DJAS., Vol. (4) (II): (18-35) (2025) DOI: 10.21608 /djas.2025.358696.1002

Damietta Journal of Agricultural Sciences
https://djas.journals.ekb.eg
ISSN: 2812-5347(Print)- 2812-5355 (Online)

Role of Four Coccinellid Predator Species in Regulating the Population of the Main Piercing-Sucking Insect Pests Attacking Certain Vegetable Crops

T. E. Ata[1], Al-Kady, H.A. [1], Awadalla, S.S. [2] and Eisa, A.E. *[1]
[1]Plant Protection Department, Faculty of Agriculture, Damietta University, Egypt.
[2]Economic Entomology Department, Faculty of Agriculture, Mansoura University, Egypt.
*Corresponding author E-mail: Abdelrahman-essa@du.edu.eg (Eisa, A.E.)

Abstract:

The experiments were conducted to investigate the role of coccinellid predators in regulating insect pest populations on vegetable crops in the Kafr-Saad area, Damietta Governorate, Egypt, during the two successive summer planting seasons of 2021 and 2022. Four predator species belonging to the order Coleoptera (*Coccinella undecimpunctata*, *Hippodamia convergens*, *Cheilomenes propinqua vicina* and *Scymnus* spp.) were recorded on cucumber, okra, eggplant, and cowpea crops. Among the coccinellid predators, *C. propinqua vicina* was the most abundant on vegetable crops, followed by *Scymnus* spp., then *H. convergens*, while *C. undecimpunctata* was the least abundant. During the first season, *C. propinqua vicina* accounted for 32.8%, 28.7%, 30.3%, and 22.8% of the total coccinellid predators on cucumber, okra, eggplant, and cowpea crops, respectively. In the second season, these percentages were 32.8%, 30.0%, 28.3%, and 25.4%, respectively. Conversely, *C. undecimpunctata* represented the smallest proportion, accounting for 21.8%, 18.6%, 20.2%, and 23.1% in the first season, and 21.3%, 19.4%, 21.5%, and 21.5% in the second season for the same crops. Regarding host plant preferences, the coccinellid predators (*C. propinqua vicina*, *H. convergens* and *C. undecimpunctata*) showed a strong preference for cucumber plants, followed by okra and eggplant, with the least preference for cowpea. In contrast, *Scymnus* spp. preferred okra plants, followed by cucumber and eggplant, with cowpea being the least preferred host, during both the first and second seasons.

Key words: Coccinellid predators, Piercing-Sucking Insects, Vegetable crops

INTRODUCTION

Vegetables play a crucial role in human nutrition and are cultivated in approximately 200 countries worldwide. They serve as an essential food source in many regions, providing vital vitamins (C, A, B1, B6, B9, E), minerals, dietary fiber, and bioactive phytochemicals **(Wargovich, 2000)**. Cucumber (*Cucumis sativus* L.) is a widely cultivated crop in Egypt, grown both in open fields and greenhouses for local consumption and export **(El-Lakwoh, 2011)**. In 2017, Egypt cultivated cucumbers on 95,328 feddans, producing 488,723 tons **(FAO statistics division, 2019**). Okra (*Abelmoschus esculentus* L.) is a nutritious vegetable high in carbohydrates, vitamins and minerals **(Glew et al., 1997; Cook *et al.*, 2000; Gopalan *et al*., 2007; Varmudy, 2011)**, and it is cultivated globally on 1.26 million hectares, producing 22.29 million tons **(Anonymous, 2017)**. In Egypt, okra is grown on 12,079.2 feddans, yielding 57,721 tons with an average of 4.7 ton/fed **(FAO, 2016)**. Eggplant (*Solanum melongena* L.) is one of the most significant solanaceous crops rich in nutrients, minerals, antioxidants, vitamins, dietary fiber and body building factors, proteins **(Matsubara *et al*., 2005)**. With global production at 51.288 million tons, Egypt is the third-largest producer, contributing 1.194 million tons **(FAOSTAT, 2020)**. Cowpea (*Vigna unguiculata* L.) is a protein-rich legume used for human food and animal feed. It thrives in poor soils due to its nitrogen-fixing ability and resilience to stresses (**Eloward and Hall, 1987; Hall, 2004)**. In Egypt, the total cultivated area of cowpea was approximately 1,853 hectares, yielding 7,180 tons of dry seeds **(FAOSTAT, 2021)**. Unfortunately, throughout its various growth stages, the aforementioned crops are vulnerable to attacks by a range of insect pests. Harmful piercing-sucking insects significantly reduce both the quality and quantity of the yield **(Jackai, 1995; Ward *et al*.,**

2002; Hassan, 2013). These pests cause direct damage by extracting plant sap and indirect harm by serving as vectors for viral diseases. Chemical insecticides have detrimental effects on the environment, domestic animals, humans, and biological control agents **(Schmutterer, 1990)**. Therefore, biological control continues to be a crucial aspect of insect pest management. This approach is especially recommended for vegetables, as they are often consumed fresh. In recent years, the Ministry of Agriculture has made significant efforts to reduce insecticide use within integrated pest management programs. Maintaining the natural balance requires the conservation of natural enemies. According to studies by **Helal *et al*. (1996), Abd El-Kareim *et al*. (2011)**, **Salman *et al*. (2014)**, **Khuhro *et al*. (2012) and Al-Deghair *et al*. (2014)**, aphidophagous predators are the primary cause of mortality for piercing-sucking insect pests, such as aphids, whiteflies, and leafhoppers. Predatory coccinellids are essential biological control agents, as they prey on a variety of phytophagous insect pests, including aphids, scale insects, mealybugs, mites, whiteflies, and thrips **(Omkar and Pervez, 2002)**. They are regarded as some of the most significant biological control agents **(Ceryngier and Hodek, 1996)**. Ladybird beetle larvae and adults are fierce predators of hemipteran insects and consume large quantities of prey throughout their development **(Dixon *et al*. 1997)**. For example, the convergent lady beetle, *Hippodamia convergens*, is a key predator of cereal aphids **(Michels *et al*. 2001, Nechols and Harvey 1998; Michaud and Qureshi 2005)**. Similarly, the eleven-spot lady beetle, *Coccinella undecimpunctata*, helps manage pests on various crops, including cotton, sunflower, citrus, vegetables and weeds **(Smith and Krischik, 2000; Naveed *et al*., 2007; Saeed *et al*., 2007; Ahmad *et al*., 2008)**. Notably, the ladybird *Cheilomenes propinqua vicina* Mulsant (syn. *Cydonia* (*Cheilomenes*) *vicina*) is widely distributed in subtropical and tropical regions of Africa and Southwest Asia **(Kovář, 2007)**. As a highly polyphagous predator with substantial population densities, it serves as a key natural enemy of numerous agricultural pests. It preys on *Aphis gossypii* Glover on pear trees in Egypt **(Youssif, 2019)** and eggplants in India **(Borkakati *et al*., 2019)**; mealybugs on guava in Egypt **(Adly, 2016)**; the cotton mealybug *Phenacoccus solenopsis* Tinsley on crops in Israel **(Spodek *et al*., 2018)**; whiteflies on cassava in Kenya **(Atuncha *et al*., 2013)**; and aphids, mealybugs, and soft scales on various cultivated plants in Egypt **(Bayoumy and Michaud, 2015; Abdel-Salam *et al*., 2018; Ramadan *et al*., 2022)**. The small Scymnus species within the Coccinellidae family are poorly known, but recent studies have explored their use as biological control agents **(Uygun and Atlihan 2000; Wanntorp 2004; Pluke *et al*. 2005; Woin *et al*. 2006)**. While they may be less competitive than larger species due to their size and lower voracity, their ability to persist at low prey densities and their long lifespan **(Tawfik *et al*. 1973; Borges *et al*. 2011; 2013)** allows them to feed on aphid colonies at various stages **(Agarwala and Yasuda 2001)** and for longer periods, enabling them to exploit different spatial and temporal niches. The host plant plays a vital role in shaping the populations of piercing-sucking pests and their predators. Natural enemies exhibit variations in foraging behavior based on the host plant species **(Abd El-Kareim, 2002)**. For the successful implementation of integrated pest management (IPM) programs, careful consideration of the host plant is essential **(Marouf, 2007; Abdel-Kareim *et al*., 201)**. Therefore, the current research focused on the Following key aspects: Investigating the seasonal abundance of coccinellid predatory insect species and their associated prey (*Aphis* spp., *Bemisia tabaci*, *Thrips tabaci*, *Empoasca* spp., *Phenacoccus solenopsis*, and *Nezara viridula*) on cucumber, okra, eggplant, and cowpea crops. Evaluating the relationship between prey, host plant species and the seasonal activity of associated coccinellid predators.

MATERIALS AND METHODS:

1. Field experiments:

A study was conducted on a private farm in the Kafr-Saad area, Damietta Governorate, Egypt, to examine the relationship between coccinellid predator insects (*Coccinella undecimpunctata*, *Hippodamia convergens*, *Cheilomenes propinqua vicina*, and *Scymnus* spp.) and piercing-sucking insect pests (*Aphis* spp., *Bemisia tabaci*, *Thrips tabaci*, *Empoasca* spp., *Phenacoccus solenopsis*, and *Nezara viridula*) on various vegetable crops. The study included the following crops: *Cucumis sativus* L. (cucumber; Cucurbitaceae), *Abelmoschus esculentus* (L.) Moench (okra; Malvaceae), *Solanum melongena* L. (eggplant; Solanaceae), and *Vigna unguiculata* (L.) Walp. (cowpea; Fabaceae). To assess the seasonal abundance of piercing-sucking insect pests and their associated coccinellid predators on these crops during two consecutive seasons (2021–2022), an area of approximately 700 m² was prepared according to agricultural recommendations. This area was divided into four equal plots (each 175 m²), with each plot dedicated to one of the aforementioned vegetable crops. The crops were sown on May 6, 2021, for the first season and May 14, 2022, for the second season. Standard agricultural practices were followed across all plots, with no pesticides applied throughout the entire production period.

2. Sampling Techniques:

Starting two weeks after planting and continuing until harvest, weekly random samples of plants were collected from each replicate. Leaves were placed in polyethylene bags in the field and transported to the laboratory for analysis. Under a stereoscopic microscope, both sides of the collected leaves were examined, and individual insects were counted. All identified insect species were recorded, along with the presence of coccinellid predators observed in the field. Additionally, coccinellid predators were counted directly on 25 plants in the field, supplementing the data from leaf samples.

3. Statistical Analysis:

Using SPSS Statistics (2020), we performed simple correlation and multiple partial regression analyses to examine the relationship between prey densities (i.e., the weekly average of each prey species) and the seasonal abundance of coccinellid predator insects.

RESULTS:

Relative abundance of vegetable crop insect pests during two seasons (2021-2022):

The results presented in Tables (1&2) indicate that vegetable crops such as cucumber, okra, eggplant, and cowpea were attacked by numerous insect species, particularly piercing-sucking insects. The recorded insect species belong to two major orders: Order Thysanoptera: The onion thrips, *Thrips tabaci* L. (Family: Thripidae). Order Hemiptera: Aphids: The cotton aphid (*Aphis gossypii* Glover), the green peach aphid (*Myzus persicae* Sulzer), and the cowpea aphid (*Aphis craccivora* Koch) (Family: Aphididae). Whiteflies: The tomato whitefly (*Bemisia tabaci* Genn.) (Family: Aleyrodidae). Leafhoppers: *Empoasca* spp. (Family: Cicadellidae). Stink bugs: The green stink bug (*Nezara viridula* L.) (Family: Pentatomidae). Mealybugs: The cotton mealybug (*Phenacoccus solenopsis* Tinsley) (Family: Pseudococcidae). Six insect species i.e. *P. solenopsis*, *A. gossypii*, *Empoasca* spp., *B. tabaci*, *T. tabaci* and *N. viridula* were recorded on each of the four crops. *M. persicae* was only recorded on cucumber and eggplant, while *A. craccivora* was only recorded on cowpea. Cucumber, eggplant, and cowpea were attacked by seven insect species, whereas okra was attacked by six insect species. During the 1st season (2021), the results displayed in Table (1) show that the most abundant insect species on the studied vegetable crops was *Aphis* spp., with the highest number and proportion, represented by 408.0 individuals (48.2%). This was followed by the whitefly, *B. tabaci*, with 269.3 individuals (31.8%). On the other hand, *N. viridula* was the least abundant, represented by only 3.7 individuals (0.4%).

