

## INFLUENCE OF PREY TYPES ON CERTAIN BIOLOGICAL CHARACTERISTICS OF *Hippodamia tridecimpunctata* L. UNDER CONSTANT TEMPERATURE AND RELATIVE HUMIDITY.

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### ABSTRACT

Laboratory experiments were carried out to study certain biological characteristics of the coccinellid predator, *Hippodamia tridecimpunctata* L. when reared on the following aphid species; *Sitobion avenae* Fabr.; *Rhopalosiphum maidis* (Fitch); *Acyrtosiphon pisum* (Harris) and *Aphis gossypii* Glover under constant temperature and relative humidity.

The data revealed that the total developmental time from egg hatching to adult eclosion of the coccinellid predator was differed significantly when reared on the four tested aphid species. Mortality percentage of *H. tridecimpunctata* from egg hatching to adult emergence ranged from 4.98 % when fed on *A. pisum* to 9.05% on *S. avenae*.

Based on statistical analysis, the mortality percentage showed significant difference among the four aphid species. The total consumption rate per *H. tridecimpunctata* larva from the four aphid species were 695.80±10.75; 781.83±15.68; 612.50±9.55 and 894.53±11.61 aphid individuals when reared on *S. avenae* ; *R. maidis* ; *A. pisum* and *A. gossypii*, respectively. The average number of aphids consumed per larva for the coccinellid predator was also significantly different.

The aphid species have a significant effect on the longevity of adult stage of the coccinellid predator and the fecundity of this female. The average number of eggs deposited per *H. tridecimpunctata* female was 948.29±15.76; 815.67±7.68; 989.54±16.11 and 728.54±6.85 eggs when reared on *S. avenae* ; *R. maidis*; *A. pisum* and *A. gossypii*, respectively. The statistical analysis showed that the aphid species have a highly significant effect on the female fecundity. It can be recommended that the coccinellid predator used as biological control agents against the four aphid species tested.

**Keywords:** Biology, *Hippodamia tridecimpunctata* L.; *Sitobion avenae* Fabr.; *Rhopalosiphum maidis* (Fitch); *Acyrtosiphon pisum* (Harris) and *Aphis gossypii* Glover.

### INTRODUCTION

In recent years much interest has been given to biological control of harmful pests specially predator insects. However, the success of these biological control agents necessitates their presence in sufficient numbers when required. These obstacles can be avoided by theirrearing on natural preys or artificial diets under controlled conitions for biological control of aphids and other soft-bodied insects on several economic crops (Majerus, 1994). Mass production of coccinellid predatory insects in biological control programs requires huge numbers at low costs. It is desirable to choose the

predator, which has short developmental time, a high survival rate and a high reproductive capacity.

Many authors supported the use of safe alternative control methods such as biological control in some cases. Predators as one of the major group of natural enemies play a noticeable role against different insect pests. Predators belonging to family Coccinellidae, comprise one of the most active groups of predatory species, that feed on different sucking pests including aphids, whiteflies, Jassids and mites as well as other soft bodied insect. This family gained the interest of many investigators as important group of predators in the biological control of insect pest attacking different crop plant (Hamed and Hassanein 1984; Fang *et al.* 1984; Goven and Ozgur 1990; Abdel-Samad, 1996; Abney *et al.* 2000; Samban 2003; Delrio *et al.* 2004; Hesler, *et al.* 2004 and Bahy El-Din, 2006).

The efficiency of the coccinellid predator *Hippodamia tridecimpunctata* L. as a biological control agents has been studied by few number of investigators in different parts of the world. (Radriguez and miller 1995; Hafez 2001 Mohamed 2001; and Prasifka *et al.* 2004).

Therefore, this study was undertaken to evaluate the effect prey types on certain biological characteristics of *H. tridecimpunctata* under constant temperature and relative humidity.

## MATERIALS AND METHODS

Experiments were carried out at the laboratory of Economic Entomology Department, Faculty of Agriculture, Mansoura University during the period from March 2010 to May 2011 under  $26\pm 1$  °C and  $65\pm 5.0$  % R.H. . Four aphid species namely, *Sitobion avenae* Fabr. , *Rhopalosiphum maidis* (Fitch), *Acyrtosiphon pisum*, (Harris) and *Aphis gossypii* Glover were used as preys for the coccinellid predator, *H. tridecimpunctata*. The predator and the prey individuals were obtained from a maintained culture in the Insectary.

### Larval experiments :

Newly hatched predator larvae from this coccinellid was put individually in a Petri-dish (10 cm. diameter ) with a filter paper on its bottom. Twenty replicates from *H. tridecimpunctata* was reared on the four aphid species. Known surplus numbers of prey species were offered and the devoured individuals were replaced daily. Attacked prey individuals were counted and recorded daily throughout the periods of the larval instars. The duration period of larval and pupal stages; consumption rate and the percentage mortality were estimated.

