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HOST SEARCHING BEHAVIOUR OF MAIN INSECT PARASITOIDS ASSOCIATED WITH OLEANDER SCALE, *Aspidiotus nerii* (BOUCHE) (HOMOPTERA: DIASPIDIDAE).

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ABSTRACT

Searching rate, mutual interference, functional response and killing power of two hymenopterous parasitoids (*Encarsia citrina* Craw. and *Habrolepis aspidioti* Comper & Annecke) as bio- control agents against the diaspidid scale, *Aspidiotus nerii* (Bouchē) were estimated, at Mansoura district.

The endoparasitoids, *E. citrina* and *H. aspidioti* showed differences in their searching interfered rates and interfered values with increasing parasitoid density. *Encarsia citrina* females showed relatively higher searching rate in comparison with *H. aspidioti*, while the mutual interference value of *E. citrina* was decreased by increasing parasitoid density in comparison with *H. aspidioti* under laboratory and field condition.

Encarsia citrina females exhibited a weak functional response to increasing host density by laying increasing numbers of eggs. While *H. aspidioti* females exhibited a high positive functional responses to increasing host density.

Encarsia citrina recorded the highest k- value at the lowest host density, while the lowest value was obtained at the highest host density. In respect to *H. aspidioti*, the efficiency of the parasitoid was increased by increasing the host density. However, the killing power (k- value) was increased by host increase.

INTRODUCTION

The oleander scale, *Aspidiotus nerii* (Bouchē) is among the most serious pests of fruit and ornamental orchards in the world as well as in Egypt (El-Minshawy *et al.* 1974, El-Hakeim & Helmy, 1985 and Abd- Rabou, 2001).

Parasitoids as bio- control agents especially species of *Aphytis* and *Encarsia* (Hymenoptera: Aphelinidae) provide an opportunity for significant reduction in their host populations in various agriculture and natural habitats. Many of them possess some of the most important attributes of effective biological control agents. They are rather host specific, are capable of inflicting high mortality in host population, develop several generations to one of their hosts, and are almost free of attack by hyperparasitic. Most significant, they appear to have an excellent searching ability (Rosen & Huffaker, 1983). These have included, *Aphytis lingnanensis* Comp. (Rosen, 1986), *A. melinus* (Alexandrakis & Benassy, 1981), *A. maculicornis* (Masi.) (Havron & Rosen, 1992 and Rochat & Gutierrez, 2001) and *E. citrina* (Viggiani, 1990; Soares *et al.*, 1997; Ofek *et al.*, 1997 and Abd-Rabou, 1999 & 2001).There are some searching characteristics that should be optimized in selecting natural enemies for biological control. They include characteristics which will tend to reduce the average population density of the host (principally the intrinsic searching efficiency) and others which promote stability, such as tendency to aggregate where host density is highest and for interference between the searching natural enemies to modify their behavior (Varley *et al.*, 1973).

Abd El- Kareim (2002) in Egypt, mentioned that the endoparasitoid, *E. citrina* and *H. aspidioti* showed differences in their searching rates and interference values in response to different host species. However, *E. citrina* exhibited higher searching rate on *Lepidosaphes beckii* New. in comparison with *A. nerii*, *Hemiperlesia lataniae* (Signoret) and *Chrysomphalus aonidum* (Ashm.). While *H. aspidioti* showed the same response on *H. lataniae* as compared to *A. nerii* and *Aonidiella aurantii* (Mask.).

The aim of this work is to evaluate searching rate, mutual interference, functional response and killing power of the main parasitoids associated with oleander scale.

MATERIAL AND METHODS

1. Searching rate and mutual interference values:-

Parasitoid sources: To start a culture of each endoparasitoid (*E. citrina* and *H. aspidioti*), parasitized hosts were collected from the experimental farm at Mansoura University. The parasitized hosts were kept in Petri dishes (10 cm in diameter) containing a piece of moistured cotton wool until parasitoid adult emergence. The emerged adults of each species were introduced into groups of pumpkin fruits infested with *A. nerii* inside screen rearing cages. The screen cage consists of a wood box (50 x 40 x 70 cm) covered with fine meshed screen.

