Laboratory Evaluation of Insecticides against Fifth-Instar Spruce budworm larvae, *Choristoneura fumiferana* (Clem.) in 1969

Project No. CC-4

by

P. C. Nigam

Chemical Control Research Institute

Ottawa, Ontario

Information Report CC-X-2

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Errata

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Page 2 - line 2 - should read Information Report CC-X-1 instead of Internal Report CC-6

CONTENTS.

CODES.

Mort.	=	Mortality
Corr. Mort.	=	Corrected Mortality
D/T	=	Dead/Total
gpa	=	Gallons per acre
SBW	=	Spruce budworm

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Introduction

The screening of insecticides against spruce budworm larvae, is a long-term program to select a better insecticide, from a growing list of new and more effective compounds. In 1968, seventeen insecticides were tested for contact toxicity against spruce budworm larvae collected from an infestation in the Ottawa area. Zectran and Matacil were highly effective (Nigam, 1969). Zectran was also effective in 1965 laboratory tests against a spruce budworm population collected from the New Brunswick area (Randall and Nigam, 1966). Matacil and Zectran have been used in field tests in New Brunswick and appeared to be effective (Randall, 1967 and 1968).

In 1969, eight insecticidal compounds provided by various firms and four analogues of DDT provided by Dr. J.R. Duffy, Department of Chemistry, St. Dunstan's University, P.E.I., were tested under laboratory conditions to find their contact toxicity against spruce budworm larvae collected from the Ottawa area. Baygon was repeated because fiducial limits were not obtained in 1968. The results of the DDT experiment of 1968 were used as a standard to compare toxicity of the insecticides tested in 1969.

Materials and Methods

The details of the materials and methods are described in Internal Report CC-6 (Nigam, 1969).

The collections of spruce budworm larvae were made late in May and to the middle of June, 1969, instead of May as in 1968, due to slower development. The details of insecticides used are presented in Table 16. The insecticide concentrations and rate of application used are given for each experiment, under plan of experiment. The observations were taken at 24, 48 and 72 hours after treatment. The data were analysed for probit analysis using a Univac 1108 Computer. The relative potencies of the insecticides were calculated using DDT as the standard insecticide (Expt. No. SBW-13, 1968). The toxicity index was also calculated using DDT as standard.

Experiments and Results

The mortality data of insecticides, Bay 77488, S 4084, AC 47470, SD 8447, MC 62,DDF-d-DDT, Baygon and DDF were subjected to probit analysis, while data of p,p'-DDT, DDD, d-DDT, DDF-DDD, DDF-DDT and carbamult could not be subjected to the probit analyses due to very low mortality in some cases, while in others mortality was too high.

The experiments which were analysed are described in detail (Expt. 1-9 and Figs. 1-9). The mortality observations for 24, 48 and 72 hours are tabulated in Tables 1-9 and a summary of the analysis is presented at the end of each table. The results of DDT analogues and carbamult are presented in Table 13.

Comparison of the DDT analogues is made taking the highest corrected percentage mortality at the lowest dose at 72 hours after treatment, because in most of the cases complete analysis could not be carried out. The LD 50 and LD 95 values of different insecticides are compared in Tables, 10, 11 and 12 and Figures 10, 11 and 12 for 24, 48 and 72 hours respectively. The relative potencies and toxicity index for different periods of observation are also presented in Tables 10, 11 and 12. The insecticides are arranged in descending order of toxicity on the basis of LD 50 values at each observation period.

Bay 77488 and S 4084 were most effective compounds against fifth instar spruce budworm larvae out of seven new compounds analysed this year. DDF and Baygon were poorest at the LD 50 level (Table 10, 11 and 12). Period of observation had no significant effect on LD 50 and LD 95 values of Bay 77488 and S 4084, i.e. mortality did not increase after 24 hours observation (Expts. 1 and 2 and Fig. 1 and 2). The toxicity of DDT and its analogues (DDF and DDF-d-DDT mixture) increased with increasing period of observation (Expt. 6,7 and 9, Fig. 6, 7 and 9). Distribution of log-dosage and probit mortality points in DDT and its analogues is very scattered as compared to the distribution of points in Bay 77488 and S 4084 (Figs. 1, 2, 6, 7 and 9). The regression lines of different insecticides for different periods of observations are compared in Fig. 10, 11 and 12. S 4084, SD 8447 and MC 62 had higher b values and steeper slopes. Baygon, DDT and its analogues had lower b values and less steep slopes. The

response to each unit dose was higher in SD 8447 than Baygon and DDT.

p,p'-DDT gave highest mortality and the other analogues were inferior to it when toxicities of DDT and its analogues and their mixtures are compared (Table 13). There appears to be some synergism between DDF and d-DDT but the toxicity was not higher than p,p'-DDT.

Zectran and Matacil were most effective in 1968 tests and Bay 77488 and S 4084 are most effective in 1969. The relative toxicities of the four most effective compounds are compared in Table 14, with Sumithion and phosphamidon taking DDT as a standard. Sumithion and phosphamidon are now being used in control operations.

Table 14

Relative toxicity of Insecticides against fifth instar Spruce budworm larvae, 72 hours after treatment

	Relative Toxicity	
Insecticide	LD 50	LD 95
Zectran	36.7	52.7
Matacil	30.7	61.5
Bay 77488	11.3	25.5
S 4084	6.3	16.2
Sumithion	4.2	10.0
Phosphamidon	3.4	8.8
DDT	1.0	1.0
SD 8447	0.75	1.8

It is evident from these results that phosphamidon and Sumithion are less toxic than Zectran, Matacil, Bay 77488 and S 4084 at both LD 50 and LD 95 levels.

The mammalian toxicity of these insecticides is summarized in Table 15.

Table 15

Comparison of mammalian toxicity of most effective compounds (against fifth instar spruce budworm larvae) with insecticides already in use

	Mammalian Toxicity[1] LD50 mg/kg	
Insecticides	AO	AD
Zectran	15-63	Rb > 500
Matacil	30	275
Bay 77488	85000-8800 *(2000-3000)	>1000
S 4084	18-238	>200
Sumithion	250-670	200- >3000
Phosphamidon	15-33	125 - 150
DDT	87-500	1931 - 3263
SD 8447	4000 - 5000	Rb > 5000

* Current production

Rb = Rabbit

AO = Acute oral to white rat

AD = Acute dermal to white rat

1 = Kenaga & Allison, 1969

When fifth instar spruce budworm toxicity results are further examined taking into consideration the mammalian toxicity of insecticides, Bay 77488 appears to be very safe and a most promising compound (Table 15). Since it is a contact insecticide, it may be at a disadvantage as compared to phosphamidon and Sumithion, because they also act as systemics.

Acute oral toxicity to mammals of Bay 77488 is approximately 70 - 100 times less than Matacil and Zectran and approximately 4 times less than Sumithion. It would appear that Bay 77488

could be safely used at higher dosages than Sumithion, phosphamidon, Zectran and Matacil for effective mortality, if needed.

SD 8447 is approximately twice as toxic as DDT at LD 95 level to spruce budworm larvae and its mammalian toxicity (AO) is approximately 10 times less than DDT.

Bay 77488 and SD 8447 are worthy of field evaluation on the basis of the contact toxicity to fifth instar spruce budworm larvae and toxicity to mammals, when compared with insecticides already in use and are under field trials.

Summary

Bay 77488 is the best of 12 insecticidal compounds tested in 1969 against fifth instar spruce budworm larvae, when evaluated on the basis of mammalian toxicity and contact toxicity to the larvae. SD 8447 also shows promise as a substitute for DDT and both compounds merit field testing.

Acknowledgement

The author is grateful to Dr. James J. Fettes, Director, Chemical Control Research Institute for encouragement and extending facilities. The technical assistance of Mr. C. Jackson and Mr. A.S. Danard is gratefully acknowledged. Sincere thanks are due to Dr. D. M. Brown and his staff of the Biometric and Computer Division of Canada Department of Fisheries and Forestry for providing the computer service. The co-operation of other members of the Department and various insecticidal firms for the supply of insecticide samples is much appreciated.

References

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Randall, A.P. 1968. Aerial application of pesticides for the control of the spruce budworm, C. fumiferana (Clem.). Interdepartmental Committee on Forest Spraying Operations - 1968.

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EXPERIMENT NO. 1

Object: To determine the contact toxicity of Bay 77488 against fifth instar Spruce Budworm larvae.

Plan of Experiment:

Treatment:	Six (Five rates of application - 0.1, 0.2, 0.4, 0.6, 0.8 gpa and control)
Concentration of insecticide:	0.3 per cent
Replications:	three
No. of larvae per treatment:	Thirty
Total No. of larvae utilized:	One hundred and eighty
Expt. Code: SBW-68	Computer Code: SBW-B78 (73-75).

