RESULTS OF TESTS WITH THE INSECTICIDES PHOSPHAMIDON AND SUMITHION AGAINST THE SWAINE JACK PINE SAWFLY IN QUEBEC, 1967

by
J. M. McLeod

FOREST RESEARCH LABORATORY
QUEBEC REGION
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FORESTRY BRANCH
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I. INTRODUCTION

The Swaine jack pine sawfly, Neodiprion swainei Middleton is an important defoliator of jack pine in Quebec. In 1965, over 135,000 acres of jack pine infested by this insect in the St.Maurice Valley, Quebec, were sprayed from the air using the insecticide Phosphamidon applied at the rate of 0.25 lb of technical insecticide (Dimecron 110) per 0.2 U.S. gal. of water per acre (McLeod, 1966). The operation was a success, and sawfly populations are still at low levels in the sprayed areas two years following application.

Additional outbreak areas (not included during the 1965 programme) were located during the course of aerial surveys by the Quebec Department of Lands and Forests in the winter of 1966. These were recommended for spraying in 1967 and a programme was developed similar to that of 1965 in which the forest industries concerned, and the Federal and Quebec governments respectively provided 1/3 of operational costs. Over 90,000 acres were sprayed south of Roberval, Quebec, along the Mattawin River and Lac Toro in the St.Maurice Watershed, and near the headwaters of the Lievre River watershed north of Mont Laurier.

This report summarizes the results of evaluation tests of the insecticides Phosphamidon and Sumithion applied at different rates; these tests were carried out just prior to the main spraying operation in August 1967. In the main operation Phosphamidon was applied throughout at a dosage of 0.25 lb per 0.2 gal. per acre, except for one area where the insecticide Novathion was applied at the same rate (Novathion is apparently identical in composition to Sumithion). The operation was carried out by Forest Protection Limited, Campbellton New-Brunswick and the biological assessment of the results jointly conducted by scientists of the Department of Forestry and Rural Devèlopment and the Quebec Department of Lands and Forests. A full report on the operational tests will appear later.

II. METHODS

A young (15-20 years) heavily infested jack pine stand in Chabanel Township 20 miles south of Roberval Quebec was selected as the test area. Two blocks, each of approximately 900 acres, were delineated for spraying (Fig. 1). Phosphamidon was applied to the north block and Sumithion to the south block. Application consisted of two consecutive treatments of 0.125 lb each to the north half of each block, followed by one treatment of 0.125 lb per acre to the south half of each block. Application rate throughout was 0.2 gal. per acre. Formulations were as follows for 270 gals. of required formulation to spray 1,350 acres in each test [1]:

(a) Sumithion test:

170 lbs. Sumithion Technical, approx.	15.5 gals.
Atlox emulsifier No. 3409	3.5 "
Aerotex solvent oil No. 3470	2.0 "
Total Emulsifiable concentrate	21.0 "

1) Data supplied by B.W. Flieger, Manager, Forest Protection Ltd., Campbellton, N.B. Personal correspondence, August 28, 1967.

Water	249.0 gals.
Total spray insecticide	270.0 "

Prepared for 1,350 acres = 900 acres at north end of block and 450 acres at south end.

(b) Phosphamidon test:

170 pounds Phosphamidon Technical	17.0 gals.
Water	253.0 "
Total spray insecticide (prepared as above)	270.0 "

Spray was applied to the Sumithion block on the evening of August 5 by two Stearman aircraft flying at 100 MPH at an emulsion rate of 8 gals./min. and a swath width of 200 feet. Lines were flown east-west along the blocks starting at the north side. The Phosphamidon block was sprayed in a similar manner on the morning of August 6. Wind direction was as indicated (Fig. 1), and in both cases sufficient to cause considerable spray drift.

Spray efficacy was assessed by calculating sawfly generation mortality in individual colonies (McLeod op. cit.) before and after spraying in both sprayed and control areas (Fig. 1). To prevent bias, all colonies were selected and tagged prior to the spray operation. In each of the four spray blocks, four sawfly colonies were tagged every four chains along lines at approximately right angles to spray swaths (Fig. 1). Lines were 24 chains in length yielding six clusters of four for each line except one (phosphamidon 0.25 block) where a total of seven clusters were obtained.

