Laboratory Evaluation of Insecticides against Fourth-Instar European Pine Sawfly larvae *Neodiprion sertifer* (Geoff.)

Project No. CC-4

by

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CODES

Mort.	=	Mortality
Corr. Mort.	=	Corrected Mortality
D/T	=	Dead/Total
gpa	=	gallons per acre
SBW	=	Spruce budworm
$\mu g/cm^2$	=	Microgram per square centimeter

Introduction

The European pine sawfly, Neodiprion sertifer (Geoff.) is an important pest of ornamental trees and Christmas tree plantations. Infestations of this sawfly rarely cause mortality of trees but defoliation of Christmas tree plantations may lower or destroy the market value of the crops and sometimes prolong the cutting cycle. The insecticides used to control this pest in the past were lead arsenate, DDT, lindane, and dieldrin (Lyons 1964; Kirby and Harnden 1967).

As a substitute for chlorinated hydrocarbon insecticides, Phosphamidon was applied by aircraft over 3,961 acres of sawfly infested pine plantations in 1966 and successfully controlled this species. Phosphamidon was selected due to its success in 1965 against Swaine jack-pine sawfly, Neodiprion swainei (Midd.) (McLeod 1966 and Randall and Nigam 1966). However, it is not satisfactory because relatively high bird mortality was observed in areas where higher dosages were deposited due to drift and other factors (Nigam 1970b). The search for an insecticide safer to the forest ecosystem and effective against the various types of sawflies of economic importance has been continuing since 1965 (Randall and Nigam 1966; Nigam 1968a and b, 1969a and c; 1970a). The present study describes the results of contact toxicity tests carried out with seven insecticidal compounds against fourth instar European pine sawfly larvae during 1968 and 1969.

Method and Material

The insecticides and their formulations used in this study are given in Table 11 with their formulae and sources. The insecticides were sprayed as described by Nigam (1968a, 1969b and 1970a). The culture of fourth instar larvae for toxicological tests was maintained from eggs collected from southern Ontario. The rearing technique was very similar to that of the jack-pine sawfly, Neodiprion pratti banksianae (Nigam 1970a). The plan of each experiment is described individually. The post treatment observations were carried out at 24, 48 and 72 hours intervals (Tables 1-7). The data were processed for probit analysis using a Univac 1108 computer and program S 103 prepared by the Canada Department of Agriculture. (Nigam 1969b).

Experiments and Results

Seven experiments were carried out using Dibrom, Herc 13462, Imidan, phosphamidon, S4084, Sumithion and Zectran (Expts. 1-7). With the exception of phosphamidon, the regression lines of each insecticide for different periods of observation are presented in Figs. 1 to 6. The probit analyses for 24, 48 and 72 hours are tabulated at the end of each experiment, giving the LD_{50} and LD_{95} values with their fiducial limits and slopes. The comparative toxicity study of the different insecticides at 24, 48 and 72 hours is presented in Tables 8, 9 and 10, along with their relative potencies and toxicity index at LD_{50} and LD_{95} levels compared with sumithion. The comparative regression lines for 24, 48 and 72 hours are given in Figs. 7, 8 and 9. The effect of the insecticides was completed within 24 hours as afterwards there is no significant increase in the

mortality in all the insecticides tested. There were slight differences in the slopes of the regression lines of some of the insecticides e.g. S4084, Hercules 13462 and Imidan in between 24 hours and 48 or 72 hours observations (Figs. 3, 5 and 6). The b values (slopes) of these insecticides are presented in Tables 3, 5, and 7,

The relative potencies are calculated using the LD_{50} and LD_{95} values of Sumithion as one since this is now being used as a standard insecticide in forestry. Zectran is 2.5 times more toxic than Sumithion at the LD_{50} level at 72 hours after treatment. Phosphamidon at 72 hours is only 0.5 times as toxic as Sumithion, i.e. Sumithion is twice as toxic to this sawfly as phosphamidon. Imidan is the poorest of all the insecticides tested and Zectran is the best.

Acknowledgement

The author is grateful to Dr. James J. Fettes, Director, Chemical Control Research Institute, for encouragement and interest in the project. The technical assistance of Mr. A.S. Danard, Mr. C. Jackson, and Miss Barbara O'Connell is gratefully acknowledged. Sincere thanks are due to the staff of Forest Insect and Disease Survey for the collection of sawfly eggs.

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EXPERIMENT NO. 1

Object: To determine the contact toxicity of Zectran against fourth instar European Pine Sawfly larvae.

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:	0.1 per cent
Replications:	Three
No. of larvae per treatment:	Thirty
Total No. of larvae utilized:	Two hundred and ten
Expt. Code: EPS-1	Computer Code: EPS-ZEC-(136-138)

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	.011	4/29	14	14	5/29	17	17	5/28	18	15
0.2	.022	16/30	53	53	19/30	63	63	20/30	67	66
0.4	.043	26/30	87	87	26/30	87	87	27/30	90	90
0.6	.056	27/30	90	90	27/30	90	90	28/30	93	93
0.8	.068	26/30	87	87	27/30	90	90	28/30	93	93
1.0	.085	30/30	100	100	30/30	100	100	30/30	100	100
Control		0/30	0		0/30	0		1/30	3	

