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Biological control of *Aulacaspis tubercularis* and *Kilifia acuminata* infested mango trees by *Chrysoperla carnea* (Neuroptera: Chrysopidae)

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Abstract

The current study was carried out to evaluate the efficacy of *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) against *Aulacaspis tubercularis* (Newstead) and *Kilifia acuminata* (Signoret) (Hemiptera: Diaspididae and Coccidae) infested mango trees (*Mangifera indica* L.) in Faculty of Agriculture-Cairo University-Giza Governorate by double release, 50 individuals of 2nd larval instar of *C. carnea* for each release and counts were recorded at 15, 30 and 45 days, post-treatment. Results indicated that in the first release, there was an effective reduction percentage in the population of both scale insects in autumn. The mean reduction percentages 45 days after treatment in *A. tubercularis* were 86.08, 78.40 and 76.07%, respectively. While, in *K. acuminata*, the mean reduction percentages were 81.48, 77.78 and 75%, respectively. In the second release, in spring, the mean reduction percentages 45 days after treatment in *A. tubercularis* were 81.48, 77.78, and 75%, respectively. However, in *K. acuminata*, the mean reduction percentages 45 days after treatment were 84.37, 66.6 and 75.1%, respectively. *C. carnea* has proven to be a highly efficient biocontrol agent against scale insects *A. tubercularis* and *K. acuminata*.

Introduction

The mango trees *Mangifera indica* L. (Family: Anacardiaceae), are one of the most widespread tropical fruits in Egypt after citrus and grapes in terms of production, marketing, and consumption due to their exotic flavor and delicious taste, as well as high nutritional value and high yield (Kawiz, 1999 and Radwan, 2003). Moreover, the cultivation of mangoes is a significant contributor to Egypt's economy, with a primary focus on eight Governorates in the Nile Delta (Hashem, 2021). Mango trees are

susceptible to various insect pests, including the white mango scale, *Aulacaspis tubercularis* (Newstead) (Hemiptera: Diaspididae), and *Kilifia acuminata* (Signoret) (Hemiptera: Coccidae), the first is a hard scale insect but the second is a soft scale insect. They cause much damage as it has pipette-piercing mouth parts, they suck plant sap from different parts of plants such as shoots, twigs, leaves, and fruits of mango trees causing momentous damage. This mechanism confused the plant physiology and led to plant weakness, which became endangered

infesting by secondary infestation with other insects. High infestation levels caused serious damage such as early leaves drop and reduced yield of mango orchards (Elwan, 1990; Kwaiz, 1999 and Nada *et al.*, 1990). These insects cause reduced mango production and decrease the quantity and quality of fruits (Elwan *et al.*, 2005; Kwaiz, 2009; Fita, 2014 and Fita *et al.*, 2023). It has three annual generations in Sharkia Governorate (Hassan *et al.*, 2012), while Amer *et al.* (2017) recorded that *A. tubercularis* had three or four peaks in Qaliobiya Governorate.

K. acuminata infested mango trees, causing serious damage to leaves and fruits. It secretes dew on leaves which reduces photosynthesis on leaves (Badawy *et al.*, 2000; El-Dash *et al.*, 2002 and Hassan *et al.*, 2012). It is crucial to manage pests effectively while also prioritizing environmental preservation through reduced pesticide use. Therefore, implementing a biological control approach to enhance the impact of natural enemies is essential in integrated pest management. The green lacewing *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) has become an increasingly popular biological control agent for agricultural insect pests in integrated management (I.P.M.) programs. Its ability to be easily mass-produced (El-Arnaouty, 1991) and its broad tolerance to many insecticides, particularly during the larval and cocoon stages, give it an advantage over other natural enemies (Medina *et al.*, 2001; Chen and Liu, 2002 and Badawy *et al.*, 2006). The larvae of *C. carnea* are known for their voracious appetite for soft-bodied arthropods, including aphids, whiteflies, thrips, mealybugs, scale insects, Leafhoppers, and eggs and small larvae of Coleoptera and Lepidoptera (Ulhaq *et al.*, 2006; El-Hawary *et al.*, 2010; Abd-Rabou *et*

al., 2012; Khan *et al.*, 2015; Rugno *et al.*, 2019; El-Dessouki and Korish, 2023 and Ismail *et al.*, 2023).

The primary objective of this research was to assess the potential of *C. carnea* larvae as a biological control agent against various life stages of two scale insects, *A. tubercularis* and *K. acuminata* infested mango trees.

