Contact Toxicity of Insecticides Against Adult White-pine Weevil, *Pissodes strobi* (Peck)

Project CC-006

by

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CONTENTS

ABBREVIATIONS

Mort.	=	Mortality (%)
Corr. Mort.	=	Corrected Mortality by Abbott's formula
D/T	=	Dead/Total
gpa	=	gallons per acre
WPW	=	White-pine weevil
$\mu g/cm^2$	=	Microgram per square centimeter
b	=	Slope
FL	=	Fiducial limits (95%)
ld-p	=	Log dosage-probit mortality regression line

INTRODUCTION

The white-pine weevil, Pissodes strobi (Peck), is the most serious pest of eastern white pine, Pinus strobus L., in North America. The insecticides used for its control were DDT (Connola et al. 1955, Crosby 1958, Connola 1961, Connola and Smith 1964, Godwin and Reeks 1967) and lindane (Crosby 1958, Hastings and Risley 1962). Due to the adverse effects of highly persistent insecticides (DDT and lindane) the less persistent methoxychlor, has been used for the last two years in Ontario without much success (Howse and Sippell 1969 and 1970). A joint meeting of Forest Protection Section, Ontario Department of Lands and Forests, the Great Lakes Forest Research Centre and the Chemical Control Research Institute was held in 1970, to plan the chemical control strategy against white-pine weevil. It was decided at this meeting that an evaluation of potential insecticides should be carried out against the weevil under laboratory conditions before the 1971 field season, so that the more effective insecticides could be tested in the field during 1971. This study describes the laboratory testing of insecticides carried out against white-pine weevil adults during the winter of 1970-71.

METHODS AND MATERIALS

(i) White-pine weevil adults

White pine (Pinus strobus L.) and Scots pine (P. sylvestris L.) shoots infested with larvae of the white-pine weevil

were collected in the Sault Ste. Marie area and in southern Ontario by staff of Forest Insect and Disease Survey, Canadian Forestry Service, and Ontario Department of Lands and Forests. The mass collections were received at C.C.R.I., in late July 1970. The infested shoots were stored in specially designed wooden cages 2' x 2' x 2', screened with 18 x 20 mesh metal screening to confine the emerged adults. The sides of the cages were covered with heavy brown paper in such a way that approximately 1½" space was left at the top for light and air circulation. This was done to prevent quick drying of the shoots and to attract the weevil adults to the top of the cages. The weevils were kept at room temperature and sufficient humidity in the shoots was maintained by periodical atomizing of water mist. The adult emergence commenced in the second week of August and continued up to the first week of September 1970. The adults were transferred every morning from the cages to small plastic trays lined with paper towels and containing white pine needles and twigs as food. They were stored in the trays at 40° to 42°F until the second week of September and then transferred into 128 oz. glass jars containing duff collected from the white pine plantation and pieces of small white pine branches. The weevils were stored in these jars at 35° to 40°F from the third week of September 1970 until used for the toxicological experiments during February and March 1971. Only those adults which were crawling at room temperature and had started feeding on the branches were used in the tests.

(ii) Insecticides and their formulations

Fourteen insecticides, BHC, C20132, chlordane, DDT, Dursban®, fenitrothion, Gardona®, lindane, Methyl Trithion®, methomyl, methoxychlor, phosphamidon, phoxim, and Zectran® (manufactured by old and new process) were tested against white-pine weevil adults during 1971. The data for C20132, chlordane, DDT, fenitrothion and Methyl Trithion are not presented because the mortality was too variable and could not be subjected to probit analysis. The chlorinated hydrocarbons - DDT, lindane, chlordane and methoxychlor, were used for developing the toxicological data and as standards for comparing the efficacy of the new compounds. The details of insecticides and their formulations used in this report are presented in Table 14, with their chemical name, source and common names. The original designation of insecticides used by the supplier is used in some cases for simplicity. The concentrations of insecticides used are given in the plan of each experiment. The insecticide concentrates were diluted with dyed Velsicol AR60 to the final concentration in most cases. When concentrate or technical grade was not soluble in the Velsicol AR60, the insecticides were first diluted with a mixture containing xylene 40%, acetone 30%, AR60 20% and Tween-80 10%, and then diluted with AR60. DuPont oil red was used as a tracer dye.

(iii) Insecticide treatment

The spraying procedure was very similar to that described by Nigam (1970a). A modified Potter's tower was

calibrated to deliver volumes of dyed insecticide solutions resulting in deposits of 0.1, 0.2, 0.4, 0.6, 0.8 and 1 gallon per acre. The calibration of the tower was carried out in time units by using a micro-syringe for the standard deposit on the required surface area (9 cm No. 1 Whatman filter paper circles) (Nigam, 1967). The deposits of insecticide were determined by the colorimetric method as described by Rayner (1956). Thirty adults per dosage in replicate groups of 10 were sprayed to determine contact toxicity. The spray was applied directly onto CO_2 anaesthetized adults placed on the Whatman filter paper circles. The deposit was calculated in $\mu g/cm^2$ and used for the probit analysis. Two types of controls were used in the preliminary studies, i.e., controls treated with dyed solvent at the rate of 0.1 to 1 gallon per acre as mentioned above, and without solvent treatment. There was no apparent effect of the solvent on the control mortality, so controls without solvent treatment were used in the final studies. The details of each experiment are described individually (Experiments 1 - 10).

(iv) Observation and analysis of data

The adults were held at 70° F. and 55 - 60% R.H. after treatment and provided with fresh white pine twigs. Mortality counts were made at 24, 48 and 72 hours after treatment and corrected for control mortality according to Abbott's formula (1925). Probit analysis of the data was carried out according

to Finney (1964) using program No. S103 prepared by Statistical Research Service, Canada Department of Agriculture for a Univac 1108 Computer. The Computer Service was provided by Biometric and Computer Division of Canada Department of Environment. The relative potencies of the insecticides were calculated according to Finney (1964) and toxicity index according to Sun (1950) using lindane as the standard insecticide.

EXPERIMENTS AND RESULTS

The plan of each insecticide treatment is presented individually (Experiments 1 - 10), and mortality observed for 24, 48 and 72 hours after treatment are tabulated for each experiment (Tables 1 - 10). The results of probit analysis for each period of observation are given at the end of each experiment and regression lines for 24, 48 and 72 hours are drawn (Figures 1 - 10). The experiments are arranged in descending order of toxicity of insecticide at LD_{50} values for 24 hours. The comparative contact toxicity of the insecticides at 24, 48 and 72 hours after treatment against the adults is presented in Tables 11 - 13, and Figures 11 - 13. The insecticides are arranged in descending order of toxicity on the basis of LD_{50} values for each period of observation in these tables and graphs. The toxicity at the LD_{50} level increased for all the insecticides with increasing time after treatment, i.e., from 24-72 hours. However, this increase in toxicity was not significant.

At the LD_{95} level also, toxicity increased with time in all cases. The increase was appreciable in Gardona, methomyl, BHC, Zectran (old), lindane and methoxychlor (Figures 3, 5, 7, 8, 9 and 10 respectively).

The slopes of the probit regression lines for each insecticide were not the same for the different periods of observations (Figs. 1 - 10). Similarly slopes were not the same when different insecticides were compared at the same period of observations (Figs. 11 - 13). Therefore the lines were neither parallel in the same insecticide for different periods of observations nor in different insecticides for the same period of observation, when analyzed for the single line probit analysis.

The relative potency and toxicity index of the insecticides are given in Tables 11 - 13 for each period of observation. Phoxim was the best as a contact insecticide followed by Dursban and Gardona at the LD_{50} and LD_{95} level. Methoxychlor was the least toxic. Lindane was more effective than methoxychlor.

DISCUSSION

Phoxim was the most effective insecticide against Sitka spruce weevil adults. It was also very effective against ambrosia beetle (Nigam 1971b), spruce budworm (Nigam 1969) and various species of sawflies (Nigam 1970b and 1971a). This insecticide is still in the experimental stage and is not available commercially, so it was not recommended for field evaluation. Dursban and Gardona were recommended for field evaluation as they were next best and are commercially available. They appear to be promising insecticides against white-

pine weevil in the field under test conditions (DeBoo and Campbell 1971). They may prove better than methoxychlor if tried at higher dosages in the future.

SUMMARY

Fourteen insecticides were tested during 1971 against the adults of white-pine weevil. Data of nine insecticides were analyzed. Phoxim was the most effective insecticide followed by Dursban and Gardona. Methoxychlor was the least effective. Lindane was better than methoxychlor. Dursban and Gardona were recommended for field evaluation. Phoxim was not recommended because it is not available commercially. Dursban and Gardona appear promising in the field against the weevil.

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EXPERIMENT NO. 1

Object: To determine the contact toxicity of phoxim against adult white-pine weevil.

Plan of Experiment:

Treatment: Seven (six rates of application - o.1, 0.2, 0.4, 0.6, o.8, 1.0 gpa and control).

