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Releasing of *Orius albidipennis* and *Chrysoperla carnea* to control aphids and thrips attacking strawberry plants in El-BeheraGovernorate Egypt

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ABSTRACT

This work was conducted to study the biological impact of releasing the *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) and *Orius albidipennis* (Reuter) (Hemiptera: Anthocoridae) to control *Thrips tabaci* Lindeman, and *Aphis* spp. infesting strawberry plants under open field conditions. Experiments were carried out during the period from November 13, 2015 till the mid of June 2016 at El-Beregate area 30 km South Kom Hamada center, El-Behera Governorate, Egypt. The obtained results indicated that, releasing of *Chrysoperla carnea* with 15 individuals at 2nd instar larvae recorded the highest mean reduction percentage (97.3%) against the aphid pest, while the highest reduction percentage of thrips insects was recorded at the treatment of releasing with five individuals of 2nd instar nymph of *Orius albidipennis* with mean reduction percentage of 98.5%. The second larval instar of *C. carnea* caused reduction percentage in the aphid population reached to 100% during last week of December, 2nd half of February and 3rd week of March, while at other weeks, the reduction percentages ranged between 84.2% (2nd week of December) and 99.1% during most weeks of the study period.

Key words: strawberry, *Chrysoperla carnea, Orius albidipennis*, Aphis spp, *Thrips tabaci*.

INTRODUCTION

Strawberry plant was attacked by various different harmful pests,(aphids, mites, thrips, mired bugs, tarsonemids and recently *Drosophila suzukii)* (Trottin-Caudal *et al.*(2012). In addition, thrips has reported as a major pest in strawberry production especially in organic production, according to its complex enzyme metabolic detoxification system and higher biotic potential thus resulted necessarily utilization nonspecific beneficial organism such as green lacewing, *Chrysoperla carnea* Hofsvang (2013). However, up to ten species of aphids were recorded on strawberry plant causing destructive damage (Turquet *et al*. (2009). Furthermore, the predator,

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Chrysoperla carnea (**Neuroptera: Chrysopidae)**, occurs naturally in a wide range of agroecosystems and is commercially available in Europe and North America (Wang and Nordlund, 1994, Tauber *et al*., 2000). It has primarily been used through augmentative release to control various aphid species in greenhouses and outdoor crops (Scopes 1969; Tulisalo andTuovinen, 1975; Turquet *et al.*, 2009). In field studies, satisfactory results were reported for *C. carnea* control of citrus thrips, ***Scirtothrips citri*** (Khan and Morse 1999), the green lacewings, ***C. carnea*** (**Stephens**) is a cosmopolitan polyphagous predator, commonly found in agricultural systems. It has been recorded as an effective generalist predator of aphids, coccids, mites and mealy bugs etc. (Yuksel and Goemen, 1992; Singh and Manoj, 2000; Zaki and Gesraha, 2001). It has been widely used for aphid bio-control (Venkatesan ***et al***., 2000, 2002) and other insect pests (Obrycki *et al*., 1989). The predator, ***Orius albidipennis*** **(Hemiptera: Anthocoridae)** play an important contribution to the success of augmentative biological control in the sweet pepper production in Almeria, Spain. Augmentative biological control has become a worldwide booming business. This increases the pressure on commercial rearing facilities to produce large numbers of biological control agents of acceptable quality (van Lenteren 2003). Many natural enemies are reared on unnatural foods rather than on their natural or target prey or host. Continued rearing of a natural enemy on unnatural food may lead to changes in its physiology or behavior. This may in turn result in a reduced capacity of the natural enemy to interact with its natural (target) prey and reduce its control efficiency (Thompson and Hagen 1999; Grenier and De Clercq 2003).This work shed light to effecting of *O*. ***albidipennis*** and *C. carnea* to control aphids and thrips in strawberry field at El-Behera Governorate, Egypt.

MATERIALS AND METHODS

1. Field preparations:

The experiment was conducted in 700 m² at El-Beregate area, Behera governorate. The predators were in 2nd instar larvae of ***Chrysoperla carnea*** & ***Orius albidipennis*** nymphs obtained from the biological control laboratory rearing predator's unit at Faculty of Agriculture, Cairo University under the supervision of Prof. Ashraf Elarnaouty. The area was divided into 25 plots, each about 28 m^2. The inspection was done in the field, with collected 5 leaves from every plot as a replicate after 48 hours from releasing process.

2. Field Experiments:

The treatments were as follows:

1. Releasing 5 individuals of 2nd instar *O. albidipennis* nymphs /plot.
2. Releasing 10 individuals of 2nd instar *O. albidipennis* nymphs /plot.