Materials and methods

1. Rearing of the predator

Chrysoperla carnea:

Adults of *C. carnea* were placed in plastic boxes 120×15×6 cm covered with black muslin for deposited eggs, semi-artificial diet (4g yeast extract, 8g honey and 4cm distilled water) drops were provided on tape stacked on the muslin for adults nutrition. The deposited eggs were collected daily, and the boxes were changed three times per week. The eggs of *C. Carnea* were kept in plastic boxes until hatching, the hatched larvae were supplied by eggs of the grain moth *Sitotroga cerealella* as a food source. Eggs of *S. cerealella* were obtained from the mass production Unit of *S. cerealella* eggs, bollworm Research Department, Plant Protection Research Institute, Agricultural Research Center, Dokki, Giza, Egypt.

2. Experimental design:

This experiment was conducted in the Faculty of Agriculture, Cairo University Giza Governorate of 31st October 2023, with a corresponding temperature of an average of 30°C and 55% (RH.). The experiment involved selecting 30-year-old mango trees that were heavily infested with *A. tubercularis* and *K. acuminata* which had not been treated with insecticides for two years before the study. The treatments consisted of replicating 5 leaves 5 times for each release, where two releases of the 2nd larval instar of *C. carnea* with 50 larvae per treatment were carried out. During the first release in Autumn *C. carnea* larvae were delicately placed on the infested

leaves using a fine camel brush. With second release in spring, the treatments were repeated with 50 larvae/ treatment.

3. Sampling procedures:

Following the treatment, counts were conducted at intervals of 15, 30, and 45 days. The samples were stored in polyethylene bags and promptly transported to the laboratory for examination. Various life stages of the

insects were identified (Living specimens) in order to determine the percentage decrease in the population.

4. Statistical analysis:

The reduction in population percentages of *A. tubercularis* and *K. acuminata* at various stages relative to the initial count before treatment was calculated according to Stafford and Summers (1963) equation.

$$R = \frac{\text{Pre-treatment count} - \text{Post-treatment counts}}{\text{Pre-treatment counts}} \times 100$$

The results were analyzed utilizing the Cost as a computer program to calculate the "F value" and Least Significant Difference (L.S.D.) between treatments (Two releases) of second larval instars of *C. carnea*.

Results and discussion

Biological control of *Aulacaspis tubercularis* and *Klifia acuminata* infesting mango trees by releasing of 2nd larval instar of *Chrysoperla carnea*:

1. The first releasing of 2nd larval instar of *Chrysoperla carnea*:

The study involved the release of the 2nd larval instar of *C. carnea* to feed on *A. tubercularis* and *K. acuminata* in different stages infesting mango trees in Faculty of Agriculture-Cairo University in October 2023.

Table (1): Reduction percentages of *Aulacaspis tubercularis* and *Klifia acuminata* infestation under first release of 2nd larval instar of *Chrysoperla carnea*.

Sampling dates	<i>Aulacaspis tubercularis</i> df= (2,6)				<i>Kilifia acuminata</i> df= (2,6)			
	Nymphs	Adults	Gravid females	Total mean reduction	Nymphs	Adults	Gravid females	Total mean reduction
1 st count	56.1	45.27	41.10	47.49±4.470b(C)	51.85	44.44	43.75	46.68± 2.59b(C)
2 nd count	76.02	69.82	67.48	71.12±2.55b(AB)	64.2	55.56	46.87	55.54± 5.00b(BC)
3 rd count	86.08	78.40	76.07	80.18±3.02a(A)	81.48	77.78	75.00	78.09± 1.88a(A)
F value	23.99**				22.30**			
P	0.001				0.002			
L.S.D.	14.96±4.87				14.89±4.85			
Total mean	62.68±8.66				59.99± 7.75			
F _{df(5,12)} value	24.64***							
P	0.000							
L.S.D	13.71±4.08							