From each group of four colonies, one was removed for analysis just prior to spraying (August 5), and two others 48 hours after spraying. The fourth in each group, covered with a plastic bag tied securely to the branch, was removed six days following spray application. This was done to test the systemic properties of the insecticides. At each cluster point, spray assessment cards, supplied by Chemical Control Institute, Department of Forestry and Rural Development were stapled on small masonite squares nailed to four-foot high pickets.

Two control points, "A" and "B" (unsprayed areas) were set out (Fig. 1) and in each, 24 sawfly colonies were tagged, of which half were removed prior to spraying and the other half 48 hours after spraying. Five spray assessment cards were placed in each of the areas.

In addition, a 2700' foot long transect was sampled along a roadside (Control "C", Fig. 1) 48 hours following spray application to test the effect of drift, and an additional experiment was carried out to test

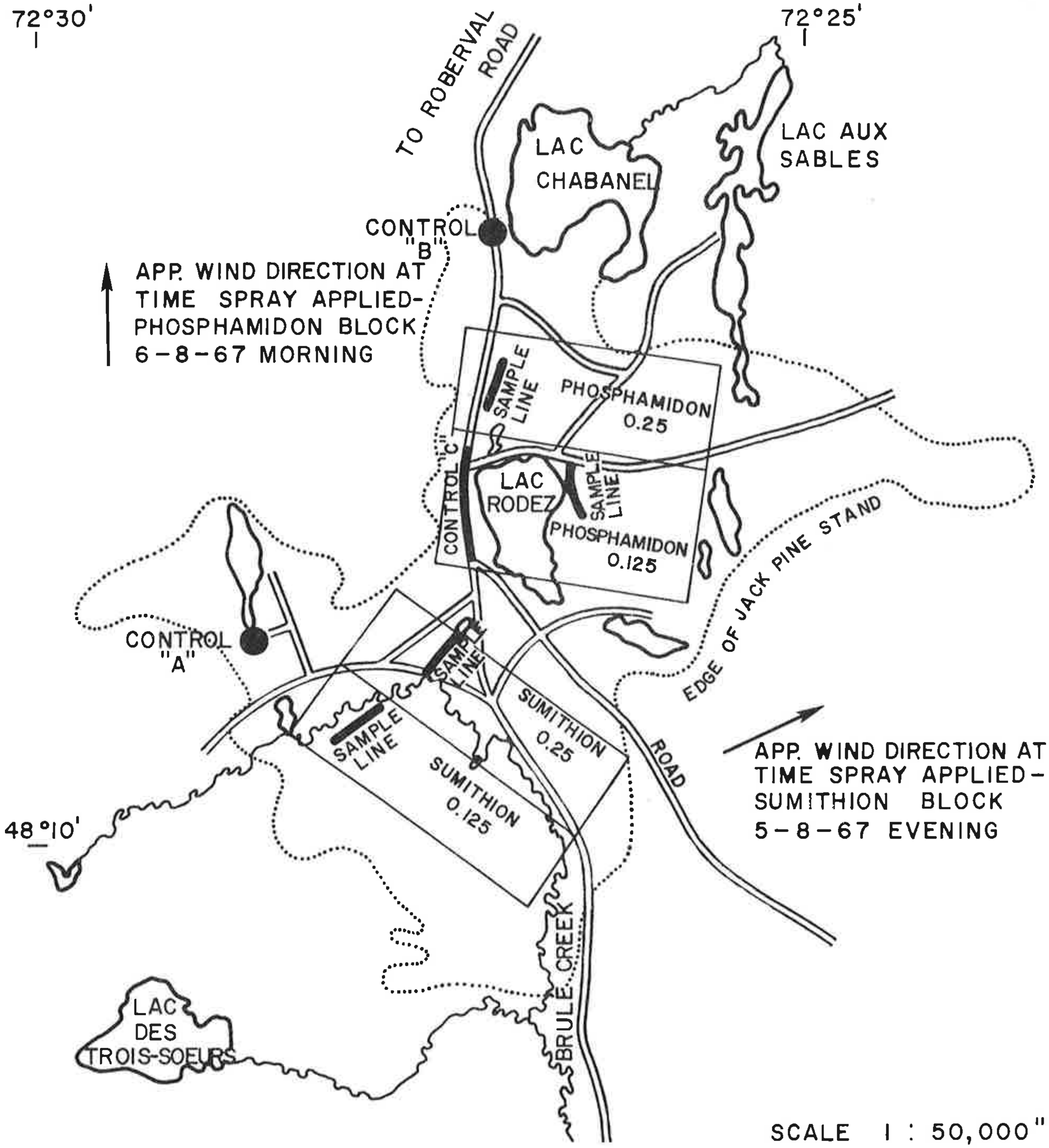

FIGURE 1. CHABANEL EXPERIMENTAL AREA SHOWING SPRAY BLOCKS AND LOCATION OF SAMPLE POINTS.

