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Field Evaluation of Insecticides for Suppression of Potato Leafhopper (Homoptera: Cicadellidae) on Peanuts in Ontario[1]

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ABSTRACT

Acephate, carbaryl, cypermethrin, fenvalerate, permethrin and methidathion applied as foliar sprays were evaluated in the field for crop protection against the potato leafhopper, *Empoasca fabae* (Harris), infesting valencia peanuts, *Arachis hypogaea* L., in Ontario. All of the insecticides significantly suppressed nymphal populations and the results obtained were consistent over the 3 years. The residual toxicity of each material at the rates applied was discussed. Sampling data demonstrated that monitoring of nymphs can be used successfully to schedule insecticidal sprays for control of this pest on peanuts grown commercially in Ontario.

Key Words: Potato leafhopper, *Empoasca fabae* (Harris), valencia peanuts, *Arachis hypogaea* L., insecticides, residual toxicity of insecticides.

After ten years of studies on the agronomic aspects of peanut culture in southern Ontario, Canada, the peanut crop has been moved from field plot tests to a commercial reality since 1980 (14,15,16). As with any new crop, some insect problems do occur. Identification of the insect pests and effective control measures are one of the major objectives for successful commercial production.

The potato leafhopper, *Empoasca fabae* (Harris), is the most common, serious and widespread pest of several important crops, such as beans, potatoes, alfalfa, and clover in North America (4,5,8,11). Chemical control of this insect is known to play an important role on yield and quality of these crops. In the United States, the potato leafhopper has also been described as an economically important pest of peanuts (2,10,13) and chemicals have been registered to control this pest (1,2,10,12). In Ontario, observations on peanuts over a 10-year period have shown that the potato leafhopper is the most consistent and economically important insect pest (3,6,7). Ellis (7) demonstrated that the potato leafhopper infestation on peanuts in Ontario had significant effects on peanut plant growth and yield. In order to recommend appropriate protection practices from this pest, there is an urgent need for field evaluation of insecticides for obtaining efficacy data to support the Canadian registration of effective chemicals against this insect. Investigations reported here are field studies on the chemical control of the potato leafhoppers on peanuts in Ontario over the 3-year period from 1980 to 1982.

Materials and Methods

Experiments were conducted on a fox loamy sand soil in 1980 at the Research Station, Agriculture Canada, Delhi, Ontario, and in 1981 and 1982 on a farm adjacent to the Delhi Research Station. Seeds of McRan, a valencia type peanut cultivar, were planted at a rate of 13 viable seeds/m in mid May of each year. Normal cultural practices were followed during the entire growing season.

Plots were 12 x 4.8 m in 1980 and 7 x 4.8 m in 1981 and 1982. A randomized complete block design with four replications was used. Each plot consisted of eight rows of peanuts with 60 cm between the rows, the outside two rows in each plot being guard rows to minimize possible interaction between treatments by spray drift.

Insecticides tested were acephate, carbaryl, cypermethrin, fenvalerate, methidathion, and permethrin. Carbaryl was included in the tests as a standard insecticide because it has a broad-spectrum insecticidal activity and has been registered and recommended for control of potato leafhoppers on potatoes for many years. Treatments were applied after nymphs of the potato leafhopper were found on the peanut plants, which were sampled periodically from the experimental plots. The first application of the insecticides was made in the beginning of July each year when the peanut plants were 14-18 cm across and 15-20 cm high. A CO_2 powered plot sprayer equipped with 80-04 Tee Jet nozzles delivering 220 L/ha at a pressure of 172 kPa was employed. In plots receiving the second application, the insecticides were applied in early August each year, depending upon nymphal populations assessed periodically by counting the number of nymphs on 5 peanut plants collected at random in the plots. Since the plants were lapping the centres of 60 cm row widths, the spray pressure was increased from 172 to 240 kPa in order to penetrate the thick foliage of the peanut plants.

Relative effectiveness of the treatments was evaluated by counting the number of living nymphs on 5 plants collected at random in each plot two days before treatment and at different dates after treatment. Nymphs were counted by taking the plants to the laboratory and examining them leaf by leaf under a Luxo Lamp magnifier. Nymphal counts in these tests were more reliable indicators of the population changes because nymphs are not as mobile as adults. Before analysis

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of variance, the numbers of living nymphs found per five plants were transformed to X + 0.5 as suggested by LeClerg *et al.* (9). An analysis of variance was used on all data and Duncan's multiple range test was used to test for significant differences between treatment means. Mean values were converted to original units for tabulation.

Changes of the nymphal populations during the entire growing season were monitored. Peanut plant samples were collected twice weekly from the untreated plots and once weekly from the treated plots from late June to early September each year. The nymphal counts for each year were treated separately to compare the peak activity of the potato leafhoppers, and the time period before the nymphal populations re-established in the treated plots from one year to another. Data on the graphs are based on the mean number of nymphs per five plants at the date of sampling.