3. Releasing 15 individuals of 2nd instar *O. albidipennis* nymphs /plot.
4. Releasing 10 individuals of 2nd instar *C. carnea* larvae /plot.
5. Releasing 15 individuals of 2nd instar *C. carnea* larvae /plot.
6. Releasing 10 2nd instar *Orius* nymphs + 10 2nd instar *C.* larvae /plot.

3. Releasing process:

The releasing periods were extended from November 13, 2015 till the mid of June 2016. Data were recorded pre releasing and 2 days after releasing every week till the end of experiment (27 weeks).

4. Statistical analysis:

The obtained data were statistically analyzed using analysis of SAS program.

RESULTS

The experiment was carried out at Kom Hamada region during November, 2015 till May 2016 to evaluate the efficiency of different releasing rate by both *Orius* and *Chrysoperla* predators as bio-control agents against aphid and thrips on strawberry crop. The obtained results were tabulated in Fig. (1). Data was discussed as the following:

I- Releasing of *Orius albidipennis*:

1- Five individuals of 2nd instar nymph:

The obtained Data in Table (1) revealed that the reduction percentages among the aphid species started with 95.6% during mid-November, ranged between 77.1% - 98.2%, through the second half of November, December, January while at the first week of February it was recorded the highest values (100%), where during the last week of February, March, April and May the reduction values were varied from 79.8 to 100%. As for reduction percentage of thrips, it ranged between 86.8 – 99.3% during November, December and the first half of January. Through the next period started from mid-January till the end of experiment (end- May) it was recording 100%.

2-Ten individuals of 2nd instar nymph:

Data illustrated in Table (2) show that the reduction percentage of aphids caused by *Orius albidipennis* ranged between 80.7 – 98.2% in different records, while it was reached 100% during second week of March, third week of May to the end of study. In case of thrips, the reduction percentage was 100% from the third week of January till the middle of June.

3- Fifteen individuals of 2nd instar nymph:

The obtained results illustrated in Table (3) Indicated that the lowest reduction percentage (75.4%) was occurred during mid-December and the highest one (100%) was observed among aphids in second and third weeks of both February and March and second week of April. The highest reduction percentage of thrips was caused by mired bug, *Orius* nymphs (100%) during the

most period of study started from the second week of January till the mid of June. The current results is in line with those of Shipp and Wang (2003) who reported significant positive reduction in thrips population by releasing ten individuals of *Orius* bugs/plant in protected tomato.

Table (1): Effect of released five individuals of 2nd instar nymphs *Orius albidipennis* against aphid species & *Thrips tabaci* during the period of November 2015 till May 2016 at strawberry field

Months	Dates	Reduction %	
		Aphids	Thrips
15th November	2 Days after releasing	95.6	97.5
	1 Week after releasing	93.8	95.6
1st December	2 Week after releasing	87.7	97.3
	3 Week after releasing	81.5	87.5
15th December	4 Week after releasing	77.1	86.8
	5 Week after releasing	95.6	96.8
1st January	6 Week after releasing	93.8	97.5
	7 Week after releasing	95.6	99.3
15th January	8 Week after releasing	95.6	99.3
	9 Week after releasing	92.1	100
1st February	10 Week after releasing	98.2	100
	11 Week after releasing	98.2	100
15th February	12 Week after releasing	91.2	100
	13 Week after releasing	100	100
1st March	14 Week after releasing	100	100
	15 Week after releasing	100	100
15th March	16 Week after releasing	100	100
	17 Week after releasing	100	100
1st April	18 Week after releasing	100	100
	19 Week after releasing	98.2	100
15th April	20 Week after releasing	88.5	100
	21 Week after releasing	98.2	100
1st May	22 Week after releasing	85.9	100
	23 Week after releasing	89.4	100
15th May	24 Week after releasing	79.8	100
	25 Week after releasing	92.1	100
1st June	26 Week after releasing	96.4	100
	27 Week after releasing	100	100
	Mean	93.73	98.486
	T. value	3.41*	
	Prob	0.0012	

Table (2) Effect of released ten individuals of 2nd instar nymphs of *Orius albidipennis* against Aphid species & *Thrips tabaci* during the period of November 2015 till May 2016 at strawberry field

