Role of Parasitoids, Entomopathogens and Chemical Compounds in Managing *Liriomyza congesta* Populations in Faba bean Fields

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Abstract

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Faba bean (*Vicia faba* L.) is an important source of dietary protein in Egypt, consumed as green vegetable, dried and canned seed. This highly nutritious crop is attacked by several insect pests, including the leafminer, *Liriomyza congesta* (Becker) (Diptera: Agromyzidae), which negatively affects the yield. The present investigation was conducted at the experimental farm of Sakha Agricultural Research Station, Kafr El Sheikh Governorate, Egypt during two growing seasons, 2021/2022 and 2022/2023, to monitor population dynamics of *L. congesta* and its larval and pupal parasitoids. In addition, the efficiency of an entomopathogen and some compounds against *L. congesta* larvae were investigated. The population density of *L. congesta* larvae was the highest in March, moderate in January and February, and lowest in December and April. Three hymenopterous parasitoids were recorded; *Diglyphus isaea* (Walker) (Eulophidae) which attacked *L. congesta* larvae with an average of 5.18 and 6.05% parasitism in the two seasons. *L. congesta* larvae exhibited highest rates of parasitism on January 29th (12.40%) and on March 12th (17.31%) during the first season and on February 26th (17.20%) and March 12th (20.90%) during the second season. The pupal parasitoid, *Opius* sp. (Braconidae) was observed with an average of 16.76 and 18.41% parasitism, in the two seasons. The highest parasitism level of *Opius* sp. reached 21.78 and 34.95% on February 12th and March 19th, respectively, in the first season and 22.78 and 33.95%, on February 26th and March 12th, respectively, during the second season, whereas the parasitoid *Chrysocharis* sp. (Eulophidae) was observed at an average of 15.96 and 16.99% in the two seasons, respectively. The conventional insecticide, abamectin reduced the larval population of *L. congesta* by 89.85% and was superior over the entomopathogenic fungicides BioMeta (*Metarhizium anisopliae*) and Biossiana (*Beauveria bassiana*), as they produced 50.68 and 42.91% larval population reduction, respectively. The present research emphasized the effectiveness of parasitoids, entomopathogens and plant–derived materials against *L. congesta* as an important safe pest control agents, and their use help to reduce conventional chemical insecticide applications.

Keywords: Faba bean, *Liriomyza congesta*, parasitoids, entomopathogens, conventional insecticides.

Introduction

Faba bean, *Vicia faba* is an important source of dietary protein in Egypt. It can be consumed as green vegetable, dried and canned in the Middle East. This crop is highly susceptible to the infestation with many insect pests such as the broad bean leafminer, *Liriomyza* spp., cowpea aphid, *Aphis craccivora* Kock, leafhoppers, *Empoasca* spp. and green stink bug, *Nezara viridula* L. These insect pests negatively affect the quality and quantity of the crop either directly by sucking plant juice or indirectly by transmitting viral diseases (Abdalla *et al.,* 2000; El-Samahy, 2008).

Liriomyza genus contains more than 300 species, widely distributed in the new and old worlds. *Liriomyza* leaf miners are economically important pests of field, ornamental, and vegetable crops throughout the world (Hernandez *et al.,* 2011; Kang *et al.* 2009). Adults of *L. congesta* lay their eggs on faba bean leaflets and the hatching maggots penetrate the blades making twisting tunnels (Ameixa *et al.,* 2007). Several parasitoid species, belonging to Braconidae and Eulophidae, were recorded parasitizing the larvae of several leaf miner species in Egypt (Aamer & Hegazi, 2014). Control of leaf miners in different crops with repeated applications of insecticides have resulted in several problems including disturbance of natural balance between insect pests and their natural enemies (Murphy & LaSalle, 1999). In addition, the misuse of pesticide applications has led to resistance of insect pests against these chemicals (Johnson, 1993; Rauf *et al.,* 2000). Using yellow sticky traps proved to be beneficial in controlling it (Price *et al.,* 1981).

Entomopathogenic fungi proved to be efficient in controlling leaf miner insects (Poprawski *et al.,* 2000). Various strains of *Metarhizium anisopliae* and *Beauveria bassiana* were found to have high efficacy against several flies. The major challenge of using entomopathogens against insect pests effectively is the field application.

