Persian J. Acarol., 2022, Vol. 11, No. 2, pp. 263–274.
https://doi.org/10.22073/pja.v11i2.71332
Journal homepage: http://www.biotaxa.org/pja

Article

Biology and life table parameters of some phytoseiid mites fed on *Oligonychus mangiferus* (Acari: Tetranychidae)

Shimaa F. Fahim* **and Faten M. Momen**

Pests and Plant Protection Department, National Research Centre (NRC), El-Buhouth Street, Dokki, Cairo, Egypt; E-mails: shimaa_fahiim@yahoo.com, fatmomen@gmail.com

* Corresponding author

ABSTRACT

The mango red spider mite, *Oligonychus mangiferus*, is a dangerous pest of mango that causes an indirect reduction in the production and quality of mango fruits. Since there is an urgent need to control *O. mangiferus*, searching for native phytoseiids that can prey on *O. mangiferus* may provide promising results in the biological control of this mite pest. In this study, biological and life table parameters of the predatory mites *Cydnoseius negevi*, *Neoseiulus barkeri*, *Paraseiulus talbii*, and *Typhlodromus athiasae* were determined when fed on *O. mangiferus* under laboratory conditions. *Cydnoseius negevi*, *N. barkeri*, and *T. athiasae* were successfully fed and developed on *O. mangiferus*, while *P. talbii* failed to develop on *O. mangiferus*. The pre-adult duration did not differ significantly among the three phytoseiids. The longest female longevity was 40.28 days for *N. barkeri*, while the shortest was 26.04 days for *C. negevi*. The lowest daily fecundity was observed in *N. barkeri* females, whereas the highest was oviposited by *C. negevi* and *T. athiasae*. Statistically, *Typhlodromus athiasae* had the maximum intrinsic rate of increase (r) and finite rate of increase (λ), followed by *N. barkeri* and *C. negevi*. The shortest mean generation time (T) and the lowest net reproductive rate (R_0) were reported for *C. negevi*. In conclusion, *C. negevi*, *N. barkeri*, and *T. athiasae* successfully fed, developed and sustained oviposition on *O. mangiferus*. Therefore, they could be considered as important biological control agents of *O. mangiferus.*

KEY WORDS: Biological parameters; *Cydnoseius negevi*; *Neoseiulus barkeri*; Phytoseiidae; tetranychid mites; *Typhlodromus athiasae*.

PAPER INFO.: Received: 23 September 2021, Accepted: 25 January 2022, Published: 15 April 2022

INTRODUCTION

The mango red spider mite, *Oligonychus mangiferus* (Rhaman & Sapra) (Acari: Tetranychidae), is a dangerous pest of mango that has a wide distribution in several areas such as Southeast Asia, Bengal, Taiwan and Egypt (Waterhouse 1993; Zaman and Maiti 1994; Lin 2013; Hussian *et al*. 2018). This mite is also a pest on other plants including pomegranate, loquat, and peach (Moutia 1958; Zaher and Shehata 1971). It usually feeds on the mango leaf, and forms tiny pale spots. Through the dry season, the population of *O. mangiferus* rapidly increases and mango leaves become pale as a result of mite feeding, which dramatically affects the photosynthesis process. Consequently, the mite infestation causes an indirect reduction in the production and quality of mango fruits (Lin 2013).

Mango is one of the important fruit crops in Egypt. The Egyptian mango is infested with *O.*

How to cite: Fahim, S.F. & Momen, F.M. (2022) Biology and life table parameters of some phytoseiid mites fed on *Oligonychus mangiferus* (Acari: Tetranychidae). *Persian Journal of Acarology*, 11(2): 263–274.

mangiferus, which is mainly controlled by acaricides. Every year, the growers frequently incur great costs for controlling this mite pest on mango (Lin 2013). However, the immoderate and repeated use of pesticides can cause an increase of pesticide resistance in many pests (Rahman *et al*. 2013) in addition to their negative effects on human and environment (Hoy and Ouyang 1986; Kumral *et al*. 2010; Momen *et al*. 2014). So, it is necessary to use environmentally harmless control measures, such as biological control. In several farming ecosystems, biological control is an environmentally and economically viable alternative to chemical acaricides (van Lenteren and Bueno 2003). It is known that phytoseiid mites are good bio-control agents that can suppress the tetranychid mite pests on many crops (e.g., Collier *et al*. 2004; Kasap 2011; Toledo *et al*. 2018).

The phytoseiid mites, *Cydnoseius negevi* (Swirski and Amitai), *Neoseiulus barkeri* (Hughes), and *Typhlodromus athiasae* Porath and Swirski are generalist predators (type III) (McMurtry *et al*. 2013) as they can prey on different foods (e.g., thrips, eriophyid, and spider mites) (Bonde 1989; Momen 1995; Momen 2009; Negm *et al*. 2014; Hussein *et al*. 2016; Li *et al*. 2017). *Paraseiulus talbii* (Athias-Henriot) is a predator closely associated with tydeid mites, and showed a high reproductive potential on *Tydeus caudatus* (Dugès) (Acari: Tydeidae) rather than spider mites and pollen grains (Camporese and Duso 1995).

The predatory mites, *C. negevi* and *N. barkeri*, are common phytoseiids in the Middle East region (Abou-Awad *et al*. 1998; Jafari *et al*. 2010), whereas *T. athiasae* and *P. talbii* occur in different countries in Africa and Europe on various plants including mango, citrus and tomato (Nomikou *et al*. 2001; Zaher *et al*. 2001). They are often occurring on Egyptian mango orchards associated with the mango pests (Hussein and Momen 2010).

