INSECTICIDES AGAINST TUBER FLEA BEETLE ON POTATOES IN BRITISH COLUMBIA (CHRYSOMELIDAE: COLEOPTERA)

D. G. FINLAYSON, M. J. BROWN, C. J. CAMPBELL, A. T. S. WILKINSON AND I. H. WILLIAMS[1]

ABSTRACT

To protect potatoes from damage by larvae of the tuber flea beetle, **Epitrix tuberis** Gent., in silt and sandy clay loam soils, carbofuran (Furadan) fensulfothion (Dasanit), and fonofos (Dyfonate) were applied as 12-inch band or broadcast treatments, rotovated to a depth of 4 inches and rows of potatoes planted in the treated areas. Three supplementary drenches were applied at about 2-week intervals to include the emergence period of the second generation adults. In silt loam the untreated and fonofos band-treated plots produced 31 and 40% marketable tubers, respectively, against 92 to 100% for the other treatments. In sandy loam the comparable figures were 0.5 and 4.5% against 10 to 97%. Residues in the tubers ranged from none detected in fonofos treatments to 0.23 ppm of fensufothion and its sulfone in potatoes from the band treatment.

INTRODUCTION

The tuber flea beetle, *Epitrix tuberis* Gent. (Fig. 1C), was present in the lower Fraser Valley by 1940 (Glendenning, 1945) and in the southern interior by 1944 (Neilson and Finlayson, 1953). It became well established and its spread to other potato areas is recorded (Fulton and Banham, 1960). The adults feed on the leaves (Fig. 1B) and the larvae on the tubers (Fig. 1A). Damage by this pest does not cause a reduction in yield, but it reduces the number of marketable tubers.

Early experiments with foliar applications reduced the adult populations and resulted in decreased oviposition (Finlayson and Neilson, 1954). This method was replaced by soil incorporation of persistent cyclodiene organochlorines (Banham, 1960). In coastal British Columbia where late blight and aphids are additional problems, a combined foliar application of a fungicide and an insecticide also controlled the beetles.

In 1964 aldrin and dieldrin failed to prevent larval damage in the Salmon River Valley near Vernon. Experiments in the laboratory showed that the flea beetles were resistant to DDT and dieldrin both there and at Lavington, and to DDT as far north as Pavilion. However, they remained highly susceptible to diazinon and presumably to other organophosphorus compounds (Banham and Finlayson, 1967). By 1970, nearly all organochlorine insecticides had been removed by legislation from agricultural use in British Columbia.

By 1968 Banham (1965, '67, '68) had demonstrated conclusively that none of the organophosphorus or carbamate insecticides investigated could produce more than 50% marketable tubers by single or split applications applied in the soil. In contrast Wilkinson (1968, '69) found that both fonofos (Dyfonate) and carbofuran (Furadan) would protect potatoes from wireworm damage in peat soil. Concurrently Finlayson (1968) had shown that fensulfothion (Dasanit) and carbofuran although excellent soil insectcides, lacked the persistence necessary to protect root crops from the damaging second and third generation of soil insects.

In 1971 the recommendation for tuber flea beetle control was carbaryl (Sevin) in the interior and endosulfan (Thiodan) at the coast, applied as spray or dust at approximately 1 lb / acre / application at 10-day intervals until harvest. The recommendation for wireworms was fonofos or carbofuran, but conflicting reports of failures of carbofuran in some soils in the interior of British Columbia placed doubt on its efficacy. With these problems in mind experiments were designed to investigate the rates, methods and persistence of these compounds for potato growing.

MATERIALS AND METHODS

In sandy clay loam at Kelowna and in silt loam at Vernon, granular fensulfothion, fonofos and carbofuran were applied to the soil

[1]Research Branch, Canada Agriculture, 6660 N.W. Marine Drive, Vancouver 8, B.C.

surface at 0.66 lb toxicant per acre in a 12-inch band, and at 5 lb toxicant per acre broadcast. The insecticides were rotovated immediately after application to a depth of 4 to 5 inches and seed potatoes of Foundation grade were sown at 1-foot intervals by hand in the treated areas in rows 3 feet apart. Each location included 32 plots consisting of a broadcast and a band treatment for each of the 3 compounds; 1 plot treated with carbaryl (Sevin), the currently recommended treatment; and an untreated plot; all in 4 replications. A plot consisted of 4 rows 25 feet long.

