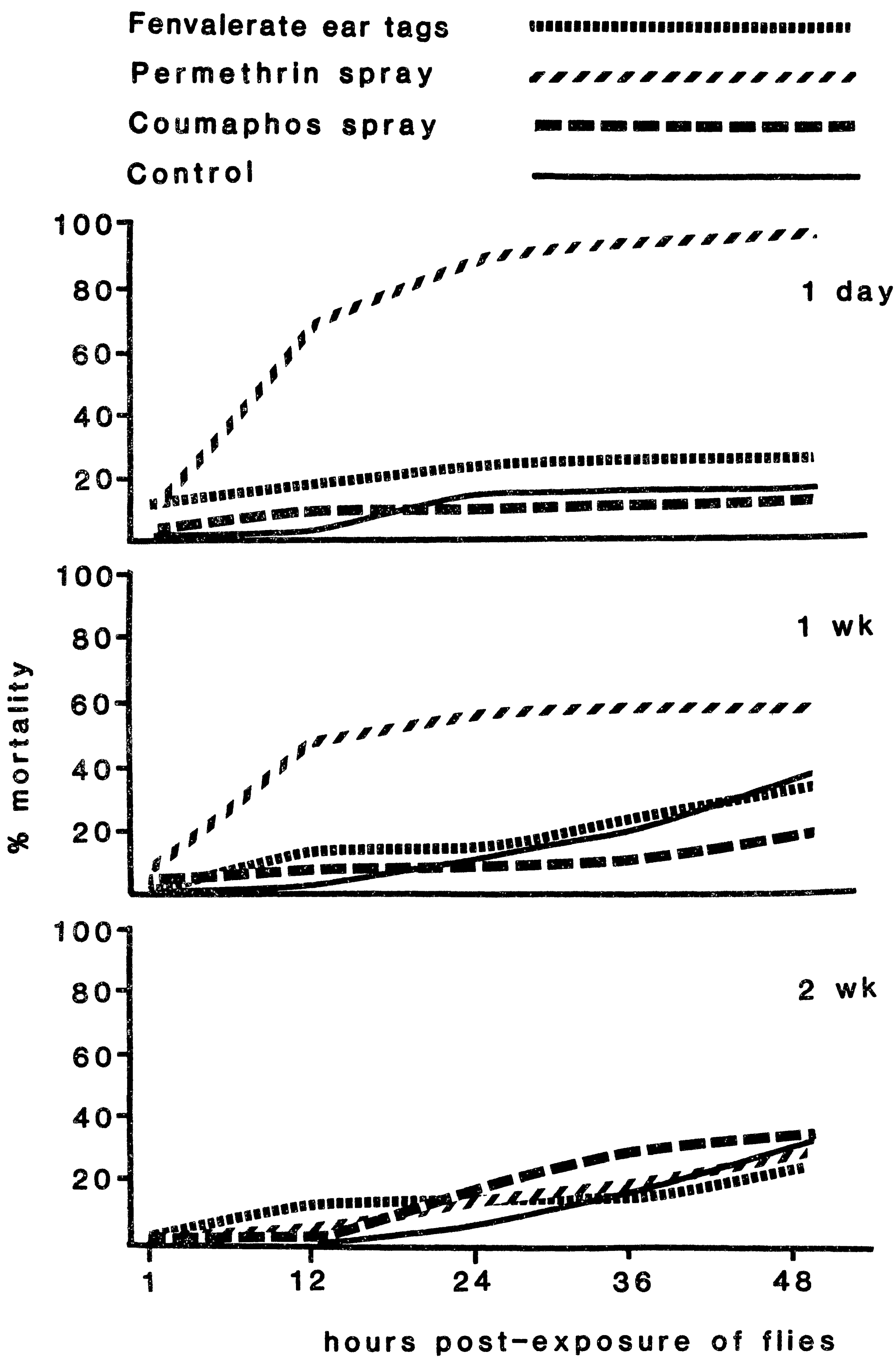
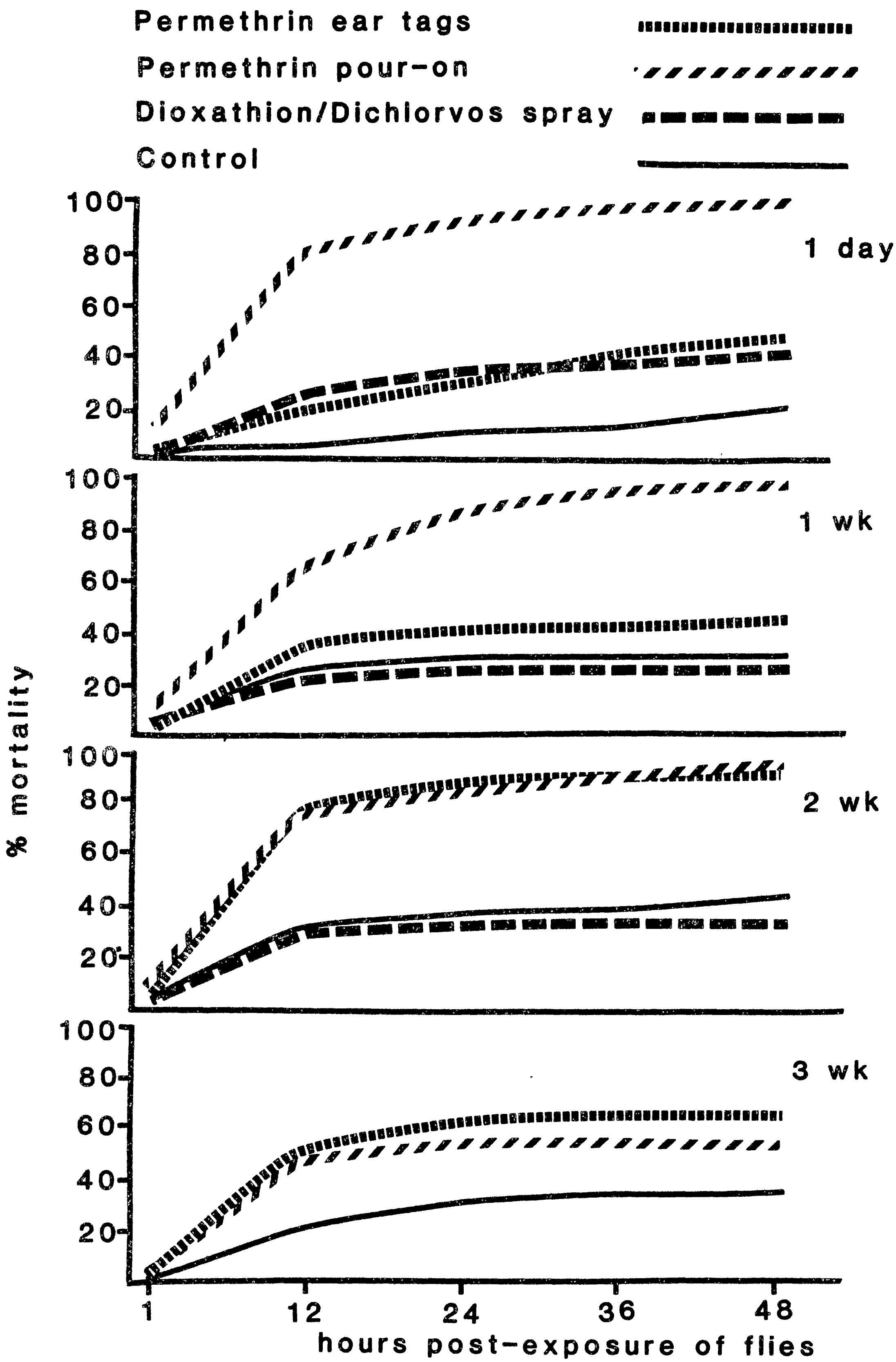