Since there is an urgent need to control *O. mangiferus,* searching for native phytoseiids that have adapted to the local climate of mango growing areas and can prey on *O. mangiferus* may provide promising results in the biological control of this mite pest. In this regard, studies providing information about the ability of predatory mites to feed, develop and reproduce on mite pests are essential to determine their potency for controlling these target pests. From literature review, it was seen that there was a knowledge gap regarding the development, and population parameters of *C. negevi*, *N. barkeri*, *P. talbii*, and *T. athiasae* preyed on *O. mangiferus*. Therefore, in order to fill this knowledge gap, our study aimed to determine the biology and life table parameters of the above-mentioned predatory mites when fed on *O. mangiferus*. In addition, this study can be considered a fundamental step in determining the suitability of tested phytoseiids as bio-control agents of *O. mangiferus*.

MATERIALS AND METHODS

Mite colonies

All the tested phytoseiids in the present study were collected in the summer season 2020 from a mango orchard at Giza Governorate, Egypt. The colonies were maintained separately on rearing units kept in an incubator at 33 ± 1 °C, 60 ± 2% R.H and 16L: 8D photoperiod. The rearing units consisted of mango leaves placed on wet cotton layers in Petri dishes. Each mango leaf was surrounded by strips of wet cotton to prevent the escaping of mites.

Leaves infested with *O. mangiferus* were provided as food for *C. negevi*, *N. barkeri*, and *T. athiasae* colonies. At the same time, the stock colony of *P. talbii* was reared on *Orthotydeus californicus* (Banks) (Acari: Tydeidae) (Momen and Abdel-Khalek 2008). Due to the difficulty of keeping colonies of *O. mangiferus* and *O. californicus,* small pieces of mango leaves heavily infested with *O. mangiferus* or *O. californicus* were directly brushed on the leaves of the rearing units to feed the tested predators. *Oligonychus mangiferus* and *O. californicus* were collected during the summer of 2020 from infested mango leaves in orchards at Giza Governorate. Two females and two males from each colony were mounted on slides for examination and to avoid any contamination every two weeks.

Experiments

In these experiments, the development, biological and population parameters of the tested predators were evaluated when they fed on *O. mangiferus*. These experiments were performed using experimental units made from mango leaf discs (3 cm in diameter) placed on water saturated cotton pads in Petri dishes. Strips of wet cotton surrounded each leaf disc to prevent the escaping of mites. Small pieces of mango leaves heavily infested with immature stages of *O. mangiferus* were brushed on each leaf disc to feed the predators. The experimental units were kept in an incubator at 33 ± 1 °C, 60 ± 2% R.H and 16L: 8D photoperiod.

For each predator, mated females were transferred to new leaf units and left 12 h for oviposition; then the females were removed. Forty five newly laid eggs (0–12 h) for each species were transferred individually to each experimental unit. Daily observations were made at 12-h intervals for recording the development of the immature stages until reaching adulthood. The emerged females and males were paired for mating. Males were then transferred separately to the experimental units and reared until death. When needed, adult males were transferred from the stock colony and introduced to the adult females in the experimental unites for mating. Mated females were daily observed for determining their longevity as well as collecting fecundity data. All individuals were observed until they died. The number of individuals (replications) subjected to statistical analyses for *C. negevi*, *N. barkeri* and *T. athiasae* were 38, 41, and 39, respectively. As for each tested predator, where multiple mating is required (Bonde 1989; Momen 1993, 1997; Jafari *et al.* 2010), an additional male was added weekly to each tested arena. The sex ratio of each predator's offspring was also recorded.

Statistical analyses

The life history data were analyzed according to the age-stage, two-sex life table theory (Chi and Liu 1985) and the method of Chi (1988). The age-stage specific survival rate (s_{xj}, where x = age, and j = stage), the age-specific survival rate (l_x), the age-specific fecundity (m_x), the age-stage specific fecundity (f_{xj}) and the population parameters including intrinsic rate of increase (r), finite rate of increase (λ), net reproduction rate (R_0), mean generation time (T) and gross reproductive rate (GRR) were calculated by the statistical software of TWOSEX-MSChart (Chi 2017). The means and standard errors of the population parameters were estimated by the bootstrap procedure. The population growth parameters of the three phytoseiids were compared using Paired Bootstrap test (Huang and Chi 2013). One-way ANOVA (using SPSS) was used to analyze duration of different life stages, female reproductive periods, and total and daily fecundity. Means were separated by Tukey's multiple range test ($P < 0.05$).

RESULTS

Development, longevity and fecundity of the predatory mites fed on Oligonychus mangiferus

Individuals of *C. negevi*, *N. barkeri*, and *T. athiasae* successfully completed their development when fed on *O. mangiferus*. In contrast, *P. talbii* failed to develop on *O. mangiferus*; its individuals died in the protonymphal stage. The pre-adult duration did not differ significantly among the tested phytoseiids ($F_{2,\,84} = 1.245$; $P = 0.293$) (Table 1). The predatory mites, *C. negevi*, *N. barkeri*, and *T. athiasae* need 6.46, 6.34, and 6.20 days to develop from the egg to adult stage, respectively. The pre-ovipositional period did not differ statistically among the tested species ($F_{2,\,84} = 0.748$; $P = 0.477$), while both the ovipositional and post-ovipositional periods were significantly different among them (ovipositional period: $F_{2,\,84} = 103.829$; $P = 0.000$, post-ovipositional period: $F_{2,\,84} = 55.264$; $P = 0.000$). The oviposition continued for 20.86, 32.17, and 26.70 days in the case of *C. negevi*, *N. barkeri*, and *T. athiasae*, respectively. The longest female longevity was 40.28 days for *N. barkeri*, while the shortest was 26.04 days for *C. negevi* ($F_{2,\,84} = 151.743$; $P = 0.000$) (Table 1).

The highest total number of eggs (41.79 eggs/female) was observed for *N. barkeri*, while the lowest value was recorded for *C. negevi* (29.89 eggs/female) ($F_{2, 84}$ = 170.577; P = 0.000). On the other hand, the lowest daily number of eggs were oviposited by *N. barkeri* females (1.30 eggs/female/day), whereas the highest were oviposited by *C. negevi* and *T. athiasae* females (1.44 eggs/female/day for both predators) ($F_{2, 84}$ = 7.716; P = 0.001). The sex ratio (♀ %) ranged from 0.52 to 0.61 % for tested predators (Table 1).