*** and ** indicate significance at 1% & 5% , respectively.

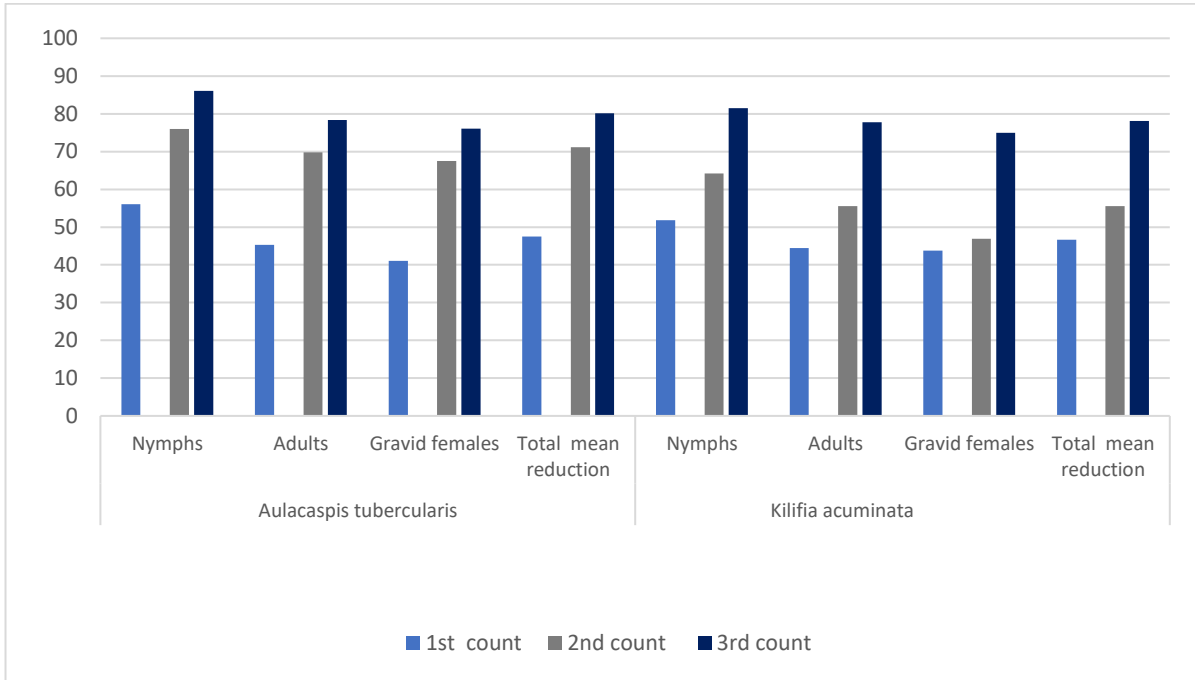


Figure (1): Reduction percentages of *Aulacaspis tubercularis* and *Klifia acuminata* infestation under first release of 2nd larval instar of *Chrysoperla carnea*.

2. The second releasing of 2nd larval instar of *Chrysoperla carnea*:

The second release of the second larval stage of *C. carnea* to feed on *A. tubercularis* and *K. acuminata* at different stages infesting mango trees in Faculty of Agriculture- Cairo University was conducted in March 2024. The data shown in Table (2) and depicted in Figure (2), indicated that the total population decreased to 48.78 % and 50.77 % respectively, after 15 days

from treatment then it gradually increased to reach 60.57 % and 66.07 % respectively, after 30 days and then reached 78.09 % and 75.36 %, respectively, after 45 days post-treatment, it became evident that there were notable variances and significant differences between 1st count and both 2nd and 3rd counts.

Table (2): Reduction percentages of *Aulacaspis tubercularis* and *Klifia acuminata* infestation under second release of 2nd larval instar of *Chrysoperla carnea*.

Sampling dates	<i>Aulacaspis tubercularis</i> df= (2,6)				<i>Klifia acuminata</i> df=(2,6)			
	Nymphs	Adults	Gravid females	Total mean reduction	Nymphs	Adults	Gravid females	Total mean reduction
1 st count	51.85	47.62	46.87	48.78±1.55c(C)	52.1	50.10	50.10	50.77±0.67a(BC)
2 nd count	60.49	55.56	65.62	60.57±2.90b(BC)	69.1	66.60	62.50	66.07± 1.92b(AB)
3 rd count	81.48	77.78	75.00	78.09±1.88aA	84.37	66.60	75.10	75.36± 5.13a(A)
F value	45.432***				15.18**			
P	0.000				0.005			
L.S.D.	9.498±3.09				13.84±4.51			
Total mean	68.64±68.64				65.38± 8.38			
F _{df(5,12)} value	15.63***							
P	0.000							
L.S. D	15.74±4.68							