The aim of this investigation was to monitor population dynamics of *L. congesta*, and its parasitoids. In addition, the efficiency of entomopathogenic fungi *Beauveria* spp. and *Metarhizium* spp. and some chemical compounds against the faba bean leafminer were investigated.

Materials and Methods

Location and cultural practices

The present investigation was conducted at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, Egypt during 2021/2022 and 2022/2023 seasons. In an area of about half feddan, Sakha 1 faba bean variety was sown on the first of November, and all the recommended agricultural

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practices were followed during the growing season without insecticide applications.

Leaf miner, *Liriomyza congesta* and its parasitoids
Weekly samples (100 leaflets) were collected randomly from the upper, middle, and lower levels of faba bean plants, placed in paper bags and transferred to the laboratory for examination. Leaflets containing mines were kept in glass jars furnished with paper tissues, and the jars were monitored daily to collect the emerging parasitoids from larvae and pupae of *L. congesta*.

Parasitoid identification
Emerging wasps were daily collected using an aspirator and kept in 75% ethyl alcohol for identification. All reared pests and parasitoid specimens were identified by the aid of Biological Control Unit, Rice Research and Training Center (R.R.T.C.), Sakha, Kafr El-Sheikh, Egypt.

Weather records
Daily records of maximum and minimum temperatures and relative humidity during the two study seasons were obtained from the Rice Research and Training Centre Meteorological Station as weekly means of the weather factors of the seven days before inspection. These records were utilized to calculate the correlation coefficient values among these factors and insect populations.

Effect of entomopathogenic fungi, plant–derived compounds and conventional insecticides against *Liriomyza congesta* on faba bean plants
An experiment was conducted during the two growing seasons, 2021/2022 and 2022/2023, to evaluate the efficacy of two entomopathogenic fungi and plant-derived insecticide (Jojoba oil) compared to a traditional insecticide (abamectin) against *L. congesta* (Table 1).The experiment was laid out in a randomized complete block design with the following four treatments: Biossiana (*Beauveria bassiana*) (1×10^8 colony-forming unit (CFU)/mg) and BioMeta (*Metarhizium anisopliae*) (1×10^8 colony-forming unit (CFU)/mg), Jojoba oil, abamectin and untreated control. Each treatment was replicated three times (42 m^2 per plot). A knapsack sprayer provided with one nozzle delivering 200 L water/feddan was used. Before spraying, 100 leaflets (20 plants × 5 leaflets each) were collected randomly, and numbers of alive *L. congesta* larvae were recorded. Three, five, seven, ten and 15-days post- treatment, 100 leaflets were collected from each plot and numbers of alive larvae were recorded. Infestation reduction rate (%) was estimated according to the formula of Henderson & Tilton (1955) as follows:

$$\text{Population reduction (\%)} = 1 - \frac{Ta \times Cb}{Tb \times Ca} \times 100$$

Where: Ta= the number of insects in treated plots after spray, Tb= the number of insects in treated plots before spraying, Ca= the number of insects in control plots after spraying, Cb= the number of insects in treated plots before spraying.

Statistical analysis
Standard errors of means of treatments were calculated. In addition, correlations were computed between each of the weather factors and larval population of *L. congesta* using SPSS program. Reduction in *L. congesta* larval populations were calculated using Henderson & Tilton equation (1955).

Results

Seasonal abundance of *Liriomyza congesta*
Seasonal abundance of *L. congesta* larvae attacking faba bean fields was monitored during 2021/2022 and 2022/2023 crop seasons. In 2021/2022 season (Table 2), numbers of larvae per 100 faba bean leaflets were very low during December, moderate in January and April, and high by late January and throughout February and March. However, three larval peaks were recorded: the first on January 15th (113 larvae/100 faba bean leaflets), the second one on February 15th (168 larvae/100 leaflets) and the third and the highest one on March 15th (357 larvae/100 leaflets). In 2022/2023 season, the results showed a trend similar to that of the first season. The density of *L. congesta* larvae was obviously high during January, February, and March, with three peaks: the first on January 22nd (132 larvae/100 faba bean leaflets), the second one on February 19th (275 larvae/100 leaflets) and the third one on March 12th (377 larvae/100 leaflets).