Table 1. Developmental periods (days), longevity (days), fecundity, and sex ratio of females of *Cydnoseius negevi*, *Neoseiulus barkeri*, and *Typhlodromus athiasae* fed on *Oligonychus mangiferus*.

Parameter	Phytoseiid mite		
	C. negevi **(28)***	***N. barkeri*** **(29)**	***T. athiasae*** **(30)**
Egg	2.14 ± 0.08a	1.86 ± 0.10a	1.90 ± 0.09a
Larva	1.04 ± 0.04a	1.14 ± 0.07a	1.07 ± 0.05a
Protonymph	1.50 ± 0.10a	1.52 ± 0.09a	1.33 ± 0.09a
Deutonymph	1.79 ± 0.11a	1.83 ± 0.07a	1.90 ± 0.09a
Pre-adult	6.46 ± 0.12a	6.34 ± 0.13a	6.20 ± 0.10a
Pre-oviposition	1.79 ± 0.12a	1.59 ± 0.11a	1.63 ± 0.13a
Oviposition period	20.86 ± 0.32c	32.17 ± 0.38a	26.70 ± 0.79b
Post-oviposition	3.39 ± 0.29b	6.52 ± 0.26a	3.10 ± 0.22b
Female longevity	26.04 ± 0.30c	40.28 ± 0.53a	31.43 ± 0.77b
Total fecundity (eggs/female)	29.89 ± 0.28c	41.79 ± 0.48a	37.53 ± 0.55b
Daily no. of eggs/female	1.44 ± 0.02a	1.30 ± 0.02b	1.44 ± 0.04a
Sex ratio (♀ %)	0.52	0.56	0.61

Means in a row followed by different letters are statistically different ($P < 0.05$; Tukey's multiple range test).
* indicate number of replicates.

Age-stage, two-sex life table

The age-stage specific survival rates (s_{xj}) of *C. negevi*, *N. barkeri*, and *T. athiasae* are displayed in Figure 1. These curves show the probability that the newly deposited eggs will survive to age x and stage j. The variation in the individual development is displayed in the overlapping of the curves of predator stages. The probability that the newly oviposited eggs survived to adult stage was 0.74, 0.71 and 0.77 for females and 0.26, 0.29 and 0.23 for males in the case of *C. negevi*, *N. barkeri*, and *T. athiasae*, respectively.

The age-specific survival rate (l_x), the age-specific fecundity (m_x) and the age-stage specific fecundity (f_{xj}) of *C. negevi*, *N. barkeri*, and *T. athiasae* are shown in Figure 2. The f_{xj} curves showed the number of eggs laid by the predator individuals of age x and stage j/day. The oviposition started at the age of 5 days for the three predatory mites. The peaks of f_{xj} occurred on the 22nd, 9th, and 8th day for *C. negevi* (2.11 eggs), *N. barkeri* (2.07 eggs), and *T. athiasae* (1.97 eggs), respectively.

Population parameters

Typhlodromus athiasae had the highest intrinsic rate of increase (r) and finite rate of increase (λ) (r = 0.238 day^{-1} and λ = 1.269 day^{-1}), followed by *N. barkeri* (r = 0.234 day^{-1} and λ = 1.264 day^{-1}) and *C. negevi* (r = 0.230 day^{-1} and λ = 1.258 day^{-1}). The pattern of the GRR was the same as r and λ parameters. The shortest mean generation time (T) and the lowest net reproductive rate (R_0) were reported in the case of *C. negevi* (13.446 days and R_0 = 22.056 female offspring), while the highest values of T and R_0 were observed for *N. barkeri*. However, for R_0 value, no significant difference was detected between *N. barkeri* and *T. athiasae* (Table 2).

