Middle East Journal of Agriculture Research
Volume: 14 | Issue: 01| Jan. – Mar.| 2025

EISSN: 2706-7955 ISSN: 2077-4605
DOI: 10.36632/mejar/2025.14.1.9
Journal homepage: www.curresweb.com
Pages: 128-145

Biological Control of Cereal Aphids on Barley Plants by Field Release of the Predator, *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae), in Integration with the Natural Role of the Parasitoid, *Aphidius matricariae* Hal. (Hymenoptera: Aphidiidae) and Coccinellidae predators

Abazaid A. A. M., Ali M. A. M., Bahy El-Din I. A. and EL-Khawas M. A. M.

Biological Control Research Dept., Plant Protection Research Institute, A.R.C., Dokki, Giza, Egypt.

Received: 10 Dec. 2024 **Accepted:** 20 Feb. 2025 **Published:** 10 Mar. 2025

ABSTRACT

Barley plant is considered as one of the most important feeding source of carbohydrate for man and livestock. Four different aphids' species were recorded attacking barley plants which were; the bird cherry-oat aphid, *Rhopalosiphum padi* (Linnaeus) (which was the most abundant aphidś species), the corn leaf aphid, *Rhopalosiphum maidis* (Fitch), the green bug, *Schizaphis graminum* (Rondani) and the English grain aphid, *Sitobion avenae* (Fabricius) (Homoptera: Aphididae). The parasitoid, *Aphidius matricariae* Hal. (Hymenoptera: Aphidiidae) was the only primary parasitoid species recorded parasitizing the different surveyed cereal aphidś species. Results cleared strongly the natural important role of the parasitoid as a biocontrol agent against cereal aphids. Two common predatory species were recorded preying on cereal aphids on barley plants; they were *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) and Coccinellidae predators (including: *Hippodamia convergens* (Geur.) and *Coccinella undecimpunctata* L.). Percentage of aphidś individualś reduction after releasing second instar predatory larvae of *Ch. carnea* per season was estimated as 46.82%, while it was evaluated as 90.01% after 3 weeks from releasing date. Also, releasing second instar larvae of *Ch. carnea* indicating that, predatory larvae were effective as a suitable larval stage to be released. In addition, there were increases in case of: means total length (cm.) per one spike for those spikes of no terminal hairs or with terminal hairs, means total spike weight (gm.), mean total numbers of grains per one spike, total weight of 100 grains and percentages of newly barley grainś germination. This situation revealed that, releasing second instar larvae of *Ch. carnea* has decreased the infestation degree caused by cereal aphids and therefore had improved barley plants development, which were positively and directly reflected on the increase happened (in released area in comparing with unreleased one), in the two cases of investigated resulted yield crop. Therefore, this study was made to direct the highly efforts towards increasing cultivating barley areas side by side with that of cultivated ones of wheat. The released predator *Ch. carnea* can be mass reared released and integrated with the natural role of both of the parasitoid, *A. matricariae* and predatory species of Coccinellidae, for controlling cereal aphids on barley plants. Where, this application could be strongly encouraged and used as a component of Integrated Pest Management (I.P.M.) programs.

Keywords barley, cereal aphidś infestation, parasitism, predation, releasing Chrysoperla carnea, biological field integration, aphids' populations' reduction.

1. Introduction

Barley (*Hordeum vulgare* L.) represents one of the most suitable cereal crops which can be cultivated in a wide scale and under many different environmental conditions (El-Bawab, 1994). Farmers cultivated barley for two reasons: for animal feeding and also human food as they have a rich supply of carbohydrates (Neelhirajan *et al.,* 2007), besides its important uses as a common model in many of new genetic researches (Hagberg, 1987). Many aphidś species could be found in a mixed

Corresponding Author: Bahy El-Din I.A., Biological Control Research Dept., Plant Protection Research Institute, A.R.C., Dokki, Giza, Egypt. E-mail: ismaeilbahyeldin@gmail.com

Middle East J. Agric. Res., 14(1): 128-145, 2025
EISSN: 2706-7955 ISSN: 2077-4605 *DOI: 10.36632/mejar/2025.14.1.9*

populationś form as pests of cereal crops including barley where they are strongly suffering from their attack (Bishara & Sourial, 1997). As, aphids are responsible by sucking plants sap, for the occurrence of an obvious decrease in plantś viability, which lead to a clear reduction in resulted cereal crop yield (Saleh *et al.*, 2006). They may also transmit many plantś pathogens (Mahmoud *et al.,* 2023), such as Barley Yellow Dwarf Virus (BYDV) (El-Heneidy, 1994), that will be responsible for the occurrence of many plants diseases.

Years after years, the repeat intensively use of chemical harmful pesticides had developed many sever problems as a result of their uses (such as; health hazards, reduction in population density of natural enemies and also lead to a disruption in the natural balance that existed between them and their pests, besides the development of pestś resistance). As a result, scientistś had directed their efforts to search strongly for another more safe control methods to face pests including aphidś attack (Easterbrook *et al.,* 2006; Arif & Ghaffar, 2009 and Sarwar, 2014). Recently, the goal was concerned on searching of alternative and more safe and friendly methods for pests' control such as using biological control techniques, which now seemed to be the most promising tool and strategy for sustainable agriculture (Hemidi & Laamari, 2020), and is considered as a cornerstone of many Integrated Pest Management (IPM) programs (Joshi *et al.* 2010). However, biocontrol agents had appeared to be of an important role in the planning and performing of many techniques and methods that can be applied against agricultural pests in different integrated ways (Banken & Stark, 1998). Biocontrol agents such as; firstly many parasitoidś species of order Hymenoptera, are important effective bioagents groups for controlling aphids including cereal aphids, being used in many diverse agricultural crops as a component of many different biological control programs (Pungerl, 1984). For example, the primary parasitoid species *Aphidius matricariae* Hal. (Hymenoptera: Aphidiidae), is considered as one of these major parasitoidś species that parasitize many aphidś species including cereal aphids (Abdel-Rahman, 2005 and El-Fatih, 2006). Secondly, the use of predatory species by mass rearing and releasing them for insects management in many applied control programs has received the same increased and directed clear attention (Atlihan, 2010). Among these predatory species, adults and larvae of family Coccinellidae (Vo¨ lkl *et al.*, 2007) and lacewing predatory larvae of family Chrysopidae feed on aphids (Vo¨ lkl *et al.*, 2007; Yadav & Pathak, 2010 and Saleh *et al.*, 2017). From them, the predatory green lacewing *Chrysoperla carnea* (Stephens) is characterized by possessing a highly searching behavioral ability with a widely geographical distribution and also has the ability to face different changes of environmental factors (Tauber *et al.*, 2000). It was shown to be continually easily mass reared in the laboratory and released as predatory larval instars in many applied biological control programs against aphids (Sarwar, 2013). Thus, present work was conducted during season 2023/2024, at the Plant Protection Research Station in Qaha district, Qalubia Governorate, to study the effect of a field integration biological control experiment including; the release of second instar larvae of the predator, *Ch. carnea*, with recording the natural existed role of the primary aphid parasitoid, *Aphidius matricariae* Hal. (Hymenoptera: Aphidiidae) and predatory species of Coccinellidae, against cereal aphids' attacking barley plants. This study had two goals: the first one was to through light on the ability to cultivate barley in a new area (Delta region) that was not cultivated in it before and the second one was concerning with the following points:

1.1- Calculating total numbers of aphidś individuals (adults & nymphs) recorded in both unreleased and released areas.

1.2- Calculating total numbers of aphidś mummies and also percentages of aphids' parasitism and percentages of parasitoid emergence of the parasitoid, *A. matricariae*.

1.3- Calculating total numbers of aphids' predatory species.

1.4- The biological control experiment which was performed to study the following points:

1.4.1.- Effect of releasing second instar predatory larvae of *Ch. carnea* on percentages of aphidś individualś reduction and on the occurrence of predatory species in barley field.

1.4.2.- Effect of releasing predatory larvae of *Ch. carnea* on resulted barley crop concerning the following two points (in comparing unreleased and released areas):

1.4.2.1.- Meanś calculations of barley spikeś length (with no terminal spikeś hairs and with terminal spikeś hairs (cm.) and also estimation of total spikeś weight (gm.).

1.4.2.2.-Meanś calculations of total numbers of spikeś grains, besides total weight of grains and also estimating percentages of newly grainś germination of resulted barley crop after 72 hours.

EISSN: 2706-7955 ISSN: 2077-4605 *DOI: 10.36632/mejar/2025.14.1.9*

1.5. Statistical analysis of obtained data:
1.5.1. Correlations recorded in barley field experiment (by comparing means values).
1.5.2. Effect of temperature and relative humidity on some tested ecological factors.

2. Materials and Methods

2.1. Experimental design.

A total experimental area of 135 m^2 (9m. × 15m.), was selected and used in the farm at the Plant Protection Research Station in Qaha district, Qalubia Governorate which affiliated to the Plant Protection Research Institute (P.P.R.I.), Agriculture Research Center (A.R.C.), that was located in Qaha district (Qalubia Governorate), during 2023/2024 season. Experimental area was cultivated with barley grains (Balady, variety Giza 123), in the first week of December, 2023 (in 4/12/2023) and it was ended in the second week of April, 2024 (in 10/4/2024). All agricultural practices were made except the use of chemical insecticides which was not allowed to be used. This experimental area was divided into two parts (areas), each one of 59.5 m^2 (8.5×7m.), i.e., a total area of both of 119m^2), representing unreleased and released areas that were chosen for experimental purpose. Figure (1) displayed a diagram that shows performed field designed barley experiment.

