Potential of Certain Insecticides in Controlling the Leaf Miner, *Liriomyza trifolii* Which Attacks Faba bean and Fenugreek and Its Effect on Some Predators

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Abstract

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During 2021 and 2022 growing seasons, two field experiments were carried out to compare the effectiveness of conventional and non-conventional pesticides, against the leaf miner, *Liriomyza trifolii* (Burgess) and its parasitoids on faba bean and fenugreek plants. Ten treatments divided into three groups were evaluated: malathion, aviesect, and carbosulfan in the first group; Naterlo mixed with each of the previous chemical insecticides in the second group; and Naterlo, Agri-flex, Chemisol, and Biofly in the third group. The findings revealed that Naterlo+Aviesect considerably reduced leaf miner larvae population by up to 73% (mortality rate), followed by Naterlo+Malathion 71%. The remaining treatments aviesect and malathion resulted in 65%and 63% mortality, respectively. On the other hand, insect pest population densities were significantly reduced after the addition of the biocides Biofly and Naterlo to the chemical insecticides. The use of natural products is a promising approach as they are less harmful to natural enemies and reduce the danger of contaminated food.

Keywords: Leaf miner, faba bean, fenugreek, natural enemies.

Introduction

Due to the serious damage, it causes on numerous crops, *Liriomyza trifolii* (Burgess) has recently attracted considerable interest in many countries, including Egypt. This pest severely harms various field and vegetable crops, causing growers to suffer significant losses (Abul Fadl *et al*., 2015). Faba bean, *Vicia faba* L., is the main source of protein for most people in Egypt. The leaf miner *Liriomyza* sp. (Diptera: Agromyzidae) is one of the many insects that attack field crops especially vegetables and ornamental plants around the world (Galande *et al*., 2005).

Insecticides were found to be effective in controlling leaf miners, but they had a negative effect on parasitoids associated with *Liriomyza trifolii* (Abul Fadl *et al* 2015). The American serpentine leaf miner fly (*Liriomyza trifolii*) is known as a serious pest throughout the world (Eldefrawy, 2022; Kashiwgi *et al*., 2005).

According to El-Sarand *et al*. (2019), the serpentine leaf miner significantly reduces faba bean yield. Leaf miners infestation reduce photosynthesis due to the consumption of palisade tissue, and the leaflets turn yellow and dry (Schusten & Everett, 1983). Because of their feeding habits, leaf miners control via chemical insecticides is challenging (Parrella *et al*., 1984), and adoption of integrated pest management can be a promising strategy to manage these insects (Liu *et al*., 2009; Salvo & Valladaros, 2007).

This study aimed to assess the effectiveness of a number of unconventional products in comparison with chemical insecticides for the control of *Liriomyza trifolii*.

Materials and Methods

Field preparation and experimental design

Two field experiments were carried out on a private farm at El- Zarkia village, Sharkia governorate during the 2021 and 2022 growing seasons. Two unconventional products were tested, (i) Biofly (Naser Fertilizer and Biocides Co., El-Sadat City, Egypt) a commercial product of the entomopathogenic fungus *Beauveria bassiana* (3×10^7 conidia/ml), and (ii) Naterlo 97% E.C. (Stoller Chemical Insect) a mix of vegetable oil, emulsifiers, and antioxidants. These two products were compared with a number of traditional chemical compounds. The normal cultural practices of growing faba bean and Fenugreek (*Trigonella foenum-graecum*) were adopted. The experimental area was split into two equal sections and planted with Fenugreek and faba bean. Each of the two halves was split into three equally sized blocks. There were 11 plots in each block (10 treatments and a control). Plots were set out using a complete random block design. Each plot area was 42 m^2 (1/100 fed). Eight rows of 50 plants each made up each plot. Fenugreek and faba bean plots were sprayed three times in the first block, twice in the second, and three times on the third block. Samples of 10 leaves were taken before and immediately after each spray, as well as 7, 14, and 21 days later. A stereo binocular microscope was used to look at and count live larvae. The equation by Henderson & Telton (1955) was used to compute the percent reduction in infestation (mortality rate %):

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$$\% \text{ Reduction} = 1 - \frac{Ta \times Cb}{Tb \times Ca} \times 100$$

Where Ta= number of infested leaves in treated plants after treatment, Tb= number of infested leaves in treated plants before treatment, Ca= number of in untreated plants after treatment; Cb = number of infested leaves in untreated plants. before treatment. According to Gameel (1973), sampling was done in the morning once every week.