the systemic, or residual effect of both insecticides on sprayed foliage. For the latter, foliage from both the Phosphamidon and Sumithion 0.25 blocks was collected six days following spray application. This foliage was then fed to healthy N. swainei colonies collected from about 20 miles from the sprayed area. As a control, larvae from the same area were fed foliage from the trees where they were collected. The larvae were reared for four days and mortality recorded at the end of each day (Table 10).

Prior to the tests, additional dyes, CIBA Violet 5-BO Oleate and American Cyanamid Calco Oil Red N1700 were added to the technical Phosphamidon and Sumithion respectively.[2] This was to ensure that spray droplets would be detectable on the cards, since past experience showed that normal operational quantities of dyes were not sufficient to be readily detectable. The exact quantities added were not recorded.

III. RESULTS

Spray Deposit

Droplets showed very well on the cards from the Sumithion blocks (Table 1), but surprisingly, no trace was found on the cards from the Phosphamidon blocks, although as will be shown later, it was virtually certain that spray fell throughout. A somewhat similar situation had occurred during the 1965 sawfly spray programme; droplet stains, when present were faint, and most cards showed none. There are a number of possible explanations; the cards have a fine glaze, and this may prevent penetration of the small droplets before evaporation occurs; evaporation may occur as the spray is falling, and droplets hit the cards as technical material, highly viscous and unable to penetrate the cards; finally, bleaching of the droplet stains may occur rapidly in the presence of sunlight (Kirby and Harnden, 1967).

The Sumithion 0.25 block showed uniform droplet distribution and size except for points H-20 and H-24 (Table 1) where there were a number of disproportionately large drops; at this point one of the aircraft had developed a leak in its pressure pump. In the Sumithion 0.125 block only the first two points (L-4 and L-8) apparently received spray. Where spray fell, however, droplet size was uniform and counts were slightly less than half those in the Sumithion 0.25 block. Incomplete coverage of the 0.125 block was probably due to two factors; the aircraft ran out of spray approximately half way through the block and there was considerable drift from a steady breeze in the direction indicated in Fig. 1. Because the aircraft ran out of spray on the south half before completion of their run, it is likely that the north end received somewhat more than the 0.25 lb/ acre which was planned.

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2) B.W. Flieger, op.cit.

Phosphamidon Block

Virtually 100 percent control was realized at both the 0.125 and 0.25 lb/acre dosages less than two days following spray application (Tables 2 and 3). Pre-spray generation mortalities in the two areas were 34 and 40 percent respectively. Generation mortality in control area "A" however (Table 6) showed no increase in the two days following spraying. It should be pointed out that control area "B" which was directly in the path of the northward drift of spray from the Phosphamidon block (Fig. 1) showed 100 percent mortality two days following spraying. According to pilots' reports a fresh steady breeze from the south was blowing the morning that spray was applied, hence control "B" cannot be used to test spray efficacy, since it is almost certain that the mortality resulted from drifting spray the morning of application.

Sumithion Block.

Here too, where spray fell, almost total mortality resulted two days following application. Only one living larva in a total of 566 was found in the Sumithion 0.25 block whereas the pre-spray population had showed only 25 percent generation mortality (Table 5). In the Sumithion 0.125 block, mortality in blocks L-4 and L-8 was 100 percent following spraying (Table 4) whereas, prior to application, generation mortality was 26 percent. These two points received spray as indicated by the deposite cards (Table 1). In those areas where no spray was indicated (L 12 - L 24 inc.), there was no mortality in the two day interval following spraying; generation mortality in these clusters averaged only 21 percent (Table 4).

