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Predation efficacy of *Amblyseius swirskii* (Acari:Phytoseiidae) on *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae)

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Abstract

Development and food consumption of the predatory mite *Amblyseius swirskii* (Athias-Henriot) (Acari:Phytoseiidae) when fed on the first instar nymph of cotton mealybug *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) were studied under constant temperature 26℃± 2 and 70 ± 5% RH. The duration of the life cycle of *A. swirskii* was average 9.5 and 6.4 days for females and males, respectively. Females laid 4 eggs during its oviposition period. The duration of life span was 31 and18 days for females and males, respectively. Total prey consumption was 3.82, 2.83, 2.84, 2.11, 6.14, 3.12, 42.51 and, 2.38 individuals of 1st nymphal stage for larvae, protonymph, deutonymph, adult male and adult female, respectively. The female consumed prey more than male and the male developed faster than the female. The results showed there was a reduction in population of *P. solenopsis.*

Introduction

The cotton mealybugs *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae) is a highly invasive and harmful pest. It causes a considerable loss of cotton crops in China, India and Pakistan. It was first recorded in Pakistan and India in 2005. It has spread to 43 countries. Insecticidal control is the primary and dominant practice for this pest and its resistance to commonly used insecticides increasing. Biocontrol agents have strong potential for the management of nymphal instar stages (Waqas *et al*.,2021). *P. solenopsis* infesting maize crop, in Egypt (Abd-El Mageed *et al*.,2020). It infests mulberry trees (*Morus* spp.) which are cultivated throughout the world (Abdel-Razzik, 2018). The pest was recorded to colonize 51 plant species belonging to 19 families (Kedar and Saini, 2015). Chandramani *et al.* (2017). *P. solenopsis* was observed as a major insect pest on ashwagandha.

This pest spreads rapidly on different host plants, which infected 29 host plant species belonging to 16 plant families including field crops, vegetables, ornamentals, weeds and fruits (Abdel-Razzik *et al*., (2015). *P.solenopsis* crinkling, twist and condenses flower, bud, bolls growth and finally it causes yield loss (Sahito *et al*., 2009). In Egypt, the pest was recorded for the first time infesting *Hibiscus* sp. In September 2009 by Abd-Rabou *et al*. (2010).

The predatory mites are beneficial organisms used to control many different plant pests, including phytophagous mites (Knapp *et al*., 2018) in vegetable crops (e.g., Tomatoes, sweet peppers, or cucumbers) and ornamental crops (e.g., Roses; Gerson and Weintraub).

Amlyseius swirskii (Athias-Henriot) (Acari:Phytoseiidae) controls several major ornamental and vegetable pests , including white flies (Calvo *et al*., 2015). Different insect species can be managed by the predaceous mite *A. swirskii* (Riahi *et al*., 2017).

Phytoseiidae species are by far the most important group of commercially available mite biocontrol agents with about 10 species offered worldwide out of these, *A. swirskii*. Predatory mites, mainly from the family Phytoseiidae play the leading role among the biocontrol agents used (Markus *et al*., 2018).

In the presence of alternative food or alternative prey, the fecundity of the predator was much higher. *A. swirskii* is a well-Known predator that is used for controlling the population of two-spotted spider mites (TSSM), *Tetranychus urticae* Koch (Acari: *Tetranychidae*) and green house whitefly (GHWF), *Trialeurodes vaporariorum* (Westwood) (Hemiptera: Aleyrodidae) Westwood, in strawberry greenhouses. Alternative food sources such as pollen and GHWF. Produced honeydew plays an important role in maintaining the predator population in the absence of pests (Mortazavi *et al*., 2019).

A. swirskii is an effective biocontrol agent against whitefly and thrips indoors on vegetable crops (Kozlova *et al*., 2020). *A. swirskii* is a generalist predator that is used to whiteflies, target thrips and pest mites (Etienne *et al.*,2021). *A. swirskii* is an effective Predatory mite for controlling whiteflies and thrips in protected crops (Paspati *et al*., 2022).

The object of this study was to determine the efficacy of *A. swirskii* mites on 1st instar nymph of *P. solenopsis* as a biological control agent.

Materials and methods

Experimental design:

1. *Phenacoccus solenopsis*:

The first instar nymph of the cotton mealybug *P. solenopsis* was found and collected from *P. solenopsis* y culture on potato tubers in the laboratory.

2. Maintenance of the mite stock culture:

The predator mite, *A. swirskii* was reared on the two-spotted spider mite, *T. urticae* under laboratory conditions at 28 ± 2°C and 70 ± 5% relative humidity (RH.) with 16:8 L:D hrs. Photoperiodic regime.

3. Effect of preys on development:

The rearing arena (3 cm diameter) of castor bean leaves, placed on saturated cotton in glass Petri dishes (9 cm diameter), was used to confine the predator. Water saturated, absorbent cotton strip, 1 cm wide, was placed around the edge of the leaf to prevent mites from escaping and to hold the leaf flat. Thirty *A.swirskii* eggs for each test were transferred individually with affine camel brush to each arena, the newly hatched larvae were supplied with the food resource to be evaluated. Developmental stages were recorded twice daily. Prey 1st nymphal instar of *P. solenopsis* consumed were replaced daily by fresh ones.

