Journal of Biological Control, 33(4): 321-325, 2019, DOI: 10.18311/jbc/2019/23197

Research Article

Food preference of *Coccinella septempunctata* (Coleoptera: Coccinellidae) winged and wingless forms of *Aphis fabae* and *Myzus persicae* (Hemiptera: Aphididae)

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ABSTRACT: Prey preference of natural enemies is an important parameter used in studies on their efficiency. Feeding preferences of individuals of *Coccinella septempunctata* (L.) (Coleoptera: Coccinellidae) for the essential prey items, winged and wingless *Aphis fabae* (Scopoli) and *Myzus persicae* (Sulzer) (Hemiptera: Aphididae) were evaluated in the laboratory using Manly's preference index. For the *C. septempunctata* prey preference experiment, equal number of winged and wingless *A. fabae* and *M. persicae* were offered to the predator adult stage. The experiment was conducted with 10 replicates. The number of aphids consumed was counted and recorded for every three hours. Two-way analysis of variance was performed to determine the interaction between the consumed aphid and time. In the statistical grouping, the highest consumption was in the first three hours in the wingless individuals, while the lowest consumption was in the 24th winged group. In addition, preferred prey experiments indicated that *C. septempunctata* consumed the wingless ones more than the winged ones. Index values > 0.5 represents preference for wingless while those < 0.5 represent non-preference for aphid species.

KEYWORDS: *Coccinella septempunctata, Aphis fabae, Myzus persicae,* preference, winged and wingless

(Article chronicle: Received: 16-07-2019; Revised: 12-11-2019; Accepted: 25-11-2019)

INTRODUCTION

Aphids (Hemiptera: Aphididae) are among the most destructive insect pests in cultivated plants worldwide (Dawson *et al*., 1990; Dong *et al*., 2011). Due to their asexual and sexual reproduction, they are capable of an extremely rapid increase in numbers (Blackman *et al*., 2000; 2007). In addition, these insects can transmit viruses (Emden *et al*., 1969). The damage they cause can be very significant, and cause real economic problems for producers since crops become unsuitable for consumption (Dedryver *et al*., 2010; Ragsdale *et al*., 2007). Nowadays, chemical control based on systemic insecticides is intensively used, and ensures effective control of aphid populations. However, it is known that use of these pesticides results in major environmental and human costs. Indeed, their repeated use has increased pest resistance (Devonshire *et al*., 1998; Foster *et al*., 2002), raised the levels of residues in harvested products (Harris *et al*., 2000), and polluted both the soil and air (Yano, 2006). These factors have led to increasing interest in the conception of agroecosystems less dependent on agrochemicals. Different alternative strategies for the control of aphids have been proposed in relation to plant physiology (i.e., increases in host plant resistance) and insect life cycle (i.e., conservation biological control) (Rousselin *et al*., 2017). The most important of these is biological control. The most important biological control agent for aphids is *Coccinella septempunctata* (L.) (Coleoptera: Coccinellidae).

Coccinella septempunctata is abundant in a wide range of Eurasian, African and now also North American agroecosystems, preying upon several economically important aphid species. (Majerus, 1994; Hodek and Honek, 1996; Dixon, 2000). When aphids are rare or missing (in early spring or autumn) the aphidophagous coccinellids eat alternative foods (other arthropod prey, fungal spores, pollen and nectar) to supply energy (Triltsch, 1999).

However, they need specific aphid food for egg laying and successful larval development. Hodek and Honek (1996) quoted records of 23 aphid species as essential prey for *C. septempunctata* (Hodek and Honek, 1996; Kalushkov, 1998).

Aphids feeding on some plants of economic value may serve as food in mass rearing of *C. septempunctata* for inundative releases. According to Hodek and Honek (1996) the essential prey is characterized in the safest way by a combination of both observation and experiment. The aim of the reported laboratory experiments and field observations was to determine the quality of 13 species of aphids as food for larvae of *C. septempunctata* by recording their development and mortality. Field observations were carried out to determine which of the aphid species are suitable for larval development of *C. septempunctata* in laboratory experiments and are also natural prey for this species (Hodek and Honek, 1996). We hoped therefore that extensive research could reveal more suitable aphid preys for *C. septempunctata*. This would enhance not only our basic knowledge but also the rational pest management.

However, no study was found investigating the food preference of *C. septempunctata* between the winged and wingless aphids. In this study, the preference of *C. septempunctata* in winged and wingless form of *Myzus persicae* and *Aphis fabae* was determined.