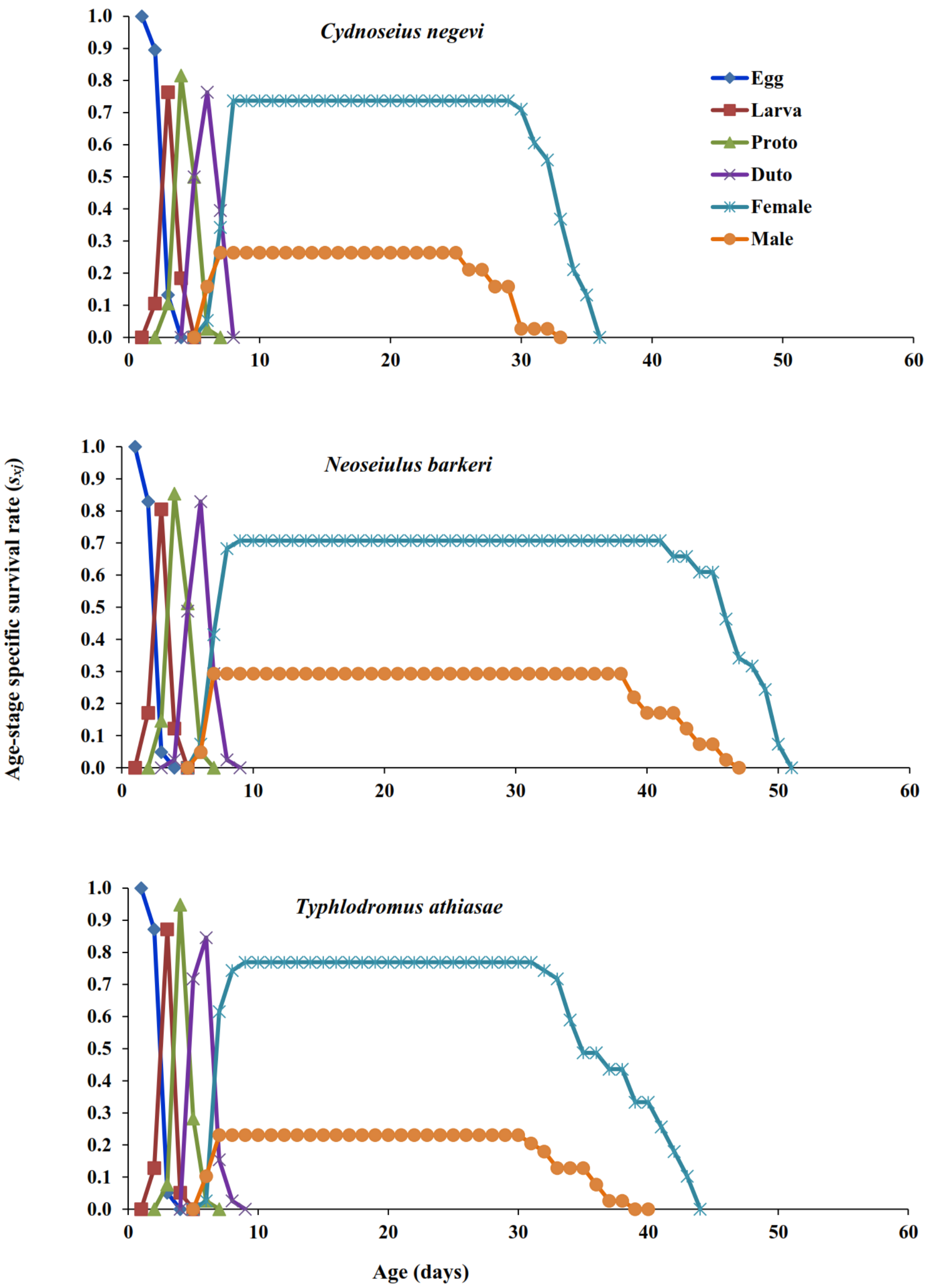

Figure 1. Age-stage specific survival rates (s_{xj}) of *Cydnoseius negevi*, *Neoseiulus barkeri*, and *Typhlodromus athiasae* fed on *Oligonychus mangiferus*.

Table 2. Life table parameters (Mean ± SE) of *Cydnoseius negevi*, *Neoseiulus barkeri*, and *Typhlodromus athiasae* fed on *Oligonychus mangiferus*.

Parameter	Phytoseiid mite		
	C. negevi	***N. barkeri***	***T. athiasae***
Intrinsic rate of increase (*r*)	0.230 ± 0.001c	0.234 ± 0.001b	0.238 ± 0.001a
Finite rate of increase (*λ*)	1.258 ± 0.001c	1.264 ± 0.001b	1.269 ± 0.001a
Net reproductive rate (R_0)	22.056 ± 0.198b	29.379 ± 0.309a	29.345 ± 0.249a
Mean generation time (*T*)	13.446 ± 0.017c	14.417 ± 0.027a	14.193 ± 0.018b
Gross reproductive rate (*GRR*)	22.207 ± 0.196c	29.448 ± 0.308b	30.245 ± 0.249a

Means in a row followed by different letters are statistically different ($P < 0.05$; Paired Bootstrap test).