Concentration of insecticide: 1.0%

Replications: Three

No. of larvae per treatment: Thirty

Total No. of larvae utilized: Two hundred and ten

Exptal. Code: WPW 16-71

Computer Code: WPW-PHX-(25-27)

Table No. 1

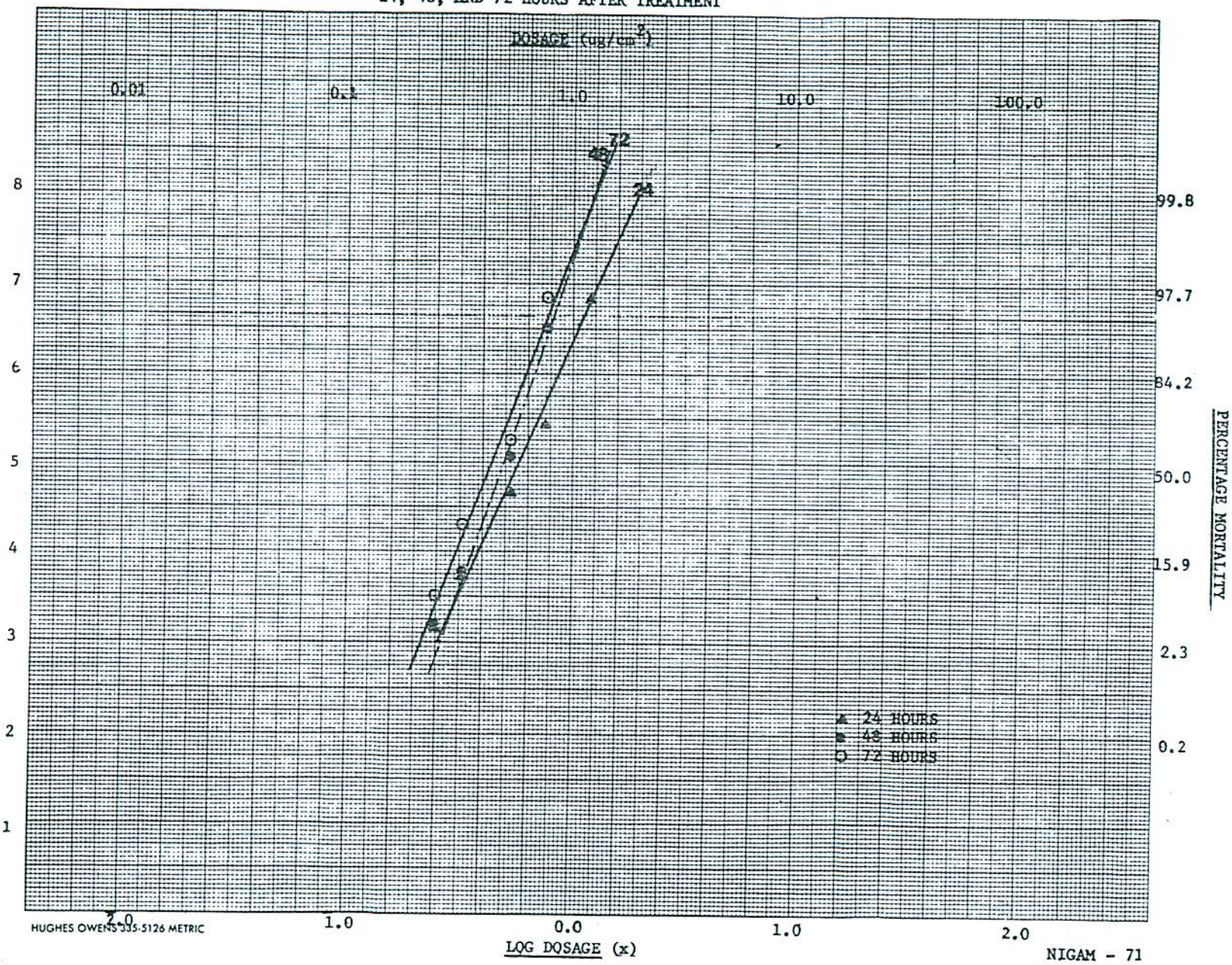
Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm^2	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	0.250	1/30	3	3	1/30	3	3	2/30	7	7
0.2	0.330	3/29	10	10	3/29	10	10	7/29	24	24
0.4	0.526	11/30	37	37	16/30	53	53	18/30	60	60
0.6	0.758	20/30	67	67	28/30	93	93	29/30	97	97
0.8	0.982	30/30	100	100	30/30	100	100	30/30	100	100
1.0	1.192	29/30	97	97	30/30	100	100	30/30	100	100
Control		0/30			0/30			0/30		

Findings: The summary of probit analysis is as follows:

Period	b	LD 50 ug/cm^2	FL	LD 95 ug/cm^2	FL
24 hours	5.80	0.57	0.51-0.63	1.10	0.95-1.35
48 hours	7.42	0.49	0.44-0.53	0.81	0.72-0.98
72 hours	6.57	0.44	0.39-0.48	0.78	0.68-0.96

Remarks: The regression lines are given in fig. 1.

FIG. 1. Ld-p LINES OF PHOXIM AGAINST ADULT PISSODES STROBI (PECK) (WHITE PINE WEEVIL) AT 24, 48, AND 72 HOURS AFTER TREATMENT



EXPERIMENT NO. 2

Object: To determine the contaxt toxicity of Dursban against adult white-pine weevil.

Plan of Experiment:

Treatment: Seven (six rates of application - o.1, 0.2, 0.4, 0.6, 0.8, 1.0 gpa and control).

Concentration of insecticide: 2.0%

Replications: Three

No. of larvae per treatment: Thirty

Total No. of larvae utilized: Two hundred and ten

Exptal. Code: WPW-18-71 Computer Code: - WPW-DUR-(28-30)

Table No. 2

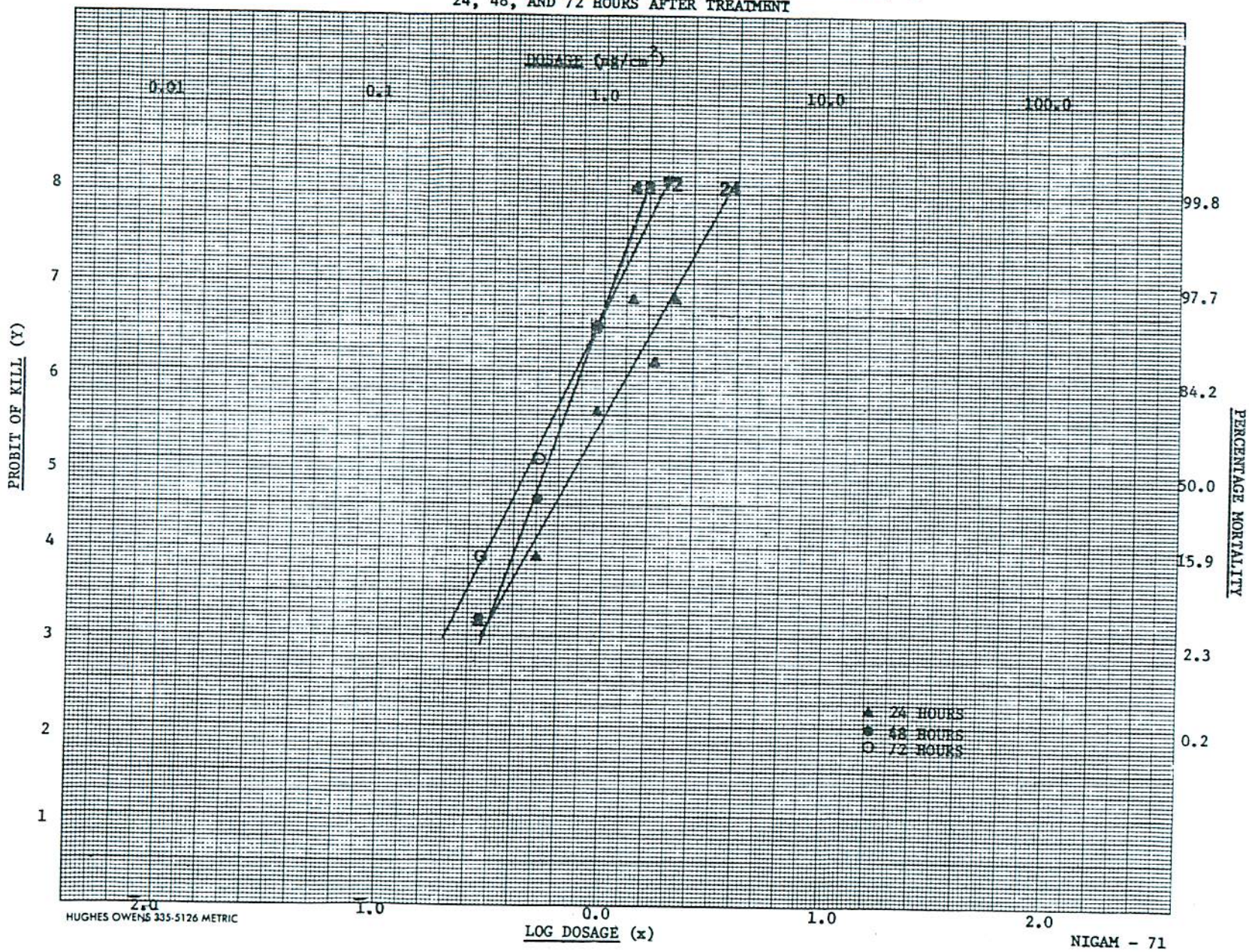
Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm^2	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	0.287	1/30	3	3	1/30	3	3	4/30	13	13
0.2	0.504	4/30	13	13	10/30	33	33	15/30	50	50
0.4	0.947	21/30	70	70	28/30	93	93	28/30	93	93
0.6	1.357	29/30	97	97	30/30	100	100	30/30	100	100
0.8	1.697	26/30	93	93	30/30	100	100	30/30	100	100
1.0	2.081	29/30	97	97	30/30	100	100	30/30	100	100
Control		0/30			0/30			0/30		

Findings: The summary of probit analysis is as follows:

Period	b	LD 50 ug/cm^2	FL	LD 95 ug/cm^2	FL
24 hours	4.59	0.78	0.67-0.88	1.77	1.50-2.26
48 hours	6.81	0.57	0.50-0.64	0.99	0.85-1.28
72 hours	5.34	0.48	0.42-0.55	0.98	0.82-1.31

Remarks: The regression lines are given in fig. 2.

FIG. 2. Ld-p LINES OF DURSBAN AGAINST ADULT PISSODES STROBI (PECK) (WHITE PINE WEEVIL) AT 24, 48, AND 72 HOURS AFTER TREATMENT



EXPERIMENT NO. 3

Object: To determine the contact toxicity of Gardona against adult white-pine weevil.

Plan of Experiment:

Treatment: Seven (six rates of application - 0.1, 0.2, 0.4, 0.6, 0.8, 1.0 gpa and control).

