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Article

Food preference of *Amblyseius swirskii* (Acari: Phytoseiidae) on different stages of *Tetranychus urticae* (Acari: Tetranychidae) and *Bemisia tabaci* (Hemiptera: Aleyrodidae)

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Abstract

The prey preference of polyphagous predators plays an important role in suppressing different species of herbivorous mites and insects. Prey stages preference of the predatory mite, *Amblyseius swirskii* Athias-Henriot was investigated among egg, protonymph and deutonymph of *Tetranychus urticae* Koch and egg, first and second instar nymphs of *Bemisia tabaci* Gennadius. All experiments were conducted using bean (cultivar: Alamoti) leaf discs in Petri dishes (9 cm in diameter) under laboratory condition with 25±2 °C, 70 ± 5% RH and 16 L: 8 D photoperiod. The preference for female predator was calculated with Manly's preference index (β). Comparison of the preference indices using a t-test showed that *A. swirskii* consumed significantly more eggs than protonymphs and deutonymphs of *T. urticae*. There was also a significant difference between consumed protonymphs and deutonymphs of *T. urticae*. *A. swirskii* consumed significantly more eggs than second instar nymphs of *B. tabaci*. There was a significant difference between first instar nymphs and second instar nymphs of *B. tabaci* and between eggs and first instar nymphs of *B. tabaci*. Our findings suggest that prey stages had effect on the prey selection of *A. swirskii*.

Key words: Biological control; predator; prey stage; spider mite; whitefly.

Introduction

Two-spotted spider mites, *Tetranychus urticae* Koch (Acari: Tetranychidae) and silverleaf whitefly *Bemisia tabaci* Gennadius, B biotype, (Hemiptera: Aleyrodidae) are major pests of greenhouse and farms around the world (Zhang 2003; Xu *et al.* 2012). Chemical control is the most efficient method to control two–spotted spider mite and silverleaf whitefly damages on crops (Prabhaker *et al.* 1985; Immaraju *et al.* 1992; Lietti *et al.* 2005), However, this management approach can be hazardous to water, environment, soil and health of human society (van der Werf 1996; Albajes *et al.* 1999). Therefore, biological control tactics are crucial to manage the populations of two-spotted spider mite and silverleaf whitefly (Gerling *et al.* 2001; Gerson and Weintraub 2007).

Among their predators, phytoseiid mites are effective biological control agents that are commercially used in IPM programs and biological control (Gerson and Weintraub 2012).

Several species of phytoseiid mites are specialists and feed mainly on tetranychid mites but others are generalists and can feed on different types of preys (mites and insects such as thrips and whiteflies) and plant pollens (McMurtry *et al.* 2013). Field observations showed that *Amblyseius swirskii* Athias-Henriot (Acari: Phytoseiidae) is often found in association with phytophagous tetranychid mites, whiteflies and scale insects (Juan-Blasco *et al*. 2012). *Amblyseius swirskii* is a generalist predatory mite (McMurtry *et al.* 2013) and can successfully reduce pest populations such as whiteflies (Messelink *et al.* 2008) and spider mites (Xu and Enkegaard 2010). Preference for different prey stages has been less considered. Thus, evaluate prey preference of *A. swirskii* on the different stages of *T. urticae* and *B. tabaci* which should indicate the predator's discrimination ability and the effect of prey stage on the predation of *A. swirskii* adults, was the purpose of this study.

Materials and Methods

Plants, prey, and predatory mite

The bean plants (*Phaseolus vulgaris* L. var. Alamoti) were grown in perlite and garden soil in greenhouse. The plants were kept at 25±2 °C and photoperiod of 16L: 8D hours. *Bemisia tabaci* (Gennadius) and *T. urticae* were originally collected from a greenhouse at the University of Tehran, Tehran, Iran. *Bemisia tabaci* were reared on bean plants in greenhouse conditions (25±2 °C and photoperiod of 16L: 8D hours). Also, *T. urticae* were reared on bean plants in laboratory at similar conditions as above.

A stock colony of *A. swirskii* was obtained from Koppert Biological Systems Inc., The Netherlands. They were kept in a germinator at 25±5 °C, 50–70 % RH and under a 16L: 8D photoperiod. Almost 85 immature stages of *Tyrophagus putrescentiae* (Schrank) (Acari: Acaridae) and soybean pollen were supplied twice per week as supplementary foods for this predator.