Fenvalerate ear tags
Permethrin spray
Coumaphos spray
Control
1 day
1 wk
2 wk
100
80
60
40
20
% mortality
1
12
24
36
48
hours post-exposure of flies

Figure 2. Effectiveness of permethrin pour-on and ear tags, and dioxathion/dichlorvos spray against *T. abactor* collected one day, one week, two weeks, and three weeks post-treatment for Test 2, 1983, Payne Co., OK.


Permethrin ear tags
Permethrin pour-on
Dioxathion/Dichlorvos spray
Control
1 day
1 wk
2 wk
3 wk
% mortality
100
80
60
40
20
1
12
24
36
48
hours post-exposure of flies

post-exposure, at one day, one week, and two weeks respectively. The permethrin ear tags killed only 19.3 and 30% of the exposed flies within the first 12h post-exposure at one day and one week post-treatment respectively. At two weeks post-treatment they killed 79% of the exposed flies, and at three weeks post-treatment they killed 55% of the flies, and were as effective as the permethrin pour-on in these exposure periods 12h following exposure. The dioxathion/dichlorvos spray caused 23.3% mortality 12h post-exposure one day after application, but was not significantly different from the mortality of the control group at one and two weeks post-treatment.

Test 3, 1984 (Figure 3, Table II).

All insecticides used in this test were ear tag formulations. The ear tags containing chlorpyrifos and cypermethrin in combination killed 19-36% of the flies within 12h post-exposure for four weeks following application, which was significantly greater than the percent mortality in the control group. Flucythrinate tags killed 18-19% of the test flies one day and one week post-treatment at 12h post-exposure, while the chlorfenvinfos ear tags were ineffective throughout the test.

Test 4, 1984 (Figure 4, Table II).

The permethrin pour-on treatment was evaluated a second time during this test period. At one day and one week post-treatment it killed about 90% of the flies, and at two weeks post-treatment killed 57% of the specimens 12h post-exposure, but was ineffective by the third week,

Figure 3. Effectiveness of chlorpyrifos/cypermethrin ear tags, flucythrinate ear tags, and chlorfenvinfos ear tags, against _T. abactor_ collected one day, one week, two weeks, and three weeks post-treatment for Test 3, 1984, Payne Co., OK.