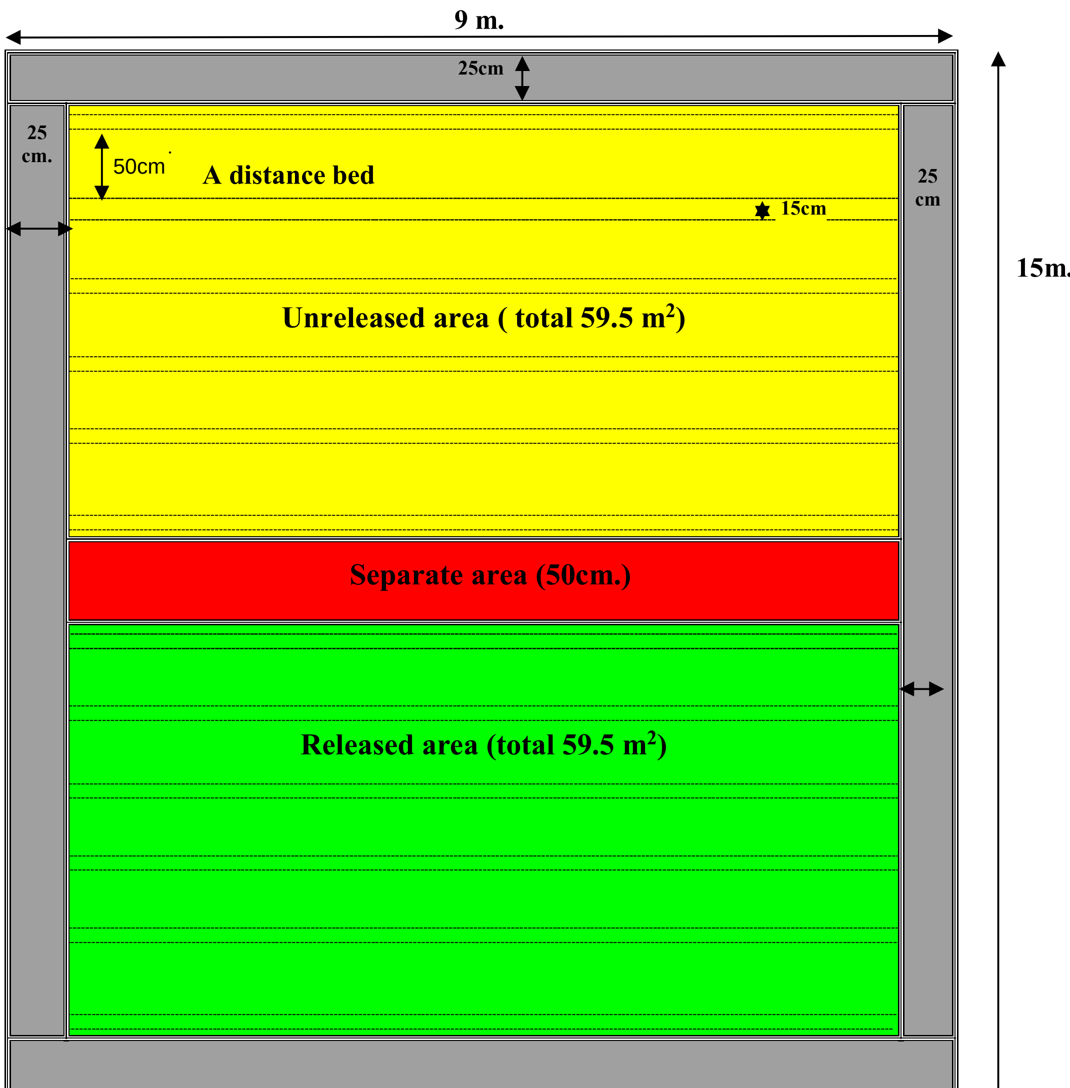

Fig. 1: A diagram that showed performed field designed experiment of barley.

The distance between the two areas (unreleased and released one), was 50 cm. (which representing the separate area) and the outer limit surrounding total experimental area was 25cm. from each side. The two experimental areas (unreleased and released one), were cultivated with barley grains on beds each of 50 cm. and the distances between these beds were 15cm. The different steps of development of cultivated barley plants in field experimental areas from planting until harvesting time were configured in Figure (2).

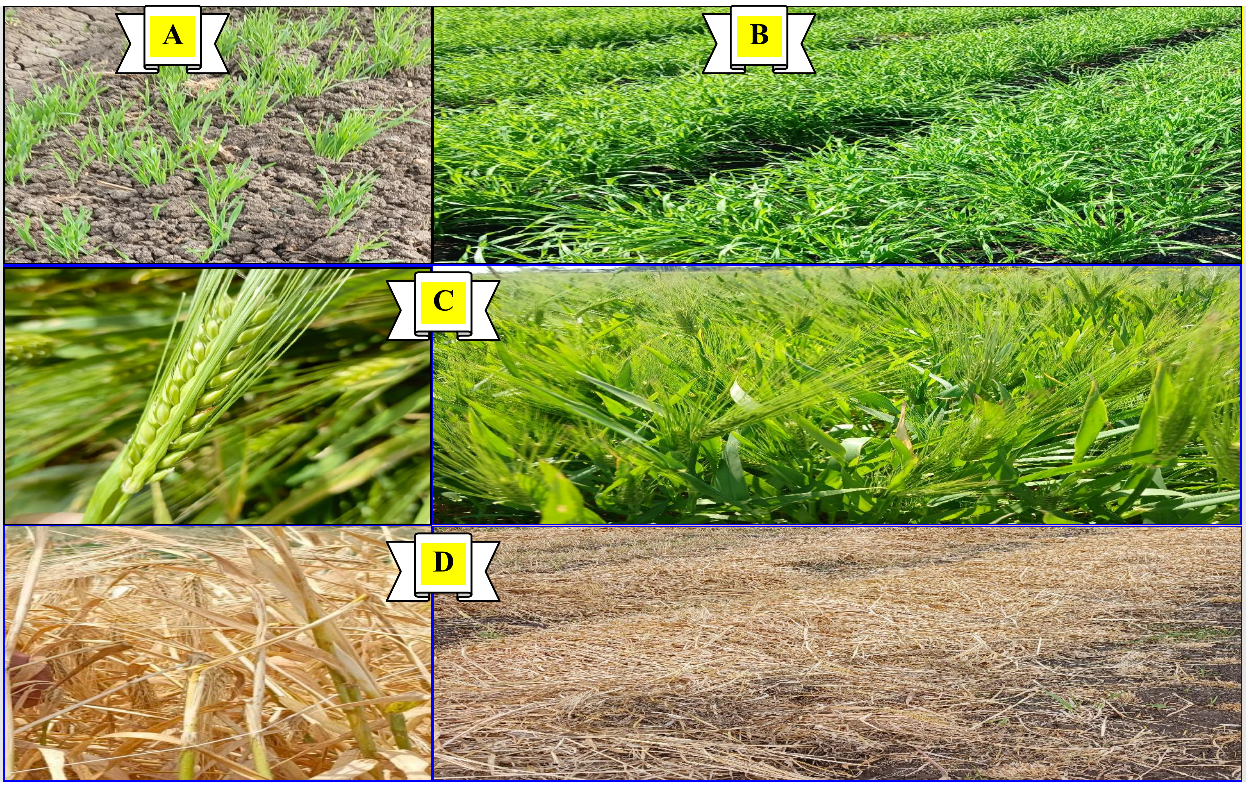

Fig. 2: Different steps concerning development of cultivated barley plants in field experimental areas from planting until harvesting time.
A- New planting **B-** Development stage **C-** Formation of spikes **D-** Harvesting of barley

2.2. Field biological control performed experiment:

2.2.1. Source and releasing second predatory instar larvae of *Ch. carnea*.

Second instar larvae of lacewing predator, *Ch. carnea* were used against cereal aphids attacking barley, according to the conclusion shown by Younes *et al.* (2013), who demonstrated that, this larval instar was the most suitable larval instars to be used and released. Source of predatory larvae was from ˝laboratory mass-rearing unit", located at Faculty of Agricultural, Cairo University, Giza. Where, Figure (3a) showed life cycle of lacewing predator, *Ch. carnea* that was used against cereal aphids attacking barley in performed field experiment (from eggs to adults' stage). While, Figure (3b) showed released area in which five similar squares plots area each one of $4m^2$ (2m.×2m.), representing a total area of $4m^2 \times 5=20$ m^2, for these five released plots), in which predatory second instar larvae of *Ch. carnea* were distributed and applied along this area. Therefore, predatory larvae of *Ch. carnea* were distributed and applied along this released area (at a rate of 10 predatory second instar larvae/$1m^2$). Releasing of these predatory larvae was done in third week of February, 2024 (in 21/2/2024), with a rate of 40 second instar larvae of predator/sequare×5squares plots of released area (i.e., a total number of 200 second instar larvae of *Ch. carnea* was released).

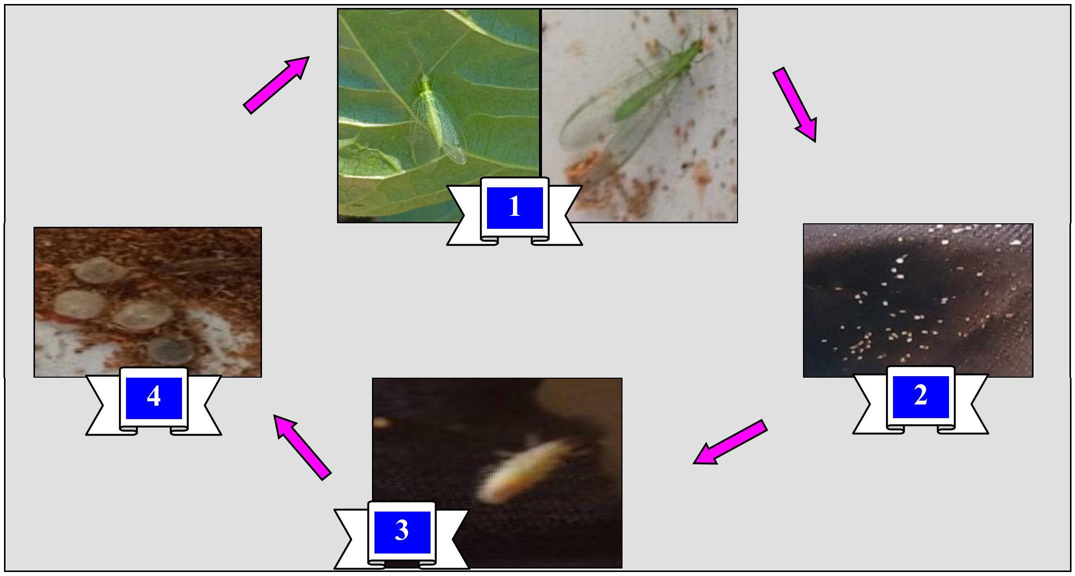

Fig. 3(a): Life cycle of lacewing predator, *Ch. carnea* that was used against cereal aphids attacking barley in performed field experiment.
1- Adult **2-** Eggs **3-** Larva **4-** Pupa