Evaluated treatments

Fenugreek and faba bean local varieties were sown across an area of approximately one feddan, and the following treatments were evaluated: Malathion extra 57% (150 cm^3/100 L of water), Aviesect (50% Sp) 500 gm/acre, Carbosulfan (150 ml/acre), Naterlo+Malathion (175+150) ml/100 L of water, Naterlo+Aviesect (175+500g)/100 L of water, Naterlo+Carbosulfan (175+150g)/100 L of water, Naterlo (97% E.C.) 175 ml/100 L of water, Agri-flex 18.5% Sc (240 ml/acre), Chemisol 1000 ml/100L of water, Bio-fly 100 ml/100 L of water and Untreated control

To determine the parasitism rate, infested leaflets with leaf miner were weekly collected and placed on papers under laboratory conditions, then checked every day until the emergence of pupae, and the emerged pupae were carefully separated from the leaflets. One hundred pupae were divided into four groups, 25 pupae were transferred to petri-dish (10 cm diam.) until the emergence of adults of *L. trifolii*, and of parasitoids. The number of parasitized pupae and emerged parasitoids were counted and recorded. The emerged parasitoids were identified at the Systematic Laboratory, Plant Protection Research Institute, Agricultural Research Center, Egypt. Sampling was performed after nearly one month of sowing and continued at weekly intervals until harvest time. Data obtained was statistically analyzed and the significance of means was determined by using Duncan's multiple range test.

Results and Discussion

The efficiency of the tested compounds on *L. trifolii* larvae infesting faba bean plants and Fenugreek

Following first spray- The Naterlo+Aviesect treatment had the highest efficacy and significantly decreased the numbers of *L. trifolii* larvae on faba bean and Fenugreek plants, by 74.18, 84.21 and 75.21, 73.25, in the first and second seasons, respectively, three weeks after application (Table 1). The least effective products were Biofly, Naterlo, Agri-flex, Chemisol, Malathion, Aviesect and carbosulfan were moderately effective and reduced infestation by 58.33, 60.29 and 57.63%; 63.94, 64.34 and 62.56% in the first and second seasons on faba bean and by 61.24, 64.86 and 63.10% and 63.64, 65.69 and 63.13% on Fenugreek in the first and second seasons, respectively.

Following second spray- After the second spray in the 2021 and 2022 growing seasons, the Naterlo+Aviesect treatment had the maximum efficacy and greatly reduced the numbers of L. trifolii larvae on faba bean and Fenugreek, giving 80.61, 76.8 and 68.47, 74.48% mortality rate, respectively (Table 1). Additionally, the effects of using Naterlo with carbosulvan and Naterlo plus malathion had around the same effect, followed by Aviesect, Malathion, Naterlo, and Agri-flex, with Carbosulfan and Chemisol treatments gave a moderate effect, and Biofly gave the lowest effect on *L. trifolii* larval population (Table 2). The treatments could be arranged in a descending order based on their effectiveness in controlling the leaf miner as follows: Naterlo+Aviesect, Naterlo+Malathion, Naterlo+carbosulvan, Aviesect, Malathion, Agri-flex, Chemisol, Naterlo and Biofly, respectively.

Table 1. General mortality rate (%) of *Liriomyza trifolii* (Burgess) infesting faba bean and Fenugreek after first and second and third spray with pesticides during 2021 and 2022 growing seasons.