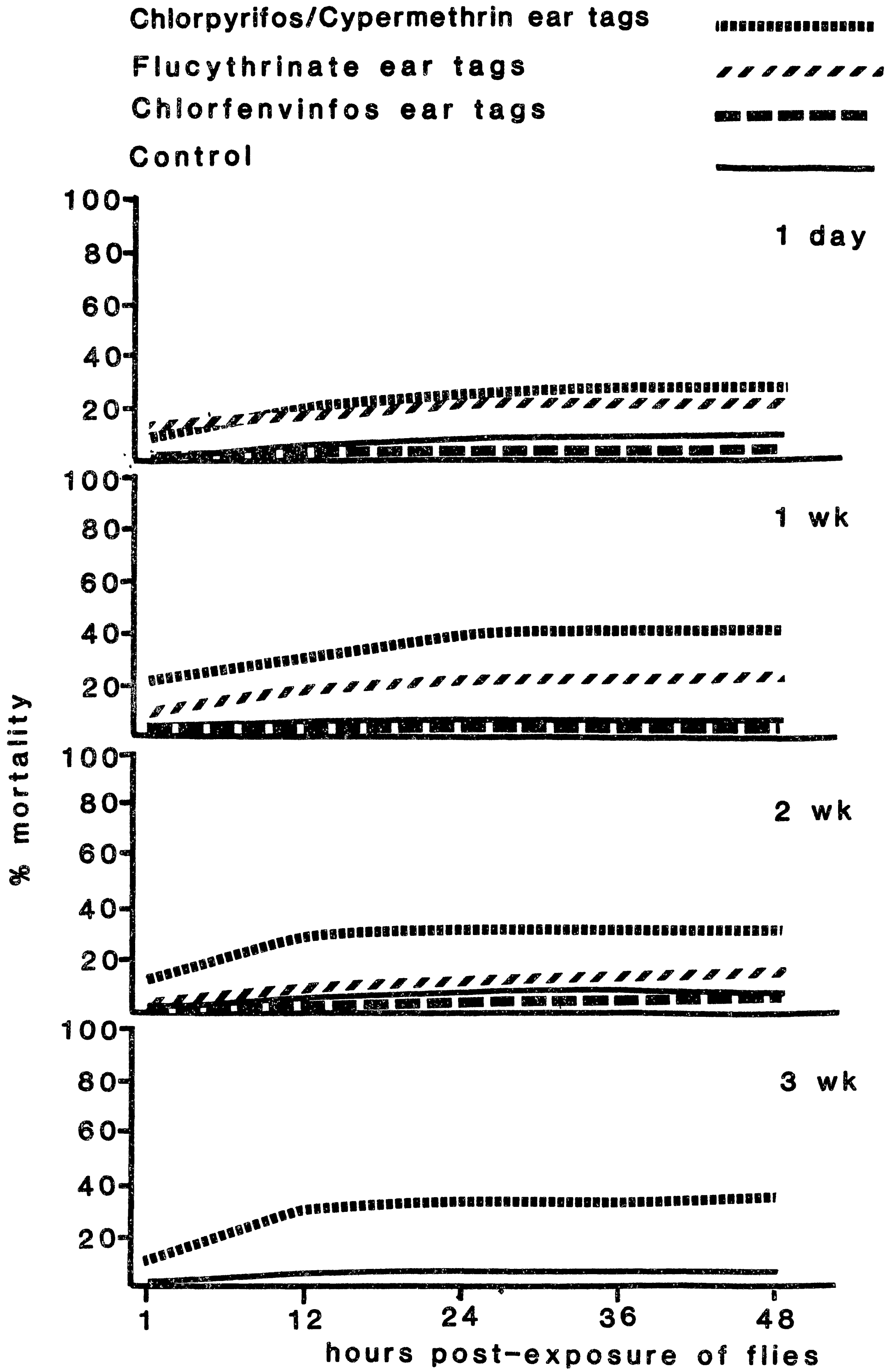
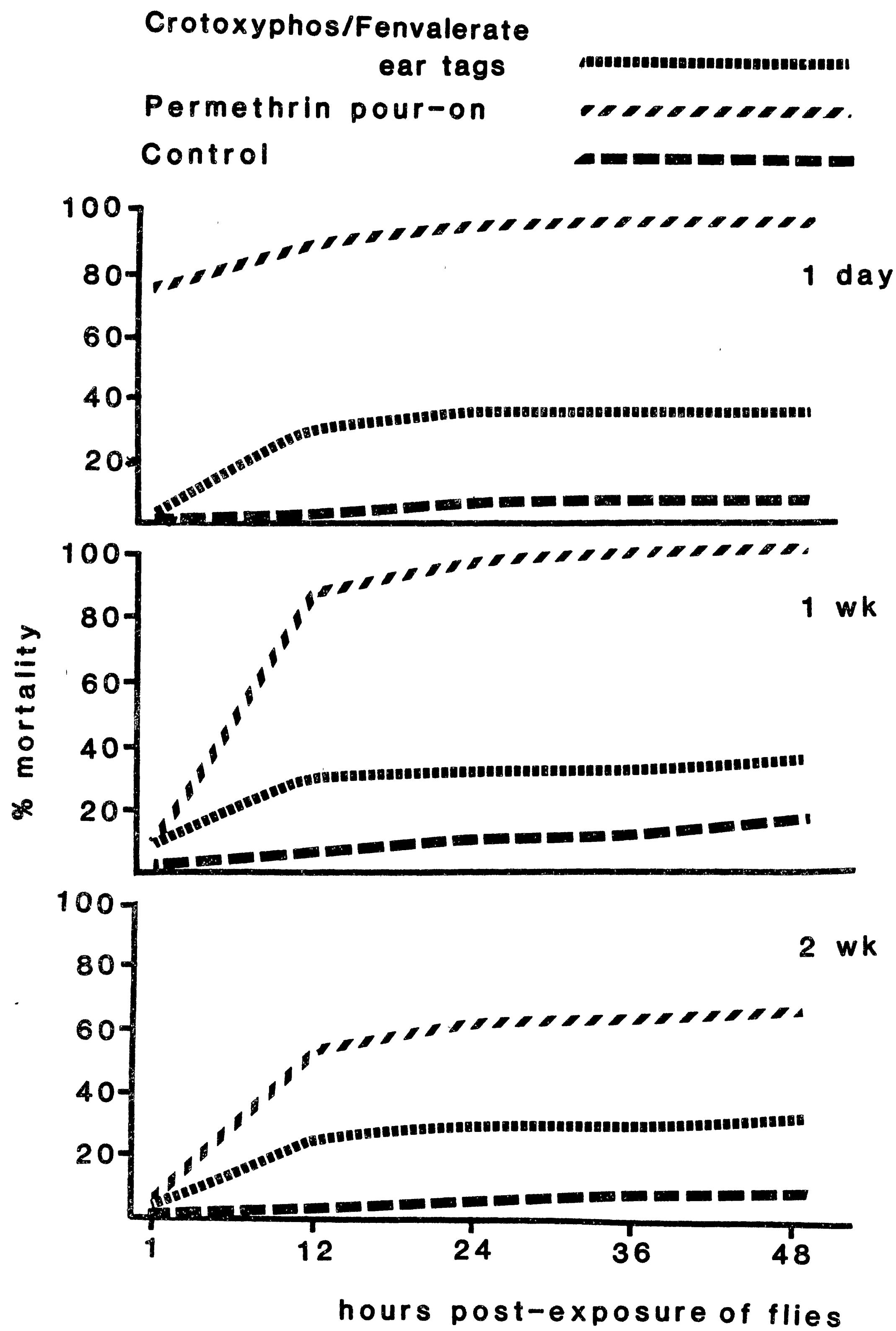

Chlorpyrifos/Cypermethrin ear tags
Flucythrinate ear tags
Chlorfenvinfos ear tags
Control
1 day
1 wk
2 wk
3 wk
% mortality
100
80
60
40
20
1
12
24
36
48
hours post-exposure of flies

Figure 4. Effectiveness of permethrin pour-on, and crotoxyphos fenvalerate ear tags, against *T. abactor* collected one day, one week, and two weeks post-treatment for Test 4, 1984, Payne Co., OK.


Crotoxyphos/Fenvalerate
ear tags
Permethrin pour-on
Control
1 day
1 wk
2 wk
% mortality
100
80
60
40
20
1
12
24
36
48
hours post-exposure of flies

which was very different from the effectiveness reported in Test 1, 1983. The crotoxyphos/fenvalerate ear tag treatment was effective during the first two weeks following treatment of the animals, but did not cause more than 31% mortality in any exposure period.

These results show differences in mortality caused by different insecticides and between different formulations of the same insecticide. To compare these differences, the percentage mortality of all treatments at 48h was corrected with Abbott's Formula;

$$\frac{\%\ \text{Live Control} - \%\ \text{Live Treatment}}{\%\ \text{Live Control}} \times 100$$

(Abbott 1925), these comparisons are depicted in Figures 5-7.

The two organophosphate sprays, coumaphos and a combined dioxathion/dichlorvos spray were ineffective against horse flies (Figure 5). A comparison of six ear tag formulations indicated that the most effective were the permethrin ear tags, which were providing 45% mortality at three weeks, and the chlorpyrifos/cypermethrin ear tags that killed 25-39% of horse flies for four weeks (Figure 6). The crotoxyphos/fenvalerate ear tags killed 36% of the flies initially, but caused less than 25% mortality at one week and two weeks post-treatment. The fenvalerate and flucythrinate ear tags were similar in effectiveness and killed less than 15% of the exposed flies at two weeks post-treatment. The chlorfenvinfos ear tag formulation never killed more than 5% of the flies (Figure 6).

The 0.25% permethrin spray and 1.0% permethrin pour-on caused 100% mortality 24 hours after application (Figure 7). The permethrin pour-on (1983) formulation killed greater than 80% of the tabanids for

Figure 5. Effectiveness of a spray formulation of coumaphos and a spray formulation of a dioxathion/dichlorvos combination against _T. abactor_, in Payne Co., OK, 1983.