Table (1) Mean number and relative abundance of insect species at Kafr-Saad region Damietta Governorate during the 1st season 2021.

Insect pests	Cucumber		Okra		Eggplant		Cowpea		Mean	%
	No.	%	No.	%	No.	%	No.	%		
Aphis spp.	741.8	41.2	715	75.5	114.9	23.7	60.4	40.1	408.0	48.2
B. tabaci	814.3	45.3	90.5	9.6	168.3	34.7	4.2	2.8	269.3	31.8
T. tabaci	213.6	11.9	11.2	1.2	62.4	12.8	5.6	3.7	73.2	8.7
Empoasca spp.	9.7	0.5	59.5	6.3	100.8	20.8	73.8	49.0	61.0	7.2
P. solenopsis	17.6	1.0	65.4	6.9	35.6	7.3	3.4	2.3	30.5	3.6
N. viridula	2.4	0.1	5.5	0.6	3.7	0.8	3.3	2.2	3.7	0.4
Total	1799.4	100.0	947.1	100.0	485.7	100.0	150.7	100.0	845.7	100.0

During the 2nd season (2022), the results displayed in Table (2) show that the most abundant insect species on the studied vegetable crops was *Aphis* spp., with the highest number and proportion, represented by 378.7 individuals (47.2%). This was followed by the whitefly, *B. tabaci*, with 286.9 individuals (35.8%). On the other hand, *N. viridula* was the least abundant, represented by only 2.8 individuals (0.3%). These results indicate that *Aphis* spp. was consistently the most abundant pest species, followed by *B. tabaci*, with *N. viridula* being the least abundant pest in both seasons.

The association between coccinellid predator insects and the tested host plants:

A - The total count and relative abundance of coccinellid predator insects across two seasons (2021–2022):

The data in Tables (3&4) and Figures (1&2) show that four predator species were recorded on the four tested vegetable crops, belonging to order: Copleoptrea (*Coccinella undecimpunctata*, *Hippodamia convergens*, *Cheilomenes propinqua vicina*, and *Scymnus* spp.). The most abundant coccinellid predatory insects on the four host plants were *C. propinqua vicina*, followed by *Scymnus* spp. and *H. convergens*. Meanwhile, *C. undecimpunctata* was the least abundant predator during both successive seasons (2021-2022).

Table (2) Mean number and relative abundance of insect species at Kafr-Saad region Damietta Governorate during the 2nd season 2022.

Insect pests	Cucumber		Okra		Eggplant		Cowpea		Mean	%
	No.	%	No.	%	No.	%	No.	%		
Aphis spp.	689	39.4	671.3	76.3	102.1	22.3	52.3	43.2	378.7	47.2
B. tabaci	849.7	48.6	103.8	11.8	189.2	41.3	5	4.1	286.9	35.8
T. tabaci	182	10.4	7.3	0.8	49.1	10.7	2.7	2.2	60.3	7.5
Empoasca spp.	6.8	0.4	46.9	5.3	74.2	16.2	54.5	45.0	45.6	5.7
P. solenopsis	19.9	1.1	46.3	5.3	40.3	8.8	4.3	3.6	27.7	3.5
N. viridula	2	0.1	4	0.5	2.8	0.6	2.3	1.9	2.8	0.3
Total	1749.4	100.0	879.6	100.0	457.7	100.0	121.1	100.0	802.0	100.0

During the 1st season, *C. propinqua vicina* accounted for 32.8%, 28.7%, 30.3%, and 22.8% of the total coccinellid predators on cucumber, okra, eggplant, and cowpea crops, respectively. In the 2nd season, these percentages were 32.8%, 30.0%, 28.3%, and 25.4%, respectively. In contrast, *C. undecimpunctata* represented the smallest proportion, accounting for 21.8%, 18.6%, 20.2%, and 23.1% in the first season, and 21.3%, 19.4%, 21.5%, and 21.5% in the second season for the same crops.

The coccinellid predatory insects (*C. propinqua vicina*, *H. convergens*, and *C. undecimpunctata*) demonstrated a strong preference for cucumber plants, followed by okra and eggplant, with the least preference for cowpea. In contrast, *Scymnus* spp. preferred okra plants, followed by cucumber and eggplant, with cowpea being the least preferred host during both the 1st and 2nd seasons. This preference pattern may be attributed to the lower population density of insects that these predators feed on in cowpea plants compared to cucumber plants.

During the 1st season, *C. propinqua vicina* showed a preference for cucumber, with 412 predators recorded, compared to 320 on okra, 228 on eggplant, and 143 on cowpea. *H. convergens* and *C. undecimpunctata* predators followed a similar trend. *H. convergens* was recorded with 296 predators on cucumber, 272 on okra, 160 on eggplant, and 155 on cowpea, while *C. undecimpunctata* had 274 predators on cucumber, 207 on okra, 152 on eggplant, and 145 on cowpea. On the other hand, the *Scymnus* spp. predator exhibited the opposite pattern, with the highest number recorded on okra 315 predators, followed by cucumber 273 predators, eggplant 212 predators and cowpea 185 predators. (Table 3)

During the 2nd season, *C. propinqua vicina* exhibited a preference for cucumber, with 499 predators recorded, compared to 437 on okra, 313 on eggplant, and 201 on cowpea. *H. convergens* and *C. undecimpunctata* predators followed the same trend.

Table (3) Total number and relative abundance of the coccinellid predator insect species on vegetable crops at Kafr-Saad region Damietta Governorate during the 1st season 2021.

Predators	Cucumber		Okra		Eggplant		Cowpea		Total
	No.	%	No.	%	No.	%	No.	%	
C. propinqua vicina	412	32.8	320	28.7	228	30.3	143	22.8	1103
Scymnus spp.	273	21.8	315	28.3	212	28.2	185	29.5	985
H.convergens	296	23.6	272	24.4	160	21.3	155	24.7	883
C.undecimpunctata	274	21.8	207	18.6	152	20.2	145	23.1	778
Total	1255	100	1114	100	752	100	628	100	3749

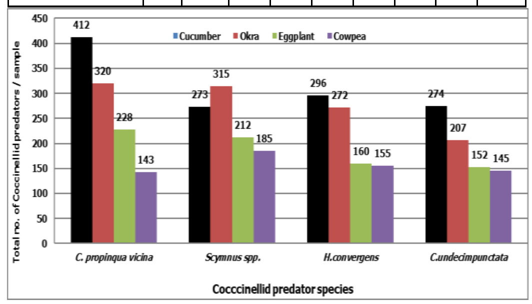

Fig. (1) Seasonal total number of the coccinellid predator insects on the four vegetable crops during the 1st season 2021 at Kafr-Saad region Damietta Governorate.

H. convergens was recorded with 366 predators on cucumber, 337 on okra, 292 on eggplant, and 205 on cowpea, while *C. undecimpunctata* had 324 predators on cucumber, 283 on okra, 238 on eggplant, and 170 on cowpea. On the other hand, the *Scymnus* spp. predator exhibited the opposite pattern, with the highest number recorded on okra 402 predators, followed by cucumber 331 predators, eggplant 263 predators and cowpea 215 predators (Table 4).

***Coccinella undecimpunctata*:**

The data presented in Figures 3 and 4 illustrate the seasonal activity of *C. undecimpunctata*, a member of the order Coleoptera and family Coccinellidae, associated with the piercing-sucking insect pests on different vegetable crops during the two successive seasons of 2021–2022. During the 1st season, the data presented in Figure 3 showed that the *C. undecimpunctata* predator first appeared on cucumber, okra, and eggplant simultaneously on May 20, while its presence on cowpea was observed later, on May 27. The predator exhibited a single peak on okra, eggplant, and cowpea, whereas two peaks were recorded on cucumber. The highest peak on cucumber (23 individuals per 25 plants) was recorded on July 1. On okra and eggplant, the highest peaks were 28 and 20 individuals per 25 plants, respectively, both recorded on June 18. Whereas, the highest peak on cowpea (20 individuals per 25 plants) was observed on July 30.

Table (4) Total number and relative abundance of the coccinellid predator insect species on vegetable crops at Kafr-Saad region Damietta Governorate during the 2nd season 2022.

predators	Cucumber		Okra		Eggplant		Cowpea		Total
	No.	%	No.	%	No.	%	No.	%	
C. propinqua vicina	499	32.8	437	30.0	313	28.3	201	25.4	1450
Scymnus spp.	331	21.8	402	27.6	263	23.8	215	27.2	1211
H. convergens	366	24.1	337	23.1	292	26.4	205	25.9	1200
C.undecimpunctata	324	21.3	283	19.4	238	21.5	170	21.5	1015
Total	1520	100	1459	100	1106	100	791	100	4876

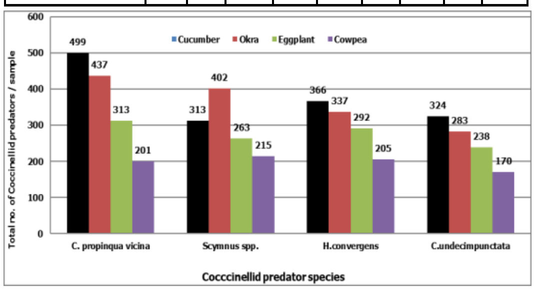

Fig. (2) Seasonal total number of the coccinellid predator insects on the four vegetable crops during the 2nd season 2022 at Kafr-Saad region Damietta Governorate.

B- Seasonal abundance of the coccinellid predator species on different vegetable crops during two seasons (2021-2022):

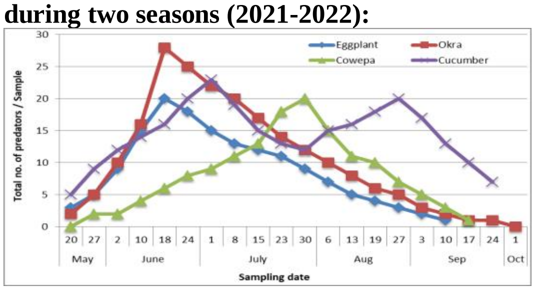

Fig. (3) Seasonal activity of *C. undecimpunctata* on different vegetable crops (cucumber, okra, eggplant and cowpea) at Kafr-Saad region Damietta Governorate during the 1st season (2021).

During the 2nd season, the data presented in Figure 4 showed that the *C. undecimpunctata* predator first appeared on all four crops cucumber, okra, eggplant, and cowpea simultaneously on May 28. The predator exhibited a single peak on okra, eggplant, and cowpea, while two peaks were recorded on cucumber. The highest peak on cucumber (27 individuals per 25 plants) was recorded on July 8. On okra, the highest peak (33 individuals per 25 plants) was observed on July 1. For eggplant, the highest peak (27 individuals per 25 plants) occurred on June 24, while on cowpea, the highest peak (23 individuals per 25 plants) was recorded on August 12.

