CONTACT AND STOMACH TOXICITY TESTS ON

Melanoplus bivittatus (Say)

By

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PREFACE

In April of 1952, the writer began this research project under the direction of Dr. Charles H. Brett[1] in the Entomology Department of Oklahoma Agricultural and Mechanical College.

The insecticides called dieldrin,[2] compound 1189[3] and systox[4] were used in this research project. Tests of their effectiveness in controlling Melanoplus bivittatus (Say) were made possible by the finding of a large population of nymphs near Loyal, Kingfisher County, Oklahoma.

The writer wishes to express his appreciation to the staff of the Entomology Department of Oklahoma Agricultural and Mechanical College for their helpful advice and criticisms and especially to Dr. Frederick A. Fenton, under whose supervision the experimental research was carried out. Dr. Fenton has offered invaluable guidance and constructive criticisms in the writing of this thesis.

Dr. Dariel E. Howell and Dr. James R. Dogger gave excellent advice in the critical reading of this thesis.

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1 Now at North Carolina State College, Division of Biological Sciences, Entomology.

2 Julius Hyman & Co., Denver, Colorado.

3 Compound 1189 was furnished by General Chemical Division, Allied Chemical & Dye Corporation, Long Island City, New York.

4 Chemagro Corporation, New York, New York.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

The two-striped grasshopper, *Melanoplus bivittatus* (Say), is one of the most injurious species of grasshoppers. It is very destructive to alfalfa and rather important on red clover, grass, corn, wheat, barley, cabbage, beets, potatoes, onions, cane fruits, and deciduous fruit trees. The distribution of this species throughout the Western and Southwestern United States is general, occurring on damp, rich vegetation, usually in well-watered areas.

Ball, et al (1942)[1] described the insect as follows: The length of the male is one and three-eighths inches. The length of the female is one and one-half inches. The general color ranges from black and white through brownish-yellow and black to black and yellow. The chief distinguishing characteristic is two conspicuous, narrow yellow stripes on either side of the pronotum and extending down the wing covers.

The rate of development of *Melanoplus bivittatus* (Say) is from five to ten days faster than that of the differential grasshopper, *Melanoplus differentialis* (Thos.). Brett (1947) reported that the rate of development of grasshoppers is controlled by the interrelated effects of food, temperature, and humidity.

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1 Refers to literature cited.

The contact and stomach toxicity tests on *Melanoplus bivittatus* (Say) were made possible by the finding of a large population of nymphs. These were found on their hatching beds during the first week of June 1952, in a pasture three miles north of State Highway 33, on the road to Loyal, Oklahoma in Kingfisher County.[1]

Classification of Insecticides

Insecticides have been classified by Brown (1951) according to the manner in which they are administered to insects and their method of entry into the body, into the following four groups:

Stomach: application to the food and entry through the mid-gut.

Contact: application to the body surface and entry through the cuticle and tracheae.

Fumigant: application as a vapor and entry through the tracheae.

Residual: application to surfaces and subsequent uptake through the cuticle, especially the tarsi.

Any given insecticide may be found to have more than one type of action.

Stomach insecticides are those which have not sufficient liposolubility to be applied by contact or are not volatile enough to act as fumigants.

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1 William J. Eitel aided in locating the hatching beds.

Contact insecticides are solid or liquid at working temperatures, but they also show fumigant toxicity if their vapor pressure is high. If the vapor pressure is low they exhibit residual toxicity. Contact insecticides always show stomach toxicity if the opportunity arises, except in cases where they are destroyed in digestion or fail to be absorbed.

Description of Insecticides Used in Contact and Stomach Toxicity Tests on Melanoplus bivittatus (Say)

The insecticides used in these tests were the chlorinated hydrocarbons: dieldrin and compound 1189; and an organic phosphate: systox.

Dieldrin is not less than 85 per cent of 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-dimethanonaphthalene. It is an odorless white crystalline solid, with a melting point of 173°C. It is scarcely volatile, showing a residual toxicity whose persistence is comparable to that of p,p'-dichlorodiphenyl-trichlorethane.