Concentration of insecticide: 2.0%

Replications: Three

No. of larvae per treatment: Thirty

Total No. of larvae utilized: Two hundred and ten

Exptal Code: WDW-8-71 Computer Code: WPW-GAR-(16-18)

Table No. 3

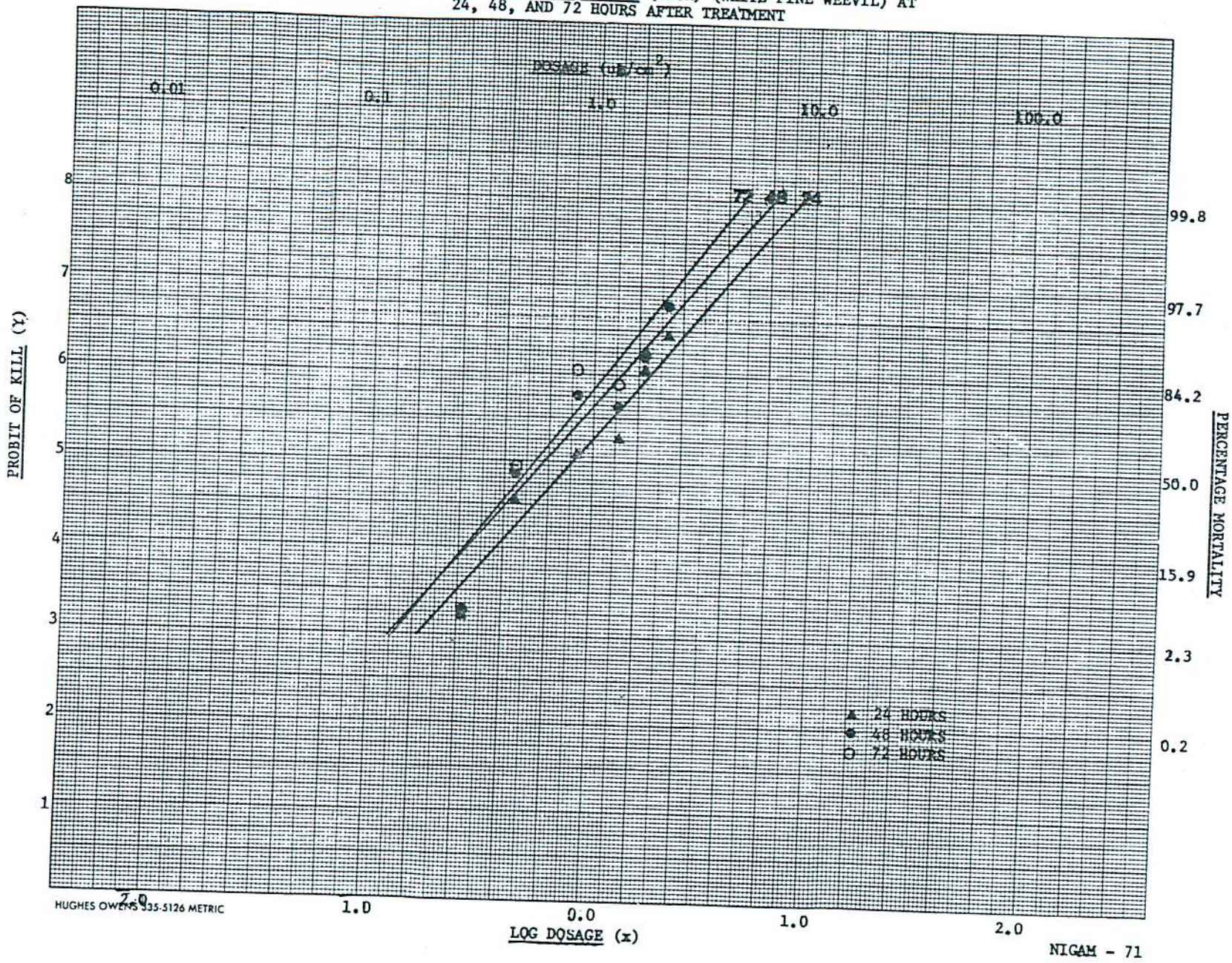
Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm^2	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	0.268	3/30	10	4	4/30	13	4	4/30	13	4
0.2	0.442	11/30	37	32	15/30	50	44	16/30	53	48
0.4	0.840	17/30	57	54	24/30	80	78	26/30	87	85
0.6	1.295	19/30	63	61	23/30	77	74	25/30	83	81
0.8	1.694	26/30	87	86	27/30	90	89	27/30	90	89
1.0	2.122	28/30	93	93	29/30	97	96	30/30	100	100
Control		2/30	7		3/30	10		3/30	10	

Findings: The summary of probit analysis is as follows:

Period	b	LD 50 ug/cm^2	FL	LD 95 ug/cm^2	FL
24 hours	2.89	0.79	0.63-0.96	2.95	2.18-4.93
48 hours	2.94	0.60	0.46-0.73	2.17	1.65-3.44
72 hours	3.23	0.54	-	1.76	-

Remarks: The regression lines are given in fig. 3.

FIG. 3. Ld-p LINES OF GARDONA AGAINST ADULT PISSODES STROBI (PECK) (WHITE PINE WEEVIL) AT 24, 48, AND 72 HOURS AFTER TREATMENT



EXPERIMENT NO. 4

Object: To determine the contact toxicity of Zectran (new) against adult white-pine weevil.

Plan of Experiment:

Treatment: Seven (six rates of application - 0.1, 0.2, 0.4, 0.6, 0.8, 1.0 gpa and control).

Concentration of insecticide: 2.0%

Replications: Three

No. of larvae per treatment: Thirty

Total No. of larvae utilized: Two hundred and ten

Exptal. Code: WPW 20-71 Computer Code: WPW-ZCN-B(31-33)

Table No. 4

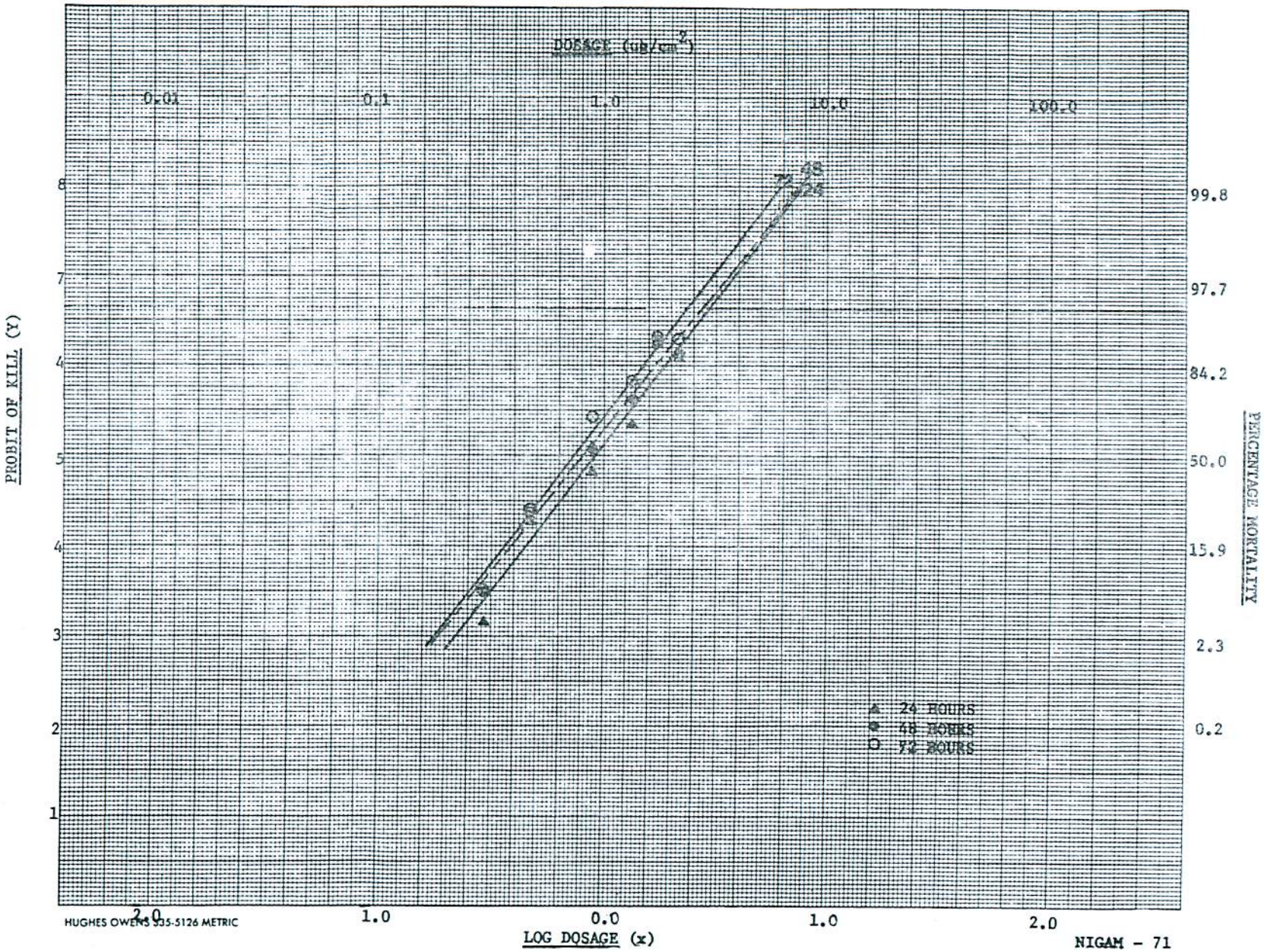
Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm^2	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	0.299	1/30	3	3	2/30	7	7	2/30	7	7
0.2	0.466	7/30	23	23	8/30	27	27	8/30	27	27
0.4	0.897	13/30	43	43	16/30	53	53	20/30	67	67
0.6	1.327	19/30	63	63	22/30	73	73	24/30	80	80
0.8	1.713	27/30	90	90	27/30	90	90	27/30	90	90
1.0	2.130	26/30	87	87	26/30	87	87	27/30	90	90
Control		0/30			0/30			0/30		

Findings: The summary of probit analysis is as follows:

Period	b	LD 50 ug/cm^2	FL	LD 95 ug/cm^2	FL
24 hours	3.28	0.92	0.78-1.07	2.92	2.26-4.34
48 hours	3.11	0.81	0.68-0.95	2.75	2.12-4.13
72 hours	3.31	0.74	0.62-0.86	2.32	1.83-3.31

Remarks: The regression lines are given in fig. 4.

