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RELATIVE EFFICACY OF ETHIOFENCARB G IN DIFFERENT CONDITIONS OF BEAN APHID INFESTATION ON BROADBEAN

Muhammad Zaman and Nasir Shafiq Kawar,

American University of Beirut, Beirut, Lebanon

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In sandy soil where both aphids and plant density were maximum the minimum effective level of ethiofencarb G was 2 Kg a.i./ha against *Aphis fabae* Scopoli but the residual effect was much shorter. The uptake was more pronounced in older (27-week-old) than younger (3-week-old) plants. In the field simulating conditons, where both plant and aphid's density was minimum and the plants were in seedling stage, the lower level (2 kg) was equally effective as the 3 and 4 Kg a.i./ha and remained persistent for over a month. In 1:1 mixture of sand and peat moss the 2 and 3 kg rates, applied 3 days after germination, were not effective while 4 kg demonstrated a more persistent effect (over seven weeks). Ethiofencarb G was not effective against otherpests feeding on bean plants.

INTRODUCTION

Broadbean (*Vicia faba* L.) is an important leguminous crop grown extensively in Lebenon. It is attacked seriously by the bean aphid, *Aphis fabae* Scopoli. The efficacy of ethiofencarb G was, therefore, studied in different conditions of the aphid infestation. The nature of soil influence the fate of soil applied insecticides in terms of their absorption, desorption and movement in soil [3, 1, 2]. The systemic and persistent effect of ethiofencarb G was studied by Hammann and Hoffmann [5] and Homeyer [6]. Drager [4] studied the metabolism of this formulation in soil and water.

MATERIALS AND METHODS

Three different sets of experiments were carried out in 1979 at the Campus of the American University of Beirut, Lebanon, in order to determine the efficacy of ethiofencarb G in different situations of aphid infestation. These were as follows:

Experiment 1. Clay pots, 16 cm dia. and 20 cm. in height, were used and were filled with sandy soil. Each pot contained four plants-two from each planting date, i.e. autumn (Sept. 7, 1978) and spring (Feb. 22, 1979). Natural infestation of old (autumn) plants started in January 1979. Three rates (0.5, 1 and 2 kg a.i./ha) of ethiofencarb G were applied on March 15, 1979 in a cross fashion between plants and watered immediately after incorporation in the soil. The treated pots were lined with plastic to avoid any leaching of the insecticide. Every treatment (including control) was replicated 4 times. Aphid colonies were marked with a white string at the bottom (lower) level and the length and number of internodes of the infested portions were noted as an index of the size of the colony. Pre-and post-treatment countings of aphid colonies (relative density) were carried out at proper intervals (usually 1 day). From the difference (+, −) obtained percentage reduction/increase was worked out and the effect of the three rates was evaluated. Data expressed percentage wise and flooedirrigated again. Broadbean seedlings, sown on analysed by analysis of variance. Means were separated by Duncan's multiple range test.

Experiment 2. A small bed was prepared and flood irrigated several times after ridge preparation to lessen the chance of leaching of the insecticide. Sand was added and floodirrigated again. Broadbean seedlings, sown on Feb. 22, 1979 in pots, were transplanted on March 30, 1979 into this small plot at spacings of 20 cm and 40 cm between plants and rows respectively. Three levels of ethiofencarb G (2, 3, 4 kg a.i./ha) were applied on April 6, 1979 in a semi-circular fashion around the plants and irrigated immediately after incorporation in the soil. Pre-and post-treatment countings of the naturally infested plants were carried out usually at one day intervals. Data expressed in densities (countings) were transformed to log x + 1.5 and then analysed by the analysis of variance. Means were separated by Duncan's multiple range test.

Experiment 3. Tin pots, 16 cm diam and 20 cm in height, were filled with a 1:1 mixture of sand and peat moss. Two seeds were sown on March 23, 1979 in each pot. Three levels of ethiofencarb G (2, 3, 4 Kg a.i./ha)

were applied on April 6, 1979, 3 days after germination, in a cross fashion between the plants and watered immediately after incorporation in the mixture. The treated pots were lined with plastic to avoid any leaching of the insecticide. Every treatment (including control) was replicated 4 times. Aphid populations were artificially supplemented with aphids for confirmation. Observations were carried out at one-day interval after treatment and actual aphid countings (absolute density) were recorded on each plant. Data expressed in countings (densities) were transformed to log x + 1.5 and then analysed by the analysis of variance. Means were separated by Duncan's multiple range test.

