EFFICACY OF INSECTICIDES AGAINST TUBER FLEA BEETLES, WIREWORMS AND APHIDS IN POTATOES

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ABSTRACT

Soil-incorporated and foliar-applied insecticides, alone and in combination, were tested in silt loam to control tuber flea beetle, *Epitrix tuberis* Gent., the green peach aphid, *Myzus persicae* (Sulz.) and the wireworm *Agriotes obscurus* (L.) Most soil-incorporated band treatments did not give adequate protection from tuber flea beetles. However, supplemental foliar applications, July 15 and 30 and August 15, reduced the percentage unmarketable tubers to 13% under a heavy infestation in 1977 and to 0% in a lighter infestation in 1978. Fonofos, broadcast and soil-incorporated, gave the best control of wireworms and of a light infestation of tuber flea beetles. Methamidophos was the best aphicide.

INTRODUCTION

Carbaryl, a carbamate, and endosulfon, a chlorinated hydrocarbon, are the only insecticides registered for the control of the tuber flea beetle, *Epitrix tuberis* Gent., in British Columbia. When used against light infestations these two insecticides give acceptable control, but they do not prevent damage to tubers in moderate and heavy infestations. Field experiments with both organophosphorous and carbamate insecticides, applied in band or broadcast with three supplemental foliar sprays to prevent damage by larvae of second and third generation flea beetles, showed that both carbofuran and fensulfothion gave excellent protection (Finlayson *et al.* 1972). Carbaryl was ineffective against the heavy infestations in these experiments.

Subsequent experiments (Campbell and Finlayson 1976) showed that carbofuran was the best insecticide for protecting potatoes against tuber flea beetle larvae, permethrin was excellent against tuber flea beetles and methamidophos was the best against aphids (mainly green peach aphid, *Myzus persicae* (Sulz.)). None was satisfactory against both aphids and tuber flea beetles. In their experiment endosulfan allowed 53% unmarketable tubers even though 8 sprays were applied at 10-day intervals throughout the growing season.

Concurrent experiments against the wireworm, *Agriotes obscurus* (L.), showed that potatoes could be protected with fonofos and terbufos (Wilkinson *et al.* 1977). Carbofuran, previously registered and recommended for wireworm control in potatoes, was removed from the Vegetable Production Guide of British Columbia because of its inability to protect potatoes against wireworms in alkaline soil (Wilkinson *et al.* 1977). Carbofuran 10G formulation was subsequently withdrawn from the market in British Columbia by the manufacturer, F.M.C. of Canada Ltd., following misapplication of the formulation which resulted in a serious duck-kill in 1975.

This paper reports experiments conducted in 1977 and 1978 to compare methods developed for wireworm control and to determine their effectiveness in a control program against aphids and tuber flea beetles.

MATERIALS AND METHODS

At Agassiz, in a silt loam, single-row plots, 10 m long, were randomized within blocks. In 1977 there were 12 blocks with 1 untreated and 9 treated plots; in 1978 there were 8 blocks with 1 untreated and 7 treated plots. Plots were spaced 1 m apart in 1977 and 90 cm in 1978. There were 2 m between blocks. Granules of aldicarb, carbofuran 5G, CGA 12223 (*O,O*-diethyl *O* [1-isopropyl-5-chloro-1,2,4-triazolyl-(3)] phosphorothioate), chlorfenvinphos, ethoprophos (Mocap®), fensulfothion, fonofos, isofenphos, permethrin and terbufos were applied as 30-cm band treatments at 2 g a.i./10 m row; fonofos was also applied at 2 g a.i./10 m in the furrow and broadcast at 5 kg a.i./ha. The band and broadcast application were incorporated to 10 cm by rototilling. Potatoes, cv. Netted Gem, were planted at approximately 30-cm spacing in the middle of the treated area immediately after incorporation of the insecticides. The potatoes were sprayed at two-week intervals starting in mid July to control second and third generation tuber flea beetle and to contain populations of aphids. In 1977 3 blocks were sprayed with carbofuran at 0.5 kg a.i. in 1100 liters of water/ha/application, 3 with methamidophos at the same rate, 3 with permethrin at 0.2 kg a.i./ha and 3 were left unsprayed. In 1978 2 blocks were sprayed with each of the 3 insecticides and 2 were left unsprayed. The plots were treated pre-emerge with the herbicide metribuzin at 1.12 kg a.i./ha and top-killed in early September with diquat at 1.12 kg a.i./ha.