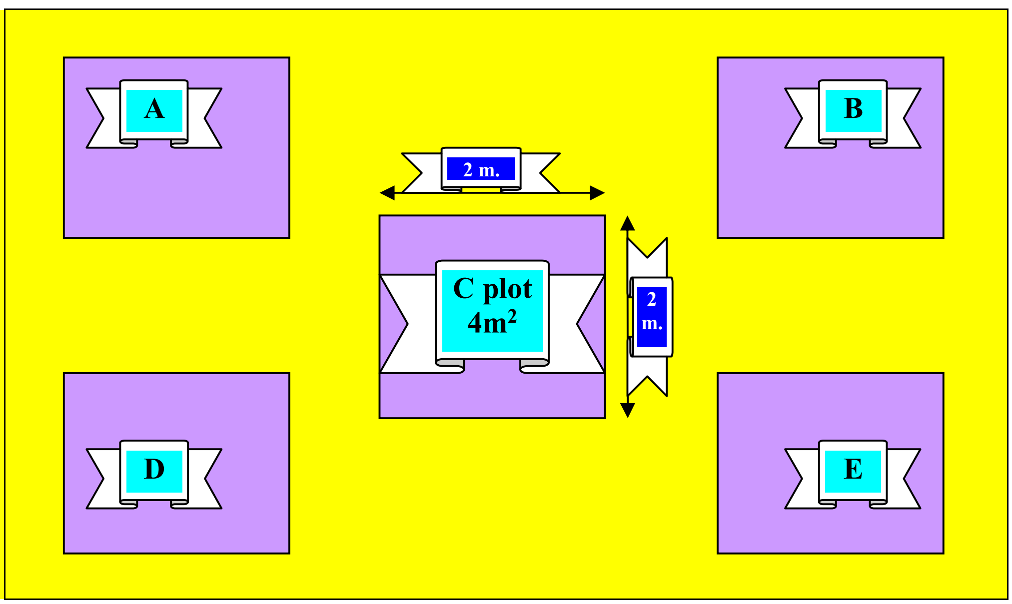

Fig. 3(b): Representing released experimental area in which the five similar squares area (A, B, C, D and E), in which predatory second instar larvae of *Ch. carnea* were distributed and applied along this released area.

2.2.2. Investigation of field samples and data calculations.

a- Random weekly barley plantś samples representing a total of 10 squares plots each of them was $1m^2$(1m.×1m.) was investigated early in the morning throughout different barley growth stages. Each barley sample was of 20 plants/one square×10 squares = a total of 200 plants/sample), for either unreleased area or released one.

b- Total numbers of cereal aphids' individuals (adults & nymphs) were counted and mean total numbers of aphidś individuals/one plant were also calculated.

$$\textbf{Mean no. of aphidś individuals/one plant} = \frac{\text{Numbers of individuals (adults \& nymphs)}}{\text{200 plantś sample}}$$

c- Percentages of reduction in aphidś individuals' populations per season and also after three weeks from releasing second instar predatory larvae of *Ch. carnea* in comparing unreleased and released area were also estimated according to the equations described by Bahy El-Din *et al.* (2024) as follow:

$$\textbf{Reduction (\%)} = \left(100 - \frac{\text{Total no. of aphidś individuals in released area}}{\text{Total no. of aphidś individuals in unreleased area}}\right) \times 100$$

d- At the same time, total numbers of predatory species that were surveyed in both unreleased and released areas were recorded and counted and percentages of increase in their populations per season in released area were also estimated

e- Then, infested barley plants samples with aphidś species were directly taken in paper bags to the laboratory, waiting for a week until formation of any newly aphids' mummies which were counted. Percentages of aphidś parasitism were estimated according to the equation described by Bahy El-Din *et al.* (2024) as follow:

$$\textbf{Parasitism (\%)} = \frac{\text{Total no. of formed aphidś mummies}}{\text{Total no. of aphidś individuals}} \times 100$$

f- After that, emerged aphidś parasitoidś species from both unreleased and released areas was recorded and identified at Department of Biological Control Research, Plant Protection Research Institute, Cairo. Egypt.

g- The effect of releasing the predatory larvae of *Ch. carnea* on barley crop yield was estimated after 106 days by many obtained features such as: mean total numbers of grains in barley spikes, representing a mean of 5 grainś groups where each grain group was represented by 5 barley spikes, mean spikes length (cm.) either with no terminal hairs or with terminal hairs (a mean of 5 groups where each one group was represented by 5 barley spikes) and weights of barley spikes (a mean of 5 groups where each one group was represented 25 barley spikes).Weights of resulted newly crop yield grains were calculated (a mean of 5 groups, each one group was represented by 100 barley grains). Also, mean percentages of newly grainś germination were also estimated after 72 hours (a mean of 5 groups, each one group was represented by 20 barley grains). These tested ecological barley crop yield features were all calculated after 106 days post barley planting in last week of March, 2024 (i.e., in 27/3/2024).

2.2.3. Statistical analysis of obtained data.

Means′ values of resulted data (where, the least significant difference was carried out at L.S.D.0.01&0.05 levels of probability) and also r-values (correlation coefficient) were estimated by using SPSS computerized program version14.0. As for means of temperature and relative humidity, they were obtained from Meteorological Station at A.R.C., to calculate the relationships between many tested ecological field factors and means of temperature and relative humidity.

3. Results and Discussion

3.1. Total numbers of aphidś individuals (adults & nymphs) recorded in both unreleased and released areas.

From Table (1) and Figures (4&7), mean total numbers of aphidś individuals (adults & nymphs) recorded in barley field experiment per season 2023/2024 were; 912.93±235.57 (8-2318) & 485.50±175.57 (8-1856 individuals), while, maximum total numbers of aphidś individuals were during last week of February, 2024 (2318 individuals, in 28/2/2024, at means of temperature and relative humidity of 17.07C°&62.70 R.H.%, respectively) and during third week of February, 2024 (1856, in 21/2/2024, at 16.63C°&54.80 R.H.%), in unreleased area (with no release of predatory larvae of *Ch.*

carnea) and released area (with release of predatory larvae of *Ch. carnea*), respectively. Also, means total numbers of aphidś individuals for one plant per season were; 4.57 (0.04-11.59) & 2.43(0.04-9.28 individuals), respectively.

Table 1: Weekly total numbers of aphidś individuals (adults & nymphs) recorded in both unreleased and released areas of barley field experiment, during season 2023/2024.

Dates of inspection	Unreleased area: Total no. of aphidś individuals (A+N)	Unreleased area: Mean total no. /one plant	Released area: Total no. of aphidś individuals (A+N)	Released area: Mean total no. /one plant	Mean weather factors: Temp (C°)	Mean weather factors: R.H. (%)
10/1/2024	8	0.04	8	0.04	17.90	60.86
17/1	27	0.14	14	0.07	16.09	49.77
24.1	136	0.68	123	0.62	18.09	45.40
31/1	464	2.32	405	2.03	15.43	60.09
7/2	1357	6.79	1258	6.29	13.17	55.91
14/2	1983	9.92	1707	8.54	17.13	60.73
21/2 *	2101	10.51	1856	9.28	16.63	54.80
28/2	2318	11.59	801	4.01	17.07	62.70
6/3	1890	9.45	378	1.89	19.26	48.96
13/3	1402	7.01	126	0.63	18.33	52.64
20/3	550	2.75	53	0.27	18.69	58.81
27/3	322	1.61	37	0.19	17.96	48.24
3/4	154	0.77	21	0.11	23.50	45.07
10/4	69	0.35	10	0.05	17.90	60.86
Total/season	12781	4.57 (0.04-11.59)	6797	2.43 (0.04-9.28)	17.65 C° (13.17-23.50C°)	54.63% (45.07-62.70%)
Mean/season (range)	912.93±235.57 (8-2318)		485.50±175.57 (8-1856)			

Note: A = Adults of aphids. N = Nymphs of aphids. * = Date of releasing predatory second instar larvae of *Ch. carnea*.

Obtained data revealed that, four different aphids' species were recorded attacking barley plants including; the bird cherry-oat aphid, *Rhopalosiphum padi* (Linnaeus) (which was the most abundant aphidś species), the corn leaf aphid, *Rhopalosiphum maidis* (Fitch), the green bug, *Schizaphis graminum* (Rondani) and the English grain aphid, *Sitobion avenae* (Fabricius) (Homoptera : Aphididae). These previous aphidś species were surveyed attacking barley fields by many authors such as: (Ahmed *et al.,* 2007); (Slman & Ahmed (2005)); (Abd El-Salam (1999) & Ahmed *et al.* (2007)) and (El-Fatih (2006) & Ahmed *et al.* (2007)), respectively. In addition, Tantawi (1985) showed that, first and second ones were the most dominant aphids' species in Middle Egypt, but, El-Fatih (2006) indicated that, only first species was the most abundant one in the same area with few recorded numbers of other aphidś species. Moreover, Slman and Ahmed (2005) observed that, the bird cherry-oat aphid, *R. padi* was found on barley plants by late February at Middle Egypt and early March at Southern Egypt and the highest recorded total numbers of aphids' individuals was after 70 days post barley planting.