FIG. 4. Ld-p LINES OF ZECTRAN (new) AGAINST ADULT PISSODES STROBI (PECK) (WHITE PINE WEEVIL) AT 24, 48, AND 72 HOURS AFTER TREATMENT



EXPERIMENT NO. 5

Object: To determine the contact toxicity of methomyl against adult white-pine weevil.

Plan of Experiment:

Treatment: Seven (six rates of application - 0.1, 0.2, 0.4, 0.6, 0.8, 1.0 gpa and control)

Concentration of insecticide: 4.0%

Replications: Three

No. of larvae per treatment: Thirty

Total No. of larvae utilized: Two hundred and ten

Exptal. Code: WPW 9-71 Computer Code: WPW-MML-(19-21)

Table No. 5

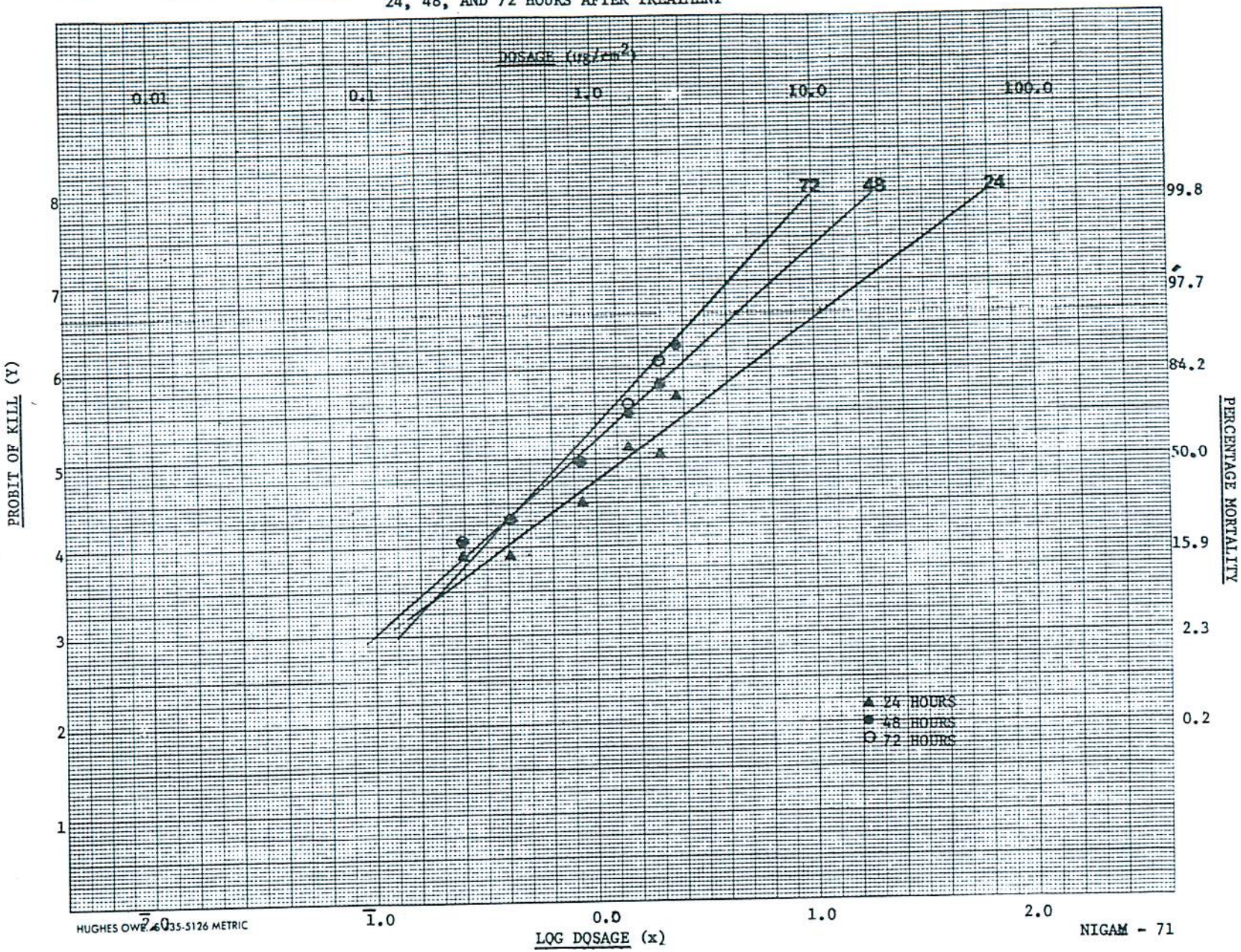
Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm^2	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	0.244	5/30	17	14	6/30	20	17	6/30	20	17
0.2	0.409	5/30	17	14	8/30	27	24	8/30	27	24
0.4	0.865	10/30	33	31	15/30	50	48	15/30	50	48
0.6	1.418	17/30	57	55	21/30	70	69	22/30	73	72
0.8	1.944	16/30	53	52	24/30	80	79	26/30	87	86
1.0	2.303	23/30	77	76	27/30	90	90	30/30	100	100
Control		1/30	3		1/30	3		1/30	3	

Findings: The summary of probit analysis is as follows:

Period	b	LD 50 ug/cm^2	FL	LD 95 ug/cm^2	FL
24 hours	1.82	1.35	1.04-1.88	10.79	5.59-43.63
48 hours	2.20	0.80	0.61-0.99	4.45	2.96-9.02
72 hours	2.65	0.73	0.58-0.88	3.03	2.23-4.94

Remarks: The regression lines are given in fig. 5.

FIG. 5. Ld-p LINES OF METHOMYL AGAINST ADULT PISSODES STROBI (PECK) (WHITE PINE WEEVIL) AT 24, 48, AND 72 HOURS AFTER TREATMENT



EXPERIMENT NO. 6

Object: To determine the contact toxicity of phosphamidon against adult white-pine weevil.

Plan of Experiment:

Treatment: Seven (six rates of application - 0.1, 0.2, 0.4, 0.6, 0.8, 1.0 gpa and control)

Concentration of insecticide: 4.0%

Replications: Three

No. of larvae per treatment: Thirty

Total No. of larvae utilized: Two hundred and ten

Exptal. Code: WPW 13-71. Computer Code: WPW-PHØ-(22-24)

Table No. 6

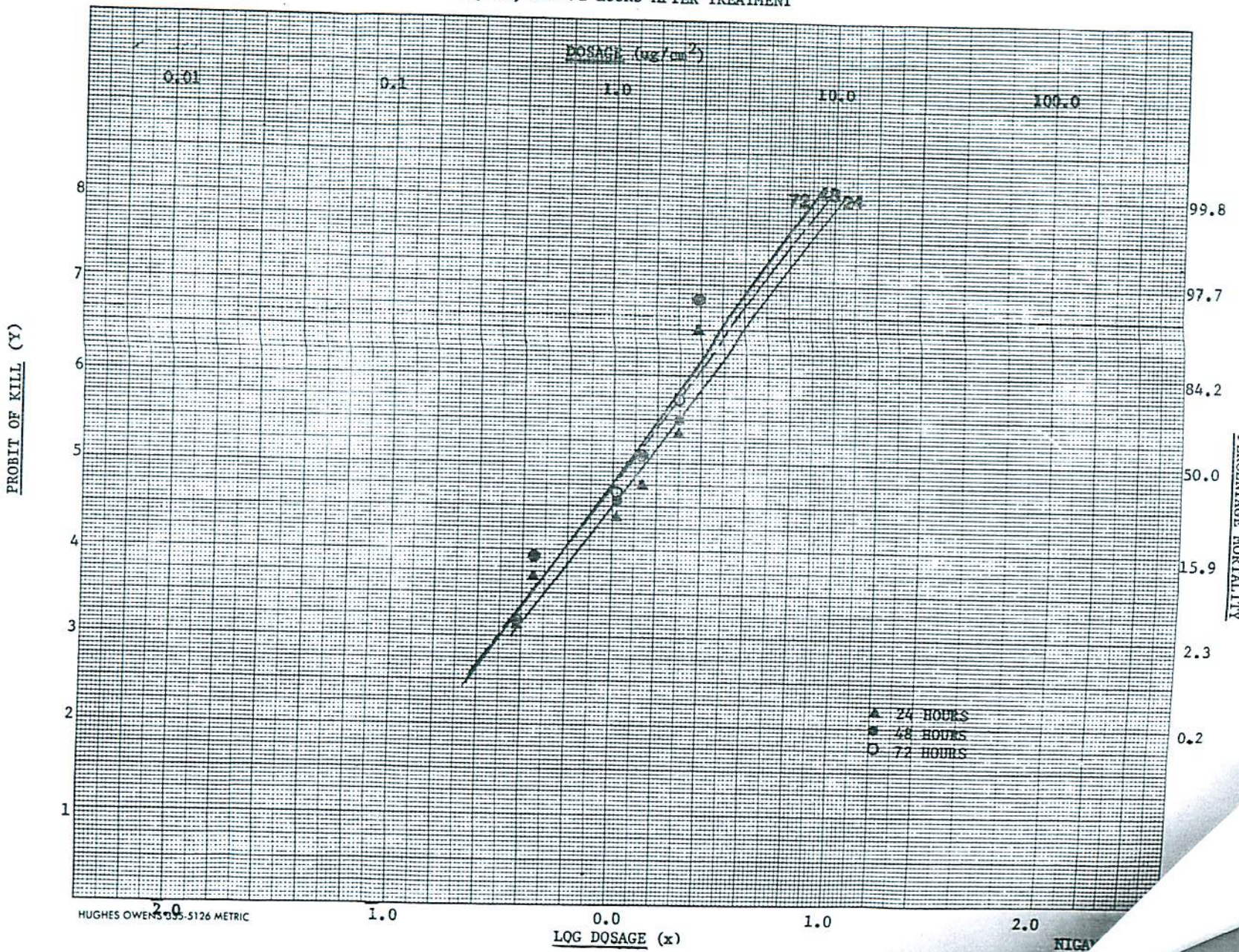
Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm^2	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	0.387	1/30	3	3	1/30	3	3	1/30	3	3
0.2	0.443	3/30	10	10	4/30	13	13	4/30	13	13
0.4	1.045	8/30	27	27	10/30	33	33	11/30	37	37
0.6	1.355	12/30	40	40	16/30	53	53	16/30	53	53
0.8	1.991	19/30	63	63	21/30	70	70	23/30	77	77
1.0	2.482	28/30	93	93	29/30	97	97	29/30	97	97
Control		0/30	0		0/30	0		0/30	0	

Findings: The summary of probit analysis is as follows:

Period	b	LD 50 ug/cm^2	FL	LD 95 ug/cm^2	FL
24 hours	3.34	1.40	1.20-1.64	4.34	3.25-6.98
48 hours	3.40	1.21	1.04-1.41	3.68	2.84-5.55
72 hours	3.53	1.16	1.00-1.34	3.38	2.65-4.93

Remarks: The regression lines are given in fig. 6.

