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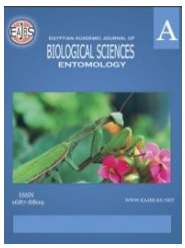

Studies on the Release of the Two Predatory Species *Ccoccinella septempunctata* L. and *Chrysoperla carnea* (Steph.) for Controlling the Legume Aphid, *Aphis craccivora* Koch., on the Faba Bean Plants, in the Greenhouses Located in Sohag Governorate

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ABSTRACT

In Egypt, the faba bean plants (*Vicia faba* L.) are considered as one of the most important winter field crops that are continuously and extensively grown year after year. This crop is subjected to attack by the legume aphid, *Aphis craccivora* Koch. (Homoptera: Aphididae), which cause obvious damage to the resulted faba bean yield. The obtained results indicated that the faba bean plants that were cultivated in the greenhouses of the two tested released areas (the ladybird beetle, *Ccoccinella septempunctata* L. (Coleoptera: Coccinellidae) and the green lacewing, *Chrysoperla carnea* (Steph.) (Neuroptera: Chrysopidae) areas), when were compared with that area of the unreleased control were as follow: for the unreleased control, the mean total numbers of the legume aphid *A. craccivora* individuals per season were; 64.91±12.66 (13.35-150.52) and 43.88±10.79 (2.57-110.00) individuals, for the two successive seasons 2016/2017 and 2017/2018, respectively. While, in case of the released area of the ladybird beetle *C. septempunctata*, the corresponding mean total numbers of the legume aphid, *A. craccivora* were; 16.92±5.25 (0.00-53.72) and 17.31±6.27 (0.00-79.02) individuals, for the two seasons respectively, with a mean percentage of reduction in the mean total numbers of the legume aphid, *A. craccivora* for the two seasons together of 67.11% (60.29 -73.93%). But, in case of the released area of the green lacewing, *C. carnea*, the mean total numbers of the legume aphid, *A. craccivora* individuals for the two seasons were; 15.15±4.95 (0.00-50.72) and 15.76±6.23 (0.00-78.47) individuals, with a mean percentage of reduction in the mean total numbers of the legume aphid, *A. craccivora* for the two seasons together of 70.34% (64.04-76.64%). Also, using the two previous biocontrol agents had led to an increase in the yield of faba bean crop. Therefore, the obtained results revealed the important role of the two predators (the ladybird beetle, *C. septempunctata* and the green lacewing, *C. carnea*), as effective biocontrol agents, (representing a major component of the biological control techniques) against the legume aphid, *A. craccivora*on the faba bean plants. As a result, they can be released in the faba bean fields and/or other related fields that suffer from the pest attack. Using such biocontrol agents must be included in Integrated Pest Management (I.P.M.) strategies, for decreasing the chemical control methods for avoiding the undesirable effects of the direct use of the insecticidal application, for protecting man and his surrounding environment from pollution.

INTRODUCTION

In Egypt, the faba bean plants (*Vicia faba* L.) are considered as one of the most important field crops that are continuously and extensively grown year after year, representing a popular local feeding and market crop for the Egyptian people. The faba bean plants are subjected to attack by many important sap-sucking insects' pests such as; the legume aphid, *Aphis craccivora* Koch. (Ali *et al.,* 2013; Ali, 2014 and Gaber *et al.,* 2015). This pest species induces much severe damage to the faba bean plants by their feeding on the plants leaves. Where, Stanković *et al.* (2015) showed that, in general, the damage caused by the aphids' infestation includes sucking the plant sap by their piercing-sucking mouthparts and the transmission of many viral diseases from the infected to the healthy plants. Aphids have a high reproductive capability and a rapid buildup of their population in a short time. Also, they secrete honeydew, which prevents the photosynthesis process resulting in the wilt and the death of the agricultural plants, where, these factors cause obvious economic losses in the yield and the quality of the resulted crops.

Although chemical control might provide satisfactory results in pests control, it is also responsible for the occurrence of the residual chemical problems and can interfere with the biological control methods of these pests **(**Gameel 2004). As, the use of chemical insecticides for controlling the insects' pests has caused many environmental pollutions and many hygienic problems, that represent a risk for both people and animals (Gallo, 2007). Besides, the occurrence of the disruption in the natural balance existed between these pests and the common natural enemies (Ibrahim *et al.,* 2014). For example, some of the commonly used insecticides were found to not only decrease the aphid outbreak but also will be responsible for removing the aphid predatory species and allowing the aphid population to dramatically increase.

The need of reducing pesticide usage has provided the need for the development of many effectives' alternatives to conventional chemical pesticides (El-Akhadar & Ouda, 2009). The field of biological control techniques has received much crucial worldwide and revealed the presence of a significant impact as a possible safe and acceptable way in the insect control programs (Sabbour & Abbas, 2007).

Many natural enemies such as predators (as one of the main components of the biological control agents) play a noticeable natural role against the different insects' pests in the view of agriculture (El-Khawas, 2005). As, for example, the predators that belong to family Coccinellidae (that are characterized by their feeding during both the larval and the adult stages) and also the predators that belong to family Chrysopidae (that are characterized by their feeding during the larval stage), on the different sap-sucking pests including aphids, whiteflies, jassids and mites as well as other small insects (Shalaby *et al.,* 2008). In addition, Rakhshan and Equbal (2015) stated that coccinellid beetles due to their high foraging performance, immense predatory potential and high reproductive efficacy and then they possess the potential to be effectively employed in biological control programs. From these predators, the coccinellid ladybird predator *Coccinella septempunctata* L. was recorded as an effective biocontrol agent against many insects' pests and was considered as an interesting potential control agent in the context of Integrated Pest Management (I.P.M.) **(**Arif *et al.,* 2017). The green lacewing, *Chrysoperla carnea* (Steph.) (Neuroptera: Chrysopidae) represented one of the most predators, which is quite common in the agricultural ecosystems in most of the world countries and received great attention in the field of biological control (Atallah *et al*., 2009 and El-Sahn & Gaber, 2012). Where, the green lacewing, adults of *C. carnea* feed on the pollen, nectar, or the honey (Abdel-Samad, 2011), while, the predatory larvae are polyphagous that feed upon a wide range of pests' species such as; the aphids, the whiteflies, the mealybugs, the scale insects,

the leafhoppers, the psyllidae, the psocides, the lepidopterans pests and the mites (Remoldi *et al*., 2008).So, the present work was carried out to study the effect of releasing the adults of the coccinellid ladybird *C. septempunctata* and the third larval instars of the green lacewing, *C. carnea*, on the faba bean plants for controlling the legume aphid, *A. craccivora* during the two successive seasons 2016/2017 and 2017/2018, in Sohag Governorate. Such experimental information is considered as one of the main concepts that may help in planning I.P.M strategies against the legume aphid, *A. craccivora* on the faba bean plants or other plants that are subjected to attack by the insect pest species, side by side with the other applied safe control methods.