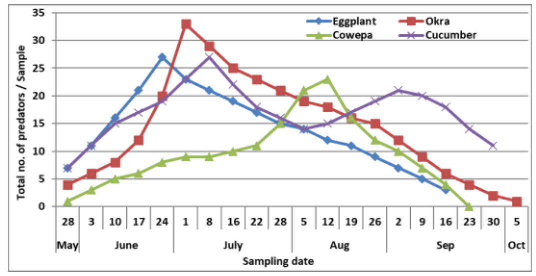

Fig. (4) Seasonal activity of *C. undecimpunctata* on different vegetable crops (cucumber, okra, eggplant and cowpea) at Kafr-Saad region Damietta Governorate during the 2nd season (2022).

***Hippodamia convergens*:**

The data presented in Figures 5 and 6 illustrate the seasonal activity of *H. convergens*, a member of the order Coleoptera and family Coccinellidae, associated with the piercing-sucking insect pests on different vegetable crops during the two successive seasons of 2021–2022. During the 1st season, the data presented in Figure 5 showed that the *H. convergens* predator first appeared on cucumber, okra, and eggplant simultaneously on May 20, while its presence on cowpea was observed later, on May 27. The predator exhibited two peaks on cucumber, okra, and eggplant, while only one peak was recorded on cowpea. The highest peak on cucumber (37 individuals per 25 plants) was recorded on August 19. On okra, the highest peak (27 individuals per 25 plants) occurred on August 6, while on eggplant, the highest peak (19 individuals per 25 plants) was observed on July 30. For cowpea, the highest peak (25 individuals per 25 plants) was recorded on July 8.

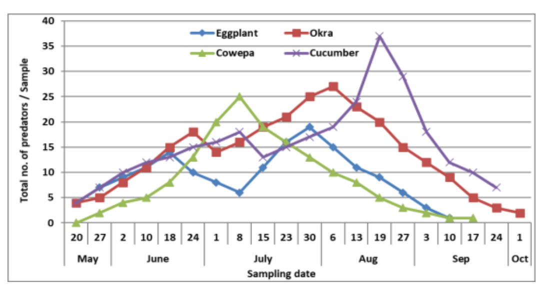

Fig. (5) Seasonal activity of *H. convergens* on different vegetable crops (cucumber, okra, eggplant and cowpea) at Kafr-Saad region

Damietta Governorate during the 1st season (2021).

During the 2nd season, the data presented in Figure 6 showed that the *H. convergens* predator first appeared on all crops cucumber, okra, eggplant, and cowpea simultaneously on May 28. The predator exhibited two peaks on cucumber, okra, and eggplant, while only one peak was recorded on cowpea. The highest peak on cucumber (34 individuals per 25 plants) was recorded on September 2. On okra, the highest peak (30 individuals per 25 plants) occurred on August 12, while on eggplant, the highest peak (26 individuals per 25 plants) was observed on August 5. For cowpea, the highest peak (22 individuals per 25 plants) was recorded on July 22.

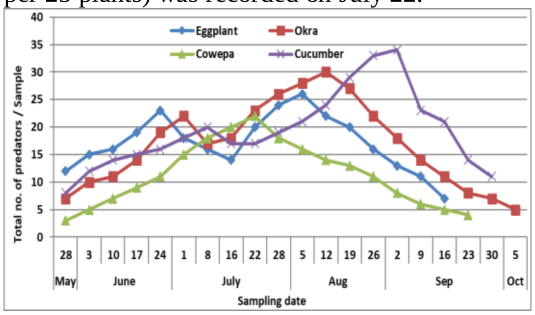

Fig. (6) Seasonal activity of *H. convergens* on different vegetable crops (cucumber, okra, eggplant and cowpea) at Kafr-Saad region Damietta Governorate during the 2nd season (2022).

***Cheilomenes propinqua vicina*:**

The data presented in Figures 7 and 8 illustrate the seasonal activity of *C. propinqua vicina*, a member of the order Coleoptera and family Coccinellidae, associated with the piercing-sucking insect pests on different vegetable crops during the two successive seasons of 2021–2022. During the 1st season, the data presented in Figure 7 showed that the *C. propinqua vicina* predator first appeared on all four crops cucumber, okra, eggplant, and cowpea simultaneously on May 20. The predator exhibited two peaks on all vegetable crops. The highest peak on cucumber (35 individuals per 25 plants) was recorded on September 3. On okra and cowpea, the highest peaks were 33 and 21 individuals per 25 plants, respectively, both recorded on August 19. Whereas, the highest peak on eggplant (22 individuals per 25 plants) was observed on July 1.

During the 2nd season, the data presented in Figure 8 showed that the *C. propinqua vicina* predator first appeared on all four crops cucumber, okra, eggplant, and cowpea simultaneously on May 28. The predator exhibited two peaks on all vegetable crops.

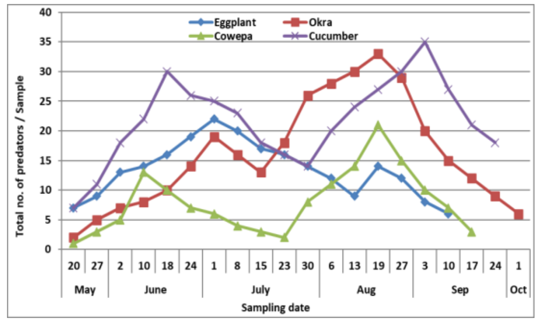

Fig. (7) Seasonal activity of *C. propinqua vicina* on different vegetable crops (cucumber, okra, eggplant and cowpea) at Kafr-Saad region Damietta Governorate during the 1st season (2021).

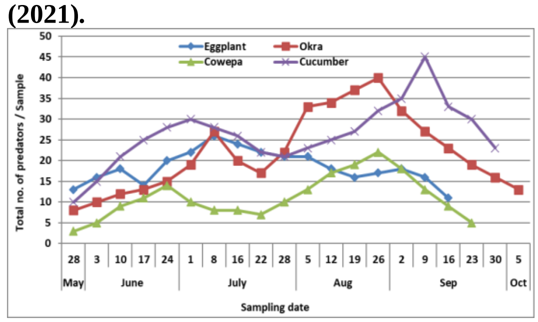

Fig. (8) Seasonal activity of *C. propinqua vicina* on different vegetable crops (cucumber, okra, eggplant and cowpea) at Kafr-Saad region Damietta Governorate during the 2nd season (2022).

The highest peak on cucumber (45 individuals per 25 plants) was recorded on September 9. On okra and cowpea, the highest peaks (40 and 22 individuals per 25 plants, respectively) were observed on August 26. Whereas, the highest peak on eggplant (26 individuals per 25 plants) was recorded on July 8.

***Scymnus* spp.:**

The data presented in Figures 9 and 10 illustrate the seasonal activity of *Scymnus* spp., a member of the order Coleoptera and family Coccinellidae, associated with the piercing-sucking insect pests on different vegetable crops during the two successive seasons of 2021–2022. During the 1st season, the data presented in Figure 9 showed that the *Scymnus* spp. predator first appeared on cowpea on May 20, on cucumber and okra on May 27, and on eggplant on June 2. The predator exhibited two peaks on cucumber, okra, and cowpea, while only one peak was recorded on eggplant. The highest peak on cucumber (38 individuals per 25 plants) was recorded on July 8. On okra, the highest peak (53 individuals per 25 plants) was observed on July 1. For eggplant, the highest peak (24 individuals per 25 plants) occurred on July 30, while on cowpea, the highest peak (26 individuals per 25 plants) was recorded on August 19.

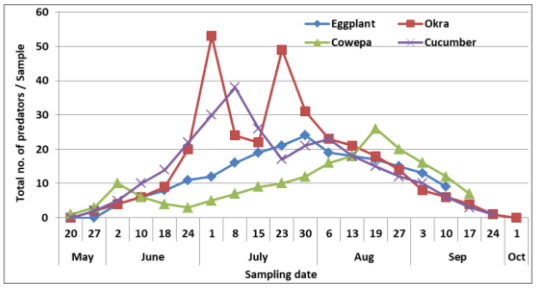

Fig. (9) Seasonal activity of *Scymnus* spp. on different vegetable crops (cucumber, okra, eggplant and cowpea) at Kafr-Saad region Damietta Governorate during the 1st season (2021).

During the 2nd season, the data presented in Figure 10 showed that the *Scymnus* spp. predator first appeared on cowpea on May 28, on cucumber and okra on June 3, and on eggplant on June 10. The predator exhibited two peaks on all crops. The highest peak on cucumber and okra (37 and 66 individuals per 25 plants, respectively) was recorded on July 8. On eggplant, the highest peak (29 individuals per 25 plants) was observed on August 5, while on cowpea, the highest peak (24 individuals per 25 plants) occurred on August 19.

C- The interaction between seasonal activity of coccinellid predators, preys and host plants during two seasons (2021-2022):

A multiple regression analysis was conducted to assess the relationship between the different prey densities and the seasonal activity of associated predatory insects on the studied host plants. The multi-regressions calculated values indicating the common effect of average prey densities (i.e. aphids, whiteflies, thrips, leafhoppers, cotton mealybugs, and green stink bugs) on the population density of each coccinellid predators (*C. undecimpunctata*, *H. convergens*, *Scymnus* spp. and *C. propinqua vicina*) on the four vegetable crops; cucumber, okra, eggplant and cowpea plants during the 1st and 2nd seasons (2021-2022) are displayed in tables 5 - 12, which indicated to the following:

On cucumber crop:

During the 1st season, the data presented in Table 5 illustrate the relationship between the population densities of coccinellid predatory insect and the tested prey on cucumber plants. For the predator *C. undecimpunctata*, a significant correlation was observed with the prey *Aphis* spp. and *N. viridula*, with correlation coefficient values (r) of 0.442 and 0.651, respectively.

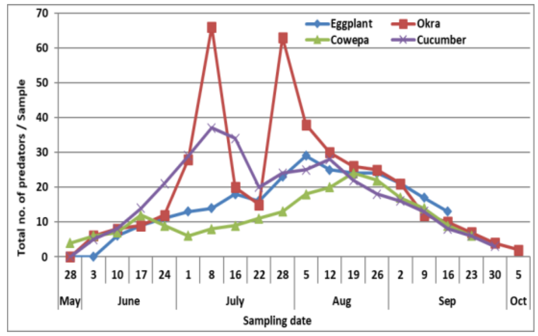

Fig. (10) Seasonal activity of *Scymnus* spp. on different vegetable crops (cucumber, okra, eggplant and cowpea) at Kafr-Saad region Damietta Governorate during the 2nd season (2022).

In contrast, no significant correlation was found with *B. tabaci*, *T. tabaci*, *Empoasca* spp., and *P. solenopsis*, with correlation values of 0.388, -0.240, -0.040, and 0.292, respectively. While, for the predator *H. convergens*, a significant correlation was observed with all its prey species, i.e. *Aphis* spp., *P. solenopsis*, and *N. viridula*, with correlation coefficient values (r) of 0.688, 0.623, and 0.495, respectively. For the predatory insect *C. propinqua vicina*, a significant correlation was observed with the prey species *B. tabaci*, *P. solenopsis*, and *N. viridula*, with correlation coefficient values (r) of 0.539, 0.623, and 0.926, respectively. In contrast, an insignificant correlation was found with *Aphis* spp., with an (r) value of 0.210. For the predator *Scymnus* spp., a significant correlation was observed with the prey *Aphis* spp., with a correlation coefficient value (r) of 0.482. In contrast, no significant correlation was found with *B. tabaci*, *Empoasca* spp., *P. solenopsis*, and *N. viridula*, with correlation values (r) of -0.060, -0.275, -0.164, and 0.069, respectively.

