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Effect of Strip-Management on the Population of the Aphid, *Aphis craccivora* Koch and its Associated Predators by Intercropping Faba bean, *Vicia faba* L. with Coriander, *Coriandrum sativum* L.

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ABSTRACT

Experiments were conducted at the experimental farm of the Environmental Studies and Research Institute, Minufiya University, El Sadat Branch, Minufiya Governorate, Egypt to investigate the effect of strip-management and intercropping system with Coriander, *Coriandrum sativum* on infestation with the cowpea aphid's (*Aphis craccivora* Koch) and its associated predators, on five faba bean varieties, during the two successive seasons 2007/08 and 2008/09. Susceptibility of the five faba bean varieties to the aphid's infestation was also estimated. Results showed a significant positive effect of *C. sativum* intercropping with the faba bean varieties, as it caused significant decreases in aphid's population, significant increases in the numbers of associated predators and increases in the seed yields in both seasons. The lowest mean numbers of aphid (263.77 and 254.97 individuals/tiller) were scored in the plot of Giza-843 variety, intercropped and surrounded by the strip management of coriander, while the highest ones (597.37 and 523.57 individuals/tiller) were recorded in the plot of Giza-3 imp. without intercropping in both seasons, respectively. Highest mean number of predators (24.8 and 24.07) were recorded in the plots of Giza-3 imp. intercropped with coriander. However, the lowest means (3.10 and 3.03 individuals) were recorded in the plots of Giza-843 variety alone in the two seasons, respectively. Highest seed yields (1.87and 1.90 ton/fed.) were recorded in the plots of Nubaria-1 and Giza-843 varieties, intercropped with coriander, while the lowest ones (1.17 and 1.20 0 ton/ fed.) were found in Giza-3 imp. plots alone in both seasons, respectively. Results showed significant positive correlation coefficient between mean number of predators and seed yield/ plant in the two seasons and a significant negative correlation between seed yield/ plant and mean number of aphid /tiller.

Key words: *Vicia faba, Coriandrum sativum, Aphis craccivora*, intercropping, predators, strip management.

INTRODUCTION

Faba bean, *Vicia faba* L. is one of the most important leguminous crops that provide a major source of protein for human and domestic animals in Egypt. This crop is highly susceptible to the infestation with the cowpea aphid, *Aphis craccivora* Koch, which is considered the key pest of faba bean cultivation in Egypt (El Defrawi *et al.* 2000 and Ragab *et al.* 2002). Susceptibility of faba bean varieties to *A. craccivora* infestation under Egyptian field conditions were studied by many authors (Mohamed and Slman 2001, El-Defrawi and Shalaby 2002 and Salem 2005).

Modern agriculture has often caused the simplification of biological and environmental structures in the agro-ecosystem mainly through intensive cropping practices (Altieri, 1999). One of the methods of enhancing the population of natural enemies is enriching the field neighborhood with flowering plants (Altieri and Whikomb 1979 and Ruppert and Mollhan 1991). Bowie *et al.* 1995 reported that coriander, *Coriandrum sativum* was a repellent plant and is used in biological control programs. Michel (2000) stated that coriander attracts hoverflies and reduces pest infestation. Rizk (2005) found that *Bemesia tabaci* population on different tomato strains intercropped with coriander recorded significantly lower means comparing to the control.

This study aims to investigate the effect of intercropping the coriander, *C. sativum* with *V. faba* varieties in strips on the population density of *A. craccivora* Koch and its associated predators in a newly reclaimed land in Egypt.

MATERIALS AND METHODS

Field studies and the experimental design

Experiments were conducted at the Experimental Farm of the Environmental Studies and Research Institute, Minufiya University, El Sadat district, Minufiya Governorate, Egypt during the two successive growing seasons (2007/08 & 2008/09).

The experimental layout was conducted in randomize complete block design with split plots and with three replicates. The main plot was divided into two subplots (with coriander intercropping and without), separated with 10 meters wide uncultivated strips. However, the subplot had five *V. faba* varieties (Giza-3 improve, Giza-843, Sakha-1, Nubaria-1 and Masr-2) distributed randomly in each replicate. Each variety was sown in 10 ridges (6 x 7 meters = 1/100 fed.). Tested varieties were sown in the second week of November in both seasons. Coriander was cultivated at the same time of planting faba bean varieties and continued at three different dates; 15 days intervals around the first area and intercropping between hills in the two sides of the ridge. Agronomic practices were applied in all

plots as recommended in the new reclaimed areas. No chemical control application was practiced throughout the growing seasons.