FIG. 6. Ld-p LINES OF PHOSPHAMIDON AGAINST ADULT PISSODES STROBI (PECK) (WHITE PINE WEEVIL) AT 24, 48, AND 72 HOURS AFTER TREATMENT



EXPERIMENT NO.7

Object: To determine the contact toxicity of B.H.C. against adult white-pine weevil.

Plan of Experiment:

Treatment: Seven (six rates of application - 0.1, 0.2, 0.4, 0.6, 0.8, 1.0 gpa and control).

Concentration of insecticide: 5.0%

Replications: Three

No. of larvae per treatment: Thirty

Total No. of larvae utilized: Two hundred and ten

Exptal. Code: WPW 2-71 Computer Code: WPW-BHC-(1-3)

Table No. 7

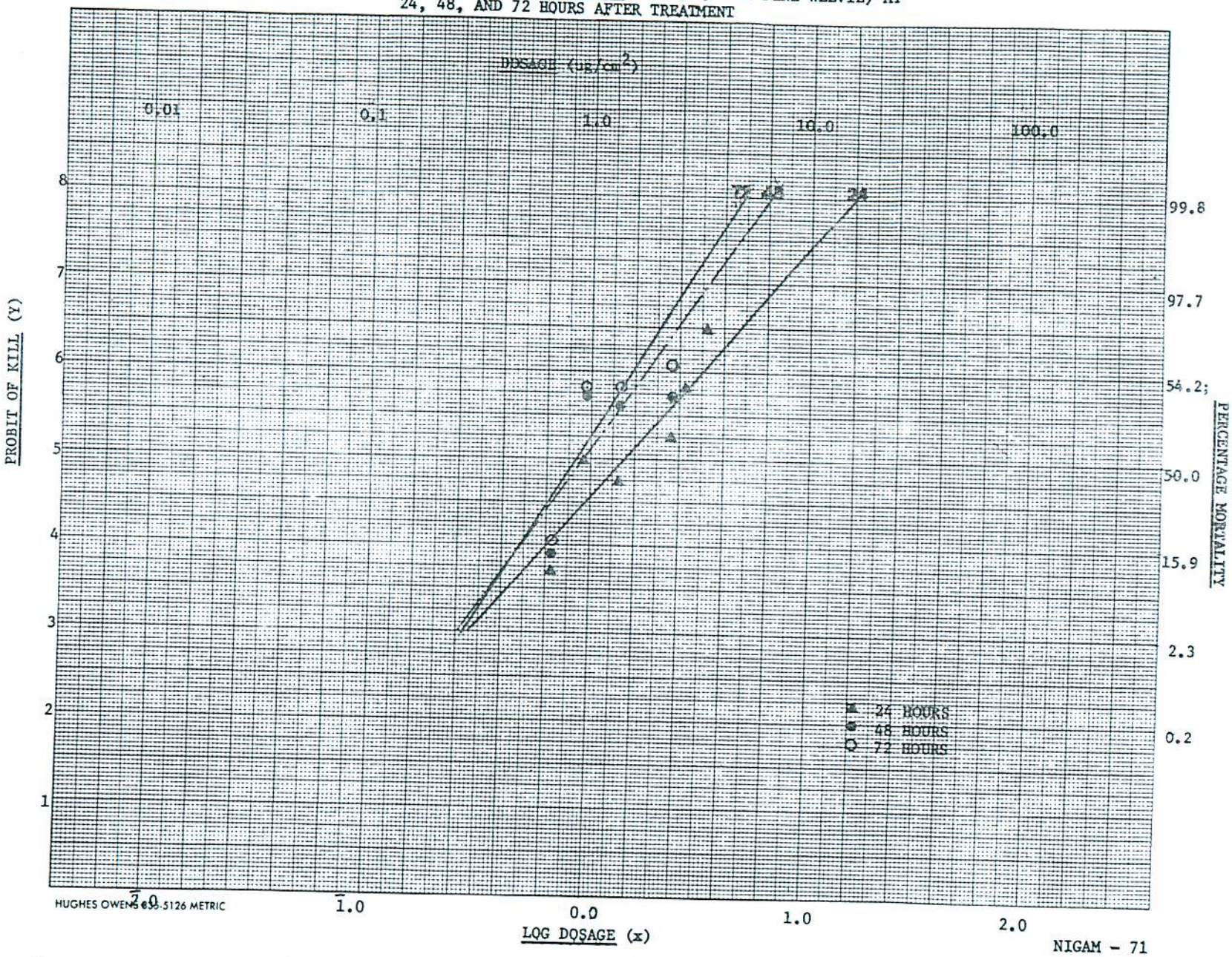
Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm^2	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	0.673	3/30	10	10	4/30	13	13	6/30	20	17
0.2	.944	15/30	50	50	23/30	77	77	24/30	80	79
0.4	1.377	12/30	40	40	22/30	73	73	24/30	80	79
0.6	2.305	18/30	60	60	23/30	77	77	26/30	87	86
0.8	2.655	24/30	80	80	30/30	100	100	30/30	100	100
1.0	3.323	28/30	93	93	30/30	100	100	30/30	100	100
Control		0/30	0		0/30	0		1/28	4	

Findings: The summary of probit analysis is as follows:

Period	b	LD 50 ug/cm^2	FL	LD 95 ug/cm^2	FL
24 hours	2.90	1.42	0.73-2.229	5.24	2.94-94.25
48 hours	3.63	0.94	-	2.66	-
72 hours	3.98	0.86		2.24	

Remarks: The regression lines are given in fig. 7.

FIG. 7. Ld-p LINES OF B.H.C. AGAINST ADULT PISSODES STROBI (PECK) (WHITE PINE WEEVIL) AT 24, 48, AND 72 HOURS AFTER TREATMENT



EXPERIMENT NO. 8

Object: To determine the contact toxicity of Zectran (old) against adult white-pine weevil.

Plan of Experiment:

Treatment: Seven (six rates of application - 0.1, 0.2, 0.4, 0.6, 0.8, 1.0 gpa and control)

Concentration of insecticide: 4.0%

Replications: Three

No. of larvae per treatment: Thirty

Total No. of larvae utilized: Two hundred and ten

Exptal. Code: WPW-5-71 Computer Code: WPW-ZC0 (10-12)

Table No. 8

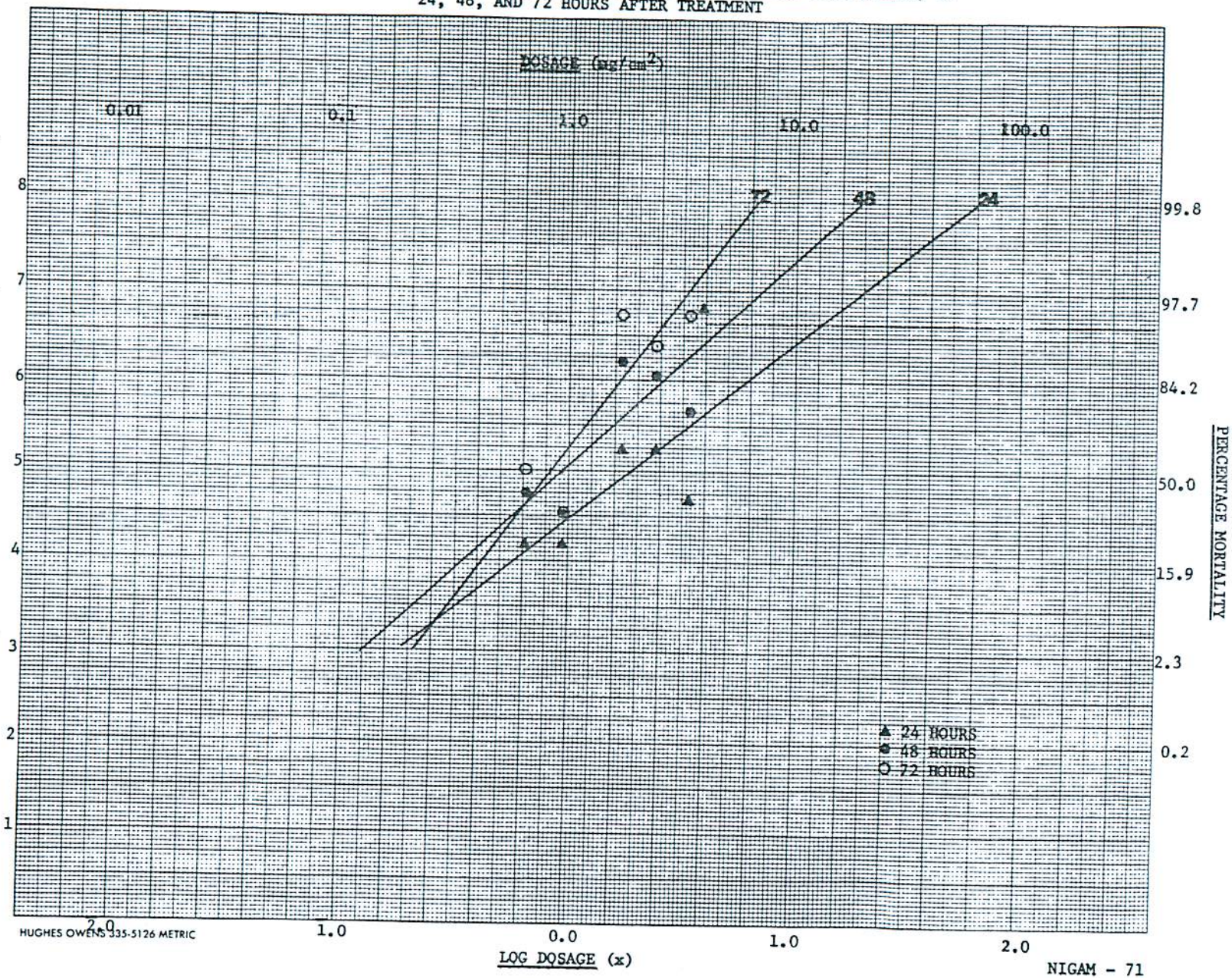
Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm^2	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	0.643	7/30	23	21	14/30	47	41	18/30	60	50
0.2	0.951	7/30	23	21	12/30	40	33	14/30	47	33
0.4	1.706	18/30	60	59	27/30	90	89	29/30	97	96
0.6	2.382	18/30	60	59	26/30	87	85	28/30	93	92
0.8	3.368	12/30	40	38	23/30	77	74	29/30	97	96
1.0	3.846	29/30	97	97	30/30	100	100	30/30	100	100
Control		1/30	3		3/30	10		6/30	20	