Fig 1. Male sipho (A) and tegmen (B) of *Coccinella septempunctata.*

MATERIALS AND METHODS

Sources of aphids and predators

The aphids used in the experiment were collected from the various plants in the campus area of Uşak University (38°40′10.51″K, 29°19′46.87″D, at an altitude of 915 m) in late May 2018. While a colony of *Aphis fabae* was cultured on broad bean, *Vicia faba* and *Myzus persicae* were cultured on leaves of rose plant, *Rosa* spp. in a laboratory of Entomology for one month. The beetles were identified to species level using characteristics of Aphid Key (Summers, 2001). The ladybirds, *Coccinella septempunctata* were collected as adults from rose plant *Rosa* spp. in Usak Atapark, (38°40′08.78″K, 29°23′57.08″D, at an altitude of 913 m) in May 2018. The beetles were identified to species level using characteristics of male genitalia that have given in Fig. 1. Taxonomic distinction of *C. septempunctata* species was completed according to published literature (Kapur, 1958; Kuznetsov, 1997; Inayatullah *et al*., 2005; Rafi *at al.,* 2005; Ali *et al*., 2012; Ashfaque *et al.,* 2013).

Preference test

A preference test was carried out using adults of *C. septempunctata* for winged and wingless forms (*A. fabae* and *M. persicae*). The aim of this test was to determine their preferred prey and whether this differed for the winged and wingless ones studied. For the choice preference trials, according to the previous experiment, the number of aphids offered was 70% of the potential consumption of each predator (Keshavarz *et al.*, 2015). In each replicate, before use in experiment, *C. septempunctata* of adult was starved for 24 hours. Then, 20 winged and 20 wingless of *A. fabae* were presented to the starved *C. septempunctata* in the Petri dish whose size is 15 x 1x 15 with the help of hair brush. The number of aphids consumed was counted and recorded every three hours. Counts were continued until the aphids were finished. The same operations were done for *M. persicae*. The experiment was carried out with 10 replications.

Data analysis

Statistical analysis was performed on the obtained data. Two-way analysis of variance was performed to determine the interaction between the consumed aphid and the time. In order to determine whether each population of predator preferred *A. fabae or A. gossypii*, Manly's preference index (άp) was calculated based on the number of prey consumed (Manly, 1974):

$$\alpha p = \frac{\ln\left[\frac{n_p - r_p}{n_p}\right]}{\ln\left[\frac{n_p - r_p}{n_p}\right] + \ln\left[\frac{n_u - r_u}{n_u}\right]}$$

Where; np and rp were the initial numbers of different aphid species (*i.e.,* 30), rp and ru were the consumed after 24 h duration, respectively. The preference of adult *C. septempunctata* was calculated. This index gives the value from 0 to 1, where 0.5 indicates no preference.

RESULTS AND DISCUSSION

In the first experiment, winged and wingless forms of *Aphis fabae* were offered to adult females of *Coccinella septempunctata*. The values are given in Fig. 2. According to Fig. 2; 10.50 ± 0.50 *A. fabae* were consumed in the first three hours.The number of consumption in wings of *A. fabae* has been observed to decrease gradually after the first count and it has been found that the number of consumption is at the minimum level on the seventh count (0.2 ± 0.40). The number of consumption of winged individuals of *A. fabae* was found to be relatively lower than wingless individuals of *A. fabae*. According to this the number of consumption of *A. fabae* was found as 6.3 ± 0.71 in the first count, 4.9 ± 0.54 in the second count, 5.5 ± 0.50 in the third count, 4.9 ± 0.83 in the fourth count, 2.6 ± 0.40 in the fifth count, 1.8 ± 0.44 in the sixth count, 1.4 ± 0.30 in the seventh count and 1.7 ± 0.36 in the eighth count.

Two-way analysis of variance; *C. septempunctata* between the number of individuals consumed and time was determined to be important ($F_{1,7}$= 15.817, P = 0.000). In the statistical grouping, the highest consumption was in the first three hours in the wingless individuals, while the lowest consumption was in the 24th in the winged group.

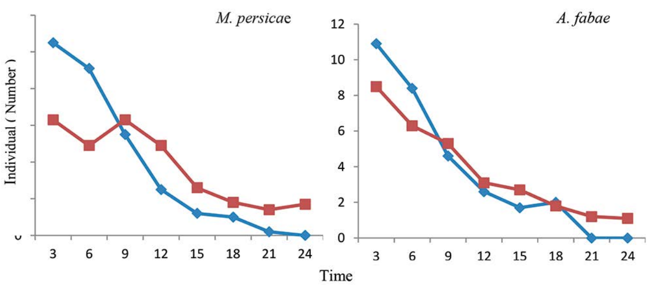

Fig. 2. Number of insects consumed by *Cocccinella smtempunctata* in 24 hours.