Experimental units

The experiments were accomplished in Petri dish (diameter: 9 cm) contained a bean leaf disc (diameter: 4 cm) placed upside down on the wet sponge (diameter: 5 cm, height: 1 cm). The Petri dish had a hole (2 cm in diameter) in the middle of the lid, which was covered by a piece of fine net to provide ventilation.

The immature stages of *T. urticae* were transferred by fine brush to experimental unites and because *B. tabaci* lays eggs into the leaf tissue and they are not movable, so we cut the leaves of bean which had *B. tabaci* eggs and they were transferred to experimental unites.

Prey stages preference

The prey stages preference of *A. swirskii* was determined using immature stages of *T. urticae* and *B. tabaci*. The three treatments consisted eggs - first instar nymphs (protonymphs); eggs - second instar nymphs (deutonymphs) and first instar nymphs (protonymphs) - second instar nymphs (deutonymphs) of *T. urticae* with densities 20:20 for each treatments and the same as treatments for *B. tabaci* with densities 8:8 for each treatments. The numbers of *T. urticae* and *B. tabaci* offered at each stage of development were 70% of the consumption of each predator in the previous experiments. Same aged

individuals were chosen from the colony and carefully transferred by a fine brush on bean leaf discs with 20 replicates. Then, one single predatory mite, starved for 24 h was released in each experimental unit and allowed to feed. After 24 h of exposure, the predatory mite was removed and the number of consumed prey was recorded for each stage.

Statistical analysis

Prey stages preference of adult female *A. swirskii* was quantified with the index β (Manly 1974).

$$\beta 1 = \frac{Log\left(\frac{e1}{A1}\right)}{Log\left(\frac{e1}{A1}\right) + Log\left(\frac{e2}{A2}\right)}$$

Where β_1 is Manly's beta for each prey stages species 1, *e1* and *e2* are the number of prey type1 and type 2 not selected by the predator, *A1* and *A2* are the number of individuals in prey stages species *1* or *2* available to the predator. For each replicate, β was averaged to produce a mean β for each prey stages species. Preference was assigned a value from 0 to 1, where 0.5 represents the random selection of prey and 1 represents only one prey being taken in cases where the two species were offered at a 1:1 ratio. Treatment means were separated by Student's t-test (Xu and Enkegaard 2010).

Results

Amblyseius swirskii consumed all stages of *T. urticae* and *B. tabaci*. In 24 h, *A. swirskii* females consumed significantly more eggs than protonymphs (t = 46.16, df = 38, $P < 0.0001$) and deutonymphs (t = −46.95, df = 38, $P < 0.0001$) of *T. urticae*. There was also a significant difference between consumed protonymphs and deutonymphs of *T. urticae* (t = −67.85, df = 38, $P < 0.0001$).

Also, *A. swirskii* females consumed significantly more eggs than second instar nymphs of *B. tabaci* (t = −63.84, df = 38, $P < 0.0001$). There was a significant difference between first instar nymphs and second instar nymphs of *B. tabaci* (t = −98.67, df = 38, $P < 0.0001$) and between eggs and first instar nymphs of *B. tabaci* (t = 8.73, df = 38, $P < 0.0001$).

Comparison of the preference indices for *A. swirskii* when offered equal numbers of different stages of *T. urticae* and *B. tabaci* has been shown in Fig. 1.

Discussion

Amblyseius swirskii has a wide prey range and can feed on insect species and several mite species as well as pollen of many plant species (McMurtry *et al.* 2013). The aim of this study was to determine the prey stage preference of *A. swirskii* at constant densities of different stages of *T. urticae* and *B. tabaci* on bean plants. The prey stage preference of a predator is correlated with prey suitability. It means preferred prey can impact on predator fitness and predator–prey dynamic (Xu and Enkegaard 2010).

Our results showed that *A. swirskii* consumed more spider mite eggs than other life stages when given a choice. Similar results were shown by Grafton-Cardwell *et al*. (1997) observed that the phytoseiid predators quickly removed *T. urticae* eggs than other stages. Also our results confirmed that *A. swirskii* consumed more of eggs and first instar nymphs

compared to second instar nymphs of *B. tabaci*. Similar obtained results by Teich (1966) expressed that eggs and first instar nymphs of *B. tabaci* in a laboratory conditions were eaten by *A. swirskii* and *Amblyseius rubini* Amitai and Swirskii (Acari: Phytoseiidae).