In 2022/23 season, data obtained (Table 2) indicated that *L. congesta* larvae began to appear on December 4th with few numbers (23 larvae/100 faba bean leaflets), then the population sharply increased to reach 71 larvae/100 faba bean leaflets on December 25. Larval population then recorded three peaks of abundance on January 22nd 132 larvae/100 faba bean leaflets, February 19th 275 larvae/100 faba bean leaflets and March 12th 377 larvae/100 faba bean leaflets, then the larval population continued to decrease until the end of the growing season.

Correlation among weather factors and populations of *Liriomyza congesta* larvae
Results obtained (Table 3) showed that population of larvae and infestation intensity of *L. congesta* correlated negatively with each of temperature (max., min, and average) which means that *L. congesta* populations increased with low temperature in the 2021/2022 season.

Impact of parasitoid species
During the two successive growing seasons (2021/2022 and 2022/2023), three hymenopterous parasitoids emerged from larvae and pupae of *L. congesta* collected from faba bean experimental field, at Kafr El-Sheikh region: *Diglyphus isaea* (Walker) (Hymenoptera: Eulophidae) as a larval parasitoid; 2- *Opuis* sp. (Hymenoptera: Braconidae) as a pupal parasitoid and *Chrysocharis* sp. (Hymenoptera: Eulophidae) as a pupal parasitoid.

Parasitism rate of *Liriomyza congesta* larvae by the larval parasitoid *Diglyphus isaea* in faba bean fields
Data obtained (Table 4) showed the parasitism of *Liriomyza congesta* larvae by *Diglyphus isaea* in faba bean fields occurred during 2021-2022 and 2022-2023 growing seasons. In the first season, the average numbers of *L. congesta* larvae ranged from 31.50 larvae/100 infested leaflets during December to 200.75 larvae/100 leaflets in March. The emerging larval parasitoid *D. isaea* averaged 8.2/100 leaflets in January, and increased to 10.75 and 21.00 individuals/100

leaflets during February and March, respectively. The parasitism of *L. congesta* larvae started at low rate during January (7.16%), increased to moderate numbers during February (8.36%) and relatively higher rate (9.50%) during March.

In the second season, the average number of *L. congesta* larvae ranged from 36.75 larvae/100 leaflets during December, to 214.75 larvae/100 leaflets in March. The emergence of parasitoid started at a very low average number of 2 wasps/100 leaflets then increased to 8 wasps/100 leaflets during January. The parasitism rate of larvae appeared at low rate during January (4.85%) while the high rates of parasitism (14.12 and 11.28%) occurred during February and March, respectively. *L. congesta* larvae exhibited highest rates of parasitism on January 29th (12.40%) and on March 12th (17.31%) in the first season (2021/2022) and on February 26th (17.20%) and on March 12th (20.90%) during the second season (2022/2023). The number of *D. isaea* was higher in 2023 than in 2022. *D. isaea* was active throughout the growing season and increased in number as the leaf miner, *L. congesta* population increased (Table 4).

Table 1. Common and trade names of tested compounds, their chemical classes and application rate.

Common name	Trade name	Manufacturer	Chemical class	Application rate/100 L
Beauveria bassiana (1×10^8 CFU/mg)	Biossiana 2.5%WP	Bio- Insecticides Production Unit Plant Protection Research Institute	entomopathogenic fungi (biocides)	200 g
Metarhizium anisopliae (1×10^8 CFU/mg)	BioMeta 2.5% WP	Bio- Insecticides Production Unit Plant Protection Research Institute	entomopathogenic fungi (biocides)	200 g
Jojoba oil	Top healthy 60% EC	Top Chemical Factory for the Manufacture of Pesticides and Specialized Chemicals	Plant oils	400 ml
Abamectin	Espinosa 1.8% EC	Jiangsu Fengyuan Bioengineering Co., Ltd China	Avermectin	40 ml

Table 2. Population abundance of *Liriomyza congesta* larvae on faba bean plants during 2021/2022 and 2022/2023 growing seasons.