Findings: The summary of probit analysis is as follows:

Period	b	LD 50 ug/cm^2	FL	LD 95 ug/cm^2	FL
24 hours	1.97	1.88	-	12.85	-
48 hours	2.32	0.95		4.83	
72 hours	3.34	0.84	-	2.62	-

Remarks: The regression lines are given in fig. 8.

FIG. 8. Ld-p LINES OF ZECTRAN (old) AGAINST ADULT PISSODES STROBI (PECK) (WHITE PINE WEEVIL) AT 24, 48, AND 72 HOURS AFTER TREATMENT



EXPERIMENT NO. 9

Object: To determine the contact toxicity of Lindane against adult white-pine weevil.

Plan of Experiment:

Treatment: Seven (six rates of application - 0.1, 0.2, 0.4, 0.6, 0.8, 1.0 gpa and control)

Concentration of insecticide: 5.0%

Replications: Three

No. of larvae per treatment: Thirty

Total No. of larvae utilized: Two hundred and ten

Exptal. Code: WPW 7-71 Computer Code: WPW-LIN (13-15)

Table No. 9

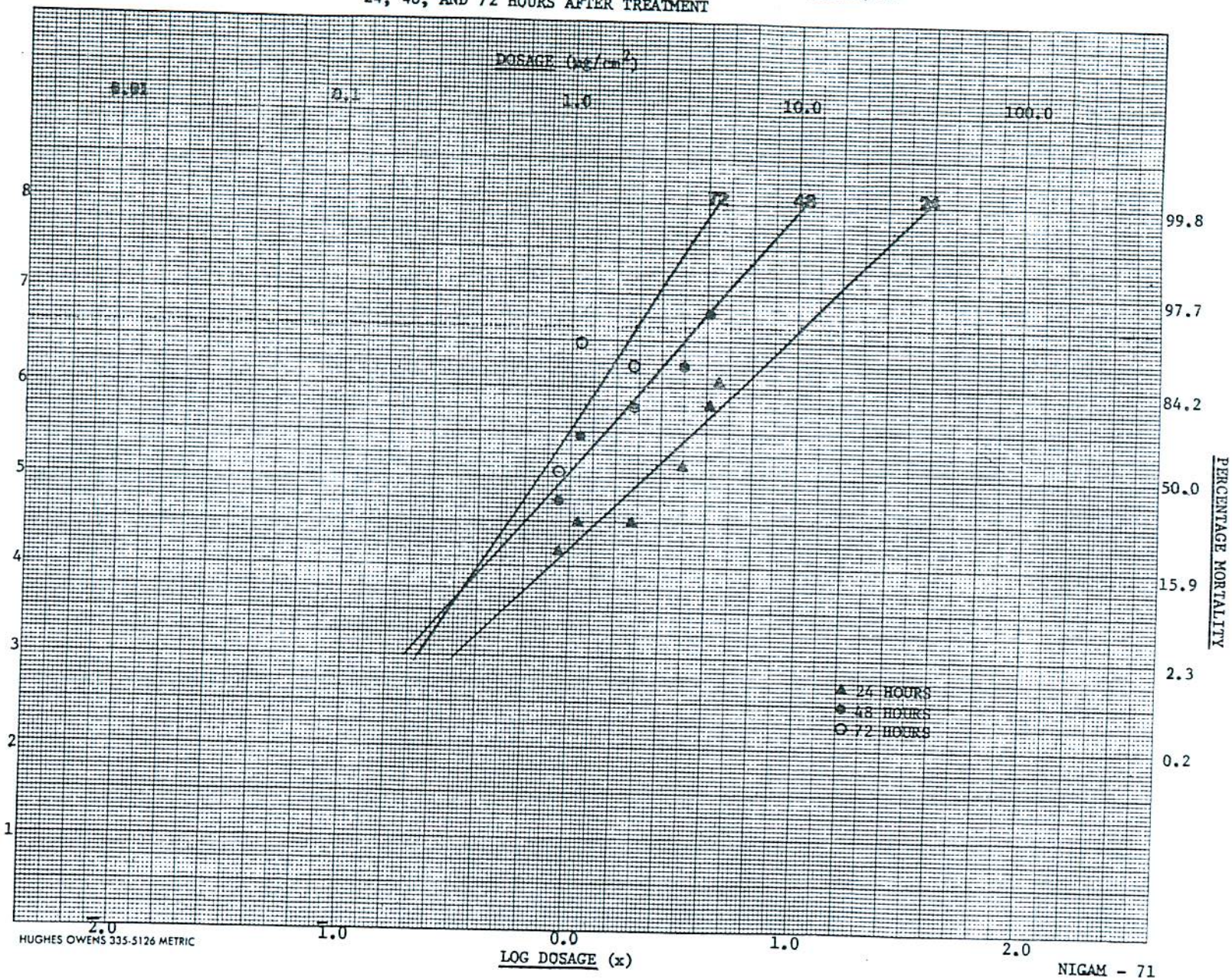
Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm^2	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	0.893	7/30	23	21	13/30	43	39	17/30	57	54
0.2	1.089	10/30	33	31	21/30	70	68	28/30	93	93
0.4	1.886	10/30	33	31	24/30	80	79	27/30	90	89
0.6	3.149	17/30	57	55	27/30	90	89	30/30	100	100
0.8	4.059	24/30	80	79	29/30	97	96	30/30	100	100
1.0	4.506	26/30	87	86	30/30	100	100	30/30	100	100
Control		1/30	3		2/30	7		3/30	10	

Findings: The summary of probit analysis is as follows:

Period	b	LD 50 ug/cm^2	FL	LD 95 ug/cm^2	FL
24 hours	2.42	2.15	1.73-2.63	10.33	6.84-22.53
48 hours	2.88	0.95	0.66-1.19	3.54	2.71-5.75
72 hours	3.89	0.72	0.41-0.91	1.92	1.53-3.36

Remarks: The regression lines are given in fig. 9.

FIG. 9. Ld-p LINES OF LINDANE AGAINST ADULT PISSODES STROBI (PECK) (WHITE PINE WEEVIL) AT 24, 48, AND 72 HOURS AFTER TREATMENT



EXPERIMENT NO.10

Object: To determine the contact toxicity of methoxychlor against adult white-pine weevil.

Plan of Experiment:

Treatment: Seven (six rates of application - 0.1, 0.2, 0.4, 0.6, 0.8, 1.0 gpa and control).

Concentration of insecticide: 10.0%

Replications: Three

No. of larvae per treatment: Thirty

Total No. of larvae utilized: Two hundred and ten

Exptal. Code: WPW 3-71 Computer Code: WPW-MXC-(4-6)

Table No.10

Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm^2	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	2.366	3/30	10	10	4/30	13	13	6/30	20	20
0.2	3.309	6/30	20	20	11/30	37	37	13/30	43	43
0.4	5.278	13/30	43	43	17/30	57	57	19/30	63	63
0.6	9.842	13/30	43	43	21/30	70	70	23/30	77	77
0.8	11.423	14/30	47	47	25/30	83	83	26/30	87	87
1.0	13.367	20/30	67	67	25/30	83	83	25/30	83	83
Control		0/30	0		0/30	0		0/30	0	

Findings: The summary of probit analysis is as follows:

Period	b	LD 50 ug/cm^2	FL	LD 95 ug/cm^2	FL
24 hours	1.77	9.810	7.59-14.61	83.55	39.21-489.0
48 hours	2.51	5.19	4.18- 6.25	23.54	16.60-43.24
72 hours	2.34	4.39	3.39- 5.36	22.11	15.36-42.58

Remarks: The regression lines are given in fig. 10.