In addition to the granular applications the broadcast and band-treated plots received 3 supplementary sprays at 1 lb toxicant/acre/application in 100 gal water to wet the plants and the soil about the base of the plant to reduce the population of adults and thus oviposition. The sprays were applied at about 2-week intervals starting in mid-July to coincide with the emergence of second-generation adults. Carbaryl was applied at 1 lb toxicant acre application in 100 gal water when approximately 75% of the plants had emerged and was repeated 9 times at 10-day intervals until 10 days before harvest.

At harvest 100 marketable tubers with a minimum diameter of 1.5 inch, were dug at random from the 2 central rows of each plot. A sub-sample of 50 tubers from each plot was peeled, and the flea beetle damage was assessed by counting the number of larval tunnels. The damage was grouped in 6 categories: 0 larval tunnels; 1 to 4; 5 to 9; 10 to 14; 15 to 19; and 20 or more. Tubers having less than 10 larval tunnels were considered marketable (Banham, 1960). The data were examined by analysis of variance and the results compared by Duncan's multiple range test (Duncan, 1955).

For residue analysis, 10 tubers from each replicate were quartered longitudinally and one quarter from each tuber was put into a plastic bag and frozen. The frozen samples were later macerated in a Waring Blendor, pooled by

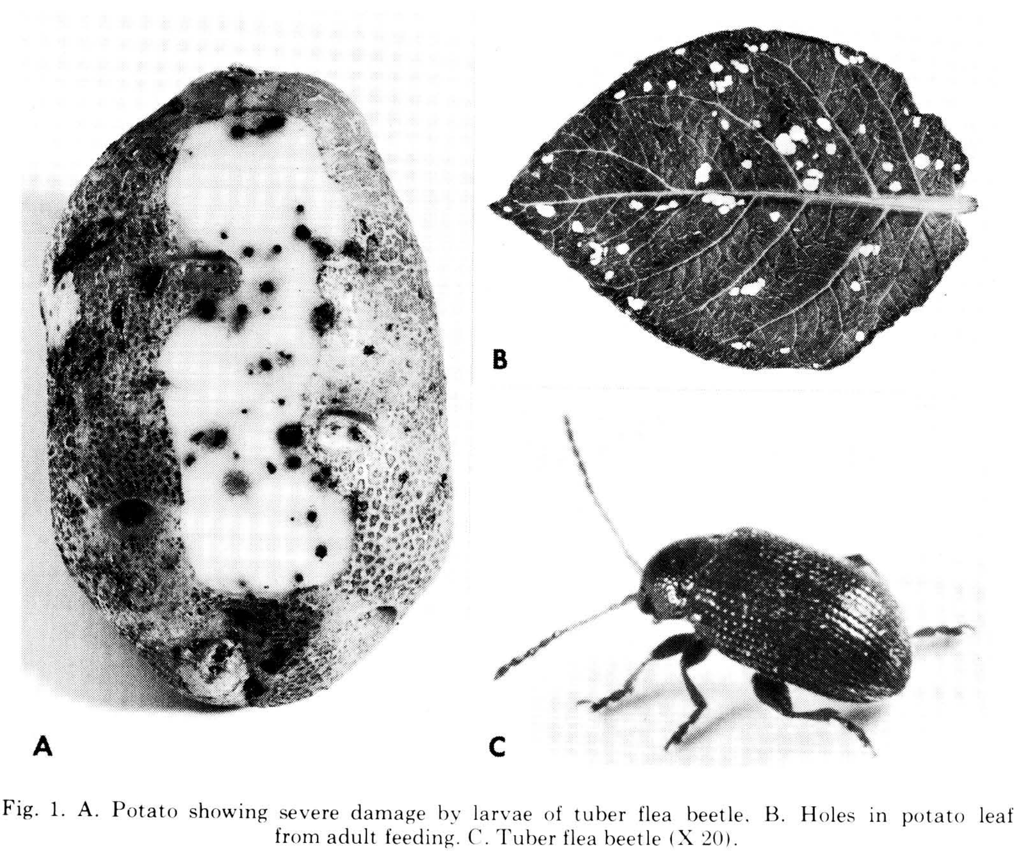

Fig. 1. A. Potato showing severe damage by larvae of tuber flea beetle. B. Holes in potato leaf from adult feeding. C. Tuber flea beetle (X 20).

treatments, mixed thoroughly and held in refrigeration during completion of the analysis. Sub-samples of the various treatments were analysed as follows:

fensulfothion. Determined by the method for carrots of Williams *et al.* (1971) but the second cleanup column containing Norit A and Celite was eliminated. Recovery from fortified potatoes at the 0.2 ppm level was: fensulfothion, 102% and its sulfone 90%.

fonofos. Determined by the same procedure as for fensulfothion except that a 180 cm gas chromatographic column was used instead of the 80 cm one used for fensulfothion. Using this procedure fonofos was eluted in Fraction 1 and its oxygen analog in Fraction 2. Recovery from fortified potatoes at the 0.5 ppm level was fonofos 106% and its oxygen analog 93%.

carbofuran. Determined by a modification of the method for corn stover described by Cook *et al.* (1969). Modifications included substitution of alumina for Nuchar-Attaclay and silica-gel in the cleanup column, and the use of a Coulson conductivity detector instead of a microcoulometric detector. Recovery from fortified potatoes at the 0.1 ppm level was: carbofuran, 81% and 3-hydroxycarbofuran, 90%.