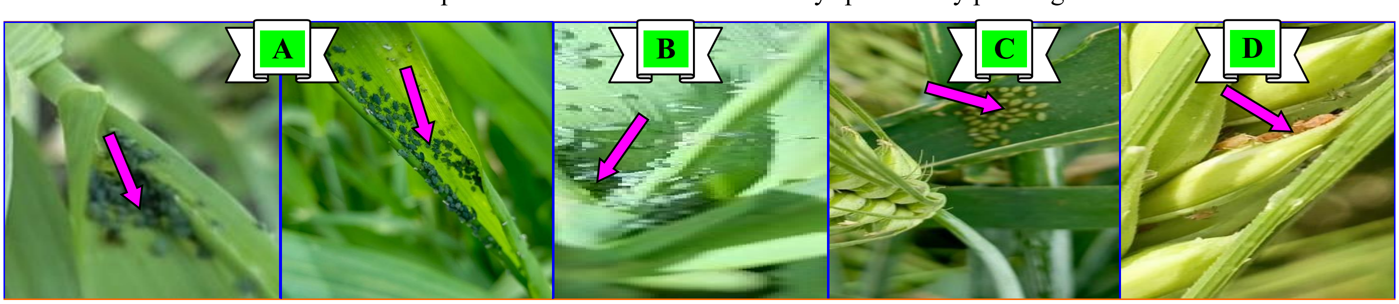

Fig. 4: Different aphids' individuals' species that were recorded in unreleased area attacking barley plants.
A= The bird cherry-oat aphid, *R. padi* **B**= The green bug, *S. graminum* **C**= The corn leaf aphid, *R. maidis*
D= The English grain aphid, *S. avenae*

Middle East J. Agric. Res., 14(1): 128-145, 2025
EISSN: 2706-7955 ISSN: 2077-4605 *DOI: 10.36632/mejar/2025.14.1.9*

3.2. Total numbers of parasitoid mummies and also percentages of aphidś parasitism and percentages of emergence of the parasitoid, *Aphidius matricariae*.

The parasitoid, *Aphidius matricariae* Hal. (Hymenoptera: Aphidiidae) was the only primary parasitoid species recorded parasitizing the different four surveyed cereal aphidś species in barley experimental field, during this study as shown in Table (2) and illustrated in Figures (5&7). This result was similar to the findings recorded by Abdel-Rahman (2005) and El-Fatih (2006) and also, where family Aphidiidae was shown to form the major part of the primary parasitoid spectrum of aphids (Stary, 1976).

Table 2: Weekly total numbers of parasitoid mummies and also percentages of aphids' parasitism and emergence of the parasitoid, *A. matricariae*, recorded in both unreleased and released areas of barley field experiment, during season 2023/2024.

	Unreleased area				Released area			
Dates of inspection	**Total no. of parasitoid mummies**	**% Aphidś parasitism**	**Total no. of emerged *A. matricariae* parasitoid**	**% *A. matricariae* parasitoid emergence**	**Total no. of parasitoid mummies**	**% Aphidś parasitism**	**Total no. of emerged *A. matricariae* parasitoid**	**% *A. matricariae* parasitoid emergence**
10/1/2024	0	0.00	0	0.00	0	0.00	0	0.00
17/1	2	7.41	1	50.00	1	7.14	0	0.00
24.1	15	11.03	13	86.67	13	10.57	10	76.92
31/1	97	20.51	84	86.60	75	18.52	51	68.00
7/2	220	16.21	179	81.36	172	13.67	116	67.44
14/2	267	13.46	223	83.52	183	10.72	124	76.67
21/2 *	245	11.66	205	83.67	156	8.41	135	86.54
28/2	235	10.14	185	78.72	28	3.50	18	64.29
6/3	172	9.10	97	56.40	10	2.65	4	40.00
13/3	101	7.20	69	68.32	2	1.59	1	50.00
20/3	35	6.36	17	48.57	0	0.00	0	0.00
27/3	14	4.35	5	35.71	0	0.00	0	0.00
3/4	6	3.90	2	12.50	0	0.00	0	0.00
10/4	4	2.90	0	0.00	0	0.00	0	0.00
Total/season	1413		1080		640		459	
Mean (range)	100.93±28.05 (0-267)	11.06% (0.00-27.37%)	77.14±23.02 (0-223)	76.43% (0.00-86.67%)	45.71±18.87 (0-183)	9.42% (0.00-18.52%)	32.79±13.88 (0-135)	71.72% (0.00-86.54%)

= Date of releasing predatory second instar larvae of *Ch. carnea*.

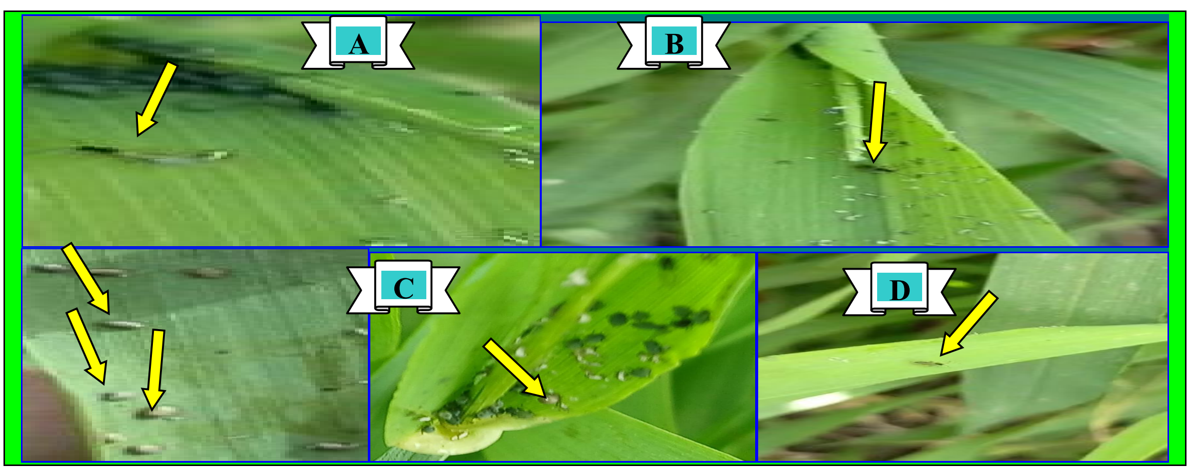

Fig. 5: Formed parasitoid mummies and adult primary parasitoid, *A. matricariae* that was recorded parasitizing aphids in barley field experiment.

A= The parasitoid begins searching for aphids. **B**= The parasitoid moved towards aphids to begin parasitism process. **C**= Success of parasitism with formation of aphidś mummies. **D**= Emergence of newly adult parasitoid species.

Mean total numbers of parasitoid mummies and also percentages of aphidś parasitism and percentages of emergence of the parasitoid, *A. matricariae* per season were; (100.93±28.05 (0-267) & 45.71±18.87) (0-183)), (11.06% (0.00-27.37%) & (9.42% (0.00-18.52%)) and (76.43% (0.00-86.67%) & (71.72% 0.00- 86.54%)). Maximum total numbers of parasitoid mummies and also the highest percentages of aphidś parasitism and percentages of emergence of the parasitoid, *A. matricariae* were; (267&183 were during second weeks of February, i.e., in 14/2/2024), (20.51% & 18.52% were during last weeks of January, 2024, i.e., in 31/1/2024) and (86.67% & 86.54% were during (third week of January, 2024, i.e., in 24/1/2024) & (third week of February, 2024, i.e., in 21/2/2024), in case of unreleased and released areas, respectively. Results obtained emphasized strongly the important natural role of the parasitoid as a biocontrol agent against cereal aphids attacking barley plants, which, seemed to be in complete accordance with that detected by Youssif *et al.* (2017). Also, there was an increase in total numbers of parasitoid mummies and percentages of aphidś parasitism which were directly related to the increase occurred in the aphidś individuals' population. In similar line, during late February-mid. April, highest percentages of aphidś parasitism were shown to be mostly existed with the highest cereal aphidś populations found on barley plants (Abdel-Rahman, 2005 & Slman, 2006). Parasitoids were peaked after two weeks following the occurrence of aphidś peak (Megahed, 2000).

3.3. Total numbers of aphids' predatory species.

Two common predators were recorded preying on cereal aphids on barley plants; they were *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) and Coccinellidae predators (including: *Hippodamia convergens* (Geur.) and *Coccinella undecimpunctata* L.). In the same line, El-Gapaly (2007) recorded the same predatory species in association with the four recorded aphidś species surveyed in the present study. As demonstrated in Table (3) and illustrated in Figures (6&7), mean total numbers of *Ch. carnea* (adults & larvae) and Coccinellidae (adults & larvae) per season were; (10.29±2.89 (0-29) & 12.57±5.32 (0-67), for *Ch. carnea*) and (4.57±1.46 (0-18) &3.14±1.05 (0-11), for Coccinellidae). Also, the mean total numbers of both predatory species together were; (14.86±3.72 (0-36) &15.71±5.90 (0-72). Highest total numbers of predators (36&72) were during second week of March, 2024 (in 13/3/2024) and during last week of February, 2024 (in 28/2/2024), in case of unreleased and released areas, respectively.

Table 3: Weekly total numbers of predatory species of aphidś recorded in both unreleased and released areas of barley field experiment, during season 2023/2024.

Dates of inspection	***Ch. carnea* (A+L)**		**Coccinellidae (A+L)**		**Total no. of predatory species**	
	Unreleased	**Released**	**Unreleased**	**Released**	**Unreleased**	**Released**
10/1/2024	0	0	0	0	0	0
17/1	0	0	0	0	0	0
24.1	0	0	0	0	0	0
31/1	0	0	0	0	0	0
7/2	0	0	0	0	0	0
14/2	9	12	1	1	10	13
21/2 *	18	26	2	3	20	29
28/2	21	67	3	5	24	72
6/3	25	39	5	8	30	47
13/3	29	21	7	11	36	32
20/3	23	9	11	9	34	18
27/3	11	1	18	4	29	5
3/4	6	1	10	2	16	3
10/4	2	0	7	1	9	1
Total/season	144	176	64	44	208	220
Mean/season (range)	10.29±2.89 (0-29)	12.57±5.32 (0-67)	4.57±1.46 (0-18)	3.14±1.05 (0-11)	14.86±3.72 (0-36)	15.71±5.90 (0-72)

Note: A = Adults. L = Larvae. * = Date of releasing predatory second intsar larva of *Ch. carnea*.