FIG. 10. Ld-p LINES OF METHOXYCHLOR AGAINST ADULT PISSODES STROBI (PECK) (WHITE PINE WEEVIL) AT 24, 48, AND 72 HOURS AFTER TREATMENT

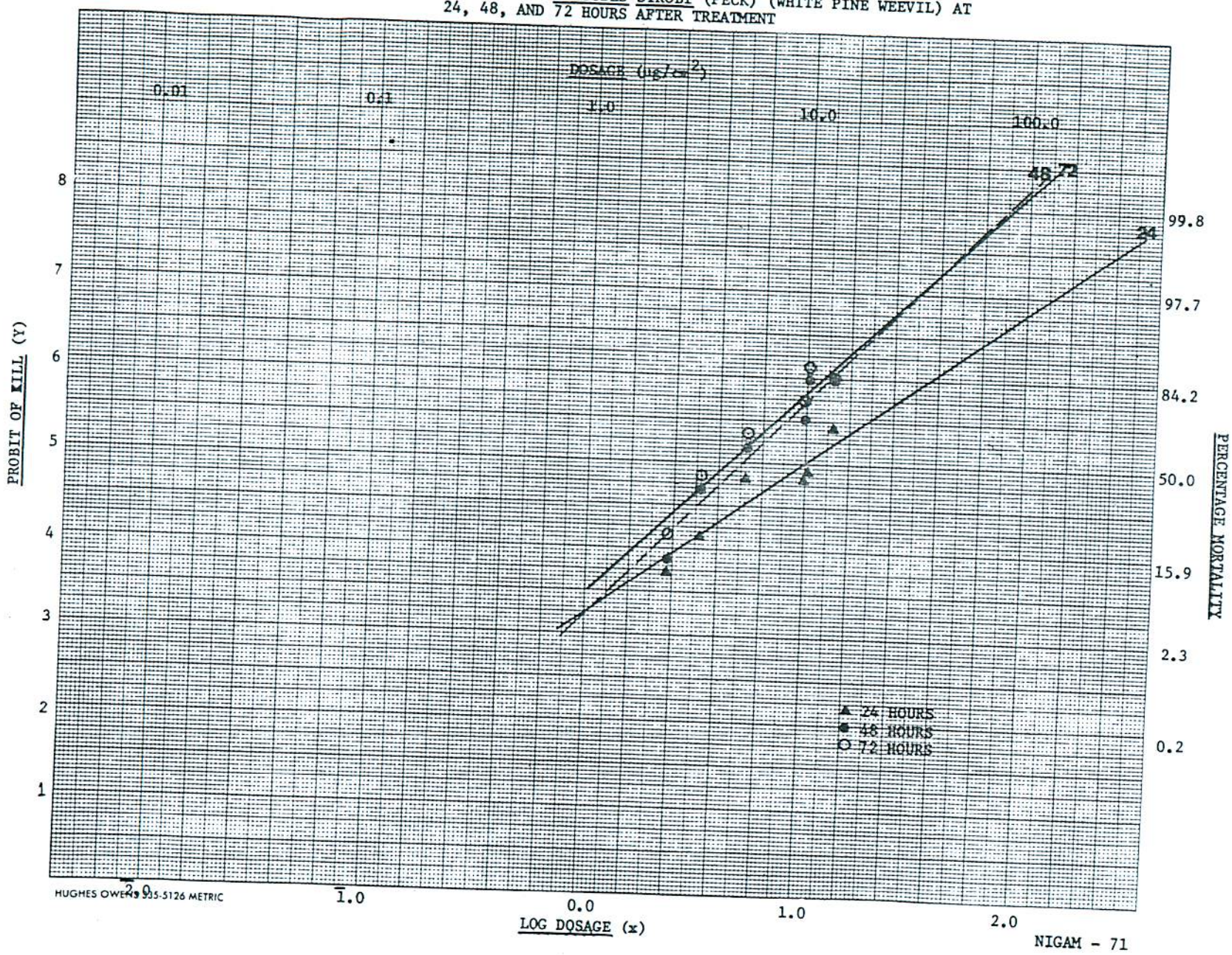


Table 11: Toxicity of Insecticides to Adult Pissodes strobi (Peck) at 24 Hours after Treatment

Insecticide	LD_{50} ug/cm^2	Fiducial Limits	Relative Potency	Toxicity Index	LD_{95} ug/cm^2	Fiducial Limits	Relative Potency
Phoxim	0.57	0.51- 0.63	3.77	377	1.10	0.95- 1.35	9.39
Dursban	.78	.67- .88	2.76	276	1.77	1.50- 2.26	5.84
Gardona	.79	.63- .96	2.72	272	2.95	2.18- 4.93	3.50
Zectran (new)	.92	.78- 1.07	2.34	234	2.92	2.26- 4.34	3.54
Methomyl	1.35	1.04- 1.88	1.59	159	10.79	5.59-43.63	.96
Phosphamidon	1.40	1.20- 1.64	1.54	154	4.34	3.25- 6.98	2.38
B.H.C.	1.42	0.73- 2.23	1.51	151	5.24	2.94-94.25	1.97
Zectran (old)	1.88		1.14	114	12.85		.80
Lindane	2.15	1.73- 2.63	1.00	100	10.33	6.84-22.53	1.00
Methoxychlor	9.81	7.59-14.61	.22	22	83.55	39.21-489.0	.12

FIG. 11. COMPARATIVE Ld-p LINES OF 10 INSECTICIDES AGAINST ADULT PISSODES STROBI (PECK) (WHITE PINE WEEVIL)
24 HOURS AFTER TREATMENT

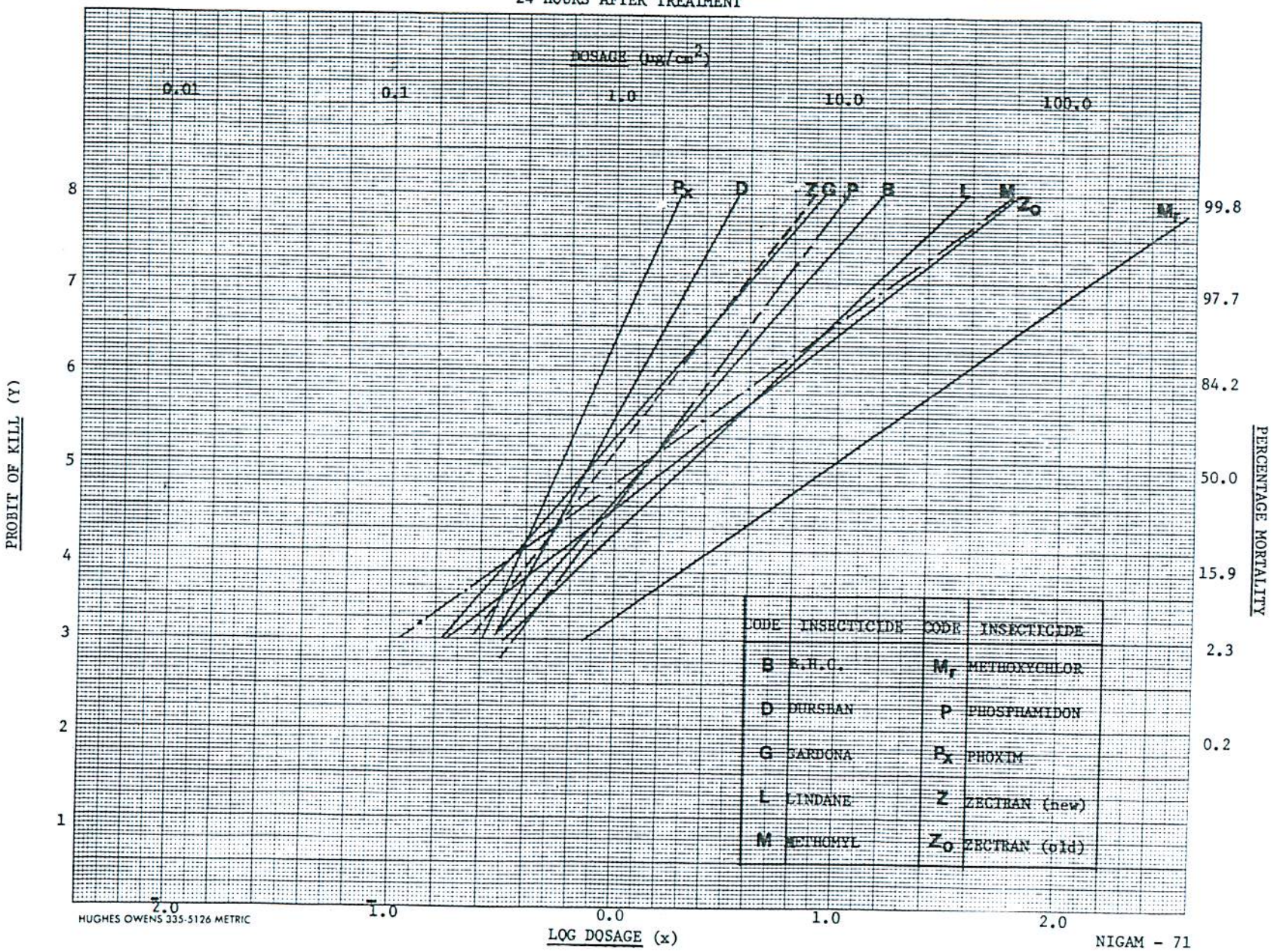


Table 12: Toxicity of Insecticides to Adult Pissodes strobi (Peck) at 48 Hours after Treatment

Insecticide	LD_{50} ug/cm^2	Fiducial Limits	Relative Potency	Toxicity Index	LD_{95} ug/cm^2	Fiducial Limits	Relative Potency
Phoxim	0.49	0.44-0.53	1.94	194	0.81	0.72- 0.98	4.37
Dursban	.57	.50- .64	1.67	167	.99	.85- 1.28	3.58
Gardona	.60	.46- .73	1.58	158	2.17	1.65- 3.44	1.63
Methomyl	.80	.61- .99	1.19	119	4.45	2.96- 9.02	0.80
Zectran (new)	.81	.68- .95	1.17	117	2.75	2.12- 4.13	1.29
B.H.C.	.94		1.01	101	2.66		1.33
Zectran (old)	.95		1.00	100	4.83		0.73
Lindane	.95	.66-1.19	1.00	100	3.54	2.71- 5.75	1.00
Phosphamidon	1.21	1.04-1.41	0.79	79	3.68	2.84- 5.55	0.96
Methoxychlor	5.19	4.18-6.25	.18	18	23.54	16.60-43.24	.15

FIG. 12. COMPARATIVE Ld-p LINES OF 10 INSECTICIDES AGAINST ADULT PISSODES STROBI (PECK) (WHITE PINE WEEVIL)
48 HOURS AFTER TREATMENT