	Faba bean						Fenugreek					
	2021 season			2022 season			2021 season			2022 season		
Treatments	1st spray	2nd spray	3rd spray	1st spray	2nd spray	3rd spray	1st spray	2nd spray	3rd spray	1st spray	2nd spray	3rd spray
Malathion	58.33 c	48.82 e	57.71 d	63.94 c	32.66 d	48.83 c	61.24 bc	27.31 g	49.32 d	63.64 b	52.84 c	45.64 e
Aviesect	60.29 c	60.71 d	71.94 c	64.34 c	43.29 c	75.24 b	64.86 b	40.54 ef	67.71 a	65.69 b	83.87 a	83.20 a
Carbosulfan	57.63 c	40.56 fg	57.80 d	62.56 c	14.70 e	39.85 d	63.10 b	35.95 f	61.90 d	63.13 b	26.20 d	46.35 e
Naterlo + Malathion	72.48 ab	87.06 a	75.82 b	82.43 ab	57.21 b	85.82 a	73.37 a	49.18 cd	48.13 d	71.03 a	38.70 e	57.75 d
Naterlo + Aviesect	74.18 a	80.61 b	82.2 a	84.21 a	76.80 a	78.69 b	75.21 a	68.47 a	60.92 b	73.25 a	74.48 b	84.20 a
Naterlo + carbosulvan	70.45 b	75.33 c	51.57 e	80.28 b	60.89 b	31.66 e	73.73 a	52.50 bc	35.01 f	73.12 a	37.77 e	71.11 b
Naterlo	53.07 d	43.26 f	56.84 d	53.92 d	40.11 c	37.13 d	54.01 d	54.77 b	45.24 c	59.03 c	31.49 c	38.93 f
Agri-flex	54.62 d	38.21 g	38.37 f	56.52 d	39.91 c	38.24 d	54.86 c	44.76 de	56.37 c	54.71 d	42.01 de	61.82 c
Chemisol	53.31 d	50.09 e	53.89 de	53.64 de	35.01 d	39.78 d	59.07 c	54.62 b	42.01 e	58.31 c	24.45 g	44.67 e
Biofly	33.94 e	16.29 h	6.78 g	50.67 e	9.45 f	21.88 f	28.82 e	8.35 h	5.90 g	50.58 e	17.80 h	25.96 g

Values represent mean mortality rate of 1, 7, 14 and 21 days after treatment. Means followed by the same letters in the same column are not significantly different according to Duncan's multiple range test at P=0.05.

Following third spray- The leaf miner *L. trifolii* larvae were found on faba bean and Fenugreek plants for Three weeks after the application of the third spray, the Naterlo+Aviesect treatment had the highest efficacy and significantly reduced the numbers of *L. trifolii* larvae on faba bean and Egyptian clover followed by Aviesect. The treatments Agri-flix and Biofly, on the other hand, had the lowest overall effect in both seasons (Table 1).

Comparative impact of one, two and three sprays on the mortality *L. trifolii* larvae on faba bean leaves

All investigated treatments, when sprayed on faba bean plants once, twice, or three times, reduced the larval population of *L. trifollii* compared to an untreated control (Table 2). Results obtained showed that the Naterlo + malathion treatment produced the highest reduction in *L. trifollii* larvae infestation in both seasons, followed by the Naterlo + aviesect treatment. Naterlo, Agriflex, Chemisol, and Biofly, on the other hand, displayed least effectiveness.

Comparative impact of one, two and three sprays on the mortality rate of *L. trifolii* larvae on Fenugreek leaves

All investigated treatments reduced *L. trifollii* larval population when sprayed on Egyptian clover plants once, twice, or three times compared to the untreated control (Table 2). Results obtained indicated that Malathion treatment achieved the highest reduction in *L. trifollii* larval infestation in both seasons, followed by Aviesect and Naterlo+aviesect treatments. Naterlo, Agriflex, Chemisol, and Biofly, on the other hand, displayed the least effectiveness. Earlier research (Rabea *et al.,* 2015), showed that the Mediterranean fruit fly Ceratitis capitata (Wiedemann) was effectively controlled by Biofly (LC_{50} = 3008 and 3126 mg/L after 48 h in females and males, respectively). In addition, malathion demonstrated high toxicity against the nymphs of the cottony cushion scale insect (Mohanny *et al.,* 2022). Agriflex recorded highest toxicity against *P. ziziphi* population (Hassan & Radwan, 2014).