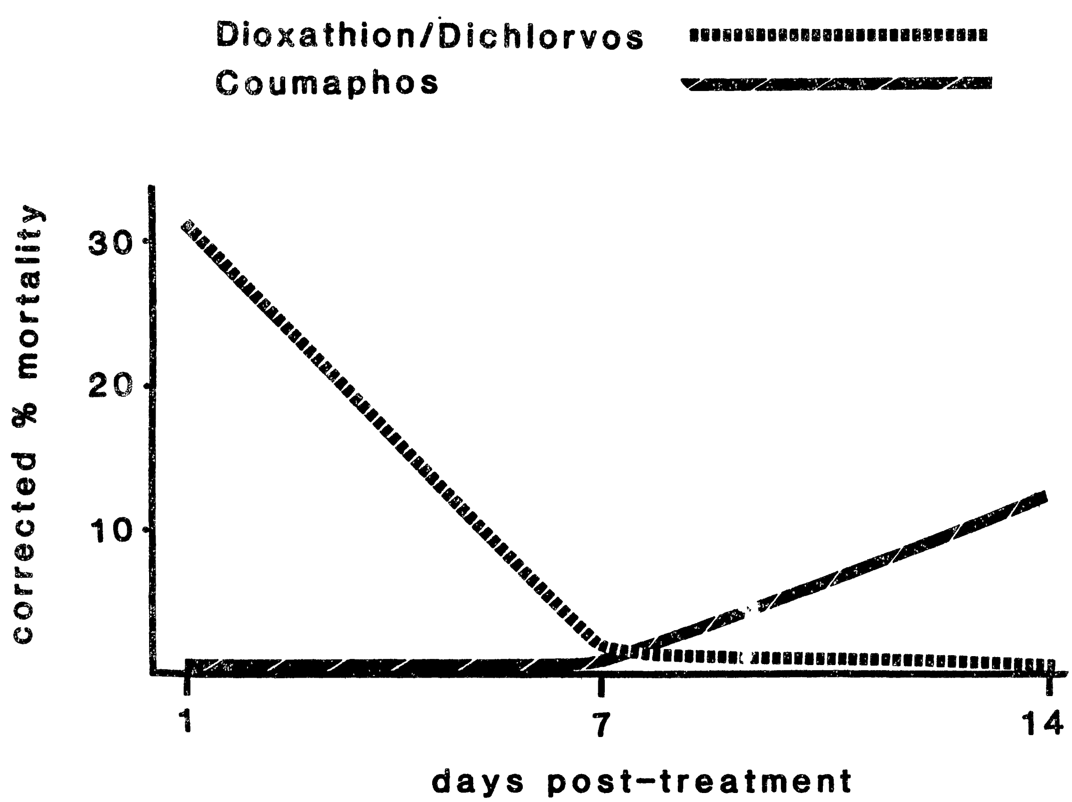

Dioxathion/Dichlorvos
Coumaphos
corrected % mortality
30
20
10
1
7
14
days post-treatment

Figure 6. Effectiveness of insecticide formulations in ear tags against T. abactor for all tests, 1983 and 1984, Payne Co., OK.

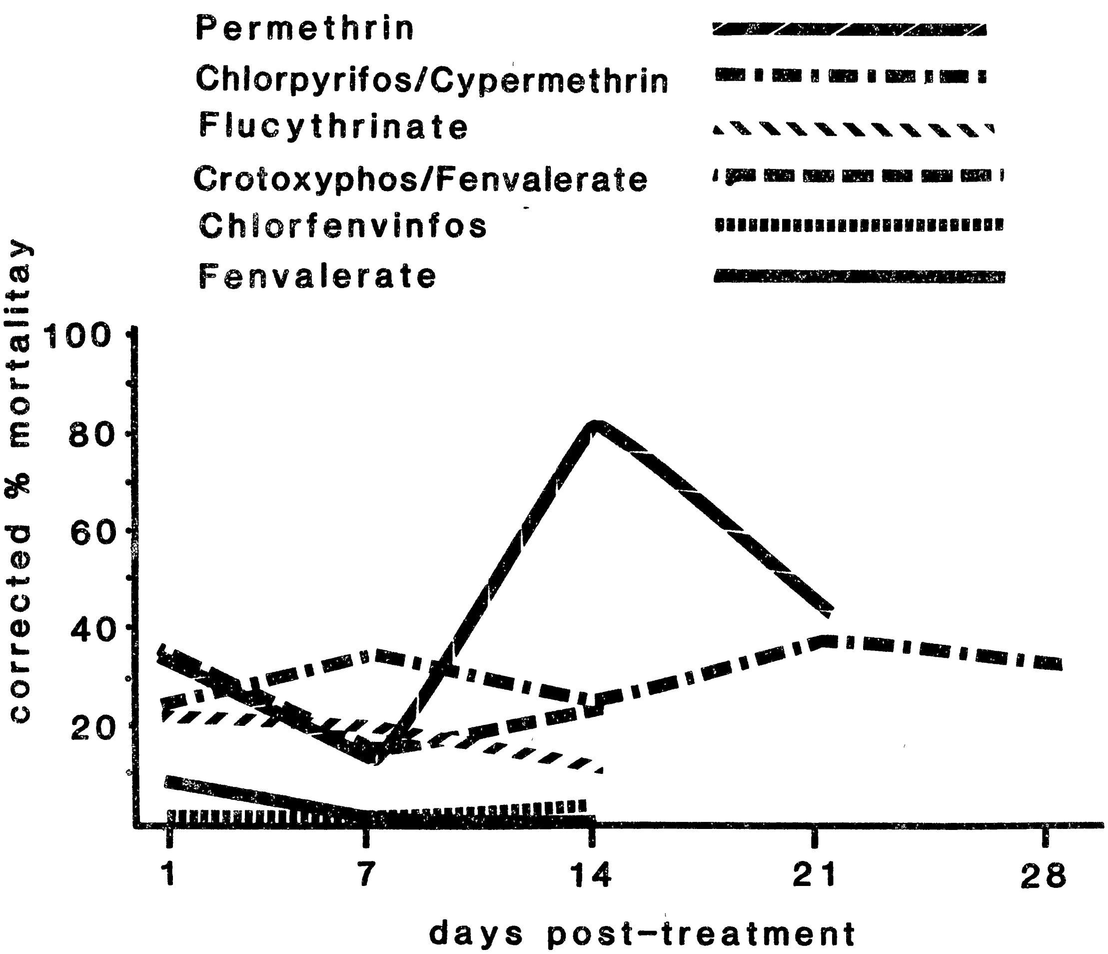
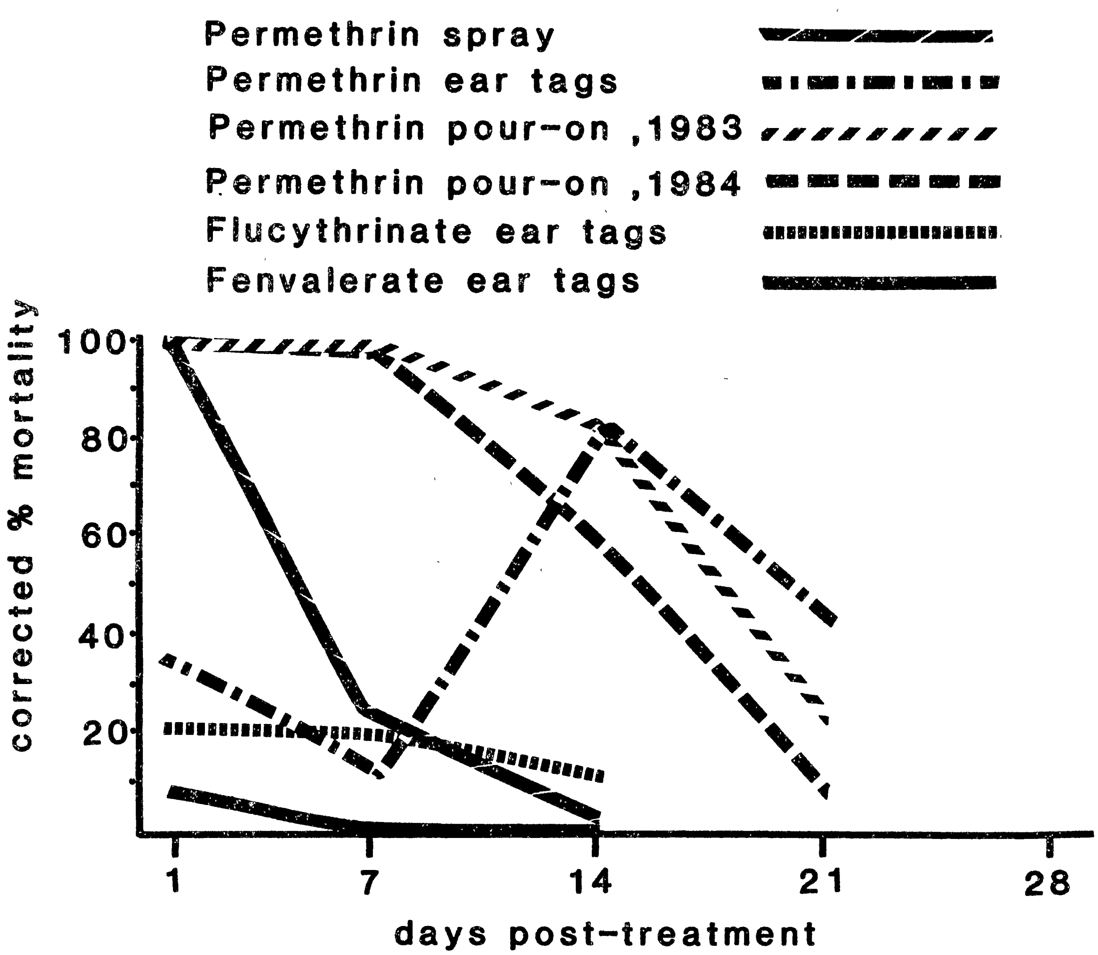