Table No. 1

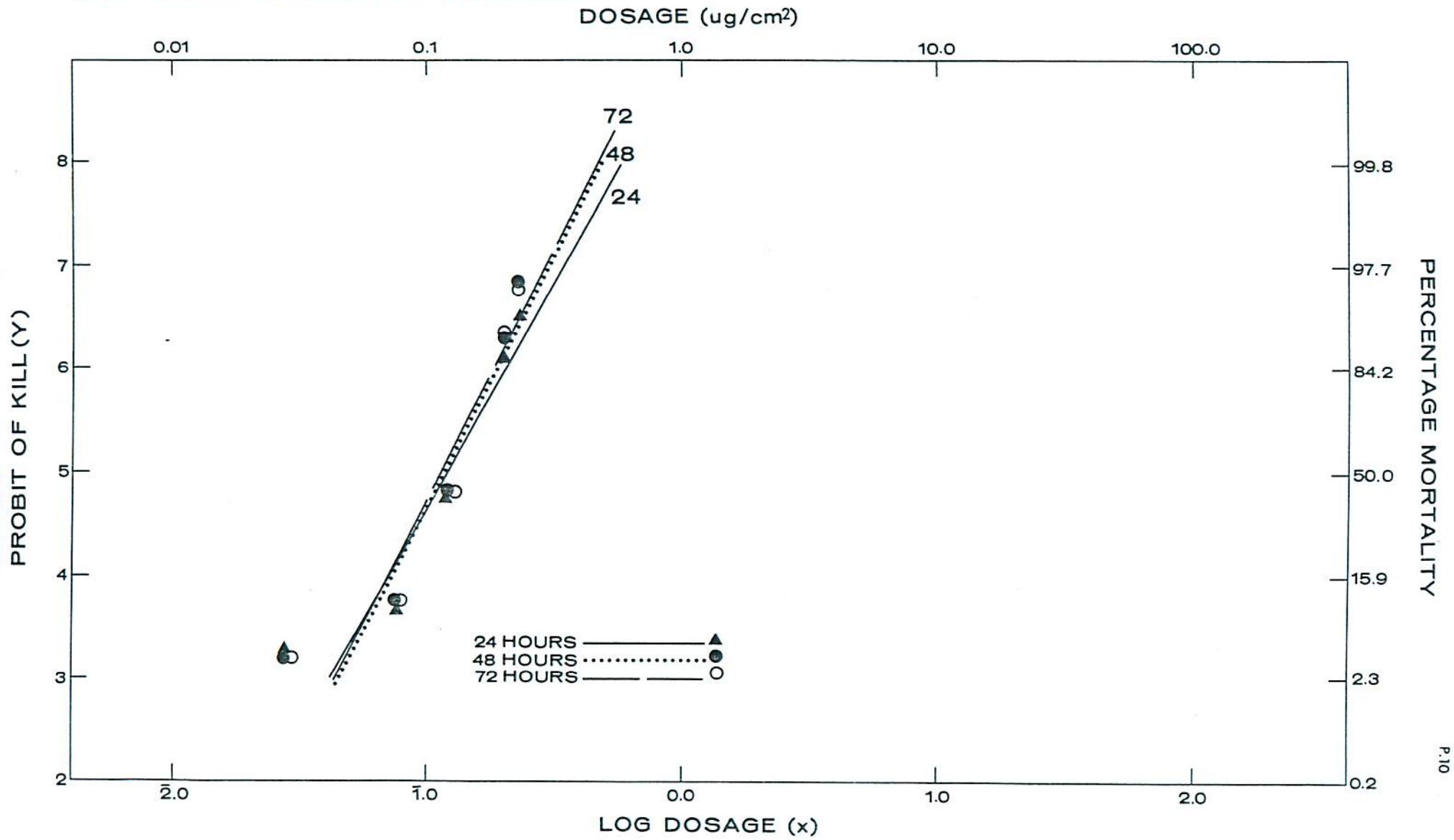
Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm^2	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	0.028	1/29	3	3	1/29	3	3	1/29	3	3
0.2	.075	3/29	10	10	3/29	10	10	3/29	10	10
0.4	.120	13/30	43	43	13/30	43	43	13/30	43	43
0.6	.200	26/30	87	87	27/30	90	90	27/30	90	90
0.8	.227	28/30	93	93	29/30	97	97	29/30	97	97
Control		0/30	0			0			0	

Findings: The regression lines are given in Fig. 1 and 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	4.46	.12	.10 - .14	.28	.23 - .40
48 hours	4.81	.117	.10 - .13	.26	.21 - .35
72 hours	4.81	.117	.10 - .13	.26	.21 - .35

Remarks:

Figure 1. Ld-p lines of Bay 77488 against fifth instar CHORISTONEURA FUMIFERANA CLEM. (spruce budworm) for 24,48 and 72 hours after treatment .



EXPERIMENT NO. 2

Object: To determine the contact toxicity of S 4084 against fifth instar Spruce Budworm 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 insecticides: 0.5 per cent

Replications: three

No. of larvae per treatment: thirty

Total No. of larvae utilized: Two hundred and ten

Expt. Code: SBW-60 Computer Code: SBW-S44 (112-114)

Table No. 2

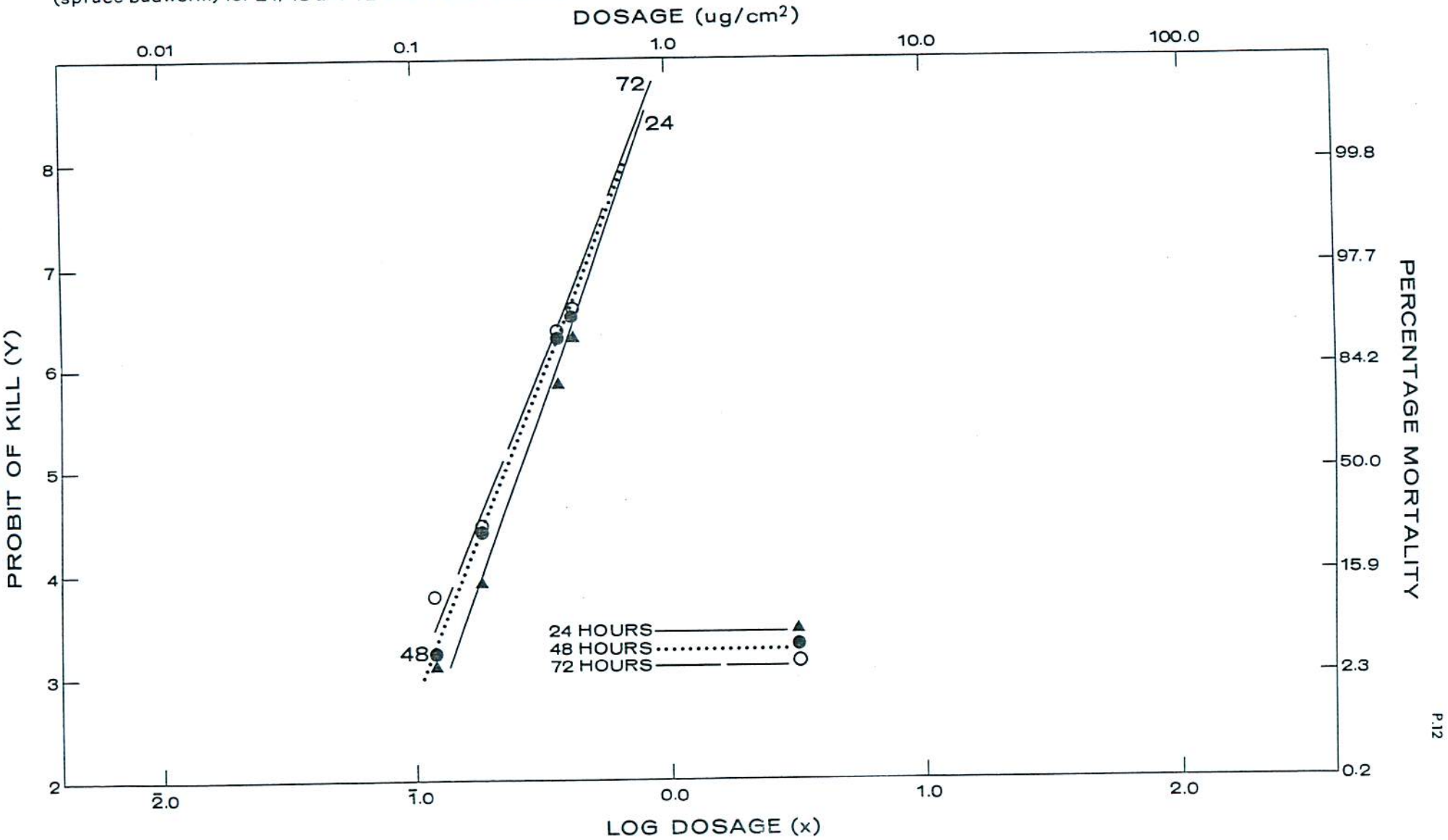
Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm^2	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	0.056	0/30	0	0	0/30	0	0	0/30	0	0
0.2	.118	1/28	4	4	1/28	4	4	3/27	11	11
0.4	.182	4/30	13	13	8/30	27	27	8/30	27	27
0.6	.356	24/30	80	80	27/30	90	90	27/30	90	90
0.8	.411	27/30	90	90	28/30	93	93	28/30	93	93
1.0	.431	29/29	100	100	29/29	100	100	29/29	100	100
Control		0/29	0		0/29	0		0/29	0	

Findings: The regression lines are given in Fig. 2 and the summary of probit analysis is as follows:-

Period	b	LD 50 ug/cm^2	FL	LD 95 ug/cm^2	FL
24 hours	6.94	.26	.23 - .28	.44	.40 - .52
48 hours	6.53	.23	.20 - .25	.40	.36 - .48
72 hours	5.85	.21	.19 - .24	.41	.35 - .50

Remarks:

Figure 2. Ld-p lines of S 4084 against fifth instar CHORISTONEURA FUMIFERANA CLEM. (spruce budworm) for 24, 48 and 72 hours after treatment.