Although decomposed by strong acids, it is completely stable to weak acids and alkalis. It is one of the most toxic and residually effective of the present insecticides.

Compound 1189 has the formula 2,3,3a,4,5,6,7,7a,8,8-decachloro-3a,3,4,7,7a-tetrahydro-4,7-methanoindene-1-one. The available toxicity data indicate that its acute oral LD50 (in olive oil) to rats is approximately 50 mg/kg, and that its acute LD50 to rabbits by skin absorption (also in olive oil) is above 200 mg/kg. It therefore appears to be reasonably safe to handle, if the usual precautions against excessive skin contact are observed.[1]

Systox is a product containing E-1059, (E-1059 is O (2-(ethylmercapto)ethyl)O,O- diethyl thiophosphate.) Systox is a colorless viscous liquid with a characteristic odor that smells like garlic. Like the other organic phosphates, it is miscible with water, organic solvents, and aromatic oils, but immiscible in paraffin oils.

Systox is a systemic insecticide. It is absorbed by plants through the roots and translocated to all parts of the growing plant. According to Brown (1951) it kills most sucking insects, such as aphids or coccids, without killing their predators. Systox is itself a weak contact insecticide and has no residual contact action; its vapor pressure is so low that its fumigant properties are almost nil.

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1 Letter dated 4-25-52 from General Chemical Division, Allied Chemical & Dye Corporation, Long Island City, New York.

REVIEW OF SYNTHETIC ORGANIC COMPOUNDS
USED AS GRASSHOPPER TOXINS

The preliminary tests of synthetic organic compounds were made by the United States Department of Agriculture, Swingle, et al (1944), on 883 compounds from July 1937 to October 1939.

Each compound was tested against one or more of twenty species, most of them leaf-feeding insects. There were no species of Acrididae included in these tests. No attempt was made to determine lethal doses or comparative toxicity.

The first stomach poison tests using technical chlordane, p,p'-dichlorodiphenyl-trichloroethane and gamma benzene hexachloride were made on the adult grasshopper, Melanoplus differentialis (Thos.), by Kearns, et al (1945).

They found the median lethal dosage, after twenty-four hours, for gamma benzene hexachloride to lie between 5 and 10 micrograms, for technical chlordane between 12.5 and 25 micrograms and for p,p'-dichlorodiphenyl-trichloroethane to be greater than 50 micrograms per gram of body weight.

Graham and Cory (1946) working on the control of Melanoplus femur-rubrum (Deg.) and Melanoplus differentialis (Thos.) injuring apple orchards in Maryland found that benzene hexachloride, containing 12 per cent gamma isomer, at strengths of 1 to 4 pounds per 100 gallons of spray, applied to both trees and ground cover, gave approximately 100 per cent kill within six hours.

Brown and Putman (1946) working in Alberta, Canada found that a spray of 10 per cent of DNOC[1] in oil solution, sprayed at the rate of 131 pounds of DNOC from a B-25 airplane in three parallel runs over an 80-acre field, one mile long by 220 yards wide, having a heavy infestation of *Melanoplus mexicanus mexicanus* (Sauss.) in Russian thistle and pigweed vegetation, caused a population reduction of between 71 and 76 per cent.

Brett and Rhoades (1946) working in alfalfa fields of Northwestern Oklahoma found that benzene hexachloride (8 per cent gamma isomer) dust gave good control of *Melanoplus differentialis* (Thos.), *Melanoplus bivittatus* (Say) and *Melanoplus mexicanus mexicanus* (Sauss.) nymphs and adults.

Grasshoppers not killed within twenty-four hours remained active. No residual or phytotoxic effects were apparent.

Weinman and Decker (1947) stated that the control of grasshoppers by the use of sprays and dusts of chlorinated hydrocarbons represented a combination of stomach-poison and contact-insecticidal effects, the action of benzene hexachloride appeared to be chiefly by contact, and p,p'-dichlorodiphenyl-trichloroethane, chlordane, and toxaphene seemed to act principally as stomach-poisons.