Systemic or Residual Effect of the Insecticides

In the bagged samples, it was possible to estimate mortality directly since all the larvae which died between spray application and the time of collection were trapped inside the bags. It is inferred that since the colonies were protected from direct contact with the spray, contamination must have resulted from translocation through foliage parts. In the absence of spraying, mortality in the six day interval between application and collection would be very low since this is a very stable interval in the sawfly developmental cycle. Unfortunately, time did not permit the setting up of control bags in either of areas "A" or "B". However, it is reasonably certain that clusters L-12 to L-24 inclusive in the Sumithion 0.125 block received no spray (Table 9 and C.F. Tables 1 and 4) and so can with safety be used as a control. Mortality in these samples in the six day period averaged 2 percent.

On this basis it seems likely that colonies in both the Phosphamidon 0.125 and 0.25 blocks (Table 8) suffered relatively high mortality. At the lower dosage, the overall mortality (17.3 percent) was not strikingly high; however, most of the colonies as indicated, showed symptoms of poisoning. The high mortality in the Phosphamidon 0.25 block however, leaves little doubt that the colonies were contaminated, as was the case also in the Sumithion 0.125 block. All the larvae in the Sumithion 0.25 block died.

Somewhat similar results obtained when larvae from outside the sprayed area were fed sprayed foliage from the Phosphamidon and Sumithion 0.25 blocks. During a four day rearing period, almost all the larvae on the contaminated foliage died whereas mortality in controls was low (Table 10). As in the previous tests, the effect was felt sooner in the Sumithion foliage. It may be significant that heavy rains(> 3") fell for two days prior to collection of these samples so that most of the contamination must have been washed off the surface of the foliage, hence the mortality was very likely due to systemic properties of both these insecticides.

Drift

Relatively low volume concentrates such as were used in these tests seem to be susceptible to drift even in light breezes. Small droplet size combined with rapid evaporation as spray leaves the aircraft are thought to be contributing factors. In the 1965, Swaine jack pine sawfly spraying programme (McLeod, op. cit.), a sizeable control area (in excess of 2 miles square) was contaminated in spite of the fact that the nearest spray blocks were over five miles distant.

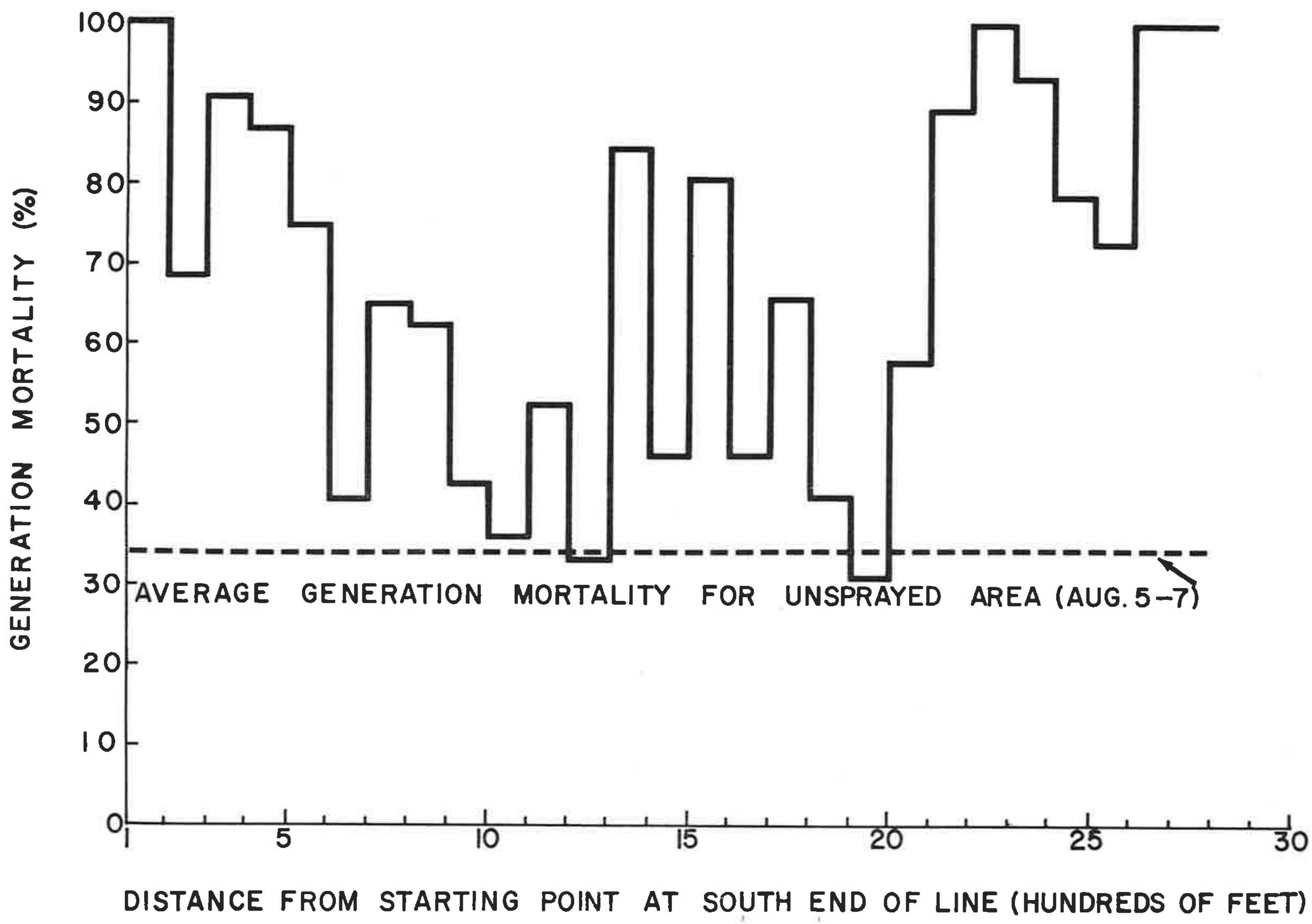
In the current tests, drift was considerable throughout. Most of the sawfly colonies located in roadside counts in the area between the Sumithion and Phosphamidon blocks (Fig. 1) were dead, presumably as a result of drift from the Sumithion block in the direction indicated. In control "C" (Figs. 1, 2) mortality from drift seems to have occurred up to at least 1,000 feet from the south starting point. In this block, as in the Sumithion block, aircraft ran out of spray a little over half way through the 0.125 block. Because of this, and the heavy northward drift of spray out of the block, it can be assumed that the south border of the Phosphamidon 0.125 block fell about 2,000 feet north of the south starting point of control line "C" (Fig. 2). Hence it is likely that the sample line to the east of Lac Rodez in the 0.125 block fell within the boundaries of the sprayed area and received little or no drift from the Sumithion block.