### Adult experiments :

After emergence from the pupae, the predator adults were sexed and then introduced singly into a Petri-dish. Known numbers of the four aphids were offered daily on a plant leaflet to each predator. Counting and removing the un-devoured aphids in each Petri-dish were practiced before introducing the new aphid individuals. After five days of emergence, copulation took place and the two sexes were immediately separated and kept singly in the dishes. Daily numbers of laid eggs per predator female during its ovipositional

period was counted. In addition, the total number of eggs laid per predator female was estimated. The daily averages of prey consumption throughout adults longevities were calculated.

**Data analysis :**

Data for the developmental time of immature stages mortality, pre-oviposition, oviposition, post-oviposition periods, fecundity, male longevity, consumption rate of the coccinellid predator reared on the tested aphid species were subjected for one way analysis of variance ( ANOVA), and the means were separated using Duncan's Multiple Range Test ( CoHors Software, 2004 ).

## RESULTS AND DISCUSSION

### Reared on *Sitobion avenae*

#### Immature stages

Data in Table (1) indicated that the incubation period of the predator eggs lasted  $3.46 \pm 0.15$  days. The duration period of the larval stage averaged  $11.74 \pm 1.46$  days. The average of the total consumption during the four larval instars were  $18.53 \pm 1.54$ ,  $70.12 \pm 2.79$ ,  $137.40 \pm 3.85$  and  $469.75 \pm 6.98$  aphid individuals, respectively, and the average of total consumption per larva was  $695.80 \pm 10.75$  aphid individuals. The percentages of feeding capacity for each of the four larval instars of this predator were 2.66, 10.08, 19.75 and 67.51 respectively, Therefore it may be obvious that the third and fourth instar larvae of this predator represent together 87.26 % the back one in predation activity. The percentages of mortality were 10.30, 6.52, 4.75 and 3.62 during the larval instars.

#### Pupal stage.

As clearly shown in Table (1), the pupal period lasted for an average of  $7.46 \pm 1.25$  days.

**Table (1): Duration period of larval and pupal stages, feeding capacity and percentage of mortality for *H. tridecimpunctata* reared on *S. avenae* under constant temperature and relative humidity.**

| Immature stages                  | Duration in days | Daily aver. consumption | Aver. of total consumption | % feeding capacity | % of mortality |
|----------------------------------|------------------|-------------------------|----------------------------|--------------------|----------------|
| <b>A: Eggs incubation period</b> | $3.46 \pm 0.15$  | -                       | -                          | -                  | -              |
| <b>B. Larval stage</b>           |                  |                         |                            |                    |                |
| 1 <sup>st</sup> inst.            | $2.36 \pm 0.42$  | $7.85 \pm 0.87$         | $18.53 \pm 1.54$           | 2.66               | 10.30          |
| 2 <sup>nd</sup> inst.            | $1.92 \pm 0.36$  | $36.52 \pm 2.79$        | $70.12 \pm 2.79$           | 10.08              | 6.52           |
| 3 <sup>rd</sup> inst.            | $2.10 \pm 0.51$  | $65.43 \pm 4.56$        | $137.40 \pm 3.85$          | 19.75              | 4.75           |
| 4 <sup>th</sup> inst.            | $5.36 \pm 0.80$  | $87.64 \pm 6.25$        | $469.75 \pm 6.98$          | 67.51              | 3.62           |
| <b>Total</b>                     | $11.74 \pm 1.46$ | $59.27 \pm 5.37$        | $695.80 \pm 10.75$         | 100                | -              |
| <b>C: Pupal stage</b>            | $7.46 \pm 1.25$  | -                       | -                          | -                  | -              |

**Predator adult stage**

**Female.**

The predators female fed on a total average of 5463.59±60.47 aphid individuals, with a daily rate of 109.53±3.78 during the longevity period of 49.88±3.56 days as seen in Table (2). The average of the pre-oviposition period was 6.89±0.82 days. The predator female consumed during this period 340.36±2.28 with a daily rate of 93.00±2.76 aphid individuals. The predators female consumed during the oviposition period an average 4250.25±46.54 aphid individuals, this period lasted an average of 34.64±2.46 days with a daily rate of 122.70±4.67. The number of deposited eggs per predator female averaged 948.29±15.76 eggs with a daily rate of 27.38±2.4 per day. During the post-oviposition period the female consumed 572.54±7.95 aphid individuals, this period lasted an average of 8.35±1.10 days with a daily rate of 68.57±1.85. The results showed that the feeding capacity of predator female was always higher than that of the male as the female fed on 1.67 times of *S. avenae* more than the male (Table 2).

**Male**

During its longevity period which lasted for an average of 37.24±2.63 days (Table 2). The predator adult male consumed a total average 3265.47±42.56 aphid individuals with a daily rate of 87.69±2.83.