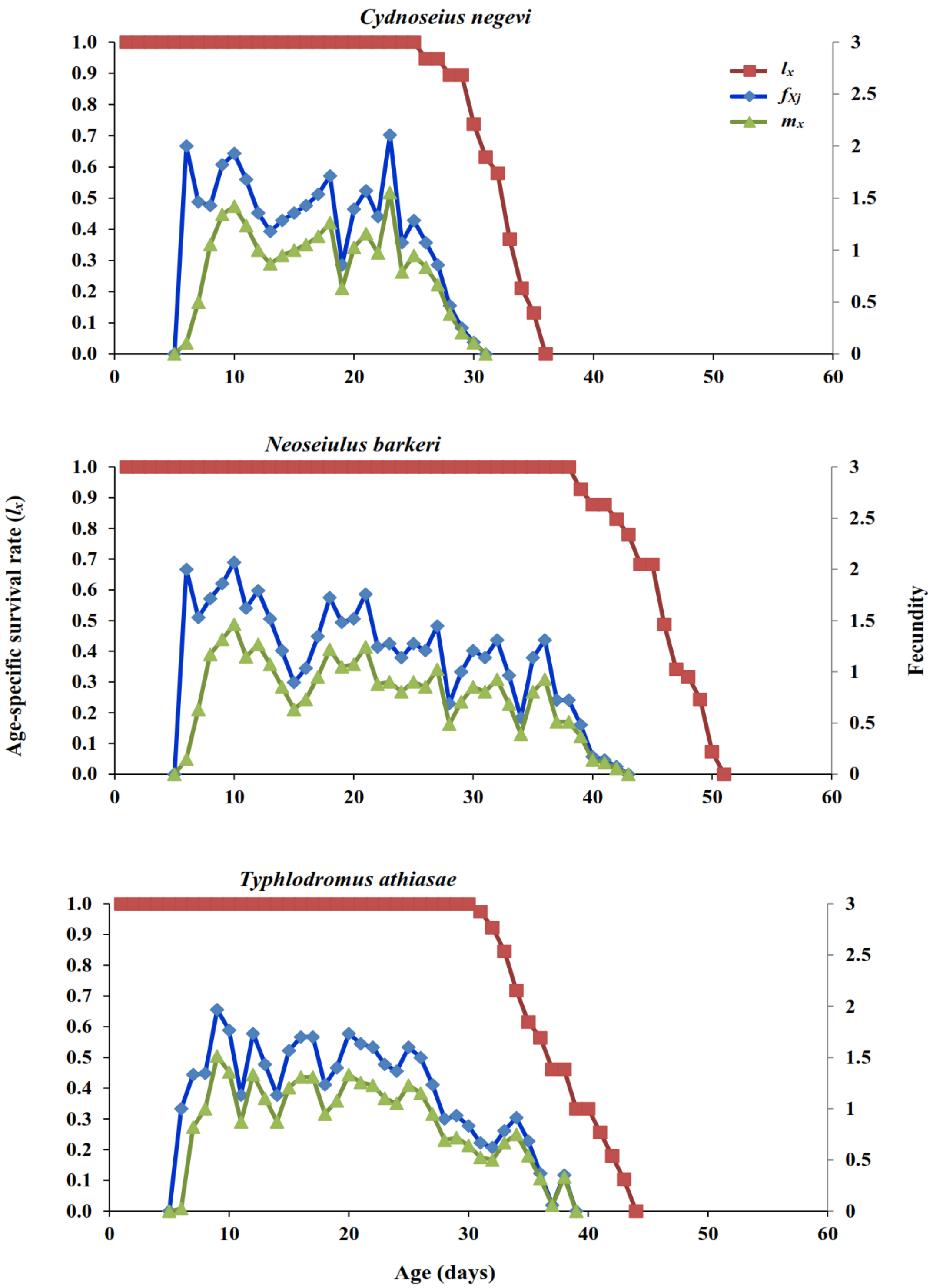

Figure 2. Age-specific survival rate (l_x), age-stage specific fecundity (f_{xj}), and age-specific fecundity (m_x) of *Cydnoseius negevi*, *Neoseiulus barkeri*, and *Typhlodromus athiasae* fed on *Oligonychus mangiferus*.

DISCUSSION

The present results showed that *C. negevi*, *N. barkeri*, and *T. athiasae* successfully fed, developed, and oviposited on *O. mangiferus*. Similarly, *C. negevi* and *N. barkeri* could develop and reproduce when preyed on *Oligonychus afrasiaticus* (McGregor) (Negm *et al*. 2014). In contrast, *P. talbii* failed to develop on *O. mangiferus*. Our results were similar to the previous studies on *P. talbii*, where this phytoseiid showed unsuccessful development when offered other diets such as *Eutetranychus orientalis* (Klein) (Momen and El-Borolossy 1999) and *Aculops lycopersici* (Massee) (Momen and Abdel-Khalek 2008).

The predatory mites, *C. negevi*, *N. barkeri*, and *T. athiasae* need 6.46, 6.34, and 6.20 days to develop from the egg to adult stage, respectively. The pre-adult development of *N. barkeri* and *C. negevi* fed on *E. orientalis* and *Ricinus communis* pollen, respectively are close to our findings (Momen and El-Borolossy 1999; Momen *et al*. 2009). The pre-adult duration and longevity of *N. barkeri*, *C. negevi*, and *T. athiasae* observed in this study were shorter than those recorded on eriophyid mites (Momen 1995; Abou-Awad *et al*. 1998; Momen and Abdel-Khalek 2008) and *T. urticae* (Momen 1995; Abou-Awad *et al*. 1998; Momen 2009; Abdel-Khalek *et al*. 2019). Negm *et al*. (2014) studied the biology of *C. negevi* and *N. barkeri* on *O. afrasiaticus* and reported longer pre-adult development and shorter longevity (at 35 °C) than that observed in our study. However, longevity of *N. barkeri* and *T. athiasae* feeding on *O. mangiferus* was longer than that of these predators fed on other spider mites (Momen and El-Borolossy 1999; Li *et al*. 2017).

Here, the total oviposition of *C. negevi* was close to that reported by Hussein *et al*. (2016) on corn pollen (29.53 eggs/female). As compared to our results, females of *C. negevi*, *N. barkeri*, and *T. athiasae* fed on eriophyid mites deposited higher number of eggs (Abou-Awad *et al*. 1998; Momen 1995, 2009; Hussein *et al*. 2016), whereas *C. negevi* and *N. barkeri* praying on *T. urticae* deposited lower ones (Abou-Awad *et al*. 1998; Li *et al*. 2017). On the other hand, higher fecundity was reported for *T. athiasae* (Momen 2009) and *C. negevi* (Abdel-Khalek *et al*. 2019) preying on *T. urticae* compared to that obtained against *O. mangiferus* (the present study). The sex ratio of predatory phytoseiid species was often characterized by having a female bias (Amano and Chant 1977; Tanigoshi 1982). This was in agreement with our results as well as the previous findings on several phytoseiid species (Momen and Abdel-Khalek 2008; Negm *et al*. 2014; Fahim and El-Saiedy 2021).

All tested predators have close values of r and λ, despite the presence of statistical variations. Fahim *et al*. (2020) mentioned that the lower value of R_0 was one of the reasons responsible for the lower value of r. This may partially explain the lowest value of r in *C. negevi* compared to the other predators, as it has a lower value of R_0 than the other predators.

Compared to the present study, feeding on *T. urticae* resulted in slightly higher values of r and λ parameters for *T. athiasae* (Momen 2009) and lower values of these parameters for *C. negevi* (Abou-Awad *et al*. 1998) and *N. barkeri* (Li *et al*. 2017). Also, lower values of r, λ, and R_0 in addition to a higher value of T were reported when *N. barkeri* preyed on *Thrips tabaci* (Lindeman) (Bonde 1989), and spider mites (Li *et al*. 2017). Higher values of λ and R_0 were reported when *C. negevi* fed on *R. communis* pollen (Momen *et al*. 2009). Herein, when *C. negevi* and *N. barkeri* fed on *O. mangiferus*, higher values of r, λ, and R_0 in addition to lower T values were observed as compared to those of the same species fed on *O. afrasiaticus* (Negm *et al*. 2014). This suggested that the two predators seemed to perform better on *O. mangiferus* than on *O. afrasiaticus*. Compared to the tested predators, *Amblyseius swirskii* Athias-Henriot and *Typhlodromus mangiferus* Zaher and El-Brolossy displayed shorter female longevity, lower fecundity, and lower values of r, λ and R_0 as well as longer mean generation time when preying on *O. mangiferus* (Abou-Awad *et al*. 2010a; b); this suggested that the tested predators may be more promising biological control agents for *O. mangiferus*.