The northward drift of spray from the Phosphamidon was considerable; a quantity of spray sufficient to kill all sawfly larvae fell over control point "B", almost three quarters of a mile north of the spray block.

IV. SUMMARY

These tests add support to the conclusions reached in the 1965 trials (McLeod op.cit.) viz excellent control of sawfly populations results from applications of Phosphamidon at 0.25 lb per 0.2 gal. per acre and it appears that 0.125 lb per acre may produce equally good results. However because of the possibility, albeit remote, of contamination from drift from the Sumithion block to the south, further lists should be carried out before recommending operational dosages of 0.125 lb per acre.

FIGURE 2. GENERATION MORTALITY IN NEODIPRION SWAINEI THREE DAYS FOLLOWING SPRAY APPLICATION IN A 2,700' TRANSECT (CONTROL LINE "C") BETWEEN PHOSPHAMIDON AND SUMITHION SPRAY BLOCKS, SHOWING THE EFFECT OF SPRAY DRIFT. EACH SAMPLE IS AVERAGE OF THREE SELECTED COLONIES.



The results of the Sumithion tests were equally convincing. Both the 0.25 and 0.125 lb per acre dosages produced nearly 100 percent larval mortality, hence this insecticide applied at 0.25 lb per acre would very likely be operationally successful and it is suggested that 0.125 lb per acre would be equally good.

Both insecticides showed rather strong systemic properties six days following spray application. Surprisingly, the systemic effect of Sumithion seemed stronger than that of Phosphamidon, which is advertised as a systemic insecticide.

V. ACKNOWLEDGMENTS

I wish especially to thank Mr. Réal Desaulniers, entomologist, Quebec Department of Lands and Forests for assistance provided during the course of this work. Grateful thanks are also due for the cooperation and helpful advice given by B.W. Flieger, Manager, Forest Protection Limited, in laying out and planning the experimental areas.

VI. REFERENCES

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Table 1. Number of Spray Droplets Falling on Each of Five Randomly Selected One Centimeter-Squares on Six Assessment Cards. Lac Rodez, 1967. Cards Distributed at Four Chain Intervals Along Lines (cf. Fig. 1).