**Table (2): Longevity, feeding capacity and fecundity of the predator *H. tridecimpunctata* adult reared on *S. avenae* under constant temperature and relative humidity.**

| Adult stage      | Period in days | Daily aver. consumption | Aver. of total consumption | No. of eggs |        |
|------------------|----------------|-------------------------|----------------------------|-------------|--------|
|                  |                |                         |                            | Daily       | Total  |
| Female           |                |                         |                            |             |        |
| Pre-oviposition  | 6.89±0.82      | 93.00±2.76              | 640.80±8.29                |             |        |
| Oviposition      | 34.64±2.46     | 122.70±4.67             | 4250.25±46.54              | 27.38       | 948.29 |
| Post-oviposition | 8.35±1.10      | 68.57±1.85              | 572.54±7.95                | ±2.4        | ±15.76 |
| Longevity        | 49.88±3.56     | 109.53±3.78             | 5463.59±60.47              |             |        |
| ♂. Male          |                |                         |                            |             |        |
| Longevity        | 37.24±2.63     | 87.69±2.83              | 3265.47±42.56              |             |        |

**Reared on *Rhopalosiphum maidis***

**Immature stages**

Data in Table (3) showed that the incubation period of the predator eggs lasted 3.54±0.54 days. The duration period of the larval stage averaged 13.17±2.42 days. The average of the total consumption during the four larval instars were 24.92±1.30, 90.35±2.96, 146.72±5.76 and 519.82±9.46 aphid individuals, respectively, and the average of total consumption per larva was 781.83±15.68 aphid individuals. The percentages of feeding capacity for each of the four larval instars of this predator were 3.19, 11.56, 18.77 and 66.48 respectively. Therefore it may be obvious that the third and fourth instar larvae of this predator represent together 85.25 % the back one in predation activity. The percentages of mortality were 10.62, 6.81, 5.10 and 4.27 during the larval instars.

**Pupal stage.**

As clearly shown in Table (3), the pupal period lasted for an average of 7.83±1.32 days.

**Table (3): Duration period of larval and pupal stages, feeding capacity and percentage of mortality for *H. tridecimpunctata* reared on *R. maidis* under constant temperature and relative humidity.**

| Immature stages        | Duration in days | Daily aver. consumption | Aver. of total consumption | % feeding capacity | % of mortality |
|------------------------|------------------|-------------------------|----------------------------|--------------------|----------------|
| Eggs incubation period | 3.54±0.54        | -                       | -                          | -                  | -              |
| B. Larval stage        |                  |                         |                            |                    |                |
| 1 <sup>st</sup> inst.  | 2.54±0.54        | 9.82±0.94               | 24.92±1.30                 | 3.19               | 10.62          |
| 2 <sup>nd</sup> inst.  | 2.16±0.92        | 41.83±2.67              | 90.35±2.96                 | 11.56              | 6.81           |
| 3 <sup>rd</sup> inst.  | 2.37±0.85        | 61.91±4.52              | 146.72±5.76                | 18.77              | 5.10           |
| 4 <sup>th</sup> inst.  | 6.10±1.26        | 85.22±3.42              | 519.82±9.46                | 66.48              | 4.27           |
| Total                  | 13.17±2.42       | 59.36±4.12              | 781.83±15.68               | 100                | -              |
| C:Pupal stage          | 7.83±1.32        | -                       | -                          | -                  | -              |

**Predator adult stage**

**Female.**

The predator female fed on a total average of 6056.06±100.65 aphid individuals, with a daily rate of 129.54±5.62 during the longevity period of 46.75±3.78 days as seen in Table (4). The average of the pre-oviposition period was 7.12±0.80 days. The predator female consumed during this period 694.74±8.56 with a daily rate of 97.58±4.67 aphid individuals. The predators female consumed during the oviposition period an average 4764.62±80.67 aphid individuals, this period lasted an average of 32.78±2.67 days with a daily rate of 145.35±6.45. The number of deposited eggs per predator female averaged 815.67±7.64 eggs with a daily rate of 24.88±1.96 per day. During the post-oviposition period the female consumed 596.70±7.35 aphid individuals, this period lasted an average of 6.85±0.56 days with a daily rate of 87.11±3.62. The results showed that the feeding capacity of predator female was always higher than that of the male as the female fed on 1.75 times of *R. maidis* more than the male (Table 4).

**Male**

During its longevity period which lasted for an average of 34.24±2.96 days (Table 4). The predator adult male consumed a total average 3457.88±70.68 aphid individuals with a daily rate of 100.99±4.22.