Permethrin
Chlorpyrifos/Cypermethrin
Flucythrinate
Crotoxyphos/Fenvalerate
Chlorfenvinfos
Fenvalerate
corrected % mortalitay
100
80
60
40
20
1
7
14
21
28
days post-treatment

Figure 7. Effectiveness of pyrethroid formulations against _T. abactor_ for all tests 1983 and 1984, Payne Co., OK.


Permethrin spray
Permethrin ear tags
Permethrin pour-on ,1983
Permethrin pour-on ,1984
Flucythrinate ear tags
Fenvalerate ear tags
corrected % mortality
100
80
60
40
20
1
7
14
21
28
days post-treatment

two weeks, but the spray formulation caused only 24% mortality at one week post-treatment.

Discussion

The insecticides tested appeared to cause the highest mortality within twelve hours after exposure. The permethrin formulations killed a higher percentage of the horse flies more rapidly than the other insecticides in all tests. The most effective treatment was the permethrin pour-on (1983-1984), which killed 60% of the tabanids for three weeks on cattle. The permethrin 0.05% spray was about 20% effective for two weeks against T. abactor. This concentration was less effective than the 0.11% permethrin spray applied to horses which killed 80% of the exposed T. sulcifrons Macquart for two weeks (Harris and Oehler 1981). Bay et al. (1976) also reported that a 0.1% permethrin spray on horses and cattle killed 50% of the exposed horse flies for two weeks.

The most effective ear tag formulation tested was the 10% permethrin tag which was killing greater than 80% of the horse flies for two weeks post-treatment. The effectiveness of the permethrin ear tag decreased to about 60% after three weeks on the animal. The chlorpyrifos/cypermethrin ear tags were about 30% effective for four weeks. The ear tag formulations appeared to become more effective after being on the animals for one week which was probably due to the slower dispersion of the insecticide over the animals body. The ear tag formulations of permethrin and chlorpyrifos/cypermethrin did provide some effective control during the one to three week post-treatment periods, but did not provide adequate control after the third week. These results show that permethrin formulations are capable of killing horse flies, but after two weeks there is not adequate residue to provide a satisfactory level of control. The rapid loss of residual concentrations on cattle may be due to animal self-grooming (Kinzer et al. 1983). Although some insecticide formulations caused some mortality of T. abactor for two to four weeks, they did not prevent the specimens from blood feeding and thus did not reduce the irritation caused by the act of feeding.

There appeared to be some correlation between the age of the tabanids exposed to the treated animals and the subsequent susceptibility to the insecticides. This is evident in the higher mortalities occurring in the control group collected during the later portion of the summer (Test 2, 1983 and Test 4, 1984), in which these older flies appeared to be more susceptible to handling and/or the insecticides.

CHAPTER III

EVALUATIONS OF PERMETHRIN AND COUMAPHOS TOPICALLY APPLIED TO *TABANUS ABACTOR* PHILIP

Introduction

Flies of the family Tabanidae are important economic pests of livestock that occur throughout much of North America (Bruce and Decker 1951; Grannet and Hansens 1958; Hollander and Wright 1980a; Howell et al. 1941, 1949; Schomberg and Howell 1955; Wright et al. 1984). Many insecticides that are used to control horn flies *Haematobia irritans* (L.), have been evaluated for their effectiveness against horse flies, including coumaphos, dioxathion, malathion, and permethrin (Harris 1976; Harris and Oehler 1976; Wilson 1968b), but these materials gave only short term control. Harris and Oehler (1976) found that a permethrin spray killed 75% of the *Tabanus sulcifrons* Macquart feeding on horses for about two weeks, and that a concentration of 10ppm was required to be effective against this species. It is generally assumed that insecticide residues remaining on animals after treatment for horn flies are not great enough to kill the larger horse flies. Wilson (1968b) tested the relative toxicity of eight insecticides against *Tabanus lineola* F. by exposing specimens to treated cages, and found that only high concentrations of ciodrin and malathion were effective.

The application of insecticides topically to insects have been done with a number of livestock pests including the face fly, *Musca autumnalis* (DeGeer), and the house fly, *Musca domestica* L. (Schouest et al. 1983; Treece 1961; Turner and Wang 1964), and the screwworm, *Cochliomyla homnivorax* (Coquerel) (Rawlins et al. 1983).