The values of r, λ, and R_0 reported by Momen and Abdel-Khalek (2008) for *T. athiasae* against *A. lycopersici* (0.167 day^{-1}, λ = 1.18 day^{-1}, and R_0 = 19.84 female offspring, respectively) were lower than our results, whereas greater values were reported for the same predator against *Aceria dioscoridis* (Soliman & Abou-Awad) (0.288 day^{-1}, λ = 1.33 day^{-1}, and R_0 = 45.51 female offspring, respectively) (Momen 2009). The observed differences in the development and population parameters of the predatory mites could be due to several factors (e.g., prey type, rearing and experimental conditions, and predator strain) and highlight the need to study the life history and development of the native strains of predatory mites which are more suitable for local agro-ecosystems.

The intrinsic rate of increase is a significant parameter, showing the developmental potential of mite populations (Sabelis 1985; Roy *et al*. 2005). The *r* value can be used to select the promising competitors in the biological control schemes (Jervis and Copland 1996). In light of the present results, the relatively high *r* value of *T. athiasae*, *C. negevi*, and *N. barkeri* suggested that *O. mangiferus* was a favorite prey for population increase of these species. Thus, these predatory mites may provide promising results in the bio-control of *O. mangiferus*. In the field condition, predatory mite species, in association with the phytophagous mites, are adapted to the host plants and play a role in the natural control of these phytophagous mites. Therefore, *T. athiasae* and *C. negevi* which are dominant species on mango are suggested to be more suitable than *N. barkeri* for controlling *O. mangiferus* on mango trees. However, the successful application of these phytoseiids still needs further field studies to gain a better understanding of their potential in the control of *O. mangiferus*.

CONCLUSION

The present results can provide a deeper understanding of the possibilities and efficiency of using *T. athiasae*, *C. negevi*, and *N. barkeri* in the management of *O. mangiferus*. This study indicated that the aforementioned predators successfully fed, developed, and oviposited on *O. mangiferus*. Therefore, our findings suggested that these phytoseiids can be considered as important biological control agents of *O. mangiferus* and be applied in Integrated Pest Management (IPM) schemes against this mite pest in order to reduce chemical control measures.

REFERENCES

Abdel-Khalek, A.A., Abou-Elella, G. & El-Saiedy, E. (2019) Comparative biology and growth rate of the two predatory mites, *Cydnoseius negevi* and *Neoseiulus californicus* (Acari: Phytoseiidae), reared on two pea cultivars. *Persian Journal of Acarology*, 8(3): 225–237. DOI: 10.22073/pja.v8i3.45254

Abou-Awad, B.A., El-Sherif, A.A., Hassan, M.F. & Abou-Elela, M.M. (1998) Laboratory studies on development, longevity, fecundity and predation of *Cydnoseius negevi* (Swirski and Amitai) (Acari: Phytoseiidae) with two mite species as prey. *Journal of Plant Diseases and Protection*, 105: 429–433.

Abou-Awad, B.A., Metwally, A.M. & Al-Azzazy, M.M. (2010a) Effect of different eriophyid and tetranychid mango mite species on development, longevity, fecundity and predation of *Typhlodromus mangiferus* Zaher and El-Brolossy (Acari: Phytoseiidae). *Archives of Phytopathology and Plant Protection*, 43: 390–403.

Abou-Awad, B.A., Metwally, A.M. & Al-Azzazy, M.M. (2010b) *Typhlodromips swirskii* (Acari: Phytoseiidae) a predator of eriophyid and tetranychid mango mites in Egypt. *Acta Phytopathologica et Entomologica Hungarica*, 45: 135–148.

Amano, H. & Chant, D.A. (1977) Life history and reproduction of two species of predacious mites, *Phytoseiulus persimilis* Athias-Henriot and *Amblyseius andersoni* (Chant) (Acarina: Phytoseiidae). *Canadian Journal of Zoology*, 55: 1978–1983.

Bonde, J. (1989) Biological studies including population growth parameters of the predatory mite *Amblyseius barkeri* at 25 °C in the laboratory. *Entomophaga*, 34: 275–287.

Camporese, P. & Duso, C. (1995) Life history and life table parameters of the predatory mite *Typhlodromus talbii*. *Entomologia Experimentalis et Applicata*, 77: 149–157.

Chi, H. (1988) Life-table analysis incorporating both sexes and variable development rates among individuals. *Environmental Entomology*, 17: 26–34.

Chi, H. & Liu, H. (1985) Two new methods for the study of insect population ecology. *Bulletin of the Institute of Zoology*, 24: 225–240.

Chi, H. (2017) TWO SEX-MSChart: A computer program for the age- stage, Two-sex life table analysis. http://140.120.197.173/Ecology/Download/TwosexMSChart.zip

Collier, K.F., Lima, J.O. & Albuquerque, G.S. (2004) Predacious mites in papaya (*Carica papaya* L.) orchards: in search of a biological control agent of phytophagous mite pests. *Neotropical Entomology*, 33: 799–803.

Fahim, S.F. & El-Saiedy, E.M. (2021) Life table parameters of *Amblyseius swirskii* and *Neoseiulus californicus* (Acari: Phytoseiidae) reared on two strawberry cultivars. *International Journal of Acarology*, 47: 568–574. DOI: 10.1080/01647954.2021.1976835

Fahim, S.F., Momen, F.M. & El-Saiedy, E.M. (2020) Life table parameters of *Tetranychus urticae* (Trombidiformes: Tetranychidae) on four strawberry cultivars. *Persian Journal of Acarology*, 9: 43–56. DOI: 10.22073/pja.v9i1.54771

Hoy, M.A. & Ouyang, Y.L. (1986) Selectivity of the acaricides clofentezine and hexythiazox to the predator *Metaseiulus occidentalis* (Nesbitt) (Acari: Phytoseiidae). *Journal of Economic Entomology*, 79: 1377–1380.

Huang, Y.B. & Chi, H. (2013) Life tables of *Bactrocera cucurbitae* (Diptera: Tephritidae): with an invalidation of the jackknife technique. *Journal of Applied Entomology*, 137: 327–339.

