INSECTICIDES FOR CONTROL OF BRASSICA PESTS IN BRITISH COLUMBIA[1]

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Introduction

The purpose of this 4-year investigation was to find a calendar recommendation for control of cole crop pests, better suited to local conditions than the existing one. An earlier paper dealt with the first season's work in 1958, when the pests were exceptionally abundant (Forbes and MacCarthy, 1959). During the next 3 years the populations at Vancouver were much lower, so that single treatments only were necessary, making it possible to study the rates of reinfestation.

Most of the insecticides were organophosphates with systemic effects. This paper reports the effectiveness of the materials, and the persistence of the best of these against the 4 common pests: the cabbage aphid, *Brevicoryne brassicae* (L.); the green peach aphid, *Myzus persicae* (Sulz.); the diamondback moth, *Plutella maculipennis* (Curt.); and the imported cabbageworm, *Pieris rapae* (L.). The last was in small numbers.

Materials and Methods

The insecticides were:

DDT; 50 per cent wettable powder.

Derris; 7.94 per cent emulsible concentrate, formulated for this experiment by P. C. Oloffs, courtesy of Laters of Canada, 330 Lysander Lane, Richmond, B.C.

Diazinon, *O, O*-diethyl *O*-(2-isopropyl-4-methyl - 6 - pyrimidinyl) phosphorothioate; 25 per cent emulsible concentrate; Fisons (Canada) Ltd., Toronto, Ont.

Dimethoate (Rogor), *O, O*-dimethyl *S*-(N-methylcarbamoylmethyl) phosphorodithioate; 46 per cent soluble concentrate; American Cyanamid Co., Stamford, Conn.

Di-Syston, *O, O*-diethyl *S*-2(ethylthio) ethyl phosphorodithioate; 5 per cent granules; Chemagro Corp., San Mateo, Calif.

Ekatin-M, *O, O*-dimethyl *S*-(morpholino-carbamionyl-methyl) dithiophosphate; emulsible concentrate containing 2.1 lb. active material per Imp. gallon; Sandoz Ltd., Basle, Switzerland.

Larvatrol "75 W", wettable powder containing 75 billion spores per gm. of *Bacillus thuringiensis* Berliner; Nutrilite Products, Inc., Buena Park, Calif.

Malathion; 57 per cent emulsible concentrate; American Cyanamid Co., Stamford, Conn.

Perthane, di(*p*-ethylphenyl) dichloroethane; emulsible concentrate containing 4 lb. of active material per U.S. gallon or 50 per cent wettable powder; Rohm & Haas Co., Philadelphia 5, Pa.

Phosdrin, dimethyl carbomethoxypropenyl phosphate; water soluble liquid containing 12.3 lb. Phosdrin per Imp. gallon; Shell Oil Co. of Canada, Toronto, Ont.

Phosphamidon, dimethyl 2-chloro-2-diethylcarbamoyl-1-methyl vinyl phosphate; "4 spray" containing 4 lb. of active material per Imp. gallon; Ortho Agricultural Chemicals Ltd., New Westminster, B.C.

Sevin, methylnaphthyl carbamate; 50 per cent wettable powder; Union Carbide Chemicals Co., New York, N.Y.

Thiodan, hexachloro - hexahydromethano-2, 4, 3-benzo-dioxathiepin oxide; emulsible concentrate containing 2 lb. of active material per Imp. gallon; Niagara Brand Chemicals, Burlington, Ont.

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The surfactant Triton B 1956 (Rohm and Haas Co., Philadelphia 5, Pa.) was added to all sprays at 4 ounces per 100 gallons. Di-Syston granules were applied at the base of the plants in 1959 and 1960; in 1961 they were mixed with the seed just before sowing. In that year the 3 brassica crops were not transplanted, but were grown directly from seed.

Brussels sprouts was the chief test crop, being used in all years. The methods of culture and appraisal of results have been published (Forbes and MacCarthy, 1959). In 1961 the size of the plots was tripled to include equal numbers of rows of broccoli and rutabagas, in order to gauge the effect of treatment on other brassica crops. In each year a randomized block design was used in 4 replicates. To determine any toxic effect of seed furrow treatment with Di-Syston by the end of the 1961 season (7 Nov.), 10 plants were taken at random and weighed, from each of the 4 replicates of the untreated, Di-Syston, and dimethoate plots. Above ground weights were recorded for Brussels sprouts and broccoli, both of which were not harvested; the weight of the entire plant was recorded for rutabagas.

Records made later than 6 weeks after spraying are not used here (with an exception noted), because after this time apparent control may result from inability of the pests to re-colonize, rather than from residual toxicity.