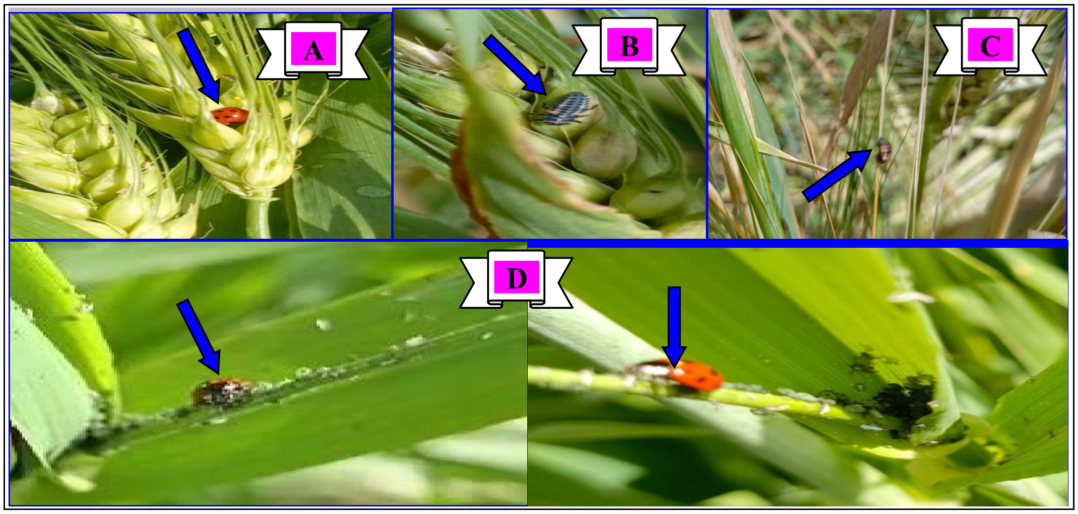

Fig. 6: Coccinellidae predatory species that were surveyed in barley field experiment.
A= Adult predator begin to search for aphidś preys. **B**= A larva of predator that prey on aphids. **C**= A formed predatory pupa. **D**= Adult predator that begin to prey on aphidś individuals.

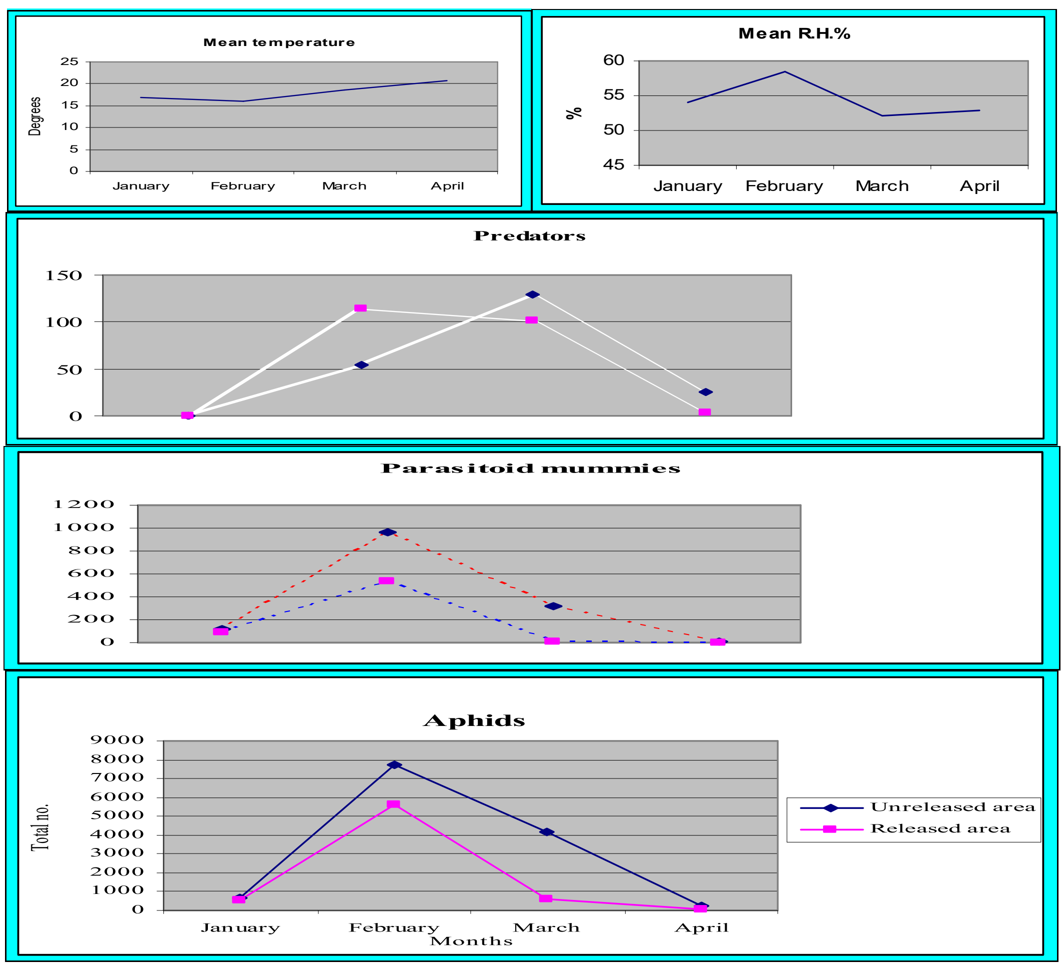

Fig. 7: Monthly total numbers of aphidś individuals (nymphs & adults), parasitoid mummies and predatory species, which were recorded in unreleased and released areas, in barley field during season 2023/2024, in Qalubia Governorate.

Middle East J. Agric. Res., 14(1): 128-145, 2025
EISSN: 2706-7955 ISSN: 2077-4605 *DOI: 10.36632/mejar/2025.14.1.9*

3.4. Effect of releasing second instar predatory larvae of *Ch. carnea* on percentages of aphidś individualś reduction and also on occurrence of predatory species in barley field.

Table (4) showed that, means total numbers of aphids' individuals before and after releasing process of second instar larvae of *Ch. carnea* were; 868.00±350.12 (8-2101) and 957.86±342.37 (69-2318), respectively. The respective for released area were; 767.29±308.59 (8-1856) and 203.71±110.69 (10-801) individuals. Indicating that, the occurrence of aphidś individualś reduction after predatory larvae release per season was 46.82%. The highest mean recorded percentage of aphidś individualś reduction was evaluated as 90.01% after 3 weeks from releasing predatory second instar larvae of *Ch. carnea* (where, total numbers of aphidś individuals were, 1402&126, in unreleased and released areas, respectively). Thus, results in this study also demonstrated that, releasing second instar larvae of this predator was effective and maximum percentage of aphidś individualś reduction was happened directly after 3 weeks post releasing time (during second week of March, 2024, i.e., in 13/3/2024) (Table, 1). Observation recorded was like that recorded by Younes *et al.* (2013), who showed that, promising and best results was achieved by releasing second instar larvae of *Ch. carnea* against *Aphis gossypii* and *myzus persicae*, on cantaloupe after 21 days from releasing date. In similar results, percentages of aphidś specieś populationś reduction after releasing the predator, *Ch. carnea* were estimated as: 98.50% (Gurbanov, 1982); 84.00% (Messina & Sorenson, 2001) and 73.90% (Younes *et al.*, 2013). Results also indicated that, releasing second instar larvae of *Ch. carnea* was an effective larval stage, that can be easily laboratory mass reared and released against aphids' populations in barley fields. So, they were supported by those of Sarwar (2014), who stated that, first instar followed by second and third instars larvae of *Ch. carnea* were most effective in reducing aphids' population compared with unreleased control. In general, results recorded in this study indicated that, this predator can considered as one of the important predators in controlling cereal aphids on barley plants and its obvious role could be strongly encouraged and can be extensively used as one of the main components of Integrated Pest Management (I.P.M.) programs. Similarly, the important role of the green lacewing, *Ch. carnea* as an effective predator against aphidś species was confirmed by many authors such as: Driesche *et al*. (1987); Ushchekov (1989) and Gurr *et al.,* (2012) and was considered also as an important component of Integrated Pest Management (I.P.M.) programs (Rashid *et al.*, 2012). An observed increase was recoded in percentage of all surveyed predatory species (*Ch. carnea* & Coccinellidae) which was evaluated as 5.77% and also an increase in percentage of *Ch. carnea* only per season which was estimated as 22.22%, while this increase was evaluated as 68.83% after 3 weeks from released time (in 21/2/2024) (Tables, 3&4). This increase in total numbers of the predator, *Ch. carnea* was due to releasing process, where it was successively reproduced after its release.

Table 4: Effect of releasing second instar predatory larvae of *Ch. carnea* on percentages of aphidś individuals' reduction and on the percentages of occurrence of predatory species, in barley field during season 2023/2024, in Qalubia Governorate.

Period	Unreleased area				Released area			
	Total		Mean total (range)		Total		Mean total (range)	
	Aphids	Predatory species	Aphids	Predatory species	Aphids	Predatory species	Aphids	Predatory species
Before releasing	6076 (0-2101)	27 (0-20)	868.00±350.12 (8-2101)	4.29±2.97 (0-20)	5371 (8-1856)	38 (0-29)	767.29±308.59 (8-1856)	6.00±4.25 (0-29)
After releasing	6705 (69-2138)	117 (9-36)	957.86±342.37 (69-2318)	25.42±3.72 (9-36)	1426 (10-801)	144 (1-72)	203.71±110.69 (10-801)	25.43±10.06 (1-72)

-The mean reduction percentage of aphids' individuals per season was estimated as **46.82%** and the mean percentage of reduction was evaluated as **90.01%** after 3 weeks from releasing predatory second instar larvae of *Ch. carnea*.

-The increase in percentage of recorded total numbers of surveyed all predatory species (*Ch. carnea* & coccinellidae) per season was recorded as **5.77%.**While, the increase in percentage of recorded total numbers of the predator, *Ch. carnea* individuals per season was estimated as **22.22%,** while this increase was evaluated as **68.83%** after 3 weeks from released time (in 21/2/20240).