Population fluctuations of the common predators on faba bean and Fenugreek fields at the two sowing dates

Because there were extremely few individuals of each predator species, the total number of predators was taken into account and summarized in Table 3. Faba bean and Fenugreek plants had an average of four predators/plant at the end of the two seasons (2021 and 2022). Four predator species: *Chrysoperla carnea* (Steph.), *Scymnus interruptus* (Goeze), true-spider, and *Paederu salfierii* (Koch.) were observed on faba bean and Egyptian clover. The various plant species were unaffected by the number of predators. Predators were more common on faba bean than on Fenugreek, which was influenced by the number of sprays. Naterlo treatment is less harmful to the parasitoids. The results obtained were in agreement with those reported by several workers (Abd-Allah, 2003; Khattab, 2003). In faba bean and Fenugreek, the following leaf miner predators *Ch. carnea, P. alfierii, Scymnus interruptus* (Goeze), and true spiders were reported earlier (El-Sarand *et al.,* 2019; Kattab *et al*., 2013; Nassef *et al.,* 2008). These findings may be helpful in developing integrated leaf miners managements programs to improve Egyptian clover and faba bean production and reduce chemical insecticides use.

Table 2. Comparison of mortality rates (%) of *Liriomyza trifolii* (Burgess) larvae attacking faba bean and fungreek after first, second and three sprays with tested pesticides during 2021 and 2022 growing seasons.

	Faba bean						Fenugreek					
	2021 season			2022 season			2021 season			2022 season		
Treatment	After 1st spray	After 2nd spray	After 3rd spray	After 1st spray	After 2nd spray	After 3rd spray	After 1st spray	After 2nd spray	After 3rd spray	After 1st spray	After 2nd spray	After 3rd spray
Malathion	58.33 c	48.82 e	57.71 d	63.94 c	32.66 d	48.83 c	61.24 bc	23.71 g	94.32 d	63.64 b	52.84 c	45.64 e
Aviesect	60.29 c	60.71 d	71.94 c	64.34 c	43.29 c	75.24 b	64.86 b	40.54 ef	67.71 a	65.69 b	83.87 a	83.20 a
Carbosulfan	57.63 c	40.56 fg	57.80 d	62.56 c	14.70 e	39.85 d	63.10 b	35.95 f	61.9 b	63.13 b	26.20 d	46.35 e
Naterlo + Malathion	72.48 ab	87.06 a	75.82 b	82.13 ab	57.21 b	85.82 a	73.37 a	49.18 cd	48.13 d	71.63 a	38.70 e	57.75 d
Naterlo + Aviesect	74.18 a	80.61 b	82.20 a	84.21 a	76.8 a	78.69 b	75.21 a	68.47 a	60.92 b	73.25 a	74.48 b	84.20 a
Naterlo + carbosulvan	70.45 b	75.33 c	51.57 e	80.28 b	60.89 b	31.66 e	73.73 a	52.50 bc	35.01 f	73.12 a	37.77 e	71.11 b
Naterlo	53.07 d	43.26 f	56.84 d	53.92 d	40.11 c	37.13 d	54.01 d	54.77 b	45.24 c	59.03 c	31.49 f	38.93 f
Agri-flex	54.62 d	38.40 g	38.37 f	56.52 d	39.41 c	38.24 d	54.86 c	44.76 de	56.37 c	54.71 d	42.01 de	61.82 c
Chemisol	53.31 d	50.09 e	53.89 de	53.64 de	35.01 d	39.78 d	59.07 c	54.62 b	42.01 c	58.31 c	24.45 g	44.67 e
Biofly	33.94 e	16.29 h	6.78 g	50.67 e	9.45 f	21.88 f	28.82 e	8.35 h	5.99 g	50.58 e	17.80 h	25.96 g

Values represent mean mortality rate 1, 7, 14 and 21 days after treatment. Means followed by the same letters in the same column are not significantly different according to Duncan's multiple range test at P=0.05.

Table 3. The mean numbers of four predators/plant after 3rd spray with tested chemicals on faba bean and Fenugreek during 2021 and 2022 seasons.