In this study we used the topical application technique to apply five concentrations of coumaphos and permethrin to determine their relative toxicity against *Tabanus abactor* Philip, the major pest species in northcentral Oklahoma attacking cattle and horses (Hollander and Wright 1980b).

METHODS AND MATERIALS

Unengorged female *T. abactor* were collected from untreated cattle, tethered in cleared areas at the edge of woodlots, in the cross-timbers experimental range located 11 km southwest of Stillwater in Payne County, Oklahoma. The horse flies were captured immediately after they landed on the cattle by placing a tapered plastic specimen cup (28.5 cc) over them and inserting a paper lid between the cup and the cow. The cup was then placed into a cold ice-chest to immobilize the flies which were then sorted and placed into specimen cups (150 ml), five flies per cup, for transport to the laboratory.

In the laboratory the flies were treated with five dilutions of permethrin and coumaphos prepared from technical grade formulations, 95.9% and 99.6% respectively (Table III). These concentrations included the recommended rates for application to cattle for control of horn flies and stable flies, *Stomoxys calcitrans* (L.). Acetone was used as

TABLE III

INSECTICIDES AND DOSES TOPICALLY APPLIED TO *T. ABACTOR* FOR EVALUATION OF RELATIVE TOXICITY, Payne Co., OK. 1984

% A. I. applied	Dose (ug/ul)	Flies/Series
Permethrin (95.9%)		
0.0004	0.004	50
0.0007	0.007	50
0.0013	0.013	50
0.0025	0.025	50
0.005	0.05	50
Coumaphos (99.6%)		
0.00073	0.0073	50
0.0022	0.022	50
0.0067	0.067	50
0.02	0.2	50
0.06	0.6	50

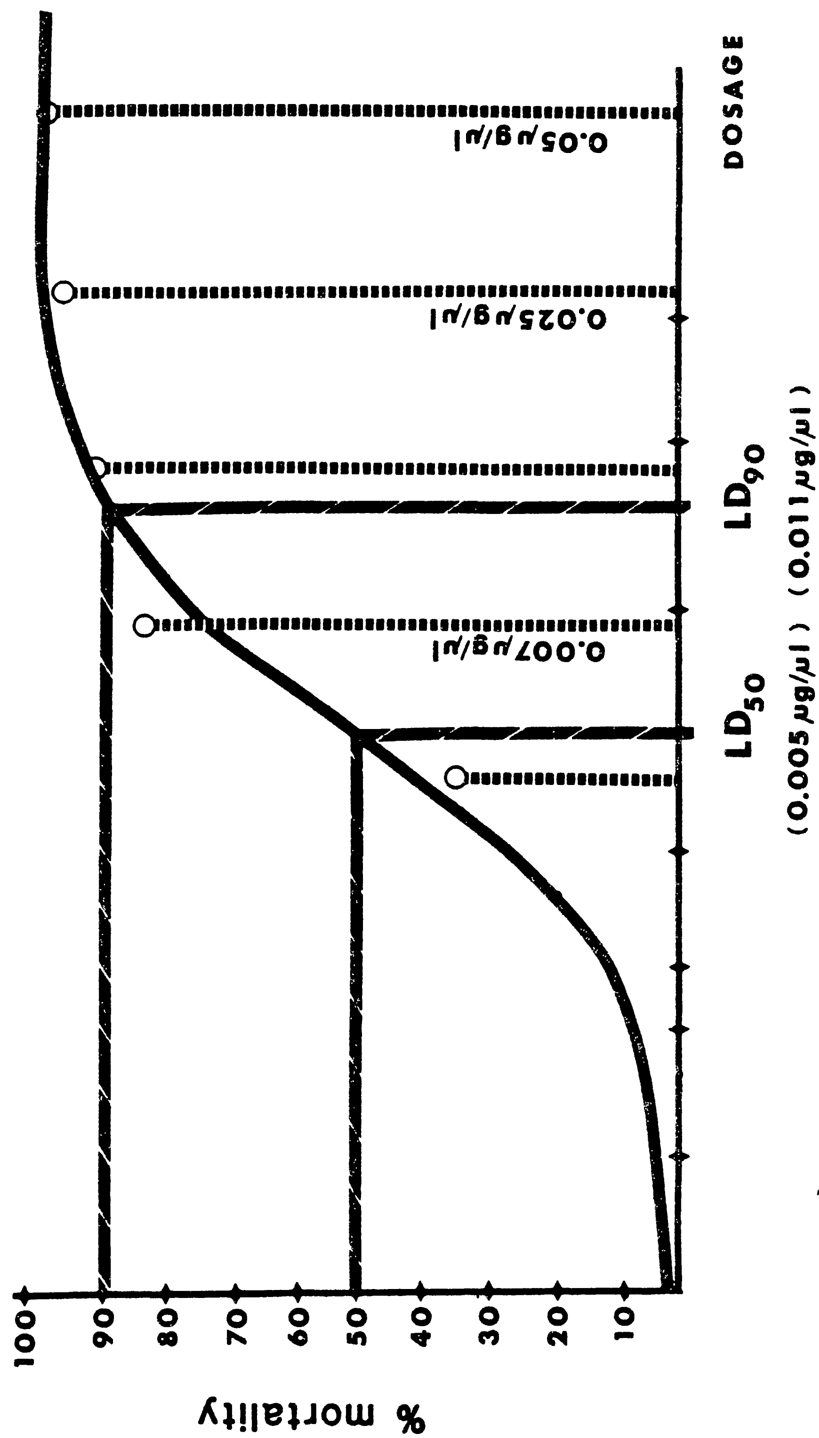
the solvent for permethrin, and xylene was used as the solvent for coumaphos. The insecticide doses were applied to the dorsum of the thorax at the rate of 1 µl per fly with a DRUMMOND® digital micro-dispenser (Model 510). Fifty flies were treated with each insecticide dilution and with the respective solvents.

The treated flies were placed into paper cannisters (0.51), ten flies each, and a nylon mesh lid was fitted over the cannister top. Cotton balls saturated with 10% sugar water solution were provided for the maintenance of the flies during the observation period. The flies were allowed to recover for one hour before the initial mortality observations were made. Mortality counts were made at one, 12, 24 and 48 hours following application. The data was analyzed by a probit analysis procedure available through a computer analysis package (S.A.S. 1979). Each insecticide trial was replicated twice during this study.

RESULTS AND DISCUSSION

The effectiveness of the permethrin treatment was evident within twelve hours following application, at which time all the flies showing any susceptibility to the insecticide were killed. The predicted mortality curve of permethrin against T. abactor is illustrated in Figure 8. Initial mortality was achieved at < 0.004 µg/µl. The predicted LD_{50} and LD_{90} values for permethrin were 0.005 µg/µl and 0.011 µg/µl respectively (LD_{50} fiducial limits = 0.001576 - 0.006557, LD_{90} fiducial limits = 0.007522 - 0.04211, slope = 0.50953). This insecticide immobilized flies immediately following application at the three highest rates, 0.05, 0.025, and 0.013 µg/µl.