The eggs of *T. urticae* may be a more profitable prey stage for *A. swirskii* compared to other stages (Xiao *et al.* 2012). Also the handling time on mite eggs is less than other stages in *Amblyseius largoensis* (Muma) (Acari: Phytoseiidae) (Carrillo and Pena 2012).

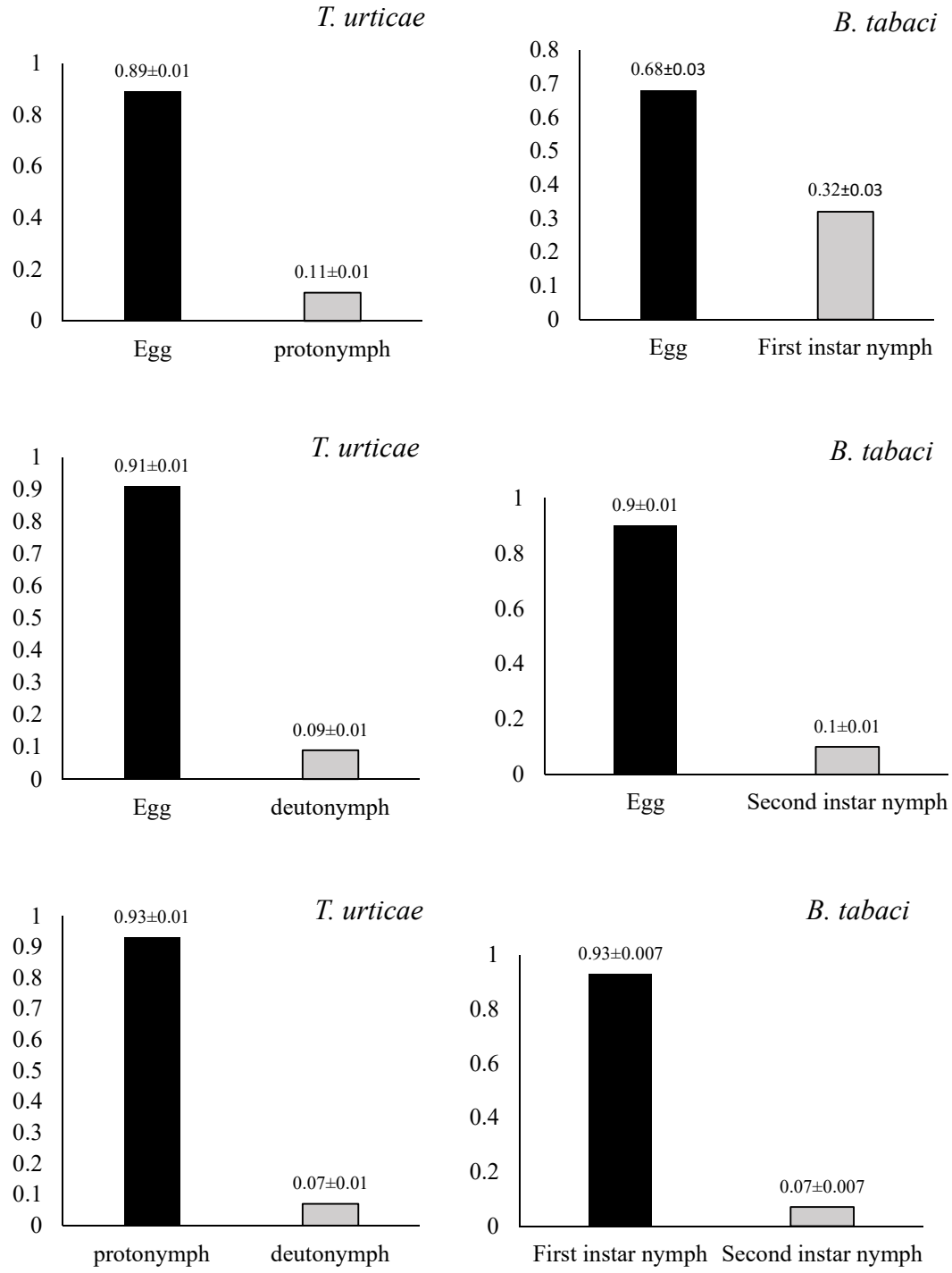

Figure 1. The Manly's preference index for *A. swirskii* when offered equal numbers of different stages of *T. urticae* and *B. tabaci*.