	2021/2022 season				2022/2023 season			
Date of sampling	Av. No. of larvae per 100 leaflets	Av. No. of mines per 100 leaflets (1)	Infestation rate % (2)	Intensity (1)/(2)	Av. No. of larvae per 100 leaflets	Av. No. of mines per 100 leaflets (1)	Infestation % (2)	Intensity (1) / (2)
December 04	12.00	16.00	12.00	1.33	23.00	24.00	23.00	1.04
December 11	23.00	35.00	24.00	1.46	29.00	39.00	24.00	1.60
December 18	34.00	48.00	31.00	1.55	38.00	49.00	29.00	1.70
December 25	27.00	89.00	39.00	2.28	71.00	76.00	35.00	2.20
Average	24.00	47.00	26.50	1.66	40.25	47.00	27.75	1.64
January 01	75.00	137.00	43.00	3.19	87.00	139.00	47.00	2.90
January 08	104.00	165.00	56.00	2.95	90.00	164.00	51.00	3.20
January 15	113.00	130.00	70.00	1.86	112.00	169.00	49.00	3.40
January 22	96.00	147.00	51.00	2.88	132.00	223.00	52.00	4.30
January 29	97.00	144.75	55.00	2.72	128.00	287.00	55.00	3.40
Average	97.00	144.75	58	2.72	109.80	196.40	50.80	3.44
February 05	145.00	213.00	67.00	3.18	180.00	271.00	63.00	5.20
February 12	168.00	265.00	57.00	4.65	240.00	348.00	79.00	3.40
February 19	98.00	324.00	61.00	5.31	275.00	311.00	85.00	5.50
February 26	119.50	248.25	62.00	4.04	109.00	229.00	81.00	4.80
Average	132.63	26256	61.75	4.30	201.00	289.75	77.00	4.73
March 05	293.00	489.00	83.00	5.89	305.00	410.00	83.00	2.80
March 12	357.00	521.00	85.00	6.13	377.00	490.00	91.00	4.90
March 19	220.00	472.00	84.00	5.62	210.00	495.00	93.00	5.40
March 26	155.00	553.00	94.00	5.88	121.00	487.00	89.00	5.30
Average	256.25	508.75	86.5	5.88	253.25	470.50	89.00	4.60
April 02	25.00	637.00	100.00	6.37	38.00	624.00	98.00	6.30
Overall average ± SE	120.08± 37.42	257.44 ± 106.90	59.67 ± 12.34	3.74 ± 0.87	142.5 ± 43.10	268.61 ± 101.40	62.61 ± 12.92	3.74 ± 0.77

Table 3. Correlation coefficient values among populations of larvae of *Liriomyza congesta* and (maximum, minimum and average) temperature and relative humidity in two faba bean growing seasons.

Item	"r" value	
	2021/2022	2022/2023
Max. Temp × larvae	-0.5287	-0.09882
Min. Temp × larvae	-0.5103	-0.3671
Av. Temp × larvae	-0.1221	-0.07766
Av. RH% × larvae	-0.5801	-0.6117
Av. Temp × intensity of infestation	0.3236	-0.06769
Av. RH% × intensity of infestation	-0.5991	-0.7451

Parasitism of *Liriomyza congesta* pupae by the pupal parasitoid, *Opius* sp. and *Chrysocharis* sp. in faba bean fields

Results obtained (Table 5) showed that, in 2021-2022 season, the average number of *L. congesta* pupae ranged from 25.5 pupae during December to 159.57 pupae in March. The parasitoid, *Opius* sp. appeared with a small number of 1.00 wasp during December 11th, then increased sharply to reach three peaks (12.00, 24.00, and 67.00 wasps) on January 8th, February 19th and March 12th, respectively. The lowest parasitism rate of *Opius* sp. (2.94%) occurred during December 18th. The highest parasitism level of *Opius* sp. (13.95, 10.84, 21.78 and 34.95%) were recorded on January 8th and 29th, February12th and March 19th, respectively.

In the second growing season (2022/2023), results obtained (Table 5) indicated that the emerging parasitoid *Opius* sp. firstly appeared with only one wasp on December 4th, then increased to reach three peaks of 12.00, 26.00, and 73.00 wasps/100 leaflets on January 15th, February 19th and March 12th, respectively. The lowest parasitism rate of *Opius* sp. rate was 2.94% during December 18th. The four peaks of parasitism rate of *Opius* sp. Were 13.21, 11.76, 22.78 and 33.95% recorded on December 25th, January 15th, February 26th, and March 12th, respectively.