Middle East J. Agric. Res., 14(1): 128-145, 2025
EISSN: 2706-7955 ISSN: 2077-4605 *DOI: 10.36632/mejar/2025.14.1.9*

3.5. Effect of releasing predatory larvae of *Ch. carnea* on resulted barley crop.

3. 5.1. Meanś calculations of barley spikeś length with no terminal hairs or with terminal hairs (cm.) and also estimation of their total spikeś weight (gm.).

Meanś Calculations of barley spikeś length with no terminal hairs or with terminal hairs (cm.) and also estimation of its total spikeś weight (gm.), after 106 days post barley planting were shown in Table (5) and Figure (8).

Table 5: Measurements of barley spikeś length with no terminal hairs or with terminal hairs (cm.) and also the estimation of their total spikeś weight (gm.) after 106 days post barley planting.

Tested Groups	Unreleased area			Released area		
	Mean total length (cm.)/spike		Total spikeś weight (gm.)	Mean total length (cm.)/spike		Total spikeś weight (gm.)
	No terminal hairs	With terminal hairs		No terminal hairs	With terminal hairs	
Group 1	8.34* (7.5-10.2)	19.30 (15-21.5)	338 (13.52**)	9.12 (8.5-9.6)	20.10 (19-22)	498 (19.92)
Group 2	9.14 (8.5-10.5)	21.20 (20-23)	340 (13.60)	9.20 (8.5-10)	20.50 (18.5-23)	380 (15.20)
Group 3	8.10 (7-9.5)	19.50 (16-22)	450 (18.00)	9.60 (9-10)	20.20 (18.5-23)	500 (20.00)
Group 4	8.60 (7-10.5)	19.60 (16.5-23.5)	380 (15.20)	8.90 (8.5-10)	21.60 (20-23)	550 (22.00)
Group 5	7.94 (6.5-9.5)	20.20 (16.5-23)	320 (12.80)	9.10 (8.5-10)	21.90 (19.5-23.5)	450 (18.00)
Means of all groups ±S.E	8.42±0.24 (7.94-9.14cm.)	19.96±0.47 (19.30-21.20cm.)	14.62±0.93 (12.80-18.00gm.) ((mean total 365.60±23.27 (320-450gm.))	9.18±0.11 (8.90-9.60cm.)	20.86±0.32 (20.10-21.90cm.)	19.02±1.15 (15.20-22.00gm.) ((mean total 475.60±28.66 (380-550gm.))

Note: * = representing a mean total of 5 barley spikes. ** = representing a mean total of one barley spike.

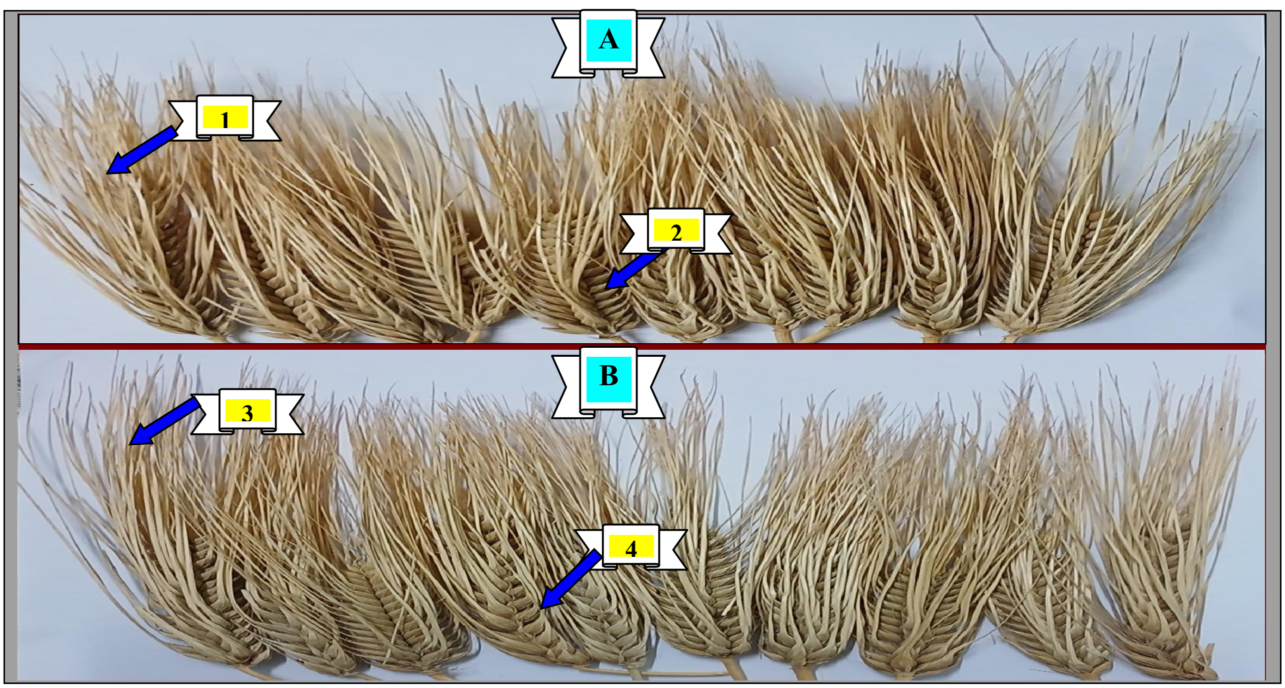

Fig. 8: Spikes of barley crop yield that was formed after 106 days post barley planting.
A= Spikes with terminal hairs that were formed in unreleased area:**1**- Shorter terminal hairs of spikes. **2**- Smaller size of barley spikes. **B**= Spikes with terminal hairs that were formed in released area:**3**- Taller terminal hairs of spikes **4**- Larger size of barley spikes.

Means total length (cm.) per one spike for those of no terminal spikeś hairs or with terminal spikeś hairs for all five tested groups were; 8.42±0.24 (7.94-9.14cm.) & 19.96±0.47 (19.30-21.20cm.), (for unreleased area) and 9.18±0.11 (8.90-9.60cm.) & 20.86±0.32 (20.10-21.90cm.), (for released area). Means spike weight (gm.) for all five tested groups per season were; 14.62±0.93 (12.80-18.00gm.), with a mean total spikeś weight of ±23.27 (320-450gm.) and 19.02±1.15 (15.20-22.00) gm., with a mean total spikeś weight of 475.60±28.66 (380-550gm.)), respectively. Results obtained revealed that, there were an increase in both means total length (cm.) per one spike for those of no terminal hairs or with terminal hairs and also means total spikeś weight (gm.) for all five tested groups, indicating that, releasing second instar larvae of Ch. carnea has decreased the infestation degree caused by cereal aphids. Therefore, this situation improved barley plants development, which were directly and positively reflected by increasing of investigated resulted yield crop cases in released area in comparing with those of unreleased one.

3.5.2. Meanś calculations of total numbers of spikeś grains, besides total weight of grains and also estimating percentages of newly grainś germination of resulted barley crop.

From Table (6) and Figures (9&10), mean total numbers of grains per one spike, total weight of 100 barley grains and percentages of newly barley grainś germination (after 72 hours) for all five tested groups were; 59.04±1.41grains (56.40-62.40 grains) & 5.74gm. (5.00-7.00 gm.) and 76.00% (65.00-90.00%), respectively (for unreleased area).

Table 6: Meanś calculations of total numbers of spikeś grains, besides total weight of grains and also estimating percentages of newly grainś germination of resulted barley crop, after 106 days post barley planting.

Tested Groups	Unreleased area			Released area		
	Mean total no. of grains/one spike	Total weight of 100 grains	% Newly grainś germination	Mean total no. of grains/one spike	Total weight of 100 grains	% newly grainś germination
Group 1	62.40* (54-72)	6.00**	65.00***	66.80 (62-74)	6.70	90.00***
Group 2	57.60 (54-66)	5.50	90.00	67.20 (62-78)	6.09	90.00
Group 3	61.20 (54-72)	7.00	80.00	70.80 (66-72)	6.00	85.00
Group 4	58.80 (54-72)	5.18	75.00	64.80 (60-72)	7.00	80.00
Group 5	56.40 (48-66)	5.00	70.00	69.60 (64-78)	6.13	85.00
means of all groups ±S.E	59.04±1.41grains (56.40-62.40)	5.74gm. (5.00-7.00)	76.00% (65.00-90.00%)	67.84±1.01grains (66.80-70.80)	6.38gm. (5.00-7.00)	86.00% (80.00-90.00%)

Note: * = representing a mean total number of grains of each spike. ** = representing a total of 100 grains. *** = representing a percentage of grains germination for 20 grains.

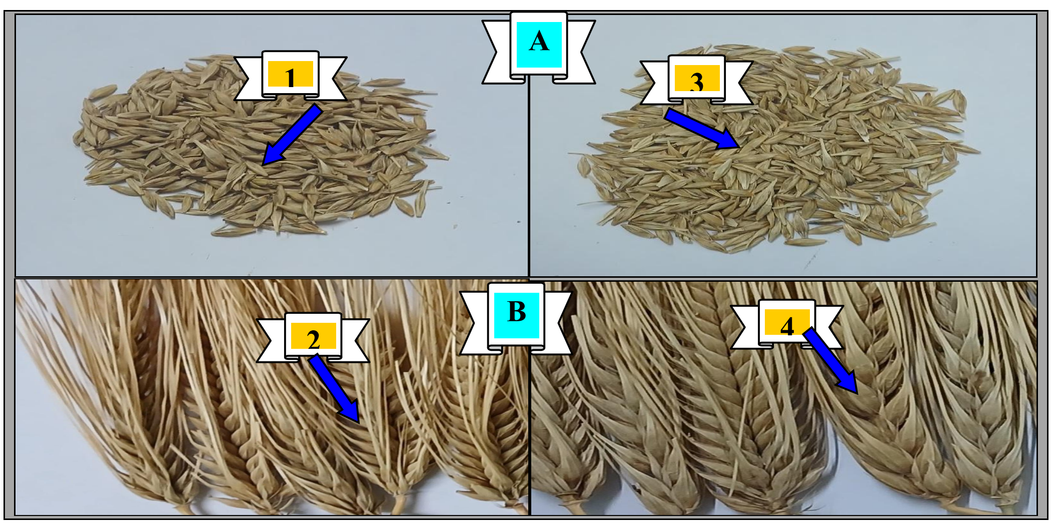

Fig. 9: Newly grains of resulted barley crop that was formed in both unreleased and released areas.
A= Grains that were formed in unreleased area. 1**-** Less total numbers of grains. 2- Smaller size of grains. **B**= Grains that were formed in released area. 3**-** More total numbers of grains. 4-larger size of grains.