Months	Dates	Reduction %	
		Aphids	Thrips
15th November	2 Days after releasing	99.1	91.2
	1 Week after releasing	89.2	83.1
1st December	2 Week after releasing	80.7	81.8
	3 Week after releasing	85.9	90.6
15th December	4 Week after releasing	84.2	94.3
	5 Week after releasing	99.1	93.1
1st January	6 Week after releasing	94.7	96.8
	7 Week after releasing	91.2	99.3
15th January	8 Week after releasing	90.3	99.3
	9 Week after releasing	93.8	100
1st February	10 Week after releasing	98.2	100
	11 Week after releasing	95.6	100
15th February	12 Week after releasing	94.7	100
	13 Week after releasing	96.4	100
1st March	14 Week after releasing	98.2	100
	15 Week after releasing	100	100
15th March	16 Week after releasing	98.2	100
	17 Week after releasing	99.1	100
1st April	18 Week after releasing	98.2	100
	19 Week after releasing	97.3	100
15th April	20 Week after releasing	96.4	100
	21 Week after releasing	100	100
1st May	22 Week after releasing	85	100
	23 Week after releasing	92.9	100
15th May	24 Week after releasing	93.8	100
	25 Week after releasing	100	100
1st June	26 Week after releasing	100	100
	27 Week after releasing	100	100
	Mean	94.72	97.482
	T. value	1.96	
	Prob.	0.0553	

Table (3) Effect of released fifteen individuals 2nd instar nymphs of *O. albidipennis* against Aphid species & *Thrips tabaci* during the period of November 2015 till June 2016 at strawberry field

Months	Dates	Reduction %	
		Aphids	Thrips
15th November	2 Days after releasing	97.3	78.7
	1 Week after releasing	98.2	99.3
1st December	2 Week after releasing	82.4	91.8
	3 Week after releasing	79.8	90.0
15th December	4 Week after releasing	75.4	91.8
	5 Week after releasing	99.1	93.7
1st January	6 Week after releasing	99.1	98.1
	7 Week after releasing	99.1	100
15th January	8 Week after releasing	97.3	100
	9 Week after releasing	90.3	100
1st February	10 Week after releasing	99.1	100
	11 Week after releasing	100	100
15th February	12 Week after releasing	100	100
	13 Week after releasing	96.4	100
1st March	14 Week after releasing	98.2	100
	15 Week after releasing	100	100
15th March	16 Week after releasing	100	100
	17 Week after releasing	99.1	100
1st April	18 Week after releasing	99.1	100
	19 Week after releasing	100	100
15th April	20 Week after releasing	99.1	100
	21 Week after releasing	99.1	100
1st May	22 Week after releasing	92.1	100
	23 Week after releasing	91.2	100
15th May	24 Week after releasing	97.3	100
	25 Week after releasing	98.2	100
1st June	26 Week after releasing	99.1	100
	27 Week after releasing	99.1	100
	Mean	95.89	97.98
	T. value	1.37	
	Prob.	0.1775	

II- Releasing of *Chrysoperla carnea*:

1-Ten individuals of 2nd instar larvae:

The larval stage of aphid lion recorded reduction percentage ranged between 73.6- 99% in the most period of study, whereas the reduction percentage reached 100% during 2nd week of January, 1st and 2nd week of March, third week of both April & May and 1st week of June Table (4).The reduction percentage of thrips recorded lowest value of 80.6% in the first week of December, while the highest value (100%) were achieved through the period extended from second week of February till the mid of Jun.

Table (4) Effect of release of ten individuals of 2nd instars *C. carnea* larvae against aphid species &*Thrips tabaci* during November 2015 till Jun 2016 at strawberry field

Months	Dates	% Reduction	
		Aphids	Thrips
15th November	2 Days after releasing	94.7	83.7
	1 Week after releasing	93.8	81.2
1st December	2 Week after releasing	88.5	80.6
	3 Week after releasing	84.2	94.3
15th December	4 Week after releasing	73.6	93.7
	5 Week after releasing	92.1	96.8
1st January	6 Week after releasing	97.3	97.5
	7 Week after releasing	100	96.8
15th January	8 Week after releasing	92.9	100
	9 Week after releasing	85.0	98.7
1st February	10 Week after releasing	99.1	99.3
	11 Week after releasing	97.3	100
15th February	12 Week after releasing	97.3	100
	13 Week after releasing	95.6	100
1st March	14 Week after releasing	100	100
	15 Week after releasing	100	100
15th March	16 Week after releasing	99.1	100
	17 Week after releasing	99.1	100
1st April	18 Week after releasing	99.1	100
	19 Week after releasing	100	100
15th April	20 Week after releasing	97.3	100
	21 Week after releasing	100	100
1st May	22 Week after releasing	89.4	100
	23 Week after releasing	89.4	100
15th May	24 Week after releasing	100	100
	25 Week after releasing	99.1	100
1st June	26 Week after releasing	100	100
	27 Week after releasing	99.1	100
	Mean	95.11	97.23
	T. value	1.32	
	Prob.	0.1933	

2- Fifteen individuals of 2nd instar larvae:

The second larval instar of *C. carnea* caused reduction percentage in the aphid population reached to 100% during first week of January, 1st & 2nd weeks of March, 1st week of April and 3rd week of May while the other weeks, the reduction percentage ranged between 84.2% (3rd week of Dec.) and 99.1% during most weeks of the study period.