MATERIALS AND METHODS

The present study was carried out in the greenhouses that were located in Shandaweel Agricultural Research (Sohag Governorate), during the two growing winters cultivated faba bean (variety Misr 1), of the two successive seasons 2016/2017 and 2017/2018. The tested designed experimental areas of faba bean plants were located under the nine green houses that were cultivated in the third and the second weeks of October, 2016&2017, respectively. Where these experiments were extended from the third week of December till the last and the third weeks of January 2017 &2018, in the two successive seasons 2016/2017 and 2017/2018, respectively. These studied areas were chosen and designed as shown in Fig. (1), for controlling the legume aphid, *A. craccivora* attacking the faba bean plants.

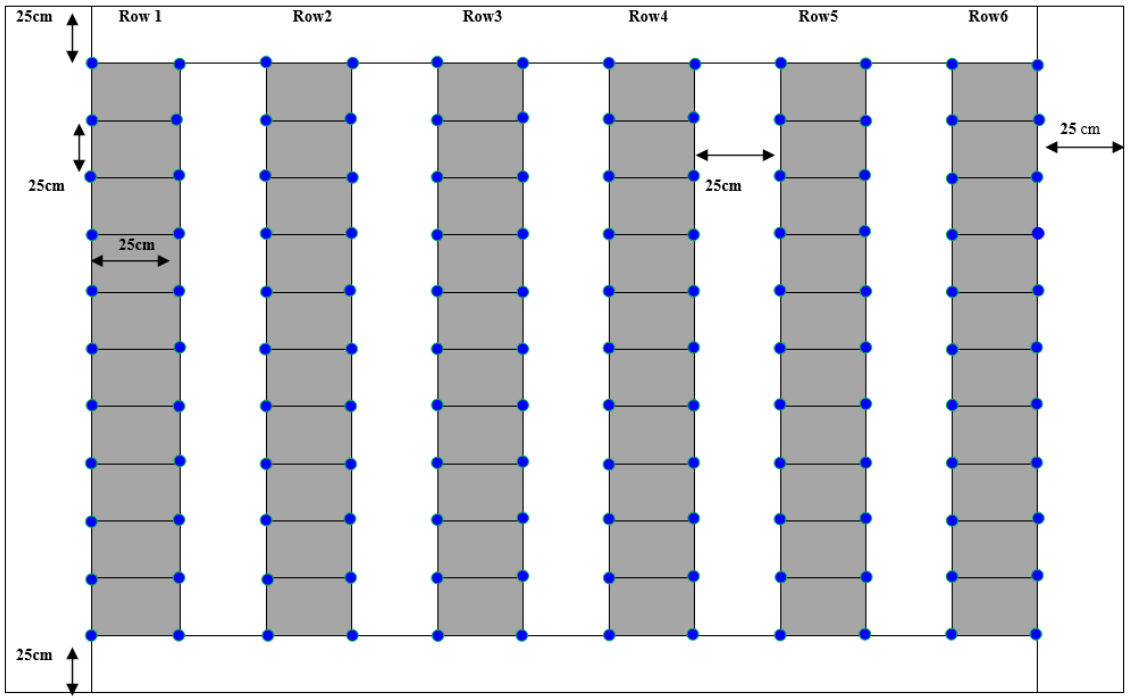


Fig. 1: The design of each of the experimental areas that was used for carrying out the study.

A- The Greenhouse Experimental Design:

The following steps were followed for carrying out the experiments in this study:

1- The nine greenhouses that were used, representing the three different areas of three replicates each (=3 experimental areas×3 replicates). The total cultivated areas of the faba bean plants were87.75m^2 (= the total areas of the unreleased control and the two releasing areas of both *C. septempunctata* and *C. carnea*).

2-Each experimental area contains three replicates of 29.25m^2(i.e., each replicate was 9.75m^2=3.25m×3m). Where each replicate was represented by six double rows that were planted with 132faba bean plants (=22 faba bean plants/one double row×6double rows). Each case contains 396 plants (=3 replicates×132 faba bean plants/one area), so, the total cultivated faba bean plants for all three areas used were 396 plants/one area×3areas =1188faba bean plants for all three tested areas.

3- The distances were equal (25cm) for the following; the distance between faba bean plants, the distance between rows and the external limits from each side of the greenhouse.

4-However, the investigated areas received all the recommended agricultural practices throughout the periods of the two seasons; except the application of the chemical insecticides which were entirely avoided.

B- The Source of The Two Biological Control Agents; *C. septempunctata* Adults and *C. carnea* Larvae:

1- A total numbers of 50 pairs (100 males and females adults, that were put in four cups; i.e., 25 adults in each plastics cup were used), indicating the use of 12 cups=4cups/replicate×3replicates (each one cup was 4.5×5.5), for all the experiment concerning the predator *C. septempunctata*).Therefore, a total number of 300 predatory adults of the ladybird beetle, *C. septempunctata* were used for the experiment concerning the release of this predator (100 predators/one replicate×3replicates).As for releasing the predatory third larval instars of the green lacewing, *C. carnea*,50 larvae were put in small paper bugs and were feed on *Sitotroga cerealella* eggs (placed on a glued paper cart).So, each experimental area contains 100 predatory larvae, so a total of 300 predatory larvae of the green lacewing, *C. carnea* (100 predators/one replicate×3replicates) were used (Fig., 2).

2- These two predatory species (the adults of the ladybird beetle, *C. septempunctata* and the third larval instars of the green lacewing, *C. carnea*), were obtained from the Biodynamic Agriculture Services Centre of the High Dam Lake Settlement Project Dependent, Ministry of Agriculture at Aswan Governorate.

Fig. (2): The releasing of the green lacewing, *C. carnea* predatory larvae for controlling the legume aphid, *A. craccivora*. **A=** Rearing unit of *C. carnea* larvae in the laboratory. **B=** *C. carnea* larval feeding on *S. cerealella* eggs on a paper cart.
C= Two plastic cups containing *C. carnea* larvae ready for their release on the faba bean plants in the greenhouse.

C- The Release of The Two Biological Control Agents; *C. septempunctata* Adults and *C. carnea* Larvae:

1-The two released areas of the two common predatory species (the area of the ladybird

beetle, *C. septempunctata* and that area of the green lace wing, *C. carnea*) were compared to the area of the unreleased control (no predators' release).

2-The two previous predatory species were both released for controlling the legume aphid, *A. craccivora* only one time in 24/12/2016and 22/12/2017, in 2016/2017 and 2017/2018 seasons, respectively.