**Table (4): Longevity, feeding capacity and fecundity of the predator *H. tridecimpunctata* adult reared on *R. maidis* under constant temperature and relative humidity.**

| Adult stage | Period in days   | Daily average consumption | Aver. total consumption | No. of eggs    |       |
|-------------|------------------|---------------------------|-------------------------|----------------|-------|
|             |                  |                           |                         | Daily          | Total |
| Female      | Pre-oviposition  | 7.12±0.80                 | 97.58±4.67              | 694.74±8.56    |       |
|             | Oviposition      | 32.78±2.67                | 145.35±6.45             | 4764.62±80.67  | 24.88 |
|             | Post-oviposition | 6.85±0.56                 | 87.11±3.62              | 596.70±7.35    | ±1.96 |
|             | Longevity        | 46.75±3.78                | 129.54±5.62             | 6056.06±100.65 | ±7.64 |
| Male        | Longevity        | 34.24±2.96                | 100.99±4.22             | 3457.88±70.68  |       |

**Reared on *Acyrtosiphon pisum***

**Immature stages**

Data in Table (5) indicated that the incubation period of the predator eggs lasted 3.26±0.10 days. The duration period of the larval stage averaged

10.44±1.15 days. The average of the total consumption during the four larval instars were 16.85±1.42, 64.44±3.56, 120.68±5.72 and 410.53±7.56 aphid individuals, respectively, and the average of total consumption per larva was 612.50±8.96 aphid individuals. The percentages of feeding capacity for each of the four larval instars of this predator were 2.75, 10.52, 19.70 and 67.03 respectively, Therefore it may be obvious that the third and fourth instar larvae of the predator represent together 86.73 % the backbone in predation activity. The percentages of mortality were 9.32, 4.64, 3.51 and 2.45 during the larval instars.

#### Pupal stage.

As clearly shown in Table (5), the pupal period lasted for an average of 6.97±1.21 days.

**Table (5): Duration period of larval and pupal stages, feeding capacity and percentage of mortality for *H. tridecimpunctata* reared on *A. pisum* under constant temperature and relative humidity.**

| Immature stages        | Duration in days | Daily aver. consumption | Ave. of total consumption | % feeding capacity | % of mortality |
|------------------------|------------------|-------------------------|---------------------------|--------------------|----------------|
| Eggs incubation period | 3.26±0.10        | -                       | -                         | -                  | -              |
| Larval stage           |                  |                         |                           |                    |                |
| 1 <sup>st</sup> inst.  | 2.08±0.60        | 8.10±0.97               | 16.85±1.42                | 2.75               | 9.32           |
| 2 <sup>nd</sup> inst.  | 1.54±0.23        | 41.84±2.67              | 64.44±3.56                | 10.52              | 4.64           |
| 3 <sup>rd</sup> inst.  | 1.97±0.35        | 61.26±4.25              | 120.68±5.72               | 19.70              | 3.51           |
| 4 <sup>th</sup> inst.  | 4.85±0.90        | 84.65±5.62              | 410.53±7.56               | 67.03              | 2.45           |
| Total                  | 10.44±1.15       | 58.67±3.26              | 612.50±8.96               | 100                | -              |
| C:Pupal stage          | 6.97±1.21        | -                       | -                         | -                  | -              |

#### Predator adult stage

##### Female.

The predator female fed on a total average of 4933.73±25.67 aphid individuals, with a daily rate of 96.17±3.62 during the longevity period of 51.30±2.96 days as seen in Table (6). The average of the pre-oviposition period was 6.53±0.86 days. The predator female consumed during this period 587.34±3.56 with a daily rate of 89.94±1.75 aphid individuals. The predators female consumed during the oviposition period an average 3925.74±18.64 aphid individuals, this period lasted an average of 35.67±1.78 days with a daily rate of 110.06±2.89. The number of deposited eggs per predator female averaged 989.54±12.57 eggs with a daily rate of 27.74±2.12 per day. During the post-oviposition period the female consumed 420.65±2.75 aphid individuals, this period lasted an average of 9.10±0.97 days with a daily rate of 46.26±1.25. The results showed that the feeding capacity of predator female was always higher than that of the male as the female fed on 1.72 times of *A. pisum* more than the male (Table 6).

##### Male

During its longevity period which lasted for an average of 36.27±2.10 days (Table 6). The predator adult male consumed a total average 2874.76±18.11 aphid individuals with a daily rate of 79.26±2.75.

**Table (6): Longevity, feeding capacity and fecundity of the predator *H. tridecimpunctata* adult reared on *A. pisum* under constant temperature and relative humidity.**

| Adult stage |                  | Period in days | Daily aver. consumption | Aver. of total consumption | No. of eggs |        |
|-------------|------------------|----------------|-------------------------|----------------------------|-------------|--------|
|             |                  |                |                         |                            | Daily       | Total  |
| Female      | Pre-oviposition  | 6.53±0.86      | 89.94±1.75              | 587.34±3.56                |             |        |
|             | Oviposition      | 35.67±1.78     | 110.06±2.89             | 3925.74±18.64              | 27.74       | 989.54 |
|             | Post-oviposition | 9.10±0.97      | 46.26±1.25              | 420.65±2.75                | ±2.12       | ±12.57 |
|             | Longevity        | 51.30±2.96     | 96.17±3.62              | 4933.73±25.67              |             |        |
| Male        | Longevity        | 36.27±2.10     | 79.26±2.75              | 2874.76±18.11              |             |        |