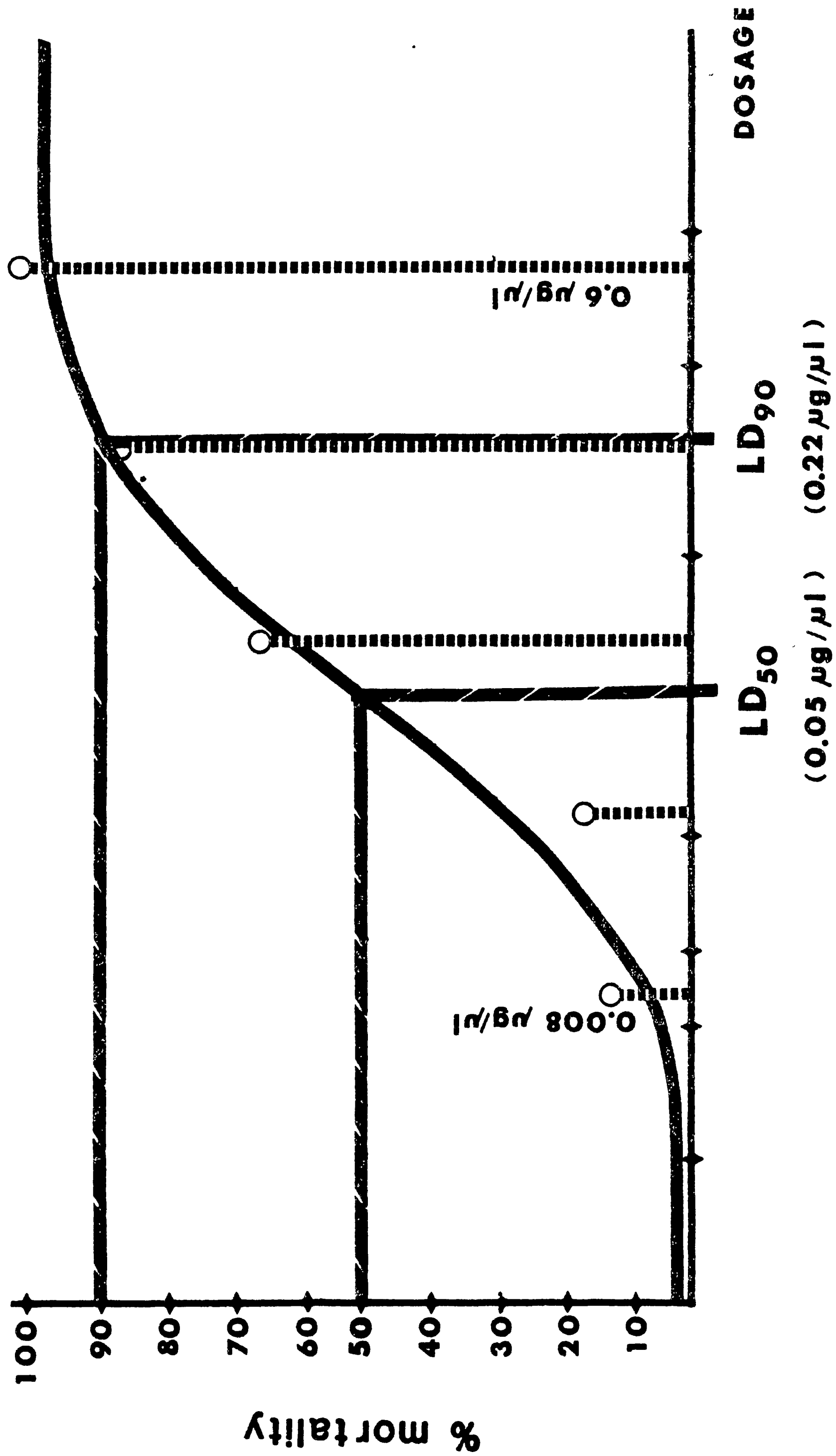
Figure 8. Predicated mortality curve calculated from the observed mortality caused by permethrin topically applied to *Tabanus abactor* 1984.


% mortality
100
90
80
70
60
50
40
30
20
10
DOSAGE
0.05 µg/µl
0.025 µg/µl
0.007 µg/µl
LD_{50}
LD_{90}
(0.005 µg/µl) (0.011 µg/µl)

The effectiveness of the coumaphos was not evident for 48 hours following application to T. abactor. The dosages of coumaphos required to kill horse flies in topical applications was similar to the recommended field rate, 0.06%, for control of horn flies. The predicted mortality curve of coumaphos against T. abactor is illustrated in Figure 9. The predicted LD_{50} and LD_{90} values for this compound were 0.05 µg/µl and 0.22 µg/µl respectively (LD_{50} fiducial limits = 0.020883 - 0.099664, LD_{90} fiducial limits = 0.101078 - 1.659234, slope = 0.059617). The coumaphos diluted in xylene left a powdery white residue at the site of application in these tests, causing concern with its' ability to penetrate the fly integument.

The doses of permethrin that caused mortality values when applied topically to T. abactor were much less than the concentration (0.05%) used to treat cattle in the field. The fact that this much higher concentration of permethrin caused much less mortality in comparison to the doses applied topically may be due to factors other than the insects susceptibility to permethrin compounds. Animal self-grooming, physical reactions of the material with the hair, and environmental factors such as sunlight and dust could possibly be involved in decreasing the insecticides effectiveness in killing tabanids.

Figure 9. Predicted mortality curve calculated from the observed mortality caused by coumaphos topically applied to *Tabanus abactor* 1984.


% mortality
100
90
80
70
60
50
40
30
20
10
DOSAGE
LD50
(0.05 µg/µl)
LD90
(0.22 µg/µl)
0.6 µg/µl
0.008 µg/µl

LITERATURE CITED

Abbott, W.S. 1925. A method for computing the effectiveness of an insecticide. J. Econ. Entomol. 18:265-267.

Bay, D.E., N.C. Ronald and R.L. Harris. 1976. Evaluation of a synthetic pyrethroid for tabanid control on horses and cattle. Southwest Entomol. 1:198-203.

Berry, I.L., and R.A. Hoffman. 1963. Use of step-on switches for control of automatic sprayers. J. Econ. Entomol. 56:888-890.

Bruce, W.N., and G.C. Decker. 1951. Tabanid control in dairy and beef cattle with synergized pyrethrins. J. Econ. Ento. 44:154-159.

Cameron, A.E. 1926. Bionomics of the Tabanidae (Diptera) of the Canadian Prairies. Bull. Entomol. Res. 17:1-42.

Decker, G.C. 1955. Fly control on livestock - does it pay. Soap Chem. Spec. 31:142-143.