Assessment

Populations of the aphid and its associated predators on different varieties were estimated. Randomized samples of ten tillers were collected weekly from each variety. Direct counts of the aphids and the predators (mainly; adults and larvae of coccinelids, larvae of chrysopids and hoverflies) were conducted in the field and the samples were transferred to the laboratory for counting. Mean no. /tiller/sample/date was recorded. Sampling started 30 days after cultivation and continued till the end of each season. 16 samples were picked up from the tested varieties during each season. At harvest, obtained seed yield/ (plant and feddan) was estimated for each variety during the two seasons. Susceptibility of different faba bean varieties for infestation with the aphid was also estimated.

Statistical analysis

Obtained data were subjected to the proper analysis of variance, according to Snedecor and Cochran 1973. Least significant difference (L.S.D.) at 0.05% level of significant was used to compare the treatments means and their interactions. Correlation and liner regression were calculated for seed yield/plant and mean no. aphid/plant, seed yield/plant and mean no. predators/plant and mean no. aphid/plant and total mean no. predators according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Effect of intercropping on aphid density, predatory numbers and seed yield

A significant positive effect of *C. sativum* intercropped with faba bean varieties on all tested traits was recorded (Table 1). Generally, results revealed a higher population density of the pest in the first year than in the second one in either with or without coriander intercropping system.

For the aphid's population, significant decreases in the total mean numbers of *A. craccivora* were recorded in the intercropping plots, recording 320.61 and 302.13 individuals/tiller in both seasons, respectively (Table 1). The total means increased sharply to 463.01 and 437.34 individuals/ tiller in the plots of faba bean alone. The lowest total mean of aphid (263.77 and 254.97) individuals/tiller was recorded in Giza-843 variety plot intercropped with coriander followed by 271.10 & 256.20 individuals/tiller in intercropped Nubaria-1 variety while the highest total population (597.37 and 523.57 individuals/tiller) was observed in the plots of Giza-3 imp. variety without intercropping in both seasons, respectively. Obtained results agree with those of Sengonca and Frings (1988) who showed a reduction in *Aphis faba* population on sugar–beet crop when *Phacelia* was sown in the field corners. Bowie *et al.* (1995) reported that coriander was a repellent plant and is used in biological control programs. Colley and Luna (2000) found that coriander was the most favored flowering plants to attract the syrphids and some other natural enemies. A critical factor for the syrphid reproduction is to access to flowering plants for pollen and nectar (Stary and Laska 1999). The same conclusion was detected by Wyss (1996) who stated that the mixture of plants sown in strips in apple orchard was helpful in enhancing the beneficial fauna and for the regulation of the aphid population. Also, by Jacek *et al.* (2005) recorded lowest number of *A. faba* in sugar–beet crop surrounded by strips of mixture of 25% *Sinapis alba*, 25% *Phacelia tancitifoli* and 50 % *C. sativum*.

For the predators, they increased significantly with intercropping giving 7.03±0.07, 5.15±0.08, 4.35±0.13 and 2.59±0.06 individuals and 7.03±0.04, 5.01±0.04, 4.21±0.15 and 2.83±0.07 for *Coccinella undecimpunctata* L. adults, *C. undecimpunctata* larvae, *Metasyrphus corollae* F. larvae and *Chrysoperla carnea* Steph. larvae, respectively, with an average of 19.09 individuals /tiller (Table 1). Averages of 3.87 and 3.64 individuals/ tiller were recorded in the plots without intercropping in both seasons, respectively. Among aphid's predators, adults and larvae of *C. undecimpunctata* were represented by 63.8 and 63.1% and 89.4 and 93.7% in the plots with and without intercropping in both seasons, respectively. Highest rate of predators recorded 8.87, 6.53, 5.97 and 3.43 and 8.97, 6.23, 5.27 and 3.60 individuals/ tiller for *C. undecimpunctata* adults, *C. undecimpunctata* larvae, *M. corollae* larvae and *C. canea* larvae, respectively, with the averages of 24.80 and 24.07 individuals/tiller found associated with the highest rate of aphid's population in Giza-3 imp. variety in intercropping plots in both seasons, respectively. Respective means decreased to 1.53, 1.27, 0.23and 0.07 and 1.53 , 1.37, 0.10 and 0.03 individuals/ tiller, with the averages of 3.10 and 3.03 individuals/tiller was associated with minimum aphid's population in Giza-843 variety without intercropping in the two seasons. From the previous results, it can be concluded that *C. sativium* might play a positive role for attracting aphid's predators (Van Emden 1965; Altieri and Whitcon 1979 and Molthan and Ruppert 1988). The incidence of aphid predators under the previous treatments might lead relatively to suppress the population of *A. craccivora*. Many studies on habitat manipulation within agricultural landscape