Table 4. Parasitism of *Liriomyza congesta* by the larval parasitoid, *Diglyphus isaea* in faba bean fields at Kafr El-Sheikh region during 2021/2022 and 2022/2023 growing seasons.

Date of sampling	2021/2022 Season			2022/2023 Season		
	Av. No. of *L. congesta* larvae/100 infested leaflets	*Diglyphus isaea*		Av. No. of *L. congesta* larvae/100 infested leaflets	*Diglyphus isaea*	
		Av. No.	Parasitism %		Av. No.	Parasitism %
December 04	13.00	0.00	0.00	18.00	0.00	0.00
December 11	19.00	0.00	0.00	25.00	0.00	0.00
December 18	36.00	0.00	0.00	39.00	0.00	0.00
December 25	58.00	2.00	3.50	65.00	0.00	0.00
Average	31.50	0.50	0.88	36.75	0.00	0.00
January 01	51.00	3.00	2.60	112.00	2.00	1.80
January 08	120.00	7.00	5.80	125.00	4.00	3.20
January 15	124.00	8.00	6.50	130.00	7.00	4.70
January 22	113.00	10.00	8.50	165.00	11.00	6.07
January 29	105.00	13.00	12.40	188.00	16.00	8.50
Average	102.60	8.20	7.16	144.00	8.00	4.85
February 05	113.00	9.00	7.96	180.00	21.00	11.67
February 12	128.00	12.00	9.38	215.00	28.00	13.02
February 19	155.00	14.00	9.68	240.00	35.00	14.60
February 26	125.00	8.00	6.40	134.00	23.00	17.20
Average	130.25	10.75	8.36	192.25	26.75	14.12
March 05	180.00	25.00	13.89	260.00	40.00	15.03
March 12	260.00	45.00	17.31	295.00	59.00	20.90
March 19	228.00	12.00	5.30	199.00	15.00	7.08
March 26	135.00	2.00	1.50	105.00	3.00	2.09
Average	200.75	21.00	9.50	214.75	29.25	11.28
April 02	46.00	0.00	0.00	38.00	0.00	0.00
Overall average ± SE	102.22±30.54	8.09±3.85	5.18±1.98	125.15±37.61	12.80±6.39	6.05±2.89

Table 5. Parasitism rates of *Liriomyza congesta* by the pupal parasitoid, *Opius* sp. and *Chrysocharis* sp. in faba bean fields at Kafr El-Sheikh region during 2021/2022 and 2022/2023 growing seasons.