Ewing, A.L., J.F. Stritzke, and J.D. Kulbeth. 1984. Vegetation of the cross timbers experimental range, Payne county, Oklahoma. Ag. Exp. Sta. Res. Report P-856.

Granett, P. and E.J. Hansens. 1956. The effect of biting fly control on milk production. J. Econ. Entomol. 49:463-467.

Hall, R.D., and M.C. Foehse. 1980. Laboratory and field tests of CGA-72662 for control of the house fly and face fly in poultry, bovine, or swine manure. J. Econ. Entomol. 73:564-569.

Hansens, E.J. 1956. Granulated insecticides against greenhead (Tabanus) larvae in the salt marsh. J. Econ. Entomol. 49:401-403.

________. 1981. Resmethrin and permethrin sprays to reduce annoyance from a deer fly: Chrysops atlanticus. J. Econ. Entomol. 74:3-4.

Harris, R.L. 1976. Susceptibility of three species of tabanids to certain insecticides. Southwest Entomol 1:52-55.

Harris, R.L., and D.D. Oehler. 1976. Control of tabanids on horses. Southwest Entomol. 1:194-197.

Hollander, A.L., and R.E. Wright. 1980a. Impact of tabanids on cattle: bloodmeal size and preferred feeding sites. J. Econ. Entomol. 73:431-433.

________. 1980b. Daily activity cycles of 8 species of Oklahoma Tabanidae (Diptera). Environ. Ento. 9:600-604.

Howell, D.E., C.E. Sanborn, L.E. Rozenbloom, G.W. Stiles and L.H. Moe. 1941. The transmission of anaplasmosis by horseflies (Tabanidae). Okla. Agri. Exp. Sta. Tech. Bull. T-11.

Howell, D.E., G.W. Eddy, and R.L. Cuff. 1949. Effect on horse fly populations of aerial spray applications to wooded areas. J. Econ. Entomol. 49:644-646.

Kinzer, H.G., E. Jacquez and J.M. Reeves. 1983. Effect of sunshine and self-licking on the residual toxicity of Ectiban applied to cattle for horn fly control. Southwest Entomol. 8:11-15.

Knapp, F.W., and F. Herald. 1983. Mortality of eggs and larvae of the face fly (Diptera: Muscidae) after exposure of adults to surface treated with BAY SIR 8514 and penfluron. J. Econ. Entomol. 76:1350-1352.

Krinsky, W.L. 1976. Animal disease agents transmitted by horseflies and deerflies (Tabanidae: Diptera). J. Med. Entomol. 13:225-275.

Philip, C.B. 1931. New Tabanidae (horseflies) with notes on certain species of the Longus group of Tabanus. Ohio J. Sci. 36:149-156.

Rawlins, S.C., C. Jim Whitten and Donald O. McInnis. 1983. Survey of resistance to insecticides among screw - worm (Diptera: Calliphoridae) populations from various geographical regions. J. Econ. Entomol. 76:330-336.

Roberts, R.H., and W.A. Pund. 1974. Control of biting flies on beef steers: Effect on performance in pasture and feedlot. J. Econ. Entomol. 67:232-234.

S.A.S. 1979. Statistical analysis system, user's guide. S.A.S. Inst. Inc. pp. 357-360.

Schmidt, C.D. and S.E. Kunz. 1980. Testing immature laboratory-reared stable flies and horn flies for susceptibility to insecticides. J. Econ. Entomol. 73:702-703.

Schomberg, O. 1952. Larval habitat of Tabanus sulcifrons in Oklahoma. J. Econ. Entomol. 45:747.

Schomberg, O., and D.E. Howell. 1955. Biological notes on Tabanus abactor (Philip) and T. Equalis (Hine). Jour. Eco. Entomol. 48:618-619.

Schouest, L.P. Jr., N. Umetsu, and T.A. Miller. 1983. Solvent-modified deposition of insecticides on house fly (Diptera: Muscidae) cuticle. J. Econ. Entomol. 76:973-982.

Spencer, R.W. 1972. A mechanical approach toward control of the greenhead fly. Public Works. 103:90-92.

Treece, R.E. 1961. A comparison of the susceptibility of the face fly (Musca autumnalis) and the house fly (Musca domestica) to insecticides in the laboratory. J. Econ. Entomol. 54:803-804.

Turner, E.C. Jr., and C.M. Wang. 1964. Residual and topical toxicity of certain insecticides to laboratory-reared face flies. J. Econ. Entomol. 57:716-719.

U.S.D.A. 1965. Livestock and poultry losses. In losses in Agric. 72-84. U.S.D.A. Handbook No. 291. 120pp.

Weaver, J.E., and J.W. Begley. 1982. Laboratory evaluation of BAY SIR 8514 against the house fly (Diptera: Muscidae): effects on immature stages and adult sterility. J. Econ. Entomol. 75:657-661.

Webb, J.C., and R.W. Wells. 1924. Horseflies biologies and relations to western agriculture. USDA Dept. Bull. No. 1218.

Wigglesworth, V.B. 1942. Some notes on the integument of insects in relation to the entry of contact insecticides. Bull. Entomol. Res. 33:205-218.

Wilson, b.H. 1968a. Reduction of tabanid populations on cattle with sticky traps baited with dry ice. J. Econ. Entomol. 61:827-829.

________. 1968b. Toxicity of selected insecticides against adult striped horseflies in laboratory tests. J. Econ. Entomol. 61:1764-1765.

Wright, R.E., R.K. Whittle, M.J. Perich, and A.L. Hollander. 1984. Seasonal occurrence of horse flies (Diptera: Tabanidae) in north central Oklahoma. J. Kansas Entomol. Soc. 57:209-215.

VITA 2

Steven Mack Presley

Candidate for the Degree of

Master of Science

Thesis: EVALUATION OF INSECTICIDES AGAINST TABANUS ABACTOR PHILIP BY EXPOSURE TO TREATED ANIMALS AND BY TOPICAL APPLICATION

Major Field: Entomology

Biographical:

Personal Data: Born in Lubbock, Texas, December 21, 1959, the second son of Don and Jerri Presley.

Education: Graduated from Abernathy High School, Abernathy, Texas in May, 1978; received the Associate in Science degree in Agriculture from South Plains College, Levelland, Texas, in May, 1980; received the Bachelor of Science degree in Agricultural Sciences from Texas Tech University, Lubbock, Texas, May, 1982; completed the requirements for the Master of Science degree in Entomology from Oklahoma State University, Stillwater, Oklahoma in May, 1985.

Professional Experience: Lab Technician, United Breeders Service, Lubbock, Texas, 1980-1981; Field Scout, Bio-Insect Control, Lubbock, Texas, 1981; Graduate Research Assistant, Department of Entomology, Oklahoma State University, Stillwater, Oklahoma, 1982-1985.

Professional Societies: Entomological Society of America.