As shown in Table 5, The multiple regression analysis revealed that the combined effect of prey population size (i.e. aphids, whiteflies, thrips, leafhoppers, cotton mealybugs, and green stink bugs) had a strong influence on the population densities of the coccinellid predatory insect, namely *C. undecimpunctata*, *H. convergens*, *C. propinqua vicina*, and *Scymnus* spp. The strongest effect shown in the case of *C. propinqua vicina* predator (87.8%) and the weakest effect shown in the case of *Scymnus* spp. predator (45.4%) of the overall population changes were caused by compound effect of the tested preys. The multiple regression analysis showed that the common effect of the population size of the aforementioned prey on *C. undecimpunctata* and *H. convergens*, population densities were 71.2 and 73.2% respectively of the overall population changes were caused by the tested prey compound effect. During the 2nd season, the data presented in Table 6 illustrate the relationship between the population densities of coccinellid predatory insect and the tested prey on cucumber plants.

Table (5) The correlation and regression coefficient between the coccinellid predators (total number) and each of thrips, cotton mealybug, whitefly, leafhoppers, aphids, and green stink bug population densities on cucumber crop during the 1st season 2021.

Predator	Prey	Simple correlation		Multiple partial regression				
		r.	P.	b.	p.	"F"	Prob>F	E.V.
C.undecimpunctata	*Aphis* spp.	0.442	0.058	0.001	0.064	4.95	0.009	71.2%
	B. tabaci	0.388	0.101	0.001	0.310			
	T. tabaci	-0.240	0.322	-0.003	0.331			
	Empoasca spp.	-0.040	0.871	0.095	0.638			
	P. solenopsis	0.292	0.225	-0.166	0.058			
	N. viridula	0.651	0.003	3.275	0.001			
H.convergens	*Aphis* spp.	0.688	0.001	0.005	0.001	13.66	0.000	73.2%
	P. solenopsis	0.623	0.004	0.123	0.072			
	N. viridula	0.495	0.031	1.215	0.296			
C. propinqua vicina	*Aphis* spp.	0.210	0.388	0.001	0.147	25.16	0.000	87.8%
	B. tabaci	0.539	0.017	-0.000	0.627			
	P. solenopsis	0.623	0.004	0.011	0.871			
	N. viridula	0.926	0.000	5.139	0.000			
Scymnus spp.	*Aphis* spp.	0.482	0.036	0.005	0.057	2.16	0.122	45.4%
	B. tabaci	-0.060	0.808	0.001	0.742			
	Empoasca spp.	-0.275	0.254	-0.512	0.250			
	P. solenopsis	-0.164	0.502	-0.346	0.163			
	N. viridula	0.069	0.779	3.672	0.138			

For the predator *C. undecimpunctata*, a significant correlation was observed with the prey *N. viridula*, with a correlation coefficient value (r) of 0.739. In contrast, no significant correlation was found with *Aphis* spp., *B. tabaci*, *T. tabaci*, *Empoasca* spp., and *P. solenopsis*, with correlation values of 0.267, 0.168, -0.291, -0.009, and 0.188, respectively. While, for the predator *H. convergens*, a significant correlation was observed with all its prey species, i.e. *Aphis* spp., *P. solenopsis*, and *N. viridula*, with correlation coefficient values (r) of 0.643, 0.593, and 0.856, respectively. For the predator *C. propinqua vicina*, a significant correlation was observed with the prey species *B. tabaci*, *P. solenopsis*, and *N. viridula*, with correlation coefficient values (r) of 0.496, 0.784, and 0.781, respectively. In contrast, an insignificant correlation was found with *Aphis* spp., with an (r) value of 0.115. For the predator *Scymnus* spp., a significant correlation was observed with the prey *Aphis* spp., with a correlation coefficient value (r) of 0.538. In contrast, no significant correlation was found with *B. tabaci*, *Empoasca* spp., *P. solenopsis*, and *N. viridula*, with correlation values of -0.014, -0.289, -0.246, and 0.409, respectively. As shown in Table 6, The multiple regression analysis revealed that the combined effect of prey population size (i.e. aphids, whiteflies, thrips, leafhoppers, cotton mealybugs, and green stink bugs) had a strong influence on the population densities of the coccinellid predatory insect, namely *C. undecimpunctata*, *H. convergens*, *C. propinqua vicina*, and *Scymnus* spp. The strongest effect shown in the case of *Scymnus* spp. predator (90.9%) and the weakest effect shown in the case of *C. propinqua vicina* predator (82.8%) of the overall population changes were caused by compound effect of the tested preys. The multiple regression analysis showed that the common effect of the population size of the aforementioned prey on *C. undecimpunctata* and *H. convergens* population densities were 84.2 and 87.5% respectively of the overall population changes were caused by the tested prey compound effect.

On okra crop:

During the 1st season, the data presented in Table 7 illustrate the relationship between the population densities of coccinellid predatory insect and the tested prey on okra plants. For the predator *C. undecimpunctata*, a significant correlation was observed with the prey species *Aphis* spp., *Empoasca* spp., and *P. solenopsis*, with correlation coefficient values (r) of 0.774, -0.703, and -0.605, respectively. In contrast, no significant correlation was found with *B. tabaci*, *T. tabaci*, and *N. viridula*, with correlation values of -0.016, 0.029, and 0.411, respectively.

While, for the predator *H. convergens*, a significant correlation was observed with the prey *Aphis* spp. and *N. viridula*, with correlation coefficient values (r) of 0.535 and 0.868, respectively. In contrast, an insignificant correlation was found with *P. solenopsis*, with an (r) value of -0.057. For the predator *C. propinqua vicina*, a significant correlation was observed with the prey species *B. tabaci*, *P. solenopsis*, and *N. viridula*, with correlation coefficient values (r) of -0.522, 0.489, and 0.710, respectively. In contrast, an insignificant correlation was found with *Aphis* spp., with an (r) value of 0.331. For the predator *Scymnus* spp., a significant correlation was observed with the prey species *Aphis* spp., *Empoasca* spp., and *N. viridula*, with correlation coefficient values (r) of 0.754, -0.503, and 0.748, respectively. In contrast, no significant correlation was found with *B. tabaci* and *P. solenopsis*, with correlation values of -0.295 and -0.219, respectively.

As shown in Table 7, The multiple regression analysis revealed that the combined effect of prey population size (i.e. aphids, whiteflies, thrips, leafhoppers, cotton mealybugs, and green stink bugs) had a strong influence on the population densities of the coccinellid predatory insect, namely *C. undecimpunctata*, *H. convergens*, *C. propinqua vicina*, and *Scymnus* spp.

Table (6) The correlation and regression coefficient between the coccinellid predators (total number) and each of thrips, cotton mealybug, whitefly, leafhoppers, aphids, and green stink bug population densities on cucumber crop during the 2nd season 2022.

Predator	Prey	Simple correlation		Multiple partial regression				
		r.	P.	b.	p.	"F"	Prob>F	E.V.
C.undecimpunctata	*Aphis* spp.	0.267	0.268	0.001	0.351	10.64	0.000	84.2%
	B. tabaci	0.168	0.492	-0.003	0.008			
	T. tabaci	-0.291	0.227	-0.002	0.430			
	Empoasca spp.	-0.009	0.971	-0.026	0.875			
	P. solenopsis	0.188	0.442	-0.021	0.570			
	N. viridula	0.739	0.000	4.531	0.000			
H.convergens	*Aphis* spp.	0.643	0.003	0.003	0.001	35.10	0.000	87.5%
	P. solenopsis	0.593	0.007	0.064	0.061			
	N. viridula	0.856	0.000	3.062	0.001			
C. propinqua vicina	*Aphis* spp.	0.115	0.640	0.000	0.614	16.80	0.000	82.8%
	B. tabaci	0.496	0.031	-0.003	0.065			
	P. solenopsis	0.784	0.000	0.198	0.002			
	N. viridula	0.781	0.000	3.876	0.001			
Scymnus spp.	*Aphis* spp.	0.538	0.017	0.007	0.002	26.08	0.000	90.9%
	B. tabaci	-0.014	0.953	-0.008	0.000			
	Empoasca spp.	-0.289	0.230	-0.709	0.004			
	P. solenopsis	-0.246	0.311	-0.160	0.021			
	N. viridula	0.409	0.082	8.580	0.000			

Table (7) The correlation and regression coefficient between the coccinellid predators (total number) and each of thrips, cotton mealybug, whitefly, leafhoppers, aphids, and green stink bug population densities on okra crop during the 1st season 2021.

Predator	Prey	Simple correlation		Multiple partial regression				
		r.	P.	b.	p.	"F"	Prob>F	E.V.
C.undecimpunctata	*Aphis* spp.	0.774	0.000	0.004	0.156	7.78	0.001	78.2%
	B. tabaci	-0.016	0.946	-0.011	0.505			
	T. tabaci	0.029	0.904	-0.137	0.406			
	Empoasca spp.	-0.703	0.001	-0.085	0.092			
	P. solenopsis	-0.605	0.005	-0.051	0.043			
	N. viridula	0.411	0.072	-0.445	0.496			
H.convergens	*Aphis* spp.	0.535	0.015	0.000	0.628	17.51	0.000	76.7%
	P. solenopsis	-0.057	0.812	-0.006	0.640			
	N. viridula	0.868	0.000	1.848	0.000			
C. propinqua vicina	*Aphis* spp.	0.331	0.154	0.004	0.084	13.12	0.000	77.8%
	B. tabaci	-0.522	0.018	0.015	0.195			
	P. solenopsis	0.489	0.029	0.087	0.001			
	N. viridula	0.710	0.000	1.760	0.002			
Scymnus spp.	*Aphis* spp.	0.754	0.000	0.011	0.031	8.48	0.001	75.2%
	B. tabaci	-0.295	0.207	0.014	0.598			
	Empoasca spp.	-0.503	0.024	0.013	0.867			
	P. solenopsis	-0.219	0.354	-0.002	0.950			
	N. viridula	0.748	0.000	2.584	0.020			

The strongest effect shown in the case of *C. undecimpunctata* predator (78.2%) and the weakest effect shown in the case of *Scymnus* spp. predator (75.2%) of the overall population changes were caused by compound effect of the tested preys. The multiple regression analysis showed that the common effect of the population size of the aforementioned prey on *H. convergens* and *C. propinqua vicina* population densities were 76.7 and 77.8% respectively of the overall population changes were caused by the tested prey compound effect. During the 2nd season, the data presented in Table 8 illustrate the relationship between the population densities of coccinellid predatory insect and the tested prey on okra plants. For the predator *C. undecimpunctata*, a significant correlation was observed with the prey species *Aphis* spp., *Empoasca* spp., *P. solenopsis*, and *N. viridula*, with correlation coefficient values (r) of 0.793, -0.644, -0.465, and 0.633, respectively. In contrast, no significant correlation was found with *B. tabaci* and *T. tabaci*, with correlation values of -0.301 and -0.185, respectively. While, for the predator *H. convergens*, a significant correlation was observed with the prey species *Aphis* spp. and *N. viridula*, with correlation coefficient values (r) of 0.567 and 0.834, respectively. In contrast, an insignificant correlation was found with *P. solenopsis*, with an (r) value of -0.202. For the predator *C. propinqua vicina*, a significant correlation was observed with the prey species *B. tabaci*, *P. solenopsis*, and *N. viridula*, with correlation coefficient values (r) of -0.560, 0.451, and 0.735, respectively. In contrast, an insignificant correlation was found with *Aphis* spp., with an (r) value of 0.266. For the predator *Scymnus* spp., a significant correlation was observed with the prey *N. viridula*, with a correlation coefficient value (r) of 0.555. In contrast, no significant correlation was found with *Aphis* spp., *B. tabaci*, *Empoasca* spp., and *P. solenopsis*, with correlation values of 0.420, -0.335, -0.365, and -0.211, respectively.