	Av. No. of *Liromyza congesta* pupae/100 infested leaflets		*Opius* sp.				*Chrysocharis* sp.				Total parasitism (%)	
			Av. No.		Parasitism rate (%)		Av. No.		Parasitism rate (%)			
Date of sampling	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
December 04	8.00	15.00	0.00	1.00	0.00	6.67	0.00	0.00	0.00	0.00	0.00	6.67
December 11	17.00	19.00	1.00	1.00	5.88	5.26	0.00	0.00	0.00	0.00	5.88	5.26
December 18	34.00	34.00	1.00	1.00	2.94	2.94	0.00	0.00	0.00	0.00	2.94	2.94
December 25	43.00	53.00	2.00	7.00	4.70	13.21	0.00	0.00	0.00	0.00	4.70	13.21
Average	25.50	30.25	1.00	2.50	3.38	7.02	0.00	0.00	0.00	0.00	3.38	7.02
January 01	92.00	89.00	11.00	9.00	11.96	8.9	1.00	1.00	1.09	1.12	13.05	10.02
January 08	86.00	95.00	12.00	5.00	13.95	5.26	3.00	0.00	3.49	0.00	17.44	5.26
January 15	90.00	102.00	3.00	12.00	3.33	11.76	0.00	1.00	0.00	0.98	3.33	12.74
January 22	94.00	113.00	5.00	9.00	5.32	7.96	2.00	1.00	2.13	0.88	7.45	8.84
January 29	83.00	125.00	9.00	9.00	10.84	7.20	3.00	3.00	3.61	2.40	14.45	9.6
Average	89.00	104.80	8.00	8.80	9.08	8.22	1.80	1.20	2.06	1.08	11.14	9.29
February 05	91.00	122.00	16.00	7.00	17.58	5.74	1.00	2.00	1.10	1.64	18.68	7.38
February 12	101.00	156.00	22.00	13.00	21.78	10.40	3.00	5.00	2.97	3.21	24.75	13.61
February 19	128.00	177.00	24.00	26.00	18.75	14.00	1.00	8.00	0.78	4.52	19.54	18.52
February 26	98.00	79.00	18.00	18.00	18.37	22.78	5.00	5.00	5.10	6.33	23.47	29.11
Average	104.50	133.50	20.00	16.00	19.12	13.23	2.5.	5.00	2.49	3.93	21.61	17.16
March 05	133.00	190.00	31.00	43.00	23.31	22.63	10.00	6.00	7.52	3.16	30.83	25.79
March 12	225.00	215.00	67.00	73.00	29.78	33.95	12.00	9.00	5.33	4.19	35.11	38.14
March 19	186.00	152.00	65.00	46.00	34.95	30.21	4.00	8.00	2.15	5.26	37.10	35.52
March 26	95.00	85.00	23.00	15.00	24.21	17.65	0.00	0.00	0.00	0.00	24.21	17.65
Average	159.75	160.5	46.50	44.25	28.0625	26.11	6.50	5.75	3.75	3.15	31.81	29.28
April 02	29.00	27.00	7.00	6.00	24.14	22.22	0.00	0.00	0.00	0.0	24.14	22.22
Overall average ±	81.55±	91.21±	16.50±	15.51±	16.76±	15.36±	2.16±	2.39±	1.66±	1.63±	18.42±	16.99±
SE	25.10	27.03	8.11	7.52	4.61	3.79	1.19	1.24	0.73	0.81	5.01	4.10

Results obtained **(**Table 5) showed that in 2021/2022 season, the parasitoid *Chrysocharis* sp. started with a low number of 1.00 wasp/100 leaflets during January 1st, then increased to reach three peaks of 3.00, 5.00, and 12.00 wasps/100 leaflets on January 29th, February 26th and March 12th, respectively. The lowest parasitism of *Chrysocharis* sp. was during January1st with 1.09%. The three highest parasitism rates of *Chrysocharis* sp. (3.61, 5.01 and 7.52%) were recorded on January 29th, February 26th and March 5th, respectively. As for the second season (2022/2023), results obtained (Table 5) indicated that *Chrysocharis* sp. first appeared with too low number of 1 wasp/100 leaflets on January 1st, then increased to reach the three highest numbers of 3.00, 8.00, and 9.00 wasps/100 leaflets on January 29th, February19th and March 12th, respectively. The lowest parasitism rate of *Chrysocharis* sp. (0.88%) was recorded on January 22nd. The three highest parasitism rates of *Chrysocharis* sp. were 2.40, 6.33 and 5.26%, recorded on January 29th, February 26th and March 19th, respectively.

Effect of entomopathogenic fungi, plant–derived compounds and conventional insecticides against *Liriomyza congesta* on faba bean plants

Results obtained (Table 6) showed the influence of tested biocides, plant extract, and traditional insecticides on the reduction rate of *L. congesta* population under field conditions during 2022 and 2023 faba bean seasons. All the tested compounds reduced the infestation. Abamectin had the highest rate of reduction, while Jojoba oil had the lowest rate in both seasons. Abamectin appeared to be the most effective (89.09% reduction), followed by BioMeta (50.68%), Biossiana (42.91%), whereas the Jojoba oil had the lowest rate of reduction (38.75%) in the first season, similar results were obtained in the second season. Abamectin had the highest rate of reduction (81.28%), followed by BioMeta (51.51%), and Biossiana (46.55%), whereas Jojoba oil had the lowest rate (32.26%).

It can be concluded that abamectin conventional insecticide exhibited the highest efficiency against *L. congesta* larvae with the highest average percentage of reduction, followed by BioMeta and Biossiana biocides in both seasons, while the least average percentage of reduction was caused by Jojoba oil during the two seasons.