Amblyseius swirskii preferred protonymphs of *T. urticae* compared to deutonymphs due to their less activity and defense and also smaller body size (Xu and Enkegaard 2010). Accordingly, high prey mobility and defensive mechanisms generally reduce the encounter rate, increase handling time, reduce attack success and result in lower prey profitability (Zarghami *et al.* 2014). Also Nomikou *et al.* (2003) expressed that *A. swirskii* consume *B. tabaci* eggs and first instar nymphs and they hardly kill later immature stages and adults, because they are smaller than the later instars. Therefore, from a management point of view, a preference for eggs and first instar nymphs of *T. urticae* and *B. tabaci* could be viewed as a desirable attribute of *A. swirskii*, because they kill their prey before it causes damage to plants.

According to the results, preference of *A. swirskii* depending on the prey stage is probably determined by prey protection mechanism, the size of immature stages and nutritional value of each prey individual (Blackwood *et al.* 2001).

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ترجیح غذایی کنه شکارگر *Amblyseius swirskii* (Acari: Phytoseiidae) روی مراحل مختلف زندگی کنه تارتن *Tetranychus urticae* (Acari: Tetranychidae) و عسلک پنبه *Bemisia tabaci* (Hemiptera: Aleyrodidae)

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چکیده

ترجیح میزبانی نقش مهمی در کاهش جمعیت کنه‌ها و حشرات گیاهخوار توسط شکارگرها ایفا می کند. ترجیح غذایی کنهٔ شکارگر *Amblyseius swirskii* Athias–Henriot روی مراحل مختلف زندگی کنهٔ تارتن *Tetranychus urticae* Koch (تخم، پورهٔ سن یکم و پوره سن دوم) و عسلک پنبه *Bemisia tabaci* Gennadius (تخم، پورهٔ سن یکم و پورهٔ سن دوم) مطالعه شد. تمامی آزمایش‌ها در روی دیسک‌های برگی لوبیا (رقم الموتی) و در تشتک‌های پتری با قطر ۹ سانتی متر در شرایط آزمایشگاهی با دمای ۲ ± ۲۵ درجهٔ سلسیوس و رطوبت نسبی ٪۵ ± ۷۰ و دورهٔ نوری ۱۶ ساعت روشنایی/۸ ساعت تاریکی انجام شد. برای محاسبهٔ شاخص ترجیح میزبانی کنه‌های ماده شکارگر از فرمول شاخص ترجیح میزبانی منلی (بتای منلی) استفاده شد و برای مقایسه شاخص ترجیح میزبانی از روش t تست استفاده شد. نتایج نشان داد که کنه شکارگر به طور معنی‌داری از تخم کنهٔ تارتن نسبت به پورهٔ سن یکم و دوم تغذیه می‌کند. همچنین بین تعداد شکارهای خورده شده از پوره‌های سن یکم و دوم کنه تارتن تفاوت معناداری وجود داشت. در مورد تعداد شکارهای خورده شده از عسلک پنبه تفاوت معناداری بین تخم و پوره سن دوم آن وجود داشت. همچنین بین پورهٔ سن یکم و پورهٔ سن دوم عسلک پنبه تفاوت معناداری مشاهده شد و بین تخم و پورهٔ سن یکم عسلک پنبه نیز تفاوت معناداری وجود داشت. نتایج به دست آمده بر اساس فرمول بتای منلی نشان داد، کنهٔ شکارگر *A. swirskii* به تخم‌ها و پوره‌های سن یکم کنهٔ تارتن و عسلک پنبه ترجیح دارد. یافته‌های این پژوهش

تأیید می‌کند که مراحل زیستی مختلف شکار روی انتخاب توسط شکارگر نقش دارد.

واژگان کلیدی: مهار زیستی، شکارگر، مراحل زیستی شکار، کنه تارتن، سفیدبالک.

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