As shown in Table 8, The multiple regression analysis revealed that the combined effect of prey population size (i.e. aphids, whiteflies, thrips, leafhoppers, cotton mealybugs, and green stink bugs) had a strong influence on the population densities of the coccinellid predatory insect, namely *C. undecimpunctata*, *H. convergens*, *C. propinqua vicina*, and *Scymnus* spp. The strongest effect shown in the case of *C. undecimpunctata* predator (88.7%) and the weakest effect shown in the case of *Scymnus* spp. predator (43.9%) of the overall population changes were caused by compound effect of the tested preys. The multiple regression analysis showed that the common effect of the population size of the aforementioned prey on *H. convergens* and *C. propinqua vicina* population densities were 80.8 and 73.9% respectively of the overall population changes were caused by the tested prey compound effect.

Table (8) The correlation and regression coefficient between the coccinellid predators (total number) and each of thrips, cotton mealybug, whitefly, leafhoppers, aphids, and green stink bug population densities on okra crop during the 2nd season 2022.

Predator	Prey	Simple correlation		Multiple partial regression				
		r.	P.	b.	p.	"F"	Prob>F	E.V.
C.undecimpunctata	*Aphis* spp.	0.793	0.000	0.006	0.033	17.03	0.000	88.7%
	B. tabaci	-0.301	0.197	-0.011	0.363			
	T. tabaci	-0.185	0.434	-0.036	0.784			
	Empoasca spp.	-0.644	0.002	-0.031	0.552			
	P. solenopsis	-0.465	0.039	-0.071	0.029			
	N. viridula	0.633	0.003	1.009	0.146			
H.convergens	*Aphis* spp.	0.567	0.009	0.003	0.068	22.48	0.000	80.8%
	P. solenopsis	-0.202	0.393	-0.029	0.127			
	N. viridula	0.834	0.000	2.030	0.000			
C. propinqua vicina	*Aphis* spp.	0.266	0.257	0.003	0.194	10.63	0.000	73.9%
	B. tabaci	-0.560	0.010	0.011	0.330			
	P. solenopsis	0.451	0.046	0.109	0.007			
	N. viridula	0.735	0.000	2.426	0.001			
Scymnus spp.	*Aphis* spp.	0.420	0.065	-0.002	0.844	2.19	0.114	43.9%
	B. tabaci	-0.335	0.149	-0.054	0.324			
	Empoasca spp.	-0.365	0.114	-0.152	0.474			
	P. solenopsis	-0.211	0.373	-0.069	0.581			
	N. viridula	0.555	0.011	1.264	0.609			

On eggplant crop:

During the 1st season, the data presented in Table 9 illustrate the relationship between the population densities of coccinellid predatory insect and the tested prey on eggplant plants. For the predator *C. undecimpunctata*, a significant correlation was observed with the prey species *Aphis* spp., *Empoasca* spp., *P. solenopsis*, and *N. viridula*, with correlation coefficient values (r) of 0.500, -0.680, -0.605, and 0.749, respectively. In contrast, no significant correlation was found with *B. tabaci* and *T. tabaci*, with correlation values of 0.025 and -0.036, respectively. While, for the predator *H. convergens*, a significant correlation was observed with the prey *Aphis* spp., with a correlation coefficient value (r) of 0.738. In contrast, no significant correlation was found with *P. solenopsis* and *N. viridula*, with correlation values of -0.174 and 0.367, respectively. For the predator *C. propinqua vicina*, a significant correlation was observed with the prey *N. viridula*, with a correlation coefficient value (r) of 0.718. In contrast, no significant correlation was found with *Aphis* spp., *B. tabaci*, and *P. solenopsis*, with correlation values of 0.462, 0.250, and -0.324, respectively. For the predator *Scymnus* spp., a significant correlation was observed with the prey species *Aphis* spp. and *B. tabaci*, with correlation coefficient values (r) of 0.562 and 0.881, respectively. In contrast, no significant correlation was found with *Empoasca* spp., *P. solenopsis*, and *N. viridula*, with correlation values of 0.326, 0.375, and 0.246, respectively. As shown in Table 9, The multiple regression analysis revealed that the combined effect of prey population size (i.e. aphids, whiteflies, thrips, leafhoppers, cotton mealybugs, and green stink bugs) had a strong influence on the population densities of the coccinellid predatory insect, namely *C. undecimpunctata*, *H. convergens*, *C. propinqua vicina*, and *Scymnus* spp.

Table (9) The correlation and regression coefficient between the coccinellid predators (total number) and each of thrips, cotton mealybug, whitefly, leafhoppers, aphids, and green stink bug population densities on eggplant crop during the 1st season 2021.

Predator	Prey	Simple correlation		Multiple partial regression				
		r.	P.	b.	p.	"F"	Prob>F	E.V.
C.undecimpunctata	*Aphis* spp.	0.500	0.041	0.009	0.592	18.92	0.000	91.9%
	B. tabaci	0.025	0.923	-0.001	0.796			
	T. tabaci	-0.036	0.892	-0.001	0.811			
	Empoasca spp.	-0.680	0.003	-0.013	0.360			
	P. solenopsis	-0.605	0.010	-0.049	0.064			
	N. viridula	0.749	0.001	1.761	0.004			
H.convergens	*Aphis* spp.	0.738	0.001	0.054	0.002	6.50	0.006	60.0%
	P. solenopsis	-0.174	0.503	-0.019	0.287			
	N. viridula	0.367	0.148	-0.416	0.443			
C. propinqua vicina	*Aphis* spp.	0.462	0.062	-0.038	0.097	8.04	0.002	72.8%
	B. tabaci	0.250	0.334	0.019	0.042			
	P. solenopsis	-0.324	0.204	-0.043	0.016			
	N. viridula	0.718	0.001	2.204	0.001			
Scymnus spp.	*Aphis* spp.	0.562	0.019	-0.052	0.014	21.14	0.000	90.6%
	B. tabaci	0.881	0.000	0.052	0.000			
	Empoasca spp.	0.326	0.202	0.031	0.044			
	P. solenopsis	0.375	0.138	-0.039	0.145			
	N. viridula	0.246	0.340	1.483	0.009			

The strongest effect shown in the case of *C. undecimpunctata* predator (91.9%) and the weakest effect shown in the case of *H. convergens* predator (60.0%) of the overall population changes were caused by compound effect of the tested preys. The multiple regression analysis showed that the common effect of the population size of the aforementioned prey on *C. propinqua vicina* and *Scymnus* spp. population densities were 72.8 and 90.6% respectively of the overall population changes were caused by the tested prey compound effect. During the 2nd season, the data presented in

Table 10 illustrate the relationship between the population densities of coccinellid predatory insect and the tested prey on eggplant plants. For the predator *C. undecimpunctata*, a significant correlation was observed with the prey species *Aphis* spp., *Empoasca* spp., and *P. solenopsis*, with correlation coefficient values (r) of 0.502, -0.742, and -0.728, respectively. In contrast, no significant correlation was found with *B. tabaci*, *T. tabaci*, and *N. viridula*, with correlation values of 0.117, 0.040, and 0.309, respectively. While, for the predator *H. convergens*, a significant correlation was observed with the prey species *Aphis* spp. and *P. solenopsis*, with correlation coefficient values (r) of 0.606 and -0.469, respectively. In contrast, no significant correlation was found with *N. viridula*, with an (r) value of 0.269. For the predator *C. propinqua vicina*, a significant correlation was observed with the prey species *Aphis* spp., *B. tabaci*, and *N. viridula*, with correlation coefficient values (r) of 0.589, 0.479, and 0.676, respectively. In contrast, an insignificant correlation was found with *P. solenopsis*, with an (r) value of -0.393. For the predator *Scymnus* spp., a significant correlation was observed with the prey species *Aphis* spp., *B. tabaci*, *Empoasca* spp., and *N. viridula*, with correlation coefficient values (r) of 0.626, 0.823, 0.528, and 0.689, respectively. In contrast, an insignificant correlation was found with *P. solenopsis*, with an (r) value of 0.406.

Table (10) The correlation and regression coefficient between the coccinellid predators (total number) and each of thrips, cotton mealybug, whitefly, leafhoppers, aphids, and green stink bug population densities on eggplant crop during the 2nd season 2022.

Predator	Prey	Simple correlation		Multiple partial regression				
		r.	P.	b.	p.	"F"	Prob>F	E.V.
C.undecimpunctata	*Aphis* spp.	0.502	0.040	0.051	0.047	9.83	0.001	85.5%
	B. tabaci	0.117	0.654	-0.017	0.061			
	T. tabaci	0.040	0.879	-0.002	0.902			
	Empoasca spp.	-0.742	0.001	-0.043	0.313			
	P. solenopsis	-0.728	0.001	-0.031	0.609			
	N. viridula	0.309	0.227	1.153	0.291			
H.convergens	*Aphis* spp.	0.606	0.010	0.038	0.082	4.12	0.029	48.8%
	P. solenopsis	-0.469	0.058	-0.032	0.143			
	N. viridula	0.269	0.297	-0.050	0.955			
C. propinqua vicina	*Aphis* spp.	0.589	0.013	-0.006	0.700	8.18	0.002	73.2%
	B. tabaci	0.479	0.052	0.002	0.664			
	P. solenopsis	-0.393	0.119	0.040	0.007			
	N. viridula	0.676	0.003	1.921	0.003			
Scymnus spp.	*Aphis* spp.	0.626	0.007	0.003	0.843	40.26	0.000	94.8%
	B. tabaci	0.823	0.000	0.035	0.000			
	Empoasca spp.	0.528	0.029	0.025	0.396			
	P. solenopsis	0.406	0.106	0.034	0.447			
	N. viridula	0.689	0.002	1.312	0.055			

As shown in Table 10, The multiple regression analysis revealed that the combined effect of prey population size (i.e. aphids, whiteflies, thrips, leafhoppers, cotton mealybugs, and green stink bugs) had a strong influence on the population densities of the coccinellid predatory insect, namely *C. undecimpunctata*, *H. convergens*, *C. propinqua vicina*, and *Scymnus* spp. The strongest effect shown in the case of *Scymnus* spp. predator (94.8%) and the weakest effect shown in the case of *H. convergens* predator (48.8%) of the overall population changes were caused by compound effect of the tested preys. The multiple regression analysis showed that the common effect of the population size of the aforementioned prey on *C. undecimpunctata* and *C. propinqua vicina* population densities were 85.5 and 73.2% respectively of the overall population changes were caused by the tested prey compound effect.

On cowpea crop:

During the 1st season, the data presented in Table 11 illustrate the relationship between the population densities of coccinellid predatory insect and the tested prey on cowpea plants. For the predator *C. undecimpunctata*, a significant correlation was observed with the prey species *P. solenopsis* and *N. viridula*, with correlation coefficient values (r) of 0.941 and 0.919, respectively. In contrast, no significant correlation was found with *Aphis* spp., *B. tabaci*, *T. tabaci*, and *Empoasca* spp., with correlation values of 0.229, 0.219, -0.384, and 0.038, respectively. While, for the predator *H. convergens*, a significant correlation was observed with the prey species *P. solenopsis* and *N. viridula*, with correlation coefficient values (r) of 0.566 and 0.873, respectively. In contrast, an insignificant correlation was found with *Aphis* spp., with an (r) value of 0.404. For the predator *C. propinqua vicina*, no significant correlation was observed with any of its prey (*Aphis* spp., *B. tabaci*, *P. solenopsis*, and *N. viridula*), with correlation coefficient values (r) of 0.294, 0.122, 0.168, and 0.043, respectively. For the predator *Scymnus* spp., a significant correlation was observed with the prey *Empoasca* spp., with a correlation coefficient value (r) of -0.470. In contrast, no significant correlation was found with *Aphis* spp., *B. tabaci*, *P. solenopsis*, and *N. viridula*, with correlation values of -0.153, -0.262, 0.412, and 0.211, respectively. As shown in Table 11, The multiple regression analysis revealed that the combined effect of prey population size (i.e. aphids, whiteflies, thrips, leafhoppers, cotton mealybugs, and green stink bugs) had a strong influence on the population densities of the coccinellid predatory insect, namely *C. undecimpunctata*, *H. convergens*, *C. propinqua vicina*, and *Scymnus* spp. The strongest effect shown in the case of *C. undecimpunctata* predator (94.7%) and the weakest effect shown in the case of *C. propinqua vicina* predator (18.6%) of the overall population changes were caused by compound effect of the tested preys. The multiple regression analysis showed that the common effect of the population size of the aforementioned prey on *H. convergens* and *Scymnus* spp. population densities were 86.7 and 37.5% respectively of the overall population changes were caused by the tested prey compound effect.