EXPERIMENT NO. 3

Object: To determine the contact toxicity of Exp. 47470 against fifth instar Spruce Budworm 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:	0.5 per cent
Replications:	three
No. of larvae per treatment:	thirty
Total No. of larvae utilized:	Two hundred and ten
Expt. Code: SBW-56	Computer Code: SBW-E40 (109-111).

Table No. 3

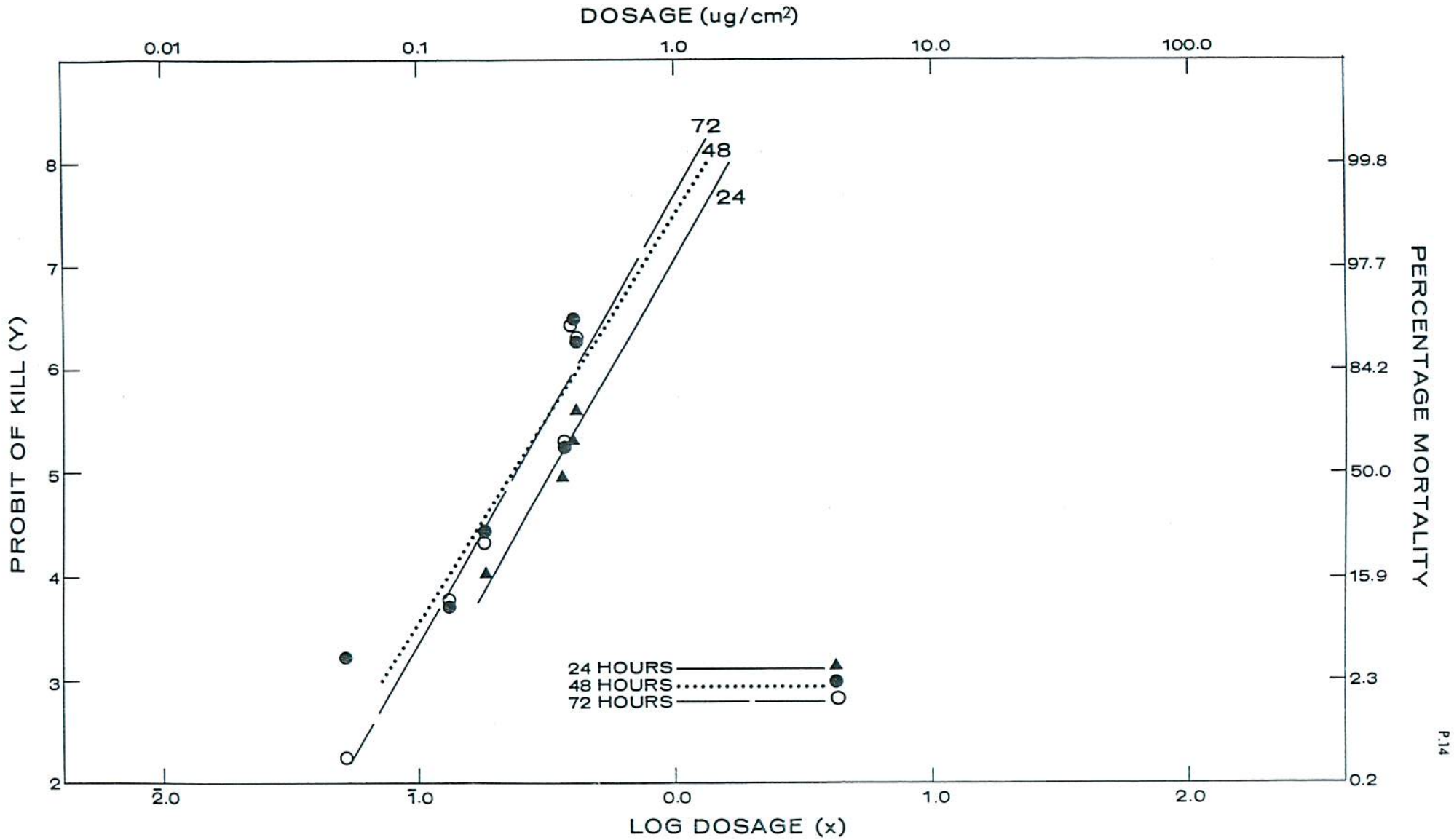
Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm^2	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	0.051	0/29	0	0	2/29	7	3	2/29	7	0
0.2	.102	0/31	0	0	4/31	13	9	5/31	16	10
0.4	.176	6/30	20	17	9/30	30	27	9/30	30	25
0.6	.361	15/30	50	48	18/30	60	58	19/30	63	60
0.8	.406	22/30	73	72	27/30	90	89	27/30	90	89
1.0	.401	19/30	63	62	28/30	93	93	28/30	93	93
Control		1/30	3		1/30	3		2/30	7	

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

Period	b	LD 50 ug/cm^2	FL	LD 95 ug/cm^2	FL
24 hours	4.33	.33	.28 - .38	.79	.60 - 1.52
48 hours	4.00	.24	.48 -.01 - .39	.61	.37 - 125.8
72 hours	4.29	.24	.20 - .28	.58	.47 - .84

Remarks:

Figure 3. Ld-p lines of AC47470 against fifth instar CHORISTONEURA FUMIFERANA CLEM. (spruce budworm) for 24,48 and 72 hours after treatment.



EXPERIMENT NO. 4

Object: To determine the contact toxicity of SD 8447 against fifth instar Spruce Budworm 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:	5.0 per cent
Replications:	three
No. of larvae per treatment:	thirty
Total No. of larvae utilized:	Two hundred and ten
Expt. Code: SBW-69	Computer Code: SBW-S87-(193-195)

Table No. 4

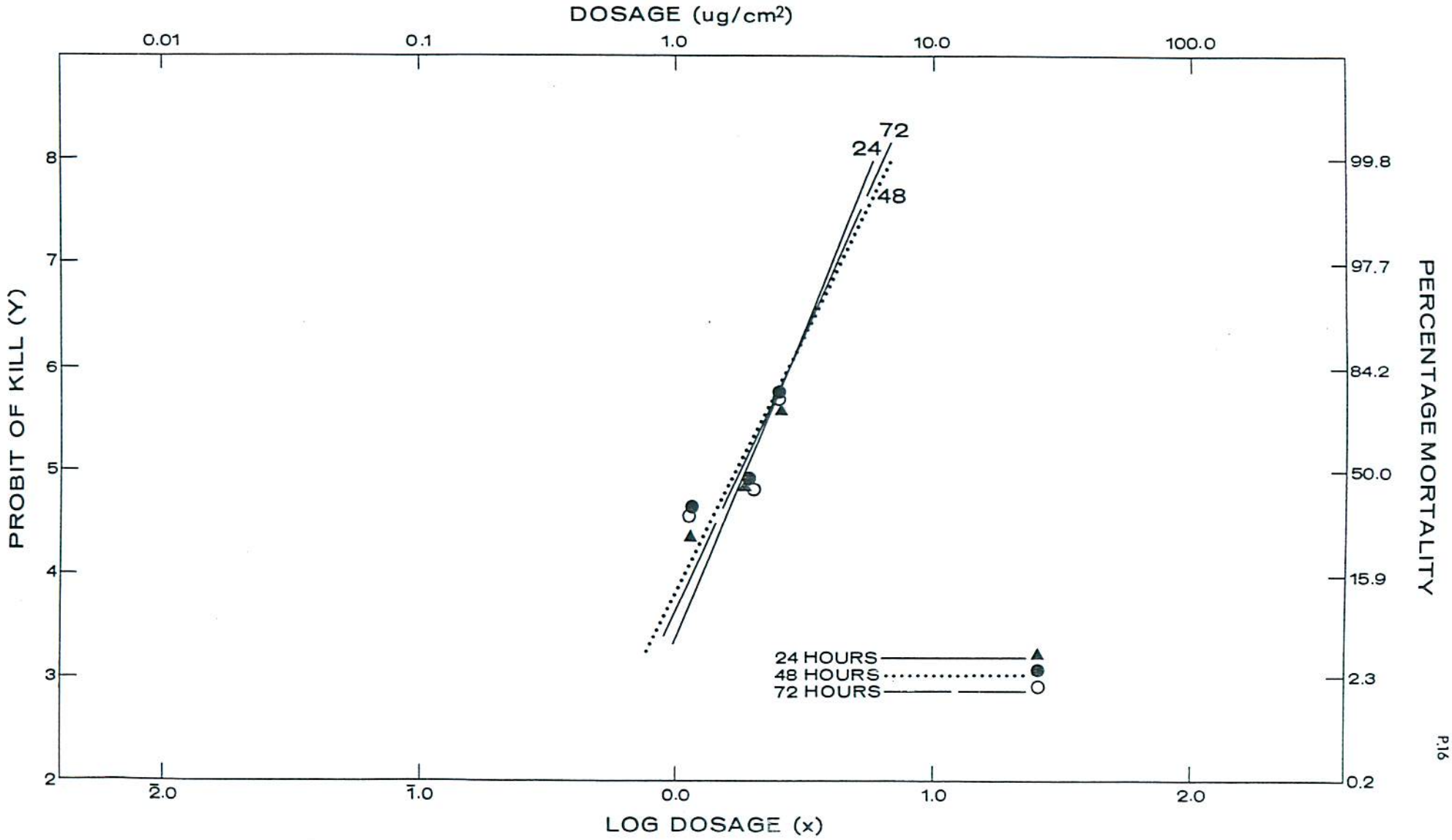
Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm^2	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	0.218	0/29	0	0	0/29	0	0	0/29	0	0
0.2	.448	1/29	3	0	1/29	3	0	2/28	7	0
0.4	1.190	10/30	33	28	12/30	40	35	12/29	41	34
0.6	1.987	15/30	50	46	15/30	50	46	15/30	50	44
0.8	2.517	22/29	76	74	23/29	79	77	23/29	79	77
1.0	3.496	30/30	100	100	30/30	100	100	30/30	100	100
Control		2/30	7		2/30	7		3/30	10	

Findings: The regression lines are given in Fig. 4 and 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	5.56	1.82	1.55 - 2.04	3.60	3.04 - 4.91
48 hours	5.07	1.73	1.44 - 1.96	3.64	3.04 - 5.11
72 hours	5.27	1.77		3.63	

Remarks:

Figure 4. Ld-p lines of SD 8447 against fifth instar CHORISTONEURA FUMIFERANA CLEM. (spruce budworm) for 24, 48 and 72 hours after treatment.