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1 DNOC is the name given to 4,6-dinitro-o-cresol.

As a stomach-poison chlordane was approximately 2.5 times as effective as 37 per cent gamma benzene hexachloride and was nearly 7 times more active than toxaphene. Chlordane was more than 18 times as toxic as p,p'-dichlorodiphenyl-trichloroethane in stomach-poison effect.

Weinman, et al. (1947) working in Illinois found that benzene hexachloride (gamma isomer) and chlordane were highly effective when applied as sprays or dusts for the control of nymphs and adults of *Melanoplus differentialis* (Thos.) and *Melanoplus femur-rubrum* (Deg.).

Benzene hexachloride acted very rapidly but had little or no residual effect. The peak residual effect was reached in twenty-four hours. Chlordane spray residues were not affected by rain after the spray had dried thoroughly. The chlordane spray, (1 pound per acre), was residually effective for a period of 10 days to 2 weeks, but chlordane was almost completely ineffective at recommended dosages of 8 ounces for nymphs and 1 pound per acre for adults of *Melanoplus differentialis* (Thos.) on old clover and other crops or crop residues which were almost devoid of succulent growth.

Hill and Hixson (1947) working in the irrigated section of the North Platte Valley near Mitchell, Nebraska found that benzene hexachloride dust remained effective in a field for 2 to 3 days.

Melanoplus differentialis (Thos.), *Melanoplus femur-rubrum* (Deg.), *Melanoplus bivittatus* (Say), and *Melanoplus mexicanus mexicanus* (Sauss.) and all developmental stages of the grasshoppers involved were equally susceptible to benzene hexachloride dust.

List and Hoerner (1947) working in Colorado found chlordane and benzene hexachloride as dusts and chlordane spray to be more effective than p,p'-dichlorodiphenyltrichloroethane dust and Colorado-9[1] spray. They found toxaphene, benzene hexachloride and chlordane when applied as dusts were killing *Melanoplus bivittatus* (Say), *Melanoplus differentialis* (Thos.) and *Melanoplus femur-rubrum* (Deg.) on the sixth and seventh days after application.

Brett and Rhoades (1948) reporting on control tests of *Melanoplus differentialis* (Thos.) and *Melanoplus mexicanus mexicanus* (Sauss.) nymphs and adults in Oklahoma during 1947 found parathion and five per cent gamma benzene hexachloride to be most effective at high temperatures, (83°-92°F.), as compared with parathion and five per cent gamma benzene hexachloride at low temperatures, (50°-60°F.). Toxaphene and chlordane dusts were slower in their action. They acted both as stomach and contact poisons. But rains washing these materials from the plants reduced their effectiveness. Benzene hexachloride was superior to chlordane in its contact action when applied as fog. But neither material appeared to be as satisfactory as the use of dusts.

Graham (1948) working on *Melanoplus femur-rubrum* (Deg.) and *Melanoplus differentialis* (Thos.) in Western Maryland

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1 Colorado-9 is 1-trichloro-2,2 bis(p-bromophenyl) ethane.

found 6 per cent gamma isomer benzene hexachloride spray to be effective against young nymphs, but a different formulation containing 25 per cent gamma isomer benzene hexachloride was ineffective against adult grasshoppers one month later. Chlordane spray was effective against adult grasshoppers.

Griffiths and King (1948) working on Schistocerca americana (Drury) in Florida citrus groves found benzene hexachloride (gamma isomer) and parathion to have little if any residual toxicity after three days. Chlordane and toxaphene had some toxicity for more than 7 days. Dusts or sprays appeared to be about equal.

Gaines and Dean (1948) working on Melanoplus differentialis (Thos.) at College Station, Texas found the contact action of benzene hexachloride and parathion to be more effective than toxaphene or chlordane.