A. Treatment - Sumithion, 0-25 lb. per Acre.

Card No.	Number of Droplets per Sample					Total	Mean
H-0	5	7	6	14	8	40	8.0
H-4	8	8	13	14	13	56	11.2
H-8	4	9	13	13	9	48	9.6
H-12	14	10	9	10	13	56	11.2
H-20	12	11	10	13	14	60	12.0
H-24	15	18	29	13	15	90	18.0
Total						350	11.6

B. Treatment - Sumithion, 0.125 lb.per Acre

L-4	5	4	5	2	1	17	3.4
L-8	3	5	7	6	4	25	5.0
L-12	0	0	0	0	0	0	0 *
L-16	0	0	0	0	0	0	0
L-20	0	0	0	0	0	0	0
L-24	0	0	0	0	0	0	0
Total						206	4.2 **

* 8 droplets on whole card, 8.6 X 6.8 cm. This may be presumed to be the edge of the sprayed part of this block.

* Average of first two cards only.

Table 2. Generation Mortality Estimates for <u>Neodiprion swainei</u> Before and After Spraying. Phosphamidon Block, 0.125 lb. per Acre. Lac Rodez, 1967.

Pre-Spray Samples (August 5)				Post-Spray Samples (August 7)			
Sample Number	Number of Eggs per Colony	Number of Larvae per Colony Living	Dead	Sample Number	Number of Eggs per Colony	Number of Larvae per Colony Living	Dead
L-4-1	65	29	0	L-4-2	86	0	53
L-8-1	46	34	0	L-4-3	91	0	58
L-12-1	31	25	0	L-8-2	68	0	11
L-16-1	72	53	0	L-8-3	59	0	35
L-20-1	82	46	0	L-12-2	115	0	62
L-24-1	51	40	0	L-12-3	35	0	21
Totals	347	227	0	L-16-2	89	0	60
				L-16-3	108	0	54
				L-20-2	52	0	43
				L-20-3	48	1	45
				L-24-2	91	0	58
				L-24-3	78	0	51
				Total	920	1	551

Generation Mortality = $\frac{347 - 227}{347} \times 100 = 34.5\%$

Generation Mortality = $\frac{920 - 1}{920} \times 100 = 99.8\%$

Table 3. Generation Mortality Estimates for <u>Neodiprion swainei</u> Colonies Before and After Spraying. Phosphamidon Block, 0.25 lb. per Acre. Lac Rodez 1967.

Pre - Spray Samples (August 5)				Post - Spray Samples (August 7)			
Sample Number	Number of Eggs per Colony	Number of Larvae per Colony Living	Dead	Sample Number	Number of Eggs per Colony	Number of Larvae per Colony Living	Dead
H-0-1	58	22	0	H-0-2	87	0	39
H-4-1	83	66	0	H-0-3	72	0	35
H-8-1	111	56	0	H-4-2	95	0	43
H-12-1	98	75	0	H-4-3	87	0	24
H-16-1	86	61	0	H-8-2	62	0	36
H-20-1	108	53	0	H-8-3	66	0	10
H-24-1	104	58	0	H-12-2	36	0	24
Totals	648	391	0	H-12-3	117	0	5
				H-16-2	79	0	45
				H-16-3	111	0	55
				H-20-2	82	0	38
				H-20-3	81	0	30
				H-24-2	61	0	36
				H-24-3	64	0	45
				Totals	1100	0	465

Generation Mortality = $\frac{648-391}{648} \times 100 = 39.6\%$

Generation Mortality= $\frac{1100-0}{1100} \times 100 = 100\%$

Table 4. Generation Mortality Estimates for *Neodiprion swainei* Colonies Before and After Spraying. Sumithion Block, 0.125 lbs per Acre, Lac Rodez 1967.