**Reared on *Aphis gossypii***

**Immature stages**

Data in Table (7) showed that the incubation period of the predator eggs lasted 3.35±0.12 days. The duration period of the larval stage averaged 13.81±1.84 days. The average of the total consumption during the four larval instars were 27.84±1.76, 89.72±2.85, 180.35±4.26 and 596.62±7.52 aphid individuals, respectively, and the average of total consumption per larva was 894.53±11.61 aphid individuals. The percentages of feeding capacity for each of the four larval instars of this predator were 3.11, 10.03, 20.16 and 66.70 respectively, Therefore it may be obvious that the third and fourth instar larvae of this predator represent together 86.86 % the back one in predation activity. The percentages of mortality were 11.96, 7.64, 5.87 and 4.65 during the larval instars.

**Pupal stage.**

As clearly shown in Table (7), the pupal period lasted for an average of 8.26±1.42 days.

**Table (7): Duration period of larval and pupal stages, feeding capacity and percentage of mortality for *H. tridecimpunctata* reared on *A. gossypii* Glover under constant temperature and relative humidity.**

| Immature stages       | Duration in days | Daily aver. consumption | Aver. of total consumption | % feeding capacity | % of mortality |
|-----------------------|------------------|-------------------------|----------------------------|--------------------|----------------|
| Eggs                  |                  |                         |                            |                    |                |
| Incubation period     | 3.35±0.12        | -                       | -                          | -                  | -              |
| Larval stage          |                  |                         |                            |                    |                |
| 1 <sup>st</sup> inst. | 2.94±0.65        | 9.47±0.96               | 27.84±1.76                 | 3.11               | 11.96          |
| 2 <sup>nd</sup> inst. | 2.10±0.49        | 42.72±2.54              | 89.72±2.85                 | 10.03              | 7.64           |
| 3 <sup>rd</sup> inst. | 2.35±0.54        | 76.74±3.78              | 180.35±4.26                | 20.16              | 5.87           |
| 4 <sup>th</sup> inst. | 6.42±0.96        | 92.93±5.35              | 596.62±7.52                | 66.70              | 4.65           |
| Total                 | 13.81±1.84       | 64.77±3.16              | 894.53±11.61               | 100                | -              |
| C:Pupal stage         | 8.26±1.42        | -                       | -                          | -                  | -              |

**Predator adult stage**

**Female.**

The predator female fed on a total average of 6608.86±48.56 aphid individuals, with a daily rate of 125.79±3.84 during the longevity period of 52.54±4.09 days as seen in Table (8). The average of the pre-oviposition period was 7.32±0.96 days. The predator female consumed during this period 819.42±5.78 with a daily rate of 111.94±3.58 aphid individuals. The predators

female consumed during the oviposition period an average  $5142.17 \pm 26.56$  aphid individuals, this period lasted an average of  $36.26 \pm 3.11$  days with a daily rate of  $141.81 \pm 7.67$ . The number of deposited eggs per predator female averaged  $728.54 \pm 6.85$  eggs with a daily rate of  $20.09 \pm 1.56$  per day. During the post-oviposition period the female consumed  $647.27 \pm 4.80$  aphid individuals, this period lasted an average of  $8.96 \pm 0.45$  days with a daily rate of  $72.24 \pm 2.50$ . The results showed that the feeding capacity of predator female was always higher than that of the male as the female fed on 1.67 times of *A. gossypii* more than the male (Table 8).

**Male**

During its longevity period which lasted for an average of  $38.72 \pm 2.96$  days (Table 8). The predator adult male consumed a total average  $3948.12 \pm 32.67$  aphid individuals with a daily rate of  $86.47 \pm 2.85$ .

**Table (8): Longevity, feeding capacity and fecundity of the predator *H. tridecimpunctata* adult reared on *A. gossypii* Glover under constant temperature and relative humidity.**

| Adult stage |                  | Period in days   | Daily aver. consumption | Aver. of total consumption | No. of eggs |            |
|-------------|------------------|------------------|-------------------------|----------------------------|-------------|------------|
|             |                  |                  |                         |                            | Daily       | Total      |
| Female      | Pre-oviposition  | $7.32 \pm 0.96$  | $111.94 \pm 3.58$       | $819.42 \pm 5.78$          |             |            |
|             | Oviposition      | $36.26 \pm 3.11$ | $141.81 \pm 7.67$       | $5142.17 \pm 26.56$        | $20.09 \pm$ | $728.54$   |
|             | Post-oviposition | $8.96 \pm 0.45$  | $72.24 \pm 2.50$        | $647.27 \pm 4.80$          | $1.56$      | $\pm 6.85$ |
|             | Longevity        | $52.54 \pm 4.09$ | $125.79 \pm 3.84$       | $6608.86 \pm 48.56$        |             |            |
| Male        | Longevity        | $38.72 \pm 2.96$ | $86.47 \pm 2.85$        | $3948.12 \pm 32.67$        |             |            |