*** & ** indicate significance at 1% &5%, respectively.

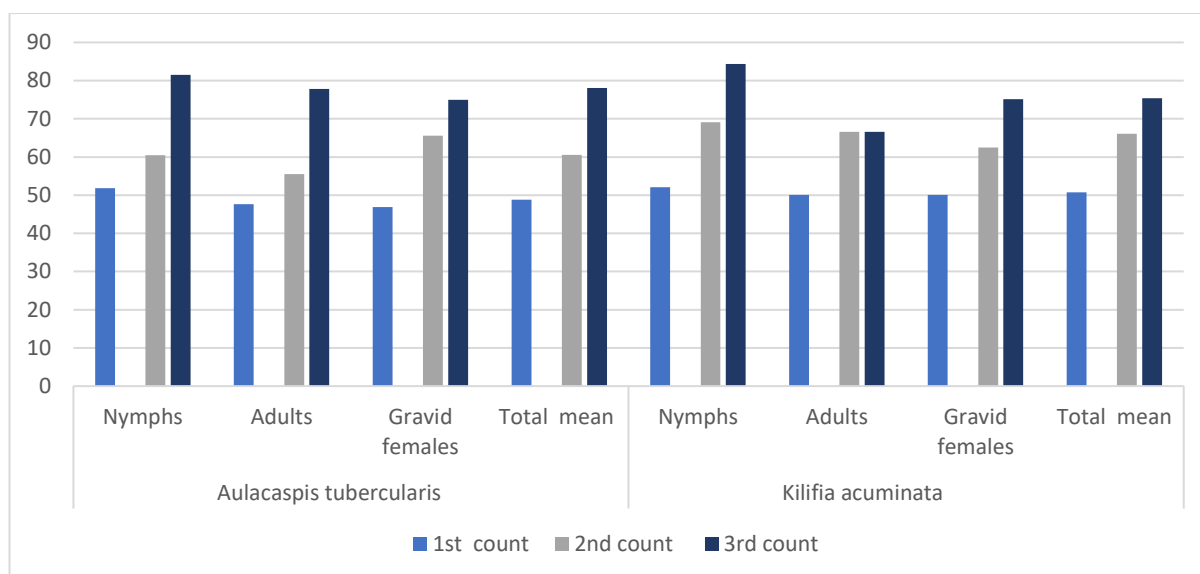


Figure (2): Reduction percentages of *Aulacaspis tubercularis* and *Klifia acuminata* infestation under second release of 2nd larval instar of *Chrysoperla carnea*.

The findings displayed in Tables (1 and 2) indicated that the decrease in population was most significant among nymphs compared to adults and ovipositing females during two releases and the three subsequent counts post-treatment. This could be attributed to the fact that nymphs, particularly the 1st instar (Crawlers) have not developed their protective scales yet making them less vulnerable to predation by *C. carnea* larvae. In contrast, adult females and ovipositing females have already developed or secreted their scales. The numbers of released *C. carnea* larvae were positively correlated with reduction percentages, with the third treatment exhibiting higher reduction percentages compared to the other two treatments. The results from the two releases are compatible with the findings of multiple researchers. El-Sahn and Gaber (2012) found that *C. carnea* is highly effective as a biological control agent against *Planococcus citri*, (Risso) (Hemiptera: Pseudococcidae) consuming approximately 194.86 nymphs/ larvae at different stages. Additionally, Helmy (2014) conducted research in Egypt and observed that the predator led to the greatest reduction (84.97%) in the total population of

Saissetia oleae (Olivier) (Hemiptera: Coccidae) in the 1st post treatment and the highest reduction (32.94%) in the 2nd post treatment of the total population of *Hemiberlesia lataniae* (Signoret) (Hemiptera: Diaspididae) in March at Giza Governorate.

Similarly, El-Zahi (2017) reported that 3rd instar larvae of *C. carnea* were the most voracious feeder compared to 1st and 2nd instar larvae and consumed 673.3+ 6.38, 2756.3+20.10, 326.9+5.07 and 115.2+3.45 insects of aphid, 1st, 2nd and 3rd instar nymphs of the mealybug *Phenacoccus solenosis* Tinsley (Hemiptera: Pseudococcidae), respectively. First instar nymphs of the mealybug were significantly the most consumed prey. In the same line, Helmy *et al.* (2020) reported that *C. carnea* has been identified as a highly efficient biocontrol agent against both diaspidid insects *Parlatoria proteus* (Curtis) and *Fiorinia phoenicis* (Balachowsky) (Hemiptera: Diaspididae). The predator achieved the greatest decrease (82.50%) in the overall population of *P. proteus* during the 3rd post-treatment period and the highest reduction (69.99%) in the total population of *F. phoenicis* during the 2nd post treatment period in October at Giza Governorate.

It is evident that *C. carnea* is a highly efficient biocontrol agent for diapsid insects *A. tubercularis* and *K. acuminata*, making it a suitable candidate for inclusion in I.P.M. programs.