The previous finding was in harmony with Turquet et al. (2009) who mentioned that, strawberry was attacked by different aphid species that require utilization nonspecific beneficial organisms such as the green lacewing, *C. carnea* and recorded successful reduction of aphid by releasing the Chrysoperla larvae at rate one or five lacewing/plant but releasing five Chrysoperla larvae gave best suppressing.

Different previous work were in line with our finding which evidenced the vital and essential role that occurred by releasing lacewing larvae against various aphid species (Messina and Sorenson, 2001, Sarwar, 2013). In case of thrips, the most period (Feb. – May) showed 100% reduction. Through the other tested weeks, the reduction percentage ranged between 71.8 – 99.3% Table (5).

III- Releasing both *Orius* and *Chrysoperla*:

As shown in Table (6) the obtained data show the effect of combination between both investigated predators at the rate of 10 individuals 2nd instar for both. The reduction percentages recorded 85.9% - 100% within the population of aphid, while this value was 100% in the case of thrips in most weeks of study (20 weeks) and ranged between 88.1- 99.3% through the remaining weeks (November, December and 1st & 2nd weeks of January).

Data in Table **(7)** show that, releasing process of the two predators in strawberry field as bio-agent for controlling aphids seems to be promising. Mean percentage of reduction by the predator *O. albidipennis* ranged between 93.7% at rate of five 2nd instar nymph, and 95. 9% when applied fifteen 2nd instar nymphs of *Orius*. On the other hand, releasing ten individuals/2ndinstar *C. carnea* larvae recorded 95.1% while, highest (97.3%) reduction was achieved associated with releasing15 individuals/2nd instar larvae. The application by combined predators (10 *Orius* + 10 *Chrysoperla*) comes recorded 96.9%. It comes over than 93.7 % till 97.3 % in both harmful insects.

The obtained data in Table (8) revealed that the releasing process of the two predators in strawberry field for controlling the Thrips seems to be promising. Mean percentage of reduction at five individuals 2nd instar of *O. albidipennis* nymphs recorded 98.5%, ten *Orius* 2nd instar nymphs recorded 97.5, 15 *Orius* 2nd instar nymphs 98%. On the other hand, ten 2nd instar of *C. carnea* larvae recorded 97.2 %, 15 2nd instar larvae recorded 97% and 10 *Orius* combined with 10 *Chrysoperla* recorded 98.2%. It comes over than 97 % till 98.5 % in both harmful insects.

Table (5) Effect of release of 15 individuals of 2nd instars *C. carnea* larvae against aphid and *T. tabaci* during November 2015 till June 2016 .

Months	Dates	% Reduction	
		Aphids	Thrips
15th November	2 Days after releasing	98.2	91.8
	1 Week after releasing	94.7	85.0
1st December	2 Week after releasing	94.7	85.6
	3 Week after releasing	85.0	71.8
15th December	4 Week after releasing	84.2	91.2
	5 Week after releasing	95.6	94.3
1st January	6 Week after releasing	100	97.5
	7 Week after releasing	96.4	100
15th January	8 Week after releasing	99.1	99.3
	9 Week after releasing	80.7	100
1st February	10 Week after releasing	99.1	100
	11 Week after releasing	96.4	98.1
15th February	12 Week after releasing	98.2	100
	13 Week after releasing	98.2	100
1st March	14 Week after releasing	100	100
	15 Week after releasing	100	100
15th March	16 Week after releasing	98.2	100
	17 Week after releasing	99.1	100
1st April	18 Week after releasing	100	100
	19 Week after releasing	99.1	100
15th April	20 Week after releasing	97.3	100
	21 Week after releasing	99.1	100
1st May	22 Week after releasing	98.2	100
	23 Week after releasing	94.7	100
15th May	24 Week after releasing	98.2	100
	25 Week after releasing	100	100
1st June	26 Week after releasing	96.4	100
	27 Week after releasing	97.3	100
	Mean	96.361	96.95
	T. value	0.38	
	Prob.	0.7049	

Table (6) Effect of released 10 *Orius albidipennis* + 10 *Chrysoperla carnea* on Aphid species & *Thrips tabaci* population during the period of November 2015 till June 2016 at strawberry field.