The respective for released area were; 67.84±1.01 grains (66.80-70.80 grains) & 6.38gm. (5.00-7.00 gm.) and 86.00% (80.00-90.00%). In comparing unreleased area with released one, an increase in mean total numbers of grains per one spike, total weight of 100 barley grains and percentages of newly barley grainś germination (after 72 hours) for all five tested groups were occurred indicating that, releasing second instar larvae of *Ch. carnea* has been decreased the infestation degree caused by cereal aphids. So, as a result, an improvement of plant development was happened and achieved, followed by an increase in the three tested factors in released area compared with unreleased one. This finding with in accordance with that found by Sarwar (2014) who demonstrated that, releasing first and second instars larvae of *Ch. carnea* were more effective that increased crop yield compared with unreleased one in Canola field.

Fig. 10: Newly grains of barley crop yield after 106 days post planting that was germinated after 72 hours.
A= Unreleased area **B**- Released area

3.6. Statistical analysis of obtained data:

3.6.1. Correlations recorded in barley field experiment (by comparing means values).

The data shown in Table (7), after 106 days post planting, in comparing unreleased and released areas, statistical analysis of obtained data revealed positive moderate significant relationships in case of comparing: total numbers of aphidś individuals (adults & nymphs), total numbers of parasitoid mummies, total numbers of total predatory species and total numbers of *Ch. carnea* (adults & larvae) (r-values were; 0.0.767**, 0.792**, 0.638** and 0.708**, respectively). A highly positive significant relationship was obtained only in case of total numbers of emerged *A. matricariae* parasitoid (r-value was 0.841***) and also a positive significant relationship was obtained in case of Coccinellidae predatory species (r-value was 0.508*).

Table 7: Correlations that were existed in barley field experiment (by comparing means).

Tested factors	Correlations (r-values)
A- Aphidś individuals (adults & nymphs).	0.0.767**(significant=0.001)
B- Parasitoid mummies.	0.792**(significant=0.001)
C- The parasitoid, *A. matricariae*.	0.841***(significant=0.000)
D- Predatory species.	0.638**(significant=0.014)
1- *Ch. carnea*.	0.708**(significant=0.005)
2- Coccinellidae.	0.508*(significant=0.064)
E- Resulted barley crop yield after 106 days post planting.	
1- Total numbers of barley grains.	0.375 (significant=0.065)
2- Length of spikes with no terminal hairs.	0.298 (significant=0.148)
3- Length of spikes with terminal hairs.	0.010 (significant=0.964)
4- Weight of barley grains.	0.459 (significant=0.436)

• Significant r-values (0.500-0.600) **Moderate significant (0.600-0.800) ***Highly significant (0.800-0.900) ****Very highly significant>0.900.

As for resulted barley crop yield, no relationships were observed in comparing: total numbers of barley grains, length of spikes with no terminal spikes hairs, length of spikes with terminal spikes hairs and weight of barley grains (r-values were; 0.375, 0.298, 0.010 and 0.459, respectively).

3.6.1. Effect of temperature and relative humidity on some tested ecological factors.

Natural relationships that were existed (in unreleased area of barley experiment), between total numbers of aphidś individuals (adults & nymphs), total numbers of parasitoid mummies, total numbers of emerged *A. matricariae* parasitoid, total numbers of predatory species, total numbers of *Ch. carnea*, total numbers of Coccinellidae predators and some weather factors (including; means of temperature and relative humidity), during season, 2023/2024 (in Qalubia Governorate), were shown in Table (8**)**.

Table 8: Natural relationships between aphidś individuals, total numbers of aphidś mummies, predatory species and weather factors (including temperature and relative humidity), in unreleased area of barley field during season, 2023/2024.

Tested factors	Tested factors × means of temp.(C°)	Tested factors × means of R.H.%
1- Aphidś individuals	r = -0.232 (significant=0.425)	r = 0.277 (significant=0.339)
2- Parasitoid mummies.	r = -0.419 (significant=0.136)	r = 0.361 (significant= 0.204)
3 – The parasitoid, *A. matricariae*.	r = -0.464 (significant=0.0.095)	r = 0.398 (significant= 0.158)
4 – Predatory species.	r = 0.418 (significant=0.137)	r = -0.110 (significant=0.708)
a- *Ch. carnea*.	r = 0.271 (significant=0.348)	r = 0.010 (significant=0.973)
b- Coccinellidae.	r = 0.526*(significant=0.053)	r = -0.299 (significant=0.299)

* Significant**.**

3.6.1.1. Relationships between many ecological factors and means of temperature.

The relationships between; total numbers of aphidś individuals (adults & nymphs), total numbers of parasitoid mummies, total numbers of emerged *A. matricariae* parasitoid, total numbers of total predatory species and total numbers of *Ch. carnea* and means of temperature were insignificant (where, r-values were; -0.232, -0.419, -0.464, 0.418 and 0.271, respectively). But, the relationship was positive in case of Coccinellidae predators (where, r-value was 0.526*).

3.6.1.2. Relationships between many ecological factors and means of relative humidity.

There were not any significant relationships were obtained between; total numbers of aphidś individuals (adults & nymphs), total numbers of parasitoid mummies, total numbers of emerged *A. matricariae* parasitoid, total numbers of total predatory species and total numbers of *Ch. Carnea,* Coccinellidae and means of relative humidity (r-values were; 0.277, 0.361, 0.398, -0.110, 0.010 and -0.299), respectively).

Thus, obtained results indicate that, relationships between tested ecological factors and means of temperature and relative humidity may be positively or negatively correlated. However, Nechols *et al*. (1999) revealed that, meteorological conditions significantly affect on insect occurrence and their distribution.

4. Conclusion

In conclusion, from present study, barely was firstly cultivated in these tested experimental Egyptian areas (in Delta region), where it was not cultivated there before. So, it was considered as an attempt that can help to cultivate barley successfully and intensively, which is an important strategy cereal crop, to increase the national Egyptian agricultural carbohydrate food source which will result in reducing the gap between the consumption and production. Where, barley can be cultivated together side by side with wheat (with presented cultivation areas), to decrease the external importation process and also the heavy need to external demand on wheat with its highly payment costs, in similar findings, Neelhirajan *et al.* (2007) stated that, barley represents the most important source of required carbohydrates. Besides, Mariey *et al.* (2021) revealed that, barley was indicated as a chief cereal crop that has well improved to numerous abiotic stresses in dry areas. It was found to have the ability to tolerant drought stress and restricted irrigation amount of water. Moreover, results also supported the natural role of the parasitoid, *A. matricariae*, where magnifying its role must be taken in consideration and with predatory species recorded of Coccinellidae, in integration with mass laboratory rearing and field release of second instar predatory larvae of *Ch. carnea*, that will be surely important in field of biological control of cereal aphids. Thus, they can be strongly applied in planning effective biological control techniques in frame of Integrated Pest Management (I.P.M.) programs, to reduce the use of harmful insecticides. Where, Boivin *et al.* (2012) stated that, aphidś parasitoids are commonly used in biological control programs in greenhouses and field situations Also, many authors support the role of mass rearing and releasing the predator, *Ch. carnea* such as: Singh & Varma (1986); Burgio *et al.* (1997); El-Arnaouty *et al.* (2000); Medina *et al.* (2002); El-Heneidy *et al*. (2006); Pappas *et al.,* 2007; Turquet *et al.* (2009) and Ragsdale *et al*. (2011).

References

Abdel-Rahman, M.A.A., 2005. The relative abundance and species composition of hymenopterous parasitoids attacking cereal aphids (Homoptera: Aphididae) infesting wheat plants at Upper Egypt. Egyptian Journal of Agricultural Research, 83(2):633-645.

Abd El-Salam, S.A., 1999. Studies on the aphid fauna of Sinai Governorates. Ph. D. Thesis, Faculty of Agriculture, Cairo University, Egypt, 222.

Ahmed, S.A., M.G., A. El-Deeb and A.H. El-Heneidy, 2007. Survey of abundant aphid species on common economic crops and wild plants in North Sinai Governorate, Egypt. Agricultural Research Journal, Suez Canal University, 7(3): 129-132.

Arif, M.I., M. Rafiqand and A. Ghaffar, 2009. Host plants of cotton mealybug (*Phenacoccus solenopsis*): a new menace to cotton agro-ecosystem of Punjab. International Journal of Agriculture and Biology, 11:163-167.

Atlihan, R., M.B. Kaydan, A. Yarimbatman and H. Okut, 2010. Functional response of the coccinellid predator *Adalia fasciatopunctata* Revelierei to walnut aphid *Callaphis juglandis*. Phytoparasitica, 38:23-29.

Bahy El-Din, I.A., M.A.M. Ali, A.A.M. Abazaid and M.A.M. EL-Khawas, 2024. Role of Biological control agents in regulating pests′ populations on cauliflower: a field study on cabbage aphid *Brevicoryne brassicae* and diamondback moth *Plutella xylostella.* Egyptian Academic Journal of Biological Sciences. 16(2):113-132.

Banken, J. and J. Stark, 1998. Multiple routes of pesticide exposure and the risk of pesticides to biological controls: A study of Neem and the sevenspotted ladybeetle (Coleoptera: Coccinellidae). J. Economic Entomology, 91:1-6.

Bishara, S.I. and L.S. Sourial, 1997. Aphids infesting cereal crops in Egypt with special reference to competition between species. Egyptian Journal of Agricultural Research,75(3) :635-644.

Boivin, G., T. Hance and J. Brodeur, 2012. Aphid parasitoids in biological control. Canadian Journal of Plant Science, 92:1-12.