EXPERIMENT NO. 5

Object: To determine the contact toxicity of MC 62 against fifth instar Spruce Budworm 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:	8.0 per cent
Replications:	three
No. of larvae per treatment:	thirty
Total No. of larvae utilized:	Two hundred and ten
Expt. Code: SBW-67	Computer Code: SBW-M62 (70-72)

Table No. 5

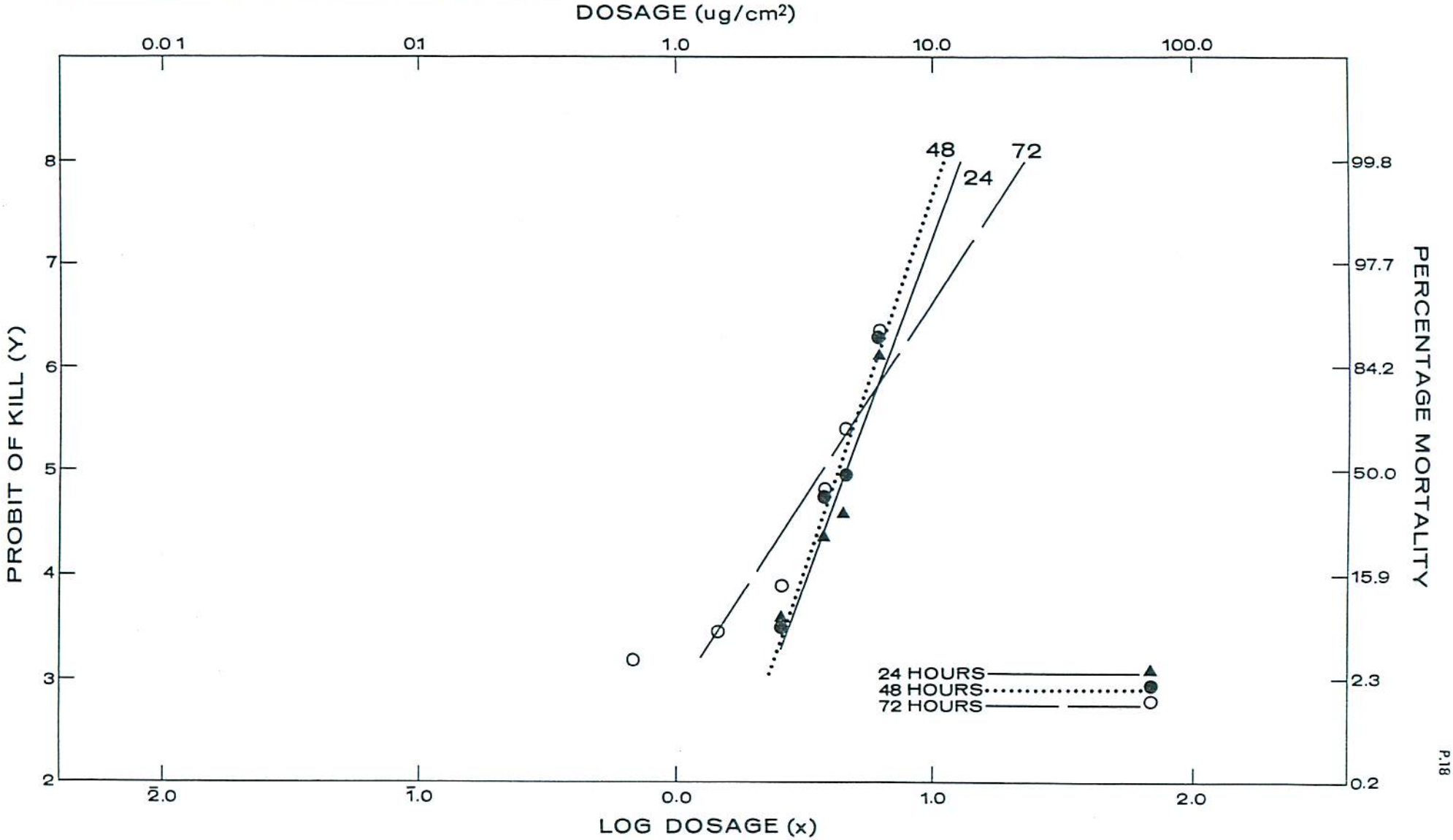
Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm^2	D/T	Mort.	Mort.	D/T	Mort.	Mort.	D/T	Mort.	Mort.
0.1	0.683	0/30	0	0	0/28	0	0	1/28	3	3
0.2	1.452	0/31	0	0	0/31	0	0	2/31	7	7
0.4	2.497	2/29	7	7	2/29	7	7	4/29	13	13
0.6	3.753	8/30	27	27	12/30	40	40	13/30	43	43
0.8	4.484	10/29	34	34	14/29	48	48	19/29	66	66
1.0	6.079	27/31	87	87	28/31	90	90	28/31	90	90
Control		0/28	0		0/28	0		0/28	0	

Findings: The regression lines are given in Fig. 5 and 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	6.92	4.60	4.24 - 5.11	7.96	6.67 - 11.26
48 hours	7.08	4.22	3.88 - 4.61	7.20	6.17 - 9.58
72 hours	3.87	3.67	3.20 - 4.24	9.77	7.52 - 15.48

Remarks:

Figure 5. Ld-p lines of MC 62 against fifth instar CHORISTONEURA FUMIFERANA CLEM. (spruce budworm) for 24, 48 and 72 hours after treatment.



EXPERIMENT NO. 6

Object: To determine the contact toxicity of DDF-d-DDT against fifth instar Spruce Budworm 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:	5.0 per cent
Replications:	three
No. of larvae per treatment:	thirty
Total No. of larvae utilized:	Two hundred and ten
Expt. Code: SBW-70	Computer Code: SBW-FDT (76-78)

Table No. 6

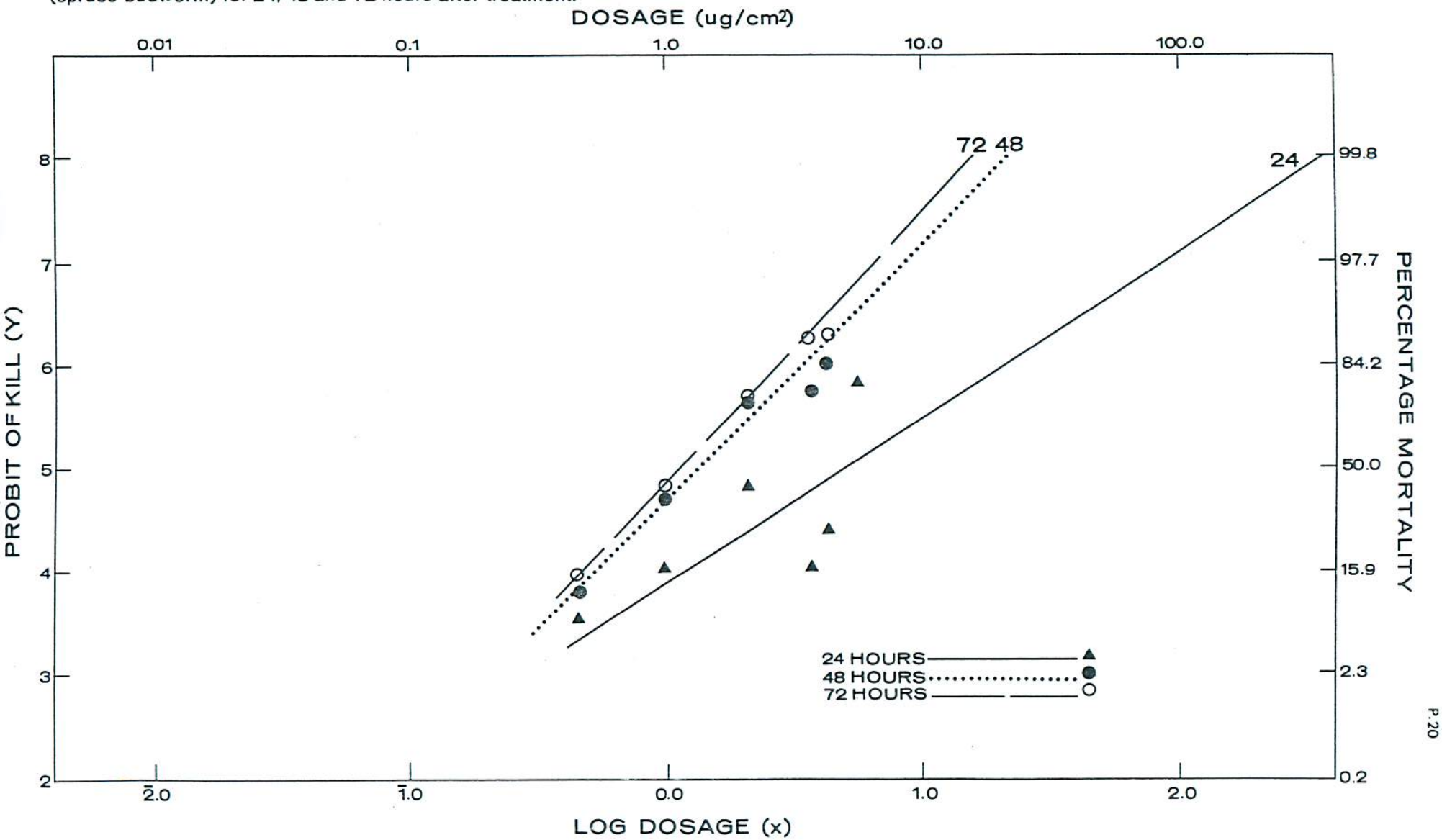
Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm^2	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	0.444	2/27	8	8	3/27	11	11	5/27	19	15
0.2	.961	2/29	7	7	11/29	38	38	13/29	45	43
0.4	2.012	13/30	43	43	22/30	73	73	22/30	77	76
0.6	3.509	5/30	17	17	23/30	77	77	27/30	90	90
0.8	4.214	9/32	28	28	27/32	84	84	29/32	91	90
1.0	5.389	24/30	80	80	30/30	100	100	30/30	100	100
Control		0/29	0		0/29	0		1/28	4	