Hussein, H. & Momen, F. (2010) Fertilisation and prey deprivation affecting reproduction, life history and life table of the predacious mite *Paraseiulus talbii* (Athias-Henriot) (Acari: Phytoseiidae). *Archives of Phytopathology and Plant Protection*, 43: 241–250.

Hussein, H.E., Abou-Elella, M.M. & Reda, A.S. (2016) Development, survival and reproduction of *Typhlodromus negevi* (Swirski and Amitai) (Acari: Phytoseiidae) on various kinds of food. *Egyptian Journal of Biological Pest Control*, 26: 43–45.

Hussian, N.A., El-Sharabasy, H.M., AboGhalia, A.H. & Soliman, M.F. (2018) Population fluctuations of the phytophagous mite, *Oligonychus mangiferus* and its predator on Mango Trees in Ismailia Governorate, Egypt. *Egyptian Academic Journal of Biological Sciences*, 11: 83–88.

Jafari, S., Fathipour, Y., Faraji, F. & Bagheri, M. (2010) Demographic response to constant temperatures in *Neoseiulus barkeri* (Phytoseiidae) fed on *Tetranychus urticae* (Tetranychidae). *Systematic & Applied Acarology*, 15: 83–99.

Jervis, M.A. & Copland, M.J. (1996) The life cycle. *In*: Jervis, M. & Kidd, B. (Eds.), *Insect natural enemies: practical approaches to their study and evaluation*. Chapman and Hall, London, pp. 63–161.

Kasap, I. (2011) Biological control of the citrus red mite *Panonychus citri* by the predator mite *Typhlodromus athiasae* on two citrus cultivars under greenhouse conditions. *BioControl*, 56: 327–332.

Kumral, N.A., Çobanoğlu, S. & Yalcin, C. (2010) Acaricidal, repellent and oviposition deterrent activities of *Datura stramonium* L. against adult *Tetranychus urticae* (Koch). *Journal of Pest Science*, 83: 173–180. DOI: 10.1007/s10340-009-0284-7

Li, Y.Y., Zhang, G.H., Tian, C.B., Liu, M.X., Liu, Y.Q., Liu, H. & Wang, J.J. (2017) Does long-term feeding on alternative prey affect the biological performance of *Neoseiulus barkeri* (Acari: Phytoseiidae) on the target spider mites?. *Journal of Economic Entomology*, 110: 915–923.

Lin, M.Y. (2013) Temperature-dependent life history of *Oligonychus mangiferus* (Acari: Tetranychidae) on *Mangifera indica*. *Experimental and Applied Acarology*, 61: 403–413.

McMurtry, J.A., De Moraes, G.J. & Sourassou, N.F. (2013) Revision of the lifestyles of phytoseiid mites (Acari: Phytoseiidae) and implications for biological control strategies. *Systematic & Applied Acarology*, 18: 297–320.

Momen, F.M. (1993) Effects of single and multiple copulation on fecundity, longevity and sex ratio of the predacious mite *Amblyseius barkeri* (Hugh.) (Acari, Phytoseiidae). *Anzeiger für Schädlingskunde Pflanzenschutz Umweltschutz*, 66: 148–150.

Momen, F.M. (1995) Feeding, development and reproduction of *Amblyseius barkeri* (Acarina: Phytoseiidae) on various kinds of food substance. *Acarologia*, 36: 101–105.

Momen, F.M. (1997) Copulation, egg production and sex ratio in *Cydnodromella negevi* and *Typhlodromus athiasae* (Acari: Phytoseiidae). *Anzeiger fur Schadlingskunde*, 70: 34–36.

Momen, F.M. (2009) Life history of predatory mites *Typhlodromus athiasae* and *Amblyseius cabonus* (Acari: Phytoseiidae) on two pest mites as prey, with special reference to *Eriophyes dioscoridis* (Acari: Eriophyidae). *Archives of Phytopathology and Plant Protection*, 42: 1088–1095.

Momen, F.M. & Abdel-Khalek, A. (2008) Effect of the tomato rust mite *Aculops lycopersici* (Acari: Eriophyidae) on the development and reproduction of three predatory phytoseiid mites. *International Journal of Tropical Insect Science*, 28: 53–57.

Momen, F., Abdel-Khalek, A. & El-Sawi, S. (2009) Life tables of the predatory mite *Typhlodromus negevi* feeding on prey insect species and pollen diet (Acari: Phytoseiidae). *Acta Phytopathologica et Entomologica Hungarica*, 44: 353–361.

Momen, F.M., Abdel Rahman, H.A., Samour, E.A., Aly, S.M. & Fahim, S.F. (2014) Acaricidal activity of *Melissa officinalis* oil and its formulation on *Tetranychus urticae* and the predatory mite *Neoseiulus californicus* (Acari: Tetranychidae and Phytoseiidae). *Acta Phytopathologica et Entomologica Hungarica*, 49: 95–115. DOI: 10.1556/APhyt.49.2014.1.10

Momen, F.M. & El-Borolossy, M.E. (1999) Suitability of the citrus brown mite *Eutetranychus orientalis* as prey for nine species of phytoseiid mites (Acari: Tetranychidae, Phytoseiidae). *Acarologia*, 40: 19–30.

Moutia, L.A. (1958) Contribution to the study of some phytophagous acarina and their predators in Mauritius. *Bulletin of Entomological Research*, 49: 59–75.

Negm, M.W., Fahad, J.A. & Yousif, N.A. (2014) Biology, predation, and life table of *Cydnoseius negevi* and *Neoseiulus barkeri* (Acari: Phytoseiidae) on the old world date mite, *Oligonychus afrasiaticus* (Acari: Tetranychidae). *Journal of Insect Science*, 14: 1–6.

Nomikou, M., Janssen, A., Schraag, R. & Sabelis, M.W. (2001) Phytoseiid predators as potential biological control agents for *Bemisia tabaci*. *Experimental and Applied Acarology*, 25: 271–291.