Results with the best materials are presented by plotting the cumulative totals (Fig. 1). This method permits easy comparison between the rates of increase in treated and untreated plots.

Bioassays were made in 1959 using discs 9 cm. in diameter, cut from middle leaves of plants in each of the control and Di-Syston plots. The leaf discs were placed in petri dishes and ten adult aphids from greenhouse colonies were put into each dish. The survivors were counted after 3 days.

Results and Discussion

The populations levels of the 4 pests varied from year to year as shown by the totals in the untreated plots in 6 weekly counts on an upper, middle, and a lower leaf of 5 Brussels sprouts plants in 4 replications, i.e. on 60 leaves per week:

	1959	1960	1961
Cabbage aphids, colonies	115	83	495
Green peach aphids, adults	591	123	155
Diamondback moth larvae	142	41	53
Imported cabbageworms	27	11	4

In 1959 green peach aphids were sufficiently abundant by 28 July to warrant spraying, but cabbage aphids did not appear until a month later. Hence in Fig. 1 (upper left) the points on the graph represent counts made from 31 to 66 days following spraying.

Tables 1, 2, and 3 show the treatments, rates and percentage control achieved, calculated by Abbott's formula. The materials are discussed here, in alphabetical order:

Since the local populations of diamondback moth and imported cabbageworm were known to be susceptible, DDT was included (Table 1) as a standard against which other larvacides could be measured.

Derris is recommended on provincial spray calendars for use against caterpillars near harvest. It reduced the numbers to about one-half of those in the control plots for 3 weeks following application. Disadvantages to its use are the high cost and the difficulty of obtaining fresh concentrate.

Diazinon gave fairly good results against aphids and caterpillars (Fig. 1), and retained its effectiveness for 2 weeks. It now appears on both the

TABLE 1.—Percentage control of brassica pests from single applications* of insecticides to Brussels sprouts, based on 6 weekly counts, 31 July-9 Sept., 1959, at Vancouver, B.C.

Treatment	Active material per acre, lb.	Cabbage aphids**	Green Peach aphids	Caterpillars
Diazinon 25% EC with Perthane 50% WP	0.5 + 1	24	71	71
Dimethoate 46% SC	1	47	86	49
Di-Syston 5 G with DDT 50% WP	1 + 1	83	41	83
Di-Syston 5 G with Perthane 50% WP	2 + 1	90	8	53
Malathion 57% EC	1.25	0	13	60
Phosdrin WS	.45	36	46	46
Phosphamidon 4	0.5	24	54	31
Thiodan 2 EC	0.75	0	34	75

* Di-Syston was applied to the soil at the base of the plants when they were 8 in. high, 3 and 4 July. Other materials applied 28 July.

** Cabbage aphids were absent until one month after application of the sprays. These data are based on the 6 counts 28 Aug.-9 Oct.

commercial and garden growers' calendars.

Dimethoate (Rogor) gave good control of all pests (Fig. 1), especially green peach aphids. Against caterpillars it had little effect after about 2 weeks. This material will be held in reserve for future recommendation.

TABLE 2.—Percentage control of brassica pests from single applications* of insecticides to Brussels sprouts, based on 6 weekly counts, 29 Aug.-7 Oct., 1960, at Vancouver, B.C.

Treatment	Active material per acre, lb.	Cabbage aphids	Green Peach aphids	Caterpillars
Dimethoate 46% SC	1	76	87	52
Di-Syston 5 G with Larvatrol 75 W	1 + 2	90	46	21
Di-Syston 5 G with derris 7.94% EC	1 + 1 pint	86	37	29
Di-Syston 5 G with Perthane 45 EC	1 + 1	90	57	85
Di-Syston 5 G with Sevin 50 W	1 + 1	83	63	71
Ekatin - M 20 EC	1	24	28	4
Malathion 57% EC with Perthane 45 EC	1.25 + 1	57	0	81
Phosdrin WS	0.5	66	18	42

* Di-Syston was applied to the soil at the base of the plants when they were 8 in. high 20 July. Other materials applied 25 Aug., 1960.

Di-Syston alone had no effect on caterpillars (Forbes and MacCarthy, 1959). Against cabbage aphids it gave superior control, and was effective for a shorter time against green peach aphids. There was a marked reduction in the numbers of aphids even when it had been applied with the seed 100 days earlier; in Brussels sprouts it reduced the numbers of cabbage aphid colonies by 74 per cent and of adult green peach aphids by 58 per cent. However, furrow application reduced the emergence of seedlings: in Brussels sprouts by 68 per cent, in broccoli by 46 per cent, and in rutabagas by 62 per cent. Some of the young plants were stunted but they had outgrown this when they were weighed on 7 November. Di-Syston appeared on the commercial growers' spray calendar for 1962-63 with the recommendation that the granules be applied at transplanting or as a side dressing.