1.1. Under laboratory conditions:-

To estimate the searching rate of the two mentioned parasitoids, five densities 1, 3, 5, 7 and 9 individuals were examined by confining 200 hosts of second instar nymphs of *A. nerii* with each parasitoid density in cylinder screen cage for 48 hours. The screen cage consists of an iron cylinder with oval shape base (50 cm diameter and 1 m high). The cylinder was covered with fine meshed screen. The top of the cylinder was closed with a sticky material. Each parasitoid density was replicated four times. After 14 days the number of living and dead insects, as well as those damaged by the parasitoid were recorded.

The searching rate (a_t) was calculated according to the formula of Varley *et al.* (1973) as follow:-

$$a_t = \frac{1}{p} \text{Log}_e \frac{N}{S}$$

Where, P: the number of parasitoids, N: the initial number of hosts, and S: number of hosts not parasitized.

1.2. Under field conditions:-

To estimate the searching rate of the two mentioned parasitoid, five ficus trees relatively homogenous in size and age were chosen and some leaves were artificially infested with *A. nerii* crawlers. The total numbers of crawlers on the leaves were recorded and covered with clear plastic bottles (7.5 cm in diameter and 12 cm height) covered with fine muslien. The bottle neck was closed with a sticky material. Infested leaves were continuously observed in the field. When crawlers developed to second instar nymphs, the parasitoids wasps were introduced in the above bottle for 48 hours. Five parasitoid densities 1, 3, 5, 7, and 9 individuals of each parasitoid were examined by confining 40 hosts of second instar nymphs of *A. nerii*. Each density was replicated four times. After 14 days, the leaves were collected from the tree and taken to the laboratory for counting.

2. Functional response:-

Parasitoids - progeny distributions for *E. citrina* and *H. aspidioti* females were assayed separately on five host densities (50, 100, 150, 200 and 250 second instar nymph, respectively), under laboratory conditions by transferring active females of parasitoid to oleander leaves infested with *A. nerii* nymphs. Each parasitoid female was confined with the host in the cylinder screen cages. Each host density was attacked by a single female parasitoid and replicated three times. The wasps were left in the cage for 48 hours. After 14 days, the numbers of parasitoid progeny were counted and recorded.

3. Killing power:-

To determine the actual efficiency of tested parasitoids, five adjacent ficus trees from the same age and size approximately 2.5 m in hight were selected and marked during summer, 2002 at the experimental farm. Some leaves on each tree were artificially infested with different densities of *A. nerii* crawlers. Infested leaves were covered with clear plastic bottles (7 cm in diameter X 12 cm length) covered with fine muslien. The bottle neck was closed with a sticky material. Infested leaves were continuously observed in the field and when crawlers developed to second instar nymphs, the wasps were released inside the bottle with parasite/ host ratios (1/10, 1/20, 1/30, 1/40 and 1/50). Each ratio was replicated four times. After 14 days the leaves were transferred to the laboratory for investigation. Collected leaves were inspected by using a binocular microscope. The number of living and dead insects, as well as, those parasitized by previously mentioned parasitoids were counted and recorded. The efficiency of parasitoid was estimated as K-value according to Podoler and Rogers (1975) as follows:-

$$K = \log \frac{N}{S}$$

Where, N: the initial number of hosts, and S: number of hosts not parasitized.