Rahman, V.J., Babu, A., Roobakkumar, A. & Perumalsamy, K. (2013) Life table and predation of *Neoseiulus longispinosus* (Acari: Phytoseiidae) on *Oligonychus coffeae* (Acari: Tetranychidae) infesting tea. *Experimental and Applied Acarology*, 60: 229–240.

Roy, A.M., Brodeur, J.B. & Cloutier, C.C. (2005) Seasonal activity of the spider mite predators *Stethorus punctillum* (Coleoptera: Coccinellidae) and *Neoseiulus fallacis* (Acarina: Phytoseiidae) in raspberry, two predators of *Tetranychus mcdanieli* (Acarina: Tetranychidae). *Biological Control*, 34: 47–57.

Sabelis, M.W. (1985) Reproductive Strategies. *In*: Helle, W. & Sabelis, M.W. (Eds.), *World crop pests: Spider mites, their biology, natural enemies and control*. Elsevier, Amsterdam, the Netherlands, pp. 265–278.

Tanigoshi, L.K. (1982) Advances in knowledge of the Phytoseiidae. *In*: Hoy, M.A. (Ed.), *Recent advances in knowledge of the Phytoseiidae*. Agricultural Sciences Publications, Berkeley, pp. 1–22.

Toledo, M.A., Reis, P.R., Liska, G.R. & Cirillo, M.A. (2018) Biological control of southern red mite, *Oligonychus ilicis* (Acari: Tetranychidae), in coffee plants. *Advances in Entomology*, 6: 74–85.

van Lenteren, J.C. & Bueno, V.H. (2003) Augmentative biological control of arthropods in Latin America. *BioControl*, 48: 123–139.

Waterhouse, D.F. (1993) The major arthropod pests and weeds of agriculture in Southeast Asia. *In*: *ACIAR, Australian Center for International Agricultural Research*. Canberra, Australia, Monograph 21, 141 pp.

Zaher, M.A., El-Borolossy, M.A. & Ali, F.S. (2001) Morphological and biological studies of *Typhlodromus talbii* Athias-Henriot (Gamasida: Phytoseiidae). *Insect Science and its Application*, 21: 43–53.

Zaher, M.A. & Shehata, K.K. (1971) Biology of the red spider mite, *Oligonychus mangiferus* (R. & S.) (Acarina: Tetranychidae). *Bulletin of the Entomological Society of Egypt*, 55: 393–401.

Zaman, Z. & Maiti, B. (1994) Insects and mites infesting seedling of mango in west Bengal. *Environment and Ecology*, 12: 734–736.

زیست‌شناسی و آماره‌های جدول زندگی برخی کنه‌های فیتوزئید تغذیه شده از *Oligonychus mangiferus* (Acari: Tetranychidae)

شیما اف. فهیم* و فاتن ام. مؤمن

گروه گیاهپزشکی و آفات، مرکز ملی پژوهش، خیابان البحوث ۳۱، ۱۲۶۲۲ الدوقی، قاهره، مصر؛ رایانامه‌ها: *shimaa_fahiim@yahoo.com* ، *fatmomen@gmail.com*

* نویسندهٔ مسئول

چکیده

کنهٔ تارتن قرمز انبه، *Oligonychus mangiferus*، آفت خطرناک انبه است که باعث کاهش غیرمستقیم تولید و کیفیت میوه‌های انبه می‌شود. از آنجایی که نیاز فوری به کنترل *O. mangiferus* وجود دارد، جستجو برای فیتوزئیدهای بومی که می‌توانند *O. mangiferus* را شکار کنند ممکن است نتایج امیدوارکننده‌ای را در مهار زیستی این کنهٔ آفت ارایه دهد. در این بررسی، آماره‌های زیستی وجدول زندگی کنه‌های شکارگر *Cydnoseius negevi*، *Neoseiulus barkeri*، *Paraseiulus talbii* و *Typhlodromus athiasae* با تغذیه از *O. mangiferus* در شرایط آزمایشگاهی تعیین شد. گونه‌های *Cydnoseius negevi*، *N. barkeri* و *T. athiasae* با موفقیت از *O. mangiferus* تغذیه و رشد کردند، در حالی که *P. talbii* نتوانست با تغذیه از *O. mangiferus* رشد کند. مدت زمان پیش از بلوغ در بین سه کنهٔ فیتوزئید تفاوت معنی‌داری نداشت. بیشترین طول عمر ماده برای *N. barkeri* ۴۰/۲۸ روز و برای *C. negevi* کوتاهترین آن ۲۶/۰۴ روز بود. کمترین باروری روزانه در *N. barkeri* مشاهده شد، در حالی که بیشترین تخمگذاری توسط *C. negevi* و *T. athiasae* صورت گرفت. شکارگر *T. athiasae* از نظر آماری دارای بیشترین میزان ذاتی افزایش (r) و میزان متناهی افزایش (λ) را داشت و به دنبال آن *N. barkeri* و *C. negevi* قرار گرفتند. کمترین میانگین زمان تولید (T) و کمترین میزان خالص تولید مثل (R_0) برای *C. negevi* گزارش شد. در نتیجه، شکارگرهای *C. negevi*، *N. barkeri* و *T. athiasae* با موفقیت از *O. mangiferus* تغذیه، رشد و تخمگذاری کردند. بنابراین می‌توان آنها را به عنوان عوامل مهم مهار زیستی *O. mangiferus* در نظر گرفت.

واژگان کلیدی: آماره‌های زیستی؛ *Cydnoseius negevi*؛ *Neoseiulus barkeri*؛ Phytoseiidae؛ کنه‌های تارتن؛ *Typhlodromus athiasae*.

اطلاعات مقاله: تاریخ دریافت: ۱۴۰۰/۷/۱، تاریخ پذیرش: ۱۴۰۰/۱۱/۵، تاریخ چاپ: ۱۴۰۱/۱/۲۶