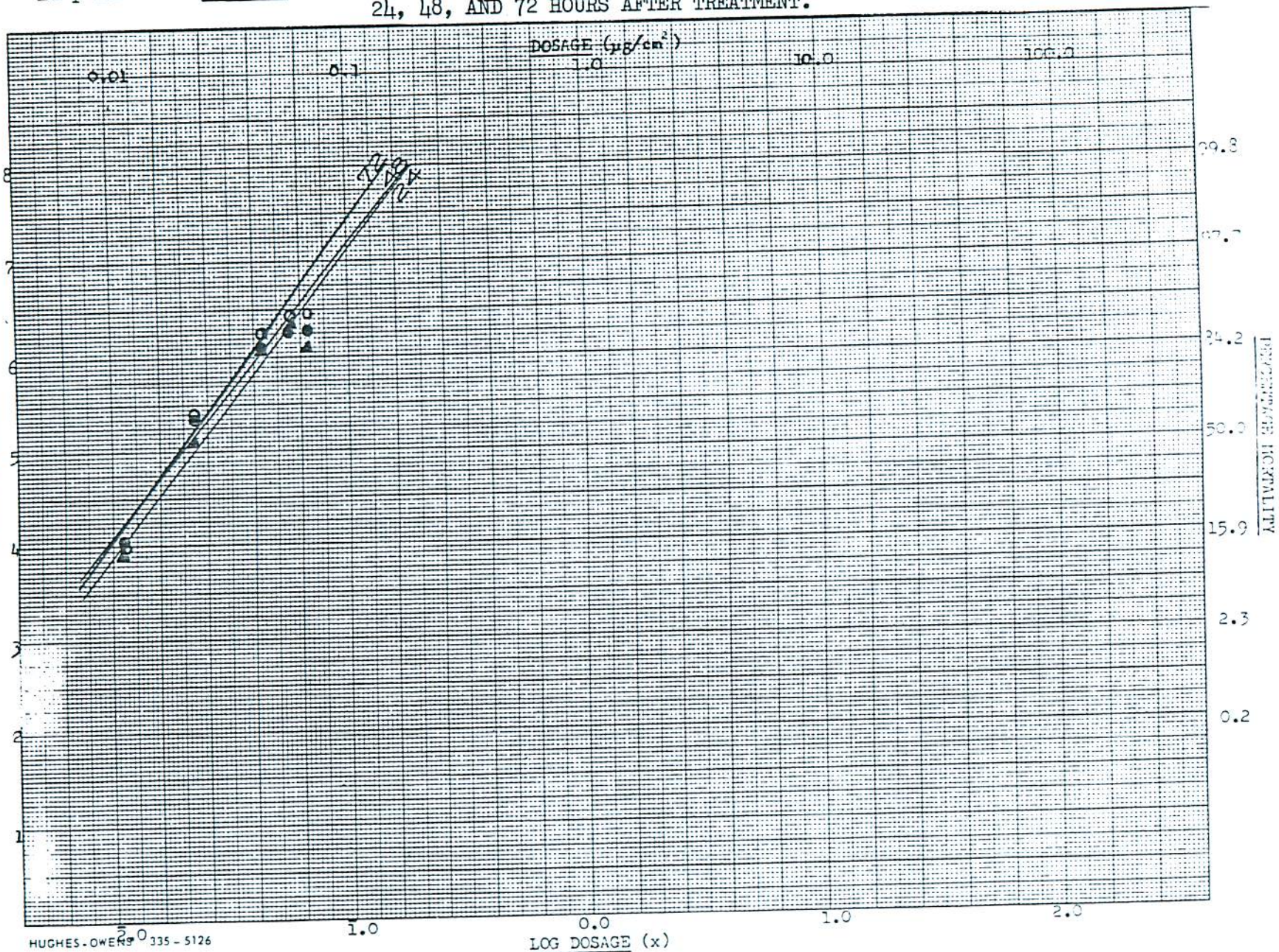
Findings: The regression lines are given in fig. 1
The summary of probit analysis is as follows:

Period	b	LD 50_2 ug/cm	FL	LD 95_2 ug/cm^2	FL
24 hours	3.208	.221-01	.180-01 - .264-01	.721-01	.574-01 - .102
48 hours	3.073	.200-01	.154-01 - .236-01	.680-01	.536-01 - .973-01
72 hours	3.404	.193-01	.150-01 - .232-01	.587-01	.470-01 - .821-01

Remarks:

FIG. 1.

Ld-p LINES OF ZECTRAN AGAINST FOURTH INSTAR NEODIPRION SERTIFER GEOFF. (EUROPEAN PINE SAWFLY) 24, 48, AND 72 HOURS AFTER TREATMENT.



EXPERIMENT NO. 2

Object: To determine the contact toxicity of Dibrom against fourth instar European Pine Sawfly larvae.

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:	0.1 per cent
Replications:	Three
No. of larvae per treatment:	Thirty
Total No. of larvae utilized:	Two hundred and ten
Expt. Code: EPS-6	Computer Code: EPS-DIB-(148-150)

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	.011	0/30	0	0	0/30	0	0	0/30	0	0
0.2	.023	0/30	0	0	0/30	0	0	1/30	3	3
0.4	.045	21/30	70	70	23/30	77	77	25/30	83	83
0.6	.073	23/27	85	85	23/27	85	85	23/27	85	85
0.8	.097	28/30	93	93	29/30	97	97	29/30	97	97
1.0	.128	29/30	97	97	29/30	97	97	30/30	100	100
Control		0/30	0		0/30	0		0/30	0	

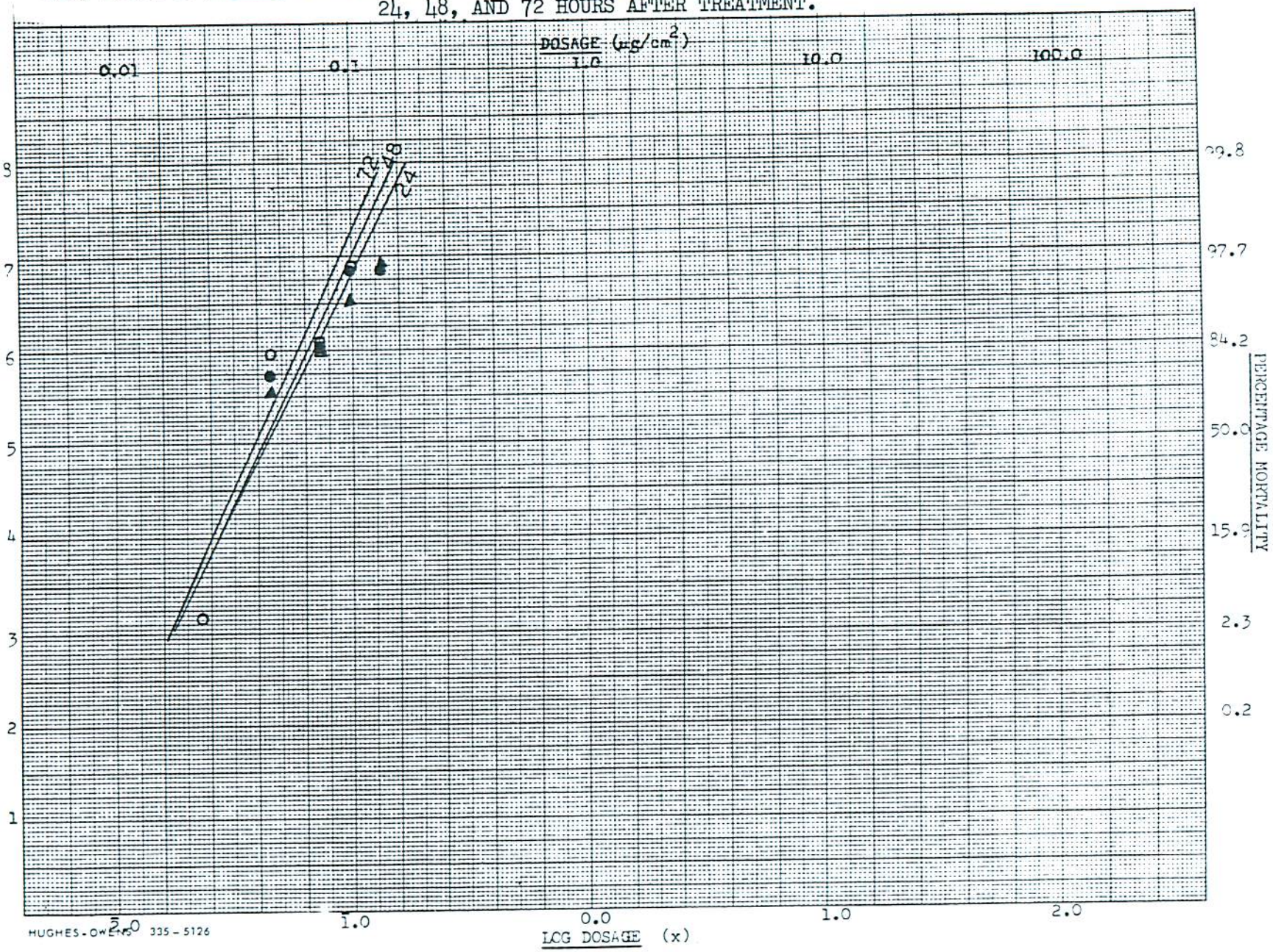
Findings: The regression lines are given in fig. 2
The summary of probit analysis is as follows:

Period	b	LD 50$_2$ ug/cm^2	FL	LD 95$_2$ ug/cm^2	FL
24 hours	5.004	.442-01	.380-01 - .503-01	.941-01	.792-01 - .121
48 hours	5.193	.421-01	.250-01 - .600-01	.874-01	.611-01 - .280
72 hours	5.464	.390-01	.251-01 - .540-01	.782-01	.561-01 - .207

Remarks:

FIG. 2.

Ld-p LINES OF DIBROM AGAINST FOURTH INSTAR NEODIPRION SERTIFER GEOFF. (EUROPEAN PINE SAWFLY) 24, 48, AND 72 HOURS AFTER TREATMENT.



EXPERIMENT NO.3

Object: To determine the contact toxicity of S 4084 against fourth instar European Pine Sawfly larvae.

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:	0.15 per cent
Replications:	Three
No. of larvae per treatment:	Thirty
Total No. of larvae utilized:	Two hundred and ten
Expt. Code: EPS-11	Computer Code: EPS-S44-(121-123)

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	0.012	0/30	0	0	0/30	0	0	0/28	0	0
0.2	0.026	2/30	7	7	2/30	7	7	2/30	7	7
0.4	0.052	22/30	73	73	23/30	77	77	23/30	77	77
0.6	0.100	27/30	90	90	30/30	100	100	30/30	100	100
0.8	0.116	30/30	100	100	30/30	100	100	30/30	100	100
1.0	0.125	30/30	100	100	30/30	100	100	30/30	100	100
Control		0/30	0		0/30	0		0/30	0	

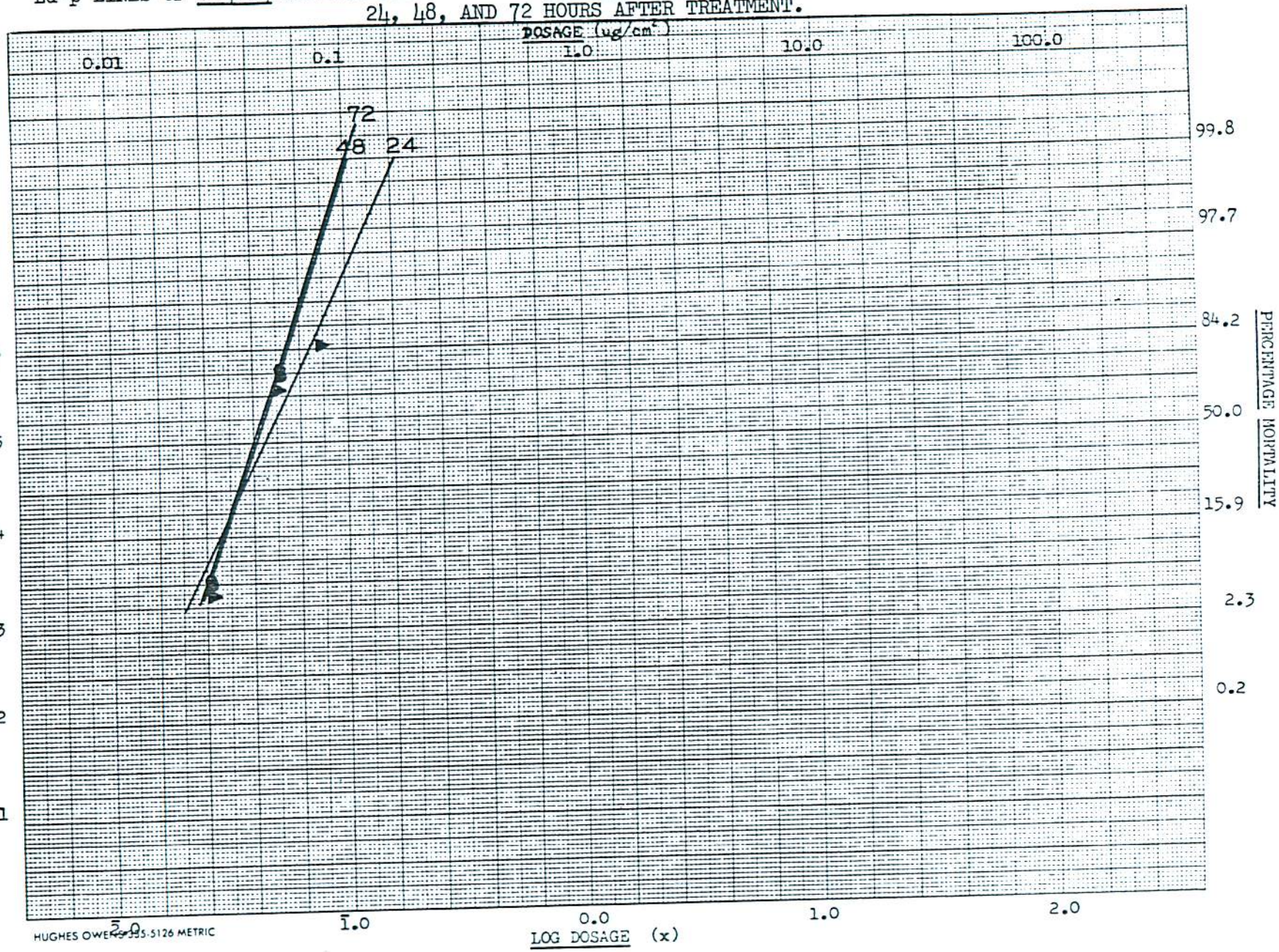
Findings: The regression lines are given in fig. 3.
The summary of probit analysis is as follows:-

Period	b	LD 50 ug/cm^2	FL	LD 95 ug/cm^2	FL
24 hours	5.34	.45-01	.39-01 - .52-01	.92-01	.77-01 - .12
48 hours	7.37	.42-01	.37-01 - .48-01	.69-01	.57-01 - .10
72 hours	7.38	.42-01	.37-01 - .48-01	.69-01	.57-01 - .10

Remarks:

FIG. 3.