**Effect of prey types on the developmental time of immature stage:**

Data in (Table 9 and Figure 1) indicated that the incubation period of *H. tridecimpunctata* varied from  $3.26 \pm 0.10$  to  $3.54 \pm 0.54$  days with significant difference among the four tested aphid species. Considering the developmental time of larval instars, the shortest developmental time was obtained when larvae reared on *A. pisum* ( $10.44 \pm 1.15$  days), while the longest time was recorded on *A. gossypii* ( $13.84 \pm 1.84$  days). The developmental of larval instars showed a significant variation among the four aphid species (Table 9 and Figure 1). Among the tested aphid species, there were significant differences between developmental times of pupal stage. The longest time was observed with *A. gossypii*, while the shortest time was obtained with *A. pisum*. The total developmental time (from egg hatching to adult eclosion) was ranged from  $20.67 \pm 2.10$  days by rearing on *A. pisum* to  $25.42 \pm 3.25$  days by feeding on *A. gossypii* with significantly differed. Mortality percentage from egg to adult ranged from 4.98 % when reared on *A. pisum* to 9.05 % with *S. avenae*. There were significant variations among the four tested aphid species. These findings agree with that of Lotfalizadeh et al., (2000) who found that the larval stage period was 20.97 days and the pupal period lasted 6.13 days when reared on *P. vovae*. Bahy El-Din (2006) found that, the total larval durations *H. convergens* were 12.91; 12.04; 10.78 and 8.84 days when fed on 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> nymphal instars of *A. craccivora*. The respective total developmental period was 21.55; 20.8; 19.49 and 17.56 days



Table (9): Developmental time of the immature stages of *H. tridecimpunctata* predator reared on certain aphid species under constant temperature and relative humidity.

| Prey species       | Incubati on period | Larval Instars  |                 |                 |                 |                 | Pupal stage   | Total of immature stages | Mortality % |
|--------------------|--------------------|-----------------|-----------------|-----------------|-----------------|-----------------|---------------|--------------------------|-------------|
|                    |                    | 1 <sup>st</sup> | 2 <sup>nd</sup> | 3 <sup>rd</sup> | 4 <sup>th</sup> | Total           |               |                          |             |
| <i>S. avenae</i>   | 3.46±<br>0.15a     | 2.36±<br>0.42b  | 1.9±<br>0.36a   | 2.1±<br>0.51a   | 5.36±<br>0.80b  | 11.74±<br>1.46c | 7.4±<br>1.25b | 22.66±<br>2.96c          | 9.05a       |
| <i>R. maidis</i>   | 3.54±<br>0.54a     | 2.54±<br>0.92a  | 2.1±<br>0.82a   | 2.3±<br>0.85a   | 6.10±<br>1.26a  | 13.17±<br>2.42b | 7.8±<br>1.32b | 24.54±<br>2.98b          | 6.70c       |
| <i>A. pisum</i>    | 3.26±<br>0.10b     | 2.08±<br>0.60c  | 1.5±<br>0.23b   | 1.9±<br>0.35a   | 4.85±<br>0.90c  | 10.44±<br>1.15d | 6.9±<br>1.21c | 20.67±<br>2.10d          | 4.98d       |
| <i>A. gossypii</i> | 3.35±<br>0.12b     | 2.94±<br>0.65a  | 2.1±<br>0.49a   | 2.3±<br>0.54a   | 6.42±<br>0.96a  | 13.84±1.<br>84a | 8.2±<br>1.42a | 25.42±<br>3.25a          | 7.53b       |

Means followed by the same letter in a column for each coccinellid predator are not significantly different at the 1 % level of probability (Duncan's Multiple Range Test).

**Feeding capacity:**

Data in (Table 10 and Figure 1) showed the consumption period rate of *H. tridecimpunctata* larval instars when reared on four aphid species. The average number of aphids consumed during first instar larvae varied from 16.85±1.42 individuals of *A. pisum* to 27.84±1.76 individuals of *A. gossypii*. Consumption percentage differed between 2.66 % on *S. avenae* to 3.19 % on *R. maidis*. There were apparent differences in average numbers of the four consumed aphid species and consumption percentage by the second instar larvae. In addition, the same trend was obtained with the third and fourth instars larvae. The total consumption rate from the four aphid species by the larval stage of *H. tridecimpunctata* showed significant difference. Concerning to the food preference for predator larvae among tested aphid species, *A. gossypii* came first, followed by *R. maidis*, *S. avenae* and *A. pisum*. The average number of consumed aphid per larvae was also significantly different.