Results and Discussion

Slight injury symptoms, "hopperburn", were observed in all plots prior to application of the insecticides in early July each year. The pretreatment plot means for living nymphs were analyzed by one-way analysis of variance. Although the nymphal counts before treatment varied slightly with the plot, there were no overall significant differences among the plots within the year during the period of study (Table 1).

Table 1 summarizes field evaluations of insecticides for potato leafhopper control. All materials tested significantly reduced the numbers of living nymphs as compared with the untreated check for 19 days after treatment. Thereafter, all insecticides except acephate lost most of their toxicity and showed inadequate residual control of the potato leafhopper at 26 days post-treatment. At 47 days, the marked reinfestation in all the treated plots suggested that none of the insecticides provided any residual control of the later reinfestation of potato leafhoppers.

Comparisons of the effectiveness among the tested materials showed that all insecticides were similar in degrees of effectiveness for 12 days in 1980 and 19 days in 1981 and 1982 after treatment at the rates applied (Table 1). Afterwards, the residual toxicity of acephate at 1120 g AI/ha fell into the first group in reducing nymphal populations according to Duncan's multiple range test. The pyrethroid insecticides, fenvalerate, cypermethrin, and permethrin, were as effective as the standard insecticide, carbaryl. Methidathion at 280 g AI/ha appeared to be the least persistent material in the 1980 experiment; thus methidathion was omitted in 1981 and 1982 experiments.

Table 2 compares the effects of single and double insecticide applications on the population density of potato leafhopper nymphs. The initial and residual toxicities of single or double applications of the insecticides tested over the 3-year period behaved in a man-

Table 1. Efficacy of insecticides as foliar sprays for control of potato leafhopper on valencia peanuts in Ontario, Canada, 1980 - 1982.

Treatment	Rate (g AI/ha)	Mean number of living potato leafhopper nymphs per 5 plants						
		Pretreatment	Days post treatment					
			5	12	19	26	33	47
			1980					
Acephate	1120	12.2†	0.0 a*	0.2 a	0.4 a	10.8 a	27.6 a	28.9†
Carbaryl	1680	18.7	0.0 a	0.8 a	2.6 ab	22.7 b	56.2 b	35.6
Fenvalerate	50	14.2	0.0 a	1.0 a	3.2 ab	19.5 ab	39.8 ab	36.9
Methidathion	280	10.7	0.2 a	4.8 a	8.7 b	28.3 bc	53.5 b	36.8
Untreated check	--	9.8	15.6 b	21.4 b	25.7 c	33.5 c	57.6 b	46.7
			1981					
Acephate	1120	15.9	1.1 a	0.0 a	0.2 a	5.4 a	46.6 a	91.1
Carbaryl	1680	16.8	0.6 a	1.9 a	2.7 a	15.3 b	65.3 ab	117.5
Cypermethrin	50	20.0	0.2 a	2.5 a	3.4 a	11.4 ab	63.0 ab	106.2
Fenvalerate	50	21.7	0.4 a	1.8 a	4.2 a	12.2 ab	44.1 a	107.6
Untreated check	--	17.6	40.8 b	63.7 b	34.5 b	23.8 b	77.2 b	98.4
			1982					
Acephate	1120	17.8	0.2 a	0.4 a	3.6 a	9.9 a	23.8 a	67.5
Carbaryl	1680	16.7	0.2 a	1.5 a	5.4 a	25.4 bc	31.9 ab	84.2
Cypermethrin	50	14.8	0.0 a	0.7 a	4.3 a	23.4 bc	37.6 ab	68.5
Fenvalerate	50	14.3	0.0 a	1.3 a	5.6 a	15.7 ab	36.6 ab	75.5
Permethrin	100	16.2	0.0 a	2.3 a	6.7 a	25.8 bc	39.4 ab	67.8
Untreated check	--	13.6	19.1 b	22.6 b	29.7 b	37.5 c	46.5 b	92.7

*Means within the year, followed by the same letter, are not significantly different at 5% level as determined by Duncan's multiple range test.

†F test not significant for these data.

ner similar to that presented in Table 1, and no significant differences in living nymphs between single and double applications were observed over all the counting days post-treatment. Thus only the seasonal values were used in comparisons. Seasonal means of potato leafhopper nymphs in plots receiving two applications, regardless of insecticides tested, were significantly lower than in plots receiving one applications and the untreated check (Table 2). Although nymphs in plots receiving one application were significantly or numerically lower than in the untreated check plots, severe hopperburn was noted in both of those plots. There was little evidence of hopperburn in plots receiving two applications.

Table 2. Seasonal density of potato leafhopper nymphs on valencia peanuts after one and two insecticide applications in Ontario, Canada, 1980 - 1982.