Discussion

In 2022/2023 season, numbers of larvae in faba bean leaflets were very low during December and March, moderate in January and high during late January, throughout February and early March. The density of *L. trifolii* larvae was obviously high during February and early March. These results are in agreement with those obtained by Mohsena *et al.* (2022). Numbers of recorded peaks of *L. trifolii* larvae varied due to variation in weather factors, different faba bean

varieties, and leaf miner species. *L. congesta* exhibited 2-3 peaks (El-Mashaly 2013), and *L. trifolii* had three peaks (Hatem, 2014). Both Abou-El Kassem (2018) and El-Sarand *et al.* (2019) reported two to four peaks. In Egypt, Aamer & Hegazi *et al.* (2014) recorded several leaf miner species infesting faba bean plants. *Liriomyza* species exhibit characteristics that allow them to rapidly attain pest status: multivolume, polyphagous feeding habits and the ability to rapidly develop insecticide resistance (Reitz & Trumble, 2002).

Diglyphus isaea (a larval parasitoid), *Opius* sp. and *Chrysocharis* sp. (pupal parasitoids), were previously recognized and identified parasitizing *L. congesta* infesting faba bean and other crops at different localities in Egypt (Mesbah & Sherif, 1994). *D. isaea* was the predominant parasitoid species emerging from *L. trifolii* (Kaspi *et al.,* 2011). In 2013/14 season, the wasp *Pseudopzomochus masii* recovered in large numbers from *Liriomyza* spp. *P. masii* was reported earlier for the first time from *Liriomyza* spp. in Egypt (Hegazy *et al.,* 2014). Nine hymenopterous parasitoid species of *L. trifolii* were recorded by Hammad (2000) in reclaimed sandy land at El-Kattara district in Egypt. However, more than 40 parasitoid species of *L. trifolii* were identified globally (Lin & Wang, 1992). *Diglyphus isaea* is widely distributed in Afro tropical, Pacific, Oriental countries (Zhu *et al.,* 2000). In absence of pesticides, naturally occurring parasitism contributes significantly to maintaining *Liriomyza* spp. population below damaging levels, in addition to other factors (Palumbo *et al.,* 1994).

The potential use of entomopathogenic fungi for the control of insect pests has been reported earlier (Inglis *et al.,* 2001). El-Khawas *et al.* (2004) evaluated five components of Mesrona oil, castor oil, *Beauveria bassiana*, Vertemic and the chemical insecticide Confidor against *L. trifolii* in faba bean fields in Egypt. Results obtained showed that abamectin insecticide exhibited a high efficiency against *L. congesta* larval population with the highest average of reduction rate, followed by BioMeta and Biossiana biocides. Whereas, the least average reduction rate was caused by Jojoba oil. Abbassy *et al.* (2008), in Egypt, reported that the bio insecticides spinosad (Tracer.24% WG) and B.T (Agerin) in addition to the botanical insecticide azadirachtin were effective against leaf miners of common bean plants. Results obtained in this study were also in agreement with the findings of El-Samahy (2008).

Table 6. Potency of entomopathogenic fungi and tested compounds in reducing *Liriomyza congesta* larval population under field conditions during 2022 faba bean growing season.

Treatment and concentration used	Population reduction (%) after treatment by days											
	3		5		7		10		15		Overall average	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
BioMeta 1×10^8 CFU/mg	22.42	25.76	38.28	34.33	47.81	51.23	68.64	63.79	76.25	82.44	50.68	51.51
Biossiana 1×10^8 CFU/mg	18.59	20.34	33.76	30.85	48.52	62.93	63.44	65.44	50.22	53.18	42.91	46.55
Jojoba oil 2395 mg a.i./L	36.48	33.18	43.28	39.69	52.53	45.47	45.55	36.62	15.92	6.35	38.75	32.26
Abamectin 7 mg a.i./L	89.21	88.01	86.75	85.5	95.13	90.32	90.02	93.52	88.15	88.11	89.85	89.09

الملخص

عبد العليم، هدى، محمد أبو العلا وأمل أبو القاسم. 2025. دور الطفيليات ومسببات الأمراض الحشرية والمركبات الكيميائية في مكافحة صانعة أنفاق الأوراق (*Liriomyza congesta*) في حقول الفول البلدي. مجلة وقاية النبات العربية، 43(2): 207–214.