Table (1): Interactions among five faba bean varieties intercropped with coriander concerning *A. craccivora* and associated predators populations and seed yield in Egypt in 2007/08 and 2008/09 growing seasons

Traits	Mean no of aphid / tiller ±SE		Mean No. of Predators±SE								Total Mean No of predators±SE		Seed yield / plant (g)±SE		Seed yield / Fed (Ton)±SE	
			C. undecimpunctata adult		*C. undecimpunctata* larvae		*M.corollae* larvae		*Ch. carnea* larvae							
treatments	Plots A	Plots B	Plots A	Plots B	Plots A	Plots B	Plots A	Plots B	Plots A	Plots B	Plots A	Plots B	Plots A	Plots B	Plots A	Plots B
Varieties	2007/2008 season															
Nubaria 1	271.10±2.70	391.90±2.70	5.90±0.08	1.60±0.08	4.53±0.11	1.30±0.11.	3.47±0.19	0.20±0.19	2.07±0.11	0.10±0.11	15.93±0.11	3.20±0.11	46.33±0.43	33.93±0.43	1.87±0.04	1.37±0.04
Skha 1	360.93±2.70	516.23±2.70	7.93±0.08	1.97±0.08	5.37±0.11	1.73±0.11	5.10±0.19	0.40±0.19	2.70±0.11	0.13±0.11	21.10±0.11	4.23±0.11	41.20±0.43	31.10±0.43	1.67±0.04	1.27±0.04
Giza 3 imp.	423.93±2.70	597.37±2.70	8.87±0.08	2.33±0.08	6.53±0.11	1.97±0.11	5.97±0.19	0.43±0.19	3.43±0.11	0.17±0.11	24.80±0.11	4.90±0.11	36.30±0.43	28.77±0.43	1.47±0.04	1.17±0.04
Masr 2	283.30±2.70	429.10±2.70	6.70±0.08	1.97±0.08	4.70±0.11	1.63±0.11	4.07±0.19	0.27±0.19	2.67±0.11	0.07±0.11	18.70±0.11	3.93±0.11	42.77±0.43	33.07±0.43	1.73±0.04	1.33±0.04
Giza 843	263.77±2.70	380.47±2.70	5.73±0.08	1.53±0.08	4.60±0.11	1.27±0.11	3.13±0.19	0.23±0.19	2.07±0.11	0.07±0.11	15.53±0.11	3.10±0.11	46.43±0.43	33.90±0.43	1.87±0.04	1.40±0.04
LSD at 0.05	5.7		0.16		0.25		0.41		0.24		0.24		0.92		0.08	
Total mean	320.61±0.69	463.01±0.69	7.03±0.07	1.88±0.07	5.15±0.08	1.58±0.08	4.35±0.13	031±0.13	2.59±0.06	0.11±0.06	19.09±0.07	3.87±0.07	42.61±0.23	32.15±0.23	1.72±0.0	1.31±0.02
	2008/2009 season															
Nubaria 1	256.20±3.71	385.63±3.71	5.93±0.15	1.50±0.15	4.50±0.14	1.40±0.14	3.57±0.23	0.17±0.23	1.97±0.11	0.06±0.11	15.97±0.22	3.13±0.22	46.80±0.67	35.73±0.67	1.90±0.03	1.40±0.03
Skha 1	344.33±3.71	494.27±3.71	7.90±0.15	1.97±0.15	5.43±0.14	1.77±0.14	4.60±0.23	0.20±0.23	3.23±0.11	0.10±0.11	21.17±0.22	4.03±0.22	42.30±0.67	32.53±0.67	1.70±0.03	1.30±0.03
Giza 3 imp.	391.33±3.71	523.57±3.71	8.97±0.15	2.07±0.15	6.23±0.14	1.87±0.14	5.27±0.23	0.02±0.23	3.60±0.11	0.07±0.11	24.07±0.22	4.23±0.22	37.33±0.67	29.53±0.67	1.50±0.03	1.20±0.03
Masr 2	263.80±3.71	409.33±3.71	6.43±0.15	1.87±0.15	4.80±0.14	1.70±0.14	3.93±0.23	0.20±0.23	3.03±0.11	0.07±0.11	18.02±0.22	3.77±0.22	44.73±0.67	34.43±0.67	1.77±0.03	1.38±0.03
Giza 843	254.97±3.71	373.90±3.71	5.90±0.15	1.53±0.15	4.10±0.14	1.37±0.14	3.70±0.23	0.10±0.23	2.33±0.11	0.03±0.11	16.03±0.22	3.03±0.22	47.17±0.67	35.57±0.67	1.90±0.03	1.40±0.03
LSD at 0.05	6.72		0.33		0.29		0.50		0.24		0.46		1.42		0.05	
Total mean	302.13±1.09	437.34±1.09	7.03±0.04	1.79±0.04	5.01±0.04	1.62±0.04	1.62±0.04	0.18±0.15	2.83±0.07	0.07±0.07	19.09±0.10	3.64±0.10	43.67±0.24	33.56±0.24	1.75±0.01	1.34±0.01