Ekatin-M used at the rate recommended by the manufacturer gave poor results and was used in 1960 only.

Larvatrol "75 W" appeared to have little persistence but this may have resulted in part from rain that fell on the 2nd, 3rd, and 4th days following the treatment in 1960.

Malathion proved in 3 seasons of trial to be ineffective against aphids, but useful against caterpillars. It has been retained in the home gardeners' calendar because of its low mammalian toxicity but dropped from the commercial growers' calendar.

Perthane was tested 5 times in the 3 years, in combination with Di-Syston, malathion, or Diazinon (Fig. 1), giving good to excellent control of caterpillars. It was included in the commercial growers' calendar on the basis of its performance and very low mammalian toxicity.

Phosdrin is recommended as a late-season and pre-harvest spray. It must be reapplied frequently in seasons of heavy infestation, since pests appear to recover rapidly. The short residual effect is clear (Fig. 1).

Phosphamidon is a promising systemic with useful characteristics. It had good contact action against the 4 pests, with some systemic effect for 2 weeks. This agrees with the manufacturers' residue studies.

Sevin was shown in earlier studies to be ineffective against aphids, but against caterpillars it was effective and persistent (Fig. 1).

Thiodan appeared to be ineffective against cabbage aphids, but it reduced the numbers of caterpillars for 3 weeks after application.

The persistence of Di-Syston was investigated in 1959. Brussels sprouts, treated at 2 and 1 lb. toxicant per acre were harvested 101 and 102 days after treatment and sent to the Chemagro Corporation, Kansas City, Mo., for analysis. No detectible residues were found.

Table 4 shows the results of a bioassay of plants treated with Di-Syston. There was a significant reduction of cabbage aphids 126 days after treatment, but not later. Green peach aphids were not affected at 126 days and were not tested again.

In 1961 the materials judged most effective during the previous 3 seasons were tested on Brussels sprouts, broccoli, and rutabagas. All the treatments (Table 3) reduced ($P = .01$) the number of cabbage aphids for at least 6 weeks. Considering green peach aphids, the numbers were reduced to a highly significant degree by dimethoate for 6 weeks, by diazinon and by Phosdrin for 4 weeks after spraying, and by Di-Syston for 17 weeks or 119 days after the granules were applied. All the treatments