D- Sampling and Data Calculations:

1- Sampling was done early in the morning on the faba bean plants during the two months of December and January. Where, it began in the second week of December and continued till the last week of January, in the two successive studied seasons 2016/2017 and 2017/2018.Random regular samples of 20faba bean plants were carefully examined from each replicate, i.e., 60 plants were examined (20 plants/one replicate×3 replicate). A total number of 180 faba bean plants were examined for the three studied areas (the unreleased control area (60plants), the released area of the ladybird beetle, *C. septempunctata* (60plants) and the released area of the green lacewing, predator *C. carnea* (60plants).

2- The total numbers of the legume aphid, *A. craccivora* individuals of the three tested areas (the unreleased control area, the released area of the ladybird beetle, *C. septempunctata* and the released area of the green lacewing, *C. carnea*), were recorded and counted throughout the two successive seasons 2016/2017 and 2017/2018.The percentages of the reduction in the legume aphid, *A. craccivora* individuals' population in the two released areas (the area of the adults release of the coccinellid ladybird beetle, *C. septempunctata* and the area of the larvae of the green lacewing, *C. carnea*, were calculated in comparing with the unreleased control area according to the following equation:

$$\% \text{ Reduction in the mean total numbers of the legume aphid, } A. \text{ craccivora} = 100 - \frac{\text{Total no. of the legume aphid, } A. \text{ craccivora in either the released area of the ladybird beetle, } C. \text{ septempunctata or the released area of the lacewing, } C. \text{ carnea}}{\text{Total no. of the faba bean aphid, } A. \text{ craccivora in the unreleased control area (no predators' release)}} \times 100$$

3- The mean total weight (gm) of the resulted faba bean seeds crop was calculated and compared for the two tested released cases (either that of the adults coccinellid ladybird *C. septempunctata* or that of the green lacewing, *C. carnea*), in relation to the unreleased control area. A mean total number of 100 faba bean seeds were weighted for each replicate (i.e.,100seeds/one replicate×3replicates=300 faba bean seeds for each case), and was estimated for the three tested cases (the unreleased control area, the released area of the ladybird beetle *C. Septempunctata* and the released area of the green lacewing *C. carnea* larvae. I.e., a total of 900 seeds were chosen and weighted (300 faba bean seeds for each case×3cases).

E- Statistical Analysis and The Weather Factors Relationships of The Obtained Data:

1- The obtained data were carefully tabulated and statistically analyzed to calculate the means and the r-values (correlation coefficient) by using SPSS program version (15.0.).

2- The weather factors including the means of temperatures and the relative humidity were obtained from the Meteorological Station at A.R.C., to find out the correlation relationships with the obtained data in this study.

RESULTS AND DISCUSSION

Data presented in Tables (1&2) and Fig. (3), showed the effect of releasing the adults of the coccinellid ladybird beetle, *C. septempunctata* and the larvae of the green lacewing, *C. carnea* on the faba bean plants for controlling the legume aphid, *A. craccivora*, during the two successive seasons 2016/2017 and 2017/2018, in the greenhouses located in Sohag Governorate.

1-The Population Density of The Legume Aphid,*A. craccivora*Individuals in The Unreleased Control Area:

As shown in Tables (1&2) and Fig. (3), in season 2016/2017, the legume aphid, *A. craccivora* individuals started to appear with a mean low number in the unreleased control area (29.15 individuals), in 15/12/2016 (at means of the temperature of13.00C˚& relative humidity 58.50%). They reached their maximum mean total number (150.52 individuals) on30/12/2016 (at 12.00C˚&56.00R.H.%).Finally, there was a decrease with a mean low total number (13.35 individuals) on23/1/2017 (at 14.00C˚&50.00 R.H. %). As for season 2017/2018, the legume aphid, *A. craccivora* individuals started to appear with a mean low number of the unreleased control (16.94 individuals), in 13/12/2017 (at 16.00 C˚&43.00 R.H. %). Then, they reached the maximum mean total number (110.00 individuals) on 25/12/2017 (at 12.00 C˚&61.00 R.H.%). A decrease in the mean total number (2.57 individuals) has occurred on 21/1/2018. The mean total numbers of the legume aphid, *A. craccivora* individuals per season were; 64.91±12.66 (13.35-150.52) and 43.88±10.79 (2.57-110.00) individuals, for 2016/2017 and 2017/2018 seasons, respectively. However, the legume aphid, *A. craccivora* was recorded as a pest of faba bean plants by many authors such as Saranya *et al.* (2010); Mahmoud *et al.* (2015); Hassan *et al.* (2016) and Abd El-Wareth (2016).

Table 1: Mean total numbers of *A. craccivora* individuals that were recorded per one faba bean plant, in comparing; the unreleased control (no predator release), with those recorded after releasing the lady bird beetle, *C. septempunctata* and the green lacewing, *C. carnea* against the pest during 2016/2017 season, in Sohag Governorate.

No.	Dates of sampling	Unreleased control	*C. septempunctata*	*C. carnea*	Weather factors	
					Mean C°	Mean R.H.%
1	15/12/2016	29.15	29.15	29.15	13.00	58.50
2	18/12	36.24	34.83	34.26	13.00	62.50
3	21/12	44.27	42.25	41.93	11.00	57.00
4	24/12	54.48	53.72	50.72	11.00	60.50
5	27/12	93.80	41.60	32.42	11.00	61.00
6	30/12	150.52	22.20	15.20	12.00	56.00
7	2 /1/2017	142.33	7.62	6.20	9.00	51.50
8	5 /1	122.12	3.40	1.90	12.00	54.00
9	8 /1	94.45	1.22	0.43	9.00	53.00
10	11/1	62.10	0.95	0.00	10.00	52.00
11	14/1	26.38	0.00	0.00	13.00	56.00
12	17/1	21.82	0.00	0.00	13.00	53.50
13	20/1	17.73	0.00	0.00	13.00	55.50
14	23/1	13.35	0.00	0.00	14.00	50.00
(Mean/ range)		64.91±12.66 (13.35-150.52)	16.92±5.25 (0.00-53.72)	15.15±4.95 (0.00-50.72)	11.71 C° (9.00-14.00C°)	55.79% (50.00-62.50%)
% Reduction			73.93%	76.64%		

- Statistical analysis of the obtained data in the first season 2016/2017 revealed that:
- There was no significant correlation between the unreleased control area and the released one of the ladybird beetles *C. septempunctata*, in case of comparing the mean total numbers of the legume aphid, *A. craccivora* (the r-value was=0.037& sig.=0.900).
- There was no significant correlation between the unreleased control area and the released one of the green lacewing *C. carnea*, in case of comparing the mean total numbers of the legume aphid, *A. craccivora* (the r-value was=-0.051& sig.=0.863).
- There was a very highly significant correlation between the released one of the ladybird beetle *C. septempunctata* and the released one of the green lacewing *C. carnea*, in case of comparing the mean total numbers of the legume aphid, *A. craccivora* (the r-value was=0.991****& sig.=0.000).