It was seen that consumption of *Myzus persicae* was similar to the consumption of *A. fabae*. The number of wingless of *M. persicae* that *C. septempunctata* has consumed in different time intervals are given in Fig. 2. According to this the number of consumption of *M. persicae* was found as 10.9 ± 0.43 in the three hours, 8.4 ± 0.60 in the in the six hours, 4.6 ± 0.37 in the nine hours, 2.6 ± 0.84 in the twelve hours, 1.7 ± 0.30 in the fifteen hours, 2.0 ± 0.63 and in the eighteen hours. In winged individuals 8.50 ± 0.40 *M. persicae* were most consumed in the first three hours. As in *A. fabae*, the number of consumption in the wingless of *M. persicae* has been observed to decrease gradually after the first count and it has been found that the number of consumption is at the minimum level on the sixth count (2.0 ± 0.53). The number of consumption of *M. persicae* on winged individuals was found to be relatively lower than the wingless of *M. persicae* individuals.

As *in A. fabae*; in *M. persicae* two-way analysis of variance; *C. septempunctata* between the number of individuals consumed and time was determined to be important ($F_{1,7}$ = 15.817, P = 0.000). In the statistical grouping, the highest consumption was in the first three hours in the wingless individuals, while the lowest consumption was in the 24th hour in the winged group (Fig. 3).

Fig. 3. *Coccinella septempunctata's* consumption of winged aphids.

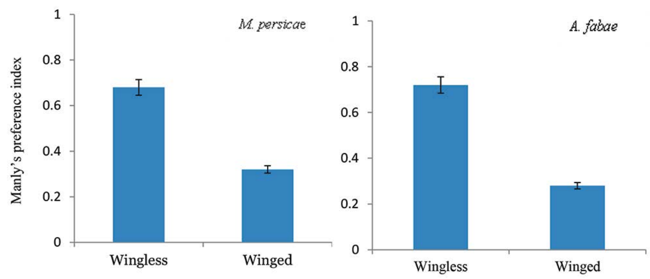

Fig. 4. Manly's preference index of *Cocccinella septempunctata* on *Myzus persicae* and *Aphis fabae.*

The results of the preference experiments indicated that *C. septempunctata* females are fed with winged and wingless forms of aphids, but according the Manly's preference index the wingless ones were consumed by *C. septempunctata* significantly more than the winged ones.Index values > 0.5 represents preference for wingless (Fig. 4), while those < 0.5 represent non preference for aphid species (Fig. 4). This preference for particular species of prey may mean that predators feed on particular species of prey independently of their abundance or accessibility (Nedved and Salvucci, 2008). Predators feed on the different types of prey available so as to maximize the nutritional gain while minimizing the costs and risks associated with predation, thus, when a predator encounters two types of prey it selects the one most likely to maximize its net energy gain (Stephens and Krebs, 1986). The phenomenon by which predators seek, locate and/recognize their suitable/ palatable prey is still unknown. This line of research is wide open and required to resolve complications in recognition and discrimination of prey. The results of Singh and Singh (2013) are in conformity with ours that voracity of *C. septempunctata* increased with the age and predate all stages (Jindal and Malik, 2006; Bilashini and Singh, 2009).

No direct study of winged and wingeless aphids consumed by *C. semtempunctata* was found. However, food preference studies were made in relation to various foods. The relationship between a *C. septempunctata* and four different aphid species (spinach aphid, *A. fabae* coriander aphid, *Hyadaphis coriandri* (Das); cabbage aphid, *Brevicoryne brassicae* L.; pea aphid, *Acyrthosiphon pisum* (Harris) was evaluated in the laboratory in no choice and free choice feeding assays. According to the results obtained larvae that are in 3rd and 4th instar stage consumed more aphids than the ones in 1st and 2nd instar stage. Besides, the consumption of pea aphid was found to be statistically higher followed by spinach, coriander and cabbage aphids and Manly's preference index (Manly, 1974) suggests that pea aphid was the most preferred aphid species followed by coriander, and the cabbage aphid was the least preferred species.

It could be concluded from the present findings that different aphid forms (winged and wingless) had a significant effect on the lifelong consumption by *C. septempunctata*. It is thought that winged aphids are not preferred and that the wings are not eaten because of their low nutritional value. The current study can offer comprehensive information to introduce *C. septempunctata* in biological-based management plans of aphids.

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