Weinman and Decker (1949) working on Melanoplus differentialis (Thos.) in Illinois found aldrin and heptachlor were of outstanding effectiveness at dosages of 2 to 4 ounces per compound per acre. Aldrin showed a longer residual action than heptachlor, chlordane, parathion or gamma benzene hexachloride. No repellent action was detected in plants heavily sprayed with aldrin or parathion. The greatest toxicity by contact was shown by dieldrin, heptachlor, aldrin, gamma benzene hexachloride and tetraethyl pyrophosphate in that order. In stomach-poison effect, aldrin was the most toxic with dieldrin, heptachlor, gamma benzene hexachloride and parathion falling in the same range.

Gaines and Dean (1949) working on Melanoplus differentialis (Thos.) at College Station, Texas found benzene hexachloride and parathion to be more effective as contact poisons than either chlordane or toxaphene. The contact action of the materials applied as spray emulsions was greater than when the materials were applied as dusts. Parathion and dieldrin were more toxic to Melanoplus differentialis (Thos.) nymphs than benzene hexachloride, chlordane, aldrin or toxaphene.

Medler and Chamberlin (1950) working in Wisconsin during 1949 found that aldrin, chlordane, toxaphene and methoxychlor sprays effectively controlled Melanoplus mexicanus mexicanus (Sauss.) and Melanoplus femur-rubrum (Deg.) in second-growth alfalfa-seed fields.

Brett, et al (1951) working in Oklahoma used chlordane as a standard for comparing the toxicity of other materials to the nymphs and adults of Melanoplus differentialis (Thos.). Dieldrin was found to be more toxic than aldrin and both compounds showed a toxic level equal to chlordane when their concentration was one-fourth or less.

Mitchener (1951) working in Manitoba, Canada found dieldrin to be more effectively toxic for a longer period of time than aldrin.

Gaines and Hanna (1951) working on Melanoplus differentialis (Thos.) at College Station, Texas found aldrin and dieldrin sprays at low rates gave control equal to chlordane and toxaphene at a higher rate. Aldrin and dieldrin dusts at 0.3 pound per acre gave complete control and equaled toxaphene, chlordane and compound 1189 at one pound per acre. Compound 1189 spray did not prove as effective as the dust.

Hanna and Gaines (1952) working on Melanoplus differentialis (Thos.) at College Station, Texas found dieldrin to be more effective than aldrin, heptachlor or toxaphene. Dieldrin exhibited a longer residual toxicity than did either of the other insecticides.

Brett and Eitel (1952) in work on the genus Melanoplus at Stillwater, Oklahoma found dieldrin to be more toxic than aldrin. Heptachlor showed a contact and stomach toxicity which compared with aldrin. EPN-300[1] was very toxic to grasshoppers by stomach toxicity. It was less effective than dieldrin or aldrin as a contact poison. Compound 1189 approached the toxicity of aldrin, but had almost no effect as a contact poison at dilutions used in the tests.

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1 EPN-300 is a wettable powder containing 25 per cent ethyl p-nitrophenyl thionobenzenephosphate.

METHODS OF PROCEDURE

Collecting Grasshoppers

The grasshoppers, Melanoplus bivittatus (Say), were collected while they were still nymphs on the hatching beds, the population of nymphs being concentrated at that time. Large numbers of nymphs were taken by sweeping the weeds and vegetation with a sweeping net. The sweeping net was emptied into a collecting cage[1] at regular intervals. This was done to reduce injury to the nymphs.

Other insects were also caught in the sweeping net. But these and other species of grasshoppers were discarded when the desired species of nymphs, Melanoplus bivittatus (Say), were sorted out and placed in holding cages.[2] This sorting was done in the labratory.

Feeding Grasshoppers

The grasshopper nymphs in the holding cages were fed daily on a diet of fresh leaf lettuce. The leaf lettuce was washed in running water to remove soil particles, foreign material and insects. This leaf lettuce had not been treated with any insecticides.

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1 Cage, 12" x 7" x 10", made of wood and screen wire.
2 Cage, 17" x 12" x 11", made of wood and screen wire.

Many of the *Melanoplus bivittatus* (Say) nymphs completed their nymphal development on a diet of leaf lettuce.