Table (10): Mean numbers consumed and percentage from different aphid species during larval instars of *H. tridecimpunctata* under constant temperature and relative humidity.

| Prey species       | Larval Instars  |       |                 |        |                  |        |                  |        | Total             |
|--------------------|-----------------|-------|-----------------|--------|------------------|--------|------------------|--------|-------------------|
|                    | 1 <sup>st</sup> |       | 2 <sup>nd</sup> |        | 3 <sup>rd</sup>  |        | 4 <sup>th</sup>  |        |                   |
|                    | No.             | %     | No.             | %      | No.              | %      | No.              | %      |                   |
| <i>S. avenae</i>   | 18.53±<br>1.54c | 2.66b | 70.12±<br>2.79b | 10.08b | 137.40±<br>3.85c | 19.75b | 469.75±<br>6.98c | 67.51a | 695.80±<br>10.75c |
| <i>R. maidis</i>   | 24.92±<br>1.30b | 3.19a | 90.35±<br>2.96a | 11.56a | 146.72±<br>5.76b | 18.77c | 519.82±<br>9.46b | 66.48b | 781.83±<br>15.68b |
| <i>A. pisum</i>    | 16.85±<br>1.42d | 2.75b | 64.44±<br>3.56c | 10.52b | 120.68±<br>5.72d | 19.70b | 410.53±<br>7.56d | 67.03a | 612.50±<br>9.55d  |
| <i>A. gossypii</i> | 27.84±<br>1.76a | 3.11a | 89.72±<br>2.85a | 10.03b | 180.35±<br>4.26a | 20.16a | 596.62±<br>7.52a | 66.70b | 894.53±<br>11.61a |

Means followed by the same letter in a column for each coccinellid predator are not significantly different at the 1 % level of probability (Duncan's Multiple Range Test).

**Longevity and fecundity of adult stage:**

Data in (Table 11 and Figure 2) showed that the mean male longevity of this predator was significantly longer when fed on *A. gossypii*, than when

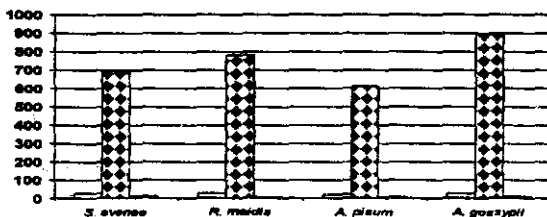
reared on *A. pisum*, and shortest on *S. avenae* and *R. maidis*. Concerning the female, there were significant differences in the total longevity periods of *H. tridecimpunctata* when reared on the tested aphid species (Table 11). Also, the aphid species have a significant effect on female fecundity. The highest numbers of eggs were obtained when females fed on *A. pisum* followed by *S. avenae* and *R. maidis*, while the lowest numbers were achieved on *A. gossypii* (Table 11 and Figure 2). Remzi and Bora (2002), indicated that the total number of eggs per female was 428.5 which lasted 75.3 days. Whereas Hafez, (2001) found that daily rate of *S. graminum* consumption by adult of *H. tridecimpunctata* was 34.24 individuals for female at 22.5°C. Mohamed (2001) found that *H. tridecimpunctata* fed on *A. craccivora* female consumed 108.46;122.57 and 81.56 preys during pre-ovipositional; ovipositional and post-ovipositional periods respectively. Saleh (2005) recorded that the number of eggs were 310.75 ± 11.64 eggs during the oviposition period which lasted 32.85 ± 2.97 days. El-Heneidy et al. (2008) recorded that the total life time fecundity of 880 eggs/ female for *H. convergens* when fed on *A. craccivora*. Mandoure (2009) found that *H. pruni* was suitable for development and reproduction of *H. convergens*. Abd El-Motaal(2011) reported that the total fecundity of *H. convergens* females were 1030.10; 1063.30 and 1010.20 eggs when reared on *A. craccivora*; *H. pruni* and *R. padi*.

**Table (11): Longevity, feeding capacity and fecundity of *H. tridecimpunctata* reared on four aphid species under controlled conditions and relative humidity.**