References

- Abd-Rabou, S.; Ahmed, N. and Mostafa, M. (2012):** Predators of scale insects (Hemiptera: Coccoidea) and their role in control in Egypt. *J. Biol. Sci.*, 5(3): 203-209. Doi.10.21608/eajbsa.2012.14286.
- Amer, M. E. S.; Salem, M.A.; Hanafy, M. E. H. and Ahmed, A. (2017):** Ecological studies on *Aulacaspis tubercularis* and its associated natural enemies on mango trees at Qaliobiya Governorate, Egypt. *Egyptian Academic Journal of Biological Sciences*, 10(7):81-89. Doi.10.21608/eajb.2017.12095.
- Badawy, M. A.; Barakat, A. A.; Helmy, E. I.; El-Imery, S. M. and Kwaiz, F. A. (2000):** Field evaluation of certain organophosphorous insecticides against mango soft scale insect, *Kilifia acuminata* (Sigret) and its residues in mango fruits. *Bull Ent. Soc., Egypt, Econ. Ser.*, 27:17-20.
- Badawy, M.A.; El-Arnaouty, S. A.; El-Gantiry, A. M. and Gaber, N. M. (2006):** Toxicity of recommended pesticides against several vegetable pests to different populations of *Chrysoperla carnea* (Stephens) in the laboratory. *Bull. Fac. Agric., Cairo Univ.*, 57: 549-570.
- Chen, T. Y. and Liu, T. X. (2002):** Susceptibility of immature stages of *Chrysoperla rufilabris* (Chrysopidae) to pyriproxyfen, a juvenile hormone analog. *J. Appl. Entomol.*,126: 125-129. DOI:10.1046/j.1439-0418.2002.00605.x.
- El-Arnaouty, S. A. (1991):** Studies on the biology and manipulation of *Chrysoperla carnea* (Stephens) and *Chrysoperla sinica* Tjeder (Neuroptera:Chrysopidae) for controlling the green peach aphid *Myzus persicae* Sulzer (Homoptera: Aphididae) in green houses. Ph. D. Thesis, Cairo University.
- El-Dash, A. A.; Kasim, Y. I. and El-Komy, S.O. (2002):** Influence of chemical components of host plant and weather factors on the population density of *Lecanium acuminata* (Sign.) (Homoptera: Coccidae). *Menufiya J. Agric. Res.*, 22(1):887-898.
- El-Dessouki, W. A. H. and Korish, S. K. (2023):** Assessment of two biological control agents and insecticide on *Spodoptera littoralis* (Boisd.) under laboratory conditions. *Egyptian Journal of Crop Protection*, 18(1):14-23. Doi: 10.21608/ejcp.2023.194541.1014.
- El-Hawary, I. S.; Farrag, Z. S.; Hendawy, A. S.; Anbar, H. A. and Salem, F. A. (2010):** Insect predators associated with scale insects and mealybugs on navel orange at Kafr, 1 (11):899-908. DOI:10.21608/jppp.2010.86954
- El-Sahn, O. M. N. and Gaber, N. M. A. (2012):** Feeding potential of *Chrysoperla carnea* (Stephens) on different stages of *Planococcus citri* (Risso) under laboratory conditions. *Egypt. J. Biol. Pest Control*, 22(2):217-221.