RESULTS

Experiment 1. Aphid populations increased upto 7 and 3 days on the older plants treated with 0.5 and 1 kg a.i./ha, respectively, and then declined correspondingly until it approached more than 90% within a few days (Table 1 A). The highest concentration (2 kg) had a more pronounced effect in reducing the aphid population after 3 days onward. Aphids increased upto 3 days on the untreated plants but gradually decreased thereafter. On the younger plants the increase in aphid population remained upto 39 and 10 days treated with 0.5 and 1 kg/ha, respectively, and then declined correspondingly (Table 1 B). Reduction in the highest concentration (2 kg) started 5 days onward and reached more than 90% on the 33rd day. On the untreated plants aphids reproduced normally. Complete reduction on 0.5 kg treated plants after 47 days is attributable to factors other than the insecticidal effect. Treated collectively (old + young) reduction in aphid population is apparent after 10, 6 and 3 days onward on plants treated with 0.5, 1 and 2 kg, respectively (Table 1 C). However, the reduction is more pronounced on plants treated with 2 kg.

These results indicate that the uptake was more pronounced in older plants than the younger plants occurring in the same habitat. A positive correlation between the concentrations and the rate of uptake by the plants is apparent as indicated by the aphid mortality.

The results obtained were significant statistically ($P < 0.05$). Ducan's multiple range test revealed that the highest level had significantly higher reduction of aphids than the two lower rates and no treatment.

Experiment 2. Complete aphid mortality was achieved within 3-6 days on the treated plants (Table 2). On the untreated plants the original aphid population reproduced normally with fluctuations until it reached zero level after 23 days. The total disappearance of aphids in no treatment could be attributed to their migration to other

Table 1. Reduction in bean aphid population following post-infestation application of ethiofencarb G.

	Concentration Kg a.i./ha	Post-treatment percent reduction/increase in days[a]													
		2	3	4	5	6	7	10	14	18	23	28	33	39	47
(A) Old plants	0.5	11.3+	13.8+	8.3	9.3+	10.7+	11.2+	55.6	86.5	92.2	86.9	83.3	89.9	97.5	100
	1	19.9+	5.0+	19.0+	9.9	12.5	23.7	59.3	87.1	94.1	98.2	99.5	99.0	100	
	2	4.0+	36.0	75.0	81.9	86.4	88.2	87.2	97.4	98.8	98.5	97.9	100		
	Untreated	33.3+	12.8+	14.7	8.9	32.8	44.3	87.8	97.2	98.7	99.6	99.3	96.0	93.2	100
(B) New plants	0.5	303+	463+	526+	412+	497+	1401+	704+	82.5+	36.3	19.7+	116+	151+	218+	100
	1	92.0+	168+	113+	221+	209+	150+	109+	15.3	49.2	68.5	18.3	50.6	16.0	23.2
	2	33.1+	13.3+	9.3+	29.3	8.9	9.5	26.9+	25.4	71.7	85.9	81.9	92.8	79.3	89.0
	Untreated	243+	327+	387+	432+	477+	482+	142+	63.3	88.9	25.0+	117+	370+	541+	47.9+
(C) Combined (Old+New)	0.5	15.3+	19.9+	0.4	18.8+	23.2+	28.8+	47.9	84.7	91.8	86.2	85.9	88.2	95.2	100
	1	22.5+	11.8+	12.9	0.5+	2.4	15.5	53.7	84.7	95.1	95.9	96.2	97.3	96.3	97.6
	2	2.1+	33.3	72.3	79.4	82.7	84.5	81.8	93.9	97.4	97.8	97.0	99.6	97.0	99.5
	Untreated	6.3+	9.1	28.3	23.7	39.6	47.0	87.3	97.2	98.9	97.9	96.4	90.5	84.0	97.9

a = Each column figures are the mean of 4 replications

+ = Indicates increase.