Note: *Significant (0.500-0.600) **Moderate significant (0.600-0.800) ***Highly significant (0.800-0.900) ****Very highly significant>0.900.

2- The Releasing of The Adults' Predator of *C. septempunctata* Against the Legume Aphid, *A. craccivora:*

As shown in Tables (1&2) and Fig. (3), in season 2016/2017, the legume aphid, *A. craccivora* individuals started to appear with a mean low number of releasing the ladybird predator *C. Septempunctata* (29.15 individuals) on 15/12/2016 (at 13.00C˚&58.00 R.H. %). They reached the maximum mean total number (53.72 individuals) on 24/12/2016 (at 11.00C˚&60.50 R.H. %). Finally, no aphid species were recorded on 14-23/1/2017. For season 2017/2018, the legume aphid, *A. craccivora* individuals started to appear with a mean low number (16.94individuals), on13/12/2017(at16.00C˚&43.00 R.H. %). Then, they reached the maximum mean total number (79.02 individuals), on 22/12/2017 (at 21.00C˚&60.00 R.H. %). Finally, no aphid species were recorded on 12-21/1/2018. The mean total numbers of the legume aphid, *A. craccivora* individuals per season were; 16.92±5.25 (0.00-53.72) and 17.31±6.27(0.00-79.02) individuals, for 2016/2017and2017/2018 seasons, respectively. The percentage of the reduction of the legume aphid, *A. craccivora* individuals in the area in which the ladybird predatory adults of *C. septempunctata* were released in comparison with that of the unreleased control area was 73.93% in season 2016/2017 and 60.29% in season 2017/2018. The mean percentage of the reduction of the legume aphid, *A. craccivora* individuals for the two seasons together was 67.11% (60.29-73.93%). So, from the obtained results it was recorded that, the percentage of reduction of the legume aphid, *A. craccivora* individuals was relatively higher in the first season (2016/2017) in comparing with that percentage of reduction recorded in the second one (2017/2018).

Many investigators such as; Benrey & Lamp (1994) showed that, in agricultural systems, the use of the natural enemy complexes, as opposed to a single enemy strategy, has been a controversial issue in the management and the biological control of pests. Aphidophagous ladybird beetles have been receiving attention as biological control agents due to some of their characteristics, such as the ability to feed on a wide range of prey, be very voracious and having a rapid numeric response (Dixon, 2000). The predators that belong to the family Coccinellidae comprise one of the most active groups of the predatory species that gained the interest of many investigators as an important group of the predators in the field of the biological control of insects' pests attacking different crop plants (Bahy El-Din, 2006). The seven-spotted coccinellid beetle, *C. septempunctata* was shown to have extensive dispersal power on the majority of the field crops (Khan& Suhail, 2001).

3- The Releasing of The Green Lacewing Predator, *C. carnea* Against the Legume Aphid, *A. craccivora*:

As shown in Tables (1&2) and Fig. (3), in season 2016/2017, the legume aphid, *A. craccivora* individuals started to appear with a mean low number of 29.15 individuals, in 15/12/2016 (at 13.00C˚&58.50R.H. %). They reached the maximum mean total number (50.72 individuals) on 24/12/2016 (at 11.00C˚&60.50 R.H. %) Finally, no aphid individuals were recorded on 8-23/1/2017.For season 2017/2018, the legume aphid, *A. craccivora* individuals started to appear with a mean low number (16.94 individuals), on 13/12/2017 (at 16.00 C˚&43.00 R.H. %). They reached the maximum mean total number (78.47 individuals), on 22/12/2017 (at 21.00 C˚&60.00 R.H. %). Finally, no aphid species were recorded on8-21/1/2018. The mean total numbers of the legume aphid, *A. craccivora* individuals per season were; 15.15±4.95 (0.00-50.72)and15.76±6.23 (0.00-78.47)individuals, for 2016/2017 and 2017/2018 seasons, respectively. In season 2016/2017, the percentage of reduction in the mean total number of the legume aphid, *A. craccivora* individuals was 76.64% in comparison with that of the unreleased control area. In season 2017/2018, the mean percentage of reduction in the mean total number of the

legume aphid, *A. craccivora* individuals was 64.04%, while, the mean percentage of reduction for the two seasons together was 70.34% (64.04-76.64%).

The green lacewing, *C. carnea*is a polyphagous predator, commonly found in agricultural systems. It has been recorded as an effective predator, where its larvae of is a generalist predator of a wide range of pests' species including; the aphids, the whiteflies, the immature scales and the mealybugs (Yuksel & Goemen, 1992 and Saminathan & Baskaran, 1999), while the adults' lacewings are free-living and feed on the honeydew and the pollen grains. Moreover, Salman *et al.* (2014) recorded both of the seven-spotted coccinellid beetle, *C. septempunctata* and the green lacewing, *C. carnea*as common predators of the legume aphid, *A. craccivora.* As a result, Ulubilir and Yabas (1996) stated that an effective biological control program can solve some problem for aphids' damageand it is necessary to be applied and is strongly needed.

Statistical analysis of the obtained data in the first season 2016/2017 indicated that:

a-There was no significant correlation between the unreleased control area and the released one of the ladybird beetle *C. septempunctata*, in case of comparing the mean total numbers of the legume aphid, *A. craccivora* (the r-value was=0.037& sig. =0.900).

b- There was no significant correlation between the unreleased control area and the released one of the green lacewing *C. carnea*, in case of comparing the mean total numbers of the legume aphid, *A. craccivora* (the r-value was=-0.051& sig.=0.863).

c- There was a very highly significant correlation between the released one of the ladybird beetle *C. septempunctata* and the released one of the green lacewing *C. carnea*, in case of comparing the mean total numbers of the legume aphid, *A. craccivora* (the r-value was=0.991****& sig. =0.000).

Statistical analysis of the obtained data in the second season 2017/2018 revealed that:

1- There was a significant correlation between the unreleased control area and the released one of the ladybird beetles *C. septempunctata*, in case of comparing the mean total numbers of the legume aphid, *A. craccivora* (the r-value was=0.556*& sig.=0.0.039).

2- There was no significant correlation between the unreleased control area and the released one of the green lacewing *C. carnea*, in case of comparing the mean total numbers of the legume aphid, *A. craccivora* (the r-value was=0.459& sig.=0.099).

3-There was a very highly significant correlation between the released one of the ladybird beetle *C. septempunctata* and the released one of the green lacewing *C. carnea*, in case of comparing the mean total numbers of the legume aphid, *A. craccivora* (the r-value was=0.993****& sig.=0.000).

Moreover, statistical analysis by making a comparison between the two seasons 2016/2017& 2017/2018, in case of the mean total numbers of the legume aphid, *A. craccivora* individuals indicated that:

1- There was a highly significant correlation between the unreleased controls, in case of comparing the mean total numbers of the legume aphid, *A. craccivora* (the r-value was=0.835***& sig. =0.000).