Months	Dates	Reduction %	
		Aphids	Thrips
15th November	2 Days after releasing	94.7	95.0
	1 Week after releasing	100	88.7
1st December	2 Week after releasing	92.1	88.1
	3 Week after releasing	85.9	93.7
15th December	4 Week after releasing	92.1	93.1
	5 Week after releasing	92.1	96.8
1st January	6 Week after releasing	99.1	96.5
	7 Week after releasing	98.2	99.3
15th January	8 Week after releasing	94.7	100
	9 Week after releasing	92.9	100
1st February	10 Week after releasing	98.2	100
	11 Week after releasing	97.3	100
15th February	12 Week after releasing	100	100
	13 Week after releasing	100	100
1st March	14 Week after releasing	99.1	100
	15 Week after releasing	100	100
15th March	16 Week after releasing	99.1	100
	17 Week after releasing	97.3	100
1st April	18 Week after releasing	100	100
	19 Week after releasing	99.1	100
15th April	20 Week after releasing	97.3	100
	21 Week after releasing	100	100
1st May	22 Week after releasing	95.6	100
	23 Week after releasing	95.6	100
15th May	24 Week after releasing	96.4	100
	25 Week after releasing	96.4	100
1st June	26 Week after releasing	100	100
	27 Week after releasing	100	100
	Mean	96.9	98.26
	T. value	1.48	
	Prob.	0.1458	

Table (7): Effect of releasing *O. albidipennis* and *Ch. carnea* on Aphid spp. population in strawberry field during the period from November 2015 till the end of Jun 2016.

levels of releasing	Mean Reduction %
5 / 2nd instar of Orius albidipennis Nymphs	93.7
10 / 2nd instar of Orius albidipennis Nymphs	94.7
15 / 2nd instar of Orius albidipennis Nymphs	95.9
10 /2nd instar of Chrysoperla carnea Larvae	95.1
15 /2nd instar of Chrysoperla carnea Larvae	97.3
10 /2nd instar of Orius nymph +10 Chrysoperla larvae	96.9

In general, the obtained data as shown in Tables (1 and 2) confirm that the releasing green lacewing,*C. carnea*, with 15 individuals 2nd instar larvae achieved great suppressing in aphid population, recorded the highest reduction (97.3%), while in case of thrips the highest percentage of reduction caused when the releasing was applied with five individuals of 2nd instar nymph of *O. albidipennis*, with mean reduction percentage reached 98.5%.

Table (8): Effect of releasing *Orius albidipennis* and *Chrysoperla carnea* on *Thrips tabaci* population in Strawberry field at El-Behera Governorate, Egypt during the period from November 2015 till the end of June 2016.

level of releasing	Mean reduction %
5 / 2nd instar of *Orius albidipennis* Nymphs	98.5
10 / 2nd instar of *Orius albidipennis* Nymphs	97.5
15 / 2nd instar of *Orius albidipennis* Nymphs	98.0
10 /2nd instar of *Chrysoperla ca*rnea Larvae	97.2
15 /2nd instar of *Chrysoperla carnea* Larvae	97.0
10 /2nd instar of (*Orius* nymph + 10 *Chrysoperla* larvae)	98.2

DISCUSSION

The obtained results are in agreement with Turquet *et al.* (2009) in France who reported that the lacewing *Chrysoperla carnea* is widely known as natural beneficial insect against aphids. However, its effective use as a predator introduced in strawberry crops has still been confirmed. *T. tabaci* reported as thrips species damaging strawberries in United Kingdom (Buxton & Easterbrook, 1988; Ckersten & Easterbrook, 1991). In pepper, suppression occurs at a ratio of approximately one *Orius insidiosus* to 180 thrips, and control occurs at a ratio of approximately one *Orius insidiosus* to 50 thrips (Funderburk 2009). Sarwar (2014) investigated the effectiveness of different green lacewing stage *Chrysoperla carnea* (1st, 2nd and 3rd) larvae against aphids infested Canola *Brassicae napus* L. crop and demonstrated that all predator stags recorded positively aphids reduction while treatment by both 1st and 2nd instar larvae observed greater efficiency in reducing pest infestation and caused higher increasing in seed yield.

Author Contributions:

Conceptualization, KMO, MSE, AMR; data curation, KMO, MSE, AMR; formal analysis, KMO, MSE, AMR; Investigations, KMO, MSE, AMR; Methodology, KMO, MSE, AMR; writing original drafts, and writing and editing KMO, MSE, AMR; All authors have read and agreed to the purplish version of the manuscript.

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The author declares no conflict of interest.

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