Table 2. Density of mature and immature forms of bean aphid following application of ethiofencarb G in field simulating conditions

Kg a.i./ha	Pre-treatment mean aphid density/plant	Post-treatment mean aphid densities/plant in days[a]											
		1	2	3	4	5	6	7	8	9	10	11	12
2	40.3	(8.8)[b]	(0.8)	(0) 0.2	0.2	0	0.1	0	0	0.1	0	0	4.3
3	44.3	(10.0)	(3.0)	(2.2) 0.2	(1.3) 0	(0.7) 0.5	0	0.3	0	0.1	0	0	0.3
4	47.2	(8.7)	(1.8)	(0.4) 0.2	(0.2) 0.2	(0.1) 0	0.2	0	0	0	0	0.2	4.7
Untreated	45.6	47.1	51.7	73.6	71.8	67.5	60.3	72.6	70.1	64.6	61.2	70.7	62.6
	Continued	13	14	15	16	17	18	19	20	21	22	23	24
2		3.3	2.2	2.0	1.4	1.6	1.4	2.5	0.5	1.1	2.7	2.7	3.8
3		4.8	2.7	0.4	1.4	1.1	1.2	0.7	0	0.5	0.8	0.1	0
4		3.2	0.7	0.3	0.6	0.9	0.9	0.1	0.4	0.8	0.1	0	0
Untreated		49.0	45.1	45.8	56.8	34.3	17.9	10.7	10.7	7.4	0.8	0	0.1
	Continued	25	26	28	29	30	31	32	33	34	35	36	37
2		4.0	4.0	1.3	1.3	0.4	0.7	0.2	0.8	0.1	1.1	1.5	0
3		2.0	0.7	0.2	0.9	0.5	2.0	0.7	0.3	0.8	0.7	0.3	0
4		0.8	1.2	0	0	0.1	0.2	0	0	0	0	0	0
Untreated		1.2	0.1	0.6	0	1.1	0	0	0	0	0	0	0

a = Each column figures are the mean density of aphids on 12 plants.
b = Figures in parenthesis indicate the original population after treatment.
N.B. No aphids were observed in any treatment 37 days onward.

host plants since the bean plants were excessively damaged by aphid's feeding and rendered unsuitable for them.

After complete or maximum suppression of the aphids (primary infestation), winged forms (migrants) that visited the treated plants were recorded daily. Immature forms were also recorded. These visiting aphids (and immature forms) were more clearly evident from the 12th day onward and their densities ranged from 0.1 to 4.8 per plant during the season with fluctuations but they failed to establish on the treated plants. It could, therefore, be concluded that the 3 rates not only worked as an eradicant but also protected the plants from secondary infestation for over a month.

The results obtained were highly significant statistically ($P < 0.05$ and 0.01). Duncan's multiple range test revealed that the three levels caused significant reduction in aphid population than the no treatment. The three rates did not differ significantly from each other in their effectiveness.

Experiment 3. No aphids were observed upto the 11th day after application in any treatment and the readings are those observed from the 12th day onward. It is evident (cf. Table 3 A) that there was no appreciable establishment of aphids for 28 days on the plants treated with 4 kg/ha. However, aphids were began to become established on the plants treated with 2 and 3 kg but not to same extent as on the untreated plants. Plants were, therefore, supplemented with aphids on the 28th and 31st day following treatment confirm this observation. It is evident that aphids established and reproduced normally (Table 3 B) on plants treated with

Table 3. Density of bean aphids following pre-infestation application of ethiofencarb G in a 1:1 mixture of sand + peatmoss soil