Ld-p LINES OF S 4084 AGAINST FOURTH INSTAR NEODIPRION SERTIFER GEOFF. (EUROPEAN PINE SAWFLY)
24, 48, AND 72 HOURS AFTER TREATMENT.



EXPERIMENT NO. 4

Object: To determine the contact toxicity of Sumithion against fourth instar European Pine Sawfly larvae.

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:	0.1 per cent
Replications:	Three
No. of larvae per treatment:	Thirty
Total No. of larvae utilized:	Two hundred and ten
Expt. Code: EPS-4.	Computer Code: EPS-SUM-(142-144)

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	.011	1/30	3	0	2/30	7	0	3/30	10	8
0.2	.022	3/29	10	7	6/29	21	15	6/29	21	5
0.4	.042	9/29	31	29	13/29	45	41	16/29	55	46
0.6	.077	25/29	86	86	26/29	90	89	26/29	90	88
0.8	.127	27/30	90	90	27/30	90	89	27/30	90	88
1.0	.168	28/30	93	93	28/30	93	93	29/30	97	96
Control		1/30	3		2/30	7		5/30	17	

Findings: The regression lines are given in fig. 4
The summary of probit analysis is as follows:

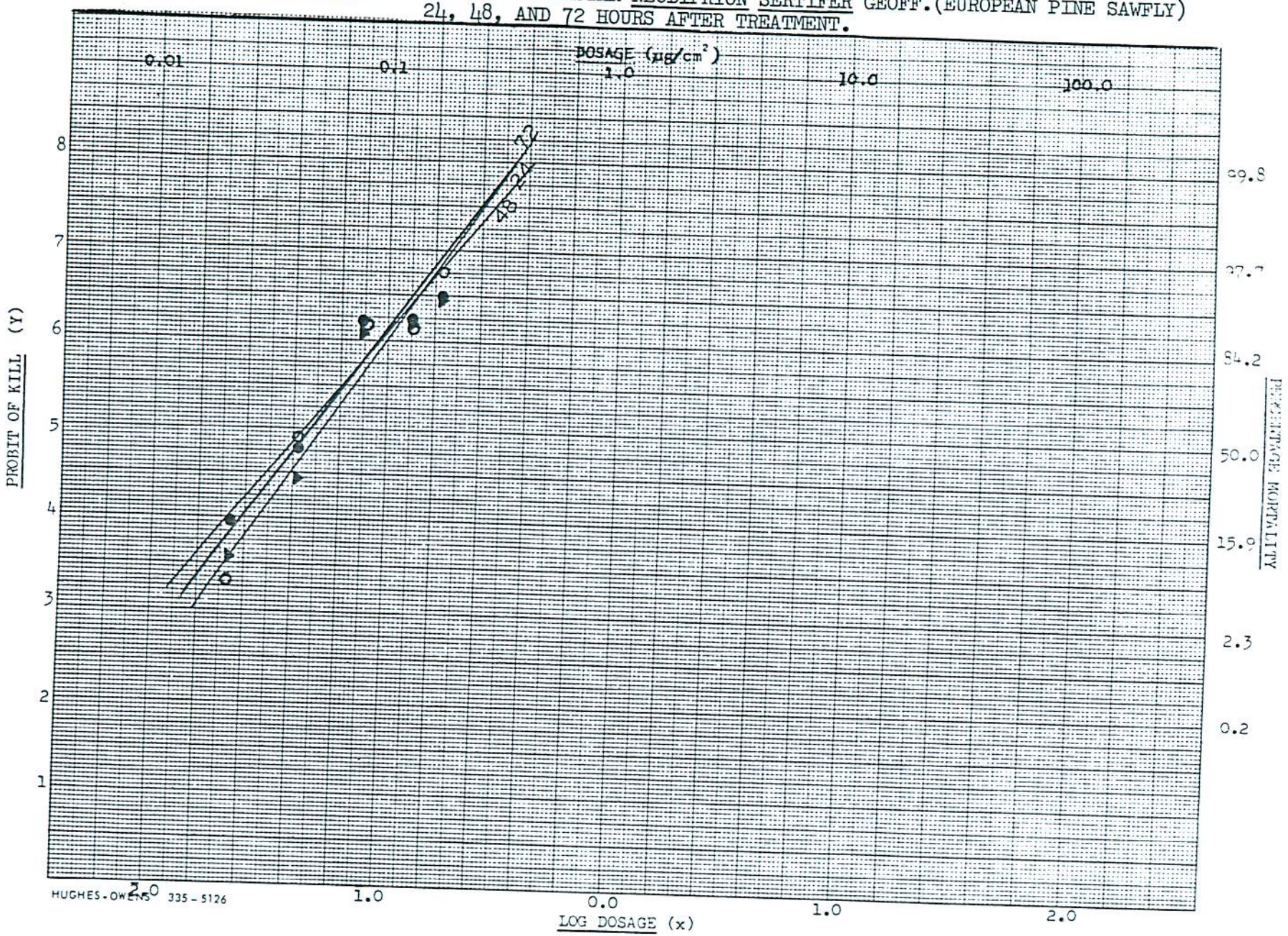
Period	b	LD 50 ug/cm^2	FL	LD 95 ug/cm^2	FL
24 hours	3.638	.534-01	.44-01 - .64-01	.151	.109 - .222
48 hours	3.140	.460-01	.36-01 - .56-01	.153	.115 - .240
72 hours	3.516	.476-01	.36-01 - .59-01	.140	.109 - .223

Remarks:

FIG. 4.

Ld-p LINES OF SUMITHION AGAINST FOURTH INSTAR NEODIPRION SERTIFER GEOFF.(EUROPEAN PINE SAWFLY) 24, 48, AND 72 HOURS AFTER TREATMENT.

NIGAM - 68



EXPERIMENT NO.5

Object: To determine the contact toxicity of Hercules 13462 against fourth instar European Pine Sawfly larvae.