Table (11) The correlation and regression coefficient between the coccinellid predators (total number) and each of thrips, cotton mealybug, whitefly, leafhoppers, aphids, and green stink bug population densities on cowpea crop during the 1st season 2021.

Predator	Prey	Simple correlation		Multiple partial regression				
		r.	P.	b.	p.	"F"	Prob>F	E.V.
C.undecimpunctata	*Aphis* spp.	0.229	0.360	-0.010	0.453	32.64	0.000	94.7%
	B. tabaci	0.219	0.383	-0.013	0.928			
	T. tabaci	-0.384	0.116	0.141	0.347			
	Empoasca spp.	0.038	0.883	-0.021	0.392			
	P. solenopsis	0.941	0.000	0.767	0.052			
	N. viridula	0.919	0.000	1.699	0.031			
H.convergens	*Aphis* spp.	0.404	0.097	0.011	0.607	30.51	0.000	86.7%
	P. solenopsis	0.566	0.014	-1.294	0.007			
	N. viridula	0.873	0.000	4.378	0.000			
C. propinqua vicina	*Aphis* spp.	0.294	0.236	0.053	0.259	0.74	0.581	18.6%
	B. tabaci	0.122	0.630	0.105	0.808			
	P. solenopsis	0.168	0.504	0.953	0.240			
	N. viridula	0.043	0.865	-1.413	0.261			
Scymnus spp.	*Aphis* spp.	-0.135	0.593	-0.016	0.735	1.44	0.279	37.5%
	B. tabaci	-0.262	0.293	-0.218	0.679			
	Empoasca spp.	-0.470	0.049	-0.061	0.240			
	P. solenopsis	0.412	0.090	0.577	0.607			
	N. viridula	0.211	0.400	0.398	0.815			

During the 2nd season, the data presented in Table 12 illustrate the relationship between the population densities of coccinellid predatory insect and the tested prey on cowpea plants. For *the C. undecimpunctata* predator, a significant correlation was observed with the prey species *P. solenopsis* and *N. viridula*, with correlation coefficients (r) of 0.603 and 0.861, respectively. In contrast, no significant correlation was found with *Aphis* spp., *B. tabaci*, *T. tabaci*, and *Empoasca* spp., with correlation values of 0.400, 0.105, -0.292, and -0.097, respectively. While, for the predator *H. convergens* predator, a significant correlation was observed with the prey species *Aphis* spp. and *N. viridula*, with correlation coefficient values (r) of 0.537 and 0.893, respectively. In contrast, an insignificant correlation was found with *P. solenopsis*, with an (r) value of 0.204. For the predator *C. propinqua vicina*, a significant correlation was observed with the prey *P. solenopsis*, with a correlation coefficient value (r) of 0.823. In contrast, no significant correlation was found with *Aphis* spp., *B. tabaci*, and *N. viridula*, with correlation values of 0.415, 0.249, and 0.348, respectively. For the predator the *Scymnus* spp., a significant correlation was observed with the prey species *P. solenopsis* and *N. viridula*, with correlation coefficients (r) of 0.887 and 0.529, respectively. In contrast, no significant correlation was found with *Aphis* spp., *B. tabaci*, and *Empoasca* spp., with correlation coefficients (r) of 0.232, 0.040, and -0.258, respectively.

Table (12) The correlation and regression coefficient between the coccinellid predators (total number) and each of thrips, cotton mealybug, whitefly, leafhoppers, aphids, and green stink bug population densities on cowpea crop during the 2nd season 2022.

Predator	Prey	Simple correlation		Multiple partial regression				
		r.	P.	b.	p.	"F"	Prob>F	E.V
C.undecimpunctata	*Aphis* spp.	0.400	0.100	-0.003	0.894	9.39	0.001	83.7%
	B. tabaci	0.105	0.677	0.137	0.508			
	T. tabaci	-0.292	0.239	0.302	0.303			
	Empoasca spp.	-0.097	0.701	-0.028	0.363			
	P. solenopsis	0.603	0.008	0.512	0.086			
	N. viridula	0.861	0.000	2.586	0.001			
H.convergens	*Aphis* spp.	0.537	0.022	0.032	0.119	30.11	0.000	86.6%
	P. solenopsis	0.204	0.417	-0.329	0.060			
	N. viridula	0.893	0.000	2.806	0.000			
C. propinqua vicina	*Aphis* spp.	0.415	0.086	0.040	0.017	35.21	0.000	91.5%
	B. tabaci	0.249	0.319	0.469	0.001			
	P. solenopsis	0.823	0.000	1.258	0.000			
	N. viridula	0.348	0.157	-0.601	0.044			
Scymnus spp.	*Aphis* spp.	0.232	0.354	-0.002	0.902	13.63	0.000	85.0%
	B. tabaci	0.040	0.875	0.254	0.170			
	Empoasca spp.	-0.258	0.301	0.009	0.693			
	P. solenopsis	0.887	0.000	1.358	0.000			
	N. viridula	0.529	0.024	0.369	0.424			

As shown in Table 12, The multiple regression analysis revealed that the combined effect of prey population size (i.e. aphids, whiteflies, thrips, leafhoppers, cotton mealybugs, and green stink bugs) had a strong influence on the population densities of the coccinellid predatory insect, namely *C. undecimpunctata*, *H. convergens*, *C. propinqua vicina*, and *Scymnus* spp. The strongest effect shown in the case of *C. propinqua vicina* predator (91.5%) and the weakest effect shown in the case of *C. undecimpunctata* predator (83.7%) of the overall population changes were caused by compound effect of the tested preys. The multiple regression analysis showed that the common effect of the population size of the aforementioned prey on *H. convergens* and *Scymnus* spp. population densities were 86.6 and 85.0% respectively of the overall population changes were caused by the tested prey compound effect.

DISCUSSION:

The attraction of various host plants to coccinellid predatory insects:

The survey of coccinellid predatory insects associated with four vegetable crops (cucumber, okra, eggplant, and cowpea) during the two consecutive summer planting seasons of 2021 and 2022 revealed that the most abundant coccinellid predators recorded were *C. undecimpunctata*, *H. convergens*, *C. propinqua vicina*, and *Scymnus* spp. As previously by previous studies, these predators have been recognized as significant natural enemies of vegetable crops such as sweet potato, cucumber, cowpea, and tomato in Egypt **(Abdel-Gawaad *et al*., 1990; Amro, 2004; Ali *et al*., 2013; Gameel, 2013; El-Fakharany *et al*., 2017)**.

According to the current study, the seasonal abundance of predaceous insects varied in response to different host plants. The recorded predators showed a strong preference for cucumber over cowpea, tomato, and sweet potato. Additionally, the predatory insects *C. motrouzari*, *Chilocorus bipustulatus* and *Rodolia cardinalis* exhibited different responses to various host plants (**Cardosa, 1990; Heidari *et al*., 1999; Abdel-Mageed, 2005**). The average numbers of *C. undecimpunctata* and *Scymnus syriacus* showed significant differences between tomato cultivars, as noted by **Yassin *et al*. (2014)**. As reported by **El-Baradey (2012)**, differences in the types of kairomones produced by various plant species may lead to variations in predator responses to different host plants. Similarly, **Abd El-Kareim (2002)**, **Abdel-Kareim *et al*. (2011)**, and **Marouf (2011)** concluded that the primary factor influencing insect attraction to host plants is the emission of auditory stimuli. **Luna and Jepson (2001)** suggested that variations in the responses of hoverflies and coccinellid beetles to the host plant species studied could be caused by either chemical or physical stimuli. For some predatory insect species, a combination of substances, including volatiles from both the prey and the plants in the environment, plays a role (**Hagen, 1986**). **Satti and Mahgoub (2018)** recorded four predators the syrphid fly *Xanthogramma aegyptium*, *C. undecimpunctata*, *C. carnea* and *H. variegate* associated with *T. tabaci* on tomato, rocket, and onion plants. Although many predators are known to attack *B. tabaci*, the most frequent ones include lacewings (*C. carnea* and *C. pallens*), bugs (*Orius sp*., *Macrolophus caliginosus* and *Nesidiocoris tenuis*) and mites (*Amblyseius swirskii* and *Euseius ovalis*) as noted by **Al-Zyoud (2014)**.

Interaction between the activity of coccinellid predators, preys and host plants:

Predator-prey interactions play an essential role in shaping the geographical distributions of organisms within biological communities (**Williams and Flaxman, 2012**). **Jalali and Michaud (2012)** demonstrated that significant host-prey interactions occur across all stages in the developmental process, affecting juvenile survival, growth duration, adult mass at emergence, and reproductive success of predators. In this study, the coccinellid predatory insects tested, including *C. undecimpunctata*, *H. convergens*, *C. propinqua vicina*, and *Scymnus spp.*, exhibited different responses to insect prey populations on various host plants, especially in relation to leafhopper populations. For instance, when the coccinellid predator *C. undecimpunctata* fed on the cotton aphid, *A. gossypii*, it showed greater search efficiency compared to when feeding on the pomegranate aphid, *Aphis punicae* (**Al-Deghair *et al*., 2014**). Similarly, the larval stage of the aphid lion, *Chrysoperla carnea*, exhibited a significantly different duration for its immature stages when fed on various aphid species, including the English grain aphid (*Sitobion avenae*), the cotton aphid (*A. gossypii*), the oleander aphid (*Aphis nerii*), and the corn aphid (*Rhopalosiphum maidis*) (**El-Serafi *et al*., 2000**). **Giles *et al*. (2002)** found that the pea aphid, *Acythosiphon pisum*, when fed on alfalfa (*Medicago sativa*), served as an ideal prey for the seven-spot ladybird (*C. septempunctata*), resulting in better survival rates, shorter developmental times, and larger adult sizes compared to when the same aphid species was reared on broad bean (*Vicia faba*). The developmental rate of *C. septempunctata* was notably faster when reared on *A. pisum* than when it was reared on *R. maidis* (**Obrycki and Orr, 1990**). Furthermore, **Cottrell and Tillman (2017)** observed that four species of lady beetles (Coleoptera: Coccinellidae) exhibited limited predation on the eggs and nymphs of *N. viridula*.

REFERENCES:

Abd El-Kareim, A. I. (2002). The potential of some natural enemies as bioagents against certain diaspidid species. *Journal of Union Arab Biology, Cairo*, 17(A), 51–63.

Abd El-Kareim, A. I., El-Naggar, M. E., and Marouf, A. E. (2011). Survey of predaceous insects associated with four medicinal plants. *Journal of Plant Protection and Pathology, Mansoura University*, 2(6), 623–636.

Abdel-Gawaad, A. A., El-Sayed, A. M., Shalaby, F. F., and Abo El-Ghar, M. R. (1990). Natural enemies of *Bemisia tabaci* and their role in suppressing the population density of the pest. *Agricultural Research Review,* 68(1), 185–195.

Abdel-Mageed, S. A. M. (2005). Influence of certain natural enemies on the populations of some mealybugs. M.Sc. Thesis, Faculty of Agriculture, Mansoura University, Mansoura, Egypt.