RESULTS AND DISCUSSION

The average population of second-generation adult flea beetles in mid-July was 10 times higher at Kelowna than at Vernon. Foliage feeding and adult beetles were readily seen in the Kelowna plots and tubers from volunteer plants were badly damaged.

Table 1 shows the results of examination of the tubers.

From the table it is clear that 9 applications with carbaryl did not prevent damage under a severe infestation. It was evident also that

TABLE I. Potatoes[1] in each damage category and percentage marketable after various treatments against tuber flea beetles in British Columbia, 1971.

Treatment	Larval tunnels per potato						%
	0	1-4	5-9	10-14	15-19	20+	marketable[2]
Kelowna							
fensulfothion band	74	83	33	6	3	1	95.0 a
" broadcast	108	60	22	8	0	2	95.0 a
fonofos band	0	5	4	12	12	167	4.5 de
" broadcast	27	30	27	19	19	78	42.0 c
carbofuran band	42	58	39	23	19	19	69.5 b
" broadcast	99	75	20	3	2	1	97.0 a
carbaryl	0	12	8	14	14	152	10.0 d
Untreated	0	0	1	3	4	192	0.5 e
Vernon							
fensulfothion band	102	77	17	3	1	0	98.0 a
" broadcast	160	40	0	0	0	0	100.0 a
fonofos band	33	31	15	17	10	94	39.5 b
" broadcast	111	54	19	7	6	3	92.0 a
carbofuran band	100	67	26	4	1	2	96.5 a
" broadcast	160	36	4	0	0	0	100.0 a
carbaryl	147	44	5	3	0	1	98.0 a
Untreated	7	22	33	22	19	97	31.0 b

[1] Fifty tubers, minimum diameter 1.5 inches, from each of 4 replicates, total 200.
[2] Percentages followed by the same letter are not significantly different at the 5% level.

under heavy infestations treatments with fonofos were unable to prevent damage. Even under light attack at Vernon protection given by fonofos was inferior to that given by fensulfothion and carbofuran.

Band treatments had much lighter applications per unit area than broadcast treatments, and they did not give good protection in all cases.

The results of the residue analyses are shown in Table 2. The treatments which afforded the least protection also had the lowest residues. There was no residue of fonofos in the tubers at harvest.

Potatoes from untreated plots, especially at Kelowna, contained both carbofuran and its 3-OH metabolite. Analysis of potatoes from the fensulfothion-treated plots also showed that there was a trace of carbofuran and its 3-OH metabolite present in the samples from Kelowna but little or none in those from Vernon. The explanation appears to lie with weather, irrigation, and the solubility of carbofuran. Rainfall at the Kelowna site was approximately 2 inches in the week preceding application, 0.4 inches immediately after and 4.5 inches in June. At Vernon the rainfall was about 30% lower. The rainfall, irrigation, and the topography of the land allowed large areas of the Kelowna site to be inundated for several hours at a time. Although the water solubility of carbofuran is only 700 ppm at 25° C it appears that the residues in the untreated potatoes may have resulted from its systemic properties and the flooding described.

TABLE II. Residues in ppm in potatoes after various treatments against tuber flea beetles in British Columbia, 1971.

Insecticides	Kelowna Band	Kelowna Broadcast	Kelowna Untreated	Vernon Band	Vernon Broadcast	Vernon Untreated
fensulfothion	0.09	0.08	T	0.04	0.09	T
fens. sulfone	0.14	0.10	ND	0.03	0.06	ND
fonofos	T	T	ND	ND	T	ND
fono. O-analog	ND	ND	ND	ND	ND	ND
carbofuran	ND	0.05	0.03	ND	0.03	<0.02
3-hydroxy carb.	0.06	0.15	0.07	0.04	0.07	<0.02

ND = None detected

T = Trace

The cost per acre of the two compounds which afforded protection were:

	fensulfothion	*carbofuran*
Broadcast + sprays	$46.90	$49.20
Band + sprays	$20.20	$22.75

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