Plots A = Intercropped with coriander Plots B = Without Intercropping

have concentrated on polyphagous predators including carabid beetles (Thomas *et al.* 1992 and Lys and Nentwing 1992). Colley and Luna (2000) found that coriander (*C. sativum)* was the most favored flowering plants to attract syrphids and other natural enemies.

Seed yield/plant and fed intercropping traits gave significantly highest total means of 42.61 and 43.67 g./plant (1.72 and 1.75 ton/fed.) in coriander intercropping plots in the two seasons, respectively (Table 1). On the other hand, respective seed yield in the faba bean plots without intercropping, recorded 32.15 and 33.56 g./plant (1.31 and 1.34 ton/feddan) in the two seasons. Highest weights (46.43 and 47.17g./plant) were recorded in Giza–843 variety under strip–management of coriander, while the lowest ones (28.77 and 29.53 g./plant) was found in Giza–3 improve variety without intercropping in both seasons, respectively. A sharp increase of seed yield (ton/ fed.) in the intercrop plots for all tested faba bean varieties, recorded the highest means of 1.87 and 1.90 ton/ fed. in Nubaria–1 and Giza-843 variety in the two seasons, respectively. On the other hand, the lowest yields (1.17 and 1.2 ton/ fed.) were found in the plots of Giza-3 imp. without intercropping in both seasons, respectively. Nubaria-1 and Giza–843 varieties seemed to be the best faba bean varieties whereas lowest mean numbers of the pest and highest mean values of seed yield/ plant and feddan were recorded. It is worth to mention that the character of tolerance to aphid attack did not necessarily mean that the variety gives the highest yield, but mainly exhibits less damage throughout unsuitability for build–up of aphid population (Bond and Lowe, 1975 and El- Defrawi & Bishara 1992).

Susceptibility of faba bean varieties to *A. craccivora* infestation

Susceptibility of tested faba bean varieties to aphid's infestation and their yields during the two seasons of the study are presented in table (2). Statistical analysis indicated highly significant variations among the varieties for all the studied traits. The varieties could be arranged descendingly according to their susceptibility to aphid's infestation as follows: Giza-3 improve, Sakha-1, Masr–2, Nubaria–1 and Giza-843. However, the two varieties Giza-843 and Nubaria-1 harbored significantly lower aphid population than the others. They showed good growth and filled large pods compared to the other varieties which were heavily infested and seriously damaged by the pest during two seasons. The Giza–843 variety received the lowest mean numbers of aphid (322.1 and 314.43 individuals/ tiller) in the two seasons; respectively. Therefore, it seemed to be the most tolerant one. On the other hand, Giza-3 improve was heavily infested, scored the highest means (510.65 and 457.45 individuals /tiller) in the two seasons, respectively. Therefore, it seemed to be the most susceptible one.