Abd-Elrahman, S. H., Fahim, M. A., Younis, T. M., El-Morshedy, R. M., Abdrabbo, M. A., and Hashem, F. A. (2022). *Middle East Journal of Agriculture Research*, 11(1), 89–102.

Abdel-Salam, A. H., El-Serafi, H. A., Bayoumy, M. H., and Abdel-Hady, A. A. (2018). Influence of temperature and aphid-host plant variety on the performance and thermal requirements of *Coccinella undecimpunctata* L. and *Cheilomenes propinqua* Isis (Mulsant). *Journal of Plant Protection and Pathology*, 9, 375–380.

Adly, D., Fadl, H. A., and Mousa, S. F. M. (2016). Survey and seasonal abundance of mealybug species, their parasitoids, and associated predators on guava trees in Egypt. *Egyptian Journal of Biological Pest Control*, 26, 657–664.

Agarwala, B. K., and Yasuda, H. (2001). Larval interactions in aphidophagous predators: effectiveness of wax cover as a defense shield of *Scymnus* larvae against predation from syrphids. *Entomologia Experimentalis et Applicata*, 100, 101–107.

Ahmad, M., Rafiq, M., Arif, M. I., and Sayyed, A. H. (2011). Toxicity of some commonly used insecticides against *Coccinella undecimpunctata* (Coleoptera: Coccinellidae). *Pakistan Journal of Zoology*, 43(6).

Ahmad, M., Sayyed, A. H., Saleem, M. A., and Ahmad, M. (2008). Evidence for field-evolved resistance to newer insecticides in *Spodoptera litura* (Lepidoptera: Noctuidae) from Pakistan. *Crop Protection, 27*(9), 1367-1372

Al-Deghair, M. A., Abdel-Baky, N. F., Fouly, A. H., and Ghanim, N. M. (2014). Foraging behavior of two coccinellid species (Coleoptera: Coccinellidae) fed on aphids. *Journal of Agricultural and Urban Entomology*, 30(1), 12–24.

Ali, S. H. A., Saleh, A. A., and Mohamed, N. E. (2013). *Aphis craccivora* Koch and its predators on faba bean and cowpea in newly reclaimed areas in Egypt. *Egyptian Journal of Agricultural Research*, 91(4), 1423–1438.

Al-Zyoud, F. A. (2014). The most common predators of *Bemisia tabaci* (Genn.): Biology, predation, preferences, releases, alternative food resources, combined use, current efforts, and future perspectives. *Journal of Biological Control*, 28(1), 1–16.

Amro, M. A. M. (2004). Incidence of certain arthropod pests and predators inhabiting cowpea, with special reference to the varietal resistance of selected cultivars to *Bemisia tabaci* (Genn.) and *Tetranychus urticae* Koch. *Assiut University Bulletin for Environmental Research*, 7(1).

Anonymous. (2017). *Horticultural statistics at a glance*. Retrieved from http://nhb.gov.in.

Ata, T. (2024). Role of the Predaceous Insects in Regulating the Population of the Main Piercing-Sucking Insect Pests Attacking Certain Vegetable Crops. Al-Azhar Journal of Agricultural Research, 49(2), 70-87.

Atuncha, H., Ateka, E., Amata, R., Mwirichia, R., Kasina, M., Mbevi, B., and Wakoli, E. (2013). Assessment of coccinellid predation potential on cassava whiteflies. *Journal of Entomology and Nematology*, 5, 84–87.

Azouz, H., Yassin, E., El-Sanady, M., & Abou-Zaid, A. (2014). Field and laboratory studies on three eggplant cultivars to evaluate their relative susceptibility to some piercing-sucking pests with relation to leaf constituents. *Journal of Plant Protection and Pathology*, 5(11), 995–1005.

Bashandy, T., and El-Shaieny, A. (2016). Screening of cowpea (*Vigna unguiculata* L. Walp) genotypes for salinity tolerance using field evaluation and molecular analysis. *Journal of Agricultural Chemistry and Biotechnology*, 7(9), 249–255.

Bayoumy, M. H., and Michaud, J. P. (2015). Cannibalism in two subtropical lady beetles (Coleoptera: Coccinellidae) as a function of density, life stage, and food supply. *Journal of Insect Behavior*, 28, 387–402.

Borges, I., Hemptinne, J. L., and Soares, A. O. (2013). Contrasting population growth parameters of the aphidophagous *Scymnus nubilus* and the coccidophagous *Nephus reunioni*. *BioControl*, 58, 351–357.

Borges, I., Soares, A. O., Magro, A., and Hemptinne, J. L. (2011). Prey availability in time and space as a driving force in the life history evolution of predatory insects. *Evolutionary Ecology*, 25, 1307–1319.

Borkakati, R. N., Venkatesh, M. R., and Saikia, D. K. (2019). Insect pests of brinjal and their natural enemies. *Journal of Entomology and Zoology Studies*, 7, 932–937.

Cardosa, A. (1990). Preliminary study of the coccinellids found on citrus in Portugal. *Boletín de Sanidad Vegetal, Plagas*, 16(1), 105–111.

Ceryngier, P., and Hodek, I. (1996). Enemies of the Coccinellidae. In I. Hodek and A. Honk (Eds.), *Ecology of Coccinellidae* (pp. 319–350). Kluwer Academic Publishers, Dordrecht.

Cook, J. A., Vander, J. D. J., Pastuszyn, A., Mounkaila, G., Glew, R. S., Millson, M., and Glew, R. H. (2000). Analysis of nutrients and chemical composition in 13 wild edible plants from Niger. *Journal of Food Composition and Analysis*, 13(1), 83–92.

Cottrell, T. E., and Tillman, P. G. (2017). Limited predation of *Nezara viridula* (Hemiptera: Pentatomidae) eggs and nymphs by four lady beetle species (Coleoptera: Coccinellidae). *Biological Control*, 114, 73–78.

Dixon, A. F. G., Hemptinne, J. L., and Kindlmann, P. (1997). Effectiveness of ladybirds as biological control agents: patterns and processes. *Entomophaga*, 42, 72–83.

Doklega, S. (2018). Okra plants' response to farmyard manure, mineral, and some bio-fertilizers. *Journal of Plant Production*, 9(2), 165–172.

El-Lakwah, F. A., Abd-Wahab, H. A., Kattab, M. M., Azaba, M. M., and El-Ghanam, M. S. (2011). Population dynamics of some pests infesting nili cucumber plantations in relation to certain ecological factors. *Journal of Agricultural Research*, 89(1), 137–153.

El-Baradey, W. M. M. (2012). Eco-physiological studies on some scale insects. PhD. Sc. Thesis, Faculty of Agriculture, Mansoura University, Mansoura, Egypt, p. 155.

El-Fakharany, S. K., Hegazy, F. H., and Samy, M. A. E. M. (2017). Survey and population fluctuations of arthropod pests and predators in sweet potato at Nile Delta, Egypt. *Egyptian Academic Journal of Biological Sciences. A, Entomology*, 10(7), 277–285.

Eloward, H. O. A., and Hall, A. E. (1987). Influence of early and late nitrogen fertilization on yield and nitrogen fixation of cowpea under well-watered and dry field conditions. *Field Crops Research*, 15, 229–244.

El-Serafi, H. A. K., Abdel-Salam, A. H., and Abdel-Baky, N. F. (2000). Effect of four aphid species on certain biological characteristics and life table parameters of *Chrysoperla carnea* Stephens and *Chrysopa septempunctata* Wesmael (Neuroptera: Chrysopidae) under laboratory conditions. *Pakistan Journal of Biological Sciences*.

El-Sharkawy, H. M., El-Santel, F. S., El-Salam, A., and Rehab, A. (2017). Studies on some parasitoids of aphid *Aphis gossypii* Glover (Homoptera: Aphididae) on cucumber plants in Egypt. *Egyptian Academic Journal of Biological Sciences. A, Entomology*, 10(7), 19–30.

Elsobky, E. E., and Hassan, H. H. (2021). Optimizing cowpea productivity by sowing date and plant density to mitigate climatic changes. *Egyptian Journal of Agronomy*, 43(3), 317–331.

FAO (2016). *Food and Agriculture Organization. FAOSTAT*, FAO Statistics Division, 2016.

FAO. (2019). *FAO Statistical Yearbook 2019. World food and agriculture*. FAO Statistics Division. Retrieved from http://www.fao.org.

FAOSTAT (2021). *Statistical Databases*. Food and Agriculture Organization of the United Nations. http://www.fao.org/faostat/en/#data/QC

FAOSTAT (2020). *Food and Agriculture Organization of the United Nations*. http://faostat.fao.org/statistics (accessed on 10 August 2020).

Gameel, S. M. M. (2013). Species composition of piercing-sucking arthropod pests and associated natural enemies inhabiting cucurbit fields at the new valley in Egypt. *Egyptian Academic Journal of Biological Sciences*, 6(2), 73–79.

Giles, K. L., Madden, R. D., Stockland, R., Payton, M. E., and Dillwith, J. W. (2002). Host plants affect predator fitness via the nutritional value of herbivore prey: Investigation of a plant-aphid-ladybeetle system. *Journal of Biological Control*, 47, 1–21.

Glew, R. H., Vander, J. D. J., Lockett, C., Grivetti, L. E., Smith, G. C., Pastuszyn, A., and Millson, M. (1997). Amino acid, fatty acid, and mineral composition of 24 indigenous plants of Burkina-Faso. *Journal of Food Composition and Analysis*, 10, 205–217.

Gopalan, C., Sastri, S. B. V., and Balasubramanian, S. (2007). *Nutritive value of Indian foods*. National Institute of Nutrition (NIN), I.C.M.R., India.

Hagen, K. S. (1986). Ecosystem analysis: plant cultivars (HRP), entomophagous species, and food supplements. In D. J. Boethal and R. D. Eikenbary (Eds.), *Interactions of plant resistance and parasitoids and predators of insects* (pp. 151–197). John Wiley & Sons, New York.

Hall, A. E. (2004). Breeding for adaptation to drought and heat in cowpea. *European Journal of Agronomy*, 21, 447–454.

Hassan, S. (2013). Effect of variety and intercropping on two major cowpea [*Vigna unguiculata* (L.) Walp] field pests in Mubi, Adamawa State, Nigeria. *International Journal of Agricultural Research and Development*, 1(5), 108–109.

Heidari, M., Hodgson, C., and Porcelli, F. (1999). Influence of host-plant physical defenses on the searching behavior and efficacy of two coccinellid predators of the obscure mealybug, *Pseudococcus viburni* (Signoret). *Entomologica*, 33, 397–402.

Helal, A. H., Salem, R. M., El-Khouly, A. S., Metwally, M. M., and ElMezaien, A. B. (1996). Population dynamics of *Aphis craccivora* Koch and *Empoasca* spp. on faba bean in relation to associated predators and some climatic factors. *Egyptian Journal of Agricultural Research*, 75(2), 461–471.

IBM Corp. (2020). IBM SPSS Statistics for Windows (Version 27.0) [Computer software]. IBM Corp.

Iqbal, J., Ali, H., Hassan, M. W., and Jamil, M. (2015). Evaluation of indigenous plant extracts against sucking insect pests of okra crop. *Pakistan Entomologist*, 37(1), 39–44.

Jackai, L. E. N. (1995). The legume pod borer *Maruca testulalis* and its principal host plant, *Vigna unguiculata* (L.) Walp. Use of selective insecticide sprays as an aid in the identification of useful levels of resistance. *Crop Protection*, 14(4), 299–306.

Jalali, M. A., and Michaud, J. P. (2012). Aphid-plant interactions affect the suitability of *Myzus* spp. as prey for the two-spot ladybird, *Adalia bipunctata* (Coleoptera: Coccinellidae). *European Journal of Entomology*, 109, 345–352.