2- There was a very highly significant correlation between the released areas of the ladybird beetle *C. septempunctata*, in case of comparing the mean total numbers of the legume aphid, *A. craccivora* (the r-value was=0.942****& sig.=0.000).

3- There was a very highly significant correlation between the released areas of the green lacewing *C. carnea*, in case of comparing the mean total numbers of the legume aphid, *A. craccivora* (the r-value was=0.93****& sig. =0.000).

Table 2: Mean total numbers of *A. craccivora* individuals that were recorded per one faba bean plant, in comparing; the unreleased control (no predator release), with those recorded after releasing the ladybird beetle, *C.septempunctata* and the green lacewing, *C.carnea* against the pest during 2017/2018 season, in Sohag Governorate.

No.	Dates of sampling	Unreleased control	*C. septempunctata*	*C. carnea*	Weather factors	
					Mean C°	Mean R.H.%
1	13/12/2017	16.94	16.94	16.94	16.00	43.00
2	16/12	27.21	25.90	26.52	16.00	63.50
3	19/12	41.37	39.48	40.66	19.00	58.00
4	22/12	81.33	79.02	78.47	21.00	60.00
5	25/12	110.00	45.05	39.13	12.00	61.50
6	28/12	108.03	21.80	14.33	14.00	56.00
7	31/1/2018	91.33	8.73	3.10	12.00	50.50
8	3/1	72.28	3.70	0.98	12.00	58.00
9	6/1	33.05	1.45	0.40	14.00	50.50
10	9/1	16.43	0.23	0.00	14.00	51.50
11	12/1	5.23	0.00	0.00	13.00	47.00
12	15/1	4.40	0.00	0.00	13.00	54.00
13	18/1	4.10	0.00	0.00	13.00	55.00
14	21/1	2.57	0.00	0.00	13.00	56.00
(Mean/range)		43.88±10.79 (2.57-110.00)	17.31±6.27 (0.00-79.02)	15.76±6.23 (0.00-78.47)	14.43 C° (12.00 -21.00C°)	54.61% (43.00 -63.50%)
% Reduction			60.29%	64.04%		

- The mean percentages of reduction in the mean total numbers of the legume aphid, *A. craccivora* individuals for the two seasons 2016/2017 and 2017/2018 together for the two predatory species *C. septempunctata* and *C. carnea* were; 67.11% (60.29-73.935%) &70.34% (64.04-76.64%), respectively.

A - Statistical analysis of the obtained data in the second season 2017/2018 revealed that:

1- There was a significant correlation between the unreleased control area and the released one of the ladybird beetles *C. septempunctata*, in case of comparing the mean total numbers of the legume aphid, *A. craccivora* (the r-value was=0.556*& sig.=0.0.039).

2- There was no significant correlation between the unreleased control area and the released one of the green lacewing *C. carnea*, in case of comparing the mean total numbers of the legume aphid, *A. craccivora* (the r-value was=0.459& sig.=0.099).

3- There was a very highly significant correlation between the released one of the ladybird beetle *C. septempunctata* and the released one of the green lacewing *C. carnea*, in case of comparing the mean total numbers of the legume aphid, *A. craccivora* (the r-value was=0.993****& sig.=0.000).

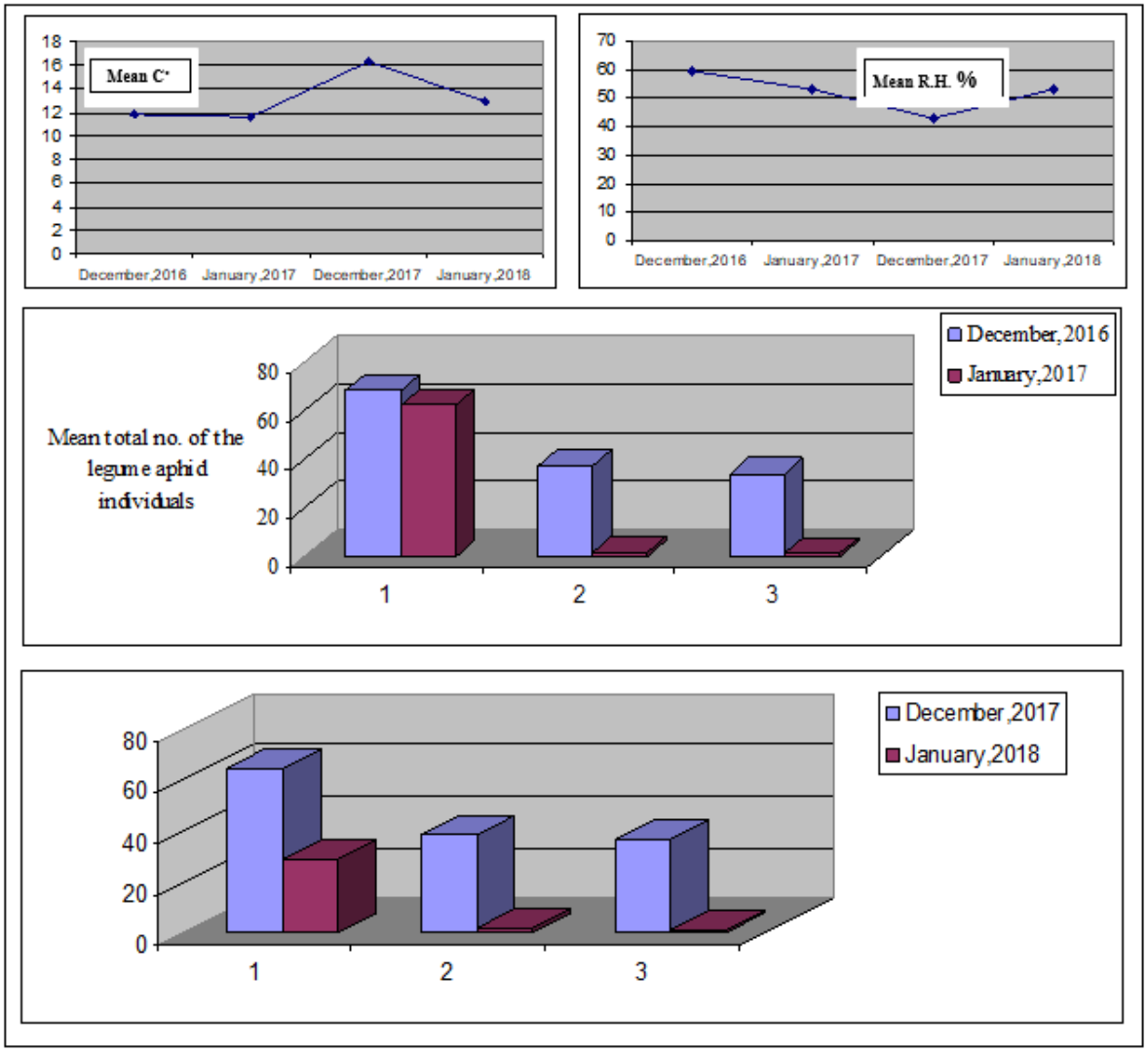
B- Moreover, statistical analysis by making a comparison between the two seasons 2016/2017& 2017/2018, in case of the mean total numbers of the legume aphid, *A. craccivora* individuals indicated that:

1- There was a highly significant correlation between the unreleased controls, in case of comparing the mean total numbers of the legume aphid, *A. craccivora* (the r-value was=0.835***& sig. =0.000).