Mixing Toxic Dusts

The toxic dusts used for contact toxicity tests were mixed by weight of materials. The percentage strength of actual toxic materials was calculated. This calculation was made by taking 100 grams and multiplying by the percentage strength (5 per cent) of actual toxic material desired in the formulation. The product of this multiplication (5 gms) was then divided by the percentage strength (50 per cent) of spray powder or wettable dust.

The quotient of this division gave (10 gms) as the amount of percentage strength (50 per cent) of spray powder or wettable dust to be added to 90 grams of carrier or diluent.[1] This totaled 100 grams of toxic dust at (5 per cent) of actual material.

Other percentage calculations were made from the above formula. This was done by substituting the percentage strength of actual toxic material desired and the percentage strength of spray powder or wettable dust. These formulations were mixed thoroughly by shaking in one-fourth pint jars.

Dieldrin came as 25 per cent wettable powder; compound 1189 came as 50 per cent spray powder; and Systox came as

1 Carrier or diluent was Attaclay. Attapulgus Clay Co., Attapulgus, Georgia.

50 per cent E-1059 on carbon.

Application of Toxic Dusts

The toxic dusts were applied as a contact poison to grasshoppers confined in pint jars. Each pint jar contained ten grasshoppers. Ten grasshoppers were treated with each concentration of toxic dust. The toxic dust was introduced into the pint jar by means of a glass elbow-tube, 4 mm in diameter by 180 mm in length, with a rubber tube and bulb attached to one end. Air pressure from the rubber bulb forced the toxic dust into a fine cloud of dust coating the grasshoppers thoroughly. The quanity of toxic material so introduced into the jar was 50 milligrams. The glass elbow-tube having been weighed on a balance and marked to measure a volume equal to 50 milligrams.

This treatment was replicated with ten other grasshoppers. The treated grasshoppers were then released, ten to a cage,[1] and fed fresh leaf lettuce daily. Results were recorded in Table One.

Mixing Toxic Emulsions

The toxic emulsions were calculated by the same formula, as the toxic dusts, with the substitution of 400 milliliters for 100 grams. The toxic emulsion material was measured with a graduated cylinder and pipette. The toxic emulsion

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1 Cage, 10" x 11" x 7", made of wood and screen wire.

material was then added to 250 milliliters of distilled water in a large mouth pint jar. Then distilled water was added to total 400 milliliters of toxic emulsion. The toxic emulsion was agitated with a wooden spoon to keep it in suspension.

Dieldrin came as 25 per cent emulsion; and Compound 1189 came as 25 per cent emulsifiable concentrate.

Application of Toxic Emulsions

Stomach Toxicity Tests

Equal portions of fresh leaf lettuce were dipped in the desired strength of toxic emulsion. The toxic emulsion was in a large mouth pint jar. The toxic emulsion was stirred thoroughly just before dipping the leaf lettuce. The leaf lettuce was shaken to remove excess material and placed on paper towels in the cages. Then ten grasshoppers were introduced into each cage. This procedure was followed for all concentrations of the toxic emulsions. All tests were replicated. The results were recorded in Table Two.

Contact Toxicity Tests with Toxic Emulsions

In this test only the abdomen of the grasshoppers were exposed to the toxic emulsions. The grasshoppers were held by the thorax, with the hind pair of legs folded upward and forward. The abdomen of the grasshopper was then immersed into the toxic emulsion in a large mouth pint jar. The toxic emulsion was stirred constantly so each grasshopper received a uniform coating of toxic emulsion on the abdomen.

Ten grasshoppers treated with the concentration of toxic emulsion were placed in a cage. This procedure was repeated until all concentrations of toxic emulsions had been applied to the grasshoppers. These tests were all replicated twice. The grasshoppers were fed fresh leaf lettuce daily. Results were recorded in Table Three.

Grasshoppers in Check Cage

Ten grasshoppers were held in a check cage and fed fresh leaf lettuce daily. There was no parasitism or cannibalism observed among the grasshoppers held in the check cage.