Concerning the predators, highest means (5.60, 4.25, 3.20 and 1.80) and (5.52, 4.05, 2.75 and 1.83) individuals/ tiller of *C undecimpunctata* adults, *C. undecimpunctata* larvae, *M. corollae* larvae and *C. canea* larvae, respectively, with the averages of 14.85 and 14.15 individuals/tiller associated with highest rates of aphid's population on Giza–3 imp. variety in the two seasons (Table 2). Respective means decreased to 3.63, 2.93, 1.68 and 1.07 and 3.72, 2.73, 1.90 and 1.18 individuals/ tiller, with the

Table (2): Effect of certain *Vicia faba* cultivars on the mean number of *A. craccivora*, associated predators and seed yield in Egypt in 2007/08 and 2008/09 growing seasons

Traits	Mean no of aphid / tiller ±SE	Mean no. of predators ±SE				Total mean no of predators ±SE	Seed yield / plant (g) ±SE	Seed yield / fed (ton) ±SE
		C. undecimpunctata		*M. corollae* larvae	*Ch. Carnea* larvae			
		adult	larvae					
varieties	2007/08 season							
Nubaria 1	331.50±1.91 [d]	3.75±0.05	2.92±0.08	1.83±0.14	1.08±0.08	9.57±0.08	40.13±0.31 [a]	1.62±0.03 [a]
Sakha 1	438.58±1.91 [b]	4.95±0.05	3.55±0.08	2.75±0.14	1.42±0.08	12.67±0.08	36.15±0.31 [c]	1.47±0.03 [c]
Giza 3 imp.	510.65±1.91 [a]	5.60±0.05	4.25±0.08	3.20±0.14	1.80±0.08	14.85±0.08	32.53±0.31 [d]	1.32±0.03 [d]
Masr 2	356.20±1.91 [c]	4.33±0.05	3.17±0.08	2.17±0.14	1.37±0.08	11.00±0.08	37.92±0.31 [b]	1.53±0.03 [b]
Giza 843	322.12±1.91 [c]	3.63±0.05	2.93±0.08	1.68±0.14	1.07±0.08	9.32±0.08	40.17±0.31 [a]	1.63±0.03 [a]
LSD at 0.05	4.04	0.12	0.17	0.29	0.17	0.17	0.65	0.05
varieties	2008/09 season							
Nubaria 1	320.92±2.32 [d]	3.72±0.11	2.95±0.10	1.87±0.16	1.02±0.08	9.55±0.15	41.27±0.61 [a]	1.65±0.02 [a]
Sakha 1	419.30±2.32 [b]	4.93±0.11	3.60±0.10	2.40±0.16	1.67±0.08	12.60±0.15	37.42±0.61 [c]	1.50±0.02 [c]
Giza 3 imp.	457.45±2.32 [a]	5.52±0.11	4.05±0.10	2.75±0.16	1.83±0.08	14.15±0.15	33.43±0.61 [d]	1.35±0.02 [d]
Masr 2	336.57±2.32 [c]	4.15±0.11	3.25±0.10	2.07±0.16	1.55±0.08	10.98±0.15	39.58±0.61 [b]	1.58±0.02 [b]
Giza 843	314.43±2.32 [c]	3.72±0.11	2.73±0.10	1.90±0.16	1.18±0.08	9.53±0.15	41.37±0.61 [a]	1.65±0.02 [a]
LSD at 0.05	4.73	0.23	0.21	0.35	0.17	0.32	1.30	0.04

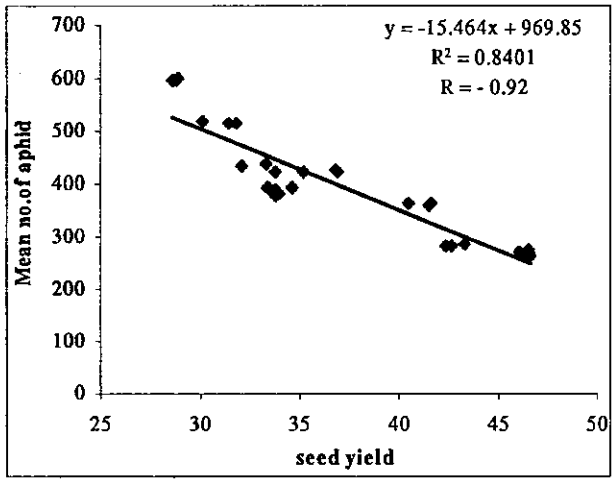

Fig. (1): Regression line of seed yield and mean no. of *A. craccivora*, season 2007/08.

