Efficacy of Two Predatory Coccinellid Specie Feeding on Different Desities of Bemisia Tabaci (Homoptera : Aleyrodidae) Nymphs in The Laboratory

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Abstract

A series of experiments were conducted laboratories of biological control in the postgraduate laboratory at the Al-Musaib Technical College, AL-Furat Al-Awsat Technical University-Iraq in 2020. The larval and adult phase of Hippodamia variegate and Coccinella Septempunctata L. were reared on different densities of Bemisia tabaci nymphs to reveal their predation and the effect on this longevity too: The average number of predation whitefly nymphs per day from each age larvae and adults of the thirteen-spoted ladybird H. variegate and the seven-spoted ladybird C. Septempunctata. L was in direct proportion to the increase in the density of the whitefly nymphs supplied for it daily. The highest average of thirteen point ladybird larva was (48.60) at density (64) nymphs/whitefly at the first larval phase. While the lowest rate of first-stage larvae was (6.40) at density (2) nymphs/whitefly for the same larval phase, while the highest average of fourth-stage larvae was (131.20) at density (64) nymphs/whitefly. While the lowest average of the fourth larvae phase was (39.20) at density (8) nymphs/whitefly. As for the seven- spotted ladybird, the highest average of first-phase larvae reached (53.80) at density (64) nymphs/whitefly, while the lowest average of first-phase larvae reached (5.40) at density (2) nymphs/whitefly for the same larval phase. While the highest average of fourth-phase larvae was (160.40) at density (64) nymph/whitefly, while the lowest average of fourth phase larvae was (46.00) at density (4) nymph/whitefly. The number of whitefly nymphs preyed by the thirteen- spotted ladybird H. variegate is less than the number of whitefly nymphs preyed by the seven- spotted ladybird C. Septempunctata. L. The daily average of predation for male predation ladybirds understudy for whitefly nymphs is less than the daily average for females with significant differences.

Keywords: Aleyrodidae, Bemisia, Coccinellid, Laboratory.

1. Introduction

Insect pests are one of the biggest problems facing agriculture, Many alternatives to chemical pesticides have been used, such as plant extracts [1,2], as well, natural which considered environmentally friendly and can be long-term solutions for insect control. The Coccinellidae family is one of the most important families of the Coleoptera order. As the number of its species reaches more than 6000 species [3]. Predatory Coccinellids spread in Many countries of the Middle East such as Egypt, Iraq, Jordan, and Saudi Arabia [4].

The benefit in predation is divided according to the stages of colony growth, where most types of ladybirds are predators in the larval stage, which reach many pests such as aphids, scale insects, whiteflies, mealybugs, and eggs of scale wings insects [5-7]. Vital enemies are based on preventing pests insects from reaching the degree of infection, especially in stable populations. Vital enemies must be abundant and appropriate conditions must be met, including a high ability to search and spread. And a high degree of adaptation to the environment and the compatibility of its life cycle with the life cycle of the prey and the ease of breeding it [8]. In light of this, the research aims to test the predatory efficiency of larvae and adults of H. variegate and C. Septempunctata.L against whitefly nymphs.
2. Materials and Methods

2.1 Rearing colony of predation Coccinellids

2.1.1 Seven-spot ladybird (C.Septempunctata. L)

The 20 pairs of adult male and female of C.Septempunctata.L were brought from one of the fields of Kutha District, Babylon province, Iraq on 10/8/2020. They were diagnosed by Prof. Razak Shaalan Akal (Research Center and the Natural History Museum / the University of Baghdad). It was placed inside a glass cage measuring (75 x 75 x 75 cm). The back and sides were covered with transparent glass, and the front was covered with muslin and the cloth was provided with a hole (50 cm) long with a zipper that could be controlled by opening and closing the box for the purpose of bringing in and taking out insects and food and to prevent the escape of adults. As for the upper and lower sides, they were covered with a piece of plywood, and each box was provided with a sufficient quantity of infected plants in the whitefly nymphs that were brought from the infected fields. Where parts of the affected plants are taken and their lower end is immersed in a container containing water added to it (5 g) of sugar to maintain the greenness of the plant to save moisture, small Petri dishes with a cotton wet with water were placed inside the cage, and the cage was placed in the laboratory at a temperature of 28 ± 2 °C and a period of 16 hours of illumination / 8 hours of darkness. The box was also provided with a layer of multi-cell sandwich made of two layers of corrugated cardboard on one side measuring (15 x 10 cm) and fixed to each other by pins, So that each corrugated side of one of the two pieces meets the corrugated side of the other, forming tubes and long cells for the purpose of preparing the appropriate place for laying eggs inside them by the female maidens. The sandwiches that contain eggs are raised and replaced daily and transferred to other cages away from the mothers to prevent self-predation of eggs (cannibalism) for the purpose of perpetuating the colony [9,10].