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:	0.1 per cent
Replications:	Three
No. of larvae per treatment:	Thirty
Total No. of larvae utilized:	Two hundred and ten
Expt. Code: EPS-7	Computer Code: EPS-H12-(115-117)

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	0.010	0/30	0	0	0/29	0	0	0/29	0	0
0.2	0.018	0/30	0	0	0/30	0	0	0/30	0	0
0.4	0.035	0/30	0	0	2/30	7	7	4/30	13	13
0.6	0.068	23/31	74	74	26/31	84	84	26/31	84	84
0.8	0.078	25/30	80	80	25/30	83	83	25/30	83	83
1.0	0.076	26/30	87	87	28/30	93	93	29/30	97	97
Control		0/30	0		0/30	0		0/30	0	

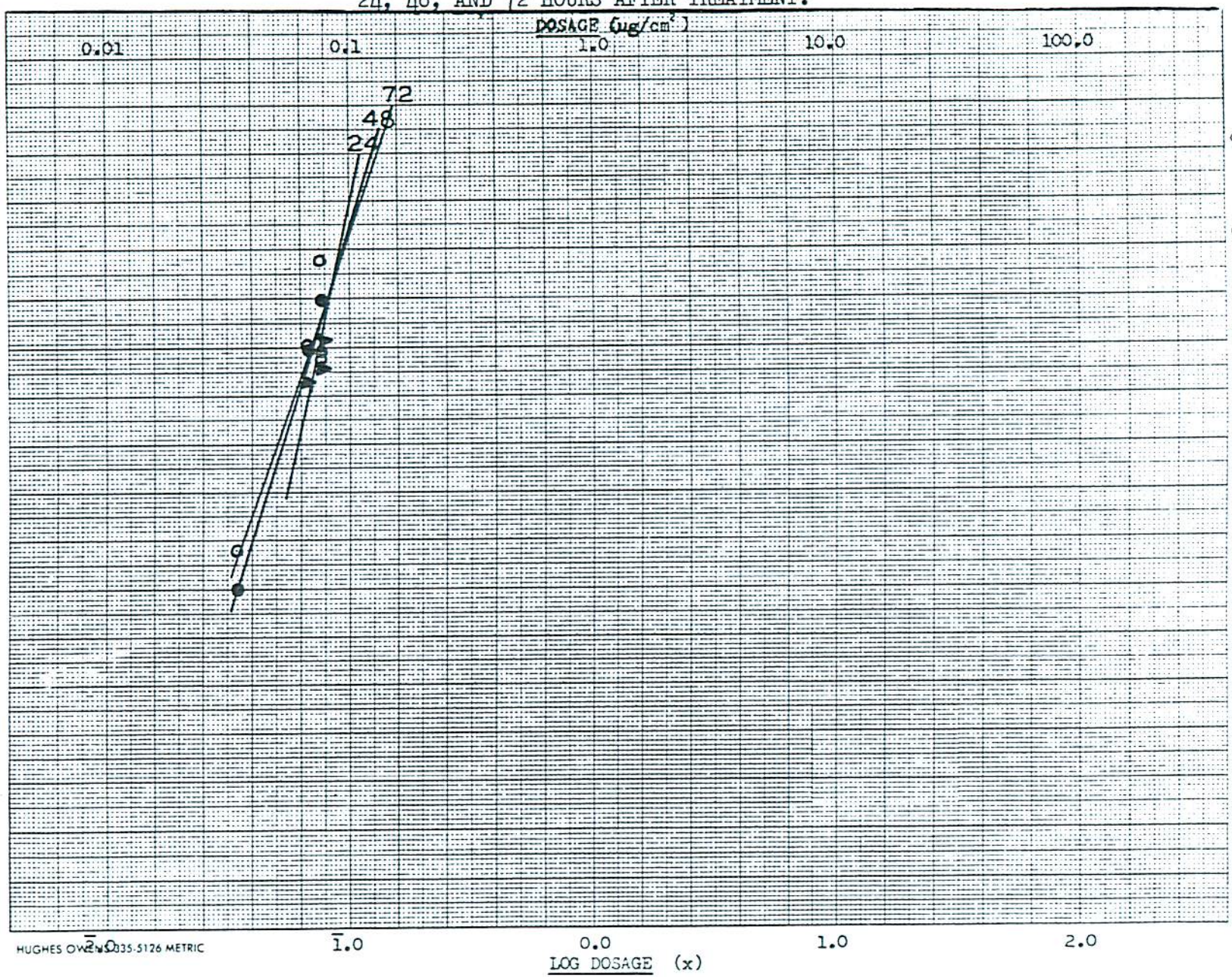
Findings: The regression lines are given in fig. 5.
The summary of probit analysis is as follows:-

Period	b	LD 50 ug/cm^2	FL	LD 95 ug/cm^2	FL
24 hours	11.76	.62-01	.57-01 - .66-01	.85-01	.79-01 - .99-01
48 hours	7.91	.53-01	.48-01 - .58-01	.86-01	.77-01 - .10
72 hours	7.36	.51-01	.45-01 - .55-01	.85-01	.76-01 - .10

Remarks:

FIG. 5.

Ld-p LINES OF HERCULES 13462 AGAINST FOURTH INSTAR NEODIPRION SERTIFER GEOFF.(EUROPEAN PINE SAWFLY) 24, 48, AND 72 HOURS AFTER TREATMENT.



EXPERIMENT NO. 6

Object: To determine the contact toxicity of Phosphamidon against fourth instar European Pine Sawfly larvae.

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:	0.1 per cent
Replications:	Three
No. of larvae per treatment:	Thirty
Total No. of larvae utilized:	Two hundred and ten
Expt. Code: EPS-3	Computer Code: EPS-PHO-(139-142)

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	.012	1/30	3	3	1/30	3	3	1/30	3	3
0.2	.022	0/30	0	0	0/30	0	0	0/30	0	0
0.4	.042	11/30	37	37	12/30	40	40	12/30	40	40
0.6	.074	11/30	37	37	13/30	43	43	14/30	47	47
0.8	.121	5/30	17	17	9/30	30	30	9/30	30	30
1.0	.148	25/30	83	83	27/30	90	90	27/30	90	90
Control		0/30	0		0/30	0		0/30	0	

Findings: No regression lines are given.
The summary of probit analysis is as follows:

Period	b	LD 50$_2$ ug/cm^2	FL	LD 95$_2$ ug/cm^2	FL
24 hours	1.961	.114		.789	
48 hours	2.241	.90-01		.487	
72 hours	2.248	.881-01		.475	

Remarks:

EXPERIMENT NO. 7

Object: To determine the contact toxicity of Imidan against fourth instar European Pine Sawfly larvae.

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:	1.0 per cent
Replications:	Three
No. of larvae per treatment:	Thirty
Total No. of larvae utilized:	Two hundred and ten
Expt. Code: EPS-5	Computer Code: EPS-IMI-(145-147)

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	.1070	1/30	3	3	4/30	13	13	12/30	40	33
0.2	.2170	0/30	0	0	4/30	13	13	10/30	33	26
0.4	.4140	16/30	53	53	20/30	67	67	26/30	87	85
0.6	.6680	24/30	80	80	28/30	93	93	28/30	93	92
0.8	.8590	29/30	97	97	29/30	97	97	29/30	97	96
1.0	1.0850	27/30	90	90	28/30	93	93	29/30	97	96
Control		0/30	0		0/30	0		3/30	10	

Findings: The regression lines are given in fig. 6
The summary of probit analysis is as follows:

Period	b	LD 50 ug/cm^2	FL	LD 95 ug/cm^2	FL
24 hours	4.256	.430	.369 - .492	1.048	.867 - 1.388
48 hours	3.378	.310	.257 - .365	.953	.759 - 1.329
72 hours	2.767	.220		.864	

Remarks:

FIG. 6.