DISCUSSION OF THE CONTACT AND STOMACH TOXICITY TESTS ON *Melanoplus bivittatus* (Say)

The opportunity for making contact and stomach toxicity tests on a single species of grasshoppers was welcomed. The finding of a large population of nymphs of *Melanoplus bivittatus* (Say) made the research project a reality.

The materials readily available at the time this research project was started were rather limited. Dieldrin as an emulsion and wettable powder, and systox, E-1059, on carbon were obtained from the Department of Entomology at Oklahoma Agricultural and Mechanical College. Samples of compound 1189 as a spray powder and emulsifiable concentrate were furnished by the General Chemical Division, Allied Chemical & Dye Corporation, Long Island City, New York.

Dieldrin was used as a known insecticide for the comparison of other insecticidal materials in these tests. Dieldrin had proved itself to be very effective, as a contact and stomach poison, as reported by Gaines and Hanna (1951), and Brett and Eitel (1952). Dieldrin again gave results consistent with previous tests.

Toxic Dusts Applied as Contact Poisons

In the contact poison tests, the toxic dusts were applied on the 2nd, 3rd and 4th instar nymphs of Melanoplus bivittatus (Say).

Of these toxic dusts, dieldrin at 0.12 and 0.25 per cent concentrations killed 95 and 100 per cent of the nymphs within 72 hours, as compared with compound 1189 which at 0.12, 0.25, 2.0, and 5.0 per cent concentrations killed 35, 15, 5, and 85 per cent of the nymphs within 72 hours.

Compound 1189, as a toxic dust, was erratic and inconsistent in its toxic power. All of the grasshoppers in one test, at 2.0 per cent concentration of compound 1189, as a toxic dust, recovered from the effects of the toxic dust and were alive after 72 hours.

Gaines and Hanna (1951) reported that dieldrin dust applied at the rate of 0.3 pound per acre gave complete control and compared favorably with compound 1189 at 1 pound per acre when used on Melanoplus differentialis (Thos.) at College Station, Texas.

In the tests reported here systox at 5.0 per cent concentration produced only a 35 per cent kill within 72 hours. Systox was very weak as a contact poison.

Toxic Emulsions Applied as Stomach Poisons

The grasshoppers used in the stomach toxicity tests were 4th, 5th and 6th instars of Melanoplus bivittatus (Say). They were fed fresh leaf lettuce which had been dipped in the toxic emulsions. These were shaken out and then placed on paper towels in the cages.

Dieldrin emulsion at 0.12 and 0.25 per cent concentration gave a 100 per cent kill for both concentrations within 48 hours. Compound 1189 emulsion at 0.12 and 0.25 per cent concentrations gave 95 per cent kill within 48 hours. The 2.0 and 5.0 per cent concentrations of compound 1189 emulsion appeared to have a phytotoxic effect on the fresh lettuce leaves.

Brett and Eitel (1952) reported that compound 1189 as a stomach poison approached the toxicity of aldrin, but had almost no effect as a contact poison at the dilutions used in their tests, and that the degree of its effectiveness, as a stomach poison, would depend upon the extent of the grasshoppers feeding at the time of application and would probably produce erratic results in the field.

Toxic Emulsions Applied as Contact Poisons

In the contact toxicity tests, the toxic emulsions were applied to the grasshoppers abdomen. This was done by dipping the abdomen of the grasshopper into the toxic emulsions. The grasshoppers used in this test being the 4th, 5th and 6th instars of Melanoplus bivittatus (Say).

Dieldrin at 0.12 and 0.25 per cent concentrations gave 100 per cent kill in 72 and 48 hours respectively. Compound 1189 at 0.12, 0.25 and 2.0 per cent concentrations resulted in 100 per cent and 95 per cent kill in 72 hours, and 100 per cent kill within 48 hours respectively.

Compound 1189, applied by dipping the abdomen of the grasshoppers into the toxic emulsion, approached the toxicity of dieldrin.