Efficacy of the treatments was determined

by counting the aphids (1978 only) on an upper and lower compound leaf from each of 5 plants/plot at 2-week intervals. Tuber flea beetle and wireworm (1978 only) damage was assessed from 50 tubers taken at harvest from each of the 120 plots in 1977 and 64 in 1978. The tubers were washed and peeled and the numbers of tuber flea beetle larval tunnels and wireworm feeding-holes/tuber recorded. Tubers were graded for larval tunnels: 0, 1-4, 5-9, 10-14, 15-19, and 20 plus. Tubers with 10 or more tunnels were deemed unmarketable. Tubers with one or more wireworm holes were considered unmarketable.

Statistical significance was determined by analysis of variance. The treatment averages were ranked and compared by Duncan's multiple range test (Duncan 1955).

RESULTS AND DISCUSSION

Aphid populations were held to low numbers when aldicarb was applied as a band treatment averaging 2 aphids/plot. When permethrin, and to a lesser degree carbofuran, were added as supplementary foliar sprays to aldicarb-treated plots the numbers of aphids increased to 64 and 18 respectively. Untreated plots averaged 41 aphids/plot whereas those sprayed with carbofuran or permethrin averaged 96 and 271 aphids respectively. Average numbers of aphids for untreated and soil-treated plots ranged from 2 (aldicarb) to 41 (untreated) and averaged 22 aphids. When the 3 supplementary foliar sprays were applied the ranges and averages were: carbofuran, 18 (aldicarb) to 117 (fonofos), average 73; permethrin, 64 (aldicarb) to 278 (chlorfenvinphos), average 183. The three supplementary sprays with methamidophos controlled the aphid population, counts ranged from 0 to 6 aphids/plot with an average of 3. Since unsprayed plots averaged only 22 aphids it appears that the numbers of parasites and predators had been reduced by both carbofuran and permethrin sprays and possibly even when sprays of methamidophos were applied.

In 1977 (Table 1) soil-incorporated insecticide treatments alone did not prevent damage to tubers by larvae of tuber flea beetle. Unmarketable tubers ranged from 37% (terbofos band treatment) to 100% (untreated). When three foliar sprays were applied the percentage unmarketable tubers was lowered to 13% with carbofuran and 17% with permethrin. Plots receiving only sprays with carbofuran or permethrin to control only the second and third generations of beetles had 95 and 85% unmarketable tubers. Methamidophos was not so effective as carbofuran and permethrin sprays

TABLE 1. Percentage of unmarketable potatoes[1] after various soil-incorporated and foliar-applied insecticides to prevent damage by tuber flea beetle larvae, Agassiz, 1977.

Soil applications	Foliar applications			
	Carbofuran	Methamidophos	Permethrin	Untreated
Carbofuran, band	29 bcd	54 bcde	29 de	72 b
CGA 12223, band	55 bc	84 b	62 abc	83 b
Fonofos, band	35 bcd	65 bcd	31 cde	63 bc
Fonofos, broadcast	23 d	38 de	20 e	66 bc
Fonofos, furrow	51 bc	67 bcd	62 abc	73 b
Isofenphos, band	26 cd	51 cde	45 bcde	55 cde
Mocap, band	35 bcd	59 bcd	55 abcd	67 bc
Permethrin, band	61 b	82 bc	67 ab	83 b
Terbufos, band	13 d	22 e	17 e	37 c
Untreated	95 a	97 a	85 a	100 a
Average	42.1 a	61.9 a	47.4 b	69.8 a

[1]Means in columns followed by the same letter are not significantly different (P = 0.05). Averages of foliar applications were compared independently.

TABLE 2. Percentage of unmarketable potatoes[1] after various soil-incorporated and foliar-applied insecticides to prevent damage by tuber flea beetle larvae, Agassiz, 1978.