Khuhro, N. H., Chen, H., Zhang, Y., Zhang, L., and Wang, M. (2012). Effect of different prey species on the life history parameters of *Chrysoperla sinica* (Neuroptera: Chrysopidae). *European Journal of Entomology*, 109, 175–180.

Kovář, I. (2007). Family Coccinellidae Latreille, 1807. In I. Löbl and A. Smetana (Eds.), *Catalogue of Palearctic Coleoptera* (Vol. 4, pp. 568–631). Apollo Books: Stenstrup, Denmark.

Luna, J., and Jepson, P. (2001). *Organic farming research project report* submitted to: Organic Farming Research Foundation. Project title: Enhancement of biological control with insectary planting. Santa Cruz.

Marouf, A. H. (2007). Studies on insect pests and their natural enemies associated with marjoram and chamomile plants. M.Sc. Thesis, Faculty of Agriculture, Mansoura University, Mansoura, Egypt, p. 150.

Marouf, A. H. (2011). Influence of some medicinal plants as a habitat management tool to enhance the role of certain natural enemies. Ph.D. Thesis, Faculty of Agriculture, Mansoura University, Mansoura, Egypt, p. 164.

Matsubara, K., Kaneyuki, T., Miyake, T., and Mori, M. (2005). Antiangiogenic activity of nasunin, an antioxidant anthocyanin in eggplant peels. *Journal of Agricultural and Food Chemistry*, 53, 6272–6275.

Merghany, M., Shahein, M. M., Sliem, M. A., Abdelgawad, K. F., and Radwan, A. F. (2019). Effect of nano-fertilizers on cucumber plant growth, fruit yield and its quality. *Plant Archives*, 19(2), 165–172.

Michaud, J. P., and Qureshi, J. A. (2005). Induction of reproductive diapause in *Hippodamia convergens* (Coleoptera: Coccinellidae) hinges on prey quality and availability. *European Journal of Entomology*, 102(3), 483–487.

Michaud, J. P., and Qureshi, J. A. (2006). Reproductive diapause in *Hippodamia convergens* (Coleoptera: Coccinellidae) and its life history consequences. *Biological Control*, 39(2), 193–200.

Michels, G. J. Jr., Elliott, N. C., Romero, R. A., Fritts, D. A., and Bible, J. B. (2001). Impact of indigenous coccinellids on Russian wheat aphids and greenbugs (Homoptera: Aphididae) infesting winter wheat in the Texas Panhandle. *Southwestern Entomologist*, 26(2), 97–114.

Naveed, M., Salam, A., and Saleem, M. A. (2007). Contribution of cultivated crops, vegetables, weeds and ornamental plants in harboring of *Bemisia tabaci* (Homoptera: Aleyrodidae) and associated parasitoids (Hymenoptera: Aphelinidae) in cotton agroecosystem in Pakistan. *Journal of Pesticide Science*, 80, 191–197.

Nechols, J. R., and Harvey, T. L. (1998). Evaluation of a mechanical exclusion method to assess the impact of Russian wheat aphid natural enemies. In S. S. Quisenberry and F. B. Peairs (Eds.), *Response Model for an Introduced Pest—The Russian Wheat Aphid* (pp. 270–279). Thomas Say Publications, Lanham, Maryland.

Obrycki, J. J., and Orr, C. J. (1990). Suitability of three prey species for native populations of *Coccinella septempunctata*, *Hippodamia variegata*, and *Propylea quatuordecimpunctata* (Coleoptera: Coccinellidae). *Journal of Economic Entomology*, 83(4), 1292–1297.

Omkar, P. A. (2002). New record of coccinellids from Uttar Pradesh. III. *Journal of Advanced Zoology*, 23(1), 63–65.

Ovchinnikov, A. N., Ovchinnikova, A. A., Reznik, S. Y., and Belyakova, N. A. (2024). Effects of two prey species combinations on larval development of the predatory ladybird *Cheilomenes propinqua*. *Insects*, 15(7), 484.

Pluke, R. W. H., Escribano, A., Michaud, J. P., and Stansly, P. A. (2005). Potential impact of lady beetles on *Diaphorina citri* (Homoptera: Psyllidae) in Puerto Rico. *Florida Entomologist*, 88, 123–128.

Ramadan, M. M., Hassan, M. A., and Afifi, M. (2022). Ecological studies on the Peach green aphid, *Myzus persicae* and its natural enemies. *Journal of Plant Protection and Pathology*, 13, 29–35.

Saeed, S., Ahmad, M., and Ahmad, M. (2007). Insecticidal control of mealybug *Phenacoccus gossypiphilous* (Homoptera: Pseudococcidae) – a new pest of cotton in Pakistan. *Entomological Research*, 37, 76–80.

Salman, A. M. A., El-Harery, M. A., and El-Solimany, E. A. (2014). Effects of population densities of *Aphis craccivora* Koch on predatory efficiency of *Coccinella septempunctata* L., *Coccinella undecimpunctata* L., and *Chrysoperla carnea* Stephens larvae under laboratory conditions. *Middle East Journal of Agricultural Research*, 3(1), 116–122.

Satti, A. A., and Mahgoub, H. A. H. (2018). Population abundance of *Thrips tabaci* Lindeman and its associated predators on some crops at Shendi, River Nile State, Sudan. *International Journal of Scientific Progress and Research*, 54(1), 37–45.

Schmutterer, H. (1990). Properties and potential of natural pesticides from the neem tree, *Azadirachta indica*. *Annual Review of Entomology*, 35, 271–289.

Sebastiao, D., Borges, I., and Soares, A. O. (2015). Effect of temperature and prey in the biology of *Scymnus subvillosus*. *BioControl*, 60(2), 241–249.

Seo, M., Rivera, M. J., and Stelinski, L. L. (2018). Trail chemicals of the *Convergens* ladybird beetle, *Hippodamia convergens*, reduce feeding and oviposition by *Diaphorina citri* (Hemiptera: Psyllidae) on citrus plants. *Journal of Insect Behavior*, 31(3), 298–308.

Smith, S. F., and Krischik, V. A. (2000). Effect of biorational pesticides on four coccinellid species (Coleoptera: Coccinellidae) having potential as biological control agents in interiorscapes. *Journal of Economic Entomology*, 93, 732–736.

Spodek, M., Ben-Dov, Y., Mondaca, L., Protasov, A., Erel, E., and Mendel, Z. (2018). The cotton mealybug, *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) in Israel: Pest status, host plants, and natural enemies. *Phytoparasitica*, 46, 45–55.

Subbiredy, K. B., Patel, H. P., Patel, N. B., and Bharpoda, T. M. (2018). Utilization of plant extract for managing fruit borers in okra (*Abelmoschus esculentus* (L.) Moench). *International Journal of Current Microbiology and Applied Sciences*, 7, 2786–2793.

Tawfik, M. F. S., Abdul-Nasr, S., and Saad, B. M. (1973). The biology of *Scymnus interruptus* Goeze (Coleoptera: Coccinellidae). *Bulletin of the Entomological Society of Egypt*, 57, 9–26.

Uygun, N., and Atlıhan, R. (2000). The effect of temperature on development and fecundity of *Scymnus levaillanti*. *BioControl*, 45, 453–462.

Varmudy, V. (2011). Market survey needed to boost okra exports. *Department of Economics, Vivekananda College, Puttur, Karnataka, India.*

Wanntorp, H. E. (2004). "Musical chairs": the Swedish species of *Scymnus* subg. *Neopullus* (Coleoptera, Coccinellidae) change places. *Entomologisk Tidskrift*, 125, 103–109.

Ward, A., Morse, S., Denholm, I., and McNamara, N. (2002). Foliar insect pest management on cowpea (*Vigna unguiculata* (L.) Walpers) in simulated varietal mixtures. *Field Crops Research*, 79(1), 53–65.

Wargovich, M. J. (2000). Anticancer properties of fruits and vegetables. *HortScience*, 35(4), 573–575.

Williams, A. C., and Flaxman, S. M. (2012). Can predators assess the quality of their prey’s resource? *Journal of Animal Behavior*, 83, 883–890.

Woin, N., Volkmar, C., and Ghogomu, T. (2006). Numerical response of predatory ladybirds (Coccinellidae) to aphid outbreaks and their diversity in major rice ecosystems of Cameroon. *Archives of Phytopathology and Plant Protection*, 39, 189–196.

Yassin, S. A., Arafat, N. F., and Baiomy, F. A. (2014). Susceptibility of some tomato varieties to some pests and predators. *Egyptian Academic Journal of Biological Sciences. A, Entomology*, 7(1), 1–10.

Youssif, M. A. I. (2019). Coccinellid species and their insect parasitoids in pear orchards at El-Khattara district, Sharkia Governorate, Egypt. *Journal of Entomology and Zoology Studies*, 7, 780–790.

دور أربعة أنواع من مفترسات أبي العيد في تنظيم تعداد الآفات الحشرية الثاقبة الماصة الرئيسية التي تهاجم بعض محاصيل الخضر

طارق السيد عطا[1]، حافظ عبد الرحمن القاضي[1]، سمير صالح عوض الله[2] وعبد الرحمن السعيد عيسي[1]

[1]قسم وقاية النبات– كلية الزراعة – جامعة دمياط

[2]قسم الحشرات الاقتصادية – كلية الزراعة– جامعة المنصورة

أجريت التجارب لمعرفة دور مفترسات أبي العيد في تنظيم تعداد الآفات الحشرية الثاقبة الماصة الرئيسية على محاصيل الخضر في منطقة كفر سعد بمحافظة دمياط بمصر خلال موسم الزراعة الصيفي للعامين المتتاليين 2021 و2022. تم تسجيل أربعة أنواع من المفترسات تنتمي إلى رتبة غمدية الأجنحة (أبي العيد أحد عشر نقطة *Coccinella undecimpunctata* وأبي العيد هيبوداميا *Hippodamia convergens* وأبي العيد شيلومينس *Cheilomenes propinqua vicina* وأبي العيد سكمنس *Scymnus* spp.) على محاصيل الخيار، البامية، الباذنجان واللوبيا. ومن بين مفترسات أبي العيد، كان أبي العيد شيلومينس *C. propinqua vicina* الأكثر وفرة على جميع محاصيل الخضر، يليه أبي العيد سكمنس *Scymnus* spp. ثم أبي العيد هيبوداميا *H. convergens*، بينما كان أبي العيد أحد عشر نقطة *C. undecimpunctata* الأقل وفرة. خلال الموسم الأول، شكل أبي العيد شيلومينس *C. propinqua vicina* 32.8% و28.7% و30.3% و22.8% من إجمالي مفترسات أبي العيد على محاصيل الخيار، البامية، الباذنجان واللوبيا على التوالي. وفي الموسم الثاني، بلغت هذه النسب 32.8% و30.0% و28.3% و25.4% على التوالي لنفس المحاصيل. وعلى العكس من ذلك، مثل أبي العيد أحد عشر *نقطة C. undecimpunctata* النسبة الأصغر، حيث بلغت 21.8% و18.6% و20.2% و23.1% في الموسم الأول، و21.3% و19.4% و21.5% و21.5% في الموسم الثاني لنفس المحاصيل. وفيما يتعلق بتفضيلات النباتات المضيفة، أظهرت مفترسات أبي العيد (أبي العيد شيلومينس وأبي العيد هيبوداميا وأبي العيد أحد عشر نقطة) تفضيلًا قويًا لنباتات الخيار، تليها البامية ثم الباذنجان، مع أقل تفضيل للوبيا. وعلى النقيض من ذلك، فضل أبي العيد سكمنس نباتات البامية، تليها الخيار ثم الباذنجان، مع كون اللوبيا هي العائل الأقل تفضيلًا، خلال كل من الموسمين الأول والثاني.