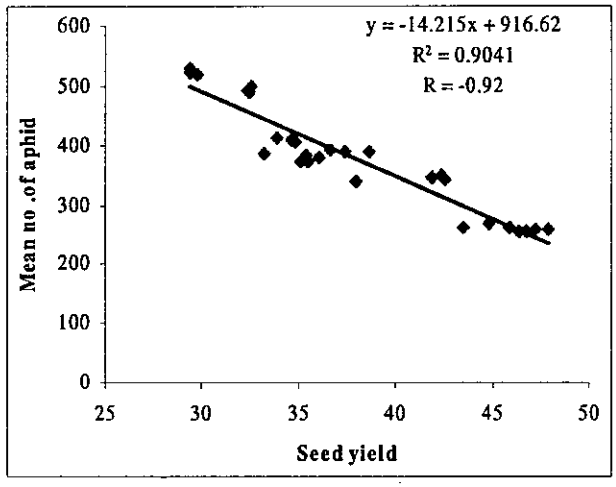

Fig. (2): Regression line of seed yield and mean no. of *A. craccivora*, season 2008/09.

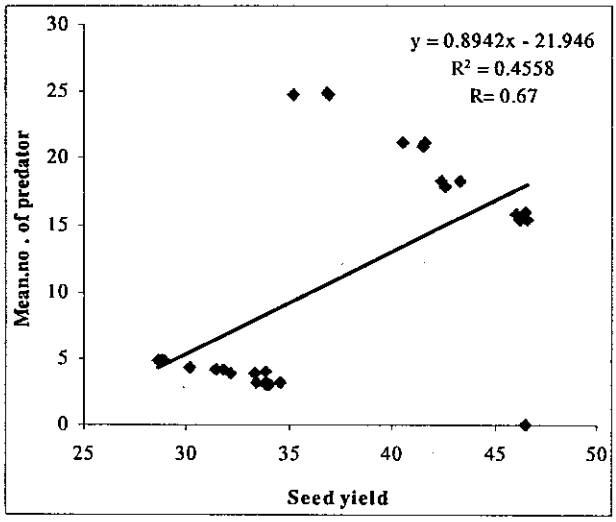

Fig. (3): Regression line of seed yield and mean no. of predators, season 2007/08.

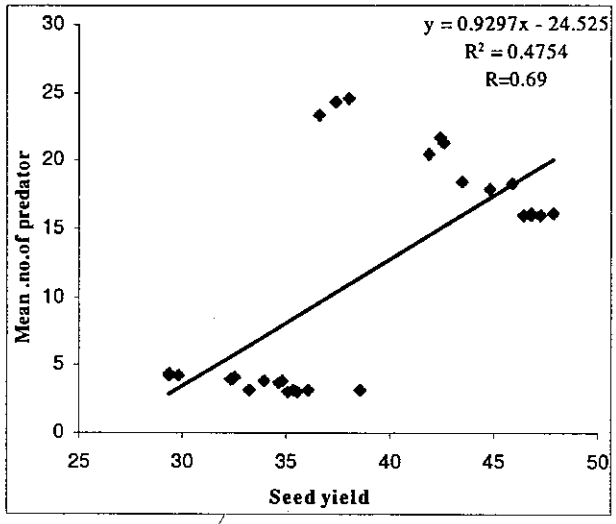

Fig. (4): Regression line of seed yield and mean no. of predators, season 2008/09.