2.1.2 The thirteen- spotted ladybird H. variegate

Pairs of male and female H. variegate were brought from the fields indicated above, and they followed the same breeding steps mentioned in (2-1-1).

2.2 Predatory efficiency of predatory ladybird

2.2.1 Effect of different densities of whitefly nymphs on predation efficiency and viability of larvae of predatory ladybirds

2.2.1.1 The seven- spotted ladybird C.Septempunctata L.

The one-day age larvae were taken from the special breeding cages for the study described in (2.1.1), then each larva was placed in a plastic container with a diameter of 6 cm and a height of 3 cm. Each larva was supplied with a number of whitefly nymphs according to the treatments (nymph densities), which are (64,32,16,8,4,2,0) nymphs with five replications for each treatment, the plates' openings were closed with a piece of muslin cloth fixed by a rubber band, then all dishes were randomly placed on a wooden table in a room with a temperature of (28 ±2°C) and under a light bulb with a capacity of (100 watts) and a light period of 16 hours per day. The number of predatory whitefly nymphs was counted daily by each ladybird larva until they Moult to the next phase. The same for procedures were performed above in the later larval ages and until the larvae enter the pupal stage.

2.2.1.2 The thirteen- spotted ladybird H. variegate

It was followed the same steps of the experiment mentioned in (2-2-1-1) except replacing the seven- spotted ladybird larvae, C. septempunctata L, with the thirteen- spotted ladybird larvae H. variegate.

2.3 Statistical analysis

The experiments were designed according to a Complete Randomized Design (C.R.D), and the results were analyzed using the ANOVA Table. The averages were compared using the Least Significant Differences (L.S.D) under the significance level (0.05) to test the significance of the results [11].
3. Results and Discussion

3.1 Predation efficiency for predatory ladybirds

3.1.1 Effect of different densities of whitefly nymphs on predation efficiency of seven-spotted ladybird larvae 
*C. Septmpunctata* L.

Table (1) showed that there is a direct relationship between the number of predation whitefly nymphs by the different larval stages of the seven-spotted predatory ladybird, where the number of predation whitefly nymphs increases with the increase in the whitefly density the nymphs equipped for each larval age, and that the least number of predation whitefly nymphs is before the first instar larvae of the seven-spotted ladybird *C. Septmpunctata*, it was 5.40 nymphs at a density of 2 whitefly nymphs/larva/day, while the highest average of predation whitefly nymphs was 53.80 nymphs at a density of 64 whitefly nymphs/larva/day for the same The first larval stage and significant differences. As for the larvae of the second and third instar, the least number of predation whitefly nymphs is 6.60 and 7.40 nymphs of the whitefly at a density of 2 nymphs/larva/day. While the highest number of predation whitefly nymphs for the second and third instars was 52.80 and 85.40 nymphs, respectively, at the density of 64 nymphs/larva/day for the same larval stage of the ladybird with significant differences. As for the fourth larval instar of this type of predation ladybirds, its consumption of whitefly nymphs was greater than the rest of the larval instars. The lowest rate of predation whitefly nymphs reached 46.00 at a density of 4 nymphs/larva/day. While the highest rate of predation whitefly nymphs was 160.40 whitefly nymphs at density 64 nymphs/larva/day for the same fourth larval instar with significant differences.

**Table 1.** Effect of different densities of whitefly nymphs on predation efficiency of seven-spotted ladybird larvae 
*C. Septmpunctata*. L.

| The number of whitefly nymphs supplied per day for each ladybug larvae | Average number of predation whitefly nymphs by each larval age |
| --- | --- |
| 0 (Control) | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | 5.40 | 6.60 | 7.40 | 0.00 |
| 4 | 7.60 | 8.20 | 12.40 | 46.00 |
| 8 | 9.60 | 14.20 | 21.00 | 81.80 |
| 16 | 15.20 | 27.60 | 38.00 | 128.40 |
| 32 | 33.60 | 45.80 | 55.60 | 142.80 |
| 64 | 53.80 | 52.80 | 85.40 | 160.40 |
| l.s.d. | 1.83 | 3.14 | 4.02 | 2.75 |