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يعدّ الفول البلدي مصدراً مهماً للبروتين الغذائي في مصر حيث يتم تناوله كأطعمة خضراء أو مجففة أو معلبة. يصاب هذا المحصول المهم بالعديد من الآفات الحشرية التي تؤثر سلباً على إنتاجيته، ومن أهمّها صانعة الأنفاق (*Liriomyza* congesta) (Diptera: Agromyzidae). تمّت هذه الدراسة في المزرعة البحثية لمحطة البحوث الزراعية في سخا (كفر الشيخ)، مصر، في موسمي 2022/2021 و 2023/2022 على الفول البلدي صنف سخا 1. هدفت هذه الدراسة لمراقبة ديناميكية تعداد صانعة الأنفاق وطفيليات اليرقات والعذارى المصاحبة لها، وتأثير بعض مسببات الأمراض وبعض المركبات النباتية والمبيدات الحشرية على يرقات الآفة. بلغت كثافة يرقات صانعة الأنفاق أعلى معدلاتها في شهر آذار/مارس، وكانت متوسطة في شهري كانون الثاني/يناير وشباط/فبراير، وبأدنى مستوياتها في شهري كانون الأول/ديسمبر ونيسان/أبريل. تمّ تسجيل ثلاث قمم (113، 168 و 357 يرقة/100 وريقة) في كانون الثاني/يناير، شباط/فبراير وآذار/مارس، على التوالي، في الموسم الأول، وثلاث قمم (132، 275 و 377 يرقة/100 وريقة) في أشهر كانون الثاني/يناير، شباط/فبراير وآذار/مارس، على التوالي، في الموسم الثاني. وجدت علاقة ارتباط سالب بين درجات الحرارة العظمى والصغرى وتعداد اليرقات وكثافة الإصابة. تم تسجيل ثلاثة أنواع من الطفيليات تتبع رتبة غشائية الأجنحة، أحدها طفيل على

اليرقات واثنين منها على العذارى. سجلت ثلاث قمم للنسبة المئوية لتطفل *Diglyphus isaea* (12.40، 9.68 و 17.31%) في أشهر كانون الثاني/يناير، شباط/فبراير وآذار/مارس، على التوالي، في الموسم الأول، وسلكت المنحى ذاته في الموسم الثاني. بلغت نسب تطفل طفيل العذارى على صانعات الانفاق (*Opius* sp.) أربع قمم (13.95، 10.84، 21.78 و 34.95%) في أشهر كانون الثاني/يناير، شباط/فبراير وآذار/مارس، على التوالي في الموسم الأول، وكذلك أربع قمم (13.21، 11.75، 22.78 و 33.95%) في أشهر كانون الأول/ديسمبر، كانون الثاني/يناير، شباط/فبراير وآذار/مارس، على التوالي، في الموسم الثاني. بينما سجل الطفيل *Chrysocharis* sp. قمتان (5.10 و 7.525%) في شهري شباط/فبراير وآذار/مارس، على التوالي، في الموسم الأول، وقمتان (6.33 و 5.25%) في الشهرين ذاتهما، على التوالي، في الموسم الثاني. أوضحت الدراسة كفاءة بعض المركبات في خفض تعداد يرقات صانعات الأنفاق، حيث كان المبيد الحشري أبامكتين أكثر كفاءةً في خفض أعداد اليرقات بنسبة 89.85%، يليه البيوميتا (BioMeta) والبيوسيانا (Biossiana) (فطور ممرضة للحشرات)، اللذان خفضا تعداد اليرقات بنسبة 50.68 و 42.91%، على التوالي. أوضح البحث أهمية دور الطفيليات وممرضات الحشرات والمواد المشتقة من أصل نباتي في مكافحة صانعة الأنفاق (*L. congesta*)، وبالتالي يمكن التوصية بها للحدّ من استخدام المبيدات الحشرية التقليدية وصولاً للحفاظ على البيئة والأعداء الحيوية.

كلمات مفتاحية: فول بلدي، *Liriomyza congesta*، متطفلات، ممرضات الحشرات، مبيدات تقليدية.

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