Burgio, G., R. Ferrari and G. Nicoli, 1997. Biological and integrated control of *Aphis gossypii* Glover (Homoptera: Aphididae) in protected cucumber and melon. Bollettino Dell: Instituto Di Entomologia. Guido Grandi Della Universita Degli Studi Di Bologna, 51:171-178.

Driesche, R., G. Van, P. Vittum and R.G. Van. Driesche, 1987. Potential for increased use of biological control against greenhouse pests in Massachusetts. Res. Bull., Massachusetts Agric. Exp. Station (718):88-11, in opportunities for increased use of biological control in Massachusetts, 7.

Easterbrook, M.A., J.D. Fitzgerald and M.G. Solomon, 2006. Suppression of aphids on strawberry by augmentative releases of larvae of the lacewing *Chrysoperla carnea* (Stephens). Biological Science Technology, 16: 893-900.

El-Arnaouty, S.A., N. Gaber and M. F.S. Tawfik, 2000. Biological control of the green peach aphid *Myzus persicae* by *Chrysoperla carnea* (Neuroptera: Chrysopidae). Egyptian Journal of Biological Pest Control, 10 (12):109-116.

El-Bawab, A.M.O., 1994. Response of some barley cultivars to grow under different environmental conditions. Ph.D. Thesis, Faculty of Agriculture, Cairo University, Egypt.

El-Fatih, M.M., 2006. Seasonal abundance and certain biological aspects of cereal aphids on barley in Egypt (Giza region). Ph. D. Thesis, Faculty of Agriculture, Cairo University, Egypt, 146.

El-Gapaly, H.M.K.M., 2007. Studies on some natural enemies of certain pests infesting sorghum and corn plants in Sohag Governorate. M. Sc. Thesis, Faculty of Agriculture, Minia University, Egypt, 159.

El-Heneidy, A.H., 1994. Efficacy of aphidophagous insects against aphids at wheat fields in Egypt, a 5-year evaluation. Egyptian Journal of Biological Pest Control, 4(2):113-123.

El-Heneidy, A.H., D. Gonzalez, M.A. Ahmed, M.M. Ibraheem, H.E. Megahed, W.M. Abdel-Awal and D. Adly, 2006. Performance of certain exotic aphid parasitoid species towards cereal aphids under laboratory, field cage and open wheat field conditions in Egypt. Egyptian Journal of Biological Pest Control, 16(2):67-72.

Gurbanov, G.G., 1982. Effectiveness of the use of the common lacewing (*Chrysopa carnea* Steph.) in the control of sucking pests and the cotton moth in cotton. Izvestiya Akademii Nauk Azerbaidzhanskoi SSR. Biologicheskikh Nauk, (2):92-96.

Gurr, G.M., S.D. Wratten and W.E. Snyder, 2012. Biodiversity and insect pests. In: Biodiversity and insect pests (eds. G.M., Gurr, S.D. Wratten and W.E. Snyder), Wiley-Blackwell, London, 4-20.

Hemidi, W. and M. Laamari, 2020. Aphid's parasitoid fauna and their atrophic associations in the oasis ecosystems of Zibans (Biskra, Algeria). Egyptian Journal of Biological Pest Control, 30(14):1-8.

Hagberg, A., 1987. Barley as a model crop on plant genetic research. In proceedings of the 5th Int. Barley Genet. Symp. S. Yasuda and T.Konishi, eds., Sanyo Press, Okoyama, Japan, 3-6.

Joshi, S., R.J. Rabindra and T.P. Rajendran, 2010. Review Article, Biological control of aphids. Journal of Biological Control, 24(3):185–202.

Mahmoud, M., M. Ghaith, A.A. Gh. Farag and A.A.A. Youssef, 2023. Effect of some different methods and natural enemies on the control of the aphid of some herbogy grass field crops in Nepal. Zagazig Journal of Agricultural Research, 50 (1) :55-65.

Mariey, A.S., N.E. Mohamed, E.Z. Ghareeb, S.E. Abo Zaher, 2021. Genetic Diversity of Egyptian Barley using Agro–physiological Traits, grain quality and molecular markers. Current Science International, 10:58-71.

Medina, P., G. Smagghe, F. Budia, P. Del Estal, L. Tirry and E. Vinuela, 2002. Significance of penetration, excretion, and transovarial uptake to toxicity of three insect growth regulators in predatory lacewing adults. Archive Insect Biochemistry, 51:91–101.

Megahed, H.E.A., 2000. Studies on aphids. Ph.D. Thesis, Faculty of Agriculture, Zagazig University, Egypt, 206.

Messina, F.J. and S.M. Sorenson, 2001. Effectiveness of lacewing larvae in reducing Russian wheat aphid population on susceptible and resistant wheat. Biological Control, 21(1) :19-26.

Neelhirajan, S., S. Karunakram, D. Jayas and N. White, 2007. Detection techniques for stored product insects in grain. Int. Fd. Control, 18:157-162.

Nechols, J.R., M.J. Tauber, C.A. Tauber and S. Masaki, 1999. Adaptation to hazardous seasonal conditions: dormancy, migration and polyphenism. In: Ecological Entomology, 2nd ed. (Huffaker C.B. and Gutierrez A.P., Ed), 159-200, New York: John Wiley& Sons.

Pappas, M.L., G.D. Broufas and D.S. Koveos, 2007. Effects of various prey species on development, survival and reproduction of the predatory lacewing *Dichochrysa prasina* (Neuroptera: Chrysopidae). Journal of Biological Control. 43:163-170.

Pungerl, N.B., 1984. Host preferences of *Aphidius* (Hymenoptera: Aphidiidae) populations parasitizing pea and cereal aphids (Hemiptera: Aphididae). Bulletin Entomological Research, 74:153-161.

Ragsdale, D.W., D.A. Landis, B. Jacques, G.E. Heimpel and N. Desneux, 2011. Ecology and management of the soybean aphid in North America. Annual Review of Entomology, 56:375-379.

Rashid, M.M., M.K. Khattak, K. Abdullah, M. Amir, M. Tariq and S. Nawaz, 2012. Feeding potential of *Chrysoperla carnea* and *Cryptolaemus montrouzieri* on cotton mealybug, *Phenacoccus solenopsis.* Journal of Animal and Plant Sciences, 22:639-643.

Saleh, A.A.A., M.S. Hashem and A.A. Abd-Elsamed, 2006. *Aphidius colemani* Viereck and *Diaeretiella rapae* (Ḿ Intoch) as parasitoids on the common reed aphid, *Hyalopterus pruni* (Geoffrey) in Egypt. Egyptian Journal of Biological Pest Control. 16(2) :93-97.

Saleh, A.A.A., H.M. El-Sharkawy, F.S. El-Santeland and R.A. Abd El-Salam, 2017. Studies on the Predator *Chrysoperla carnea* (Stephens) in Egypt. International Journal of Environment. 2(6):70-77.

Sarwar, M., 2013. Studies on incidence of insect pests (aphids) and their natural enemies in Canola *Brassica napus* L. (Brassicaceae) crop ecosystem. International Journal of Scientific Research in Environmental Sciences, 1(5) :78-84.

Sarwar, M., 2014. The propensity of different larval stages of lacewing *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) to control aphid *Myzus persicae* (Sulzer) (Homoptera: Aphididae) evaluated on Canola *Brassica napus* L. Songklanakarin J. Science Technology, 36 (2) :143-148.

Singh, P.P. and G.C. Varma, 1986. Comparative toxicities of some insecticides to *Chrysoperla carnea* (Chrysopidae: Neuroptera) and *Trichogramma brasiliensis* (Trichogrammatidae: Hymenoptera), two arthropod natural enemies of cotton pests. Agricultural Ecosystems Environment. 15:23-30.

Slman, F.A.A. and M.A. Ahmed, 2005. Seasonal abundance of cereal aphids and ladybird beetle, *Coccinella undecimpunctata* (L.) on four cereal crops in South Egypt. Assiut Journal of Agricultural Science, 36 (4):205-215.

Slman, F.A.A., 2006. Incidence of cereal aphids and seasonal abundance of their parasitoids in wheat fields in Sohag (Upper Egypt). Assiut Journal of Agricultural Science, 37(2):211-220.

Stary, P., 1976. Aphid parasite (Hymenoptera: Aphidiidae) of the Mediterranean area. Transactions of the Czechoslovak Academy of Sciences, Series of Mathematical and Natural Sciences, 86: 1-95.

Tantawi, A.M., 1985. Studies on wheat aphids in Egypt. 1- Surveys. Rachis, 4(2):25-26.

Tauber, M.J., C.A. Tauber, K.M. Daane and K.S. Hagen, 2000. Commercialization of predators: recent lessons from green lacewings (Neuroptera: Chrysopidae: *Chrysoperla*). American Entomologist. 46:26-38.

Turquet, M., J.J. Piron, M. Pommier, E. Lascaux, and G. Lorin, 2009. Biological control of aphids with *Chrysoperla carnea* on strawberry. Acta Hortic. 842:641–644.

Ushechekov, A.T., 1989. *Chrysoperla* for aphid control. Zashchita Rastenii (Moskva). 11:20-22.

Vo¨ lkl, W., M. Mackauer, J. Pelland and J. Brodeur, 2007. Predators, parasitoids and pathogens. Pages 187-233 in H. Van Emden and R. Harrington, eds. Aphids as crop pests. CAB International, Oxford, UK.

Yadav, R. and P.H. Pathak, 2010. Effect of temperature on the consumption capacity of *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) reared on four aphid species. The bioscan. 5:271-274.

Younes, M.W.F., I.F. Shoukry, S.A.G. Metwally and Y.N.M. Abd-Allah, 2013. Efficiency of second instar larvae of *Chrysoperla carnea* to suppress some piercing sucking insects infesting cantaloupe under semi-field conditions. Egyptian Journal of Agricultural Research. 91(1):169-179.

Youssif, M.A.I., SH.A.M. Ali and W.M.M. Helaly, 2017. Cereal aphid species (Homoptera: Aphididae) Infesting wheat plants and their aphidophagous insects at El-Khattara District, Sharkia Governorate, Egypt. J. Plant Protection and Pathology, Mansoura University, 8 (11):581–589.