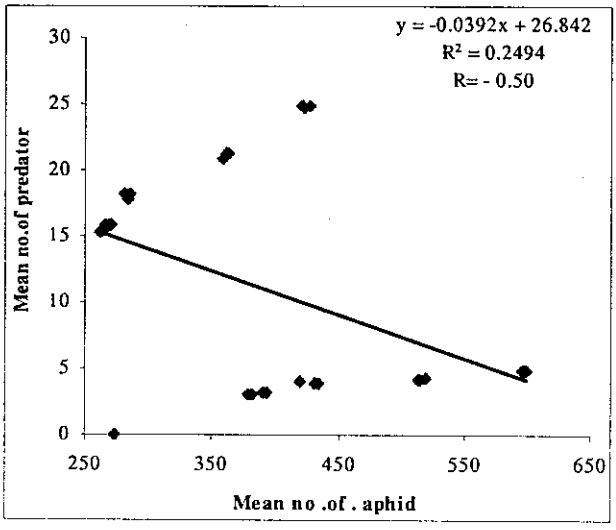

Fig. (5): Regression line of mean no. of *A. craccivora* and mean no. of predators, season 2007/08.

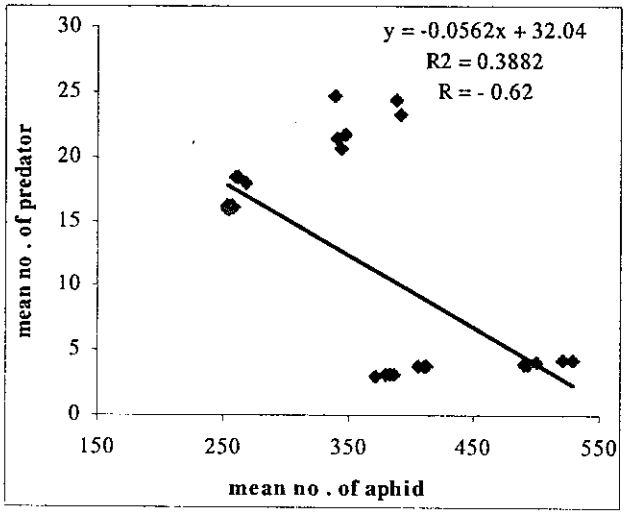

Fig. (6): Regression line of mean no. of *A. craccivora* and mean no. of predators, season 2008/09.

averages of 9.32 and 9.53 individuals/ tiller and with a minimum aphid's population on Giza–843 variety.

Data presented in table (2), showed also that the yields varied and significantly influenced by infestation's level, number of predators and susceptibility of the tested varieties to aphid's attack in two seasons. Seed yield (g./ plant), highest weight (40.17 and 41.37 g./ plant) was found in Giza–843 variety, while Giza–imp. scored the lowest yield (32.53 and 33.43 g./ plant) in both years, respectively. Estimated yield (ton/ fed.) was the highest (1.63 and 1.65) in Giza-843 during the two seasons, respectively. Giza–3 imp. scored the lowest yield (1.32 and 1.35 ton /fed.). Obtained results are in agreement with those of Hinze and Daebel (1984) who found that the initial infestation with aphid on faba bean, which started at the flowering stage, caused a reduction of 52-84% in seed yield. El-Defrawi *et al.* (1998) reported that the avoidable loss in seed yield of faba bean Giza 2 variety due to *A. craccivora* attack was 0.081 to 1.308 t./fed.

Correlation and liner Regression Coefficient

Figures (1 and 2) illustrate a significant negative correlation between seed yield/plant and mean number of aphid/ plant (R= -0.92 and –0.92) in both seasons. The negative linear relationship (Y= -15.464 X +969.85 and Y = -14.215 X +916.62) was found in both seasons, respectively. The relationship indicated that increasing aphid's population adversely affect seed yield. These results confirm obtained data in tables (1 and 2). Figs. (3 and 4) show a significant positive correlation coefficient between mean numbers of predators and seed yield/ plant (R= +0.67 and +0.69) and a positive linear relationship (Y = 0.8942 X – 21.946 and Y = 0.9297 X – 24.525) in the two seasons, respectively. Figs. (5 and 6) indicate a significant negative correlation between mean number of aphid/ plant and mean number of associated predators (R = -0.50 and 0.62), as well a negative linear relationship (Y = 0.0392 X + 26.842 and Y = 0.0562 X + 32.04) in both seasons, respectively. This result may reflex the positive role of predators in maintaining a low aphid's population and cause of a significant increase in seed yield.

From the previous results, it could be concluded that intercropping faba bean crop with *C. sativum* is a highly recommended method in pest control programs; it is a cheap, effective and safe method to minimize *A. craccivora* population, to attract more predators as well to conserve biodiversity.

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