SUMMARY

This study was concerned with contact and stomach toxicity tests on the two-striped grasshopper, *Melanoplus bivittatus* (Say). Nymphs of this species were collected in the field. They were confined in cages and fed fresh leaf lettuce.

The insecticides or toxic materials used in these tests were two chlorinated hydrocarbons: dieldrin and compound 1189; and an organic phosphate: systox.

In the contact poison tests, using toxic dusts, the grasshopper nymphs, were dusted with each concentration of toxic dust. Dieldrin at 0.12 and 0.25 per cent was more toxic than the other materials and killed 95 per cent and 100 per cent of the grasshopper nymphs, in 72 hours. Compound 1189 at 5 per cent killed 85 per cent of the grasshopper nymphs in 72 hours. Compound 1189 was erratic and inconsistent as a contact poison. All of the grasshopper nymphs, in one test, at 2.0 per cent concentration of compound 1189, as a toxic dust, recovered from the effects of the toxic dust and were alive after 72 hours. Systox was very weak as a contact poison. Systox at 5 per cent killed only 35 per cent of the grasshopper nymphs, in 72 hours.

In the stomach toxicity tests, the grasshoppers were fed equal portions of fresh leaf lettuce which had been dip-

ped in toxic emulsions at different concentrations.

Dieldrin emulsion at 0.12 and 0.25 per cent killed 100 per cent of the grasshoppers in 48 hours. Compound 1189 at 0.12 and 0.25 per cent killed 95 per cent of the grasshoppers in 48 hours.

Compound 1189 compared, in toxicity, favorably with dieldrin in these tests.

In the contact toxicity tests with toxic emulsions, the abdomen of the grasshoppers were dipped into the toxic emulsions.

Dieldrin at 0.12 and 0.25 per cent gave 100 per cent kill in 72 and 48 hours respectively. Compound 1189 at 0.12 and 0.25 per cent resulted in 100 per cent and 95 per cent kill within 72 hours. Compound 1189, as a contact emulsion applied to the abdomen of the grasshoppers, approached the toxicity of dieldrin.

TABLE ONE

Toxic Dusts Applied as Contact Poisons[1]

Toxin	Concentration Per Cent	Per Cent Kill			
		8 hrs	24 hrs	48 hrs	72 hrs
Dieldrin	0.12	0	45	75	95
	0.25	0	55	90	100
Compound 1189	0.12	0	20	30	35
	0.25	0	10	10	15
	2.00	0	0	5	5
	5.00	0	20	75	85
Systox	0.12	0	10	10	10
	0.25	0	0	0	0
	2.00	0	5	15	15
	5.00	0	30	35	35

1 These toxic dusts were applied as contact poisons on 2nd, 3rd and 4th instar nymphs of <u>Melanoplus bivittatus</u> (Say).

TABLE TWO

Toxic Emulsions Applied as Stomach Poisons[2]

Toxin	Concentration Per Cent	Per Cent Kill			
		8 hrs	24 hrs	48 hrs	72 hrs
Dieldrin	0.12	0	35	100	--
	0.25	10	70	100	--
Compound 1189	0.12	0	70	95	100
	0.25	0	75	95	100
	2.00	0	100	--	--
	5.00	0	85	100	--

2 The toxic emulsions were applied to the food of the grasshoppers. The grasshoppers used in these stomach toxicity tests were 4th, 5th and 6th instars of Melanoplus bivittatus (Say).

TABLE THREE

Toxic Emulsions Applied as Contact Poisons[3]

Toxin	Concentration Per Cent	Per Cent Kill				
		4 hrs	8 hrs	24 hrs	48 hrs	72 hrs
Dieldrin	0.12	0	0	35	90	100
	0.25	0	0	60	100	--
Compound 1189	0.12	0	0	15	45	100
	0.25	0	0	30	75	95
	2.00	10	10	35	100	--

3 The toxic emulsions in these tests were applied to the grasshoppers abdomen. This was done by dipping the abdomen into the toxic emulsion. The grasshoppers used in these contact toxicity tests were 4th, 5th and 6th instars of *Melanoplus bivittatus* (Say).

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