RESULTS AND DISCUSSION

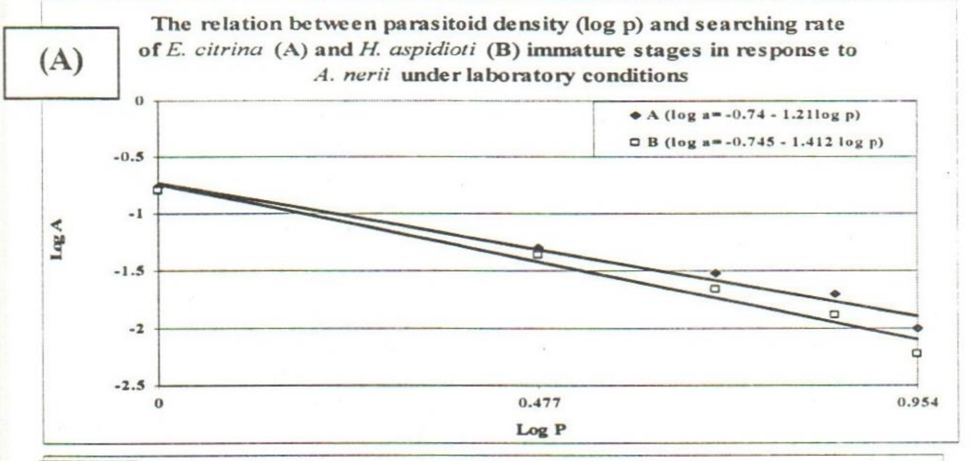
1. Searching rate and mutual interference values:-

1.1. Under laboratory conditions:-

The searching rate of both parasitoids at different host densities under laboratory conditions was illustrated in Fig. 1 (a). *Encarsia citrina* females showed relatively higher searching rate in comparison with *H. aspidioti*. By increasing parasitoid density, the searching rate of *E. citrina* was slightly decreased in comparison with *H. aspidioti*. Mutual interference value of *E. citrina* was (1.21) relatively lower than *H. aspidioti* (1.41). Therefore, by increasing parasitoid density, searching rate per *H. aspidioti* adult was relatively decreased in comparison with *E. citrina*.

1.2. Under field conditions:-

As shown in Figure 1 (b), the searching rate of *E. citrina* was relatively higher than *H. aspidioti* at different host densities. *H. aspidioti* also showed higher mutual interference value (1.53) than *E. citrina* (1.34).



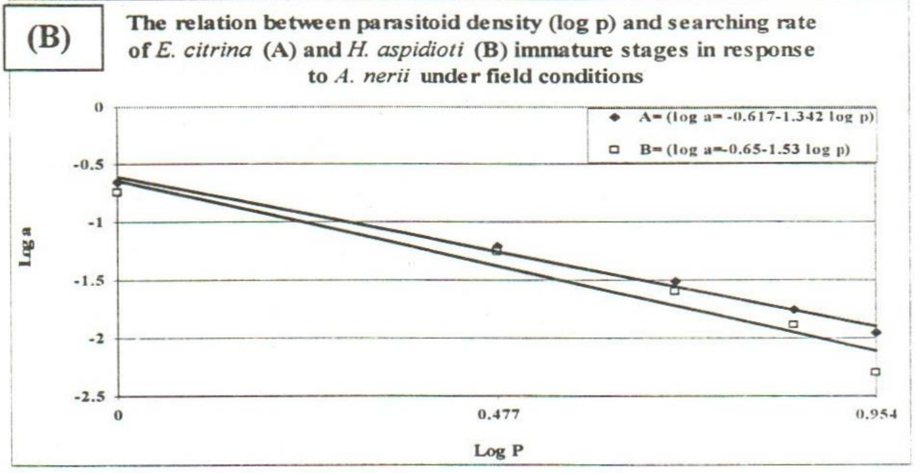


Fig. 1: The relationship between parasitoid density (log p) and searching rate (a_t) of *E. citrina* (A) and *H. aspidioti* (B) in response to *A. nerii* under laboratory (a) and field (b) conditions.

The relationship between parasitoid density (log $_p$) of each parasitoid and searching rate (log a_t) in laboratory and field conditions could be represented by the following formula:

In respect to *E. citrina*:
$\log a_t = -0.74 - 1.211 \log_p$ (under laboratory conditions).
$\log a_t = -0.617 - 1.342 \log_p$ (under field conditions).
In respect to H. aspidioti:
$\log a_t = -0.745 - 1.412 \log_p$ (under laboratory conditions).
$\log a_t = -0.65 - 1.53 \log_p$ (under field conditions).

From the above mentioned formula, the parasitoid *E. citrina* showed relatively higher searching rate and lower mutual interference in comparison with *H. aspidioti* under laboratory and field conditions.