Ld-p LINES OF IMIDAN AGAINST FOURTH INSTAR NEODIPRION SERTIFER GEOFF. (EUROPEAN PINE SAWFLY) 24, 48, AND 72 HOURS AFTER TREATMENT.

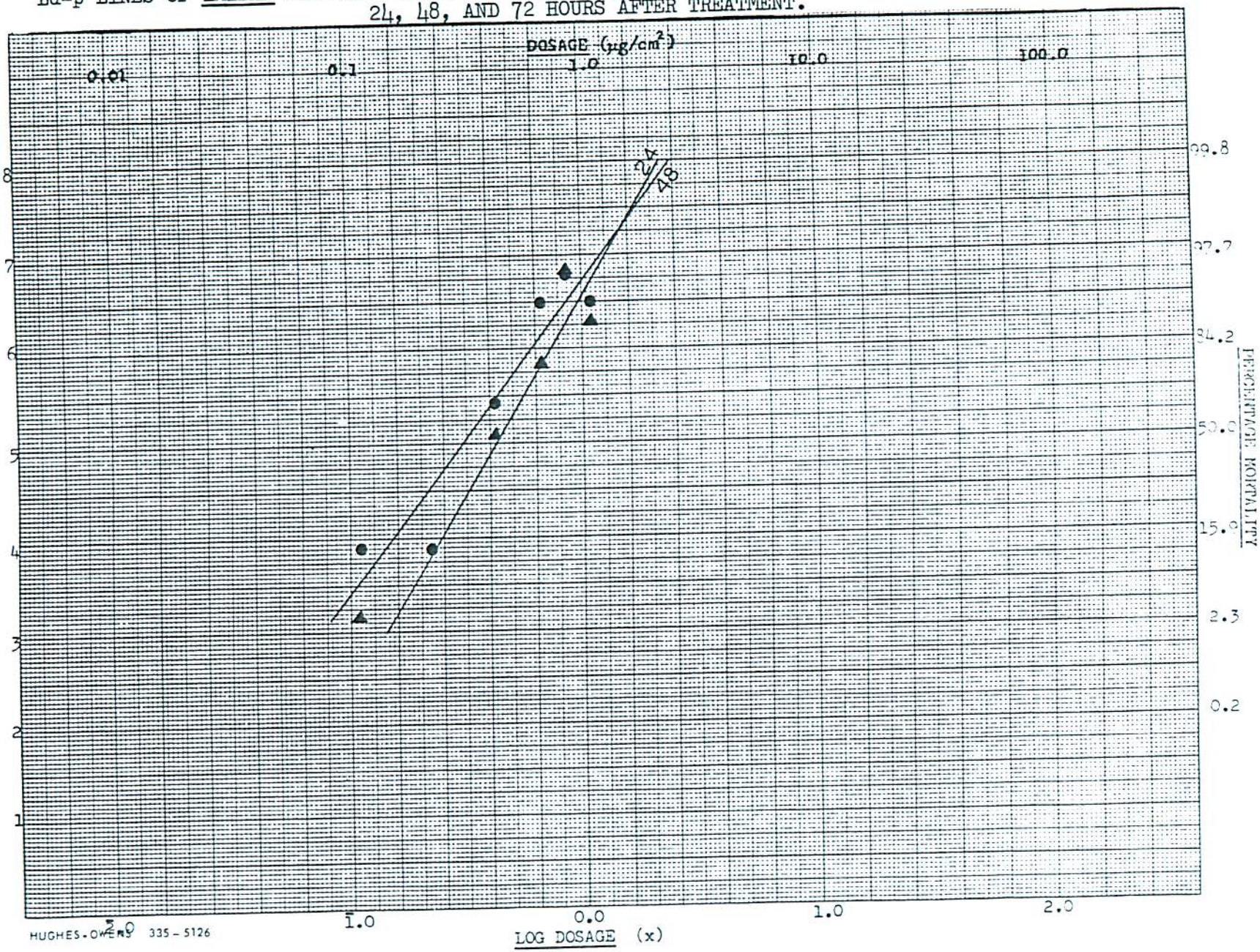


Table 8: Toxicity of Insecticides to European Pine Sawfly Larvae at 24 Hours After Treatment

Insecticide	LD 50 ug/cm^2	Fiducial Limits	Relative Potency	Toxicity Index	LD 95 ug/cm^2	Fiducial Limits	Relative Potency
Zectran	.022	.018 - .026	2.4	240	.072	.057 - .100	2.1
Dibrom	.044	.038 - .050	1.2	120	.094	.079 - .122	1.6
S 4084	.045	.039 - .052	1.2	117	.092	.077 - .120	1.7
Sumithion	.053	.044 - .064	1.0	100	.152	.120 - .222	1.0
Herc 13462	.062	.057 - .066	.9	85	.085	.079 - .099	1.8
Phosphamidon	.114		.5	46	.788		.2
Imidan	.430	.369 - .492	.1	12	1.048	.867 - 1.388	.15

FIG. 7.

COMPARATIVE Ld-p LINES OF INSECTICIDES AGAINST FOURTH INSTAR NEODIPRION SERTIFER GEOFF. (EUROPEAN PINE SAWFLY) FOR 24 HOURS AFTER TREATMENT.