Pre-Spray Samples (August 5)				Post-Spray Samples (August 7)			
Sample Number	Numbe of Eggs per Colony	Number of Larvae per Colony Living	Dead	Sample Number	Number of Eggs per Colony	Number of Larvae per Colony Living	Dead
L-4-1	97	81	0	L-4-2	81	0	69
L-8-1	93	79	0	L-4-3	86	0	37
L-12-1	113	78	0	L-8-2	51	0	32
L-16-1	92	43	0	L-8-3	81	0	34
L-20-1	88	64	0	L-12-2	55	19	9
L-24-1	80	70	0	L-12-3	68	45	21
Totals	563	415	0	L-16-2	73	70	0
				L-16-3	87	52	5
				L-20-2	16	15	0
				L-20-3	93	88	2
				L-24-2	45	43	1
				L-24-3	64	64	0
				Totals	800	396	210

Generation Mortality = $\frac{563 - 415}{563} \times 100 = 26.2\%$

Generation Mortality (First Four Samples) = $\frac{299 - 0}{299} \times 100 = 100\%$ ☆

Generation Mortality (Last Eight Samples) = $\frac{501 - 396}{501} \times 100 = 20.9\%$

☆ Cf. Tables 1 and 9. Adequate spray deposit likely only on first four samples.

Table 5. Generation Mortality Estimates for <u>Neodiprion swainei</u> Before and After Spraying. Sumithion Block, 0.25 lbs per Acre Lac Rodez, 1967.

Pre-Spray Samples (August 5)				Post-Spray Samples (August 7)			
Sample Number	Number of Eggs per Colony	Number of Larvae per Colony Living	Dead	Sample Number	Number of Eggs per Colony	Number of Larvae per Colony Living	Dead
H-0-1	87	76	0	H-0-2	58	0	52
H-4-1	79	56	0	H-0-3	76	0	48
H-8-1	105	79	0	H-4-2	75	0	61
H-12-1	94	76	0	H-4-3	56	1	25
H-20-1	82	52	0	H-8-2	74	0	53
H-24-1	96	68	0	H-8-3	29	0	21
Totals	543	407	0	H-12-2	162*	0	69
				H-12-3	85	0	47
				H-20-2	77	0	63
				H-20-3	91	0	57
				H-24-2	75	0	33
				H-24-3	71	0	36
				Totals	929	1	565

Generation Mortality = $\frac{543 - 407}{543} \times 100 = 25.0\%$

Generation Mortality = $\frac{929 - 1}{929} \times 100 = 99.8\%$

* Two colonies.

Table 6. Generation Mortality Estimates for *Neodiprion swainei* Colonies Before and After Spraying. Control area "A". Lac Rodez, 1967.

Pre-Spray Samples (August 5)				Post-Spray Samples (August 7)			
Sample Number	Number of Eggs per Colony	Number of Larvae per Colony Living	Dead	Sample Number	Number of Eggs per Colony	Number of Larvae per Colony Living	Dead
A-1	49	15	0	A-1	80	49	0
A-2	120	104	0	A-2	53	38	0
A-3	107	86	0	A-3	67	50	0
A-4	105	89	0	A-4	60	50	0
A-5	71	38	0	A-5	138 x	107	0
A-6	35	33	0	A-6	81	75	0
A-7	96	44	0	A-7	168 x	126	0
A-8	67	37	0	A-8	113	83	0
A-9	41	17	0	A-9	185 x	137	0
A-10	32	21	0	A-10	67	61	0
A-11	62	58	0	A-11	73	65	0
A-12	44	32	0	A-12	64	21	0
Totals	829	574	0	Totals	1149	862	0

Pre-spray: Generation Mortality = $\frac{829 - 574}{829} \times 100 = 30.8$

Post-spray: Generation Mortality = $\frac{1149 - 862}{1149} \times 100 = 25.0$

x Double Colonies

Table 7. Generation Mortality Estimates for *Neodiprion swainei* Colonies Before and After Spraying. Control Area "B". Lac Rodez 1967.

Pre-Spray Samples (August 5)				Post Spray Samples (August 7)			
Sample Number	Number of Eggs per Colony	Number of Larvae per Colony Living	Number of Larvae per Colony Dead	Sample Number	Number of Eggs per Colony	Number of Larvae per Colony Living	Number of Larvae per Colony Dead
B-1	41	33		B-1	101	0	45
B-2	86	67		B-2	98	0	29
B-3	26	17		B-3	50	0	41
B-4	34	28		B-4	69	0	7
B-5	67	15		B-5	79	0	20
B-6	50	19		B-6	87	0	49
B-7	59	33		B-7	77	0	8
B-8	85	80		B-8	80	0	3
B-9*	224	33		B-9	45	0	17
B-10*	187	75		B-10	88	0	39
B-11	64	23		B-11	42	0	21
B-12*	201	132		B-12	52	0	12
Totals	1124	555		Totals	868	0	291

Generation Mortality = $\frac{1124 - 555 \times 100}{1124} = 50.6$

Generation Mortality = $\frac{868 - 0 \times 100}{868} = 100\%$

* Double Colonies

Table 8. Interval Mortality in *Neodiprion swainei* Colonies Covered Individually with Plastic Bags One day Prior to Spray Application and Collected Six Days Following Application. Phosphamidon Blocks. Lac Rodez 1957.