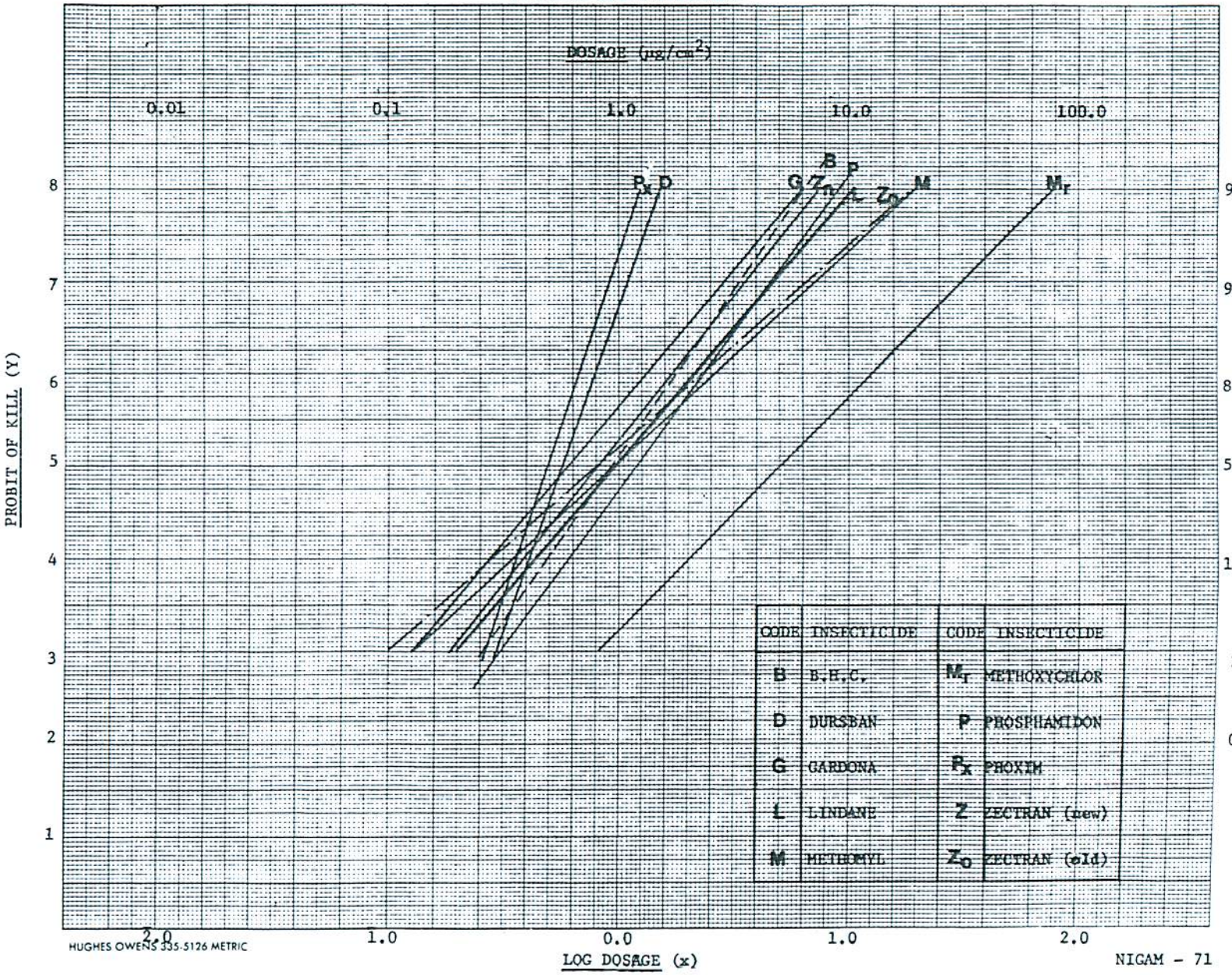


Table 13: Toxicity of Insecticides to Adult Pissodes strobi (Peck) at 72 Hours after Treatment

Insecticide	LD_{50} ug/cm^2	Fiducial Limits	Relative Potency	Toxicity Index	LD_{95} ug/cm^2	Fiducial Limits	Relative Potency
Phoxim	0.44	0.39-0.48	1.63	163	0.78	0.68-0.96	2.46
Dursban	.48	.42- .55	1.50	150	.98	.82-1.31	1.96
Gardona	.54		1.33	133	1.76		1.09
Lindane	.72	.41- .91	1.00	100	1.92	1.53-3.36	1.00
Methomyl	.73	.58- .88	0.99	99	3.03	2.23-4.94	0.63
Zectran (new)	.74	.62- .86	.97	97	2.32	1.83-3.31	.83
Zectran (old)	.84		.86	86	2.62		.73
B.H.C.	.86		.84	84	2.24		.86
Phosphamidon	1.16	1.00-1.34	.62	62	3.38	2.65-4.93	.57
Methoxychlor	4.39	3.39-5.36	.16	16	22.11	15.36-42.58	.09

FIG. 13. COMPARATIVE Ld-p LINES OF 10 INSECTICIDES AGAINST ADULT PISSODES STROBI (PECK) (WHITE PINE WEEVIL) 72 HOURS AFTER TREATMENT

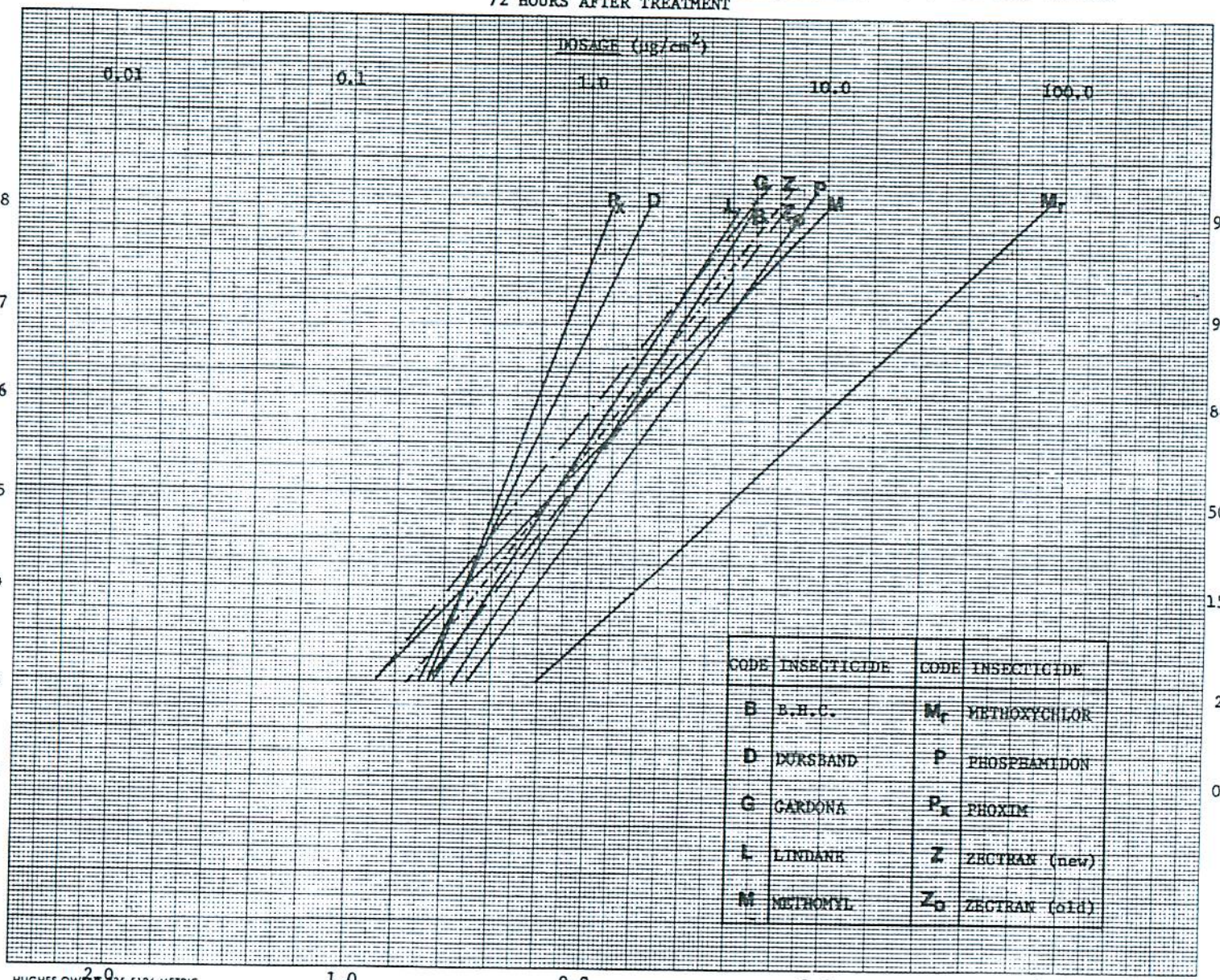


Table 14: List of insecticides and sources

INSECTICIDE	TYPE	CHEMICAL NAME	SOURCE
BHC (Benzene hexachloride) 10% E.C.	Chlorinated hydrocarbon	1,2,3,4,5,6-hexachloro-cyclohexane, mixed isomers and 1 lb. gamma isomer/gal.	Green Cross
Dursban® 48% E.C.	Organo-phosphorus	0,0-diethyl 0-(3,5,6-trichloro-2-pyridyl) phosphorothioate	Dow
GARDONA® (SD 8447) 99% tech.	Organo-phosphorus	2-chloro-1-(2,4,5-trichloro-phenyl) vinyl dimethyl phosphate	Shell
Lindane	Chlorinated hydrocarbon	1,2,3,4,5,6-hexachloro-cyclohexane, 99% gamma isomer	Green Cross
Methomyl 99% tech.	Carbamate	methyl N-[(methylcarbamoyl) oxy] thioacetimidate	Dupont
Methoxychlor 99% tech.	Chlorinated hydrocarbon	1,1,1-trichloro-2,2-bis= (p-methoxyphenyl) ethane	Dupont
Phosphamidon 90% WM	Organo-phosphorus	2-chloro-N,N-diethyl-3-hydroxycrotonamide dimethyl phosphate	Ciba
Phoxim (Bayer 77488) 73% tech.	Organo-phosphorus	phenylglyoxylonitrile oxime 0,0-diethyl phosphorothioate	Chemagro
Zectran® 22% E.C.	Carbamate	4-dimethylamino-3,5-xylyl methylcarbamate	Dow

E.C. - emulsifiable concentrate

WM - water miscible

tech. - technical grade