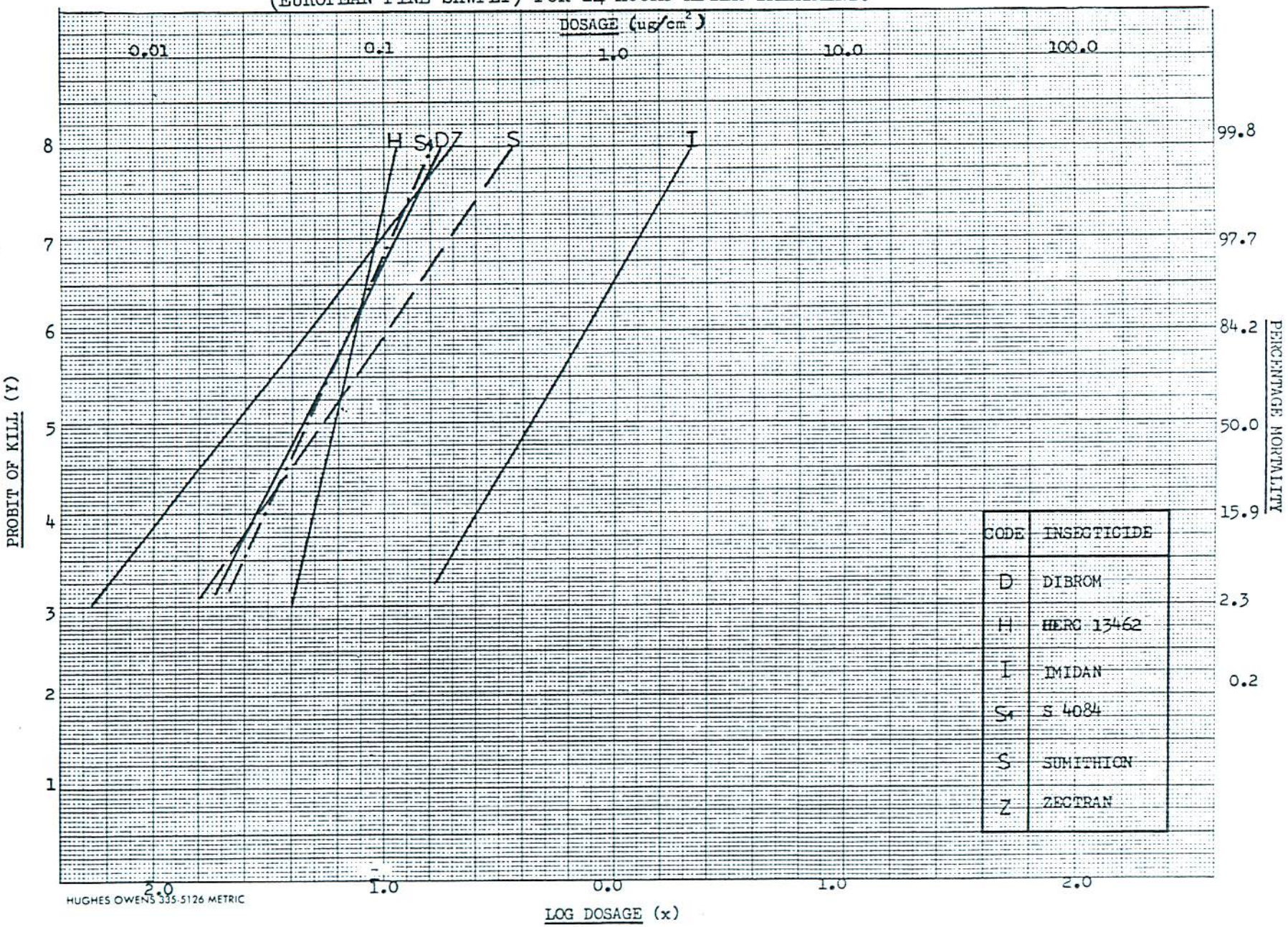


Table 9: Toxicity of Insecticides to European Pine Sawfly Larvae at 48 Hours After Treatment

Insecticide	LD 50 $_2$ ug/cm^2	Fiducial Limits	Relative Potency	Toxicity Index	LD 95 $_2$ ug/cm^2	Fiducial Limits	Relative Potency
Zectran	.020	.015 - .024	2.3	230	.068	.053 - .097	2.3
Dibrom	.042	.025 - .060	1.1	110	.087	.061 - .279	1.8
S 4084	.042	.037 - .048	1.1	110	.069	.057 - .100	2.2
Sumithion	.046	.036 - .056	1.0	100	.154	.116 - .240	1.0
Herc 13462	.053	.048 - .058	.9	90	.086	.077 - .100	1.8
Phosphamidon	.090		.5	50	.487		.3
Imidan	.310	.257 - .365	.15	15	.953	.759 - 1.329	.2

FIG. 8.

COMPARATIVE Ld-p LINES OF INSECTICIDES AGAINST FOURTH INSTAR NEODIPRION SERTIFER GEOFF. (EUROPEAN PINE SAWFLY) FOR 48 HOURS AFTER TREATMENT.

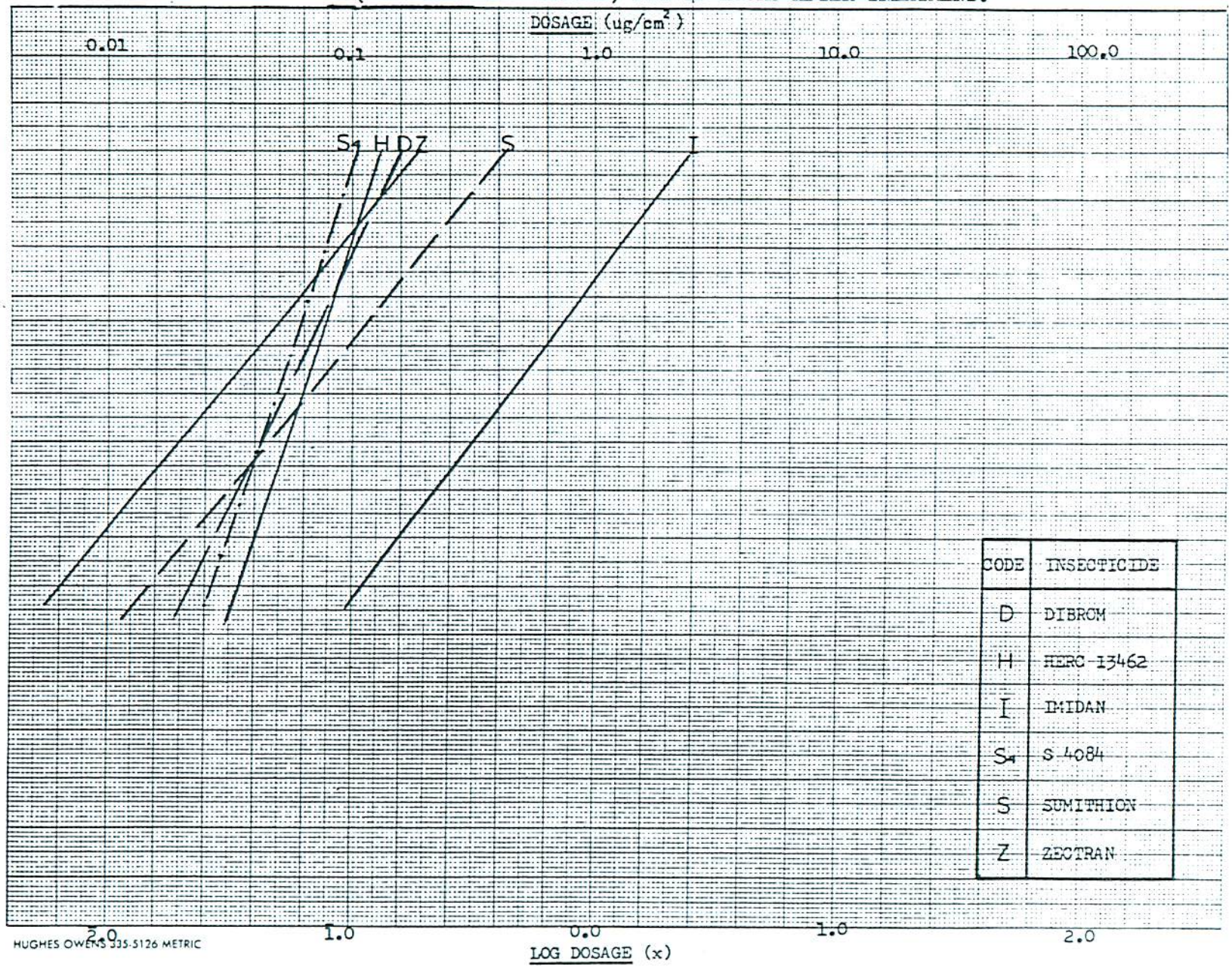


Table 10: Toxicity of Insecticides to European Pine Sawfly Larvae at 72 Hours After Treatment