- Elwan, E. A. (1990):** Ecological and biological studies on certain insects pests of Coccoidea (Homoptera) infesting mango trees. Ph.D. Thesis, Fac. of Agric., Al-Azhar University.
- Elwan, E. A.; Assem, S. M.; Khewa, M.M. and Shalaby, M.S.I. (2005):** Field evaluation of some Pesticides for controlling *Pulvinaria tenuivalvata* (Newstead) (Homoptera: Coccidae) on sugarcane in Kom Ombo district, Aswan Governorate. Egypt J. Agric. Res., 83(4):1669-1679. DOI:10.21608/ejar.2005.255005.
- El-Zahi, S. E. (2017):** Preference and predatory potential of *Chrysoperla carnea* (Stephens) and *Coccinella undecimpunctata* Linnaeus on *Phenacoccus solenopsis* Tinsley: A new threat to the Egyptian economic crops. Alex. Sci. Exchange J., 38(4):837-843. DOI:10.21608/asejaiqjsae.2017.4592.
- Fita, T. (2014):** White Mango Scale, *Aulacaspis tubercularis*, Newstead (Homoptera: Diaspididae) distribution and severity status in East and West Wollega Zones, Western Ethiopia; Department of Plant Sciences, Wollega University. Science, Technology and Arts Research (STAR) Journal, 3 (3): 1-10. DOI: <http://dx.doi.org/10.4314/star.v3i3.1>.
- Fita, T.; Getu, E.; Wakgari, M. and Woldetsadike, K. (2023):** Host Preference of *Aulacaspis tubercularis* Newstead (Homoptera: Diaspididae) to Different Mango Cultivars in East Wollega and East Shewa Zones, Ethiopia. American Journal of Entomology, 7(2): 70-82. DOI:10.11648/j.aje.20230702.14.
- Hashem, M. H. (2021):** Some scale insects and fungi infesting mango trees in Ismailia, Egypt. Agriculture Tropica et Subtropica, 54: 136–146. DOI:10.2478/ats-2021-0014.
- Hassan, A. S.; Nabil, H. A.; Shahein, A. A. and Hammad K. A. A. (2012):** Some ecological aspects of *Kilifia acuminata* (Hemiptera:Coccidae) and its parasitoids on mango trees at Sharkia Governorate, Egypt. Acad. J. Biolog. Sci., 5(3):33-41. DOI:10.21608/eajbsa.2012.13833.
- Helmy, S. M. Y., El-Sahn, O. M. N. and Abd El-Razek, M. I. (2020):** Predation efficacy of *Chrysoperla carnea* (Steph.) on *Parlatoria proteus* (Curtis) and *Fiorinia phoenicis* (Balachowsky) under semi field conditions at Giza Governorate, 663-666. DOI:10.21608/jppp.2020.158677.
- Helmy, S.M.Y. (2014):** Ecological studies on some olive pests in Egypt and their biocontrol. Ph.D. Thesis. Fac. Agric. Cairo University.
- Ismail, S. M.; Abo-Shanab, A. S. H. M. and El-Malla, A. (2023):** Field evaluation of certain compounds against *Spodoptera littoralis* (Lepidoptera: Noctuidae): Their impact on its predator, *Chrysoperla carnea* (Neuroptera: Chrysopidae). Proceedings of the National Academy of Science, India. DOI: 101007/s40011-023-01485-0.

- Khan, S. Z.; Ullah F.; Khan S.; Khan, M. A. and Khan, M. A. (2015):** Residual effect of insecticides against different stages of green lacewing, *Chrysoperla carnea* (Neuroptera: Chrysopidae). J. Ento-Mol Zool Studies, 3(4):114-119.
- Kwaiz, F. A. (1999):** Ecological and toxicological studies on the mango soft scale, *Kilifia acuminata* (Signoret) with special reference to insecticide residues in mango fruits. Ph.D. Thesis, Cairo, University.
- Kwaiz, F. A. (2009):** Ecological studies on the mango scale insect, *Aulacaspis tubercularis* Newstead (Homoptera: Diaspididae) infesting mango trees under field conditions at Qualubia Governorate. Egypt. J. Agric. Res., 87 (1): 71-83. DOI: 10.21608/ejar.2009.1930 91.
- Medina, P.; Budia, F.; Smagghe, G. and Vinuela, E. (2001):** Activity of Spinosad, tebufenozide and azadirachtin on eggs and pupae of the predator *Chrysoperla carnea* (Stephens) under laboratory conditions. Biocontrol Sci and Tech., 11:597-610.
- Nada, S.; Abd-Rabou, S. and Hussein, G. (1990):** Scale insects infesting mango trees in Egypt (Homoptera: Coccidae). Proc. ISSIS, VI, part Krakow, II: 133-134.
- Radwan, S. G. (2003):** Toxicological studies on some scale insects infesting mango and guava trees. Ph. D. Diss., Fac. Agric., Cairo University.
- Rugno, G. R.; Zanardi, O. Z.; Parra, J. R. P.; Yamamoto, P. T. (2019):** Lethal and sublethal toxicity of insecticides to the lacewing *Chrysopa cubana*. Neotrop. Entomol., 48(1):162-172. <https://doi.org/10.1007/s13744-018-06263>.
- Stafford, E. M. and Summers, F.M. (1963):** Evaluation control of San Jose scale *Hilgardia*, 35(2): 13-32.
- Ulhaq, M. M.; Sattar, A.; Salihah, Z.; Farif, A.; Usman, A.; and Khattak, S.U.K. (2006):** Effect of different artificial diets on the biology of adult green lacewing *Chrysoperla carnea* (Stephens). Journal of Science and Technology, 28:1-8.