2. Functional response:-

Data illustrated in Fig (2) indicate the efficiency of the parasitoids *E. citrina* and *H. aspidioti* in response to five host densities (50, 100, 150, 200 and 250 individuals of *A. nerii*.

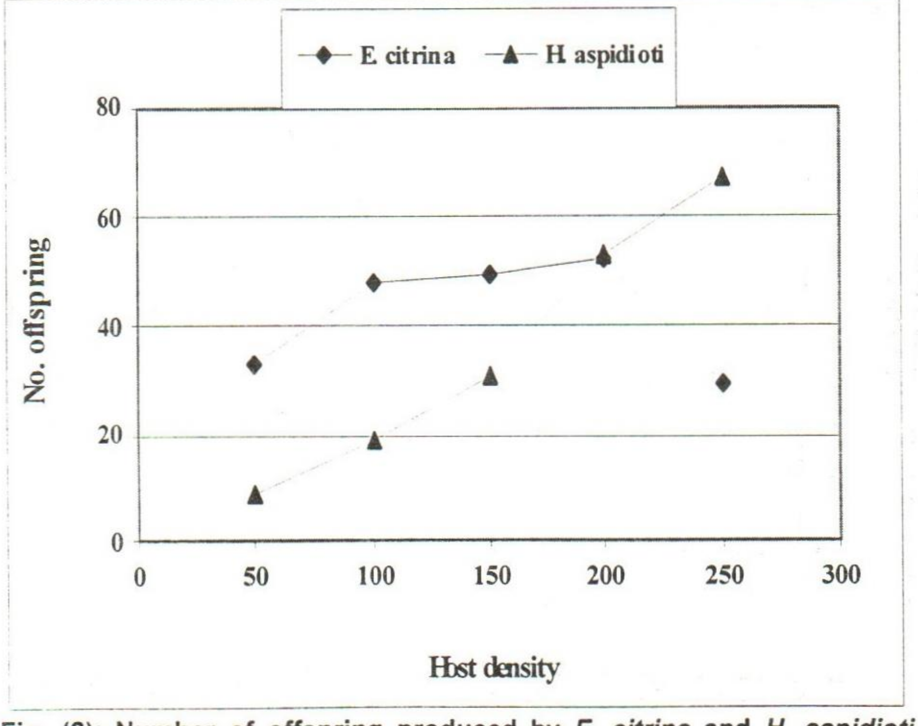


Fig. (2): Number of offspring produced by *E. citrina* and *H. aspidioti* females on different host densities of *A. nerii* under laboratory conditions.

Encarsia citrina female exhibited a weak functional response to increasing host density by laying an increasing numbers of eggs (Fig. 2). The highest numbers of parasitized host were observed at host density (200 individuals), then the numbers of parasitized host were decreased with increasing number of host.

While, *H. aspidioti* female exhibited a highly positive functional response to increasing host density in comparison with *E. citrina* female. The number of eggs laid by *H. aspidioti* female was increased as the parasitoid host increased. However, the highest numbers of offspring was obtained at the highest host density (250 individuals).

5.3. Killing power (Efficiency of the parasitoids):-

The killing power (K- value) of each parasitoid species was estimated and illustrated in response to different host density under field conditions.
As shown in Fig. (3), *E. citrina* recorded the highest k- value (0.40) at the lowest host density, while the lowest value was obtained at the highest host density (0.07).

In respect to *H. aspidioti* (Fig. 3), the efficiency of the parasitoid was increased by increasing the host density. However, k- value was increased as host increase. The parasitoid recorded the highest k- value (0.162) at the highest host density, while the lowest value (0.131) was obtained at the lowest host density.