Insecticide	LD 50_2 ug/cm^2	Fiducial Limits	Relative Potency	Toxicity Index	LD 95 ug/cm^2	Fiducial Limits	Relative Potency
Zectran	.019	.015 - .023	2.5	250	.059	.047 - .082	2.4
Dibrom	.039	.025 - .054	1.2	123	.078	.056 - .207	1.8
S 4084	.042	.037 - .048	1.1	114	.069	.057 - .100	2.0
Sumithion	.048	.036 - .059	1.0	100	.140	.107 - .223	1.0
Herc 13462	.051	.045 - .055	.9	94	.085	.076 - .100	1.6
Phosphamidon	.088		.5	54	.475		.3
Imidan	.220		.2	20	.864		.2

FIG. 9.

COMPARATIVE Ld-p LINES OF INSECTICIDES AGAINST FOURTH INSTAR NEODIPRION SERTIFER GEOFF. (EUROPEAN PINE SAWFLY) FOR 72 HOURS AFTER TREATMENT.

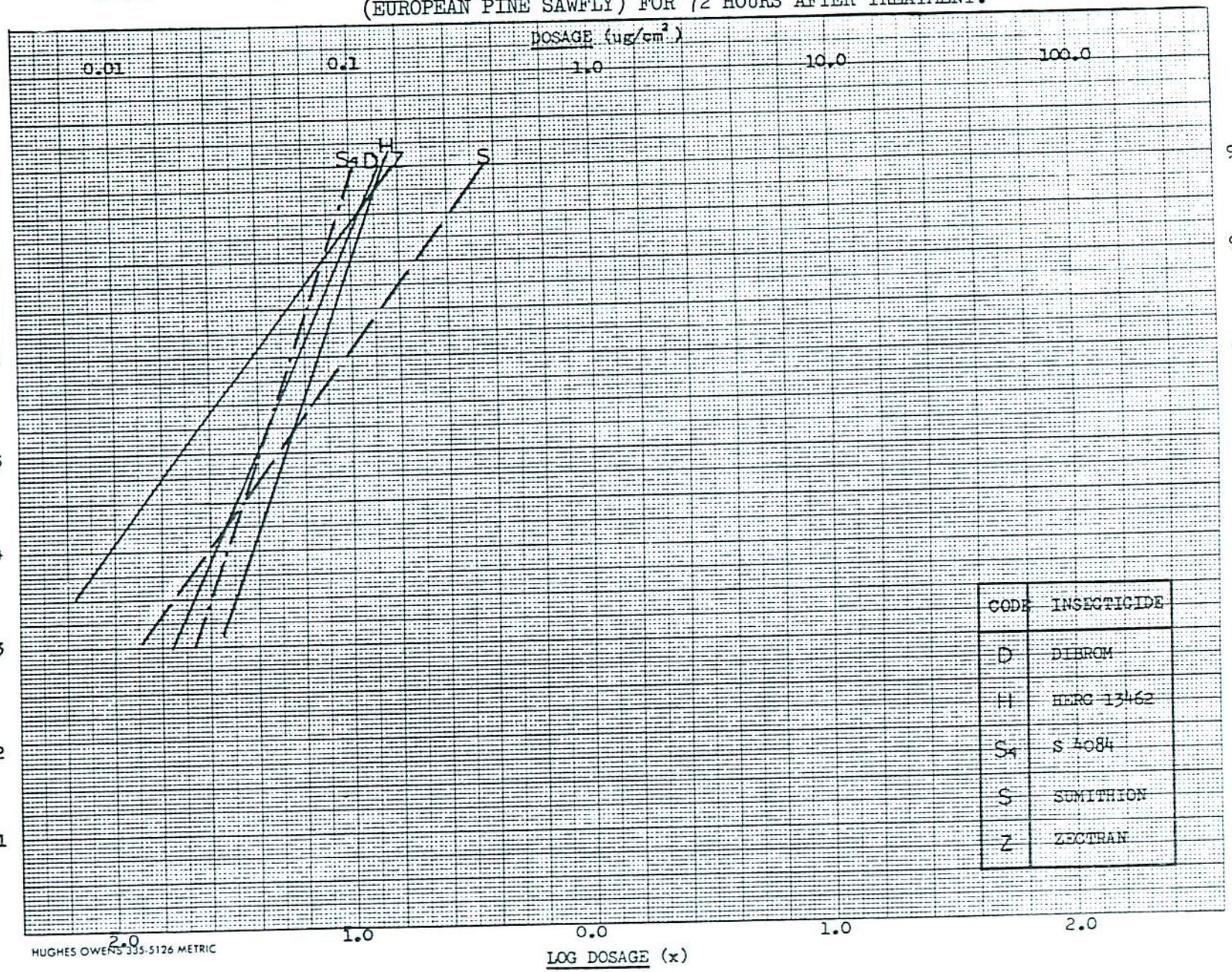


Table 11: List of Insecticides and Sources

No.	Name	Type	Formula	Source
1.	Dibrom® (30% E.C.)	organo-phosphate contact	1,2-dibromo-2,2-dichloroethyl dimethyl phosphate	Chevron
2.	Herc 13462 (12.5% E.C.)	organo-phosphate systemic	0,0 dimethyl S (1-sucini= midoethyl) phosphorodithioate	Hercules
3.	Imidan® (12% E.C.)	organo-phosphate contact	0,0-dimethyl S-phthalimidomethyl phosphorodithioate	Stauffer
4.	Phosphamidon (90% W.M.)	organo-phosphate systemic	dimethyl phosphate, ester with 2-chloro-N,N diethyl-3-hydroxycrotonamide	Ciba
5.	S 4084 (40% E.C.)	organo-phosphate	0-p-cyanophenyl 0,0-dimethyl phosphorothioate	Sumitomo
6.	Sumithion® (50% E.C.)	organo-phosphate systemic	0,0-dimethyl 0-(4-nitro-m-tolyl) phosphorothioate	Sumitomo
7.	Zectran® (tech. 92.6% A.I.)	carbamate systemic	4-dimethylamino-3, 5-xylyl methylcarbamate	Dow

A. I. = Active Ingredient
E. C. = Emulsifiable Concentrate
W. M. = Water Miscible