2- There was a very highly significant correlation between the released areas of the ladybird beetle *C. septempunctata*, in case of comparing the mean total numbers of the legume aphid, *A. craccivora* (the r-value was=0.942****& sig.=0.000).

3- There was a very highly significant correlation between the released areas of the green lacewing *C. carnea*, in case of comparing the mean total numbers of the legume aphid, *A. craccivora* (the r-value was=0.93****& sig. =0.000).

Note: *Significant (0.500-0.600) **Moderate significant (0.600-0.800) ***Highly significant (0.800-0.900) ****Very highly significant>0.900.



1= The unreleased control **2**= The ladybird beetle, *C. septempunctata***3**= The green lacewing, *C. carnea*

Fig. 3: The mean total numbers of the legume aphid, *A. craccivora* individuals that were recorded in the three experimental areas cultivated with the faba bean plants, during the two successive seasons 2016/2017 and 2017/2018, in the greenhouses located in Sohag Governorate.

4- The Effect of Releasing the Two Predatory Species; *C. septempunctata* and *C. carnea* Against the Legume Aphid, *A. craccivora* on the Resulted Faba Bean Seeds' Crop Yield:

Table (3) showed the effect of releasing the two predatory species; the ladybird beetle, *C. septempunctata* and the green lacewing, *C. carnea* against the legume aphid, *A. craccivora* on the resulted faba bean seeds' crop yield. From the obtained results, in the first season 2016/2017, the mean total weights of the resulted seeds crop were; 1.41, 2.41 and 2.74 (kg), for the unreleased area, the released area of the ladybird beetle, *C. septumpunctata*, and the released area of the green lacewing. *carnea*, respectively. The corresponding values for the second season 2017/2018 were; 1.43, 2.43 and 2.75 kg., respectively, while, the mean total weights for the two seasons together were; 1.42, 2.42 and 2.75 kg., for the three tested cases; the unreleased control, the ladybird beetle, *C. septempunctata* and the green lacewing, *C. carnea*, respectively.

However, the mean percentage of increase in mean total weights (kgs) of the faba

bean seeds, for the two seasons 2016/2017 and 2017/2018 together, in case of the releasing areas of the predatory ladybird beetle, *C. septempunctata*, in comparing with the unreleased control area was 70.42% (69.93-70.92%). The corresponding mean percentage of increase in mean total weights (kgs) of the faba bean seeds for the two seasons 2016/2017 and 2017/2018 together was 92.31% (92.31-94.33%).

Moreover, the obtained data in Table (3) indicated that the mean percentage of increase in mean total the weight of 100 seeds (gm), for the two seasons 2016/2017 and 2017/2018 together, in case of the releasing areas of the green lacewing, *C. carnea*, in comparing with the unreleased control area was 5.08% (4.37-5.79%). The corresponding mean percentage of increase in mean total the weight of 100 seeds (gm), for the two seasons 2016/2017 and 2017/2018 together was 7.84% (7.83-7.85%).

Table 3: The production of the faba bean (including; the mean total numbers (kgs)& the weight of 100 seeds/gm), in case of the two released areas (the released area of the lady bird beetle *C. septempunctata* &the released area of the green lacewing *C. carnea*), in comparing with the unreleased control, on the faba bean plants, during the two successive seasons 2016/2017 and 2017/2018, in the greenhouses located in Sohag Governorate.

Tested factors	Unreleased control			*C. septempunctata*			*C. carnea*		
	Season 2016/2017	Season 2017/2018	Mean/2 seasons	Season 2016/2017	Season 2017/2018	Mean/2 seasons	Season 2016/2017	Season 2017/2018	Mean/2 seasons
Mean total weight (kgs)	1.41	1.43	1.42	2.41	2.43	2.42	2.74	2.75	2.75
% of increased the faba bean weight				70.92%	69.93%	70.42%	94.33%	92.31%	92.31%
The weight of 100 seeds (gm)	73.16	73.55	73.36	76.36	77.81	77.09	78.89	79.32	79.11
% of increased the seeds weight /100 seeds				4.37%	5.79%	5.08%	7.83%	7.85%	7.84%

5- The Relationships Existed Between Many Tested Factors and The Weather Factors Concerning the Means of Temperatures and The Relative Humidity, During the Two Successive Seasons 2016/2017 And 2017/2018, In the Greenhouses Located in Sohag Governorate:

Data obtained in Table (4) showed the relationships that were occurred between the mean total numbers of the legume aphid, *A. craccivora* individuals; in the unreleased control area, the mean total numbers of the legume aphid, *A. craccivora* individuals in the released area of the ladybird beetle, *C. septempunctata*, the mean total numbers of the legume aphid, *A. craccivora* individuals in the released area of the green lacewing, *C. carnea*, with the means of the temperatures and the relative humidity during the two successive seasons 2016/2017 and 2017/2018, in the greenhouses located in Sohag Governorate.

Table 4: The correlation relationships (r-values), that were occurred between the mean total numbers of the legume aphid, *A. craccivora* individuals in the unreleased control area, the mean total numbers of the legume aphid, *A. craccivora* individuals in the released area of the ladybird beetle, *C. septempunctata*, the mean total numbers of the legume aphid, *A. craccivora* individuals in the released area of the green lacewing, *C. carnea*, with the means of the temperatures and the relative humidity, during the two successive seasons 2016/2017 and 2017/2018, in the greenhouses located in Sohag Governorate.

Tested factors	The correlation coefficient	2016/2017		2017/2018	
		The means of the temperatures (C°)	The means of the relative humidity (R.H. %)	The means of the temperatures (C°)	The means of the relative humidity (R.H. %)
- The unreleased control area	r-values	-0.622**	-0.128	0.027	0.396
- The released area of the ladybird beetle *C. septempunctata*	r-values	-0.084	0.822***	0.747**	0.522*
- The released area of the green lacewing, *C. carnea*	r-values	-0.055	0.813***	0.802***	0.510*

Note: *Significant (0.500-0.600) **Moderate significant (0.600-0.800) ***Highly significant (0.800-0.900) ****Very highly significant>0.900.