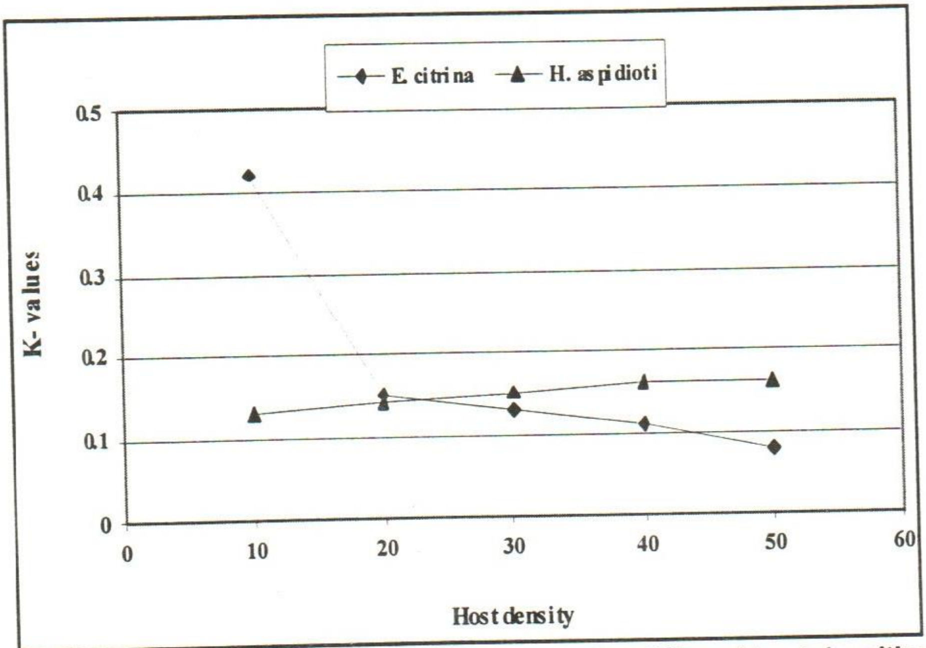


Fig. (3): K- values of *E. citrina* and *H. aspidioti* at different host densities on *A. nerii* under field conditions at Mansoura district.

Encarsia citrina showed relatively higher searching rate with relatively lower interference value on oleander scale at all host densities under laboratory and field conditions in comparison with *H. aspidioti*. These results agree with those of Abd El- Kareim (2002).

All – host parasitoid theories so far developed at least agree on that the higher the searching efficiency with low interference value, the lower average densities of both host and parasitoid population (Varley *et al.*, 1973). Therefore, the parasitoid *E. citrina* promises to be a good bio- agent against oleander scale population.

The female parasitoid *H. aspidioti* female exhibited a high functional response and higher K- value to increasing host density in comparison with *E. citrina*. Similar finding were obtained by Abd El- Kareim (2002).

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سلوك البحث عن العائل لأهم الطفيليات المرتبطة بحشرة الزيتون القشرية الصلبة

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تم تقدير بعض خصائص سلوك البحث عن العائل لأثنين من طفيليات غشائية الاجنحـة هما *Encarsia citrina* و *Habrolepis aspidioti* كعوامل مكافحة بيولوجية ضـد حشرة الزيتون القشرية الصلبة.

أوضحت الطفيليات الداخلية *E. citrina* و*H. aspidioti* أختلافات فى سلوكها البحثى وقيمة التداخل التبادلى مع زيادة كثافة الطفيل. أوضحت أناث طفيل الـ *E. citrina* معدل بحثـى عالى بالمقارنة بطفيل الـ *H. aspidioti* بينما كانت قيم التداخل التبادلى لطفيل الـ *E. citrina* منخفضة مع زيادة كثافة الطفيل بالمقارنة بطفيل الـــ *H. aspidioti* تحـت ظـروف المعمـل والحقل.

أظهرت أنثى طفيل الـ *E. citrina* أستجابة وظيفية ضئيلة مع زيادة كثافة العائل وذلك بوضـع أعداد متزايدة من البيض بينما أظهرت أنثى طفيل الـ *H. aspidioti* أستجابة وظيفيـة موجبـة عالية مع زيادة كثافة العائل.

سجل طفيل الـ *E. citrina* أعلى قيمة للقتل (k- value) عند أقل كثافة للعائل بينمـا كانت أقل قيمة للقتل عند كثافة العائل العالية. أما بالنسبة لطفيل الـ *H. aspidioti* فقد وجـد أن فاعلية الطفيل أزدادت بزيادة كثافة العائل كذلك أزدادت قيمة القتل (k- value) كلما أزدادت كثافة العائل.