Findings: The regression lines are given in Fig. 6 and the summary of probit analysis is as follows:-

Period	b	LD 50 ug/cm^2	FL	LD 95 ug/cm^2	FL
24 hours	1.60	4.97		52.82	
48 hours	2.44	1.33	1.02 - 1.64	6.25	4.57 - 10.11
72 hours	2.64	1.11	0.83 - 1.39	4.67	3.51 - 7.25

Remarks:

Figure 6 . Ld-p lines of DDF-dDDT against fifth instar CHORISTONEURA FUMIFERANA CLEM. (spruce budworm) for 24, 48 and 72 hours after treatment.



EXPERIMENT NO. 7

Object: To determine the contact toxicity of DDT against fifth instar Spruce Budworm larvae (Expt. 13 Int. Rep. CC-6, 1968)

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 insecticides: 5 per cent

Replications: three

No. of larvae per treatment: thirty

Total No. of larvae utilized: Two hundred and ten

Expt. Code: SBW-43 Computer Code: SBW-DDT (151-153)

Table No. 7

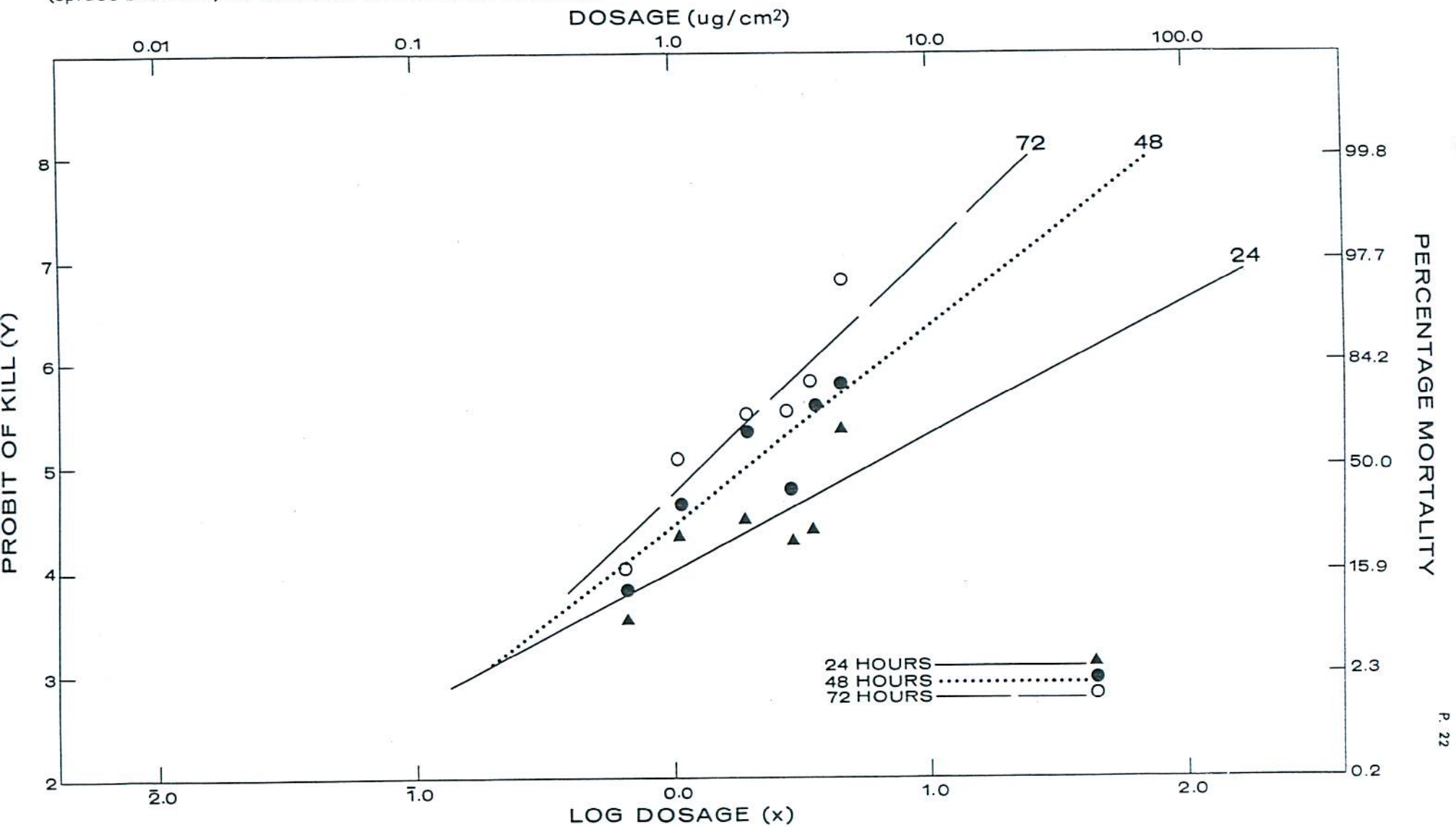
Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm^2	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	0.654	2/30	7	7	4/30	13	13	5/30	17	17
0.2	1.056	8/30	27	27	10/29	34	34	15/28	54	54
0.4	1.966	10/30	33	33	19/30	63	63	21/30	70	70
0.6	2.859	7/29	24	24	12/29	41	41	20/29	69	69
0.8	3.655	8/30	27	27	21/29	72	72	23/29	79	79
1.0	4.655	18/29	62	62	23/29	79	79	28/29	97	97
Control		0/30	0		0/30	0		0/30	0	

Findings: The regression lines are given in Fig. 7 and 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	1.304	5.50	3.57 - 18.06	100.50	25.54 - 9922.0
48 hours	1.913	1.99	1.54 - 2.55	14.43	8.31 - 44.43
72 hours	2.344	1.32	1.00 - 1.63	6.64	4.67 - 12.34

Remarks:

Figure 7. Ld-p lines of DDT against fifth instar CHORISTONEURA FUMIFERANA CLEM. (spruce budworm) for 24, 48 and 72 hours after treatment.



EXPERIMENT NO. 8

Object: To determine the contact toxicity of Baygon against fifth instar Spruce Budworm 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: 8.0 per cent

Replications: three

No. of larvae per treatment: thirty

Total No. of larvae utilized: Two hundred and ten

Expt. Code: SBW-63 Computer Code: SBW- Bay (64-66)