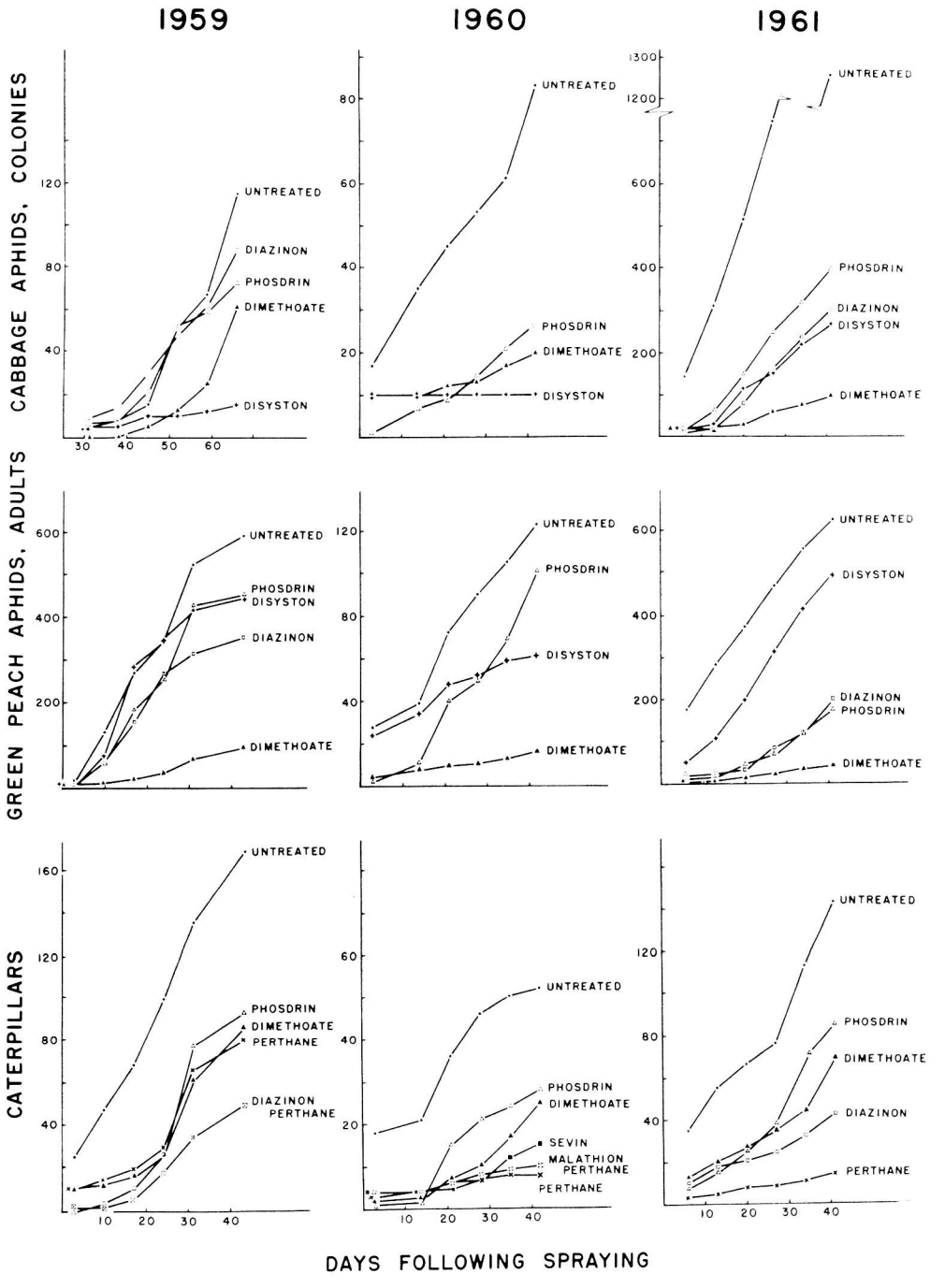

Fig. 1—Cumulative total numbers of brassica pests showing the comparative rates of reinfestation for 6 weeks following application of sprays.

TABLE 3.—Percentage control of brassica pests from single applications* of insecticides to Brussels sprouts, broccoli, and rutabagas, based on 6 weekly counts, 5 Sept.-10 Oct., 1961, at Vancouver, B.C.

Treatment	Active material per acre, lb.	Cabbage aphids	Green Peach aphids	Caterpillars
Diazinon 25% EC	1	80	79	70
Dimethoate 46% SC	1	94	96	44
Di-Syston 5 G with Perthane 45 EC	1 1	82	49	90
Phosdrin WS	0.5	73	82	35

* Di-Syston was applied with the seed 17 May. Other materials applied 30 August.

significantly reduced the numbers of caterpillars for 2 weeks, with further highly significant reductions during the 5th week with Diazinon, dimethoate and Perthane.

In the check plots there were fewer cabbage aphids (P = .001) in broccoli than in Brussels sprouts or rutabagas, but fewer green peach aphids (P = .10) in Brussels sprouts. The caterpillars were uniformly distributed.

Summary

Thirteen insecticides were tested during 1959, 1960, and 1961 for control of low to medium populations of cabbage aphids (*Brevicoryne brassicae* (L.)), green peach aphids (*Myzus persicae* (Sulz.)), diamondback moth larvae (*Plutella maculipennis* (Curt.)), and imported cabbageworms (*Pieris rapae* (L.)). The results are based on weekly appraisals, following single applications of the insecticides to Brussels sprouts. Alone or in combinations the spray materials were: DDT, derris, diazinon, dimethoate, Ekatin-M, Larvatrol, malathion, Perthane, Phosdrin, Phosphamidon, Sevin and Thiodan. Di-Syston granules were applied in the soil or with the seed. The best all-around control was achieved with Dimethoate, Diazinon, Di-Syston plus Perthane, and Phosdrin. Di-Syston was found to kill cabbage aphids up to 126 days, although it could not be detected by chemical means 102 days after application. Applied in the seed furrow it reduced emergence by up to 68 per cent, and caused stunting.

TABLE 4.—Surviving aphids out of 40 caged for 3 days on 9 cm. discs cut from middle leaves of Brussels sprouts plants, treated with Di-Syston, 1959, Vancouver, B.C.

Active material per acre, lb.	Days following treatment: Cabbage aphids			Green peach aphids
	126	137	144	126
2	3	6	26	35
1	19	10	22	25
Control	30	9	16	36

Acknowledgments

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Reference

Forbes, A. R., and H. R. MacCarthy. Control of aphids and caterpillars on Brussels sprouts in British Columbia. Proc. Entomol. Soc. Brit. Columbia 56: 33-39. 1959.