3.1.2 Effect of different densities of whitefly nymphs on predation efficiency of the thirteen-spotted larvae of the predation ladybird *H. variegata*

Table (2) shows that the total number of whitefly nymphs preyed by the first, second, and third larvae instar of the thirteen-spotted ladybird *H. variegate* was 5.40, 6.60, and 7.40 whitefly nymphs, respectively, at a density of 2 nymphs/larva/day compared with 48.60 and 51 40, 73.60 and 131.20 whitefly nymphs for the first, second, third and fourth larval instar, respectively, at a density of 64 nymphs/larva/day. When comparing the results of the seven-spotted ladybird *C. Septmpunctata*. L with the results of the thirteen-spotted ladybird *H. variegate*, it was found that the total number of whitefly nymphs preyed by the larva of a different instar of the seven-spotted ladybird *C. Septmpunctata*. L is more than that of the thirteen-spotted ladybird, *H. variegate* point. This discrepancy in the results may be due to the difference in the period of the different larval instar of insects and may be due to the obtaining of whitefly nymphs of homogeneous sizes, which means that there are differences in the basic food quantity necessary for development and growth, and this is reflected in the total of predation nymphs by the larvae of predation ladybirds. [12], indicated that predation ladybirds positively select their available prey with good food quality and reject prey with poor nutritional quality, referring to the role of experience and expertise in the predator. Therefore, these results are consistent with the memorandum of [13-15], that the consumption rate of seven-spotted ladybird larvae increases with the increase in the density of daily processed aphids.
Table 2. Effect of different densities of whitefly nymphs on predation efficiency of thirteen- spotted ladybird larvae *H. variegate*.

| The number of whitefly nymphs daily supplied for each ladybug larvae | Average number of predation whitefly nymphs by each larval age (per adult) | Length of duration survival (day) |
|---|---|---|
| | First instar | Second instar | Third instar | Fourth instar |
| 0 (Control) | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | 6.40 | 6.40 | 7.46 | 0.00 |
| 4 | 8.40 | 8.80 | 10.40 | 0.00 |
| 8 | 12.40 | 15.00 | 16.20 | 39.20 |
| 16 | 22.80 | 28.40 | 30.40 | 72.00 |
| 32 | 32.00 | 39.40 | 56.80 | 85.40 |
| 64 | 48.60 | 51.40 | 73.60 | 131.20 |
| l.s.d. | 1.83 | 2.88 | 3.59 | 5.31 |

3.1.3 Effect of different densities of whitefly nymphs on the predation efficiency of males and females of the seven- spotted ladybird *C.Septmpunctata* L

Table (3) shows the total number of whitefly nymphs that were preyed upon by each female and male of the seven- spotted ladybird *C.Septmpunctata* L at the density of 32, 64, and 128 nymphs/adult/day for the female was 866.76, 2088.67, and 4271.05 nymphs/female/day, As for the male, the percentage of predation was less than the female, reached 758.07, 2074.61 and 3776.55 nymphs/male/day, respectively, where both females and males preyed on all the whitefly nymphs presented to them during the experiment period, especially at densities 4-16 nymphs/adult/day. At a high density of 128 nymphs/adult/day, the daily rate of predation of whitefly nymphs by females was the highest in males, reaching 97.96 nymphs/female/day, while it was 88.86 nymphs/male/day. Table (3) also indicated the length of survival for both males and females, as all the adults (female and male) continued to survive until the end of the experiment, while the adult female died after 6.08 days, and the adult males died after 5.78 days when they were left without food in the treatment In general, there is an increase in the survival time of both females and males with an increase in the density of whitefly nymphs prepared daily. The minimum age of the female reached 10.00 days at the density of 4 nymphs/female/day, while An increase in the duration of survival of both female and male reached 43.60 days at the density of 128 nymphs/female/day. While the minimum age of the male reached 10.00 days at the density of 4 nymphs/male/day, while the highest age of the male reached 42.50 days at the density of 128 nymphs/male/day with significant differences.