Table No. 8

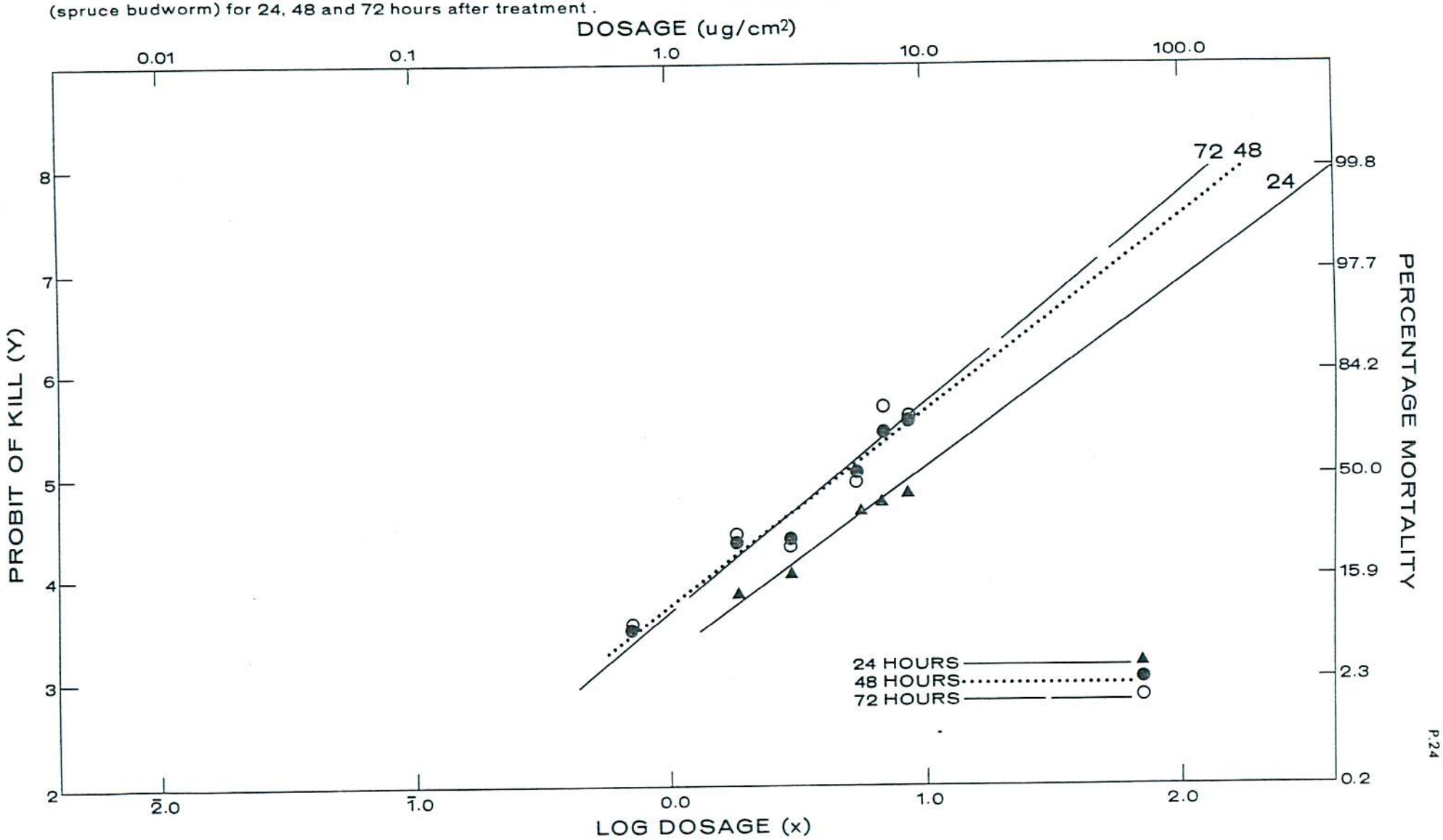
Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm^2	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.	D/T	% Mort.	Corr. Mort.
0.1	0.697	0/30	0	0	2/30	7	7	4/30	13	7
0.2	1.794	4/31	13	13	8/31	26	26	10/31	32	27
0.4	2.890	5/30	17	17	8/30	27	27	9/30	30	25
0.6	5.227	11/30	37	37	15/29	52	52	15/29	52	48
0.8	6.758	12/30	40	40	20/30	67	67	23/30	77	75
1.0	8.534	13/30	43	43	21/30	70	70	22/30	73	71
Control		0/30	0		0/30	0		2/30	7	

Findings: The regression lines are given in Fig. 8 and the summary of probit analysis is as follows:-

Period	b	LD 50 ug/cm^2	FL	LD 95 ug/cm^2	FL
24 hours	1.84	9.21	6.72 - 16.96	71.92	30.99 - 525.3
48 hours	1.89	4.63	3.62 - 6.19	34.29	19.07 - 106.5
72 hours	2.02	4.42	3.38 - 5.86	28.84	16.13 - 103.7

Remarks:

Figure 8. Ld-p lines of Baygon against fifth instar CHORISTONEURA FUMIFERANA CLEM. (spruce budworm) for 24, 48 and 72 hours after treatment.



EXPERIMENT NO. 9

Object: To determine the contact toxicity of DDF against fifth instar Spruce Budworm 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:	5.0 per cent
Replications:	three
No. of larvae per treatment:	thirty
Total No. of larvae utilized:	Two hundred and ten
Expt. Code: SBW-71	Computer Code: SBW-DDF (79-81)

Table No. 9

Insecticide		Mortality Counts After								
		24 Hours			48 Hours			72 Hours		
gpa	Dosage ug/cm^2	D/T	Mort.	Mort.	D/T	Mort.	Mort.	D/T	Mort.	Mort.
0.1	0.696	0/29	0	0	3/29	10	0	6/29	21	1
0.2	1.166	1/29	3	0	5/29	17	0	7/29	24	5
0.4	1.958	0/30	0	0	4/27	15	0	5/27	18	0
0.6	3.261	7/29	24	22	13/29	45	31	14/27	52	40
0.8	4.139	4/28	14	11	8/28	29	11	14/28	50	38
1.0	5.547	7/30	23	21	22/30	73	66	24/30	80	75
Control		1/30	3		6/30	20		6/30	20	

Findings: The regression lines are given in Fig. 9 and the summary of probit analysis is as follows:-

Period	B	LD 50 ug/cm^2	FL	LD 95 ug/cm^2	FL
24 hours	2.67	10.21	6.26 - .10+ .31	42.49	13.19 - .10 + .31
48 hours	7.86	4.94		8.00	
72 hours	5.07	4.23	3.44 - 5.13	8.92	6.54 - 32.31

Remarks:

Figure 9. Ld-p lines of DDF against fifth instar CHORISTONEURA FUMIFERANA CLEM. (spruce budworm) for 24, 48 and 72 hours after treatment.

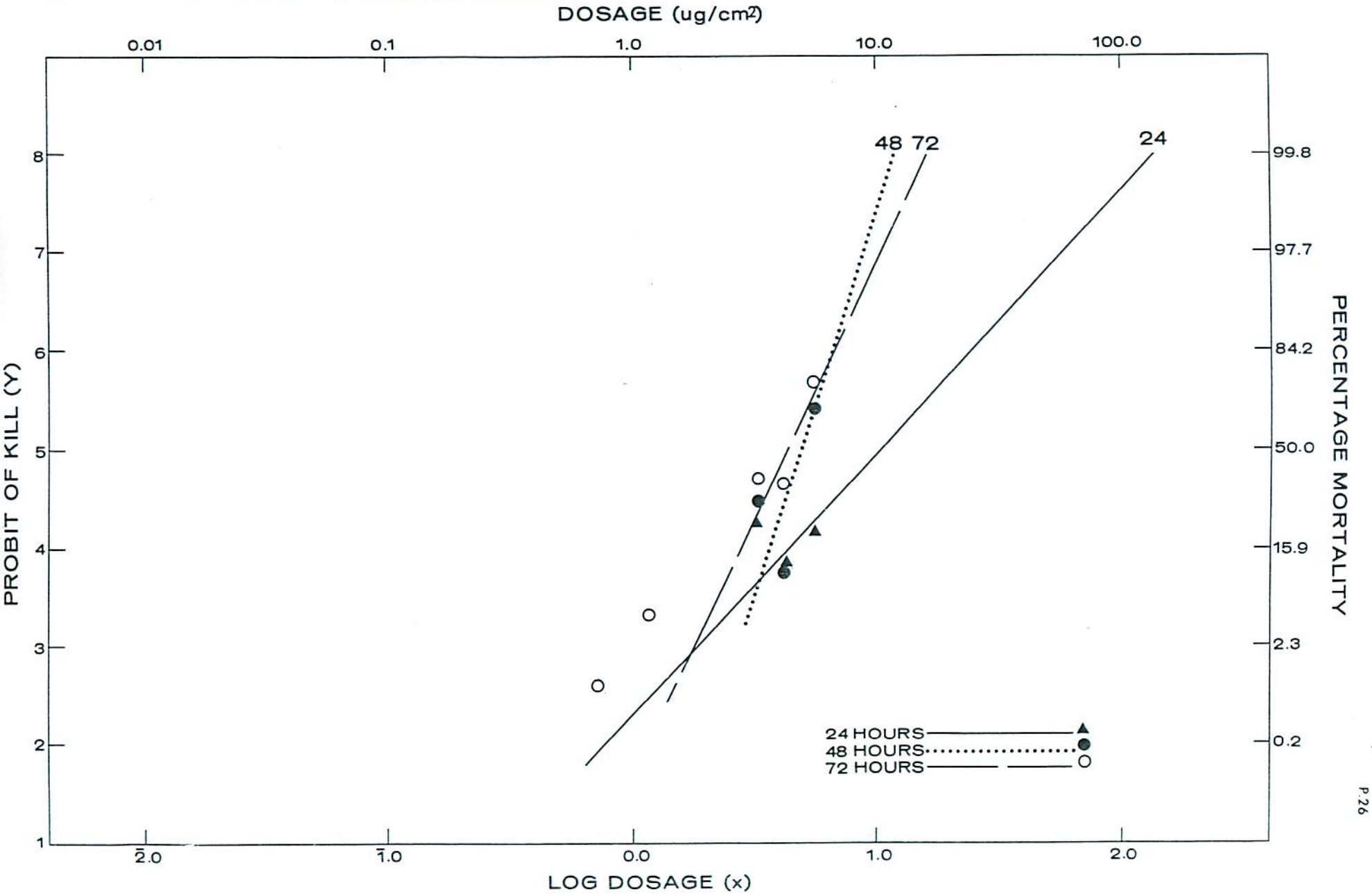


Table 10: Toxicity of Insecticides to Fifth Instar Spruce Budworm Larvae 24 Hours After Treatment

Insecticide	LD 50 ug/cm^2	Fiducial Limits	Relative Potency	Toxicity Index	LD 95 ug/cm^2	Fiducial Limits	Relative Potency
Bay 77488	0.12	0.10 - 0.14	45.8	4580	0.28	0.23 - 0.40	358.9
S 4084	.26	.23 - .28	21.2	2120	.44	.40 - .52	228.4
Exp. Cy. 47470	.33	.28 - .38	16.7	1670	.79	.60 - 1.52	127.2
SD 8447	1.82	1.55 - 2.04	3.0	300	3.60	3.04 - 4.91	27.9
MC 62	4.60	4.24 - 5.11	1.2	120	7.96	6.67 -11.26	12.6
DDF-d-DDT	4.97		1.1	110	52.82		1.9
DDT (from 1968 data)	5.50	3.57 -18.06	1.0	100	100.50	25.54 -9922.00	1.0
Baygon	9.21	6.72 -16.96	0.6	60	71.92	30.99 - 525.3	1.4
DDF	10.21	6.26 - 0.10 + 31	.5	50	42.49	13.19 - 0.1 + 31	2.4

Figure 10. Comparative Ld-p lines of insecticides against fifth instar CHORISTONEURA FUMIFERANA CLEM. (spruce budworm) for 24, hours after treatment.