	Concentration Kg a.i./ha	Post-treatment mean aphid densities/plant in days[a]													
		12	13	14	15	16	17	18	22	23	24	25	26	28	
(A) Natural Infestation	2	0.5	1.9	3.3	5.1	9.0	8.6	9.0	9.4	2.0	4.6	6.3	6.4	9.6	
	3	0.4	0.3	0.1	1.3	1.6	3.2	3.9	7.0	14.8	12.1	17.1	23.0	26.0	
	4	0.9	1.4	2.5	2.6	4.3	2.4	4.5	1.0	1.4	2.3	7.4	2.9	0.1	
	0	11.0	10.3	15.6	18.5	25.0	24.1	24.3	26.3	26.4	27.5	30.9	43.5	44.5	
	Continued	31	32	33	34	35	36	37	38	39	40	41	42	43	44
(B) Following supplementation	2	14.0	31.6	39.8	63.0	56.4	80.9	80.4	75.3	63.4	56.9	42.6	32.0	28.8	25.8
	3	37.3	76.6	58.5	125	128	128	130	144	121	121	117	107	127	118
	4	2.0	26.0	24.8	32.2	16.8	7.4	7.4	1.4	0	0	0	0	0	0
	0	61.3	73.8	80.8	104	97.9	90.9	117	108	89.0	85.4	80.5	69.3	66.1	69.8
	Continued	45	46	47	48	49	50	51	52	53	54	55	56	57	58
	2	24.0	20.4	19.1	19.8	8.5	4.6	0							
	3	106	95.0	85.9	59.8	31.3	13.3	8.8	4.4	2.6	0				
	4	0	0	0	0	0[b]	0	0	8.1	4.5	5.0	5.5	4.9	3.4	0
	0	67.4	69.1	54.4	52.3	20.2	20.1	15.8	4.1	0.4	0				

a = Each column figures are the mean densities of mature and immature forms on 8 plants.
b = Aphids released.

the two lower rates and no treatment but were not able to do so on the plants treated with the highest rate (4 kg). Aphid population declined rapidly after reaching a peak level on the untreated plants and plants treated with the two lower rates which may be attributed to overcrowding and subsequent damage to the plants.

Aphids were again released on the 4 kg treated plants on the 49th day of treatment but they did not establish which may indicate that the plants were still toxic to them. However, the results could be inconclusive since the plants were drying up progressively and no conclusion could be drawn as to whether the aphids were actually poisoned or migrated to other host plants due to the unsuitability of the original host.

Statistical analysis of the peak densities of aphid (34 to 41 days) following supplementation were significant ($P < 0.05$ and 0.01). Duncan's multiple range test revealed that the 4 kg treated plants had a significantly lowest or no aphid densities than the two corresponding lower rates and no treatment. The two lower rates and the no treatment had a comparable trend which did not differ significantly from each other.

In all these experiments (1-3) jassids, snails and certain lepidopterous pests were observed feeding on the leaves and a growing portion of the treated plants and were not affected by this formulation.

It is interesting to note that aphids changed their position just at 180° (head position downward = positively geotropic) after sucking the sap of ethiofencarb G treated plants. This behaviour correlated with the different concentrations used. At the higher concentrations they were readily affected and died immediately while at the lower concentrations they remained in this position for relatively a longer time and gradually came down to the ground and then died. However, if the lower concentration affected aphids could find untreated plants they may live and reproduce normally.

DISCUSSION

In sandy soil where there were 4 plants (2 old + 2 young)/pot the two lower rates of ethiofencarb G (0.5 and 1 kg) were practically not effective as compared to the higher rate (2 kg) but the effect was much shorter. It is also evident that the uptake was more pronounced in the

older plants (27 weeks) than the younger (3 weeks) on a quantitative basis demonstrated by the relatively high aphid reduction. In the field-simulating condition the lower rate (2 kg) was equally effective as the corresponding higher rates (3 and 4 kg) and completely eradicated the primary infestation as well as persisted for more than a month in checking the secondary infestation. The presence of organic matter in soil influenced the uptake and translocation of ethiofencarb G and hence the 2 rates (2 and 3 kg) failed to check the aphid establishment as compared to the 4 kg which persisted for longer (over 7 weeks) in checking the infestation. Thus these studies indicated that the efficacy of ethiofencarb G was influenced by the nature of soil, aphids density and host's age and density.

Work of such a nature has not been reported in the literature about ethiofencarb G. However, studies by Hammann and Hoffmann [5] and Homeyer [6] could be in partial comparison with ours. The presence of organic matter in soil affected the uptake and translocation of ethiofencarb and similar effects have been reported about other soil applied insecticides [1, 3] and reviewed by Bailey and White [2] in detail.

This formulation showed a selective aphicidal action as no other pests, feeding on bean plants, were affected.

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