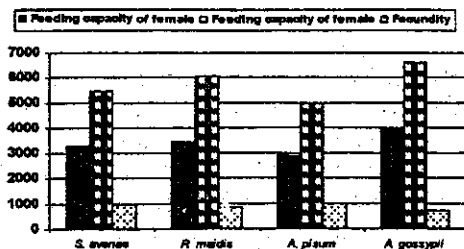
| Aphid species      | Female longevity |                 |                |                 | Male longevity  | Ave. of total consumption |                    | Female fecundity |                   |
|--------------------|------------------|-----------------|----------------|-----------------|-----------------|---------------------------|--------------------|------------------|-------------------|
|                    | Pre-ovip.        | Oviposition     | Post-ovip.     | Total           |                 | Female                    | Male               | Daily            | Total             |
| <i>S. avenae</i>   | 6.89±<br>0.82b   | 34.64±<br>2.46c | 8.35±<br>1.10c | 49.88<br>±3.56b | 34.24±<br>2.63c | 5463.59±<br>60.47c        | 3265.47±<br>42.56c | 27.38<br>±2.4b   | 948.29<br>±15.76b |
| <i>R. maidis</i>   | 7.12±<br>0.80a   | 32.78±<br>2.67d | 6.85±<br>0.56d | 46.75<br>±3.78c | 34.24±<br>2.96c | 6056.06±<br>100.65b       | 3457.88±<br>70.68b | 24.88<br>±1.96c  | 815.67<br>±7.68c  |
| <i>A. pisum</i>    | 6.53±<br>0.86b   | 35.67±<br>1.78b | 9.10±<br>0.97a | 51.3±<br>2.96ab | 36.27±<br>2.10b | 4933.73±<br>25.67d        | 2874.76±<br>18.11d | 27.74<br>±2.12a  | 989.54<br>±16.11a |
| <i>A. gossypii</i> | 7.32±<br>0.96a   | 36.26±<br>3.11a | 8.96±<br>0.45b | 52.54<br>±4.09a | 38.72±<br>2.96a | 6608.86±<br>48.56a        | 3948.12±<br>32.67a | 20.09±1.<br>56d  | 728.54<br>±6.85d  |

Means followed by the same letter in a column for each coccinellid predator are not significantly different at the 1 % level of probability (Duncan's Multiple Range Test).

□ Total of immature stage ■ Total consumed % Mortality



**Figure(1): Effect of prey types on certain biological characteristics of *H. tridecimpunctata* immature stages under constant temperature and relative humidity.**



**Figure(2): Effect of prey types on certain biological characteristics of *H. tridecimpunctata* adults under constant temperature and relative humidity.**

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تأثير أنواع الفرائس على بعض الخصائص البيولوجية لأبو العيد نو ثلاثة عشر نقطة *Hippodamia tridecimpunctata* L. تحت درجة حرارة و رطوبة ثابتة

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اجريت تجارب معملية لدراسة بعض الخصائص البيولوجية لمفترس أبو العيد نو ثلاثة عشر نقطة *H. tridecimpunctata* عند تربيته على أنواع المن التالية من الحبوب *Sitobion avenae* Fabr و من الذرة *Rhopalosiphum maidis* (Fitch) و من البسلة *Acyrtosiphon pisum* (Harris) و من القطن *Aphis gossypii* Glover تحت درجة حرارة و رطوبة ثابتة و كانت النتائج المتحصل عليها توضح مدة التطور من قس البيض حتى خروج الحشرات الكاملة لهذا المفترس أظهرت تأثيرا معنويا واضحا عند التربية على أنواع المن السابقة كما أن النسبة المئوية للموت لهذا المفترس من قس البيض و حتى خروج الحشرة الكاملة ترواحت بين ٤.٨٩% عند التغذية على من البسلة إلى ٩.٠٥% عند التغذية على من الحبوب و أوضح التحليل الإحصائي اختلافات نسبة الموت معنويا بين أنواع المن الأربعة و لكن النتائج أن معدل الاستهلاك الكلي لكل يرقة من المفترس لأنواع المن الأربعة كانت كالآتي ١٠.٧٥±١٩٥.٨ و ١٠.٧٥±٧٨١.٨٣ و ٩.٥٥±٦١٢.٥ و ١١.٦١±٨٩٤.٥٣ فرد من المن عند التربية على من الحبوب و من الذرة و من البسلة و من القطن على التوالي و كان متوسط عدد المن المستهلك لكل يرقة لهذا المفترس مختلف معنويا لأنواع المن الأربعة السابقة كما أثرت أنواع المن المختلفة تأثيرا معنويا على فترة حياة لطور الكامل لهذا المفترس كذلك للكفاءة التناسلية لإنائه فكان متوسط عدد البيض الذي تم وضعه للأنثى ١٥.٧٦±٩٤٨.٢٩ و ٧.٧٨±٨١٥.٦٧ و ١٦.١١±٩٨٩.٥٤ و ٦.٨٥±٧٢٨.٥٤ بيضة عند التربية على من الحبوب و من الذرة و من البسلة و من القطن على التوالي و أكد التحليل الإحصائي أن أنواع المن الأربعة التي تم دراستها كان تأثيرها على المعنوية على الكفاءة التناسلية للإناث و توضح للنتائج أن من البسلة كان أفضل أنواع المن المختبرة لهذا المفترس حيث وضعن إبنائه أكبر كمية من البيض عليه لذلك ننصح بأن مفترس أبو العيد نو ثلاثة عشر نقطة *H. tridecimpunctata* يمكن استخدامه كعنصر من عناصر مكافحة البيولوجية لأنواع المن الأربعة

قلم بتحكيم البحث

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