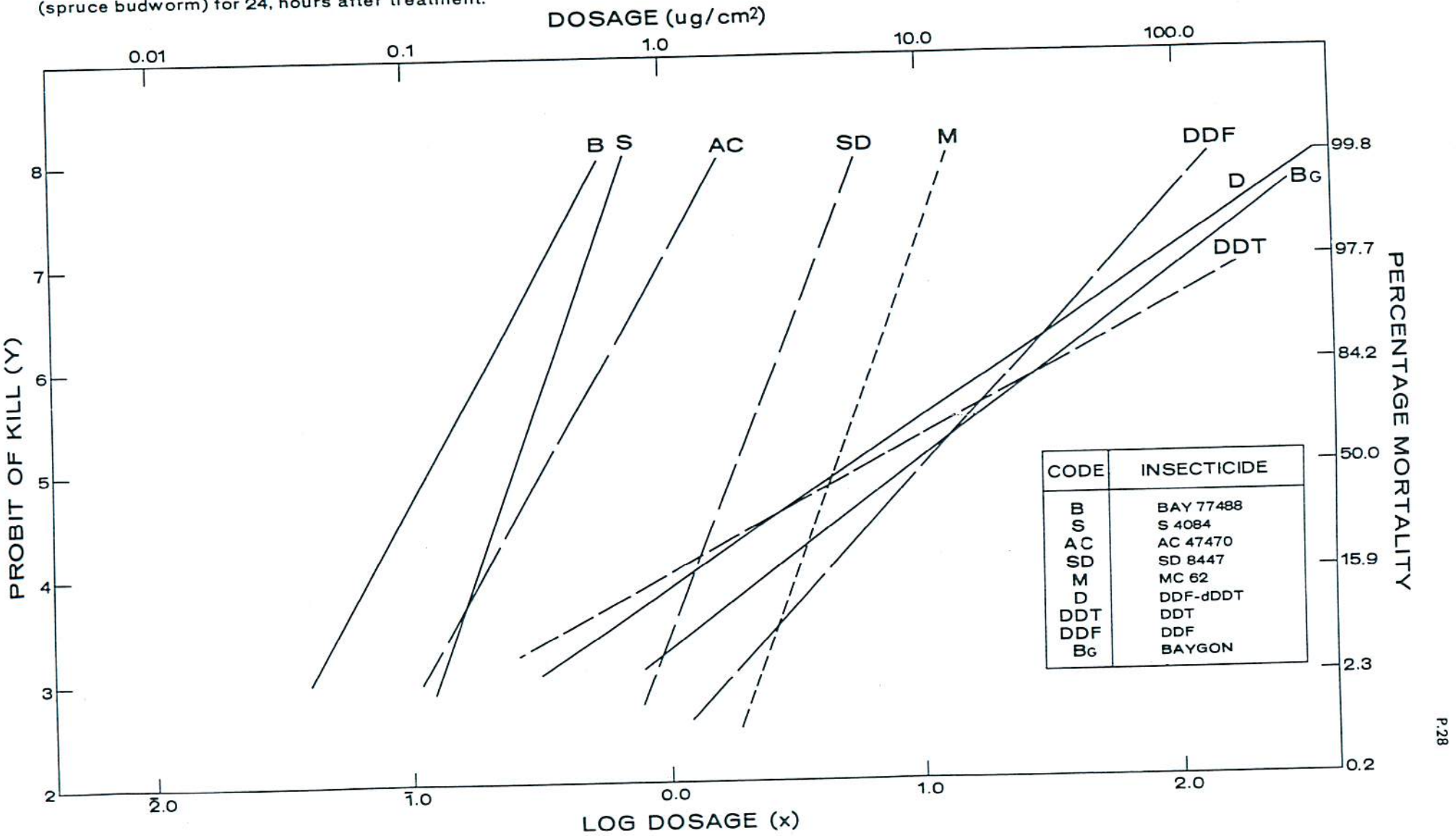


Table 11: Toxicity of Insecticides to Fifth Instar Spruce Budworm Larvae 48 Hours After Treatment

Insecticide	LD 50 ug/cm^2	Fiducial Limits	Relative Potency	Toxicity Index	LD 95 ug/cm^2	Fiducial Limits	Relative Potency
Bay 77488	0.117	0.10 - 0.13	17.0	1700	0.26	0.21 - .35	55.5
S 4084	.23	.20 - .25	8.7	870	.40	.36 - .48	36.1
Exp. Cy. 47470	.24	.48-01-.39	8.3	830	.61	.37 -125.8	23.7
DDF-d-DDT	1.33	1.02 - 1.64	1.5	150	6.25	4.57 - 10.11	2.3
SD 8447	1.73	1.44 - 1.96	1.2	120	3.64	3.04 - 5.11	3.9
DDT (1968)	1.99	1.54 - 2.55	1.0	100	14.43	8.31 - 44.43	1.0
MC 62	4.22	3.88 - 4.61	0.5	50	7.20	6.17 - 9.58	2.0
Baygon	4.63	3.62 - 6.19	.42	42	34.29	19.07 -106.50	0.4
DDF	4.94		.40	40	8.00		1.8

Figure 11. Comparative Ld-p lines of insecticides against fifth instar CHORISTONEURA FUMIFERANA CLEM. (spruce budworm) for 48 hours after treatment.

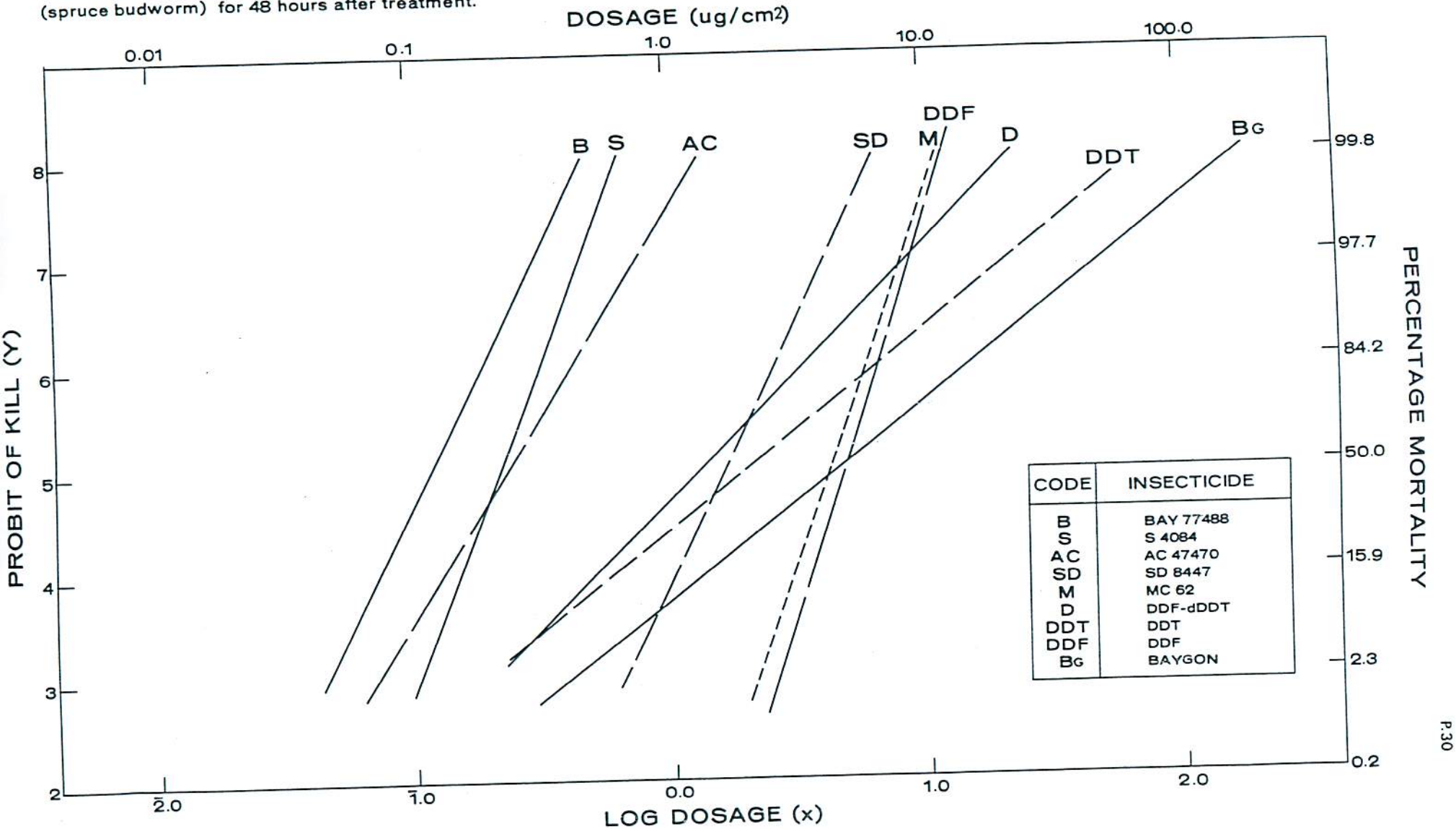


Table 12: Toxicity of Insecticides to Fifth Instar Spruce Budworm Larvae
72 Hours After Treatment