	Faba bean				Fenugreek			
Compounds	**True-spider**	***Scymius interruptus***	***Ch. carnea***	***Paederu salfierii***	**True-spider**	***Scymius interruptus***	***Ch. carnea***	***Paederu salfierii***
2021 season								
Pre-treatment	0.76	0.55	1.11	0.37	0.22	0.35	0.64	0.18
Malathion	0.76	0.55	1.11	0.37	0.22	0.35	0.64	0.18
Aviesect	0.82	0.62	1.02	0.35	0.36	0.22	0.38	0.04
Carbosulfan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Naterlo	0.06	0.38	0.28	0.11	0.06	0.02	0.02	0.00
Naterlo + Malathion	0.22	0.16	0.33	0.04	0.06	0.08	0.00	0.00
Naterlo + Aviesect	0.43	0.32	0.71	0.16	0.13	0.04	0.00	0.00
Naterlo + carbosulvan	0.00	0.00	0.02	0.00	0.13	0.12	0.28	0.02
Agri-flex	0.08	0.51	0.42	0.26	0.00	0.00	0.00	0.00
Chemisol	0.11	0.00	0.00	0.16	0.02	0.01	0.26	0.04
Biofly	1.22	0.78	1.82	0.84	0.68	0.44	0.98	0.52
Control	2.88	1.17	3.14	1.08	1.62	1.02	1.88	0.78
2022 season								
Pre-count	0.62	0.44	0.62	0.20	0.11	0.23	0.41	0.06
Malathion	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aviesect	0.00	0.39	0.87	0.28	0.02	0.04	0.32	0.06
Carbosulfan	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
Naterlo	0.03	0.21	0.12	0.08	0.02	0.01	0.01	0.00
Naterlo + Malathion	0.12	0.04	0.09	0.00	0.02	0.00	0.00	0.00
Naterlo + Aviesect	0.32	0.19	0.42	0.00	0.04	0.02	0.18	0.00
Naterlo + carbosulvan	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.00
Agri-flex	0.02	0.11	0.18	0.03	0.00	0.02	0.02	0.00
Chemisol	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Biofly	0.78	0.39	1.02	0.56	1.46	0.32	1.22	0.32
Control	2.08	0.98	2.08	0.74	1.64	0.77	1.86	0.38

الملخص

عبد الفتاح، عاطف، أحمد عبد الله وهند سعد الطحاوي. 2025. الاتجاهات الحديثة في مكافحة صانعات أنفاق أوراق الفول (*Liriomyza trifolii*) التي تهاجم الفول والحلبة الخضراء وتأثيرها على الأعداء الحيوية المرافقة. مجلة وقاية النبات العربية، 43(3):361–365.

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أجريت تجربتان حقليتان لتقييم فاعلية مركبات تقليدية وأخرى غير تقليدية في مكافحة صانعات أنفاق أوراق الفول البلدي والحلبة وكذلك المفترسات المصاحبة لها خلال الموسمين الزراعيين 2021 و 2022. تضمنت المركبات المختبرة ثلاثة مركبات كيميائية، وهي: المالاثيون، إفيسكت، كاربوسلفان، وأربعة مركبات غير تقليدية، وهي: ناتيرلو (زيت طبيعي)، أجري فليكس، كيمسول وبيوفلاي. كما تمّ اختبار خليط من نايترلو مع كلٍّ من ملاثيون، إفيسكت والكاربوسلفان. أوضحت النتائج أن خليط ناتيرلو+ملاثيون و ناتيرلو+افيسكت قد زادت بدرجة معنوية النسبة المئوية لانخفاض تعداد اليرقات الحيّة الصانعة لأنفاق أوراق الفول بعد الرشة الأولى، الثانية والثالثة، على التوالي. وجاء في المرتبة الثانية إفيسكت، كاربوسلفان وملاثيون. بينما كان تأثير كلٍّ من نايترلو، أجري فليكس، كيمسول وبيوفلاي ضعيفاً، على مستوى الرّشات الثلاثة. من جهةٍ أخرى، كان متوسط تعداد الأعداء الحيوية الموجودة على نباتات الفول البلدي أعلى منها في نباتات الحلبة الخضراء. يمكن استخدام النتائج التي حصلنا عليها في هذه الدراسة لتحسين برامج المكافحة المتكاملة لصانعة أنفاق الأوراق على كلٍّ من محصولي الفول البلدي والحلبة. أشارت النتائج أن المواد الطبيعية مثل البيوفلاي والناتيرلو ذات فعالية مقبولة ضد الآفة المدروسة وفي الوقت نفسه فإنّها تحافظ على الكائنات الحية النافعة، فضلاً عن كونها تقلل من المخاطر الناجمة عن استخدام مبيدات الآفات التقليدية على المحاصيل الغذائية.

كلمات مفتاحية: صانعة أنفاق الأوراق، الفول البلدي، الحلبة، الأعداء الحيوية

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