Table 3. Effect of different densities of whitefly nymphs on predation efficiency and length of survival of male and female seven- spotted ladybirds *C.Septmpunctata*. L.

| Density of daily supplied whitefly nymphs | Average predation nymphs per adult | Daily average of predation per adult | Length of duration survival (day) |
|---|---|---|---|
| | Female | Male | Female | Male | Female | Male |
| 0 (Control) | 0.00 | 0.00 | 0.00 | 0.00 | 6.08 | 5.78 |
| 2 | 4.00 | 4.00 | 4.00 | 4.00 | 10.00 | 10.00 |
| 4 | 152.00 | 136.00 | 8.00 | 8.00 | 19.00 | 17.00 |
| 8 | 352.00 | 336.00 | 16.00 | 16.00 | 22.00 | 21.00 |
| 16 | 866.76 | 758.07 | 30.52 | 29.52 | 28.40 | 25.68 |
| 32 | 2088.67 | 2074.61 | 59.27 | 59.96 | 35.24 | 34.60 |
| 64 | 4271.05 | 3776.55 | 97.96 | 97.52 | 88.86 | 85.40 |
| 128 | 2.60 | 2.59 | 1.14 | 1.00 | 0.65 | 1.01 |
| l.s.d. | 0.00 | 0.00 | 0.00 | 0.00 | 6.08 | 5.78 |

3.1.4 Effect of different densities of whitefly nymphs on the predation efficiency of males and females of the thirteen- spotted ladybird *H. variegate*

Table (4) showed that the effect of different densities of whitefly nymphs on predation efficiency and length of survival duration the thirteen- spotted ladybird *H. variegate*. Where the results were similar with the seven-spotted ladybird *C.Septmpunctata* L although the thirteen-spotted ladybird *H. variegate* is smaller, It reached (4185.42 and 3576.80) for each of the female and male of the thirteen- spotted ladybird *H. variegate*, respectively, while it reached (4271.05 and 3776.55) for each of the female and male with the seven- spotted ladybird *C.Septmpunctata* L. The results indicated that the number of eggs laid by the seven- spotted ladybird and the thirteen- spotted ladybird was 0838.4 eggs for both ladybirds, respectively, during
the experiment period. These results agreed with [3,10], who found that the predation efficiency of female seven-pointed ladybirds is greater than that of males. The reason for the difference in the number of eggs may be due to the chemical composition of the food, which is responsible for the process of laying eggs, and the quality of the nutritional host has an impact on egg production, as well as the different physiological effects of food [9], showed that female predation ladybirds need to store fat in their body to produce eggs, and accordingly they must be equipped with sufficient quantities of proteins and fats in their diet to mature eggs and lay the largest number of eggs [16]. It found that the ovary branches (Ovarioles) of the seven-spotted ladybird C.Septmpunctata. will not mature unless the insect communities reach the critical limit, which is one insect per 200-400 cm of the leaf area.

Table 4. Effect of different densities of whitefly nymphs on predation efficiency and length of survival of male and female thirteen-spotted ladybirds H.variegate.

| The density of daily supplied whitefly nymphs | Average predation nymphs per adult | Daily average of predation per adult | Length of duration survival (day) |
|---------------------------------------------|------------------------------------|------------------------------------|----------------------------------|
|                                             | Male | Female | Male | Female | Male | Female |
| 0 (Control)                                 | 0.00 | 0.00   | 0.00 | 0.00   | 7.74 | 7.22   |
| 2                                           | 40.00 | 40.00 | 4.00 | 4.00   | 10.00 | 10.00  |
| 4                                           | 144.00 | 136.00 | 8.00 | 8.00   | 18.00 | 17.00  |
| 8                                           | 352.00 | 320.00 | 16.00 | 16.00 | 22.00 | 20.00  |
| 16                                          | 780.18 | 640.64 | 28.96 | 26.85 | 26.94 | 23.86  |
| 32                                          | 2195.20 | 1945.88 | 58.57 | 57.81 | 37.48 | 33.66  |
| 64                                          | 4185.42 | 3576.80 | 92.68 | 86.90 | 45.16 | 41.16  |
| 128                                         | 2.37 | 2.88 | 1.83 | 1.77 | 1.22 | 0.98 |
| 1.s.d.                                      | 0.00 | 0.00 | 0.00 | 0.00 | 7.74 | 7.22  |

Conclusions

It was observed that the thirteen-spotted ladybird H.variegate, and the seven-spotted ladybird C.Septmpunctata. L is a density-dependent predator, and its predation efficiency, length of life, and number of eggs laid are affected by the different densities of the whitefly nymphs that are prepared for them daily.

- Male predation ladybirds are less efficient than females.
- The thirteen-spotted ladybird H.variegate is less efficient than the seven-spotted ladybird C.Septmpunctata. L.
- The results showed that the thirteen-spotted ladybird H.variegate and the seven-spotted ladybird C.Septmpunctata. L is an effective control agent against whitefly insects and can be successfully controlled.

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