Phosphamidon 0.125 lb/acre			
Sample Number	Number of Eggs per Colony	Number of Larvae per Colony Living	Number of Larvae per Colony Dead
L-4	46	22*	8
L-8	78	75	2
L-12	15	21*	0
L-16	69	72*	4
L-20	80	48*	10
L-24	95	29*	32
Totals	383	267	56

Mortality = $\frac{323 - 267}{323}$ x 100 = 17.3

* Individual larvae dispersed and sickly.

Phosphamidon 0.25 lb/acre			
Sample Number	Number of Eggs per Colony	Number of Larvae per Colony Living	Number of Larvae per Colony Dead
H-0	96	15	15
H-4	71	0	56
H-8	60	30	11
H-12	89	26	21
H-16	92	32	25
H-20 *	94	0	33
H-24	61	0	45
Totals	469	103	173

Mortality = $\frac{276 - 103}{276}$ x 100 = 62.7

* Sample edited from data - bag pierced.

Table 9. Interval Mortality in *Neodiprion swainei* Colonies Covered Individually with Plastic Bags One Day Prior to Spray Application and Collected Six Days Following Application. Sumithion Blocks, Lac Rodez 1967.

Sumithion 0.125 lb/acre				Sumithion 0.25 lb/acre			
Sample Number	Number of Eggs per Colony	Number of Larvae per Colony Living	Dead	Sample Number	Number of Eggs per Colony	Number of Larvae per Colony Living	Dead
L-4	77	21	26	L-0	69	0	61
L-8	90	0	59	L-4	130*	0	124
L-12	63	64	0	L-8	85	0	49
L-16	71	61	0	L-12	66	0	52
L-20	55	46	1	L-20	98	0	77
L-24	67	63	4	L-24**	37	0	3
Totals	423	235	90	Totals	485	0	412

Mortality in first two samples $= \frac{106 - 21 \times 100}{106} = 80.1$

Mortality in last four samples (did not receive spray) $= \frac{219 - 214 \times 100}{219} = 2.3$

Mortality $= \frac{409 - 0 \times 100}{409} = 100\%$

* Double Colony
** Sample edited from data; plastic bag ripped and dead larvae fell through.

Table 10. Mortality of *Neodiprion swainei* larvae collected from and Unsprayed Area and Reared in Containers Supplied with Phosphamidon and Sumithion. - Sprayed Foliage Collected from Trees Six Days Following Spray Application (August 12,1967) Compared with Mortality of Controls.

Date Checked	Treatment		Number of Larvae Healthy	Number of Larvae Wandering and "Sick"	Number of Larvae Dead	% Mortality
August 13	Sumithion container	no 1	8	76	46	35.3
	"	no 2	71	53	155	55.5
	Phosphamidon "	no 1	53	65	27	18.0
	"	no 2	3	131	52	28.0
	Control "	no 1	215	18	1	0.4
	"	no 2	139	10	10	6.3
	"	no 3	146	50	1	0.5
August 14	Sumithion "	no 1	0	37	93	71.5
	"	no 2	0	58	221	79.2
	Phosphamidon"	no 1	0	94	56	37.3
	"	no 2	0	93	93	50.0
	Control "	no 1	216	17	1	0.4
	"	no 2	107	40	12	7.5
	"	no 3	0	196	1	0.5
August 15	Sumithion "	no 1	0	7	123	94.6
	"	no 2	0	2	277	99.3
	Phosphamidon"	no 1	0	2	148	98.7
	"	no 2	0	3	183	98.4
	Control "	no 1	0	231*	3	1.3
	"	no 2	0	144	15	9.4
	"	no 3	0	165	32	16.2

* Control larvae at this time were feeling, effects of foliage quality deterioration after four days in rearing without changing foliage.