Insecticide	LD 50 ug/cm^2	Fiducial Limits	Relative Potency	Toxicity Index	LD 95 ug/cm^2	Fiducial Limits	Relative Potency
Bay 77488	.117	0.10 - 0.13	11.3	1128	0.26	0.21 - 0.35	25.5
S 4084	.21	.19 - .24	6.3	630	.41	.35 - .50	16.2
Exp. Cy. 47470	.24	.20 - .28	5.5	550	.58	.47 - .84	11.4
DDF-d-DDT	1.11	.83 - 1.39	1.2	120	4.67	3.51 - 7.25	1.4
DDT (1968)	1.32	1.00 - 1.63	1.0	100	6.64	4.67 -12.34	1.0
SD 8447	1.77		0.75	75	3.63		1.8
MC 62	3.67	3.20 - 4.24	.36	36	9.77	7.52 -15.48	0.68
DDF	4.23	3.44 - 5.13	.3	30	8.92	6.54 -32.31	.7
Baygon	4.42	3.38 - 5.86	.3	30	28.84	16.13 -103.7	.2

Figure 12. Comparative Ld-p lines of insecticides against fifth instar CHORISTONEURA FUMIFERANA CLEM. (spruce budworm) for 72 hours after treatment.

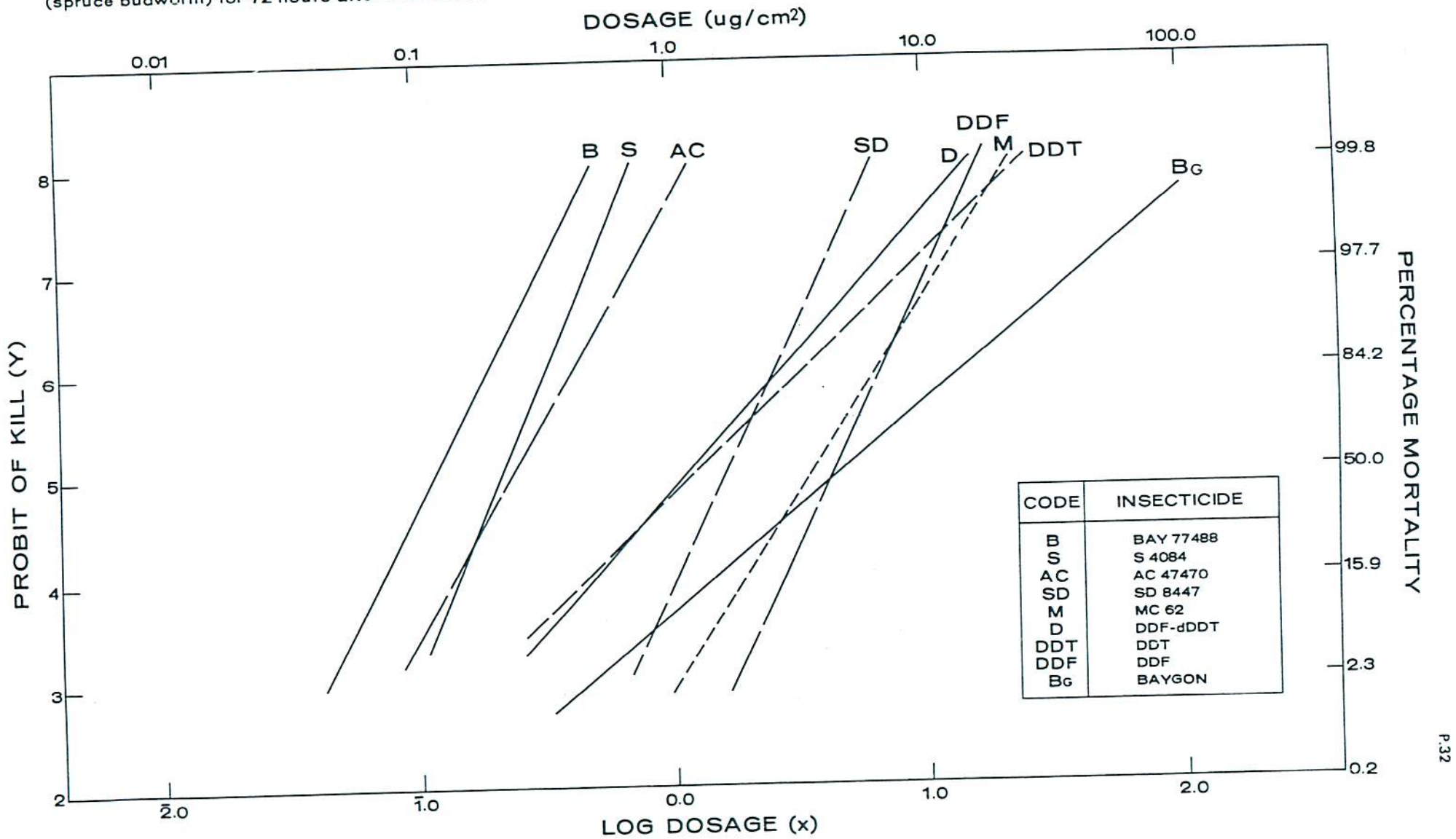


Table 13: Corrected Percentage Mortality of Fifth Instar Spruce Budworm Larvae 72 Hours After Insecticide Treatment

Expt. Code	Insecticide	Conc. %	Rate of Application in gal./acre						Highest Mortality at Lowest Dose	
			0.1	0.2	0.4	0.6	0.8	1.0	ug/cm^2	% Mortality
SBD 1	p,p'-DDT	5.0	0	20	100	90	100	100	2.24	100
SBD 2	DDD	5.0	0	0	0	38	38	38	3.36	38
SBW 71	DDF	5.0	1	5	0	40	38	75	5.55	75
SBD 4	d-DDT	5.0	0	25	38	63	63	88	5.61	88
SBD 5	DDF-d-DDT (1:1)	5.0	16	43	76	90	94	100	5.39	100
SBD 6	DDF-DDD (1:1)	5.0	0	21	10	21	66	66	4.48	66
SBD 7	DDF-p,p'-DDT (1:1)	5.0	0	14	0	43	71	20	4.48	71
SBW 65	Carbamult	5.0	0	3	51	26	65	50	4.48	65

1% @ 1 gal. per acre = 1.121 ug/cm^2 or 1.6 oz./acre.

Table 16: List of Insecticides and Source

No.	Name	Type	Formula	Source
1.	Baygon® (13.9% E.C.)	carbamate systemic	O-isopropoxphenyl methyl carba= mate	Chemagro
2.	Bay 77488 (65% E.C.)	organo-phosphate	phenylglyoxylonitrile oxime O,O-diethyl phosphorothioate	Chemagro
3.	Carbamult® (25% E.C.)	carbamate contact	m-cym-5-yl methylcarbamate	Green Cross
4.	DDD	chlorinated hydro-carbon, contact		St. Dunstan Univ. Charlottetown, P.E.I.
5.	DDF	chlorinated hydro-carbon, contact		St. Dunstan "
6.	DDF-DDD Mix (1:1)	chlorinated hydro-carbon, contact		"
7.	DDF-DDT Mix (1:1)	chlorinated hydro-carbon, contact		"
8.	DDF-d-DDT Mix (1:1)	chlorinated hydro-carbon, contact		"
9.	d-DDT	chlorinated hydro-carbon, contact		"
10.	p,p'-DDT	chlorinated hydro-carbon, contact	1,1,1-trichloro-2,2-bis (p-chloro=phenyl) ethane	Math. Col. & Bell
11.	Tech. DDT	chlorinated hydro-carbon, contact	1,1,1-trichloro-2,2-bis (p-chloro=phenyl) ethane	

Table 16: List of Insecticides and Source (cont'd.)

No.	Name	Type	Formula	Source
12.	AC 47470 (36% E.C.)	organo-phosphate systemic	P,P-diethyl cyclic propylene ester of phosphonodithio= imidocarbonic acid	American Cyan.
13.	Herc 13462 (12.5%E.C.)	organo-phosphate systemic	O,O, dimethyl S-(1-sucini= midoethyl) phosphorodithioate	Hercules
14.	MC 62 (25% E.C.)	organo-phosphate	O,O-dimethyl S-(N-methoxymethyl= carbamoylmethyl) phosphorothiol othionate	Murphy Chemical
15.	NIA 10242 (Tech. 99.5% C.P.)	Tech. carbamate systemic	2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate	Niagara Chemical
16.	S 4084 (40% E.C.)	organo-phosphate	O-p-cyanophenyl O,O-dimethyl phosphorothioate	May & Baker
17.	SD 8447 Gardona (Tech. 99% C.P.)	organo-phosphate	2-chloro-1-(2,4,5-trichloro= phenyl) vinyl dimethyl phos= phate	Shell

E.C. = emulsifiable concentrate

C.P. = crystalline powder