- Statistical analysis of the obtained data for seasons 2016/2017 and 2017/2018, revealed the following:

A- In Case of The Means of The Temperatures (C°):

1- There was a negative moderate significant correlation between the unreleased control area and the means of temperatures (C°), in case of the mean total numbers of the legume aphid, *A. craccivora* in the first season 2016/2017(the r-value was=-0.622**). While, there was no significant correlation between the unreleased control area and the means of temperatures (C°), in the case of the mean total numbers of the legume aphid, *A. craccivora* in the second season 2017/2018 (the r-value was=0.027).

2- There was no significant correlation between the released area of the ladybird beetle *C. septempunctata* and the means of temperatures (C°), in case of the mean total numbers of the legume aphid, *A. craccivora* in the first season 2016/2017 (the r-value was=-0.084). while, there was a moderate significant correlation between the released area of the ladybird beetle *C. septempunctata* and the means of temperatures (C°), in case of the mean total numbers of the legume aphid, *A. craccivora* in the second season 2017/2018 (the r-value was=0.747**).

3- There was no significant correlation between the released area of the green lacewing, *C. carnea* and the means of temperatures (C°), in case of the mean total numbers of the legume aphid, *A. craccivora* in the first season 2016/2017 (the r-value was=-0.055). While, there was a highly significant correlation between the released area of the green lacewing, *C. carnea* and the means of temperatures (C°), in case of the mean total numbers of the legume aphid, *A. craccivora* in the second season 2017/2018 (the r-value was=0.802***).

B- In Case of The Means of The Relative Humidity (R.H. %):

1- There was no significant correlation between the unreleased control area and the means of the relative humidity (R.H. %), in case of the mean total numbers of the legume aphid, *A. craccivora* in the first season 2016/2017(the r-value was=-0.128). While, there was no significant correlation between the unreleased control area and the means of the relative humidity (R.H. %), in case of the mean total numbers of the legume aphid, *A. craccivora* in the second season 2017/2018 (the r-value was=0.396).

2- There was a highly significant correlation between the released area of the ladybird beetle *C. septempunctata* and the means of the relative humidity (R.H. %), in case of the

mean total numbers of the legume aphid, *A. craccivora* in the first season 2016/2017 (the r-value was=0.822***).While, there was a significant correlation between the released area of the ladybird beetle *C. septempunctata* and the means of the relative humidity (R.H. %), in case of the mean total numbers of the legume aphid, *A. craccivora* in the second season 2017/2018 (the r-value was=0.522*).

3- There was a highly significant correlation between the released area of the green lacewing, *C. carnea* the means of the relative humidity (R.H. %), in case of the mean total numbers of the legume aphid, *A. craccivora* in the first season 2016/2017 (the r-value was=0.813***). While, there was a significant correlation between the released area of the green lacewing, *C. carnea* and the means of the relative humidity (R.H. %), in case of the mean total numbers of the legume aphid, *A. craccivora* in the second season 2017/2018 (the r-value was=0.510*).

Conclusion

1- In the case of the unreleased control area, the released area of the ladybird beetle, *C. septempunctata* and that area of the green lacewing, *C. carnea*; the legume aphid, *A. craccivora* individuals started to appear with a mean low number of the three tested cases, in the second weeks of December. Then, they reached the maximum mean total numbers in the third week of April. Finally, there was a decrease in the means total numbers of the legume aphid, *A. craccivora* individuals in the last weeks of April, in the two successive seasons 2016/2017 and 2017/2018.

2- In the case of the unreleased control area, the mean total numbers of the legume aphid, *A. craccivora* individuals per season were; 64.91±12.66 (13.35-150.52) and 43.88±10.79 (2.57-110.00), for 2016/2017 and 2017/2018 seasons, respectively. While, the mean total number of the legume aphid, *A. craccivora* individuals for the two seasons together was 54.40(43.88-64.91) individuals.

3- In the case of the released area of the ladybird beetle, *C. septempunctata*, the mean total numbers of the legume aphid, *A. craccivora* individuals per season were; 16.92±5.25 (0.00-53.72) and 17.31±6.27 (0.00-79.02), for 2016/2017 and 2017/2018 seasons, respectively. While the mean total number for the two seasons together was 17.12(16.92-17.31) individuals. The percentage of the reduction of the legume aphid, *A. craccivora* individuals in the area that the adults of the ladybird beetle, *C. septempunctata* were released in comparison with that of the unreleased control areas was 73.93% in season 2016/2017, while, in season 2017/2018, it was 60.29%. The mean percentage for the two seasons together was 67.11% (60.29 %-73.93%), i.e., the percentage of reduction was relatively higher in the first season is compared with the second one.

4- In case of the released area of the green lacewing, *C. carnea*, the mean total numbers of the legume aphid, *A. craccivora* individuals per season were; 15.15±4.95 (0.00-50.72) and 15.76±6.23 (0.00-78.47), for 2016/2017 and 2017/2018 seasons, respectively, with a mean total number for the two seasons together of 15.46 (15.15-15.76) individuals. The percentage of reduction of the legume aphid, *A. craccivora* individuals in comparison to the unreleased control was 76.64% in season 2016/2017, while, in season 2017/2018, this percentage was 64.04%. The mean percentage of reduction for the two seasons together was 70.34% (64.04-76.64%).

5- The obtained results indicated the important role of releasing the two predators; the ladybird beetle, *C. septempunctata* and the green lacewing, *C. carnea* as biocontrol agents against the legume aphid, *A. craccivora* on the faba bean plants and/or the other related plants that suffer from pest attack. Using such biocontrol agents must be included in I.P.M. strategies, for substituting the chemical control methods in order to avoid the hazards of direct insecticide application. Using the two previous biocontrol agents against the legume aphid, *A. craccivora* individuals had led to an acceptable increase in the yield crop of faba

bean. The predators that belong to the family Coccinellidae comprise one of the most active groups of the predatory species that gained the interest of many investigators as an important group of the predators in the field of the biological control of insects' pests attacking different crop plants (Bahy El-Din, 2006). The seven-spotted coccinellid beetle, *C. septempunctata* was shown to have extensive dispersal power on the majority of the field crops (Khan& Suhail, 2001). Also, many attempts were made to use the green lacewing, *C. carnea* in the field of biological control (Nordlund & Marrison, 1992), however, the green lacewing, *C. carnea* is taken as representative of Chrysopidae to be used in biological control programs. This predator is characterized by its expanded geographical distribution, high compatibility to a different system, high searching ability *(Azema & Mirabzadae, 2004).* Besides, it seems to be a good candidate in IPM programs, as it is a voracious feeder (Balasubramani & Swamiappan, 1994). Moreover, it displays a relatively broad range of acceptable preys (Hydron & Whitecomb, 1979), easy to mass-produced in the laboratory (El-Arnaouty, 1991 and Azema & Mirabzadae, 2004) and its tolerance to some groups of pesticides (Azema & Mirabzadae, 2004).