Soil applications	Foliar applications			
	Carbofuran	Methamidophos	Permethrin	Untreated
Aldicarb, band	6 bc	12 bc	3 b	93 ab
Chlorfenvinphos, band	12 b	19 ab	29 a	78 b
Fensulfothion, band	0 e	9 bc	6 b	76 b
Fonofos, band	2 c	6 c	1 c	31 c
Fonofos, broadcast	1 d	1 d	1 c	13 d
Isofenphos, band	0 e	10 c	1 c	42 c
Terbufos, band	3 c	5 c	4 b	38 c
Untreated	29 a	33 a	21 a	95 a
Average	6.6 c	11.9 b	8.3 c	58.3 a

[1]Means in columns followed by the same letter are not significantly different (P = 0.05). Averages of foliar applications were compared independently.

TABLE 3. Percentage unmarketable potatoes by wireworms after application of soil-incorporated insecticides at Agassiz, 1978.

Insecticide and method of application	Unmarketable tubers[1] (%)
Aldicarb, band	54.8 ab
Fensulfothion, band	40.0 bc
Chlorfenvinphos, band	61.3 a
Fonofos, band	27.0 cd
Fonofos, broadcast	16.3 d
Isofenphos, band	32.0 cd
Terbufos, band	26.5 cd
Untreated	67.5 a

[1]Means followed by the same letter are not significantly different (P = 0.05).

for preventing damage by second and third instar larvae.

In 1978 (Table 2) *E. tuberis* larval damage to tubers was not so severe as in 1977. Untreated plots had 95% unmarketable tubers, but three sprays for second and third generation control reduced damage to less than 33%. Both the 1977 and 1978 results show the need to control the first generation beetles. Fonofos broadcast and soil-incorporated allowed 4% unmarketable tubers. This was reduced to 1% unmarketable tubers by 3 applications of any of the foliar treatments. Soil-incorporated band treatments with the exception of chlorfenvinphos followed by the 3 sprays all produced acceptable control ranging from 88 to 100% marketable tubers. Again carbofuran and permethrin were equally effective and both significantly better than methamidophos.

Although aldicarb applied as a band treatment gave satisfactory control of aphids by systemic action, its contact activity did not prevent wireworm damage (Table 3). Of the soil-incorporated treatments, only the fonofos broadcast treatment with 16% unmarketable tubers, and possibly band treatments with fonofos (25% unmarketable tubers), isofenphos (32% unmarketable) and terbufos (27% unmarketable) can be considered as possible condidate materials for preventing damage to potatoes by *A. obscurus*.

In summary, *aldicarb* is an excellent Systemic aphicide, but appears to lack sufficient effectiveness against wireworms and possibly tuber flea beetle even when foliar sprays are applied against second and third generation beetles. *Fonofos* broadcast was the most effective soil-incorporated insecticide but even it allowed 16% damage by wireworm. *Carbofuran* and *permethrin* were the most effective sprays against flea beetles, but aphid populations increased when these insecticides were applied. *Methamidophos* was the best aphicide and against a low level infestation of tuber flea beetle good protection was afforded. However, under a high level of infestation (1977) the percentage of unmarketable tubers from methamidophos sprayed plots was not significantly different from that of plots which had no foliar applications.

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The recent death of Colin Curtis marks the passing of one of British Columbia's early authorities on biting insects which affect man, livestock and wildlife.

Formerly a science teacher and a director of audio-visual education in Victoria, Mr. Curtis was employed at the Federal Department of Agriculture, "Mission Flats" laboratory at Kamloops, from 1948 until his retirement in 1969. During this period he was engaged in various phases of life-history, identification and control studies involving blackflies, no-see-ums, snipeflies and mosquitoes, as well as spiders. Among his publications are several pertaining to mosquito control and a Monograph on the Mosquitoes of British Columbia published by the Provincial Museum.

Mr. Curtis was also widely known among Ham Radio operators, with whom he kept in regular touch until his recent illness, and, in addition, maintained a knowledgeable interest in early B.C. steamship and railway history.

His wife Audrey, two sons and four grandchildren are left to mourn.