Treatment	Rate (g AI/ha)	No. of application	Seasonal mean of living potato leafhopper nymphs per 5 plants*
		1980	
Acephate	1120	1	80.8 c
		2	12.5 a
Carbaryl	1680	1	130.1 d
		2	25.7 a
Fenvalerate	50	1	121.5 d
		2	24.0 a
Methidathion	280	1	129.6 d
		2	51.1 b
Untreated check	--		220.1 e
		1981	
Acephate	1120	1	302.0 b
		2	21.6 a
Carbaryl	1680	1	389.7 b
		2	48.8 a
Cypermethrin	50	1	314.3 b
		2	45.6 a
Fenvalerate	50	1	333.8 b
		2	54.0 a
Untreated check	--		499.6 b
		1982	
Acephate	1120	1	301.1 c
		2	11.9 a
Carbaryl	1680	1	394.8 c
		2	89.3 b
Cypermethrin	50	1	311.7 c
		2	26.8 a
Fenvalerate	50	1	365.1 c
		2	33.6 a
Permethrin	100	1	394.8 c
		2	40.2 ab
Untreated check	--		552.1 d

*Means within the year, followed by the same letter, are not significantly different at 5% level as determined by Duncan's multiple range test.

Figure 1 shows the seasonal distribution of potato leafhopper nymphs and insecticidal sprays in relation to nymphal activity at the study area near Delhi, Ontario over the 3 years. First nymphs were recorded from the samples collected in late June and were present continuously until mid September each year. Population of the nymphs began to increase in early July in the plots. In general, two peaks of nymphal activity occurred on the crop in the untreated plots. The first peak was observed between July 5 and 20 and was very pronounced in 1981 (Fig. 1). The second peak appeared between August 10 and 25 in 1980 and 1981, and between August 25 and September 10 in 1982, about 15 days later than the two previous years. Ellis and Roy (6) reported that significant populations of nymphs were present every year by early July and severe damage to peanuts became noticeable shortly after the initial appearance of the nymphs.

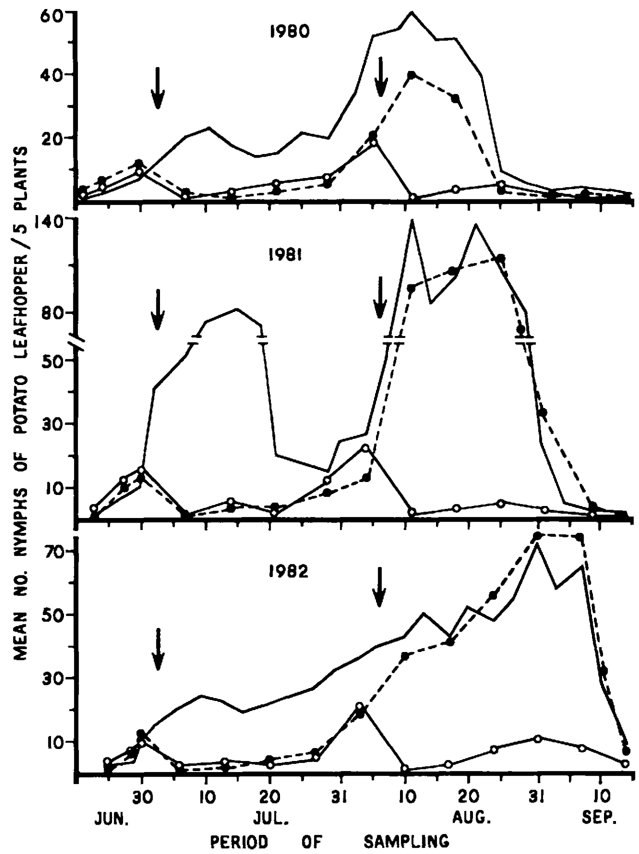

Fig. 1. Seasonal trends of potato leafhopper nymphal populations on valencia peanuts treated with insecticides near Delhi, Ontario, 1980 to 1982. Untreated check (———); one spray (—•— — —• —); two sprays (o———o). Arrows indicate insecticide applications.

The first insecticidal sprays were applied on July 3 when the nymphal populations began to increase in the experimental plots. After application, a great reduction in numbers of nymphs was manifested in all treated plots, and this spray suppressed the nymphal populations until the end of July (Fig. 1). Nymphal populations began to increase again in early August. Plots receiving the second applications were sprayed on August 7 and again the nymphal numbers fell close to zero; thereafter, the populations remained at a low level for the rest of the growing season each year. In contrast, nymphal populations in plots receiving one application increased very rapidly and there were no significant differences in numbers from the untreated check plots after the 10th of August each year. These results would indicate that the second application of insecticides may be desirable.

Results from the field observations in the peanut district of Ontario from 1980 to 1982 along with that of Ellis and Roy (6, 7) clearly show that greater numbers of nymphs and adults occurred from early July to the beginning of September each year. Based upon the series of chemical tests, acephate, fenvalerate, cypermethrin, and permethrin were suitable alternatives to carbaryl for potato leafhopper control on peanuts. Acephate was superior to carbaryl against potato leafhoppers from the standpoint of residual toxicity and results obtained were consistent over the 3 years. No visible phytotoxicity was detected on peanut plants as a result of insecticidal treatments.

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