6-Statistical analysis of the obtained concerning the relationships that were occurred between the mean total numbers of the legume aphid, *A. craccivora* individuals in the unreleased control area, the mean total numbers of the legume aphid, *A. craccivora* individuals in the released area of the ladybird beetle *C. septempunctata*, the mean total numbers of the legume aphid, *A. craccivora* individuals in the released area of the green lacewing, *C. carnea*, with the means of the temperatures and the relative humidity, reveled the following:

A- In Case of The Means of The Temperatures:

a- There was a negative moderate significant correlation between the unreleased control area and the means of temperatures, in case of the mean total numbers of the legume aphid, *A. craccivora* in the first season 2016/2017. While, there was no significant correlation between the unreleased control area and the means of temperatures, in case of the mean total numbers of the legume aphid, *A. craccivora* in the second season 2017/2018.

b- There was no significant correlation between the released area of the ladybird beetle *C. septempunctata* and the means of temperatures, in case of the mean total numbers of the legume aphid, *A. craccivora* in the first season 2016/2017. While, there was a moderately significant correlation between the released area of the ladybird beetle *C. septempunctata* and the means of temperatures, in the case of the mean total numbers of the legume aphid, *A. craccivora* in the second season 2017/2018.

c- There was no significant correlation between the released area of the green lacewing, *C. carnea* and the means of temperatures, in case of the mean total numbers of the legume aphid, *A. craccivora* in the first season 2016/2017. While, there was a highly significant correlation between the released area of the green lacewing, *C. carnea* and the means of temperatures, in the case of the mean total numbers of the legume aphid, *A. craccivora* in the second season 2017/2018.

B- In Case of The Means of The Relative Humidity (R.H. %):

a- There was no significant correlation between the unreleased control area and the means of the relative humidity (R.H. %), in case of the mean total numbers of the legume aphid, *A. craccivora* in the first season 2016/2017. While, there was no significant correlation between the unreleased control area and the means of the relative humidity (R.H. %), in case of the mean total numbers of the legume aphid, *A. craccivora* in the second season 2017/2018.

b- There was a highly significant correlation between the released area of the ladybird beetle *C. septempunctata* and the means of the relative humidity (R.H. %), in case of the mean total numbers of the legume aphid, *A. craccivora* in the first season 2016/2017.

While, there was a significant correlation between the released area of the ladybird beetle *C. septempunctata* and the means of the relative humidity (R.H. %), in case of the mean total numbers of the legume aphid, *A. craccivora* in the second season 2017/2018.

c- There was a highly significant correlation between the released area of the green lacewing, *C. carnea* the means of the relative humidity (R.H. %), in case of the mean total numbers of the legume aphid, *A. craccivora* in the first season 2016/2017. While, there was a significant correlation between the released area of the green lacewing, *C. carnea* and the means of the relative humidity (R.H. %), in case of the mean total numbers of the legume aphid, *A. craccivora* in the second season 2017/2018.

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ARABIC SUMMARY

دراسات على إطلاق المفترسين. *Ccoccinella septempunctata* و *Chrysoperla carnea* لمكافحة من البقول .*Aphis craccivora*، على نباتات الفول البلدي في الصوب الزراعية المتواجدة في محافظة سوهاج.

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يعتبر الفول البلدي(.*Vicia faba* L) أحد أهم المحاصيل الحقلية الشتوية في مصر، حيث يزرع باستمرار عاما"تلو الآخر. ويتعرض هذا المحصول للإصابةبمنَ البقول .*Aphis craccivora* Koch والذي يحدث ضرراً واضحاً على محصول الفول الناتج.

وقد أظهرت النتائج المتحصل عليها من خلال هذهالدراسة،أننباتات الفول البلديالتي زرعتفي الصوبات الزراعيةبمنطقتي الإطلاق المختبرة(الخاصة بالمفترسين:مفترس أبى العيدذو السبع نقاط. *Ccoccinella septempunctata* L ومفترس أسد المنَ(.Steph) *Chrysoperla carnea*،لمكافحة من البقول *Aphis craccivora* Koch.، على نباتات الفول البلدي في الصوب الزراعية المتواجدة في محافظة سوهاج مقارنة بمناطق الكنترول (بدون إطلاق للمفترسات) ، كانت تلك النتائج المتحصل عليها كما يلي:-

بالنسبة لمنطقة الكنترول (بدون إطلاق أي من المفترسات)، كانت متوسط التعداد الكلى لأفراد منَ البقول *A. craccivora*في الموسم 12.66±64.91 (13.35-150.52) فرداً و 10.79±43.88 (2.57- 110.00) فرداً ، للموسمين 2016/2017& 2017/2018 ، على التوالي. بينما في منطقة إطلاق مفترس أبى العيد ذو السبع نقاط *C. septempunctata*، كان متوسط التعداد الكلى المقابل لمنَ البقول *A. craccivora* 5.25±16.92 (0.00- 53.72) فرداً, 6.27±17.31 (0.00- 79.02) فرداً للموسمين على التوالي، مع متوسط نسبة خفض في تعداد المنَ للموسمين معاً بلغت 67.11% (60.29-73.93%). ولكن في حالة منطقة إطلاق مفترس أسد المنَ*C. carnea* كان متوسط التعداد الكلى لمنَ البقول *A. craccivora*المقابل 4.95±15.15 (0.00-50.72) فرداً و 6.23±15.76 (0.00- 78.47) فرداً، مع متوسط نسبة خفض في تعداد منَ البقول *A. craccivora* للموسمين معاً بلغت 70.34% (64.04%-76.64%).

وتبين من النتائج المتحصل عليها أيضا" ، أن استخدامهما (عندما تم إطلاق كلا المفترسين عند مكافحة من البقول *A. craccivora* على نباتات الفول البلدي في الصوب الزراعية) ، قد أدى إلى حدوث زيادة واضحة في وزن البذور المتواجدة في قرون نباتات الفول البلدي ، ترتب على ذلك حدوث زيادة ملحوظة في كمية الإنتاج للمحصول.

لذا، فقد أظهرت النتائج المتحصل عليها مدى أهمية الدور الذي يؤديه المفترسين (*C. septempunctata*, *C. carnea*) كعوامل حيوية فعالة) من تطبيقات المكافحة الحيوية) ، لمكافحة منَ البقول *A. craccivora* على نباتات الفول البلدي. لذلك يمكن العمل على استخدام كلا المفترسين السابقين بإطلاقهما في حقول الفول البلدي أو الحقول الأخرى التي تهاجم بنفس الآفة. ويجب أن يكون استخدام عوامل المكافحة البيولوجية تلك ضمن إستراتيجية المكافحة المتكاملة للآفات(.I.P.M) ، لتقليل الاستخدام المباشر للمكافحة الكيميائية حفاظا" على الإنسان وبيئته المحيطة خالية من التلوث.