4. Effect of preys on longevity and fecundity:

Newly emerged females, after mating, were confined individually in test arenas, along with food to be tested. A few strands of cotton wool were provided as an ovipositor site in each arena. Oviposition and survival were recorded. Thirty females of *A.swirskii* in each experiment were observed daily and each experiment was repeated three times. *A. swirskii* passed through egg, larvae, protonymph and deutonymph stages for both sexes before reaching adulthood as

in other phytoseiid species. Duration of the developmental stages, preoviposition, oviposition, postoviposition periods, longevity, fecundity, lifespan, and food consumption were recorded by using the stereoscopic microscope which was recorded daily.

5. Statistical analysis:

Data were statistically analyzed using analysis of variance (F test) and means were compared according to Duncan's Multiple Range test to evaluate the significant differences between the developmental periods and prey consumption of the male and female of the predator *A.swirskii* reared on the 1st nymphal instar of *P. solenopsis*.

Results and discussion

1. Developmental periods of *Amblyseius swirskii* reared on 1st nymphal instar of *Phenacoccus solenopsis*:

Both sexes of *A. swirskii* passed through an egg, larvae, protonymph and deutonymph stages before reaching adulthood as in other phytoseiid species. As shown in Table (1). Egg incubation period of females and males of phytoseiid mite *A.swirskii* was recorded 1.8 days. The duration of the larval stage lasted 2.24 and 1.42 days. The protonymph was 2.44 and 1.83, the deutonymph was 3.42 and 2.22 days. The life cycle duration of *A.swirskii* was average 9.52 and 6.42 days for females and males, respectively. Females laid 19.44 eggs during their oviposition period. The life span recorded 31.21 and 18.34 days for females and males, respectively.

These results are in agreement with El-Sharabasy *et al.* (2017) life span lasted 31.34 days for a female of the predatory mite, *Euseius scutalis* (Athias-Henriot) (Acari: Phytoseiidae) when it fed on eggs of scale insect *Parlatoria ziziphi* (Lucas) (Hemiptera: Diaspididae). While fecundity, longevity and lifespan were lower at 27℃, also feeding capacities were increased with increasing temperature from 22℃ to 25℃ and then decreased at 27 ℃.

Table (1): Mean developmental periods days (±SD) of *Amblyseius swirskii* females and males reared on 1st nymphal instar of *Phenacoccus solenopsis* at constant temperature 26 ±2 ℃ and 70±5 %RH.

Developmental stage	Developmental periods days (Mean ± SD.)	
	Male	Female
Egg	1.81±0.44a	1.82±0.84a
Larva	1.42±0.55b	2.24±0.22a
Protonymph	1.83±0.45b	2.44±0.53a
Deutonymph	2.22±0.63b	3.42±0.54a
Life cycle	6.42±1.14b	9.52±1.91a
Pre-oviposition	…….	1.82±0.83
Oviposition	…….	14.42±3.43
Post-oviposition	……	3.80±0.30
Life span	18.34±3.14b	31.21±2.79a
No. of eggs	…….	19.44±2.79

(Means within in row followed by the same letter are not statistically different, p > 0.05 Duncan's Multiple Range test).

While life cycle recorded 22.3 and 15.8 days for females and males, respectively, when phytoseiid mite *A. swirskii* reared on eggs of *Parlatoria oleae* (Colvee) (Hemiptera: Diaspididae). at constant temperature 25℃ and 70%RH. Life span was 38.85 and 5.6 days for females and males, respectively (Helmy and Sholla, 2022).

2. Number of consumed preys of *Amblyseius swirski*i reared on 1st nymphal instar of *Phenacoccus solenopsis* at constant temperature 26±2°C and 70±5% RH.

The average number of 1st instar of *P. solenopsis* consumed by *A. swirskii* female and male larvae, protonymph and deutonymphal stages as shown in Table (2) were 3.82, 2.83, 2.84, 2.11, 6.14 ,3.12,42.51 and 2.38, respectively. The highest mean of total prey consumption of females recorded 42.51of 1st nymphal instar of *P. solenopsis* but 86.37 when *Amblyseius californicus* (McGregor) (Acari: Phytoseiidae) reared on eggs of *Aulacaspis tubercularis* Newstead (Hemiptera: Diaspididae) under 25 °C temperature (Helmy and Sholla, 2019). While the average number of eggs of *P. oleae* when consumed by phytoseiid mite *A. Swirskii* adult females and males 102 and 60 respectively (Helmy and Sholla, 2022).

Table (2): Number of consumed preys (Mean ±S.D.) by *Amblyseius swirskii* (Acari: Phytoseiidae) reared on *Phenacoccus solenopsis* on temperature 26±2 °C and 70 ± 5 %RH.

Predator stage	No. of consumed prey (Mean±SD)	
	Female	Male
Larva	3.82±0.84a	2.83±0.83b
Protonymph	2.84±0.04a	2.11±0.70ba
Deutonymph	6.14±0.22a	3.12±0.23b
Adult	42.51±3.31a	2.38±2.58b

Means in row followed by the same letter are not statistically different p >0.05 Duncan's Multiple Range test

The present studies found that, the predator *A. swirskii* may help in planning a successful IPM program for the cotton mealybug *P. solenopsis* in Egypt.

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